Department of Agriculture

The Department of Agriculture supports and conducts research to improve the understanding, use, and management of natural resources at high latitudes. Research is directed toward solving problems in agriculture, forestry, and the environment and improving technology for enhancing the economic well-being and quality of life for Alaskans.

Agricultural Research Service

The research activities of the Agricultural Research Service (ARS) are focused on 22 multidisciplinary and cross-cutting National Program Areas of high priority designed to develop a knowledge base to promote timely responses to technical agricultural problems of broad scope and national interest. Programs in the Arctic or adjacent northern regions are limited in scope. They are, however, providing critical information necessary to solve issues in such diverse areas as preservation of plant germplasm, integrated pest management for grasshoppers, and biodiversity of pathogens and parasites in northern ruminants. This research addresses the sustainability of renewable natural resources in the Arctic and has implications for managing plants and animals elsewhere.

Plant Germplasm Research

The primary mission of the National Arctic Plan Germplasm Resources Unit (NAPGRU) is the acquisition, propagation, storage, and distribution of plant germplasm for all presently existing agricultural crops and nonagricultural species in Arctic, sub-Arctic, and alpine regions of the world. NAPGRU also serves as a grow-out site for both seed and clonal samples for some of the cooler-season accessions from other plant germplasm repositories. The mission also includes research of diseases affecting the germplasm increases and/or preservation of Arctic crop and native species.

To date, there has been no systematic effort on the part of any U.S. agency to preserve high-latitude or high-elevation plant germplasm. There is no way of knowing what possible medical, commercial, or other research benefits are to be gained from the preservation and study of some of these unique and environmentally isolated plant species.

	Funding (thousands)	
	FY 02	FY 03
Forest Service–Global Change	729	653
Natural Res Cons Svc–Soil Survey	560	360
Ag Res Service–Global Change	2,000	2,000
Total	3,289	3,013

In addition, there are accessions that are high latitude or altitude in nature that are difficult to grow at low-latitude sites where the summer days are much shorter and warmer than in Palmer, Alaska. The long days during the growing season on the Palmer site may also reduce the time necessary for seed production of accessions from other National Plant Germplasm System sites (for example, cauliflower produces seed in the first year instead of the expected second year for a biennial). Plant diseases, both indigenous and introduced, in Alaska are poorly understood; comprehensive plant disease surveys in crop, exotic, and native plant species are negligible, especially for plant viruses. Viral diseases can have a significant impact on the short-season crops as well as the growth of native species.

Arctic germplasm preservation will be improved by the ability to detect and understand the biology of viruses in native plant species living in natural environments. The study of diseased twisted-stalk in Denali State Park and near Skwentna revealed two different viruses, which were partially characterized from the plants with either single or multiple infections from each site. The significance of this study is the added biological knowledge of plant pathogens in native plants and, in this specific case, the unexpected high number of infected plants in two isolated natural habitats.

Little is known about pathogens and the management of wetland plants in the Arctic. Barley yellow dwarf virus was identified for the first time in the Palmer area using molecular tools. Germplasm

increase plots were established to regenerate depleted or endangered seed supplies with local wetland accessions and those transferred from the state of Washington, Switzerland, and the Chinese Himalayas; this is the first time an Arctic germplasm repository has been established for Arctic, sub-Arctic, alpine, and sub-alpine plant taxa in the U.S. This will have considerable impact on restoration and site rehabilitation efforts in the future.

Grasshopper Pests

Grasshoppers are economically important pests in rangeland and crop agro-ecosystems throughout western North America, including parts of Alaska. Efforts to develop a local agricultural industry in the Delta Junction area of Alaska based on hay, grain, and livestock are hampered by periodic outbreaks of grasshoppers. The mix of state and private lands, as well as environmentally sensitive and agricultural areas, restricts the options for controlling grasshoppers. The ability to predict outbreaks and the development of new cultural and biological tactics will be a major step toward resolving grasshopper problems in Alaska. Additionally, much of the information generated in Alaska will also be directly relevant to grasshopper population management in other areas of North America. During years of high grasshopper densities, severe losses may be inflicted on barley crops; in 1990, crop losses were estimated at 50%. There are many hurdles to be overcome by the fledgling row-crop industry in Delta Junction, such as access to markets, cultivar selection, and weed control, in addition to the normal challenges of farming, such as vagaries of weather and low market prices. At this stage of development, farming operations may not be as resilient as in more established farming areas. Therefore, it is important to the success of the Delta agriculture project that farmers have the tools to avoid preventable losses.

