launch failed to uncover the problem. The glitch was noticed only during a recent test of the 2001 lander, which has the same design. The cause of the failure of the small probes—designed to be released by the lander in flight to bury into the martian soil—remains unclear. What is clear is that they were inadequately tested. "The microprobes were not ready for launch," states the Young report bluntly.

But the technical glitches are only part of a much larger story. According to members of the investigative teams and the Young panel, Lockheed Martin also bid too low, forcing it to rely on younger and, thus, more affordable workers. Even then, the company was unable to hire them in a timely fashion. A stressed and overworked team at JPL could not oversee the contractor's effort properly. And the JPL team received little guidance from experienced system engineers and support from senior managers, the reports state.

Both JPL and Lockheed took to "circling the wagons," states the Young report, at a time when they "deviated from accepted and well-established engineering and management practices." There was, the Young panel found, "a failure to clearly communicate" between JPL and NASA headquarters. Headquarters, for example, ordered new instruments to be added to the lander without boosting the budget. "JPL management did not effectively express their concerns" about the tight constraints, and "NASA headquarters did not seem receptive to receiving bad news," states the report. "This combination of inadequate management oversight and violations of fundamental engineering and management principles became the underlying contributor to mission failure," the Young panel concluded.

Those words harken back to the report of the commission that investigated the 1986 Challenger accident. Its authors cited Marshall Space Flight Center's penchant "to contain potentially serious problems and to attempt to resolve them internally rather than communicate them forward." They also laid much of the blame for the shuttle disaster on NASA's insistence on an aggressive shuttle launch rate.

No turning back

Senator John McCain (R–AZ), chair of the Senate Commerce Committee and former GOP presidential hopeful, calls the Young findings "an embarrassment to the agency" and has threatened to conduct his own investigation. "It may be time to amend NASA's mantra of 'faster, better, cheaper' to include 'back to the basics,' " sneers Senator Bill Frist (R–TN). Representative Ralph Hall (D–TX), ranking Democrat on the House Science Committee, says that "it is a shame that we are stalked by ineptness. I hope that NASA heeds this wake-up call."

Goldin insists he will—up to a point. "These failures are not a basis for reversing our course in pursuit of revolutionary change," he told McCain at a hearing just before the Young report was issued. However, some observers fear that the mounting attacks on NASA could roll back that policy. "I'm concerned about it getting sunk," says Alan Binder, director of the Tucson-based Lunar Research Institute and principal invesigator of the Lunar Prospector, a mission described by many as the "poster child" of the philosophy.

But others say there is no going back to the way NASA did science in the 1970s and 1980s, with multibillion-dollar probes that took more than a decade to build and could swallow a good chunk of a scientist's career. "Faster, cheaper, better is the only game in town," says Zuber. "It can work—you just can't get rid of prudent testing."

Although many researchers were highly skeptical of Goldin's revolution in its early days, the NRC study says it has led to more launch opportunities, more flexibility, and a chance to play a larger role in the development of missions once largely the domain of engineers. "I was dubious at the start," says Donald Brownlee, an astronomer at the University of Washington, Seattle, and principal investigator for the $205 million Stardust mission to collect comet material. "I thought cheaper missions were not scientifically worthwhile." But now he's a convert, cautioning that it is "really important that people not overreact" to the Mars failures.

A revamping of the way faster, cheaper, better is managed could actually improve NASA science, believes Steven Squyres, a Cornell University astronomer and principal investigator of the Mars 2001 mission. "Now when a project is in trouble, it will get help," he says. "And as someone who has spent the last years devoted to building instruments for Mars missions, I find this absolutely delightful."

For NASA to increase its chances of success, however, alarms must be sounded—and answered. Zuber and others say that Goldin, who was unavailable for comment for this story, was taken aback by the Young panel's finding that people were afraid to speak up when trouble was brewing. "Make sure you say something," he pleaded with JPL employees. "Don't hold it in." Congress and the scientific community will be watching closely to see if the new Goldin can jump-start his old revolution. **–ANDREW LAWLER**

CONSERVATION

Bringing Science to the National Parks

A new program aims to bolster the science underlying park management, but it will require a culture change among agency leaders

