AUGUSTA FIRE HISTORY

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by

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and

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INTRODUCTION

Fire has been an important disturbance process in the western Cascade Mountain landscape (Burke 1979, Teensma 1987, Morrison and Swanson 1990, Agee 1991). Fires of varying intensities and of diverse temporal and spatial extent have resulted in an extremely complex mosaic of forest composition and stand age structure. This complexity of forest composition and structure has created a diversity of habitats for biological organisms. The maintenance of this rich biological diversity might be achieved by managing the forest landscape more closely along the patterns of natural disturbance. The patterns of historical fire occurrence and extent might be used as a "template" for forest management.

This project was initiated by the Blue River Ranger District to provide information for use in an Integrated Resource Analysis for the Augusta Project Area. The Augusta Project Area includes approximately 20,000 acres of steeply dissected topography. Elevations range from the highest point at Chucksney Mountain at 5760′ to 2160′ along the South Fork of the McKenzie River. The majority of the study area is in the western hemlock zone.

The objective of this research project was to determine the disturbance history of the project area, specifically concentrating on the frequency and extent of stand-replacement or partial stand replacement fire events. Although low intensity (under-burns) fires have probably been important in the development of current stand conditions, time and sampling intensity did not allow for the determination of these events. We also noted other important disturbance processes such as windthrow (particularly noted on ridgetops), insect and disease damage, and landslide occurrences. These disturbance processes also influence stand conditions to varying extents within the study area.

Native Americans may have provided important ignition sources for fire events. The study area includes portions of historical travel routes used by the aboriginal peoples that were subsequently used by early Euroamerican explorers and settlers. Routes included most of the high ridgeline areas in the Augusta Project including Hiyu Ridge, Chucksney Mountain ridgeline, and the Rebel Rock ridgeline. The South Fork of the McKenzie was also a major travel and trade route. It is likely that fire frequency was increased in areas adjacent to these routes through human activities (Burke 1979). Many of these travel routes became important avenues for herding cattle and sheep into mountain meadows and as routes of travel to the eastside ranges for livestock forage resources (Colville 1898). Sheep herders particularly utilized Cascade mountain meadows as an important summer forage resource. Before leaving these meadows at the end of the grazing season, sheep herders often ignited meadows with the belief that burning would improve the forage resource for the next grazing season (Colville 1898). It is possible that these ignitions resulted in widespread forest fires.

The Augusta Project area contains a number of blueberry species that were known to be of great importance as aboriginal food resources. It is commonly thought that the native peoples managed these blueberry resources with prescribed burns to enhance their berry productivity. Therefore, areas containing blueberry plants in abundance may have been exposed to repeated burning by aboriginal peoples.

Many fires were probably ignited by lightning, particularly along prominent ridgelines. Fire spread would depend on a host of climatic and fuel factors including fuel biomass and moisture content, ambient temperature, humidity, wind direction and wind speed. Areas exposed to east winds are typically thought to experience more frequent fire occurrence due to the drying effect on fuels. South aspects tend to be warm and dry although fuel biomass tends to be less on south than north aspects. The classic supposition is that south aspects would burn more frequently than north aspects, although fire severity would be less for any one fire event occurring on a south aspect. When a fire event does occur on a north aspect, fire intensity may be greater than on a south aspect due to the typically greater fuel accumulation.

Fires may be localized small events that follow topographic contours related to parameters of weather and fuels. Conversely, during droughty conditions and extreme fire weather, fires may be topographically independent. The complexity of fire behavior causes problems when one attempts to draw discrete boundaries of fire occurrence for successive fire events from a historical perspective.

METHODS

Data collection occurred between June and October, 1991. Sample sites were selected from 1972 and 1990 aerial photographs. Samples were particularly selected along stand age-class boundaries since these boundaries were presumed to represent fire boundaries.

Two types of field sampling techniques were employed to determine fire history. Samples were collected from clear-cut units and from live forest stands. Tree ages and fire signs were determined from individual tree stumps where clear-cuts were available. We utilized increment borers to determine tree ages and discern any apparent evidence of fire scars where clear cuts were not available for sampling. Core samples do not provide as reliable fire information as stump samples because only a small portion of the bole is viewed. Also, core samples often did not reach the pith of large diameter trees, so total tree ages had to be estimated. Thus, increment boring samples were less reliable than stump data in determining stand age structure for sample points. Because stump sampling provided more reliable data, most sampling was concentrated in clear-cut units (refer to Table 1).

The intensity of sampling at a site and within an area was determined by stand-age complexity. Individual trees or stumps were chosen to obtain a representative cross-section of age classes at a sample site and to include a large number of fire scar dates. Sites with numerous age-classes and fire scars were sampled at higher density than sites with few age-classes and little fire scar evidence.

<u>Table 1. Sampling intensity</u>

Total acreage in study area		20,000
Total number of points sampled		291
in clear-cuts	xxx	
by increment coring	xx	
Total number of trees sampled		1837
Total number of sampled 'fire evidence' records		2042

Field sampling was designed to include measurements of the physical environment to examine (at some later date) correlations between environmental factors and the frequency and extent of fire events. Measurements of the physical environment at each sample site included percent slope, aspect, topographic position, plant association, and elevation. Measurements for each individual tree sampled within a sample site included:

1) Tree number, used particularly to identify increment core samples that were brought into the office for laboratory counts.

2) Tree species.

3) Years to origin, is the actual field count of age for a tree which was entered into the data sheets. The age counts were adjusted for the height at which a sample was collected and for the harvest date (where applicable). So, "T_AGE" in the database file indicates the ages all trees would be if none had been harvested and one were looking at the age of a tree today (ie. 254 years old). "Orig" in the database indicates the date when each tree became established (ie. 1747 for a tree 254 years old).

4) Accuracy of count is a numeric expression of the accuracy the

sampler felt for a count of the total tree age. Typically, on old trees, the outer rings were often difficult to distinctly discern. Thus, as a general rule, count reliability decreased with increasing age. Values for count reliability ranged between 1-6, with 1 = rough estimate and 5 = "perfect" count, 6 = core sample numeric estimate.

5) Diameter of the living tree or stump at the height of the sample.

6) Bark thickness.

7) Height of the sample, generally measured on the upslope side of the sample tree.

8) Core length, measured when an estimate of tree age from a core sample was necessary.

9) Count of rings from a core sample, used to estimate total tree age.

10) The number of tree growth rings in the inner inch of growth, measured as the very innermost rings on a tree stump or as the innermost rings from an increment core sample that did not reach the pith. This measure was used to determine the growth rate of a tree at establishment to help determine age classes following fire disturbances. Within a cohort of trees establishing after a major disturbance the earliest trees to establish will have wider growth rings (fewer rings per inner inch) than later establishing trees (narrow rings = more rings per inner inch). This measurement was also use to help estimate total tree age from core samples that did not reach the pith of sampled trees.