Predicting grasshopper outbreaks requires a thorough understanding of the parameters affecting grasshopper growth and reproduction. At the Subarctic Agricultural Research Unit on the campus of the University of Alaska Fairbanks, growth and respiration rates of eggs, nymphs, and adults were measured at several temperature regimes. These data were used to refine phenological models of pest species of grasshoppers. This information from high-latitude populations will lead to more robust models of grasshopper development, which will be used to predict outbreaks and will be included in an individual-based model of grasshopper populations used for research purposes.

Very little information is available regarding the effect of grasshopper damage on cultivated crops, and no information is available on the interactions between insect damage and other biotic and abiotic factors in small-grain crops. Field experiments were conducted to evaluate the effect of grasshopper feeding and weed competition on barley and oats. This information is essential for the development of economic thresholds for management of grasshoppers in cultivated crops. Currently, there is no reliable means of sampling grasshoppers with dense crop canopies, making it difficult to study the invasion of crops by grasshoppers. Further field tests of windowpane/pan traps were conducted to examine the efficiency of the traps in relation to grasshopper population density, species composition, and vegetation type. A spatially extensive survey of grasshopper populations in the Delta Junction area was repeated to assess the influence of habitat attributes on the distribution of grasshopper populations.

Parasites of Wild Ruminants

Parasitic worms of large food animals cause production losses to farmers and ultimately result in higher prices to consumers. The economic impact of parasites is significant, leading to additional production costs of 2 billion dollars annually. Slower weight gain, death of young animals, higher feed costs, costs of drugs to remove parasites, and contamination of pastures all contribute to substantial losses for producers. Scientific research aimed at reducing the diverse impacts of parasitic worms is hampered by difficulties in identifying and classifying economically important helminths, especially the forms of the parasites that are found in the environment or in the waste products of the host. Parasites found in wild ruminants in Arctic regions are important in our understanding of parasite host ranges, their impacts on wild animals, co-evolution with their hosts, and potential reservoirs in wild populations.

ARS research provides basic information on structural and molecular characteristics, particularly documentation of variation, useful for assessing parasite biodiversity. Accurate determination of the species causing the losses and construction of classifications to predict the appropriate control measures for new, emerging, or invasive pathogens depends on a comparative approach integrating morphological and molecular data. Such baseline information is used by scientists to understand patterns of parasite biodiversity and distribution requisite for documenting invasive

and emergent pathogens, to determine the importance of reservoir hosts such as wildlife, to develop specific diagnostic tools, and to evaluate biological or chemical control agents.

With the curation of the U.S. National Parasite Collection, one of the largest specimen-based research collections in the world, ARS also provides a resource for reference specimens and information to support parasitology and animal health nationwide and globally. Predictive classifications of related parasites provide information useful for recognizing and controlling imported, invasive, or emerging pathogens that threaten farm animals or contaminate our food or water. Accurate systematics is the foundation for understanding the distribution and impact of parasites, emerging and invasive pathogens, local versus introduced species, and the interface between agricultural and natural ecosystems.

Biodiversity knowledge in Arctic and northern systems serves both theoretical and real-world issues. Current research programs serve as models for research, such as that under the Beringian Coevolution Project (BSP), to reveal evolutionary, biogeographic, and ecological structure and the history of biotas. It is apparent that these systems can serve as important historical analogs for understanding contemporary global change. Additionally, we can apply parasite biodiversity data in the context of real-world issues such as those considered under the Research Group for Arctic Parasitology (RGAP), including animal health, emerging pathogens, impacts to keystone species such as caribou, and potential impacts of global change driven by both climatological or anthropogenic forces. The cross cuts between basic knowledge and the application of biodiversity information indicate the degree to which the BCP and RGAP are complementary programs with a strong interface. They serve as model systems for programs in biodiversity assessment. Taxonomy and systematics integrating comparative morphology, molecular systematics, and phylogeographic approaches are requisite. We need robust theoretical frameworks for studies of cospeciation, historical biogeography, and historical ecology. Contemporary surveys and inventories continue to serve as the basis for demonstrating distribution and host association and how these are linked through relationships to landscape ecology, pathogen distribution, and disease. Ecosystem approaches that shift the focus from a single host species to a broader context are clearly necessary to identify the role of parasites and pathogens at the community level. Synoptic baselines to monitor change or stability in terrestrial systems in the Arctic are important contributions from these studies. The BCP and RGAP are works in progress and serve to show our continued need for the most basic of information about the distribution and host associations of parasites and pathogens.

