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LATE-GLACIAL AND HOLOCENE VARIATIONS IN FIRE FREQUENCY IN THE CENTRAL PLATEAU AND YELLOWSTONE-LAMAR PROVINCES OF YELLOWSTONE NATIONAL PARK

by

SARAH HOOPER MILLSPAUGH

A DISSERTATION

Presented to the Department of Geography
and the Graduate School of the University of Oregon
in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy

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"Late Glacial and Holocene Variations in Fire Frequency in the Central Plateau and Yellowstone-Lamar Provinces of Yellowstone National Park," a dissertation prepared by Sarah H. Millspaugh in partial fulfillment of the requirements for the Doctor of Philosophy degree in the Department of Geography. This dissertation has been approved and accepted by:

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Title: LATE-GLACIAL AND HOLOCENE VARIATIONS IN FIRE FREQUENCY IN THE CENTRAL PLATEAU AND YELLOWSTONE-LAMAR PROVINCES OF YELLOWSTONE NATIONAL PARK

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The fire history in two geovegetation provinces in Yellowstone National Park was reconstructed to determine relations between postglacial climate change, fire frequency, and vegetation. Fire reconstructions were based on charcoal preserved in lake-sediment cores from the Central Plateau and Yellowstone-Lamar Provinces, and fire-related erosional events were inferred from changes in sediment magnetism. The fire records were compared with pollen data and paleoclimatic reconstructions for the past 17,000 years.

In the Central Plateau Province, infertile soils restricted the vegetation response to Holocene climate changes, but fire frequency changed continuously as a result of variations in the intensity of summer drought. Fire frequency was highest (ten to 15 events/1000 years) when summer temperatures were high and effective precipitation was

low in the early Holocene (ca. 10,000 cal yr BP). These conditions were caused by greater-than-present summer insolation and the expansion of the eastern Pacific subtropical high pressure system, which affected temperature and moisture conditions in the southern and central part of Yellowstone National Park. After 8000 cal yr BP, fire incidence decreased to present frequencies (two to three events/1000 years). The trend towards fewer fires coincided with decreasing summer insolation and cooler, effectively wetter conditions than before.

In the Yellowstone-Lamar Province, fire frequency was moderate (six to ten events/1000 years) in the early Holocene. Pollen data indicate that summers then were warmer and wetter as a result of stronger-than-present monsoonal circulation that brought increased precipitation to the northern part of Yellowstone National Park during the summer insolation maximum. In the last ca. 2000 years, xerophytic vegetation has increased in the Yellowstone-Lamar Province, and fire frequency reached its highest levels (12 to 17 events/1000 years).

The contrast in the two fire histories suggests that fire regimes reflect variations in the intensity of summer drought that resulted from variations in the seasonal cycle of insolation. Fire regimes in both provinces have been non-stationary during the Holocene as fire frequency changed continuously with millennial-scale climate variations. Fire incidence has also changed on submillennial-time scales. Several ca. 500-year periods were characterized by high fire occurrence in both provinces, including the period from ca. 500-1000 cal yr BP, which corresponded with the Medieval Warm Period.

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CHAPTER I

INTRODUCTION

The vegetational changes associated with postglacial climate transformations are generally known in many regions, yet there is little information on the changes in fire regimes that accompanied long-term changes in climate. Few fire records have both the temporal resolution and the length to address questions about the relations between changes in climate and fire frequency, and vegetational response on centennial-to-millennial time scales.

Most information on prehistoric fire regimes is based on dendrochronological records of fire scars and forest-age classes. These data allow reconstruction of fire chronologies that have high spatial and temporal resolution, and are used to determine the frequency and magnitude of fires on annual-to-centennial time scales (e.g., Romme, 1982, Swetnam, 1993). In regions where fires are often severe and stand-replacing, including the northern Rocky Mountains, the fire record is only as long as the age of the last fires, generally less than ca. 500 years (e.g., Barrett, 1994; Barrett *et al.*, 1991; Johnson and Larsen, 1991; Romme, 1982). Dendrochronological records from the northern Rocky Mountains are not long enough to describe variations in fire regimes on time scales that span the entire postglacial period when large-scale climate and vegetation changes occurred.

Long-term fire reconstructions are obtained from particulate charcoal and other fire indicators preserved in lake sediments. Stratigraphic changes in charcoal can be compared with variations in pollen from the same core to determine relations between changes in fire incidence and vegetation. Fluctuations in magnetic properties in lake-sediment cores provide information about changes in sedimentation events associated with variations in fire occurrence in the watershed (Thompson and Oldfield, 1986; Millspaugh and Whitlock, 1995).

The earliest studies of charcoal in lake sediments focused on microscopic particles (<50 microns in diameter) encountered when analyzing pollen (e.g., Iversen, 1941; Swain 1973; 1978; Tolonen, 1978; Cwynar, 1978). Because microscopic particles are carried aloft and transported great distances from a fire, these records provide information on trends in regional burning rather than on the occurrence of individual fire events. Clark (e.g., 1988a,b; 1990) refined fire history reconstructions by analyzing macroscopic charcoal particles (>50 microns in minimum diameter) in laminated sediments. Macroscopic charcoal particles settle close to the source area and their abundance in laminated lake sediments allows for the precise dating of fires that burn in the watershed. Lakes that preserve annually-laminated sediments are uncommon, so it has not been possible to apply these methods in many regions. Whitlock and Millspaugh (1996) and Millspaugh and Whitlock (1995) contributed to the understanding of how macroscopic charcoal in unlaminated sediments registered local fires by 1) monitoring charcoal inputs to small lakes following modern fires, and 2) examining the relationship between macroscopic charcoal in unlaminated sediments and dendrochronologic records of fires in the vicinity of the lakes. In turn, this research laid the groundwork for the present study in which contiguous-interval sampling of macroscopic charcoal in long sediment cores provides both the spatial and temporal resolution to address questions about the linkages between changes in climate, fire frequency and vegetation during the postglacial period.

In 1988, ca. 45% (730,000 ha) of Yellowstone National Park (YNP) was burned by a few, very large fires. In partial response to the negative publicity surrounding the 1988 fires (i.e., the public's perception that the fires were "bad" and that they could have been prevented if it were not for YNP's "natural burn policy"), scientists have sought to learn more about the natural variability of fires prior to Euro-American settlement and about the role of fire in shaping the Yellowstone landscape. Information about past fire regimes in YNP is provided by 1) dendrochronological records for the past ca. 400 years (Romme and Despain, 1989; Barrett, 1994; Houston, 1973) and 2) a 7000-year record of fire-related sedimentation events (Meyer *et al.*, 1992; 1995). While the record of fire-related sedimentation events provides evidence of fire occurrence on longer time scales than the dendrochronological record, it does not have the temporal resolution to determine how intervals between fire events have changed through time.

Lake-sediment records of fires in YNP build upon this knowledge by providing the opportunity to determine whether fire regimes have been stationary (i.e., cyclic or regularly occurring) on long time scales and how fire regimes have responded to changes in climate and vegetation during the entire postglacial period. Furthermore, these data help infer the changing size of fires through time and assess whether the Yellowstone landscape has been characterized by "non-equilibrium" or non-steady-state conditions (i.e., whether proportions of different stand-age classes have changed continuously through time) on longer time scales than those of the past ca. 400 years (Romme, 1982).

YNP is divided into distinct geovegetation provinces that are characterized by different geology, local climate, vegetation, and modern fire regimes. These heterogeneous patterns of local climate, vegetation, and modern fire regimes are partially attributed to the effects of two large-scale climate regimes that provide different amounts of precipitation to northern and southern/central YNP (Whitlock and Bartlein, 1993). Today, southern and central areas of YNP experience dry summer conditions with a maximum of precipitation during the winter. In contrast, northern YNP receives a maximum of precipitation in the spring and summer. Paleoecologic data suggest that the climatic and vegetational history of northern YNP has differed from that of southern/central YNP during the Holocene as well (Whitlock and Bartlein, 1993; Whitlock *et al.*, 1995). Increased insolation in the early Holocene intensified both regimes and the contrast between northern and southern/central climates was more extreme. Until now, there has been no evidence about the fire regimes that accompanied the large-scale climatic and vegetational changes during the Holocene in either northern or southern/central areas of YNP.

The objective of this research was to reconstruct the postglacial fire history for two geovegetation provinces, including the Central Plateau Province of southern/central YNP and the Yellowstone-Lamar Province of northern YNP. The reconstructions were compared to local climate and vegetation histories to evaluate the relations between changes in climate, vegetation, and fire frequency during the postglacial period.

Comparison of the fire records from northern and southern/central provinces on millennial time scales provided information on how fire regimes in diverse regions respond to the same large-magnitude climate controls (i.e., changes in summer insolation). Comparison of the two records on submillennial time scales provided information on how fire occurrence responds to climate changes on shorter time scales and whether responses are linked between provinces.

The dissertation is organized into four chapters. Chapter II describes a 17,000-year history of fire from Cygnet Lake in the Central Plateau Province. Summer conditions there were warmer and drier in the early Holocene when summer insolation was greater than at present. Infertile soils in this province limited the response of vegetation to Holocene climate changes following the transition (ca. 11,300 cal yr BP) from tundra/meadow communities to *Pinus* forest. Thus, the charcoal record from Cygnet Lake allowed examination of the long-term variations in fire frequency that were primarily the result of climate. Furthermore, these data enabled me to evaluate whether warm and dry conditions in the early Holocene led to more frequent fires. It also provided the opportunity to consider the impact that changes in the fire regimes had on the landscape mosaic through time (i.e., how the size of patches has shifted through time).

Chapter III compares the record from Cygnet Lake in the Central Plateau Province with a ca. 14,500-year record from Slough Creek Lake in the Yellowstone-Lamar Province. In the Yellowstone-Lamar Province, vegetation shifted from mesic species in the early Holocene when conditions were warmer and wetter to xeric species in the middle-to-late Holocene with increasing dry conditions. Thus, the charcoal record from

Slough Creek Lake allowed examination of whether fire frequency increased with increasing warm and dry conditions in the late Holocene. Because the climate and vegetation history of the two provinces have differed throughout the Holocene, the comparison of the two records allowed evaluation of controls of fire incidence on different spatial and temporal scales. Chapters II and III are written as manuscripts that will be revised and submitted to scientific journals.

Chapter IV summarizes the main points of the dissertation. Appendix A contains raw charcoal and magnetic susceptibility data from Cygnet Lake. Appendix B contains log-transformed charcoal accumulation rates (integrated over 10-year intervals), background (determined by a locally-weighted moving average), peaks (determined by selection of a "threshold ratio"), detrended charcoal accumulation rates (determined by subtracting background), and fire frequency (a locally-weighted average of peaks) for Cygnet Lake (see Chapter II, Data Analysis). Appendices C and D contain the same data for Slough Creek Lake.

CHAPTER II

A 17,000-YEAR HISTORY OF FIRE FOR THE CENTRAL PLATEAU PROVINCE OF YELLOWSTONE NATIONAL PARK

The nature of vegetational changes associated with postglacial climate transformations are well known in many regions, yet little is known of the changes in fire regimes that accompanied long-term climate changes. Dendrochronological analysis of fire scars and forest age classes is the most common method used to reconstruct prehistoric fire regimes. This method allows reconstruction of fire chronologies with high spatial and temporal resolution and can be used to determine the frequency and magnitude of fires on annual-to-centennial time scales. Estimates of the average time period between fires (mean fire intervals) for different forest ecosystems are derived from dendrochronological determinations of fire frequency. In ecosystems where fires are severe and stand-replacing, the fire record is only as long as the age of the last fire, generally less than ca. 500 years (e.g., Barrett, 1994; Barrett *et al.*, 1991; Johnson and Larsen, 1991; Romme, 1982). In ecosystems where fires are not stand replacing, fire histories have extended as far back as 2000 years (Swetnam, 1993). A critical limitation of all dendrochronologic studies, however, is that they are not long enough to describe variations in fire regimes on time scales that span the entire postglacial period when large-magnitude climate and vegetation changes occurred.

Long-term fire reconstructions are based on charcoal and other fire indicators preserved in lake sediments and their association with pollen records that disclose vegetational changes. Lake-sediment records span several thousands of years and thus provide information on a wide range of climatic and vegetational conditions in the past. Sedimentary records of microscopic charcoal particles (<100 microns in diameter) have been used to describe the history of regional fires, because small particles are carried aloft and transported long distances before deposition (e.g., Clark and Royall, 1995; Cwynar, 1978; 1987; Horn, 1993; MacDonald *et al.*, 1991; Mehringer *et al.*, 1977; Patterson *et al.*, 1987; Smith and Anderson, 1992; Swain, 1973, 1978). Macroscopic charcoal particles (>100 microns in diameter) settle close to the source area, and their abundance in laminated and unlaminated lake sediments allows reconstruction of fires in the vicinity of the watershed (e.g., Clark, 1988a,b,c; Millspaugh and Whitlock, 1995). Analysis of magnetic properties of lake sediments in combination with macroscopic charcoal, provides information about erosion associated with fires in the watershed (Thompson and Oldfield, 1986; Millspaugh and Whitlock, 1995).

On annual-to-centennial time scales, fire frequency and severity are important determinants of the vegetation composition and mosaic. The character of the vegetation, in turn, plays an important role in determining the location, intensity, and timing of subsequent burns (Shugart, 1984; Pickett and White, 1985; Turner and Romme, 1994). For example, in modern *Pinus contorta* (see Table 2.1 for common names of plants) forests of YNP, the distribution of young and mature stands may constrain or encourage fire spread (Turner and Romme, 1994). Fires are more likely to spread in mature stands

Table 2.1. Common names of plant taxa referred to in text *.

Scientific name	Common name
Abies lasiocarpa	Subalpine fir
Abies grandis	Grand fir
Agropyron spicatum	Bluebunch wheatgrass
Alnus incana	Mountain alder
Alnus rubra	Red alder
Alnus sinuata	Sitka alder
Artemisia tridentata	Big sagebrush
Betula occidentalis	Water birch
Compositae	Composite family
Cyperaceae	Sedge family
Festuca idahoensis	Idaho fescue
Juniperus scopulorum	Rocky Mountain juniper
Larix occidentalis	Western larch
Picea engelmannii	Engelmann spruce
Picea sitchensis	Sitka spruce
Pinus albicaulis	Whitebark pine
Pinus contorta	Lodgepole pine
Pinus flexilis	Limber pine
Pinus ponderosa	Ponderosa pine
Poaceae	Grass family
Polygonaceae	Buckwheat family
Populus tremuloides	Quaking aspen
Pseudotsuga menziesii	Douglas fir
Rosaceae	Rose family
Salix	Willow
Sequoia	Redwood
Thuja plicata	Western red cedar
Tsuga heterophylla	Western hemlock

* Nomenclature follows Hitchcock and Cronquist (1990).

of *P. contorta* (trees >150 years old) than in younger stands because dense understory and dead fuels create continuity between woody fuels on the ground and the living tree canopy (Romme and Despain, 1989a,b,c).

Knowledge of the importance of vegetation in influencing fire on short time scales has led to the assumption that fire occurrence is a stationary process, i.e., one that is cyclic or regularly occurring through time. For example, Johnson and Van Wagner (1985) suggested that, although fire is a stochastic process, the intervals between fires in a forest ecosystem remain more or less constant (i.e., fire intervals can be described by a probability density function) in the absence of large-magnitude climate change. Dendrochronologic fire records are generally too short to test whether fire regimes are stationary on long time scales, with the exception of those from the *Sequoia* ecosystem where fire occurrence was found to be non-stationary for the last 2000 years. Whether fire occurrence has been non-stationary on longer time scales cannot be addressed from dendrochronological data.

A conceptual model regarding vegetation-fire interactions is that the continual process of burning and post-fire regeneration maintains a "steady-state" or "equilibrium" landscape. Equilibrium conditions exist when the creation of new patches by burning is balanced by the maturation of old patches (Sprugel, 1991), and thus proportions of different stand-age classes are roughly equal through time (Borman and Likens, 1979; Shugart, 1984). Equilibrium landscapes occur where fires are frequent and small compared with natural landscape units (Pickett and White, 1985; Sprugel, 1991; Turner *et al.*, 1993). In forests characterized by infrequent large fires, however, non-equilibrium conditions prevail because large portions of these landscapes become covered by stands of the same age (Hemstrom and Franklin, 1982; Romme, 1982; Baker, 1989a,b; Johnson, 1992; Turner and Romme, 1994). For example, 430,000 ha of YNP were burned in 1988 by a few, very large fires (Schullery, 1989). As a result, extensive areas of YNP are covered by young, regenerating forests today and the proportions of different stand-age classes are unequal. It is uncertain whether non-equilibrium conditions can exist on longer time scales under different climate conditions or whether equilibrium conditions have been present during any period.

The linkages between fire, vegetation, and climate on millennial time scales are less clear than on shorter time scales. Are changes in fire frequency driven by climatic changes in the absence of vegetation change? Most charcoal studies shed little light on this question because Holocene changes in fire frequency coincide with large-scale shifts in vegetation (e.g., Cwynar, 1987; Mehringer *et al.*, 1977; Smith and Anderson, 1992).

In this chapter, I discuss the fire history of the past 17,000 cal yr BP in the Central Plateau Province of YNP, based on charcoal and pollen data and sediment magnetism from Cygnet Lake. Cygnet Lake (Lat. 44°49'N, Long. 110°36'W, altitude 2530 m) is the largest (10.7 ha) of a series of small lakes within a large sedge fen (Fig. 2.1). The fen lies in a glacially-scoured shallow depression characterized by low-gradient slopes (ca. 1°-11°) and has a small intermittent inflow and outflow; the watershed is ca. 1215 ha. The Central

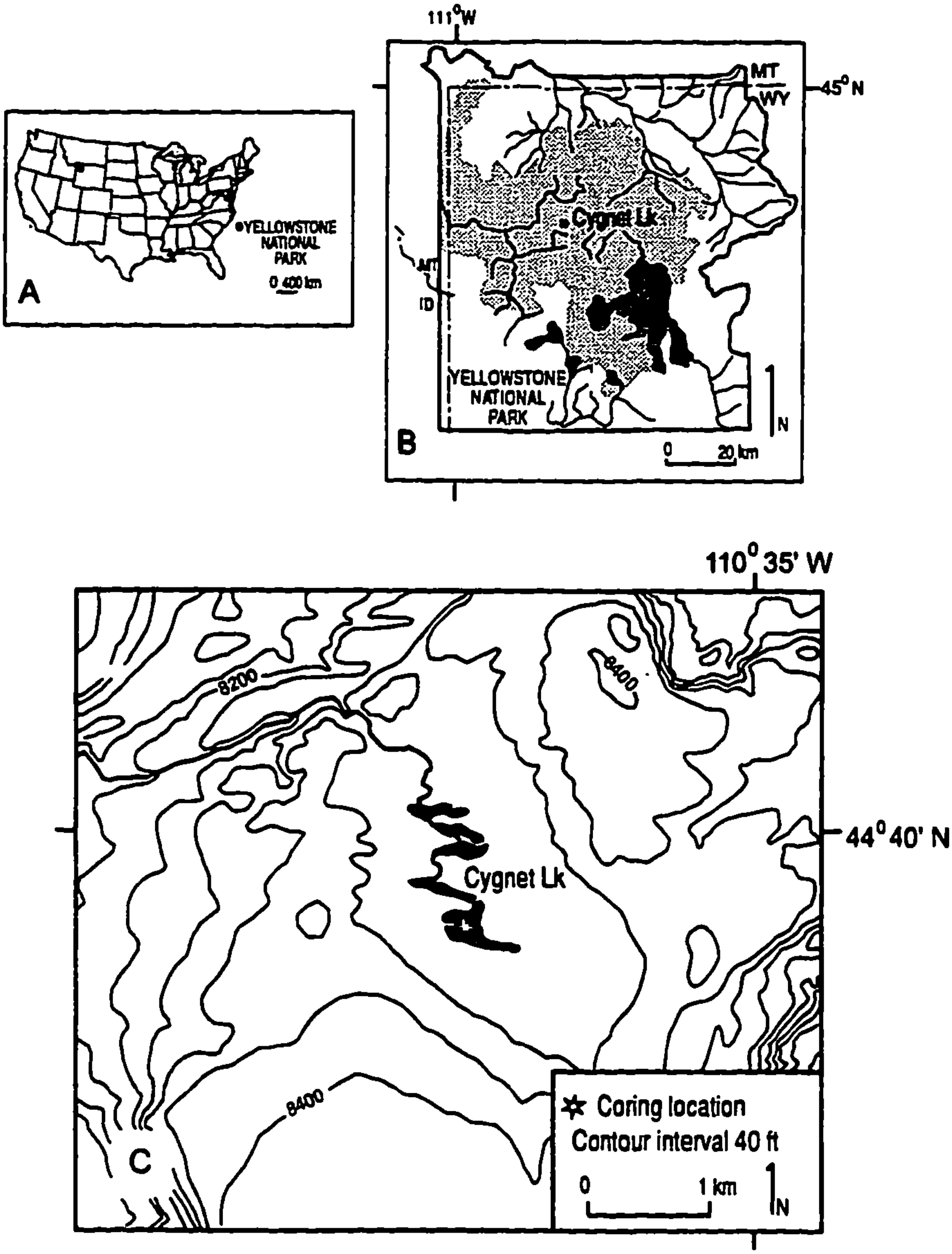


Figure 2.1. Location of study area in (A) Yellowstone National Park. (B) Central Plateau Province (shaded) and Cygnet Lake which consists of a series of small lakes within a sedge fen surrounded by low gradient (1-11°) slopes. (C) Coring location (*) (USGS 7-1/2' Crystal Falls Quadrangle, WY, 1986).

Plateau Province was chosen because poor soil conditions there have limited the response of Holocene vegetation to large-scale climate changes that have affected the Northern Rocky Mountains as a whole (Whitlock, 1993). Lack of Holocene vegetation changes on the Central Plateau permits the linkages between climate and fire to be considered in the absence of major changes in forest composition.

The Central Plateau Province

Modern Setting

The climate of southern and central YNP, including the Central Plateau Province (Fig. 2.1), is characterized by dry summers and wet winters. Summer conditions are produced by large-scale subsidence associated with the eastern Pacific subtropical high-pressure system. In the winter, storms following the path of the jet stream bring moisture from the Pacific Ocean via the Columbia River Basin and the Snake River Plain (Bryson and Hare, 1974) to southern and central YNP (Whitlock and Bartlein, 1993). Climate data from Lake Station at the north end of Yellowstone Lake indicate a mean January temperature of -11.8°C and a mean July temperature of 12.8°C for the period from 1948 to 1970. Annual snowfall averages 508 cm for the same period. Prevailing winds are generally from the southwest (Dirks and Martner, 1982).

The Central Plateau Province is characterized by glaciated rhyolitic plateaus that average 2400 m in elevation. *Pinus contorta* forest covers approximately 80% of the total forested area of the Central Plateau. Alluvial and lacustrine soils support meadows of

Artemisia tridentata, Poaceae, and herbs (Romme and Knight, 1982). The dominance of *P. contorta* is attributed to infertile rhyolitic substrates and to infrequent stand-replacing crown fires (Despain, 1983; 1990). The present fire regime promotes the regeneration of *P. contorta*, which produces serotinous cones that enable seedling establishment soon after a fire.

During the history of the park, fires have generally occurred every year between the months of July to mid-October but most are small in size and burn less than 0.5 ha (Despain, 1990). Larger fires that burn 100s to several 1000 ha have occurred less frequently and only when climate and fuel conditions were conducive to fire spread. The fires of 1988 burned more than 730,000 ha in YNP. Their size was unprecedented in the history of the park and was attributed to the extreme drought conditions and high winds during the summer of 1988 (Christensen *et al.*, 1989). During the 1988 fires, ca. 78% of the Cygnet Lake watershed burned.

Dendrochronologic evidence indicates that the fire regime on the Central Plateau during the last few centuries has been characterized by infrequent large fires (Romme 1982; Romme and Knight, 1982; Romme and Despain 1989a,b,c). For example, 26% of the Central Plateau was burned in 1988. Nineteen percent burned between 1690 to 1710, and 15% burned between 1730 to 1750. These data suggest that a ca. 200 to 400-year mean fire interval of large fires has led to the coarse mosaic of stand ages that characterizes the modern landscape (Turner and Romme, 1994).

Late-Pleistocene and Holocene History of Climate, Glaciation, and Vegetation

The climate variations that have occurred since deglaciation in YNP have been a response to large-scale changes in the climate system that affected the western U.S. as a whole. These variations are known from paleoclimate model simulations and a network of paleoecologic sites (e.g., Thompson *et al.*, 1993). The recession of the Laurentide ice sheet after 21,000 cal yr BP led to an increase in temperature of 4-10°C in northern middle latitudes (Kutzbach and Guetter, 1986; Broccoli and Manabe, 1987). As the ice sheet decreased in size, the latitudinal position of the jet stream moved north, increasing precipitation in the northwestern U.S. Concurrently, changes in the seasonal cycle of insolation, as a result of variations in the earth's orbit, caused major changes in the climate system. In the early Holocene (beginning ca. 10,000 cal yr BP) insolation was 8.5% greater in summer and 10% less in winter at the latitude of YNP (ca. 45° N) as a result of the greater tilt of the earth's axis and the occurrence of perihelion in the summer then (Berger, 1978). The direct result of greater summer insolation was to increase temperatures, which resulted in increased evaporation and decreased effective moisture. Indirectly, increased summer insolation affected atmospheric circulation. An expansion of the eastern Pacific subtropical high-pressure system during the early Holocene intensified summer drought in much of the northwestern U.S., including southern and central regions of YNP (Whitlock, 1993). After its maximum in the early Holocene, summer insolation gradually declined to present values. The influence of the subtropical high pressure system declined in the middle and late Holocene, and conditions became progressively cooler and moister in the Central Plateau Province (Whitlock, 1993; Whitlock and Bartlein, 1993).

Deposits from the Pinedale Glaciation (ca. >40,000 to 14,000 ^{14}C yr BP; Pierce, 1979) are present in the Central Plateau Province of YNP (Richmond and Waldrop, 1975; Richmond, 1976). The age of basal sediments in Cygnet Lake, ca. 17,360 cal yr BP (14,490 ^{14}C yr BP; Whitlock, 1993), suggests ice had receded from the Central Plateau Province prior to that time. No glacial deposits of Holocene age are found in the province.

Several pollen records are available from southern and central YNP (Baker, 1976, 1983; Waddington and Wright, 1974; Whitlock, 1993; Whitlock *et al.*, 1995). Whitlock (1993) summarizes the climate and vegetation history of this region as follows: prior to ca. 13,400 cal yr BP (ca. 11,500 ^{14}C yr BP), pollen assemblages from all of the sites record a period of tundra or meadow vegetation characterized by high percentages of *Artemisia*, Poaceae, and Cyperaceae. After ca. 13,400 cal yr BP (ca. 11,500 ^{14}C yr BP) the vegetation history of areas underlain by non-rhyolitic substrates diverges from that of the Central Plateau rhyolite region.

Pollen records from lakes on non-rhyolitic soils show changes in vegetation that are attributable to variations in summer insolation. *Picea* parkland developed between ca. 13,400 and ca. 12,400 cal yr BP (ca. 11,500 and 10,500 ^{14}C yr BP), followed by a *Picea-Abies-Pinus albicaulis* forest between ca. 12,400 and ca. 11,000 cal yr BP (ca. 10,500 and 9500 ^{14}C yr BP), and *P. contorta* forest after ca. 11,000 cal yr BP. Warmer and drier conditions in the early Holocene resulted in the expansion of *Pseudotsuga menziesii* and *Populus tremuloides* on non-rhyolite substrates, and cooler and moister conditions in the late Holocene led to an increase in *Picea* and *Abies*.

In contrast, a pollen record from Cygnet Lake reveals that tundra or meadow communities persisted until ca. 11,300 cal yr BP (ca. 10,000 ^{14}C yr BP) on the rhyolitic Central Plateau. The establishment of *P. contorta* forest at the site occurred at ca. 11,300 cal yr and has persisted with little modification in composition. In the Central Plateau, *Pinus albicaulis*-type, *Picea* and *Abies* were not an important component of the forest at any time. The persistence of *P. contorta* forest surrounding Cygnet Lake for the past 11,300 cal years suggests the infertile rhyolitic soils limited the vegetational response to large-scale climatic changes recorded elsewhere in YNP.

Methodology

Particulate charcoal and magnetic susceptibility were analyzed in a short core and a long core from Cygnet Lake. Variations in the abundance of charcoal particles provided the primary record of past fires. Magnetic susceptibility analysis identified the presence of allogenic minerals in the sediment and thus provided an index of erosional events in the watershed of each lake (Thompson and Oldfield, 1986). Charcoal and magnetic susceptibility data were compared with pollen data from the core to determine whether the frequency of fires and sedimentation events changed in response to changes in vegetation.

Field and Laboratory

A 6.10-m-long core (CL#88A) was taken in 1988 from the fen margin at Cygnet Lake to reconstruct the vegetation history of the Central Plateau Province (Whitlock, 1993). The organic content of the sediment from Cygnet Lake was determined in CL#88A by the loss-on-ignition method (Dean, 1974). The record of vegetational change from CL#88A provided a template on which to reconstruct postglacial fire history.

In August 1991, a short core (ca. 40 cm in length) was collected in 4.8 m of water with a piston corer from Cygnet Lake (Fig. 2.1). This equipment recovered the sediment-water interface intact, and sediment was extruded at 1-cm intervals and stored in plastic bags. A 6.69-m-long core (CL#91B) was collected next to the short core site with a 5-cm diameter square-rod corer (Wright *et al.*, 1983). The long core was extruded and wrapped in cellophane and aluminum foil in the field. Samples were taken to the laboratory and refrigerated. The short core (40 cm in length) was analyzed to reconstruct a record of fire for the last 600 years with subdecadal resolution which could be compared with similar records from nearby lakes (Millspaugh and Whitlock, 1995). The long core (6.69 m in length) was analyzed to reconstruct fire history on decadal time scales for the late-glacial and Holocene periods.

Pollen

The postglacial vegetation history of the Central Plateau was reconstructed from core CL#88A (Whitlock, 1993). Pollen was analyzed at 20-cm intervals throughout the length of CL#88A to provide information on the broad vegetation changes during the postglacial period. Core CL#88A was correlated with the long core CL#91B by a series of radiocarbon dates and the ages of known volcanic eruptions. Correlation of the chronology from CL#88A with that from CL#91B enabled direct comparison of the pollen record from CL#88A with the charcoal and magnetic susceptibility records from CL#91B.

Pollen was also analyzed in CL#91B at 4- and 8-cm intervals above and below (4.38-5.80 m depth) the lithologic transition from clay to gyttja (5.13-5.16 m depth), to compare the charcoal and pollen stratigraphy during the late-glacial to early Holocene transition in a single core.

Pollen samples were processed according to standard laboratory procedures (Faegri *et al.*, 1989). The residue was mounted in silicon oil and examined at magnifications of 400 and 1000x. At least 400 terrestrial pollen grains were counted for each level and used as the denominator to calculate the percentages of each terrestrial pollen type.

Charcoal

To detect individual fire events in the record, the sampling interval had to represent a shorter amount of time than the likely interval between fires (Long *et al.* in review). Thus, a sampling interval of 1-cm was selected, which represents, on average, ca. 20 years of deposition (based on ^{210}Pb and ^{14}C age-versus-depth relations) and is sufficiently short to resolve fire events in the charcoal record given that the mean fire interval is estimated to be ca. 200 to 400 years (Romme and Despain, 1989a,b,c).

Subsamples of 5 cm^3 volume were taken from contiguous 1-cm intervals of both cores and carefully washed through an analytical sieve with a mesh size of 0.125 mm. Sieved samples were put in a gridded petri dish, and macroscopic charcoal (>0.125 mm in minimum diameter) was tallied under a stereomicroscope (Millspaugh, 1991; Millspaugh and Whitlock, 1995; Whitlock and Millspaugh, 1995). Macroscopic charcoal particles >0.125 mm in minimum diameter were tallied from contiguous 1-cm intervals and recorded as charcoal concentration values (particles cm^{-3}).

Magnetic Susceptibility

Magnetic susceptibility measurements of lake sediments detect the presence of allochthonous minerals that are deposited in the lake and incorporated in the sediment. An important source of allochthonous minerals is from soil erosion that often follows fire events or other disturbances in the watershed (Thompson and Oldfield, 1986). The abundance of allochthonous minerals as well as their magnetic properties (i.e., the amount and type of iron minerals) determine the concentration or degree of magnetic susceptibility. Occasionally, burning of soils by intense fires results in the conversion of iron minerals to secondary ferromagnetic minerals, and inwashing of these minerals from burned soils produces especially high magnetic susceptibility measurements (Rummery *et al.*, 1979). Volcanic ash deposition also contributes magnetic minerals to lake sediments that result in high magnetic susceptibility values (Oldfield *et al.*, 1983).

Magnetic susceptibility was measured in contiguous 1-cm intervals (the same intervals as the charcoal analysis) from both the long and short cores by use of a coil-cup sampling device attached to a SI-2 magnetic susceptibility meter (Sapphire Instruments, 1988). Subsamples of 8 cm^3 from each 1-cm interval were placed in plastic vials. Four susceptibility readings, separated by air readings, were taken for each sample and the average of the four-sample readings was presented in electromagnetic units (emu).

Data Analysis

Stratigraphy and Chronology

The short core consisted of fine detritus gyttja from a 40 cm depth to the mud-water interface. Samples were dated by the ^{210}Pb method at the University of Minnesota Limnological Research Center to determine ages and sediment accumulation rates for the last ca. 200 years (Table 2.2). Dates and sedimentation accumulation rates were determined by a c.r.s. (constant rate of supply) model (Appleby and Oldfield, 1978). Age-versus-depth relations were used to extrapolate the record back to 600 years (Fig. 2.2). The average sediment accumulation rate for the top three cm of sediment was 0.0225 g cm^{-2} yr^{-1}, and 0.0124 g cm^{-2} yr^{-1} for the next 12 cm. The standard deviation of the ages was calculated by a first-order error analysis of the counting uncertainty (D. R. Engstrom, personal communication, 1995). One standard deviation ranged from $\pm$0.82 yr at the top of the core to $\pm$31.3 yr at ca. 200 years (Table 2.2).

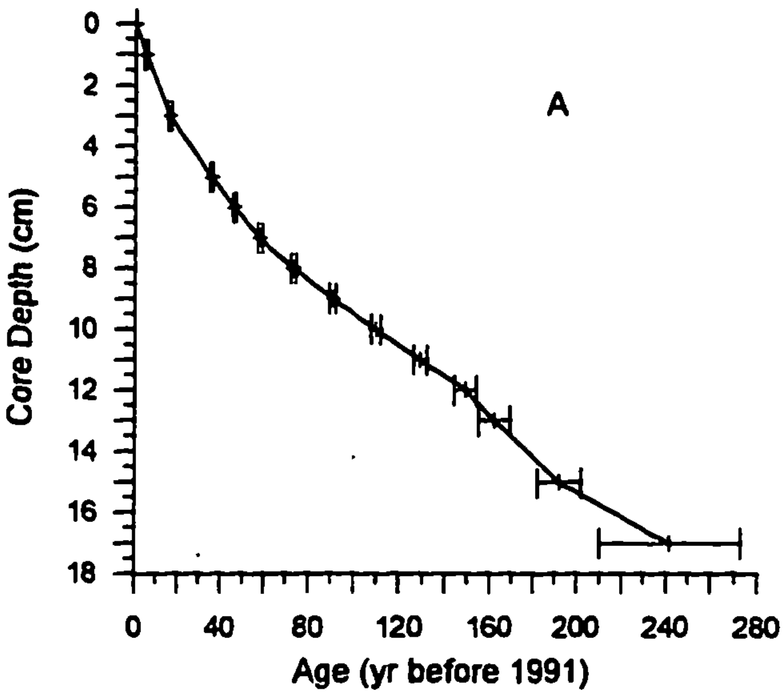
The long core (CL#91B) was characterized by inorganic clay and silt from 6.69 to 5.16 m depth and overlain by fine-detritus gyttja from 5.16 m depth to the sediment-water surface. The ages of two tephras, Mazama O (7630 cal yr BP; 6845 ^{14}C yr BP; Bacon, 1983) and Glacier Peak B (13,755 cal yr BP; 11,800 ^{14}C yr BP; Whitlock, 1993), were used in combination with nine radiocarbon (including six AMS) dates to establish age-versus-depth relations (Table 2.3). Radiocarbon ages were converted to calendar years (cal yr BP) using the program CALIB 3.0 (Stuiver and Reimer, 1993).

A weighted third-order polynomial regression (constrained to pass through age 0)

Table 2.2. ^{210}Pb for Cygnet Lake.

Depth	Age (yr)	Error of Age (± yr)	Date (yr AD)	Sediment Accum. ($g\ cm^{-2}\ yr^{-1}$)
0-1	4.67	0.82	1987	0.0225
2-3	16.01	0.85	1976	0.0188
4-5	35.48	0.8	1956	0.0128
5-6	46.16	0.87	1945	0.0142
6-7	58.07	0.94	1933	0.0125
7-8	72.87	1.02	1919	0.011
8-9	90.66	1.42	1901	0.0095
9-10	109.7	1.96	1882	0.0084
10-11	129.12	2.91	1862	0.0088
11-12	148.97	4.96	1843	0.0091
12-13	161.99	7.14	1830	0.0128
14-15	191.95	10	1800	0.0128
16-17	241.5	31.28	1750	0.0063

Data from D. R. Engstrom, Limnological Research Center
University of Minnesota (1994)



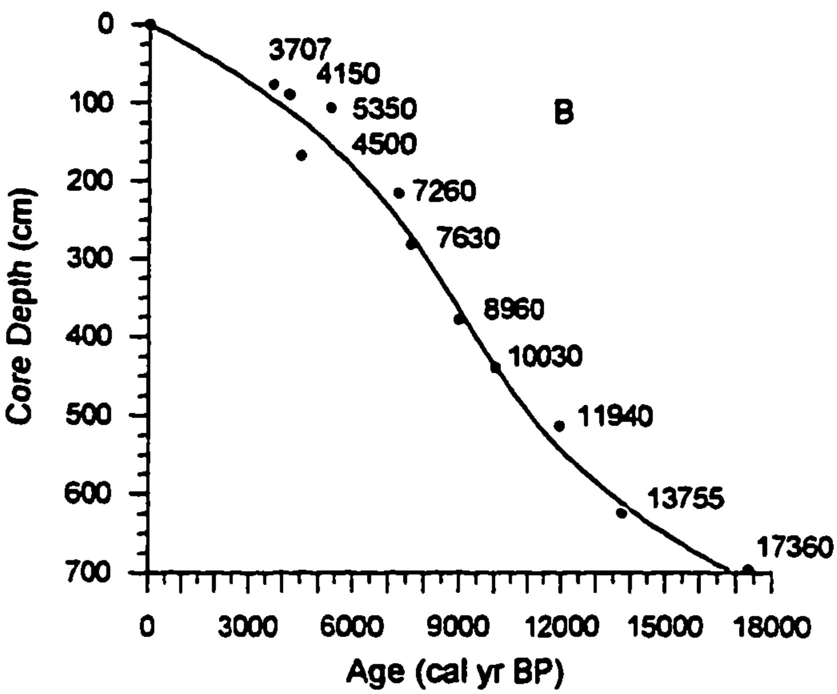


Figure 2.2. Age-versus-depth models for Cygnet Lake. (A) Ages for the short core derived by the ^{210}Pb method (Table 2.2). Error bars represent 1 ± SD. (B) Age-versus-depth model for the long core based on a weighted third-order polynomial regression of calibrated ^{14}C ages (see Table 2.3 for age conversions). Ages of 0 and Mazama O tephra were assigned the highest weight of 1.00

Table 2.3. Uncalibrated and calibrated age determinations for Cygnet Lake.

Depth (CL#91B) (m)	Material	Lab No.	Age $\pm$ 1 σ (^{14}C yr BP)	Calibrated Calendar Age & 1 σ range[a] (cal yr BP)	Weighting[b]
0					1.00
0.75-0.79	charcoal	Beta-80620	3480 $\pm$ 100	3627 (3707) 3863	0.10
0.88-0.90	charcoal	Beta-77421	3800 $\pm$ 60	4087 (4149) 4267	0.10
1.05-1.08	charcoal	Beta-80621	4720 $\pm$ 100	5313 (5349) 5587	0.10
1.67-1.70	charcoal	Beta-74921	4010 $\pm$ 60	4411 (4502) 4532	0.10
2.16-2.18	charcoal	Beta-77422	6390 $\pm$ 60	7212 (7262) 7376	0.10
2.80-2.81	Mazama O		6845 $\pm$ 50[c]	7578 (7631) 7664	1.00
3.78-3.80	charcoal	Beta-77423	8030 $\pm$ 80	8675 (8960) 8991	0.50
4.38-4.40	charcoal	Beta-74922	9100 $\pm$ 60	9988 (10033) 10073	0.50
5.13-5.17	charcoal	Beta-77424	10190 $\pm$ 110	11344 (11939) 12180	0.50
6.24-6.25	Glacier Peak B	Pitt-0554	11800 $\pm$ 190[d]	13522 (13755) 14008	0.50
6.86-6.96	sediment	Pitt-0459	14490 $\pm$ 700[d]	16532 (17358) 18117	0.10

a. Minimum of 1 σ calibrated age range (calibrated calendar age) maximum of 1 σ calibrated age range, (1 σ = square root of sample SD^2 + curve SD^2; Stuiver and Reimer, 1993).

b. Value assigned to a calibrated age depending on my confidence in accuracy of date (i.e., ages of 0 and Mazama O tephra assigned the highest weight of 1.00). Weighting values used in determination of weighted 3rd-order polynomial regression.

c. From Bacon (1983).

d. Ages for Glacier Peak B (Pitt-0554)and basal sediments (Pitt-0459) determined in core CL#88A (Whitlock, 1993), but used to establish chronology for CL#91B.

was used to interpolate between calibrated radiocarbon ages for the long core (Fig. 2.2). Each calibrated date was assigned a weight of 0.1, 0.5, or 1.0 depending on my confidence in its accuracy (Table 2.3). A weight of 1.0 was assigned to both age 0 (1991 AD) and to 7630 cal yr BP (the accepted age of Mazama O tephra; see Bacon, 1983; Brown *et al.*, 1989). Low confidence in the calibrated ages for the late Holocene is evidenced by assignment of weights of 0.1 to each age. The basal age of the core (17,360 cal yr BP) was also assigned a weight of 0.1 because it was obtained from sediment with little organic material. Calibrated ages for the early Holocene were given weights of 0.5 because I had moderate confidence in their accuracy. The age assignments based on this weighted polynomial regression were compared with a simpler model based on linear interpolation between 0, 7630 cal yr BP (Mazama O tephra), and 13,760 cal yr BP (Glacier Peak B tephra). Age assignments based on linear interpolation were similar to those based on the polynomial model (with the exception of two dates in the late Holocene that are out of order; Fig. 2.2).

Identification of Fire Events in the Sedimentary Record

In order to select a data-analytical method that could identify fire events in the charcoal record, it was important to consider the processes that contribute charcoal to the deep-water sediments of a lake. Following a fire event, the rate of charcoal accumulation in lake sediments depends on 1) the abundance of charcoal produced by a fire (which varies with standing biomass, fuel load, and fire severity), 2) the atmospheric and geomorphologic processes that entrain and transport charcoal to a lake, and 3) the hydrologic and sedimentologic processes that operate within the lake. Thus, the goal in selecting a data-analytical method is to separate the component of charcoal that indicates fire occurrence from that related to the combined effects of charcoal production and sedimentation. This objective is accomplished by statistically decomposing the record of charcoal accumulation rates (CHARs; particles cm^{-2} yr^{-1}) into separate series that represent each of these components (Long *et al.*, in review).

Records of CHARs consist of two components: 1) a low-frequency (slowly varying) component that can be described as background, and 2) a high frequency (rapidly varying) component which defines peaks. Decomposition of CHARs into these two components is based on previous research involving 1) examination of charcoal accumulation in the sediments of small lakes following modern fires (Whitlock and Millspaugh, 1996), 2) correlation of charcoal records with historical and dendrochronologic records of fire (Clark, 1988a,b; 1990; Macdonald *et al.*, 1991; Millspaugh and Whitlock, 1995) and 3) development of conceptual models that describe how charcoal data record fires (Patterson *et al.*, 1987; Whitlock and Millspaugh, 1996; Clark and Royall, 1996; Whitlock *et al.*, 1997; Clark and Patterson, 1997; Long *et al.*, in review).

Peaks consist primarily of charcoal from local or extralocal fire events that occurred within or near the watershed (Whitlock and Millspaugh, 1996; Millspaugh and Whitlock, 1995). In addition, peaks also contain a minor "noise" sub-component that includes both analytical error (Whitlock and Millspaugh, 1996) as well as natural, random variations in charcoal accumulation (Long *et al.*, in review).

Background charcoal includes several sub-components, which cannot be distinctly separated from one another. These sub-components include 1) charcoal that is sequestered in the watershed and littoral zone of the lake for a protracted period before it is deposited in deep-water sediments (e.g., Whitlock and Millspaugh, 1996; Bradbury, 1996), 2) charcoal that varies in abundance depending on standing biomass and fuel load (i.e., charcoal production), and 3) charcoal from regional fires that do not burn within or adjacent to the watershed of the lake (Clark and Royall, 1996). The relative importance of the first two sub-components varies with large-scale changes in vegetation (i.e., standing biomass, fuel load), and depositional systems within the watershed. Levels of charcoal contributed by regional sources may also vary with large-scale changes in climate and vegetation (Long *et al.*, in review).

The charcoal record from the short core was decomposed into peaks and background by visual inspection. The record of CHARs from the long core CL#88A was decomposed by using a locally-weighted (moving) average to define background and assigning a CHARs threshold ratio to define the peaks component. These procedures made it possible to distinguish between charcoal from fire events and charcoal related to the effects of charcoal production and sedimentation.

Decomposition of the Charcoal Record

Short core

In the short core, charcoal concentration was divided by deposition time (yr cm^{-1})

for each 1-cm interval to determine CHARs. Differentiation of peaks of CHARs from background CHARs was based on visual inspection. The short temporal length of the core (i.e., 600 years) made it unfeasible to decompose CHARs into peaks and background by the same method applied to the long core.

Long core

Variations in sedimentation rate and compaction of sediment with depth preclude the possibility of sampling at equally-spaced time intervals. Furthermore, direct interpolation of CHARs to constant depth intervals may not conserve the quantity of charcoal within intervals. Thus, charcoal concentration data and deposition time were interpolated to pseudo-annual values. Subsequently, the averages of these concentration values were integrated over ten-year intervals and divided by average deposition time to produce a series of CHARs spaced at ten-year time intervals (Long *et al.*, in review).

Background CHARs were determined by use of a locally-weighted (moving) average. Locally-weighted averages were calculated by moving a window along the CHARs, and at each point determining a weighted average of CHARs within the window (Long *et al.*, in review). Weights were determined using a "tri-cube" weight function (Cleveland, 1979), which allowed points closer to the center of the window to influence the weighted average more than points near the edges of the window. Specification of a window width was necessary to perform this function. Because the width of the window controls the smoothness of the background component, short window-width parameters (e.g., ≤500 years) produce "noisy" background curves that are highly variable and fluctuate closely with the peaks component. Long window-width parameters (e.g., >900 years) produce relatively flat background curves that probably do not adequately represent true long-term variations in charcoal productivity.

To determine the peaks component of the charcoal record, a CHARs threshold was established by selecting a "threshold ratio" (individual CHAR at a point in time divided by background CHAR at the same point in time; Long *et al.*, in review). CHARs above the threshold were considered peaks, i.e., fire events. For example, a threshold-ratio parameter of 1.00 would identify any CHAR greater than background as a peak, whereas assignment of 1.20 would mean a CHAR had to be 1.20 times greater than background at a particular point to be designated a peak. The beginning of a peak ("peak start") occurred if an individual CHAR exceeded the background level by the predetermined threshold ratio and the end of the peak occurred when a subsequent CHAR was less than the threshold. Many peaks spanned several samples. When a series of contiguous samples with CHARs greater than the threshold occurred, the age of the peak was set equal to the first of the contiguous samples because it was inferred that this was the time of fire event. The frequency of peaks (e.g., peaks/1000 years = fire events/1000 years) was calculated by smoothing a binary series of peaks (1 = peak, 0 = no peak) using a locally weighted average with a 2000-year window width (Long *et al.*, in review).

A specific set of parameters for window width and threshold ratio was selected based on comparison with the dendrochronological record of mean fire intervals for the Central Plateau. Threshold ratios ranging from 1.00 to 1.20 were combined with different window-width parameters (i.e., 200 to 1000 years) for both untransformed and transformed (logarithmic) CHARs. These series of iterations were carried out to test the robustness of the method and to test the sensitivity of the results to different combinations of parameters. CHARs were transformed to logarithmic values because it was assumed that charcoal entered the lake from a three-dimensional area during a fire, and thus charcoal abundance would increase by orders of magnitude when a fire was nearby.

Spectral Analysis of Charcoal

Spectral analysis was applied to interpolated CHARs to determine if there were inherent periodicities in the charcoal record that might indicate a long-term fire cycle. Individual autoregressive (MEM) spectra were calculated every 200 years between 16,000 and 1,000 cal yr BP, using overlapping 2000-year-long segments of data. A 10th-order autoregressive model was fit to each data segment, and the associated spectrum was plotted at the age of the midpoint of the data segment. This order was selected by fitting models of order one to 200 to individual segments of data, and calculating the Akaike Information Criterion for (AIC) each order. Frequent global or local minima in the AIC values occurred for models of order ten, and so this order was selected for use throughout the record (Priestley, 1981).

Decomposition of the Magnetic Susceptibility Record

Records of magnetic susceptibility, like those of charcoal, consist of a slowly varying component that can be described as background and a rapidly varying component, which define peaks. Like peaks of CHARs that represent fire events, peaks of electromagnetic accumulation rates (EMARs) probably reflect individual sedimentation events caused by disturbance events, including floods or fires.

The background component of EMARs likely consists of subcomponents including 1) magnetic minerals that vary in abundance depending on the degree of soil stabilization of the surrounding landscape (i.e., more allochthonous minerals were deposited in the lake during the late-glacial period than the Holocene when soil formation and stabilization occurred), and 2) magnetic minerals that are sequestered in the watershed and littoral zone of the lake for protracted periods before they are transported to deep water.

Because an objective of the magnetic susceptibility data analysis was to separate the component of EMARs that signaled sedimentation events from that which was related to more gradual pedologic and geomorphologic processes that contributed magnetic minerals to the lake, the EMARs were decomposed into background EMARs and EMAR peaks by the same method that was applied to the CHARs.

In the short core, magnetic susceptibility values (emu cm^{3}) were divided by the deposition time (yr cm^{-1}) to determine EMARs (emu cm^{-2} yr^{-1}). All positive EMARs were considered to be "peaks". In the long core, emu concentration data were transformed to EMARs and were decomposed into background and peak components by the same method that was applied to CHARs.

Correlation of Charcoal with Magnetic Susceptibility

To determine if CHARs were correlated with EMARs and whether charcoal peaks were associated with the occurrence of sedimentation events during the last 17,000 cal yr BP, the two series were detrended (CHARs and EMARs minus their background components) and Pearson Correlations were determined between them. CHARs and EMARs were detrended so Correlations would reflect how closely primary charcoal (i.e., charcoal from local/extralocal fires) fluctuated with that of allochthonous minerals. If the series were not detrended, results of Pearson Correlations would reflect long term trends in background CHARs and EMARs (i.e., in the late-glacial period, background CHARs are relatively low compared to the Holocene, whereas background EMARs are relatively high compared with those in the Holocene).

To test whether erosion occurred at the same time as a fire or in the decades following a fire, possibly as a response to burning, CHAR "peak starts" were compared with EMAR "peak starts" at the same level and at one and two levels higher in the core by cross-tabulation. Cross tabulations tallied the number of times a peak of CHARs started at the same time as a peak of EMARs and were constructed for the entire data set (17,000 cal yr BP to present) and for a subset of the data, including Holocene values from 11,300 cal yr BP to present (the period of *P. contorta* forest).

Results

The Last 600 years

The AD 1988 fire is recorded at Cygnet Lake by peaks in charcoal and magnetic susceptibility in the surface sediment (0-3 cm below the mud/water interface) of the short core (Fig. 2.3). The period from ca. AD 1720 to 1760 features high CHARs that suggest nearby fires and positive EMARs indicate fire-related sedimentation in the watershed. Dendrochronologic data confirm that large areas of the Central Plateau Province burned between AD 1730 and 1750 (Romme and Despain, 1989a,b,c). High CHARs between ca. AD 1500 and 1560 most likely signify local fires and a single EMAR peak at ca. AD 1540 suggests associated allochthonous sedimentation. An EMAR peak at ca. AD 1400-1450 is not concordant with high CHARs and may reflect nonfire-related erosion or flooding events.

The Last 17,000 Years

Pollen

The pollen record from core CL#91B revealed the transition from tundra or meadow vegetation, dominated by *Artemisia* and Poaceae to *Pinus* forest (Fig. 2.4). At 12,900 cal yr BP *Artemisia* accounted for ca. 60% and Poaceae for ca. 10% of the pollen. Pollen from herbaceous and shrub taxa, including Asteraceae, Rosaceae, Polygonaceae, and Apiaceae, was present in small amounts. Between ca. 12,900 and 11,300 cal yr BP, *Artemisia* percentages gradually declined to ca. 15-20% and Poaceae percentages declined to ca. 5%. Percentages of Haploxylon pine, Diploxylon pine, and undifferentiated pine gradually increased during this period. Haploxylon pine could be attributed to either *P. albicaulis* or *Pinus flexilis*, but in this study, it was assigned to *P. albicaulis*-type based on modern phytogeography. Diploxylon pine was attributed to *P. contorta*, the dominant conifer in YNP today. By ca. 11,300 cal yr BP, total *Pinus* pollen comprised ca. 60-70%

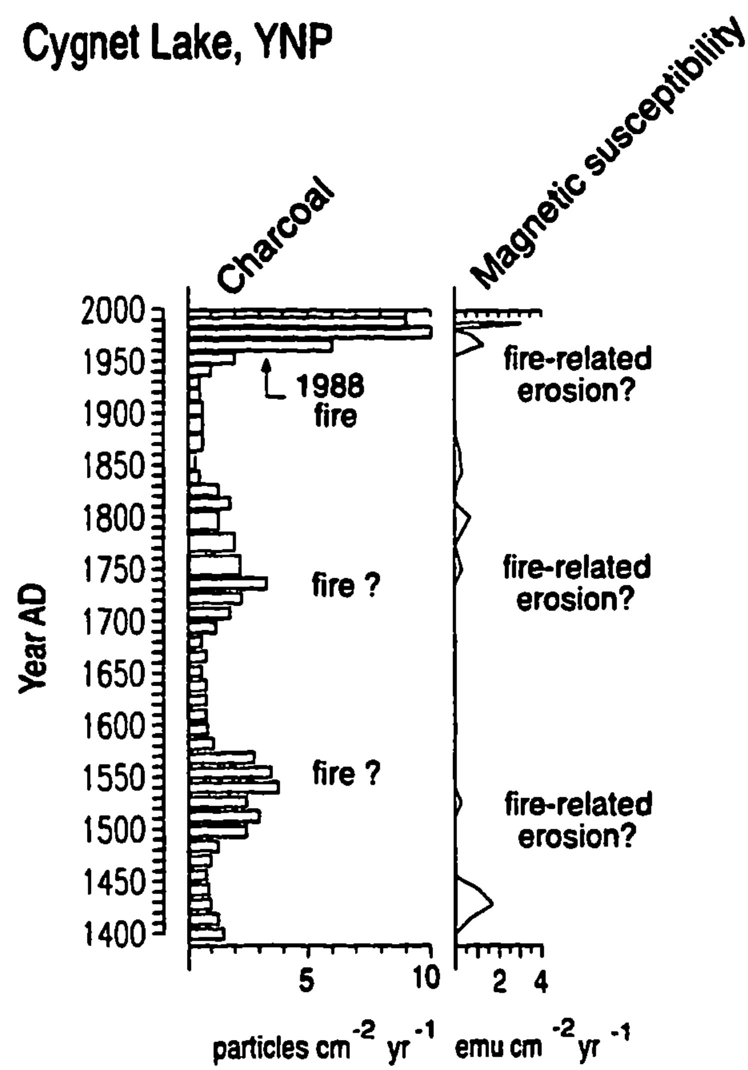


Figure 2.3. Charcoal and magnetic susceptibility stratigraphy back to AD 1400 for Cygnet Lake. Fires in 1988 are represented by high CHARs and EMARs. High CHARs from ca. AD 1720 to 1760 and 1500 to 1560 probably represent local watershed fires. Positive EMARs at ca. AD 1750 and 1530 likely represent fire-related sedimentation.

