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 2008

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◃ Natural Resources ▹

Integrated Programs and Findings

Denali's Resource Stewardship Strategy

In 2001, the National Park Service (NPS) instituted a new program document for resource management. Instead of having a Resource Management Plan, each park will develop a Resource Stewardship Strategy (RSS), a 15- to 20-year program planning document that serves as a bridge between the desired conditions as articulated in the park's General Management Plan and the implementation actions taken to protect park resources and values. The RSS will replace Denali's Resource Management Plan (1998). Existing specific park program plans (e.g., Subsistence Management Plan, Museum Management Plan, and Bear Management Plan) will continue to provide the details for day-to-day operations, but may need to be modified.

Following public meetings and expert input in 2006 and 2007, the Denali RSS team (primarily resource staff) worked to complete a draft document in spring 2008. The document is currently in "expert review" (summer 2008), and will be finalized later in 2008.

The park GMP specifies desired conditions for most of Denali's fundamental and other important resources and values.

The *fundamental resources and values* are:

1. Wildlife populations, wildlife habitat, and the processes and components of the park's natural ecosystem
2. Wilderness character, wilderness resource values, and wilderness recreational opportunities
3. Scenic and geologic values of Mount McKinley and surrounding mountain landscape
4. Visitor enjoyment and inspiration from observing wildlife in its natural habitat and other natural features

The *other important resources and values* are:

5. Historic, archaeological, and ethnographic resources
6. Paleontological resources
7. Air quality
8. Subsistence resources and opportunities
9. Scientific research, education, and interpretation about natural ecosystems and geologic features and processes

Desired conditions are a qualitative description of the integrity and character of a resource or value that the NPS has committed to achieve and maintain. Some of these desired conditions are articulated for Denali (park and preserve,) others apply only to specific management zones (also called "management areas" in some Denali plans).

Indicators were selected so they can be used to evaluate resource conditions and to determine whether management actions are effective at protecting park values. *Standards* for some indicators are different for different park zones.

Comprehensive strategies were developed to (1) learn more about resources for which insufficient knowledge is available to select indicators for them, (2) measure resource indicators to make sure desired conditions are being achieved, and (3) carry out additional mandates about park resources. The RSS focuses on providing park managers with these recommended comprehensive strategies to guide the NPS in achieving and maintaining the desired conditions for the park's cultural and natural resources.

Denali Park Road Capacity Study

In 2006, Denali began a multidisciplinary study designed to optimize 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, an annual use limit of 10,512 vehicle trips has been in effect. Faced with increasing visitation and pressure to defend or change the limits to road traffic, park managers have designed a study to better understand the impacts of traffic volume and traffic patterns on the physical, biological, and social environment of the park. Updates are posted on the website at: **http://www.nps.gov/dena/naturescience/denali-park-road-capacity-study.htm**

Wildlife movements

A GPS telemetry study of grizzly bears and Dall's sheep is intended to detect impacts of traffic on animal movements near the road.

Bears

In spring 2006, Researchers captured 20 grizzly bears within the road corridor and outfitted them with GPS collars for the season. The collars were programmed to calculate the position of each bear once every hour all summer and were programmed to fall off in September. To see the data from 2006 for bears, see *Current Resource Projects 2007*, or go to www.nps.gov/dena, click on Management, then Planning, then Road study, and select Wildlife Update February 2007. For an animation of how a bear moved over time, choose a bear number from the list on the same page. Alternatively, you can connect directly to: www.nps.gov/dena/naturescience/denali-park-road-capacity-study.htm

Researchers considered a bear inactive when movement rates were less than 11 meters in one hour. Bears were inactive about 15 percent of the time, and usually during early morning hours (especially between 3 and 4 am). For short rests, bears were resting closer to the road than would be expected, but for longer rests, bears were found further from the road. Bears seemed to cross the road during their preferred periods of activity, and did not adjust their crossings to be at low-traffic times.

Dall's Sheep

In March 2007, researchers captured 20 Dall's sheep within 1 mile of the park road between the Teklanika and Toklat Rivers and fitted them with GPS collars. In September 2007, data were retrieved from 18 collars, yielding over 60,000 hourly locations (see Figure 1). Sheep were grouped by their movements into two groups "Igloo" and "Polychrome."

Dall's sheep crossed the Denali park road 121 times during the study. Both males and females (88 M, 33 F) made crossings in both areas (15 Igloo, 106 Polychrome). Sheep varied from 0 crossings to 51 crossings. Two males crossed the road 51 and 34 times, respectively, and some sheep crossed infrequently (e.g., once or twice) or never. Male sheep crossed the park road only during the spring season (15 May to 30 June), while females crossed in all seasons. Dall's sheep crossed the park road during all hours of the day and night, but most (>80%) crossings occurred during the day when traffic volumes were highest on average.

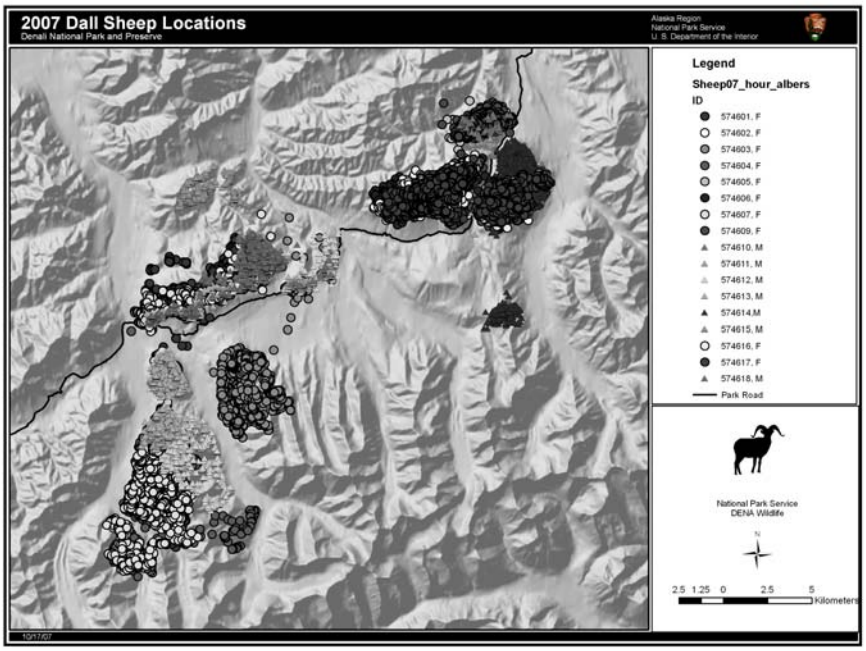


Figure 1. Locations of 17 GPS-collared Dall's sheep during the summer of 2007.

Road crossings by GPS-collared sheep occurred between miles 33 to 38, 44 to 48, and 51 to 53 of park road with the most crossings occurring between miles 45 to 47 (Figure 2).

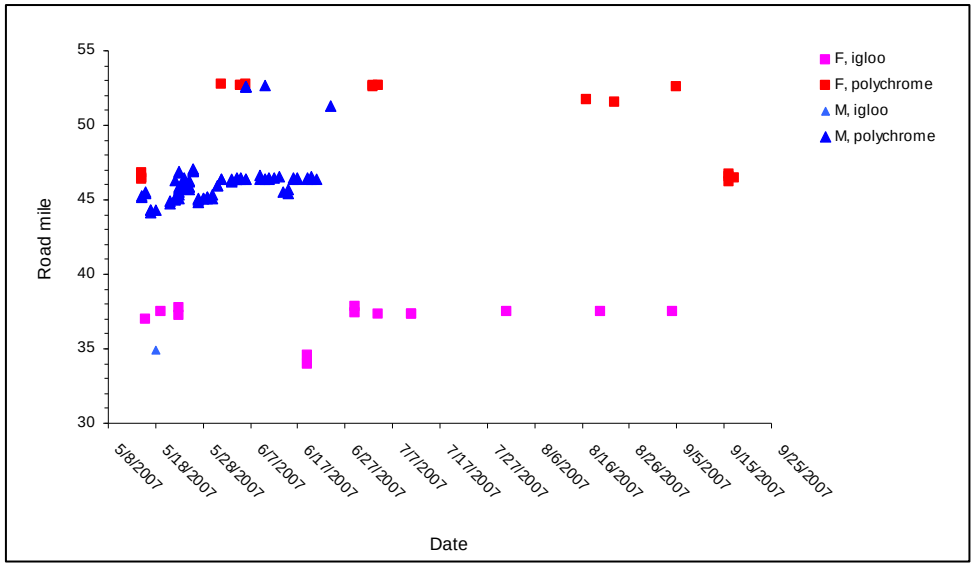


Figure 2. Date and mile of park road crossings made by Dall's sheep in 2007.

Average movement rates of female sheep when crossing the park road (average about 778 meters per hour for 33 sheep) were more than 4 times faster than movement rates when not crossing (164 meters per hour) (Figure 3). When male sheep crossed the road, they moved at more than double the movement rates than when they weren't crossing the road (295 m/hr versus 144 m/hr).

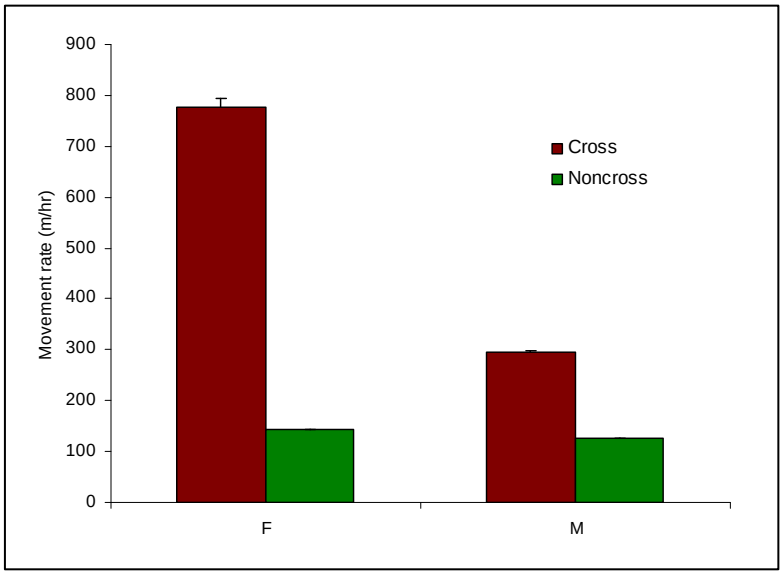


Figure 3. Average movement rates of Dall's sheep (n = 18) when crossing the park road compared to all other movements.

Visitor survey

In 2006, researchers examined the expectations and quality of experiences on the Denali Park Road of visitors who used (1) shuttle buses, (2) tour buses, (3) buses from lodges in Kantishna, and (4) their own recreational vehicle (RV) to access the park (Teklanika campers). Visitors were asked to identify and describe issues important to their experience on the Denali Park road.

Interviewers asked visitors questions about the quality of their experience on the park road, impacts to their experience, the number of vehicles on the road, and the management of vehicles using the road. Results from these interviews suggest a wide variety of potential indicators for the quality of a visitor's experience. These variables include the number of vehicles seen, number of encounters with other vehicles, frequency/duration of wildlife stops, distance of wildlife from the road, dust generated by vehicle traffic, number of visitors at rest stops, the condition and maintenance of buses, behavior/actions of other visitors while on buses, number/type of facilities along the road, vehicle congestion, and the quality of educational information provided by bus drivers. Results also provide insights into *how* these variables affect visitor experiences and into potential differences among user groups. For example, seeing moving buses diminished the sense of "being in the wilderness" for some visitors, but seeing stopped buses positively affected the experience by indicating areas where wildlife might be viewed.

In 2007, researchers conducted the second phase of the study—gathering data that will help set standards for indicators selected from results of the first phase. Written quantitative surveys were completed by 695 park visitors who travelled the park road. Park managers will use the resulting indicators and standards to evaluate and manage vehicle traffic by monitoring indicator variables and using a computer simulation model to estimate maximum acceptable vehicle use levels. Panels of photos with different traffic volumes were shown to visitors.

Traffic constraints

A study of logistical and physical constraints on traffic is examining vehicle behavior and determining factors that constrain traffic flow on the park road. In 2006, park staff, with

assistance from Joint Venture, installed 130 GPS units on vehicles that use the park road on a regular basis. GPS units were installed on all JV tour, shuttle, and camper buses. Approximately 40 NPS vehicles also had GPS units installed, including heavy equipment, road crew vehicles, and vehicles driving the park road on a regular basis.

In 2007, bus drivers on 20 buses used LCD touch screen panels (Fig. 4) to record information about the location of stops made along the road for wildlife sightings, passenger pick-up and drop-off, and road maintenance. The information was automatically downloaded to base stations along with the vehicle's GPS location data.

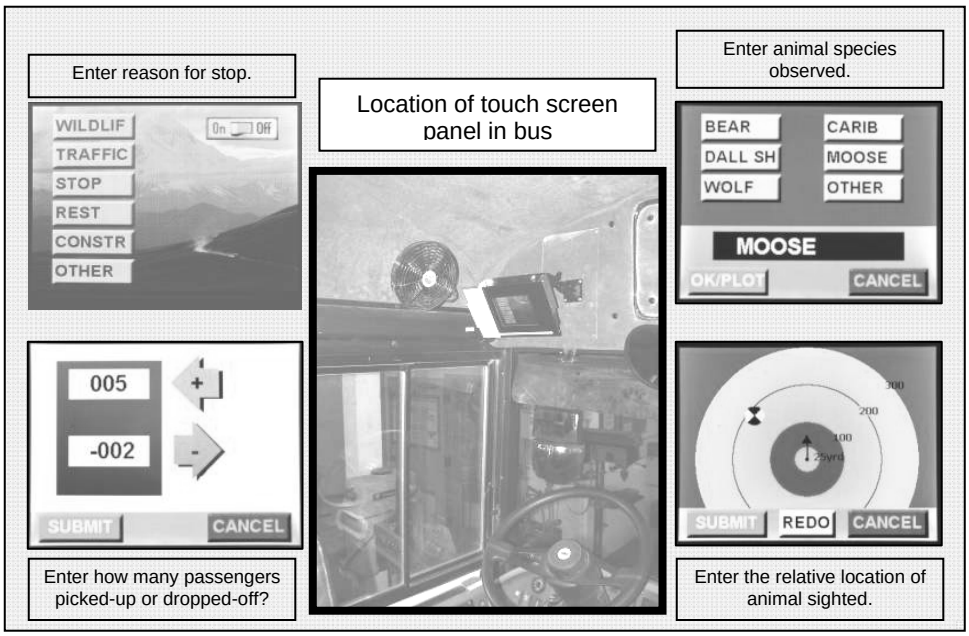


Figure 4. Touch panel data loggers were installed on 20 buses in 2007 and will allow drivers to automatically geo-locate various reasons for stopping such as wildlife sighting or passenger pick-up locations.

Traffic patterns on the Denali Park Road are affected by locations of wildlife sightings, numbers and behavior of buses on the road each day, weather, and road maintenance. To account for the effects of these various factors on traffic flow, researchers will use GPS and wildlife sighting data collected from vehicles driving the park road in 2006/2007 to create a traffic model capable of simulating location and vehicle-specific driving behaviors. Researchers can use the model to vary bus schedule scenarios, wildlife encounter probabilities, and other road logistic rules to quantify and visually analyze travel times, predicted bunching, and following distances of buses and of other vehicles along the road. The results can be used to predict and better study traffic related impacts on visitor experience and wildlife behavior.

Data collected in 2007 by drivers using the SLCD data panels provided data about duration of stops for use in the traffic model. Stops made by drivers for grizzly bear sightings were generally longer on average than stops for other types of wildlife (Figure 5). Drivers with touch screen panels also provided the project with data about the location and date of wildlife sightings along the road (Figures 6-7).

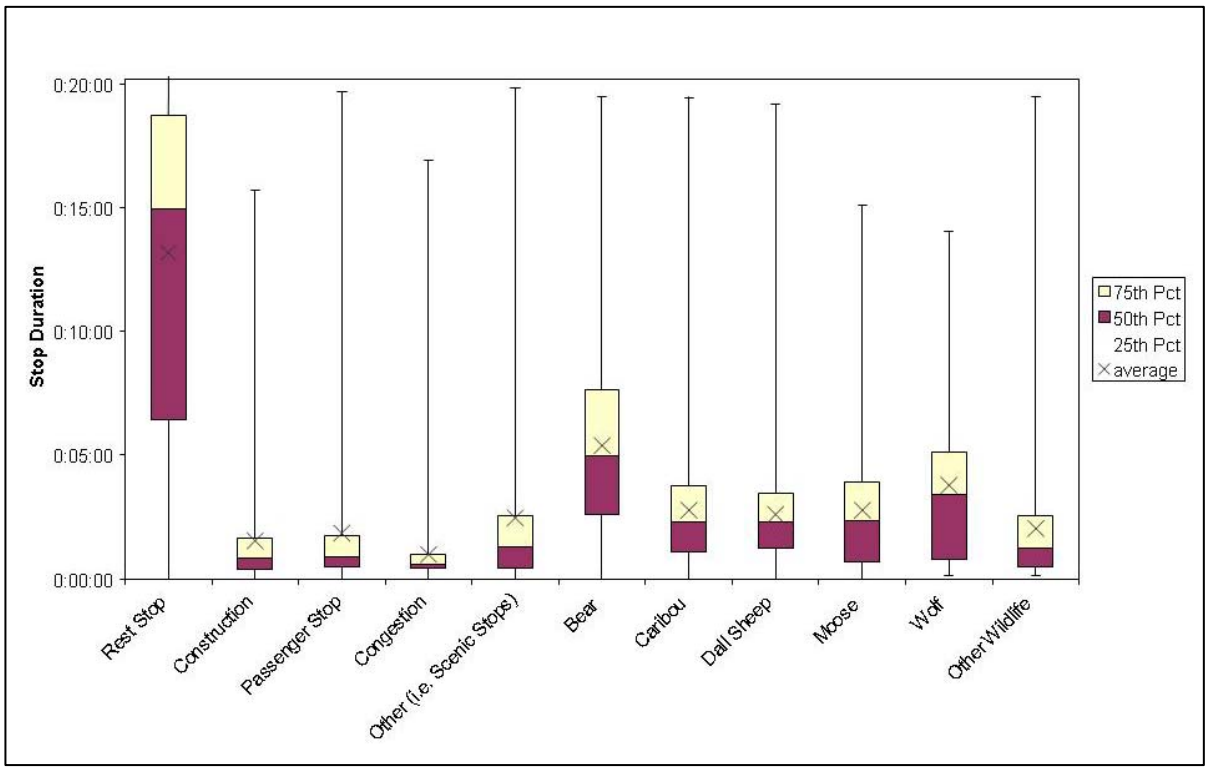


Figure 5. Average stop time at wildlife, rest, and passenger stops on the park road.

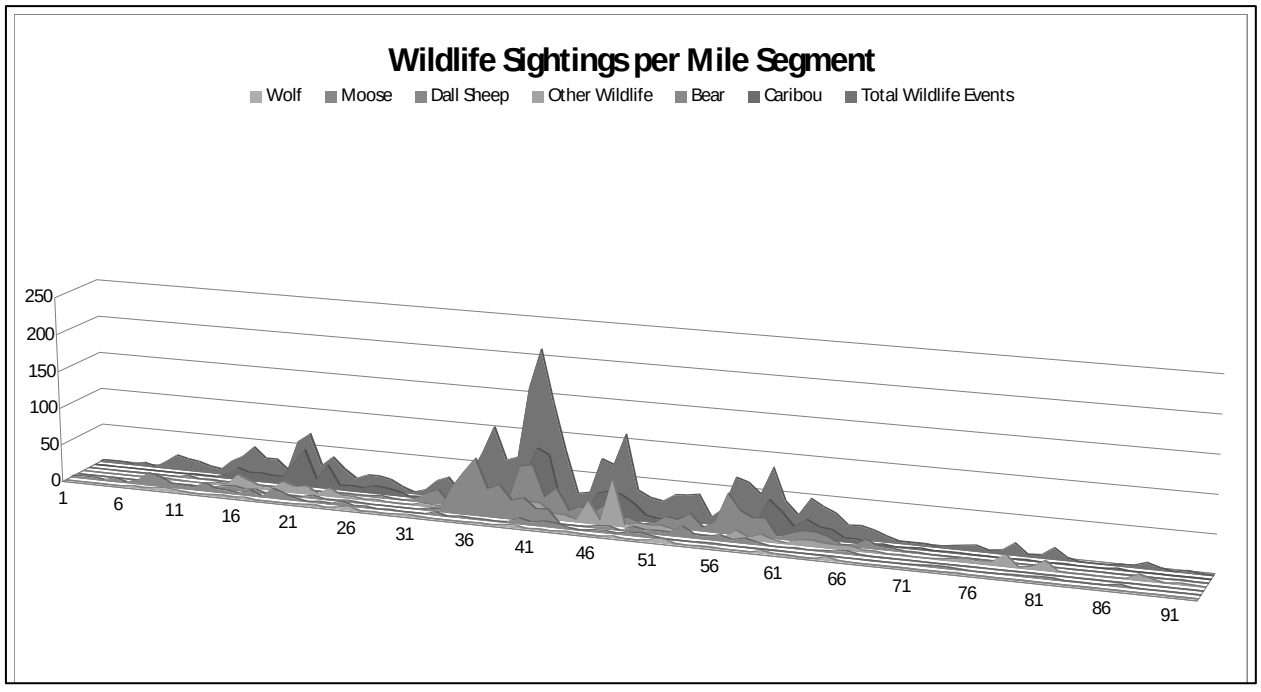


Figure 6. Number of wildlife sightings by park road mile, as reported by drivers with SLCD touch screen panels in 2007.

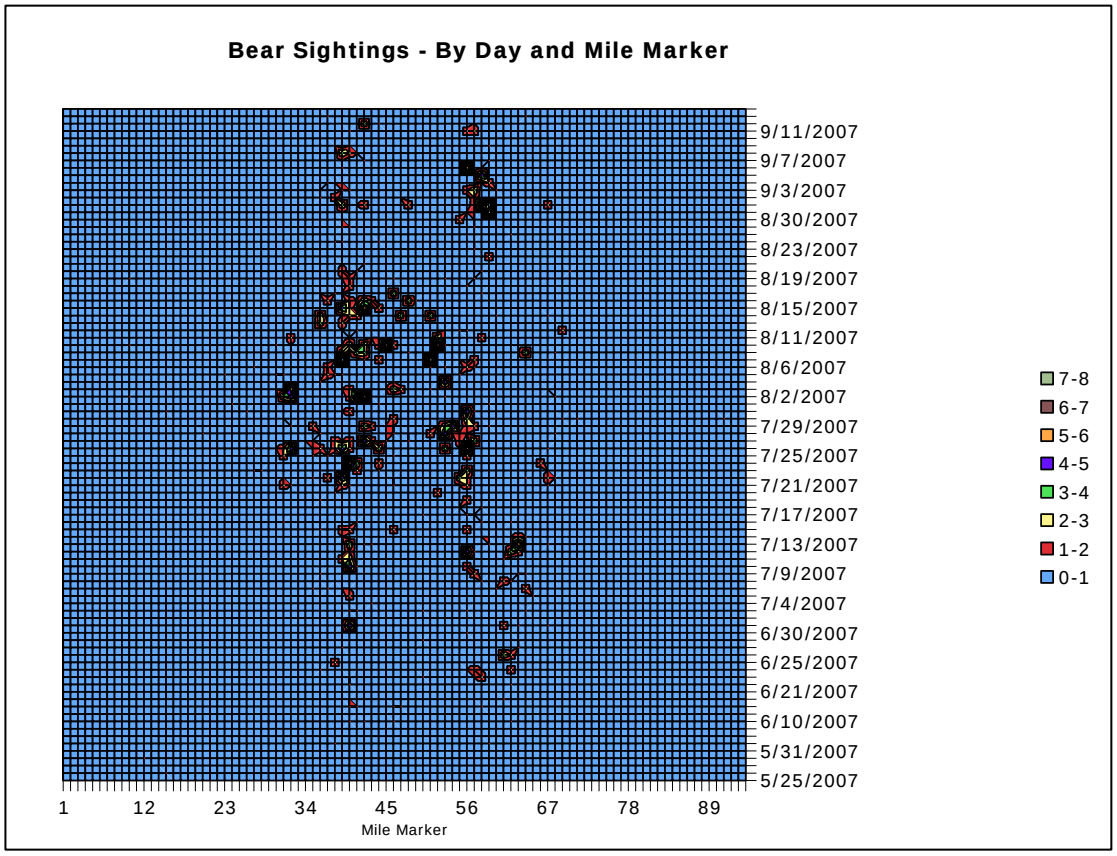
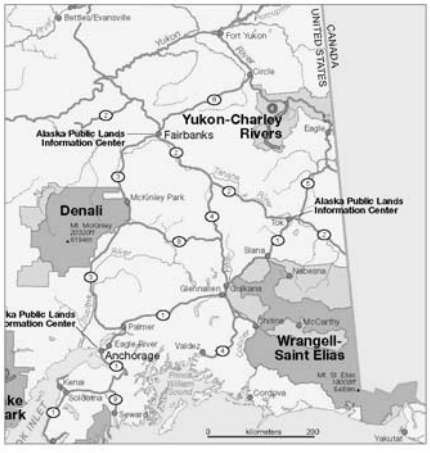


Figure 7. Date and numbers of wildlife sightings by mile of the park road, 2007.

