STRATIGRAPHIC RECORDS OF BLACK CARBON FROM LAKE SEDIMENTS AS ARCHIVES OF CONTINENTAL ENVIRONMENTAL CHANGE. W. Tinner and F. S. Hu, Department of Plant Biology, 265 Morrill Hall, University of Illinois, Urbana IL 61801, USA (fshu@life.uiuc.edu).

Introduction: The abundance and size distribution of charcoal in lake sediments are commonly used by paleoecologists to infer fire history in relation to natural (e.g., vegetation and climate) and anthropogenic changes. For this purpose, various techniques have been developed to quantify charcoal in lake sediments in the past two decades. This presentation will provide an overview of charcoal in lake sediments as a paleoenvironmental indicator, followed by a discussion on the strengths and limitations of major existing techniques for charcoal analysis. Two case studies from North America and Europe will then be examined to illustrate interactions among fire, vegetation, climate, and human disturbance during the Late Glacial and Holocene. These case studies represent two different biome types where fires play an essential role in vegetation structure, ecosystem function, and biogeochemical cycling, but the relative importance of climatic versus anthropogenic factors differs greatly in controlling fire occurrence between the two systems.

Results and Discussion: Wien Lake (64^{o} 20' N, 152^{o} 16' W) is located in the modern closed boreal forests of central Alaska, where fire occurrence during the late Quaternary was primarily driven by climate and vegetation variations. Microscopic charcoal analysis of a lake-sediment core from this lake shows increasing charcoal abundance from 12,200 to 11,000 BP, suggesting that *Betula* shrub tundra in the region became increasingly fire-prone in response to biomass increases and dry climatic conditions. A marked decrease in charcoal influx 10,800 - 9800 BP suggests a reduction of shrub-tundra fires, which was probably caused by a climatic cooling during the Younger Dryas. Following an early-Holocene increase, charcoal influx rates decrease substantially 8500-7200 BP, likely reflecting a transitory decrease of boreal forest fires during an episode of climatic cooling. Charcoal influx rates increase with the establishment of modern closed boreal forests dominated by *Picea mariana* ca. 6500 BP. This charcoal record provides strong evidence that climate change exerted a deterministic control over fire occurrence.

Lago di Origlio (46° 03' N, 8° 57' E) is a lake in the southern Swiss Alps surrounded by temperate chestnut-oak forests and small patches of cultivated land. Microscopic charcoal analysis of the sediments reveals that charcoal abundance 14,500 - 9300 BP is similar to that of the same period at Wien Lake. A marked decrease of charcoal influx also occurs 10,800 - 9800 BP at Lago di Origlio, suggesting that the Younger Dryas cooling diminished forest fire incidence. Charcoal influx increases during the early Holocene but then decreased to reach a minimum ca. 7500 BP. Subsequently human activities gradually replaced climatic factors as the dominant control over the regional fire regime. During the Neolithic (6500 to 3900 BP) natural forests were greatly altered by anthropogenic fires, and certain natural vegetation species (e.g., *Abies alba*) disappeared partially or completely in favor of fire-tolerant species that expanded to form new fire-adapted vegetation types. The charcoal record from Lago di Origlio documents the central role of forest fires as a human tool for land use.

In addition to paleoecological applications, charcoal analysis of lake sediments offers information on the biogeochemical significance of black carbon in terrestrial systems. For example, charcoal influx rates at Wien Lake are broadly consistent with those from other boreal sites in North America and Europe, with a range of 0.1-2.8 $mm^2\ cm^{-2}\ year^{-1}$. By making various assumptions, we have estimated the abundance of black carbon in boreal lake sediments and soils. Our results suggest that the mean mass influx rate of black carbon is ~42,000 $g\ km^{-2}\ year^{-1}$, with a wide range of 3500 – 98,000 $g\ km^{-2}\ year^{-1}$ in Alaska, Quebec, and Finland. If the modern boreal forests of the world became established ca. 7000 years ago on average, this influx rate is equivalent to an accumulation of 3.528 X 10^{12} g black carbon in boreal sediments and soils during this period. This black-carbon pool represents only a small fraction of organic carbon in the boreal system. Given the high frequencies of forest fires in boreal regions, the fraction of biomass and soil organic matter converted to CO_2 during fire events and the associated release of nutrients likely play a greater role in biogeochemical cycling than does the pool of largely recalcitrant black carbon.