11) Event dates and codes were entered using acronyms. The first parameter of an event code was the numeric determination of the accuracy of ring counts to the event. Values ranged between 1-5 with 1 = rough estimate and 5 = "perfect" count. The second entry in an event code was the event type with S = Scar, P = Pitch, R = Release, Su = Suppression. The third entry in an event code is the amount of coverage of the circumference that a scar or pitch ring covered of the tree at the event date. This was used to give an idea of the severity of the particular fire event. Typically, if there was less than about 1/10th coverage for an event, this parameter was omitted. Also, if an event covered the entire circumference of the tree, a coverage value was not entered, but was indicated as an 'E' in the 'location' position for the event code (explained below). The event date parameter in an event code was the ring-count back to the fire event from the barkside of the tree to the innermost growth ring (counted as years ago). Following this ring count date was the position of the event location; U = upslope, C = cross-slope, D = downslope, E = entire circumference. And lastly, a numeric value

determined by the sampler was included to indicate the probability that the event was fire-related; 1 = low probability of fire occurrence to 5 = absolute certainty that the event record was of fire origin.

Example: "5 SPR 2/3 192 U4"

This event has a perfect count score (1st parameter) of 5. The event was a scar-pitch-release event type (2nd parameter) with the scar and pitch ring covering (3rd parameter-optional) 2/3rds of the tree circumference (at the time of the event). The event occurred (4th parameter) 192 years ago, was on the uphill side (5th parameter) of the tree and scored a fairly high probability (4) of being of fire origin (6th parameter).

ANALYSIS

Ultimately, three database (DBASE4) files were compiled that encompass all of the sample information. A complete description of the fields within these files is included in Appendix A. Computer database files were checked and corrected against the original data sheets for accuracy. At this time, inconsistencies in field techniques (as we developed our sampling strategy) were adjusted to make all records as consistent as possible.

A number of adjustments to the original field data were necessary to get the data into a usable format for analysis. An explanation of all data adjustments is included in Appendix B.

As field collection of elevation (with an altimeter) was not always taken (or calibrated), all elevations for sample sites were ultimately determined from half-quad topographic maps.

Aerial photos were used to help guide the sampling strategy as well as to help in locating sampling sites. Sample sites were often marked on aerial photos and later transposed onto half-quad overlays and digitized into GIS.

Graphs of the frequency of tree origins and fire events were generated to help determine fire episode dates (Figures 1 and 2, respectively). Generally, tree origin peaks lagged just behind peak years for fire event occurrence. Figures 3 and 4 represent data smoothed into five year increments for tree origins and events respectively. These smoothed graphs accentuate the correspondence between fire events and tree origins.

We followed rules similar to Morrison and Swanson (1990) to determine fire episodes. We required that:

1) Both scar and tree origin dates had to exist for each fire episode.

2) Each episode include at least five sites with fire evidence or tree origins dating from a particular fire.

3) Only the most reliable counts and fire reliability data were included in the analysis of fire episodes with more leniency allowed for earlier episodes. Only dates with count and fire reliability values of 4 and 5 were used to determine fire events back until 1600. Prior to 1600, dates with count and fire reliabilities between 3-5 were used to determine fire events.

4) A cluster of sites had to have both spatial and temporal affinity.

5) Generally, timespans for fire episodes increased with increasing years ago for events. Table 2 contains the timespans for all identified fire episodes.

Restrictions on count and fire reliabilities resulted in a reduced data set to determine fire episodes. For the final analysis, only points containing data with high count and fire reliabilities were included in fire episodes.

It was apparent that these criteria excluded or lumped a number of apparently low intensity more localized burns.

RESULTS

Most of the oldest trees within the study site were between 400-550 years old, implying that a series of stand replacing fire events occurred during than time period. These fires resulted in the removal of the existing forest and regeneration of new stands of trees across the landscape. The very oldest trees (550-801 years of age) found in the study area were mainly located in the uppermost drainages of Grasshopper and Augusta creeks at intermediate elevation. Many of these older trees were aged based on estimates of tree cores. The algorithm used to estimate tree ages from core samples may substantially overestimate some tree ages making these data somewhat unreliable in fire event designation.

EPISODE MAPS

These maps were generated through a reiterative process comparing successive events geographically in the GIS system. Episode boundaries were determined based on patterns of regeneration and the occurrence of fire scars. When one site showed evidence of a fire and an adjacent site did not, a boundary was draw approximately half-way between them following elevational contour lines.
Table 2 contains the determined fire episodes for the Augusta Project Area. Many of these fire episodes corresponded with

episodes identified by Teensma (1987) and Morrison and Swanson (1990).

Table 2. Fire chronology for the Augusta Project Area.

Mean fire year	Fire episode	Length of episode	Time since previous fire	Sites with record of fire scar	Sites with record of tree regen.
	Years			Number	
1973	1973-1975	3	53	12	
1920	1917-1922	6	23	19	10
1897	1893-1900	8	24	4	4
1873	1872-1879	8	13	13	31
1860	1860-1863	4	3	3	10
1857	1857-1860	4	6	3	31
1851	1849-1853	5	17	5	8
1834	1831-1839	8	10	32	82
1824	1820-1828	9	14	9	65
1810	1802-1817	16	25	32	72
1785	1781-1791	11	2	10	13
1787	1784-1795	12	19	32	45
1768	1761-1776	16	35	5	2
1733	1727-1741	15	98	10	15
1635	1633-1640	8	43	3	11
1592	1587-1596	10	17	3	8
1575	1561-1578	18	36	4	49
1539	1531-1545	15	16	8	98
1523	1515-1529	15	24	6	63
1499	1492-1500	9	30	2	39
1469	1469	1	N/A	1	13

The mean fire return interval for the entire study area is 25 years. The mean fire return interval was determined by summing the 'time since previous fire' column plus 18 years up to present (1991) and dividing this sum by the total number of fire occurrences. Similarly, the mean fire return interval was determined for each of the landscape sections (Table 3). Additionally, the fire frequency by century was determined for landscape sections to get a sense of similarity and difference of sections (Table 4)

Overall, there appears to be a higher frequency of fire events during 1800-1900 than in other centuries (Tables 2-4, Figures 1 and 2). Some of this elevated occurrence of fires may be attributed to aboriginal cultural changes and to the appearance of Euroamericans into the area. Native American people

