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*Glaciers as Indicators of Climate Change* - Glaciers in Olympic, North Cascades, and Mount Rainier National Parks are relatively small, have large annual snow accumulations and snowmelt, and are sensitive to changes in precipitation and temperature. We are monitoring several of these glaciers in cooperation with the U.S. Geological Survey to determine changes in total mass over time.

*Effects of Vegetation Change on Soil Development* - There is evidence of a dramatic increase in the regeneration of subalpine and lowland forest tree species in meadows during the past century. We are measuring associated changes in the rate of soil development due to this change in vegetation distribution.

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► **PUBLICATIONS**

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We have published several recent articles on the effects of global change on natural resources in the Pacific Northwest. These articles are available on request:

*Climatic effects on establishment of subalpine fir in meadows of the Olympic Mountains* - A. Woodward, M.B. Gracz, E.G. Schreiner

*Global environmental change in mountain protected areas: consequences for management* - D.L. Peterson, A. Woodward, E.G. Schreiner, R.D. Hammer

*Growth and genetic response of subalpine fir in a changing environment* - G.J. Ettl, D.L. Peterson

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*On the chemical and physical limnology of Crater Lake* - J. McManis

*Sensitivity of subalpine forests in the Pacific Northwest to global climate change* - D.L. Peterson

*Tree establishment in subalpine meadows of Mount Rainier National Park* - R.M. Rochefort, D.L. Peterson

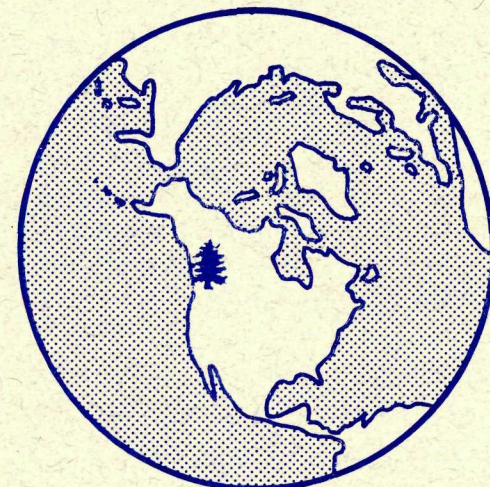
**PLEASE CONTACT US**

We welcome your comments, ideas, and questions about the NPS Global Change Research Program in the Pacific Northwest.

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# GLOBAL CHANGE RESEARCH



NATIONAL PARK SERVICE  
PACIFIC NORTHWEST REGION

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## ► *RESEARCH PROGRAM*

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There is growing concern that global warming caused by the "greenhouse effect," as well as other changes in the atmospheric environment, may cause large scale changes in the earth's ecosystems. As part of a national program, the Pacific Northwest Region of the National Park Service (NPS) is studying the potential effects of climate change and other environmental factors on national park resources. Directed by NPS scientists, the Pacific Northwest research program includes a wide range of studies on terrestrial and aquatic resources. These studies contribute to a better understanding of natural resources in the national parks and help park managers respond to possible changes in resource conditions.

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## ► *GLOBAL CHANGE IN THE PACIFIC NORTHWEST*

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National parks in the Pacific Northwest sustain a wide range of ecosystems, ranging from temperate rainforests to alpine glaciers. Future changes in temperature and precipitation could place great stress on park ecosystems. Potential climate-induced changes include:

- ◆ More large wildfires
- ◆ Higher treelines and fewer subalpine meadows
- ◆ Decrease in native salmon and trout populations

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- ◆ Loss of rare and endangered plant species
  - ◆ Increase in sea level

The rate and magnitude of these changes are difficult to determine. Only by understanding the patterns and processes of natural systems can we accurately predict these changes. National parks provide excellent natural laboratories for studying the specific dynamics of ecosystem relationships, and shifts within these relationships over time.

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## ► *COOPERATION*

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Ecosystems do not stop at park boundaries. Because national parks border on other public and private lands, a cooperative effort is underway to address different management objectives in approaching the challenges of global change. The NPS Global Change Research Program works with several agencies and institutions, including the USDA Forest Service, U.S. Geological Survey, U.S. Environmental Protection Agency, Battelle Labs, University of Washington, Oregon State University, and Olympic Natural Resources Center.

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## ► *APPLICATION AND OUTREACH*

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Managing natural resources in a rapidly changing environment is a new concept. Better information on the condition of natural

resources will allow the National Park Service to anticipate potential climate change and develop appropriate management strategies. The Global Change Research Program works cooperatively with the parks to integrate study results with resource management planning. We also convey global change issues and concerns to the public through park interpretive programs, public lectures, and teaching.

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## ► *CURRENT STUDIES*

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Global change research in the Pacific Northwest focuses on four National Parks (Olympic, Crater Lake, Mount Rainier, North Cascades). Both long-term and short-term studies are underway:

*Effects of Climate on Growth and Distribution of Subalpine Conifers* - We are studying the effects of past climate on growth and regeneration of several subalpine conifer species with the use of tree ring analysis at Olympic, Mount Rainier, North Cascades, and Crater Lake National Parks. Fossil pollen is being analyzed at sites in Olympic National Park to determine changes in tree species distribution over the last 12,000 years.

*Effects of Climate on Physical and Chemical Characteristics of Crater Lake* - Crater Lake is one of the deepest, clearest lakes in the world and has been referred to as "the world's largest natural rain gauge." Detailed monitoring provides data that is being used to predict potential effects of changes in temperature and precipitation on the complex lake ecosystem.