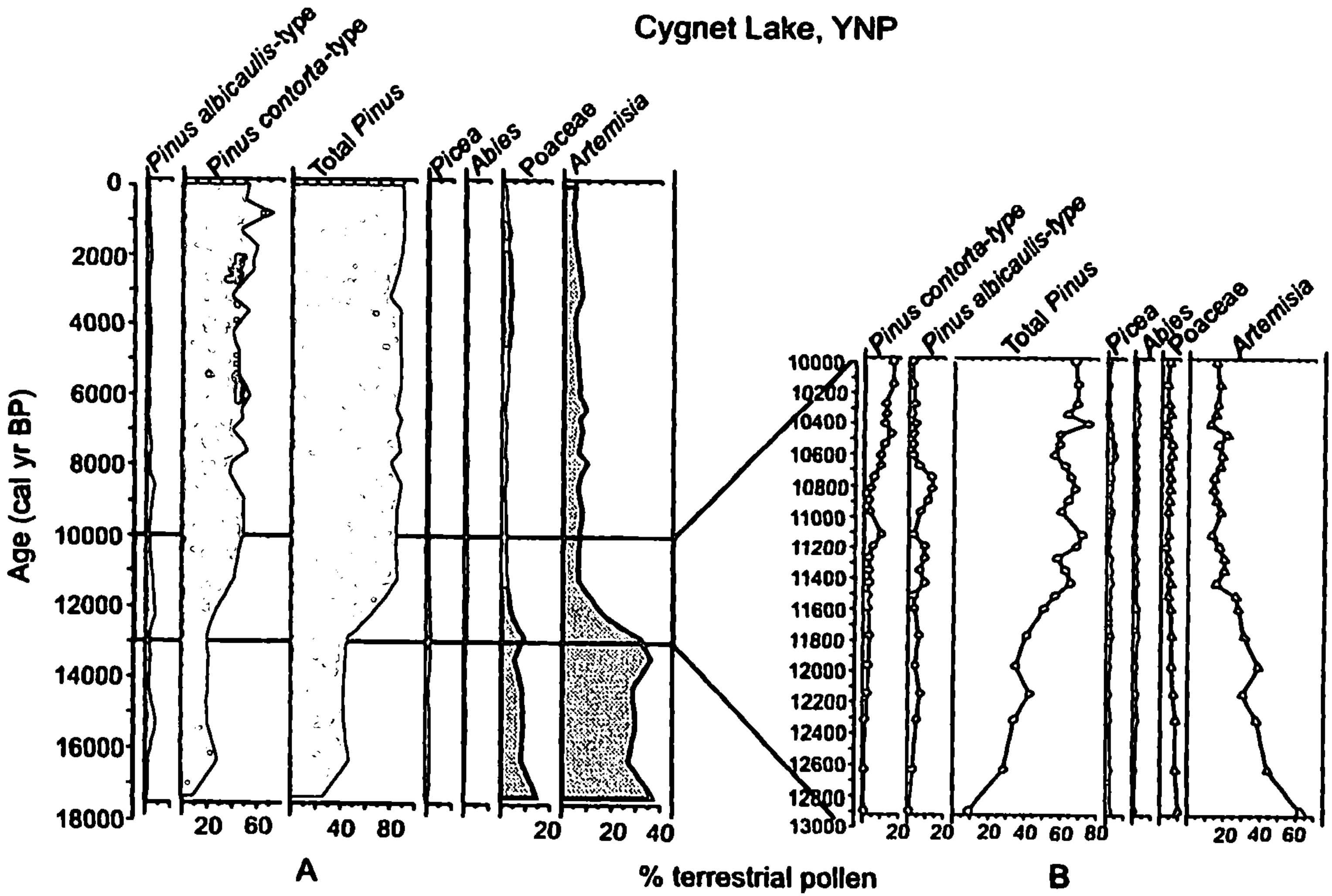


Figure 2.4. Pollen percentage diagram of selected taxa at Cygnet Lake (A) from core CL#88A for the last ca. 17,000 years (data from Whitlock, 1993) and (B) from core CL#91B between 12,900 and 10,000 cal yr BP.

of the terrestrial pollen, indicating the presence of closed *Pinus* forest. Between ca. 11,300 and 10,700 cal yr BP, the majority of the *Pinus* pollen was undifferentiated, however, *P. albicaulis*-type percentages ranged between ca. 8-15% and were slightly higher than *P. contorta*-type percentages at ca. 1-5%. After ca. 10,700 cal yr BP, *P. contorta*-type increased to 10-20% and *P. albicaulis*-type decreased to 1-5%. Percentages of *Picea* and *Abies* were low (1-3%) throughout the entire record.

Results from core CL#91B are consistent with the previous pollen interpretations of core CL#88A described by Whitlock (1993) (Fig. 2.4), with the exception of higher percentages of *P. albicaulis*-type pollen between 11,300 and 10,700 cal yr BP. This discrepancy could be a result of different sampling intervals in the two studies.

Charcoal

An intermediate window width of 750 years and a threshold ratio of 1.00 were chosen to decompose CHARs because they generated results that suggested the mean fire interval ranged between 200 to 500 years during the last 2000 years. This mean fire interval is similar to the 200- to 400-year mean fire interval determined for the last several centuries in the Central Plateau Province (Romme, 1982; Romme and Despain, 1989a,b,c).

Charcoal was present throughout the sedimentary record indicating that fires have occurred near Cygnet Lake since deglaciation (Fig. 2.5). Background CHARs increased by an order of magnitude (from 0.07 to 1.5 cm^{-2} yr^{-1}) between the late-glacial period and early Holocene suggesting a change in the amount of burnable biomass. The time between

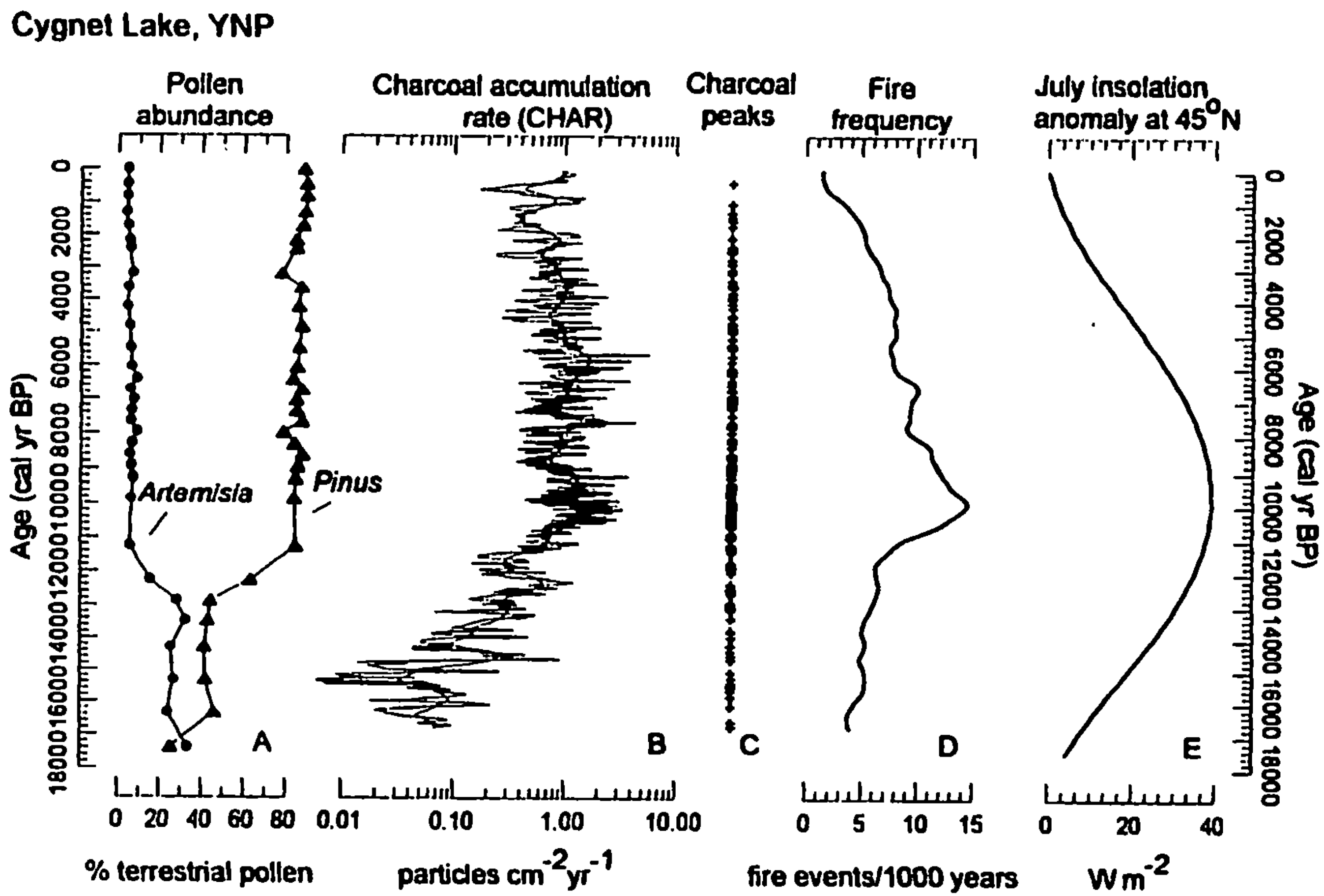


Figure 2.5. Comparison of pollen and charcoal data from Cygnet Lake with the July insolation anomaly at Lat. 45° N. (A) Pollen percentages of *Artemisia* and *Pinus* (data from Whitlock, 1993). (B) Log-transformed CHARs decomposed into background (slowly-varying line) and peaks using a window width of 750 years and a threshold ratio of 1.00. (C) CHAR peaks. (D) Fire frequency, represented by fire events/1000 years. (E) July insolation anomaly, calculated as the difference from present of average daily insolation at Lat. 45° N in mid July (Berger, 1978).

CHAR peaks has varied over the past ca. 17,000 years, indicating changes in fire frequency. The frequency of fires was four events/1000 years at ca. 17,000 cal yr BP indicating low fire frequency in the late-glacial period (Fig. 2.5). Fire frequency gradually increased from four to six events/1000 years between 17,000 and 11,700 cal yr BP. After ca. 11,700 cal yr BP, fire frequency increased rapidly and reached its highest rate (15 events/1000 years) at ca. 9900 cal yr BP. Fires occurred every century or less between ca. 11,000 and 8,000 cal yr BP (>ten events/1000 years). After 9900 cal yr BP, the number of fires gradually decreased to the present frequency of <two to three events/1000 years, signifying a reduction in fire occurrence over this period. From 11,000 cal yr BP to the present day, the level of background CHARs remained relatively high and relatively constant.

The robustness of the results is confirmed by the series of graphs in Figure 2.6. Different combinations of parameters for window width (200 to 1000 years) and threshold ratio (1.00 to 1.20) performed on both untransformed and transformed (logarithmic) CHARs generated results that showed the same dominant trends in fire frequency as those described above. Minor variations occurred in the timing of changes in fire frequency and in the number of fire events/1000 years during a given millennia. All of the graphs revealed that fire frequency was initially low (four events/1000 years) at 17,000 yr BP, but gradually increased to six-eight events/1000 years during the late-glacial period (Fig. 2.6). A sharp increase in fire frequency occurred at some point between 11,000 and 11,700 cal yr BP. In all of the graphs, fire frequency was highest at 9900 cal yr BP, however, the maximum number of fires varied during this time from ten to 17 events/1000 years

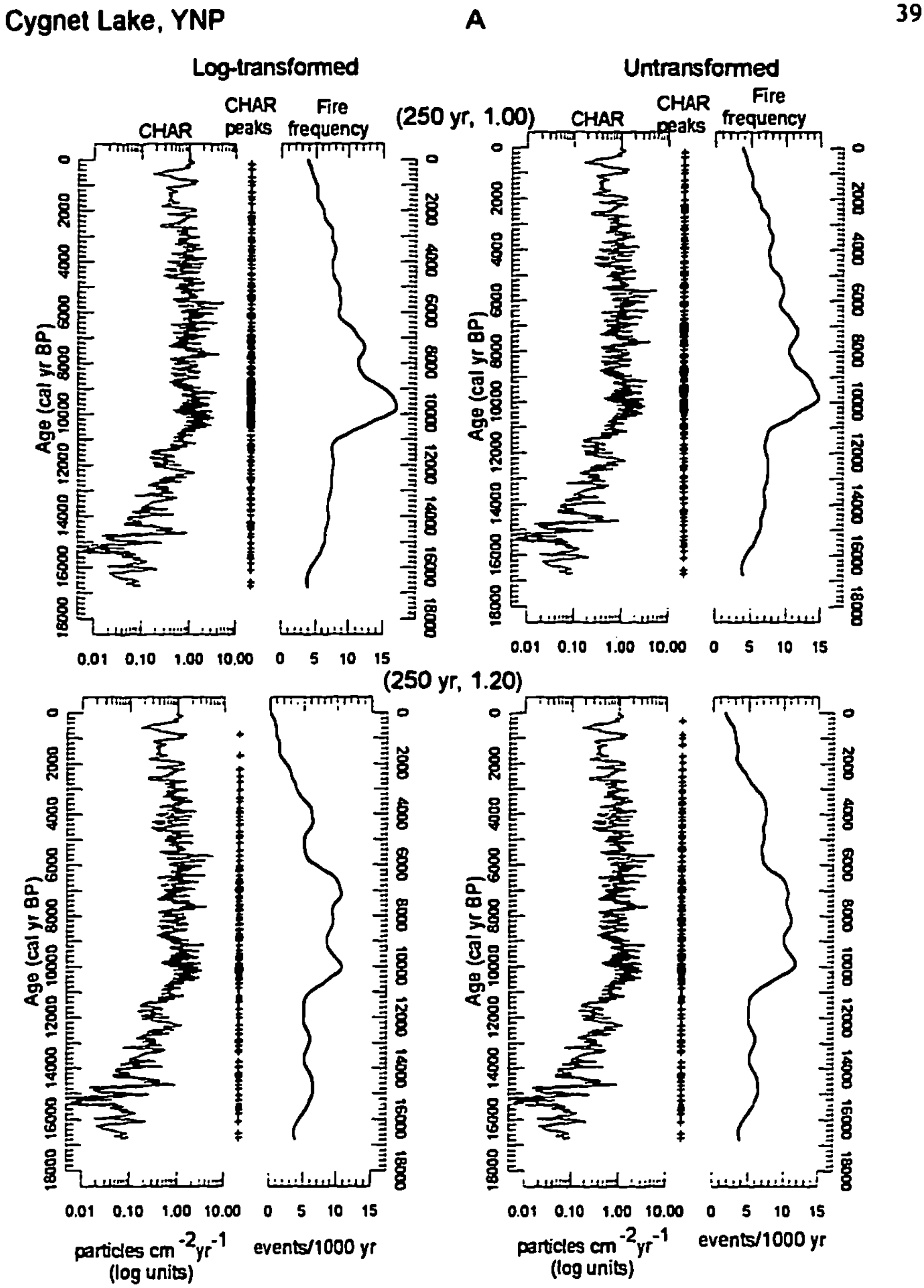


Figure 2.6. Comparison of fire frequency using different parameters for window width of (A) 250, (B) 500, (C) 750, and (D) 1000 years with threshold ratios of 1.00 and 1.20 for untransformed and log-transformed CHARs from Cygnet Lake. Crosses (+) represent CHAR peaks. Fire frequency is represented by fire events/1000 years.

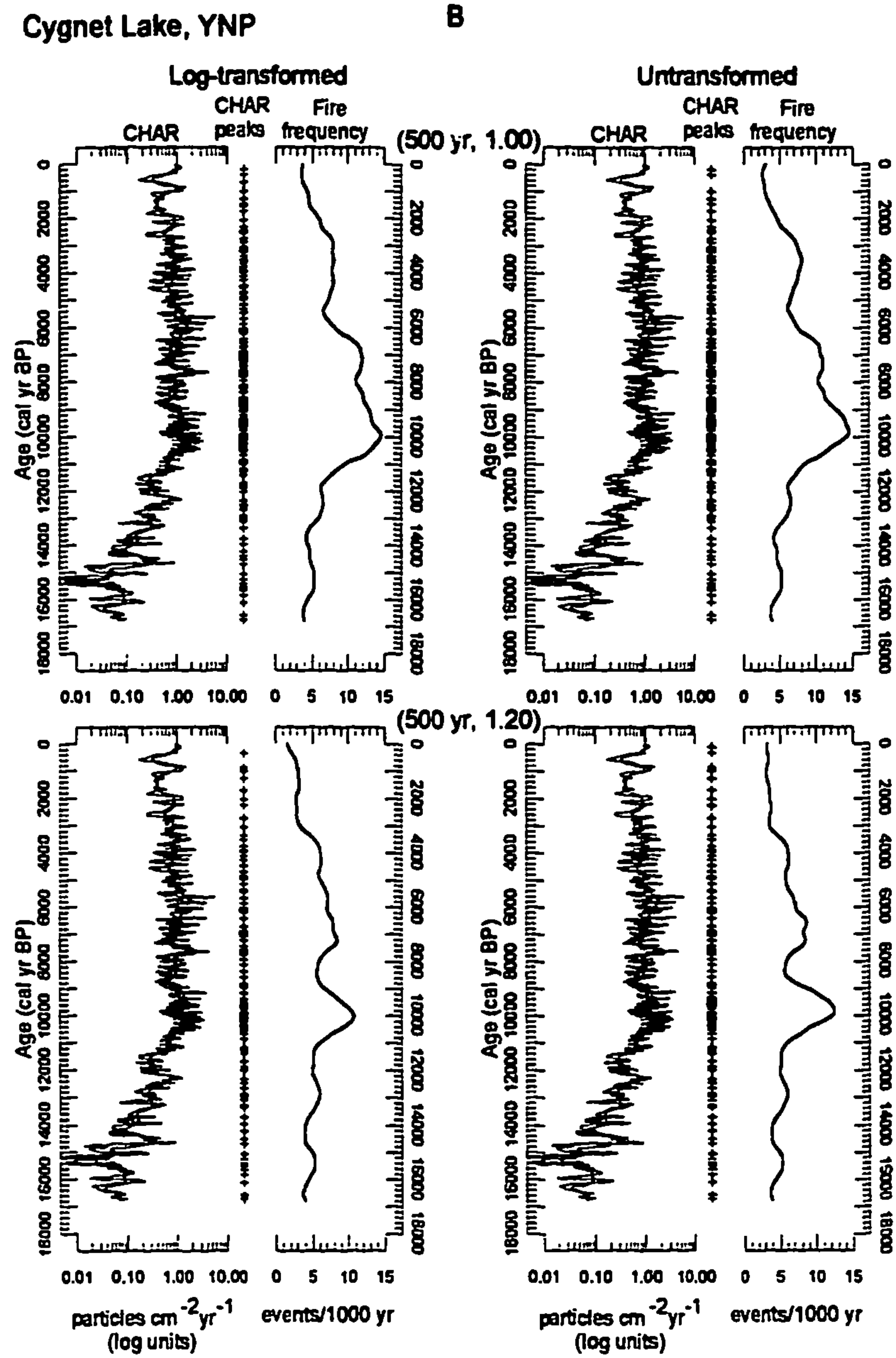


Figure 2.6. (Continued).

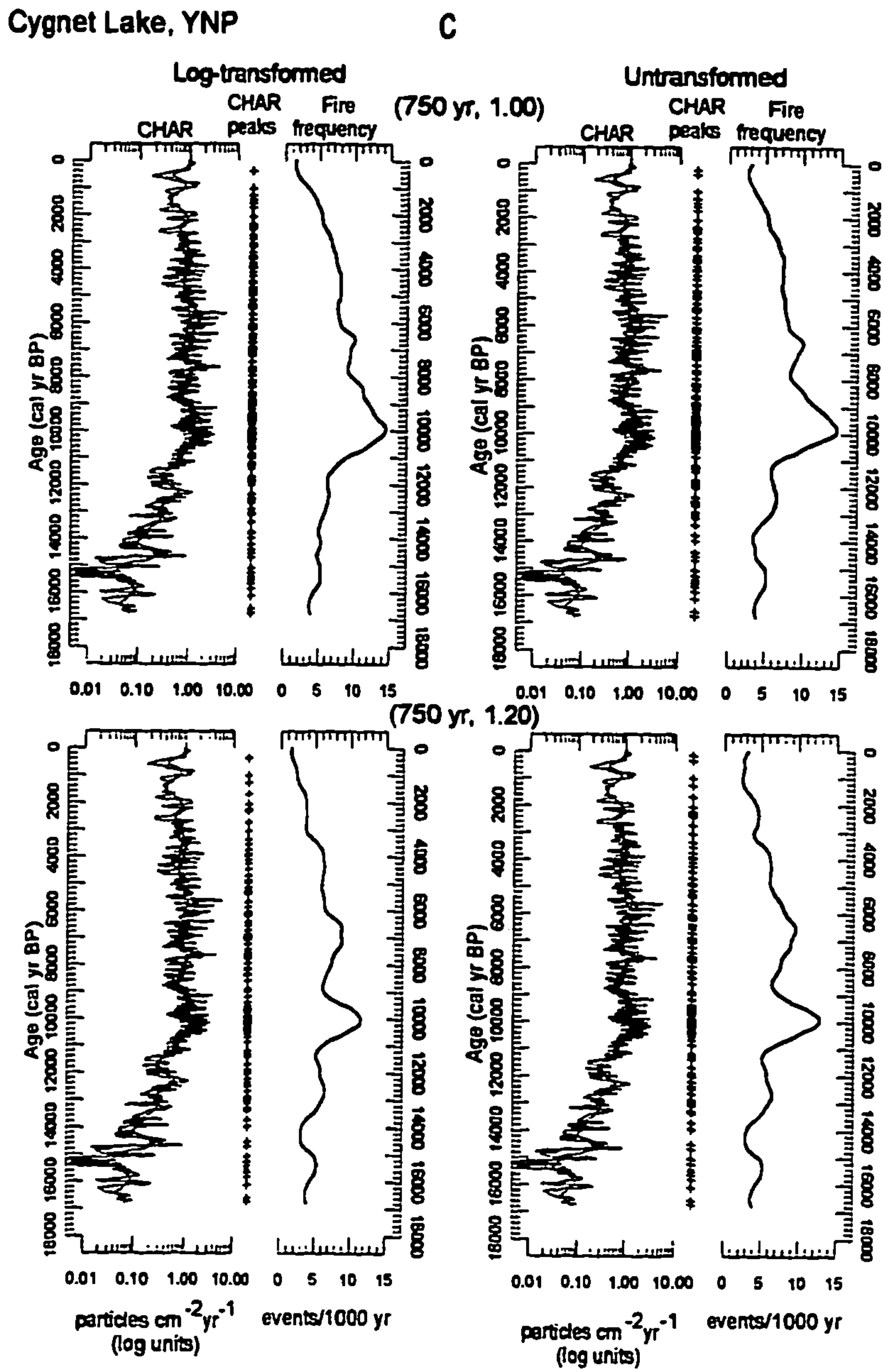


Figure 2.6. (Continued).

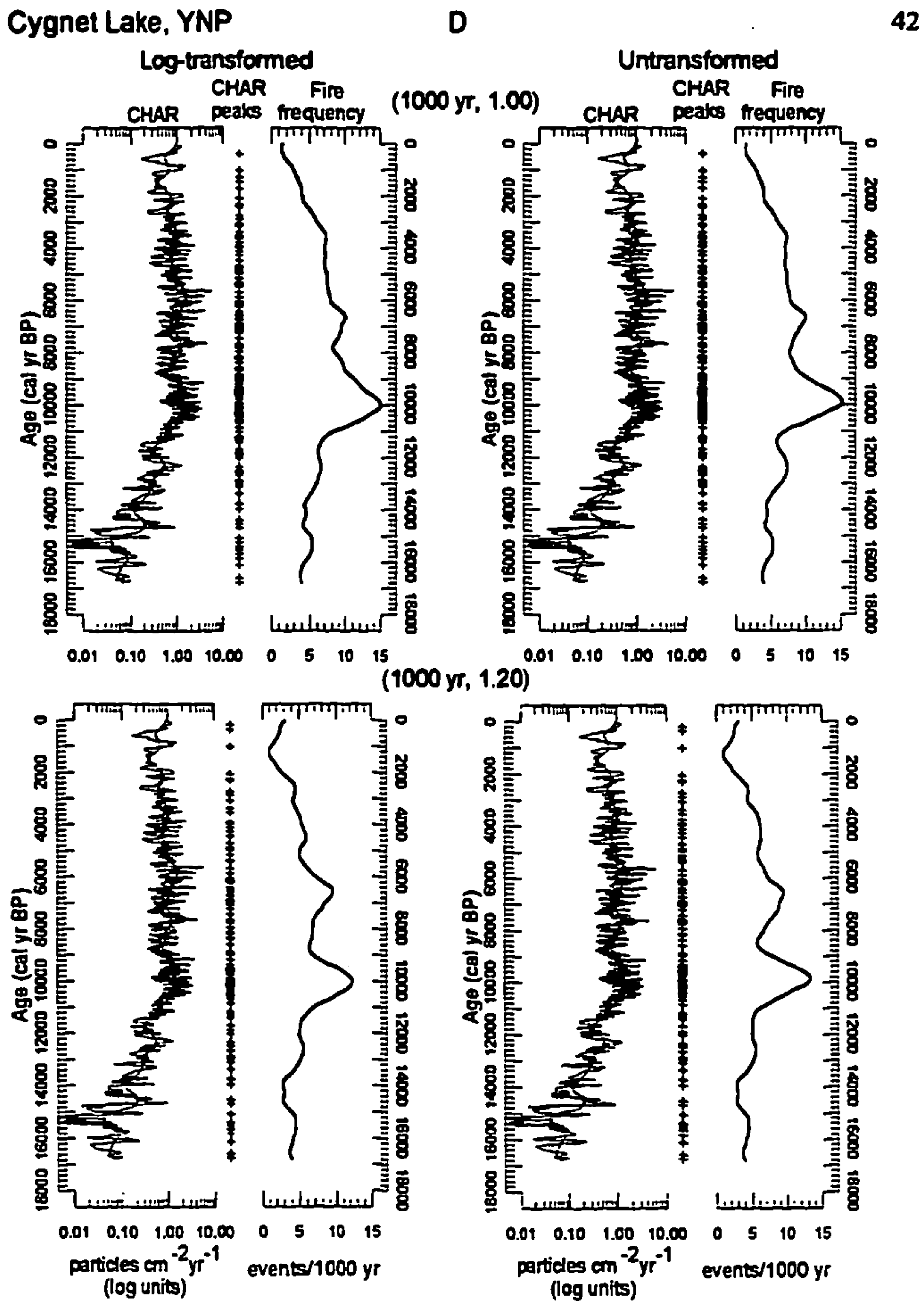


Figure 2.6. (Continued).

depending on the parameters. After 9900 cal yr BP, a general decline in fire frequency occurred, however, the rate of decline differed among graphs. For example, when window widths of 250, 500, and 750 years were combined with a threshold ratio of 1.00, fire frequency declined gradually after 9900 cal yr BP to the present frequencies of two to four events/1000 years. Window widths of 500 and 750 years with threshold ratios of 1.20 and a window width of 1000 years with threshold ratios of 1.00 to 1.20 suggest that fire frequency declined rapidly between 9900 and ca. 8500 cal yr BP, then more gradually between 8500 cal yr BP to the present. The finding that trends in fire frequency were robust among variations of the parameter values while the magnitude of fire frequency at a given time varied among reconstructions, suggests that more weight should be given to the relative changes in the number of fire events rather than to the absolute number of fire events/1000 years. Minor variations in the rates of change in fire frequency among reconstructions do not change the overall interpretation of the results.

Spectral analysis of CHARs showed no peaks or concentrations of variance that would imply periodic or quasi-periodic variations in CHARs (Fig. 2.7), and, thus, suggests there were no prolonged cycles in mean fire intervals over the past 17,000 years. The relative importance of variations at different periods changed throughout the record. In the late-glacial period, >1000-year variations dominated the record as a result of the overall increase in background CHARs. These ca.1000-year variations were less prominent in the Holocene because the level of background CHARs remained relatively stable when *P. contorta* forest was present. From ca. 11,000 to 3000 cal yr BP, 30- to 50-year period variations attained maximum importance. In addition, broad "shoulders" in

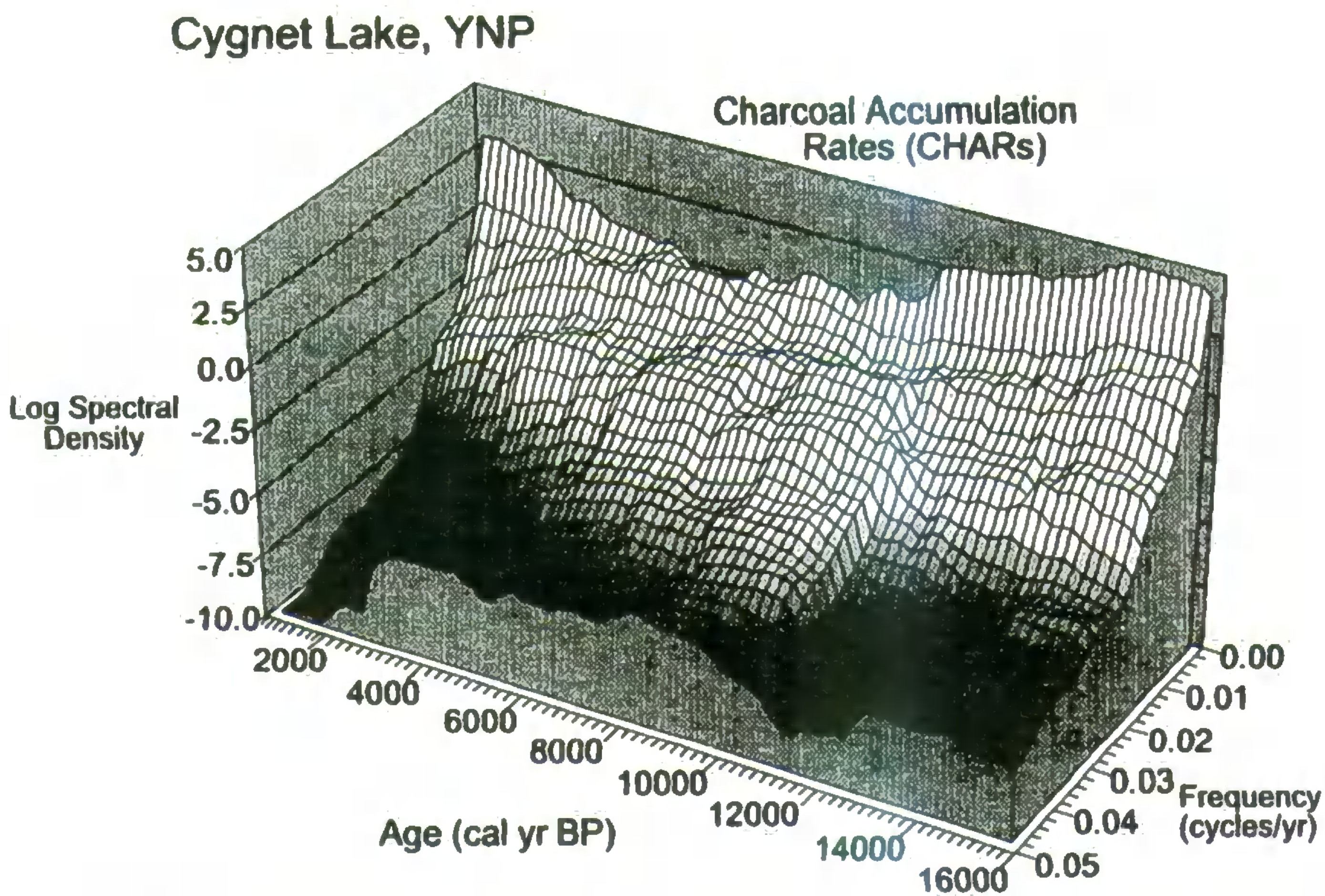


Figure 2.7. Evolutionary spectrum of the CHAR series from Cygnet Lake shows changes in the relative importance of different frequencies (which indicate mean fire intervals) through time. The importance of a particular frequency (i.e., mean fire interval) at a particular time is revealed by the log spectral density. The shading is an enhancement to help differentiate mean fire intervals of <100 years from longer mean fire return intervals.

the spectrum occurred at periods of 80 years between 10,800 and 8800 cal yr BP, and at 200 years between 6600 and 4600 cal yr BP. These features indicate that short mean fire intervals were prevalent in the early Holocene, and both short and medium fire intervals were important in the middle Holocene. From ca. 3000 cal yr BP to the present, short- and medium-period variations decreased and longer-period variations (>200 years) increased. This trend suggests that short and medium mean fire intervals have given way to longer mean fire intervals in the last 3000 years.

Lithology

The lithology of sediments deposited before ca. 11,200 cal yr BP was characterized by inorganic clay and silt. Loss-on-ignition analysis suggests that the organic content of the sediments was low (6%) prior to 12,200 cal yr BP, but increased to >27% by 11,200 cal yr BP (Fig. 2.8). The increase in organic content ca. 11,200 cal yr BP suggests the lake became more productive. From ca. 11,200 cal yr BP to present, sediments consisted of fine-detritus gytjja. Percentages of organic matter changed little after ca. 11,200 cal yr BP until the period from ca. 3000 to 1000 cal yr BP when they increased to >36%. The organic content of the sediments from ca. 1000 cal yr BP to present was not analyzed.

Magnetic Susceptibility

A window width of 750 years and a threshold ratio of 1.00 were used to identify background and peak components of EMARs. These parameters were selected because

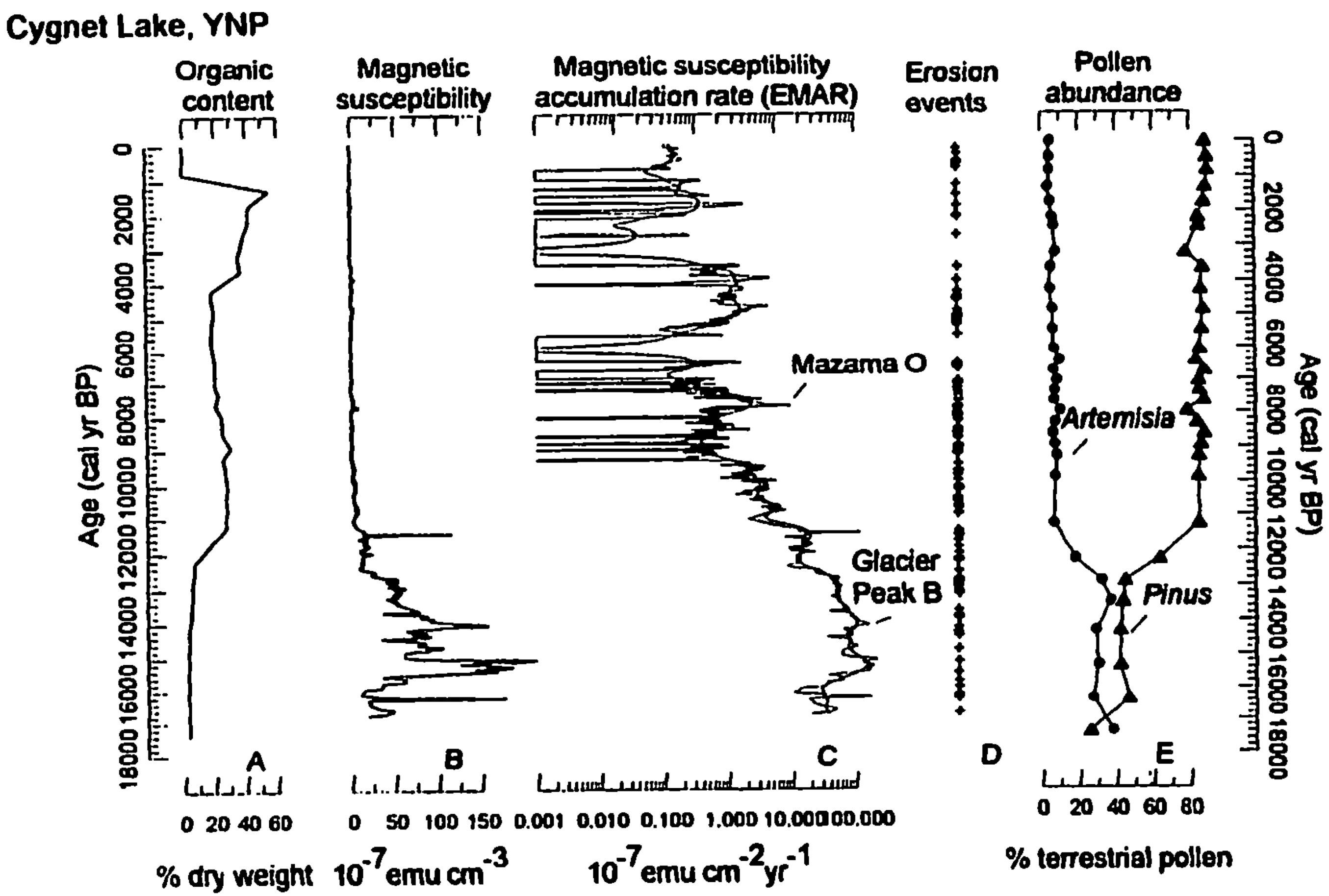


Figure 2.8. Comparison of lithology, magnetic susceptibility, and pollen data from Cygnet Lake. (A) Organic content of sediments. (B) Untransformed EMARs. (C) Log-transformed EMARs decomposed into background (slowly-varying line) and peaks using a window width of 750 years and a threshold ratio of 1.00. (D) EMAR peaks. (E) Pollen percentages of *Artemisia* and *Pinus* (data from Whitlock, 1993).

they were the same as those used for the decomposition of the CHARs.

Background EMARs were several orders of magnitude higher in the late-glacial period than at any time in the Holocene (Fig. 2.8). The highest background levels (>100 x 10^{-7} emu cm^{-2} yr^{-1}) occurred between 17,000 and ca. 14,000 cal yr BP after which time they steadily declined to ca. 1.0 x 10^{-7} emu cm^{-2} yr^{-1} at ca. 9500 cal yr BP. Throughout the Holocene, the record has been characterized by periods with low positive EMARs separated by periods with negligible values. Peaks in EMARs occurred throughout the record. An EMAR peak at ca. 7700 cal yr BP was produced by Mazama O tephra. Glacier Peak B tephra was represented by a peak dated at ca. 14,000 cal yr BP.

Comparison of Charcoal to Magnetic Susceptibility

A low negative correlation coefficient ($r = -0.075$) indicated that detrended CHARs did not co-vary with detrended EMARs. Low CHARs did not correspond to low EMARs and high CHARs did not correspond to high EMARs (Fig. 2.9). Thus variations in CHARs were apparently unrelated to processes of erosion.

Cross tabulation revealed that CHAR peaks and EMAR peaks rarely began at the same time. A total of 121 CHAR "peak starts" were tallied from 17,000 cal yr BP to present, and only ten of these began at the same time as an EMAR peak (Fig. 2.10). From 11,300 cal yr to present, only nine CHAR peaks started with EMAR peaks. EMAR peaks that started ten and 20 years after a CHAR "peak start" numbered four and six respectively. Therefore, fire-related erosional events rarely occurred in the two decades following a fire.

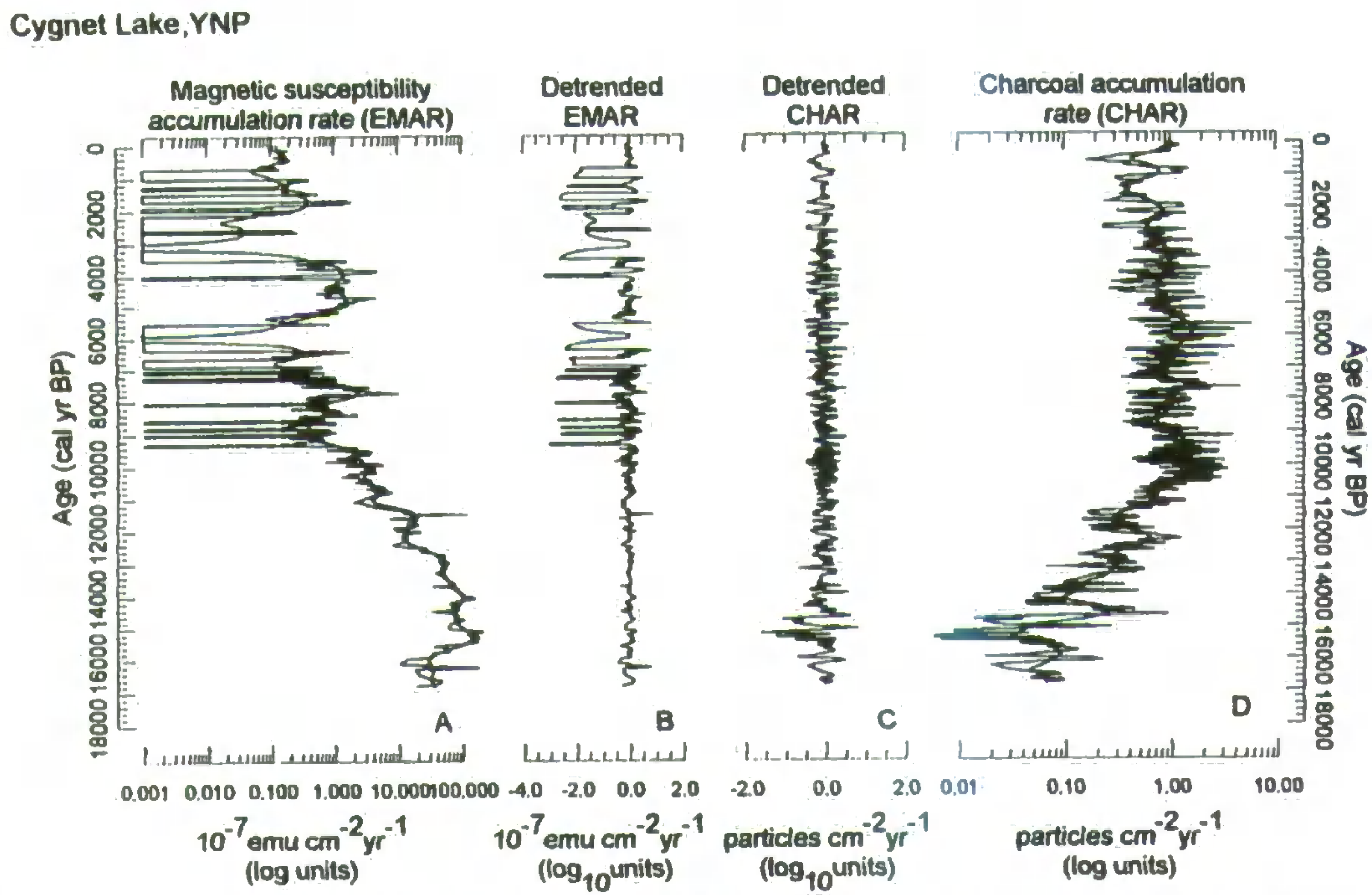


Figure 2.9. Comparison of magnetic susceptibility and charcoal data for Cygnet Lake. (A) Log-transformed EMARs decomposed into background (slowly-varying line) and peaks. (B) Detrended EMARs (EMARs minus their background components) and (C) CHARs (CHARs minus their background components). (D) Log-transformed CHARs decomposed into background and peaks.

Cygnet Lake, YNP

A

Beginning of a charcoal peak with beginning of a magnetic susceptibility peak

		EMARs no start	EMARs start	EMARs total
CHARs	no start	1477	83	1560
	start	111	10	121
	total	1588	93	1681

B

Beginning of a charcoal peak with beginning of a magnetic susceptibility peak with 10-yr lag

		EMARs no start	EMARs start	EMARs total
CHARs	no start	1470	89	1559
	start	117	4	121
	total	1587	93	1680

C

Beginning of a charcoal peak with beginning of a magnetic susceptibility peak with 20-yr lag

		EMARs no start	EMARs start	EMARs total
CHARs	no start	1471	87	1558
	start	115	6	121
	total	1586	93	1679

Figure 2.10. Cross tabulations between charcoal and magnetic susceptibility peaks from Cygnet Lake and with different lags.

Discussion

Fire History for the Last 750 Years

The 600-year record of CHARs from Cygnet Lake indicates that local fires occurred in AD 1988, and during the periods from AD 1720 to 1760, and ca. AD 1500 to 1560. Comparison of the record of fires from Cygnet Lake with those from other lakes in the Central Plateau Province (Millspaugh and Whitlock, 1995) reveals that periods of local fires at Cygnet Lake coincide closely with the timing of fires recorded in other small lakes. The co-occurrence of fires near Cygnet Lake at AD 1988, from AD 1720 to 1760, and ca. AD 1500 to 1560 with local fires at Dryad, Duck, Grizzly, and Mallard lakes suggest that these were periods of widespread burning when large or several small fires burned the region during particular decades. Of these five lakes, Dryad, Duck and Mallard also record fires during the last ca. 750 years that were not always associated with widespread fires, but burned within a localized area surrounding a lake (Millspaugh and Whitlock, 1995). The intervals between fires in small-lake watersheds were variable over the last 750 years. The likelihood of local fire was determined by a combination of local and regional weather conditions, characteristics of the age-class of the nearby forest, and fuel loading conditions and for that reason the fire regimes were non-stationary (Millspaugh and Whitlock, 1995). Episodes of widespread burning in the mid AD 1700s and 1500s were likely a response to drought conditions that influenced the entire region, such as those that occurred in 1988.

Fire, Vegetation, and Climate Change for the Last 17,000 Years

Comparison of the charcoal data and pollen records from Cygnet Lake, and the July insolation anomaly for the latitude of YNP during the last 17,000 cal yr BP reveals linkages between fire, vegetation, and large-scale climatic controls (Fig. 2.5). The frequency of local fires was initially low (ca. four events/1000 years) at ca. 17,000 cal yr BP when the Central Plateau was unforested. July insolation at this time was similar to or slightly higher than present, but summer conditions were cooler than today because of the influence of the Laurentide Ice Sheet (Kutzbach *et al.*, 1993). A gradual increase in fire frequency from four to six events/1000 years between 17,000 and 11,700 cal yr BP was likely a response to climate amelioration with increasing summer insolation (Berger, 1978) to values >33 Wm^{-2}. During this period, increasing background CHARs probably reflect changes in biomass as tundra vegetation was replaced by *Pinus* parkland and then *Pinus* forest. Local fires became more frequent after ca. 11,700 cal yr BP as summers became warmer and drier with the expansion of the eastern Pacific subtropical high pressure system in response to increased July insolation. The establishment of closed forests after ca. 11,300 cal yr BP most likely facilitated fire spread. *Pinus albicaulis* was initially present in the forest between ca. 11,300 and 10,700 cal yr BP (Fig. 2.4). Its demise after 10,700 cal yr BP is attributed to increasing temperature and drought (>11 events/1000 years).

Near the time of the early-Holocene insolation maximum (>39 Wm^{-2}; Berger 1978), ca. 9900 cal yr BP, dry summers increased the fire frequency to 15 events/1000 years. The short intervals between fires at Cygnet Lake suggest that most fires were small and likely limited by the availability of fuels. The palynological data do not detect changes in understory vegetation associated with changes in stand-age distribution, but the dominance of *P. contorta*-type pollen in this region and low amounts of *Artemisia* and herbaceous pollen suggest few forest openings. After 9900 cal yr BP, the number of fires gradually decreased to present-day frequencies (<two to three events/1000 years). The trend coincides with decreasing summer insolation and increasing cool and effectively wetter conditions than before, which shortened the fire season (e.g., probability of ignition, fuel moisture, fire weather) of any given year. Because the composition of the forest and its above-ground biomass did not change significantly, background CHARs remained relatively constant in the Holocene. In the last two millennia, fire frequency has been lower (two to five events/1000 years) than at any time since the establishment of *P. contorta* forest. Protracted periods without fires have allowed forest stands to mature and the mosaic to become more connected in the late Holocene. This type of landscape pattern has likely contributed to the current fire regime, which features severe fires in anomalous dry years (Balling *et al.*, 1992).

Landscape Dynamics

Fire regimes in the *P. contorta* forests of the Central Plateau Province have been non-stationary during the past ca. 17,000 years. Lack of peaks of variance in the evolutionary spectrum of CHARs suggests there was no long-term cyclicity in mean fire intervals (Fig. 2.7). Between ca. 10,800 and 8,800 cal yr BP, mean fire intervals of 80 years were common. Short fire intervals (30-to 50-years) were generally more prevalent in the early and middle Holocene BP, than in the late Holocene. Short intervals between fires in a stand-replacement fire regime would have produced a mosaic of *P. contorta* forest dominated by young-aged stands (<100 years old). Between 6600 and 4600 cal yr BP, a 200-year mean fire interval was important. From ca. 3000 cal yr BP to the present, short and medium fire intervals decreased and longer (>200 years) fire intervals have increased. Thus, a fine-grained forest mosaic dominated by stands that were between ca. 30 and 200 years old in the early and middle Holocene probably shifted to a coarse mosaic characterized by ca. 200- to 400-year-old stands in the late Holocene.

The Cygnet Lake record suggests that the *P. contorta* forests of the Central Plateau may have been characterized by equilibrium conditions during certain periods, such as the early Holocene, but have been characterized by non-equilibrium conditions over the course of the entire Holocene. From 11,300 cal yr BP to the present, changes in fire frequency on millennial time scales (Fig. 2.5) indicate that the intervals between fires have changed continuously. Thus, the ages and sizes of patches within the *P. contorta* mosaic have most likely changed on millennial time scales in response to shifting mean fire intervals. It is possible, however, that equilibrium conditions may have prevailed in the *P. contorta* forest at submillennial time scales in the early Holocene when fire frequency was higher than at present. If equilibrium conditions existed, the most likely period was between ca. 10,000 and 9000 cal yr BP. At this time, fires occurred at ca. 70-year intervals and mosaic patches were likely small in size because fuel was limiting. Thus, the mosaic would have been composed of small patches in numerous different age classes. In the late Holocene, non-equilibrium conditions prevailed when fire frequency gradually decreased to two to five events/1000 years. Longer intervals (200 to 500 years) between fires would have enabled large areas of the mosaic to reach maturity. Greater fuel in mature forests would have fostered large fires and shifted the forest mosaic to large patches of even-aged stands. Thus, long mean fire intervals in the late Holocene produced a landscape characterized by non-equilibrium conditions. These examples demonstrate that determination of whether a landscape is characterized by equilibrium or non-equilibrium conditions is partially dependent on the temporal scale under consideration and on the prevailing climatic conditions.

Fire and Erosion

High background EMARs during the late-glacial period (Fig. 2.8) resulted from the continuous influx of allochthonous mineral material to the lake in a sparsely vegetated landscape. Lake productivity was low during the late-glacial period as evidenced by the low organic content of the sediments. Apparently, the development of a closed *Pinus* forest and stabilization of soils in the early Holocene resulted in a sharp decline in erosion from previous high rates.

Peaks of EMARs occurred throughout the record. The low correlation between detrended CHARs and detrended EMARs during the last 17,000 cal yr suggests that charcoal deposition is generally not associated with sedimentation events. Most sedimentation events occurred during non-fire years, and charcoal was largely introduced to the lake during fires as airborne fallout, not by surficial processes. The general lack of correspondence of the timing of EMAR and CHAR peaks (i.e., only ten CHAR peaks began at the same time as EMAR peaks during the last 17,000 cal years) provides further evidence that sedimentation events were generally not related to fires. In the late-glacial period, EMAR peaks probably reflect sedimentation events caused by solifluction or flooding during spring snow melt. EMAR peaks in the Holocene were produced by the inwashing of minerogenic sediment resulting from geomorphic events in response to floods and fires. The finding that few EMAR peaks started ten and 20 years after a fire suggests that episodes of sedimentation did not occur during or in the decades after fires. Thus, the discrepancy in timing between CHAR "peak starts" and EMAR "peak starts" could not be explained in terms of lags in erosion following fires (i.e., delays in the input of clastic sediments from burned, destabalized slopes into the lake). Because the size of the watershed is large (1215 ha) and the watershed slopes are low in gradient (ca. 1°-11°), erosion following fires in a distant area of the watershed would not deliver clastic sediment to the lake. Fires of low intensity or followed by rapid regrowth of vegetation were probably not associated with erosion. Peaks in EMARs not associated with charcoal were likely from other types of disturbance in the watershed, including surficial erosion caused by spring floods and summer storms. In addition, fine minerogenic sediments from the shoreline may have been resuspended and redeposited in deeper water by wave and current activity (Larsen and MacDonald, 1993) thereby producing positive EMARs.

Despite the effectiveness of magnetic susceptibility to identify fire events in other small lakes in YNP on century-long time scales (Millspaugh and Whitlock, 1995), the record of EMARs from Cygnet Lake provides little information about fire-related erosion in the local watershed. This discrepancy may be related, in part, to a more rigorous assessment of 'co-occurrence' between EMAR and CHAR peaks in the long record from Cygnet Lake. In the long record from Cygnet Lake, an EMAR peak had to start at the same time, or ten or 20 years after a CHAR peak to be considered fire-related sedimentation, whereas, in the century-long records, positive EMARs only had to broadly overlap with CHAR peaks.

Comparison of the Central Plateau to Other Regions in the Western U.S.

Other studies of climate-vegetation-fire-interactions in the western U.S. reveal that changes in fire occurrence coincided with changes in vegetation and climate during the postglacial period. Many of these studies suggest that fires were more common in the early Holocene than in the late Holocene. At Kirk Lake in northwestern Washington, microscopic charcoal particles (ca. 5-20 mm) on pollen slides provided information about trends in fire occurrence (Cwynar, 1987). In the late-glacial period (between ca. 13,900 and 12,900 cal yr BP; 12,000 and 11,000 ^{14}C yr BP), fire frequency was moderate when an open forest of *P. contorta*, *Picea sitchensis*, and *Alnus sinuata* grew locally. Between ca. 12,900 and 7600 cal yr BP (11,000 and 6800 ^{14}C yr BP), *Pseudotsuga* and *Alnus rubra* colonized the region and fires were frequent. Fire frequency decreased with colonization of *Tsuga heterophylla* and *Thuja plicata* in the late Holocene. Northwestern Washington, just as the Central Plateau, was influenced by expansion of the eastern Pacific subtropical high pressure system in the early Holocene. Greater summer drought conditions apparently led to changes in both vegetation and fire regime.

A record of macroscopic charcoal particles in sediments from Little Lake in the Oregon Coast Range provided information about changes in fire frequency during the past ca. 9000 years (Long *et al.*, in review). Fire intervals ranged between 100 and 175 years from ca. 9000 to 6700 cal yr BP, when climate conditions were warmer and dryer than today and *Pseudotsuga* and *A. rubra* were present. Between ca. 6700 and 3500 cal yr BP, fire intervals were similar to those during the previous period. *Thuja plicata* and *T. heterophylla*, were present during this period indicating a shift towards cool and humid climate conditions. In the past 3500 years, intervals between fires have been longer than before (160-300 years) when fire-sensitive species including *Picea* and *Abies* have been present. In the Oregon Coast Range, vegetation and fire frequency have changed in response to increased summer drought during the early Holocene and decreased drought conditions in the late Holocene (as a result of expansion and contraction of the eastern Pacific subtropical high pressure system).

Microscopic charcoal (<12 mm in diameter) was examined in pollen preparations from Swamp Lake in the Sierra Nevada of California (Smith and Anderson, 1991). Mixed conifers, including several *Pinus* and *Abies* species, grew at the site from ca. 13,900 to 11,100 cal yr BP (12,000 to 10,000 ^{14}C yr BP). Fire occurrence was initially low but increased after ca. 11,100 cal yr BP. In the early Holocene, between ca. 11,100 and 7380 cal yr BP (10,000 and 6500 ^{14}C yr BP), upper montane conifers were replaced by *Quercus*, Compositae, and Rosaceae. After ca. 7380 cal yr BP (6500 ^{14}C yr BP), an increase in *Abies* and a decrease in herbaceous taxa coincided with a decline in fire occurrence. Changes in both vegetation and fire occurrence were most likely a response to the shift from drought in the early Holocene to cool wet conditions in the late Holocene.

A record of microscopic charcoal (ca. 25-50 mm in diameter) and pollen from Lost Trail Pass Bog in the Bitterroot Range of Montana suggests that fire frequency was higher in the middle and late Holocene than it was in the early Holocene (Mehringer *et al.*, 1977). After a brief period of tundra, *P. albicaulis* colonized the region ca. 11,500 ^{14}C yr BP (ca. 13,400 cal yr BP) and persisted for the next ca. 4000 years. Charcoal influx was low during this period, suggesting few fires. Cooler conditions recorded at this site (Mehringer *et al.*, 1977) are attributed to strengthened monsoonal circulation in the early Holocene (Whitlock and Bartlein, 1993). Fire frequency increased in the middle Holocene between ca. 7800 and 4400 cal yr BP (7000 and 4000 ^{14}C yr BP) when *Pseudotsuga menziesii* and/or *Larix occidentalis*, and *P. contorta* grew locally. *P. albicaulis* and *P. contorta* replaced *Pseudotsuga* and *L. occidentalis* as the dominant species after ca. 4,400 cal yr BP (4000 ^{14}C yr BP) suggesting a shift to cooler and perhaps drier conditions in the late Holocene. Fire frequency increased to its highest level in the last 2000 years. Mehringer *et al.* (1977) suggested that the recent increase in charcoal may be related to an increase in burning by Native Americans whose populations were increasing.

