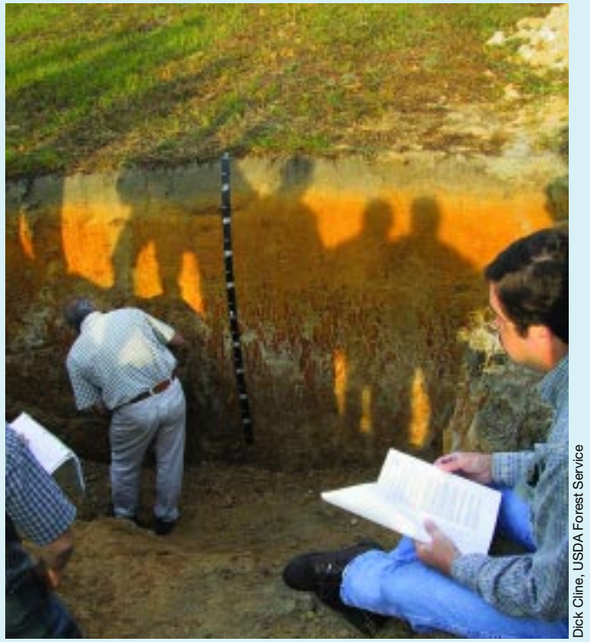
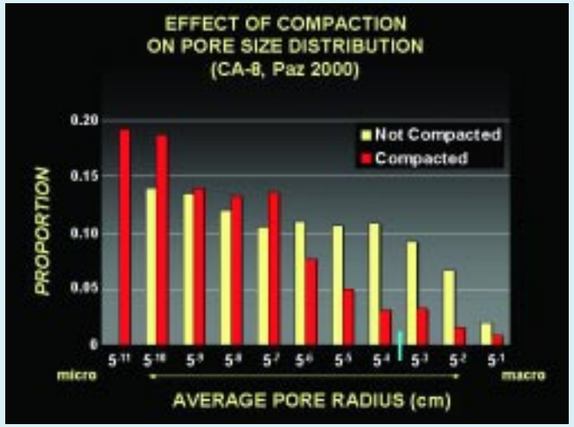
Deborah Page-Dumroese, USDA Forest Service

Rob Harrison, University of Washington



Dick Cline, USDA Forest Service



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United States Department of Agriculture

Forest Service

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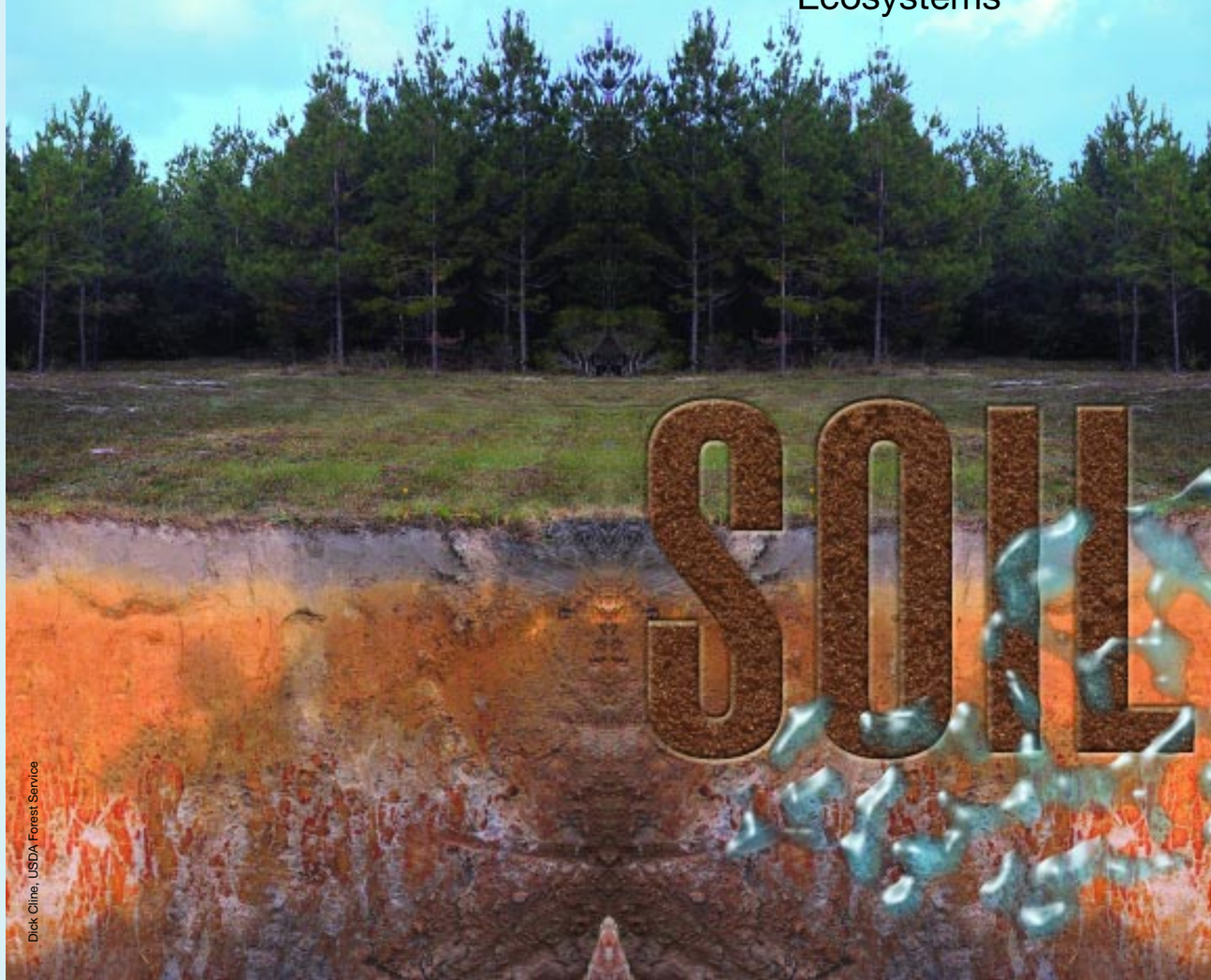
Long-Term Soil Productivity Research:

A Program in Sustaining Forest Ecosystems



Dick Cline, USDA Forest Service

The Long-Term Soil Productivity (LTSP) Study

Sustaining productivity is a goal of forest management and a legal obligation for the Forest Service, U.S. Department of Agriculture.

Under Section 6(g) of the National Forest Management Act of 1976 the Secretary of Agriculture is required, through research and continuous monitoring, to ensure that management systems "will not produce substantial and permanent impairment of the productivity of the land."

Society's concern about the effects of management activities on our forest ecosystems led to the initiation of this study of long-term soil productivity on national forest lands. This joint National Forest System and Forest Service Research and Development project was initially established to evaluate timber management impacts on long-term soil productivity. The importance of the issues involved has lead the Canadian Forest Service, the British Columbia Ministry of Forests, universities, and industry groups to become program cooperators.

Mike Curran, British Columbia Ministry of Forests

Neil Foster, Canadian Forest Service

Research will further our understanding of sustainable productivity and how soil disturbance affects —

- Photosynthesis and carbon allocation
- Water use
- Nutrient use
- Resistance to pests
- Fundamental soil productivity
- Biotic diversity
- Other processes

To increase the accuracy of the study, monitoring efforts will —

- Calibrate changes in soil properties against:
  1. stand productivity (trees only)
  2. total productivity (all forest vegetation)
- Evaluate and improve field monitoring methods
- Find ways to extend results to other sites

Objectives:

USDA Forest Service, Canadian, university, and industry research scientists and professionals from U.S. national forests are working together in this cooperative study to find answers to many questions concerning long-term soil productivity. Main objectives are to —

1. Quantify the effects of soil disturbance on soil productivity,
2. Validate standards and methods for soil quality monitoring,
3. Understand the fundamental relationships between soil properties, long-term productivity, and forest management practices, and
4. Evaluate the potential for mitigating the adverse effects of disturbance.

Findings from this research will show us how changes in site organic matter and soil porosity affect fundamental site processes controlling forest health, productivity, and sustainability. Results will also enable us to more thoroughly comprehend the basic functions of forest soils. That knowledge will be applied to restore ecosystem health, maintain and enhance long-term forest productivity, and improve sustainable forest management practices.