Forest Service

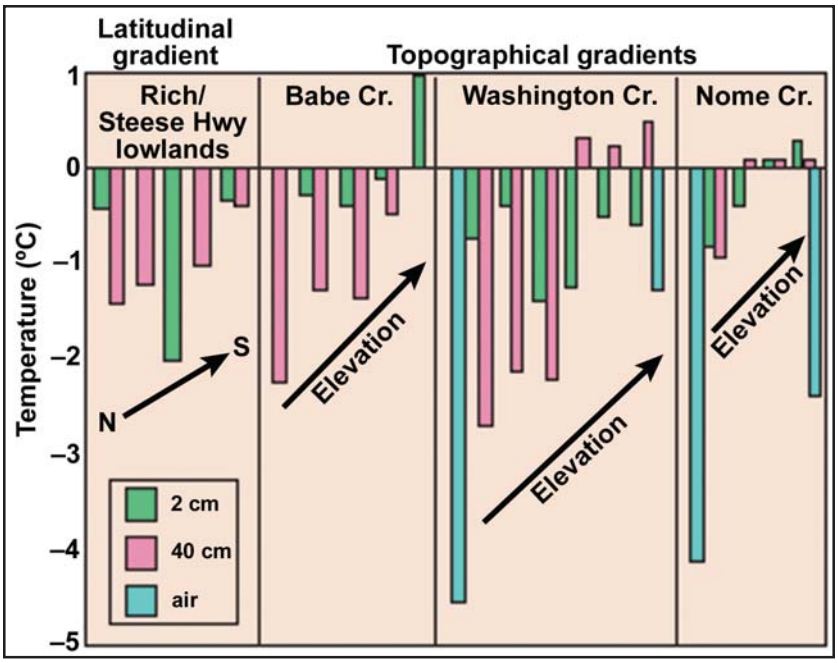
The USDA Forest Service's Pacific Northwest Research Station (PNW) is responsible for boreal forest research in Alaska through the Boreal Ecology Cooperative Research Unit (BECRU) located on the campus at the University of Alaska Fairbanks. The research activity of BECRU is, in part, a commitment to the NSF-sponsored Long-Term Ecological Research (LTER) conducted at the Bonanza Creek Experimental Forest (BCEF). The BCEF-LTER seeks to understand the Alaskan boreal forest as an integrated regional system in which climate, disturbance regime, and ecological processes are interactive components, with the objective to document the controls over these interactions and their ecological consequences. Research focuses on four major disturbance types—fire, flooding, forest harvest, and beetle outbreaks—and is organized around three major themes:

- Forest dynamics;
- The changing boreal carbon cycle; and
- Landscape controls over a changing disturbance regime.

These themes operate at different scales and have key societal relevance but require improved understanding of the basic scientific processes.

Forest dynamics research focuses on the interactions between population/community processes, disturbance regime, and ecosystem dynamics. Study of the changing boreal carbon cycle focuses on ecosystem processes. These changes hinge on interactions with the hydrologic cycle and other element cycles. Carbon balance depends on spatial and temporal variation in climate and disturbance regime and on population and community processes associated with succession. Landscape controls over changing disturbance regime focus on landscape and regional processes such as disturbance spread. These landscape processes are a logical consequence of changes in population, community, and ecosystem processes occurring at the stand scale.

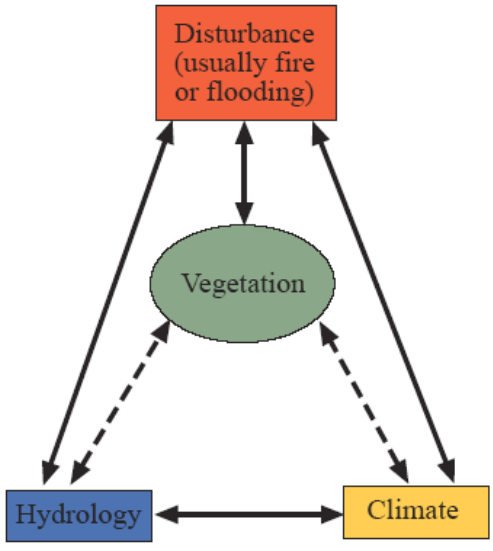
In 2003, scientists at the Boreal Ecology Cooperative Research Unit, USDA Forest Service in



Air and soil temperatures from 20 black spruce sites. These data will aid in relating temperature gradients to the structure and function of black spruce communities.