The fire history at Cygnet Lake builds upon this literature by providing evidence of the direct linkages between changes in climate and fire frequency on millennial time scales. At Cygnet Lake, *P. contorta* forest has been dominant for the past ca. 11,300 cal yr, and thus, changes in fire frequency during that period can be attributed to changes in climate alone. In contrast, studies of climate-fire-vegetation interactions in Washington, Oregon, California, and Montana show changes in fire frequency that coincide with changes in vegetation. While climate was likely the ultimate driving force in changing fire frequency in other regions, it is not possible to rule out the possibility that changes in fire regimes occurred as a result of changes in vegetation composition.

Fire Management in YNP

In YNP, fire is recognized as a natural process and fires that are started by lightning are allowed to burn in remote areas of the park. This "natural burn policy" has been in place since 1972, but was temporarily suspended for review after 1988 fires. The 1988 fires were perceived to be unnaturally large and severe and the Park Service was criticized for ineffectual fire management. The decision to retain the "natural burn policy" was based, in part, on dendrochronological evidence that showed that large areas of YNP burned between ca. 1690 and 1750 (Romme and Despain, 1989a,b,c). Thus, the large scale of the 1988 fires was not unnatural but resulted from a combination of extreme weather conditions and the fact that large areas of YNP were covered by large accumulations of ca. 300-year fuels developed through natural succession. The fire record from Cygnet Lake provides evidence that fires have occurred at ca. 300- to 500-year intervals for much of the late Holocene and it is likely that fires burning at such long intervals have been large in size and severe.

The use of human-ignited prescribed fire (i.e., fires ignited intentionally under climatic conditions classified as "low fire hazard" so the size and intensity can be carefully controlled) is becoming more common in forests of the western U.S. as a means of attempting to restore a natural range of fire frequencies, sizes and intensities that existed prior to European settlement (e.g., Brown, 1991; Swanson *et al.*, 1993, 1997). For example, it has been used to mitigate the effects of fire suppression in forests characterized by frequent (e.g., <25 mean fire intervals), low-intensity fires, such as the *Pinus ponderosa* forests of the western U.S. Elimination of fires in those forests has allowed the growth of dense understory fuels, and thereby increased the stand susceptibility to severe crown fires. In such forests, the use of prescribed fire serves as an effective means of reducing understory fuels and thereby preserving the structure of the *P. ponderosa* forest that existed prior to suppression.

Although the use of prescribed fire was never implemented in YNP, after the 1988 fires, it was considered as a possible means of reducing fuel loads and thereby preventing large, severe fires in the future (Knight, 1991; Varley and Schullery, 1991). In forests characterized by infrequent stand-replacement fires, such as the *P. contorta* forests of YNP, effective fire suppression (ca. 1945 to 1972) may have resulted in minor increases in fuels. However, dendrochronological evidence (Romme and Despain, 1989a,b,c) and data from Cygnet Lake indicate such increases in fuels have also occurred naturally in the past as a result of long mean fire intervals. In YNP, the use of prescribed fire as a means to reduce fuel accumulation to attempt to prevent future large fires would likely be ineffective. Prescribed fires would likely be set only under low-fire-hazard conditions so fires would be small in size and thus would not reduce fuel accumulations on the scale necessary to prevent large fires in the future. Furthermore, under conditions of extreme drought, the structure of fuels would have little influence on fire occurrence and large stand-replacing fires would be inevitable (Turner and Romme, 1994).

The fire record from Cygnet Lake provides evidence that the frequency, and most likely the size, of fires in the *P. contorta* forests of central Yellowstone have changed continuously for the past ca. 11,000 years with changes in climate. Thus, management approaches that attempt to define a natural range of fire frequency, severity, and size based on dendrochronological records are only considering a portion of a continuously shifting range of these variables that characterize ecosystems.

Conclusions

The fire record from Cygnet Lake highlights the importance of long-term climate changes in influencing fire regimes in the Central Plateau Province of southern/central YNP. Fire frequency was highest (>ten events/1000 years) between 11,000 and 8000 cal yr BP during the period of maximum summer insolation when summers were warmer and drier than at present. As insolation decreased in the late Holocene and conditions became cooler and wetter than before, fire frequency decreased to its present low frequencies of two to three events/1000 years (Fig. 2.5). Mean fire intervals have shifted continuously over the postglacial period in response to climate change. Short and medium fire intervals (30 to 200 years) were common between ca. 11,000 to 3000 cal yr BP. During this period, the forest mosaic was characterized by small patches of 30- to 200-year-old stands. From ca. 2000 cal yr BP to the present, long fire intervals have become more important than before and the mosaic has been transformed to a coarse mosaic of 200- to 400-year-old stands.

CHAPTER III

COMPARISON OF A POSTGLACIAL HISTORY OF FIRE FROM THE YELLOWSTONE-LAMAR PROVINCE WITH THE CENTRAL PLATEAU PROVINCE OF YELLOWSTONE NATIONAL PARK

Fire is a major form of disturbance in forested and non-forested ecosystems in the western U.S. Fire regimes are influenced by interactions between climatology, topography, and vegetation, and as a result, vary dramatically at subregional scales. On interannual-to-decadal time scales, fires occur in response to variations in weather patterns and changes in the structure and maturity of vegetation (e.g., Pickett and White, 1982). Topography influences local temperature and moisture gradients, and thus, affects vegetational patterns and the susceptibility of vegetation to burning. Topographic features also determine local-to-regional-scale weather patterns and thereby affect wind direction and the frequency of lightning ignitions (Swanson *et al.*, 1988). Thus, subregions within a topographically complex region are generally characterized by heterogeneous patterns of local climate, vegetation, and fire regimes.

Dendrochronological analyses of fire scars and forest-age classes are generally used to reconstruct past fire regimes in topographically complex regions. Dendrochronological records provide evidence that the patterns of fire occurrence observed in topographically complex regions today have persisted over the past several hundred years (e.g., Barrett *et al.*, 1991). Such records, however, are not long enough to describe variations in fire regimes on the time scales over which large-scale climate and vegetation changes have occurred.

Long records of fire are provided by an analysis of charcoal in lake sediments. Analysis of macroscopic charcoal particles in lake sediments (>100 microns in minimum diameter) allow the reconstruction of local fire events in a several-hundred-ha radius around a lake (Clark, 1988a,b,c; Millspaugh and Whitlock, 1995; Clark and Royall, 1996; Long *et al.*, in review). Thus, records of macroscopic charcoal provide a means of reconstructing fire histories in different subregions of topographically complex regions.

In the Northern Rocky Mountains, paleoecological data provide evidence that the spatial heterogeneity of climatic and vegetational patterns at present was also a feature of the past. For example, Yellowstone National Park (YNP) is divided into distinct geovegetation provinces that are characterized by different geology, local climate, vegetation, and fire regime today (Despain, 1990). During the Holocene, changes in summer insolation resulted in a complex history of subregional climatic and vegetational responses in different provinces (Whitlock and Bartlein, 1993). Whether variations in fire regimes in different geovegetation provinces also accompanied changes in insolation is not known.

In Chapter III, I describe the fire history of the last ca. 15,000 cal years from Slough Creek Lake in the Yellowstone-Lamar Province in YNP (Fig. 3.1). The accumulation rates of charcoal and magnetic minerals provided information on fire

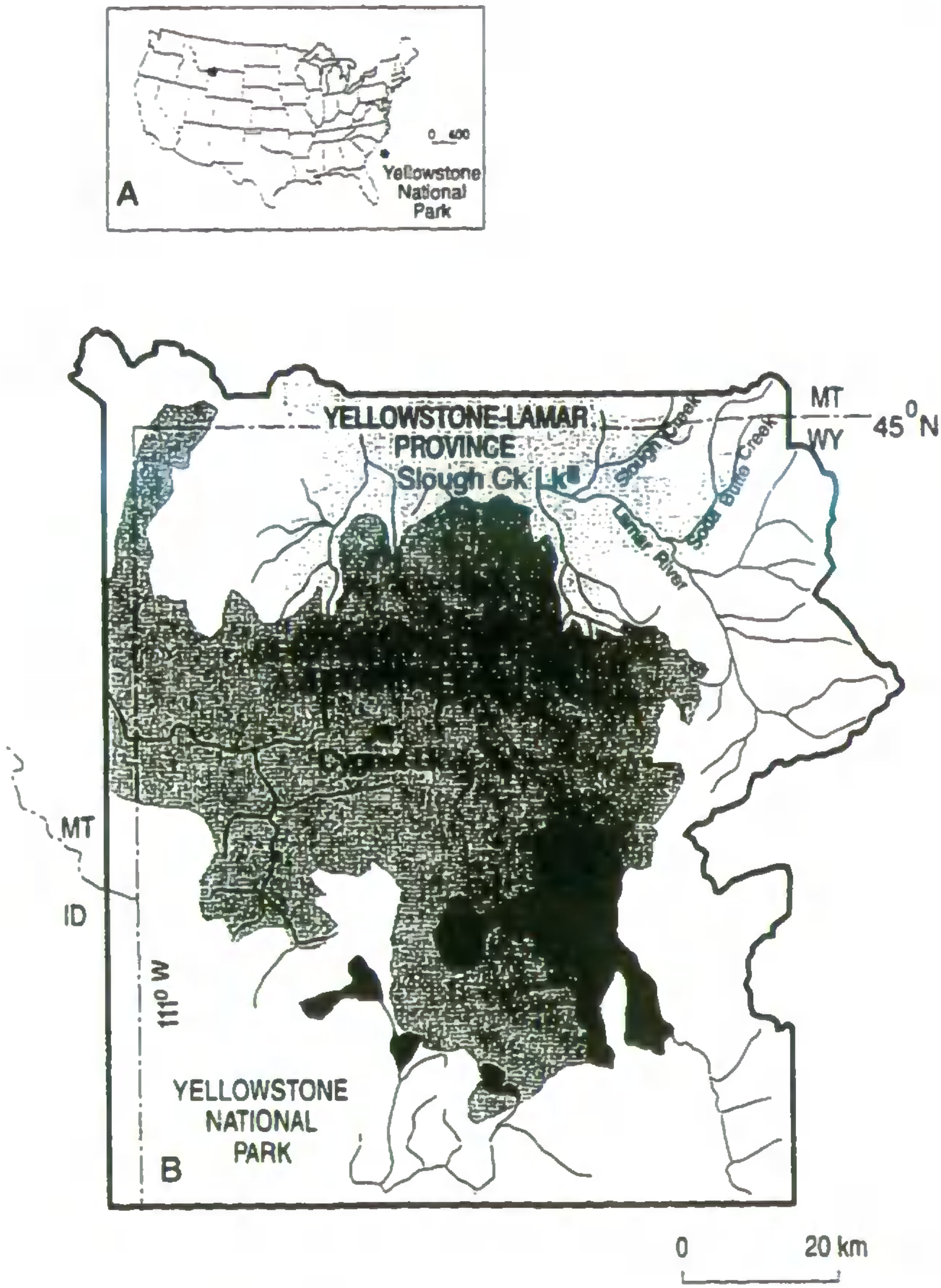


Figure 3.1. Location of study sites in (A) Yellowstone National Park. (B) Slough Creek Lake in the Yellowstone-Lamar Province and Cygnet Lake in the Central Plateau Province.

occurrence and fire-related erosion. Pollen data provided information on vegetational and climatic changes. The fire history of the Yellowstone-Lamar Province was also compared with that from the Central Plateau (described in Chapter II) to examine how fire regimes in diverse regions respond to the same large-scale climate controls (i.e., changes in summer insolation) on millennial time scales. Comparison of the two records on submillennial time scales provided information on how fire occurrence responds to climate changes on shorter time scales and whether responses are linked between provinces.

The Yellowstone-Lamar Province

Slough Creek Lake (Lat., 44° 57'N, Long., 110° 21'W, altitude, 1884 m) lies in a kettle-hole depression in the Yellowstone-Lamar Province in northern YNP (Fig. 3.1). The lake is surrounded by *Artemisia tridentata* grassland with isolated stands of *Pseudotsuga menziesii* nearby. A margin of *Typha*, *Scirpus*, and *Carex* surrounds the lake. The watershed of Slough Creek Lake is ca. 185 ha in size and is bound by slopes of moderate gradient (4-30°).

The Yellowstone-Lamar Province includes the Yellowstone, Lamar, and Gardner Rivers and several of their major tributaries (Despain, 1990). Broad valleys range from ca. 1500 to 2000 m in elevation and are underlain by andesitic volcaniclastic rocks and carbonate rocks and shales. Most of the soils derive from glacial till deposited during the Pinedale Glaciation (Pierce, 1979).

The Yellowstone-Lamar Province receives most of its annual precipitation in the spring and summer months, and winters are relatively dry (Despain, 1987; Whitlock and

Bartlein, 1993; Mock, 1996). The late spring and summer precipitation maximum (May-June) is produced by a combination of isolated upper-level low pressure systems and convection from increased land surface temperatures (Mock, 1996). In July, surface warming causes moist air from the northern Gulf of California to flow northward into the interior of the continent (along the western edge of an upper-level subtropical ridge; Higgins *et al.*, 1997). Some of the moist air from this monsoonal regime reaches the basins of Wyoming (Higgins *et al.*, 1997) including northern YNP (Whitlock and Bartlein, 1993; Mock, 1994). Climate data from the Lamar Ranger Station indicate a mean January temperature of -25° C and an average July temperature of 15.3° C from 1948 to 1972. Average annual precipitation from 1948 to 1972 was 36 cm yr^{-1} (Dirks and Martner, 1982).

Low-elevation areas of the province (1500-2500 m) are covered by dry grasslands of *Agropyron spicatum*, *Festuca idahoensis*, and *Artemisia tridentata* with scattered stands of *Pseudotsuga menziesii* (Despain *et al.*, 1986). *Pinus flexilis* and *Juniperus scopulorum* grow along streams, with riparian shrubs including *Betula occidentalis*, *Salix*, and *Alnus incana* (Engstrom *et al.*, 1991). Small groves of *Populus tremuloides* occur along forest-grassland boundaries. *P. contorta*, *Picea engelmannii*, and *Abies lasiocarpa* are present at elevations above 2300 m, and *Pinus albicaulis* is present above ca. 2700 m (Despain *et al.*, 1986; Despain, 1990).

The fire regime of the *Pseudotsuga* parkland is characterized by low-intensity surface fires that are generally lethal to understory vegetation, but do not kill the mature trees. Dendrochronological records back to ca. 300 years suggest that mean fire intervals for the *Pseudotsuga* parkland were between 20 to 50 years before ca. 1890 when fire suppression efforts were first initiated (Houston, 1973; Barrett, 1994). Between ca. 1850 and 1988 there were only a few small fires in this province (Houston, 1973). In 1988, 34% of the Slough Creek Lake catchment burned.

Methodology

Particulate charcoal and magnetic susceptibility were analyzed in a short core and a long core by the same methods described in Chapter II. The abundance of charcoal particles was the primary record of past fires; local and extralocal fires were identified in the stratigraphic record by increases in macroscopic charcoal particles (Millspaugh and Whitlock, 1995; Whitlock and Millspaugh, 1996). Magnetic susceptibility analysis provided a record of sedimentation events. The short core was analyzed to reconstruct a record of fires for the past ca. 120 years with decadal resolution that could be compared with a dendrochronological record of fires from the Yellowstone-Lamar Province; the long core was analyzed to reconstruct fire events on decadal time scales for the late-glacial and Holocene periods. On millennial time scales, charcoal data were compared to pollen data from the same core to determine whether the frequency of fires and sedimentation events varied in response to changes in climate and vegetation.

Field and Laboratory

In 1988, two long (ca. 6.5-m long) sediment cores (SCP#88A and SCP#88C) were collected in 7.8 m of water with a five-cm diameter piston corer (Wright *et al.*, 1983) from

Slough Creek Lake. Cores were extruded and wrapped in cellophane and aluminum foil in the field and taken to the laboratory for refrigeration.

The lithology of the core SCP#88A was described and subsamples of 0.5 cm^3 in volume were collected at 10- to 20-cm intervals for pollen and macrofossil analysis. The vegetational record from SCP#88A, described by Whitlock and Bartlein (1993), provided a template on which to reconstruct postglacial fire history.

Particulate charcoal and magnetic susceptibility were analyzed in core SCP#88A to reconstruct the fire history. Because previous analyses (i.e., pollen and macrofossil analysis) on core SCP#88A had consumed much of the sediment, a second core, SCP#88C, was subsampled for charcoal and magnetic susceptibility between Mazama O tephra and Glacier Peak B tephra and was correlated to pollen data in SCP#88A. A short core (20 cm in length) was collected in August 1991 from 7.8 m of water with a piston corer. The mud-water interface appeared to be undisturbed. Samples were extruded at 1-cm intervals and stored in plastic bags in the refrigerator.

Charcoal and Magnetic Susceptibility

An interval of 1 cm was selected for subsampling because it represented ca. five to ten years of deposition (based on ^{210}Pb and ^{14}C age-versus-depth relations). This interval was short enough to resolve fire events in the charcoal record given that the mean fire interval is estimated to be ca. 20 to 50 years (Houston, 1973; Barret, 1994). Subsamples of 5 cm^3 volume were collected from contiguous 1-cm core intervals in the short and long cores, and carefully washed through an analytical sieve with a mesh size of 0.125 mm.

Charcoal particles (>125 microns in minimum diameter) were tallied at contiguous 1-cm core intervals and raw counts were converted to charcoal concentration values (See Chapter II).

Magnetic susceptibility was measured from the same intervals as charcoal by use of a coil-cup sampling device attached to a SI-2 magnetic susceptibility meter (Sapphire Instruments, 1988). Four susceptibility readings were taken for each sample, and the average value was presented as electromagnetic units (emu).

Charcoal and magnetic susceptibility data from the long cores were compared with pollen data from the same lake described by Whitlock and Bartlein (1993). Charcoal and magnetic susceptibility data were analyzed from the same core (SCL#88A) as pollen (with the exception of a small segment between Mazama O tephra and Glacier Peak B tephra in SCL#88C that was analyzed for charcoal and magnetic susceptibility and was correlated with the pollen record from SCL#88A).

Data Analysis

Chronology

The short core was dated by the ^{210}Pb method at the University of Minnesota, Limnological Research Center to determine ages and sediment accumulation rates for the last ca. 120 years (Table 3.1). Ages were calculated using the c.r.s. (constant rate of supply) model (Appleby and Oldfield, 1978) and the standard deviation of the ages was calculated by a first-order error analysis of the counting uncertainty (D. R. Engstrom,

Table 3.1. ^{210}Pb Data for Slough Creek Lake.

Depth	Age (yr)	Error of Age (± yr)	Date (yr AD)	Sediment Accum. (g cm^{-2} yr^{-1})
0-1	0.69	0.57	1992	0.0258
1-2	2.2	0.58	1990	0.0325
2-3	4.4	0.6	1988	0.0344
4-5	9.15	0.62	1983	0.0326
5-6	11.6	0.64	1981	0.0281
6-7	15.3	0.67	1977	0.0191
7-8	18.71	0.7	1974	0.0204
8-9	22	0.74	1971	0.024
10-11	29	0.84	1963	0.0209
12-13	38.5	1	1954	0.0155
14-15	52.4	1.22	1940	0.0089
15-16	58.5	1.4	1934	0.0088
16-17	64	1.64	1928	0.0098
18-19	79.9	2.6	1913	0.0064
20-21	104	3.4	1888	0.005
21-22	120	5.4	1873	0.0043

Data from D. R. Engstrom, Limnological Research Center, University of Minnesota (1994) personal communication, 1995). The average sedimentation rate for the top 12 cm was 0.025 g cm^{-2} yr^{-1} and 0.007 g cm^{-2} yr^{-1} from 12 to 22 cm (Table 3.1). One standard deviation ranged from $\pm$0.57 years near the surface to $\pm$5.4 years at ca. 120 years. The chronology is presented in years AD (Fig. 3.2).

The stratigraphic positions of Mazama O tephra (7630 cal yr BP; 6845 ^{14}C yr BP; Bacon, 1983) and Glacier Peak B tephra (13755 cal yr BP; 11,800 ^{14}C yr BP; Whitlock, 1993) were used in combination with radiocarbon dates to establish age-versus-depth relations for the long core (Table 3.2). Radiocarbon ages were converted to calendar years (cal yr BP) using the program CALIB 3.0 (Stuiver and Reimer, 1993). The basal radiocarbon date for SCP#88A was 14,065 cal yr BP (12,060 ^{14}C yr BP) (Whitlock and Bartlein, 1993).

A weighted third-order polynomial regression (constrained to pass through age 0) was used to interpolate between ages (Fig. 3.2). Each calibrated date was assigned a weight of 0.10 or 1.00 depending on my confidence in its accuracy (Table 3.2). A weight of 1.00 was assigned to both age 0 and to 7630 cal yr BP (the age of repeatedly dated Mazama O tephra) and a weight of 0.10 was assigned to all of the other ages. Linear interpolation between 0, 7630 cal yr BP (Mazama O tephra), and 13,760 cal yr BP (Glacier Peak B tephra) was also undertaken and the age assignments were similar to those based on the polynomial model.

Slough Creek Lake, YNP

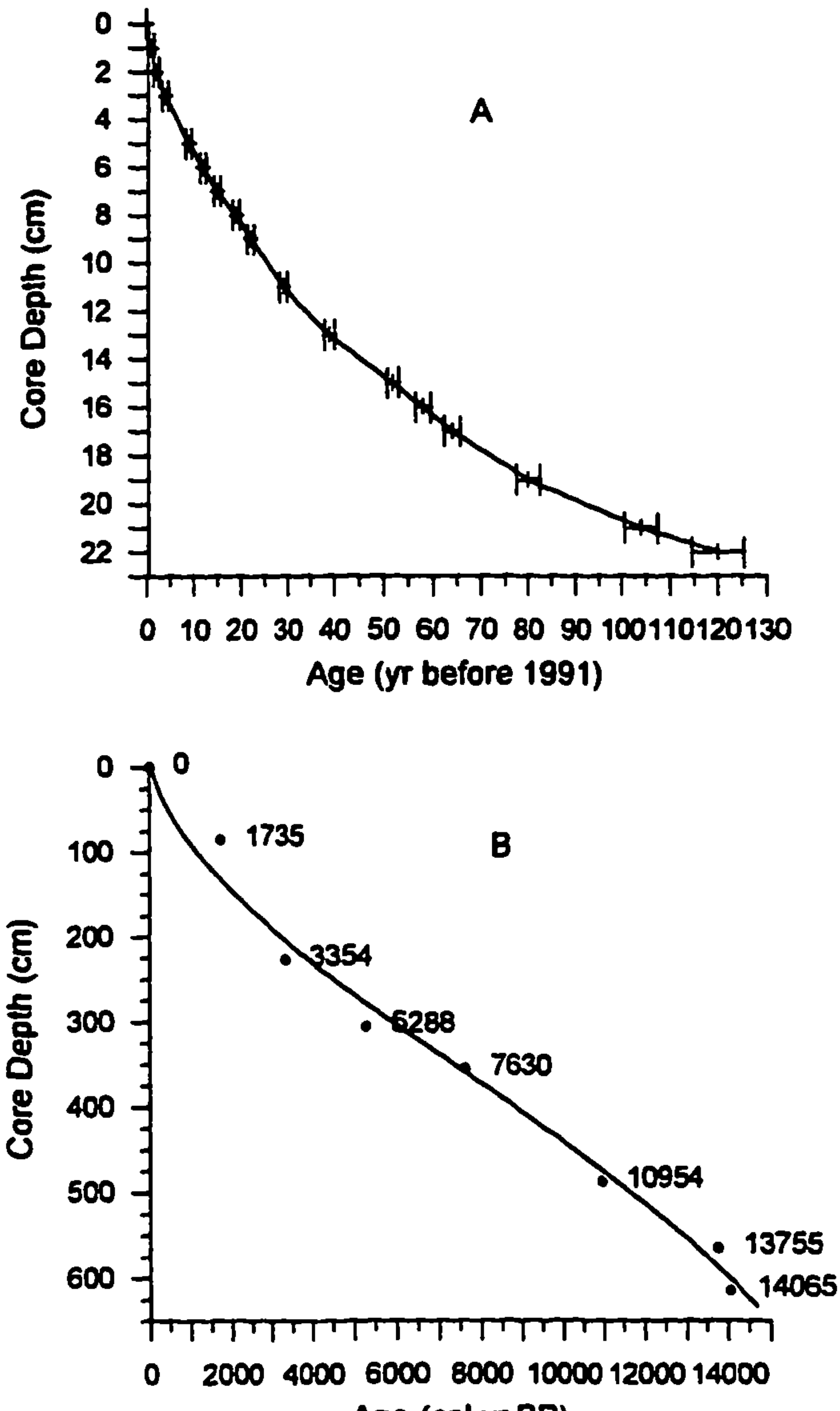


Figure 3.2. Age-versus-depth models for Slough Creek Lake. (A) Ages for the short core derived by the ^{210}Pb method (Table 3.1). Error bars represent 1± SD. (B) Age-versus-depth model for long core based on a weighted third-order polynomial regression of calibrated ^{14}C ages (see Table 3.2 for age conversions). Ages of 0 and Mazama O tephra assigned the highest weight of 1.00.

Table 3.2. Uncalibrated and calibrated age determinations for Slough Creek Lake.

Depth (SCL#88A) (m)	Material	Lab No.	Age $\pm$ 1 σ (^{14}C yr BP)	Calibrated Calendar Age & 1 σ range[a] (cal yr BP)	Weighting[b]
0					1.00
0.85-0.95	charcoal	AA-4519	1840 $\pm$ 70	1635 (1735) 1863	0.10
2.28-2.29	charcoal	Beta-87009	3130 $\pm$ 60	3266 (3354) 3386	0.10
3.05-3.15	charcoal	AA-4520	4550 $\pm$ 80	5047 (5288) 5317	0.10
3.46-3.47	Mazama O		6845 $\pm$ 50[c]	7578 (7631) 7664	1.00
4.86-4.88	charcoal	Beta-87010	9710 $\pm$ 60	10889 (10954) 10980	0.10
5.64-5.65	Glacier Peak B	Pitt-0554	11800 $\pm$ 190[d]	13522 (13755) 14008	0.10
5.95-6.05	charcoal	AA-4523	12060 $\pm$ 130	13873 (14065) 14272	0.10

a. Minimum of 1 σ calibrated age range (calibrated calendar age) maximum of 1 σ calibrated age range, (1 σ = square root of sample SD^2 + curve SD^2; Stuiver and Reimer, 1993).

b. Value assigned to a calibrated age depending on my confidence in accuracy of date (i.e., ages of 0 and Mazama O tephra assigned highest weighting. Weighting used in determination of weighted 3rd-order polynomial regression.

c. From Bacon (1983)

d. From Whitlock (1993)

Charcoal Accumulation Rates

Because the rate of charcoal accumulation in lake sediments following a fire event depends on 1) the abundance of charcoal produced by a fire (which varies with standing biomass, fuel load, and fire severity), 2) the atmospheric and geomorphologic processes that entrain and transport charcoal to a lake, and 3) the hydrologic and sedimentologic processes that operate within the lake, it was necessary to select a data-analytical method to separate the component of charcoal that indicates fire occurrence from that related to the combined effects of charcoal production and sedimentation. This objective was accomplished by statistically decomposing the charcoal record into a peaks components and a background component (Long *et al.*, in review).

Charcoal peaks, defined by high charcoal accumulation rates (CHARs; particles $cm^{-2}\ yr^{-1}$), are superimposed on background CHARs (e.g., Long *et al.*, in review; Millspaugh and Whitlock, 1995). Peaks consist primarily of charcoal from local or extralocal fire events, but also contain a small amount of charcoal that is attributed to both analytical error (Whitlock and Millspaugh, 1996) as well as natural, random variations in accumulation (Long *et al.*, in review). The spacing of charcoal peaks provides an estimate of local/extralocal fire frequency. The source of background CHARs includes 1) charcoal that is sequestered in the watershed and littoral zone of the lake and is introduced to the lake (e.g., Whitlock and Millspaugh, 1996; Bradbury, 1996), 2) charcoal that varies depending on standing biomass and fuel load (i.e., charcoal production), and 3) charcoal that is transported to the lake from distant fires (e.g., Clark and Royall, 1996; Long *et al.*, in review).

Decomposition of Charcoal Records

For the short cores, charcoal concentration was divided by the deposition time (yr cm^{-1}) to determine CHARs and results were plotted against the age of the cores. Absence of dendrochronological data from the watershed precluded comparison of the charcoal record with known fire events, and it was not feasible to identify charcoal peaks that might represent past fires based solely on using charcoal levels from the 1988 fires to define a threshold level (Millspaugh and Whitlock, 1995). Identification of fires was based on visual inspection.

Variations in sedimentation rate throughout the long core precluded the possibility of sampling at equally-spaced time intervals. Direct interpolation of CHARs to constant depth intervals may not conserve the quantity of charcoal within intervals. Thus, charcoal concentration (particles cm^3) and deposition time (yr cm^{-1}) were interpolated to pseudo-annual values. Subsequently, the pseudo-annual values of charcoal concentration were integrated over ten-year time intervals and their average was divided by the average deposition time to determine the average CHARs over the ten-year time interval (Chapter II; Long *et al.*, in review). Background CHARs were determined by use of a locally-weighted running mean with a moving window, and CHAR peaks were determined by selection of a threshold ratio (Chapter II).

A specific set of parameters for window width and threshold ratio was selected based on comparison with the dendrochronological record of mean fire intervals for the Yellowstone-Lamar Province. To test the robustness of the method and the sensitivity of the results to different combinations of parameters, threshold ratios ranging from 1.00 to 1.20 were combined with different window-width parameters (i.e., 200 to 1000 years) for both untransformed and transformed (logarithmic) CHARs.

Magnetic Susceptibility Accumulation Rates

Records of magnetic susceptibility, like those of charcoal, consist of a slowly-varying component that can be described as background and a rapidly-varying component which defines peaks. Background levels of magnetic susceptibility reflect changes in the influx of minerogenic sediment that are likely related to changes in the depositional environment within the watershed. During the late-glacial period, the landscape was sparsely vegetated and highly susceptible to erosion. Thus, inwashing of minerals into the lake was continuous and background levels of magnetic susceptibility were high. Background levels declined significantly in the core when the landscape became forested. Peaks of magnetic susceptibility probably reflect individual sedimentation events caused by disturbance events, including floods or fires. In the late-glacial period, peaks most likely record pulses of sediment entering the lakes from sparsely vegetated slopes, or from solifluction, or fires. During the Holocene, peaks may represent rapid sedimentation events caused by fires, debris flows produced by intense summer storms, floods caused by rapid snowmelt, windstorms, or lake-level fluctuations (Thompson and Oldfield, 1986;

Meyer *et al.*, 1995; Millspaugh and Whitlock, 1995). Stratigraphic levels containing volcanic ash also produce peaks.

The objective of the magnetic susceptibility data analysis was to separate the component of emu accumulation rates (EMARs; emu cm^{-2} yr^{-1}) that signaled sedimentation events from that which was related to more gradual pedologic and geomorphic processes that contributed magnetic minerals to the lake. Thus, the long record was statistically decomposed into background EMARs and EMAR peaks by the same method that was applied to the charcoal (see Chapter II, *Decomposition of the Charcoal Record*). Background EMARs were determined by use of a locally-weighted average with a moving window and EMAR peaks were identified by designation of a threshold ratio (see Chapter II). It was necessary to select both a window width and a threshold ratio to perform this function.

Correlation of Charcoal with Magnetic Susceptibility

To determine whether charcoal peaks were associated with episodes of sedimentation, CHARs and EMARs were detrended (CHARs and EMARs minus their background components) and Pearson Correlations were calculated between the two series (See Chapter II). Variations in detrended CHARs and EMARs revealed fluctuations above and below their background levels. It was necessary that CHARs and EMARs were detrended so that correlations would measure how closely CHAR peaks fluctuated with EMAR peaks rather than how long-term trends in background CHARs and EMARs were related to one another.

To test whether sedimentation events occurred at the same time as charcoal peaks, cross tabulation was used to compare whether CHAR peaks started at the same time as EMAR peaks. To test whether sedimentation occurred in the decades following a fire, the beginning time of a CHAR peak was compared with the beginning time of an EMAR peak that occurred one and two levels higher in the core.

Comparison of Charcoal Records from Slough Creek Lake and Cygnet Lake

To assess whether trends in fire frequency differed between the Yellowstone-Lamar and the Central Plateau Provinces on millennial time scales, fire frequency (fire events/1000 years) from Slough Creek Lake was compared to that from Cygnet Lake (See Chapter II). Because the age models for each site were based on interpolation of radiocarbon dates (using a weighted third-order polynomial regression), it was likely that they contained some inherent error. While the error that was generated was not enough to affect interpretations of trends in fire frequency on millennial time scales (see Chronology), it may have influenced the timing of individual fire events and consequently the alignment of the two series. Thus, it was unrealistic to expect individual charcoal peaks (i.e., fire events) to correlate between sites. To test whether fire occurrence was similar between sites on submillennial time scales, detrended CHARs were aggregated at 100- to 1000-year intervals for each site. Detrended CHARs were aggregated by moving a window with a specified width along the data at steps of half the window width. At each step, the average for all detrended CHARs within the window was calculated and plotted at the center of the window. Window widths of 100, 200, 300, 500, 700 and 1000 years were used to aggregate the detrended CHARs for both sites. Pearson Correlations were obtained between the aggregated series from Slough Creek Lake and Cygnet Lake to test whether CHARs at one lake co-varied with CHARs from the other lake (i.e., to test whether periods of positive CHARs, which was considered an index of high fire occurrence, at one site corresponded to periods of positive CHARs at the other site).

Results

The Last 120 Years

In the short core, high CHARs between ca. A.D. 1991 and 1963 most likely include charcoal from the 1988 fires which burned 34% of the watershed of Slough Creek Lake (Fig. 3.3). Low CHARs between ca. A.D. 1963 and 1873 coincides closely with a period of low fire occurrence in the region as a result of fire suppression (Houston, 1973). Small fires in ca. A.D. 1893 and 1876 (Houston, 1973), which burned east (downwind) of the watershed, were not recorded as peaks in charcoal. No positive EMARs were recorded in the short core, implying little fire or flood-related sedimentation occurred on the slopes surrounding the lake.

The Last ca. 14,000 Years

Charcoal

A window-width parameter of 500 years and a threshold ratio of 1.00 were selected to decompose CHARs into peaks and background components in the long core.

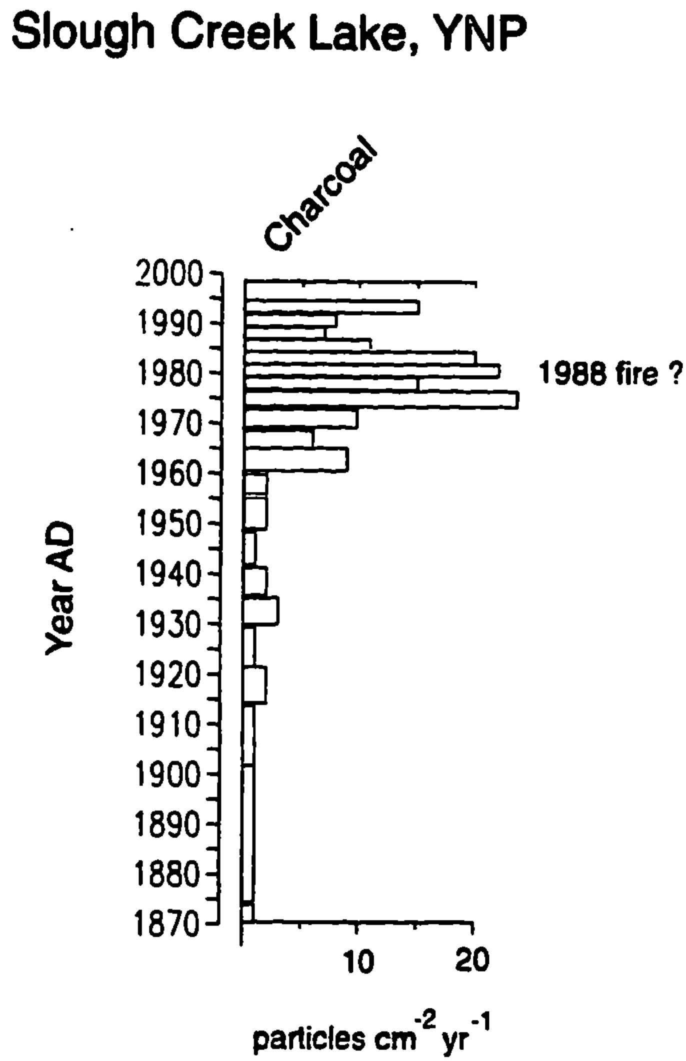


Figure 3.3. Charcoal and magnetic susceptibility stratigraphy back to ca. AD 1870 for Slough Creek Lake. Fires in 1988 are represented by a broad peak at top of record; no other fires are recorded in watershed because of effects from fire suppression.

This combination generated results that suggested the mean fire interval ranged between ca. 50 and 80 years during the last 3000 years (Fig. 3.4) which overlaps with the 20 to 50-year range determined by dendrochronological methods (Houston, 1973; Barrett, 1994).

Background CHARs were initially low at ca. 0.11 particles cm^{-2} yr^{-1} in the late-glacial period but increased by an order of magnitude to 3.0 particles cm^{-2} yr^{-1} at ca. 12,000 cal yr BP. After 12,000 cal yr BP, background CHARs remained relatively high throughout the Holocene and ranged between 1.0 and 6.0 particles cm^{-2} yr^{-1}.

The frequency of CHAR peaks was initially ten events/1000 years at ca. 14,700 cal yr BP, but declined to a low level of five events/1000 years by 12,500 cal yr BP (Fig. 3.4). This suggests a brief period of moderate fire frequency in the late-glacial period was followed by a decrease in fire frequency to low levels at 12,500 cal yr BP. Peak frequency remained at low levels (ca. five events/1000 years) between 12,500 and 11,200 cal yr BP. Between ca. 11,000 and 8000 cal yr BP, peak frequency gradually increased from six to ten events/1000 years. Peak frequency remained at ca. ten events/1000 years between 8000 and 6000 cal yr BP, then declined to ca. six events/1000 years between 6000 and 5000 cal yr BP. After 5000 cal yr BP, peak frequency increased steadily to the present. Fire frequency has been at the highest level (12 to 17 events/1000 years) in the last ca. 2000 years.

Different combinations of window widths (200 to 1000 years) and threshold ratios (1.00 to 1.20) generated fire-frequency reconstructions with the same dominant trends as those described above, but minor variations in the number of fire events/1000 years occurred (Fig. 3.5). Threshold ratios of 1.00 to 1.10 produced reconstructions of fire

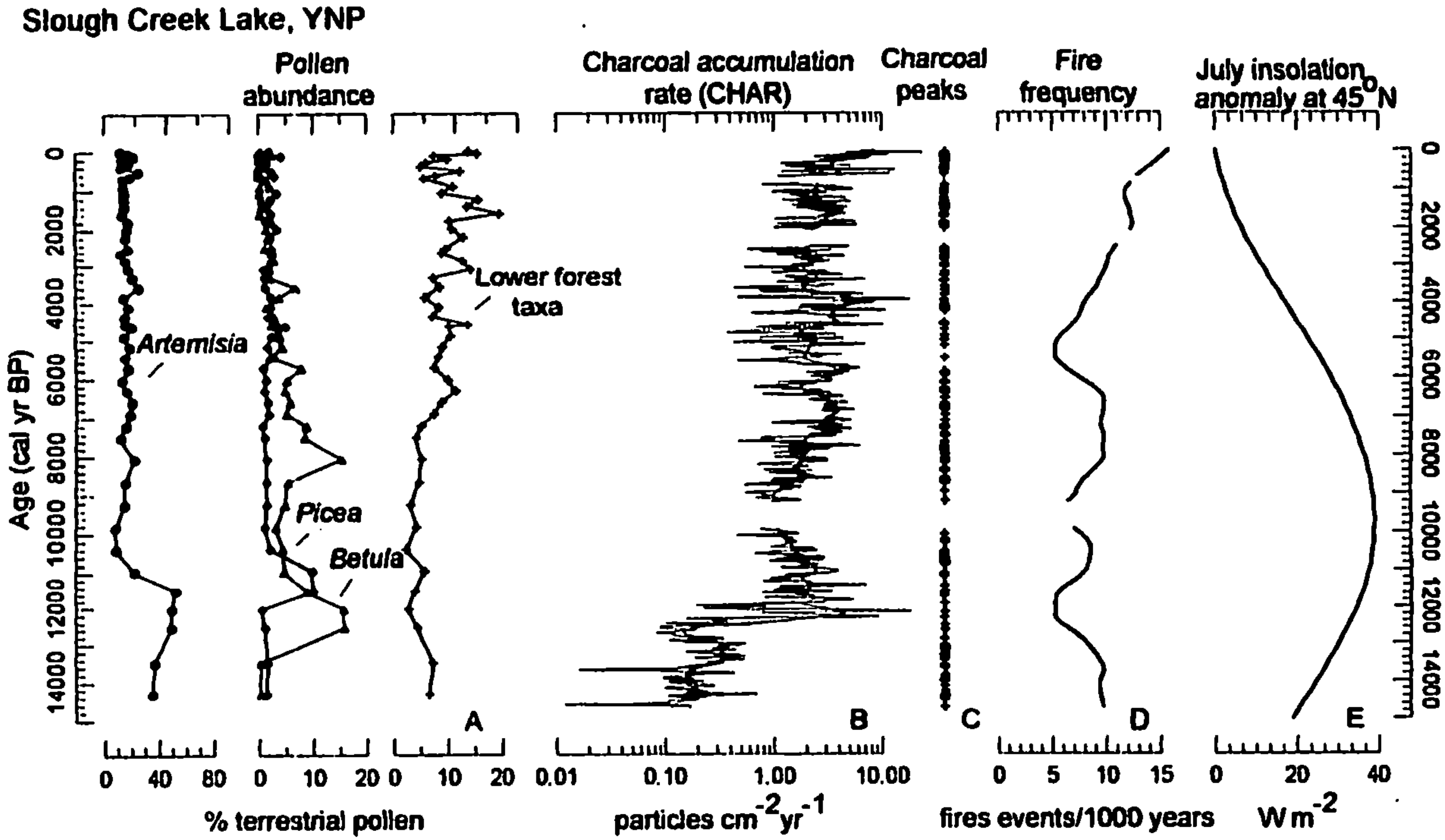


Figure 3.4. Comparison of pollen and charcoal data from Slough Creek Lake with the July insolation anomaly at Lat. 45° N. (A) Pollen percentages of *Artemisia*, *Picea*, *Betula*, and lower forest taxa (including Poaceae, *Pseudotsuga*, and *Populus tremuloides*) (data from Whitlock and Bartlein, 1993). (B) Log-transformed CHARs decomposed into background (slowly-varying line) and peaks using a window width of 500 years and a threshold ratio of 1.00. (C) CHAR peaks. (D) Fire frequency, represented by the fire events/1000 years. (E) July insolation, calculated as the difference from present of average daily insolation at Lat. 45° N in mid July (Berger, 1978).

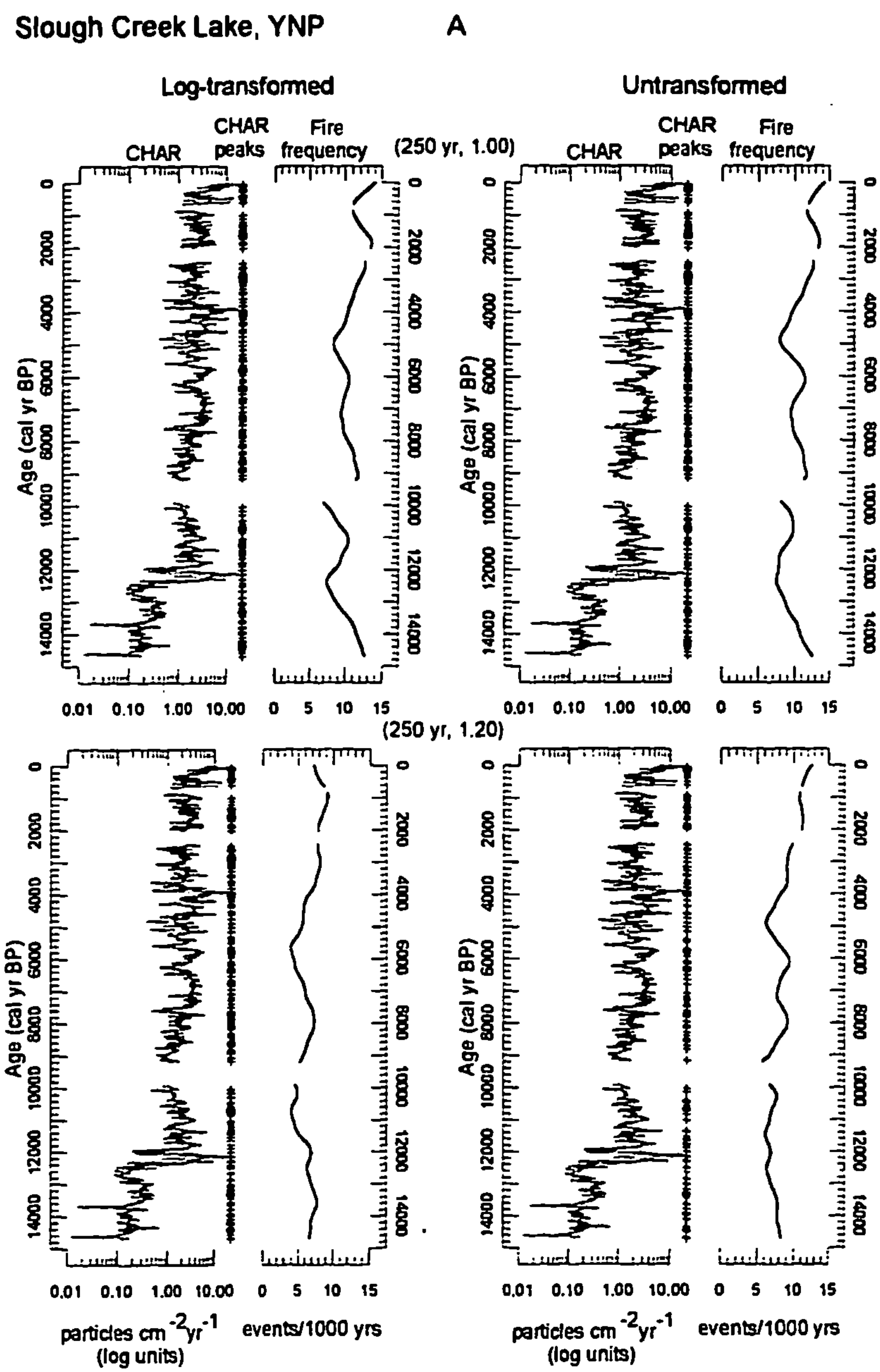


Figure 3.5. Comparison of fire frequency using different parameters for window width of (A) 250, (B) 500, (C) 750, and (D) 1000 years with threshold ratios of 1.00 and 1.20 for untransformed and log-transformed CHARs from Slough Creek Lake. Crosses (+) represent CHAR peaks. Fire frequency is represented by fire events/1000 years.

Slough Creek Lake, YNP B

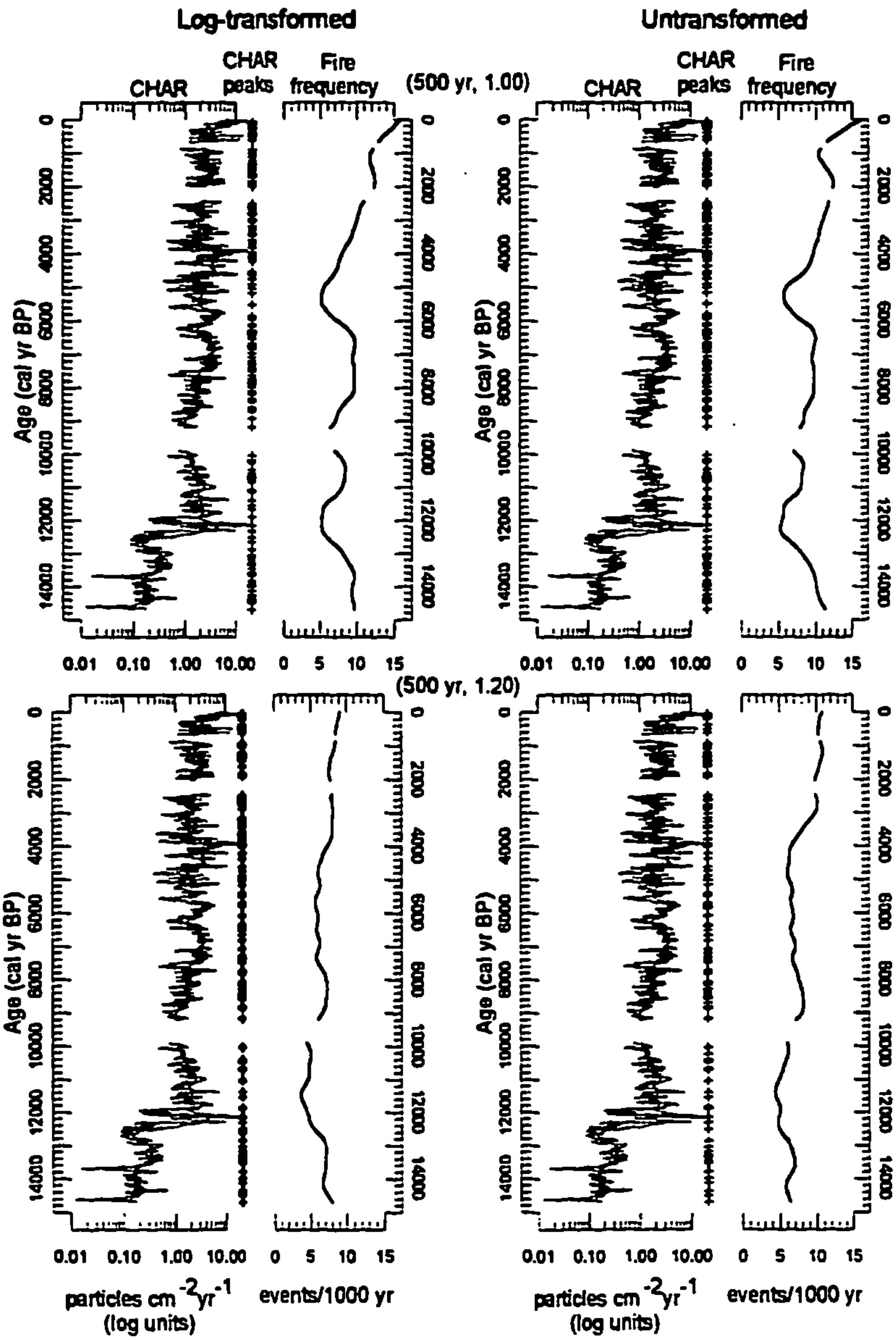


Figure 3.5. (Continued).

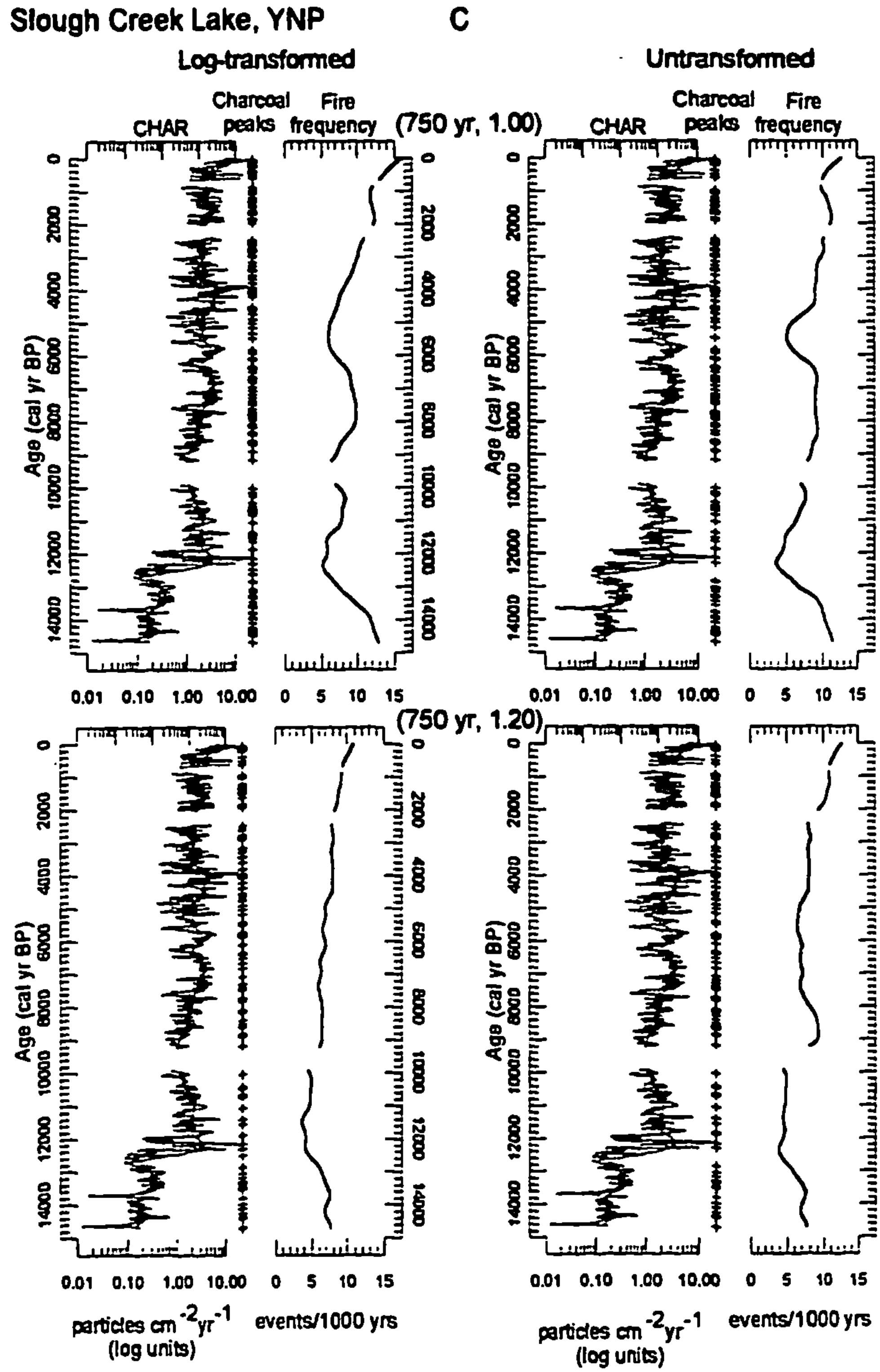


Figure 3.5. (Continued).

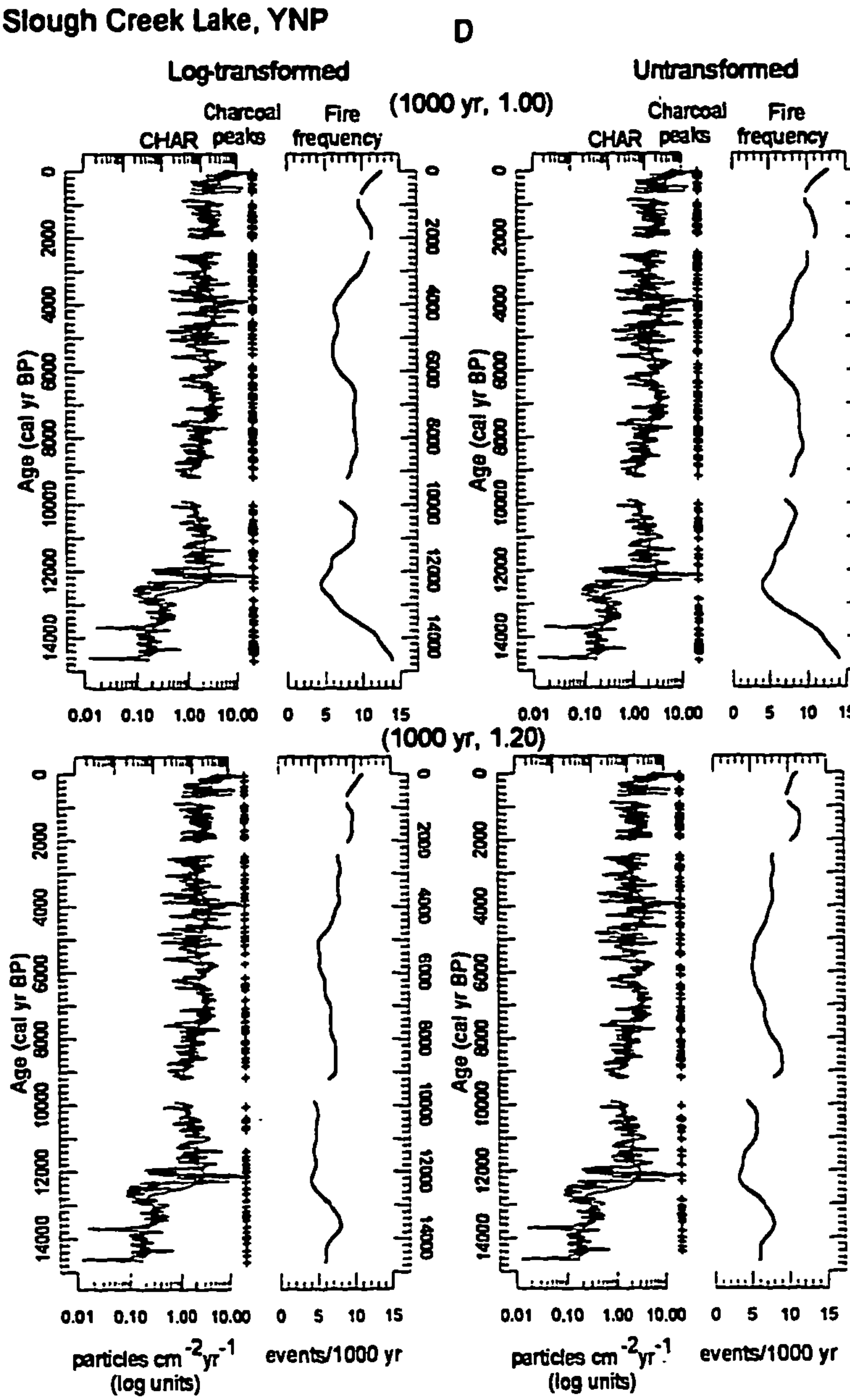


Figure 3.5. (Continued).

frequency that were initially moderate to high (nine to 15 events/1000 years) at 14,700 cal yr BP. Fire frequency declined to low levels between ca. 12,500 and 11,500 cal yr BP; the minimum number of fires varied from four to six events/1000 years. In all of the reconstructions, the number of fires gradually increased from ca. four to six events/1000 years at ca. 12,000 cal yr BP to 11 to 18 events/1000 years at present, although a short-term (<1000 years) decrease in fire frequency occurred at ca. 5500 cal yr BP. Fire frequency has been highest in all of the combinations in the last ca. 2000 years. When a threshold ratio of 1.20 was combined with the range of window widths (200 to 1000 years), reconstructions of fire frequency showed the same trends as those using peak ratios of 1.00 and 1.10 although the curves were more subtle. The finding that trends in fire frequency were robust among variations of the parameter values, while the magnitude of fire frequency at a given time varied among reconstructions, suggests that more weight should be given to the relative changes in the number of fire events rather than to the absolute number of fire events/1000 years.