Ultimately, a comprehensive model of park road traffic will be developed to predict the effects of changes in traffic volume and timing on visitor experience and wildlife movements. If the model and an environmental impact statement suggest that an increase in traffic volume is feasible, an experimental increase in road traffic, timed to produce the greatest value in understanding impacts, will be undertaken as part of a Before-After-Control-Impact (BACI) study. The goal of the road study is to provide park managers with a tool to make the most well-informed decisions about the future of traffic on the park road.

Central Alaska Network Inventory and Monitoring (I&M) 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.



Information is posted at the CAKN website
http://science.nature.nps.gov/im/units/cakn/

Biological Inventories

Biological inventories were completed in 2005. These inventories documented the occurrence of 90 percent of the plant species, small mammal species, and freshwater fish species hypothesized to exist in Central Alaska Network parks.

Vital Signs Monitoring
The 2008 field season is the third year of program implementation after four years of planning and development. The focus has been to bring 11 of the 378 Vital Signs into full operation with collecting field data and analyzing and reporting on the data to parks and the public. The network produced full protocols for the 11 initial 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.

Kiosks
Interactive kiosks have been installed in four locations: the Murie Science and Learning Center (for Denali), the visitor centers in Eagle (Yukon-Charley Rivers), Copper Center (Wrangell-St. Elias, and the Fairbanks Public Lands Information Center. These kiosks 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 I&M data for management purposes.

Program review
The Central Alaska Inventory and Monitoring Program (CAKN) underwent a review in early 2008 to assess if the network was responsive to park needs and was meeting the scientific standards established by the national program. The CAKN program received very positive reviews with several characterizing our program as one of the Nation's best. A national A-123 review for OPM standards was held in summer of 2007 which recognized Denali's integration with the I&M program (linking park research goals and I&M goals) as being a "best practices" example nationally.

Challenges for the future
CAKN staff and reviewers jointly recognized three primary challenges for the future:
1) maintaining park support and interconnectedness given the highly ambitious number of network indicators, 2) increasing the outreach and education products from the program, and 3) improving data analysis and database management of the program results. To respond to these challenges, the CAKN Board agreed to put together a joint funding request for the three parks, build even tighter connections with the Murie Science and Learning Center, identify more outreach products, build efficiencies with the other networks, and increase our efforts to analyze and database results.

Recent findings
Read about CAKN activities and results under these vital signs:
Vegetation, Small Mammals, Climate, and Shallow Lakes

International Polar Year (IPY) Activities at Denali
The International Polar Year 2007 – 2009 is a huge, exciting scientific campaign focusing on the polar regions – both the Arctic and Antarctic regions. The official IPY launch date was March 1, 2007. For the next two years, scientists from around the world will focus their efforts on understanding the role of the polar ecosystems on global climate systems. The 9th International Conference on Permafrost (ICOP) takes place in Fairbanks on June 29 – July 3, 2008.

Current programs and research at Denali will contribute to this effort. The park will host an ICOP field trip July 4-6, 2008 to include stops inside and outside of the park, at areas of geologic, glacial, and

permafrost interest. In particular, the vital signs monitoring program (Central Alaska Network), and data from long-term studies will be highly supportive of Alaska efforts. Denali's contributions will include some of the longest running climate and biological monitoring records in the region. It is anticipated that Denali resource staff will work with UAF scientists on IPY projects related to climate change, permafrost, glaciers, vegetation changes, and wildlife. One example is Martin Jeffries, University of Alaska Fairbanks, who continues measurements of lake ice and snow at Horseshoe Lake as part of the Alaska Lake Ice and Snow Observatory Network (ALISON). He has enlisted the help of Tri-Valley students and teaches, as well as park staff and the Murie Science and Learning Center.

The website for the International Polar Year Alaska is http://www.alaska.edu/ipy/.

Alaska Park Science Symposium Proceedings

A proceedings of the fall 2006 Alaska Park Science Symposium held at Denali is now published as a special issue of Alaska Park Science (Volume 6, Issue 2). Many of the fifty presentations and thirty-five posters on topics including geology, monitoring a changing environment, landscape ecology, vertebrate ecology, profiles in history, educational strategies, evaluating the visitor experience and subsistence management are included in the issues as expanded abstracts with illustrations.

Plants/Vegetation

Long-term Vegetation Monitoring

Field work continued in 2007 for the vegetation component of the long-term monitoring of park resources, including landscape monitoring of vegetation and white spruce cone production.

- **Landscape-scale vegetation monitoring project**

  The goal of this project is to detect changes in the 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. The vegetation protocol for the Central Alaska Network vegetation monitoring has received a full peer-review, and the official implementation phase of the program began in 2006.

  In 2007, two vegetation crews completed sampling of the following mini-grids: Moose Creek, Fish Creek, Nika Ridge, Gorge Creek, Panorama, Summit, and Bull River. Sampling involved installing new plots and measuring vegetation in these seven mini-grid study areas, scattered across the northern part of the Park from Polychrome Glacier area to Broad Pass to the Stampede Corridor. In 2008, the minigrids to be sampled are: East Sushana, Birch Creek Bend, Middle Birch Creek, Middle McKinley River, Middle Moose Creek, Upper Stony Creek, and Rock Creek.

- **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—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.

  The spruce sample population produced virtually no cones in 2006 and 2007 (no bar visible in Fig. 8), which is not surprising considering 2004 and 2005 were two consecutive years of sizable cone production that depleted the trees' reserves. 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, but in 2004 and 2005 there were more cones per tree at treeline.

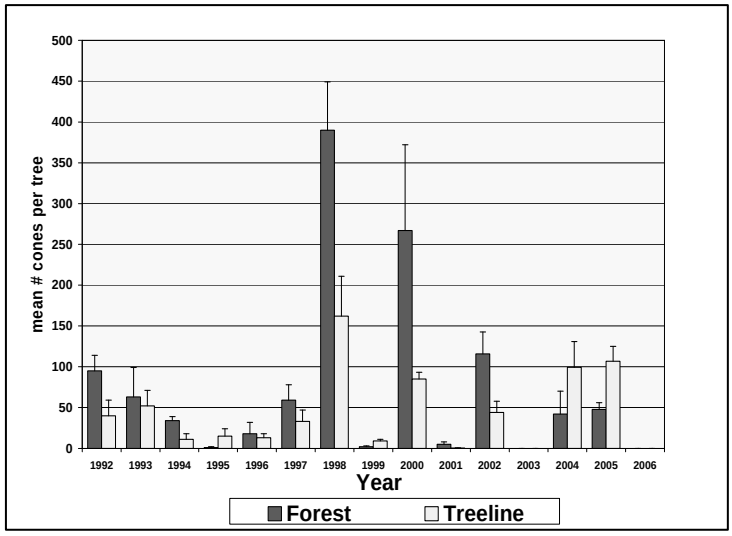


Figure 8. Average number of cones per white spruce tree observed in 3 treeline and 3 forest (valley bottom) plots in the Rock Creek drainage 1992-2006, 2007 not included.

❖ **Repeat photography**

The repeat photography project is part of vegetation monitoring in the Central Alaska Network. Approximately 2,500 slides of Denali taken in 1976 have been scanned and metadata on each picture recorded in an Access database. A number of repeat photographs (a subset of the entire aerial photos of park landscapes taken in the mid-1970's) were taken in 2005 to 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 and what changes are evident on the landscape over a 30-year span of time.

The CAKN is working on ways to objectively quantify the vegetation change. While there was no repeat photography taken in 2006 or 2007, additional repeat photography will be done in the future.

A Ton of Exotic (Non-native) Plants Removed

In 2007, several individuals and groups helped Wendy Mahovlic and "the exotic plant management team" remove hundreds of pounds of non-native plants from the Denali Park Road corridor, the Entrance Area of the park, and the Parks Highway near the park entrance. Counting volunteer hours for the native seed collection, 25 volunteers worked 1896 hours and pulled 2257 lbs. of exotic plants.

❖ **Non-native plants with greatest biomass removed**

Here's the roster of non-native plants removed in/near the park in 2007 (more than 50 lbs):

* Dandelion (*Taraxacum officinale)*: 605 lbs
* White Sweet Clover (*Melilotus alba*): 117 lbs
  (Miles 239 to 227 Parks Hwy; Miles 0 – 3 Park Road)
* Hawk's-Beard (*Crepis tectorum*): 1501 lbs
  (Sewage lagoon; Miles 0 – 3 Park Road)
* Mustard (*Erysimum cheiranthoides*): 70 lbs
  (Toklat area; Miles 41 and 43.4 Park Road)

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

Six additional non-native species other than dandelions were removed in 2007:

* *Vicia cracca* (bird vetch): 5 lbs. (Miles 1 – 3 of Park Road)
* *Lupinus polyphyllus* (bigleaf lupine): 5 lbs. (Mile 1.5 and Mile 7 pull-out)
* *Trifolium repens*, *T. pretense* (red and white clover): 10 lbs. (Miles 0 – 3 Park Road)
* *Leucanthemum vulgare* (oxeye daisy): a few plants (Nenana Canyon, near bus barn)
* *Tripleurospermum perforata* (scentless false mayweed): 23 lbs (Railroad Depot)
* *Linaria vulgaris* (yellow toadflax): 3 lbs (Railroad Depot; tracks near Triple Lakes Trail)

In 2008, for the tenth consecutive year, volunteers will be enlisted to pull dandelions and other non-native plants in the park.

Revegetation of Construction/Disturbed Sites

- **Seed collections**

In 2007 there was an increased need for seed due to revegetation of the new Eielson Visitor Center and the future Savage Bus Turn-around and Rest Stop. From August 14-17, eight volunteers from all over Alaska gathered seeds along the park road from Mile 1 through Mile 13. Because of the beautiful summer weather, 2007 was a banner year for wildflowers and the volunteers collected large volumes of seeds from: *Hedysarum alpinum, Oxytropis campestris, Agropyron macrourum, Elymus innovatus, Calamagrostis purpurascens*, and *Poa alpine*. During August 20-24, four volunteers collected seeds at the Toklat Road Camp, Eielson Visitors Center, in the Kantishna area, increasing the supplies of *Arnica frigida* and *Arnica lessingii*.

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 2008 for revegetation of present and future construction projects.

- **Revegetation**

The big revegetation projects for the 2008 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.

Off-Road Vehicle (ORV) Impacts

In 2007, park staff used mapping-grade GPS to map nearly 30 linear km of tracks made by ORVs in the park. 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. The ORV tracks in this area were initially mapped in 2005.

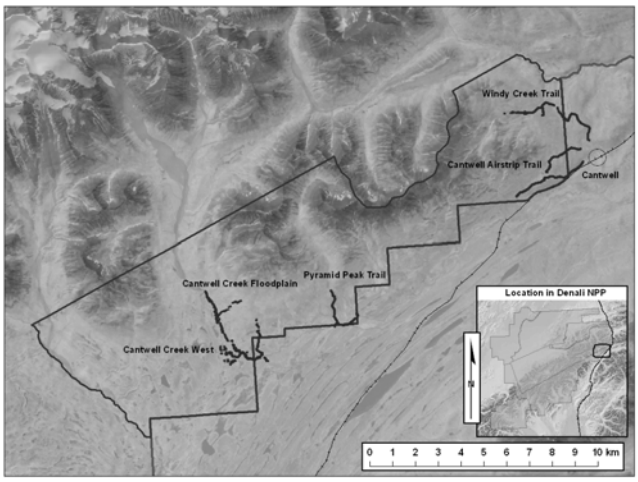


Figure 9. Sites for long-term monitoring of vegetation in areas now closed to ORV use.

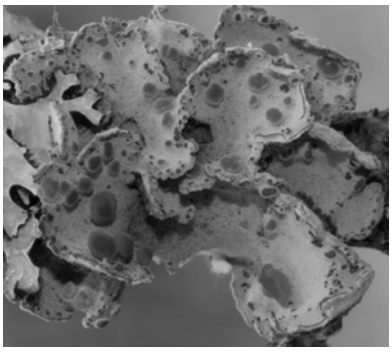
In the 2008 field season, Denali staff is implementing a strategy for monitoring the impacts of ORV use over time. In areas now closed to ORV use, park staff has established 7 long-term vegetation monitoring sites (see map). 2008 is also the third iteration of GPS trail mapping to look at changes in trail attributes of the Windy Creek, Cantwell Creek, Cantwell Airstrip, and Pyramid Peak trails, and collecting repeat photographs as another tool to look at changes over time.

Bryophyte and Lichen Inventory

2007 marked the beginning of a multi-year project to compile a rigorous, voucher-based inventory of the nonvascular plant flora (mosses, liverworts, lichens) of Denali and to summarize current knowledge of these organisms in the Park.

In August and September, reconnaissance fieldwork was conducted at 21 locations that spanned a diversity of ecological gradients and habitat types primarily along the south side of the Alaska Range. Notable nonvascular plant collection areas included alpine heath tundra, alpine fen and wetland sites, dry fellfield and talus slopes, and lowland mixed hardwood and white spruce forests. Several hundred voucher specimens were collected, and an initial rapid assessment of these collections has produced a provisional list of at least 30 taxa not listed on Denali's current nonvascular plant species list. Several of these new taxa represent important range extensions and globally uncommon species status. As detailed microscopic identification of voucher specimens begins in 2008, additional taxa that are new to Denali are expected.

Some significant species collected in August 2007 include:



- Boreal Felt Lichen (*Erioderma pedicellatum*) – (photo at right). Currently listed as Critically Endangered on the IUCN Red List of Threatened Species. This lichen was previously known only from a very narrow range of sites in boreal northeastern North America and northern Europe.
- Waterfan Lichen (*Peltigera hydrothyria*) – Known only from North America, this lichen grows completely submerged in mountain streams. It is considered rare throughout its range in western North America.
- Methuselah's Beard Lichen (*Usnea longissima*) – An extremely pollution-sensitive species, this lichen is considered threatened or extirpated throughout much of its circumboreal range, due, in part, to deteriorating air quality.

2008 fieldwork will focus on remote mountainous regions of the Park, as well as in the lowland plains of the northwest region of the Park.

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 ($CaCl_2$) to the surface of the park road. The application reduces dust and the need for replacing the fine materials constantly lost from the road as dust. However, adding this compound also has the potential for adversely affecting ecosystems adjacent to the road. NPS has developed a monitoring plan to assess and monitor the possible effects on soil, water, and vegetation of applying calcium chloride as a dust palliative on the park road.

In 2005, park staff buried 15 pairs of lysimeters (instruments designed to sample water from within the topsoil) at Mile 15.2, 18.6, 22.2, 23.4, 26.9, 28.9, 31.2, 41.5, 49.1, 58.4, 60.4, 64.5, 71.3, 79.8, and 88.4—one lysimeter was buried near the road, and one about 10 meters away. Water samples are being taken annually from lysimeters and nearby water bodies to test for chloride ions. The data from the first three years of sampling, 2005 - 2007 show that there is little chloride reaching the water bodies. Two sites on east end have shown high levels of Chloride (up to 327 ppm) adjacent to the road. These levels of chloride represent levels that may begin to show biological effects and we will be monitoring the levels of chloride in these sites carefully. The lysimeters will be sampled again in fall 2008.

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) lies within "limited fire management options". These options allow fire to play its natural role in the ecosystem. Although some wildland fires are suppressed because they threaten natural or cultural values, the emphasis of the fire management program at Denali is on actively monitoring wildland fires while they burn and on protecting individual isolated structures in the fire's path.

Six wildland fires and three prescribed fires occurred in Denali in 2007:

Fire Name	Burn Period	Acres	Fire Type	Comments
Nenana Overlook	April 27-28, 2007	0.1	Wildland Fire: Suppression	Fire caused by downed power-line and was suppressed
Turtle Hill	July 4-9, 2007	10	Wildland Fire: Fire Use	Fire caused by lighting in a limited management option and was monitored
McKinley River	July 4-9, 2007	80	Wildland Fire: Fire Use	Fire caused by lighting in a limited management option and was monitored
Sanctuary River	July 5, 2007	0.1	Wildland Fire: Natural Out	Fire was discovered out.
Allen 42	July 13, 2007	0.1	Wildland Fire: Natural Out	Fire was discovered out.
Cod Lake	July 17-September 30, 2007	0.7	Wildland Fire: Fire Use	Fire caused by lighting in a limited management option and was monitored
Stampede Mine	September 4-6, 2007	2.4	Prescribed fir e[1]	Burn biomass debris hazard fuels reduction projects
Lower East Fork Patrol Cabin	September 4-5, 2007	0.8	Prescribed fire	Burn biomass debris hazard fuels reduction projects
Lower Toklat Patrol Cabin	September 5-6, 2007	0.8	Prescribed fire	Burn biomass debris hazard fuels reduction projects

Several prescribed fires are completed or planned for 2008:

Fire Name	Burn Period	Acres	Fire Type	Comments
Sewer Lagoon	November 19-21, 2007	2.5	Prescribed fire[1]	Burn biomass debris from roadside maintenance projects (Pile Burn)
Lower Windy Patrol Cabin	TBA -- Spring	0.8	Prescribed fire	Burn biomass debris from roadside maintenance projects (Pile Burn)
Stampede Mine	TBA -- Fall	2.4	Prescribed fire	Burn biomass debris from roadside maintenance projects (Pile Burn)
Pearson Cabin	TBA -- Fall	0.8	Prescribed fire	Burn biomass debris from roadside maintenance projects (Pile Burn)
Igloo Patrol Cabin	TBA -- Fall	0.8	Prescribed fire	Burn biomass debris from roadside maintenance projects (Pile Burn)
Sushana Patrol Cabin	TBA -- Fall	0.8	Prescribed fire	Burn biomass debris from roadside maintenance projects (Pile Burn)
Riley Creek Patrol Cabin	TBA -- Fall	0.8	Prescribed fire	Burn biomass debris from roadside maintenance projects (Pile Burn)

[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.

Fire monitoring includes observing a fire from aircraft, digitally photographing and mapping its progress, and keeping an updated narrative of the fire's status and behavior. Current and forecasted weather over the fire area is also monitored to ensure that the fire will continue to burn only where allowed. Protecting isolated structures that lie in the fire's path is generally accomplished by setting up a water pump and sprinkler system on or around the structure as most structures tend to be located adjacent to water sources.

Creating Defensible Space Around Structures

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. Firewise is the name given to the creation of defensible space by thinning, limbing, or clearing space around structures. Throughout the project, Denali employees receive project updates and other fire information. Two hazard fuel project success stories are posted at http://www.nps.gov/akso/Fire/firehome.htm

- **Developed areas**. In 2007, defensible space totaling ~ .5 acres was improved at Park Headquarters, trimming branches to varying heights from the ground to give a natural appearance. In 2008, as the need is identified, additional areas will be treated in the maintenance cycle of defensible space.

- **Cultural resource sites**. In 2007, debris accumulated from past hazard fuels projects were burned at the Lower East Fork and Lower Toklat Patrol Cabins and at the Stampede Mine, completing the cycle for the initial treatment of the sites. They will enter a maintenance cycle. In 2008, the remaining unburned piles at the Stampede Mine will be burned; the Crooked Creek Cabin, Pearson Cabin, Sanctuary, Moose Creek, Lower Savage and Igloo Ranger Patrol Cabins are candidates for hazard fuels reduction initial and improvement treatments.

Videography Landcover Reclassification and Moose Browse Utilization

The purposes of this 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 also necessary in order to identify potential abnormal effects associated with long-term climate change or management activities.

The current fire fuels map for Denali is based on LANDSAT imagery compiled from scenes over several years. Approximately 12.9 percent of the park, which is prone to natural ignitions, is classified as "burn" on the current map or has burned since the Landcover Classification map was made. The analysis and imagery used to develop the landcover classes are unable to detect other classes of vegetation for up to 15 years after a fire. In the short term, these "burn" areas need to be reclassified into another Landcover classification other than "burn" to update maps so fire managers can predict fire behavior with some confidence. In the long term, fire managers would like to combine data about vegetation recovery after fires to model plant succession after a fire on a landscape scale, then apply this information to create maps.

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) due to fire. In general, the greater the fire severity, the further the plant succession is reduced to its earlier stages and the longer recovery will take to its pre-fire condition.

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. Moose play a major role in the dynamics of boreal forest ecosystems and are an important resource for subsistence users. In much of the natural fire-prone portion of Denali, if the fire severity encourages shrub development, then browsing by moose (moose browse utilization) may increase. Extremely high fire severity may delay shrubs development and extremely low fire severity may induce little change in species composition and structure.

In 2007, the Fire Management staff resampled vegetation in 55 selected plots that were installed and sampled in 2002 as part of the Satellite Burn Severity Project, recording whether browsing by moose was low, moderate, or high. Transects were chosen to span burned areas ranging from 3-to 50 years ago. 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.

Courtesy of Tom Walker

Analysis for this project is in progress and will continue in 2008 (no further field sampling).

Fire Education

- ✧ **Murie Science and Learning Center Science Series.** In 2007, after working with Western Area Fire Management and the Regional Fire Communication and Education Specialist,

MSLC staff developed and presented "Feel the Burn: Wildland Fires And Management in Denali." A total of 195 visitors attended this fire program during the 2007 summer season.

- ✧ **Denali Discovery Camp.** As part of the annual Denali Discovery Camp in June 2007, the Fire Management staff participated in short hikes and taught several students about the wildland fire triangle, fire behavior, firefighter tools, and the range of work of a firefighter.

- ✧ **Firewise Workshops.** Fire managers create defensible space around park structures and encourage community members to do the same. Firewise workshops teach community members how to reduce the combustible material around their homes in order to reduce the wildland fire risk. Workshops also focus on "Why" create defensible space by teaching residents about the fire environment they live in. In 2007, workshops took place at Panguingue Creek and the Denali Education Center. One workshop at the Denali Education Center was specifically designed for the non-governmental organization and the other was hosted by the Foundation and for the community.

- ✧ **Alaska Interagency Wildland Fire Key Messages.** To communicate clearly and consistently across all agencies and disciplines, the Interagency Wildland Fire Prevention, Education, and Awareness Committee has developed key messages about wildland fire..

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". Anecdotal observations continue to indicate that the program is successful. Fewer reports of human-wildlife conflict due to food conditioning have been reported each year the program has been in effect. The program includes bookmarks, buttons, brochures, and signs bearing a universal symbol "Do not feed the animals" with text explaining why this is important. Again in 2007, staff distributed these materials around the park and will do so in 2008. Signs appear on trash cans, picnic tables, and toilet stall doors. The message has also become part of every interpretive program.

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

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 from den emergence to the end of September to locate and follow the mortality of the sows and their cubs.

Bear capture was conducted on May 24 and 25, 2007. Collars were replaced on six female grizzly bears. Three new three-year-old females were captured and collared. Captures were conducted from a helicopter with fixed wing support. The number of collared bears in the study is 13, all female. The oldest study bear is 19 yrs old.

At den emergence, two sows each had two spring cubs. By the end of September one cub could not be accounted for and was presumed dead. One sow had a single two year old that could not be accounted for at the season's end.

Plans for 2008 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 (BMP) 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.

Between May 7, 2007 and September 19, 2007, 142 bear-human interactions were documented (see chart for breakdown into observations, encounters, incidents, and control actions), a 23.2 percent decrease from the previous year's total of 185. Of those interactions rated as encounters, 41 occurred in frontcountry areas and 81 occurred in the backcountry. There were 11

interactions classified as incidents this season, with five incidents occurring in frontcountry areas and six in backcountry settings. This is about the same as last year's number of recorded incidents.

Interactions	FRONTCOUNTRY	BACKCOUNTRY	TOTAL
Observations	4	4	**8**
Encounters	41	81	**122**
Incidents	5	6	**11**
Control Actions	1	0	**1**
Total	**51**	**91**	**142**

Type and number of bear-human interactions by location in 2007, Denali National Park and Preserve.

Backcountry and frontcountry incidents involved property damage and close approaches to people. There was only a single control action in 2007 compared with 17 in 2006. This one control action involved a young grizzly bear that was hazed out of Wonder Lake campground.

Wildlife Observations along the Park Road

This study relies on those bus drivers who volunteer to help monitor wildlife along the park road and continued in 2007 (and became part of the larger road capacity study). 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.

Based on the groups of wildlife observed per bus trip from 1999 through 2006, a visitor taking one bus trip into the park could expect (based only on averages) to see 3 groups of caribou, 2 groups of grizzlies, and 1 or 2 groups of Dall's sheep (Fig. 10).