Fig 1

Origin dates for trees

Count reliability greater than 2

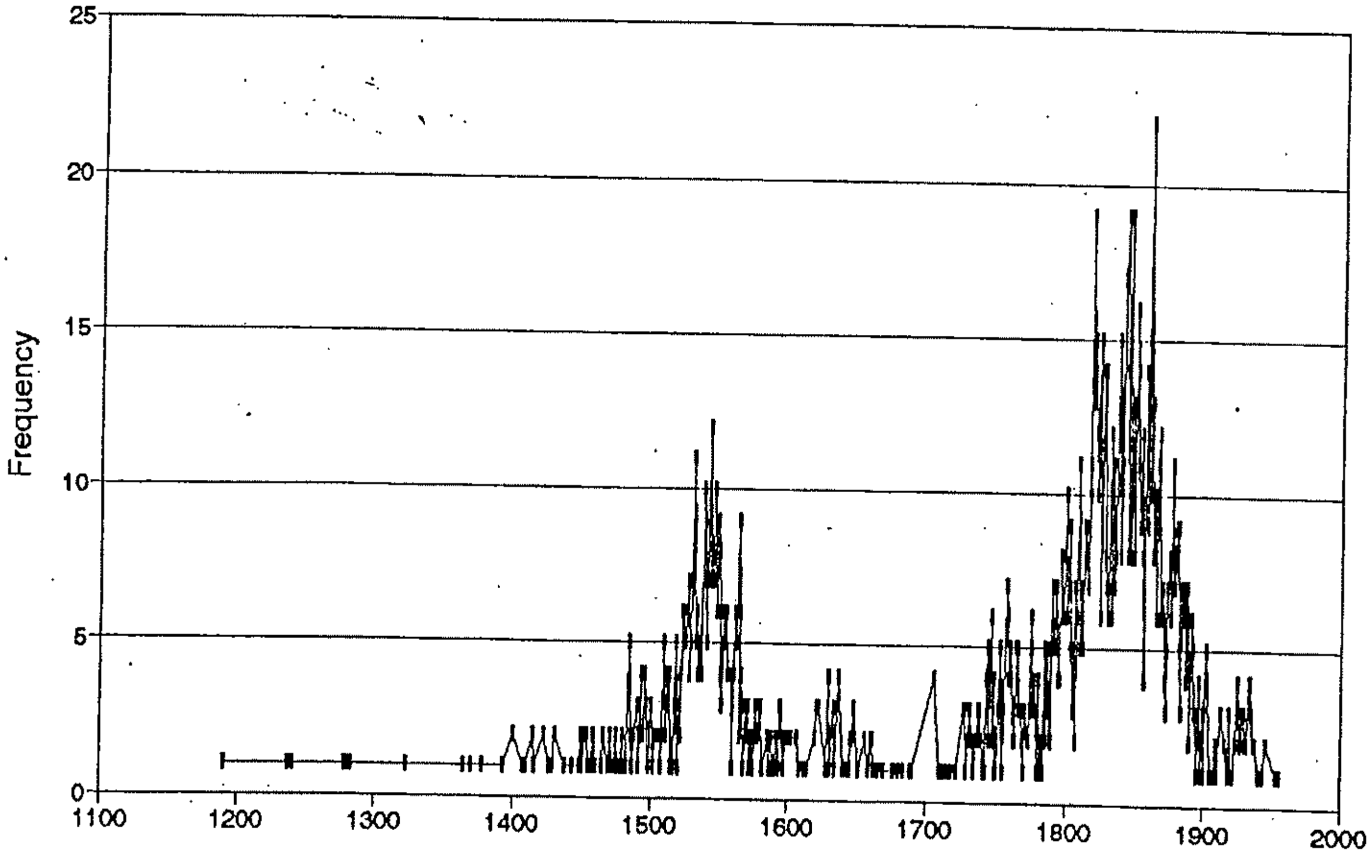


FIG 2

FIRE EVENTS 1400-2000

