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Table of Contents

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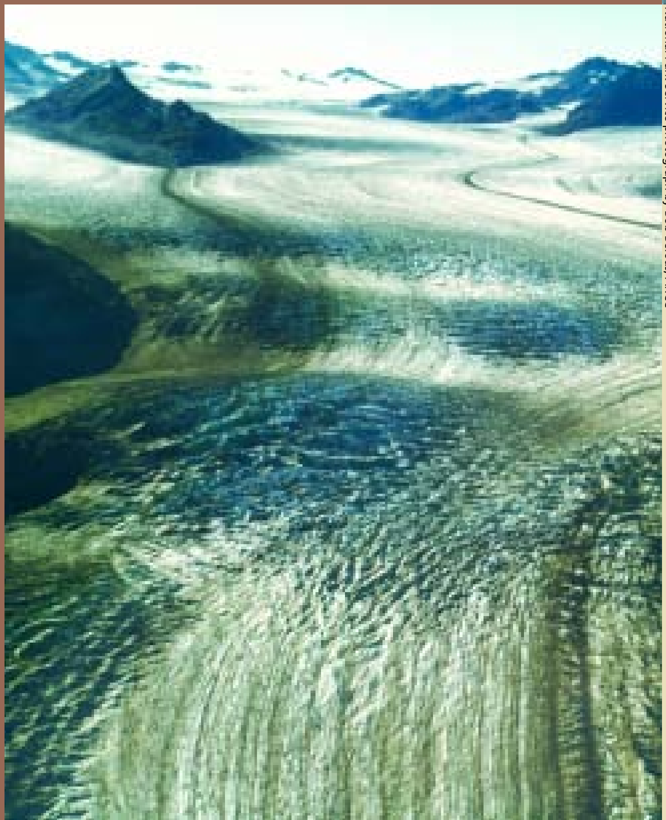
National Park Service photograph by Bob Belous, ARCC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National Park Service photographs by Bob Belous, ARCC

In Celebration of ANILCA

The Carter Center/Rick Diamond

When I was president, I became thoroughly familiar with four maps. One was of Israel and the occupied territories; I knew it almost by heart. I also learned in detail about the Panama Canal Zone. Another focus was on a very small area of Iran. Finally, I learned the map of Alaska.

Just as memorable to me as Alaska's map are the people who were deeply involved in the political contest over the future of her public lands. The debate really began as soon as Alaska became a state and culminated on December 2, 1980, when I signed the Alaska National Interests Lands Conservation Act into law.

This was the largest and most comprehensive piece of conservation legislation ever passed, involving fierce debate and compromise. One of the gifts to the nation bequeathed to us by the act was the 54 million acres of national park lands in Alaska.

The national parks in Alaska are different from parks elsewhere in the nation in both scope and scale. They contain the largest units in the National Park Service system, and most measure their acreage in the millions. Alaska's parks represent two-thirds of the acres in the entire park system and three-fourths of our wilderness areas. Alaska's parks were perhaps the last ones of large size that will be created anywhere in the United States, protecting natural landscapes on an ecosystem scale. And finally, Alaska's parks both preserve an archeological record of more than 10,000 years of human occupation, and are used today by both local residents and visitors. Alaska's national parks are different, but like their counterparts elsewhere in the nation, they represent the promise of the future even as we preserve and honor the past.

This anniversary issue of ***Alaska Park Science*** explores how ANILCA has shaped science in the parks, and provides a history and an overview of the kinds of science needed as a result of the act. It highlights subsistence use—fisheries, caribou, and the human tradition; mining legacy and abandoned mine restoration; access to parks and wilderness; and opportunities for future research. Included is a discussion of what we know and what we need to know to manage these parks in perpetuity.

ANILCA has been in place for 25 years—a generation of excitement and pleasure. The passage of this act is one of the proudest achievements of my presidency and one that will endure through the centuries. Poll after poll has shown that the American people remain firmly committed to the protection that makes these unspoiled lands the envy of the world. It has been my pleasure to introduce this issue of ***Alaska Park Science*** and to join in celebrating the 25th anniversary of ANILCA. Happy Anniversary!

Jimmy Carter

History

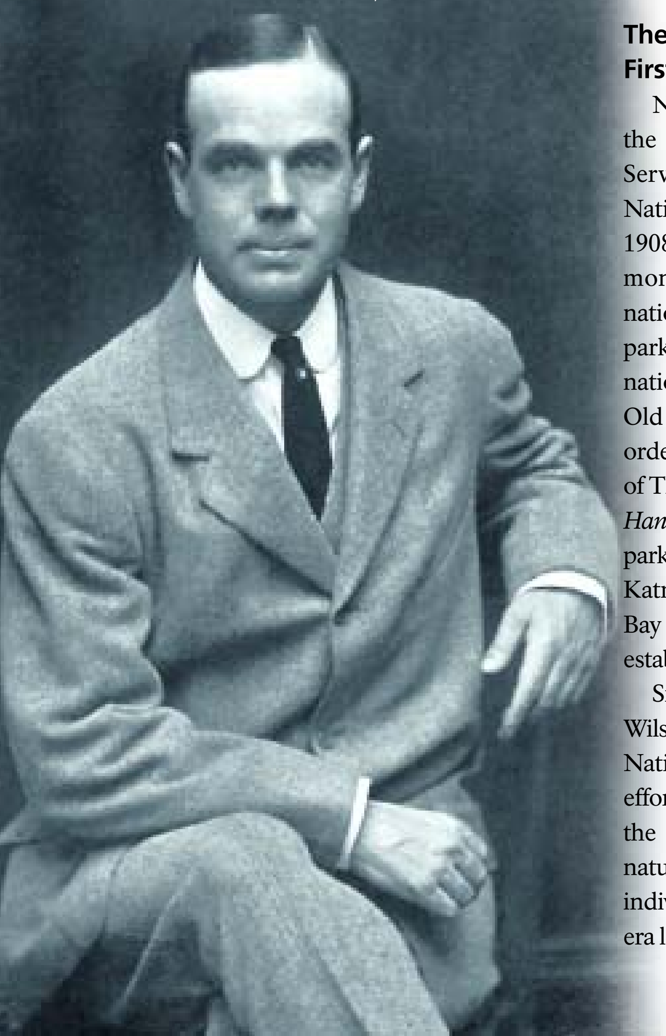
Arno Cammerer, NPS director from 1933 to 1940, made a series of key decisions in the long-running wolf-sheep controversy.

Photograph by Grant/Rinehart, file number WASO-D-713, 3942/3089, NPS Photo Collection, Harpers Ferry Center. National Park Service photograph

Biologist Victor Cahalane's month-long visit to Katmai in 1940 was the basis for his *Biological Survey of Katmai National Monument,* published in 1959.

Photograph by Allan Rinehart, NPS Photo Collection, Harpers Ferry Center. National Park Service photograph

Charles Sheldon was the inspiration behind Mount McKinley National Park; he first visited the area in 1906 and retained a keen interest in the area until his death in 1928. From Sheldon's book, *The Wilderness of Denali.*



A History of Science in Alaska's National Parks

By Frank Norris

The Establishment of Alaska's First Parks, 1910-1925

National park units in Alaska precede the establishment of the National Park Service in 1916. The first park unit, Sitka National Monument, was conceived in 1908, and by the mid-1920s four national monuments along with Alaska's first national park were part of the growing park system. Two small, historically-based national monuments—Sitka (1910) and Old Kasaan (1916)—were established in order to preserve remarkable assemblages of Tlingit and Haida artifacts *(Antonson and Hanable 1987, Norris 2000).* The other three park units, Mount McKinley National Park, Katmai National Monument, and Glacier Bay National Monument, however, were established in the name of science.

Signed into law by President Woodrow Wilson in February 1917, Mount McKinley National Park was largely the result of efforts by Charles Sheldon, who first visited the area in 1906. Sheldon was a hunter-naturalist, one of several public-spirited individuals who helped set Progressive-era land management policy. These wealthy easterners typically combined their love of hunting and other outdoor sports with a broad concern for the protection of wildlife and fish populations *(Brown 1991).* Sheldon was concerned about North America's Dall sheep populations, so he decided to visit their habitat, north of the Alaska Range, in order to study their distribution, habits, and migratory patterns *(Brown 1991).* Though Sheldon loved to hunt, he was primarily a scientist. As Theodore Roosevelt noted in a 1911 book review, *...the most important part of Mr. Sheldon's book is that which relates not to hunting but to natural history. No professional biologist has worked out the problems connected with these Northern mountain sheep as he has done. ... still more notable is his description of the life history of the sheep... (Brown 1991:76).*

And as a fulfillment of Sheldon's wishes, the park's purpose includes "the preservation of animals, birds, and fish and... the preservation of the natural curiosities and scenic beauties thereof."

After two extended expeditions to these gamelands, in the summer of 1906 and between August 1907 and June 1908, Sheldon began to lobby agency officials and legislative leaders for the establishment of a "Denali National Park" in 1915. When asked to draw the boundaries of the proposed park, he took pains to include all areas within "the limits of the caribou run" *(Kauffman 1954:3).* And as a fulfillment of Sheldon's wishes, the park's purpose includes "the preservation of animals, birds, and fish and... the preservation of the natural curiosities and scenic beauties thereof." *(Alaska Planning Group 1974c:558ff).*

Shortly afterward, Interior Department officials undertook a series of activities that brought forth another large park unit, Katmai National Monument. A large area in southwestern Alaska had literally exploded into prominence in June 1912 with the eruption of an enormous volcano, popularly thought to be Mount Katmai *(Hussey 1971).* (Only much later, in 1954, did a scientific party reveal that the actual eruption site was Novarupta, a side vent located six miles west of Mount Katmai.) Not surprisingly, the eruption aroused the curiosity of many in the scientific commu-

Photograph courtesy of University of Alaska Anchorage

Baked Mountain Camp with Mount Martin in the background, 1919.
UAA Archives and Manuscripts Department, National Geographic Society Katmai Expeditions Collection, Box 5, 6061.

nity, and before the end of June, the National Geographic Society (NGS) asked George C. Martin, a U.S. Geological Survey geologist, to travel to the area as part of a long-term volcanic study. However, Martin made it only as far as Katmai's eastern coastline.

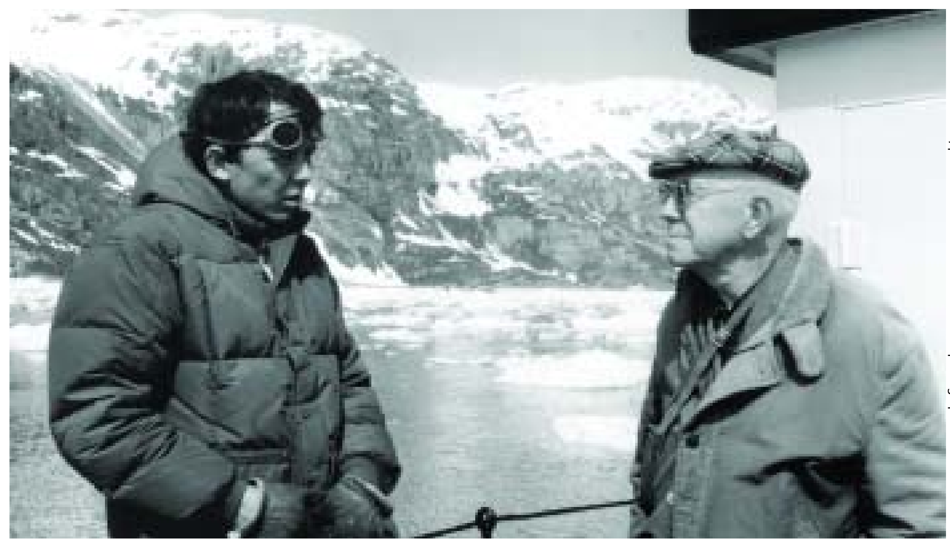
The NGS board of directors, not to be dissuaded, then contacted Robert F. Griggs, an Ohio State University botanist. Griggs had recently botanized on Kodiak Island, and with NGS sponsorship, he traveled to Katmai in 1915, though the team was turned back by poorly-consolidated ash deposits and vast debris clouds *(Hussey 1971)*. The following year, Griggs returned to the area. Before reaching Katmai Pass, he "caught sight of a tiny puff of vapor" —a fumarole or steam jet. Intrigued, he climbed a nearby hillock for a better look, and… *there, stretching as far as the eye could reach… were hundreds—no, thousands—of little volcanoes like those we had just examined… Many of them were sending up columns of steam which rose a thousand feet before dissolving (Griggs 1922:63).*

Griggs was understandably excited by the discovery, but a change in the weather forced a quick retreat. So in 1917, Griggs returned with a ten-man scientific party and spent about a month in the "Valley of Ten Thousand Smokes" gathering geological, chemical, and biological data. The information that they gathered, like that from the two previous years' explorations, was reported in the Society's popular magazine *(Hussey 1971)*.