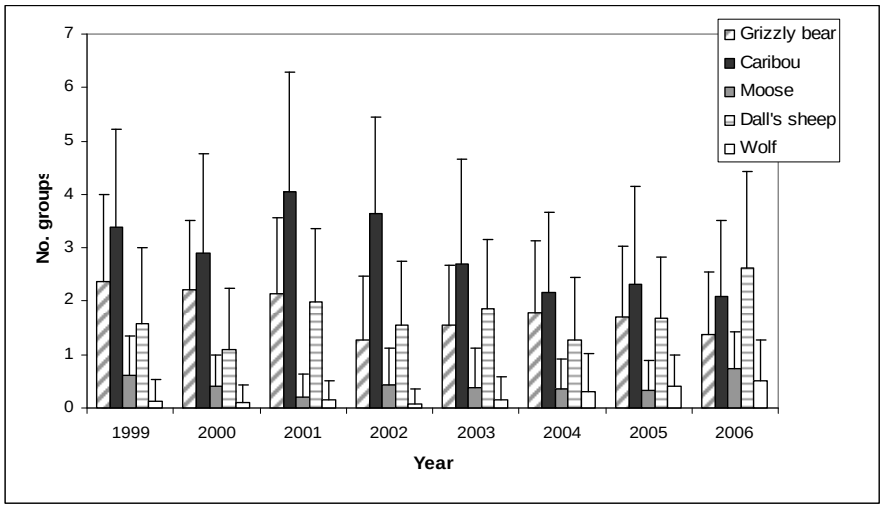


Figure 10. The average number of groups (+ SD) observed per trip on the Denali Park Road, 1999-2006.

Based on bus driver observation data from 1999 – 2006, a visitor taking 10 trips into the park would be expected to see a moose on 3 out of 10 trips, and a wolf on 2 out of 10 trips (Fig. 11).

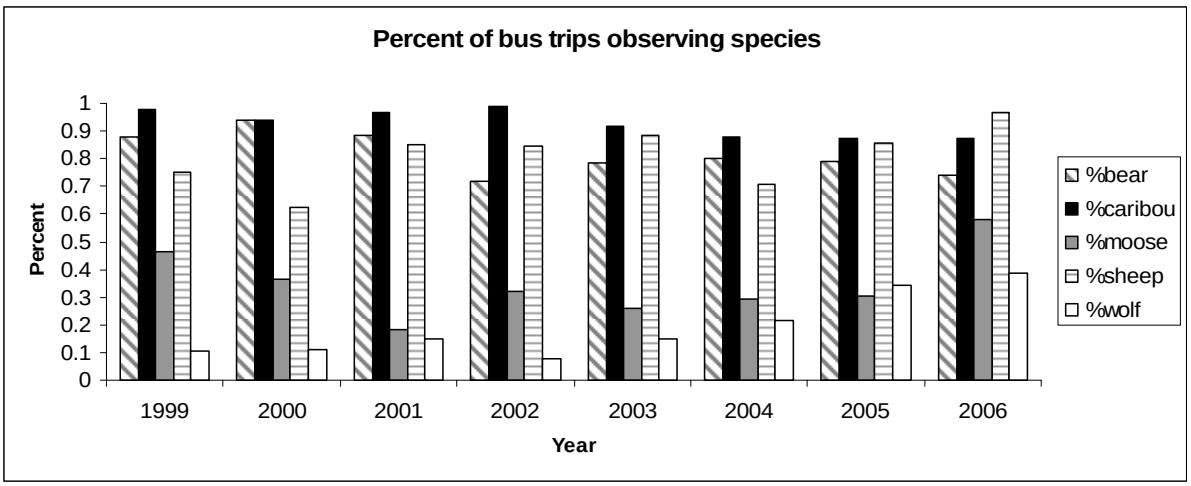


Figure 11. The percentage of bus trips during which different species of large mammals were observed on the Denali Park Road, 1999-2006.

In summary, beyond the Savage River, the odds (based on averages over the last 8 years) of seeing the five large mammals are: caribou (92%), grizzly bear (82%), Dall sheep (81%), moose (35%), and wolf (19%). For wildlife viewing odds in more recent years, see Fig. 11 and note the height of the bars by species for 2005 and 2006.

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 one to three radio-collared wolves in each known pack inhabiting the park north of the Alaska Range. Radio collared wolves are located every two weeks, with additional locations during late September-early October to determine fall pack sizes and to count pups, and locations during March and April to determine late winter pack sizes.

Telemetry locations acquired over two to three biological years (a biological year runs from May 1 to 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.

As of April 1, 2008, 22 wolves in 20 packs in and around Denali wore conventional, VHF radio collars that are located from antennae-equipped airplane. Another 8 wolves carried GPS collars that determine the animal's location once per day, store the data, and upload it through the ARGOS satellite system. (Only 18 packs appear on the map (Fig. 12), because two wolf pairs farther west, formed by collared wolves dispersing from park packs, are not shown)

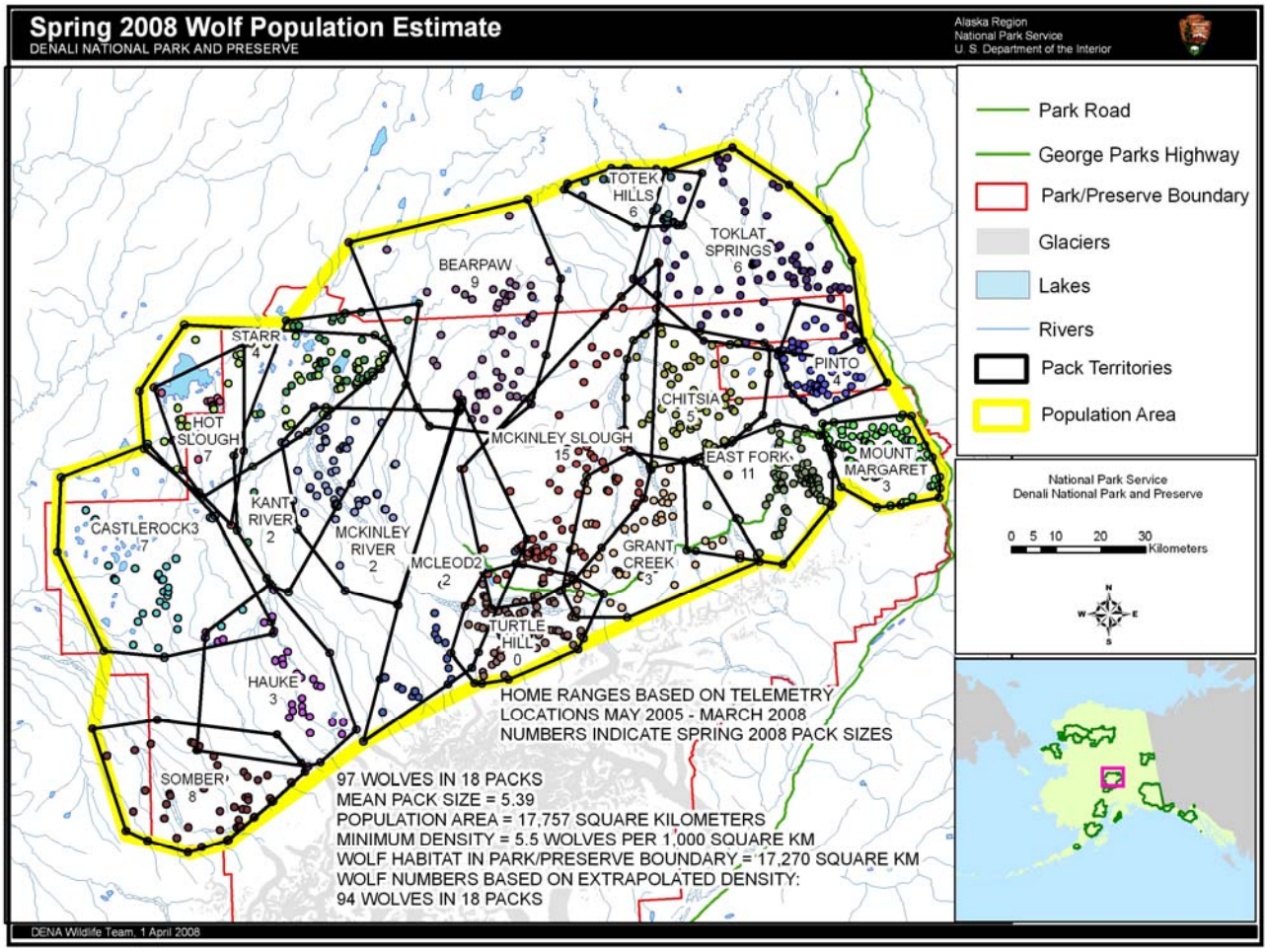


Figure 12. Spring 2008 wolf pack territories and population estimate for Denali.

In April 2008, there were approximately 97 wolves in the 18 packs being monitored by park biologists. The estimated density of wolves in Denali (about 5.5 wolves per 1000 square kilometers) was very close to last year's estimate of 5.3 wolves per 1000 square kilometers.

More collared wolves died in 2007-2008 than usual. Between March 2007 and March 2008, 11 collared wolves died of natural causes and 12 were killed by humans. The number of traplines operating close to the eastern park boundary has increased in recent years. The Alaska Department of Fish and Game has established buffer zones which protect wolves in some areas adjacent to the park from hunting and trapping (Figure 13).

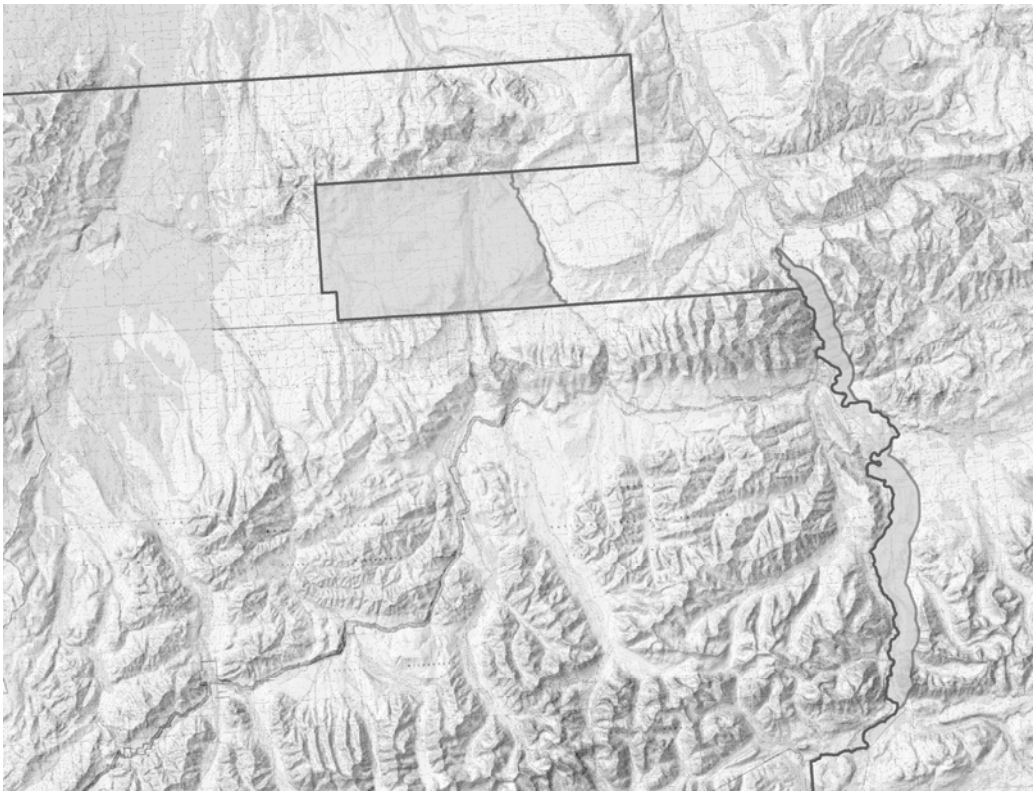


Figure 13. Wolf buffer zones adjacent to Denali National Park. Shaded areas are closed to wolf hunting and trapping.

Caribou

The Denali Caribou Herd has been the focus of continuous, intensive research since 1984. Methods that are currently employed to monitor population trends and vital rates have been in place since September 1986 and probably represent the longest and most consistent effort of its kind on caribou in North America. One unique aspect of the research design is that a sample of 50-60 radiocollared females representative of the herd's age structure has been maintained since 1987, thus providing annual assessments of population vital rates that are faithful to the herd's age structure, and not influenced by biases common to radiotelemetry studies of long-lived animals. Even with the general acceptance of the important influences of age on productivity and survival, this age-structured sample is the only one of its kind ever attempted in a wildlife population and has been maintained for 20 years.

To date, the park biologists and cooperators have learned much 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%/year through a period of relatively mild winters in the mid-1980s. Winter survival of caribou cows was high (96%/year) and about 50% of the calves produced were recruited into the herd. With the onset of a period of severe winters in 1988, caribou numbers plateaued at about 3,200 in fall 1989 and then declined by over a third by fall 1993. During the period of decline, adult cow winter survival dropped substantially (85%/year) and calf recruitment dropped to a mere 5%. With a return to more average winter conditions after 1993, the herd trend has been essentially flat through 2007. During this period, adult cow survival was comparable to the mid-1980s, but calf recruitment continued to be

relatively low (35 calves:100 cows during Autumn 1984-89 vs. 16:100 during Autumn 1994-2007), although calf recruitment has improved some in the last 4 years (23:100 during Autumn 2004-07).

With the overall decline in calf recruitment since 1990, the female age structure became heavily weighted towards older females. We expected that the loss of these old females over a few years would result in a noticeable decline in the herd. However, the loss of many of these old cows was followed closely, and therefore offset, by an increase in calf recruitment beginning in 2004. 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 we expect the herd to maintain its numbers, particularly if the increase calf recruitment continues.

Caribou capture operations were conducted in March 2008, and researchers placed or replaced radiocollars on 26 cows. In addition, 45 bull caribou were radio-collared in September 2007, initiating a four-year effort to learn more about the movements and survival of the male component of the Denali herd.

Herd size. We tentatively estimated herd size in late September 2007 at 2,080 caribou (Fig. 14). Herd size has increased slightly over the last 4 years primarily as a result of increased calf recruitment. During the last 4 years, calf:cow ratios and estimated calf numbers have averaged about twice that of 1998-2003, while estimates of adult females are about the same and bull numbers have increased slightly. Herd trend over the next few years will largely depend on whether the increases in calf recruitment continue.

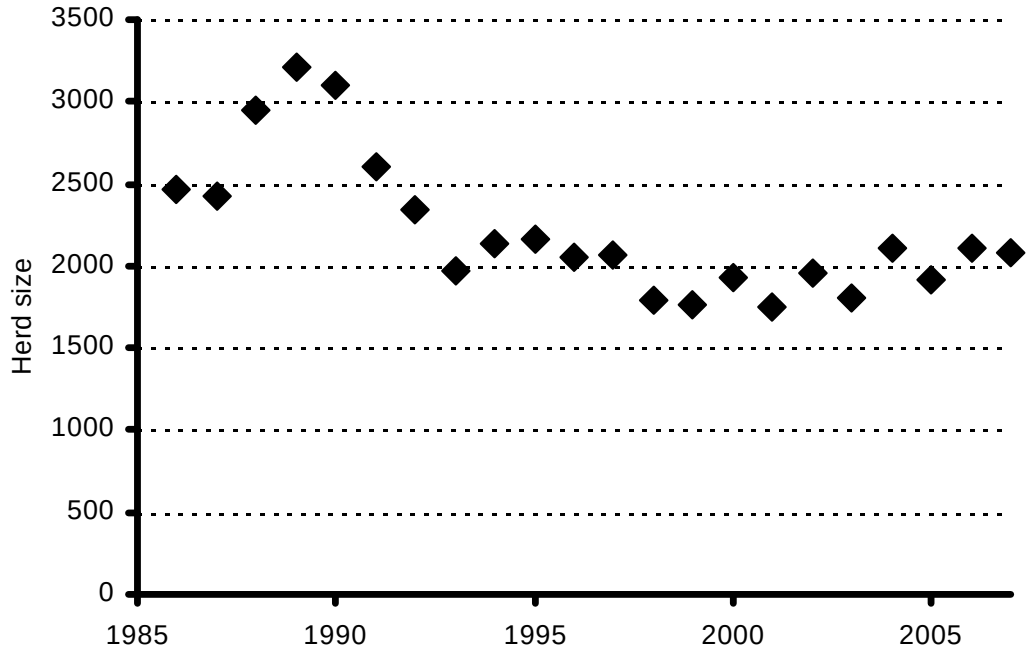


Figure 14. Population estimates (late September) for the Denali Caribou Herd, Denali National Park, 1986-2007. The estimate of 2080 caribou in fall 2007 is tentative.

Adult Sex Ratios. We noted a bull:cow ratio of 36:100 during the September 2007 composition survey. Adult sex ratios declined from an average of 56:100 during 1984-1989 to a low of 29:100 during 1997-98 as a result of increased mortality of males during severe winters in the late 1980s and early 1990s. The sex ratio has increased since then, averaging 37:100 over the last 4 years.

Calf Production And Survival. We estimated a natality rate of 71% for cows ≥ 1 year old in mid-May 2007, based on observations of 66 radiocollared cows that comprised the age-structured sample at that time. Natality rates have averaged 78% over the 20 years of the study. The lower than average rate in 2007 was largely due to the preponderance of yearlings and 2-year-olds in the population resulting from increased calf recruitment in 2005 and 2006.

In early June 2007, we observed 34 calves:100 cows during the annual census and post-calving composition survey. By late September, the calf:cow ratio had declined to 23:100, indicating 31% survival of the 2007 calf cohort. During 1990-2003, fall calf:cow ratios have been chronically low, averaging 13.1 calves:100 cows. Calf recruitment has improved since 2004. Given the calf sex ratio, approximately 12 female calves were recruited per 100 older females.

Adult Female Survival and Age Structure. During October 2006 – September 2007, 4 radiocollared caribou from the age-structured sampled died resulting in an annual mortality rate of 6.3%. Thus summer survival was comparable to the long-term average of 96.4%, while overwinter survival was lower than the average at 91.1%.

As with last year, changes in the female age structure in May 2007 were largely due to recruitment of a relatively large number of individuals from the 2006 cohort that entered the age structure as yearlings. The proportion of old cows (≥ 13 years old) in the population increased some with the low overwinter mortality that has been noted in the last 2 years. Although the proportion of old cows in the herd has declined since 2001-2002, it is still more than double that of 1987-1989 when calf recruitment was high and the herd was growing at about 8% per year.

Large Mammal Surveys Planned for 2008

In addition to the ongoing wolf, bear and caribou work, additional wildlife surveys are planned for 2008. In July, we hope to resurrect the tradition of periodic Dall's sheep surveys in Denali. The last sheep survey in the park was in 1995. We will do an aerial survey, using fixed-wing aircraft, of all sheep habitat between the eastern Park boundary and the Muldrow Glacier. A protocol for Dall's sheep surveys in the Central Alaska Network has yet to be written, but the protocol will probably call for rotating surveys between the three parks in the network, so that Denali would conduct a survey every 3 years. If the monitoring protocol involves only surveys in the east end of the park, we will conduct more infrequent surveys of the smaller sheep populations west of Mount McKinley and in the southwest Preserve.

The Central Alaska moose monitoring protocol calls for rotating surveys between the three parks. In the rotation, November 2008 (fiscal year 2009) is the time for Denali to once again conduct an aerial moose survey over a 10,000-square-kilometer area on the north side of the Alaska Range (roughly the entire park east of the Foraker River).

In FY09, Denali has also obtained funding from the National Park Service Biological Resource Management Division to conduct moose surveys in two areas south of the Alaska Range, the Cantwell area (as far south as the West Fork of the Chulitna River) and the upper Yentna River (Denali National Preserve, south portion). Moose in both of these areas are harvested by subsistence users, and the Preserve is also open to sport hunting. Up-to-date information on

moose numbers and demography in these areas will be invaluable in helping make decisions about wildlife management. Denali National Park has also proposed a registration permit hunt in the southwest Preserve area of Game Management Unit (GMU) 16B, similar to the system in place near Cantwell in GMU 13E. The permit system will enable NPS to collect more accurate and current information on moose harvest.

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 1). Denali's three most common species (based on inventory collections) are northern red-backed voles, tundra voles, and the cinereus shrews.

Table 1. 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, yellow-cheeked (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

Voles (*Microtus* spp. and *Clethrionomys* sp.) 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, voles consume seeds, fungi and invertebrates, and provide a key prey source for raptors, and carnivorous mammals. Voles play another important ecological role by having the ability to influence species above and below them in the food chain.

Since 1992 vole 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 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 voles, we may detect effects of human-induced change (like global warming).

The 2007 field season of small mammal sampling in Rock Creek added a sixteenth year to the data series begun in 1992. Sampling occurred at the trapping grids in the Rock Creek drainage—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.

Birds

- **Monitoring abundance and distribution of passerines**. Biologists from the National Park Service and the Alaska Bird Observatory conducted ten-minute point transect surveys in Denali National Park and Preserve, Alaska, as part of the Central Alaska Network's Vital Signs monitoring program. The protocol for this project was peer-reviewed in 2005 and the project is in full-implementation.

  Surveys were conducted June 1 to 26 between 0300 and 0900 hours. All birds detected (seen or heard) at each sampling point were recorded during a 10-minute sampling period in one of four time intervals (0 to 3 min, >3 $\leq$5 min, >5 $\leq$8 min, and >8 $\leq$10 min) and one of 13 distance intervals (10-m intervals up to 100 m, 25-m intervals to 150 m, and >150-m). The survey crew sampled 187 points on 8 minigrids in 2007, and detected 1,941 birds (1982 detection events). The number of detections per grid ranged from 55 to 396 birds and detections per point ranged from 3.9 to 16.5 birds. Species richness ranged from 14 to 23 species per minigrid and 2.6 to 7.6 species per point.

  Fifty-eight species were detected on minigrids (47 species during the 10-minute counts and 11 species on the minigrids but not during the 10-minute counts). Members of two families, *Emberizidae* (Sparrows) and *Parulidea* (Warblers), compromised approximately

84% of all detections. White-crowned Sparrow was the most commonly detected species, occurring at approximately 81% of all points and comprising 28.2% of all detections.

Point transect surveys will continue in June 2008; approximately 200 points will be sampled.

Table 2. Summary statistics for birds detected on 10-minute point transect surveys by minigrid, Central Alaska Network passerine monitoring program, Denali National Park and Preserve, Alaska, 2007.

Minigrid name	Points surveyed	# birds	# species	Average number of birds per point	Average number of species per point
Reindeer Hill	24	268	17	11.1	5.9
Moose Creek Cabin	25	318	22	12.5	7.1
Gorge Creek	16	55	15	3.9	2.6
Mount Healy	25	66	15	5.9	3.8
Sanctuary Flats East	24	396	23	16.5	7.6
Tributary Creek	24	249	14	10.6	5.2
Divide Mountain	24	325	21	13.8	6.4
Upper Savage	25	264	17	11.8	5.9

- **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 changes of a species in certain states are related to a continental decline or merely represent population shifts within their breeding range. At Denali, park staff conduct two standardized Breeding Bird Survey (BBS) routes along the park road—the Savage BBS and the Toklat BBS. Each route contains 50 sampling points located 0.50 miles apart. At each point, the surveyor conducts a three-minute count and records all birds detected within 0.25 miles.

  The Savage BBS route was completed on June 14, 2007. The surveyed started at the west end of Savage River Bridge at 0300 and ended near Sable Pass at 0850. All 50 points were surveyed in 2007. Twenty-nine species and 895 individual birds were detected in 2007. White-crowned Sparrow (n=136) was the most commonly detected bird along the Savage BBS route followed by, American Tree Sparrow (n=122), Fox Sparrow (n = 100) and Orange-crowned Warbler (n=92). This was the first year that Herring Gull was observed on the Savage BBS route.

  The Toklat BBS route was completed on June 15, 2007. The survey started at the Toklat Ranger Station at 0315 and ended at 0904. All 50 points were surveyed in 2007. Thirty-six species and 680 individuals were detected in 2007. Wilson's Warbler (n = 101) was the most commonly detected bird along the Toklat BBS route followed by White-crowned Sparrow (n= 84), Savannah Sparrow (n = 82), and Fox Sparrow (n=81). This is the first year that Ring-necked Duck was observed on the Toklat BBS route.

