Science in the Park

Why conduct scientific studies at Denali?

Denali is a remarkable place for piquing the curiosity of visitors, park managers, and researchers. Myriad questions in nature's classroom call for the scientific satisfaction of answers… Why have some of the low shrubs turned brown near Park Headquarters? What is the best method to reduce dust on the road? What are the effects of snowmachine exhaust on stream quality? How does winter severity affect animals and plants in the park? Is the treeline changing because of global climate change? Does the nutritional quality of willow and dwarf birch leaves determine how many calves moose will have? Why do glaciers surge (show advancing waves within the glacier)? How does air quality at Denali compare to other parks nationwide? Do the harvest limits or seasons for trapping or hunting in the preserve need to be adjusted because of wildlife population trends?

Seeking answers to questions about how Denali ecosystems work is the "stuff" of Denali science. Denali science takes on an international importance because the ecosystems at Denali are globally significant—there are few places today that haven't been greatly affected by human activities and land development. Where in the world can researchers study largely pristine mountain and subarctic landscapes? The answer is Denali! Within Denali's boundaries, there are 2.4 million hectares (6 million acres) where wildness and wilderness still predominate. At Denali, there are outstanding opportunities to study plants of the tundra and taiga (boreal forest), wildlife, geology, soils, air quality, glaciers, and streams in a condition unrivaled in few places outside Alaska.

Despite the fact that Denali's ecosystems are relatively pristine, because Denali ecosystems have connections far beyond the park boundaries, what happens elsewhere influences park resources. Science recognizes the importance of understanding these linkages and of being alert to how changes at Denali may signal warnings about more global conditions. Air quality monitoring at Denali reveals air pollutants that are transported from other continents. The health and status of migratory species that spend only a portion of their lives at Denali may reveal factors affecting the animals during their travels and in their far-away habitats. For example, the chum and coho salmon that spawn in the Upper Kantishna River are miles and miles from where they lived their salty lives in the Bering Sea. Golden eagles soaring over Denali in the summer spend the winter as far south as northern Mexico.

Not only does park science satisfy the curiosity of researchers and visitors, and increase our basic understanding of subarctic ecosystems, but what we learn about Denali's ecosystems also helps park administrators make informed management decisions. Understanding Denali's resources through scientific studies is critical to knowing how to care for them as a lasting natural and cultural legacy.

What is park science?
Research in the broad sense (also called science) is an approach to learning new facts or information that relies on careful study and investigation. Scientists uses rigorous sampling techniques to obtain unbiased results. Depending on the focus, park science is either *inventory, monitoring, or research*. Park managers rely on information from all three approaches to make informed decisions about the management of park resources and to resolve problems. Some projects use more than one type of science.

Inventory
Inventories are designed to assess the status of a resource at a given time. Inventories describe the resource in terms of what's there (e.g., what plant species occur in the park?), its distribution (e.g., where are the cabins used for winter patrols by dogteams?), abundance (e.g., how many glaciers are found on the north side of the Alaska Range?) or condition (what is the percent body fat on bears emerging from dens?)

Monitoring
Monitoring tracks a resource over time. Scientists rely on repeated observations or measurements to detect changes or trends in presence, numbers, distribution, or condition of a resource. Examples of questions to be answered by monitoring would include: Has the number of wolves changed over the last two decades? Have non-native plants including dandelion spread westward from the Savage Checkpoint along the road corridor? Have bear-human interactions increased or decreased since the 1990's?

Research
Using the *scientific method*, researchers develop a hypothesis to explain how things work in nature. If the hypothesis is not supported by the data collected, then a new hypothesis is developed. Hypotheses being tested at Denali include…Moose populations are larger after harsh winters when wolves' movements are hampered by deep snow. Joe and Fanny Quigley's lives typified life in the Kantishna mining camps.

How long has science been a part of Denali?

Scientific studies have been important at Denali for decades. During the early years of the park, keen observations of wildlife and the mapping of geologic features laid the groundwork for later scientific studies. Since the park's inception, there have been more than 600 natural and cultural resource studies conducted in the park, counting those one hundred or so that are underway at present.

Historical Studies at Denali (Mount McKinley National Park)

Any history of science in the park is sure to mention these naturalists and scientists. Earliest pioneering work preceded the establishment of Mount McKinley National Park in 1917.

- **A.H. Brooks** recorded the first field observations about the topography and geology of what is the northern half of the park while on a U.S. Geological Survey (USGS) expedition in 1902.
- **Stephen Capps** led several USGS mapping expeditions in Alaska. He studied mineral deposits in Kantishna in 1916, but also recorded wildlife observations.