Griggs was well aware that the "thousands of little volcanoes" had enormous potential for tourists, and after his 1917 trip he wrote that it was "one of the greatest wonders of the world, if not indeed the very greatest of all the wonders on the face of the earth" *(Hussey 1971:406)*. Griggs's reports helped convince the National Geographic Society to encourage protection for the area. With the support of Interior Secretary Franklin Lane and Horace Albright of the National Park Service (NPS), a proclamation was written and forwarded to President Wilson, who signed Katmai National Monument into law on September 24, 1918 *(Norris 1996)*.

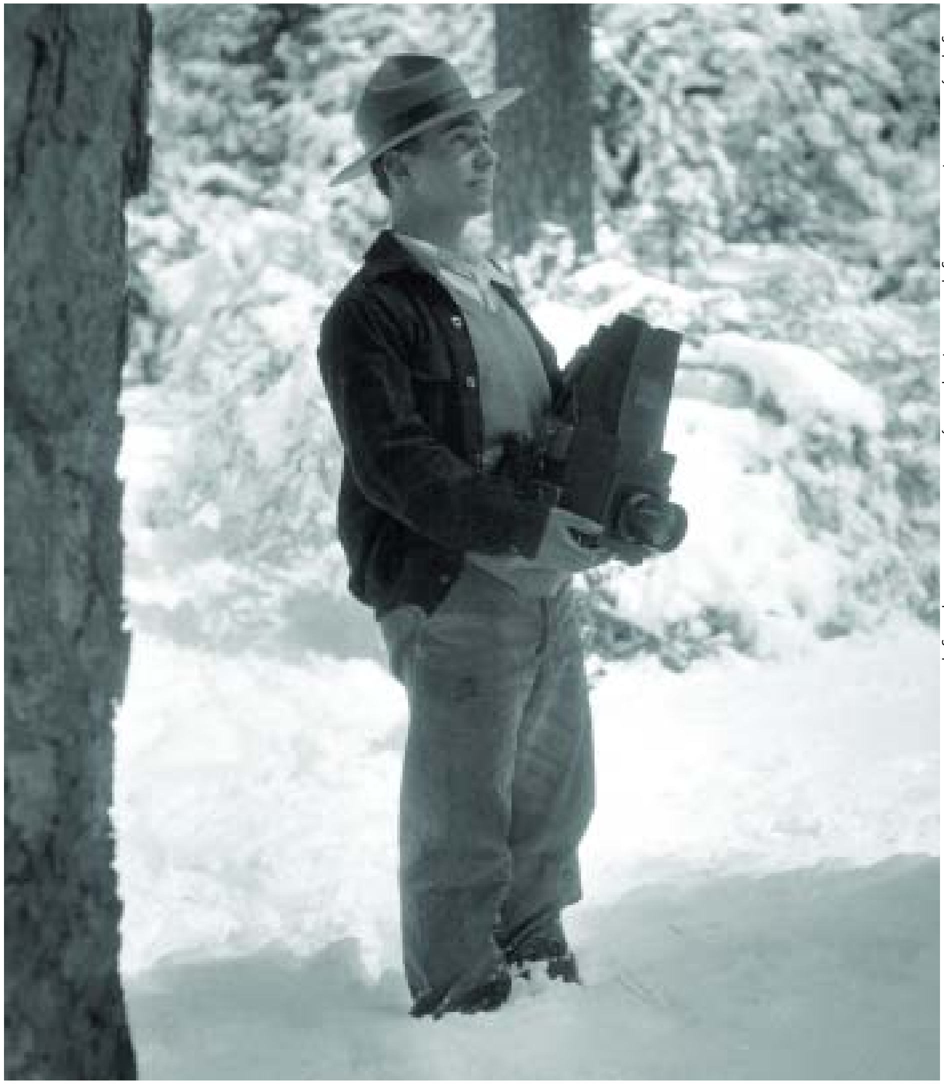
Although Glacier Bay National Monument was not designated until 1925, scientists had been interested in the bay since 1879, when naturalist and advocate John Muir had made the first of several visits. Scientists in Muir's wake included professors George F. Wright (1886), Harry F. Reid (1890 and 1892), and a coterie of experts on the E.H. Harriman expedition (1899). But on September 10, 1899, a major earthquake shattered the face of Muir Glacier and brought an abrupt end to Glacier Bay tourism *(Norris 1985, Catton 1995)*. Few non-Natives visited the bay in the years that followed, but in 1916 a young University of Minnesota ecology professor, William S. Cooper, arrived in the bay. In hopes of making a longitudinal study of changing soil and plant composition, he established a series of one-meter quadrats at varying distances from many of the bay's glaciers *(Catton 1995)*.

Those quadrats anchored a lifetime of glaciological investigation. Equally important, Cooper's visit set into motion a series of events that resulted in the area's 1924 withdrawal and, the following year, its reservation as a national monument. The proclamation made it clear that the monument's primary purpose was scientific; it stated that the area "presents a unique opportunity for the scientific



Robert Howe Collection, photo GB 184, National Park Service photograph

William S. Cooper, (on right) seen here with author Dave Bohn during the 1960s, worked in Glacier Bay starting in 1916. His 1922 speech to the Ecological Society of America started the process that resulted in the bay's designation as a national monument.



Photograph by Carl P. Russell, Historical Photograph Collection, Harpers Ferry Center. National Park Service photograph

George Wright, one of the NPS's first notable scientists, spent two months at Mount McKinley National Park in 1926 collecting mammal and bird specimens.

study of glacial behavior and of resulting movements and development of flora and fauna and of certain valuable relics of ancient interglacial forests" *(Catton 1995:325)*.

Scientific Research in Alaska's Parklands, 1925-1971

During the 40 plus years between the establishment of Glacier Bay National Monument and the passage of the Alaska Native Claims Settlement Act of 1971, no new NPS units were established in Alaska *(Norris 2000)*. In fact, the number of NPS units during this period actually decreased, since Congress removed Old Kassan's designation in 1955. All three of the territory's large units, however, had acreage added. Some of the scientific work performed during this period was done in conjunction with potential or actual boundary expansions, but other work was performed in the support of more generalized natural resource management.

At Mount McKinley National Park, government scientists arrived just a year after the superintendent. In the spring of 1922, a young assistant biologist with the U.S. Biological Survey, Olaus J. Murie, arrived in hopes "of capturing young bull caribou" *(SMR June 1922)*. Later that summer he and a crew built a corral for that purpose at the head of the Savage River valley *(SMR October 1922)*. The corral was used for only a short time, but by the end of the year he had inveigled his brother, biologist Adolph Murie, to return to the park with him. Three years later, Olaus Murie compiled the first classification of the park's flora, fauna, and natural phenomena *(SMR December 1925)*. In 1926, biologists Joseph M. Dixon and George M. Wright spent the summer there "collecting specimens of this park's mammal life" *(SMR July 1926:6)*. Wright, to his credit, was also the first person to discover the nest and eggs of the surf bird, for which scientists had been searching for more than 150 years *(SMR February 1936)*.

In addition to observations by professionals, park rangers at Mount McKinley were asked to make general comments on the number, distribution, and condition of the park's fauna; as a result, monthly government reports provide almost a half-century of observations and inventories of the park's mammals, birds, and plant life and even measurements of the major glaciers.

Much of the scientific attention directed at the park during the 1930s and 1940s pertained to the wolf-sheep controversy. Local sentiment in those days strongly favored killing all wolves and coyotes, and at first, park rangers went along, killing predators from time to time *(Rawson 2001)*. Biologist Joseph Dixon, dispatched to the park in 1932 to ascertain why so many sheep had been lost the previous winter, had a simple solution; he "suggested that the rangers make a little more effort to kill off some of the wolves and coyotes" *(SMR June 1932:3)*. Although the Wildlife Division in Washington, D.C. urged the cessation of all wolf control programs, control efforts were not halted until 1935 by Arno Cammerer, the new director of the NPS. That decision resulted in a strong wave of protest, both from Alaskans and from hunting and conservation groups *(Rawson 2001)*. Just a year later, in fact, he was forced to recant his policy, and from 1936 through 1938 rangers assigned to "springtime predator control" harvested 14 wolves. A year later, NPS officials asked Adolph Murie to return to the park to study its predators and their relation to other wildlife in the park *(Rawson 2001, SMR April 1939)*. Murie spent much of the next three years on his wolf-sheep study, and the product of his efforts, *The Wolves of Mount McKinley,* was published in 1944 *(SMR May-September*

1940, SMR May-July 1941). Murie continued his work, and worked there almost every year until 1970. During those years he conducted sheep and caribou studies, wrote generalized studies about the park's mammals and birds, and penned monographs on the park's bear, wolverine, and small-mammal populations *(NPS 1973, Rawson 2001).*

Some of the scientific work at the other park units during this period was done as part of proposed boundary studies. At Katmai National Monument, the huge boundary expansion of 1931 took place just a year after Robert F. Griggs made an extended visit. Griggs made further observations about plant succession, particularly on the margins of the Valley of Ten Thousand Smokes, and he also appraised the brown bear habitat in areas north and west of the existing monument. Shortly after returning from the area, Griggs recommended the expansion of Katmai's boundaries, primarily to ensure high quality bear habitat. The presidential proclamation that President Herbert Hoover signed on April 24, 1931, more than doubled Katmai's acreage *(Norris 1996).*

At Glacier Bay National Monument, the major scientific presence during this period was Dr. William O. Field, Jr. A young Harvard glaciologist, Field first visited the bay in 1926 and returned every few years for another half century. Because of his work, the NPS learned much about the monument's resources. The agency also sent Joseph Dixon, a wildlife biologist, to the monument in 1932, and six years later, Dixon returned with NPS chief forester John D. Coffman. Both visits were aimed at

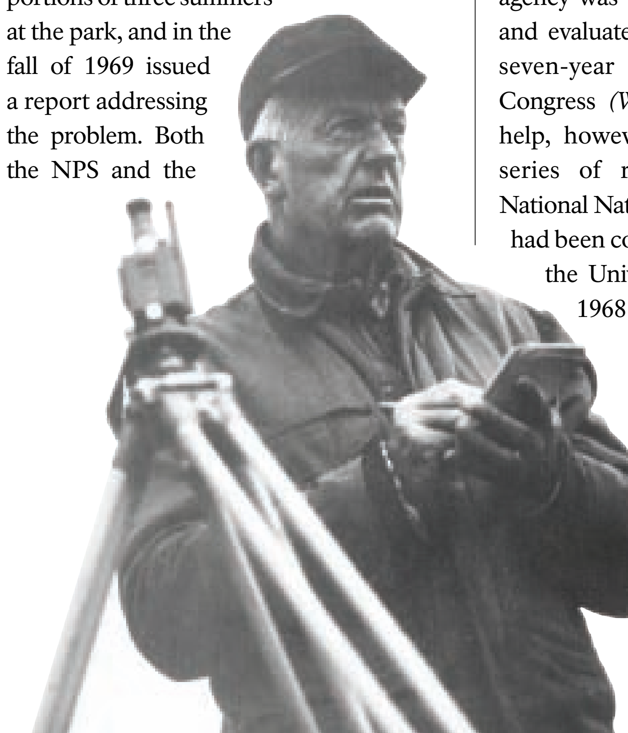
NPS photograph, Denali National Park & Preserve Historical Collection

Mount McKinley's museum opened in 1943. Here, visitors for years afterward learned about the park's natural and human history.

collecting bear habitat data, and both had an ulterior motive: the possible expansion of the monument's boundaries. Based on their research, on April 18, 1939, President Franklin Roosevelt signed into law a major addition to the monument *(Catton 1995).*

During the early 1950s, NPS officials organized the Katmai Project, an interdisciplinary effort funded primarily by the Defense Department. Scientists from universities and public agencies fanned out across the monument and produced a series of papers related to geology, mammalogy, parasitology, entomology, archeology, and similar fields. It was at this time that scientists discovered that Novarupta, not Mount Katmai, had erupted in 1912; another key contribution was Victor Cahalane's biological survey *(Norris 1996).*

During the mid-1960s, Katmai research was focused at Baked Mountain, within the Valley of Ten Thousand Smokes. Here, the University of Alaska Geophysical Institute commenced seismic and volcanic investigations, and researchers collected data each summer from 1965 to 1977 *(Norris 1996).* Katmai was also the scene of groundbreaking bear research. Responding to a 1966 incident in which a bear injured a sleeping camper, the agency asked Dr. Frederick Dean, a University of Alaska wildlife biologist, to investigate human-bear relationships in the area. Dean spent portions of three summers at the park, and in the fall of 1969 issued a report addressing the problem. Both the NPS and the concessioner accepted the suggestions, and the number of bear-human incidents diminished *(Norris 1996).*



Glaciologist William O. Field, Jr. first visited Glacier Bay in 1926. He returned, at intermittent intervals, for decades afterwards.