National Park Service biologists will complete the two BBS routes in Denali in June 2008. Results from the Denali BBS routes are available at: http://www.pwrc.usgs.gov/bbs/retrieval/summary/stateform.cfm

- **Reproductive success of Golden Eagles and Gyrfalcons:** As part of the National Park Service's Central Alaska Network Vital Signs Monitoring Program, National Park Service (NPS) biologists monitored the occupancy of nesting territories and reproductive success of Golden Eagles and Gyrfalcons in the northeast region of Denali National Park and Preserve (Denali) in 2007. This marked the 20th consecutive year of this study. NPS biologists collected data using two standardized aerial surveys conducted from a Robinson R-44 helicopter, and additional ground observations and foot surveys. The occupancy survey was conducted in late April, additional foot surveys from May through July, and the productivity survey in mid-July 2007. NPS biologists also visited a sample of occupied Golden Eagle nesting territories in early July to collect shed feathers for ongoing DNA analyses.

  It was a banner year for Golden Eagles in Denali in 2007; 81 of the 89 territories that were monitored were occupied (91% occupancy rate) and rates of nesting (73%), nest success (74%), and fledgling production (n = 72; fledglings per occupied territory = 0.99; mean brood size = 1.65) were higher than the study's long term mean. NPS biologists attributed the high eagle reproductive success to high numbers of snowshoe hare in the study area.

  Gyrfalcon reproductive success in Denali was lower than most years despite apparently high numbers of Willow Ptarmigan in the study area. NPS biologists monitored 15 Gyrfalcon nesting territories in 2007; occupancy (33%) was lower than most years, but success rate (100%) was high. Many park visitors enjoyed opportunities to view Gyrfalcons at Marmot Rock near Polychrome Rest Stop in 2007.

  Proposed activities for 2008 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.

- **Christmas Bird Count:** The National Audubon Society organizes the Christmas Bird Count (CBC) and each year more than 50,000 observers participate each year in this all-day census of early-winter bird populations. The results of their efforts are compiled into the longest running database in ornithology, representing over a century of unbroken data on trends of early-winter bird populations across the Americas. The primary objective of the Christmas Bird Count is to monitor the status and distribution of bird populations across the Western Hemisphere. When data with Christmas Bird Counts and other surveys such as the Breeding Bird Survey are combined, scientists begin to see a clearer picture of how the continent's bird populations have changed in time and space over the past hundred years.

  Local naturalist Nan Eagleson organizes and compiles the results of the Denali CBC which has been conducted every year since 1992. The 2007 Denali CBC was held on December 29, 2007. Sixteen participants recorded 18 species of birds including Ruffed Grouse, Spruce Grouse, Willow Ptarmigan, Northern Goshawk, Great-horned Owl, Northern Hawk Owl, Boreal Owl, Three-toed Woodpecker, Gray Jay, Black-billed Magpie, Common Raven, Black-capped Chickadee, Boreal Chickadee, Dark-eyed Junco, Pine Grosbeak, White-winged Crossbill, Hoary Redpoll, and Common Redpoll on the count

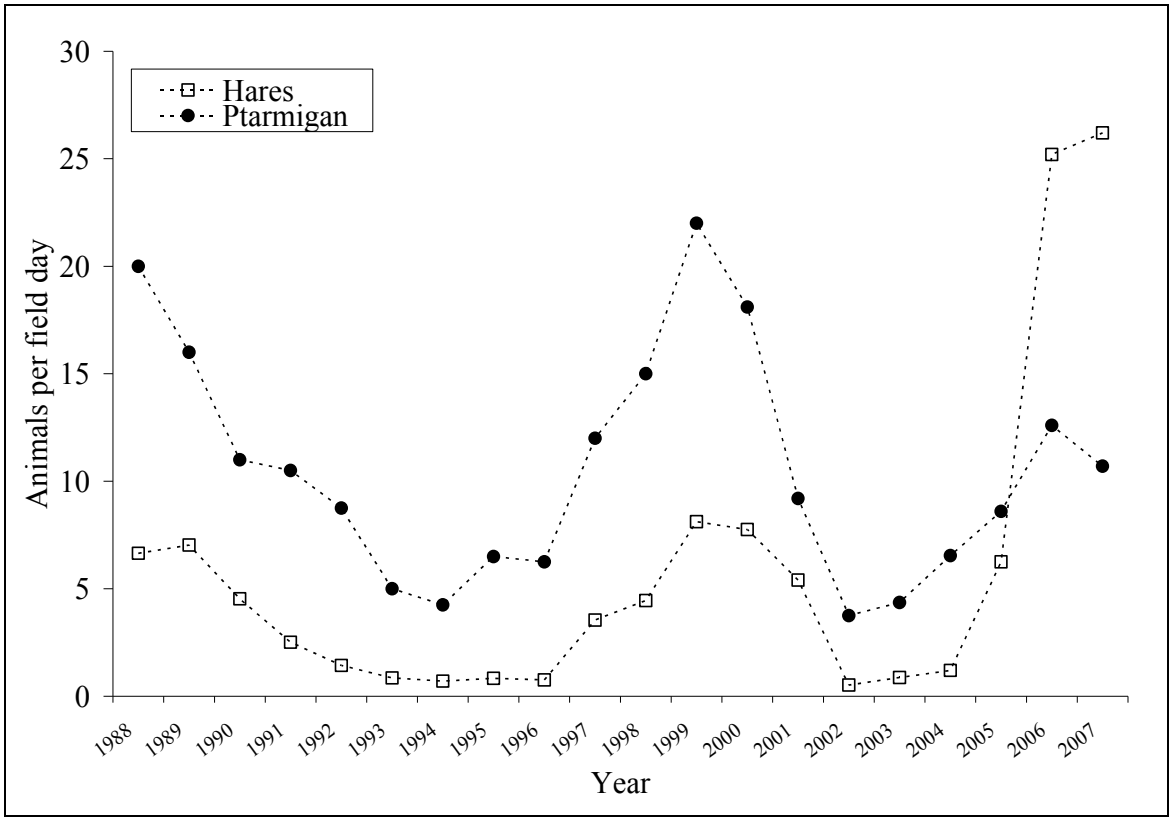
day. Boreal Chickadee, with 87 individuals, was the most common bird species recorded on the 2007 Denali CBC. Although Boreal Owl has been observed during the same week as previous counts, this was the first year that this species was observed on the count day.

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

- **Surveillance sampling for Asian H5N1 avian influenza:** No surveillance sampling for Asian H5N1 avian influenza was conducted in Denali in 2007. As of this writing, the statewide U.S. Fish and Wildlife Service surveillance project in 2008 will focus on waterfowl and shorebirds, and no sampling will be conducted in Denali.

Please tell park visitors not to pick up dead birds; instead, park visitors should report dead birds and their location to NPS staff at the Denali Visitor Center, the Murie Science and Learning Center, or the Denali Center for Resources, Science, and Learning. To learn more about avian influenza in Alaska, visit the web site: http://alaska.fws.gov/media/avian_influenza/index.htm.

- **Developing indices of 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 National Park Service biologists to track broad-scale abundance trends of both species over time. The abundance of snowshoe hare increased slightly in 2007 and abundance of willow ptarmigan decreased slightly in 2007 (see graph below).



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 3).

Table 3. Species of fish expected or documented in Denali

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

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) conducted 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. 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. No breeding activity was observed at bog sites dominated by sphagnum mats. Breeding activity of wood frogs was *not* associated with elevation or distance to boreal forest.

In 2007, Robert Newman, University of North Dakota, conducted a study of the population biology of wood frogs as one of the Discover Denali Research Fellows. Dr. Newman and one assistant surveyed ponds in the area between Eielson Visitor Center and Wonder Lake in early summer, identifying frog breeding sites and collecting samples for genetic analysis. See page 72.

Physical Resources

Parkwide Climate Monitoring

Climate monitoring continues at established locations around the park. These data are especially useful for weather forecasting related to fires and detecting ecological 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 gains 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.

Climate monitoring at Denali is part of the vital signs monitoring of the Central Alaska Network (CAKN), which also includes Wrangell – St. Elias National Park and Preserve and Yukon-Charley Rivers National Preserve (Fig 15). The main objective of the climate portion of the CAKN 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.

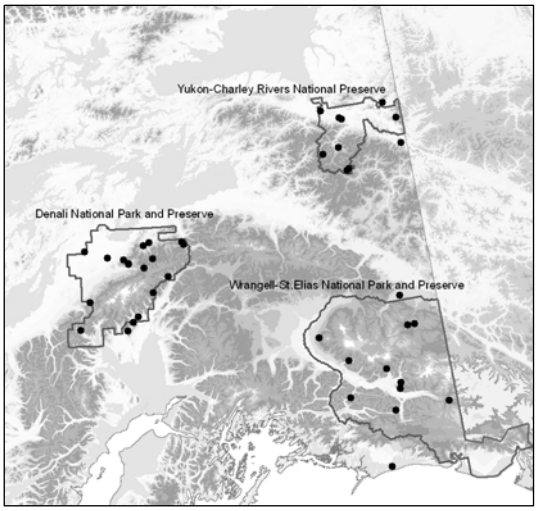
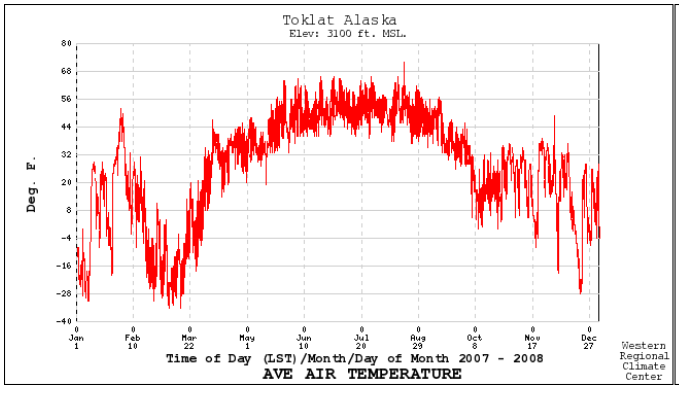
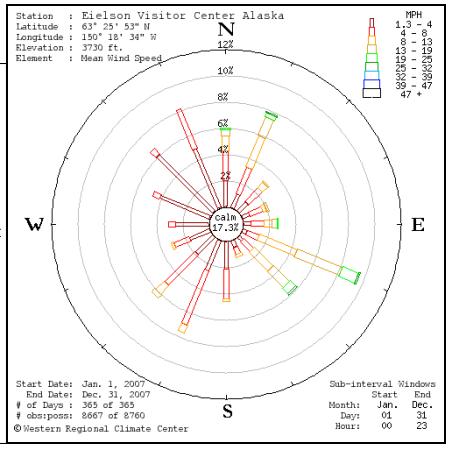


Figure 15. Distribution of climate stations and snow survey locations in the Central Alaska Network.

In 2007, all of the sites were visited for annual maintenance. The sensors on the station were swapped and calibrated and the data were downloaded. The comprehensive annual climate monitoring report will be available on the web in the spring of 2008 at http://www1.nature.nps.gov/im/units/cakn/monitoring.cfm.

Most of the stations are automated and send hourly data via satellite. Data summaries and data analysis tools are available at http://www.wrcc.dri.edu/NPS. See examples of the data summaries available below:





Weather Monitoring at Park Headquarters

For more than 80 years, weather information has been collected at Park Headquarters. 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 are **summaries of the 2007 climate data** for temperature and precipitation collected at Park Headquarters and compared with averages from the long-term database. Weather summaries are done by the calendar year, so for reporting purposes, summaries of the preceding year will be presented.

Weather Notes for 2007:

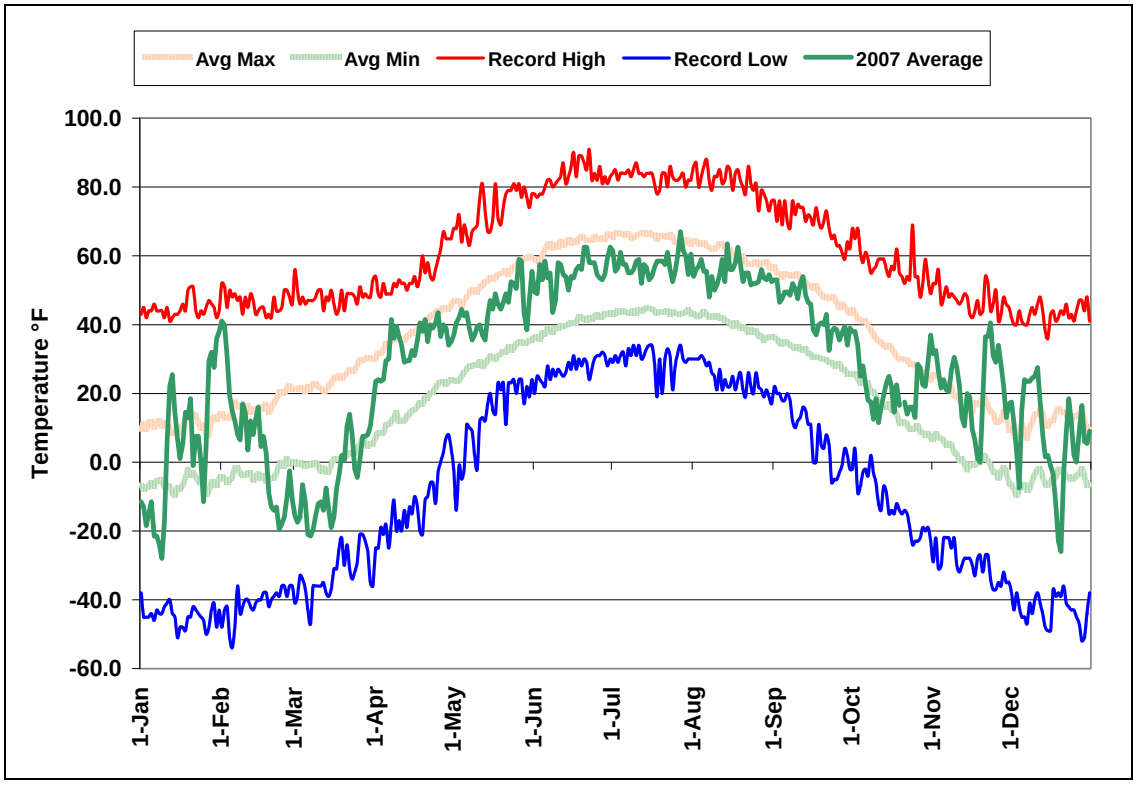
- Record high temperatures at the beginning of February (52°F!), and cold by month's end
- The coldest March in 81 years (average daily temperature was below 0° F until March 19)
- April was 7 degrees warmer than normal
- Precipitation total was near normal, but break-up was one of the driest in recent history
- Snowpack disappeared rapidly so the last round of snow surveys on May 1 had little snow (even on the south side where normally snowpack lasts until June)
- May, June and July were warm (May wetter than normal and June and July drier)
- Frequent thunder and lightning events were accompanied by rain, minimizing wildfire starts (relatively smoke-free summer)
- November was mild (temperatures 13 degrees warmer than normal)

Temperature

- maximum temperature 82° F on August 18
- minimum temperature -33°F on February 23
- mean annual air temperature 28.8°F which is warmer than the historical average of 27.2°F

Denali Headquarters **Average Monthly Temperatures** (°F)

	2007	81-Year Historic Average
January	3.9	*2.3*
February	5.2	*6.7*
March	-5.5	*12.8*
April	34.4	*27.2*
May	44.7	*41.6*
June	55.1	*52.1*
July	57.6	*54.9*
August	54.8	*50.7*
September	43.9	*41.0*
October	22.1	*24.2*
November	22.4	*9.3*
December	7.5	*3.4*
Yearly Average	**28.8**	***27.2***



Precipitation

Denali Headquarters Monthly **Precipitation** (in)		
	2007	Historic Average
January	0.48	*0.73*
February	0.63	*0.58*
March	0.24	*0.43*
April	0.31	*0.43*
May	1.12	*0.80*
June	1.49	*2.20*
July	1.57	*2.99*
August	4.17	*2.69*
September	2.05	*1.59*
October	0.35	*0.97*
November	0.34	*0.76*
December	0.27	*0.82*
Yearly Total	**13.02**	***15.03***

Precipitation Notes for 2007

Total Precipitation	13.02 inches
Departure from Normal	-2.01 inches
Max. 24 hr precipitation	1.13 inches on August 7
Total Snowfall	38.2 inches from July 1 – June 30
Departure from normal	-41.5 inches
Maximum 24 hr snowfall	3.3 inches on February 10

2007 Records for Denali Park Headquarters

February 1:	52° F maximum temperature (previous record 42° F 1994)
February 2:	51° F maximum temperature (previous record 42° F 1994)
March 2007:	-5.5°F coldest March on record
April 7:	52° F maximum temperature
May 29:	0.57" record rainfall
August 7, 13:	1.3" and 0.94" record rainfall in 24-hour period

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.

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 2007 expedition took place in June. The weather station is transmitting temperature and air pressure but no wind speed because they were unable to save the tripod that had busted off of the rock last year. They think that heavy icing and strong wind pulled the tripod over so far that the cables broke. When they found it, it was leaning with only one leg attached. They did their best to remedy the situation and attach the new sensors to the rocks. The old data logger has been sent to Climatec in Japan to download any data and try to reconstruct what happened.

Information and data are available at: www.denali.gi.alaska.edu

Snow Surveys

In the winter of 2006-2007, park staff conducted snow surveys in Denali during the survey window (last 4 days of each month) during the winter season. Thirteen snow courses and aerial snow markers were surveyed throughout the season. The following narrative describes the 2006 – 2007 season:

In January while Southeast Alaska was getting hit with record snowfall, the Central Yukon and Tanana Valleys were 50 – 69 % of normal. The first measurable snow that stuck around was on October 21, 2006 on the north side of Denali, and October 24 south of the Alaska Range. On the south side the early season measurements were less than 50% of normal for the snow markers in the eastern part of the Susitna Valley. The high elevation sites were closer to normal, which leads one to believe that some of the early season precipitation was falling as rain rather than snow at lower elevations. On the north side very little snow fell in the early season and the snowpack, as of February 1, was between 50 and 60% of normal.
On March 1 the south side sites were 64% of normal with the least amount of snow at the lower elevations. The north side sites continued to be 50-60% of normal. There was little change in the

snowpack during the month March. Temperatures were well below normal and the skies were mostly clear for the entire month. North side sites remained virtually unchanged, but the southside sites picked up some of the moisture from the storms centered over the Gulf of Alaska; on April 1 they were 80% of normal.

The snowpack in Interior Alaska melted quickly in April with persistent warm temperatures. There was no measurable snow at any of the north side sites on May 1, only upper elevation sites in interior Alaska had any snow remaining. Surprisingly, there was very little snow at the south side snow markers for this survey. This is very unusual. At Tokositna Valley this was the first time in 28 years that there was not measurable snow at the marker on May 1. The upper elevation sites still had snow but it was about 50 to 60% of normal for this time of year.

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 2006 through May 2007).

The snowpack was slow to develop for the 2006-2007 season. Very little snow fell in October and November to create any kind of base to protect vegetation. The last 10 days of December brought snow, and by the second week of January there was adequate snow cover on the south side except for the area between the West Fork of Chulitna River and Windy Creek at the north end of Broad Pass. After additional snowfall between January 12 and 17, the use of snowmobiles for traditional activities in all the 1980 additions to Denali National Park and Preserve opened for snowmachine use, including the areas on the north side of the range. Generally the snowpack on the north side deteriorates first, closing the area in mid-April, while south of the range the snowpack remains deep enough until May 1. Depending on the spring conditions the south side may remain open until mid May.

Air Quality Monitoring

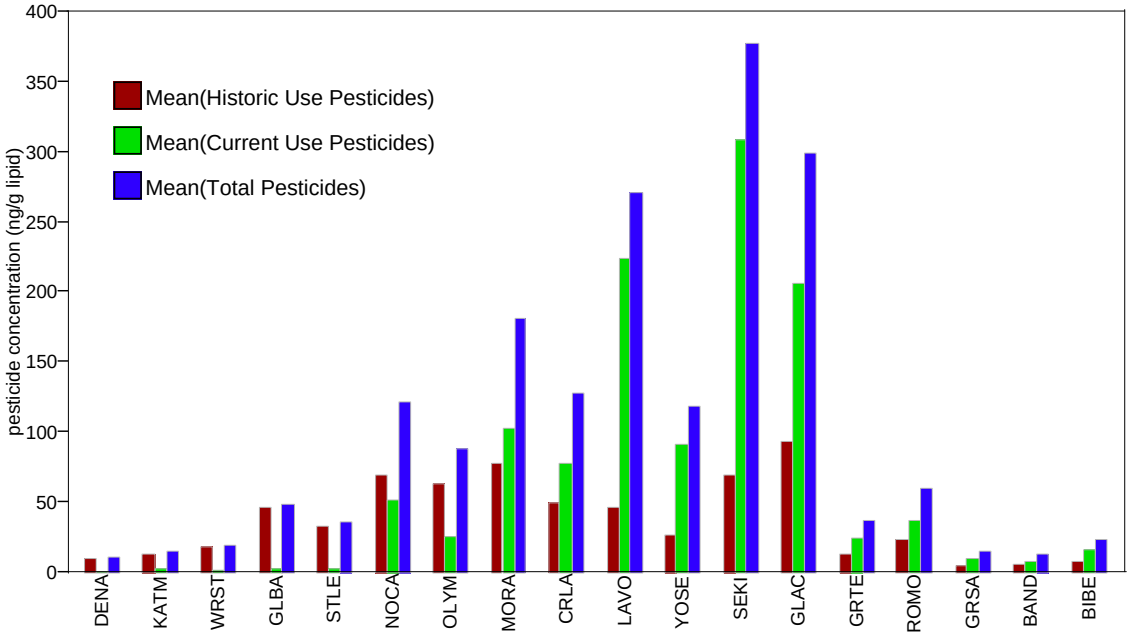
Long-term monitoring of air quality continues at the stations near Park Headquarters and Trapper Creek. 2008 marks the 29th year of uninterrupted air quality monitoring in the park through national monitoring networks. Parameters measured at the headquarters station include atmospheric deposition, ground-level ozone, sulfur and nitrogen oxides, fine particles, and associated meteorological parameters. The Trapper Creek station measures fine particles through the nationwide IMPROVE monitoring network (Interagency Monitoring of Protected Visual Environments).

While Denali has some of the cleanest air measured in the United States, small amounts of industrial and agricultural contaminants from other continents make their way into the park each year in a recurring seasonal pattern. The peak concentrations of international contaminants generally occur in the late winter and spring. 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: www.nature.nps.gov/air/.

Western Airborne Contaminants Assessment Project (WACAP)

The final report for the Western Airborne Contaminants Assessment Project (WACAP) was released in February 2008. Denali was one of eight core parks studied from 2002 through 2007 to determine the extent to which airborne contaminants are accumulating in park ecosystems in the western United States. Out of over 100 contaminants tested in fish, lake sediments, snow, water, and vegetation, 70 were found at detectable levels in the study area, which extends from the Rocky Mountains to the Brooks Range.



Mean Concentrations of Historic-Use and Current-Use Pesticides in Two-Year-Old Conifer Needles from WACAP Parks.

Parks are ordered, left to right, from north to south along the Pacific Coast (DENA – Denali NP&P → SEKI), and from north to south in the Rocky Mountains (GLAC → BIBE). Current-use pesticides were not detected often in Alaska parks, comprised about one-third to one-half the total pesticide concentrations in northern Washington, and most of the pesticide burden elsewhere. Conifer needles were not sampled in NOAT and GAAR. Total pesticide burdens (current use + historic use) were highest in national parks of Washington, Oregon, California, and Montana.

Key findings in Denali include lower concentrations of many contaminants compared to parks in the lower 48 states. Some contaminants which persist in the environment and become more concentrated at higher levels of the food chain were found in high concentrations in Alaska fish. Fish from the two Denali sample lakes, Wonder Lake and McLeod Lake, contained high levels of mercury and dieldrin, a pesticide banned in the U.S. since 1987. Dieldrin concentrations in some Denali fish exceeded the EPA human cancer risk threshold for adults eating 19 or more servings of these fish per month, but according to the Alaska Division of Public Health, this recommendation is conservative. In consideration of the numerous health advantages to eating

fish, the State of Alaska guidelines advise that fish from these lakes are safe to eat in unlimited quantities.

Mercury levels in Denali fish were within EPA human health consumption thresholds, but concentrations in some fish exceeded published health thresholds for fish-eating birds and mammals such as belted kingfishers and mink. Contaminant levels in snow, lake water, sediments and vegetation were, in general, relatively low. The sources of contaminants measured in Denali are thought to be primarily international, transported through the air on intercontinental transport pathways.

The final report and additional information about this collaborative interagency project can be found on the WACAP web site at: www.nature.nps.gov/air/Studies/air_toxics/wacap.cfm.

Visibility Web Camera

The Denali visibility web camera is part of a nationwide network of webcams operated by the NPS Air Resources Division. During summer, the camera takes a picture once every 15 minutes, pointed in the direction of Mt. McKinley, 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 (AQRVs) protected under the Clean Air Act. The Denali visibility webcam can be found through an internet search on "Denali National Park webcam," or you can type www.nature.nps.gov/air/WebCams/parks/denacam/denacam.cfm.

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.