Count and fire reliability >2

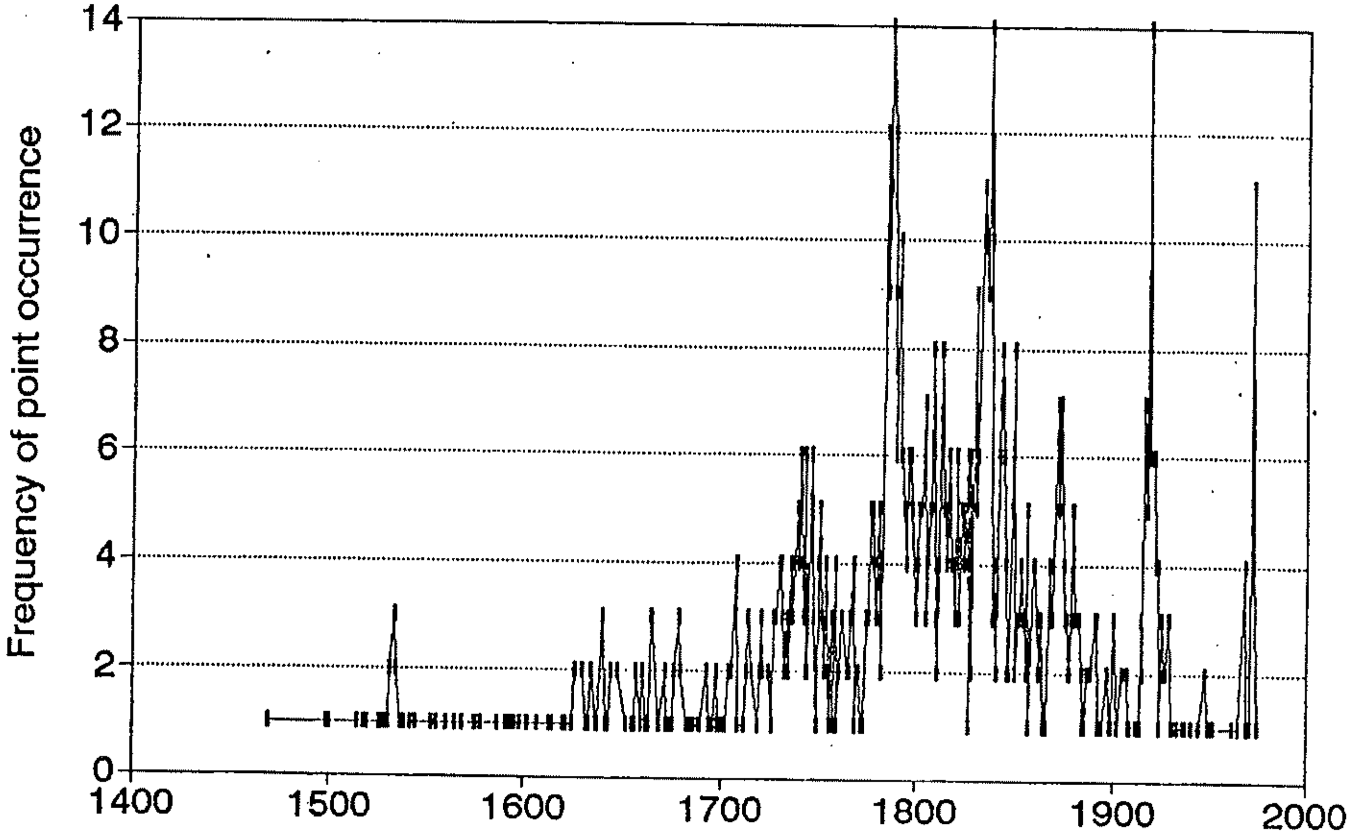
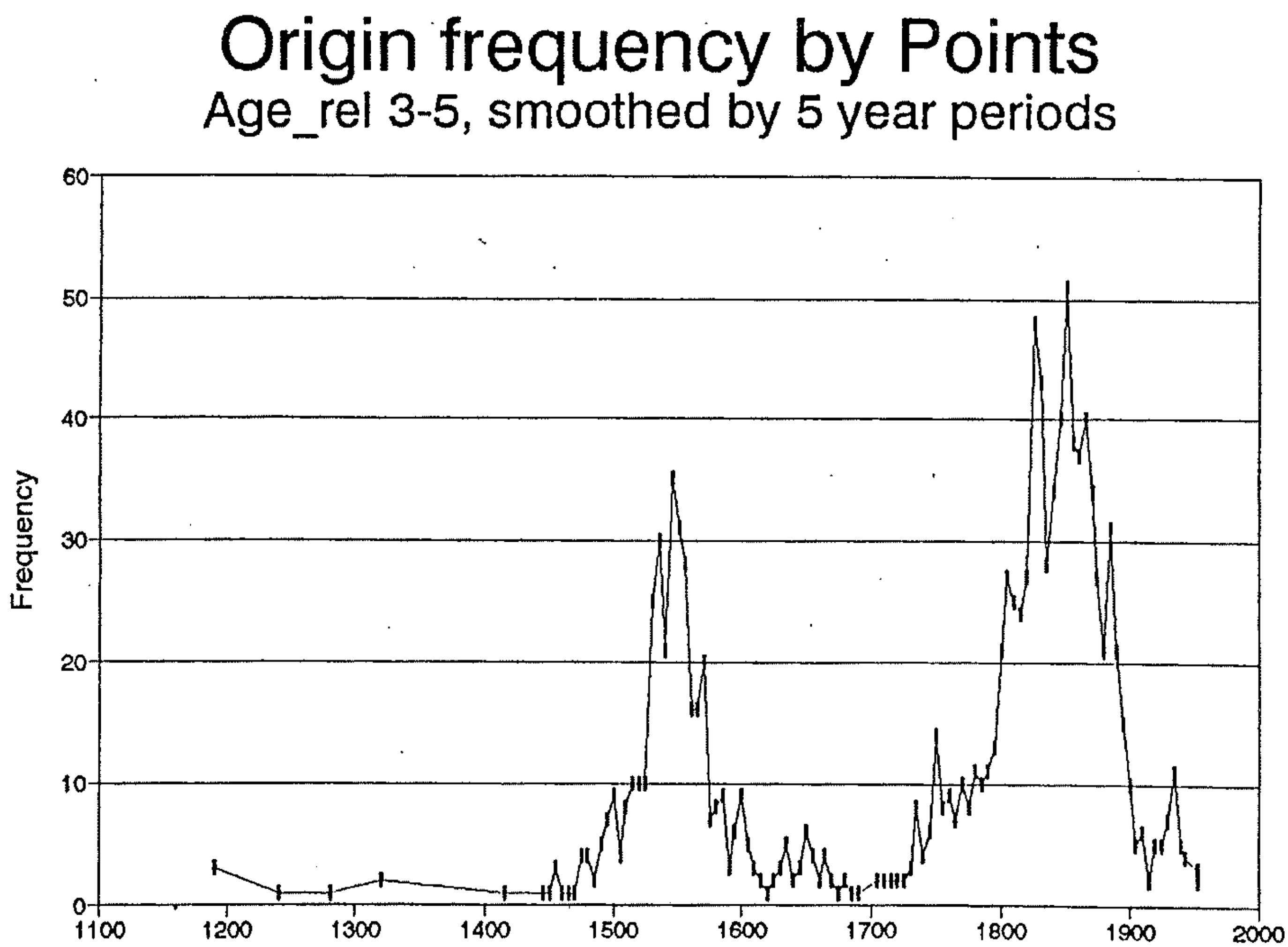
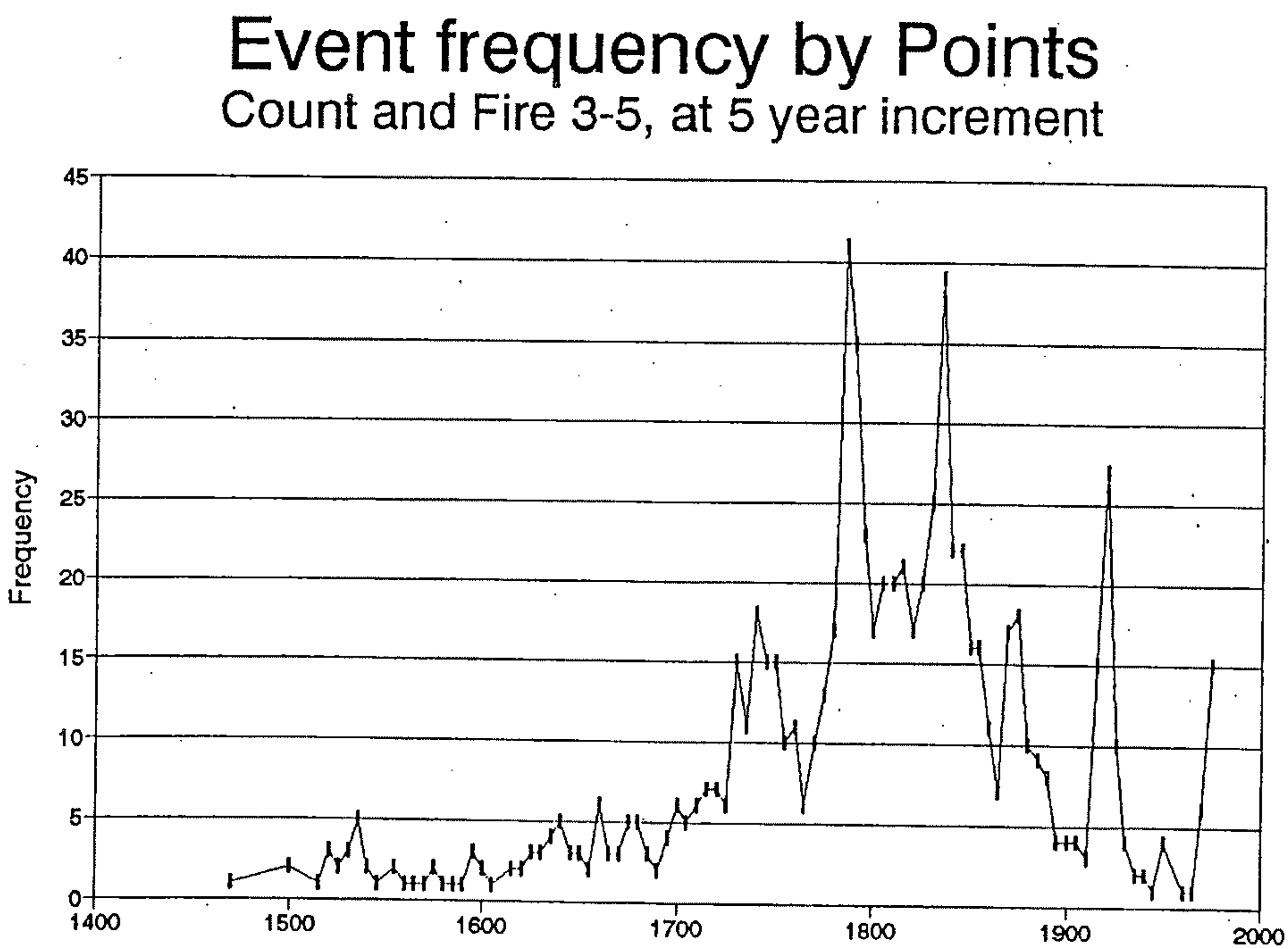