Photograph by Dave Bohn

Science and the Formulation of New Park Proposals, 1971-1975

The National Park Service entered a new era in December 1971, when President Richard Nixon signed the Alaska Native Claims Settlement Act (ANCSA). Section 17(d)(2) of the act gave the Interior Secretary the authority to withdraw up to 80 million acres "suitable for addition to or creation as" national parks and other conservation areas *(Williss 1985:89-92).* The NPS reacted to ANCSA by commencing a wild scramble to study Alaska's unreserved public lands, with an eye toward proposing appropriate acreage as parklands. The agency was woefully unprepared to study and evaluate such a large area within the seven-year time frame mandated by Congress *(Williss 1985).* Of considerable help, however, was a recently-compiled series of reports evaluating potential National Natural Landmarks. These studies had been conducted under the auspices of the University of Alaska in 1967 and 1968 *(Williss 1985).*

To overcome its ignorance

about other resources, the Park Service dispatched a broad range of personnel into the field in 1972 and 1973, which resulted in numerous environmental impact statements for proposed park lands. In almost every proposal, a primary purpose for protecting an area was its potential for scientific study and analysis. A purpose for the Chukchi-Imuruk (Bering Land Bridge) proposal, for example, was the "provision of opportunities for non-manipulative baseline research on essentially undisturbed representative arctic tundra and coastal ecosystems" *(Alaska Planning Group 1974b:5)*. The Cape Krusenstern proposal called for the NPS to "preserve, scientifically investigate, and interpret the nationally significant archeological remains [and] the geological and biological features of the area," and the Wrangell-St. Elias proposal called for "research and related educational opportunities in northern ecosystems" *(Alaska Planning Group 1974a:1, 1974d:8)*.

NPS Photo Collection,Harpers Ferry Center, neg. 66-182. National Park Service photograph

In 1953 and 1954, several agencies collaborated on the Katmai Project, which brought a diverse group of scientists to the monument. Included in this photo are (front row, left to right) Dr. Rolf Juhle (Johns Hopkins), William F. Thompson (U.S. Army), and Dr. John Lucke (Univ. of Connecticut); (back row) a mechanic, the pilot, and Everett Schiller (Public Health Service).

The CPSU and the Refinement of Park Proposals, 1975-1980

After the completion of the environmental statements for the proposed park areas, both agency professionals and Congress knew that more information was needed to assess their viability. To provide that information, the Interior Department officials tapped the Cooperative Park Studies Unit (CPSU), the University of Alaska Fairbanks-based program that had been in place since 1972. The CPSU consisted of two programs: a Biology and Resource Management Program, chaired by wildlife management professor Frederick Dean, and an Anthropology and Historic Preservation Program, headed by anthropologist Zorro Bradley *(Williss 1985)*.

By the end of 1973, CPSU's natural resource component was handling contracts related to visitation at Gates of the Arctic, biological diversity at Chukchi-Imuruk, and a biological survey of a proposed addition to Glacier Bay National Monument. Later that decade, Dean's program continued its work and churned out reports on geomorphology, climate, limnology, biology, wildlife management, and zoology *(Williss 1985)*.

NPS photograph by Victor Cahalane, neg. 11,922. Harpers Ferry Center

One of the major findings of the 1953-54 Katmai Project was that Novarupta Volcano, not Mount Katmai, was the primary site of the 1912 volcanic eruption.

The cultural resource component first contracted large-area studies under this program in 1974. The first study, of traditional Eskimo life in the proposed Kobuk Valley National Park area, was written by Richard Nelson, Ray Bane, and Douglas Anderson. Following in its wake were subsistence studies of the Aniakchak, Yukon-Charley Rivers, and Gates of the Arctic areas; and by the early 1980s, similar studies had been completed for virtually all of the remaining new or expanded park units *(Williss 1985)*.

Given the results of the many CPSU studies, as well as the efforts of agency personnel, Congress was able to substantially benefit from scientific expertise during its deliberations over the evolving Alaska lands bill. And, perhaps as a result, the Alaska National Interest Lands Conservation Act—passed by Congress in November 1980 and signed by President Jimmy Carter

Photograph courtesy of Zorro Bradley

Zorro Bradley (pictured), an NPS anthropologist, and Fred Dean, a longtime biology professor, ran the University of Alaska's Cooperative Park Studies Unit during the 1970s and early 1980s.

a month later—was laden with scientific references. Of the thirteen new or expanded park units included in ANILCA, five offered specific language calling for future study or research (and for Noatak, it called for a "board consisting of scientists and other experts in the field of arctic research" to be established), while for the remaining units, Congress underscored the need for continued scientific investigation when it called for all units established by the act "to maintain opportunities for scientific research and undisturbed ecosystems" *(Public Law 96-487)*. Science has continued to be a dominant theme in Alaska's parks in the quarter century that has followed ANILCA's passage.

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Old Is Getting Older

Figure 2. Alaska map, showing the general locations of sites older than 8,000 years before present.

By Becky Saleeby and Brian Wygal

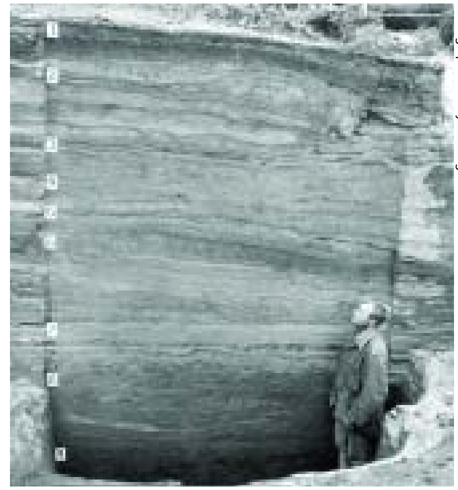
Small and almost undetected on the sweeping landscape of the ANLICA parklands are a scattering of ancient sites where hunters produced, and sometimes discarded, their stone weapons. Obsidian, basalt, and chert spear points, knives, and tiny razor-sharp slivers called microblades *(Figure 1)*, have hidden stories to tell about their makers. It seems incredible that these small sites, sometimes only a few square meters in size, can provide such a wealth of information about the colonization of the vast North American continent. Alaska's earliest known sites have not yet proven to be as old as the oldest in the Lower 48 states *(Anderson et al. 2002)*, but in the last 25 years, persistent archeological survey and improved scientific techniques have resulted in new data which confirms that Alaska sites are actually much earlier than we once believed *(Figure 2)*.

The presence of ancient sites was well known to the framers of the ANILCA legislation. The language of Public Law 96-487 (ANILCA), Section 201, states that several of the newly created park units—Bering Land Bridge National Preserve, Cape Krusenstern National Monument, Kobuk Valley National Park, Noatak National Preserve, and Yukon-Charley Rivers National Preserve—would be managed to protect archeological sites. The oldest of the sites were recognized as providing links between the cultural traditions of Asia and those of North America.

Figure 1: Microblades are a distinctive tool type found at many Alaska prehistoric sites.

Photograph by Richard VanderHoek

Figure 4: Excavation at the Swan Point site, near the Tanana River, Alaska.



Photograph courtesy of Douglas Anderson

Figure 3: Douglas Anderson, who supervised excavation of the Onion Portage site in the late 1960s, points out the many layers of occupation at the site.

The continents, now separated by the waters of the Bering Sea, were once connected in a vast land mass, known as Beringia. Sometime during the last glacial maximum between 21,000 and 17,000 years ago, archeological evidence suggests that groups of people from what is today the Russian far east, began their migration further eastward into North America. Although the routes of their migrations are greatly debated by archeologists, evidence of human presence is well documented by 11,000 years ago, at the end of the geological epoch known as the Pleistocene, when glacial melt waters breached the land and separated Beringia into two continents *(Elias 2001)*.

In 1980 when ANILCA was enacted, archeologists had recorded only a handful of Alaska sites 8,000 years old or older. The dramatic climatic fluctuations and shifts in plant and animal populations at the end of the Pleistocene had leveled off by 8,000 years ago, and the earliest human populations were well established in all regions of

Photograph by Richard VanderHoek

Figure 5: Mammoth tusk fragment, excavated at the Swan Point site.

Alaska. Among the previously recorded sites in the new parklands were Trail Creek Caves in Bering Land Bridge and Onion Portage in Kobuk Valley *(Figure 3)*. Stone tools and bone fragments from several species of animals, including caribou and Pleistocene bison and horse, had been excavated at Trail Creek Caves during the 1960s, but the question of whether human beings were responsible for hunting and butchering these animals was not conclusively determined at that time *(Vinson 1993)*. The picture at the deep, many-layered Onion Portage site was much clearer. The oldest of eight distinct tool complexes was dated at about 8,500 years ago and contained a suite of stone tools, including microblades, similar to those found at Trail Creek Caves *(Anderson 1968)*.

These two sites were dated by conventional radiometric techniques by analysis of charcoal samples from fire hearths or other organic remains, such as bone. The scientific basis of this dating method is that radiocarbon (C14) decays at a known rate, and thus the amount of C14 remaining in a sample can be measured and compared to the level of radiocarbon in the atmosphere in 1950, the year established as 0 BP (before present). Radiocarbon laboratories report the results of the analysis in radiocarbon years before present (rcbp), along with an error factor, giving an age range for human occupation at each site.

The oldest radiocarbon dated Alaska site known in 1980 was the Dry Creek site, near Denali National Park in the Interior. The bones of large Pleistocene mammals, such as elk and bison, were found at Dry Creek, proving beyond a doubt that ancient hunters killed species of animals now extinct in Alaska. There were also a variety of tools, including small triangular or teardrop-shaped stone points. Archeologists hypothesized that these tools might represent a different culture, made by earlier people, than those documented at Trail Creek Caves and Onion Portage. The oldest cultural level at Dry Creek was dated to 11,200 years before present (rcbp), on the basis of charcoal within an ancient soil layer or paleosol at the site *(Hoffecker et al. 1996)*.

National Park Service photograph by Steve Klingler

Figure 6: National Park Service archeologist, Bob Gal, at the Amakomanak site in Noatak National Preserve.

Since 1980, the number of recorded sites with ages of greater than 8,000 years (rcbp)

Figure 7: Sluiceway points found at sites in Noatak National Park and Preserve

National Park Service photographs by Steve Klingler

has increased dramatically; over 50 of these earliest Alaska sites are from all regions of the state *(Wygal 2003)*. The oldest are still found in the Interior, with three in the Tanana Valley — the Broken Mammoth, Mead, and Swan Point sites — considered the most ancient in the state. Artifacts made of mammoth tusk ivory were excavated at the lowest levels of Broken Mammoth and Swan Point *(Figure 4)*, where paleosols and ivory were dated at between 11,600 and 12,000 years (rcbp) *(Holmes et al. 1996)*. One ivory artifact, excavated from Swan Point in 1993 *(Figure 5)*, was thought to be used as a wedge.

The success in finding these early sites has been matched by increasing laboratory capabilities. By using a C14 counting technique called Accelerator Mass Spectrometry (AMS), labs can provide dates on miniscule amounts of carbon or organic materials. For comparison between the conventional and AMS methods, it is useful to look at sample size specifications of Beta Analytic, the largest C14 laboratory in the country. They specify that a charcoal sample of no less than 1.7 grams be submitted for conventional dating, while only 5 milligrams is needed for an AMS date *(Table 1, Beta Analytic 2005)*. The benefit of this significant decrease in sample size is that it is now possible for archeologists to date sites that were previously not datable.

Another extremely significant scientific breakthrough has been in the realm of radiocarbon calibration. The amount of C14 in the atmosphere has varied considerably in the past millennia. Before the mid-1980s, these fluctuations were not accounted for when reporting radiocarbon ages, thus giving erroneously late dates to early sites. To offset and correct for this error factor, radiocarbon dates of ancient trees, such as the bristlecone pine, were compared with growth ring dates (dendrochronology). As a result, scientists were able to produce a calibration curve which now extends back over 10,000 years *(Higham 2005)*. Using this curve, radiocarbon laboratories can now provide archeologists with radiocarbon dates in years before present, and also in calendar calibrated years. For the earliest sites, calibration can add almost 2,000 years to the radiocarbon age. For example, at the earliest level of Swan Point, the mammoth ivory artifacts dated to approximately 12,000 years BP by conventional radiocarbon methods, but were given a more accurate calibrated calendar date (cal BP) of 14,300 years cal BP *(Holmes and Potter 2002)*.