- **Charles Sheldon** systematically observed the wildlife of Denali, including Dall sheep during the period 1902-1906. As a hunter-naturalist, he helped create the park-refuge idea that resulted in the protection of Mount McKinley National Park in 1917.
- **Olaus Murie** worked in and around the park in 1920-1922. He added to the biological work begun by Sheldon, describing the flora and fauna using the life-zone concepts of the time.
- **Adolf Murie** conducted numerous studies on mammals, birds, and their ecological connections from the early 1920's through the 1970's. His fieldnotes and letters are philosophical as well as scientific. His works include *Wolves of Mount McKinley* and *Grizzlies of Mount McKinley*.
- **Joseph Dixon** and **George Wright** conducted early surveys of birds and mammals in Denali in 1926. Dixon returned to Denali in 1932 to complete his study of animal life. By studying the dynamics and geography of the flora and fauna, they fostered the development of ecological thinking. Wright thought only science-based management could save parks from exploitation and development.
- **Bradford Washburn** spearheaded a 90-day expedition for weather observations on Mount McKinley in 1947. They also made sufficient survey measurements to produce a detailed map of "the roof of North America" that is still in use today.

What current scientific studies are there?

Recent and on-going projects probe questions in the natural and social sciences, and about Denali's cultural and subsistence resources. Some studies are completed in one to several years while some monitoring projects will continue indefinitely. Some scientific projects are conducted by park staff (~50%), others have been planned or funded by the park but contracted out to cooperating researchers (~20%). The remainder of projects are carried out by investigators from universities, organizations, or other agencies with independent funding.

This partial list of recent or on-going projects illustrates the variety and scope of Denali science.

Natural Sciences (biological and physical)

Inventory

Floristic inventory of Denali NPP
(to collect plants to find species not previously documented in the park)

Lepidoptera (butterflies and moths) and Bombidae (bees) of Denali NPP
(to list what species of butterflies, moths and bees live in the park)

Spiders of Denali NPP
(to list what species of spiders live in the park)

Denali soils inventory
(to describe soil layers by digging pits at numerous locations, and to map the park's soil types)

Denali landcover mapping
(to map the park's vegetation using a combination of satellite images and field sampling)

Brown and black bear surveys in south central Alaska
(to determine the density of brown and black bears in the park south of the Alaska Range)

Insect diversity and habitat types
(to identify possible associations of insects with certain plant communities)

Assessment of the status and threats of exotic plants
(to evaluate the distribution of the park's exotic plants and their threat to native species)

Monitoring

Monitoring wildfire activity in the park
(to locate wildfires each year and determine what areas are the most prone to fire)

Trumpeter swan surveys
(to determine if the number of trumpeter swans is increasing, decreasing or stable)

Wildlife observations and monitoring by busdrivers
(to record changes in numbers and species of wildlife observed along the park road)

Soundscape inventory and monitoring in the park
(to determine the level of sounds heard at sites in the park in high- and low-use areas)

Soil slump-mudflows along the park road
(to measure how fast the slump-mudflows are moving and assess what risk they pose to the road)

Seismic monitoring
(to document seismic activity (earthquakes) in the park)

Denali's Long-term Ecological Monitoring Program
(to monitor and detect changes and trends in such attributes as…

- Location of treeline
- Inter-annual variation in growth and reproduction of white spruce
- Wolf, caribou, grizzly bear, and moose populations
- Abundance, productivity, and survivorship of songbirds
- Raptor populations (eagles, gyrfalcon, merlin)
- Golden eagle nesting productivity
- Small mammal community dynamics in different habitats
- Aquatic invertebrates
- Water quality and flow, erosion, and sediment size of reference stream channels
- Snow depth, density, and water equivalent
- Weather
- UVB
- Air quality
- Glacier movement and mass balance

Research

Road traffic impacts on wildlife
(to determine whether animals avoid or prefer being near the park road)

Impacts of snow compaction from snowmobiles on soil temperature and vegetation
(to test the relationship between temperature of soil in the spring, vegetation growth, and compaction from snowmobiles)

Comparison of ectomycorrhizal fungi in early successional sites across a latitudinal gradient
(to compare for different latitudes how fungi associated with plant roots help plants colonize disturbed areas such as glacial moraines)

Population dynamics of wolves and their prey
(to determine wolf density and population trends in relation to mortality, availability of prey items, and the number of young)

Ecology of moose
(to learn about the ecology of moose behaviors associated with calving (spring) and the rut (fall))