Both horizontal and vertical movement has been monitored since 1993. Approximately 60 stations have been established over the entire period. Some have been lost due to surface fracturing or squeeze-out, and animal damage, and new ones are added almost every year.

Although the 2007 data has not been analyzed, no increase in downslope movement (or other movement that is threatening to the park road) can be detected by the most recent survey, or history of surveys. Although the downslope migration of the slump continues, the rates of movement, and their spatial situation, suggests no immediate threats to the park road for the medium term (5 to possibly10 years). Of course, all bets are off if there is a period of exceptionally high precipitation.

Paleontological Survey of the Lower Cantwell Formation

It has been well known for many years that the Cantwell Formation was formed in the right age and partly under the correct terrestrial conditions for dinosaur fossil preservation. Although some geologic mapping and other geo-investigative work had occurred in the Cantwell Formation prior to 2005, 2005 was the year the first dinosaur fossil material (footprint) was found

in Igloo Canyon—within 200 feet of the park road. This first footprint found was that of a theropod, a carnivorous dinosaur that walked upright and probably weighed some 200 pounds. Although the footprints and skeletal remains of theropods have been found on the North Slope of Alaska, among other dinosaur types, this was the first evidence of dinosaurs in the interior of Alaska.

Since that park find, the NPS and other researchers have stepped up the search and geologic mapping effort in the Igloo Creek and tributaries just north of the park road, and on buttress ridges on the north side of Double Mountain. The park road courses right through Cantwell Formation rocks in Igloo Canyon.

At the close of the 2006 field season, field parties had located dozens of additional dinosaur footprints including hadrosaurs (duck billed dinosaurs) and 4 sizes of theropods, bird tracks, numerous plant fossils or imprints, and other paleo-biotic features. Some of the rock strata have numerous tracks on the same horizon or surface, and researchers have come to call these sites "Cretaceous dance floors." These finds have provided insight into the paleoecology (plants, plant-eaters, animal eaters) of the Late Cretaceous (65 to 145 million years ago).

In the 2007 field season, three major research efforts took place on the Lower Cantwell. The primary project work, led by Dr. Tony Fiorillo (Dallas Museum of Natural History), involved roughly two weeks of field time and assistance from two other researchers, Dr. Steve Hasiotis (University of Okalahoma), and Dr. Yoshi Kobayashi (Hokkaido University Museum, Japan).

Double Mountain (North and Northeast buttress ridges was the focus). - Trace fossil finds in this location prior to 2007 included small theropod footprints, avian tracks, and other unknown smaller creature track impressions. In the 2007 investigation, Dr. Hasiotis identified the possibility of several insect tracks or trackways, as well as potential fin traces of perhaps several types of fish. These features and sites were photo documented, some features were latex molded, and some trace fossil (rock) samples were taken for further analysis.

Cabin Peak – Several days of field effort at Cabin Peak revealed similar floodplain-fluvial system materials here as in the Tattler Creek vicinity. Trace fossil material identified here included both theropod and hadrosaur footprints.

Tattler Creek – Similar to previous years, the Fiorillo team investigated known, as well as new found, trace fossil sites. Additional theropod and hadrosaur footprints were cataloged and molded.

Two independent but closely related research efforts on the Cantwell (McCarthy and Tomsich; Sunderlin) were carefully coordinated to maximize field data collection with a minimum of overlap of effort and duplication of area coverage. These projects involving the understanding of the paleoecology of the Cantwell (McCarthy and Tomsich), and a paleofloristic evaluation of the Cantwell (Sunderlin), will complement the NPS-Dallas Museum coordinated effort (Brease and Fiorillo).

Field Class for Geologic Mapping

The University of Alaska Fairbanks under the direction of Rainer Newberry conducted its Field Geology class in Denali Park from June 23 to July 2, 2007. Class objectives are: (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 based out of several campsites at the Teklanika Campground. 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 maps a different but overlapping 10 square km area. The objective by 2011 is to complete a detailed geologic map in the vicinity of the Park Road between Teklanika Campground and the Toklat River, by conducting the field class at Denali in alternate (odd) years. The field class was also held in 2003 and 2005. One field team discovered the dinosaur footprint near Igloo Creek in 2005. No field visit is scheduled for 2008.

Mining Issues—Comstock Claims

Based on a court decision made in the fall of 2005, the owner of several hard-rock unpatented* claims, known as the Comstock claims (on Upper Eldorado Creek in Kantishna), was allowed to re-open an adit (horizontal shaft) for mineral sampling purposes (to assess the potential of the mine to produce minerals) to evaluate the value of the property. In the summer of 2006, the adit was opened, and both the NPS and the claimant accomplished the required sampling. With this information in hand, the court may now decide to allow additional sampling (by subsurface drilling) or decide that the information is adequate to render a decision on validity of the claim.

In the 2007 field season, the Comstock claimant and the NPS have agreed on a buy-out, acquisition was made, and the Comstock claims are now null and void, and back into federal owmership. Additionally, 10 unpatented placer claims (US vs. 191.7 Acres) returned to full NPS ownership in September of 2007, when an appeal deadline was not met by the claimant.
*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

Crooked Creek - Since mining efforts ended in 1985, Denali has had continuing efforts to clean up abandoned mining sites in Kantishna. A number of abandoned barrels along Crooked Creek were identified for characterization and removal by a hazmat contractor in 2007. Crooked Creek, a tributary of the Toklat River, is approximately 23 miles northeast of Kantishna. In early August, resource management staff and contractors from North Wind, Inc. assessed the site and remaining mining waste, finding a total of thirty-seven 55-gallon fuel drums and a variety of 30-gallon drums and smaller fuel containers - some engulfed in beaver ponds and the surrounding wetlands. The barrels were hauled to Kantishna by helicopter in six sling loads. Overland transport then continued to salvage yards and landfills.

Centennial Challenge Restoration Plans

A nation-wide National Park Service funding initiative, the Centennial Challenge, aims to strengthen and expand national park operations, staffing, services, and facilities in preparation for the 100th anniversary of the National Park Service in 2016.
Condition monitoring and restoration planning was accomplished on eight different mining properties this 2007 field season. Initial or new restoration plans will be developed for seven of those properties (Slate Creek, Upper Caribou, Moose Creek, Spruce Creek, Red Top, and

Glen Creek) in response to Centennial Challenge funding. The project proposals involve all facets of mining claim clean-up and restoration including equipment and debris removal, hazardous material mitigation, upland floodplain reconstruction and revegetation, and stream and riparian restoration. With its Centennial Challenge funding, Denali staff will be working to restore the disturbed mined lands between 2008 and 2010. In 2008, reclamation work will begin on Glenn Creek. Reclamation design work will begin in 2008 on Caribou and Slate Creek, with actual reclamation taking place in 2009 and 2010.

Water Quality in Kantishna Streams

In coordination with the reclamation efforts, the USGS will be performing a comprehensive water quality analysis of previously mined streams in Kantishna to baseline water quality conditions. The mined sites listed above, plus Rock Creek (an unmined stream near Glenn Creek) will be tested for standard water quality parameters, algae, and macroinvertebrates. The study will evaluate whether streams show a degraded condition, and will provide a foundation from which any successes of the overall mine reclamation program can be monitored.

Geoscience Education and Outreach

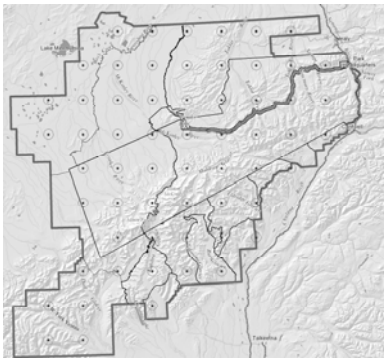
Phil Brease provided over 30 different geoscience outreach classes or presentations in 2007. Three geoscience courses were offered in the MSLC teacher training of field seminar series, as well as over 20 presentations to visitors, staff, educational groups, and professional societies, 5 programs were offered at local and out-of-state schools, 8 pamphlets or guidebooks were prepared for professional or public consumption, and 3 professional papers (1 oral delivery) for conferences or society meetings.

Soundscape Inventory and Monitoring Program

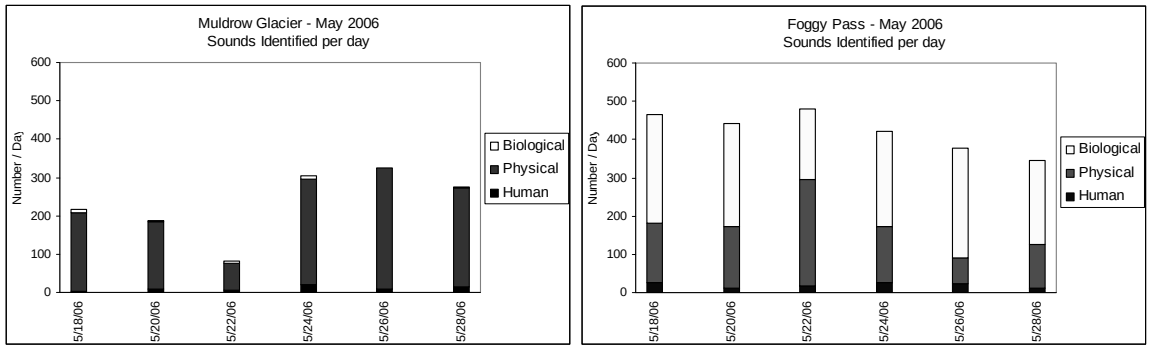
A soundscape research program has been underway at Denali National Park and Preserve since 2001. Natural and human-generated sounds have been inventoried at numerous locations around the park including along the Park Road, south of Broad Pass near Cantwell, at the Stampede Airstrip, in the Ruth Amphitheater, at Base Camp on the Kahiltna Glacier, on the Pika Glacier, and at the toe of the Tokositna Glacier. From the 7000+ hours of digital recordings and sound levels that have been documented in the park's three acoustical zones (alpine, sub-alpine, and scrub/forest), park staff can calculate for each audible sound the percent time and the number of times per day that it is audible. The sound level data is used to compare the levels of human-made sounds to the natural ambient levels.

The second sampling season of a newly revised systematic (random) sampling plan was implemented in 2007. Five automated sound monitoring stations (see photo) were deployed and rotated to occupy 10 locations in Denali National Park and Preserve. These included 2 winter season sites, 6 Long-term Ecological Monitoring (LTEM) grid points, and 2 locations of interest in support of the Backcountry Management Plan. Over a ten-year period, stations will be placed at six new locations each year—these stations will be randomly selected from a coarse grid of 60 points spread evenly throughout the park (see map next page).

From the sound data processed thus far from 23 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 24-hours a day. At locations with brush or trees, birds can also be heard throughout the day (and "night") 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 more than 100 overflights per day. At locations away from common flightseeing routes, the number of overflights heard per day rarely exceeds ten. At every site sampled, there are usually around five commercial jets heard per day.



The data collected with the sound stations can be used to characterize the soundscape. For example, Figure 15 shows the relative abundances of human-made sounds, physical sounds, and biological sounds for two locations, Muldrow Glacier (Figure 15A) and Foggy Pass (Figure 15B), during the month of May, 2006. From these two figures we can see that physical sounds dominated the soundscape on the Muldrow Glacier, in contrast to Foggy Pass, where biological sounds were more abundant. Wind and rock avalanches made up most of the physical sounds on Muldrow, and bird calls were nearly continuous at Foggy Pass.



A. B.

Figure 16. In May, physical sounds dominated the Muldrow Glacier site (A), while biological were more abundant at the Foggy Pass (B). Bar height indicates the number of 5-second recording intervals in which sounds of each category were heard during one week in May. Sounds were identified as human (black portion of bar), physical (dark gray bar), and biological (light bar).

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

Permafrost Monitoring

The Central Alaska Inventory and Monitoring Network staff is 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 developing thermokarst near the park.

In 2006, a third aspect of permafrost monitoring was initiated through a partnership with 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 centers 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, and (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. The study will guide monitoring of Carbon cycle processes that can be affected by permafrost thawing and thermokarst. The development of a monitoring protocol began in 2007, in coordination with Dr. Schuur, and is expected to be completed in 2008. Permafrost conditions and trends are gaining increasing attention, highlighted in part by an international permafrost conference being held in Fairbanks in 2008 with a special field trip focused on Denali's condition.

Wonder Lake Water Quality and Limnology Study

In 2006, the U.S.Geological Survey (USGS) began 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. (See also page 57).

Historic Photos of Glaciers

In 2008, there may be the opportunity to re-visit additional 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.

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).

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.

Monitoring on the Southeast Fork of the Kahiltna Glacier began in 2004 and will continue in 2008 and beyond. 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 and is moving approximately 0.60 meters/day. The thickest measured ice in the park is in the Ruth Gorge. Near the center of the glacier the thickness based on seismic measurements is 3805 feet (1150 meters). From the summit of Mt. Dickey (9545 feet) to the bottom of the ice-filled valley is almost 9000 feet. The ice moves 3.1 feet per day (0.95 meters per day) in the center of the glacier, with much less movement near the glacier margins.

Shallow Lakes Monitoring

In 2006, the Central Alaska Inventory and Monitoring Network (CAKN) began a shallow lake monitoring program in Denali. In the three CAKN parks, 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.

In 2006, researchers implemented the shallow lake monitoring protocol at 30 lakes in Denali. In 2007, 28 of those lakes were re-visited. Limnologists collected data on all the variables as outlined

in the protocol except for vegetation. Researchers observed that 27 lakes showed a significant drawdown from 2006 (on average 16 cm lower than last year). This difference was explained by low winter snow pack and early melt. The data were visually corroborated with observations of newly exposed mud flats on many of the lakes in the Minchumina Basin. The one lake that had a rise in water level was the third lake in a string of lakes. This lake experienced a 28-cm increase in water level and is within the 2005 Highpower burn. The increased water level may be explained by increased run-off from the upland areas where hydrophobic soils frequently occur following fire. Researchers were pleased to find that lake level monitoring techniques could be verified visually and that virtually all lakes showed similar trends. This provided confidence that the techniques are viable for monitoring water level in shallow lakes.

In 2008, researchers will inventory 90 lakes in Denali, to add to the body of knowledge and to classify shallow lakes into categories based on physical and biological properties. (See also page 63-64.)

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 occurred in 2003. 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 ground movement in all three directions.

In September 2006, a new seismometer was installed at Castle Rocks (after an Environmental Assessment identified some mitigation measures) 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 seismic gap that occurs between the eastern and western portion of the Alaska Range (all of Denali).

(See also page 60-61.)

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 Park Road traffic, bus passengers, railroad passengers, climbers, and backcountry users, for both recreational and non-recreational purposes as well as visits to the Talkeetna Ranger Station and those who visit via aircraft landings. According to this report, there were 458,306 recreational visitors to the park in 2007, compared to 415,935 in 2006 and 403,520 in 2005. 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 2008.

- **Road traffic monitoring:** Because the road corridor is a human 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 2007 (to assist with the Monthly Public Use Report) is the one in the entrance area across from the road to the post office. In 2007, approximately 1,519 vehicles entered the park on July 4 compared to 21 on December 25. Vehicle trips are also counted at the Savage Check Station during summer months.

◅ Subsistence ▻

Construction of Two Replacement Subsistence Use Trapline Cabins

In June 2008 the acting National Park Service (NPS) Alaska Regional Director Vic Knox signed a Finding of No Significant Impact (FONSI) for the selected action that was evaluated in the "Construction of Two Replacement Subsistence Use Trapline Cabins on the Herron River and at Live Trap Lake". The NPS prepared an environmental assessment (EA) to evaluate a proposal to replace two subsistence use cabins on the site in the northwest Preserve area of Denali.

The selected action (Alternative 2) allows the replacement of the Herron River and Live Trap Lake Cabins, with the mitigation measures listed in the EA. Under this alternative, the NPS will permit Dan Hytry, the applicant, to construct a replacement cabin on the traditionally used tent site location near the collapsed cabin at Live Trap Lake, and he would be permitted to construct a small cabin in the near vicinity of the collapsed cabin on the Herron River.

Selection of the reconstruction alternative will satisfy the purpose and need of the project because construction of replacement cabins is needed to reasonably accommodate the applicant's subsistence activities and reduce reliance on tent camps along the applicant's traplines. On remote and long distance traplines the over-reliance on tents as primary shelter is potentially dangerous, especially if the trapper is operating alone or with younger family members learning the way. The project is in keeping with providing an opportunity for the subsistence way of life to continue by making safer the customary and traditional subsistence activities in the area.

Moose Harvest in GMU 16B

The Federal Subsistence Board (Board) approved Proposal WP08-23, submitted by the Denali National Park and Preserve, which requested that the Federal Subsistence Board (Board) reestablish a Federal registration permit for the Preserve portion of Unit 16B remainder during the September 1-30 and December 1-February 28 moose seasons. Federal registration permits will be limited to one permit per household.

Adoption of the regulatory change will re-establish a Federal registration permit for moose in the affected area. The change will affect the State Tier II hunting opportunities only if the harvest of moose on Preserve lands are determined to unsustainable, leading to an unhealthy moose population. In that case, the Board could restrict moose harvests in the Preserve to local qualified subsistence users only. The Federal registration permit hunt should protect subsistence opportunities for local residents. Adoption of the proposal will allow resource managers to track moose harvest in the Preserve portion of Unit 16B remainder.

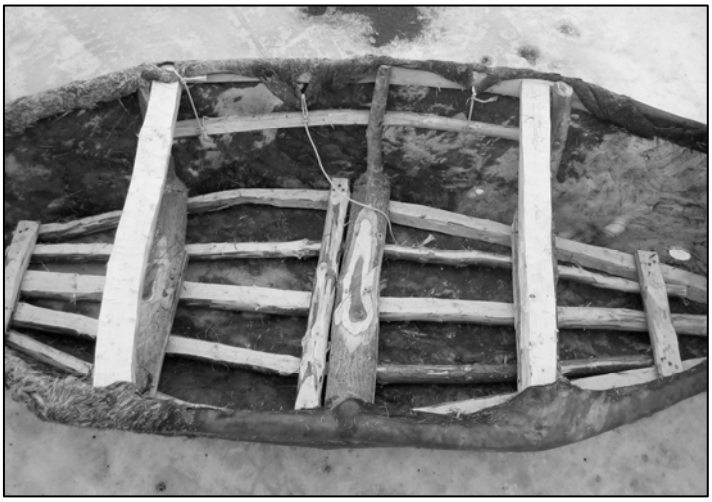
The re-establishment of the Federal registration permit for the affected area will allow resource managers to track moose harvests in the affected area. The need to place restrictions on hunting opportunities within the subunit in recent years, has created concerns that excessive hunting pressure may be concentrated on Preserve lands in the upper Yentna River drainage. Local residents who do not obtain a State Tier II permit have no option than to access the Preserve in order to fulfill their subsistence needs for moose. The implementation of a Federal permit system will ensure there is not an over harvest of moose in the Preserve portion of Unit 16B.

Traditional Moosehide Boat Project

In March 2008, elders Nick and Verdrisia Dennis and their nephew Dan Esai traveled from Nikolai to Cantwell to instruct and help BJ Gore construct a traditional moosehide boat. Gore, an Alaska Native high school student senior at Cantwell School, learned traditional moosehide boat building skills while the Dennises supervised the project. After the moosehide boat was completed it was unveiled during a community potluck.

Jay Elhard from Denali documented the boat building process on video and created a video podcast which is now posted on Denali's website.

In support of the project, the National Park Service coordinated with the Cantwell Village Council, the Denali School District, the Murie Science and Learning Center, and Alaska Geographic.



Cultural Resources

New Hire in Cultural Resources

Jeremy Karchut will begin his Cultural Resources position at Denali in September, 2008. Jeremy is a Colorado native who has primarily worked as an archaeologist for the NPS and USFS. His archaeological background focuses on Environmental Archaeology and includes research projects in Colorado, New Mexico, Arizona, Utah, Texas, Oklahoma, Alaska, Wyoming, and Polynesia. He holds a BA in Anthropology from Fort Lewis College and a MA degree in Archaeology from the University of Leicester. Jeremy has most recently worked as the Forest Archaeologist/ Heritage Program Manager on the Shoshone National Forest in Cody, Wyoming.

Kantishna Cultural Landscape Inventory

A survey of various locations in the Kantishna area on foot and with helicopter support is planned for 2008. One purpose of this survey is to verify that no historic material will be affected by planned stream reclamation projects in specified areas. As part of the section 106 compliance effort, Upper Caribou Creek, Upper Slate Creek, and the lower sections of the west and east forks of Glenn Creek would be surveyed for historic material prior to proposed reclamation work in the stream beds and floodplain areas.

The second objective of the inventory is to revisit various historic sites surveyed by the 1986-89 mining compliance effort, update condition assessments, verify the accuracy of the 1986-89 surveys, obtain accurate GPS coordinates, and document any landscape characteristics or other features not included in the initial surveys.

Denali's Historic Resources and National Register

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. Work continued in 2008 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.

Steve Carwile and Mary Tidlow met with the SHPO architect and archeologist to review several projects. The first project was the Busia Cabin. SHPO found no adverse effects with the proposed work, as outlined in the HSR. Stephanie Ludwig was present at the meeting and fully supported the archeological site visit and clearance. To date the HSR needs to be finalized for official confirmation.

A Determination of Eligibility was underway for 4 houses in the Headquarters housing area that were designed by well known NPS Mission 66 architect Cecil Doty. Steve Carwile and Mary Tidlow also met with SHPO to discuss the Doty Houses with regard to the need to restore one or two interiors to the historic floor plan. SHPO agreed that only one house needs to be restored

and also agreed that House # B26 was the most logical as that would most likely be on a future historic walking tour. Because the fire places are not reinforced and a seismic event could cause much more damage, it was determined that all the fire places and chimneys could be removed but that the wall, chimney and a propane fire place insert would need to be added back to House #B26 to recreate the floor plan.

Historical Research and Oral History

Cultural resource staff continues to participate in planning for interpretive exhibits and programs. Staff continues to produce educational programs interpreting park history for staff and visitors, acquire and accession historic photos, and conduct oral history interviews with park "elders", i.e., park staff, former employees, local residents, and others to document conditions and experiences in the park. To celebrate the opening of the new Eielson Visitor Center and the return of tourism to the area, a new photographic program detailing the cultural resources and varied history of the Eielson Visitor Center area is being presented in 2008.

Current and recent work included the following projects:

- Alaska Regional Support Office Historian Frank Norris worked on the research for and writing of *Crown Jewel of the North: An Administrative History of Denali National Park and Preserve, Volume 2* (1981 to present and selected thematic chapters) during 2008. Jane Bryant worked to collect, select, prepare and caption photographs for the illustration of Volume 2. This second volume of the administrative history will be published in late summer 2008.

- Cultural staff provided information and assistance for park projects including planning for a new Savage River Reststop, Kantishna Reclamation projects and restoration of the historic Busia Cabin in Kantishna.

- Cultural staff has begun research for a guide to park history through sites visible from the park road. Historic photographs and interpretive text will illustrate the themes of park history, including transportation, tourism, park administration, mining and significant placenames.

Native Place Name Mapping Project

The Native Place Names project for Denali was begun in the 1990s. Working with Athabaskan elders in the Denali area, Dr. James Kari identified and collected over one thousand Native Place Names associated with Denali. This current project will conclude with the layout, production, and publication of a Native Place Names Map for Denali.

All the data collected by Dr. Kari is currently in a written format in a one volume study. Developing a map with the place names identified will be an excellent education tool for both park staff and visitors to Denali. This mapping project will provide park managers and staff with information to better understand Native use of the park resources.

Comprehensive Archeological Survey and Inventory

Brian Wygal, hired in a 4-year term position as park archeologist starting in 2006, continues the park archaeological survey. The overall project goals are to identify and inventory previously

unknown cultural resources and to retrieve information that could date these sites. Additionally, Brian Wygal will revisit previously recorded sites and conduct condition assessments that will aid in the management and preservation of these resources. The data collected during the course of this project will contribute to the development of a comprehensive cultural chronology of the Park.

- More than 4000 acres of pedestrian survey was completed during the 2007 field season with 16 new sites discovered and 17 previously documented sites revisited. The 2008 survey will cover remote regions of the Front Range including along Hauke Creek, a small tributary of Birch Creek, and also in along Somber Creek, a tributary of the Highpower River.

- During the winter (2007-2008), analysis of the data collected during the summer was undertaken by Brian and students at the University of Nevada, Reno (UNR) Prehistory Archaeology Laboratory. UNR has thus far provided significant direct and in-kind funding for the Denali Survey project in return for "real-world" experience gained by its students. Thus far, UNR has funded 10 weeks of full-time research positions for two undergraduates during the summer of 2007 field work and provided part-time funding for an undergraduate laboratory technician during the 2007 and 2008 academic year. For the summer of 2008, UNR has funded one full time field technician position for the Denali Survey.