FIG 3



Origin frequency by Points
Age_rel 3-5, smoothed by 5 year periods
Frequency
60
50
40
30
20
10
0
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000

FIG 4



Event frequency by Points
Count and Fire 3-5, at 5 year increment
Frequency
45
40
35
30
25
20
15
10
5
0
1400
1500
1600
1700
1800
1900
2000

historically applied fire to the landscape for a variety of reasons including the management of game populations and management of staple plant foods (Colville 1898, Boyde 1986). Shifts in use by aboriginal peoples occurred during the mid-1800's. Many cultural changes resulted following mass epidemics (diseases contracted from initial contact with European explorers) among these native peoples (Burke 1979,Boyde 1986). Euroamericans probably began settling the Augusta study area around the 1850's. Settlers burned forested areas to clear for building and farming. Many forest fires likely resulted from unattended campfires and intentional ignitions by sheepherders to improve forage resources (Coville 1898). For more information concerning fire and cultural influences upon the western Cascade Mountain landscape, refer to a thesis by Constance J. Burke (1979).

DESCRIPTIONS FOR 'HOOD OF THE BLAZER' MAP

The landscape was separated into nine sections based upon similarities in stand-age structure, fire frequency and fire intensity (refer to Figure ************). Boundaries between sections were generally set to follow prominent topographic features such as streams or ridgelines. In the following pages, a description of the general fire regime and stand-age structure is included for each landscape section.

Mean fire return intervals were determined for the entire Augusta area as well as for each of the landscape sections (Table ****). Mean fire return intervals were further defined by major cultural periods. Cultural periods included: 1) the pre-settlement era, prior to 1840. Euroamerican settlement in the Augusta study area probably occurred sometime during the 1840's to the 1860's. Most of the native Americans had been destroyed by disease or had been removed to Indian reservations by the 1840's. 2) Euroamerican settlement period up to the advent of an active fire suppression program by the Forest Service, 1840-1910. 3) Post-fire suppression era, 1910-present.

SECTION A: North of the South Fork of the McKenzie River.

EVENTS: 1973, 1897, 1860, 1851, 1810, 1785, 1635, 1592, 1570, 1499.

There are more than five different age classes within this section of the study area. Ages range from 96-136, 152-172, 170-198, (269,273), 314-345, 353-385, 402-427, 431-488. Although, there appears to be many different age classes, the most dominant tree age is currently younger than 200 years, with many trees less than 150 years old.

The fire regime for this area appears to be one of fairly frequent, low to moderate intensity fires resulting in a composite of intermediate age classes. Numerous low intensity under burns may have occurred here as well as an occasional high intensity burn. Fire events have created a mosaic of median to larger patches on the landscape within this block.

Stand replacement probably ranged between 30-60% with each fire event. There may be more frequent stand replacing events as one increases in elevation up Rebel Rock ridge. Fires may have originated from ridgetops with fire movement down and across slope. All of our sample points were located at the base of the Rebel Rock ridge, so the extent of individual events is very approximate. From aerial photography, the higher elevation stands appear to be of young age class(es), however, additional sampling would be necessary to confirm these suppositions.

New tree regeneration following a fire event was probably very slow on the predominant south aspects (warm and droughty) and thin, rocky soils of this section of the Augusta Project. This would naturally tend to result in a wide-span of years for a particular tree cohort following a specific event. It also appears that there may have been a recurrence of events as often as every 20 years between 1800-1900. This may also explain why there are such mixed distributions of tree ages across the landscape.

Ignition origins might have included native American ignitions as well as lightning strikes since the Rebel Rock ridgeline and the South Fork of the McKenzie were historical travel routes.

SECTION B: Stream corridor along the South Fork of the McKenzie.

The predominant age class is between 400-500 years. There are trees of some other age classes probably caused by intrusion of fire events into the stream corridor. The moist, cool microclimate of this section of the landscape appears to have excluded fires of stand replacing magnitude for the past 400-500 years. Additional intensive sampling would be recommended to determine tree age composition through this riparian corridor and to determine the disturbance types, frequencies, and intensities important in this area.

OTHER DISTURBANCE FACTORS: Stream channel movement is probably an important disturbance element in recruitment and mortality of individual trees within this section of the study area.

SECTION C: South of the South Fork of the McKenzie River along the north face of the Chucksney Ridge.

EVENTS: 1920, 1834, 1824, 1810, 1785, 1733, 1635, 1539, 1499.

The stand age structure within this section is extremely complex, often with 3-4 apparent age classes present at any sample site. Predominant age classes were 101-118, 136-166, and 226-260-279 with lesser amounts of 166-226, 325-342-369 and 400-plus ages. The older age compositions were more typically lower in elevation, near the South Fork stream terrace. Most of the trees in this area are older than 150 years, with many greater than 200 years of age.