Fairbanks, Alaska, created a Landsat classification of spruce stands in Interior Alaska based on a combination of soil conditions and vegetation. In this classification, sites were grouped into the categories wet/cold, dry/warm, and intermediate. This classification, although in its early phases, has helped in examining the complex role of disturbance, particularly fire, in black spruce communities.

In collaboration with scientists from the Bonanza Creek LTER, these data were analyzed and presented at the recent Long-Term Ecological Research Symposium. Data presented included soil and air temperatures along climatic gradients within a subsample of black spruce communities and stand age data for 75 black spruce sites. These results are aiding scientists in understanding the potential differences in ecosystem drivers between the different black spruce communities. In particular, these findings are important in the context of the carbon cycle in black spruce forests and the key roles of vegetation, permafrost, and the fire cycle.



Conceptual model of the role of fire in changing the vegetation, hydrology, and climate of black spruce communities.

PNW is continuing to develop a conceptual model of the role of fire in black spruce communities. This model is unique in that it addresses the interactions between vegetation, permafrost, and abiotic factors, not as processes, but as relationships. The principal idea is that fire "weakens" these relationships, and by understanding how, we can predict landscape patterns in black spruce communities in the interior of Alaska.

Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) cooperates with and provides assistance to private, Alaska Native, state, and Federal landowners. NRCS field office personnel and other cooperating agencies in Alaska work together to provide technical resource planning and application assistance to landowners, users, and planners. Coordinated resource management plans, allotment management plans, or interim plans are developed. Engineering assistance is provided to individual landowners and managers and to Alaska Native villages, both to assist in sound resource management and to assist in overcoming natural threats including flooding and accelerated coastal and stream erosion. Soil data are collected, with maps and interpretations prepared for private, Alaska Native, and government lands in Alaska. The NRCS provides assistance to all landowners with USDA Farm Bill programs. NRCS also cooperates with the University of Alaska Fairbanks and the Pacific Northwest Forest Research Station with research on permafrost soils and wetland soils.

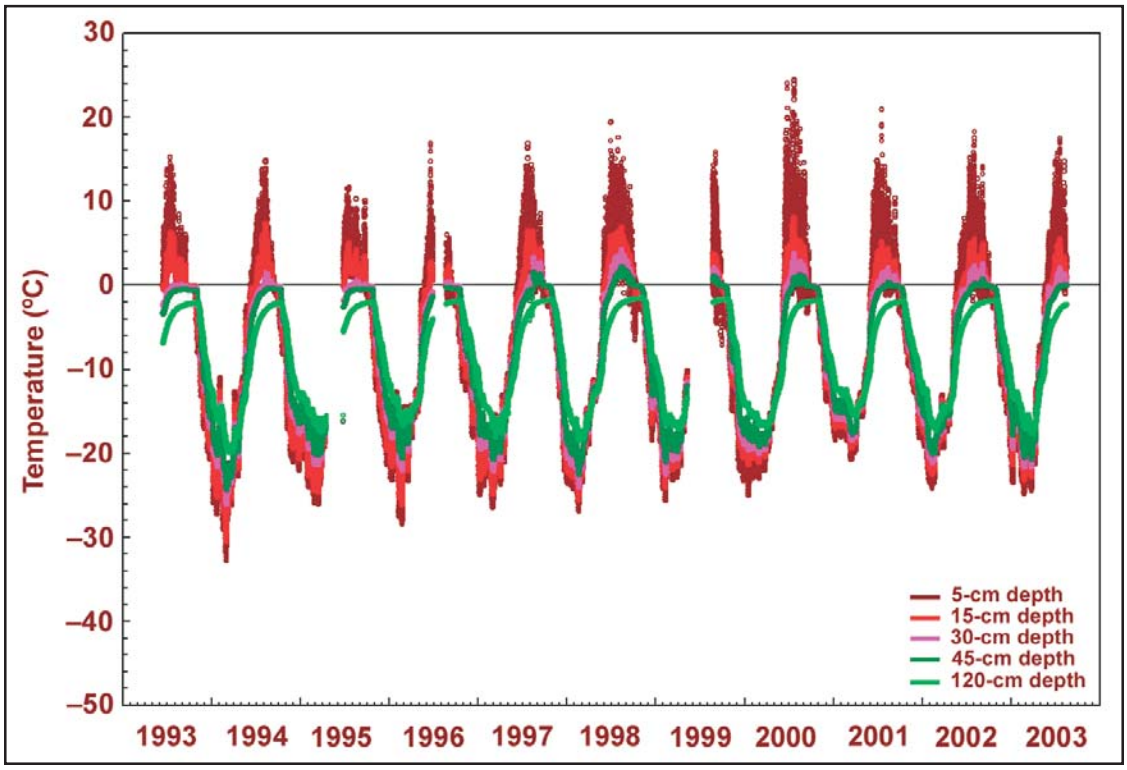
The research activities of the NRCS are done in cooperation with several universities (the University of Alaska Fairbanks, the University of Wisconsin, the University of Delaware, and the University of Cincinnati). The major joint project is monitoring soil temperature and moisture, along with several above-ground parameters, to study changes to the active layer and other possible

