Alaska Region

Natural Resources Conservation Service photograph

Inventorying Soils in Alaska National Parks

By Parker Martyn

Introduction

Soil inventories in Alaska national parks provide valuable information about the influences soil has on landscapes and ecosystems. On various scales, soil influences ecological processes that modify and drive vegetation patterns, regional hydrology, nutrient dynamics, habitat development, and landscape evolution. Through its structure, texture, and permeability, soil influences vegetation and succession processes and provides a way for nutrients to be recycled and used again. Soil also modifies the atmosphere by emitting and absorbing gases such as carbon dioxide, methane, and water vapor. In Alaska, and in permafrost-affected soils in particular, soil can be a long-term reservoir of organic carbon sequestered from the atmosphere. Such processes create complex and diverse landscapes that challenge soil scientists and park stewards as they search to understand the ecological status and trends of national parks in Alaska.

National Park Service (NPS) Alaska Region Inventory and Monitoring Program (I&M) staff are working with soils experts and ecologists to conduct soils inventories for all 16 NPS units in the state. This effort is sponsored and managed by the I&M Inventory Program based in Anchorage, and includes assistance from soil scientists and ecologists from the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) in Alaska, and ecologists from ABR-Environmental Research and Services, Inc. (ABR) in Fairbanks.

What is a Soil Inventory?

A soil inventory is a snapshot in time of the condition and status of soil resources in a particular park. The primary objective with each inventory is to increase our understanding of national parks by describing and mapping the locations of soils. Climate, topographic relief, biological activity, time, and parent material, all influence and form soil (*Jenny 1941*). Soil scientists study these five factors to identify and classify soils. When mapping soils, they look for areas with similar soil-forming factors, collect information by digging 1-2 m deep soil pits, and describe what they find (*Figure 2*). Using samples taken from soil pits (*Figure 3*), scientists describe physical and chemical properties of soil horizons, such as soil color, texture, structure, and soil pH. Although the main focus is on soils, data is collected on vegetation, landforms, and surface hydrology, because soil inventories are also comprehensive ecological studies. Soils that are susceptible to erosion or other disturbances are identified. The affects wildfire has on the soil temperature, moisture, and vegetation succession are observed and recorded. Variations in the depth to permafrost are measured, and the geographic extents of these frozen soils are mapped. Observations of vegetation community type and species percent cover are also recorded.

Soil inventories are time and labor intensive. During the course of a soil inventory, scientists can dig hundreds of soil pits on transects that cross the map in the survey area. Because field seasons are short in Alaska, averaging about 100 days, it can take several years to describe the different soil types and ecological sites in the project area. Once field work is complete, scientists generate reports from their data that describe the physical and chemical properties of the soils. They also produce maps that illustrate where and how soil types and ecological sites are spatially distributed. Employing their electronic databases, soil scientists also generate interpretations for potential uses and management issues of soils, or ecological sites that exist in a given survey area. When soil inventories are finished, these reports, maps, and associated databases are published and made available to park staff and the public.

Figure 1. A scenic view of the Yukon Flats Lowlands along the Yukon River in Yukon-Charley Rivers National Park and Preserve.

Figure 2. (Inset) An inventory technician describes a soil pit in Aniakchak National Monument and Preserve.

NPS photograph

Photo courtesy of ABR-Environmental Research and Services, Inc.

Figure 3. Soils vary widely across the landscape, seen here are a rocky well-developed soil from an alpine site, a well-drained sandy soil from an inactive vegetated dune, a poorly developed soil with interbedded organic and silt layers from infrequent flooding, and a thick peaty soil from a bog showing the upward transition from sedge peat to a sphagnum peat.

Soil Inventory Methods

In Alaska, many challenges exist when matching the size and scale of parks with the level of detail needed for each inventory. With a cumulative acreage of approximately 54 million acres, or roughly 65% of all parklands in the NPS system, most Alaska national parks are large. In fact, nine of the ten largest parks in the NPS system are located in Alaska, all ranging in size from 2.5-13 million acres. Most parks are very remote and lack developed infrastructures, which necessitates the use of small boats, fixed-wing airplanes, helicopters, and in general increases the amount of logistical support needed to conduct field work. These and other related challenges influence the level of detail, the amount of data that can be collected, and the time it takes to conduct soil inventories.

To address such challenges, our soil inventory efforts take advantage of two methodologies. One utilizes expertise from the NRCS located in Alaska, and leverages the well established and nationally standardized soil survey methodology that other non-Alaskan I&M soils inventories also use. The second method, which is particularly well suited for the large expanses of parklands in Alaska, is produced by an organization that specializes in Alaska ecosystem mapping, ABR. This method merges satellite image processing techniques and statistical analysis with field data to build ecological models through which soils information (soil landscapes) can be extracted. Both methods use extensive field observations and soil sampling, and both provide ecological descriptions and use similar NRCS soil taxonomy classifications. This combination of expertise allows us to rapidly complete soil inventories, and at the same time provide reliable and consistent scientific information for subsequent soil monitoring activities, park management, and protection.