Of all the ANILCA parks, Noatak National Preserve has been the most extensively surveyed by NPS archeologists in recent years *(Figure 6)*. Their success rate in finding early sites along tributaries of the Noatak River was discussed in an *Alaska Park Science* article by Jeff Rasic (2003). He describes a distinctive type of projectile point, known as a Sluiceway point, manufactured with a unique flaking pattern along each side and polished at the base that has been found in as many as 19 sites in northwestern Interior Alaska *(Figure 7)*. Unfortunately, animal bones have not been preserved at the Sluiceway sites recorded thus far, so we are not sure what animals were being hunted. Sites with Sluiceway-like points are dated fairly consistently at about 10,000 -11,000 radiocarbon years, which can be converted to 11,400 - 13,300 calendar years. Clearly, these discoveries bring home the message that old is getting older.

The textbook archeology notion of human beings entering North America overland via the unglaciated portions of the continent in the waning years of the Pleistocene has been challenged by hypotheses about other migration routes, such as along the Beringia coastline. Alaska has traditionally been considered the gateway into North America, but recent theories suggest the possibility of migration routes from the east, across the Atlantic, or from the high Canadian Arctic. Over the next 25 years, the upcoming generation of archeologists will be challenged to search for solid evidence proving, or rejecting, these alternative theories. Even then, the ANILCA parks will continue to give archeologists fertile fields for investigation and for the discovery of sites which will expand our perceptions about the earliest Alaskans and the earliest Americans.

Radiometric Technique			Accelerator Mass Spectrometry Technique (AMS Technique)		
Material	**Recommended**	**Minimum**	**Material**	**Recommended**	**Minimum**
Charcoal	30 gms	1.7 gms	Charcoal	50 mgs	5 mgs
Shell	100 gms	7 gms	Shell	100 mgs	30 mgs
Bone	500 gms	200 gms	Bone	30 gms	2 gms

Table 1: General sample size requirements for radiocarbon dating.

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Subsistence

Winter hunting is an important subsistence activity in many Northwest Alaska communities and park areas.

National Park Service photograph by Bob Belous, ARCC

Subsistence

By John Quinley

Title VIII of ANILCA provided rural residents with a priority for subsistence activities in many parks, activities such as hunting and trapping that were unusual in Lower 48 national parks. Originally managed by the State of Alaska, subsistence users saw an intensified federal management role after a series of state and federal court decisions regarding the terms of the Lands Act and the constitution of the State of Alaska.

A 1988 state case, McDowell vs. State of Alaska, determined that the state's subsistence law illegally discriminated against urban residents *(Norris 2002)*. The Alaska Legislature was unable to resolve the issue, and on July 1, 1990, the federal government began managing certain subsistence activities, primarily hunting. Five years later, in a federal case (Katie John vs. USA), Anchorage District Court Judge H. Russel Holland ruled "the federal government has the legal power and obligation to take over management of subsistence fisheries on all navigable waters" *(Norris 2002:245)*. A year later, the Ninth Circuit Court of Appeals generally agreed, broadening the federal role for a second time.

The effect of the enlarged federal role has been seen not only in the developing mechanics of subsistence management—for instance, proposals made by a public process and the setting of seasons and bag limits by the Federal Subsistence Board—but in a growing series of research projects focused on understanding better the resources and the users involved in subsistence.

The study of subsistence resources in parks has been a mix of long-term work and projects instigated by issues facing the Federal Subsistence Board. An example of the latter was when managers saw declining moose numbers in the Koyukuk drainage south of Gates of the Arctic National Park in 2002. Recognizing the need for current data to support restrictions in the park, in 2004 the NPS and partners conducted the first moose survey in the area since 1987. The research determined that numbers in the park were down from earlier levels, similar to the decline reported south of the park. This information, along with

National Park Service photograph by Bob Belous, ARCC

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National Park Service photograph by Bob Belous, ARCC

A subsistence lifestyle frequently involves many family members and multiple generations participating in taking and processing fish and game.

other factors, led to regulatory changes by the Federal Subsistence Board restricting moose hunting.

Likewise, provisions in the Lands Act regarding access and subsistence eligibility were tested, on the south side of Denali National Park in an area near Cantwell which was added to the park in 1980. Section 811(b) of ANILCA allows "surface transportation traditionally employed…by local residents" for access to subsistence resources. In the Cantwell area, all-terrain vehicles were generally used for subsistence access. While the legal status of that access was debated over the years, there was minimal impact to parkland and the issue was somewhat in the background for both users and park managers.

However, in the fall of 2003, a small number of local hunters ventured into an area where their all-terrain vehicles caused clear disturbance in the wetlands. The park promptly revisited research into whether all-terrain vehicles had been traditionally employed by local residents prior to the establishment of the park. In the early 1980s, park managers had documented some vehicle use as part of doing other habitat research in the Cantwell area. The State of Alaska, as part of its subsistence management work, had also documented access for subsistence harvests, looking at areas both outside and inside the park boundary. Additional information was gathered in the 1990s, but no definitive determination was reached.

As the issue came to a head in 2003 and 2004, more detailed research was employed to fill in the knowledge gaps. The park needed to determine if motorized access to subsistence resources had occurred prior to 1980, and was a multi-generational activity—not just a chance use of a vehicle a year or two before the park was established.

"We interviewed residents, looked at oral histories, maps, agency records that went back several decades, letters, community archives, family photos, mining records, harvest records, and many other actions," Superintendent Paul Anderson said (2005). Don Callaway, an NPS ethnographer, and Hollis Twitchell, the park's subsistence manager, "found a high correlation in the information gathered from many different sources" *(Anderson 2005)*.

"Without question, to a high degree of certainty, we can show a long, unbroken pattern of use of all-terrain vehicles for access to subsistence resources by several families, and how they have shared those resources within the community…Without the legal issues being brought to a head by the 2003 hunting season and requests from the community, I doubt we would have done this extensive work at this time" *(Anderson 2005)*.

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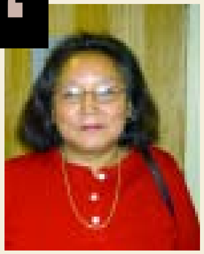
COMMUNITY PERSPECTIVES



Eleanor C. Johnson,
President and CEO of Kijik Corp, Anchorage

"As far as the [Federal government] taking over subsistence, I haven't heard anything negative. I think that's been positive. I think the people felt they had more input and more control as a Native group than under state management…The state just hasn't had a good relationship with subsistence users. And I think people think why not just leave it under federal control, because the state hasn't done that much to help us manage fish and game…even today, I don't see anything that the state has done to come to a satisfactory conclusion for everybody in the state...

Changes in availability of resources are mostly linked to changes in the weather, I think. A couple years ago when we didn't have fish, we had high water and the fish couldn't get up the falls. Now we get kings and silvers where before they were a rare sight. Also, in the past few years I've seen circular sores on the fish that no one had seen before. Even the plants and berries...we used to get all the berries. Now you either get one or the other whereas years ago you had all of them. We're chalking it up to global warming."

Dave Spirtes, 1948-2004

Dave Spirtes left Alaska with his wife and daughter in the spring of 2003, for new challenges as Superintendent of Fire Island National Seashore. Back in his home state of New York, Dave's determination, integrity, and commitment quickly gained the respect of co-workers and community alike. Dave was unexpectedly diagnosed with cancer little more than a year after leaving Alaska, and he succumbed to the illness on April 15, 2004. *Alaska Park Science* is proud to include these tributes to our friend, colleague, and mentor in this article about the Western Arctic Caribou Herd that Dave worked so hard to conserve and protect.

National Park Service photograph by Bob Belous, ARCC

As a friend and colleague of Dave Spirtes for many years, it is fitting to honor his contributions to Alaska parks by dedicating this issue of *Alaska Park Science* to his memory. He had passion for the parks and for the people of northwest Alaska, quietly garnering support and understanding by his personal example. Dave left us too soon—yet his spirit continues to guide our actions in preserving and protecting these special places he loved.

Marcia Blaszak, Regional Director
National Park Service, Alaska Region

Photograph courtesy of Bob Adkins

Dave Spirtes (on left) in 2003 with Ron Arnberger, Alaska Regional Director (retired).

I worked with Dave Spirtes from 1997 until early 2003. We had a mutual interest in organizing and working with the Western Arctic Caribou Herd Working Group, a stakeholder organization concerned with the management of Alaska's largest caribou herd. When we met, Dave was NPS Superintendent of Western Parklands at Kotzebue and I was a wildlife biologist with the Alaska Department of Fish and Game.

Dave Spirtes was a results-oriented administrator who wasn't afraid to try new ideas. He backed up his words with actions. And he had a knack for working effectively with others and producing results. His affable and energetic persona made it easy for people from differing cultures and backgrounds to work with him and, as a result, together. He was particularly effective in working with Alaska Native communities in northwestern Alaska.

Dave wrote the first draft of the Western Arctic Caribou Herd Cooperative Management Plan. He contributed significantly to the growth of shared trust and vision in the Western Arctic Caribou Herd Working Group—no mean feat.

I, along with the WACH Working group, last saw him in Nome, in the bright March sunshine of 2003. Most of the group members were wearing hats that Dave and his assistant Willie Goodwin had made. We had just signed our Cooperative Caribou Management Plan and had said heartfelt good-byes to Dave who was off to Fire Island, New York.

In my mind Dave Spirtes was, and still is, the quintessential public servant in the Alaska natural resources arena. He brought people together, and together they created resource management legacies that will not soon be forgotten.

John N. Trent, Ph.D.,
Supervisory Wildlife Biologist
US Fish and Wildlife Service

Photographs courtesy of John Trent, ADF&G

July 2003, two aerial photos of portions of the Western Arctic Caribou Herd taken south of Point Lay as the herd heads east into the Brooks Range. These pictures form part of a photocensus effort by the Alaska Department of Fish and Game.

ANILCA and the Western Arctic Caribou Herd Cooperative Management Plan

By Don Callaway

What is ANILCA?

The Alaska National Interest Lands Conservation Act (ANILCA) of 1980 was a negotiated Congressional compromise between Native, state, mining, sports, and environmental interest groups. Environmental groups saw a doubling of the National Park and Wildlife Refuge systems and a tripling of the National Wilderness Preservation system. Mining and oil interests saw the opening of Prudhoe Bay with concomitant huge profits. The state also benefited from development of oil, currently 85% of its revenues come from royalties and taxes on North Slope oil development. Rural communities, under Title VIII, were allowed to continue hunting and fishing for subsistence purposes in any area traditionally used in the past regardless of whether that area now exists as a “conservation system unit” (CSU) — e.g., National Parks or Wildlife Refuges.

The framers of ANILCA seem prescient in their structuring of Title VIII, which reflects an awareness of the necessity to integrate local knowledge, values, and cooperation in the framing of a wildlife management regime. This awareness begins with Section 805, “Local and Regional Participation,” which establishes an upwelling of local information, opinion, and input into the regulatory process.

Section 812 of ANILCA, “Research,” directs the Secretary, acting through federal agencies such as the National Park Service, to undertake research on fish and wildlife and subsistence uses on the public lands; seek data from, consult with and make use of, the special knowledge of local residents engaged in subsistence uses…

Finally, Section 809, “Cooperative Agreements,” allows the Secretary of the Interior and his or her agents (e.g., the National Park Service) to share aspects of their authority with other concerned and involved agents.

Essentially these three sections of Title VIII form a vision of how the basic functions of wildlife management may be cooperatively enacted. This article describes how this basic framework was applied by John Trent and Dave Spirtes to overcome the very contentious issue of managing the Western Arctic Caribou Herd (WACH).

The Western Arctic Caribou Herd

In March and April barren-ground caribou begin their great migration, small groups join together and long lines form as they move steadily north. The Western Arctic Caribou Herd ranges over a territory bounded by Prudhoe Bay on the north, south to the Yukon River and west to Unalakleet on the Seward Peninsula *(Figure 1)*.

During their migration, which might encompass several hundred miles over varying routes, the caribou may cross multiple boundaries and jurisdictions, including state, Native Corporation and various federal lands (all with differing management mandates).

The Western Arctic Caribou Herd at 450,000 animals is only one of about 32 herds in Alaska but is by far the largest, comprising about half of the caribou in the state (and about 10% of the world total of 5 million animals). Within the expanse of this great herd's range are nestled about forty small communities that harvest caribou as part of a traditional subsistence lifestyle. In addition, the herd has a number of other human "constituencies," including conservationists, sport hunters, hunting guides, and transporters.

Caribou and Indigenous Communities in Northwest Alaska

The size of human populations embedded in the herd's territory vary; at one extreme is Kotzebue with slightly more than 3,000 people, 75% of which are Inupiat, and at the other extreme is Deering with about 140 people, more than 90% of which are Inupiat.