Magnetic Susceptibility

A window-width parameter of 500 years and a threshold ratio of 1.00 were selected to identify background and peaks of EMARs. These parameters were selected because they were the same as those selected for the decomposition of the CHARs.

EMARs were significantly higher in the late-glacial period than in the Holocene (Fig. 3.6). Background EMARs were highest (100×10^{-7} emu cm^{-2} yr^{-1}) prior to 13,500 cal yr BP. Sparse vegetation and poorly developed soils apparently promoted inwashing

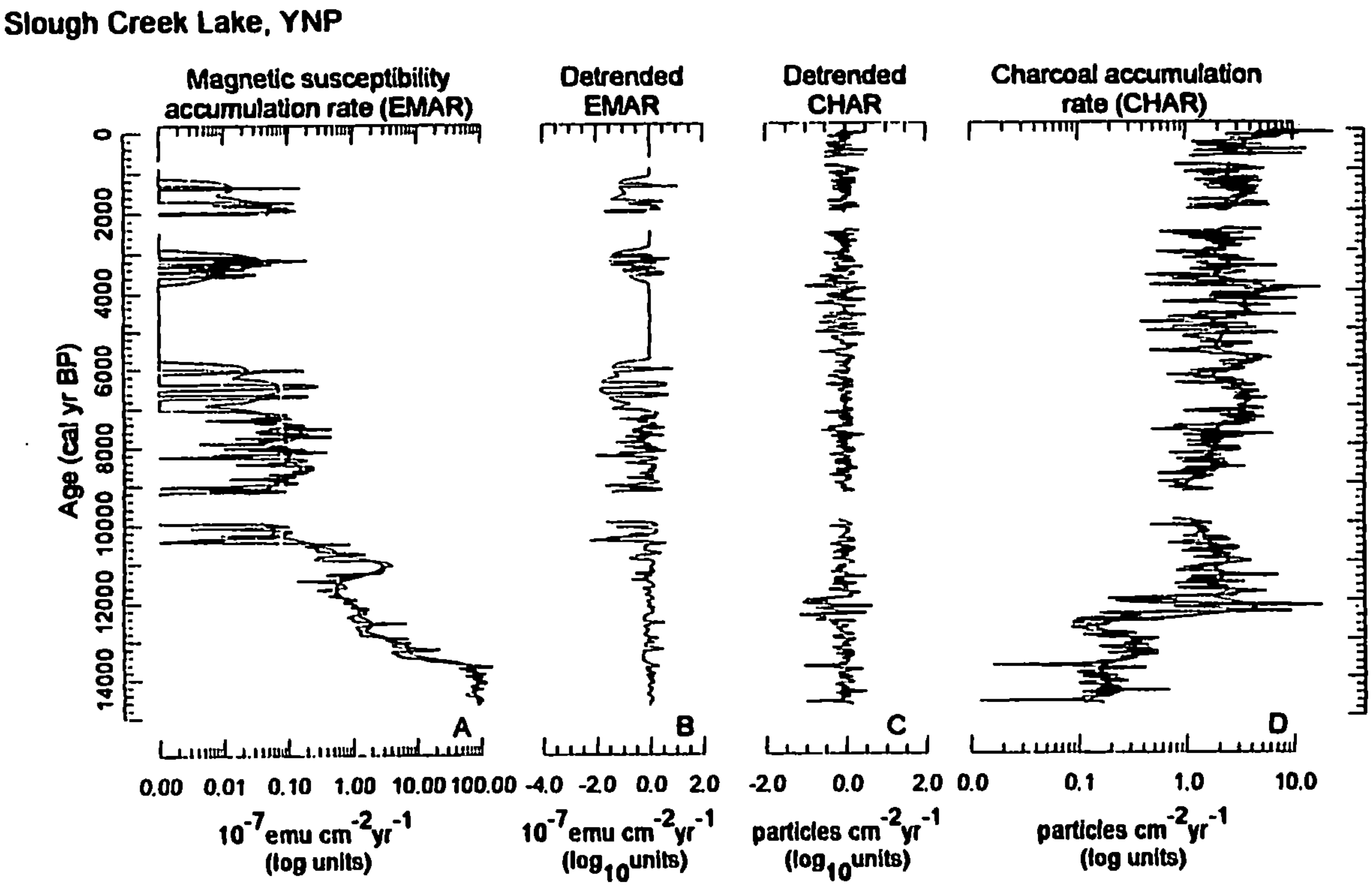


Figure 3.6. Comparison of magnetic susceptibility and charcoal data for Slough Creek Lake. (A) Log-transformed EMARs decomposed into background (slowly-varying line) and peaks. (B) Detrended EMARs (EMARs and minus their background components) and (C) CHARs (CHARs minus their background components). (D) Log-transformed CHARs decomposed into background and peaks.

of minerogenic soils to the lake. After 13,500 cal yr BP, background EMARs steadily declined to ca. 0.1×10^{-7} emu cm^{-2} yr^{-1} at ca. 10,000 cal yr BP. The decline in background EMARs after ca. 13,500 cal yr BP likely coincided with increased lake productivity and more vegetation cover. From 10,000 cal yr BP to present, background EMARs have remained low ($<0.1 \times 10^{-7}$ emu cm^{-2} yr^{-1}).

A low negative correlation coefficient of ($r = -0.002$) between detrended CHARs and detrended EMARs suggests that CHAR peaks did not co-vary with EMAR peaks and that fire events were generally not associated with episodes of sedimentation (Fig. 3.6). A total of 107 CHAR "peak starts" and 54 EMAR "peak starts" were tallied from 14,700 cal yr BP to present. Cross tabulation reveals that only four CHAR peaks started at the same time as EMAR peaks (Fig. 3.7). Apparently, most fires were not associated with sedimentation events and episodes of minerogenic sedimentation were minor and occurred during non-fire years. Lags between fire events and sedimentation episodes also did not explain the lack of correspondence between CHAR and EMAR peaks, because EMAR peaks that started ten and 20 years after a CHAR "peak start" numbered three and four respectively. Thus, fire-related erosion events rarely occurred in the decades following a fire in this watershed.

Slough Creek Lake, YNP

A Beginning of a charcoal peak with beginning of a magnetic susceptibility peak

		EMARs no start	EMARs start	EMARs total
CHARs	no start	1145	50	1195
	start	103	4	107
	total	1248	54	1302

B Beginning of a charcoal peak with beginning of a magnetic susceptibility peak with 10-year lag

		EMARs no start	EMARs start	EMARs total
CHARs	no start	1142	51	1193
	start	104	3	107
	total	1246	54	1300

C Beginning of a charcoal peak with beginning of a magnetic susceptibility peak with 20-year lag

		EMARs no start	EMARs start	EMARs total
CHARs	no start	1139	50	1189
	start	104	4	108
	total	1243	54	1297

Figure 3.7. Cross tabulations between charcoal and magnetic susceptibility peaks from Slough Creek Lake and with different lags.

Discussion

Climate, Vegetation, and Fire Relations on Millennial Time Scales

Comparison of the fire record from Slough Creek Lake in the Yellowstone-Lamar Province with that from Cygnet Lake in the Central Plateau Province reveals that fire regimes responded to contrasting subregional climate conditions as a result of differential responses to changes in summer insolation. Interpretation of the fire record from the Yellowstone-Lamar and the Central Plateau Provinces rests upon an understanding of the history of climate variation in the two provinces on different time scales and of the biotic responses.

An important large-scale control of climate has been the variation in the seasonal cycle of insolation caused by the tilt of the earth's axis and the timing of perihelion (Kutzbach and Guetter, 1986). After ca. 18,000 cal yr BP summer insolation gradually increased and winter insolation decreased in the Northern Hemisphere (Thompson *et al.*, 1993). The contrast between summer and winter insolation was greatest in the early Holocene (between ca. 11,000 and 8000 cal yr BP) as a result of the greater tilt of the earth's axis and the occurrence of perihelion in summer then (Kutzbach and Guetter, 1986; Thompson *et al.*, 1993). Between ca. 10,000 and 9400 cal yr BP insolation at the latitude of YNP was 8.5% greater in summer and 10% less in winter (Berger, 1978). The direct result of greater summer insolation in the early Holocene was to increase temperatures and decrease effective moisture in the continental interior of the U.S. Indirectly, increased summer insolation affected atmospheric circulation. The increased temperature contrast between the land and ocean strengthened the eastern Pacific subtropical high-pressure system and this intensified summer-drought conditions in the northwestern U.S., including southern and central YNP (Whitlock and Bartlein, 1993). The Central Plateau Province was drier between ca. 11,000 to 8000 cal yr BP than it is today.

The amplification of the land to ocean temperature contrast in the summer also produced intensified monsoonal circulation that was present during the early Holocene (Thompson *et al.*, 1993). The greater pressure differential between the continent and the ocean in the summer caused stronger onshore flow of moist air from the Gulf of California. Moist air flowed northward into the interior of the continent and some of it likely reached the basins of Wyoming. Thus, the Yellowstone-Lamar Province was probably wetter in the summer between 11,000 to 8000 cal yr BP than it is today because of strengthened monsoonal circulation. After a maximum anomaly in the early Holocene, summer insolation gradually declined to present values. Concurrently, the influence of the eastern Pacific subtropical high pressure system on summer climate regimes declined and conditions became progressively cooler and moister in central and southern regions of YNP (Whitlock and Bartlein, 1993). Monsoonal circulation weakened as summer insolation decreased and northern YNP became drier in the late Holocene.

Whitlock (1993) and Whitlock and Bartlein (1993) describe the postglacial vegetation changes in YNP based on a series of pollen records (Waddington and Wright, 1974; Baker, 1976; 1983; Gennett and Baker, 1986; Whitlock, 1993; Whitlock and Bartlein, 1993; Whitlock *et al.*, 1995). High percentages of *Artemisia* and herbs prior to ca. 13,400 cal yr BP (ca. 11,500 ^{14}C yr BP) suggest tundra grew in all of the provinces of

YNP following deglaciation. In geovegetation provinces of southern/central YNP underlain by non-rhyolitic soils, *Picea* parkland developed between ca. 13,400 and ca. 12,400 cal yr BP (ca. 11,500 and 10,500 ^{14}C yr BP), followed by *Picea-Abies-P. albicaulis* forest between ca. 12,400 and ca. 11,000 cal yr BP (11,500 and 9800 ^{14}C yr BP). In contrast, a pollen record from Cygnet Lake indicates that *Picea, Abies* and *P. albicaulis* were uncommon in the Central Plateau Province during the late-glacial period because they were unable to establish on the infertile rhyolite substrates (Fig. 2.4). Instead, tundra or meadow communities persisted until ca. 11,300 cal yr BP (ca. 10,000 ^{14}C yr BP) on the Central Plateau, when it was replaced by *P. contorta* forest. *P. contorta* forest became widespread in all of the geovegetation provinces in southern/central YNP (on both rhyolitic and non-rhyolitic substrates) after ca. 11,000 cal yr BP.

In the Yellowstone-Lamar Province of northern YNP, a pollen record from Slough Creek Lake described by Whitlock and Bartlein (1993) shows increases in *Betula* percentages between ca. 12,600 and 12,400 cal yr BP, followed by increases in *Picea* at ca. 12,000 cal yr BP (10,200 ^{14}C yr BP; Fig. 3.8). These taxa suggest the presence of *Picea* parkland with riparian areas of shrub *Betula*. A decline in *Picea* after ca. 11,000 cal yr BP (9800 ^{14}C yr BP) and a simultaneous rise in *Juniperus*-type and *Pinus* pollen at that time reflect a transition from *Picea* parkland to a forest with *P. contorta, P. flexilis* and/or *albicaulis, Juniperus,* and *Betula* species.

After ca. 11,000 cal yr BP, the vegetational history of northern Yellowstone diverged from that of southern and central YNP (Whitlock and Bartlein, 1993). In

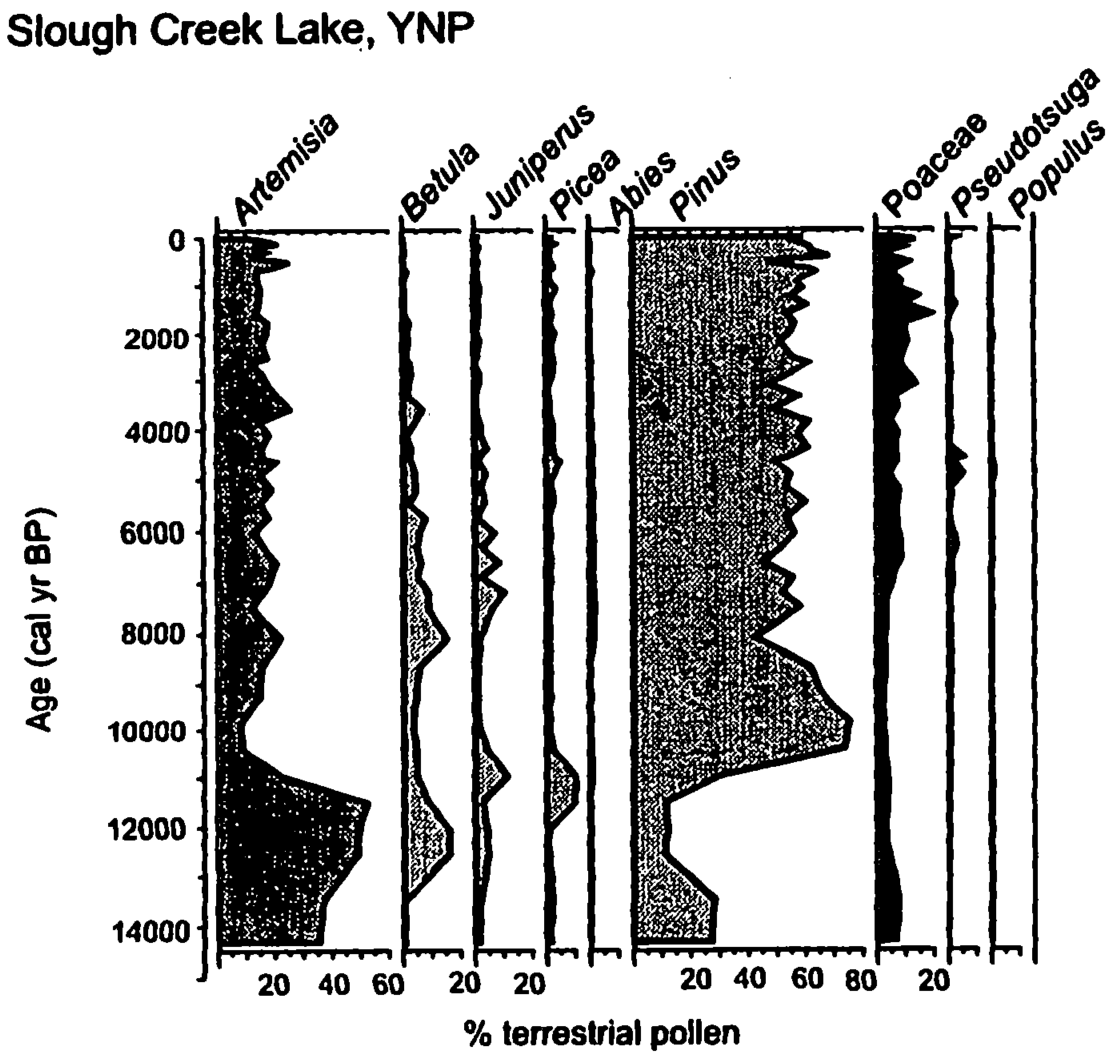


Figure 3.8. Pollen percentage diagram of selected taxa at Slough Creek Lake (data from Whitlock and Bartlein, 1993).

southern and central YNP, warmer and drier conditions in the early Holocene resulted in the expansion of *Pseudotsuga* and *Populus tremuloides* on non-rhyolite substrates, and cooler and moister conditions in the late Holocene led to an increase in *Picea, Abies* and Haploxylon pine. On the rhyolitic substrates in the Central Plateau Province, *P. contorta* forest persisted with little modification for the last 11,300 cal yr BP suggesting that infertile rhyolitic soils limited their response to climatic changes recorded elsewhere in YNP.

Pseudotsuga was prevalent in other geovegetation provinces in southern and central YNP during the early Holocene, yet it was absent in the northern Yellowstone-Lamar Province. Apparently, *Pseudotsuga* was unable to tolerate wet conditions associated with increased monsoonal circulation in the Yellowstone-Lamar Province. Percentages of Poaceae, *Pseudotsuga* and *Populus* started to increase gradually after 7000 cal yr BP (ca. 6200 ^{14}C yr BP), and more rapidly after 3000 cal yr BP (ca. 2900 ^{14}C yr BP) suggesting that *Pseudotsuga* parkland developed as summers became drier with weakening monsoonal circulation (Whitlock and Bartlein, 1993).

On millennial time scales, comparison of the charcoal and pollen records from Slough Creek Lake and Cygnet Lake with the July insolation curve for the latitude of YNP provides information about regional differences in the response of fire and vegetation to large-scale climatic controls. At Slough Creek Lake, fire frequency was moderate (ten events/1000 years) at ca. 14,700 cal yr BP, but declined to a low of five events/1000 years by ca. 12,500 cal yr BP (Fig. 3.4). Tundra vegetation surrounded the site during this period. July insolation was increasing and summer conditions were becoming progressively warmer than before. With warming, the abundance of *Betula* shrubs increased after ca. 12,600 cal yr BP, followed by an increase in the abundance of *Picea* trees after ca. 12,000 cal yr BP. A rapid increase in background CHARs after ca. 12,000 cal yr BP from 0.11 to 3 particles cm^{-2} yr^{-1} probably reflects the transition from tundra (with riparian *Betula* shrubs) to *Picea* parkland. Fire frequency remained at a low level (ca. five events/1000 years) between ca. 12,500 and 11,200 cal yr BP. Summers were probably becoming wetter as a result of intensified monsoonal circulation.

After ca. 11,000 cal yr BP, *Picea* parkland was replaced by a forest with *P. contorta*, *P. flexilis* and/or *P. albicaulis*, and *Juniperus* that persisted until ca. 7000 cal yr BP. Wetter-than-present conditions in the early Holocene are indicated by the persistence of *Betula* species and the absence of Poaceae and *Pseudotsuga* (a relative xerophyte in the Yellowstone-Lamar Province), which occurred in other geovegetation provinces of YNP at that time. Between ca. 11,000 and 8000 cal yr BP, fire frequency in the *Pinus-Juniperus* forest steadily increased from six to ten events/1000 years. Summer convective storms would have been frequent at this time as a result of increased surface heating associated with high summer insolation and would have decreased after that time. Increased incidence of lightning probably contributed to the steady increase in the frequency of fires after ca. 11,000 cal yr BP. Summer precipitation may have kept fire frequency at moderate levels (six to ten events/1000 years) during this period. Between ca. 8000 and 6000 cal yr BP, fire frequency was at ten events/1000 years.

A gradual increase in Poaceae, *Pseudotsuga* and *Populus tremuloides* after ca. 7000 cal yr BP indicates development of *Pseudotsuga* parkland and implies that summers were drier than before. After a brief period (between ca. 6000 and 5000 cal yr BP) when fire frequency declined to six events/1000 years, the number of fires increased continuously through the late Holocene to ca. 17 events/1000 years at present (charcoal of grass was common during this period). The general trend of increasing fire frequency in the late Holocene paralleled a trend towards drier summers in the Yellowstone-Lamar Province as monsoonal circulation weakened with decreasing summer insolation. In the last 2000 years, fire frequency reached its highest level of 12 to 17 events/1000 years.

Charcoal and pollen records from Cygnet Lake in the Central Plateau Province reveal a different history of fire and vegetation than that of the Yellowstone-Lamar Province. At Cygnet Lake, the frequency of local fires was initially low (ca. four events/1000 years) at ca. 17,000 cal yr BP when tundra or open meadow covered the Central Plateau Province (Fig. 2.5). July insolation at that time was similar to or slightly higher than present, however, summer conditions were cooler than today as a result of continental-scale circulation patterns and locally retreating glaciers. A gradual rise in fire frequency from four to six events/1000 years between 17,000 and 11,700 cal yr BP was most likely a response to increasing summer insolation values of $<33\ Wm^{-2}$. During this period, increasing background CHARs probably corresponded with a change from open vegetation to parkland as *P. contorta* colonized the Central Plateau Province.

The incidence of fires increased rapidly around Cygnet Lake after ca. 11,700 cal yr BP when summers became warmer and drier in the Central Plateau Province with the expansion of the eastern Pacific subtropical high-pressure system (and the direct effects of greater insolation). *Pinus contorta* forest was present in the watershed by ca. 11,300 cal yr BP. At the time of the early-Holocene insolation maximum (>39 Wm^{-2}), ca. 9900 cal yr BP, effectively drier summers than before resulted in an increase in fire frequency near Cygnet Lake to 15 events/1000 years. Because insolation was greater than at present during the months of April (2%), May (6%), June (8%), July (8.5%), August (6.5%), and September (2%) (Berger, 1978), the eastern Pacific subtropical high may have influenced the fire season for a longer period of time than today. After 9900 cal yr BP, fire frequency gradually decreased to the present levels (<two to three events/1000 years). The trend of declining fire frequency paralleled decreasing summer insolation and a shift to cooler and effectively wetter conditions than before. The reduced drought in the late Holocene shortened the fire season (e.g., by influencing the probability of ignition, fuel moisture, and fire weather) to its present length of ca. 3.5 months (i.e., July to mid-October) in any given year. Background CHARs remained relatively stable through the Holocene despite variations in the stand-age distribution (and thus, above-ground biomass) of the *P. contorta* forest. In the last two millennia, fire frequency has been lower (two to five events/1000 years) than at any time since the establishment of *P. contorta* forests. Protracted periods without fire probably allowed *P. contorta* stands to mature, and the forest mosaic to become more connected. This type of landscape pattern has helped to maintain the current fire regime, which features infrequent severe fires in dry years.

The period of maximum fire frequency in the Holocene has therefore differed between the Yellowstone-Lamar Province and the Central Plateau Province (Fig. 3.9). The fire record from Slough Creek Lake indicates that the period of maximum fire frequency in the Yellowstone-Lamar Province occurred in the last 2000 years with

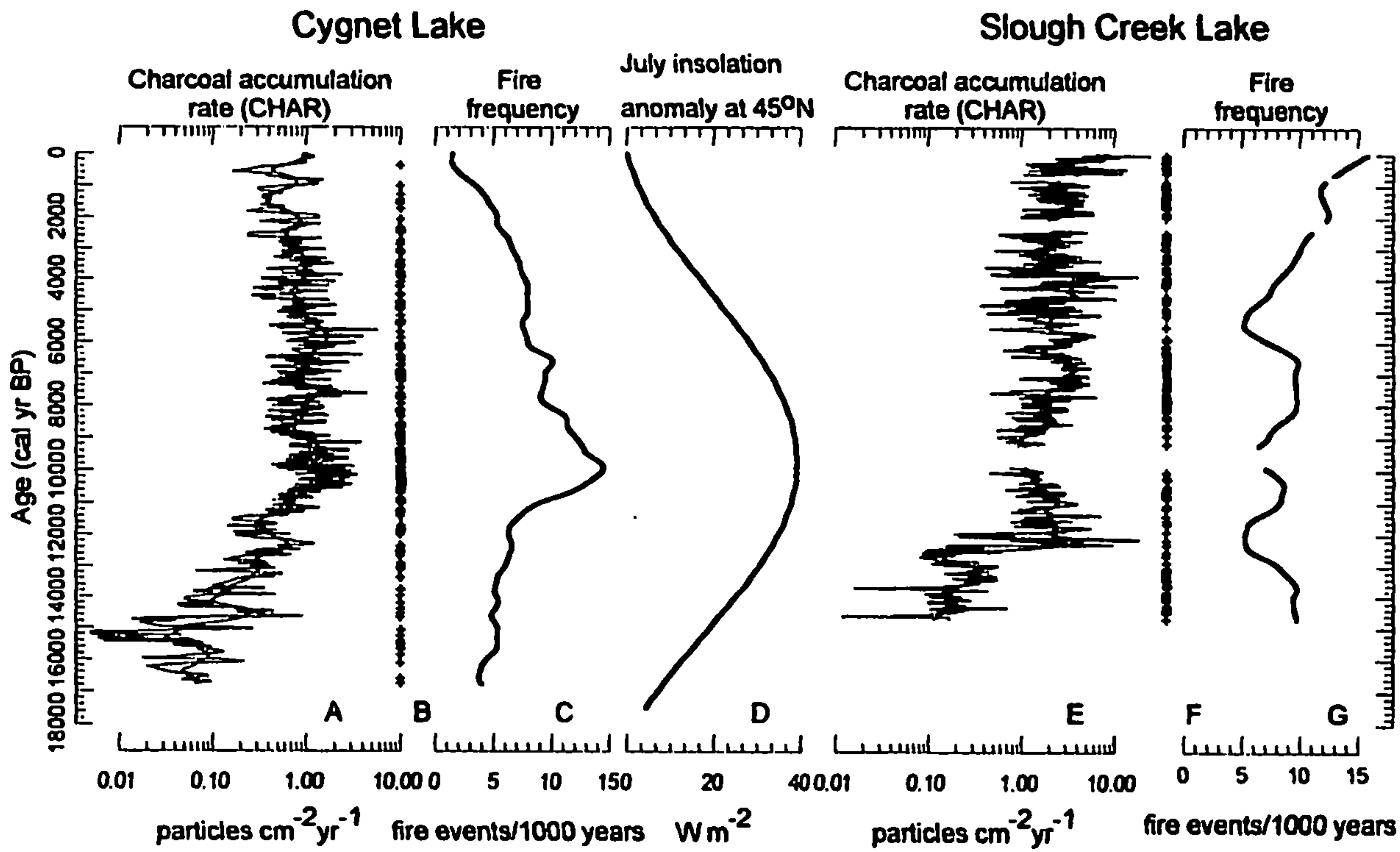


Figure 3.9. Comparison of charcoal data from Slough Creek Lake with Cygnet Lake on millennial time scales. For Cygnet Lake, (A) log-transformed CHARs, (B) CHAR peaks, and (C) fire frequency. (D) July insolation anomaly, calculated as the difference from present of average daily insolation at Lat. 45° N in mid July (Berger, 1978). For Slough Creek Lake, (E) log-transformed CHARs, (F) CHAR peaks, and (G) fire frequency.

increasing drought conditions. In contrast, the fire record from Cygnet Lake suggests that fire frequency was highest between ca. 11,000 and 8000 cal yr BP on the Central Plateau when drought conditions prevailed there.

The finding that fire frequency was highest in the Yellowstone-Lamar Province during the last 2000 years is consistent with charcoal data from a site in western Montana that suggests fire occurrence was greatest in the last 2000 years (Mehringer *et al*, 1977). Mehringer *et al.* (1977) suggested that the increase in charcoal in the last 2000 years might have been related to an increase in burning by Native Americans. However, the site in western Montana was likely influenced by the same changes in summer precipitation regimes during the Holocene as the Yellowstone-Lamar Province, and thus, recent increases in fire occurrence in western Montana were likely controlled by changes in climate. That fire frequency was highest in the Central Plateau during the period of maximum summer drought in the early Holocene is consistent with records from sites in Washington (Cwynar, 1987), Oregon (Long *et al.*, in review), and northern California (Smith and Anderson, 1991). These regions, just as the Central Plateau Province, were influenced by the expansion of the eastern Pacific subtropical high pressure system.

Climate and Fire Linkages on Submillennial Time Scales

Embedded within the different millennial-scale climate regimes in northern and southern/central YNP, are submillennial (annual to multi-centennial) climate variations. While some of these submillennial climate variations affected only one province, others probably were registered in both provinces.

Few submillennial climate excursions, such as the Medieval Warm Period (1000 to 650 cal yr BP; Hughes and Diaz, 1994; Lamb, 1977) and the Little Ice Age (ca. 500 to 100 cal yr BP; Jones and Bradley, 1992), have been identified in several regions. For example, evidence from moraine sequences in the Rocky Mountains suggests the Little Ice Age was cold enough to produce glacial advances in many mountain ranges (e.g., Carrara, 1987; Davis, 1988). Such submillennial climate excursions, are attributed to changes in volcanic aerosol production (e.g., Bryson and Goodman, 1980), solar activity (e.g., Stuiver and Braziunas, 1992; Jirikowic and Damon, 1994), oceanic thermohaline circulation (Rind and Overpeck, 1993), atmospheric composition, and autovariations within the climate system (Bartlein, 1988)

The biotic response to submillennial climate changes is poorly known in YNP because of a lack of high-resolution paleoecological records. In the Yellowstone-Lamar Province, a 3200-year record of mammalian fossils in a cave deposit suggests a shift from mesic to xeric habitat conditions at ca. 1200 cal yr BP (Hadly, 1996). A peak in dry-grassland species occurred from ca. 670 to 272 cal yr BP when conditions were probably the most xeric of the last 3000 years. This period (ca. 1200 to 300 cal yr BP) is generally concordant with the Medieval Warm Period. Evidence for the Little Ice Age cooling in the province is less clear (Hadly, 1996).

The response of fire occurrence to decadal-to-century-long climate variations is recorded by instrumental, dendrochronological, and sedimentological data from YNP. Instrumental records suggest that summer temperatures have increased and winter precipitation has decreased since 1895 in YNP. This trend towards aridity has been paralleled by an increase in area burned during fire years (Balling *et al.*, 1992). Dendrochronological data from the Central Plateau suggest that before 1988, the last large fires occurred between ca. AD 1690 to 1710 and 1730 to 1750 (Romme and Despain, 1989a,b,c). A 750-year record of fire contained in sediments from several small lakes on the Central Plateau suggests that widespread fires occurred ca. AD 1450, 1560, 1700, and 1988, and that few fires occurred from AD 1220 to 1440 and 1700 to 1988 (Millspaugh and Whitlock, 1995). The 600-year record from Cygnet Lake corroborates the evidence that fires burned on the Central Plateau between ca. AD 1550 and 1560, ca. 1730, and 1988 (see Chapter II). In the Yellowstone-Lamar Province, large fires burned in the *Pseudotsuga* parkland in AD 1740, 1758, 1776 and 1855 (Barrett, 1994; Houston, 1973). Few small fires burned in the province between 1855 and 1988. The near-absence of fires between ca. AD 1700 and 1988 in the Central Plateau and between ca. AD 1855 and 1988 in the Yellowstone-Lamar Province may be related to cooler wetter conditions during the late Little Ice Age. Neither the dendrochronological records nor the 750-year lake-sediment records are long enough to test whether fire intervals were shorter in the Central Plateau Province during the Medieval Warm Period or in earlier warm intervals.

Comparison of the fire history at Slough Creek Lake and Cygnet Lake on centennial time scales reveals several ca. 500-year periods when fire occurrence was high in both the Central Plateau and the Yellowstone-Lamar Provinces (Fig. 3.10). Detrended CHARs from Cygnet Lake and Slough Creek Lake were weakly positively correlated ($r = 0.264$) when data were aggregated at 500-year intervals. Fire occurrence was high in both provinces during many of the same 500-year periods (Fig. 3.10), including the period

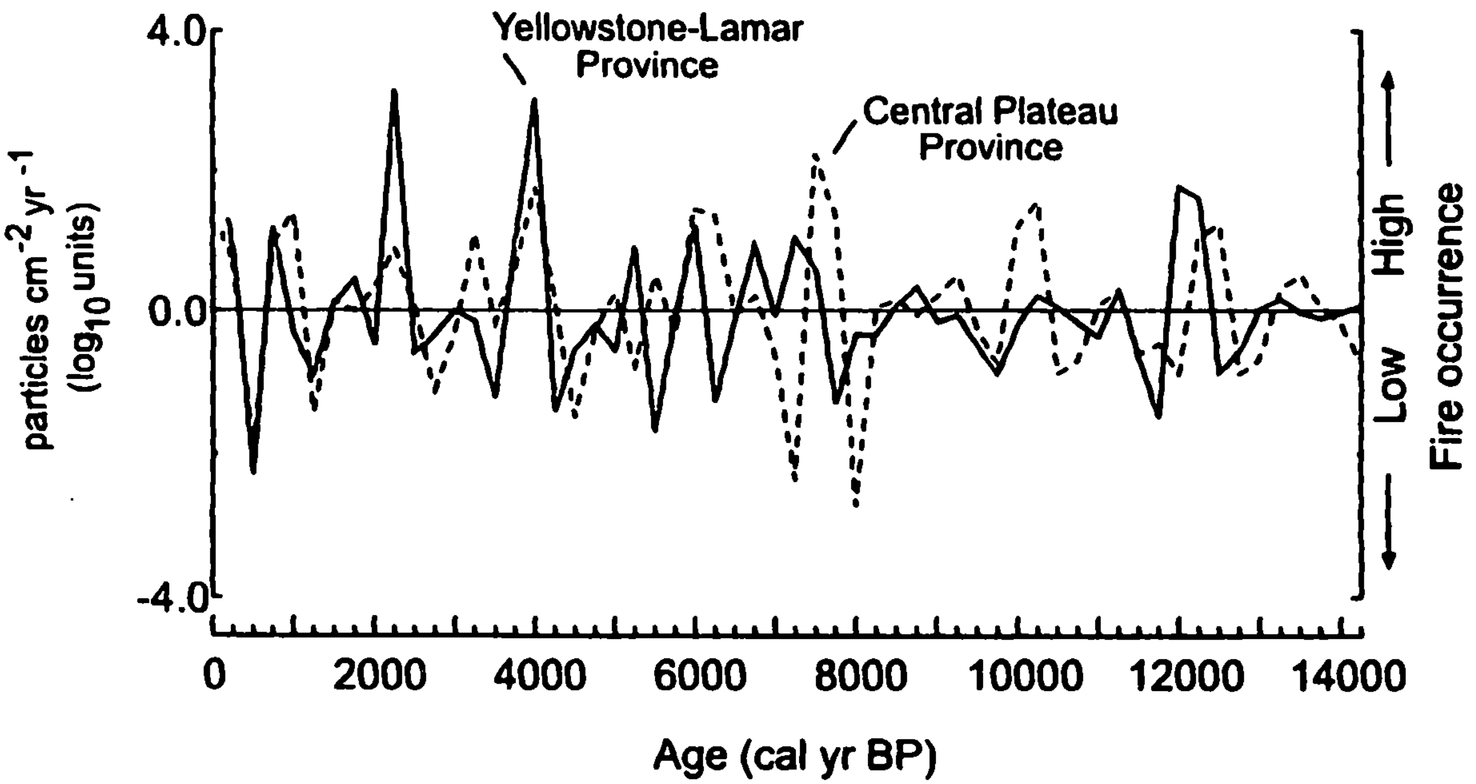


Figure 3.10. Fire occurrence during 500-year periods in the Yellowstone-Lamar and Central Plateau Provinces. Mean CHARs for each 500-year period transformed to standard scores (i.e., z scores calculated by subtracting mean and dividing by standard deviation) and plotted at the center of the period (i.e., every 250 years); each 500-year period is offset by 250 years.

between 1000-500 cal yr BP. Similarly, it was also low in both provinces during other 500-year periods. None of the other correlations between CHARs from both sites (e.g., aggregates of 100, 200, 300, 700, and 1000 years) produced significant positive or negative correlations.

In the Yellowstone-Lamar Province, records of fire-related debris flows provide evidence of severe fire episodes during the middle and late Holocene (Meyer *et al.*, 1992, 1995). Most fire-related debris flows in northern YNP are produced by convective-storm rainfall which generate erosive surface runoff in steep, severely-burned basins (Meyer *et al*, 1992, 1995). Sediments, organic matter, ash, and charcoal are entrained in the flow and deposited on alluvial fans. Thus, alluvial fans are partially (ca. 30% by volume) composed of fire-related sediments and charcoal particles contained in the alluvial fan sediments provide evidence of past fire episodes (Meyer *et al.*, 1992, 1995). Since ca. 7000 cal yr BP, several episodes of fire-related sedimentation events were registered in the Slough Creek and Soda Butte drainages (Fig. 3.1), including the periods from ca. 2300 to 2050 cal yr BP and 900 to 750 cal yr BP when major peaks in fire-related sedimentation occurred (Table 3.3, Fig. 3.11). Meyer *et al.* (1992, 1995) suggest that periods of high fire-related sedimentation occurred during relatively warm dry intervals. These warm dry intervals were associated with higher fire frequency as well as increased summer convective-storm activity which resulted in an increase in debris flows and fan deposition.

Meyer *et al's* (1995) finding that the greatest episodes of fire-related sedimentation occurred during the last ca. 2300 years in the Slough Creek and Soda Butte drainages of the Yellowstone-Lamar Province corresponds broadly with data from Slough Creek Lake

TABLE 3.3. A) High Fire Occurrence in the Central Plateau and Yellowstone-Lamar Provinces.
B) High fire-related debris flow activity in the Yellowstone-Lamar Province (Data from Meyer *et al*., 1995).

A (cal yr BP)	B (cal yr BP)
7000-6500	
6250-5750	6450-5950
5400-5000*	5450-4350
4250-3500	3900-3150
2500-2000	2750-1600, major peak: 2300-2050
1000-500	1300-750, major peak: 900-750

*high fire occurrence in the Yellowstone-Lamar Province only.

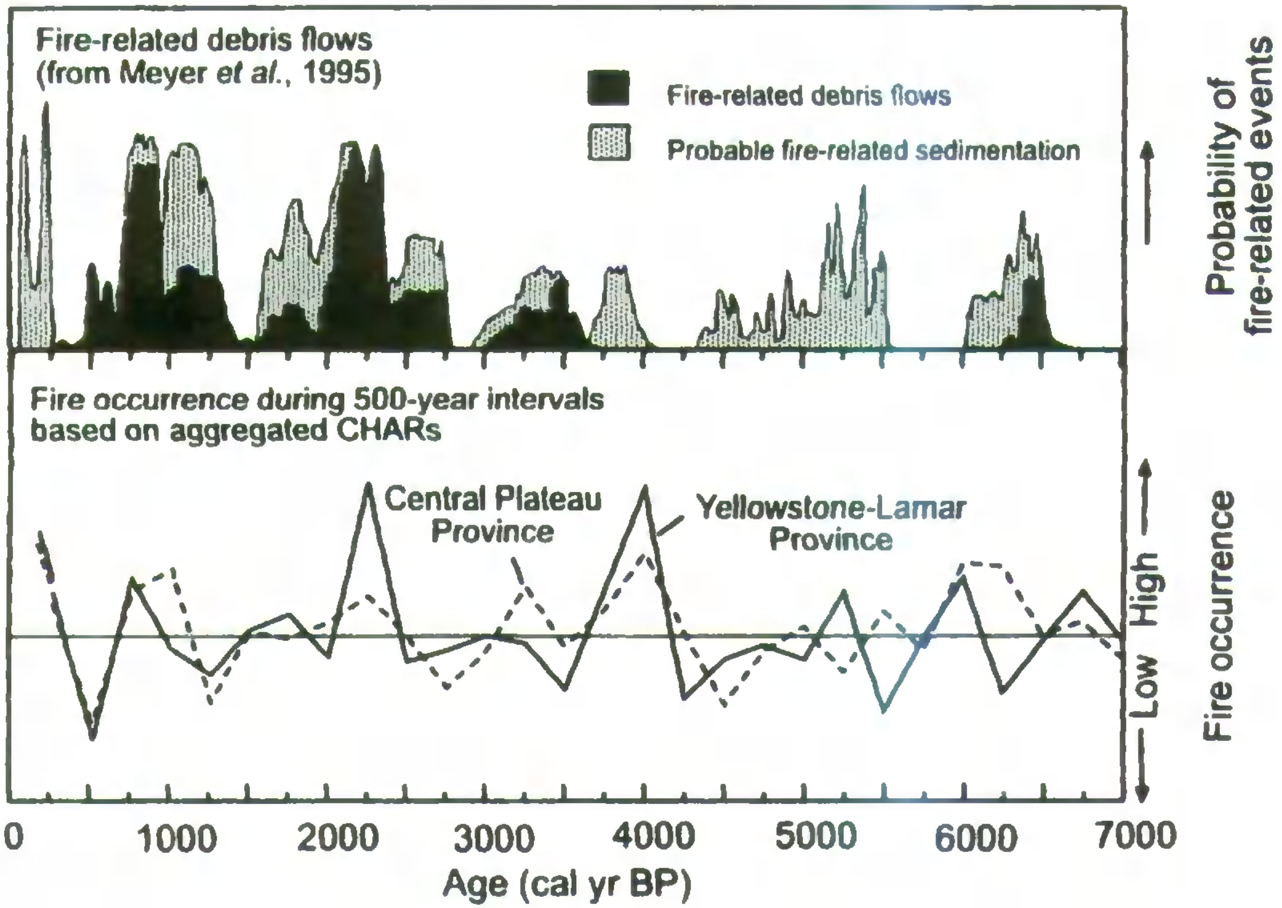


Figure 3.11. Comparison of 500-year periods of fire occurrence with fire-related debris flow activity (data from Meyer *et al.*, 1995). Many of the 500-year periods when fire occurrence was high in both provinces overlapped with periods of high fire-related debris flow activity (see Table 3.3).

that suggest fire frequency has been at the highest level in the last ca. 2000 years. On submillennial time scales, comparison of the charcoal records from Cygnet Lake and Slough Creek Lake with the 7000-year record of fire-related debris flows reveals that many of the 500-year periods when fire occurrence was high in both the Yellowstone-Lamar and the Central Plateau Provinces overlapped with periods of fire-related debris flow activity in the Yellowstone-Lamar Province (Table 3.3, Fig. 3.11). For example, the records from Cygnet Lake and Slough Creek Lake suggest that fire occurrence was widespread between ca. 6240 and 5750, 4250 and 3500, 2500 and 2000, 1000 and 500 cal yr BP. Fire-related debris flows occurred in the Yellowstone-Lamar Province between 6450 and 5950, 3900 and 3150, 2750 and 1600 with a major peak between 2300 and 2050, and 1300 and 750 with a major peak between 900 and 750 cal yr BP (Meyer *et al.*, 1995). The period of high fire occurrence in both provinces between 1000 and 500 cal yr BP overlaps with the Medieval Warm Period (Lamb, 1977) and also corresponds in time with high fire-related debris flow activity (ca. 1300-750 cal yr BP; Meyer *et al*, 1995) and more xerophytic small mammals (Hadly, 1996). Another period of probable fire-related debris flow activity, between 5450 and 4350 cal yr BP, also corresponds to a period of high fire occurrence in the Yellowstone-Lamar Province (between 5400 and 5000 cal yr BP), but not in the Central Plateau Province. In the last 7000 years, there was only one-period of high fire occurrence in both provinces (between 6990 and 6500 cal yr BP) that did not overlap with a period of high fire-related debris flow activity.

Close correspondence between periods of high fire occurrence in the Central Plateau and Yellowstone-Lamar Provinces with periods of high fire-related debris-flow activity suggests that these multi-centennial periods were characterized by drought episodes that affected the entire region. The higher incidence of fire-related debris flows also suggests that many of these periods were characterized by increased convective summer storms (Meyer *et al.*, 1995). The 1988 fires and widespread fire-related sedimentation events that followed are an example of a natural sequence of processes that was likely more common during these drought periods.

The evidence at Slough Creek Lake that most fire events were not associated with local erosional episodes does not contradict the conclusions of Meyer *et al* (1995) which specifically focused on past debris flow activity. Meyer *et al.* (1995) used the debris flow record as a fire proxy and data were collected from >60 sites in steep tributary canyons of Soda Butte and Slough Creek drainages. In contrast, my data on the linkages between fire and erosion are from two small lakes that are not located in areas of active sediment transport.

Controls of Fire Regimes on Different Time Scales

Comparison of the fire history in the two provinces on decadal-to-millennial time scales sheds light on linkages between climate change, fire incidence, and vegetation change between provinces. On millennial time scales, different trends in fire frequency between the two provinces during the Holocene suggests fire incidence is responding to variations in the intensity of summer drought resulting from changes in atmospheric circulation governed by large-scale controls, such as changes in summer insolation. Similarly, shifts in the composition of vegetation in the Yellowstone-Lamar Province and other non-rhyolite provinces have been primarily a response to large-scale changes in the climate system (e.g., Whitlock, 1993; Whitlock and Bartlein, 1993). In the Central Plateau Province, where edaphic controls limited the vegetational response to large-scale climate changes during the Holocene, millennial-scale changes in fire frequency probably caused shifts in the stand ages of the forest mosaic.

Embedded within millennial-scale trends in fire frequency are centennial-scale variations in fire occurrence that are likely caused by changes in climate on submillennial time scales in response to controls, such as variations in solar activity (i.e., short-term variations in solar irradiance caused by changes in sun-spot activity). Many of these multi-centennial periods of high fire occurrence were synchronous in both regions probably in response to widespread drought episodes that affected both northern and southern/central provinces. Some fires during these periods, such as the 1988 fires, likely occurred in all provinces. The synchroneity of fire occurrence among provinces implies that climate variation, rather than characteristics of the vegetation, is the primary determinant of fire on these time scales.

As temporal scales decrease, climate continues to be the primary determinant of fire incidence, but, vegetational controls probably become increasingly more important. For example, in the *P. contorta* forests of the Central Plateau Province, flammability increases with increasing stand age (i.e., higher amounts of dead fuels) and the distribution of old and young stands may have constrained or enhanced fire spread in the past (Knight, 1987; Romme and Despain, 1989a,b,c). Between 1972 and 1987, fires burned intensively in 300-year-old forests, but "died out" when they reached 100-year-old patches of forest

(Despain and Sellers, 1977; Turner and Romme, 1994). In contrast, the 1988 fires burned through forest stands of all ages because of extreme weather conditions. These examples suggest that fires are likely to respond to variations in fuel availability on the landscape, except during years characterized by extreme drought and wind conditions (Turner and Romme, 1994).

On decadal- to centennial-time scales, the fire records from Slough Creek Lake, Cygnet Lake and other small lakes (Millspaugh and Whitlock, 1995) show that the intervals between fires have been highly variable among sites. Such variability indicates that fires occur in response to interactions between climatological and ecological controls, although the relative importance of these two controls in promoting fire cannot be determined in the sedimentary records.

Natural Range of Variability of Fire in Montane Ecosystems

The fire records from Cygnet Lake and Slough Creek Lake shed light on the natural range of variability of fire in montane ecosystems on millennial time scales. Recent developments in the management of forest ecosystems on public lands are based on the concept that landscapes are subject to periodic disturbances, which are characterized by a natural range of frequency, severity, and size. Because native species have adapted to these disturbance regimes over thousands of years, their survival would be threatened if either the frequency, severity, or size of the disturbances changed dramatically and exceeded some threshold (Swanson *et al.*, 1993, 1997). For example if fire frequency were to increase so that the time between fire was shorter than the time needed for the species to recover and reproduce, then the species would likely not survive under the new fire regime (Perry and Amaranthus, 1997). The management implication of this perspective is that disturbance processes should be managed so that their frequency, severity, and size are within a "natural range of variability" that is similar to that of the past (Swanson *et al.*, 1993, 1997). The "past", in this case, is generally the period of time encompassed by local dendrochronological records of fires (i.e., a maximum of 500 years).

Examples from the *P. contorta* forests of the Central Plateau Province and the *Pseudotsuga* parkland of the Yellowstone-Lamar Province suggest that mean fire intervals determined from dendrochronological records represent only a narrow portion of the natural range of variability in mean fire intervals. In the *P. contorta* forests of the Central Plateau Province, the frequency and size of fires have varied considerably over the last ca. 11,300 cal years in response to large-scale climate changes. At ca. 9900 cal yr BP, fires occurred every ca. 65 years whereas in the last ca. 2000 years, fires have occurred every ca. 330 to 500 years. Furthermore, fire size likely varied from those that were small at ca. 9900 cal yr BP to the relatively large fires that characterize the modern landscape. If fire frequency were to increase to mean fire intervals of less than 60 years in the Central Plateau Province, it is possible that *P. contorta* would not be able to regenerate quickly enough to survive in the density that it does today. Because non-fertile rhyolite in the Central Plateau Province is a strong deterrent of competitors, *P. contorta* there would likely survive a shift to longer mean fire intervals than those of today (>500 years). In contrast, in non-rhyolite provinces of southern/central YNP, long fire-free intervals in the late Holocene have resulted in increases in late-successional species, including *Picea* *engelmannii* and *Abies lasiocarpa* as well as *P. contorta*. This suggests that the *P. contorta* forests of YNP are capable of tolerating a wide range of fire frequencies and sizes. The edaphically-controlled *P. contorta* forests are somewhat unique, however, because the infertile substrates make it less likely that other species would be able dominate there even if fire frequency were to increase or decrease beyond its natural range of variability of the last ca. 11,300 cal years.

In the Yellowstone-Lamar Province, the range of variability of fire frequency in the *Pseudotsuga* parkland for the past ca. 7000 cal years has also been large. Fire frequency has varied from a low of ca. six events/1000 years (i.e., every ca. 170 years) at ca. 5500 cal yr BP to a high of ca. 17 events/1000 years (i.e., every ca. 50 years) at present. The severity and size of fires may have shifted during this period (i.e., from moderate severity fires to low severity fires), but apparently, the shift was not enough to promote a major change in the composition of the vegetation. These data suggest that the Poaceae, *Pseudotsuga* and *Populus* species that have been present in the Yellowstone-Lamar Province since ca. 7000 cal yr BP have been able to tolerate a wide range of fire frequencies (fires every ca. 50 to 165 years). Increases in the frequency of low severity fires would likely enable the *Pseudotsuga* parkland to persist in the Yellowstone-Lamar Province, while decreases in fire frequency (fires at >165 year intervals) could enable less fire-tolerant species to increase in abundance.

In both provinces, fire regimes have shifted continuously with climate changes on millennial and submillennial time scales and thus have been non-stationary. Examples from the *P. contorta* forest of the Central Plateau Province and the *Pseudotsuga* parkland of the

Yellowstone-Lamar Province suggest that management approaches that attempt to define a natural range of variability for fire regimes based on dendrochronological records are only considering a portion of a continuously shifting range of fire frequency, severity, and size that characterize ecosystems.

Potential Response of Fire Regimes and Vegetation to Global Warming

Early Holocene fire regimes at Cygnet Lake and Slough Creek Lake provide insights into how fire incidence in regions characterized by topographic complexity and different climate regimes might respond to global warming. Predictions of future fire regimes based on examples from the early Holocene should be considered cautiously because the controls of the early Holocene climate were different from those implicated in future climate change (Webb and Wigley, 1985; Mitchell, 1990; Crowley, 1990). Climate model simulations based on increased levels of CO_2 predict that many regions of the western U.S. will experience both warmer and drier conditions in the next century (Rind *et al.*, 1990). The models further predict that higher temperatures and greater atmospheric loading will result in increased thunderstorm activity (Overpeck *et al*, 1990) and a consequent increase in lightning fires (Price and Rind, 1994). Bartlein *et al.* (1997) used high-resolution climatic and vegetational models to predict future environmental changes for the YNP region in a doubled CO_2 climate. In YNP, simulations suggest mean July temperatures will increase and mean July precipitation will decrease throughout the region, but the resolution of the models allows no differentiation between northern versus southern/central provinces. Evidence that fire frequency increased in response to intensified summer drought in the early Holocene in the Central Plateau Province suggests fire frequency will likely increase there in the future with increasing warm, dry summer conditions. Furthermore, results suggest that under a regime of higher-than-present fire frequency, the composition of the *P. contorta* forests on the Central Plateau are not likely to change but the stand-age distribution will. The mosaic of the *P. contorta* forests of the Central Plateau could shift from one dominated by middle-to-old-aged stands to younger stands (Romme and Turner, 1991; Turner and Romme, 1994). Future climate and disturbance regimes will likely serve to perpetuate lodgepole pine where it now grows and also allow it to dominate on more fertile non-rhyolite substrates and at higher elevations (Bartlein *et al*, 1997).

In the Yellowstone-Lamar Province, early-Holocene fire regimes characterized by lower-than-present frequencies in response to wetter-than-present conditions may not be a good analogue for the future when summer conditions will likely become drier there. In the future, warmer, drier summers in the Yellowstone-Lamar Province will likely result in increases in fire frequency and an expansion of the *Pseudotsuga* parkland to middle elevations in YNP (Bartlein *et al.*, 1997). If, on the other hand, higher summer temperatures result in greater onshore flow, summer conditions in the Yellowstone-Lamar Province may become wetter and fire frequency may decrease as it did in the early Holocene. A decrease in fire frequency in this province could enable less fire-tolerant species, such as *Picea*, to colonize the province.

Conclusions

Records from Cygnet Lake and Slough Creek Lake suggest that fire regimes in different geovegetation provinces of YNP vary in response to climate changes on millennial and submillennial time scales. On millennial time scales, fire regimes in the Central Plateau and the Yellowstone-Lamar Provinces have changed in response to shifts in atmospheric circulation in response to changes in summer insolation. Maximum fire frequency coincided with the period of greatest drought in each province (Fig. 3.12). The fire record from Cygnet Lake in the Central Plateau Province suggests that fire frequency was highest (ten to 15 events/1000 years) in the *P. contorta* forest between ca. 11,000 and 8000 cal yr BP. Thus, changes in fire frequency in the last 11,300 cal yr BP occurred without changes in forest composition. In contrast, the record from Slough Creek Lake indicates that the period of maximum fire frequency (12 to 17 events/1000 years) in the Yellowstone-Lamar Province occurred in the last 2000 years. Changes in fire frequency at Slough Creek Lake did not correlate closely with large-scale changes in vegetation there. Fire regimes in both the Central Plateau and Yellowstone-Lamar Provinces have been non-stationary on millennial time scales because fire frequency has shifted continuously in both regions with large-scale changes in climate.

Superimposed on these millennial scale trends are variations in fire occurrence on submillennial time scales. Fire occurrence was high in both provinces during several of the same 500-year periods when drought was more pervasive in both provinces.