- Some significant findings to date pertain to the prehistory of Denali. Newly discovered sites in the Bull River and Costell Creek regions southwest of Cantwell have yielded information suggesting prehistoric hunter-gatherers were living south of Alaska Range earlier than previously thought. Radiocarbon dating of charcoal recovered from one such location may date the occupation to as early as 12,000 years before present. In February 2008, these results were presented at the annual conference of the Alaska Anthropological Association in Fairbanks and, in March, before an international group of scholars at the Society of American Archaeology annual meetings in Vancouver, B.C.

Museum Collections

During FY2007, Museum Curator Jane Lakeman completed many organizational changes. Compressed shelving was installed in the secure Collections Room and all cataloged and yet-to-be-cataloged objects, specimens, and archives were securely stored.

The primary tasks of the Museum Curator are caring for the park's museum collection, updating the collections database, and providing customer service to park staff and the public. To this end the following projects were completed in 2007:

- The Museum Collection Housekeeping Plan was updated and put into practice.

- Backlog Cataloging: 5550 objects/specimens were added to the museum database including herbarium specimens, Natural History Observation Records, and photographic prints and negatives.

- New Cataloging: 603 photographic prints and negatives were added to the database.

- Visitors and Tours: Tours were provided to 97 visitors.

- Research Requests: The museum curator responded to 117 requests (for information about, or use of, Museum Collections)—65 requests from within the park and 52 requests from outside the park.

Figure 17. Visitors to the Denali Museum Collections can view some of the many cultural (as shown here) and natural history objects.

Fiscal year 2008 will bring about even more changes to the park's Museum Collections. Flexible park base funding for a Museum Standards project was approved through the Centennial Challenge Initiative. The project funding allows for the purchase of new museum storage cabinets, increasing storage space for cultural and natural history objects by 40%. New open shelving will increase archival storage by 300%. Other components of the project to be completed during fiscal year 2008 include:

- A seasonal museum technician will be hired to catalog museum collections.

- Museum plans to be written are: Scope of Collections Statement, Integrated Pest Management Plan, and Collections Storage Plan.

- Archival quality supplies for the preservation of museum collections will be purchased.

Additionally, with the help of two winter volunteers, the park curator was able to catalog approximately 3,000 historic photographs and cross-reference them to a file system used in the past, to inventory all herbarium specimens stored in Collections, and to inventory all objects stored in museum storage cabinets.

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 analysis of park resources, preparing maps for planning purposes, and public displays. 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, laptops and other mobile devices. Efforts are on-going to make the technology and/or products more useful and available. A simplified interface called ArcReader requires no GIS background makes much of the information available to casual users. Applications such as Google Earth have brought GIS technology to anyone with an internet connection.

One notable addition to the park's GIS dataset involves an 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 hoped that eventually the entire park will be collected as clear images become available 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. Major infrastructure layers are updated to reflect changes as a result of work accomplished in the summer season.

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

Research and Resource Communications

Several more color fact sheets about Denali resources and research became available in 2007. These fact sheets are available and more will be developed in 2008 and future years.

- Central Alaska Network: Inventory & Monitoring Program
- Climate Change
- Climate-related Vegetation Changes
- Dinosaur Track Found in Denali
- Ecology of Upwelling Areas in the Toklat River
- An Integrated Study of Park Road Capacity – Spring/Summer 2006, Summer 2007 (two sheets)
- Large Lakes and Landscape Limnology
- Large Mammals…How many are there? [2008 Update]
- Moose Surveys
- Painted Fossil Bison Skull: When, how, and why was it painted?
- Permafrost Landscapes
- Population Biology of the Wood Frog
- Reconstructing Ecosystems of the Lower Cantwell: Plants in the Age of Dinosaurs
- Resource Stewardship Strategy
- Rivers and Streams (4-pages)
- Soil Survey and Ecological Classification
- Soundscapes
- Wildland Fire Risk and Response: Why are you cutting those trees?

Research Administration

As of April 1, 2008, 767 study numbers have been assigned to scientific and scholarly studies (some continuing 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.

Brief Synopsis of Research Findings in 2007

The following researchers (non-park staff) held research permits in 2007. 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-Alaska Science Center	Population dynamics of wolves and their prey in a subarctic ecosystem (caribou only)
Information about this caribou project is reported on page 22-24.		
Akasofu	International Arctic Research Center, UAF	Weather conditions on Mt. McKinley
When we arrived at the weather station in June 2007, we found that the weather station had been completely blown over, which explained why the 2006 transmission stopped in January. Icing and strong persistent winds are thought to be the cause of the collapse of the weather station. Some of the cables were broken, including the antenna for the transmission. Without a way to securely mount the anemometers and antenna, only thermisters and a data logger were left at the weather station site. Bad weather also prevented further attempts to fix the weather station. The 2007 weather station's last transmission came in on December 4, 2007. The problem is most likely a broken cable to the antenna. We hope that there are some usable data stored in the data logger. [See also information reported on page 35.]		
Arp	USGS-Alaska Science Center	Using beaver colonies as a model for ecosystem land use and recovery in Denali
During August we conducted a detailed topographic survey of one beaver complex with both abandoned and active lodges, which serves a baseline for future monitoring and to calibrate aerial observations. Aerial surveys were conducted in portions of southern, west-central, and northwest Denali NP (covering approximately 6 percent of the park area) in which we located 239 beaver works. The majority of these sites was concentrated in the Kantishna Hills, east of Lake Minchumina, and on the southern toe-slope of the Alaska Range, with large portions of the landscape with visually suitable habitat, but lacking any noticeable beaver works. We estimated that 47 percent of these works were active (53 percent abandoned); however ground work will be needed to confirm these numbers. The hydrologic habitats associated with these works were rivers and streams (49%), lakes and ponds (18%), floodplains (18%), and hillslope springs (15%). Likely the most interesting and tangible finding of this work was the very patchwork nature of beaver activity on the landscape in Denali warranting future work into the particular qualities of these places and what historic activities may have reduced beaver activity in certain areas.		

Researcher	Affiliation	Project
Arp	USGS-Alaska Science Center	Limnology and water quality of Wonder Lake and other selected lakes, Denali National Park and Preserve, Alaska
In 2007 water quality samples were collected in March, June, and September at Wonder Lake and Lake Minchumina and Chilchukabena Lake. At each lake recording water temperature probes were placed at various depths to determine lake mixing characteristics. Results will be analyzed in 2008.		
Brown	Tri-Valley School	A study of aquatic invertebrates in creeks and rivers in Denali National Park and Preserve [tributaries to the Nenana River].
I did an inventory of Riley Creek just before first main snowfall. I looked at the abundance and diversity of the creek and compared with other tributaries of the Nenana River found outside the park. At Riley Creek in a total of 3 samples (30 square feet) I found: 8 Caddisflies (9.52 % of invertebrates sampled), 7 Craneflies (8.33 % of total sample), 21 Mayflies (25% of total sample), 7 Midges (8.33% of total sample), 39 Stoneflies (46.4% of total sample), and 2 Predaceous Diving Beetles (2.45% of total sample). Total aquatic invertebrate abundance (total number) was 2.4 invertebrates per square foot; the diversity of aquatic invertebrates found (total kinds) was 6.		
Densmore	USGS-Alaska Science Center	Long-term monitoring of restoration of placer-mined watersheds in Denali
The Glen Creek stream restoration project experienced a major flood (50 yr) in 2000, eight years after construction. The reconstructed floodplains largely survived the flood, but the riparian vegetation was battered, and much of the stream channel was wider and shallower. By 2006, the riparian vegetation had recovered, and the stream channel morphology showed little change from post-flood conditions. A manuscript is in preparation. Monitoring initiated on the Caribou Creek restoration project included resurveying stream cross-sections and thalweg. A report with monitoring recommendations is being prepared.		
Densmore	USGS-Alaska Science Center	Factors controlling establishment and growth of *Taraxacum officinale* in Alaskan national parks
In the study comparing establishment and growth of non-native plant species among revegetation treatments, invasion of dandelions began in 2006, four years after disturbance. The number of dandelions increased slightly in 2007, but density was still low, and was not affected by seeded native legumes or fertilization.		
Dortch	University of Cincinnati	Terrestrial cosmodating of the Wonder Lake moraines, McKinley River Basin: in pursuit of understanding the nature of glaciation and climate change in Denali National Park
Using analyzing how long the surface of a boulder has been exposed after glacial retreat (a technique called Surface Exposure Dating (SED), I could compare the boulders in the Wonder Lake moraines and ones in moraines in the Nenana River Valley to reconcile their ages. Field		

Researcher	Affiliation	Project
Dortch (cont'd)		

mapping using IKONOS satellite imagery confirmed the extent of three ancient glacial stages. These are the MP stages 1-3. The oldest and most extensive glacial stage (MP-1) encloses Wonder Lake on its northern end, the MP-2 glacial stage crosses the southern end of Wonder Lake, and the MP-3 glacial stage is found just south of Wonder Lake (Fig. 2). The MP-1 and 3 glacial stage moraine deposits can be traced east to the contemporary terminus of the Muldrow Glacier. In addition to this, three dead ice zones composed of ice-cored, boulder-y till deposits have been delineated at the terminus of the contemporary Muldrow Glacier.

Nine SED samples from were collected from boulders on the MP-1, two from the MP-2, and 4 from MP-3 glacial stage moraines. In addition, seven samples were collected from dead ice zone 1 (DIZ-1), four samples from DIZ-2, and four samples from active ice on the Muldrow Glacier. These additional samples were collected to test the accuracy of SED dating and to act as a control for 10Be concentrations. None of the boulders sampled are visible from the Park Road. The smallest possible sample (chip) was collected and any vegetative cover was replaced.

These samples are currently being processed in the Geochronology Laboratories at the University of Cincinnati. Preparation of the samples will be completed by May 2008. The samples will then be sent to the Purdue Rare Isotope Measurement Laboratory (PRIME Lab) for analytical analysis. After the results are obtained from PRIME Lab an article for Alaska Park Science will be submitted. This article will include the complete Wonder Lake moraine chronology and comparison to the chronology in the Nenana River Valley.

Fiorillo	Dallas Museum of Natural History	Paleontological survey of the lower Cantwell Formation, Denali National Park and Preserve

In 2007, investigators discovered thousands of new dinosaur and fossil bird track sites in the vicinity of Double Mountain, Tattler Creek, and Cabin Peak, as well as new records of invertebrate trace fossils. The tracks record the presence of small-, medium-, and large-sized meat-eating dinosaurs, and plant-eating duck-billed dinosaurs. At least three types of fossil birds are also recorded by footprints. Further, at one locality, Cabin Peak, numerous coprolites (fossil feces) were also discovered. Based on morphology, the coprolites seem to represent herbivorous as well as carnivorous dinosaurs.

In addition to these fossil footprint localities, the trace fossil Undichna, a trace fossil attributed to fossil fishes was also recorded at Double Mountain and Cabin Peak. The discovery of this new trace fossil adds further diversity to the emerging ancient ecosystem recorded in the Cantwell Formation.

The invertebrate trace fossil record is well-preserved. The trace fossils are analogous to traces produced by behaviors exhibited by nematodes (Animalia: Nematoda) [thin diameter Cochlichnus], aquatic oligochaetes (Annelida: Oligochaeta) [larger diameter Cochlichnus], extant mud-loving beetles (Coleoptera: Heteroceridae) [Steinichnus], predaceous diving beetles (Coleoptera: Hydrophilidae) [paired bracket marks as traces], midge fly larvae (Diptera: Chironomidae) [short U-shaped burrows rarely with the bottom of the U preserved, cf. Arenicolites; or short, thin vertical burrows, cf. Trichichnus; irregular patterns of surface trails, cf. Haplotichnus], such hopping insects as grasshoppers, katydids, or crickets (Orthoptera: Gryllidae, Acrididae, Tettigoniidae) [hopping traces], scarab beetles (Coleoptera: Scarabaeidae) [adhesive meniscate

Researcher	Affiliation	Project
Fiorillo (cont'd)		

burrows; Naktodemasis bowni], soil bugs (Hemiptera: Cydnidae) [adhesive meniscate burrows; Naktodemasis bowni], tiger beetles (Coleoptera: Cicindelidae) [mainly vertical burrows; Cylindricum], rove beetles (Coleoptera: Staphylinidae) [mainly J-shaped burrows], and mayflies (Insecta: Ephemeroptera) [U-shaped burrows, cf. Arenicolites], as well as others whose behavior and modern analog (or homolog) has yet to be identified (trace fossils cf. Copeza, cf. Lithographus, cf. Bifurculapes, cf. Acanthichnus). Many of these insects are known from Late Cretaceous amber and compression fossils of North America and China. Also discovered were the swimming traces of different types of fishes in interbedded fine-grained sandstone and shale, as well as backfilled meniscate burrows, rhizoliths, and rhizohaloes in pedogenically modified mudrock and interbedded sandstone and shale associated with dinosaur- and bird-track bearing deposits.

In combination, these discoveries establish that Denali National Park preserves a remarkable ancient ecosystem. Further, the abundance of fossil data contained within the Cantwell Formation makes Denali National Park one of the major paleontological park units in the National Park Service system.

Freymueller	University of Alaska Fairbanks	Repeated Global Positioning System (GPS) and absolute gravity measurements to measure active crustal deformation in southern Alaska

This project began with two goals: (1) carry out absolute gravity measurements at the Wonder Lake to learn about subsurface mass movements caused by "viscoelastic relaxation" following the 1964 Alaska earthquake, and (2) carry out Global Positioning System (GPS) measurements (also relate to the first goal) to understanding the Denali fault system, which cuts through the Alaska Range and Denali Park, and the effects of the Nov 3, 2002 magnitude 7.9 earthquake.

Previous GPS data from a profile along the Parks Highway shows ~8 mm/year of steady slip on the Denali fault at depth, but another parallel fault may be active north of the main fault (probably the Hines Creek fault that runs through the park entrance). From the Parks Highway data alone, we could not precisely tell how much slip was on each of the two faults (most likely the majority on the main Denali fault).

The data from Wonder Lake show that it moved differently from the Parks Highway sites, and appeared to be affected substantially by post-seismic deformation. In 2002, we carried out a high precision GPS survey of four survey marks along the Denali Park road within the Park (Wonder Lake, Eielson Visitor Center, East Fork Toklat River, and Savage River). Additional surveys in 2003 were compared to the pre-earthquake data to measure the surface displacements from the 2002 earthquake, and determine the distribution of fault slip on the Denali fault. In 2003, we made absolute gravity measurements at Wonder Lake – these measurements will be repeated in a future year. Since 2002, we have carried out annual surveys of the GPS sites within the park to better characterize the hazards posed by the western part of the Denali fault, which did not rupture in 2002. In 2006, we repeated surveys of all four survey marks along the Denali Park road. The 2005 and 2006 measurements may be consistent with the pre-earthquake trend. If correct, this means that in a few years we can use the time series to evaluate the current tectonic deformation of this part of the Denali fault system.

Researcher	Affiliation	Project
Freymueller (cont'd)		

In 2007, we repeated surveys of all four survey marks along the Denali Park road that we have measured in the past (WOND, M126, EFRK, and B124), and made first measurements at new sites (A127, J127, L125, V124). Two of these sites (J127 and L125) are old leveling benchmarks close to sites we have been using, so our goal was to determine the vertical offset between these points for future studies of long-term uplift or subsidence. We do not plan to visit those sites again. A127 is located about 15 miles from Wonder Lake, and V124 is located on the Teklanika River Bridge, and these sites fill in gaps in our network.

Although we did not survey most of these sites before 2002, at Wonder Lake and along the Parks Highway we had made repeated measurements before the earthquake, so we can compare the post-earthquake motions to the pre-earthquake motions. Because the post-earthquake measurements combine a steady long-term signal with a short-term, transient response to the earthquake, one of the key questions we face is how to separate the long-term trend from the post-2002 reactions. Comparison of the post-earthquake series of measurements of sites in the Park and along the parks highway to the pre-earthquake series suggests that the 2005- 2007 measurements are consistent with the pre-earthquake trend in the north-south component, but they move faster to the west than before the earthquake. Thus a transient component related to the post-seismic deformation following the earthquake remains. More time will be needed to untangle this signal from the strain associated with the Denali fault.

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. The annual report for this research, covering biological year 2007, i.e., May 2007-April 2008, will be available by the end of August 2008. Go to www.alaskawolves.org for the previous annual report and other reports (Reports and Reports2 pages) and ongoing excerpts, with photos, from the field observations (Blog section).

Hansen	University of Alaska Fairbanks	Denali Seismic Monitoring Sites (including repeater on Double Mountain)

The seismic network in Denali consists of four seismic stations (Castle Rocks (added August 2006), Wickersham, Thorofare (installed 1988, upgraded 2003), and park entrance (installed July 1964 and upgraded in 1998), two telemetry "repeater" sites (Double Mountain and Mount Healy), and a receiver site (MSLC). All existing sites worked in 2007 so no maintenance was required. Data from the park entrance is available in near-real-time on the internet at: http://quake.wr.usgs.gov/waveforms/crest/indexc.html

These stations are part of the regional seismic network of ~450 seismic stations in Alaska. Most Alaskan earthquakes are caused by the active plate boundary between the North American and the Pacific tectonic plates. One of the problems of interest is the deep seismicity beneath Mt McKinley and its relation to the deep root of the mountain, and how deep seismicity relates to the shallow Kantishna cluster of seismicity.

Researcher	Affiliation	Project
Hansen (cont'd)		
On November 3, 2002 at 1:12 PM Alaska time, the largest earthquake to occur in the world in the year 2002 struck central Alaska. The epicenter was located approximately 68 km east of Denali National Park. This major activity on the Denali fault system increases concern that the western portion of the Denali fault, the part that that bisects Denali National Park, may have increased likelihood of rupture. We plan to continue removing the older analog seismic stations now that the new digital stations are stable. The addition another station west of Wonder Lake, and adding a seismometer at Double Mt. are also considered for sometime in the future. These would be necessary to obtain a better resolution on the source of that very active zone of seismicity located roughly between Mount McKinley and Wonder Lake at a shallow depth. This would also provide valuable insight to the rupture process should the western portion of the Denali Fault rupture. After the construction of the new Eielson Visitor Center, we plan to modernize the display we maintained there.		
Hansen	University of Alaska Fairbanks	Expanded earthquake monitoring near Kantishna with portable seismometers
The temporary earthquake-monitoring network (6 sites) was installed on June 2, 2007, having been cleared by the Park archaeologist in June 2006. Each site consisted of a Guralp 6TD seismometer, a GPS antenna for timing and a set of Cellaire batteries. The data were recorded within the instruments for later retrieval and analysis. The equipment was retrieved on September 11, 2007 and returned to the Alaska Earthquake Information Center for analysis. It is anticipated that graduate students will use the data to further define the unusual seismicity in the Kantishna region.		
Jackson	UNAVCO Inc.	Plate Boundary Observatory (PBO) component in Denali National Park to monitor tectonic and magmatic process using high precision Global Positioning Systems (GPS)--Reconnaissance of sites south of the Alaska Range
Two potential sites for locating instrumentation were identified in Denali. They are located at Wickersham Dome (to be installed in 2008) and Tokosha Communications facility (installed on September 21, 2007). These sites will add to the network of sites that can monitor tectonic and magmatic activity in Alaska and beyond.		
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).		

Researcher	Affiliation	Project
Jeffries (cont'd)		

The Alaska Lake Ice and Snow Observatory Network (ALISON) study site on Horseshoe Lake was set up on December 7, 2007. This is the fifth year that ALISON measurements have been made at this site.

This year teachers Dorothy DeBlauw and Mark Harris and their respective Tri-Valley School 4-5 grade students having been making measurements during the winter every two weeks. These measurements include the ice thickness and the depth, density and top-and-bottom temperatures of the snow accumulate on the ice. The conductive heat flow through the snow was derived from these snow data.

Measured ice thicknesses are greater this season than those obtained in any other year (no ice thickness data were acquired in winter 2005-2006 due to equipment failure). The snow depth was the lowest of any previous winter (2002-2007). The snow density values fell squarely with the range of previous seasons. The conductive heat flow appears to have been on average lower than during previous years.

The Tri-Valley School group continues to contribute to acquisition of knowledge about winter processes at Horseshoe Lake. They have laid the foundation for a long-term data set that is important at this time of environmental change in Alaska. Their participation in the ALISON project during the 2007-08 ice growth and decay season represents a contribution to the International Polar Year (IPY) effort that began 1 March 2007 and continues until March 2009. It should be noted that Dorothy DeBlauw and Kris Capps obtained a prestigious TOYOTA Tapestry grant ($10,000) to support the ALISON effort in Denali NPP.

The current Horseshoe Lake data are posted at http://www.gi.alaska.edu/alison/HLY_CURRENT_Graph.html. Previous years' data are posted at http://www.gi.alaska.edu/alison/HLY_PAST_Graph.html.

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.

No new data were collected in 2006 or 2007. A summary of findings is in progress.

Researcher	Affiliation	Project
Khurana	University of Pennsylvania	Patho-physiological changes induced by hypoxia

Tejvir S. Khurana MD, PhD. and Gabriel Willmann MD climbed to the summit of Denali with 6 vials containing dystrophic flies via the West Buttress climbing as a 2-man, alpine-style research expedition. The fruit-flies (UASdsDysC-term/P-tub GAL4) were maintained in 12-ml polypro vials containing molasses wrapped in plastic. Worms were carried in 100-mm petri dishes. Vials were kept in the inside chest pocket of climbing salopettes/ jackets to avoid exposure to cold. Unfortunately, despite our best efforts the worms perished during a storm on June 6 at Motorcycle Hill Camp (3,350 m) and could not be studied further. Aliquots of normal flies were euthanized on June 13 at Medical Camp (4, 350 m) and the vial of 6 dystrophic flies that we carried to the summit were euthanized on June 16 at High Camp (5150 m). Flies were frozen in "RNAlater" to preserve genetic material, and kept on ice after freezing.

All study-related material (including samples) was carried out of the Park and shipped back to the laboratory by Fedex from Anchorage. Upon return, the Denali team and MDA-funded research fellow (Dr. Matias Mosqueira) have been able to successfully extract high quality RNA and undertake expression profiling using Affymetrix GeneChips (microarrays) from the dystrophic *Drosophila*.

Our preliminary analysis (using a highly stringent FDR of 0% and 2X expression cutoff) has identified c. 706 genes that were up-regulated and 575 genes that were down-regulated due to hypoxia in the dystrophic *Drosophila* that were carried to the summit of Mt. McKinley/ Mt. Denali. Our scientific collaborators are Prof.'s Ruohola-Baker (Univ. of Washington), Lahiri, Hoshi and Lamitina (Univ. of Penn) and material support was provided by REI and EMS. The study is being prepared for publication and primary data will also be submitted to the GEO database at the NCBI, NIH. A research abstract describing the findings (Role of hypoxia in muscle function and muscular dystrophy- 1163APS EB08 9453; Mosqueira et al. 2008) has been submitted for presentation at the "Experimental Biology 2008" meeting to be held in San Diego, CA. In the interim please feel free to contact Dr. Khurana by phone/email at University of Pennsylvania for details/ preliminary results.

Larsen	Central Alaska Network	Central Alaska Network shallow lake monitoring project

We re-sampled twenty-eight of the lakes in the northwestern corner of Denali National Park and Preserve in summer 2007. Sampling followed the standard operating procedures outlined in draft monitoring protocols for shallow lake monitoring. Samples were collected for analysis of water and macroinvertebrates. Surveys on lake morphology were also conducted to estimate lake level and bathymetry. These data will be used to determine lake volume. Vegetation surveys and peat profiles were also completed on each lake.

We compared changes in water level and depth between the two subsections in the northwestern section of Denali: (1) the Eolian Lowlands (EL) and (2) the Minchumina Basin Lowlands (MBL). We related changes in water depth to permafrost distribution and soil composition.

Changes in lake surface area and depth: Historical analysis of remote sensing data shows 94% of lakes in the MBL have remained stable over the past 30 years. While virtually all lakes within the EL displayed some amount of drawdown over the past 30 years. Lake surface area in the EL decreased in 26% of lakes, and 19% of lakes have been converted to wet meadow. On the ground, water level measurements demonstrated a 7

Researcher	Affiliation	Project
Larsen (cont'd)		

cm decline in water level between years in the MBL and a 42 cm drawdown in the EL. These small changes in lake depth in the MBL corroborate the stability of this area demonstrated via remote sensing. Lakes make up a large portion of the landscape in the MBL (24%) and only 2% of the EL is made up of lakes. So, in general lakes in the Park are fairly stable.

Soil composition: Lakes in the MBL consist largely of thermokarst features with deep peat deposits underlain with permafrost. Soil profiles from this area show a thick layer of peat (0-56 cm) underlain by a layer of fine particles of silt loam (56-150 cm). The sandy nature of the EL likely determines the rapid rate of drying we have observed in this area. The water holding capacity of the sand (1.7-2.2 cm) in the EL is considerably less than fine particles of silt (16.0-18.8 cm) found in the MBL.