While the typical U.S. per capita consumption of meat, fish and poultry is about 225 lbs., these two communities in northwest Alaska harvest more than twice that poundage of wildlife resources. While many northwest Alaska communities depend upon caribou for about a quarter of their subsistence harvest, some like Noatak, rely on caribou for nearly half of their subsistence needs *(Table 1)*.

Rural northwest arctic communities are accessible only by air, and bulk items such as food and fuel oil are extremely expensive to transport. In 1990 while Anchorage food costs were about 25% greater than most cities in the Western U.S., the rural communities of northwest Alaska had food costs more than twice that of Anchorage. In 1990 the four communities enumerated in Table 1 had per capita incomes ranging from $5,000 to $14,000. If these communities were forced to replace wildlife harvests with store bought foods, the total replacement costs would range from 13% to 77% of the total per capita income for that community.

And while the nutrition and economic aspects of wildlife harvests seem the critical issue, in fact, it is the social relations in the harvest, processing, and sharing of these resources that are of paramount concern to the Alaska Natives of the region. Subsistence resources and the activities associated with their harvest provide more than food. Participation in family and community subsistence activities, whether it be clamming, processing fish at a fish camp or seal hunting with a father or brother provide the most basic memories and values in an individual's life. These activities define and establish

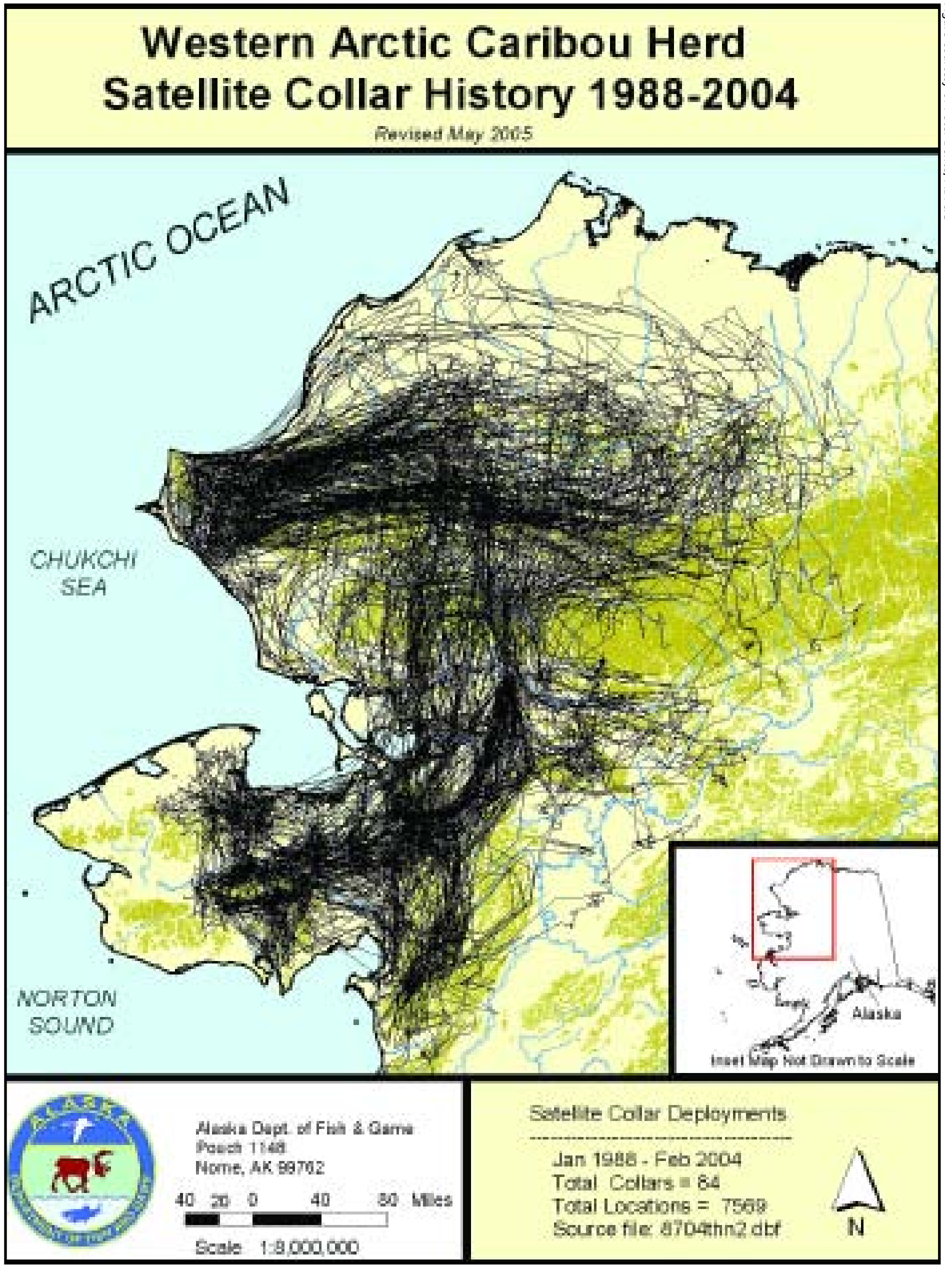


Figure courtesy of Peter Bente, ADF&G

Figure 1: Movement patterns and range use of the Western Arctic Caribou Herd, based on satellite collar locations 1988-2004.

the sense of family and community. These activities also teach how a resource can be identified, methods of harvest, efficient and non-wasteful processing of the resource and preparation of the resource as a variety of food items.

The distribution of these resources establishes and promotes the most basic ethical values in Native and rural culture — generosity, respect for the knowledge and guidance of elders, self-esteem for the hunter engaged in the successful harvest of a resource, and public appreciation in the distribution of the harvest. No other set of activities provide a similar moral foundation.

Community	Human Population	All species harvested, per capita (pounds)	Caribou harvested, per capita (pounds)	Subsistence from caribou, per capita (percent)
Noatak	413	461	221	48%
Kotzebue	3,083	592	141	24%
Kivalina	349	761	138	18%
Deering	136	672	131	19%

Table 1: Community population and per capita subsistence harvests from four communities in northwest Alaska. All of these communities harvest caribou from the Western Arctic caribou Herd.

Conflict: The Western Arctic Caribou Herd Crashes

Caribou lead a precarious existence. The population of large herds fluctuates through dramatic ups and downs, influenced by a complex number of factors. With herds the size of the WACH, the predominant factors seem to be related to climate.

In the mid 1970s the Western Arctic Caribou Herd seemed to have experienced a severe crash. Based on aerial surveys, the herd size went from about 250,000 animals in 1970 to about 75,000 animals in 1976. During this period human harvest was estimated at 15,000-20,000 per year. The Alaska Department of Fish and Game (ADF&G) immediately imposed a harvest limit of 3,000 bull caribou. Unfortunately, the main herd was passing closer than usual to coastal and lower Kobuk River communities, so the villagers who depended on this resource did not believe the biologists' assertion that caribou had sharply declined.

Lacking collared animals, the aerial surveys had probably missed a significant number of animals that had been seen by Native hunters. This conclusion is supported by the fact that two years later another survey counted over 106,000 animals, a 30% increase over the 1976 estimate. It is extremely unlikely that biological processes accounted for this increase in such a short time.

Despite the threat of arrest, the local harvest of caribou during this crisis period substantially exceeded the quota established by the Alaska Board of Game. In addition, the vast majority of harvesters evaded compliance with "compulsory" harvest reporting provisions. In 1977 ADF&G reported that for the entire range of the herd, only 19% of the hunters had returned permits as required by law (ADF&G 1977).

It was in this context of distrust and widespread non-compliance that a trio of individuals, John Trent and his supervisor John Cody of the ADF&G and Dave Spirtes of the National Park Service, utilized research conducted by the NPS and the provisions of ANILCA to initiate a new management plan.

The Cooperative Management Research Project

In 1995 the NPS completed a draft report entitled *The Western Arctic Caribou Herd: Barriers and Bridges to Cooperative Management (Spaeder et al. 2003)*. This report investigated how a cooperative caribou harvest assessment program might contribute to greater trust among Native hunters and federal and state managers. The report detailed a number of case studies and also described and analyzed how cooperative management approaches might be devised to deal with the four general functions of wildlife resource management — research, allocation, regulation, and enforcement. Topically, the report included:

Photograph courtesy of Peter Bente, ADF&G

Figure 2: Anaktuvuk Pass, August 2000. Members and guests of the Western Arctic Caribou Herd working group who were engaged in developing the caribou management plan.

1) A history of the response by subsistence communities to wildlife regulations;
2) A discussion of issues related to law enforcement versus self-regulation and local enforcement;
3) A detailed description of the deficiencies in existing harvest reporting programs and an explanation for lack of community compliance with harvest reporting requirements;
4) An extensive description of Traditional Ecological Knowledge (TEK) and the important role it plays in cooperative management regimes; and
5) A comparison of three case studies of harvest allocation methods from Alaska.

The WACH Cooperative Management Plan

In the mid 1990s an initiative was spearheaded by John Trent of the ADF&G to create a cooperative management plan for the Western Arctic Caribou Herd, and shortly thereafter Dave Spirtes, NPS Superintendent for northwest Alaska parks, partnered with Trent. Both agencies, along with the U.S. Fish and Wildlife Service and the Bureau of Land Management, supplied fiscal resources and administrative support to create the Western Arctic Caribou Herd Working Group in 1997. In addition to personnel from the federal agencies, the working group contained 20 voting chairs representing communities and user groups (including hunting guides and conservation groups) dependent on the herd *(Figure 2)*.

… after hunters regularly complained that transects flown by observer planes often missed pockets of caribou, photographic surveys of caribou are now often carried out with hunters on board the planes. Both sides benefit from this process…

Using the 1995 draft research report as a conceptual structure, the working group engaged in a number of meetings, including a key meeting in August of 2000 at Anaktuvuk Pass where Dave Spirtes presented a draft management plan. Wishing to avoid the breakdown in communication and conflicts surrounding the last crash of caribou in the 1970s, John Trent, Dave Spirtes, and the working group succeeded in drafting a plan, despite the absence of a pressing management crisis, making this plan all the more remarkable and perhaps unique in Alaska literature. After considerable work and debate, The Western Arctic Caribou Herd Cooperative Management Plan was signed in March of 2003.

The purpose of the plan is to ensure the long-term conservation of the Western Arctic Caribou Herd and to maintain traditional and other uses of this important species. The plan itself, endorsed by twenty-four signatories, provides for joint management actions at three threshold points. At the lowest threshold point, when herd size is below 200,000 animals, a variety of recommendations kick into place, including a ban on the harvest of cows or calves, maintenance of a minimum bull:cow ratio, and the restriction of harvest to local residents only.

Several elements dealing with research, allocation, and regulation will be discussed in the sections below. The whole plan itself, including detailed maps, graphs and charts is available at:
http://www.wildlife.alaska.gov/management/planning/Caribou_web.pdf

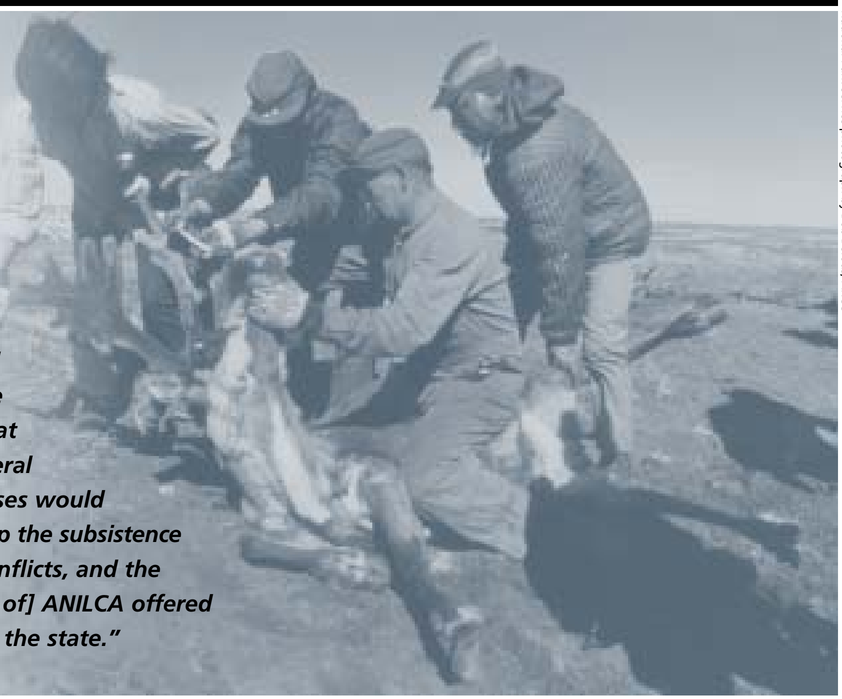
Research

As mentioned above, there had been very little agreement between land managers and local communities as to the actual size of

COMMUNITY PERSPECTIVES

Wilson Justin, Vice President for the Mount Sanford Tribal Consortium, Chistochina and Twin Lakes

"Without ANILCA it's almost certain that Athabaskan cultural values would have gone extinct. Subsistence is the one common thread that ties all Athabaskan people together. Without federal intervention, the state's political and legal processes would have exhausted limited Native resources to keep up the subsistence battle. Even though ANILCA is full of statutory conflicts, and the federal system has its own oppressions, [Title VIII of] ANILCA offered a tool to unite all Indian groups to do battle with the state."