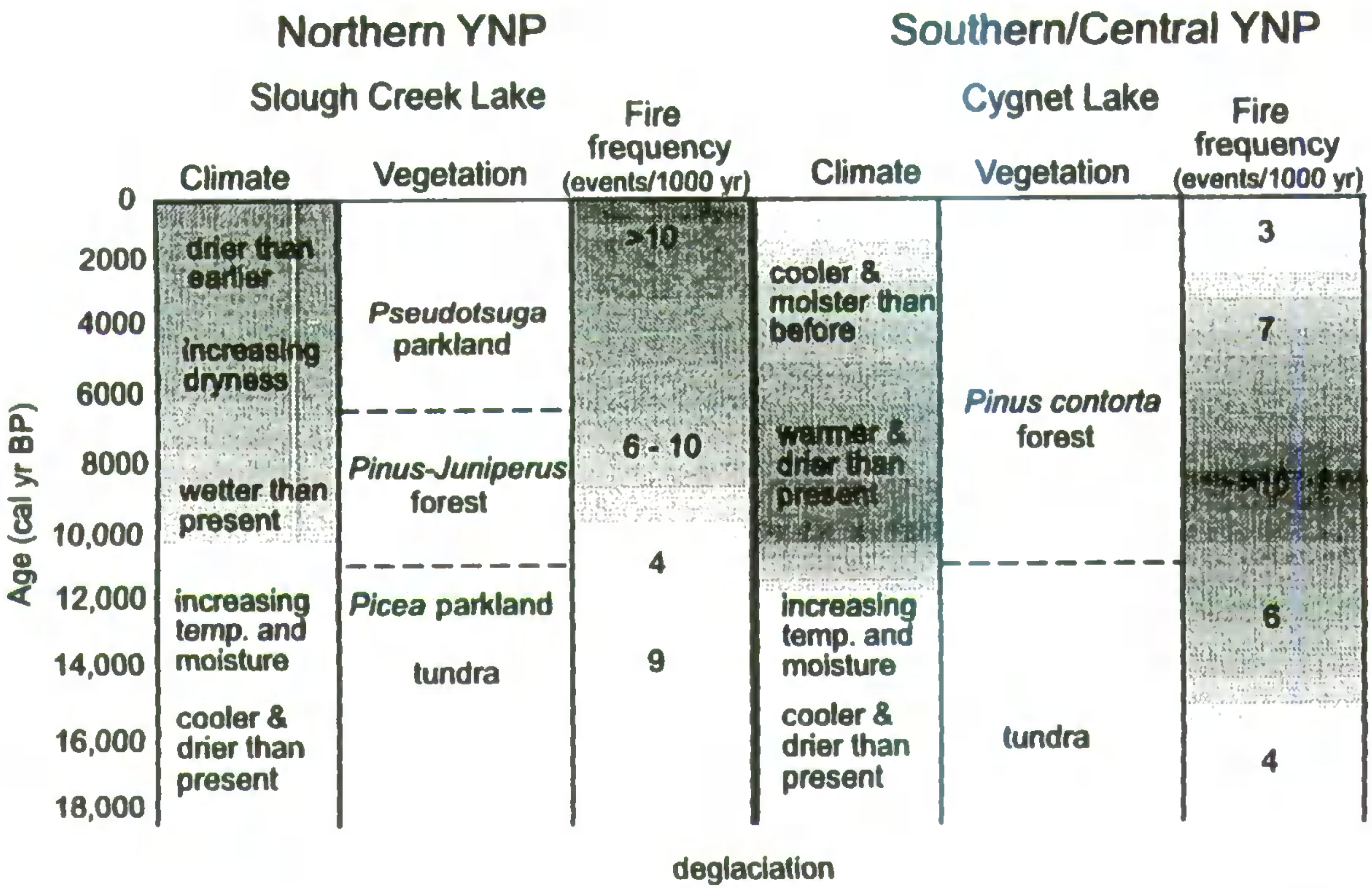


Figure 3.12. Summary of late-glacial and Holocene changes in climate, vegetation, and fire frequency for the Yellowstone-Lamar and the Central Plateau Provinces. Shading indicates the intensity of aridity (darker shading = greater aridity).

One such period was from ca. 500 to 1000 cal yr BP which corresponds to the Medieval Warm Period.

CHAPTER IV

SUMMARY

Analysis of stratigraphic charcoal from lakes in the Central Plateau and Yellowstone-Lamar geovegetation provinces of YNP provides important information about the relations between changes in climatic change, fire frequency and vegetation on different spatial and temporal scales. On millennial time scales, fire regimes in the Central Plateau Province of southern/central YNP and the Yellowstone-Lamar Province of northern YNP have changed in response to changes in summer temperatures and moisture conditions controlled by long-term shifts in atmospheric circulation as a result of changes in summer insolation. The period of maximum fire frequency coincided with the period of greatest drought in each province. The fire record from Cygnet Lake suggests that fire frequency was highest (ten to 15 events/1000 years) in the Central Plateau Province between ca. 11,000 and 8000 cal yr BP when summer temperatures were high and effective precipitation was low. These conditions were caused by greater-than-present summer insolation and the expansion of the eastern Pacific subtropical high pressure system, which affected the southern and central part of YNP. After 8000 cal yr BP, fire incidence decreased to present frequencies (two to three events/1000 years). The trend towards fewer fires coincided with decreasing summer insolation and cooler, effectively wetter conditions than before. *Pinus contorta* forest has been present in the Central

Plateau Province for the last ca. 11,300 cal yr BP, and thus changes in fire frequency can only be attributed to changes in climate.

The record from Cygnet Lake on the Central Plateau provided an opportunity to infer how the *P. contorta* forest mosaic may have shifted during the Holocene as a result of changes in fire frequency. In the early-Holocene (ca. 9900 cal yr BP), when fire frequency was at its highest (15 events/1000 years), fires were likely small and limited by fuel availability. Short intervals between fires would have produced a mosaic that that was dominated by young stands (<100 years old). As the intervals between fires increased in the late Holocene, forest stands matured and the mosaic has become more connected.

The record from Slough Creek Lake in the Yellowstone-Lamar Province suggests fire frequency then was moderate (six to ten events/1000 years) in the early Holocene. Pollen data indicate that summers then were warmer and wetter than present as a result of stronger-than-present monsoonal circulation that brought moist conditions to the northern part of Yellowstone National Park. In the last ca. 2000 years, xerophytic vegetation has increased in the Yellowstone-Lamar Province and fire frequency has reached its highest levels (12 to 17 events/1000 years).

Embedded within millennial-scale trends in fire frequency are centennial-scale variations in fire occurrence that are likely caused by submillennial-scale variations in climate. Many of these periods of high fire occurrence were apparently synchronous in both regions reflecting drought conditions that influenced both the Yellowstone-Lamar and Central Plateau Provinces. Several ca. 500-year periods when fire occurrence was high in both provinces overlapped with times of fire-related debris flows in the

Yellowstone-Lamar Province. The 1988 fires, and the fire-related sedimentation events that followed them, represent an example of a natural sequence of processes that may have characterized these drought periods. Sedimentation events associated with widespread fires in 1988 were caused by intense convective-storm precipitation, which generated erosive surface run-off in severely burned areas (Meyer *et al.*, 1994). One period characterized by high fire occurrence in both the Central Plateau and the Yellowstone-Lamar Provinces was the period from ca. 500-1000 cal yr BP, which corresponds with the Medieval Warm Period.

Fire regimes in both the Central Plateau and Yellowstone-Lamar Provinces have been non-stationary on millennial and submillennial time scales because fire frequency has shifted continuously in both regions as climate has changed. Examples from the *P. contorta* forest of the Central Plateau Province and the *Pseudotsuga* parkland of the Yellowstone-Lamar Province suggest that mean fire intervals determined from dendrochronological records only represent a narrow portion of the natural range of variability in mean fire intervals in either ecosystem. In the *P. contorta* forests of the Central Plateau Province, the fire intervals have varied from ca. 65 years in the early Holocene to ca. 330 to 500 years in the late Holocene. In the *Pseudotsuga* parkland in the Yellowstone-Lamar Province, fire frequency has varied from a low of ca. six events/1000 years (i.e., every ca. 170 years) at ca. 5500 cal yr BP to a high of ca. 17 events/1000 years (i.e., every ca. 50 years) at present. These examples suggest that management approaches that attempt to define a natural range of variability for fire regimes based on dendrochronological records are only considering a portion of a continuously shifting range of fire frequency, severity, and size that characterize ecosystems.

High-resolution climate models that incorporate a doubled CO_2 climate predict that mean July temperatures will increase and mean July precipitation will decrease in YNP in the future (Bartlein *et al.*, 1997). Evidence that increases in fire frequency were linked to increases in drought conditions in the past suggests that fire frequency will increase in all provinces of YNP in the future. Changes in fire regimes will facilitate the spread of fire-adapted species, such as *P. contorta*, into areas where they are not abundant today.

APPENDIX A

RAW CHARCOAL AND MAGNETIC SUSCEPTIBILITY DATA

FOR CYGNET LAKE

CYGNET LAKE

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
1.0	46.36	43.00	0.00
2.0	92.54	57.40	5.00
3.0	138.55	54.80	9.00
4.0	184.37	48.80	6.00
5.0	230.01	38.80	6.00
6.0	275.47	36.60	7.00
7.0	320.76	47.00	8.00
8.0	365.86	33.20	5.00
9.0	410.79	20.80	8.00
10.0	455.54	14.00	9.00
11.0	500.12	12.20	7.00
12.0	544.52	9.80	5.00
13.0	588.74	7.00	5.00
14.0	632.79	12.40	3.00
15.0	676.66	19.00	5.00
16.0	720.36	16.20	0.00
17.0	763.89	23.20	0.00
18.0	807.24	27.40	0.00
19.0	850.42	67.00	0.00
20.0	893.43	43.60	0.00
21.0	936.27	54.40	0.00
22.0	978.93	57.20	0.00
23.0	1021.43	31.60	0.00
24.0	1063.76	22.00	17.00
25.0	1105.91	12.80	8.00
26.0	1147.9	13.20	0.00
27.0	1189.72	14.20	8.00
28.0	1231.37	22.20	5.00
29.0	1272.85	22.80	0.00
30.0	1314.17	14.40	0.00
31.0	1355.32	16.20	7.00
32.0	1396.31	14.00	10.00
33.0	1437.13	17.40	12.00
34.0	1477.78	15.80	17.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
35.0	1518.27	15.60	0.00
36.0	1558.6	16.60	0.00
37.0	1598.76	15.40	0.00
38.0	1638.76	13.20	0.00
39.0	1678.6	24.20	0.00
40.0	1718.27	20.00	0.00
41.0	1757.79	13.00	74.00
42.0	1797.14	12.20	0.00
43.0	1836.33	9.00	5.00
44.0	1875.37	18.40	3.00
45.0	1914.24	27.80	0.00
46.0	1952.96	50.40	0.00
47.0	1991.51	50.80	0.00
48.0	2029.91	52.00	9.00
49.0	2068.15	34.80	0.00
50.0	2106.24	25.60	2.00
51.0	2144.17	11.60	0.00
52.0	2181.94	19.00	0.00
53.0	2219.56	56.60	0.00
54.0	2257.02	28.60	0.00
55.0	2294.33	37.00	0.00
56.0	2331.48	28.40	0.00
57.0	2368.49	23.60	0.00
58.0	2405.33	30.00	0.00
59.0	2442.03	21.80	0.00
60.0	2478.58	19.60	0.00
61.0	2514.97	23.80	0.00
62.0	2551.21	8.60	0.00
63.0	2587.3	9.40	0.00
64.0	2623.25	8.20	8.00
65.0	2659.04	12.60	0.00
66.0	2694.69	53.00	0.00
67.0	2730.18	31.40	0.00
68.0	2765.53	21.40	0.00
69.0	2800.74	17.20	0.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
70.0	2835.79	31.60	0.00
71.0	2870.7	31.00	0.00
72.0	2905.46	20.80	0.00
73.0	2940.08	20.00	0.00
74.0	2974.56	21.40	0.00
75.0	3008.89	39.00	0.00
76.0	3043.07	57.60	0.00
77.0	3077.12	22.40	0.00
78.0	3111.02	18.40	0.00
79.0	3144.77	32.00	0.00
80.0	3178.39	18.00	0.00
81.0	3211.87	28.00	0.00
82.0	3245.2	18.80	0.00
83.0	3278.4	22.80	0.00
84.0	3311.45	13.40	0.00
85.0	3344.37	54.40	0.00
86.0	3377.15	43.60	0.00
87.0	3409.78	21.40	0.00
88.0	3442.29	26.60	0.00
89.0	3474.65	52.00	0.00
90.0	3506.88	64.00	0.00
91.0	3538.97	23.40	50.00
92.0	3570.93	33.80	23.00
93.0	3602.75	36.60	8.00
94.0	3634.44	29.60	9.00
95.0	3665.99	18.60	22.00
96.0	3697.41	11.60	11.00
97.0	3728.7	20.60	23.00
98.0	3759.85	38.20	12.00
99.0	3790.88	27.40	7.00
100.0	3821.77	25.40	0.00
101.0	3852.53	15.00	151.00
102.0	3883.16	77.80	114.00
103.0	3913.66	22.00	63.00
104.0	3944.03	46.20	48.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
105.0	3974.27	18.00	4.00
106.0	4004.38	9.60	0.00
107.0	4034.37	13.40	0.00
108.0	4064.22	11.80	0.00
109.0	4093.95	63.40	33.00
110.0	4123.56	19.20	45.00
111.0	4153.04	16.20	54.00
112.0	4182.39	14.40	46.00
113.0	4211.62	38.60	51.00
114.0	4240.72	54.00	36.00
115.0	4269.7	18.20	33.00
116.0	4298.56	10.40	29.00
117.0	4327.29	7.60	27.00
118.0	4355.9	16.20	20.00
119.0	4384.39	7.80	40.00
120.0	4412.76	50.20	37.00
121.0	4441	25.20	16.00
122.0	4469.13	25.20	44.00
123.0	4497.14	14.20	22.00
124.0	4525.02	20.60	36.00
125.0	4552.79	6.80	14.00
126.0	4580.44	10.20	21.00
127.0	4607.98	12.80	25.00
128.0	4635.39	8.60	20.00
129.0	4662.69	12.00	21.00
130.0	4689.87	52.40	21.00
131.0	4716.94	17.80	132.00
132.0	4743.89	25.00	67.00
133.0	4770.73	23.20	56.00
134.0	4797.45	19.20	62.00
135.0	4824.06	32.60	38.00
136.0	4850.55	60.20	59.00
137.0	4876.93	29.60	33.00
138.0	4903.2	14.80	31.00
139.0	4929.36	16.20	42.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
140.0	4955.41	34.00	39.00
141.0	4981.35	13.80	34.00
142.0	5007.17	24.20	25.00
143.0	5032.89	15.40	32.00
144.0	5058.5	12.00	25.00
145.0	5083.99	22.80	12.00
146.0	5109.38	15.80	24.00
147.0	5134.67	55.40	26.00
148.0	5159.84	31.20	12.00
149.0	5184.91	16.20	31.00
150.0	5209.87	16.00	4.00
151.0	5234.73	16.20	14.00
152.0	5259.48	26.00	22.00
153.0	5284.13	31.80	8.00
154.0	5308.67	29.80	2.00
155.0	5333.11	26.00	5.00
156.0	5357.45	21.00	3.00
157.0	5381.68	37.80	2.00
158.0	5405.81	24.00	0.00
159.0	5429.84	32.80	0.00
160.0	5453.77	31.80	3.00
161.0	5477.6	14.80	4.00
162.0	5501.33	8.00	3.00
163.0	5524.96	20.20	0.00
164.0	5548.49	23.40	8.00
165.0	5571.92	10.40	20.00
166.0	5595.25	21.20	0.00
167.0	5618.49	29.80	0.00
168.0	5641.63	147.40	0.00
169.0	5664.67	40.80	0.00
170.0	5687.61	45.60	0.00
171.0	5710.46	23.60	0.00
172.0	5733.22	15.80	0.00
173.0	5755.88	12.40	0.00
174.0	5778.45	16.60	0.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
175.0	5800.92	41.60	0.00
176.0	5823.3	81.20	0.00
177.0	5845.59	89.20	0.00
178.0	5867.78	45.80	0.00
179.0	5889.89	20.40	0.00
180.0	5911.9	17.40	0.00
181.0	5933.82	23.20	0.00
182.0	5955.66	13.80	0.00
183.0	5977.4	23.00	0.00
184.0	5999.06	11.20	0.00
185.0	6020.62	21.20	0.00
186.0	6042.1	72.40	0.00
187.0	6063.49	65.40	0.00
188.0	6084.79	16.00	0.00
189.0	6106.01	46.60	0.00
190.0	6127.14	31.20	0.00
191.0	6148.19	15.00	0.00
192.0	6169.15	48.60	0.00
193.0	6190.03	18.20	0.00
194.0	6210.82	32.80	0.00
195.0	6231.53	34.00	0.00
196.0	6252.16	14.60	0.00
201.0	6354.06	17.00	0.00
202.0	6374.2	16.80	0.00
203.0	6394.26	28.00	3.00
204.0	6414.25	84.80	36.00
205.0	6434.15	18.20	28.00
206.0	6453.98	22.00	0.00
207.0	6473.72	9.20	3.00
208.0	6493.4	6.40	12.00
209.0	6512.99	15.80	0.00
210.0	6532.51	21.20	8.00
211.0	6551.95	24.40	0.00
212.0	6571.32	27.00	2.00
213.0	6590.62	10.80	2.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
214.0	6609.84	15.00	0.00
215.0	6628.99	11.00	5.00
216.0	6648.06	12.80	2.00
217.0	6667.07	60.80	0.00
218.0	6686	21.00	0.00
219.0	6704.86	37.20	0.00
220.0	6723.65	11.40	0.00
221.0	6742.37	29.60	0.00
222.0	6761.02	15.60	0.00
223.0	6779.6	10.00	0.00
224.0	6798.11	7.80	0.00
225.0	6816.55	8.20	0.00
226.0	6834.93	9.00	0.00
227.0	6853.24	12.80	0.00
228.0	6871.48	25.00	0.00
229.0	6889.66	23.80	0.00
230.0	6907.77	13.00	0.00
231.0	6925.81	18.40	0.00
232.0	6943.79	46.40	11.00
233.0	6961.71	7.40	0.00
234.0	6979.56	11.80	3.00
235.0	6997.35	30.40	8.00
236.0	7015.08	14.00	6.00
237.0	7032.74	7.40	0.00
238.0	7050.35	21.60	0.00
239.0	7067.89	21.60	0.00
240.0	7085.37	10.00	0.00
241.0	7102.79	14.00	12.00
242.0	7120.15	9.00	2.00
243.0	7137.45	16.40	0.00
244.0	7154.7	15.20	4.00
245.0	7171.89	10.00	0.00
246.0	7189.01	8.00	2.00
247.0	7206.08	17.40	7.00
248.0	7223.1	33.40	17.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
249.0	7240.06	10.60	0.00
251.0	7273.81	7.00	0.00
252.0	7290.6	8.00	0.00
253.0	7307.34	15.40	18.00
254.0	7324.03	11.40	13.00
255.0	7340.66	5.40	12.00
256.0	7357.24	7.00	9.00
257.0	7373.77	11.00	7.00
258.0	7390.25	14.60	2.00
259.0	7406.68	15.40	12.00
260.0	7423.05	8.60	5.00
261.0	7439.38	35.00	0.00
262.0	7455.66	18.00	21.00
263.0	7471.88	14.80	25.00
264.0	7488.06	12.20	13.00
265.0	7504.19	14.20	6.00
266.0	7520.28	12.20	4.00
267.0	7536.31	26.00	33.00
268.0	7552.3	28.60	54.00
269.0	7568.25	36.00	48.00
270.0	7584.15	26.60	49.00
271.0	7600	22.40	16.00
272.0	7615.81	26.40	38.00
273.0	7631.58	35.60	23.00
274.0	7647.3	77.60	33.00
275.0	7662.98	30.20	31.00
276.0	7678.62	13.60	31.00
277.0	7694.21	20.80	53.00
278.0	7709.77	23.80	50.00
279.0	7725.28	32.40	72.00
280.0	7740.75	37.80	98.00
281.0	7756.19	16.40	130.00
282.0	7771.58	9.20	168.00
283.0	7786.93	12.00	15.00
284.0	7802.25	19.80	12.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
285.0	7817.53	9.20	7.00
286.0	7832.77	4.80	10.00
287.0	7847.97	12.40	35.00
288.0	7863.14	8.00	7.00
289.0	7878.28	5.00	6.00
290.0	7893.37	10.20	5.00
291.0	7908.44	6.60	0.00
292.0	7923.46	12.00	11.00
293.0	7938.46	22.60	11.00
294.0	7953.42	17.40	8.00
295.0	7968.35	9.00	5.00
296.0	7983.24	8.40	16.00
297.0	7998.11	7.20	8.00
298.0	8012.94	8.40	13.00
299.0	8027.74	6.00	11.00
300.0	8042.52	13.80	9.00
301.0	8057.26	20.60	0.00
302.0	8071.97	24.00	0.00
303.0	8086.66	16.00	0.00
304.0	8101.31	20.40	11.00
305.0	8115.94	18.80	5.00
306.0	8130.54	22.60	7.00
307.0	8145.12	11.40	6.00
308.0	8159.67	16.00	5.00
309.0	8174.19	10.20	8.00
310.0	8188.69	20.20	13.00
311.0	8203.16	4.80	6.00
312.0	8217.61	7.40	3.00
313.0	8232.04	15.20	3.00
314.0	8246.44	14.20	8.00
315.0	8260.82	10.20	5.00
316.0	8275.18	7.40	12.00
317.0	8289.51	9.00	16.00
318.0	8303.83	11.40	19.00
319.0	8318.12	23.60	8.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
320.0	8332.4	21.20	11.00
321.0	8346.65	14.20	0.00
322.0	8360.89	27.00	11.00
323.0	8375.1	16.20	9.00
324.0	8389.3	8.60	13.00
325.0	8403.48	4.80	19.00
326.0	8417.65	7.00	36.00
327.0	8431.79	10.80	3.00
328.0	8445.93	10.80	4.00
329.0	8460.04	9.20	6.00
330.0	8474.14	7.60	5.00
331.0	8488.23	7.80	5.00
332.0	8502.3	4.40	4.00
333.0	8516.36	13.20	0.00
334.0	8530.41	22.80	11.00
335.0	8544.44	20.80	2.00
336.0	8558.46	15.00	13.00
337.0	8572.47	17.60	2.00
338.0	8586.47	22.60	0.00
339.0	8600.46	11.40	0.00
340.0	8614.44	6.80	0.00
341.0	8628.41	12.40	2.00
342.0	8642.37	7.00	0.00
343.0	8656.32	10.60	0.00
344.0	8670.27	10.60	16.00
345.0	8684.2	5.40	0.00
346.0	8698.13	8.00	0.00
347.0	8712.05	10.40	3.00
351.0	8767.69	4.60	0.00
352.0	8781.59	6.40	0.00
353.0	8795.49	9.80	2.00
354.0	8809.38	6.60	0.00
355.0	8823.27	6.00	0.00
356.0	8837.16	14.00	0.00
357.0	8851.04	8.20	10.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
358.0	8864.93	5.40	4.00
359.0	8878.82	10.00	13.00
360.0	8892.7	18.40	0.00
361.0	8906.59	9.00	0.00
362.0	8920.48	10.80	2.00
363.0	8934.36	8.20	0.00
364.0	8948.26	7.20	16.00
365.0	8962.15	13.40	12.00
366.0	8976.05	27.00	11.00
367.0	8989.95	13.00	0.00
368.0	9003.85	12.00	0.00
369.0	9017.76	8.80	0.00
370.0	9031.68	11.00	3.00
371.0	9045.6	10.60	0.00
372.0	9059.53	13.80	5.00
373.0	9073.46	18.60	9.00
374.0	9087.4	11.60	5.00
375.0	9101.35	10.60	2.00
376.0	9115.31	15.20	5.00
377.0	9129.27	13.00	7.00
378.0	9143.25	20.20	10.00
379.0	9157.23	62.00	8.00
380.0	9171.23	39.20	6.00
381.0	9185.23	14.80	6.00
382.0	9199.25	20.00	6.00
383.0	9213.28	16.40	6.00
384.0	9227.32	7.60	4.00
385.0	9241.38	12.80	3.00
386.0	9255.44	16.60	0.00
387.0	9269.53	11.40	5.00
388.0	9283.62	9.00	4.00
389.0	9297.73	12.60	0.00
390.0	9311.86	14.00	0.00
391.0	9326	18.80	0.00
392.0	9340.16	25.00	6.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
393.0	9354.33	13.80	18.00
394.0	9368.53	16.00	15.00
395.0	9382.74	46.60	20.00
396.0	9396.96	15.00	30.00
397.0	9411.21	18.20	33.00
398.0	9425.48	24.00	25.00
399.0	9439.77	16.80	34.00
400.0	9454.07	21.20	0.00
401.0	9468.4	12.20	7.00
402.0	9482.75	12.40	16.00
403.0	9497.12	17.20	46.00
404.0	9511.52	31.20	62.00
405.0	9525.93	15.40	27.00
406.0	9540.37	18.00	25.00
407.0	9554.84	24.60	28.00
408.0	9569.33	9.60	45.00
409.0	9583.84	10.40	52.00
410.0	9598.38	10.60	37.00
411.0	9612.94	47.40	34.00
412.0	9627.54	12.00	39.00
413.0	9642.15	11.20	22.00
414.0	9656.8	13.20	29.00
415.0	9671.47	48.00	33.00
416.0	9686.18	7.80	31.00
417.0	9700.91	10.00	31.00
418.0	9715.67	9.20	13.00
419.0	9730.46	14.60	25.00
420.0	9745.28	27.40	27.00
421.0	9760.14	27.80	39.00
422.0	9775.02	14.80	41.00
423.0	9789.94	6.80	29.00
424.0	9804.89	16.20	14.00
425.0	9819.87	10.00	38.00
426.0	9834.88	8.60	6.00
427.0	9849.93	6.00	35.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
428.0	9865.02	7.80	25.00
429.0	9880.14	51.00	26.00
430.0	9895.29	40.20	52.00
431.0	9910.48	7.60	78.00
432.0	9925.71	9.40	91.00
433.0	9940.98	6.00	46.00
434.0	9956.28	44.00	17.00
435.0	9971.62	27.60	63.00
436.0	9987	15.40	57.00
437.0	10002.42	9.60	54.00
438.0	10017.87	10.80	54.00
439.0	10033.37	22.60	51.00
440.0	10048.91	55.20	53.00
441.0	10064.49	11.60	67.00
442.0	10080.11	36.60	57.00
443.0	10095.78	19.00	59.00
444.0	10111.48	50.00	47.00
445.0	10127.23	6.80	36.00
446.0	10143.03	19.00	70.00
447.0	10158.86	66.80	36.00
448.0	10174.75	15.60	73.00
451.0	10222.67	38.40	23.00
452.0	10238.73	46.60	39.00
453.0	10254.85	25.00	32.00
454.0	10271.01	10.80	35.00
455.0	10287.22	26.20	36.00
456.0	10303.48	28.00	18.00
457.0	10319.78	10.60	36.00
458.0	10336.14	20.80	38.00
459.0	10352.55	44.00	39.00
460.0	10369.01	19.20	46.00
461.0	10385.52	17.00	50.00
462.0	10402.08	25.60	63.00
463.0	10418.69	17.60	47.00
464.0	10435.36	53.80	41.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
465.0	10452.08	42.40	57.00
466.0	10468.85	10.80	32.00
467.0	10485.68	16.80	44.00
468.0	10502.56	26.40	61.00
469.0	10519.5	19.60	54.00
470.0	10536.5	43.80	62.00
471.0	10553.55	28.80	74.00
472.0	10570.65	10.20	58.00
473.0	10587.82	20.00	63.00
474.0	10605.04	18.80	76.00
475.0	10622.32	15.20	99.00
476.0	10639.66	9.80	103.00
477.0	10657.06	24.80	104.00
478.0	10674.52	23.80	111.00
479.0	10692.04	12.80	76.00
480.0	10709.62	11.40	48.00
481.0	10727.26	12.20	117.00
482.0	10744.96	13.60	114.00
483.0	10762.73	10.60	99.00
484.0	10780.56	8.40	61.00
485.0	10798.45	12.00	115.00
486.0	10816.41	20.60	145.00
487.0	10834.43	18.00	94.00
488.0	10852.52	23.00	108.00
489.0	10870.67	9.20	103.00
490.0	10888.89	13.80	90.00
491.0	10907.17	11.20	72.00
492.0	10925.52	7.60	62.00
493.0	10943.94	14.00	83.00
494.0	10962.43	11.80	72.00
495.0	10980.98	11.80	53.00
496.0	10999.6	13.80	55.00
501.0	11093.78	8.20	36.00
502.0	11112.83	11.80	47.00
503.0	11131.95	20.60	52.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
504.0	11151.14	26.40	54.00
505.0	11170.41	24.60	70.00
506.0	11189.75	18.60	56.00
507.0	11209.17	10.20	83.00
508.0	11228.66	7.40	101.00
509.0	11248.23	7.60	79.00
510.0	11267.87	11.40	108.00
511.0	11287.59	20.00	118.00
512.0	11307.39	8.00	127.00
513.0	11327.26	8.60	163.00
514.0	11347.21	8.40	211.00
515.0	11367.25	10.20	268.00
516.0	11387.36	13.80	235.00
517.0	11407.55	9.60	295.00
518.0	11427.82	3.80	270.00
519.0	11448.17	6.20	235.00
520.0	11468.6	3.80	296.00
521.0	11489.11	4.00	2930.00
522.0	11509.71	3.20	302.00
523.0	11530.39	4.40	351.00
524.0	11551.15	3.40	348.00
525.0	11572	3.80	324.00
526.0	11592.93	3.80	357.00
527.0	11613.94	6.20	129.00
528.0	11635.04	10.00	311.00
529.0	11656.23	8.40	347.00
530.0	11677.5	11.00	306.00
531.0	11698.86	7.40	366.00
532.0	11720.3	3.80	342.00
533.0	11741.83	2.80	296.00
534.0	11763.46	5.80	314.00
535.0	11785.17	6.00	348.00
536.0	11806.97	8.20	465.00
537.0	11828.86	5.80	330.00
538.0	11850.84	8.20	364.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
539.0	11872.91	10.00	343.00
540.0	11895.07	11.20	397.00
541.0	11917.32	3.60	152.00
542.0	11939.67	4.20	284.00
543.0	11962.11	4.40	282.00
544.0	11984.64	4.80	232.00
545.0	12007.26	17.40	198.00
546.0	12029.98	4.60	570.00
547.0	12052.8	4.00	317.00
551.0	12145.02	7.60	253.00
552.0	12168.32	10.00	271.00
553.0	12191.71	13.60	287.00
554.0	12215.2	17.20	317.00
555.0	12238.79	16.80	257.00
556.0	12262.49	20.00	311.00
557.0	12286.28	24.80	300.00
558.0	12310.17	31.20	279.00
559.0	12334.16	24.00	309.00
560.0	12358.26	21.60	269.00
561.0	12382.45	11.40	222.00
562.0	12406.75	14.00	211.00
563.0	12431.15	13.60	199.00
564.0	12455.66	14.40	240.00
565.0	12480.26	24.00	317.00
566.0	12504.98	7.60	503.00
567.0	12529.79	7.00	688.00
568.0	12554.72	13.00	652.00
569.0	12579.75	5.60	557.00
570.0	12604.88	6.40	610.00
571.0	12630.13	18.00	555.00
572.0	12655.48	15.60	714.00
573.0	12680.94	6.00	836.00
574.0	12706.5	5.60	935.00
575.0	12732.18	5.00	1324.00
576.0	12757.96	4.20	1357.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
577.0	12783.86	4.80	1332.00
578.0	12809.87	3.20	979.00
579.0	12835.98	5.00	1183.00
580.0	12862.21	8.60	1344.00
581.0	12888.55	9.80	1172.00
582.0	12915.01	7.40	1407.00
583.0	12941.57	4.20	1075.00
584.0	12968.25	11.00	1362.00
585.0	12995.05	8.00	1677.00
586.0	13021.95	8.40	1280.00
587.0	13048.98	6.60	1409.00
588.0	13076.12	11.00	1368.00
589.0	13103.37	13.40	1513.00
590.0	13130.75	3.80	1539.00
591.0	13158.23	4.60	1255.00
592.0	13185.84	1.60	1393.00
593.0	13213.57	4.60	1468.00
594.0	13241.41	10.20	1357.00
595.0	13269.37	16.00	1229.00
596.0	13297.45	14.80	1055.00
597.0	13325.66	8.40	1377.00
598.0	13353.98	13.60	1313.00
599.0	13382.42	7.40	1485.00
601.0	13439.68	5.40	1486.00
609.0	13673.64	2.80	2306.00
610.0	13703.45	4.80	959.00
611.0	13733.39	11.40	2091.00
612.0	13763.45	2.40	2336.00
613.0	13793.65	4.80	2636.00
614.0	13823.97	1.80	2535.00
615.0	13854.42	3.00	2356.00
616.0	13885	1.80	2858.00
617.0	13915.71	6.60	2827.00
618.0	13946.55	16.00	2747.00
619.0	13977.53	2.60	3193.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
620.0	14008.63	2.40	3141.00
621.0	14039.87	1.80	4144.00
622.0	14071.24	1.60	4691.00
623.0	14102.75	1.80	5031.00
624.0	14134.38	1.60	3211.00
625.0	14166.16	1.80	3278.00
626.0	14198.06	3.20	2443.00
627.0	14230.11	3.20	2034.00
628.0	14262.28	1.20	2118.00
629.0	14294.6	3.40	2818.00
630.0	14327.05	1.40	2439.00
631.0	14359.64	1.60	2250.00
632.0	14392.36	6.60	2975.00
633.0	14425.23	5.80	2772.00
634.0	14458.23	6.20	1056.00
635.0	14491.38	14.60	1359.00
636.0	14524.66	15.00	2444.00
637.0	14558.08	5.20	2634.00
638.0	14591.65	11.00	2829.00
639.0	14625.35	11.20	2559.00
640.0	14659.2	34.80	2539.00
641.0	14693.19	2.60	2881.00
642.0	14727.32	1.40	3628.00
643.0	14761.6	0.40	2941.00
644.0	14796.02	1.40	3049.00
645.0	14830.59	0.80	2483.00
646.0	14865.3	0.60	2113.00
650.0	15005.59	1.00	2127.00
651.0	15041.04	10.40	2476.00
652.0	15076.63	1.60	4162.00
653.0	15112.37	1.20	7698.00
654.0	15148.25	0.20	7172.00
655.0	15184.29	0.00	5254.00
656.0	15220.48	0.20	4389.00
657.0	15256.82	1.80	5355.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
658.0	15293.3	0.00	6514.00
659.0	15329.94	0.40	6826.00
660.0	15366.74	0.20	5255.00
661.0	15403.68	2.40	5359.00
662.0	15440.78	0.00	6343.00
663.0	15478.03	2.40	5399.00
664.0	15515.44	3.00	3484.00
665.0	15553	1.40	2065.00
666.0	15590.71	1.60	1264.00
667.0	15628.58	3.80	2134.00
668.0	15666.61	2.80	2345.00
669.0	15704.79	2.60	2353.00
670.0	15743.14	4.60	2366.00
671.0	15781.63	5.20	1336.00
672.0	15820.29	4.00	1342.00
673.0	15859.11	3.20	1375.00
674.0	15898.08	2.00	1235.00
675.0	15937.21	1.80	1280.00
676.0	15976.51	0.60	527.00
677.0	16015.96	3.00	503.00
678.0	16055.58	7.20	491.00
679.0	16095.36	9.00	421.00
680.0	16135.29	2.40	412.00
681.0	16175.4	2.00	1158.00
682.0	16215.66	1.20	806.00
683.0	16256.09	0.80	7627.00
684.0	16296.69	1.00	751.00
685.0	16337.44	1.00	715.00
686.0	16378.37	1.20	817.00
687.0	16419.46	1.40	861.00
688.0	16460.71	1.80	819.00
689.0	16502.13	2.60	984.00
690.0	16543.72	3.80	1117.00
691.0	16585.48	3.40	1311.00
692.0	16627.4	2.20	1951.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
693.0	16669.5	2.00	1925.00
694.0	16711.76	4.20	1732.00
695.0	16754.19	3.00	1533.00
696.0	16796.8	2.80	821.00

APPENDIX B

INTERPOLATED AGE, LOG-TRANSFORMED CHARCOAL ACCUMULATION RATES, BACKGROUND, PEAKS, DETRENDED CHARCOAL ACCUMULATION RATES, AND FIRE FREQUENCY FOR CYGNET LAKE

CYGNET LAKE

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
0	0.933	1.015	0.00	-0.037	1.50
10	0.933	1.013	0.00	-0.036	1.40
20	0.933	1.010	0.00	-0.035	1.40
30	0.933	1.007	0.00	-0.033	1.40
40	0.933	1.004	0.00	-0.032	1.40
50	0.933	1.001	0.00	-0.030	1.40
60	0.933	0.997	0.00	-0.029	1.40
70	0.933	0.993	0.00	-0.027	1.40
80	0.933	0.988	0.00	-0.025	1.40
90	1.149	0.983	1.00	0.068	1.40
100	1.232	0.978	1.00	0.100	1.40
110	1.221	0.972	1.00	0.099	1.40
120	1.209	0.965	1.00	0.098	1.40
130	1.198	0.959	1.00	0.097	1.40
140	1.177	0.951	1.00	0.092	1.40
150	1.150	0.944	1.00	0.086	1.40
160	1.122	0.935	1.00	0.079	1.40
170	1.094	0.926	1.00	0.072	1.40
180	1.064	0.917	1.00	0.065	1.40
190	1.019	0.907	1.00	0.051	1.40
200	0.972	0.897	1.00	0.035	1.40
210	0.925	0.886	1.00	0.019	1.40
220	0.878	0.874	1.00	0.002	1.40
230	0.847	0.862	1.00	-0.008	1.40
240	0.837	0.849	1.00	-0.006	1.40
250	0.828	0.836	1.00	-0.004	1.40
260	0.818	0.822	1.00	-0.002	1.40
270	0.813	0.807	1.00	0.003	1.40
280	0.853	0.792	1.00	0.032	1.40
290	0.904	0.776	1.00	0.066	1.40
300	0.956	0.760	1.00	0.100	1.40
310	1.007	0.743	1.00	0.132	1.40
320	1.014	0.726	1.00	0.145	1.50

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
330	0.948	0.708	1.00	0.127	1.50
340	0.881	0.691	1.00	0.106	1.50
350	0.814	0.673	1.00	0.083	1.50
360	0.747	0.655	1.00	0.057	1.50
370	0.685	0.638	1.00	0.031	1.50
380	0.624	0.620	1.00	0.002	1.50
390	0.563	0.603	0.00	-0.030	1.50
400	0.502	0.587	0.00	-0.068	1.50
410	0.452	0.570	0.00	-0.101	1.60
420	0.418	0.554	0.00	-0.123	1.60
430	0.384	0.539	0.00	-0.147	1.60
440	0.351	0.525	0.00	-0.175	1.60
450	0.319	0.511	0.00	-0.204	1.60
460	0.306	0.498	0.00	-0.211	1.60
470	0.297	0.486	0.00	-0.214	1.70
480	0.288	0.475	0.00	-0.217	1.70
490	0.279	0.465	0.00	-0.221	1.70
500	0.269	0.456	0.00	-0.229	1.70
510	0.257	0.448	0.00	-0.242	1.70
520	0.245	0.442	0.00	-0.256	1.80
530	0.233	0.437	0.00	-0.273	1.80
540	0.221	0.434	0.00	-0.293	1.80
550	0.207	0.432	0.00	-0.320	1.80
560	0.193	0.432	0.00	-0.349	1.90
570	0.179	0.433	0.00	-0.383	1.90
580	0.165	0.435	0.00	-0.421	1.90
590	0.175	0.439	0.00	-0.400	1.90
600	0.203	0.445	0.00	-0.341	2.00
610	0.231	0.452	0.00	-0.291	2.00
620	0.259	0.460	0.00	-0.250	2.00
630	0.288	0.471	0.00	-0.213	2.10
640	0.322	0.482	0.00	-0.175	2.10
650	0.357	0.495	0.00	-0.142	2.10
660	0.392	0.510	0.00	-0.114	2.10

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
670	0.424	0.525	0.00	-0.093	2.20
680	0.423	0.541	0.00	-0.107	2.20
690	0.408	0.559	0.00	-0.136	2.20
700	0.394	0.576	0.00	-0.165	2.30
710	0.380	0.594	0.00	-0.194	2.30
720	0.387	0.612	0.00	-0.199	2.40
730	0.424	0.630	0.00	-0.172	2.40
740	0.461	0.648	0.00	-0.148	2.40
750	0.499	0.665	0.00	-0.125	2.50
760	0.534	0.682	0.00	-0.106	2.50
770	0.558	0.697	0.00	-0.097	2.50
780	0.581	0.712	0.00	-0.088	2.60
790	0.604	0.726	0.00	-0.080	2.60
800	0.632	0.739	0.00	-0.068	2.70
810	0.788	0.750	1.00	0.021	2.70
820	1.001	0.761	1.00	0.119	2.70
830	1.214	0.770	1.00	0.198	2.80
840	1.428	0.778	1.00	0.264	2.80
850	1.503	0.785	1.00	0.282	2.80
860	1.379	0.791	1.00	0.242	2.90
870	1.254	0.795	1.00	0.198	2.90
880	1.128	0.799	1.00	0.150	3.00
890	1.037	0.802	1.00	0.112	3.00
900	1.082	0.804	1.00	0.129	3.00
910	1.142	0.805	1.00	0.152	3.10
920	1.202	0.805	1.00	0.174	3.10
930	1.260	0.804	1.00	0.195	3.20
940	1.286	0.802	1.00	0.205	3.20
950	1.303	0.800	1.00	0.212	3.20
960	1.319	0.797	1.00	0.219	3.30
970	1.336	0.793	1.00	0.227	3.30
980	1.265	0.788	1.00	0.206	3.30
990	1.125	0.782	1.00	0.158	3.40
1000	0.984	0.776	1.00	0.103	3.40

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
1010	0.843	0.768	1.00	0.040	3.40
1020	0.731	0.760	1.00	-0.017	3.50
1030	0.676	0.751	0.00	-0.046	3.50
1040	0.623	0.741	0.00	-0.075	3.50
1050	0.570	0.730	0.00	-0.107	3.60
1060	0.517	0.717	0.00	-0.142	3.60
1070	0.466	0.704	0.00	-0.179	3.60
1080	0.414	0.691	0.00	-0.222	3.70
1090	0.363	0.676	0.00	-0.270	3.70
1100	0.315	0.661	0.00	-0.322	3.70
1110	0.306	0.645	0.00	-0.324	3.70
1120	0.309	0.629	0.00	-0.309	3.80
1130	0.312	0.613	0.00	-0.293	3.80
1140	0.314	0.596	0.00	-0.278	3.80
1150	0.319	0.580	0.00	-0.259	3.80
1160	0.325	0.564	0.00	-0.239	3.90
1170	0.331	0.548	0.00	-0.219	3.90
1180	0.337	0.533	0.00	-0.199	3.90
1190	0.362	0.518	0.00	-0.156	3.90
1200	0.409	0.504	0.00	-0.091	4.00
1210	0.455	0.492	0.00	-0.034	4.00
1220	0.502	0.479	1.00	0.020	4.00
1230	0.535	0.468	1.00	0.058	4.00
1240	0.539	0.458	1.00	0.071	4.00
1250	0.543	0.449	1.00	0.083	4.10
1260	0.547	0.440	1.00	0.094	4.10
1270	0.540	0.433	1.00	0.096	4.10
1280	0.494	0.427	1.00	0.064	4.10
1290	0.445	0.421	1.00	0.024	4.20
1300	0.397	0.417	0.00	-0.021	4.20
1310	0.356	0.413	0.00	-0.065	4.20
1320	0.361	0.410	0.00	-0.056	4.20
1330	0.372	0.408	0.00	-0.041	4.20
1340	0.383	0.407	0.00	-0.026	4.30

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
1350	0.391	0.406	0.00	-0.017	4.30
1360	0.383	0.406	0.00	-0.025	4.30
1370	0.370	0.406	0.00	-0.040	4.30
1380	0.357	0.406	0.00	-0.056	4.30
1390	0.346	0.407	0.00	-0.070	4.40
1400	0.359	0.408	0.00	-0.055	4.40
1410	0.380	0.408	0.00	-0.031	4.40
1420	0.401	0.409	0.00	-0.009	4.40
1430	0.421	0.410	1.00	0.012	4.40
1440	0.420	0.410	1.00	0.010	4.50
1450	0.411	0.411	1.00	0.000	4.50
1460	0.402	0.411	0.00	-0.010	4.50
1470	0.393	0.411	0.00	-0.020	4.50
1480	0.389	0.411	0.00	-0.024	4.50
1490	0.388	0.411	0.00	-0.025	4.50
1500	0.387	0.410	0.00	-0.025	4.50
1510	0.386	0.409	0.00	-0.025	4.60
1520	0.390	0.408	0.00	-0.020	4.60
1530	0.397	0.407	0.00	-0.011	4.60
1540	0.403	0.406	0.00	-0.004	4.60
1550	0.410	0.406	1.00	0.005	4.60
1560	0.408	0.405	1.00	0.003	4.60
1570	0.401	0.404	0.00	-0.004	4.70
1580	0.394	0.404	0.00	-0.011	4.70
1590	0.387	0.405	0.00	-0.019	4.70
1600	0.377	0.406	0.00	-0.032	4.70
1610	0.363	0.407	0.00	-0.050	4.70
1620	0.350	0.410	0.00	-0.068	4.70
1630	0.337	0.413	0.00	-0.088	4.80
1640	0.371	0.417	0.00	-0.051	4.80
1650	0.440	0.422	1.00	0.018	4.80
1660	0.510	0.428	1.00	0.076	4.80
1670	0.580	0.435	1.00	0.125	4.80
1680	0.593	0.444	1.00	0.126	4.90

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
1690	0.567	0.453	1.00	0.097	4.90
1700	0.541	0.463	1.00	0.067	4.90
1710	0.515	0.475	1.00	0.035	4.90
1720	0.478	0.487	1.00	-0.008	4.90
1730	0.433	0.500	0.00	-0.062	5.00
1740	0.389	0.514	0.00	-0.121	5.00
1750	0.345	0.528	0.00	-0.185	5.00
1760	0.326	0.542	0.00	-0.221	5.00
1770	0.322	0.557	0.00	-0.238	5.00
1780	0.317	0.571	0.00	-0.256	5.00
1790	0.312	0.586	0.00	-0.273	5.10
1800	0.296	0.599	0.00	-0.306	5.10
1810	0.275	0.613	0.00	-0.348	5.10
1820	0.255	0.626	0.00	-0.390	5.10
1830	0.238	0.638	0.00	-0.428	5.10
1840	0.281	0.649	0.00	-0.364	5.10
1850	0.343	0.660	0.00	-0.284	5.10
1860	0.405	0.670	0.00	-0.219	5.20
1870	0.467	0.680	0.00	-0.163	5.20
1880	0.530	0.689	0.00	-0.114	5.20
1890	0.592	0.698	0.00	-0.072	5.20
1900	0.655	0.707	0.00	-0.033	5.20
1910	0.730	0.716	1.00	0.009	5.20
1920	0.872	0.725	1.00	0.080	5.20
1930	1.024	0.733	1.00	0.145	5.20
1940	1.176	0.742	1.00	0.200	5.20
1950	1.296	0.751	1.00	0.237	5.30
1960	1.309	0.760	1.00	0.236	5.30
1970	1.313	0.770	1.00	0.232	5.30
1980	1.317	0.779	1.00	0.228	5.30
1990	1.323	0.789	1.00	0.224	5.30
2000	1.333	0.799	1.00	0.222	5.30
2010	1.342	0.809	1.00	0.220	5.30
2020	1.352	0.818	1.00	0.218	5.30

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
2030	1.304	0.828	1.00	0.197	5.30
2040	1.188	0.837	1.00	0.152	5.30
2050	1.071	0.846	1.00	0.102	5.30
2060	0.955	0.854	1.00	0.049	5.30
2070	0.872	0.861	1.00	0.005	5.30
2080	0.810	0.868	0.00	-0.030	5.30
2090	0.747	0.873	0.00	-0.068	5.30
2100	0.683	0.878	0.00	-0.109	5.30
2110	0.594	0.881	0.00	-0.171	5.30
2120	0.497	0.883	0.00	-0.250	5.30
2130	0.400	0.883	0.00	-0.344	5.30
2140	0.324	0.882	0.00	-0.435	5.30
2150	0.360	0.880	0.00	-0.388	5.30
2160	0.413	0.877	0.00	-0.327	5.30
2170	0.465	0.872	0.00	-0.273	5.30
2180	0.578	0.866	0.00	-0.176	5.30
2190	0.838	0.859	1.00	-0.011	5.30
2200	1.105	0.851	1.00	0.113	5.30
2210	1.372	0.842	1.00	0.212	5.30
2220	1.410	0.833	1.00	0.229	5.30
2230	1.212	0.823	1.00	0.168	5.30
2240	1.014	0.812	1.00	0.096	5.40
2250	0.823	0.801	1.00	0.012	5.40
2260	0.811	0.790	1.00	0.011	5.40
2270	0.872	0.779	1.00	0.049	5.40
2280	0.933	0.768	1.00	0.084	5.40
2290	0.978	0.757	1.00	0.111	5.40
2300	0.932	0.747	1.00	0.096	5.40
2310	0.870	0.736	1.00	0.073	5.40
2320	0.809	0.726	1.00	0.047	5.40
2330	0.756	0.716	1.00	0.023	5.50
2340	0.721	0.707	1.00	0.008	5.50
2350	0.687	0.699	1.00	-0.007	5.50
2360	0.653	0.691	0.00	-0.025	5.50

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
2370	0.668	0.684	1.00	-0.010	5.50
2380	0.716	0.678	1.00	0.024	5.50
2390	0.764	0.672	1.00	0.056	5.60
2400	0.803	0.667	1.00	0.081	5.60
2410	0.761	0.662	1.00	0.061	5.60
2420	0.701	0.658	1.00	0.028	5.60
2430	0.641	0.654	1.00	-0.009	5.60
2440	0.593	0.650	0.00	-0.040	5.70
2450	0.576	0.646	0.00	-0.050	5.70
2460	0.560	0.642	0.00	-0.060	5.70
2470	0.544	0.639	0.00	-0.070	5.70
2480	0.557	0.635	0.00	-0.057	5.70
2490	0.589	0.631	0.00	-0.030	5.80
2500	0.621	0.628	1.00	-0.005	5.80
2510	0.639	0.624	1.00	0.010	5.80
2520	0.546	0.621	0.00	-0.056	5.80
2530	0.431	0.619	0.00	-0.157	5.90
2540	0.315	0.617	0.00	-0.292	5.90
2550	0.242	0.615	0.00	-0.405	5.90
2560	0.246	0.614	0.00	-0.397	5.90
2570	0.253	0.614	0.00	-0.385	6.00
2580	0.259	0.613	0.00	-0.374	6.00
2590	0.255	0.614	0.00	-0.381	6.00
2600	0.246	0.614	0.00	-0.397	6.00
2610	0.237	0.615	0.00	-0.414	6.10
2620	0.236	0.616	0.00	-0.416	6.10
2630	0.268	0.617	0.00	-0.362	6.10
2640	0.302	0.618	0.00	-0.311	6.10
2650	0.337	0.620	0.00	-0.265	6.20
2660	0.526	0.622	0.00	-0.073	6.20
2670	0.845	0.625	1.00	0.131	6.20
2680	1.164	0.628	1.00	0.268	6.20
2690	1.427	0.633	1.00	0.353	6.20
2700	1.324	0.638	1.00	0.317	6.30

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
2710	1.154	0.644	1.00	0.254	6.30
2720	0.983	0.651	1.00	0.179	6.30
2730	0.853	0.658	1.00	0.112	6.30
2740	0.773	0.667	1.00	0.064	6.30
2750	0.694	0.676	1.00	0.011	6.40
2760	0.618	0.686	0.00	-0.045	6.40
2770	0.577	0.696	0.00	-0.081	6.40
2780	0.544	0.706	0.00	-0.113	6.40
2790	0.510	0.717	0.00	-0.148	6.40
2800	0.535	0.727	0.00	-0.133	6.40
2810	0.652	0.737	0.00	-0.053	6.50
2820	0.770	0.747	1.00	0.013	6.50
2830	0.880	0.757	1.00	0.066	6.50
2840	0.900	0.766	1.00	0.070	6.50
2850	0.896	0.774	1.00	0.063	6.50
2860	0.892	0.782	1.00	0.057	6.50
2870	0.858	0.789	1.00	0.037	6.50
2880	0.775	0.795	1.00	-0.011	6.50
2890	0.691	0.800	0.00	-0.064	6.50
2900	0.614	0.804	0.00	-0.117	6.60
2910	0.594	0.807	0.00	-0.133	6.60
2920	0.588	0.809	0.00	-0.139	6.60
2930	0.582	0.811	0.00	-0.144	6.60
2940	0.584	0.811	0.00	-0.143	6.60
2950	0.597	0.811	0.00	-0.133	6.60
2960	0.609	0.810	0.00	-0.124	6.60
2970	0.639	0.808	0.00	-0.102	6.60
2980	0.771	0.806	0.00	-0.019	6.60
2990	0.921	0.804	1.00	0.059	6.60
3000	1.072	0.803	1.00	0.126	6.60
3010	1.228	0.801	1.00	0.185	6.60
3020	1.389	0.801	1.00	0.239	6.60
3030	1.550	0.801	1.00	0.287	6.70
3040	1.617	0.802	1.00	0.305	6.70

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
3050	1.344	0.803	1.00	0.224	6.70
3060	1.042	0.806	1.00	0.112	6.70
3070	0.746	0.809	0.00	-0.035	6.70
3080	0.634	0.812	0.00	-0.107	6.70
3090	0.600	0.816	0.00	-0.133	6.70
3100	0.566	0.819	0.00	-0.161	6.70
3110	0.587	0.824	0.00	-0.147	6.70
3120	0.706	0.828	0.00	-0.069	6.70
3130	0.826	0.832	1.00	-0.003	6.70
3140	0.919	0.837	1.00	0.041	6.80
3150	0.831	0.842	1.00	-0.006	6.80
3160	0.708	0.847	0.00	-0.078	6.80
3170	0.586	0.853	0.00	-0.163	6.80
3180	0.591	0.860	0.00	-0.163	6.80
3190	0.681	0.867	0.00	-0.105	6.80
3200	0.771	0.874	0.00	-0.054	6.80
3210	0.812	0.881	0.00	-0.035	6.80
3220	0.735	0.888	0.00	-0.082	6.90
3230	0.653	0.896	0.00	-0.137	6.90
3240	0.582	0.903	0.00	-0.191	6.90
3250	0.600	0.910	0.00	-0.181	6.90
3260	0.637	0.917	0.00	-0.158	6.90
3270	0.673	0.923	0.00	-0.137	6.90
3280	0.636	0.930	0.00	-0.165	6.90
3290	0.551	0.936	0.00	-0.230	7.00
3300	0.466	0.943	0.00	-0.306	7.00
3310	0.530	0.949	0.00	-0.253	7.00
3320	0.900	0.955	0.00	-0.026	7.00
3330	1.280	0.961	1.00	0.125	7.00
3340	1.598	0.966	1.00	0.218	7.00
3350	1.556	0.972	1.00	0.204	7.10
3360	1.458	0.977	1.00	0.174	7.10
3370	1.356	0.983	1.00	0.140	7.10
3380	1.181	0.988	1.00	0.078	7.10

Age	CHARs	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency
(cal yr BP)	(particles cm^{-2} yr^{-1})				(events/1000 yr)
3390	0.974	0.992	1.00	-0.008	7.10
3400	0.767	0.997	0.00	-0.114	7.10
3410	0.681	1.000	0.00	-0.167	7.20
3420	0.731	1.004	0.00	-0.138	7.20
3430	0.781	1.007	0.00	-0.110	7.20
3440	0.881	1.009	0.00	-0.059	7.20
3450	1.117	1.011	1.00	0.043	7.20
3460	1.362	1.012	1.00	0.129	7.20
3470	1.591	1.013	1.00	0.196	7.30
3480	1.726	1.014	1.00	0.231	7.30
3490	1.844	1.014	1.00	0.260	7.30
3500	1.945	1.014	1.00	0.283	7.30
3510	1.692	1.014	1.00	0.222	7.30
3520	1.300	1.014	1.00	0.108	7.30
3530	0.907	1.013	0.00	-0.048	7.30
3540	0.788	1.012	0.00	-0.109	7.30
3550	0.890	1.011	0.00	-0.056	7.30
3560	0.993	1.011	1.00	-0.008	7.30
3570	1.070	1.010	1.00	0.025	7.30
3580	1.099	1.009	1.00	0.037	7.30
3590	1.129	1.009	1.00	0.049	7.30
3600	1.136	1.008	1.00	0.052	7.30
3610	1.073	1.008	1.00	0.027	7.30
3620	1.004	1.007	1.00	-0.001	7.30
3630	0.931	1.006	0.00	-0.034	7.30
3640	0.826	1.005	0.00	-0.085	7.30
3650	0.717	1.004	0.00	-0.146	7.40
3660	0.609	1.002	0.00	-0.216	7.40
3670	0.531	1.000	0.00	-0.275	7.40
3680	0.461	0.997	0.00	-0.335	7.40
3690	0.394	0.993	0.00	-0.401	7.40
3700	0.435	0.989	0.00	-0.357	7.40
3710	0.528	0.984	0.00	-0.270	7.40
3720	0.621	0.979	0.00	-0.198	7.40