Soil/Ecological Site

Three soil mapping products, or orders of mapping, are used by NRCS to map parks in Alaska. Mapping orders provide varying levels of detail. Each order varies in intensity and has associated with it an amount of field collection effort and level of product usefulness. Soil orders can be combined with one another, which provides the flexibility to use higher levels of detail where needed, and more generalized soils information for less accessible areas, or areas with non-vegetated terrain, rock, or ice that support little or no vegetation. The three levels of mapping orders (2, 3 / 4, and 5) have standardized data collection and analysis procedures, and each adheres to the published standards and procedures of the National Cooperative Soil Survey (*NRCS 2009*). Once inventories are complete, soil survey manuscripts, ecological site reports, and interpretations for potential soil management practices are made available on the NRCS Web Soil Survey website (http://websoilsurvey.nrcs.usda.gov).

To date, one park unit in Alaska, Denali National Park and Preserve (approximately 6 million acres) has a completed NRCS soil survey. One other soil survey in Yukon-Charley Rivers National Preserve is underway and on target for completion by the end of 2012. Future NRCS soil surveys are being planned for the Southeast Alaska I&M Network (SEAN) park units (Glacier Bay National Park & Preserve, Klondike Gold Rush National Historical Park, and Sitka Historical Park).

Soil Landscapes

To expedite the soil inventory process in Alaska, a "Soil Landscapes" product has recently been developed by ABR for the Arctic I&M Network (ARCN) parks (Bering Land Bridge National Preserve, Cape Krusenstern National Monument, Gates of the Arctic National Park and Preserve, Kobuk Valley National Park, and Noatak National Preserve), an area of approximately 20 million acres, and Wrangell-St. Elias National Park and Preserve in the Central Alaska I&M Network (CAKN), an area of about 13 million acres. The soil landscape product provides classifications for soils derived from an ecological land survey (ELS), which is developed using a combined set of ecological state factor relationships (e.g., vegetation, hydrology, geomorphology, topography, climate, time, and disturbance), field plot data analysis, and the use of satellite image processing techniques (*Jorgenson 2009*). Using

Figure 4. An example of a raster-based GIS map of soils landscape classifications for the Noatak National Preserve and Kobuk Valley National Park, both in the Arctic Network.

specialized automation routines, this method is well suited for mapping large areas of parklands. Products include reports that describe soils and ecological associations, which are published as part of the NPS Natural Resource Technical Report series, a raster-based GIS dataset, and an electronic database of the ELS from which the soil landscapes are derived. These products are made available on-line through the NPS DataStore (http://science.nature.nps.gov/nrdata/index.cfm). Figure 4 illustrates a map of soil landscape classifications that have been derived from an ELS.

In addition to the ARCN and CAKN completed efforts, this Soil Landscapes approach is currently being implemented and is in progress for the five parks that make up the Southwest Alaska I&M Network (Alagnak Wild River, Aniakchak National Monument and Preserve, Katmai National Park and Preserve, Kenai Fjords National Park, and Lake Clark National Park and Preserve).

Conclusion

Using expertise from Alaska-based ecologists and soil scientists, the Alaska I&M Program is conducting soil inventories for all 16 national parks in the state. To date, approximately 50% of the 54 million acres of national parklands in Alaska have a completed Soil Landscape inventory. By the end of 2012, with the completion of the Yukon-Charley Rivers soil survey, about 16% of NPS lands in Alaska will have a National Cooperative Soil Survey completed by NRCS. Both soil inventory methods include field data collection, ecological process analysis, and soil classifications. NRCS soil surveys provide comprehensive soils taxonomy and ecological site descriptions for polygon-delineated soil map units that are based on national soil mapping standards. Spatial and tabular data are delivered through the Internet-based Web Soil Survey according to National Cooperative Soil Survey standards. Soil Landscape products, from ABR, combine extensive ecological land survey data, satellite image processing techniques, and statistical modeling to provide a multifaceted ecological association dataset from which soil landscapes and other ecological related maps may be derived. The reports, raster datasets, and associated databases are made available on-line through the NPS DataStore. Using both of these methods, we are able to provide reliable and consistent scientific soil inventories for use in monitoring activities, park management, and protection. In more general terms, soil inventories in Alaska national parks increase our understanding of soil ecosystem processes in parks, on a regional level, and on a global scale.

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Related Websites

Natural Resources Conservation Service, Alaska
http://www.ak.nrcs.usda.gov/soils/index.html

ABR
http://www.abrinc.com

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