changes that may be taking place as the level of atmospheric greenhouse gases increases, creating possible global warming. Sites have been established along the Dalton Highway in the area of Barrow and other locations in Alaska. Similar sites have been established in the Himalayas and in Antarctica. At each of the sites the soils are sampled and completely characterized (chemical, mineralogical, and physical properties are measured). The soil moisture data are being reviewed to see if there is any warming and if the thickness of the active layer is changing. Early data suggest that the active layer thickness is increasing, which may suggest warming. Longer-term monitoring will be needed to see if this trend continues.

Soil climate monitoring stations were maintained and/or upgraded throughout the state. Sites are now established on the North Slope, in western Alaska, and along the populated road/rail corridor extending from Fairbanks to Homer. The data collected at all soil climate monitoring sites in Alaska are also being incorporated into USDA's overall national study on global climate change. Wetland soil study sites have also been established in southeast Alaska. Data from these sites will be used to help develop an Alaska-specific field manual for wetlands covered by the Clean Water Act. Several of the sites are now connected to a USDA telemetry network so that the analyzed data are readily available to the public via the World Wide Web.

Research also continued in cooperation with the NSF-funded university group to look at carbon storage near Barrow, Alaska. The major part of the NRCS activity is to develop better ways to determine the thickness of frozen peat layers. Much of the peat is in the permafrost zone, and if there is global climate change and an increase in the thickness of the active layer, more of the carbon may be thawed. This carbon may then be oxidized by microbes, resulting in more carbon dioxide or methane emissions. The problem with determining the thickness of the peat is the difficulty of sampling the frozen material. Cores are taken when the active layer is frozen so that coring equipment can be moved about the tundra. Ground-penetrating radar is used to develop patterns that show the depth and thickness of the peat and other soil layers so that large areas can be surveyed. Fieldwork is difficult when using ground-penetrating radar equipment in the harsh environment, and field calibration is a challenge.

Scientists sampling soil along the Dalton Highway for characterization.



Soil temperature records for Barrow, Alaska, for a 10-year period.

The techniques are being refined so that this can be done on the North Slope.

Approximately one million additional acres of land in Alaska were covered by new soil surveys in the last year. The projects are in both permafrost and non-permafrost areas. Current projects include private and Alaska Native lands in the Yukon–Kuskokwim River basins, the western Kenai Peninsula, and interior Alaska. Fieldwork was completed on public lands at Denali National Park and Fort Greely Army installation, with preliminary products available in 2004. The soil surveys often represent the only comprehensive baseline resource data in some of the more remote areas of Alaska. Requests for surveys are increasing and are driven by resource development, as well as health and safety issues, especially on Alaska Native lands and in villages. Issues related to climate change, including the impacts of forest pest infestations, warming permafrost, and coastal storms, are also driving the increased requests for survey data. Soil temperature and moisture studies, comprehensive laboratory analyses, and vegetation surveys are being conducted as part of the soil surveys. Survey products are being released to the public as GIS datasets and through the World Wide Web.

Data collection using ground-penetrating radar. The plastic bag is to exclude the bright ambient light and allow the operator to see the readout.