National Park Service photograph by Bob Belous, ARCC the herd. To overcome the impasse, a number of cooperative research arrangements were put into place. Two efforts stand out. First, after hunters regularly complained that transects flown by observer planes often missed pockets of caribou, photographic surveys of caribou are now often carried out with hunters on board the planes. Both sides benefit from this process — the biologists attain more valid estimates of herd size and local hunters are more likely to accept these estimates since their input is now an integral part of the process.

The second cooperative research arrangement involves collecting key information about the health of the herd. One way to achieve this is by having hunters collect measurements on the individual caribou they kill. These measurements and observations include proportion of body fat, condition of bone marrow, presence of parasites, gross body weight, and so forth.

Local hunters using aspects of traditional knowledge maintain a dialogue with the biologists (who input these measurements into a variety of models) as they jointly assess the health of the herd. Efforts such as these tend to lead to a convergence of estimates on both herd size and the health of the herd, although both parties may still disagree as to why and how these outcomes have occurred.

Allocation

Although the draft co-management plan has set threshold limits for reducing human harvests (see above), it has not established community allocation quotas. Since the numbers of caribou in the WACH are at historic highs, formula for community specific allocations have not yet been developed. When an eventual crash does occur, the process will probably unfold along lines similar to the Kilbuck Caribou Management Agreement, whereby community harvest limits will be assigned by the Native representatives in the working group. Their decision, as Spaeder notes, can be seen as an expression of the indigenous value of sharing. Respondents stated that they felt it was important to share things over which one cannot extend ownership, such as big game. No one "owns" the caribou, respondents asserted... *(Spaeder 1995).*

Regulation

In their negotiations and discussions leading to the enactment of ANILCA, the U.S. Congress determined that: *the opportunity for rural residents of Alaska, with personal knowledge of local conditions and the requirements to participate effectively in the management and regulation of subsistence resources on the public is important in order to assure both the continued viability of fish and wildlife populations of national importance and the ability of rural people engaged in a subsistence lifestyle to continue to do so.*

Section 805 of ANILCA mandates the implementation of Regional Advisory Councils (RACs), which are composed of local subsistence hunters, who develop proposals that are forwarded to the Federal Subsistence Board. These proposals suggest who should be eligible to hunt, when the hunt should occur (seasons), and what is a reasonable amount to meet community and household needs (bag limits). Proposals from RACs carry considerable weight with the Federal Subsistence Board. In fact, the board is under substantial constraints if they choose to reject the proposals. Grounds for rejection revolve around proposals that might potentially harm the resource. Thus Section 805 provides for the incorporation of local experience and perspective of the landscape into western management practices. The WACH planning committee and working group intend to utilize the RAC process to submit proposals for reasonable and equitable seasons and bag limits to the Federal Subsistence Board.

COMMUNITY PERSPECTIVES

Karen E. Stickman, Project Coordinator
Native American Fish and Wildlife Society, Anchorage

"There have been a lot of studies done and a lot of money spent on documenting subsistence resource use — harvests, how much we eat, how many people live in our homes, how much money we make, and so on — that's really putting us under the microscope. Researchers get the data they need to satisfy their programs and discard the other concerns. For example, subsistence users are continually saying that sport hunting and fishing is affecting the subsistence resources — especially caribou and moose. The increasing numbers of motorized boats and planes are scaring the animals away. These observations continually gets documented, but with no action."

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the NPS under the Mining in the Parks Act, the Alaska Mineral Resource Assessment Program (AMRAP), which was mandated by ANILCA, assesses minerals in the entire state, including national park units. The AMRAP program, headed by the U.S. Geological Survey, helps identify strategic and necessary mineral deposits for national security and the overall economic health of the United States.

Associated with mining is the need for access to the mining site. Some mines were accessed during the winter when route conditions were adequate for travel by heavy equipment. Others were accessed by airplane, including shipping supplies and fuel to the site by air. An all-season road was constructed across Cape Krusenstern National Monument for the Red Dog Mine, which is a major world source for lead and zinc concentrates *(Figure 4)*.

Alaska's history of mining has left some NPS areas in disarray, with tailings piles, disturbed un-vegetated areas, abandoned equipment and hazardous substances, such as barrels of diesel fuel. The NPS is currently conducting site clean-up and land restoration on several streams including Eureka Creek, Caribou Creek and Glen Creek, located in Denali National Park and Preserve.

Even though mining claims and mining in Alaska parks has all but disappeared, a rich mining history has been left in places such as the Kennecott mill and mines in Wrangell-St. Elias, and the mines in the Kantishna area of Denali. Interpretation of these and other historic mining sites enables park visitors to better understand mining's effects on Alaska.

National Park Service photograph by Lynn Griffiths

Figure 3: Modern placer mining operation in the early 1980s in the Kantishna area of Denali. An excavator feeds a washplant which cleans and sizes material allowing gold to be trapped in the sluice box.

National Park Service photograph by Lynn Griffiths

Figure 4: Trucks hauling ore concentrates across monument lands to the port and storage facility.

Mining in the Parks

By John Quinley

The ANILCA parks were vast, but within their boundaries were existing private uses, even whole towns in a few cases. Mining was among the uses, both on parcels of patented property and on unpatented mining claims. Mining is subject to the Mining in the Parks Act of 1978, giving the NPS jurisdiction over mining plans of operation and their effects on neighboring park land. In 1985, the government was sued, with plaintiffs asserting the NPS had failed to meet its legislated responsibilities to protect Alaska's park resources and account for the cumulative effects of mining. The courts eventually agreed, ruling that the NPS had to consider the effects of past mining as it evaluated proposals for new mining.

That order initiated a lengthy series of environmental impact statements regarding mining in Denali National Park and Preserve, Wrangell-St. Elias and Yukon-Charley Rivers National Preserve. Investigations were launched to look at resources in and near areas where there were concentrations of claims. The work included studies of water quality and flows, soils, vegetation, fish, wildlife, and historic resources.

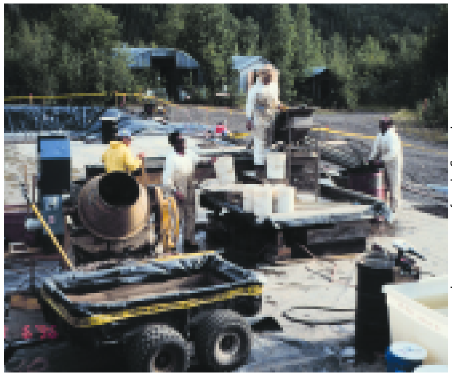
There had been precursor studies of mining in parks, but the requirement for environmental impact statements brought about an effort to "gather more specific, in-depth information to try to assess the cumulative effects of mining on key resources, and determine how those effects related to the rest of the park," remembered Alex Carter, a manager in the Mineral Resources Division of the NPS in the late 1980s *(Personal communication, 2005)*.

The environmental impact statements established "resource protection goals," essentially limits to the amount of change in resource categories such as vegetation. Resource managers could then compare past uses and impacts with proposed uses. In addition, the studies determined that the NPS should purchase mining claims in these park units and conduct restoration of the environment in the vicinity of previously mined areas in order to reestablish natural conditions and processes.

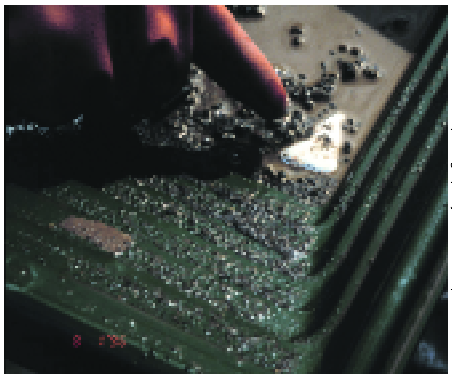
Resource protection goals, resource data, the study areas and other decisions made in the environmental impact statement process held up under public scrutiny and federal appeals court review, and became an integral part of evaluating new mining plans of operations in parks. In Yukon-Charley Rivers and Wrangell-St. Elias, the data also formed some of the first baseline resource studies for the new parks, a forerunner to the more recent and expansive Natural Resource Challenge.

Mining and Mitigation: The Coal Creek Remediation Project

By Linda Stromquist


National Park Service photograph by Linda Stromquist

Overview of soil-washing process to remove mercury from soil.


National Park Service photograph by Linda Stromquist

Example of mercury recovered in mitigation process.


National Park Service photograph by Mike Shields

These explosives were found near Kennecott in Wrangell-St. Elias National Park and Preserve. Manufactured in 1917, they remained dangerous until destroyed in 1988.

A bucket-line dredge operation which mined the Coal Creek valley between 1936 and 1977 resulted in numerous petroleum spills, stockpiles of drums, hazardous debris, and areas of heavy metal contamination in the Coal Creek watershed. With the transfer of the Coal Creek claims to the National Park Service in 1986, NPS assumed the responsibility for the cleanup of the contaminants. After this acquisition, the NPS initiated site investigations to characterize the nature and extent of contamination and hazardous debris in the valley.

As a result, 830 55-gallon drums, 18 lead-acid batteries, 2,500 pounds of solid waste, and 46,000 pounds of scrap steel were removed from the area in 1994. By 1996, park managers initiated an effort to remediate lead-and mercury-contaminated soils in the watershed. NPS crews excavated approximately five cubic yards of lead-contaminated soils from the historic blacksmith shop. This material was packed into drums and shipped for disposal to a licensed facility in Washington State.

For the mercury-contaminated soils, a different process was followed. NPS crews built an on-site soil washing facility to treat the contaminated soils. A 4,000 square foot work pad and 14,000 gallon recycle pond were constructed in the maintenance yard of the main camp complex. Approximately 45 cubic yards of mercury-contaminated soil were excavated from the area surrounding the historic assay building and transported to the work pad. The soils were then mixed in a slurry, treated with an ore cleaning solution, and passed across a hydraulic jig, a copper plate, and a series of sluice boxes. Process waters were directed into the recycle pond and process solids were retained on the work pad until laboratory analysis verified cleanup standards had been obtained. An on-site lab utilized X-ray fluorescence analysis to monitor excavation and soil washing operations. Northern Testing Laboratory in Fairbanks also analyzed samples, confirming the on-site findings. Approximately 172 pounds of mercury concentrates generated by the soil washing effort were shipped off-site for disposal.

The NPS continued environmental mitigation of Coal Creek camp with a detailed investigation of petroleum-contaminated soil in and around the Coal Creek area. After excavation of the petroleum-contaminated soils, the material was treated by thermal desorption, utilizing a portable thermal treatment unit that was flown to the site in the summer of 1998. With the close of the field season in 1998, the NPS completed the multi-year remediation of the contaminants that were part of the legacy of mining in the Coal Creek valley.

Physical Hazards Abatement: "Look but Don't Touch; Stay Out, Stay Alive"

By Logan Hovis

With the creation of the ANILCA parks, the NPS in Alaska was forced to deal with the physical hazards associated with mining on a scale never before contemplated. The new parks were huge and the land therein had long been used for mining and other industrial purposes. Chief among the dangers were mine openings such as adits and shafts, abandoned explosives, and the collapsing fabric of the mines. Mine sites ranged in size from simple prospecting pits to expansive placer mining areas and on to the Kennecott mines complex.

Mine sites are attractive hazards drawing in the unwary and the unprepared — residents, visitors, and staff. Over the past 25 years, the NPS undertook an increasingly active and coherent program to identify, prioritize, and mitigate such hazards. Abandoned explosives became a major issue when a misinformed effort to eliminate explosives at the Stampede Mine caused the destruction of much of the site. Thereafter, the NPS brought Mike Shields to Alaska to develop a program of training, consultation, and disposal that provides the highest possible standard of safety for all concerned. Numerous classes in the hazards of old explosives and their identification have been held for park staff and, on several occasions, park residents. Literally tons of explosives and thousands of blasting caps have been removed from the landscape and destroyed.

Controlling access to underground workings was developed for public safety. A number of methods were used including foam plugs, slotted gates (accessible to bats but not humans), and the deliberate collapse of existing openings. Care was taken to ensure that the mine workings continued to drain and were ventilated to prevent different problems in the future. To date, 29 mine openings have been closed in parks as diverse as Glacier Bay, Kenai Fjords, Denali, and Wrangell-St. Elias.

