



FOREST, CLIMATE, AND FIRE HISTORY OF THE HUDSON HIGHLANDS, SOUTHEAST NEW YORK DURING THE LAST >12,500 YEARS

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Over 12,500 years of Hudson Highlands forest, climate, and fire history have been revealed through analysis of plant fossils (pollen, seeds, conifer needles, and charcoal) isolated from sediment cores of Sutherland Pond (Black Rock Forest, New York) and Spruce Pond (Harriman State Park, New York). These fossils serve as biological indicators of past environmental conditions. The ages were determined using the AMS radiocarbon dating method and are reported in radiocarbon years.

The earliest pollen assemblages deposited after glacial retreat, some time greater than 12,500 years ago, are dominated by herbaceous and shrub types such as Willow (*Salix*), Birch (*Betula*), Alder (*Alnus*), Heath (Ericaceae), Sedge (Cyperaceae), Grass (Gramineae), and Composites (Tubuliflorae), with some trees, Pine (*Pinus*) and Spruce (*Picea*), possibly representing a tundra-like environment with scattered trees. The onset of organic deposition into each pond, the first occurrence of seeds and other plant macrofossils, and large increases in pollen influx to the ponds suggest dramatic environmental change (for example, climatic warming) at 12,500 years ago. At this time, development of a mixed boreal coniferous - temperate deciduous woodland occurred and featured Spruce, Fir (*Abies*), Paper Birch (*Betula papyrifera*), Oak (*Quercus*), Hop Hornbeam/Hornbeam (*Ostrya/Carpinus*), and Ash (*Fraxinus*) as suggested by pollen and/or seeds and conifer needles. An abrupt climatic flip back to cold conditions occurred at approximately 11,000 years ago and lasted for roughly 1000 years. The cool climatic episode is inferred from the dominance of Spruce, Fir, and Alder with a reduction of Oak, Ash, and Hornbeam. Warm conditions, similar to the present, were established by 10,175 years ago. This is inferred from expanding Oak-dominated forests and invasion by White Pine (*Pinus strobus*), followed by Eastern Hemlock (*Tsuga canadensis*) at 9645 years ago, and replacement of Paper Birch (*Betula papyrifera*) by Gray Birch (*Betula populifolia*) at approximately 9575 years ago. American Beech (*Fagus grandifolia*) immigrated at 8100, Hickory (*Carya*) at 6200, and American Chestnut (*Castanea dentata*) at 3600 years ago.

Fossil charcoal indicates that fire was more abundant during the last 10,000 years than between 12,500 and 10,000 years ago. Early expansion of Oak forests at around 10,000 years ago likely occurred in a setting of frequent fire. About 9500 years ago, decrease in fire apparently was a factor enabling expansion of Eastern Hemlock populations; however, centuries later, increase of fire appears to have restricted Eastern Hemlock and permitted expansion of Oak. Consistently high values of Oak pollen in association with high charcoal amounts for some nine millennia suggest that fire played an important role in the development and maintenance of Oak forest.

Euroamerican settlement (approximately 1700 A.D.) is well-documented in the pollen record by dramatic rises in Ragweed (*Ambrosia*), Grass (Gramineae), and Composites (Tubuliflorae). Harvest of Oak, Pine, and Eastern Hemlock is also registered in the record as decreased percentages of these taxa. Increased post-settlement charcoal amounts may be explained by use of fire in connection with land-clearance, wood related industries (charcoal, iron, and brick manufacturing), and operation of railroads (track fires).