Permafrost distribution: Approximately 24% of the land is occupied by water in the MBL and only 2% of the EL is water. Permafrost is a dominant feature in both regions, however lakes in the MBL tend to be more directly influenced by permafrost. Ice in the MBL is thicker and more contiguous. We observed large areas of recent thermokarsting along the majority of lakes in the MBL during our field work, but lake expansion was detected in only 3% of MBL lakes via remote sensing. Peat profiles across the littoral zone showed melting near the lake edges in many of lakes we surveyed. Thermokarsting varied in width from 1-3 m. Several large lakes in the EL appear to have dried prior to 1980. These meadows correspond to areas of land where permafrost is thin and patchy, making them more susceptible to melting and corresponding lake drying. Because the ice is thin and patchy it is less stable than the MBL as evidenced by the high amount of lake expansion (11%). In general, it appears the permafrost in the EL has been exposed to degradation for a longer time period than the MBL where we are just beginning to see lake expansion.

Future plans: In 2008, we plan to conduct water quality sampling on 90 additional lakes in Denali. This information will be used to develop a lake classification system for Denali . We also plan to expand our historical analysis of remote sensed imagery to quantify the extent and distribution of lake drying within Denali.

Molly Lee (and Amy Wiita)	University of Alaska Fairbanks	Artists' Sense of Place: The Connection of Art and Environment

Data Collection: The four primary data sources for the research are: written documentation; participant interviews; observations of artists; and observations of Artist in Residence (AIR) program activities.

2007 fieldwork included three trips to Denali National Park and Preserve (DNPP) to observe artist-in-residence (AIR) program artists' educational presentations, to experience the park, observe AIR program displays at the visitor center, conduct in-depth interviews, interact with AIR program staff, and research written records.

Observations: During fieldwork I observed all three 2007 Denali AIR program artists' presentations, spent time in the Denali Visitor Center to experience the AIR program art as a visitor and to observe visitors' experiences, and experienced/observed park resources used by the AIRs.

Researcher	Affiliation	Project
Lee / Wiita (cont'd)		

Semi-structured In-depth and Unstructured Interviews:
I conducted ethnographic semi-structured in-depth narrative interviews with two 2007 DNPP AIR program artists, with two National Park Service (NPS) staff, and with one a relevant stakeholder in the AIR program. The interviews with NPS staff and stakeholders were conducted in-person during on-site fieldwork. The interviews ranged from 1.5 to 2 hours in length. I conducted the interviews with DNPP Air program artists by phone. The in-depth interviews with artists took approximately 2 hours each to complete.

Photo Recording, Artist Journals, & Maps:
All 2007 AIR program artists volunteered to photo-record, map, and keep a journal of their experiences of the landscape at Denali as it related to their AIR experience. The journals were kept during artists' backcountry experiences to provide an account of their experience. I used the journals to guide and inform the in-depth interviews with the artists and for content analysis. I used photography to record the landscapes, artwork and AIR program activities throughout the research. I recruited all the 2007 DNPP AIR program artists (four in total). Artists' have been very willing to participate and interested in this research. There have been no barriers to artist recruitment. In 2008, I will attempt to recruit all 2008 Denali AIR artists and past AIRs.

Loso	Alaska Pacific University	Trajectory and fate of human waste on the Kahiltna Glacier

Between June 10 and July 7, 2007, Michael G. Loso studied the crevassed human waste disposal in relation to the velocity and melt behavior of the Kahiltna Glacier. Fieldwork was completed within the context of an existing NPS-sponsored search and rescue patrol led by NPS ranger Tucker Chenoweth and attended by three VIPs. All were supportive of the research, helpful in research-related duties like GPS surveying and snowpit excavation, and willing to assist Loso in briefing the public about the research.

We established 5 study sites on the lower glacier. Each site was established near the centerline of the glacier (but off the main travel route) and marked by a stake. Stakes were numbered from 1-5 and located at 1992, 2322, 2777, 3062, and 3360 m, respectively. Stakes 1 and 4 were established solely to measure melt rate and surface velocities by measurement (with mapping grade GPS receiver) at the beginning and end of the patrol. In addition to velocity measurements, we measured temperature and winter accumulation (via snowpit) at the other stakes. All stakes were emplaced between the dates of June 16 and June 18, during the team's initial ascent of the West Buttress. All stakes were removed and measurements completed between July 6 and 7, during the descent.

As expected, the bulk of waste disposal on the lower Kahiltna occurs near camps. Commonly used crevasses were located with GPS for subsequent mapping. Velocities of stakes during the measurement period were 0.06 meters per day at stake 5, 0.10 m/d at stake 4, 0.25 m/d at stake 3, 0.32 m/day at stake 2, 0.43 m/day at stake 1, and by incidental measurement, 0.38 m/day at basecamp (no stake was established at this location). All stakes moved in directions consistent with expected flow directions.

Researcher	Affiliation	Project
Loso (cont'd)		

Average temperatures measured by shielded Hobo temperature loggers suspended approximately 1 meter over the snow surface average 9.2, 5.8, and 3.4 degrees Celsius over the period of measurement at stakes 2, 3, and 5 respectively. These measurements (taken hourly) will be used in conjunction with full summer data from the NPS index site to estimate full season ablation rates.

Ablation, defined as the surface lowering averaged over the period of stake emplacement, was 0.023 m/day at stake 1, 0.020 m/day at stake 2, 0.003 m/day at stake 3, -0.011 m/day at stake 4, and -0.005 m/day at stake 5. Negative numbers indicate accumulation of new snow. Direct measurement of the density of melted or accumulated snow was not possible, nor was a full season of measurement.

We found snowpack depths of 2.67 at stake 2, 1.40 at stake 3, and 4.59 m at stake 5. Measurements of density for individual layers allowed us to convert these measurements to water equivalent: 1.07 m at stake 2, 0.45 m at stake 3, and 1.54 m at stake 5.

The data discussed above provide for an assessment of likely meltout times and locations for crevassed human waste. I await the release of 2007 melt-year data from the NPS index site before final calculations can be completed (primarily to improve currently estimated rates of annual melt). However, I estimated the distance traveled (in vertical meters downglacier) and time (in years) before meltout of waste deposited in 25 m deep crevasses at a variety of starting elevations. For instance, waste deposited at 3062 m melts out 127 years later at 1087 m. Waste deposited at 2322 m melts out 77 years later at 1244 m. And waste deposited at 1930 m melts out 34 years later at 1378 m. Although details of the data and model will continue to be refined, I believe these estimates are based on conservative assumptions and hence estimate maximum time and distance to meltout.

MacCluskie	Central Alaska Network (NPS)	Small mammal monitoring at the landscape scale and synthesis of monitoring data in Denali NPP

The legacy trapping grids in Rock Creek were sampled 13-17 August 2007. Study plots included two riparian grids (RR1 and RR2) and two forested grids (RF1 and RF2). Sherman live traps were deployed on the plots for 4.5 days (Sunday evening to Friday afternoon) for a total of 14 trap checks. Note that the protocol for the small mammal study is to run the trapping session for 4 days with 12 trap checks. Two additional trap checks were done in 2007.

Each sampling plot was approximately 0.8 ha in area, and laid out in a square. 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 and released. Data were error-checked in the field and PIT tag codes were verified against an inventory list to ensure integrity of the data collected.

Abundance estimates were computed for Clethrionomys rutilus (CLRU), Microtus oeconomus (MIOE), and Microtus miurus (MIMI). We also used the program Density to estimate population density for C. rutilus, M. oeconomus, and M. miurus at 3 different scales: plot (RF1, RF2, RR1,

Researcher	Affiliation	Project
MacCluskie (cont'd)		

RR2), habitat (forest, riparian), and overall. Because Density requires recapture information for the purposes of discerning movement distances, we were unable to estimate density for shrews. We employed our measure of system health on small mammal populations at all 4 grids sampled. The measure, termed 'conformance' (C) reflects how aberrant the population estimates from the current year are when compared with estimates from past years.

There were 125 Clethrionomys captured (traditionally the most abundant species) which was four times more than the number in 2006. The number of M. oeconomus was 17 (almost double the 2006 number), while M. miurus remained at only two individuals.

After the "high" year of 2005 and the "low" year of 2006, population size for small mammals in 2007 were fairly "ordinary". Clethrionomys density was at its fourth highest level, while M. oeconomus density was consistent with its long-term average. M. miurus was all but missing this year as has been the case in most years. All in all, it was a typical year in Rock Creek for small mammals.

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 from the Brooks Range to the Kenai Peninsula, 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) in several trees. Temperature is monitored with thermistors implanted in the vegetation tissue and at various depths in the soil. Xylem sap flow is inferred though monitoring the heat dissipation within a small volume of hydroactive tissue surrounding a heated needle-like probe implanted into the tree trunk.

As part of our 2007 field work, we connected our field station located near Rock Creek to line power at the nearby pump house. This should increase reliability of this equipment, ensuring a more stable source of electrical power, rather than relying exclusively on solar power. During September 2007. We also began adding soil moisture sensors at both sites to measure soil water content and the relationship of vegetation growth with soil water. We anticipate completing installation of 3 to 6 soil moisture probes in the upper soil regime of each station during our 2008 site visits.

This work was conducted at the Jet Propulsion Laboratory, California Institute of Technology, under contract to the National Aeronautics and Space Administration.

Researcher	Affiliation	Project
McCarthy / Tomsich	University of Alaska Fairbanks	Integrated paleoenvironmental reconstruction of the lower Cantwell Formation near Sable Mountain, Denali National ark, Aaska

This two-year project involves a paleoenvironmental reconstruction for the dinosaur footprint-bearing Campanian-Maastrichtian lower Cantwell Formation in the Sable Mountain area based on fluvial sedimentary facies, bedform analyses, paleosol characterization, and paleofloristic and trace fossil information.

During the 2007 field season, the stratigraphy, sedimentology and fossils from nine closely-spaced localities in the Sable Mountain area were described. The vertical successions exposed in the Sable Mountain area are ~1500 m thick and consist of numerous, fining upwards sequences that are often bracketed by sharp bounding surfaces. Beds are, on average, 10 to 50 cm thick and grade from conglomerate to coarse-grained pebbly sandstone to mudstone. All coarser-grained facies are laterally discontinuous. Detritus is moderately sorted and consists of both reworked and angular clasts. Sandstones frequently display ripple laminations and cross-bedding. Common iron oxide nodules and rare concretions indicate diagenic processes, and small rootlets provide evidence for soil formation. Sedimentological data and the presence of incipient paleosols suggest that these deposits comprise small channels, splays, overbank, and lacustrine environments typical of a low-lying floodplain. Preliminary interpretations of the depositional environment suggest infrequent river discharge, rapid local subsidence, and immature paleosol development due to continuous aggradation. These observations are consistent with deposition in distal wet alluvial fan deposits.

Where exposed via erosion, individual dinosaur footprint casts and load casts (large undefined forms) can be identified on the underside of protruding beds. Most tracks are poorly defined in shape due to improper parting along grain-size boundaries. A few footprints have well-defined outlines and even dinosaur skin impressions. According to Dr. Anthony Fiorillo (Dallas Museum of Nature and Science), these prints were made by hadrosaurs and theropods. Preferential preservation is suggested by the consistent appearance of tracks along sharp grain-size boundaries and may indicate that environmental factors such as climate played an important role. For example, some tracks are up to 30 cm deep indicating that they were made in wet mud. Subsequent drying of the sediment during periods of drought allowed the track to harden prior to being filled following renewed deposition. Invertebrate trace fossils such as burrows were identified on site with the help of Dr. Steven Hasiotis (University of Kansas) as Scolithos, Planolites, Mermia, Cochlichnus, and Phycodes. Moreover, in what are interpreted as lacustrine deposits, the shells of small bivalves, gastropods and limpids were discovered and these are now being analyzed for more taxonomic information. These organisms testify to a diverse faunal substrate community in a variety of depositional settings.

Fine sandstones yield abundant plant fragments of cycads, ferns, and *Equisetum*, the branches and cones of the cypress *Metasequoia*, and a variety of dicotyledonous angiosperm leaf imprints of the platanoid type. These leaves exhibit a significant morphological variability reflecting high taxonomic diversity or leaf polymorphism. All fossils were described in terms of sedimentary facies and floristic assemblages. The cycads, ferns, cypresses and the *Equisetum* probably grew alongside streams and lakes. The diverse angiosperm leaves were produced by deciduous hardwood trees and shrubs and are at times found together with fern fronds or *Metasequoia* sprigs. These floral associations are interpreted as a mixed mesophytic forest community growing on more elevated grounds within the floodplain. The plant fossils thus imply two different types of vegetation: a hydrophytic floodplain flora and a mesophytic forest occupying the interfluves.

Researcher	Affiliation	Project
Manning	University of Vermont	A predictive study of use impacts on the Denali park Road: a study plan to support analysis and management of carrying capacity

Seven-hundred twenty-three (723) quantitative surveys were conducted with Denali Park Road vehicle users during the 2007 season. Surveys were conducted with users from three road use groups: (1) VTS bus users (including both general and camper buses), (2) commercial bus users (including tour and lodge buses), and (3) Recreational Vehicle (RV) users at Teklanika Campground. These surveys collected data to help formulate standards to measure and manage the quality of the visitor experience on the road for relevant indicators identified in the previous year's research. Respondents were asked questions about their appropriate levels of vehicle use on the road and about their expectations for seeing wildlife.

Results from these surveys suggest what visitors find to be appropriate vehicle use levels and appropriate opportunities for seeing wildlife while riding on the Denali Park Road. Crowding on the Park road and at rest areas was measured using photographs depicting increasing levels of use.

Results from the 2007 surveys will be used to inform the development of standards for these variables and assist the park in managing vehicle use of the park road.

Migaszewski	Collaborating with U.S.Geological Survey (Colorado)	Distribution patterns of polynuclear aromatic hydrocarbons (PAHs) and trace elements in mosses, *Hylocomium splendens* and *Pleurozium schreberi*, collected from different forest communities in Alaska and Eastern Europe.

Compared to the same mosses in Poland, *Hylocomium splendens and Pleurozium schreberi* from Alaska showed more uneven areal distribution pattern of PAHs with prevailing phenanthrene across the landscape, despite distinctly lower mean concentrations of these hydrocarbons. This is due to the interactions that occur between camp and residential wood combustion emissions and highly diversified topographic features combined with spatial distribution of higher vegetation. The Alaskan versus Polish mosses exhibited relatively higher concentrations of 3-ring aromatic hydrocarbons and Hg. This seems to be linked to lower annual temperatures and shorter insolation periods in Alaska, which may constrain the escape of volatile species to the atmosphere. Compared to the HCM, *P. schreberi* from Alaska revealed stronger bioaccumulative capabilities than *H. splendens*. This evidence may suggest that there may be some physiological differences between the same species from Poland and Alaska induced by different climatic and edaphic factors.

The comparison of element concentrations in Alaska and the HCM indicated a greater role of airborne soil and rock particulates in the chemistry pattern of mosses in pristine areas.

No statistically significant correlations were found between PAH and element concentrations. This evidence indicates different sources of these chemical species. However, in Poland, some of the pollutants can overlap, for example, combustion of hard and brown coals produces both PAHs and trace metals. These and previous biogeochemical studies conducted in the HCM have shown two opposite trends, i.e., decrease in element emissions and increase in PAH emissions.

Researcher	Affiliation	Project
Milner	University of Alaska Fairbanks	Long-term ecological monitoring of streams in Denali NPP

In both July and August of 2007, six Surber samples for macroinvertebrates were collected at 13 of the 14 long term study sites (not Rock Creek). These samples are in storage presently being sorted and identified. One aspect of the collection was the August sampling was done in connection with Trey Simmons of the NPS who sampled at the same sites but using a D-net approach which will allow for a comparison of the techniques employed.

Researcher	Affiliation	Project
Milner	University of Alaska Fairbanks	Hydroecology of upwelling zones in a glacierized catchment

In 2007 we studied a series of upwelling channels on the Tolkat River floodplain. These areas are potentially 'hotspots' of biodiversity, where the mixing of different water sources increase productivity and hence biodiversity. This project aims to investigate interactions between physical and ecological processes operating within these 'biodiversity hotspots', at a sufficiently small scale so as to generate a fuller understanding of the mechanisms operating between the two fields.

Nested piezometers and pressure transducers were used for determining water pressure at a variety of depths (15, 30, 50 and 100cm). Periodic samples of surface water taken in sample vials, and of ground water from piezometers using tubing and hand pump were collected for isotope and anion/cation content to characterize water sources. Thermistors were attached to dataloggers and placed in piezometers, allowing comparisons between surface and subsurface water temperature fluctuations, and between upwellings and glacial sites. Macroinvertebrates were collected in upwelling channels and the main glacial river bimonthly and samples of hyporheic fauna were collected weekly using water removed from the piezometer tubes.

Our initial findings indicate rises and falls in glacial channel stage due to peaks and troughs in glacial melt were mirrored by the upwelling channels, with a significant time lag, suggesting that upwelling channels are fed predominantly by the glacial meltwater. Increases in glacial stage following heavy rainfall, were reflected in the groundwater channel, supporting the glacial channel as the major source, but which might also be indicative of additions by rainwater from valley sides. Upwelling channels were significantly warmer than the glacial channel and with stable flow regimes. Upwelling channels supported a higher species diversity of macroinvertebrates (> 18 taxa with Chrionomidae with abundance more than 20x higher (> 2000 m2) than the glacial channel. It is evident that the upwelling channels are hotspots for stream macroinvertebrate communities with diversity exceeding 18 taxa and densities exceeding 2000 m2. Chlorophyll analysis revealed highest concentrations in upwelling channels B2 and B3, those with the highest macroinvertebrate abundance.

Research in 2008 will include macroinvertebrate collection over an extended time period, more fully determining seasonal alterations in diversity and abundance. Hydrological and chemical studies will be conducted similar to 2007, to assess annual stability in the relevant characteristics of the upwelling channels. Extensive mapping of the area will be carried out, using an EDM, to provide a comprehensive picture of the system and of vegetation plots associated with this upwelling. In addition further piezometers will be installed upstream on the terrace to aid water source identification.

Researcher	Affiliation	Project
Newberry	University of Alaska Fairbanks	Geological mapping exercises in Central Denali Park

In 2007, we took 14 students and 5 instructors into the region between Cathedral Mountain and Polychrome Pass June 23 - July 3, 2007. We divided the students into 4 teams, each of which was responsible for geologic mapping in an approximately 15-20 sq km area; instructors rotated through the groups. All students prepared geologic maps as part of their work; a compilation geologic map for the area studied is in preparation.

(1) Students who chose to map in areas of the late Cretaceous Cantwell formation were primarily concerned with better understanding the structure and stratigraphy in the general area of the dinosaur tracks we discovered 3 years ago. These students found more evidence for considerable structural complications, including overturned beds and multiple folding events. (2) A second group concentrated on the north end of Cathedral Mountain; the complex structural relationships between the mafic and felsic igneous rocks and the structural relations between these early Tertiary rocks and the young coal-bearing group and younger Nenana Gravel. Progress in the volcanic rocks was impeded by difficulties in distinguishing between altered versions of the rocks but showed the presence of both intrusive and extrusive rocks, and not merely volcanic rocks. Geologic mapping combined with gravity surveys indicates that the south end of Cathedral Mountain is a steeply dipping reverse fault, which truncates the Igloo Creek fault. (3) A third group worked in the area between the E fork of the Toklat River and Sable Mountain. Their mapping was limited by the difficulty of access (Sable closure): a long hike along Tattler Creek or a difficult hike along the East Fork. Students in this area recognized a thrust fault and several folds in the Cantwell formation—a previously unrecognized complication. They studied the geometry of mafic dikes and recognized nearly invisible bedding plane shears in the Cantwell formation—seen as small, but consistent, displacements of the mafic dikes. This group also performed an EM survey along the Park road in the area between the East Fork Bridge and Sable Pass, and determined the approximate locations of faults in this covered area. (4) The final group worked in completely new territory between the East Fork and Polychrome Pass. This group made several geologic discoveries, including a down-dropped wedge of Coal-bearing group northeast of Polychrome Pass, and attempted to work out the complex relationships between hydrothermally altered early Tertiary felsic volcanic, mafic volcanic, and mafic intrusive rocks in the region. We employed a hand-held magnetic susceptibility meter to help with rock distinctions, but found that hydrothermal alteration made such distinctions quite difficult. A magnetic survey similarly produced equivocal results.

The objectives of our study are daunting: to both teach students how to undertake geologic mapping and to produce high-quality geologic maps. Obviously, if our students were already capable of making high-quality geologic maps, they wouldn't need the course! Consequently, our progress is slower than we predicted and in some areas the instructors are still not satisfied with the level of geologic mapping. However, the combination of geologic mapping and geophysical studies clearly shows that the area is considerably more deformed than indicated by previous workers. We intend to continue our mapping in 2009 using additional geophysical (EM, magnetics, graivity) and geochemical (hand-held XRF analyzer) tools to help clarify the geology of this complex area.

Researcher	Affiliation	Project
Newman	University of North Dakota	Population biology of the wood frog in a rapidly changing environment: Site 1-Denali

I initiated field studies of wood frogs in several areas of interior Alaska during the summer of 2007, including Denali National Park (Wonder Lake area). I present here an overview of our findings, including habitat use, breeding activity, and proportion of available habitat ("occupancy") used for breeding. Additional analyses are in progress.

Sample sites were chosen to encompass a large number and variety of wetlands in an area where wood frogs had previously been found (Hokit DG and A Brown). 2006. Distribution patterns of wood frogs (Rana sylvatica) in Denali National Park. Northwestern Naturalist 87: 128-137). The majority of wetlands were in alpine tundra between 750-900 m elevation, with some in spruce-dominated boreal forest between 600-700m.

We surveyed 174 wetlands and breeding activity was detected at 82 (47%) of wetlands. The amount of breeding at many ponds was low, but breeding intensity was highly variable, with egg mass counts (~breeding females) ranging from 1 to 37. Wood frogs in Denali use a wide variety of wetland types, from small, shallow ponds with a lot of emergent vegetation to very large beaver ponds with mostly open water. All breeding wetlands had some shallow areas with emergent vegetation, which is required for egg laying. Statistical analyses of habitat utilization, distribution, and occupancy patterns, including a comparison with previous data on use of specific ponds, will permit development of predictive models of distribution and landscape-level population dynamics. Typically, populations of amphibians that breed in wetlands such as those found in Denali National Park depend on availability and seasonal persistence of at least some wetlands, somewhere on the landscape, in most years, for long-term persistence.

Work in progress based on 2007 sampling includes: construction of GIS with mapped wetlands, for estimation of landscape characteristics, statistical modeling of occupancy patterns – exploratory data analysis to detect possible predictors of pond use, and processing of tissue samples (DNA extraction, microsatellite genotyping) and analysis of spatial patterns of genetic variation.

Palso	Pennsylvania State University	2007 Alaska and Yukon self-drive tourism study

This study was conducted during the 2007 summer tourist season in Alaska. Questionnaires were distributed to self-drive non-Alaskan/non-Yukon visitors camping in the Riley Creek Campground of Denali National Park and Preserve. Interviews were also recorded of visitors who wished to elaborate on the questionnaire. Data was collected on June 24, July 3, 18, 28-31, and August 1. 155 completed questionnaires were collected from the park, with an additional 74 from other sites in Alaska and the Yukon Territory. Data were obtained from a wide variety of visitors, representing many regions of the United States and Canada, as well Western Europe. Vehicle types, income levels, and education also varied. However, the majority of respondents were decidedly older, with the mean age being 55.7 (standard deviation of 13.76). 60.8% of respondents were retired.