Disturbance patch sizes appear to be smallest in this landscape section. Fires with small aerial extent and with low to moderate-intensity appear to have been prevalent within this section. This has resulted in a mosaic of intermediate and older age classes. Sections C and E have the most complex age compositions in the Augusta Project Area. Patch sizes are also similar between Sections C and E, however Section C has an overall older age composition.

The mosaic of age classes may have been caused by numerous spot-fires. It is likely that fires spotted-over from the southwest face of Chucksney ridge as well as spotted-over from fires occurring along the south aspect slopes across the South Fork of the McKenzie River. Fires could also have crept downhill from the ridgetop as backing fires with low intensity underburns flaring up to become high mortality patches in scattered locations.

SECTION D: Loon Creek drainage.

EVENTS: ~~1873, 1857, 1834, 1824, 1810, 1787, 1592, 1570, 1539,~~ 1523, 1499.

Stands within this section of the study area are generally composed of age classes ranging from 94-120, 121-153, 168-200, 201-214, (307), 403-411, 433, and 444-462 years. The predominant age classes include 94-120 and 121-153 years. Some of these age classes appear similar to those in Section A implying they both experienced some common fire events. There are fewer age classes as one moves toward the southern boundary with Section G. Section D contains very little of the old age class (400 years plus). Most of these old-age class trees are located along small draws and along the main body of Loon Creek.

The fire event of 1787 was probably fairly large and intense as a considerable amount of regeneration post-dates this event. The fire events of 1873 and 1832 also appear to have been fairly intense and may have removed 1787 regeneration as well as regeneration resulting from previous events. It appears that the overall fire regime for this area is one of large patch-size with relatively moderate frequency and moderate to high intensity. There are also scattered lower intensity (1857, 1824, 1810) burns within this area with variable patch sizes.

Sections D, G, and F have somewhat similar patch sizes although intensities and frequencies of events are different. Patch sizes in all three sections include intermediate and small patches of events. However, intermediate patches predominate in Sections D and G while small patches predominate in Section F. Overall stand complexity appears greater in D and F than in G. Age classes are older in D than in F with a couple of intermediate age classes interspersed with an old age class.

The high frequency of fires within this area may suggest the presence of historical cultural sites.

SECTION E: Lower tongue of Chucksney spine

EVENTS: 1920, 1857, 1834, 1824, 1810, 1787, 1768, 1733, 1570, 1539, 1523.

This section appears to be much like an 'ecotone' in fire blocks. It shares many fire episodes with sections around it. It has a very complex age structure composition, although is appears to be a bit younger overall than Section C. Much of the tree age composition is less than 200 years of age. This section and Section C contain the greatest number of fire events.

Disturbance patch sizes are relatively small in this section. The stand age composition is a mosaic of intermediate and older age classes. It also appears that fire intensity is greater in Section E than in C.

This area may potentially contain at least one significant aboriginal cultural site as suggested by its very frequent fire return interval (with often apparently isolated low elevational episodes).

SECTION F: Southwest slopes of Chucksney Ridge.

EVENTS: 1920, 1873, 1834, 1824, 1810, 1787, 1570, 1539, 1523, 1499.

Most of the tree composition is younger than 200 years of age within this section. There were typically two age classes present at any sample point. Age classes included: 40-74, 88-104-113, 142-163-183-215, 245, 276-285, 342, 353 and 400-plus. Much of the area is covered with a very young age class of trees established after the 1920 fire event. This event appears to have covered about one-third of the block area and was fairly intense over much of the area.

This landscape section contains one of the lowest densities of old-age class (400-500) trees. Old trees were frequently located adjacent to Augusta Creek in dense stands and scattered singly and in clumps up draws and along northern aspects. There was a greater proportion of older-aged trees in the higher elevation, southern portion of the block.

The soils within this section of landscape appear to be very thin and rocky with aspects predominantly southerly and westerly. Therefore, one would expect a long period of forest reestablishment following disturbance events. This may help to explain why there were unclear periods of tree reestablishment following determined episodes.

Much of the stand age and fire scar events within this area were determined using increment boring techniques since there were few cut-over areas to investigate. We therefore used somewhat laxer rules (including dates with fire reliability between 3-5 instead of only 4 and 5) to help determine fire events within this section of the landscape.

Patch size is intermediate and of similar size to Section D and G. Fire intensity is probably low to moderate and similar to the apparent fire intensity of Section D. Recent fire events in Section F have resulted in some very young successional stages. Among Section D, G and F, stand complexity is probably greatest in Section F as it contains a mosaic of young age classes interspersed with a couple of intermediate and older age classes.

SECTION G: Section south of Loon Creek drainage.

EVENTS: 1873, 1834, 1824, 1810, 1787, 1570, 1539, 1523, 1499, 1469.

Approximately 60-80 percent of the landscape is composed of trees less than 200 years old with the remainder composed of the 400-500 year age class(es). Age classes include 136-156-182-191, 426-473, 481-484, 494-518. There appears to be a number of major events (1832, 1810, 1787) about 150-200 years ago that resulted in the establishment of present stands. The 1534, 1787, and 1832 events appear to have been relatively large and intense events.

This section is very similar to section D, with many events in common between the two sections. However, recent events within Section D appear to have been more intense than in Section G resulting in younger stand conditions in Section D than in Section G.

Although patch size is intermediate and similar to D and F, fire intensity appears to be less severe as a large component of old age classes remain within this area. Stand ages are more homogeneous in G than in D or F. Section G has predominantly only one or two age classes per sampling site: all intermediate age, all old age, or a composite of intermediate and old.

SECTION H: Upper drainages of Grasshopper and Augusta Creeks.

EVENTS: 1787, 1570, 1539, 1523, 1499, 1469.

The predominant age class is between 400-450 years (resulting from the events during the 1500's) with some trees extending into 550 years of age. Most of the 500-plus aged trees are located in the extreme headwater areas of Loon, Grasshopper and Augusta Creeks. This is consistent with other observations that the oldest trees within the west Cascade landscape are typically present in high-elevation cirque basins.

Stand structure is simple and patch sizes are large. The last high intensity burns occurred some 400-550 years ago as indicated by the predominant age structure(s). There are some apparent inclusions of low to moderate intensity fire events that caused some small-patch stand replacement in restricted pockets. The 1787 event is substantiated by both scar evidence and tree regeneration within these pockets. Younger age classes may compose 1-5% of the total area of this section. Younger-aged trees range between 109-350 years of age. This wide age-range may indicate the occurence of periodic underburns within the area or natural gap processes. Very evident fire scars were found on tree stumps in clear-cut units and little to no regeneration of Douglas fir was observed. This may suggest that underburns have been important in maintaining an old-age Douglas fir composition in some areas (removing shade tolerant and fire sensitive western hemlock and western red cedar).