Given the historical significance of many mining areas, explosives management and mine closure efforts have been coordinated closely with cultural and natural resource managers to identify the best approaches for mitigating often extreme hazards and protecting public and employee safety with cultural sensitivity.

Mine structures along with numerous other historic resources have been addressed through park maintenance programs and preservation efforts based on park needs and historical significance. Nonhistoric structures have been removed as funds allowed to improve the esthetics and safety of the mining districts. In other cases, structures in mining areas such as the Chisana and Bremner historic districts in Wrangell-St. Elias have been rehabilitated and opened as public-use cabins.

Abandoned Mineral Land Restoration Activities in Alaska

By Lynn Griffiths

The NPS has had an ongoing Abandoned Mineral Land restoration program (AML) since the 1990s. Since much of mining activity on lands now managed by NPS occurred prior to environmental compliance regulations, mined areas were not necessarily restored to their original condition. To date a substantial amount of disturbed lands have been restored, and numerous dangerous conditions have been made safe. However, more work remains to be done.

National Park Service photograph by Lynn Griffiths

Mine hazard at Wrangell-St. Elias.

The AML program has focused on two distinct aspects of land restoration. The first is the safety of park visitors. A seemingly endless number of hazards exist—underground mine openings including shafts and adits, deteriorating equipment, hazardous materials, explosives, and deteriorating structures. The Kennecott mine, which was created to extract copper ore, in Wrangell-St. Elias National Park and Preserve is an example of a mine where visitor safety is a concern. It has 70 miles of dangerous underground workings with numerous openings, and deteriorating mill buildings and equipment. Methods used to close unsafe mines include steel gates made of manganal steel (jail cell steel), polyurethane plugs and blasting to collapse openings.

The second emphasis of the program has been restoration of disturbed lands, primarily those in flood plains and riparian habitat disturbed by placer mining. Restoration projects have used innovative methods to remove hazardous waste, reduce hazardous conditions, reshape the mined area to approach original surface contours, meander streams, and promote stream bank stabilization, sediment control, and revegetation by indigenous plants.

National Park Service photograph by Lynn Griffiths

Upper Caribou Creek in Denali National Park and Preserve, where large barren tailings piles have been leveled and re-contoured.

Upper Caribou Creek, in the Kantishna area of Denali is an example of a restoration project of a placer mined area. Sections of the stream bed have been mined from bank to bank. Restoration activities included removing hazardous materials and equipment from the park, leveling and contouring large tailings piles establishing more natural channel meanders, and applying erosion controls.

Many mined areas remain to be restored and made safe for public use. The National Park Service will continue this work in an effort to protect the public and preserve mining history in Alaska National Parks.

Science

National Park Service photograph by Jim Pfeiffenberger

Dr. Bruce Molnia, a glaciologist with the U.S. Geological Survey, photographs Bear Glacier in Kenai Fjords National Park as part of a study of glacier dynamics and climate change. By comparing his photos with those taken in the early 1900's, a century of change is revealed.

Science in Wilderness Marine Reserves

By John Quinley

The addition of 10 new national park areas and three major expansions of existing parks by ANILCA in 1980 is rightfully remembered as the largest conservation act in American history. But the act can also be thought of as the establishment of the largest scientific laboratory ever—vast protected places where the effects of humans had been slight, natural processes were still running, and unique research could be undertaken.

What research was funded, how three decades of inquiry were conducted, and where science made an impact in park management is a less tidy story—one that was often influenced by forces outside the realm of science including the federal courts, legislation, Congress, and administrative policy.

Three areas of inquiry over the last 25 years saw a significant amount of field work, research, and exploration, each for unique reasons tied to the 1980 law. Both subsistence research and mining research have been discussed earlier in this issue, however, one aspect remains—research in wilderness areas. Resource protection was at the heart of this third issue, and it launched considerable research, work that continues today.

While continuing to allow for certain traditional uses, ANILCA also established 33 million acres of "Wilderness" in Alaska national parks. As described in the 1964 Wilderness Act, wilderness is *…an area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions…with the imprint of man's work substantially unnoticeable…(Public Law 88-577)*. Allowable public purposes include recreational, scenic, scientific, educational, conservation, and historical use.

Almost 48,000 acres of the ANILCA wilderness areas were marine waters in Glacier Bay, primarily around the Beardslee Islands and in the relatively narrow East Arm and West Arm in the upper reaches of the bay. In 1999, Congress prohibited commercial fishing in these wilderness waters, establishing one of the nation's largest marine reserves.

Those decisions, in turn, led to a unique opportunity for studying marine reserves in a high latitude ecosystem. The closures created five protected areas, each of which is adjacent to areas remaining open to commercial fishing. This has provided researchers an opportunity to compare populations of crab, halibut, and other marine life under different management regimes.

In particular, studies led by Jim Taggart of the U.S. Geological Survey and others are looking at the transfer rate of Pacific halibut, tanner crab, and red king crab between the reserves and adjacent areas. The studies are allowing measurements of movement patterns, and helping identify essential habitat, changes in distribution, and migration patterns. Additionally, crab size data from before the commercial fishing closures and after are being compared with initial results showing increasing abundance of large male crabs in the reserve areas. This research is described in more detail in the Winter 2003 issue of *Alaska Park Science*. **(http://www.nps.gov/akso/AKParkScience/index.htm).**

Public Law 88-577. 1964.
Wilderness Act (16 USC 1131-1136).

Figure 1: Wallace Lake watershed ecosystem study site, Isle Royale National Park, Michigan.

Long-term Research in Remote Parks: Opportunites and Obstacles

By Robert Stottlemyer

Introduction

In establishing a number of new expansive parks and enlarging several existing NPS units in Alaska, the opportunity for remote site investigations and conducting important baseline research was enhanced. Remote wilderness areas provide unique opportunities and challenges for the conduct of interdisciplinary ecological studies. One advantage is the opportunity to document baseline conditions for future reference. If the remote area is large, the baseline may have to represent a region. Disadvantages include logistics and constraints on research, particularly experimental designs and the quality of monitoring necessary for a research context.

National parks are not often used for long-term interdisciplinary research. There can be good reasons for this. Data gathering in the more intensively used and developed parks is often prioritized to address specific resource management issues. Objectively designed long-term studies are rarely suited to address immediate issues. However, in developing policies and in order to support them, it became evident that long-term, ecosystem level, interdisciplinary studies were needed. Below are examples of these types of studies that are carried out in remote wilderness areas.

Conceptual Ecosystem Model

Since the 1930s, scientists recognized that ecosystems have detailed energy and nutrient input and output budgets, with nutrient supply as the factor most limiting biological growth. But a lack of understanding of internal processes regulating nutrient and energy transformations and movements in ecosystems made it difficult to separate and quantify the effects of regulatory processes such as human activity.

National parks are not often used for long-term interdisciplinary research. There can be good reasons for this. …Objectively designed long-term studies are rarely suited to address immediate issues.

To gain insight into such complex systems, a new conceptual approach was needed, one that considered ecological systems as interacting units rather than a set of individual components. By the 1950s, an ecosystem model was developed where major parameters could be measured directly in the field *(Bormann and Likens 1967, Likens 1983)*. By linking hydrology with other ecosystem processes, the "small watershed ecosystem" model permitted quantification of biogeochemical cycles, i.e., the movement and transformation of nutrients and energy between the biotic and abiotic components.

Application of Model in Boreal Ecosystems

In 1980 we began long-term studies using this conceptual model in a network of

Photograph courtesy of Bob Stottlemyer

Figure 2: Looking northeast along the Agashashok River with the Asik watershed off center left, Noatak National Preserve.

national parks. One site, the boreal Wallace Lake watershed, is in Isle Royale National Park, Lake Superior Basin, Michigan *(Stottlemyer et al. 1998) (Figure 1)*. About 99% of the park is wilderness, and it is one of the least visited national parks, accessible only by boat or float plane. Isle Royale is located along the southern ecotone (the boundary or transition area between two or more ecosystems or landscapes) between the boreal and northern hardwood forests. Globally, the boreal biome covers 32% of forested areas, second only in extent to tropical forests *(Mayer et al. 2005)*. About 20% of national park lands are in the boreal biome; however, the biome is little studied relative to its global importance.

In 1989, we began similar monitoring and research in Noatak National Preserve, Alaska. Noatak is one of the few national park units with research specified as a priority in its enabling legislation (ANILCA).

Photograph courtesy of Bob Stottlemyer

Figure 3: The 1,980 acre Asik watershed looking north from the alpine into the subalpine treeline boreal spruce *(Picea glauca).*

The preserve provided the opportunity to study the northern boreal treeline ecotone and compare it to the ecotone found at Isle Royale. Ecotones, with many of their species at the limits of their range, are especially sensitive to stressors.

At our sites research emphasizes below-ground, physiochemical and biological processes, and microbial functional biodiversity. Greater than 99% of ecosystem biodiversity usually is in the subsurface layers. Half of the total terrestrial system production can occur below-ground, primarily in the form of microbial (bacteria, fungi) and small root growth. Therefore, the below-ground community regulates the quality and quantity of most nutrients and almost half the energy available to aboveground biota.

One of our Noatak intensive study sites, the 1,980 acre Asik watershed, is located in the south-central portion of the preserve. The Asik watershed drains into the Agashashok River *(Figure 2)*, and 50% of the treeline watershed is vegetated by white spruce *(Figure 3)*. Another site is located along the Kugururok River just north of its confluence with the Noatak River, at the northern extent of treeline *(Figure 4)*. The region is characterized as "cold desert" with annual precipitation less than one foot and with discontinuous permafrost.

Photograph courtesy of Bob Stottlemyer

Figure 4: Kugururok River with south slope of Brooks Range in background, Noatak National Preserve. Series of vegetated river terraces to north (right) of Kugururok River are study sites.

A number of examples exist demonstrating the value of remote boreal sites, especially in national parks with the restricted land use, where they provide benchmark interdisciplinary studies. One such example is the continuous (1951-present) long-term, predator-prey studies on Isle Royale (Allen 1979, Post et al. 1999). This research has provided much needed resolution and evolution in predator-prey conceptual models.

Study in Remote Area Sites

Science benefits in unique ways from work in regions where the human "imprint" remains less evident. Remote sites can provide another interdisciplinary "data point" in regions where such information often has disproportionately high value because of its scarcity *(Figure 5)*. The study design and factors, such as quality assurance, are particularly important in this context.

A number of examples exist demonstrating the value of remote boreal sites, especially in national parks with the restricted land use, where they provide benchmark interdisciplinary studies. One such example is the continuous (1951-present) long-term, predator-prey studies on Isle Royale *(Allen 1979, Post et al. 1999)*. This research has provided much needed resolution and evolution in predator-prey conceptual models. Such studies cannot be repeated because of the loss of suitable sites, and new ones cannot recreate the detailed changes that have already occurred.

Photograph courtesy of Bob Stottlemyer

Figure 5: Installing a standard 33 foot meteorological tower in the lower portion of the Asik watershed, Noatak National Preserve.

Photograph courtesy of Bob Stottlemyer

High latitude sites are, in general, simpler ecologically. An important component of the Noatak landscape is the diverse vegetation along river terraces.

Figure 6. Inoculating soil cores with ^{15}N to quantify how nitrogen availability might respond to change in soil temperature and moisture in different vegetation types, Asik watershed, Noatak National Preserve.

For the level of effort, simple monitoring in remote regions for limiting nutrients like nitrogen can be quite productive. In the contiguous 48 states, one hypothesis suggests in regions of anthropogenic-elevated atmospheric dissolved inorganic nitrogen (DIN) deposition, stream water nitrogen concentrations should be dominated by atmospheric DIN inputs. The stream water should not be dominated by other nitrogen forms, such as dissolved organic nitrogen (DON), which are more indicative of terrestrial processes. In Alaska, atmospheric DIN deposition is low (<0.3 kg N per hectare per year), or about 5% of the deposition on Isle Royale, yet stream water nitrogen is dominated by DIN. This has led investigators to look for the causes for why treeline and taiga ecosystems are losing this nutrient when atmospheric inputs are so low.

Remote parks can be valuable in quantifying the historical sources of substances, such as polychlorinated compounds, which are only associated with human activity. When such compounds are found cycling in the ecosystem where they were never used, it simplifies the task of finding the source. The results for the remote sites generally indicate ambient conditions representative of the larger region. A complex study of the inputs and cycling of polychlorinated compounds in Siskiwit Lake at Isle Royale National Park documented past and present cycling of dioxins and furans at a site where atmospheric inputs could be the only source *(Czuczwa et al. 1984)*. Such studies were the impetus for the present widespread monitoring for such compounds in the Arctic and Antarctic.