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
3730	0.765	0.973	0.00	-0.104	7.40
3740	0.948	0.966	1.00	-0.008	7.40
3750	1.131	0.960	1.00	0.071	7.40
3760	1.177	0.953	1.00	0.092	7.40
3770	1.067	0.946	1.00	0.052	7.40
3780	0.956	0.940	1.00	0.007	7.40
3790	0.879	0.934	0.00	-0.026	7.40
3800	0.858	0.929	0.00	-0.035	7.40
3810	0.838	0.924	0.00	-0.043	7.40
3820	0.792	0.920	0.00	-0.065	7.40
3830	0.686	0.917	0.00	-0.126	7.40
3840	0.577	0.914	0.00	-0.200	7.40
3850	0.656	0.912	0.00	-0.143	7.50
3860	1.291	0.911	1.00	0.151	7.50
3870	1.962	0.910	1.00	0.333	7.50
3880	2.382	0.910	1.00	0.418	7.50
3890	1.870	0.911	1.00	0.312	7.50
3900	1.272	0.913	1.00	0.144	7.50
3910	0.820	0.915	0.00	-0.048	7.50
3920	1.008	0.918	1.00	0.041	7.50
3930	1.272	0.921	1.00	0.140	7.50
3940	1.452	0.924	1.00	0.196	7.60
3950	1.204	0.928	1.00	0.113	7.60
3960	0.897	0.931	1.00	-0.016	7.60
3970	0.619	0.934	0.00	-0.178	7.60
3980	0.503	0.936	0.00	-0.270	7.60
3990	0.411	0.937	0.00	-0.358	7.60
4000	0.336	0.937	0.00	-0.445	7.60
4010	0.363	0.936	0.00	-0.411	7.70
4020	0.405	0.933	0.00	-0.363	7.70
4030	0.440	0.930	0.00	-0.325	7.70
4040	0.430	0.925	0.00	-0.333	7.70
4050	0.413	0.919	0.00	-0.347	7.70
4060	0.479	0.912	0.00	-0.280	7.80

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
4070	0.996	0.905	1.00	0.042	7.80
4080	1.582	0.897	1.00	0.246	7.80
4090	2.003	0.889	1.00	0.353	7.80
4100	1.609	0.882	1.00	0.261	7.80
4110	1.106	0.874	1.00	0.102	7.80
4120	0.686	0.867	0.00	-0.102	7.90
4130	0.613	0.860	0.00	-0.147	7.90
4140	0.580	0.854	0.00	-0.168	7.90
4150	0.549	0.848	0.00	-0.189	7.90
4160	0.528	0.842	0.00	-0.203	7.90
4170	0.508	0.837	0.00	-0.217	7.90
4180	0.564	0.832	0.00	-0.169	7.90
4190	0.835	0.828	1.00	0.004	8.00
4200	1.120	0.824	1.00	0.133	8.00
4210	1.374	0.821	1.00	0.224	8.00
4220	1.560	0.819	1.00	0.280	8.00
4230	1.744	0.816	1.00	0.330	8.00
4240	1.695	0.814	1.00	0.318	8.00
4250	1.276	0.813	1.00	0.196	8.00
4260	0.851	0.811	1.00	0.021	8.00
4270	0.585	0.809	0.00	-0.141	8.00
4280	0.492	0.806	0.00	-0.214	8.00
4290	0.399	0.802	0.00	-0.303	8.00
4300	0.341	0.798	0.00	-0.369	8.00
4310	0.308	0.793	0.00	-0.411	8.00
4320	0.278	0.787	0.00	-0.452	8.00
4330	0.341	0.781	0.00	-0.360	8.00
4340	0.447	0.773	0.00	-0.238	8.00
4350	0.539	0.766	0.00	-0.153	8.00
4360	0.479	0.758	0.00	-0.199	8.00
4370	0.376	0.750	0.00	-0.300	8.00
4380	0.355	0.743	0.00	-0.321	8.00
4390	0.807	0.736	1.00	0.040	8.00
4400	1.336	0.729	1.00	0.263	8.00

Age	CHARs	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency
(cal yr BP)	(particles cm^{-2} yr^{-1})				(events/1000 yr)
4410	1.675	0.723	1.00	0.365	8.00
4420	1.409	0.718	1.00	0.293	8.00
4430	1.097	0.714	1.00	0.187	8.00
4440	0.898	0.711	1.00	0.102	8.00
4450	0.896	0.708	1.00	0.102	7.90
4460	0.897	0.707	1.00	0.104	7.90
4470	0.823	0.706	1.00	0.067	7.90
4480	0.684	0.706	1.00	-0.013	7.90
4490	0.551	0.706	0.00	-0.108	7.90
4500	0.569	0.708	0.00	-0.095	7.90
4510	0.652	0.711	0.00	-0.037	7.90
4520	0.710	0.714	1.00	-0.003	7.90
4530	0.572	0.719	0.00	-0.100	7.90
4540	0.394	0.725	0.00	-0.265	7.90
4550	0.265	0.732	0.00	-0.441	7.90
4560	0.298	0.740	0.00	-0.395	7.90
4570	0.343	0.749	0.00	-0.339	7.90
4580	0.384	0.758	0.00	-0.295	7.90
4590	0.419	0.767	0.00	-0.263	7.90
4600	0.453	0.776	0.00	-0.234	7.90
4610	0.430	0.786	0.00	-0.262	7.90
4620	0.375	0.795	0.00	-0.326	7.90
4630	0.328	0.803	0.00	-0.389	7.90
4640	0.356	0.811	0.00	-0.357	7.90
4650	0.403	0.818	0.00	-0.307	7.90
4660	0.565	0.825	0.00	-0.164	7.90
4670	1.087	0.831	1.00	0.117	7.90
4680	1.636	0.837	1.00	0.291	7.90
4690	1.715	0.842	1.00	0.309	7.90
4700	1.245	0.847	1.00	0.167	7.90
4710	0.792	0.852	0.00	-0.032	7.90
4720	0.735	0.857	0.00	-0.066	7.90
4730	0.835	0.861	1.00	-0.013	8.00
4740	0.916	0.866	1.00	0.024	8.00

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
4750	0.905	0.871	1.00	0.017	8.00
4760	0.881	0.875	1.00	0.003	8.00
4770	0.846	0.881	1.00	-0.017	8.00
4780	0.791	0.886	0.00	-0.049	8.00
4790	0.741	0.892	0.00	-0.080	8.00
4800	0.854	0.898	1.00	-0.022	8.00
4810	1.045	0.904	1.00	0.063	8.00
4820	1.266	0.911	1.00	0.143	8.00
4830	1.640	0.918	1.00	0.252	8.00
4840	2.037	0.925	1.00	0.343	8.00
4850	2.100	0.931	1.00	0.353	8.00
4860	1.669	0.938	1.00	0.250	8.00
4870	1.238	0.944	1.00	0.118	8.00
4880	0.963	0.950	1.00	0.006	8.00
4890	0.751	0.955	0.00	-0.104	8.00
4900	0.583	0.959	0.00	-0.216	8.00
4910	0.589	0.962	0.00	-0.213	8.00
4920	0.610	0.965	0.00	-0.199	8.00
4930	0.756	0.967	0.00	-0.107	8.00
4940	1.020	0.968	1.00	0.023	8.00
4950	1.237	0.968	1.00	0.106	8.00
4960	1.037	0.968	1.00	0.030	8.00
4970	0.739	0.968	0.00	-0.117	8.00
4980	0.590	0.967	0.00	-0.215	8.00
4990	0.739	0.966	0.00	-0.116	8.00
5000	0.889	0.965	0.00	-0.036	8.00
5010	0.843	0.964	0.00	-0.058	8.00
5020	0.711	0.962	0.00	-0.131	8.00
5030	0.597	0.961	0.00	-0.207	8.00
5040	0.541	0.960	0.00	-0.249	8.00
5050	0.491	0.959	0.00	-0.291	8.00
5060	0.570	0.958	0.00	-0.226	8.00
5070	0.737	0.958	0.00	-0.114	8.00
5080	0.863	0.958	0.00	-0.045	8.00

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
5090	0.784	0.958	0.00	-0.087	7.90
5100	0.676	0.959	0.00	-0.152	7.90
5110	0.941	0.960	1.00	-0.009	7.90
5120	1.562	0.961	1.00	0.211	7.90
5130	2.068	0.963	1.00	0.332	7.90
5140	1.824	0.966	1.00	0.276	7.80
5150	1.445	0.969	1.00	0.173	7.80
5160	1.132	0.973	1.00	0.066	7.80
5170	0.895	0.977	0.00	-0.038	7.80
5180	0.682	0.981	0.00	-0.158	7.80
5190	0.646	0.985	0.00	-0.183	7.70
5200	0.643	0.990	0.00	-0.187	7.70
5210	0.644	0.994	0.00	-0.189	7.70
5220	0.649	0.998	0.00	-0.187	7.70
5230	0.671	1.002	0.00	-0.174	7.70
5240	0.811	1.005	0.00	-0.093	7.60
5250	0.972	1.007	0.00	-0.015	7.60
5260	1.101	1.009	1.00	0.038	7.60
5270	1.199	1.011	1.00	0.074	7.60
5280	1.278	1.012	1.00	0.101	7.60
5290	1.261	1.015	1.00	0.094	7.50
5300	1.230	1.019	1.00	0.082	7.50
5310	1.181	1.023	1.00	0.062	7.50
5320	1.119	1.030	1.00	0.036	7.50
5330	1.053	1.038	1.00	0.006	7.50
5340	0.972	1.047	0.00	-0.032	7.50
5350	0.897	1.058	0.00	-0.072	7.50
5360	1.067	1.071	1.00	-0.001	7.50
5370	1.356	1.084	1.00	0.097	7.50
5380	1.485	1.098	1.00	0.131	7.50
5390	1.263	1.113	1.00	0.055	7.50
5400	1.054	1.128	0.00	-0.030	7.50
5410	1.131	1.144	1.00	-0.005	7.50
5420	1.285	1.159	1.00	0.045	7.50

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
5430	1.361	1.174	1.00	0.064	7.50
5440	1.346	1.189	1.00	0.054	7.50
5450	1.284	1.203	1.00	0.028	7.50
5460	1.013	1.218	0.00	-0.080	7.50
5470	0.718	1.232	0.00	-0.234	7.50
5480	0.540	1.247	0.00	-0.363	7.50
5490	0.420	1.262	0.00	-0.478	7.50
5500	0.413	1.277	0.00	-0.490	7.50
5510	0.626	1.294	0.00	-0.315	7.50
5520	0.830	1.310	0.00	-0.198	7.50
5530	0.913	1.328	0.00	-0.163	7.50
5540	0.971	1.345	0.00	-0.142	7.50
5550	0.856	1.363	0.00	-0.202	7.60
5560	0.620	1.381	0.00	-0.348	7.60
5570	0.509	1.398	0.00	-0.439	7.60
5580	0.696	1.416	0.00	-0.308	7.60
5590	0.892	1.433	0.00	-0.206	7.60
5600	1.059	1.450	0.00	-0.136	7.60
5610	1.231	1.466	0.00	-0.076	7.60
5620	2.605	1.482	1.00	0.245	7.60
5630	4.808	1.497	1.00	0.507	7.60
5640	5.717	1.511	1.00	0.578	7.60
5650	3.814	1.525	1.00	0.398	7.60
5660	2.054	1.538	1.00	0.126	7.70
5670	1.867	1.550	1.00	0.081	7.70
5680	1.953	1.561	1.00	0.097	7.70
5690	1.704	1.571	1.00	0.035	7.70
5700	1.285	1.581	0.00	-0.090	7.70
5710	0.976	1.591	0.00	-0.212	7.70
5720	0.826	1.600	0.00	-0.287	7.70
5730	0.693	1.608	0.00	-0.366	7.70
5740	0.623	1.616	0.00	-0.414	7.70
5750	0.567	1.624	0.00	-0.457	7.70
5760	0.620	1.632	0.00	-0.420	7.70

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
5770	0.706	1.638	0.00	-0.366	7.70
5780	1.037	1.644	0.00	-0.200	7.80
5790	1.534	1.650	1.00	-0.032	7.80
5800	2.141	1.654	1.00	0.112	7.80
5810	2.934	1.657	1.00	0.248	7.80
5820	3.611	1.659	1.00	0.338	7.80
5830	3.824	1.661	1.00	0.362	7.80
5840	3.913	1.661	1.00	0.372	7.80
5850	3.232	1.659	1.00	0.290	7.80
5860	2.361	1.657	1.00	0.154	7.80
5870	1.721	1.654	1.00	0.017	7.80
5880	1.204	1.650	0.00	-0.137	7.80
5890	0.897	1.645	0.00	-0.263	7.80
5900	0.837	1.639	0.00	-0.292	7.80
5910	0.829	1.632	0.00	-0.294	7.90
5920	0.946	1.624	0.00	-0.235	7.90
5930	1.018	1.616	0.00	-0.201	7.90
5940	0.852	1.608	0.00	-0.276	7.90
5950	0.685	1.598	0.00	-0.368	7.90
5960	0.806	1.589	0.00	-0.295	7.90
5970	0.993	1.579	0.00	-0.202	7.90
5980	0.883	1.570	0.00	-0.250	7.90
5990	0.633	1.560	0.00	-0.392	7.90
6000	0.636	1.549	0.00	-0.387	7.90
6010	0.852	1.538	0.00	-0.256	7.90
6020	1.421	1.526	1.00	-0.031	7.90
6030	2.529	1.512	1.00	0.223	7.90
6040	3.301	1.498	1.00	0.343	8.00
6050	3.196	1.483	1.00	0.333	8.00
6060	2.880	1.468	1.00	0.293	8.00
6070	1.871	1.452	1.00	0.110	8.00
6080	0.980	1.437	0.00	-0.166	8.00
6090	1.414	1.423	1.00	-0.003	8.00
6100	2.037	1.409	1.00	0.160	8.00

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
6110	1.912	1.397	1.00	0.136	8.10
6120	1.569	1.386	1.00	0.054	8.10
6130	1.213	1.376	0.00	-0.055	8.10
6140	0.858	1.367	0.00	-0.202	8.10
6150	1.197	1.360	0.00	-0.055	8.20
6160	1.965	1.354	1.00	0.162	8.20
6170	1.953	1.349	1.00	0.161	8.20
6180	1.259	1.345	1.00	-0.029	8.30
6190	1.026	1.342	0.00	-0.117	8.30
6200	1.365	1.339	1.00	0.008	8.30
6210	1.590	1.336	1.00	0.076	8.40
6220	1.623	1.332	1.00	0.086	8.40
6230	1.503	1.327	1.00	0.054	8.50
6240	1.063	1.321	0.00	-0.094	8.50
6250	0.734	1.314	0.00	-0.253	8.60
6260	0.730	1.305	0.00	-0.252	8.60
6270	0.741	1.294	0.00	-0.242	8.70
6280	0.753	1.282	0.00	-0.231	8.70
6290	0.765	1.269	0.00	-0.220	8.80
6300	0.777	1.255	0.00	-0.208	8.80
6310	0.789	1.241	0.00	-0.197	8.90
6320	0.801	1.226	0.00	-0.185	8.90
6330	0.813	1.211	0.00	-0.173	9.00
6340	0.824	1.196	0.00	-0.162	9.00
6350	0.835	1.183	0.00	-0.151	9.10
6360	0.836	1.170	0.00	-0.146	9.20
6370	0.875	1.160	0.00	-0.122	9.20
6380	1.124	1.150	1.00	-0.010	9.30
6390	1.562	1.143	1.00	0.136	9.30
6400	2.858	1.137	1.00	0.400	9.40
6410	3.862	1.133	1.00	0.532	9.40
6420	2.538	1.131	1.00	0.351	9.50
6430	1.111	1.129	1.00	-0.007	9.50
6440	1.018	1.129	0.00	-0.045	9.60

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
6450	1.053	1.129	0.00	-0.030	9.60
6460	0.769	1.129	0.00	-0.167	9.70
6470	0.484	1.129	0.00	-0.368	9.70
6480	0.390	1.129	0.00	-0.462	9.80
6490	0.377	1.129	0.00	-0.476	9.80
6500	0.599	1.128	0.00	-0.275	9.80
6510	0.823	1.127	0.00	-0.136	9.90
6520	0.973	1.125	0.00	-0.063	9.90
6530	1.103	1.123	1.00	-0.008	9.90
6540	1.192	1.120	1.00	0.027	9.90
6550	1.275	1.117	1.00	0.057	10.00
6560	1.347	1.113	1.00	0.083	10.00
6570	1.251	1.109	1.00	0.052	10.00
6580	0.827	1.104	0.00	-0.126	10.00
6590	0.609	1.099	0.00	-0.256	10.00
6600	0.720	1.094	0.00	-0.182	10.00
6610	0.732	1.088	0.00	-0.172	10.10
6620	0.624	1.082	0.00	-0.239	10.10
6630	0.603	1.076	0.00	-0.252	10.10
6640	0.666	1.070	0.00	-0.206	10.10
6650	1.528	1.064	1.00	0.157	10.10
6660	2.792	1.059	1.00	0.421	10.10
6670	2.385	1.054	1.00	0.355	10.10
6680	1.372	1.049	1.00	0.116	10.10
6690	1.500	1.045	1.00	0.157	10.00
6700	1.833	1.042	1.00	0.245	10.00
6710	1.276	1.040	1.00	0.089	10.00
6720	0.760	1.038	0.00	-0.135	10.00
6730	1.173	1.037	1.00	0.054	10.00
6740	1.462	1.037	1.00	0.149	10.00
6750	1.100	1.037	1.00	0.026	10.00
6760	0.785	1.037	0.00	-0.121	9.90
6770	0.621	1.038	0.00	-0.223	9.90
6780	0.508	1.039	0.00	-0.311	9.90

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
6790	0.446	1.039	0.00	-0.367	9.90
6800	0.430	1.038	0.00	-0.383	9.80
6810	0.443	1.036	0.00	-0.369	9.80
6820	0.465	1.033	0.00	-0.347	9.80
6830	0.499	1.029	0.00	-0.314	9.80
6840	0.600	1.025	0.00	-0.232	9.70
6850	0.764	1.019	0.00	-0.125	9.70
6860	1.115	1.013	1.00	0.042	9.70
6870	1.355	1.006	1.00	0.129	9.70
6880	1.329	0.999	1.00	0.124	9.60
6890	1.154	0.992	1.00	0.066	9.60
6900	0.834	0.985	0.00	-0.072	9.60
6910	0.832	0.978	0.00	-0.070	9.60
6920	1.047	0.972	1.00	0.033	9.60
6930	1.776	0.965	1.00	0.265	9.50
6940	2.309	0.958	1.00	0.382	9.50
6950	1.289	0.951	1.00	0.132	9.50
6960	0.485	0.944	0.00	-0.289	9.50
6970	0.592	0.938	0.00	-0.200	9.50
6980	0.953	0.932	1.00	0.010	9.50
6990	1.518	0.927	1.00	0.214	9.40
7000	1.341	0.922	1.00	0.163	9.40
7010	0.851	0.917	0.00	-0.032	9.40
7020	0.593	0.913	0.00	-0.187	9.40
7030	0.535	0.909	0.00	-0.230	9.40
7040	0.960	0.905	1.00	0.026	9.40
7050	1.229	0.901	1.00	0.135	9.40
7060	1.228	0.897	1.00	0.136	9.40
7070	0.984	0.893	1.00	0.042	9.40
7080	0.650	0.889	0.00	-0.136	9.40
7090	0.694	0.885	0.00	-0.105	9.40
7100	0.761	0.880	0.00	-0.063	9.40
7110	0.613	0.875	0.00	-0.155	9.40
7120	0.628	0.871	0.00	-0.142	9.40

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
7130	0.870	0.866	1.00	0.002	9.40
7140	0.922	0.860	1.00	0.030	9.40
7150	0.868	0.855	1.00	0.006	9.40
7160	0.712	0.850	0.00	-0.077	9.40
7170	0.568	0.845	0.00	-0.173	9.40
7180	0.498	0.840	0.00	-0.227	9.40
7190	0.645	0.836	0.00	-0.113	9.40
7200	0.983	0.833	1.00	0.072	9.40
7210	1.488	0.831	1.00	0.253	9.40
7220	1.770	0.830	1.00	0.329	9.40
7230	1.068	0.830	1.00	0.110	9.40
7240	0.600	0.832	0.00	-0.142	9.40
7250	0.537	0.835	0.00	-0.192	9.30
7260	0.474	0.839	0.00	-0.248	9.30
7270	0.427	0.845	0.00	-0.297	9.30
7280	0.455	0.853	0.00	-0.273	9.30
7290	0.582	0.863	0.00	-0.171	9.30
7300	0.836	0.875	0.00	-0.020	9.30
7310	0.820	0.888	0.00	-0.035	9.30
7320	0.667	0.903	0.00	-0.132	9.30
7330	0.458	0.920	0.00	-0.303	9.30
7340	0.350	0.938	0.00	-0.428	9.30
7350	0.409	0.958	0.00	-0.370	9.30
7360	0.530	0.979	0.00	-0.266	9.30
7370	0.675	1.001	0.00	-0.171	9.30
7380	0.810	1.024	0.00	-0.102	9.30
7390	0.901	1.047	0.00	-0.065	9.30
7400	0.921	1.071	0.00	-0.066	9.30
7410	0.742	1.096	0.00	-0.169	9.30
7420	0.747	1.121	0.00	-0.176	9.30
7430	1.662	1.146	1.00	0.162	9.30
7440	1.821	1.170	1.00	0.192	9.30
7450	1.220	1.194	1.00	0.009	9.20
7460	1.002	1.218	0.00	-0.085	9.20

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
7470	0.889	1.240	0.00	-0.144	9.20
7480	0.792	1.261	0.00	-0.202	9.20
7490	0.805	1.281	0.00	-0.202	9.20
7500	0.862	1.300	0.00	-0.178	9.20
7510	0.803	1.317	0.00	-0.215	9.20
7520	0.988	1.333	0.00	-0.130	9.20
7530	1.504	1.347	1.00	0.048	9.20
7540	1.709	1.359	1.00	0.099	9.20
7550	1.863	1.370	1.00	0.133	9.20
7560	2.145	1.379	1.00	0.192	9.20
7570	2.031	1.387	1.00	0.166	9.20
7580	1.691	1.393	1.00	0.084	9.20
7590	1.505	1.397	1.00	0.032	9.20
7600	1.488	1.401	1.00	0.026	9.20
7610	1.665	1.402	1.00	0.075	9.10
7620	1.996	1.402	1.00	0.153	9.10
7630	2.787	1.401	1.00	0.299	9.10
7640	4.377	1.399	1.00	0.496	9.10
7650	3.560	1.395	1.00	0.407	9.10
7660	1.900	1.390	1.00	0.136	9.10
7670	1.154	1.383	0.00	-0.079	9.10
7680	1.046	1.375	0.00	-0.119	9.10
7690	1.320	1.366	1.00	-0.015	9.00
7700	1.466	1.356	1.00	0.034	9.00
7710	1.703	1.344	1.00	0.103	9.00
7720	2.052	1.331	1.00	0.188	9.00
7730	2.303	1.318	1.00	0.242	9.00
7740	2.103	1.303	1.00	0.208	9.00
7750	1.248	1.289	1.00	-0.014	9.00
7760	0.813	1.273	0.00	-0.195	9.00
7770	0.643	1.257	0.00	-0.291	9.00
7780	0.760	1.241	0.00	-0.213	9.00
7790	1.035	1.224	0.00	-0.073	9.00
7800	1.163	1.207	1.00	-0.016	9.00

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
7810	0.745	1.189	0.00	-0.203	9.00
7820	0.472	1.171	0.00	-0.395	9.10
7830	0.400	1.153	0.00	-0.460	9.10
7840	0.696	1.134	0.00	-0.212	9.10
7850	0.692	1.115	0.00	-0.207	9.10
7860	0.514	1.096	0.00	-0.329	9.10
7870	0.383	1.077	0.00	-0.449	9.10
7880	0.473	1.059	0.00	-0.350	9.20
7890	0.630	1.040	0.00	-0.218	9.20
7900	0.503	1.023	0.00	-0.308	9.20
7910	0.584	1.006	0.00	-0.236	9.30
7920	0.867	0.990	0.00	-0.058	9.30
7930	1.317	0.975	1.00	0.130	9.30
7940	1.370	0.961	1.00	0.154	9.40
7950	1.112	0.948	1.00	0.069	9.40
7960	0.751	0.937	0.00	-0.096	9.40
7970	0.587	0.927	0.00	-0.198	9.50
7980	0.556	0.918	0.00	-0.218	9.50
7990	0.505	0.912	0.00	-0.256	9.60
8000	0.520	0.906	0.00	-0.241	9.60
8010	0.540	0.903	0.00	-0.223	9.70
8020	0.448	0.901	0.00	-0.303	9.70
8030	0.647	0.900	0.00	-0.143	9.70
8040	0.995	0.901	1.00	0.043	9.80
8050	1.308	0.903	1.00	0.161	9.80
8060	1.514	0.905	1.00	0.223	9.90
8070	1.524	0.909	1.00	0.224	9.90
8080	1.194	0.913	1.00	0.116	10.00
8090	1.253	0.918	1.00	0.135	10.00
8100	1.365	0.923	1.00	0.170	10.10
8110	1.312	0.929	1.00	0.150	10.10
8120	1.440	0.934	1.00	0.188	10.20
8130	1.337	0.938	1.00	0.154	10.20
8140	0.886	0.942	0.00	-0.027	10.30

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
8150	0.988	0.946	1.00	0.019	10.30
8160	0.968	0.948	1.00	0.009	10.40
8170	0.800	0.950	0.00	-0.075	10.40
8180	1.190	0.952	1.00	0.097	10.50
8190	0.968	0.952	1.00	0.007	10.50
8200	0.406	0.952	0.00	-0.370	10.60
8210	0.478	0.952	0.00	-0.299	10.60
8220	0.771	0.951	0.00	-0.091	10.70
8230	1.030	0.950	1.00	0.035	10.70
8240	0.989	0.949	1.00	0.018	10.80
8250	0.832	0.948	0.00	-0.057	10.80
8260	0.661	0.946	0.00	-0.156	10.80
8270	0.545	0.945	0.00	-0.239	10.90
8280	0.589	0.943	0.00	-0.205	10.90
8290	0.687	0.942	0.00	-0.137	11.00
8300	0.882	0.940	0.00	-0.028	11.00
8310	1.429	0.938	1.00	0.183	11.00
8320	1.579	0.935	1.00	0.227	11.00
8330	1.405	0.933	1.00	0.178	11.10
8340	1.110	0.930	1.00	0.077	11.10
8350	1.493	0.926	1.00	0.207	11.10
8360	1.695	0.923	1.00	0.264	11.10
8370	1.187	0.919	1.00	0.111	11.20
8380	0.787	0.915	0.00	-0.065	11.20
8390	0.508	0.911	0.00	-0.254	11.20
8400	0.374	0.907	0.00	-0.385	11.20
8410	0.461	0.903	0.00	-0.292	11.20
8420	0.625	0.898	0.00	-0.158	11.20
8430	0.759	0.894	0.00	-0.071	11.30
8440	0.760	0.889	0.00	-0.068	11.30
8450	0.696	0.884	0.00	-0.104	11.30
8460	0.616	0.879	0.00	-0.154	11.30
8470	0.549	0.873	0.00	-0.202	11.30
8480	0.549	0.867	0.00	-0.199	11.30

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
8490	0.447	0.861	0.00	-0.285	11.30
8500	0.435	0.854	0.00	-0.293	11.30
8510	0.858	0.847	1.00	0.006	11.30
8520	1.336	0.840	1.00	0.202	11.30
8530	1.580	0.832	1.00	0.279	11.30
8540	1.457	0.824	1.00	0.247	11.30
8550	1.189	0.816	1.00	0.163	11.30
8560	1.151	0.809	1.00	0.153	11.30
8570	1.314	0.801	1.00	0.215	11.30
8580	1.527	0.794	1.00	0.284	11.30
8590	1.156	0.787	1.00	0.167	11.30
8600	0.722	0.780	0.00	-0.033	11.30
8610	0.552	0.773	0.00	-0.147	11.30
8620	0.772	0.768	1.00	0.002	11.30
8630	0.720	0.763	0.00	-0.025	11.30
8640	0.560	0.758	0.00	-0.132	11.30
8650	0.717	0.755	0.00	-0.022	11.30
8660	0.760	0.752	1.00	0.005	11.30
8670	0.647	0.750	0.00	-0.064	11.40
8680	0.436	0.748	0.00	-0.235	11.40
8690	0.526	0.748	0.00	-0.153	11.40
8700	0.654	0.747	0.00	-0.058	11.40
8710	0.723	0.747	1.00	-0.014	11.40
8720	0.654	0.747	0.00	-0.058	11.40
8730	0.579	0.747	0.00	-0.111	11.50
8740	0.504	0.747	0.00	-0.171	11.50
8750	0.430	0.747	0.00	-0.240	11.50
8760	0.357	0.747	0.00	-0.321	11.50
8770	0.394	0.747	0.00	-0.278	11.50
8780	0.514	0.747	0.00	-0.163	11.60
8790	0.661	0.748	0.00	-0.053	11.60
8800	0.556	0.748	0.00	-0.129	11.60
8810	0.459	0.750	0.00	-0.213	11.60
8820	0.515	0.753	0.00	-0.165	11.70

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
8830	0.878	0.758	1.00	0.064	11.70
8840	0.787	0.764	1.00	0.013	11.70
8850	0.542	0.771	0.00	-0.153	11.70
8860	0.435	0.780	0.00	-0.254	11.70
8870	0.617	0.791	0.00	-0.108	11.80
8880	0.967	0.804	1.00	0.080	11.80
8890	1.190	0.817	1.00	0.163	11.80
8900	0.774	0.832	0.00	-0.032	11.80
8910	0.722	0.848	0.00	-0.070	11.90
8920	0.722	0.865	0.00	-0.079	11.90
8930	0.599	0.882	0.00	-0.168	11.90
8940	0.541	0.900	0.00	-0.221	11.90
8950	0.719	0.917	0.00	-0.106	12.00
8960	1.143	0.934	1.00	0.088	12.00
8970	1.750	0.951	1.00	0.265	12.00
8980	1.330	0.967	1.00	0.138	12.00
8990	0.911	0.983	0.00	-0.033	12.10
9000	0.841	0.999	0.00	-0.075	12.10
9010	0.691	1.014	0.00	-0.167	12.10
9020	0.709	1.029	0.00	-0.162	12.10
9030	0.781	1.043	0.00	-0.126	12.10
9040	0.778	1.057	0.00	-0.133	12.20
9050	0.908	1.071	0.00	-0.072	12.20
9060	1.113	1.085	1.00	0.011	12.20
9070	1.249	1.098	1.00	0.056	12.20
9080	0.943	1.111	0.00	-0.071	12.30
9090	0.795	1.124	0.00	-0.151	12.30
9100	0.839	1.137	0.00	-0.132	12.30
9110	1.039	1.150	0.00	-0.044	12.30
9120	0.985	1.162	0.00	-0.072	12.30
9130	1.123	1.175	1.00	-0.019	12.40
9140	1.836	1.186	1.00	0.190	12.40
9150	3.765	1.198	1.00	0.497	12.40
9160	3.584	1.209	1.00	0.472	12.40

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
9170	2.391	1.221	1.00	0.292	12.50
9180	1.284	1.232	1.00	0.018	12.50
9190	1.301	1.242	1.00	0.020	12.50
9200	1.330	1.252	1.00	0.026	12.50
9210	1.095	1.262	0.00	-0.062	12.50
9220	0.684	1.271	0.00	-0.269	12.60
9230	0.730	1.280	0.00	-0.244	12.60
9240	0.969	1.287	0.00	-0.123	12.60
9250	1.124	1.294	0.00	-0.061	12.60
9260	0.941	1.300	0.00	-0.140	12.60
9270	0.749	1.305	0.00	-0.241	12.70
9280	0.680	1.309	0.00	-0.285	12.70
9290	0.833	1.313	0.00	-0.198	12.70
9300	0.940	1.315	0.00	-0.146	12.70
9310	1.059	1.317	0.00	-0.095	12.70
9320	1.297	1.319	1.00	-0.007	12.70
9330	1.590	1.320	1.00	0.081	12.80
9340	1.520	1.320	1.00	0.061	12.80
9350	1.053	1.319	0.00	-0.098	12.80
9360	1.090	1.318	0.00	-0.083	12.80
9370	2.031	1.317	1.00	0.188	12.80
9380	2.841	1.314	1.00	0.335	12.90
9390	1.491	1.312	1.00	0.056	12.90
9400	1.171	1.309	0.00	-0.048	12.90
9410	1.371	1.306	1.00	0.021	12.90
9420	1.601	1.303	1.00	0.090	12.90
9430	1.361	1.300	1.00	0.020	13.00
9440	1.276	1.297	1.00	-0.007	13.00
9450	1.394	1.294	1.00	0.032	13.00
9460	1.025	1.292	0.00	-0.100	13.00
9470	0.856	1.289	0.00	-0.178	13.10
9480	0.916	1.287	0.00	-0.148	13.10
9490	1.148	1.286	0.00	-0.049	13.10
9500	1.693	1.284	1.00	0.120	13.20

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
9510	1.909	1.282	1.00	0.173	13.20
9520	1.232	1.280	1.00	-0.017	13.20
9530	1.173	1.278	0.00	-0.037	13.30
9540	1.376	1.276	1.00	0.033	13.30
9550	1.577	1.273	1.00	0.093	13.30
9560	1.007	1.271	0.00	-0.101	13.40
9570	0.681	1.267	0.00	-0.270	13.40
9580	0.714	1.263	0.00	-0.248	13.50
9590	0.736	1.259	0.00	-0.233	13.50
9600	1.790	1.255	1.00	0.154	13.50
9610	2.793	1.250	1.00	0.349	13.60
9620	1.358	1.246	1.00	0.038	13.60
9630	0.795	1.241	0.00	-0.194	13.70
9640	0.792	1.237	0.00	-0.194	13.70
9650	0.934	1.233	0.00	-0.121	13.70
9660	2.144	1.230	1.00	0.241	13.80
9670	2.635	1.227	1.00	0.332	13.80
9680	0.949	1.224	0.00	-0.110	13.90
9690	0.614	1.222	0.00	-0.299	13.90
9700	0.663	1.220	0.00	-0.265	13.90
9710	0.648	1.220	0.00	-0.275	14.00
9720	0.840	1.220	0.00	-0.162	14.00
9730	1.222	1.221	1.00	0.000	14.10
9740	1.751	1.223	1.00	0.156	14.10
9750	1.861	1.226	1.00	0.181	14.10
9760	1.612	1.230	1.00	0.117	14.20
9770	1.046	1.235	0.00	-0.072	14.20
9780	0.651	1.240	0.00	-0.280	14.20
9790	0.647	1.246	0.00	-0.285	14.30
9800	0.992	1.252	0.00	-0.101	14.30
9810	0.815	1.259	0.00	-0.189	14.30
9820	0.637	1.267	0.00	-0.299	14.30
9830	0.569	1.275	0.00	-0.351	14.40
9840	0.461	1.285	0.00	-0.445	14.40

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
9850	0.434	1.294	0.00	-0.475	14.40
9860	0.692	1.305	0.00	-0.275	14.40
9870	2.307	1.316	1.00	0.244	14.40
9880	3.158	1.328	1.00	0.376	14.40
9890	2.604	1.342	1.00	0.288	14.50
9900	1.345	1.356	1.00	-0.003	14.50
9910	0.538	1.370	0.00	-0.406	14.50
9920	0.591	1.385	0.00	-0.370	14.50
9930	0.488	1.401	0.00	-0.458	14.50
9940	0.982	1.417	0.00	-0.159	14.50
9950	2.465	1.433	1.00	0.236	14.50
9960	2.295	1.449	1.00	0.200	14.40
9970	1.651	1.466	1.00	0.052	14.40
9980	1.137	1.482	0.00	-0.115	14.40
9990	0.816	1.497	0.00	-0.264	14.40
10000	0.645	1.513	0.00	-0.370	14.40
10010	0.687	1.528	0.00	-0.347	14.40
10020	1.023	1.542	0.00	-0.178	14.40
10030	1.673	1.555	1.00	0.032	14.30
10040	2.952	1.568	1.00	0.275	14.30
10050	2.540	1.580	1.00	0.206	14.30
10060	1.096	1.591	0.00	-0.162	14.30
10070	1.768	1.601	1.00	0.043	14.20
10080	2.021	1.611	1.00	0.098	14.20
10090	1.439	1.620	0.00	-0.051	14.20
10100	2.305	1.629	1.00	0.151	14.10
10110	2.592	1.637	1.00	0.200	14.10
10120	0.963	1.645	0.00	-0.232	14.10
10130	0.786	1.652	0.00	-0.323	14.00
10140	1.568	1.658	1.00	-0.024	14.00
10150	3.379	1.663	1.00	0.308	14.00
10160	3.060	1.668	1.00	0.264	13.90
10170	1.290	1.672	0.00	-0.113	13.90
10180	1.268	1.675	0.00	-0.121	13.80

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
10190	1.565	1.678	0.00	-0.030	13.80
10200	1.862	1.681	1.00	0.044	13.80
10210	2.158	1.683	1.00	0.108	13.70
10220	2.458	1.685	1.00	0.164	13.70
10230	2.763	1.686	1.00	0.214	13.60
10240	2.413	1.687	1.00	0.155	13.60
10250	1.609	1.687	1.00	-0.021	13.50
10260	1.022	1.686	0.00	-0.217	13.50
10270	0.883	1.684	0.00	-0.280	13.40
10280	1.442	1.680	0.00	-0.066	13.40
10290	1.662	1.675	1.00	-0.003	13.40
10300	1.595	1.669	1.00	-0.020	13.30
10310	0.995	1.661	0.00	-0.222	13.30
10320	0.829	1.652	0.00	-0.299	13.20
10330	1.235	1.641	0.00	-0.124	13.20
10340	1.988	1.630	1.00	0.086	13.10
10350	2.416	1.617	1.00	0.174	13.10
10360	1.579	1.603	1.00	-0.006	13.00
10370	1.119	1.588	0.00	-0.152	13.00
10380	1.068	1.572	0.00	-0.168	13.00
10390	1.308	1.555	0.00	-0.075	12.90
10400	1.453	1.538	0.00	-0.025	12.90
10410	1.185	1.520	0.00	-0.108	12.80
10420	1.814	1.502	1.00	0.082	12.80
10430	2.966	1.483	1.00	0.301	12.70
10440	2.845	1.464	1.00	0.288	12.70
10450	2.235	1.445	1.00	0.189	12.60
10460	1.134	1.425	0.00	-0.099	12.60
10470	0.762	1.406	0.00	-0.266	12.60
10480	0.981	1.386	0.00	-0.150	12.50
10490	1.292	1.367	0.00	-0.024	12.50
10500	1.488	1.348	1.00	0.043	12.40
10510	1.275	1.329	1.00	-0.018	12.40
10520	1.573	1.311	1.00	0.079	12.30

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
10530	2.346	1.293	1.00	0.259	12.30
10540	2.156	1.275	1.00	0.228	12.20
10550	1.615	1.258	1.00	0.109	12.20
10560	0.987	1.240	0.00	-0.099	12.10
10570	0.729	1.223	0.00	-0.225	12.10
10580	1.049	1.206	0.00	-0.061	12.00
10590	1.135	1.189	1.00	-0.020	12.00
10600	1.084	1.172	0.00	-0.034	11.90
10610	0.974	1.155	0.00	-0.074	11.90
10620	0.836	1.137	0.00	-0.133	11.80
10630	0.657	1.118	0.00	-0.231	11.80
10640	0.804	1.100	0.00	-0.136	11.70
10650	1.282	1.081	1.00	0.074	11.60
10660	1.396	1.061	1.00	0.119	11.60
10670	1.320	1.042	1.00	0.103	11.50
10680	1.001	1.023	1.00	-0.009	11.40
10690	0.728	1.004	0.00	-0.139	11.40
10700	0.671	0.985	0.00	-0.167	11.30
10710	0.659	0.966	0.00	-0.166	11.20
10720	0.684	0.948	0.00	-0.142	11.10
10730	0.722	0.929	0.00	-0.110	11.00
10740	0.751	0.912	0.00	-0.084	11.00
10750	0.675	0.894	0.00	-0.122	10.90
10760	0.584	0.878	0.00	-0.177	10.80
10770	0.513	0.861	0.00	-0.225	10.70
10780	0.515	0.846	0.00	-0.216	10.60
10790	0.627	0.832	0.00	-0.123	10.50
10800	0.830	0.819	1.00	0.006	10.50
10810	1.078	0.806	1.00	0.126	10.40
10820	1.079	0.795	1.00	0.133	10.30
10830	1.027	0.785	1.00	0.117	10.20
10840	1.149	0.776	1.00	0.170	10.10
10850	1.160	0.768	1.00	0.179	10.00
10860	0.765	0.762	1.00	0.002	9.90

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
10870	0.563	0.757	0.00	-0.128	9.80
10880	0.696	0.752	0.00	-0.034	9.80
10890	0.712	0.748	0.00	-0.022	9.70
10900	0.632	0.746	0.00	-0.072	9.60
10910	0.532	0.743	0.00	-0.145	9.50
10920	0.448	0.741	0.00	-0.219	9.40
10930	0.582	0.739	0.00	-0.104	9.30
10940	0.730	0.737	1.00	-0.004	9.30
10950	0.689	0.736	0.00	-0.029	9.20
10960	0.640	0.734	0.00	-0.060	9.10
10970	0.636	0.733	0.00	-0.062	9.00
10980	0.654	0.731	0.00	-0.048	9.00
10990	0.707	0.729	0.00	-0.014	8.90
11000	0.718	0.728	1.00	-0.006	8.80
11010	0.687	0.726	0.00	-0.024	8.80
11020	0.655	0.723	0.00	-0.043	8.70
11030	0.623	0.721	0.00	-0.063	8.60
11040	0.591	0.718	0.00	-0.085	8.60
11050	0.559	0.715	0.00	-0.107	8.50
11060	0.527	0.712	0.00	-0.130	8.50
11070	0.496	0.708	0.00	-0.154	8.40
11080	0.464	0.704	0.00	-0.181	8.40
11090	0.453	0.699	0.00	-0.188	8.30
11100	0.539	0.694	0.00	-0.110	8.30
11110	0.666	0.689	0.00	-0.015	8.20
11120	0.898	0.684	1.00	0.118	8.20
11130	1.112	0.678	1.00	0.215	8.20
11140	1.270	0.672	1.00	0.276	8.10
11150	1.353	0.667	1.00	0.307	8.10
11160	1.305	0.661	1.00	0.296	8.00
11170	1.207	0.655	1.00	0.266	8.00
11180	1.045	0.649	1.00	0.207	8.00
11190	0.853	0.642	1.00	0.123	7.90
11200	0.629	0.636	1.00	-0.005	7.90

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
11210	0.485	0.629	0.00	-0.113	7.90
11220	0.410	0.621	0.00	-0.181	7.80
11230	0.381	0.614	0.00	-0.207	7.80
11240	0.387	0.605	0.00	-0.194	7.80
11250	0.449	0.596	0.00	-0.123	7.70
11260	0.548	0.587	0.00	-0.030	7.70
11270	0.725	0.577	1.00	0.099	7.70
11280	0.935	0.567	1.00	0.217	7.60
11290	0.799	0.556	1.00	0.157	7.60
11300	0.499	0.546	0.00	-0.039	7.60
11310	0.414	0.535	0.00	-0.111	7.60
11320	0.427	0.524	0.00	-0.089	7.50
11330	0.428	0.512	0.00	-0.078	7.50
11340	0.423	0.501	0.00	-0.074	7.50
11350	0.452	0.490	0.00	-0.035	7.40
11360	0.497	0.479	1.00	0.016	7.40
11370	0.572	0.468	1.00	0.088	7.40
11380	0.655	0.456	1.00	0.157	7.40
11390	0.610	0.445	1.00	0.137	7.30
11400	0.505	0.435	1.00	0.065	7.30
11410	0.376	0.424	0.00	-0.052	7.30
11420	0.237	0.413	0.00	-0.241	7.20
11430	0.226	0.403	0.00	-0.251	7.20
11440	0.282	0.393	0.00	-0.144	7.20
11450	0.267	0.383	0.00	-0.157	7.10
11460	0.210	0.374	0.00	-0.251	7.10
11470	0.188	0.366	0.00	-0.289	7.10
11480	0.193	0.358	0.00	-0.268	7.00
11490	0.184	0.350	0.00	-0.280	7.00
11500	0.165	0.343	0.00	-0.318	7.00
11510	0.168	0.337	0.00	-0.303	6.90
11520	0.196	0.332	0.00	-0.228	6.90
11530	0.202	0.326	0.00	-0.209	6.90
11540	0.179	0.322	0.00	-0.255	6.90

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
11550	0.167	0.317	0.00	-0.279	6.80
11560	0.175	0.313	0.00	-0.253	6.80
11570	0.182	0.310	0.00	-0.231	6.80
11580	0.181	0.306	0.00	-0.228	6.70
11590	0.193	0.303	0.00	-0.196	6.70
11600	0.244	0.300	0.00	-0.090	6.70
11610	0.302	0.298	1.00	0.006	6.60
11620	0.384	0.296	1.00	0.113	6.60
11630	0.457	0.294	1.00	0.191	6.60
11640	0.438	0.293	1.00	0.175	6.60
11650	0.407	0.292	1.00	0.144	6.50
11660	0.443	0.291	1.00	0.182	6.50
11670	0.496	0.291	1.00	0.231	6.50
11680	0.460	0.291	1.00	0.198	6.50
11690	0.380	0.292	1.00	0.114	6.40
11700	0.301	0.293	1.00	0.012	6.40
11710	0.222	0.294	0.00	-0.122	6.40
11720	0.168	0.295	0.00	-0.245	6.40
11730	0.146	0.297	0.00	-0.308	6.30
11740	0.149	0.298	0.00	-0.302	6.30
11750	0.211	0.300	0.00	-0.153	6.30
11760	0.263	0.302	0.00	-0.059	6.30
11770	0.272	0.303	0.00	-0.047	6.30
11780	0.280	0.304	0.00	-0.036	6.30
11790	0.319	0.305	1.00	0.019	6.30
11800	0.361	0.306	1.00	0.072	6.30
11810	0.337	0.307	1.00	0.041	6.30
11820	0.287	0.307	0.00	-0.030	6.30
11830	0.292	0.308	0.00	-0.023	6.30
11840	0.341	0.308	1.00	0.044	6.30
11850	0.386	0.309	1.00	0.097	6.30
11860	0.422	0.309	1.00	0.135	6.30
11870	0.455	0.310	1.00	0.167	6.30
11880	0.479	0.311	1.00	0.188	6.30

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
11890	0.486	0.312	1.00	0.193	6.30
11900	0.359	0.313	1.00	0.059	6.30
11910	0.209	0.315	0.00	-0.178	6.30
11920	0.170	0.318	0.00	-0.272	6.30
11930	0.182	0.321	0.00	-0.246	6.30
11940	0.189	0.324	0.00	-0.235	6.30
11950	0.193	0.329	0.00	-0.232	6.30
11960	0.198	0.334	0.00	-0.227	6.30
11970	0.205	0.340	0.00	-0.220	6.30
11980	0.241	0.348	0.00	-0.159	6.30
11990	0.455	0.356	1.00	0.107	6.30
12000	0.688	0.365	1.00	0.276	6.30
12010	0.587	0.374	1.00	0.195	6.30
12020	0.338	0.385	0.00	-0.056	6.30
12030	0.196	0.396	0.00	-0.305	6.30
12040	0.184	0.407	0.00	-0.345	6.30
12050	0.178	0.419	0.00	-0.372	6.30
12060	0.194	0.431	0.00	-0.347	6.30
12070	0.210	0.443	0.00	-0.324	6.40
12080	0.227	0.455	0.00	-0.302	6.40
12090	0.244	0.466	0.00	-0.281	6.40
12100	0.261	0.478	0.00	-0.263	6.40
12110	0.278	0.489	0.00	-0.245	6.40
12120	0.295	0.500	0.00	-0.229	6.40
12130	0.311	0.511	0.00	-0.216	6.40
12140	0.331	0.522	0.00	-0.198	6.40
12150	0.370	0.532	0.00	-0.158	6.40
12160	0.412	0.542	0.00	-0.119	6.40
12170	0.469	0.552	0.00	-0.071	6.40
12180	0.533	0.561	1.00	-0.022	6.40
12190	0.598	0.570	1.00	0.021	6.40
12200	0.662	0.579	1.00	0.058	6.40
12210	0.720	0.587	1.00	0.089	6.50
12220	0.723	0.594	1.00	0.085	6.50

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
12230	0.714	0.602	1.00	0.074	6.50
12240	0.743	0.608	1.00	0.087	6.50
12250	0.798	0.614	1.00	0.114	6.50
12260	0.860	0.620	1.00	0.142	6.50
12270	0.943	0.624	1.00	0.179	6.50
12280	1.027	0.629	1.00	0.213	6.50
12290	1.131	0.633	1.00	0.252	6.50
12300	1.241	0.636	1.00	0.290	6.50
12310	1.248	0.639	1.00	0.291	6.50
12320	1.121	0.641	1.00	0.242	6.60
12330	1.006	0.644	1.00	0.194	6.60
12340	0.954	0.645	1.00	0.170	6.60
12350	0.910	0.646	1.00	0.149	6.60
12360	0.785	0.647	1.00	0.084	6.60
12370	0.609	0.646	0.00	-0.026	6.60
12380	0.488	0.645	0.00	-0.121	6.60
12390	0.522	0.643	0.00	-0.091	6.60
12400	0.563	0.640	0.00	-0.056	6.60
12410	0.569	0.636	0.00	-0.048	6.60
12420	0.561	0.631	0.00	-0.051	6.60
12430	0.561	0.624	0.00	-0.047	6.60
12440	0.573	0.617	0.00	-0.032	6.60
12450	0.596	0.609	1.00	-0.009	6.50
12460	0.726	0.599	1.00	0.083	6.50
12470	0.883	0.589	1.00	0.176	6.50
12480	0.857	0.578	1.00	0.171	6.50
12490	0.589	0.566	1.00	0.017	6.50
12500	0.346	0.554	0.00	-0.204	6.50
12510	0.297	0.541	0.00	-0.260	6.50
12520	0.287	0.527	0.00	-0.264	6.50
12530	0.327	0.513	0.00	-0.196	6.50
12540	0.423	0.500	0.00	-0.072	6.50
12550	0.494	0.486	1.00	0.007	6.50
12560	0.404	0.472	0.00	-0.067	6.40

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
12570	0.285	0.458	0.00	-0.206	6.40
12580	0.229	0.445	0.00	-0.288	6.40
12590	0.241	0.432	0.00	-0.254	6.40
12600	0.272	0.420	0.00	-0.188	6.40
12610	0.429	0.408	1.00	0.022	6.40
12620	0.610	0.397	1.00	0.187	6.40
12630	0.694	0.387	1.00	0.254	6.40
12640	0.656	0.377	1.00	0.241	6.40
12650	0.609	0.368	1.00	0.219	6.40
12660	0.480	0.360	1.00	0.125	6.40
12670	0.331	0.352	0.00	-0.027	6.30
12680	0.234	0.345	0.00	-0.169	6.30
12690	0.226	0.339	0.00	-0.176	6.30
12700	0.220	0.333	0.00	-0.180	6.30
12710	0.211	0.328	0.00	-0.191	6.30
12720	0.202	0.322	0.00	-0.203	6.30
12730	0.191	0.318	0.00	-0.221	6.30
12740	0.179	0.313	0.00	-0.243	6.30
12750	0.167	0.309	0.00	-0.267	6.30
12760	0.168	0.305	0.00	-0.259	6.30
12770	0.177	0.302	0.00	-0.232	6.20
12780	0.180	0.299	0.00	-0.220	6.20
12790	0.159	0.296	0.00	-0.270	6.20
12800	0.136	0.294	0.00	-0.334	6.20
12810	0.135	0.291	0.00	-0.334	6.20
12820	0.161	0.289	0.00	-0.255	6.20
12830	0.189	0.287	0.00	-0.182	6.20
12840	0.235	0.286	0.00	-0.085	6.20
12850	0.287	0.284	1.00	0.005	6.10
12860	0.330	0.282	1.00	0.069	6.10
12870	0.348	0.280	1.00	0.095	6.10
12880	0.364	0.278	1.00	0.117	6.10
12890	0.350	0.276	1.00	0.103	6.10
12900	0.316	0.274	1.00	0.062	6.10

Age	CHARs	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency
(cal yr BP)	(particles cm^{-2} yr^{-1})				(events/1000 yr)
12910	0.280	0.273	1.00	0.012	6.10
12920	0.236	0.271	0.00	-0.060	6.10
12930	0.190	0.270	0.00	-0.153	6.00
12940	0.189	0.269	0.00	-0.154	6.00
12950	0.281	0.269	1.00	0.019	6.00
12960	0.375	0.269	1.00	0.144	6.00
12970	0.385	0.270	1.00	0.154	6.00
12980	0.342	0.271	1.00	0.101	6.00
12990	0.305	0.272	1.00	0.049	6.00
13000	0.303	0.274	1.00	0.043	5.90
13010	0.308	0.277	1.00	0.046	5.90
13020	0.304	0.279	1.00	0.037	5.90
13030	0.280	0.282	1.00	-0.003	5.90
13040	0.255	0.285	0.00	-0.048	5.90
13050	0.277	0.288	0.00	-0.017	5.90
13060	0.336	0.291	1.00	0.063	5.90
13070	0.393	0.294	1.00	0.127	5.80
13080	0.431	0.296	1.00	0.163	5.80
13090	0.463	0.299	1.00	0.190	5.80
13100	0.464	0.301	1.00	0.188	5.80
13110	0.347	0.303	1.00	0.059	5.80
13120	0.219	0.305	0.00	-0.143	5.80
13130	0.143	0.306	0.00	-0.330	5.70
13140	0.153	0.307	0.00	-0.302	5.70
13150	0.163	0.307	0.00	-0.275	5.70
13160	0.142	0.307	0.00	-0.336	5.70
13170	0.103	0.307	0.00	-0.475	5.70
13180	0.068	0.307	0.00	-0.654	5.70
13190	0.092	0.306	0.00	-0.522	5.60
13200	0.130	0.305	0.00	-0.370	5.60
13210	0.175	0.303	0.00	-0.239	5.60
13220	0.244	0.301	0.00	-0.092	5.60
13230	0.316	0.300	1.00	0.023	5.60
13240	0.388	0.297	1.00	0.116	5.50

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
13250	0.462	0.295	1.00	0.195	5.50
13260	0.535	0.292	1.00	0.262	5.50
13270	0.563	0.290	1.00	0.288	5.50
13280	0.547	0.287	1.00	0.280	5.50
13290	0.529	0.284	1.00	0.270	5.50
13300	0.469	0.281	1.00	0.222	5.40
13310	0.387	0.278	1.00	0.144	5.40
13320	0.317	0.275	1.00	0.062	5.40
13330	0.354	0.272	1.00	0.115	5.40
13340	0.418	0.269	1.00	0.192	5.40
13350	0.461	0.266	1.00	0.239	5.40
13360	0.397	0.263	1.00	0.180	5.40
13370	0.320	0.259	1.00	0.091	5.30
13380	0.259	0.256	1.00	0.004	5.30
13390	0.243	0.253	0.00	-0.018	5.30
13400	0.230	0.250	0.00	-0.037	5.30
13410	0.217	0.247	0.00	-0.057	5.30
13420	0.205	0.244	0.00	-0.076	5.30
13430	0.192	0.241	0.00	-0.100	5.30
13440	0.184	0.238	0.00	-0.113	5.30
13450	0.180	0.235	0.00	-0.116	5.30
13460	0.176	0.232	0.00	-0.120	5.30
13470	0.172	0.228	0.00	-0.123	5.20
13480	0.168	0.225	0.00	-0.126	5.20
13490	0.164	0.221	0.00	-0.129	5.20
13500	0.160	0.217	0.00	-0.131	5.20
13510	0.157	0.212	0.00	-0.131	5.20
13520	0.153	0.207	0.00	-0.132	5.20
13530	0.149	0.202	0.00	-0.133	5.20
13540	0.145	0.198	0.00	-0.134	5.20
13550	0.141	0.192	0.00	-0.135	5.20
13560	0.137	0.188	0.00	-0.136	5.20
13570	0.133	0.183	0.00	-0.138	5.20
13580	0.130	0.178	0.00	-0.137	5.20

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
13590	0.126	0.174	0.00	-0.139	5.10
13600	0.122	0.170	0.00	-0.144	5.10
13610	0.118	0.166	0.00	-0.149	5.10
13620	0.114	0.163	0.00	-0.156	5.10
13630	0.110	0.161	0.00	-0.165	5.10
13640	0.107	0.159	0.00	-0.171	5.10
13650	0.103	0.157	0.00	-0.183	5.10
13660	0.099	0.156	0.00	-0.197	5.10
13670	0.100	0.155	0.00	-0.190	5.10
13680	0.120	0.154	0.00	-0.108	5.10
13690	0.141	0.154	0.00	-0.037	5.10
13700	0.172	0.153	1.00	0.050	5.10
13710	0.242	0.153	1.00	0.199	5.10
13720	0.315	0.153	1.00	0.314	5.10
13730	0.356	0.153	1.00	0.367	5.10
13740	0.269	0.153	1.00	0.245	5.00
13750	0.169	0.153	1.00	0.044	5.00
13760	0.092	0.153	0.00	-0.220	5.00
13770	0.109	0.153	0.00	-0.146	5.00
13780	0.135	0.152	0.00	-0.052	5.00
13790	0.151	0.152	1.00	-0.003	5.00
13800	0.123	0.151	0.00	-0.090	5.10
13810	0.090	0.151	0.00	-0.224	5.10
13820	0.064	0.150	0.00	-0.369	5.10
13830	0.073	0.149	0.00	-0.309	5.10
13840	0.086	0.148	0.00	-0.235	5.10
13850	0.095	0.146	0.00	-0.188	5.10
13860	0.085	0.145	0.00	-0.232	5.10
13870	0.072	0.144	0.00	-0.300	5.10
13880	0.066	0.142	0.00	-0.333	5.10
13890	0.107	0.140	0.00	-0.118	5.10
13900	0.158	0.139	1.00	0.057	5.10
13910	0.212	0.137	1.00	0.190	5.20
13920	0.301	0.135	1.00	0.349	5.20