SECTION I: High elevation areas of Grasshopper and Augusta drainages

This part of the study area is concentrated within very high elevations. Tree ages range between 67-569 with most trees younger than 200 years. The predominant age classes are between 94-104 and 136-172. Most of the tree composition is of species other that Douglas fir including Pacific silver fir, grand fir, noble fir, and mountain hemlock.

There are a number of hypotheses for the occurrence of predominantly young-aged trees within this area. First, it is possible these plant communities are slowly proceeding toward climax communities at these high elevation sites. It is possible that large-scale fires have not been an integral component of this landscape. The old Douglas fir present may be vestiges of a bygone dominant seral plant community. It has also been noted that some 500-600 years ago the climate was in a warming period when Douglas fir could have established in these high elevation areas.

A second hypothesis for these predominant young age-class forest stands includes fire as an important ecological process. A great number of lightning ignitions may be possible at these high elevation sites. However, fires may have been of relatively small extent due to the nature of fuel packing, abundance and moisture at these sites. This scenario would result in extremely varied mixtures of stand ages within this region.

A third hypothesis for these young-aged stands also includes fire as an important disturbance component in stand development. It is possible that large-scale fire events have resulted in young forest stands. Old Douglas-fir have remained in protected areas through successive fires. Due to the low sampling intensity within this area, distinct fire events were impossible to discern. However, the predominant age classes in this section could line-up with some of the determined fire episodes for other sections. It has been observed from the recent Warner Creek fire on the Oakridge District that fire burned at very low intensity through high elevation true fir forest which resulted in almost complete mortality of true fir stands.

Within this section are a number of high elevation meadows that were possibly used during the late 1800's through the mid-1900's as a summer forage resource for sheep herds (Coville 1898, Burke 1979). There is also an abundance of huckleberry (_Vaccinium_ spp.) plants throughout this section, especially along the ridgelines. Therefore, the potential for a varied scenario of human ignitions is probable within this section. These human influences further complicate the interpretation of fire as a 'natural' disturbance process and the use of a fire 'template' for management. Due to the low sampling intensity that this area received and the potentially complicated role of fire, additional sampling would be suggested to determine the importance of fire within this area. Sampling was insufficient to determine an estimate of disturbance type, frequency and aerial extent (patch size).

OTHER DISTURBANCE FACTORS: Windthrow appears to be of moderate importance as a disturbance factor within this section of the study area. Windthrown trees were especially noted along ridgelines with thin rocky soils. The ridgeline that separates the Grasshopper drainage from the Augusta drainage experienced the most blowdown of all of the areas that were surveyed during the field season.

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APPENDIX A: COMPUTER FILE DESCRIPTIONS

Structure for database: B:\POINT.DBF
Number of data records: 291
Date of last update : 12/02/91

Field	Field Name	Type	Width	Dec
1	PT_ID	Numeric	4	
2	DATE	Date	8	
3	SAMPLER	Character	2	
4	PHOTO_ID	Numeric	10	
5	T	Character	3	
6	R	Character	3	
7	S	Character	3	
8	SAMPLE_ID	Character	6	
9	ELEV	Numeric	4	
10	ACT_CD	Character	5	
11	ACT_DT	Numeric	4	
12	TRI_COMP	Numeric	4	
13	TRI_CELL	Numeric	4	
14	STAND_EX	Numeric	7	
15	POSIT	Character	2	
16	ASP	Numeric	3	
17	SLOPE	Numeric	3	
18	TOPO	Numeric	1	
19	P_ASS	Character	10	
20	TREE1	Character	5	
21	TREE2	Character	5	
22	TREE3	Character	5	
23	SH_1	Character	5	
24	SH_2	Character	5	
25	SH_3	Character	5	
26	SH_4	Character	5	
27	SH_5	Character	5	
28	H_1	Character	5	
29	H_2	Character	5	
30	H_3	Character	5	
31	COM	Character	1	
** Total **			143	

Number of data records: 1837

Date of last update : 12/02/91

Field	Field Name	Type	Width	Dec
1	REC_NO	Numeric	4	
2	PT_ID	Numeric	4	
3	SP	Character	5	
4	S1_I2	Numeric	1	
5	HT_CT	Numeric	3	
6	CH	Numeric	3	
7	DIAM	Numeric	4	1
8	BARK	Numeric	4	1
9	OFF_FLD	Numeric	1	
10	RING_1	Numeric	2	
11	RW	Numeric	2	
12	AGE	Numeric	4	
13	S_AGE	Numeric	4	
14	T_AGE	Numeric	4	
15	ORIG	Numeric	4	
16	AGE_REL	Numeric	1	
17	CORE_L	Numeric	5	2
18	CORE_AGE	Numeric	3	
** Total **			59	

Structure for database: B:\EVENT.DBF
Number of data records: 2042
Date of last update : 12/02/91

Field	Field Name	Type	Width	Dec
1	REC_NO	Numeric	4	
2	PT_ID	Numeric	4	
3	SP	Character	5	
4	S1_I2	Numeric	1	
5	EVENT	Numeric	3	
6	EVT_ORIG	Numeric	4	
7	CT_REL	Numeric	1	
8	TYPE	Character	4	
9	COVER	Character	4	
10	POS	Character	2	
11	FIRE_REL	Numeric	1	
** Total **			34	

COMPUTER FILES

Three database files were developed to contain all of the pertinent data: POINT.DBF, TREE.DBF, EVENT.DBF. The attached pages include the data structures for these three files. All fields contain the field item PT_ID which can be used as a relate item between the files.

POINT.DBF contains all information gathered for a particular patch area in which trees were sampled for age and fire evidence. Fields included in this file contain descriptive information for a particular sample site such as elevation, aspect, percent slope, and location. A description of all fields follows:

PT_ID	Is a unique number assigned to each site of data collection. It is also the number assigned to the digitized point. It can be used as a relate item between all DBASE and GIS files.
DATE	Is the sample date for sites.
SAMPLER	The initials of one of the samplers.
PHOTO_ID	The 1990 color aerial photo that contains the site.
T	Township
R	Range
S	Section
SAMPLE_ID	Used to help in locating the sites from aerial photos
ELEV	Elevation of a sample point; determined from topographic maps.
ACT_CD	Management activity code for managed stands. HCC = Harvest Clear-Cut.
ACT_DT	Year in which management activity took place. Typically, the year of harvest of a clear-cut unit.
TRI_COMP	TRI compartment; to help in site location.
TRI_CELL	TRI cell; to help in site location.
STAND_EX	Stand exam number; to help in site location.
POSIT	Position of a sample point or patch within a clearcut unit.
ASP	Aspect for the sample point; determined on site.