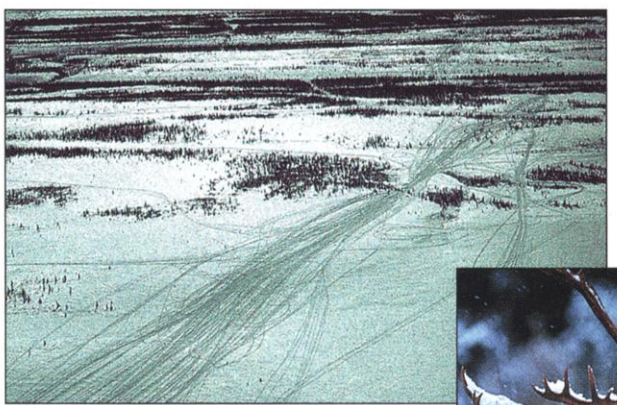
When Alaska's snow machine association last year challenged a new policy to ban snowmobiles in an 800,000-hectare wilderness at the heart of Alaska's Denali National Park, the park's managers were thrown into a quandary. They could marshal plenty of studies from the Rockies and northern U.S. states showing that the machines damage vegetation and harm wildlife. But when it came to demonstrating those effects in Denali—where they suspected that the fragile subarctic ecosystem was even more vulnerable—park officials came up short. Even when they needed basic information on where caribou and moose overwinter, the most they could find were piecemeal data, for example, from a student's master's thesis about one corner of the park and from a wolf predation study. "There just isn't the information base there," says Joe Van Horn, a park natural resource manager.

The scramble to collect data in Denali is just one example of how inadequate science is hampering management decisions in the national park system, which includes some 270 major parks with natural resources stretching from the Alaskan mountain ranges to the coral reefs off Florida. Critics have long charged that the National Park Service (NPS) manages parks to make them look good to visitors—a strategy that can lead to very different decisions from those ecology might dictate. With few exceptions, critics charge, agency officials have tended to view science with anything from benign neglect to outright hostility. The result has been a number of decisions that have been slammed by scientists, challenged in court, and even debated in Congress, involving everything from elk management in Yellowstone, to pollution in Oregon's Crater Lake, to the restoration of the Florida Everglades.

All that is about to change, says Robert Stanton, director of the NPS. Last summer he launched a new program, the Natural Resource Challenge, to bolster the science underlying park management. Just getting under way, the plan will invest millions more dollars in inventorying species and monitoring park conditions, hiring more scientifically trained managers, and enticing academics to conduct research in the

parks—an about-face from years past, when academic research was actively discouraged in many parks. The goal, says Michael Soukup, who will lead the new effort, is to gather enough data to enable managers to anticipate problems rather than lurch from crisis to crisis.

Biologists are welcoming these moves, but many question whether the Park Service can pull it off. Indeed, the last time the Interior Department, the NPS's parent agency, attempted a major reform—folding park basic scientists into a new agency—science was left worse off, say critics like ecologist Mark Boyce of the University of Alberta in Edmonton. "I'm optimistic but skeptical at the same time," says David Parsons, a former NPS ecologist who now directs the federal Aldo Leopold Wilderness Research Institute in Missoula, Montana.



Data dearth. Denali park is scrambling to document snowmobile impacts on caribou and other wildlife.

CREDITS: (LEFT TO RIGHT) NATIONAL PARK SERVICE; JOHNNY JOHNSON/ALASKA STOCK

Separation anxiety

The Park Service's new plan is meant to address a litany of criticism that started in the 1960s. A 1992 study by the National Academy of Sciences, for instance, found that "almost invariably … management of the parks was done with inadequate understanding of ecological systems." And the science that has been done has often been manipulated to support policy, critics allege. Park managers "have very carefully controlled the actual research that's done and the reporting of that research," says ecologist Fred Wagner of Utah State University in Logan, citing studies of elk and grizzly bears in Yellowstone National Park.

In 1993, Interior Secretary Bruce Babbitt came up with a solution: Free scientists from the influence of park managers. As part of a plan to beef up science scattered across Interior's various agencies, he pulled out their Ph.D.-level scientists—including all 100 in the Park Service—and put them together in a new science agency, the National Biological Survey. But from the outset the move was controversial, both within the agency and among outside scientists, who feared that scientists would lose touch with the short-term research needs of park managers (*Science*, 20 August 1993, p. 976). The fledgling agency soon fell victim to a Republican Congress concerned that its plans to inventory species might trample the rights of property owners. In 1995 Congress finally folded the biological survey into the U.S. Geological Survey (USGS), where it has been eking out a smaller budget than originally envisioned.