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
13930	0.399	0.133	1.00	0.477	5.20
13940	0.487	0.131	1.00	0.570	5.20
13950	0.406	0.129	1.00	0.498	5.20
13960	0.266	0.127	1.00	0.320	5.20
13970	0.129	0.125	1.00	0.013	5.20
13980	0.082	0.123	0.00	-0.177	5.30
13990	0.080	0.121	0.00	-0.181	5.30
14000	0.078	0.119	0.00	-0.185	5.30
14010	0.073	0.118	0.00	-0.207	5.30
14020	0.067	0.116	0.00	-0.237	5.30
14030	0.061	0.114	0.00	-0.271	5.30
14040	0.057	0.112	0.00	-0.293	5.30
14050	0.054	0.110	0.00	-0.310	5.40
14060	0.052	0.109	0.00	-0.320	5.40
14070	0.052	0.107	0.00	-0.314	5.40
14080	0.053	0.106	0.00	-0.300	5.40
14090	0.055	0.104	0.00	-0.278	5.40
14100	0.056	0.103	0.00	-0.265	5.40
14110	0.055	0.102	0.00	-0.268	5.40
14120	0.053	0.101	0.00	-0.279	5.40
14130	0.051	0.100	0.00	-0.292	5.40
14140	0.052	0.099	0.00	-0.280	5.40
14150	0.054	0.098	0.00	-0.261	5.40
14160	0.057	0.098	0.00	-0.236	5.40
14170	0.068	0.098	0.00	-0.159	5.40
14180	0.082	0.098	0.00	-0.079	5.40
14190	0.095	0.099	0.00	-0.018	5.40
14200	0.100	0.100	1.00	-0.001	5.40
14210	0.100	0.102	1.00	-0.007	5.40
14220	0.100	0.103	0.00	-0.015	5.40
14230	0.091	0.106	0.00	-0.065	5.40
14240	0.072	0.108	0.00	-0.178	5.30
14250	0.052	0.112	0.00	-0.332	5.30
14260	0.043	0.115	0.00	-0.428	5.30

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
14270	0.063	0.119	0.00	-0.276	5.30
14280	0.084	0.123	0.00	-0.167	5.30
14290	0.100	0.128	0.00	-0.108	5.30
14300	0.086	0.134	0.00	-0.191	5.30
14310	0.067	0.139	0.00	-0.318	5.30
14320	0.049	0.146	0.00	-0.473	5.20
14330	0.044	0.152	0.00	-0.539	5.20
14340	0.046	0.159	0.00	-0.539	5.20
14350	0.048	0.166	0.00	-0.539	5.20
14360	0.072	0.173	0.00	-0.381	5.20
14370	0.118	0.181	0.00	-0.185	5.20
14380	0.165	0.188	0.00	-0.056	5.20
14390	0.197	0.195	1.00	0.005	5.10
14400	0.192	0.202	1.00	-0.022	5.10
14410	0.184	0.209	0.00	-0.055	5.10
14420	0.178	0.215	0.00	-0.082	5.10
14430	0.179	0.221	0.00	-0.092	5.10
14440	0.183	0.227	0.00	-0.093	5.10
14450	0.187	0.232	0.00	-0.093	5.00
14460	0.235	0.237	1.00	-0.003	5.00
14470	0.311	0.241	1.00	0.111	5.00
14480	0.387	0.244	1.00	0.200	5.00
14490	0.439	0.248	1.00	0.249	5.00
14500	0.444	0.250	1.00	0.249	5.00
14510	0.447	0.252	1.00	0.248	4.90
14520	0.439	0.254	1.00	0.238	4.90
14530	0.363	0.255	1.00	0.153	4.90
14540	0.275	0.256	1.00	0.032	4.90
14550	0.188	0.256	0.00	-0.134	4.90
14560	0.188	0.255	0.00	-0.133	4.90
14570	0.239	0.255	1.00	-0.027	4.90
14580	0.291	0.253	1.00	0.060	4.90
14590	0.326	0.251	1.00	0.113	4.90
14600	0.329	0.249	1.00	0.121	4.80

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
14610	0.330	0.247	1.00	0.127	4.80
14620	0.349	0.244	1.00	0.156	4.80
14630	0.520	0.240	1.00	0.336	4.80
14640	0.725	0.236	1.00	0.487	4.80
14650	0.930	0.232	1.00	0.603	4.80
14660	0.877	0.228	1.00	0.586	4.80
14670	0.598	0.223	1.00	0.429	4.80
14680	0.318	0.218	1.00	0.164	4.90
14690	0.093	0.213	0.00	-0.359	4.90
14700	0.065	0.207	0.00	-0.504	4.90
14710	0.054	0.202	0.00	-0.572	4.90
14720	0.044	0.196	0.00	-0.649	4.90
14730	0.035	0.190	0.00	-0.735	4.90
14740	0.026	0.184	0.00	-0.850	4.90
14750	0.018	0.178	0.00	-0.995	4.90
14760	0.014	0.172	0.00	-1.088	4.90
14770	0.023	0.165	0.00	-0.857	5.00
14780	0.031	0.159	0.00	-0.710	5.00
14790	0.039	0.152	0.00	-0.592	5.00
14800	0.036	0.146	0.00	-0.608	5.00
14810	0.031	0.139	0.00	-0.653	5.00
14820	0.026	0.133	0.00	-0.708	5.00
14830	0.022	0.126	0.00	-0.759	5.10
14840	0.021	0.120	0.00	-0.756	5.10
14850	0.019	0.113	0.00	-0.776	5.10
14860	0.017	0.107	0.00	-0.800	5.10
14870	0.018	0.101	0.00	-0.749	5.10
14880	0.019	0.095	0.00	-0.699	5.10
14890	0.020	0.089	0.00	-0.649	5.10
14900	0.020	0.083	0.00	-0.620	5.20
14910	0.021	0.078	0.00	-0.569	5.20
14920	0.022	0.073	0.00	-0.519	5.20
14930	0.023	0.068	0.00	-0.470	5.20
14940	0.024	0.063	0.00	-0.422	5.20

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
14950	0.024	0.059	0.00	-0.394	5.20
14960	0.025	0.056	0.00	-0.350	5.20
14970	0.026	0.053	0.00	-0.309	5.20
14980	0.027	0.051	0.00	-0.272	5.20
14990	0.028	0.049	0.00	-0.239	5.30
15000	0.034	0.047	0.00	-0.141	5.30
15010	0.095	0.046	1.00	0.315	5.30
15020	0.170	0.045	1.00	0.575	5.30
15030	0.244	0.045	1.00	0.737	5.30
15040	0.267	0.044	1.00	0.780	5.30
15050	0.199	0.044	1.00	0.655	5.30
15060	0.129	0.044	1.00	0.469	5.30
15070	0.062	0.044	1.00	0.153	5.30
15080	0.042	0.043	1.00	-0.014	5.30
15090	0.039	0.043	0.00	-0.043	5.30
15100	0.036	0.043	0.00	-0.076	5.30
15110	0.032	0.043	0.00	-0.124	5.30
15120	0.024	0.042	0.00	-0.246	5.30
15130	0.016	0.042	0.00	-0.419	5.30
15140	0.009	0.042	0.00	-0.665	5.30
15150	0.005	0.041	0.00	-0.917	5.30
15160	0.003	0.041	0.00	-1.134	5.30
15170	0.002	0.040	0.00	-1.306	5.30
15180	0.001	0.040	0.00	-1.601	5.30
15190	0.002	0.039	0.00	-1.295	5.30
15200	0.003	0.039	0.00	-1.113	5.30
15210	0.005	0.038	0.00	-0.884	5.30
15220	0.010	0.038	0.00	-0.576	5.30
15230	0.023	0.037	0.00	-0.207	5.30
15240	0.035	0.036	0.00	-0.017	5.30
15250	0.046	0.036	1.00	0.110	5.30
15260	0.039	0.035	1.00	0.046	5.30
15270	0.025	0.034	0.00	-0.139	5.30
15280	0.012	0.034	0.00	-0.450	5.30

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
15290	0.002	0.033	0.00	-1.221	5.30
15300	0.003	0.033	0.00	-1.038	5.30
15310	0.006	0.032	0.00	-0.732	5.30
15320	0.009	0.032	0.00	-0.552	5.30
15330	0.010	0.032	0.00	-0.504	5.30
15340	0.009	0.032	0.00	-0.550	5.30
15350	0.007	0.032	0.00	-0.662	5.30
15360	0.006	0.032	0.00	-0.733	5.30
15370	0.018	0.033	0.00	-0.263	5.30
15380	0.034	0.034	1.00	0.004	5.30
15390	0.050	0.035	1.00	0.160	5.30
15400	0.060	0.036	1.00	0.227	5.30
15410	0.046	0.037	1.00	0.097	5.30
15420	0.028	0.038	0.00	-0.134	5.30
15430	0.011	0.039	0.00	-0.555	5.30
15440	0.007	0.041	0.00	-0.768	5.30
15450	0.024	0.043	0.00	-0.249	5.30
15460	0.041	0.044	0.00	-0.032	5.30
15470	0.058	0.046	1.00	0.102	5.30
15480	0.067	0.048	1.00	0.149	5.30
15490	0.071	0.049	1.00	0.158	5.30
15500	0.075	0.051	1.00	0.166	5.30
15510	0.078	0.053	1.00	0.168	5.30
15520	0.070	0.055	1.00	0.106	5.30
15530	0.058	0.057	1.00	0.010	5.30
15540	0.047	0.058	0.00	-0.095	5.30
15550	0.038	0.060	0.00	-0.200	5.30
15560	0.039	0.062	0.00	-0.201	5.30
15570	0.040	0.064	0.00	-0.202	5.30
15580	0.041	0.065	0.00	-0.202	5.30
15590	0.048	0.067	0.00	-0.144	5.30
15600	0.063	0.068	0.00	-0.035	5.30
15610	0.079	0.070	1.00	0.054	5.30
15620	0.094	0.071	1.00	0.122	5.20

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
15630	0.096	0.072	1.00	0.124	5.20
15640	0.089	0.073	1.00	0.086	5.20
15650	0.082	0.074	1.00	0.045	5.20
15660	0.075	0.075	1.00	0.002	5.20
15670	0.072	0.075	0.00	-0.020	5.20
15680	0.071	0.076	0.00	-0.029	5.20
15690	0.069	0.076	0.00	-0.044	5.10
15700	0.070	0.077	0.00	-0.040	5.10
15710	0.081	0.077	1.00	0.021	5.10
15720	0.095	0.078	1.00	0.088	5.10
15730	0.108	0.078	1.00	0.142	5.10
15740	0.120	0.078	1.00	0.185	5.00
15750	0.124	0.079	1.00	0.196	5.00
15760	0.128	0.080	1.00	0.206	5.00
15770	0.132	0.080	1.00	0.216	5.00
15780	0.132	0.081	1.00	0.211	4.90
15790	0.124	0.082	1.00	0.180	4.90
15800	0.116	0.083	1.00	0.146	4.90
15810	0.108	0.084	1.00	0.110	4.90
15820	0.101	0.085	1.00	0.076	4.80
15830	0.096	0.086	1.00	0.048	4.80
15840	0.090	0.087	1.00	0.015	4.80
15850	0.085	0.088	0.00	-0.014	4.70
15860	0.078	0.089	0.00	-0.056	4.70
15870	0.070	0.089	0.00	-0.106	4.70
15880	0.062	0.090	0.00	-0.162	4.70
15890	0.054	0.091	0.00	-0.225	4.60
15900	0.050	0.091	0.00	-0.260	4.60
15910	0.049	0.091	0.00	-0.269	4.60
15920	0.048	0.091	0.00	-0.278	4.60
15930	0.046	0.091	0.00	-0.296	4.50
15940	0.040	0.091	0.00	-0.355	4.50
15950	0.032	0.090	0.00	-0.450	4.50
15960	0.025	0.090	0.00	-0.554	4.50

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
15970	0.018	0.089	0.00	-0.693	4.40
15980	0.028	0.088	0.00	-0.497	4.40
15990	0.043	0.087	0.00	-0.305	4.40
16000	0.058	0.086	0.00	-0.170	4.40
16010	0.074	0.085	0.00	-0.058	4.40
16020	0.099	0.083	1.00	0.075	4.30
16030	0.125	0.082	1.00	0.183	4.30
16040	0.152	0.081	1.00	0.275	4.30
16050	0.177	0.079	1.00	0.349	4.30
16060	0.191	0.078	1.00	0.389	4.30
16070	0.203	0.077	1.00	0.423	4.20
16080	0.214	0.075	1.00	0.452	4.20
16090	0.220	0.074	1.00	0.471	4.20
16100	0.188	0.073	1.00	0.410	4.20
16110	0.146	0.072	1.00	0.306	4.20
16120	0.105	0.071	1.00	0.169	4.20
16130	0.067	0.070	0.00	-0.021	4.10
16140	0.058	0.069	0.00	-0.078	4.10
16150	0.055	0.069	0.00	-0.095	4.10
16160	0.053	0.068	0.00	-0.106	4.10
16170	0.050	0.067	0.00	-0.126	4.10
16180	0.045	0.066	0.00	-0.167	4.10
16190	0.040	0.065	0.00	-0.212	4.00
16200	0.035	0.064	0.00	-0.265	4.00
16210	0.030	0.064	0.00	-0.326	4.00
16220	0.028	0.063	0.00	-0.350	4.00
16230	0.025	0.062	0.00	-0.393	4.00
16240	0.023	0.061	0.00	-0.422	4.00
16250	0.020	0.060	0.00	-0.476	4.00
16260	0.021	0.059	0.00	-0.448	3.90
16270	0.022	0.058	0.00	-0.420	3.90
16280	0.023	0.057	0.00	-0.392	3.90
16290	0.024	0.056	0.00	-0.365	3.90
16300	0.025	0.055	0.00	-0.339	3.90

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
16310	0.025	0.053	0.00	-0.330	3.90
16320	0.025	0.052	0.00	-0.321	3.90
16330	0.025	0.051	0.00	-0.313	3.90
16340	0.025	0.050	0.00	-0.304	3.90
16350	0.026	0.050	0.00	-0.280	3.80
16360	0.028	0.049	0.00	-0.241	3.80
16370	0.029	0.048	0.00	-0.220	3.80
16380	0.030	0.048	0.00	-0.201	3.80
16390	0.031	0.047	0.00	-0.184	3.80
16400	0.032	0.047	0.00	-0.169	3.80
16410	0.033	0.047	0.00	-0.156	3.80
16420	0.035	0.048	0.00	-0.133	3.80
16430	0.037	0.048	0.00	-0.112	3.80
16440	0.040	0.048	0.00	-0.083	3.80
16450	0.042	0.049	0.00	-0.068	3.80
16460	0.045	0.050	0.00	-0.044	3.80
16470	0.050	0.051	0.00	-0.006	3.80
16480	0.055	0.052	1.00	0.028	3.80
16490	0.059	0.052	1.00	0.051	3.80
16500	0.064	0.053	1.00	0.079	3.80
16510	0.071	0.054	1.00	0.117	3.70
16520	0.078	0.055	1.00	0.150	3.70
16530	0.085	0.056	1.00	0.180	3.70
16540	0.090	0.057	1.00	0.198	3.70
16550	0.089	0.058	1.00	0.186	3.70
16560	0.086	0.059	1.00	0.165	3.70
16570	0.084	0.060	1.00	0.148	3.70
16580	0.081	0.061	1.00	0.126	3.70
16590	0.075	0.061	1.00	0.087	3.80
16600	0.068	0.062	1.00	0.038	3.80
16610	0.061	0.063	0.00	-0.014	3.80
16620	0.054	0.064	0.00	-0.073	3.80
16630	0.052	0.065	0.00	-0.094	3.80
16640	0.050	0.065	0.00	-0.116	3.80

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
16650	0.049	0.066	0.00	-0.129	3.80
16660	0.048	0.067	0.00	-0.142	3.80
16670	0.054	0.067	0.00	-0.095	3.80
16680	0.066	0.068	0.00	-0.011	3.80
16690	0.078	0.068	1.00	0.058	3.80
16700	0.090	0.069	1.00	0.118	3.80
16710	0.097	0.069	1.00	0.148	3.90
16720	0.091	0.069	1.00	0.117	3.90
16730	0.084	0.070	1.00	0.081	3.90
16740	0.077	0.070	1.00	0.041	3.90
16750	0.071	0.070	1.00	0.004	3.90
16760	0.069	0.070	0.00	-0.009	3.90
16770	0.068	0.071	0.00	-0.016	4.00
16780	0.067	0.071	0.00	-0.024	4.00
16790	0.066	0.071	0.00	-0.031	4.00

APPENDIX C

RAW CHARCOAL AND MAGNETIC SUSCEPTIBILITY DATA

FOR SLOUGH CREEK LAKE

SLOUGH CREEK LAKE

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
1	40.03	36.00	0.00
2	45.45	56.00	0.00
3	51.01	84.00	0.00
4	56.69	92.00	0.00
5	62.50	237.00	0.00
6	68.44	33.00	0.00
7	74.51	23.00	0.00
8	80.71	42.00	0.00
9	87.03	45.00	0.00
10	93.48	36.00	0.00
11	100.06	163.00	0.00
12	106.77	20.00	0.00
13	113.60	31.00	0.00
14	120.55	39.00	0.00
15	127.64	65.00	0.00
16	134.84	47.00	0.00
17	142.17	14.00	0.00
18	149.63	20.00	0.00
19	157.21	22.00	0.00
20	164.92	72.00	0.00
21	172.74	60.00	0.00
22	180.69	52.00	0.00
23	188.77	30.00	0.00
24	196.96	47.00	0.00
25	205.28	68.00	0.00
26	213.72	50.00	0.00
27	222.28	31.00	0.00
28	230.96	17.00	0.00
29	239.77	31.00	0.00
30	248.69	50.00	0.00
31	257.73	29.00	0.00
32	266.89	34.00	0.00
33	276.17	28.00	0.00
34	285.57	37.00	0.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
35	295.09	38.00	0.00
36	304.73	24.00	0.00
37	314.48	13.00	0.00
38	324.35	10.00	0.00
39	334.34	19.00	0.00
40	344.45	25.00	0.00
41	354.67	20.00	0.00
42	365.01	12.00	0.00
43	375.46	18.00	0.00
44	386.03	40.00	0.00
45	396.71	63.00	0.00
46	407.51	8.00	0.00
47	418.42	18.00	0.00
48	429.45	17.00	0.00
49	440.59	43.00	0.00
50	451.84	26.00	0.00
51	463.21	20.00	0.00
52	474.69	36.00	0.00
53	486.28	100.00	0.00
54	497.98	187.00	0.00
55	509.79	122.00	0.00
56	521.72	26.00	0.00
57	533.76	16.00	0.00
58	545.90	14.00	0.00
59	558.16	24.00	0.00
60	570.52	26.00	0.00
61	583.00	30.00	0.00
62	595.58	40.00	0.00
63	608.28	206.00	0.00
64	621.08	24.00	0.00
65	633.99	39.00	0.00
66	647.01	26.00	0.00
67	660.13	15.00	0.00
•	•	gap in core	•
82	869.63	24.00	0.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
83	884.42	9.00	0.00
84	899.32	24.00	0.00
85	914.31	37.00	0.00
86	929.41	28.00	0.00
87	944.61	63.00	0.00
88	959.90	34.00	0.00
89	975.30	64.00	0.00
90	990.79	87.00	0.00
91	1006.39	80.00	0.00
92	1022.08	26.00	0.00
93	1037.87	21.00	0.00
94	1053.76	19.00	0.00
95	1069.74	14.00	0.00
96	1085.83	54.00	0.00
97	1102.01	47.00	0.00
98	1118.28	36.00	0.00
99	1134.65	22.00	0.00
100	1151.12	26.00	0.00
101	1167.69	28.00	0.00
102	1184.34	29.00	0.00
103	1201.10	66.00	0.00
104	1217.94	86.00	0.00
105	1234.88	31.00	0.00
106	1251.92	39.00	0.00
107	1269.05	17.00	0.00
108	1286.27	30.00	0.00
109	1303.58	102.00	0.00
110	1320.99	25.00	0.00
111	1338.48	47.00	0.30
112	1356.07	73.00	0.00
113	1373.75	50.00	3.40
114	1391.53	24.00	0.00
115	1409.39	38.00	0.00
116	1427.34	90.00	0.00
117	1445.38	83.00	0.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
118	1463.51	25.00	0.00
119	1481.73	40.00	0.00
120	1500.04	73.00	0.00
121	1518.44	87.00	0.00
122	1536.92	37.00	0.00
123	1555.49	75.00	0.00
124	1574.15	82.00	0.00
125	1592.90	61.00	0.00
126	1611.73	97.00	0.00
127	1630.65	52.00	0.00
128	1649.66	73.00	0.00
129	1668.75	46.00	0.00
130	1687.93	63.00	0.00
131	1707.19	74.00	0.00
132	1726.53	39.00	1.20
133	1745.96	18.00	2.80
134	1765.48	24.00	0.90
135	1785.07	54.00	0.00
136	1804.75	92.00	1.20
137	1824.52	120.00	0.90
138	1844.36	81.00	0.00
139	1864.29	31.00	2.10
140	1884.30	14.00	1.80
141	1904.39	137.00	1.50
142	1924.56	30.00	0.90
143	1944.81	28.00	3.00
144	1965.15	18.00	0.00
145	1985.56	56.00	0.00
146	2006.05	40.00	0.80
147	2026.62	43.00	0.00
*	*	gap in core	*
167	2454.16	44.00	0.00
168	2476.31	122.00	0.00
169	2498.54	48.00	0.00
170	2520.83	41.00	0.50

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
171	2543.20	14.00	0.00
172	2565.64	12.00	0.00
173	2588.15	90.00	0.00
174	2610.73	15.00	0.00
175	2633.38	28.00	0.00
176	2656.10	62.00	0.00
177	2678.88	30.00	0.00
178	2701.74	24.00	0.00
179	2724.66	27.00	0.00
180	2747.65	118.00	0.00
181	2770.71	68.00	0.00
182	2793.83	33.00	0.00
183	2817.02	64.00	0.00
184	2840.28	67.00	0.00
185	2863.61	38.00	0.00
186	2887.00	84.00	0.00
187	2910.45	55.00	0.00
188	2933.97	49.00	0.00
189	2957.55	54.00	0.00
190	2981.20	32.00	0.00
191	3004.91	57.00	0.00
192	3028.69	56.00	0.00
193	3052.53	11.00	0.00
194	3076.43	19.00	0.00
195	3100.39	44.00	1.00
196	3124.42	28.00	0.00
197	3148.51	38.00	0.00
198	3172.66	83.00	5.20
199	3196.87	15.00	2.20
200	3221.14	53.00	0.00
201	3245.47	91.00	0.00
202	3269.86	110.00	1.70
203	3294.31	36.00	0.00
204	3318.82	31.00	0.00
205	3343.39	40.00	0.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
206	3368.02	34.00	0.60
207	3392.71	198.00	0.00
208	3417.45	22.00	0.60
209	3442.25	85.00	0.00
210	3467.11	33.00	0.00
211	3492.02	26.00	0.00
212	3517.00	36.00	0.90
213	3542.03	95.00	0.00
214	3567.11	70.00	0.60
215	3592.25	76.00	0.00
216	3617.44	9.00	0.00
217	3642.69	15.00	0.00
218	3668.00	26.00	0.00
219	3693.35	64.00	0.00
220	3718.77	17.00	0.00
221	3744.23	26.00	0.00
222	3769.75	19.00	0.00
223	3795.32	188.00	0.00
224	3820.94	87.00	0.00
225	3846.62	17.00	0.00
226	3872.34	10.00	0.00
227	3898.12	76.00	0.00
228	3923.95	504.00	0.00
229	3949.83	218.00	0.00
230	3975.76	77.00	0.00
231	4001.74	238.00	0.00
232	4027.76	106.00	0.00
233	4053.84	168.00	0.00
234	4079.97	45.00	0.00
235	4106.14	49.00	0.00
236	4132.37	131.00	0.00
237	4158.64	27.00	0.00
238	4184.95	110.00	0.00
239	4211.32	328.00	0.00
240	4237.73	37.00	0.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
241	4264.19	38.00	0.00
242	4290.69	10.00	0.00
243	4317.24	72.00	0.00
244	4343.84	58.00	0.00
245	4370.48	181.00	0.00
246	4397.16	84.00	0.00
252	4558.19	111.00	0.00
253	4585.18	20.00	0.00
254	4612.21	314.00	0.00
255	4639.28	53.00	0.00
256	4666.39	26.00	0.00
257	4693.54	15.00	0.00
258	4720.73	68.00	0.00
259	4747.96	83.00	0.00
260	4775.24	19.00	0.00
261	4802.55	19.00	0.00
262	4829.90	8.00	0.00
263	4857.29	29.00	0.00
264	4884.72	109.00	0.00
265	4912.18	60.00	0.00
266	4939.68	33.00	0.00
267	4967.22	18.00	0.00
268	4994.80	133.00	0.00
269	5022.41	85.00	0.00
270	5050.06	26.00	0.00
271	5077.75	10.00	0.00
272	5105.47	38.00	0.00
273	5133.23	210.00	0.00
274	5161.02	125.00	0.00
275	5188.84	25.00	0.00
276	5216.70	38.00	0.00
277	5244.60	25.00	0.00
278	5272.52	34.00	0.00
279	5300.48	45.00	0.00
280	5328.48	48.00	0.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
281	5356.50	53.00	0.00
282	5384.56	34.00	0.00
283	5412.65	125.00	0.00
284	5440.77	58.00	0.00
285	5468.92	77.00	0.00
286	5497.10	76.00	0.00
287	5525.31	38.00	0.00
288	5553.55	37.00	0.00
289	5581.82	12.00	0.00
290	5610.12	21.00	0.00
291	5638.45	50.00	0.00
292	5666.81	48.00	0.00
293	5695.20	48.00	0.00
294	5723.61	148.00	0.00
295	5752.05	97.00	0.00
296	5780.52	187.00	0.00
297	5809.01	124.00	0.00
298	5837.53	105.00	0.00
299	5866.08	149.00	0.00
300	5894.65	50.00	0.00
301	5923.25	125.00	0.00
302	5951.87	109.00	0.00
303	5980.52	59.00	0.00
304	6009.19	93.00	0.00
305	6037.89	84.00	6.10
306	6066.61	102.00	0.80
307	6095.35	97.00	0.00
308	6124.12	27.00	0.00
309	6152.91	74.00	0.00
310	6181.72	44.00	0.00
311	6210.55	37.00	0.00
312	6239.40	16.00	0.00
313	6268.28	34.00	0.00
314	6297.17	56.00	0.00
315	6326.09	32.00	0.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
316	6355.03	85.00	0.00
317	6383.98	52.00	0.00
318	6412.96	105.00	6.90
319	6441.95	19.00	9.20
320	6470.96	48.00	4.10
321	6500.00	133.00	0.30
322	6529.05	99.00	0.00
323	6558.11	70.00	0.00
324	6587.20	60.00	0.00
325	6616.30	75.00	0.00
326	6645.42	144.00	0.00
327	6674.55	132.00	6.60
328	6703.70	80.00	3.40
329	6732.87	110.00	0.00
330	6762.05	112.00	0.00
331	6791.24	73.00	0.00
332	6820.45	180.00	0.00
333	6849.68	72.00	0.00
334	6878.91	116.00	0.00
338	6996.00	96.00	0.00
339	7025.30	85.00	0.00
340	7054.61	108.00	0.40
341	7083.94	161.00	0.80
342	7113.27	55.00	1.30
343	7142.62	20.00	2.90
344	7171.97	111.00	2.80
345	7201.34	133.00	2.00
346	7230.72	76.00	0.40
347	7260.10	57.00	3.90
348	7289.49	174.00	0.00
349	7318.90	67.00	0.80
350	7348.31	88.00	2.10
351	7377.73	136.00	0.70
352	7407.15	104.00	2.80
353	7436.58	57.00	5.60

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
354	7466.03	116.00	3.00
355	7495.47	71.00	1.00
356	7524.92	20.00	15.00
357	7554.38	28.00	1.40
358	7583.85	30.00	0.90
359	7613.31	10.00	1.20
360	7642.79	62.00	6.70
361	7672.27	31.00	0.30
362	7701.75	54.00	8.30
363	7731.23	210.00	16.20
364	7760.72	24.00	0.00
365	7790.21	52.00	3.10
366	7819.71	108.00	0.90
367	7849.20	34.00	1.80
368	7878.70	65.00	0.80
369	7908.20	52.00	0.00
370	7937.70	27.00	1.20
371	7967.20	64.00	2.60
372	7996.71	52.00	2.50
373	8026.21	38.00	0.00
374	8055.71	28.00	5.80
375	8085.21	96.00	0.00
376	8114.71	43.00	13.20
377	8144.21	98.00	5.10
378	8173.71	64.00	0.00
379	8203.20	40.00	1.10
380	8232.70	19.00	0.00
381	8262.19	36.00	0.00
382	8291.68	64.00	3.40
383	8321.16	50.00	6.00
384	8350.64	49.00	5.20
385	8380.12	18.00	1.20
386	8409.59	74.00	2.90
387	8439.06	31.00	0.00
388	8468.52	26.00	4.70

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
389	8497.98	74.00	7.60
390	8527.43	52.00	4.90
391	8556.87	52.00	7.80
392	8586.31	109.00	5.60
393	8615.74	22.00	3.10
394	8645.16	60.00	6.30
395	8674.58	24.00	4.10
396	8703.99	58.00	1.40
397	8733.39	26.00	1.50
398	8762.78	13.00	4.10
399	8792.17	49.00	3.10
400	8821.54	54.00	0.00
401	8850.90	35.00	3.10
402	8880.25	46.00	1.20
403	8909.60	32.00	3.30
404	8938.93	34.00	4.40
405	8968.25	14.00	3.00
406	8997.56	25.00	0.60
407	9026.86	22.00	0.00
408	9056.15	29.00	0.00
409	9085.42	25.00	1.60
410	9114.68	19.00	0.00
411	9143.93	39.00	2.90
412	9173.16	54.00	0.00
413	9202.38	27.00	0.00
*	*	gap in core	*
438	9927.36	22.00	0.00
439	9956.09	29.00	0.00
440	9984.81	36.00	2.10
441	10013.50	40.00	1.70
442	10042.16	53.00	3.40
443	10070.80	11.00	0.00
444	10099.42	26.00	0.60
445	10128.01	38.00	0.70
446	10156.58	44.00	3.20

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
447	10185.12	37.00	3.30
448	10213.63	36.00	2.30
449	10242.12	47.00	2.70
450	10270.58	39.00	0.00
451	10299.01	38.00	1.80
452	10327.42	35.00	1.80
453	10355.79	35.00	0.00
454	10384.15	24.00	0.30
455	10412.47	70.00	0.00
456	10440.76	41.00	0.00
457	10469.02	79.00	5.10
458	10497.25	24.00	28.50
459	10525.46	34.00	9.10
460	10553.63	16.00	4.60
461	10581.77	57.00	8.10
462	10609.88	30.00	7.30
463	10637.96	78.00	7.90
464	10666.01	87.00	7.30
465	10694.03	24.00	8.90
466	10722.01	88.00	13.10
467	10749.96	18.00	45.40
468	10777.88	63.00	37.50
469	10805.77	45.00	7.00
470	10833.62	74.00	10.30
471	10861.43	49.00	7.30
472	10889.21	58.00	7.00
473	10916.96	29.00	9.90
474	10944.67	78.00	74.90
475	10972.35	93.00	91.00
476	10999.99	113.00	99.80
477	11027.59	105.00	98.20
478	11055.16	77.00	117.00
479	11082.69	61.00	104.00
480	11110.18	32.00	70.70
481	11137.64	57.00	86.60

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
482	11165.05	38.00	70.10
483	11192.43	24.00	85.90
484	11219.77	40.00	55.30
485	11247.08	34.00	80.50
486	11274.34	19.00	16.80
487	11301.56	59.00	8.00
488	11328.74	57.00	41.10
489	11355.88	54.00	16.80
490	11382.98	215.00	18.70
491	11410.04	30.00	14.50
492	11437.06	32.00	2.30
493	11464.03	54.00	15.20
494	11490.97	30.00	14.00
495	11517.86	27.00	19.50
496	11544.71	101.00	19.30
497	11571.51	17.00	20.00
498	11598.27	45.00	21.80
499	11624.99	46.00	15.70
500	11651.66	67.00	7.20
501	11678.29	30.00	7.70
502	11704.87	21.00	13.50
503	11731.41	40.00	14.70
504	11757.90	97.00	14.70
505	11784.35	152.00	13.80
506	11810.75	78.00	10.00
507	11837.10	80.00	13.60
508	11863.40	61.00	23.00
509	11889.66	80.00	21.50
510	11915.87	21.00	32.40
511	11942.03	11.00	21.00
512	11968.15	4.00	19.80
513	11994.21	17.00	17.60
514	12020.23	23.00	26.90
515	12046.19	4.00	27.40
516	12072.11	12.00	29.10

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
517	12097.97	13.00	25.60
518	12123.79	309.00	22.50
519	12149.55	534.00	50.00
520	12175.26	15.00	32.00
523	12252.09	58.00	41.60
524	12277.59	155.00	38.90
525	12303.04	271.00	23.80
526	12328.44	4.00	25.70
527	12353.78	4.00	19.80
528	12379.07	7.00	23.80
529	12404.30	10.00	26.70
530	12429.48	8.00	25.40
531	12454.61	4.00	25.10
532	12479.68	2.00	27.80
533	12504.69	17.00	52.90
534	12529.65	5.00	202.00
535	12554.55	2.00	70.50
536	12579.39	3.00	34.10
537	12604.18	2.00	49.10
538	12628.90	5.00	25.80
539	12653.58	4.00	30.00
540	12678.19	1.00	28.00
541	12702.74	2.00	28.60
542	12727.23	1.00	34.50
543	12751.67	3.00	29.70
544	12776.04	3.00	32.80
545	12800.36	3.00	32.60
546	12824.61	4.00	32.10
547	12848.81	7.00	29.40
548	12872.94	9.00	45.40
549	12897.01	2.00	53.90
550	12921.02	4.00	68.10
551	12944.97	6.00	191.00
552	12968.85	3.00	102.00
553	12992.67	14.00	73.60

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
554	13016.43	11.00	103.00
555	13040.13	12.00	117.00
556	13063.76	7.00	204.00
557	13087.32	9.00	107.00
558	13110.83	9.00	90.00
559	13134.26	6.00	110.00
560	13157.63	8.00	102.00
561	13180.94	11.00	137.00
562	13204.18	7.00	216.00
563	13227.35	3.00	576.00
564	13250.46	6.00	303.00
565	13273.50	4.00	124.00
566	13296.47	12.00	84.30
567	13319.38	5.00	111.00
568	13342.21	13.00	100.00
569	13364.98	11.00	121.00
570	13387.68	3.00	108.00
571	13410.31	8.00	131.00
572	13432.87	13.00	133.00
573	13455.36	8.00	204.00
574	13477.78	7.00	284.00
575	13500.13	5.00	323.00
576	13522.41	8.00	367.00
577	13544.61	7.00	491.00
578	13566.75	6.00	706.00
579	13588.81	6.00	954.00
580	13610.80	4.00	1120.00
581	13632.72	3.00	1420.00
582	13654.57	5.00	2220.00
583	13676.34	2.00	3600.00
584	13698.04	0.00	1750.00
585	13719.66	2.00	835.00
586	13741.21	2.00	1290.00
587	13762.68	4.00	1840.00
588	13784.08	10.00	1320.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
589	13805.41	3.00	1200.00
590	13826.66	4.00	1560.00
591	13847.83	1.00	1510.00
592	13868.92	1.00	2770.00
593	13889.94	2.00	1750.00
594	13910.88	2.00	1080.00
595	13931.75	4.00	1290.00
596	13952.53	1.00	2020.00
597	13973.24	2.00	2180.00
598	13993.87	5.00	1430.00
599	14014.42	2.00	1580.00
600	14034.89	1.00	1730.00
601	14055.28	1.00	1980.00
602	14075.59	1.00	2460.00
603	14095.82	5.00	1740.00
604	14115.97	6.00	2550.00
605	14136.04	3.00	1870.00
606	14156.03	2.00	1560.00
607	14175.93	2.00	1450.00
608	14195.76	2.00	1340.00
609	14215.50	4.00	1380.00
610	14235.15	3.00	1430.00
611	14254.73	4.00	2220.00
612	14274.22	5.00	1710.00
613	14293.63	3.00	1510.00
614	14312.95	4.00	1370.00
615	14332.19	2.00	1470.00
616	14351.34	15.00	1420.00
617	14370.41	6.00	1270.00
618	14389.39	2.00	1060.00
619	14408.29	2.00	1050.00
620	14427.10	5.00	1110.00
621	14445.82	2.00	1140.00
622	14464.46	4.00	1680.00
623	14483.01	3.00	1710.00

Depth (cm)	Age (cal yr BP)	Charcoal (particles cm^{-3})	Magnetic susceptibility (emu x 10^{-7} cm^{-3})
624	14501.47	4.00	1630.00
625	14519.84	2.00	1770.00
626	14538.12	2.00	1890.00
627	14556.32	1.00	1810.00
628	14574.43	1.00	2000.00
629	14592.44	2.00	1460.00
630	14610.37	1.00	1730.00
631	14628.21	0.00	1640.00
632	14645.96	2.00	1600.00
633	14663.61	3.00	1570.00
634	14681.17	1.00	1570.00

APPENDIX D

INTERPOLATED AGE, LOG-TRANSFORMED CHARCOAL ACCUMULATION RATES, BACKGROUND, PEAKS, DETRENDED CHARCOAL ACCUMULATION RATES, AND FIRE FREQUENCY FOR SLOUGH CREEK LAKE

SLOUGH CREEK LAKE

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
0	6.557	8.458	0.00	-0.111	15.80
10	6.557	8.322	0.00	-0.104	15.70
20	6.557	8.184	0.00	-0.096	15.70
30	6.557	8.043	0.00	-0.089	15.60
40	8.736	7.902	1.00	0.044	15.60
50	17.159	7.763	1.00	0.344	15.60
60	24.235	7.626	1.00	0.502	15.50
70	4.712	7.490	0.00	-0.201	15.50
80	6.795	7.356	1.00	-0.034	15.40
90	11.036	7.220	1.00	0.184	15.40
100	11.388	7.082	1.00	0.206	15.30
110	4.582	6.940	0.00	-0.180	15.30
120	7.417	6.793	1.00	0.038	15.30
130	6.291	6.639	1.00	-0.023	15.20
140	2.387	6.476	0.00	-0.433	15.20
150	3.013	6.305	0.00	-0.321	15.10
160	7.851	6.125	1.00	0.108	15.10
170	7.390	5.937	1.00	0.095	15.00
180	5.159	5.741	1.00	-0.046	15.00
190	5.113	5.537	1.00	-0.035	15.00
200	7.396	5.327	1.00	0.143	14.90
210	5.662	5.112	1.00	0.044	14.90
220	3.197	4.895	0.00	-0.185	14.80
230	2.610	4.679	0.00	-0.253	14.80
240	4.587	4.469	1.00	0.011	14.70
250	4.079	4.271	1.00	-0.020	14.70
260	3.515	4.095	0.00	-0.066	14.70
270	3.215	3.943	0.00	-0.089	14.60
280	3.739	3.818	1.00	-0.009	14.60
290	3.806	3.719	1.00	0.010	14.50
300	2.548	3.645	0.00	-0.156	14.50
310	1.429	3.590	0.00	-0.400	14.40
320	1.163	3.549	0.00	-0.485	14.40

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
330	1.864	3.517	0.00	-0.276	14.30
340	2.327	3.490	0.00	-0.176	14.30
350	1.922	3.469	0.00	-0.256	14.20
360	1.322	3.451	0.00	-0.417	14.20
370	1.779	3.439	0.00	-0.286	14.20
380	3.473	3.433	1.00	0.005	14.10
390	5.172	3.434	1.00	0.178	14.10
400	2.265	3.442	0.00	-0.182	14.00
410	1.313	3.458	0.00	-0.421	14.00
420	1.582	3.480	0.00	-0.342	13.90
430	2.585	3.507	0.00	-0.132	13.90
440	3.280	3.536	1.00	-0.033	13.80
450	2.193	3.569	0.00	-0.211	13.80
460	2.022	3.603	0.00	-0.251	13.80
470	3.513	3.640	1.00	-0.015	13.70
480	7.837	3.678	1.00	0.329	13.70
490	13.624	3.719	1.00	0.564	13.60
500	12.784	3.762	1.00	0.531	13.60
510	7.059	3.809	1.00	0.268	13.50
520	2.120	3.856	0.00	-0.260	13.50
530	1.362	3.903	0.00	-0.457	13.50
540	1.219	3.947	0.00	-0.510	13.40
550	1.707	3.988	0.00	-0.369	13.40
560	2.024	4.023	0.00	-0.298	13.30
570	2.191	4.052	0.00	-0.267	13.30
580	2.510	4.074	0.00	-0.210	13.30
590	3.845	4.089	1.00	-0.027	13.20
600	12.159	4.097	1.00	0.472	13.20
610	9.182	4.095	1.00	0.351	13.10
620	2.309	4.085	0.00	-0.248	13.10
630	2.803	4.061	0.00	-0.161	13.10
640	2.185	4.022	0.00	-0.265	13.00
650	1.455	3.962	0.00	-0.435	13.00
660	1.093	3.878	0.00	-0.550	12.90

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
•	•	gap in core	•	•	•
860	1.696	2.549	0.00	-0.177	12.20
870	1.334	2.569	0.00	-0.285	12.20
880	0.780	2.581	0.00	-0.520	12.20
890	1.284	2.585	0.00	-0.304	12.10
900	1.902	2.582	0.00	-0.133	12.10
910	2.339	2.574	1.00	-0.042	12.10
920	2.046	2.563	0.00	-0.098	12.10
930	2.616	2.550	1.00	0.011	12.00
940	3.786	2.535	1.00	0.174	12.00
950	2.889	2.520	1.00	0.059	12.00
960	2.793	2.507	1.00	0.047	12.00
970	4.017	2.497	1.00	0.206	11.90
980	5.009	2.492	1.00	0.303	11.90
990	5.473	2.490	1.00	0.342	11.90
1000	5.081	2.493	1.00	0.309	11.90
1010	3.319	2.500	1.00	0.123	11.90
1020	1.666	2.508	0.00	-0.178	11.80
1030	1.397	2.517	0.00	-0.256	11.80
1040	1.270	2.525	0.00	-0.298	11.80
1050	1.167	2.531	0.00	-0.336	11.80
1060	0.977	2.535	0.00	-0.414	11.80
1070	1.609	2.537	0.00	-0.198	11.80
1080	3.023	2.537	1.00	0.076	11.80
1090	3.105	2.534	1.00	0.088	11.80
1100	2.785	2.528	1.00	0.042	11.80
1110	2.365	2.520	1.00	-0.027	11.80
1120	1.876	2.509	0.00	-0.126	11.80
1130	1.426	2.498	0.00	-0.244	11.80
1140	1.480	2.488	0.00	-0.226	11.80
1150	1.596	2.478	0.00	-0.191	11.80
1160	1.664	2.469	0.00	-0.171	11.80
1170	1.706	2.464	0.00	-0.160	11.80
1180	1.907	2.462	0.00	-0.111	11.80

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
1190	3.068	2.465	1.00	0.095	11.80
1200	4.157	2.474	1.00	0.225	11.80
1210	4.826	2.491	1.00	0.287	11.80
1220	3.822	2.514	1.00	0.182	11.80
1230	2.129	2.542	0.00	-0.077	11.80
1240	2.084	2.573	0.00	-0.092	11.80
1250	2.059	2.606	0.00	-0.102	11.80
1260	1.332	2.639	0.00	-0.297	11.80
1270	1.227	2.670	0.00	-0.338	11.80
1280	1.763	2.701	0.00	-0.185	11.80
1290	3.710	2.731	1.00	0.133	11.90
1300	5.228	2.760	1.00	0.277	11.90
1310	3.083	2.790	1.00	0.043	11.90
1320	1.716	2.819	0.00	-0.216	11.90
1330	2.398	2.849	0.00	-0.075	11.90
1340	3.181	2.879	1.00	0.043	11.90
1350	3.919	2.910	1.00	0.129	11.90
1360	3.509	2.940	1.00	0.077	11.90
1370	2.750	2.970	0.00	-0.033	12.00
1380	1.928	3.000	0.00	-0.192	12.00
1390	1.502	3.030	0.00	-0.305	12.00
1400	1.910	3.061	0.00	-0.205	12.00
1410	2.944	3.092	1.00	-0.021	12.00
1420	4.504	3.123	1.00	0.159	12.00
1430	4.836	3.156	1.00	0.185	12.00
1440	4.476	3.188	1.00	0.147	12.10
1450	2.968	3.220	0.00	-0.035	12.10
1460	1.598	3.251	0.00	-0.308	12.10
1470	1.868	3.278	0.00	-0.244	12.10
1480	2.475	3.303	0.00	-0.125	12.10
1490	3.439	3.323	1.00	0.015	12.10
1500	4.158	3.338	1.00	0.095	12.10
1510	4.550	3.348	1.00	0.133	12.20
1520	3.823	3.353	1.00	0.057	12.20

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
1530	2.435	3.353	0.00	-0.139	12.20
1540	2.828	3.349	0.00	-0.073	12.20
1550	3.848	3.341	1.00	0.061	12.20
1560	4.201	3.329	1.00	0.101	12.20
1570	4.278	3.315	1.00	0.111	12.20
1580	3.755	3.300	1.00	0.056	12.20
1590	3.500	3.287	1.00	0.027	12.30
1600	4.414	3.276	1.00	0.129	12.30
1610	4.730	3.268	1.00	0.161	12.30
1620	3.519	3.262	1.00	0.033	12.30
1630	2.976	3.257	0.00	-0.039	12.30
1640	3.537	3.252	1.00	0.036	12.30
1650	3.469	3.247	1.00	0.029	12.30
1660	2.724	3.243	0.00	-0.076	12.30
1670	2.667	3.239	0.00	-0.084	12.30
1680	3.120	3.235	1.00	-0.016	12.40
1690	3.468	3.229	1.00	0.031	12.40
1700	3.724	3.220	1.00	0.063	12.40
1710	3.143	3.207	1.00	-0.009	12.40
1720	2.218	3.190	0.00	-0.158	12.40
1730	1.564	3.167	0.00	-0.306	12.40
1740	1.050	3.141	0.00	-0.476	12.40
1750	1.057	3.110	0.00	-0.469	12.40
1760	1.262	3.075	0.00	-0.387	12.40
1770	1.930	3.038	0.00	-0.197	12.40
1780	2.725	2.998	1.00	-0.041	12.40
1790	3.669	2.957	1.00	0.094	12.50
1800	4.612	2.917	1.00	0.199	12.50
1810	5.355	2.879	1.00	0.270	12.50
1820	5.847	2.844	1.00	0.313	12.50
1830	5.058	2.813	1.00	0.255	12.50
1840	4.023	2.786	1.00	0.160	12.50
1850	2.788	2.763	1.00	0.004	12.50
1860	1.638	2.744	0.00	-0.224	12.50

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
1870	1.116	2.727	0.00	-0.388	12.50
1880	1.159	2.712	0.00	-0.369	12.50
1890	3.805	2.699	1.00	0.149	12.50
1900	6.098	2.687	1.00	0.356	12.50
1910	4.133	2.676	1.00	0.189	12.40
1920	1.814	2.664	0.00	-0.167	12.40
1930	1.433	2.650	0.00	-0.267	12.40
1940	1.360	2.634	0.00	-0.287	12.40
1950	1.143	2.613	0.00	-0.359	12.40
1960	1.008	2.587	0.00	-0.409	12.40
1970	1.735	2.553	0.00	-0.168	12.40
1980	2.542	2.513	1.00	0.005	12.40
1990	2.393	2.467	1.00	-0.013	12.40
2000	2.032	2.415	0.00	-0.075	12.30
2010	1.976	2.360	0.00	-0.077	12.30
2020	2.007	2.305	0.00	-0.060	12.30
2030	2.016	2.252	0.00	-0.048	12.30
*	*	gap in core	*	*	*
2450	2.283	2.249	1.00	0.007	11.00
2460	3.693	2.214	1.00	0.222	11.00
2470	5.073	2.182	1.00	0.366	10.90
2480	4.264	2.152	1.00	0.297	10.90
2490	2.768	2.125	1.00	0.115	10.90
2500	2.071	2.100	1.00	-0.006	10.80
2510	1.927	2.079	1.00	-0.033	10.80
2520	1.634	2.062	0.00	-0.101	10.80
2530	1.095	2.050	0.00	-0.272	10.70
2540	0.654	2.040	0.00	-0.494	10.70
2550	0.579	2.034	0.00	-0.546	10.70
2560	0.656	2.030	0.00	-0.490	10.70
2570	1.898	2.027	1.00	-0.028	10.70
2580	3.408	2.025	1.00	0.226	10.60
2590	3.054	2.024	1.00	0.179	10.60
2600	1.580	2.025	0.00	-0.108	10.60

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
2610	0.771	2.026	0.00	-0.420	10.60
2620	1.011	2.028	0.00	-0.302	10.50
2630	1.339	2.031	0.00	-0.181	10.50
2640	1.965	2.035	1.00	-0.015	10.50
2650	2.548	2.041	1.00	0.096	10.50
2660	2.204	2.049	1.00	0.032	10.50
2670	1.586	2.061	0.00	-0.114	10.50
2680	1.249	2.076	0.00	-0.221	10.40
2690	1.133	2.095	0.00	-0.267	10.40
2700	1.068	2.117	0.00	-0.297	10.40
2710	1.120	2.142	0.00	-0.282	10.40
2720	1.370	2.169	0.00	-0.200	10.40
2730	2.869	2.197	1.00	0.116	10.40
2740	4.541	2.225	1.00	0.310	10.30
2750	4.477	2.250	1.00	0.299	10.30
2760	3.531	2.274	1.00	0.191	10.30
2770	2.697	2.295	1.00	0.070	10.30
2780	2.037	2.313	0.00	-0.055	10.30
2790	1.578	2.329	0.00	-0.169	10.30
2800	2.038	2.342	0.00	-0.060	10.30
2810	2.596	2.352	1.00	0.043	10.20
2820	2.795	2.360	1.00	0.073	10.20
2830	2.847	2.364	1.00	0.081	10.20
2840	2.648	2.364	1.00	0.049	10.20
2850	2.114	2.359	0.00	-0.048	10.20
2860	1.817	2.348	0.00	-0.111	10.20
2870	2.540	2.332	1.00	0.037	10.20
2880	3.337	2.311	1.00	0.160	10.20
2890	3.188	2.286	1.00	0.144	10.20
2900	2.657	2.256	1.00	0.071	10.10
2910	2.298	2.223	1.00	0.014	10.10
2920	2.186	2.187	1.00	0.000	10.10
2930	2.105	2.149	1.00	-0.009	10.10
2940	2.173	2.110	1.00	0.013	10.10

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
2950	2.250	2.072	1.00	0.036	10.10
2960	2.011	2.036	1.00	-0.005	10.10
2970	1.616	2.001	0.00	-0.093	10.10
2980	1.509	1.970	0.00	-0.116	10.10
2990	1.941	1.942	1.00	0.000	10.00
3000	2.335	1.917	1.00	0.086	10.00
3010	2.381	1.896	1.00	0.099	10.00
3020	2.358	1.879	1.00	0.099	10.00
3030	1.890	1.867	1.00	0.005	10.00
3040	1.097	1.859	0.00	-0.229	10.00
3050	0.531	1.856	0.00	-0.544	10.00
3060	0.628	1.858	0.00	-0.471	9.90
3070	0.781	1.863	0.00	-0.378	9.90
3080	1.145	1.872	0.00	-0.213	9.90
3090	1.579	1.882	0.00	-0.076	9.90
3100	1.716	1.893	0.00	-0.043	9.90
3110	1.440	1.905	0.00	-0.122	9.90
3120	1.220	1.918	0.00	-0.196	9.80
3130	1.336	1.931	0.00	-0.160	9.80
3140	1.510	1.945	0.00	-0.110	9.80
3150	2.037	1.962	1.00	0.016	9.80
3160	2.806	1.983	1.00	0.151	9.80
3170	3.122	2.009	1.00	0.192	9.80
3180	2.055	2.039	1.00	0.003	9.70
3190	0.955	2.073	0.00	-0.337	9.70
3200	1.111	2.112	0.00	-0.279	9.70
3210	1.754	2.154	0.00	-0.089	9.70
3220	2.396	2.198	1.00	0.037	9.70
3230	3.036	2.244	1.00	0.131	9.70
3240	3.648	2.291	1.00	0.202	9.60
3250	4.021	2.336	1.00	0.236	9.60
3260	4.336	2.378	1.00	0.261	9.60
3270	3.928	2.415	1.00	0.211	9.60
3280	2.686	2.447	1.00	0.041	9.60

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
3290	1.602	2.472	0.00	-0.188	9.60
3300	1.384	2.491	0.00	-0.255	9.50
3310	1.300	2.504	0.00	-0.285	9.50
3320	1.347	2.512	0.00	-0.271	9.50
3330	1.495	2.517	0.00	-0.226	9.50
3340	1.596	2.518	0.00	-0.198	9.50
3350	1.514	2.518	0.00	-0.221	9.50
3360	1.441	2.515	0.00	-0.242	9.50
3370	3.122	2.511	1.00	0.095	9.50
3380	5.808	2.506	1.00	0.365	9.40
3390	7.208	2.499	1.00	0.460	9.40
3400	4.612	2.490	1.00	0.268	9.40
3410	1.818	2.478	0.00	-0.135	9.40
3420	1.610	2.463	0.00	-0.185	9.40
3430	2.632	2.444	1.00	0.032	9.40
3440	3.163	2.421	1.00	0.116	9.40
3450	2.388	2.395	1.00	-0.001	9.40
3460	1.566	2.367	0.00	-0.179	9.30
3470	1.242	2.338	0.00	-0.275	9.30
3480	1.128	2.307	0.00	-0.311	9.30
3490	1.090	2.274	0.00	-0.319	9.30
3500	1.241	2.239	0.00	-0.256	9.30
3510	1.424	2.201	0.00	-0.189	9.30
3520	2.146	2.159	1.00	-0.003	9.30
3530	3.085	2.113	1.00	0.164	9.20
3540	3.651	2.065	1.00	0.248	9.20
3550	3.292	2.017	1.00	0.213	9.20
3560	2.906	1.972	1.00	0.168	9.20
3570	2.856	1.933	1.00	0.170	9.20
3580	2.948	1.902	1.00	0.190	9.10
3590	2.738	1.880	1.00	0.163	9.10
3600	1.723	1.868	1.00	-0.035	9.10
3610	0.691	1.865	0.00	-0.431	9.10
3620	0.423	1.869	0.00	-0.645	9.10

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
3630	0.517	1.880	0.00	-0.561	9.00
3640	0.628	1.893	0.00	-0.479	9.00
3650	0.796	1.907	0.00	-0.379	9.00
3660	0.971	1.921	0.00	-0.296	8.90
3670	1.410	1.937	0.00	-0.138	8.90
3680	2.000	1.958	1.00	0.009	8.90
3690	2.340	1.990	1.00	0.070	8.90
3700	1.708	2.034	1.00	-0.076	8.80
3710	0.981	2.094	0.00	-0.329	8.80
3720	0.748	2.172	0.00	-0.463	8.80
3730	0.886	2.268	0.00	-0.408	8.80
3740	0.990	2.382	0.00	-0.381	8.70
3750	0.909	2.515	0.00	-0.442	8.70
3760	0.801	2.667	0.00	-0.522	8.70
3770	1.972	2.839	0.00	-0.158	8.60
3780	4.555	3.028	1.00	0.177	8.60
3790	6.773	3.233	1.00	0.321	8.60
3800	5.926	3.450	1.00	0.235	8.60
3810	4.384	3.675	1.00	0.077	8.50
3820	3.017	3.902	1.00	-0.112	8.50
3830	1.949	4.127	0.00	-0.326	8.50
3840	0.926	4.342	0.00	-0.671	8.40
3850	0.578	4.543	0.00	-0.895	8.40
3860	0.471	4.725	0.00	-1.001	8.40
3870	0.647	4.885	0.00	-0.878	8.40
3880	1.596	5.023	0.00	-0.498	8.30
3890	2.635	5.140	0.00	-0.290	8.30
3900	7.040	5.237	1.00	0.128	8.30
3910	13.449	5.316	1.00	0.403	8.30
3920	18.214	5.378	1.00	0.530	8.20
3930	14.975	5.424	1.00	0.441	8.20
3940	10.695	5.456	1.00	0.292	8.20
3950	7.434	5.476	1.00	0.133	8.20
3960	5.331	5.486	1.00	-0.012	8.10