Felipe Sanchez, USDA Forest Service

LTSP Key Points:

- **Evaluate timber management impacts on LTSP**

  Initiated by the Forest Service in 1989, the study provides a network of installations and research data across a broad range of forest ecosystems throughout the United States and Canada.

- **Evaluate the sustainability of managed stands**

  Research is expanding to provide a better understanding of soil and plant growth processes and to enhance productivity of managed forests.

- **Set calibration and soil monitoring standards**

  Land productivity is simply defined as the capacity of a given site to sustain plant growth. Along with climate and energy from the sun, soil establishes the productive potential for a site and can be directly affected by management. To identify soil properties most vital to forest growth and to determine if long-term soil productivity has been seriously altered by management, the Forest Service must develop accurate calibrations and effective soil monitoring standards. It must be known what the inherent carrying capacity of forest land for producing vegetation is, what the key soil variables controlling this capacity are, and what fundamental processes key soil variables reflect.

- **Evaluate forest practices to enhance productivity**

  At its core, the LTSP study is concerned with how productivity is influenced by disturbance. On many intensively managed forested lands, disturbance is frequent and treatments often are prescribed to mitigate adverse effects and to enhance productivity. To expand the scope of this research to cultural treatments used in modern forest management, Forest Service Research and Development is forging partnerships with the broader forestry community. Thus, new study sites are being established on cooperators' lands and include progressive operational practices and innovative treatments meant to enhance the soil resource.

LTSP: A National Scientific Network

An International Partnership

LTSP research focuses on the joint role of soil porosity and site organic matter and their effect on the site processes that control productivity. The study is being carried out through a standard series of experimental treatments designed to create varying degrees of stress and to provide measures of biological response and soil recovery. Work centers on national forest lands in the United States and dedicated sites in Canada covering major forest and soil types. The Canadian sites are managed by the Canadian Forest Service in Ontario and the British Columbia Ministry of Forests. The experimental sites are protected from conflicting uses and are dedicated to long-term research.

California

California's forests are extremely productive. Although accounting for only 3 percent of the Nation's commercially forested land, this state has played a major role in meeting our Nation's needs for forest products. In terms of productive capacity, only Oregon and Washington rank higher.

In California, LTSP research centers on the mixed conifer forest. This forest type occupies 9.3 million acres (40 percent of our forested land). The first experimental site (the Nation's second) was established in 1991 at the Challenge Experimental Forest, operated by the Forest Service's Pacific Southwest Research Station. Since then, other sites have been established. And by 1995, a dozen installations were operating across the western slopes of the Sierra Nevada and Cascade Range.

Besides a standard set of measurements to be recorded at all installations, the California sites are providing valuable insights into rates of soil erosion, soil faunal activity, and organic matter recycling in response to site disturbance. The effectiveness of both conventional and innovative recovery treatments are also being tested.

Dick Cline, USDA Forest Service

Intermountain Region and Southern Oregon Cascades

Mixed conifer forests of western redcedar, mountain hemlock, Western white pine, Douglas-fir, and spruce are typical of the mountainous West. Their range extends from the Oregon Cascades eastward to Western Montana. Much of the growing season is characterized by low soil moisture with high evaporation, which can reduce the success of forest regeneration. Soils are weakly developed and formed from parent materials including volcanic ash, granitics, basalts, and sedimentary rocks. LTSP cooperation among the Forest Service's Rocky Mountain and Pacific Northwest Research Stations and the Intermountain, Rocky Mountain, and Pacific Northwest Regions has led to the installation of experimental sites in north and central Idaho and southern Oregon.

Central States

The upland oak-hickory forest is the single most extensive forest type in the Nation, south of Alaska. Covering over 114 million acres from central Texas to the Dakotas, and eastward to the Appalachian Mountains, this forest is found in all topographic positions with moist subhumid to dry subhumid climates. Soils often are gravelly and are formed from a variety of materials of glacial and sedimentary origin. LTSP collaboration between the Forest Service's North Central and Northeastern Research Stations and the Eastern Region is underway in Missouri and West Virginia.