High latitude sites are, in general, simpler ecologically. An important component of the Noatak landscape is the diverse vegetation along river terraces. In a study conducted on a river terrace adjacent to the Asik watershed, the depth of silt and sand cap above a gravel floodplain greatly influenced species composition, production, and response to change *(Binkley et al. 1995)*.

Likely one of the most valuable contributions to science by protected, remote sites will be documenting global change effects, principally climate *(Figure 6)*. In Alaska these studies are being driven by the rapid rate of change in temperature and moisture in taiga-tundra regions. The rapid change rates may also be a weakness in the study of ecosystem processes responsive to temperature and moisture, since there is no baseline for the last five decades.

The boreal biome contains large but mostly unavailable subsurface reservoirs of organic carbon, nitrogen, and phosphorus. High latitude ecosystems contain about a third of the global soil carbon pool as organic matter *(Shaver et al. 1992)*. In the Noatak treeline, most of the organic matter is below the annual thaw depth (soil active layer) and unavailable to biota. Any factor that increases the depth of the soil active layer would also alter soil temperature and moisture, organic decomposition, soil respiration rates, and nutrient availability. The alteration of nutrient availability is through increased mineralization rates *(Figure 7)*. Such change would realign below-ground and eventually above-ground biodiversity.

Another apparent effect of a warming climate in the Noatak area is the expansion of the growing season into autumn. At Asik, air temperatures peak in June, but soil temperatures now peak in late August or early September. This permits soil carbon and nitrogen mineralization processes to continue late in the season, after biological uptake has slowed. This process likely accounts for the high dissolved organic carbon and nitrate found in late summer stream water. Along with phosphorus, these substances are important aquatic nutrient and energy sources especially for the base of the aquatic food web. This increase in available nutrients and energy sources will likely alter aquatic food web biodiversity.

In sum, longer-term studies in remote parks likely provide the best remaining opportunities to catalog baseline ecological structure and function. Documenting baseline conditions assumes still greater importance now that there is increased appreciation of the significant economic value ecosystem services provide. Yet such study remains difficult to justify and sustain because it falls victim to immediate issues, many of which were brought about by the lack of a basic understanding of ecosystem function through time. And the latter, more often than not, is the product of little commitment to anticipatory science. The Park Service is left with a unique opportunity and major obstacle. The opportunity is to actively support and become substantively involved in sustained study. The obstacle is to overcome a myopic view of the information base necessary to professionally care for its public lands.

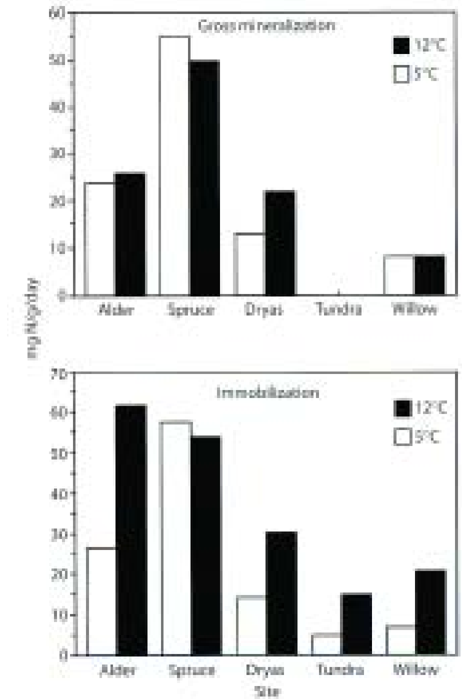


Figure 7: Results of laboratory study showing potential effects of soil warming on soil organic N mineralization rates (top plot), and soil microbial uptake of N (bottom plot) beneath major vegetation types, Asik watershed (from *Binkley at al. 1994*)

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National Park Service photograph by Jennifer Adleman

Balancing the Benefits and Impacts of Science in Alaska's Wilderness

By Peter Landres

The large parks and preserves in Alaska, the wildest places that keep our nation's legacy of wilderness character for future generations, are not immune from onslaughts such as trans-oceanic air pollutants, non-native species, and global climate change. No manager today doubts or questions the need for reliable and accurate information as a basis for preserving the natural heritage and character of Alaska's wilderness. Science is the principal means for deriving such information and has indisputably improved both park and wilderness stewardship *(e.g., Peterson 1996, Graber 2002)*. However, do some types of scientific activities compromise wilderness? Could science threaten wilderness, making it something less and not quite wilderness? Is it possible to have too much science in wilderness? Proposed use of drilling, use of helicopters, and installation of structures for volcanic research in the Katmai Wilderness, for example, caused significant conflict over the benefits and impacts of this research in wilderness *(Eichelberger and Sattler 1994)*.

The signing of the Wilderness Act in 1964 created a National Wilderness Preservation System, and defined wilderness as *…an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain… (Public Law 88-577)*. ANILCA makes unique provisions for access in Alaska, even in designated wilderness, because of the dependence on subsistence resources by local rural residents. For example, access by motorboat, airplane, and snow machine is allowed for traditional activities. But unless ANILCA expressly states otherwise (Sections 707 and 1315), Alaska wilderness is still managed under the provisions of the Wilderness Act, including the Section 4(b) mandate for "preserving the wilderness character of the area."

In this short article I build on the work of others *(Franklin 1987, Graber 1988, Parsons and Graber 1991, Parsons 2000, Landres et al. 2003)* to explore some of the tensions between the benefits and impacts from science in wilderness created or managed under ANILCA. Because Alaska wilderness is the best of what remains of the wilderness ideal, there is more at risk from the impacts of science as well as more to gain from the benefits of science. Therefore it is vitally important to think carefully about the potential risks and benefits of science to wilderness character in Alaska.

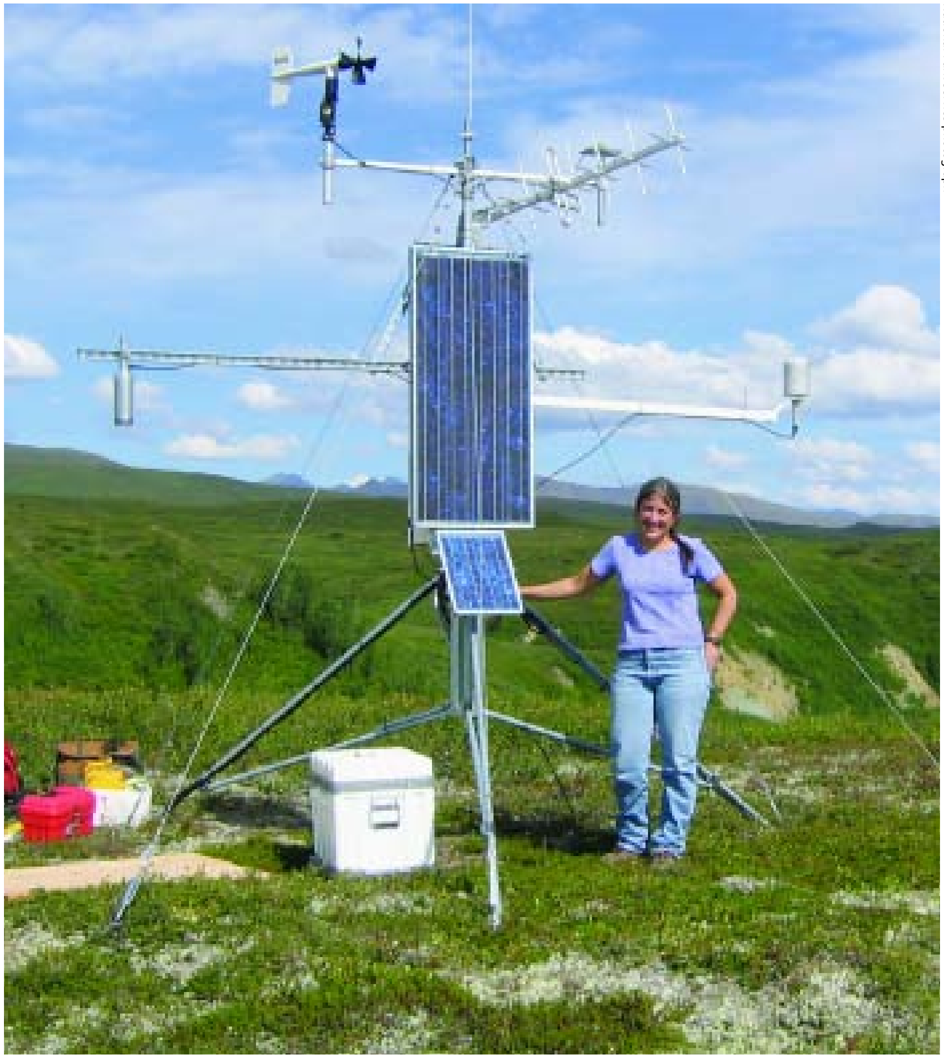
But what is wilderness character? Wilderness character is the combination of biophysical, experiential, and symbolic ideals that distinguish wilderness from other lands *(Landres et al. 2005)*. All three ideals are equally important, forming a complex and subtle set of relationships between the land, its management, and the meanings people associate with wilderness.

Symbolic ideals are generally the least recognized and understood *(Scott 2002)*, yet arguably the most important for understanding the impacts of science to Alaska wilderness. Symbolic ideals in wilderness address the need for some areas where mechanization and developments are not allowed, where managers intentionally restrain themselves, where people are not in control. Such places are what Leopold (1949) described as "a blank spot on the map." This notion of wilderness as a "blank spot" implies that we intentionally do not need to know everything we can about an area. As a society, the dilemma we face is balancing the need to understand how natural ecological systems function that are relatively unaffected by modern people, while still protecting the notion of a "blank spot." The stakes of this dilemma are high because Alaska wilderness potentially represents our nation's largest and best "blank spots."

Evaluating how much is too much impact from science in wilderness areas depends on many things, including legislation, management policy, agency culture, and public and personal values. All scientific activities impact wilderness, but some (such as a simple inventory) have little impact, while others (such as the use of motorized equipment or installation of monitoring devices) have large impacts. The essential question about science in wilderness focuses on whether the benefits outweigh the impacts. Wilderness managers, following legislation and policy, typically identify benefits in terms of preserving wilderness character. There are other benefits, however, that in my view also need to be considered. These are the benefits to society from scientific research that recognizes wilderness as the best and sometimes only place to understand natural ecological systems and human relationships to these systems.

In weighing benefits and impacts from scientific activities, an analysis that considers all three ideals of wilderness character will be more complete than one focused on only one or two aspects. For example, if just biophysical impacts are considered, then uses of mechanized tools and transportation could be justified to reduce impacts to soil and vegetation. Such justification ignores impacts to the experiential and symbolic aspects of wilderness character. In Alaska the use of motorboats, airplanes, and snow machines is allowed and may fit the "minimum requirement" (see *Anderson 1999* for explanation and application of this concept to science activities in wilderness), but these uses nonetheless compromise the wilderness character of the area as defined by the 1964 Wilderness Act *(Hendee and Dawson 2002, Landres et al. 2005)*.

While many types of scientific activities are appropriate in wilderness, some are



National Park Service photograph

Achieving consistency in permitting decisions across multiple units of the National Park System remains a constant challenge. When opportunities allow, park managers combine environmental compliance for related projects spanning several units, such as the installation of climate monitoring stations for the Inventory & Monitoring networks.

Opposite Page: Novarupta Volcano, which erupted in 1912, was the largest (by volume) eruption in the 20th century. During the 1990s, the NPS received a proposal for a large multi-year research drilling project at Novarupta. The proposed activities raised serious questions about the appropriate level of scientific research in wilderness. The proposal was withdrawn following the NPS selection of "no-action" as the preferred management alternative.

simply not or would at least require careful scrutiny to determine if the benefits outweigh the impacts. For example, extensive use of motorized equipment or mechanical transport and long-term or permanent installations would need careful scrutiny. Likewise, scientific activities that set a national precedent for impacts, or cause significant, lasting, or cumulative degradation of any aspect of wilderness character raise very serious issues.

Alaska wilderness is too important to assume that all scientific activities are benign and therefore approved, or that they are harmful and therefore denied. A comprehensive evaluation framework that considers legislation, policy, and the benefits and impacts of the proposed work is needed most. This framework would stimulate dialogue between managers and scientists when the scientific activity is first being considered. Such dialogue offers the best chance for balancing scientific research on ecological systems and human relationships to these systems with preserving the wilderness character of Alaska wilderness.

U.S. Geological Survey photograph

Despite the obvious challenges and costs involved, remote instrument stations are often the most effective and least intrusive way to collect needed data. The Alaska Volcano Observatory has established a network of seismic stations, like this one in Aniakchak Caldera, to monitor volcanic activity.

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Alaska Park Science

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National Park Service photograph by Bob Belous, ARCC