The effects of moving park researchers to the new agency have been mixed, many scientists say. It did give biologists independence and enable them to "do real science," says ecologist Rolf Peterson of Michigan Technological University in Houghton. But it also meant that park managers lacked direct access to basic researchers. "That cuts both ways," says Peterson. Although some 750 natural resource managers—usually master's- or bachelor's-level biologists—were left in the Park Service, the loss of research scientists "was devastating to a lot of parks," adds Boyce. At Yellowstone, for instance, park scientists were transferred to distant USGS units. In 1996 and 1997, no one bothered to do aerial surveys of park elk herds, Boyce notes. And the service's few strong research programs, such as Sequoia Kings Canyon in California, lost ground as staff members struggled to adapt to a succession of new managers and layers of bureaucracy.

The creation of a separate agency also did little to change the cold climate that outside scientists perceived. To be sure, some top-notch research has been done in parks such as Sequoia and Michigan's Isle Royale, where an NPS-supported 4-decade study of gray wolves and moose by Peterson and others has become a textbook example of predator-prey interactions. But such studies have been the exception. Although the Park Service issues over 3000 permits to perhaps 2000 visiting research teams each year, many biologists and geologists, stymied by the confusing permit system and unfriendly attitudes of some park managers, have opted to work in adjacent national forests or military bases. As a result, the flora just outside a park's boundaries are often better documented than the plants within, says Soukup, the Park Service's associate director of natural resources stewardship and science.

Responding to the long string of critical reports, Congress in 1998 passed the National Parks Omnibus Act, which directed that the parks' management be "enhanced by … the highest quality science and information." As Congress was considering that measure, the most scathing critique yet came along: a 1997 book by NPS historian Richard Sellars. "The National Park Service remains a house divided—pressured from within and without to become a more scientifically informed and ecologically aware manager of public lands, yet remaining profoundly loyal to its traditions," wrote Sellars in *Preserving Nature in the National Parks*. The book had a powerful impact, even more than the legislation. Among park leaders, "the light went on," says Jon Jarvis, superintendent of Mount Rainier National Park in Washington.

Bringing science back into the fold

So in August 1999, NPS director Stanton announced the Natural Resource Challenge. The 5-year plan does not return Ph.D. scientists to the parks—the cadre still exists in the Biological Resources Division within USGS. But it does attempt to bolster scientific decision-making in other ways. One of the first priorities, says Soukup, is to build data banks on natural resource conditions in the parks, from mapping soils and vegetation, to tallying species, to monitoring air and water quality. To do so, the Park Service is investing $14 million this year in natural resources management, on top of the existing $100 million, much of it on a long-recommended monitoring plan and inventory of vertebrates and vascular plants. The agency, which also wants to hire 700 more resource managers, hopes Congress will fund the program at $20 million a year for four more years.

Soukup also wants to open the parks to university researchers. Within the next few weeks, the NPS will blanket universities with brochures describing a new "Sabbatical in the Parks" program starting later this year. It will offer scientists who want to spend a few months doing field studies in parks logistical support such as housing, computers, and dry lab space. "The hope is that a lot of people will bite," says NPS resource manager Bob Krumenaker.

To ease the way for academic researchers, the NPS is simplifying the permitting process, says Gary Machlis of the University of Idaho in Moscow, who is now helping steer the science plan as the NPS's

visiting chief social scientist. That includes putting forms on a Web site, standardizing rules for all parks, and scrapping a policy that encourages park managers to turn down a study if it can be done elsewhere.

Scientists within and outside Interior welcome these reforms. "It's a good step in the right direction, more than I could have asked for," says Sellars. But good intentions aside, some former Park Service scientists, such as Nate Stephenson, a plant ecologist at Sequoia Kings Canyon, question whether this new program can forge the kinds of close ties between researchers and park managers that existed when basic scientists were still part of the Park Service. "My fear is that with turnover in personnel, some of the communications that developed when we were part of the Park Service will become weaker and weaker," Stephenson says.

Critics also question the extent of support for the science program among top Park Service leaders. "Part of the challenge is to change the culture of the Park Service," concedes Machlis. Each park is a fiefdom ruled by its superintendent, and superintendents vary in their interest in science, Sellars points out. Indeed, only one superintendent from the largest parks rose from the ranks of natural resource managers rather than park rangers. Soukup wants to address that by promoting resource managers and grading superintendents on how well they use science. After all, the best scientific advice in the world won't help if no one at the top is listening.