Productivity of moose in Interior Alaska
(to determine the relationship between the nutritious proteins or non-nutritious tannin compounds in the willows and other plants they eat and the number of moose calves they produce)

Breeding biology and dietary analysis of northern hawk owls in interior Alaska taiga forests
(to learn what northern hawk owls eat, and what nesting habitat they select)

Assessing breeding habitat, movements, and survivorship of golden eagles in and from Denali
(to study where golden eagles nest from year to year and how this affects the success of raising young for each pair of eagles)

Assessing the presence and potential impacts of polyaromatic hydrocarbons from snowmobiles
(to assess how products from snowmachine exhaust affect stream water quality and organisms)

Monitoring freeze-thaw transition on a regional scale in boreal forests
(to determine how latitude in Alaska affects the process of soil freezing and thawing)

Use of pulsed radar to determine characteristics of snow
(to predict avalanche hazards using pulsed radar from aircraft to check snow properties)

Tectonic studies of the Alaska Range using temporary seismometers
(to describe the mountain building associated with tectonic plates in the Denali area)

Developing a geologic cross-section through Denali NP--Analysis of the Kahiltna Formation
(to make a map of the geology of the park showing a cross-section of the Alaska Range)

Social Sciences

Monitoring

Subsistence use community profile
(to interview subsistence users about their resource use and to identify any trends over time)

Backcountry visitor use
(to record and assess trends in the number of backcountry users of the park)

Concession statistics
(to record and assess trends in the number of users of concession programs (buses, flightseeing, guides)

Aircraft use monitoring
(to record and assess trends in aircraft use over the park and landings in the park)

Visitor satisfaction with the bus system
(to assess how the visitor viewed and valued the Denali bus experience)

Research

Relationship between acute mountain sickness and rating of perceived exertion in climbers
(to determine how exertion by climbers and the mountain sickness they experience may be related)

Studies of traditional ecological knowledge of fish resources
(to interview Native Alaskans and others involved in subsistence fishing to learn about customs, harvests, and trends related to fisheries)

Removing human waste associated with mountaineering expeditions
(to test pack-out bags to address the problem of human waste while mountaineering)

Cultural and Subsistence

Inventory

Parkwide ethnographic study
(to determine the Native Alaskan history and culture in the Denali vicinity)

Native place names mapping
(to map the Native Alaskan names for the natural features in the Denali vicinity)

Mountaineering history "jukebox"
(to document and present oral history of Denali mountaineering through short videos of interviews with climbers)

Monitoring

Condition assessments of all cultural sites (mining camps, backcountry cabins, buildings, etc.) (to determine what work is needed to maintain or restore cultural sites) Assessment of salmon in the Tanana and Kantishna Rivers (to use fishwheels to recapture marked fish to learn how many salmon return upstream in the two major watersheds of the Tanana River)

Research

Effects of hunting and trapping on population dynamics of large mammal populations (to determine if bag limits or seasons for trapping and hunting should be changed based on population trends)

What are the logistics of park science?

Park science has many tools. Some projects rely on satellite images or maps, while others use "fieldwork" or personal interviews. Every project has its own methods. Some studies deploy specialized instrumentation and gadgets, technical contraptions that record information about temperature or sound, or more commonplace items such as compass, binoculars, shovels, and rock hammers. Other projects might use vials, fish wheels, increment borers, plant presses, radio-collars, binoculars, bird bands, seismometers, needles, and probes. Some methods have changed over the years, while others have changed little.

Science happens along the road corridor and in remote locations of the park. Scientists haul gear and themselves around by helicopter or fixed wing aircraft, or travel on foot, by boat, or in vehicles along the park road. The high cost of travel and the time it takes to travel to remote locations have to be taken into account when decisions are made about what research can be accomplished in a given field season.

Any scientist wanting to conduct research must submit a study proposal and fill out an application. Usually the project has been discussed with a park liaison who makes sure the project fits in with the overall science goals of the park. Appropriate research gathers information while making minimal impacts to park resources. Permits are granted for some limited collecting of objects, whole organisms, or parts of organisms. In past projects, collections have been made of plant roots or leaves, or the entire plant, voles, moose pellets, feathers, rocks, or soils. Some of these samples are destroyed while being analyzed. Some animals are collected and released after they have been measured or tagged. Data and records are kept in fireproof file cabinets. Archived documents and collections are housed in the Denali park museum.

How has science benefited the park?