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
3970	3.544	5.490	0.00	-0.190	8.10
3980	5.051	5.491	1.00	-0.036	8.10
3990	7.432	5.491	1.00	0.131	8.10
4000	8.506	5.488	1.00	0.190	8.10
4010	6.658	5.482	1.00	0.084	8.00
4020	4.747	5.469	1.00	-0.062	8.00
4030	4.682	5.447	1.00	-0.066	8.00
4040	5.590	5.412	1.00	0.014	8.00
4050	6.063	5.360	1.00	0.054	7.90
4060	4.511	5.289	1.00	-0.069	7.90
4070	2.707	5.196	0.00	-0.283	7.90
4080	1.747	5.081	0.00	-0.464	7.90
4090	1.804	4.947	0.00	-0.438	7.90
4100	1.924	4.797	0.00	-0.397	7.80
4110	2.866	4.636	0.00	-0.209	7.80
4120	4.056	4.471	1.00	-0.042	7.80
4130	4.558	4.309	1.00	0.024	7.80
4140	3.159	4.158	0.00	-0.119	7.80
4150	1.661	4.023	0.00	-0.384	7.70
4160	1.729	3.907	0.00	-0.354	7.70
4170	2.927	3.810	0.00	-0.115	7.70
4180	4.321	3.731	1.00	0.064	7.70
4190	7.169	3.666	1.00	0.291	7.70
4200	10.298	3.615	1.00	0.455	7.70
4210	10.979	3.576	1.00	0.487	7.70
4220	6.919	3.548	1.00	0.290	7.60
4230	2.810	3.531	0.00	-0.099	7.60
4240	1.409	3.523	0.00	-0.398	7.60
4250	1.422	3.522	0.00	-0.394	7.60
4260	1.377	3.525	0.00	-0.408	7.60
4270	1.023	3.530	0.00	-0.538	7.60
4280	0.624	3.535	0.00	-0.753	7.60
4290	0.721	3.539	0.00	-0.691	7.60
4300	1.591	3.539	0.00	-0.347	7.50

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
4310	2.442	3.535	0.00	-0.161	7.50
4320	2.565	3.527	0.00	-0.138	7.50
4330	2.365	3.514	0.00	-0.172	7.50
4340	2.474	3.497	0.00	-0.150	7.50
4350	4.025	3.478	1.00	0.063	7.50
4360	5.755	3.459	1.00	0.221	7.50
4370	6.220	3.446	1.00	0.257	7.50
4380	4.862	3.440	1.00	0.150	7.50
4390	3.533	3.444	1.00	0.011	7.40
4400	3.178	3.458	1.00	-0.037	7.40
4410	3.240	3.483	1.00	-0.031	7.40
4420	3.302	3.518	1.00	-0.027	7.40
4430	3.364	3.560	1.00	-0.025	7.40
4440	3.426	3.608	1.00	-0.023	7.40
4450	3.489	3.658	1.00	-0.021	7.30
4460	3.551	3.705	1.00	-0.018	7.30
4470	3.613	3.743	1.00	-0.015	7.30
4480	3.675	3.770	1.00	-0.011	7.30
4490	3.737	3.784	1.00	-0.005	7.20
4500	3.799	3.784	1.00	0.002	7.20
4510	3.861	3.772	1.00	0.010	7.20
4520	3.923	3.748	1.00	0.020	7.20
4530	3.986	3.712	1.00	0.031	7.10
4540	4.048	3.668	1.00	0.043	7.10
4550	4.099	3.615	1.00	0.055	7.10
4560	3.336	3.555	1.00	-0.028	7.00
4570	2.078	3.490	0.00	-0.225	7.00
4580	1.315	3.420	0.00	-0.415	7.00
4590	4.491	3.347	1.00	0.128	6.90
4600	8.512	3.271	1.00	0.415	6.90
4610	10.515	3.193	1.00	0.518	6.90
4620	7.223	3.114	1.00	0.365	6.80
4630	3.659	3.031	1.00	0.082	6.80
4640	1.764	2.946	0.00	-0.223	6.80

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
4650	1.396	2.859	0.00	-0.311	6.70
4660	1.038	2.771	0.00	-0.426	6.70
4670	0.837	2.682	0.00	-0.506	6.70
4680	0.687	2.595	0.00	-0.577	6.60
4690	0.692	2.509	0.00	-0.559	6.60
4700	1.338	2.424	0.00	-0.258	6.60
4710	2.053	2.341	1.00	-0.057	6.50
4720	2.571	2.261	1.00	0.056	6.50
4730	2.776	2.183	1.00	0.104	6.50
4740	2.965	2.108	1.00	0.148	6.40
4750	2.482	2.038	1.00	0.086	6.40
4760	1.620	1.974	0.00	-0.086	6.40
4770	0.838	1.917	0.00	-0.359	6.30
4780	0.696	1.869	0.00	-0.429	6.30
4790	0.696	1.830	0.00	-0.420	6.30
4800	0.660	1.800	0.00	-0.436	6.20
4810	0.519	1.779	0.00	-0.535	6.20
4820	0.372	1.766	0.00	-0.677	6.10
4830	0.421	1.762	0.00	-0.622	6.10
4840	0.701	1.764	0.00	-0.401	6.10
4850	0.999	1.773	0.00	-0.249	6.00
4860	1.824	1.785	1.00	0.009	6.00
4870	2.887	1.799	1.00	0.205	6.00
4880	3.752	1.814	1.00	0.316	5.90
4890	3.334	1.831	1.00	0.260	5.90
4900	2.683	1.850	1.00	0.162	5.90
4910	2.111	1.874	1.00	0.052	5.80
4920	1.742	1.904	1.00	-0.039	5.80
4930	1.384	1.941	0.00	-0.147	5.80
4940	1.103	1.986	0.00	-0.256	5.70
4950	0.905	2.038	0.00	-0.353	5.70
4960	0.751	2.095	0.00	-0.445	5.70
4970	1.754	2.154	0.00	-0.089	5.70
4980	3.265	2.214	1.00	0.169	5.60

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
4990	4.538	2.272	1.00	0.300	5.60
5000	4.206	2.325	1.00	0.257	5.60
5010	3.575	2.371	1.00	0.178	5.60
5020	2.909	2.409	1.00	0.082	5.50
5030	2.141	2.437	1.00	-0.056	5.50
5040	1.369	2.454	0.00	-0.253	5.50
5050	0.847	2.461	0.00	-0.463	5.50
5060	0.638	2.459	0.00	-0.586	5.50
5070	0.437	2.448	0.00	-0.748	5.50
5080	0.607	2.430	0.00	-0.602	5.40
5090	0.971	2.408	0.00	-0.394	5.40
5100	1.486	2.382	0.00	-0.205	5.40
5110	3.386	2.354	1.00	0.158	5.40
5120	5.616	2.327	1.00	0.383	5.40
5130	7.191	2.300	1.00	0.495	5.40
5140	6.317	2.275	1.00	0.444	5.40
5150	5.214	2.249	1.00	0.365	5.30
5160	4.042	2.225	1.00	0.259	5.30
5170	2.751	2.202	1.00	0.097	5.30
5180	1.461	2.181	0.00	-0.174	5.30
5190	0.993	2.162	0.00	-0.338	5.30
5200	1.160	2.147	0.00	-0.267	5.30
5210	1.313	2.135	0.00	-0.211	5.30
5220	1.232	2.126	0.00	-0.237	5.30
5230	1.065	2.121	0.00	-0.299	5.30
5240	0.931	2.117	0.00	-0.357	5.30
5250	1.010	2.114	0.00	-0.321	5.20
5260	1.125	2.111	0.00	-0.273	5.20
5270	1.246	2.105	0.00	-0.228	5.20
5280	1.385	2.096	0.00	-0.180	5.20
5290	1.525	2.083	0.00	-0.135	5.20
5300	1.623	2.067	0.00	-0.105	5.20
5310	1.661	2.049	0.00	-0.091	5.20
5320	1.699	2.030	0.00	-0.077	5.20

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
5330	1.752	2.011	0.00	-0.060	5.20
5340	1.815	1.994	0.00	-0.041	5.20
5350	1.864	1.981	0.00	-0.026	5.20
5360	1.696	1.971	0.00	-0.065	5.20
5370	1.454	1.965	0.00	-0.131	5.20
5380	1.383	1.962	0.00	-0.152	5.20
5390	2.358	1.962	1.00	0.080	5.20
5400	3.510	1.962	1.00	0.253	5.20
5410	4.192	1.961	1.00	0.330	5.20
5420	3.442	1.959	1.00	0.245	5.20
5430	2.593	1.954	1.00	0.123	5.20
5440	2.159	1.948	1.00	0.045	5.20
5450	2.389	1.940	1.00	0.090	5.20
5460	2.628	1.931	1.00	0.134	5.20
5470	2.726	1.921	1.00	0.152	5.20
5480	2.712	1.912	1.00	0.152	5.20
5490	2.686	1.904	1.00	0.149	5.20
5500	2.341	1.900	1.00	0.091	5.20
5510	1.863	1.900	1.00	-0.008	5.30
5520	1.425	1.903	0.00	-0.126	5.30
5530	1.334	1.912	0.00	-0.156	5.30
5540	1.321	1.927	0.00	-0.164	5.30
5550	1.255	1.948	0.00	-0.191	5.30
5560	0.966	1.976	0.00	-0.311	5.40
5570	0.653	2.011	0.00	-0.488	5.40
5580	0.465	2.052	0.00	-0.645	5.40
5590	0.567	2.100	0.00	-0.569	5.50
5600	0.679	2.153	0.00	-0.501	5.50
5610	0.900	2.213	0.00	-0.391	5.50
5620	1.261	2.278	0.00	-0.257	5.60
5630	1.620	2.350	0.00	-0.162	5.60
5640	1.749	2.428	0.00	-0.142	5.60
5650	1.723	2.511	0.00	-0.164	5.70
5660	1.699	2.599	0.00	-0.185	5.70

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
5670	1.691	2.689	0.00	-0.201	5.70
5680	1.691	2.780	0.00	-0.216	5.80
5690	1.804	2.872	0.00	-0.202	5.80
5700	2.842	2.965	1.00	-0.018	5.90
5710	4.079	3.057	1.00	0.125	5.90
5720	4.992	3.149	1.00	0.200	5.90
5730	4.518	3.239	1.00	0.145	6.00
5740	3.886	3.325	1.00	0.068	6.00
5750	3.736	3.407	1.00	0.040	6.10
5760	4.791	3.482	1.00	0.139	6.10
5770	5.899	3.551	1.00	0.220	6.20
5780	6.246	3.612	1.00	0.238	6.20
5790	5.478	3.665	1.00	0.175	6.20
5800	4.700	3.711	1.00	0.103	6.30
5810	4.220	3.748	1.00	0.052	6.30
5820	3.986	3.777	1.00	0.023	6.40
5830	3.766	3.798	1.00	-0.004	6.40
5840	4.056	3.811	1.00	0.027	6.50
5850	4.594	3.816	1.00	0.081	6.50
5860	5.031	3.813	1.00	0.120	6.60
5870	4.194	3.802	1.00	0.043	6.60
5880	2.980	3.783	0.00	-0.104	6.70
5890	2.017	3.754	0.00	-0.270	6.70
5900	2.652	3.718	0.00	-0.147	6.80
5910	3.568	3.672	1.00	-0.013	6.80
5920	4.267	3.620	1.00	0.071	6.90
5930	4.148	3.562	1.00	0.066	7.00
5940	3.951	3.498	1.00	0.053	7.00
5950	3.634	3.432	1.00	0.025	7.10
5960	3.035	3.363	0.00	-0.045	7.10
5970	2.426	3.292	0.00	-0.133	7.20
5980	2.228	3.220	0.00	-0.160	7.20
5990	2.636	3.147	0.00	-0.077	7.30
6000	3.049	3.074	1.00	-0.004	7.40

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
6010	3.184	3.000	1.00	0.026	7.40
6020	3.074	2.927	1.00	0.021	7.50
6030	2.967	2.855	1.00	0.017	7.60
6040	3.070	2.782	1.00	0.043	7.60
6050	3.287	2.709	1.00	0.084	7.70
6060	3.493	2.637	1.00	0.122	7.70
6070	3.502	2.566	1.00	0.135	7.80
6080	3.440	2.496	1.00	0.139	7.90
6090	3.312	2.428	1.00	0.135	7.90
6100	2.599	2.361	1.00	0.042	8.00
6110	1.752	2.297	0.00	-0.118	8.00
6120	1.109	2.235	0.00	-0.304	8.10
6130	1.527	2.176	0.00	-0.154	8.20
6140	2.093	2.120	1.00	-0.006	8.20
6150	2.459	2.068	1.00	0.075	8.30
6160	2.150	2.021	1.00	0.027	8.30
6170	1.788	1.979	0.00	-0.044	8.40
6180	1.510	1.942	0.00	-0.109	8.40
6190	1.419	1.909	0.00	-0.129	8.50
6200	1.334	1.880	0.00	-0.149	8.60
6210	1.182	1.854	0.00	-0.196	8.60
6220	0.931	1.830	0.00	-0.293	8.70
6230	0.678	1.808	0.00	-0.426	8.70
6240	0.664	1.788	0.00	-0.430	8.80
6250	0.880	1.772	0.00	-0.304	8.80
6260	1.096	1.761	0.00	-0.206	8.80
6270	1.341	1.755	0.00	-0.117	8.90
6280	1.604	1.756	0.00	-0.039	8.90
6290	1.852	1.765	1.00	0.021	9.00
6300	1.726	1.781	1.00	-0.014	9.00
6310	1.439	1.805	0.00	-0.098	9.10
6320	1.204	1.836	0.00	-0.183	9.10
6330	1.638	1.872	0.00	-0.058	9.10
6340	2.271	1.913	1.00	0.075	9.20

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
6350	2.801	1.957	1.00	0.156	9.20
6360	2.563	2.004	1.00	0.107	9.20
6370	2.168	2.052	1.00	0.024	9.30
6380	1.929	2.101	0.00	-0.037	9.30
6390	2.459	2.151	1.00	0.058	9.30
6400	3.090	2.203	1.00	0.147	9.40
6410	3.368	2.255	1.00	0.174	9.40
6420	2.441	2.308	1.00	0.024	9.40
6430	1.418	2.362	0.00	-0.222	9.50
6440	0.783	2.417	0.00	-0.490	9.50
6450	1.087	2.472	0.00	-0.357	9.50
6460	1.432	2.528	0.00	-0.247	9.60
6470	2.017	2.583	0.00	-0.107	9.60
6480	3.019	2.637	1.00	0.059	9.60
6490	4.026	2.690	1.00	0.175	9.60
6500	4.398	2.743	1.00	0.205	9.60
6510	3.994	2.796	1.00	0.155	9.70
6520	3.590	2.848	1.00	0.101	9.70
6530	3.219	2.899	1.00	0.045	9.70
6540	2.875	2.949	1.00	-0.011	9.70
6550	2.533	2.997	0.00	-0.073	9.70
6560	2.331	3.043	0.00	-0.116	9.70
6570	2.213	3.087	0.00	-0.145	9.80
6580	2.102	3.130	0.00	-0.173	9.80
6590	2.192	3.172	0.00	-0.161	9.80
6600	2.368	3.215	0.00	-0.133	9.80
6610	2.577	3.257	0.00	-0.102	9.80
6620	3.243	3.297	1.00	-0.007	9.80
6630	4.056	3.336	1.00	0.085	9.80
6640	4.789	3.374	1.00	0.152	9.80
6650	4.814	3.409	1.00	0.150	9.80
6660	4.672	3.443	1.00	0.133	9.80
6670	4.473	3.475	1.00	0.110	9.80
6680	3.920	3.504	1.00	0.049	9.80

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
6690	3.307	3.532	0.00	-0.029	9.80
6700	2.857	3.557	0.00	-0.095	9.80
6710	3.124	3.582	0.00	-0.059	9.80
6720	3.476	3.605	0.00	-0.016	9.80
6730	3.756	3.629	1.00	0.015	9.80
6740	3.797	3.651	1.00	0.017	9.80
6750	3.820	3.671	1.00	0.017	9.80
6760	3.710	3.689	1.00	0.002	9.80
6770	3.267	3.703	0.00	-0.054	9.70
6780	2.809	3.713	0.00	-0.121	9.70
6790	2.934	3.717	0.00	-0.103	9.70
6800	4.162	3.716	1.00	0.049	9.70
6810	5.415	3.711	1.00	0.164	9.70
6820	5.636	3.703	1.00	0.182	9.70
6830	4.383	3.692	1.00	0.074	9.70
6840	3.118	3.682	0.00	-0.072	9.70
6850	2.711	3.672	0.00	-0.132	9.70
6860	3.225	3.664	0.00	-0.055	9.70
6870	3.738	3.657	1.00	0.009	9.70
6880	3.932	3.653	1.00	0.032	9.60
6890	3.873	3.649	1.00	0.026	9.60
6900	3.815	3.644	1.00	0.020	9.60
6910	3.756	3.636	1.00	0.014	9.60
6920	3.697	3.625	1.00	0.009	9.60
6930	3.639	3.610	1.00	0.004	9.60
6940	3.580	3.590	1.00	-0.001	9.60
6950	3.522	3.567	1.00	-0.006	9.60
6960	3.463	3.542	1.00	-0.010	9.60
6970	3.405	3.516	0.00	-0.014	9.60
6980	3.346	3.490	0.00	-0.018	9.60
6990	3.283	3.463	0.00	-0.023	9.50
7000	3.169	3.437	0.00	-0.035	9.50
7010	3.040	3.411	0.00	-0.050	9.50
7020	2.945	3.385	0.00	-0.061	9.50

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
7030	3.146	3.361	0.00	-0.029	9.50
7040	3.413	3.337	1.00	0.010	9.50
7050	3.722	3.317	1.00	0.050	9.50
7060	4.293	3.301	1.00	0.114	9.50
7070	4.908	3.289	1.00	0.174	9.50
7080	5.240	3.280	1.00	0.204	9.50
7090	4.188	3.272	1.00	0.107	9.50
7100	2.955	3.267	0.00	-0.044	9.50
7110	1.883	3.262	0.00	-0.239	9.50
7120	1.418	3.258	0.00	-0.361	9.50
7130	1.011	3.255	0.00	-0.508	9.50
7140	0.951	3.253	0.00	-0.534	9.50
7150	1.936	3.252	0.00	-0.225	9.50
7160	2.992	3.252	0.00	-0.036	9.50
7170	3.822	3.254	1.00	0.070	9.50
7180	4.100	3.257	1.00	0.100	9.50
7190	4.354	3.260	1.00	0.126	9.50
7200	4.304	3.264	1.00	0.120	9.50
7210	3.659	3.267	1.00	0.049	9.50
7220	2.998	3.270	0.00	-0.038	9.50
7230	2.507	3.273	0.00	-0.116	9.50
7240	2.283	3.276	0.00	-0.157	9.50
7250	2.063	3.278	0.00	-0.201	9.50
7260	2.537	3.281	0.00	-0.112	9.60
7270	3.889	3.283	1.00	0.074	9.60
7280	5.243	3.285	1.00	0.203	9.60
7290	5.298	3.285	1.00	0.208	9.60
7300	4.060	3.283	1.00	0.092	9.60
7310	2.824	3.277	0.00	-0.065	9.60
7320	2.414	3.267	0.00	-0.131	9.60
7330	2.656	3.251	0.00	-0.088	9.60
7340	2.901	3.227	0.00	-0.046	9.60
7350	3.334	3.194	1.00	0.019	9.60
7360	3.889	3.152	1.00	0.091	9.60

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
7370	4.429	3.102	1.00	0.155	9.70
7380	4.372	3.045	1.00	0.157	9.70
7390	4.002	2.981	1.00	0.128	9.70
7400	3.627	2.912	1.00	0.095	9.70
7410	3.135	2.840	1.00	0.043	9.70
7420	2.592	2.766	1.00	-0.028	9.70
7430	2.101	2.691	0.00	-0.107	9.70
7440	2.475	2.613	1.00	-0.024	9.70
7450	3.156	2.535	1.00	0.095	9.70
7460	3.765	2.456	1.00	0.186	9.70
7470	3.500	2.377	1.00	0.168	9.70
7480	2.981	2.302	1.00	0.112	9.70
7490	2.456	2.231	1.00	0.042	9.70
7500	1.880	2.168	0.00	-0.062	9.70
7510	1.292	2.113	0.00	-0.214	9.70
7520	0.774	2.068	0.00	-0.427	9.70
7530	0.767	2.030	0.00	-0.423	9.70
7540	0.859	1.998	0.00	-0.367	9.70
7550	0.942	1.971	0.00	-0.321	9.70
7560	0.974	1.948	0.00	-0.301	9.70
7570	0.997	1.928	0.00	-0.287	9.70
7580	0.979	1.913	0.00	-0.291	9.70
7590	0.773	1.902	0.00	-0.391	9.70
7600	0.542	1.896	0.00	-0.544	9.70
7610	0.471	1.895	0.00	-0.605	9.70
7620	1.009	1.898	0.00	-0.274	9.70
7630	1.607	1.904	0.00	-0.074	9.70
7640	1.991	1.914	1.00	0.017	9.70
7650	1.685	1.927	0.00	-0.058	9.70
7660	1.329	1.942	0.00	-0.165	9.70
7670	1.134	1.960	0.00	-0.238	9.70
7680	1.375	1.981	0.00	-0.159	9.70
7690	1.640	2.004	0.00	-0.087	9.70
7700	2.364	2.028	1.00	0.067	9.70

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
7710	4.120	2.054	1.00	0.302	9.70
7720	5.914	2.081	1.00	0.454	9.70
7730	6.364	2.108	1.00	0.480	9.70
7740	4.283	2.133	1.00	0.303	9.70
7750	2.144	2.156	1.00	-0.002	9.70
7760	0.953	2.176	0.00	-0.359	9.70
7770	1.257	2.192	0.00	-0.241	9.70
7780	1.579	2.202	0.00	-0.145	9.70
7790	2.040	2.208	1.00	-0.034	9.70
7800	2.683	2.208	1.00	0.085	9.70
7810	3.326	2.202	1.00	0.179	9.70
7820	3.254	2.190	1.00	0.172	9.70
7830	2.403	2.172	1.00	0.044	9.70
7840	1.552	2.150	0.00	-0.141	9.70
7850	1.341	2.122	0.00	-0.199	9.70
7860	1.698	2.092	0.00	-0.091	9.70
7870	2.052	2.059	1.00	-0.002	9.70
7880	2.117	2.025	1.00	0.019	9.70
7890	1.967	1.991	1.00	-0.005	9.70
7900	1.817	1.958	0.00	-0.032	9.70
7910	1.582	1.928	0.00	-0.086	9.70
7920	1.294	1.901	0.00	-0.167	9.70
7930	1.019	1.878	0.00	-0.266	9.70
7940	1.204	1.862	0.00	-0.189	9.70
7950	1.630	1.851	0.00	-0.055	9.70
7960	2.040	1.846	1.00	0.043	9.70
7970	2.069	1.846	1.00	0.050	9.70
7980	1.931	1.848	1.00	0.019	9.70
7990	1.792	1.852	0.00	-0.014	9.70
8000	1.637	1.854	0.00	-0.054	9.70
8010	1.477	1.854	0.00	-0.099	9.70
8020	1.318	1.852	0.00	-0.148	9.70
8030	1.193	1.849	0.00	-0.190	9.70
8040	1.078	1.845	0.00	-0.233	9.70

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
8050	1.027	1.840	0.00	-0.253	9.70
8060	1.636	1.836	0.00	-0.050	9.70
8070	2.417	1.831	1.00	0.121	9.70
8080	3.071	1.827	1.00	0.226	9.70
8090	2.688	1.822	1.00	0.169	9.60
8100	2.079	1.818	1.00	0.058	9.60
8110	1.613	1.815	0.00	-0.051	9.60
8120	2.076	1.812	1.00	0.059	9.60
8130	2.708	1.809	1.00	0.175	9.60
8140	3.198	1.806	1.00	0.248	9.60
8150	2.920	1.803	1.00	0.209	9.50
8160	2.529	1.798	1.00	0.148	9.50
8170	2.158	1.793	1.00	0.080	9.50
8180	1.872	1.787	1.00	0.020	9.50
8190	1.596	1.779	0.00	-0.047	9.50
8200	1.327	1.771	0.00	-0.125	9.40
8210	1.084	1.761	0.00	-0.211	9.40
8220	0.842	1.749	0.00	-0.318	9.40
8230	0.702	1.735	0.00	-0.393	9.40
8240	0.875	1.717	0.00	-0.293	9.30
8250	1.070	1.697	0.00	-0.200	9.30
8260	1.300	1.675	0.00	-0.110	9.30
8270	1.617	1.652	1.00	-0.009	9.20
8280	1.939	1.630	1.00	0.076	9.20
8290	2.113	1.608	1.00	0.119	9.20
8300	1.964	1.588	1.00	0.092	9.10
8310	1.803	1.572	1.00	0.060	9.10
8320	1.694	1.559	1.00	0.036	9.10
8330	1.681	1.550	1.00	0.035	9.00
8340	1.669	1.547	1.00	0.033	9.00
8350	1.522	1.549	1.00	-0.008	8.90
8360	1.168	1.555	0.00	-0.124	8.90
8370	0.811	1.567	0.00	-0.286	8.90
8380	0.894	1.583	0.00	-0.248	8.80

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
8390	1.538	1.601	0.00	-0.018	8.80
8400	2.183	1.622	1.00	0.129	8.80
8410	2.268	1.644	1.00	0.140	8.70
8420	1.773	1.665	1.00	0.027	8.70
8430	1.278	1.684	0.00	-0.120	8.60
8440	1.021	1.701	0.00	-0.222	8.60
8450	0.963	1.715	0.00	-0.251	8.60
8460	0.909	1.725	0.00	-0.278	8.50
8470	1.213	1.733	0.00	-0.155	8.50
8480	1.767	1.738	1.00	0.007	8.40
8490	2.312	1.741	1.00	0.123	8.40
8500	2.347	1.742	1.00	0.130	8.40
8510	2.094	1.741	1.00	0.080	8.30
8520	1.845	1.740	1.00	0.026	8.30
8530	1.766	1.736	1.00	0.007	8.20
8540	1.766	1.731	1.00	0.009	8.20
8550	1.789	1.725	1.00	0.016	8.20
8560	2.268	1.717	1.00	0.121	8.10
8570	2.926	1.708	1.00	0.234	8.10
8580	3.500	1.698	1.00	0.314	8.10
8590	2.881	1.688	1.00	0.232	8.00
8600	1.877	1.677	1.00	0.049	8.00
8610	0.974	1.665	0.00	-0.233	7.90
8620	1.132	1.653	0.00	-0.164	7.90
8630	1.571	1.640	1.00	-0.019	7.90
8640	1.930	1.626	1.00	0.074	7.80
8650	1.651	1.612	1.00	0.010	7.80
8660	1.235	1.596	0.00	-0.111	7.80
8670	0.917	1.580	0.00	-0.236	7.80
8680	1.206	1.561	0.00	-0.112	7.70
8690	1.599	1.540	1.00	0.016	7.70
8700	1.878	1.518	1.00	0.092	7.70
8710	1.584	1.495	1.00	0.025	7.70
8720	1.213	1.471	0.00	-0.084	7.60

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
8730	0.884	1.446	0.00	-0.214	7.60
8740	0.717	1.421	0.00	-0.297	7.60
8750	0.567	1.396	0.00	-0.391	7.60
8760	0.544	1.370	0.00	-0.401	7.50
8770	0.931	1.345	0.00	-0.160	7.50
8780	1.348	1.320	1.00	0.009	7.50
8790	1.669	1.296	1.00	0.110	7.50
8800	1.739	1.273	1.00	0.135	7.50
8810	1.798	1.252	1.00	0.157	7.50
8820	1.768	1.233	1.00	0.156	7.40
8830	1.553	1.216	1.00	0.106	7.40
8840	1.333	1.200	1.00	0.046	7.40
8850	1.241	1.185	1.00	0.020	7.40
8860	1.366	1.170	1.00	0.067	7.40
8870	1.494	1.156	1.00	0.112	7.40
8880	1.498	1.142	1.00	0.118	7.30
8890	1.336	1.128	1.00	0.073	7.30
8900	1.174	1.115	1.00	0.022	7.30
8910	1.102	1.103	1.00	0.000	7.30
8920	1.125	1.091	1.00	0.013	7.30
8930	1.149	1.080	1.00	0.027	7.30
8940	1.030	1.070	0.00	-0.017	7.20
8950	0.797	1.061	0.00	-0.124	7.20
8960	0.567	1.052	0.00	-0.269	7.20
8970	0.558	1.044	0.00	-0.272	7.20
8980	0.686	1.036	0.00	-0.179	7.20
8990	0.811	1.028	0.00	-0.103	7.20
9000	0.829	1.020	0.00	-0.090	7.10
9010	0.794	1.013	0.00	-0.106	7.10
9020	0.763	1.007	0.00	-0.120	7.10
9030	0.814	1.001	0.00	-0.090	7.10
9040	0.895	0.998	0.00	-0.047	7.00
9050	0.970	0.995	0.00	-0.011	7.00
9060	0.952	0.994	0.00	-0.019	7.00

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
9070	0.905	0.994	0.00	-0.041	7.00
9080	0.856	0.995	0.00	-0.065	6.90
9090	0.791	0.997	0.00	-0.100	6.90
9100	0.721	1.000	0.00	-0.142	6.90
9110	0.686	1.004	0.00	-0.165	6.80
9120	0.879	1.010	0.00	-0.060	6.80
9130	1.113	1.017	1.00	0.039	6.70
9140	1.338	1.025	1.00	0.116	6.70
9150	1.519	1.034	1.00	0.167	6.70
9160	1.695	1.045	1.00	0.210	6.60
9170	1.773	1.057	1.00	0.225	6.60
9180	1.493	1.070	1.00	0.145	6.50
9190	1.179	1.084	1.00	0.036	6.50
9200	0.943	1.098	0.00	-0.066	6.40
9210	0.928	1.113	0.00	-0.079	6.40
*	*	gap in core	*	*	*
9910	0.762	1.114	0.00	-0.165	7.00
9920	0.762	1.115	0.00	-0.165	7.10
9930	0.821	1.117	0.00	-0.134	7.10
9940	0.908	1.119	0.00	-0.091	7.20
9950	0.996	1.122	0.00	-0.052	7.20
9960	1.081	1.126	0.00	-0.018	7.30
9970	1.167	1.130	1.00	0.014	7.30
9980	1.248	1.135	1.00	0.041	7.40
9990	1.302	1.141	1.00	0.057	7.40
10000	1.351	1.147	1.00	0.071	7.50
10010	1.419	1.155	1.00	0.089	7.50
10020	1.569	1.163	1.00	0.130	7.60
10030	1.728	1.173	1.00	0.168	7.60
10040	1.707	1.183	1.00	0.159	7.60
10050	1.219	1.193	1.00	0.009	7.70
10060	0.707	1.204	0.00	-0.231	7.70
10070	0.458	1.215	0.00	-0.424	7.80
10080	0.635	1.225	0.00	-0.285	7.80

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
10090	0.819	1.235	0.00	-0.178	7.80
10100	0.984	1.245	0.00	-0.102	7.90
10110	1.131	1.253	0.00	-0.045	7.90
10120	1.277	1.261	1.00	0.005	7.90
10130	1.378	1.268	1.00	0.036	8.00
10140	1.452	1.274	1.00	0.057	8.00
10150	1.519	1.278	1.00	0.075	8.00
10160	1.473	1.282	1.00	0.060	8.10
10170	1.388	1.284	1.00	0.034	8.10
10180	1.309	1.288	1.00	0.007	8.10
10190	1.286	1.291	1.00	-0.002	8.20
10200	1.274	1.296	0.00	-0.008	8.20
10210	1.288	1.303	1.00	-0.005	8.20
10220	1.411	1.312	1.00	0.032	8.20
10230	1.547	1.323	1.00	0.068	8.30
10240	1.620	1.337	1.00	0.083	8.30
10250	1.529	1.353	1.00	0.053	8.30
10260	1.431	1.370	1.00	0.019	8.30
10270	1.367	1.388	0.00	-0.007	8.40
10280	1.354	1.406	0.00	-0.016	8.40
10290	1.342	1.423	0.00	-0.025	8.40
10300	1.317	1.437	0.00	-0.038	8.40
10310	1.280	1.450	0.00	-0.054	8.40
10320	1.244	1.459	0.00	-0.069	8.50
10330	1.233	1.465	0.00	-0.075	8.50
10340	1.234	1.469	0.00	-0.076	8.50
10350	1.225	1.471	0.00	-0.079	8.50
10360	1.115	1.471	0.00	-0.120	8.50
10370	0.979	1.470	0.00	-0.177	8.50
10380	0.943	1.469	0.00	-0.193	8.50
10390	1.441	1.468	1.00	-0.008	8.60
10400	2.015	1.468	1.00	0.138	8.60
10410	2.358	1.469	1.00	0.205	8.60
10420	2.038	1.473	1.00	0.141	8.60

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
10430	1.676	1.480	1.00	0.054	8.60
10440	1.634	1.491	1.00	0.040	8.60
10450	2.104	1.504	1.00	0.146	8.60
10460	2.581	1.521	1.00	0.230	8.60
10470	2.419	1.539	1.00	0.196	8.60
10480	1.730	1.560	1.00	0.045	8.60
10490	1.061	1.583	0.00	-0.174	8.60
10500	0.942	1.606	0.00	-0.232	8.60
10510	1.068	1.629	0.00	-0.183	8.60
10520	1.165	1.651	0.00	-0.151	8.60
10530	1.002	1.671	0.00	-0.222	8.60
10540	0.775	1.689	0.00	-0.338	8.60
10550	0.677	1.704	0.00	-0.401	8.60
10560	1.131	1.717	0.00	-0.181	8.60
10570	1.649	1.728	1.00	-0.020	8.60
10580	1.911	1.737	1.00	0.042	8.60
10590	1.592	1.744	0.00	-0.040	8.50
10600	1.251	1.751	0.00	-0.146	8.50
10610	1.349	1.758	0.00	-0.115	8.50
10620	1.958	1.766	1.00	0.045	8.50
10630	2.563	1.775	1.00	0.159	8.50
10640	2.855	1.787	1.00	0.203	8.50
10650	2.971	1.801	1.00	0.217	8.50
10660	3.032	1.817	1.00	0.222	8.50
10670	2.424	1.835	1.00	0.121	8.50
10680	1.622	1.853	0.00	-0.058	8.50
10690	1.060	1.872	0.00	-0.247	8.50
10700	1.713	1.891	0.00	-0.043	8.50
10710	2.531	1.909	1.00	0.122	8.50
10720	2.872	1.927	1.00	0.173	8.40
10730	2.029	1.944	1.00	0.019	8.40
10740	1.134	1.960	0.00	-0.238	8.40
10750	0.907	1.976	0.00	-0.338	8.40
10760	1.484	1.992	0.00	-0.128	8.40

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
10770	2.053	2.009	1.00	0.009	8.40
10780	2.105	2.029	1.00	0.016	8.40
10790	1.875	2.050	0.00	-0.039	8.40
10800	1.686	2.075	0.00	-0.090	8.40
10810	1.942	2.102	0.00	-0.034	8.40
10820	2.317	2.133	1.00	0.036	8.40
10830	2.572	2.166	1.00	0.075	8.40
10840	2.309	2.201	1.00	0.021	8.40
10850	1.986	2.237	0.00	-0.052	8.30
10860	1.807	2.274	0.00	-0.100	8.30
10870	1.916	2.311	0.00	-0.081	8.30
10880	2.034	2.347	0.00	-0.062	8.30
10890	1.891	2.380	0.00	-0.100	8.30
10900	1.515	2.411	0.00	-0.202	8.30
10910	1.170	2.437	0.00	-0.319	8.30
10920	1.527	2.459	0.00	-0.207	8.30
10930	2.166	2.476	0.00	-0.058	8.20
10940	2.754	2.488	1.00	0.044	8.20
10950	3.010	2.496	1.00	0.081	8.20
10960	3.207	2.498	1.00	0.108	8.20
10970	3.422	2.497	1.00	0.137	8.20
10980	3.682	2.490	1.00	0.170	8.10
10990	3.946	2.480	1.00	0.202	8.10
11000	4.045	2.466	1.00	0.215	8.10
11010	3.941	2.449	1.00	0.207	8.10
11020	3.833	2.429	1.00	0.198	8.00
11030	3.553	2.406	1.00	0.169	8.00
11040	3.186	2.380	1.00	0.127	8.00
11050	2.834	2.351	1.00	0.081	8.00
11060	2.599	2.319	1.00	0.050	7.90
11070	2.389	2.284	1.00	0.020	7.90
11080	2.139	2.246	1.00	-0.021	7.90
11090	1.766	2.206	0.00	-0.097	7.90
11100	1.383	2.163	0.00	-0.194	7.80

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
11110	1.310	2.118	0.00	-0.209	7.80
11120	1.640	2.071	0.00	-0.101	7.80
11130	1.963	2.025	1.00	-0.013	7.70
11140	1.905	1.981	1.00	-0.017	7.70
11150	1.653	1.943	0.00	-0.070	7.60
11160	1.407	1.910	0.00	-0.133	7.60
11170	1.211	1.885	0.00	-0.192	7.60
11180	1.025	1.867	0.00	-0.260	7.50
11190	0.939	1.857	0.00	-0.296	7.50
11200	1.136	1.853	0.00	-0.212	7.40
11210	1.351	1.854	0.00	-0.138	7.40
11220	1.426	1.861	0.00	-0.116	7.30
11230	1.347	1.872	0.00	-0.143	7.30
11240	1.263	1.887	0.00	-0.174	7.30
11250	1.097	1.904	0.00	-0.239	7.20
11260	0.896	1.922	0.00	-0.331	7.20
11270	0.793	1.940	0.00	-0.388	7.10
11280	1.246	1.957	0.00	-0.196	7.00
11290	1.787	1.973	1.00	-0.043	7.00
11300	2.149	1.989	1.00	0.034	6.90
11310	2.136	2.004	1.00	0.028	6.90
11320	2.110	2.020	1.00	0.019	6.80
11330	2.076	2.035	1.00	0.009	6.80
11340	2.036	2.050	1.00	-0.003	6.70
11350	2.141	2.065	1.00	0.016	6.70
11360	3.881	2.080	1.00	0.271	6.60
11370	6.076	2.094	1.00	0.463	6.50
11380	7.276	2.108	1.00	0.538	6.50
11390	5.034	2.122	1.00	0.375	6.40
11400	2.509	2.134	1.00	0.070	6.40
11410	1.123	2.145	0.00	-0.281	6.30
11420	1.150	2.152	0.00	-0.272	6.30
11430	1.186	2.156	0.00	-0.260	6.20
11440	1.411	2.156	0.00	-0.184	6.20

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
11450	1.714	2.150	0.00	-0.098	6.10
11460	1.924	2.139	0.00	-0.046	6.10
11470	1.659	2.121	0.00	-0.107	6.00
11480	1.329	2.097	0.00	-0.198	6.00
11490	1.103	2.067	0.00	-0.273	5.90
11500	1.060	2.032	0.00	-0.283	5.90
11510	1.032	1.992	0.00	-0.286	5.90
11520	1.686	1.952	0.00	-0.064	5.80
11530	2.714	1.912	1.00	0.152	5.80
11540	3.492	1.877	1.00	0.270	5.80
11550	2.623	1.849	1.00	0.152	5.70
11560	1.455	1.830	0.00	-0.099	5.70
11570	0.783	1.820	0.00	-0.366	5.70
11580	1.143	1.822	0.00	-0.203	5.60
11590	1.532	1.835	0.00	-0.078	5.60
11600	1.692	1.859	0.00	-0.041	5.60
11610	1.708	1.894	0.00	-0.045	5.50
11620	1.751	1.937	0.00	-0.044	5.50
11630	2.005	1.987	1.00	0.004	5.50
11640	2.302	2.041	1.00	0.052	5.50
11650	2.347	2.096	1.00	0.049	5.50
11660	1.846	2.150	0.00	-0.066	5.50
11670	1.328	2.201	0.00	-0.219	5.40
11680	1.049	2.248	0.00	-0.331	5.40
11690	0.922	2.290	0.00	-0.395	5.40
11700	0.838	2.326	0.00	-0.443	5.40
11710	1.051	2.355	0.00	-0.350	5.40
11720	1.322	2.377	0.00	-0.255	5.40
11730	1.770	2.392	0.00	-0.131	5.40
11740	2.573	2.399	1.00	0.030	5.40
11750	3.387	2.400	1.00	0.150	5.40
11760	4.185	2.395	1.00	0.242	5.40
11770	4.974	2.386	1.00	0.319	5.40
11780	5.520	2.373	1.00	0.367	5.40

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
11790	4.679	2.355	1.00	0.298	5.40
11800	3.620	2.333	1.00	0.191	5.40
11810	2.977	2.306	1.00	0.111	5.40
11820	2.999	2.273	1.00	0.120	5.40
11830	3.022	2.236	1.00	0.131	5.40
11840	2.837	2.193	1.00	0.112	5.40
11850	2.564	2.145	1.00	0.078	5.40
11860	2.393	2.093	1.00	0.058	5.40
11870	2.629	2.038	1.00	0.111	5.40
11880	2.907	1.985	1.00	0.166	5.40
11890	2.635	1.937	1.00	0.134	5.30
11900	1.778	1.899	1.00	-0.029	5.30
11910	0.966	1.875	0.00	-0.288	5.30
11920	0.676	1.868	0.00	-0.441	5.30
11930	0.531	1.879	0.00	-0.549	5.30
11940	0.397	1.907	0.00	-0.682	5.30
11950	0.293	1.951	0.00	-0.823	5.30
11960	0.193	2.008	0.00	-1.017	5.30
11970	0.275	2.075	0.00	-0.878	5.30
11980	0.466	2.152	0.00	-0.664	5.30
11990	0.644	2.235	0.00	-0.540	5.30
12000	0.745	2.323	0.00	-0.494	5.30
12010	0.834	2.414	0.00	-0.462	5.30
12020	0.764	2.506	0.00	-0.516	5.30
12030	0.484	2.600	0.00	-0.730	5.30
12040	0.224	2.696	0.00	-1.081	5.30
12050	0.253	2.796	0.00	-1.043	5.30
12060	0.373	2.902	0.00	-0.891	5.30
12070	0.464	3.017	0.00	-0.813	5.30
12080	0.482	3.143	0.00	-0.814	5.30
12090	0.545	3.278	0.00	-0.779	5.30
12100	3.402	3.420	1.00	-0.002	5.30
12110	7.846	3.566	1.00	0.342	5.30
12120	12.126	3.715	1.00	0.514	5.30

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
12130	15.621	3.861	1.00	0.607	5.30
12140	19.025	4.000	1.00	0.677	5.30
12150	16.878	4.130	1.00	0.611	5.30
12160	9.044	4.243	1.00	0.329	5.30
12170	1.909	4.337	0.00	-0.356	5.30
12180	0.787	4.407	0.00	-0.748	5.30
12190	1.006	4.450	0.00	-0.646	5.30
12200	1.225	4.463	0.00	-0.561	5.30
12210	1.444	4.443	0.00	-0.488	5.30
12220	1.663	4.391	0.00	-0.422	5.30
12230	1.882	4.305	0.00	-0.359	5.30
12240	2.101	4.186	0.00	-0.299	5.30
12250	2.668	4.037	1.00	-0.180	5.30
12260	4.121	3.861	1.00	0.028	5.30
12270	5.625	3.662	1.00	0.186	5.30
12280	7.324	3.446	1.00	0.327	5.30
12290	9.122	3.218	1.00	0.453	5.30
12300	9.693	2.985	1.00	0.512	5.30
12310	5.927	2.753	1.00	0.333	5.30
12320	1.813	2.529	1.00	-0.145	5.30
12330	0.158	2.317	0.00	-1.166	5.40
12340	0.158	2.121	0.00	-1.128	5.40
12350	0.166	1.943	0.00	-1.068	5.40
12360	0.208	1.783	0.00	-0.933	5.40
12370	0.256	1.642	0.00	-0.807	5.40
12380	0.303	1.514	0.00	-0.699	5.50
12390	0.350	1.395	0.00	-0.601	5.50
12400	0.387	1.281	0.00	-0.520	5.50
12410	0.365	1.169	0.00	-0.506	5.50
12420	0.334	1.056	0.00	-0.500	5.60
12430	0.286	0.943	0.00	-0.518	5.60
12440	0.223	0.833	0.00	-0.572	5.60
12450	0.164	0.727	0.00	-0.647	5.70
12460	0.128	0.628	0.00	-0.691	5.70

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
12470	0.096	0.538	0.00	-0.749	5.80
12480	0.195	0.458	0.00	-0.371	5.80
12490	0.435	0.390	1.00	0.047	5.80
12500	0.626	0.334	1.00	0.273	5.90
12510	0.492	0.289	1.00	0.231	5.90
12520	0.300	0.255	1.00	0.070	6.00
12530	0.177	0.231	0.00	-0.116	6.00
12540	0.129	0.215	0.00	-0.221	6.10
12550	0.089	0.204	0.00	-0.361	6.10
12560	0.097	0.197	0.00	-0.307	6.20
12570	0.113	0.191	0.00	-0.228	6.20
12580	0.113	0.186	0.00	-0.216	6.30
12590	0.096	0.180	0.00	-0.274	6.30
12600	0.089	0.175	0.00	-0.294	6.40
12610	0.131	0.170	0.00	-0.114	6.40
12620	0.181	0.166	1.00	0.039	6.50
12630	0.193	0.162	1.00	0.077	6.50
12640	0.177	0.158	1.00	0.048	6.60
12650	0.161	0.156	1.00	0.015	6.60
12660	0.144	0.153	0.00	-0.028	6.70
12670	0.128	0.152	0.00	-0.074	6.70
12680	0.112	0.151	0.00	-0.129	6.80
12690	0.095	0.150	0.00	-0.198	6.90
12700	0.084	0.149	0.00	-0.250	6.90
12710	0.091	0.150	0.00	-0.216	7.00
12720	0.100	0.150	0.00	-0.176	7.00
12730	0.108	0.151	0.00	-0.146	7.10
12740	0.117	0.153	0.00	-0.116	7.10
12750	0.123	0.155	0.00	-0.101	7.20
12760	0.123	0.158	0.00	-0.109	7.20
12770	0.123	0.162	0.00	-0.119	7.30
12780	0.123	0.166	0.00	-0.130	7.30
12790	0.123	0.170	0.00	-0.141	7.40
12800	0.131	0.176	0.00	-0.127	7.40

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
12810	0.148	0.181	0.00	-0.089	7.50
12820	0.169	0.188	0.00	-0.046	7.50
12830	0.216	0.195	1.00	0.044	7.50
12840	0.267	0.203	1.00	0.119	7.60
12850	0.309	0.211	1.00	0.166	7.60
12860	0.344	0.220	1.00	0.195	7.70
12870	0.346	0.229	1.00	0.180	7.70
12880	0.234	0.238	1.00	-0.007	7.80
12890	0.118	0.247	0.00	-0.320	7.80
12900	0.109	0.256	0.00	-0.370	7.80
12910	0.144	0.264	0.00	-0.264	7.90
12920	0.179	0.273	0.00	-0.183	7.90
12930	0.214	0.280	0.00	-0.117	8.00
12940	0.240	0.288	0.00	-0.079	8.00
12950	0.201	0.295	0.00	-0.166	8.00
12960	0.149	0.301	0.00	-0.306	8.10
12970	0.235	0.307	0.00	-0.116	8.10
12980	0.430	0.313	1.00	0.138	8.10
12990	0.566	0.318	1.00	0.251	8.10
13000	0.526	0.322	1.00	0.213	8.20
13010	0.477	0.326	1.00	0.165	8.20
13020	0.478	0.330	1.00	0.161	8.20
13030	0.497	0.333	1.00	0.174	8.30
13040	0.468	0.335	1.00	0.145	8.30
13050	0.379	0.337	1.00	0.051	8.30
13060	0.311	0.339	0.00	-0.037	8.30
13070	0.336	0.340	1.00	-0.006	8.40
13080	0.371	0.342	1.00	0.036	8.40
13090	0.383	0.342	1.00	0.049	8.40
13100	0.383	0.343	1.00	0.048	8.50
13110	0.363	0.344	1.00	0.024	8.50
13120	0.309	0.344	0.00	-0.047	8.50
13130	0.268	0.344	0.00	-0.108	8.50
13140	0.294	0.344	0.00	-0.068	8.60

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
13150	0.331	0.343	0.00	-0.016	8.60
13160	0.381	0.342	1.00	0.046	8.60
13170	0.437	0.341	1.00	0.107	8.70
13180	0.445	0.340	1.00	0.117	8.70
13190	0.373	0.339	1.00	0.042	8.70
13200	0.299	0.337	0.00	-0.053	8.70
13210	0.225	0.336	0.00	-0.175	8.80
13220	0.154	0.336	0.00	-0.339	8.80
13230	0.170	0.336	0.00	-0.295	8.80
13240	0.226	0.336	0.00	-0.172	8.90
13250	0.245	0.336	0.00	-0.137	8.90
13260	0.208	0.337	0.00	-0.209	8.90
13270	0.204	0.337	0.00	-0.219	8.90
13280	0.341	0.338	1.00	0.004	9.00
13290	0.480	0.339	1.00	0.151	9.00
13300	0.417	0.340	1.00	0.089	9.00
13310	0.284	0.340	0.00	-0.079	9.10
13320	0.297	0.341	0.00	-0.060	9.10
13330	0.451	0.342	1.00	0.121	9.10
13340	0.555	0.342	1.00	0.210	9.10
13350	0.524	0.343	1.00	0.184	9.20
13360	0.474	0.343	1.00	0.140	9.20
13370	0.337	0.344	0.00	-0.009	9.20
13380	0.186	0.344	0.00	-0.267	9.20
13390	0.199	0.344	0.00	-0.237	9.30
13400	0.297	0.343	0.00	-0.063	9.30
13410	0.395	0.342	1.00	0.062	9.30
13420	0.494	0.341	1.00	0.161	9.30
13430	0.550	0.339	1.00	0.210	9.30
13440	0.463	0.337	1.00	0.139	9.40
13450	0.371	0.333	1.00	0.047	9.40
13460	0.339	0.329	1.00	0.013	9.40
13470	0.319	0.324	0.00	-0.006	9.40
13480	0.286	0.317	0.00	-0.045	9.40

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
13490	0.247	0.311	0.00	-0.099	9.50
13500	0.251	0.303	0.00	-0.082	9.50
13510	0.311	0.295	1.00	0.023	9.50
13520	0.352	0.286	1.00	0.090	9.50
13530	0.336	0.278	1.00	0.083	9.50
13540	0.316	0.269	1.00	0.070	9.50
13550	0.296	0.261	1.00	0.055	9.60
13560	0.277	0.253	1.00	0.040	9.60
13570	0.272	0.245	1.00	0.045	9.60
13580	0.272	0.238	1.00	0.057	9.60
13590	0.249	0.232	1.00	0.031	9.60
13600	0.208	0.226	0.00	-0.036	9.60
13610	0.175	0.220	0.00	-0.100	9.60
13620	0.154	0.215	0.00	-0.145	9.70
13630	0.148	0.210	0.00	-0.151	9.70
13640	0.187	0.205	0.00	-0.040	9.70
13650	0.216	0.200	1.00	0.033	9.70
13660	0.167	0.196	0.00	-0.069	9.70
13670	0.105	0.192	0.00	-0.261	9.70
13680	0.057	0.188	0.00	-0.518	9.70
13690	0.016	0.184	0.00	-1.060	9.70
13700	0.028	0.180	0.00	-0.808	9.70
13710	0.070	0.176	0.00	-0.402	9.70
13720	0.093	0.173	0.00	-0.269	9.70
13730	0.093	0.169	0.00	-0.261	9.70
13740	0.108	0.166	0.00	-0.187	9.70
13750	0.151	0.163	0.00	-0.034	9.70
13760	0.215	0.161	1.00	0.126	9.70
13770	0.342	0.159	1.00	0.332	9.70
13780	0.432	0.158	1.00	0.438	9.70
13790	0.309	0.157	1.00	0.295	9.70
13800	0.170	0.156	1.00	0.037	9.70
13810	0.161	0.156	1.00	0.014	9.70
13820	0.182	0.156	1.00	0.067	9.60

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
13830	0.177	0.157	1.00	0.053	9.60
13840	0.163	0.157	1.00	0.016	9.60
13850	0.148	0.158	0.00	-0.028	9.60
13860	0.133	0.159	0.00	-0.077	9.60
13870	0.118	0.160	0.00	-0.132	9.60
13880	0.103	0.161	0.00	-0.193	9.60
13890	0.095	0.162	0.00	-0.231	9.60
13900	0.096	0.163	0.00	-0.229	9.50
13910	0.113	0.164	0.00	-0.161	9.50
13920	0.159	0.164	0.00	-0.014	9.50
13930	0.184	0.164	1.00	0.049	9.50
13940	0.163	0.164	1.00	-0.003	9.50
13950	0.140	0.164	0.00	-0.069	9.50
13960	0.117	0.163	0.00	-0.145	9.50
13970	0.112	0.163	0.00	-0.162	9.50
13980	0.176	0.162	1.00	0.036	9.50
13990	0.225	0.162	1.00	0.144	9.40
14000	0.168	0.161	1.00	0.018	9.40
14010	0.108	0.161	0.00	-0.174	9.40
14020	0.116	0.161	0.00	-0.143	9.40
14030	0.134	0.162	0.00	-0.081	9.40
14040	0.152	0.162	0.00	-0.028	9.40
14050	0.171	0.163	1.00	0.020	9.40
14060	0.189	0.164	1.00	0.061	9.40
14070	0.208	0.165	1.00	0.100	9.40
14080	0.226	0.166	1.00	0.133	9.40
14090	0.246	0.168	1.00	0.167	9.40
14100	0.269	0.169	1.00	0.202	9.40
14110	0.289	0.171	1.00	0.229	9.40
14120	0.235	0.173	1.00	0.134	9.40
14130	0.164	0.175	0.00	-0.028	9.40
14140	0.129	0.178	0.00	-0.139	9.40
14150	0.106	0.181	0.00	-0.232	9.40
14160	0.100	0.184	0.00	-0.266	9.40

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
14170	0.101	0.188	0.00	-0.269	9.40
14180	0.101	0.191	0.00	-0.277	9.40
14190	0.105	0.194	0.00	-0.268	9.40
14200	0.146	0.197	0.00	-0.131	9.40
14210	0.192	0.200	0.00	-0.018	9.40
14220	0.180	0.203	0.00	-0.052	9.40
14230	0.159	0.205	0.00	-0.110	9.40
14240	0.178	0.207	0.00	-0.065	9.40
14250	0.204	0.208	1.00	-0.009	9.40
14260	0.231	0.209	1.00	0.043	9.40
14270	0.247	0.210	1.00	0.070	9.40
14280	0.203	0.211	0.00	-0.017	9.40
14290	0.164	0.212	0.00	-0.111	9.40
14300	0.184	0.212	0.00	-0.062	9.40
14310	0.194	0.212	0.00	-0.039	9.40
14320	0.146	0.213	0.00	-0.163	9.40
14330	0.201	0.213	0.00	-0.025	9.40
14340	0.541	0.213	1.00	0.405	9.40
14350	0.697	0.213	1.00	0.515	9.40
14360	0.461	0.212	1.00	0.336	9.50
14370	0.271	0.212	1.00	0.107	9.50
14380	0.160	0.211	0.00	-0.119	9.50
14390	0.106	0.209	0.00	-0.295	9.50
14400	0.107	0.207	0.00	-0.286	9.50
14410	0.159	0.204	0.00	-0.108	9.50
14420	0.239	0.200	1.00	0.077	9.50
14430	0.204	0.196	1.00	0.017	9.50
14440	0.128	0.192	0.00	-0.176	9.50
14450	0.157	0.187	0.00	-0.077	9.50
14460	0.204	0.183	1.00	0.048	9.50
14470	0.186	0.178	1.00	0.020	9.60
14480	0.170	0.173	1.00	-0.007	9.60
14490	0.196	0.168	1.00	0.067	9.60
14500	0.198	0.163	1.00	0.085	9.60

Age (cal yr BP)	CHARs (particles cm^{-2} yr^{-1})	Background CHARs	Peak CHARs	Detrended CHARs	Fire frequency (events/1000 yr)
14510	0.141	0.158	0.00	-0.050	9.60
14520	0.109	0.154	0.00	-0.149	9.60
14530	0.110	0.149	0.00	-0.133	9.60
14540	0.110	0.145	0.00	-0.121	9.60
14550	0.110	0.141	0.00	-0.109	9.60
14560	0.110	0.138	0.00	-0.098	9.60
14570	0.111	0.135	0.00	-0.085	9.70
14580	0.111	0.132	0.00	-0.077	9.70
14590	0.104	0.130	0.00	-0.098	9.70
14600	0.074	0.129	0.00	-0.240	9.70
14610	0.043	0.127	0.00	-0.471	9.70
14620	0.012	0.126	0.00	-1.021	9.70
14630	0.040	0.124	0.00	-0.493	9.70
14640	0.102	0.123	0.00	-0.081	9.70
14650	0.141	0.122	1.00	0.065	9.70
14660	0.168	0.120	1.00	0.146	9.70
14670	0.170	0.119	1.00	0.155	9.70
14680	0.170	0.118	1.00	0.158	9.70
14690	0.170	0.117	1.00	0.161	9.70
14700	0.170	0.117	1.00	0.162	9.70

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