From the data collected, it appears that the passport requirements of the Western Hemisphere Travel Initiative (WHTI) for drivers moving between Alaska and Canada will not affect tourist visitation to the region. 82.9% of North American visitors felt extremely strongly that they would still come to Alaska if it required obtaining a passport for each member of their party. 80% felt extremely strongly that obtaining a passport

Researcher	Affiliation	Project
Palso (cont'd)		
for each member of their party would not cost more than they would be willing to spend. In fact, 89.4% of visitors already had passports. Visitors were more polarized on their support for this homeland security policy, resulting in a non-normal distribution. 46.6% were very strongly in favor of the measure, while 18.1% were very strongly opposed. Interestingly, while regional government and tourism organizations are greatly concerned about how the WHTI will affect tourism, it appears as though the cost of fuel will be a greater detriment to this industry. 56.4% of visitors very strongly agreed that the price of gas was a major inconvenience for them. 61.3% felt that current average prices of fuel in Northwestern Canada and rural Alaska were at or near rates that would deter future visitation to this region. Many American visitors expressed concern that rising fuel prices, combined with a weakened U.S. dollar and the repeal of the Canadian GST tax refund for non-Canadians, could limit their ability to make future trips to Alaska. Analysis is still being performed on the data obtained in this study to determine if a typology of different visitor types based upon demographics, mode and style of travel, routes of travel, self-identity, and other tourist characteristics.		
Pfeifer	U.S. Geological Survey, Arizona	Effects of climate change, glacial retreat, and snowfield loss on habitat condition and the effect on wild sheep populations and distribution in polar and high mountain ecosystems in Alaska, Russia, and Asia.
Landsat imagery of the Alaska Range (August 2000, September 1994, August 1987, and August 1979) was used to provide for change detection analysis of glacial and snowfield extent over a four decade period. Seven distinct classes were established (ice, snow, moraine, rock, water, vegetation, and unclassified). Aerial photography from1952 will be included in the change products for the Denali study area. Field work was scheduled and took place at the Denali study site the last couple of days of July 2007 and 1st week of August. Ed Pfeifer, Jana Ruhlman, and Barry Middleton of the USGS attempted to access the Polychrome glacier field to take GPS point data of the nose of glaciers in the study area to incorporate into the change detection products and verify ice extent. Unfortunately bear activity was extreme and after several encounters this task was rescheduled for summer 2008. Location photographs were taken of the study area. Dall's sheep fecal samples were collected, along with GPS point data for each sample, on Cathedral Mountain and Sable Mountain. Analysis of Dall's Sheep feces samples collected in the Denali study area were sent off to Washington State University, Wildlife Laboratory for Fecal Nitrogen analysis, Fecal DAPA, ash content, and diet composition. Work started on the development of a Web Site for the project. In FY08, we will return to Denali to collect additional Dall's sheep fecal samples, primarily in the Cathedral Mountain, Sable Mountain, and Igloo Mountain area, and in Dall's sheep habitat adjacent to the glaciers in the Polychrome glacier field. GPS point data will be collected along the margins of selected glaciers in the Polychrome glacier field to aid in the identification of changes in glacial extent. GPS point data will be acquired in these areas of vegetation types (woody plants, grasses etc.) for use in developing course vegetation maps using Quickbird imagery. Ongoing collection and analysis of fecal samples, vegetation type transitions, and glacial margins will assist in the development of a baseline and ongoing set of data describing changes in the landscape and how that may be effecting Dall's sheep habitat, health, and carrying capacity.		

Researcher	Affiliation	Project
Simmons	Central Alaska Network	Development and implementation of a long-term ecological monitoring program for the streams and rivers of Denali National Park and Preserve

Invertebrates were collected from 15 DENA streams in 2007. Observed taxa richness varied tremendously among the sampled sites. Chironomid midges accounted for approximately 30% (7/22) of taxa richness, and 37% of individuals. This is substantially lower than reported by Oswood, who found that chironomids constituted about 59% of individuals in Alaskan streams.

The lowest richness (5 taxa) was found in the EF Toklat River; this is not surprising given the unstable nature of this glacial river, and is consistent with other studies. Similarly, Highway Pass Creek, another unstable (though clearwater) system, was next lowest with 10 taxa. The highest richness was found in Moose Creek (34 unique taxa). Densities varied from a low of 7 individuals/m2 at EF Toklat River to a high of 8000/m2 at Igloo Creek above Tattler. 15 aquatic insect taxa not reported by Milner et al. (2003) or by Conn (1998) were collected in 2007 and include both a family not previously reported (Muscidae)and an unidentified chironomid taxon:
Ephemeroptera (mayflies): Acentrella lapponica, Drunella doddsii; Plecoptera (stoneflies): Capnia, Isocapnia, Prostoia, Arcynopteryx, Diura, Taenionema; Trichoptera (caddisflies): Apatania; Diptera (true flies): Limnophora (Muscidae), Heterotrissocladius, Micropsectra, Pseudosmittia, Sympotthastia, unknown Orthocladiinae.

Diatoms were collected from the same 15 sites; a total of 129 unique species were identified. Observed species richness for diatoms was higher than for macroinvertebrates, and varied from a low of 18 species (Highway Pass Creek) to a high of 56 species (McKinley Bar spring creek), with a mean of 32 species per site. The lowest species richness and density was found in unstable braided systems, and the highest in stable spring-fed creeks. I compared our 2007 data to work conducted in 15 streams in the Cook Inlet basin in 2002. The total taxonomic richness in the Cook Inlet streams (140 species) was similar to what we found in 15 streams in DENA; however, only 48 species were common to both data sets.

Sampling for fish took place in 20 streams. Fish were successfully captured at 12 of these sites using a combination of electrofishing, minnow traps and angling. Electrofishing was conducted at only a handful of sites. Because different capture methods are biased toward different species, these results are illustrative rather than definitive. Fish collected by river (with number captured) are as follows:

Savage River Arctic grayling (5); Sanctuary River Slimy sculpin (11), Arctic grayling (2); E.F. Toklat River Arctic grayling (15); E.F. Toklat tributary Arctic grayling (10); Igloo Creek Arctic grayling (1); Igloo Creek above Tattler Arctic grayling (10); Little Stony Creek Arctic grayling (10); Moose Creek Chinook salmon (3), slimy sculpin (1); McKinley Bar spring Arctic grayling (~25); McKinley Bar south creek Arctic grayling (~11); McKinley Bar center creek Arctic grayling (~10); McKinley Bar north creek Arctic grayling (~40).

Two results are of potential importance. First, the capture of juvenile Chinook salmon at the Moose Creek site constitutes a substantial expansion of its known range in the drainage (some 40 km upstream of its previously documented extent). Second, the high concentrations of juvenile Arctic grayling observed in the spring-fed creeks along the McKinley Bar trail (the only places in the park we observed large numbers of juveniles) suggests that these sites may be important rearing areas.

Researcher	Affiliation	Project
Spalinger	USGS	Proteins and tannins in summer browse may limit productivity of moose

Since 2001, we have monitored and sampled the major moose forages in Denali National Park and the Nelchina Basin for protein, tannin concentrations, and estimated digestible protein for moose. We have sampled all the major willows (Salix alaxensis, S. pulchra, S. richardsonii, S. glauca, S. hastata), birches (Betula nana, B. glandulosa), poplar (Populus balsamifera), and alder (Alnus crispa) consumed by moose on these two moose ranges across the summer (generally sampling once in June, July and August). To date, we have analyzed the protein-precipitating capacity (PPC) of the tannins and the nitrogen concentration (N), and calculated the digestible protein (DP) in over 650 samples of plants. This past year, we collected an additional 282 samples in 5 collecting visits in Denali, and added a third sample site to our protocol (Togiak National Wildlife Refuge).

The results to date indicate that Denali browses are significantly lower in PPC and higher in N and DP than Nelchina browses, and these differences are consistent among all browse species. Likewise, we have found significant differences in all 3 nutritional parameters among years, with 2001 being the most nutritious, and 2004 being the least nutritious to moose. The consequences of the variance between study sites and between years to moose were evaluated using a simple nutritional requirement model, and by estimating the nitrogen balance of a female moose over summer consuming these browses. Our model suggests that a female supporting no calf in the summer may not reach a nitrogen deficit until mid-September, and may gain up to 7% in lean body mass in Denali, but will reach nitrogen deficiency by mid-August in Nelchina. Likewise, females supporting 1 or two calves become nitrogen deficient as early as early August in Denali and mid- July in Nelchina basin. Hence, our results suggest that Denali browse is more likely to sustain moose in summer than browse in Nelchina Basin, and that nitrogen availability to moose is likely to have a significant impact on reproductive potential in Nelchina Basin, and in some years, in Denali National Park as well.

Sunderlin	Lafayette College	The floral ecosystem in the lower Cantwell Formation of Denali National Park and Preserve: evolutionary, paleoecological, and paleoclimatic implications

In summer 2007, my field team measured stratigraphic section from six localities in the Park. The depositional environment interpretations and results corroborate the basin model of Ridgway et al. 1997. We re-measured hundreds of meters of section in the Mt. Sheldon area and the north side of Double Mountain. We measured new section at Triple Lakes, at a locality near McKinley Village, at Polychrome Mountain, and along the Toklat River both at the Park Road and downstream 2 miles on the western bank. We made fossil plant collections at Mt. Sheldon, Tattler Creek, and Double Mountain that amount to nearly 300 specimens. Ongoing taxonomic work in the laboratory has revealed that our collections include 12 fossil foliage taxa from dicotyledonous angiosperms, conifers, and a solitary cycadophyte. Both coalified and permineralized wood remains (with growth rings) have been collected at a few of these sites. Our collections also contain poorly-preserved, small, likely freshwater, bivalve and gastropod fossils from fine sandstones and siltstones near Tattler Creek. Work is progressing in the laboratory as we assess the utility of leaf and wood fossil remains as paleoclimate indicators (i.e., leaf margin analysis and tree ring analysis).

Researcher	Affiliation	Project
Trainor	UAF-Dept of Chemistry and Biochemistry	Chemical fate and transport of antimony in aqueous geochemical systems of Interior Alaska and the Yukon

Our work during the 2007 field season focused on the Slate Creek deposit and drainage as a follow up to our initial work there in 2005. In 2007, we sampled intensively throughout the Slate Creek drainage in order to investigate the downstream transport of dissolved and particulate associated metals. Similar to our previous results we observed elevated antimony and arsenic concentrations near to the Slate Creek tailings area. In general the concentrations of other priority trace metals are below EPA drinking water standards, or rapidly decline as a function of distance from the source environment. However, the elevated antimony (Sb) concentrations persist several kilometers from source materials indicating that Sb remains highly mobile in the well buffered, circum-neutral pH waters characteristic of the drainage.

A major effort during the fall and winter of 2007/8 has been the analysis of the water samples to determine the chemical form (or "speciation") of the dissolved antimony. The analytical work provides part-per-billion (ppb) sensitivity, and can distinguish between antimony in the (V) and (III) oxidation states. This allows us to address the question of which dissolved form of antimony predominates (Sb(V) is less toxic but more mobile, and Sb(III) is the more toxic but less mobile). The results of the analysis indicate that the majority of antimony is in the (V) form, even within the tailings impacted areas. This suggests that oxidation of antimony is very rapid in these systems, and the extensive oxidation is well correlated with observation of downstream transport of dissolved Sb.

Van Ballenberghe		Ecology of Moose in Denali National Park and Preserve

Fieldwork occurred from 25 May to 10 June and from 17 August to 3 October 2007, the 28th year of the study. Data on production and survival of calves were gathered during spring. For the seventh year, few instances of predation on neonates were reported in the area east of Sanctuary River. This correlates with fewer observations of bears and their signs in this area during both spring and fall. This is in marked contrast to events occurring in the 1980s and 1990s when bear sightings and predation on moose calves were common. Radioed cows produced calves at rates similar to previous years. Predation on calves in this area has been the major cause of calf mortality for the past 30 years. During spring 2007, a radioed cow again had twin calves near Riley Creek Campground and occupied the area for several weeks. We closely monitored her interactions with people and dogs. After my departure in early June she remained in the area until mid-July and was closely monitored by rangers and wildlife techs. During autumn, data were gathered on behavioral ecology, mainly on 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 9-10 area. Data on mating success and mate choice were gathered on radioed females. Calves were again relatively abundant in roadside areas during autumn compared to the 1980s and 1990s. Calf survival from May to September was estimated at about 35 percent in 2007, higher than in recent years. Less stable, smaller rutting groups were observed in 2007 compared to recent years. I monitored one group of 5-12 that contained two collared females that remained with the group for the entire rut. The moose population in the eastern part of Denali National Park appears stable following a sharp decline 1970-1990. This was due to low recruitment as a result of high predation rates on young calves, primarily as a result of predation by bears. Current population stability is correlated with less bear predation on neonates.

Researcher	Affiliation	Project
Wolfe		Does a normobaric hypoxia sleep regimen affect work performance at high altitude?
This study was to partially benefit the knowledge of the Air National Guard and was contingent on the use of volunteers from a military unit. Although there were Operational and Wing level approvals, some legal concerns with regards to the liability and pay status of the unit members could not be resolved in time for the study's proposed dates. No work was accomplished in the park.		

◃ Murie Science and Learning Center ▹

Background

The Murie Science and Learning Center (MSLC), hosted at Denali National Park and Preserve, consists of many strong partnerships focused on ultimately increasing the effectiveness and communication of research and science results in the national parks. Specifically, the MSLC focuses its mission on providing research, discovery, and learning opportunities within Northern Alaska National Parks to promote appreciation and caring for our national and cultural heritage. This is the fourth season of operation for the center. Visit the MSLC website at http://www.murieslc.org

Partners

Although based in Denali, the MSLC serves seven other national parks across two NPS Inventory & Monitoring Networks. Partner parks are Cape Krusenstern National Monument, Noatak National Preserve, Kobuk Valley National Park, Wrangell-St. Elias National Park and Preserve, Yukon-Charley Rivers National Preserve, Bering Land Bridge National Preserve, and Gates of the Arctic National Park and Preserve. The area covered by these parks represents more than 50 percent of the lands administered by the National Park Service nationwide.

Other partners include:

- Alaska Geographic (manages and promotes the Murie Science and Learning Center with the National Park Service—providing management assistance for the facility and field camp; experiential education programs; arts programs; services for visiting education and researcher groups; and funding to support the facilities, exhibits, research grants, NPS education programs, and arts programs. Their financial contribution totals approximately 500k/annually)
- Denali Education Center (partners on educational programs, provides housing for researchers (as available), and assists with the Discover Denali Research Fellowship Program)
- Doyon-Aramark Joint Venture (park concessioner who operates the MSLC Dining Hall 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 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 Hall (next door) is shared with the park concessioner. The MSLC field camp is now located within the park by the Teklanika River (Mile 29) and consists of five tent cabins, a yurt and a food & equipment storage shed. 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; in-park transportation coordination and food service. In 2008, the MSLC programming included citizen science programs; curriculum-based education programs for K-12 grades; school-to-work experiential learning programs; internships; multi-day accredited field seminars and teacher trainings; youth camps; science presentations; and research fellowship grants.

Services Specifically for Researchers
The MSLC facilitates science across all the parks it serves in a variety of ways. For example, requests for proposals were solicited from all eight parks related to the MSLC, and approximately $30,000 will be awarded to researchers and science communicators in 2008 (see page 81, "Research Awards"). Access to office space, housing, internet, data sets, equipment, and subject matter expertise are other ways the MSLC assists researchers in the ultimate goal of increasing science-informed decision-making in areas of national significance.

Programs

Citizen Science

ALISON Project. Throughout the 2007-2008 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 nine 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 students, teachers Dorothy DeBlauw and Mark Harris and NPS Education Specialist Kristen Friesen were only turned back on occasion by temperatures colder than -10°F and extremely icy trail conditions. Students provide data that may help detect changes in the ice and snow levels throughout the state over time through this ALISON citizen science program.

Youth Camps

Denali Backcountry Adventures. This week-long learning camp for high school students was developed in partnership with the Denali Education Center, 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 12 participants and two instructors and the group spends three nights in Denali's backcountry. Areas for exploration and monitoring are identified by park managers. In 2008, the MSLC will offer the Denali Backcountry Adventures camp July 14-17 with a skill building workshop on July 11.

Denali Discovery Camp. This will be the ninth 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 Education Center, 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 23 – 27, 2008.

Denali-Susitna Exploration Camp. This camp offers local youth from the Northern Susitna Valley the opportunity to explore the natural and cultural history of the area utilizing technology. Developed in partnership with Kigluait Educational Adventures and Upper Susitna Soil and Water Conservation District, the camp also seeks to foster leadership skills in local high school

students who serve as youth leaders for the participants in grades four through seven. In its fourth season, camp participants and youth leaders will culminate their knowledge through the creation of podcasts (sixth and seventh graders) or a play (fourth and fifth graders) that will be presented to the community. The camp will take place June 2.

Alaska Summer Research Academy. July 14-25, the Alaska Summer Research Academy (ASRA) will offer two programs in Denali for students grades 8-12 who are interested in working with university faculty and industry professionals. "All Shook Up in Denali: Earthquakes Module" will explore seismic activity. The "Photography Module" will include photo documentation of landscapes in the park. ASRA is sponsored by the University of Alaska Fairbanks in partnership with the National Park Service, the MSLC and other partners. For more information visit: www.uaf.edu/asra.

Field Seminars and Teacher Training

Field Seminars. The MSLC will be offering 14 field seminars in the 2008 season. These multi-day seminars are active learning experiences that cover a range of topics including geology, wildflowers, birds, large mammals, Dall sheep, bears, science of fly fishing and field journaling. Most courses are based out of the MSLC field camp, located within the park near the Teklanika River at mile 29 of the park road. Many park research staff members serve as leads and content experts for the seminars. All field seminars are available for optional university credit through the University of Alaska - Anchorage.

Teacher Training. The MSLC will offer four teacher trainings in June and July. These three- to four-day programs will investigate using i-movie, science writing, paleontology, and wolf ecology. All teacher trainings include one to three credits through the University of Alaska - Anchorage or the University of Alaska - Southeast.

Day Programming

Experience Denali Excursion. This MSLC program, offered 3 days per week, helps Princess Tours visitors explore wildlife and wildlife research in Denali through small-group outdoor-based activities with MSLC science instructors, funded by Alaska Geographic. Participants learn about different habitats as they travel by bus to the Savage River area, where they take a short walk and participate in hands-on activities. This program coordinated by the Alaska Geographic returns all proceeds to the Murie Science and Learning Center operations, approximately $207,500 annually.

Discover Denali. Developed to provide a meaningful park experience for Royal-Celebrity Tours passengers, this fee-based program is offered every Monday, June – September in partnership with the Denali Education Center. The program consists of a lecture in the MSLC classroom, a skins-and-skulls hands-on session, interpretive walk through an area significant in early park history, and a ranger-introduced viewing of the new park film. A portion of the proceeds support the Discover Denali Research Fellowship Program, approximately $30,000, annually.

Science Series Presentations. The MSLC staff, funded by the Alaska Geographic, also offer free science presentations to the public. These one hour presentations in the classroom provide park visitors with an in-depth glimpse into current research areas in Denali and expose them to content not otherwise being shared with the public. The programs are offering approximately 5 times per week.

Evening Speaker Series. The MSLC and Alaska Geographic hosts guest speakers throughout the summer as the opportunities arise. Guest speakers include; park researchers, visiting researchers and conservationists, writers, artists, and adventure travelers.

Special Programming

Education Internship. 2008 will be the fourth year of the MSLC offering the summer education internship. These 14-18-week internships expose students to all facets of education programming and provide field experience in areas of experiential education as well as research and park management.

Custom Education and Facility Services. The MSLC coordinates the needs for visiting science and education groups. The MSLC arranges short education programs, food services, transportation services and meeting space to these groups.

Research Awards

Discover Denali Research Fellowship Program. 2008 is the third year of the Discover Denali Research Fellowship Program. Recipients are awarded grants up to approximately $5,000 for research, especially projects that will assist park managers with critical resource issues.

Discover Denali Research Fellowships are made possibly by the Denali Education Center through the MSLC. Fellowships were awarded in 2008 to the following researchers (listed alphabetically), conditional on their obtaining a research and collecting permit as with any research project in a national park:

- Patrick Brennan, Purdue University (graduate student)
  "A park visitor's view of the growth of a continent" [Hines Creek fault]

- Dr. Jessica Cable, University of Wyoming
  "The consequence of permafrost degradation and plant water use strategies for plant community composition"

- Dr. Alexander Milner, Institute of Arctic Biology, University of Alaska
  "Hydroecology of upwelling zones in a glacierized catchment: pinpointing water sources and spatial extent"

- Kirk Stueve, Texas A&M University
  "Spatial patterns of tree establishment at the alpine treeline ecotone: Denali National Park"

- Susi Tomsich, University of Alaska Fairbanks (graduate student)
  "Integrated paleoenvironmental reconstruction of the lower Cantwell Formation in the Sable Mountain area, Denali National Park, Alaska"

In 2007, the following research fellowships were awarded:

- Roseann Densmore, USGS Alaska Science Center
  Monitoring the success of the Caribou Creek restoration project
- Michael Loso, Alaska Pacific University
  Trajectory and fate of human waste on the Kahiltna Glacier
- Robert Newman, University of North Dakota
  Population biology of the wood frog in Denali National Park
- David Sunderlin, Lafayette College, Easton, Pennsylvania
  The floral ecosystem in the lower Cantwell Formation of Denali National Park and Preserve: evolutionary, paleoecological, and paleoclimatic implications
- Martin Wilmking, Greifswald University, Germany
  A shrubby future for Denali? – Investigation on the effect of a recent warming on alpine shrubs in Denali National Park and Preserve

Murie Science and Learning Center – Research Awards. For the first time in 2008, financial support was available for research projects in any of the eight national parks across two NPS Inventory & Monitoring Networks (Central Alaska Network or Arctic Network). These research awards were provided by the Murie Science and Learning Center through Alaska Geographic. Three of the awards were offered to researchers working in or near Denali. The awards were conditional on obtaining a research and collecting permit, if working within rather than near a national park:

- Andrew Brown, University of Alaska Fairbanks (graduate student)
  Denali National Park and Preserve
  "Developing a multi-year trend model for habitat use of wood frogs in Denali"

- Barbara-Lynn Concienne, University of Colorado, Boulder (graduate student)
  Denali National Park and Preserve
  "Microbial succession in soils at retreating glaciers"

- Hanna Lee, University of Florida (graduate student)
  Denali National Park and Preserve
  "Monitoring effects of climate change and permafrost carbon in Denali National Park"

- Gretchen Roffler, USGS, Alaska Science Center, Anchorage
  Wrangell – St. Elias National Park and Preserve
  "Evaluating the genetic structure of Dall's sheep in Wrangell – St. Elias National Park and Preserve"

- Dr. Patrick Sullivan, University of Alaska Anchorage
  Noatak National Preserve
  "Microtopographic controls on treeline advance in Noatak National Preserve, Alaska"

- Andrew Tremayne, University of Wyoming (graduate student)
  Gates of the Arctic National Park and Preserve
  "Dating the Denbigh Flint Complex in Alaska's Brooks Range"

In 2007, the MSLC Researchers Awards were given to three researchers for projects at Denali:

- Chris Arp, USGS, Alaska Science Center
  Using beaver colonies as a model for ecosystem disturbance and recovery in Denali

- Jason Dortch, University of Cincinnati

Terrestrial cosmodating of the Wonder Lake moraines, McKinley River Basin: in pursuit of understanding the nature of glaciation and climate change in the Denali National Park

- Alexander Milner, Institute of Arctic Biology, UAF
  Hydroecology of upwelling zones in a glacierized catchment

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

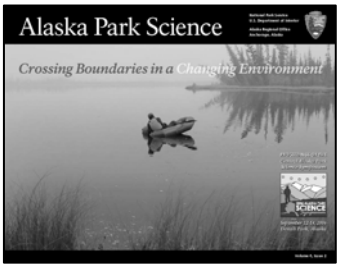
Selected Resource Highlights from 2007

Another wildly successful summer for fossil finds

Field work in 2007 by three research teams and Denali park staff brought the fossil tally for the Lower Cantwell formation to hundreds and hundreds of dinosaur tracks (theropods of various sizes and hadrosaurs) and other traces (skin impression, feces or coprolites). Fossil traces are also numerous for plants, invertebrates, and vertebrates (fish and birds). Searches for evidence of dinosaurs and how they lived (entire ecosystems) will continue in 2008. See pages 38-39, 58-59.

Road study – update from 2007, what's planned for 2008?

What makes for a great visitor experience on the park road? This question is being revealed in an integrated study of traffic, wildlife, and visitor experience that began in 2006 and continues in 2008. Researchers from the University of Vermont and the University of Minnesota continue to collaborate with Denali staff to conduct the multifaceted research. See pages 2-7.



Alaska Park Science Symposium –proceedings is published

"Park Science in Central Alaska: Crossing Boundaries in a Changing Environment" was the theme of the Alaska Park Science Symposium, held at Denali in September 2006. Expanded abstracts for selected papers are published in a recent issue of Alaska Park Science. See page 9.

Looking Ahead – 2008 and Beyond

- **Denali's Resource Stewardship Strategy**

  In 2008 Denali will complete a Resource Stewardship Strategy (RSS) that will guide its research and resource program for the next 15 to 20 years. The RSS document describes the desired conditions for park resources and values based on what the General Management Plan specifies, selects indicators to evaluate resource condition, and lists strategies and projects needed to maintain Denali's resource values. See page 1-2.

- **National Park Service Centennial 1916 – 2016**

  The National Park Service (NPS) will celebrate its 100th anniversary in 2016. To strengthen and prepare parks for another century of conservation, preservation, and public enjoyment, the NPS is funding many parks to address park issues prior to the centennial year. The goal is to initiate projects now so the NPS can celebrate its accomplishments 10 years from now. Denali is funded to address deficiencies in museum standards and restore all park areas affected by Kantishna mining.

  Our national parks are an inheritance we will hand down to our children and grandchildren. We invite all Americans who cherish this inheritance to rise to the challenge so the 100th anniversary of our national park system will be a great celebration of our country and our heritage. –Dick Kempthorne, Secretary of the Interior.