At Denali, managers have applied science findings in several ways. For one, science has helped park staff *develop efficient methods to inventory and monitor* the natural and cultural resources the National Park Service is mandated to protect. In addition, park administrators use information from scientific studies to *make management decisions* that minimize impacts on resources. Managers also apply scientific knowledge to *mitigate impacts* of past disturbances or to resolve park problems. For example, research may give insight into the most effective treatments for restoring lands that have been altered by mining or construction by removing exotic species and revegetating disturbed areas. In the following examples of how science has benefited Denali National Park and Preserve, which ways of applying park science are illustrated?

- Hunting for new plant species in a 6-million acre park

The location of trips to search for plants species expected to be in the park but not yet documented have been chosen by sorting the expected species list by where the species were likely to be found (by habitat, landscape position (elevation), and geographic regions of the park. The combinations of habitat type, elevation, and region that were expected to yield the most "new" plants were targeted for further exploration.

- Acquiring river gravel for park roads

Gravel to maintain Denali's 90-mile access road is excavated from the braided Toklat River using scrapes that have been determined to best mimic natural meanders. Some scrape patterns are not used because they were slower to refill with gravel and slower to recover a natural appearance.

- Assessing impacts of subsistence harvests

Results of wildlife research provide managers with information on what kind of natural fluctuations in wolf populations are to be expected. As long as the wolf mortality due to human harvests is a minor percentage of the mortality of wolves, harvest limits and seasons can remain unmodified.

- Deciding when there's adequate snow

Studies of seasonal snow depth and density help provide guidelines for "adequate snow cover" for snowmachine use in the preserve. Managers rely on reports of snow conditions in certain areas to determine if these areas would be opened to snowmachine use. Only when the snow conditions are such that snowmachine use will not damage vegetation would the areas be open for use.

- Locating new facilities

New visitor facilities on the south side of the park will be located with the knowledge of where the development would have the least impact to natural resources. To map potential nesting habitat for waterfowl and raptors, habitat variables measured in known nest locations were included in a predictive computer model.

- Protecting cultural resources

To reduce risk of wildfire damage to cultural features, such as historic cabins, fire management crews remove trees and brush around these features. How much area is cleared of "hazardous fuels" is based on past studies of fire fuels and fire behavior.

- Restoring Caribou Creek watershed

Several methods of reconstructing the stream bank were compared, and the one that was most effective at restoring the vegetation was selected for use in the Caribou Creek watershed where mining had channelized the stream in the 19xx's.

During your visit to the park, you are encouraged to ask, how does or could science help resource management at Denali? What questions do *you* think should be answered by scientific studies at Denali National Park and Preserve?

More about science at Denali

The National Park Service promotes research in parks and wants to make the scientific heritage of the national park system more accessible to scientists and the public. Denali National Park and Preserve strives to have park science shared via interpretive programs, information shared by busdrivers, programs for school groups and the public, posters, and presentations at professional meetings. By promoting science at Denali, and by utilizing the results of scientific studies, Denali reinforces the idea of "Parks for Science, Science for Parks".

Here are a few ways to learn more about science at Denali National Park and Preserve:

Science results on the web
Each year investigators at all National Park Service parks submit a brief synopsis of their science findings via the Investigator Annual Report. Anyone can read these reports at the website: http://science.nature.nps.gov/research. It is possible to search for projects of interest by National Park Service region, by park, by key words in the title, or by year.

Applying to conduct scientific studies
Research permits and collecting permits are required to conduct scientific studies at Denali National Park and Preserve or any other national park. A scientific and administrative review of each proposal helps ensure that the projects are appropriate for the park setting and won't interfere with on-going studies. A web-based application process has been established nationwide. For further information visit the website: http://science.nature.nps.gov/research .

Sabbatical in the Parks
Scientists who are seeking ideas for sabbaticals, and national parks who have research opportunities are matched according to common research interests in a program called Sabbatical in the Parks. For more information, visit the website: http://www.nature.nps.gov/sabbaticals

Denali Science and Learning Center
Nationwide, the National Park Service plans to establish 32 learning centers to facilitate research in the parks and to provide information to the public about the park's resources. Several learning centers are operational now. It is hoped that Denali's Science and Learning Center will be funded in 2003. This center would serve as the focus for cooperative research and educational opportunities for eight park units in northern Alaska.

National Park Service websites
Here are some additional websites of interest to scientists and the public:

- National Park Service: http://www.nps.gov
- National Park Service's Natural Resource Challenge: http://www.nature.nps.gov/challenge/nrc.htm
- National Park Service social science website: http://www.????

For further information about park resources and science in Denali National Park and Preserve, contact the Division of Research and Resource Preservation, or visit Denali's webpage: http://www.nps.gov/dena