–JOCELYN KAISER

GENETICS

Uphill Battle to Honor Monk Who Demystified Heredity

Scientists are renewing a drive to found a "Cold Spring Harbor East" in tribute to Gregor Mendel, whose work was rediscovered 100 years ago

BRNO, CZECH REPUBLIC—In what may be the most unlikely birthplace of a science, the discipline of genetics took root in a humble garden in the courtyard of a monastery in this ancient Moravian city. Today, a weathered stone foundation is all that remains of the garden's hothouse, and only a grass yard and a lone sycamore mark the spot where Gregor Mendel, an obscure Augustinian monk, bred pea plants nearly a century and a half ago to learn how traits are handed down from one generation to the next. What Mendel learned from those pea plants revealed the fundamental laws of inheritance.

To help mark the rediscovery of Mendel's work 100 years ago, a group of researchers has drafted ambitious plans to transform part of his old monastery, which now has only a small museum, into a modern center that would host scientific meetings and perhaps a bioinformatics institute—a kind of Cold Spring Harbor East. "We want to link Mendel's heritage to the international community of scientists," says Emil Palecek, a molecular biologist at the Czech Academy's Institute of Biophysics in Brno.

If Palecek and his colleagues succeed, their center would be a triumph not only for Mendel's legacy, but also for a discipline still haunted in Eastern Europe by one of the ugliest scientific frauds of last century—Lysenkoism, which poisoned genetics behind the Iron Curtain in the early years of the Cold War. But even though they have won endorsements from high-powered individuals such as Nobel Prize winner James D. Watson and Czech President Vaclav Havel, backers of the so-called Mendel Center have so far received only a lukewarm response from the European scientific community, including potential funders. They are now broadening their appeal through symposia this year to mark the centennial of the establishment of Mendelian genetics.

History suggests they face an uphill battle. Attempts to grandly honor Mendel's scientific legacy, like the monk's own efforts to promote his laws of heredity, have been a study in frustration. Mendel was born in 1822 in what was then a province of Austrian Silesia and studied at the University of Vienna before moving to Brno, where he did all of his landmark research. He first outlined his findings in a series of lectures in 1865 and published his seminal work, "Experiments in Plant Hybridization," in Brno in 1866. The monograph, however, was all but ignored until after Mendel, dispirited by the lack of recognition, died in 1884. It would take another 16 years for Mendel to get the credit he was due, when three prominent and competing European botanists—Hugo de Vries, Karl Correns, and Erich Tschermak von Seysenegg—rediscovered Mendel's work in the course of their own research and Correns cited "Mendel's laws" of heredity in 1900. Suddenly, the forgotten monk—thanks to the citations and the ensuing efforts of British zoologist William Bateson to promote Mendel's reputation—was hailed for his pioneering contributions to genetics.

A monk and his disciples. Pavel Braveny and Eduard Schmidt are hoping Brno will host more than a statue in tribute to Mendel.

CREDIT: R. KOENIG

When Czechoslovakia was carved out of the defeated Austro-Hungarian Empire after World War I, scientists in the nascent country planned to honor Mendel by establishing a genetics research center near his monastery. The Nazi occupation and World War II dashed those plans, however. Brno scientists hid Mendel's manuscripts and notes in a local institute's safe, says Anna Matalova, director of a small Mendel museum, the Mendelianum, that now occupies several rooms of a monastery building. Shortly before the Soviet occupation in 1945, a relative of Mendel's spirited the original manuscript of "Experiments in Plant Hybridization" into Germany for safekeeping. "It's a miracle that the artifacts in the Mendel museum survived at all," says Pavel Braveny, a Brno physiology professor who is among the local Mendel Center organizers, along with Palecek and physicist Eduard Schmidt of Brno's Masaryk University.

The end of the war marked only the beginning of the troubles for Mendelian geneticists in Czechoslovakia, who soon came under the thumb of Trofim Lysenko, a Ukrainian agronomist who rose to power in the Soviet Union in the 1930s under dictator Joseph Stalin. Lysenko's dogmatic view that nature could be sculpted at will and the corollary—that the laws of genetics were a hoax—held sway for more than 25 years. Soviet scientists who publicly avowed the existence of genes often were