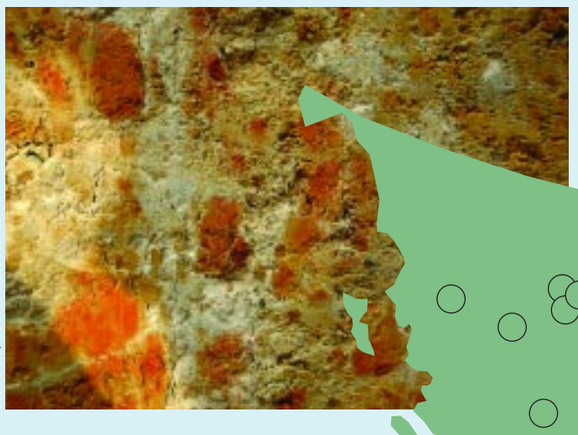
Lake States

More than 80 percent of the eastern aspen cover type grows on 13 million acres of commercial forest land in the Great Lakes region. Soils range from well-drained sands to poorly-drained clays. This forest type, characterized by gentle topography, humid, warm summers, and cold, continental winters, is being studied in Minnesota, Michigan, and Wisconsin through the LTSP efforts of the Forest Service's North Central Research Station and the Eastern Region.

Southern Coastal Plain

The Forest Service's Southern Research Station is directing its work toward loblolly pine, the most commercially important forest tree in the Southern United States. While this species grows on nearly 29 million acres in humid, warm temperate regions from eastern Texas to the Valley and Ridge Provinces of the Appalachian Highlands, forests on Coastal Plain sediments are the most important. Research is underway on sites that include excessively drained sands in Texas, medium-textured sites in Louisiana and Mississippi, and poorly-drained sites in North Carolina.

Felipe Sanchez, USDA Forest Service



Dick Cline, USDA Forest Service

Dick Cline, USDA Forest Service

Felix Ponder, USDA Forest Service

British Columbia

The LTSP sites are in interior British Columbia and include the Sub-Boreal Spruce, Boreal Black and White Spruce, and Interior Douglas-Fir Biogeoclimatic Zones in stands dominated by spruce-subalpine fir, aspen, and Douglas-fir, respectively. Growing seasons are marked by cold mountain climates and a definite summer dry period (especially in southern British Columbia). The dry period is shorter than that of the Northwestern region of the United States. Soils are medium to fine textured, weakly developed, and formed mainly from glacial till derived from volcanic or sedimentary rocks, with minor inclusions of metamorphics and granitics. Cooperation between the USDA Forest Service network and the British Columbia Ministry of Forests has led to four separate installations, each with three replicates, of the core LTSP experiment.

Mike Curran, British Columbia Ministry of Forests

Ontario

LTSP installations are centered in the Boreal Forest of central and northeastern Ontario in stands dominated by black spruce and jack pine. The continental climate is characterized by warm to cool summers, very cold winters, and low precipitation. Soils are formed mainly from medium to coarse textured glacial till or sandy glacial outwash materials overlaying granites and metamorphic rocks of the Canadian Shield. Long-term productivity concerns center around the ability of these sites to sustain nutrient reserves and productivity through successive forest removals. The Canadian Forest Service and the Ontario Ministry of Natural Resources have each installed nine replications of a partial LTSP study design in Ontario.

Neil Foster, Canadian Forest Service

Neil Foster, Canadian Forest Service

Dick Cline, USDA Forest Service

Affiliate Sites

Many sites with treatments similar to LTSP can complement the aims of the main study. Researchers investigating questions in common with LTSP have been welcomed into an expanded research family. Affiliate field experiments are earmarked by sound experimental design, certain treatments in common with LTSP, and by their investigators' willingness to follow certain measurement protocols and share data and findings. Benefits include expanding the network of field sites and researchers, and establishing links between experimental and operational treatments. Affiliate members in the United States and Canada include Federal, provincial, university and private sector scientists. They participate actively at annual LTSP Technical Committee meetings.

Reaching out

This research is attractive…

For cooperative research. Often located on national forest lands, LTSP study sites represent a wide range of management, soil, and vegetation conditions. This project has already attracted scientists and practitioners from many other public and private forestry institutions, including private industry and state agencies.

For university partnerships. Forest Service researchers are encouraging university scientists to collaborate on studies of fundamental ecosystem processes. University response has been enthusiastic and numerous cooperative studies have been established.

Internationally. Complementary LTSP work is underway in New Zealand, as well as that noted in Canada.

The national LTSP study will establish a landmark towards understanding how ecosystems respond to disturbance. Its findings will provide forest managers with the tools they need to sustain and improve forest productivity.