SLOPE Slope for a sample point; determined on site.

TOPO Topographic type; numeric value. 1 = Ridgetop, 2 = Concave slope, 3 = Even slope, 4 = Convex slope, 5 = Benchy, 6 = Valley Bottom.

P_ASS Plant association type. Determined on site if a sample was located in a living stand (increment core) or determined in an adjacent stand if a sample was located in a cut unit (stump sample).

TREE1-TREE3 The three most dominant trees within a sample site.

SH_1-SH_5 The three most dominant shrubs within a sample site.

H_1-H_3 The three most dominant herbs within a sample site.

COM Indicates whether comments were present on the field data sheet describing particulars about the sample site. Y = Yes, N = No.

TREE.DBF

REC_NO A unique number for each tree sample.

PT_ID Is a unique number assigned to each site of data collection. It is also the number assigned to the digitized point. It can be used as a relate item between all DBASE and GIS files.

SP Species of tree sampled.

S1_I2 Numeric symbol for whether the sample was from a stump (Stump = 1) or from an increment core (Increment core = 2).

HT_CT The height (in inches) at which a sample was taken.

CH The height (in centimeters) at which a sample was taken.

DIAM The diameter (in inches) of a tree at the height at which a sample was collected.

BARK Bark thickness measured in inches.

OFF_FIELD Numeric indication indicating whether the sample was read in the office (=2) or in the field (=1)

RING_1 The number of rings counted in the inner 1 inch of the core sample.

RW Width (in centimeters) of the innermost three rings of a sample.

AGE The age of a sample tree as counted in the field.

S_AGE The age of a sample adjusted for the height of the sample.

T_AGE The total adjusted age of samples including adjustments for sample height and harvest date.

ORIG Tree age adjusted to the origin date or establishment year (1991 - T_AGE).

AGE_REL A subjective evaluation (on a scale of 1-6) by the sampler of the accuracy of an "age" count. 5 = Perfect 1 = estimate, and 6 = an age estimated from an increment boring sample.

CORE_L Core length of sample measured in inches.

CORE_AGE The number of rings counted within the core sample.

EVENT.DBF contains all information about fire events that were recorded from individual trees sampled at sample sites. Fields included in this file contain descriptive information about the date, type, and reliability of fire events that were documented. A description of all fields follows:

REC_NO A unique number for each tree sample.

PT_ID Is a unique number assigned to each site of data collection. It is also the number assigned to the digitized point. It can be used as a relate item between all DBASE and GIS files.

SP Species of tree sampled.

S1_I2 Numeric symbol for whether the sample was from a stump (Stump = 1) or from an increment core (Increment core = 2).

EVENT The event date parameter in an event code was the ring-count back to the fire event from the barkside of the tree to the innermost growth ring (counted as years ago).

EVT_ORIG The date that an event occurred (ie. 1874).

CT_REL A subjective evaluation (on a scale of 1-5) by the sampler of the accuracy of an "event" count: 5 = perfect count and 1 = an estimate

TYPE The type of event that was recorded. S = Scar, P = Pitch, R = Release, Su = Suppression.

COVER The amount of coverage of the circumference that a scar or pitch ring covered of the tree at the event date. This was used to give an idea of the severity of the particular fire event. Typically, if there was less than about 1/10th coverage for an event, this parameter was omitted. Also, if an event covered the entire circumference of the tree, a coverage value was not entered, but was indicated as an 'E' in the 'location' position for the event code (explained below).

POSITION The position of the event location, U = upslope, C = cross-slope, D = downslope, E = entire circumference.

FIRE_REL A numeric value determined by the sampler included to indicate the probability that the event was fire-related, 1 = low probability of fire occurrence to 5 = absolute certainty that the event record was of fire origin.

APPENDIX B: DATA ADJUSTMENTS

DATA ADJUSTMENTS

All expressions within quotes ("") are the designated labels within the computer files.

1) Estimates of age for core samples were determined from the formula:

CORE AGE =

(((("Diam"/2) - "Bark") - "Core_L") * "Ring_1")+ "Core_Age"

Where:

"Diam" = Diameter of tree at sample height measured in inches.
"Bark" = Bark thickness in inches.
"Core_L" = Core length of sample measured in inches.
"Ring_1" = The number of rings counted in the inner 1 inch of the core sample.
"Core_Age"= The number of rings counted within the core sample.

The estimated tree ages were entered into the "Age" column of the Tree database file and differentiated by a 6 value in the count reliability for each specific tree sample.

2) There were a number of adjustments made to the data files to account for the effect of sample height on the age count.

a) A column ("CH") for converting count height from inches to centimeters was added to the Tree file :

"CH" = "Ht_Ct" * 2.54

Where:

"CH" = The height that the sample was collected at in centimeters.

"Ht_Ct"= The height that the sample was collected at in inches (from the field data sheets)

b) A column ("RW") for converting the number of rings of the inner inch to the number of centimeters of the innermost three rings was added to the Tree file.

"RW" = 75 ÷ "Ring_1""

Where:

"RW" = Width in centimeters of the innermost three rings of a sample.

"Ring_1" = The number of rings in the innermost inch of a sampl e.

c) A new field labeled "S_Age" was added to the Tree file utilizing two formulas:

<u>If "RW" ≤ 2 mm:</u>

"S_Age" = (0.1852 * "CH"/"RW") + "Age"

<u>If "RW" > 2 mm:</u>

"S_Age" = (0.1825 * "CH"/2) + "Age"

Where:

"S_Age" = The age of a sample adjusted for the height of the sample

"RW" = Width in centimeters of the innermost three rings of a sample.

"CH" = The height that the sample was collected at in centi meter s.

"Age" = The age of a sample as determined in the field.

3) A new field labeled "T_Age" was added which adjusted "S_Age" values for harvest dates (where applicable).

"T_Age" = "S_Age" + (1991 - "Act_Dt")

Where:

"T_Age" = The total adjusted age of samples including adjustments for sample height and harvest date.

"S_Age" = The age of a sample adjusted for the height of the sample.

"Act_Dt" = The activity date, typically the year of harvest.

The values in the "T_Age" column represent the tree ages present if no harvesting had occurred and we were looking at ages of trees across the landscape today (1991). These values could be used to compose a stand age map of the Augusta area.

4) A field labelled "Orig" was added to the Tree file that adjusts the age of trees to the origin date or establishment year of sample trees.

"Orig" = 1991 - "T_Age"

5) A new field labelled "Evt_Orig" was added to the Event file to adjust all fire event evidence to the year of occurrence of each fire event.

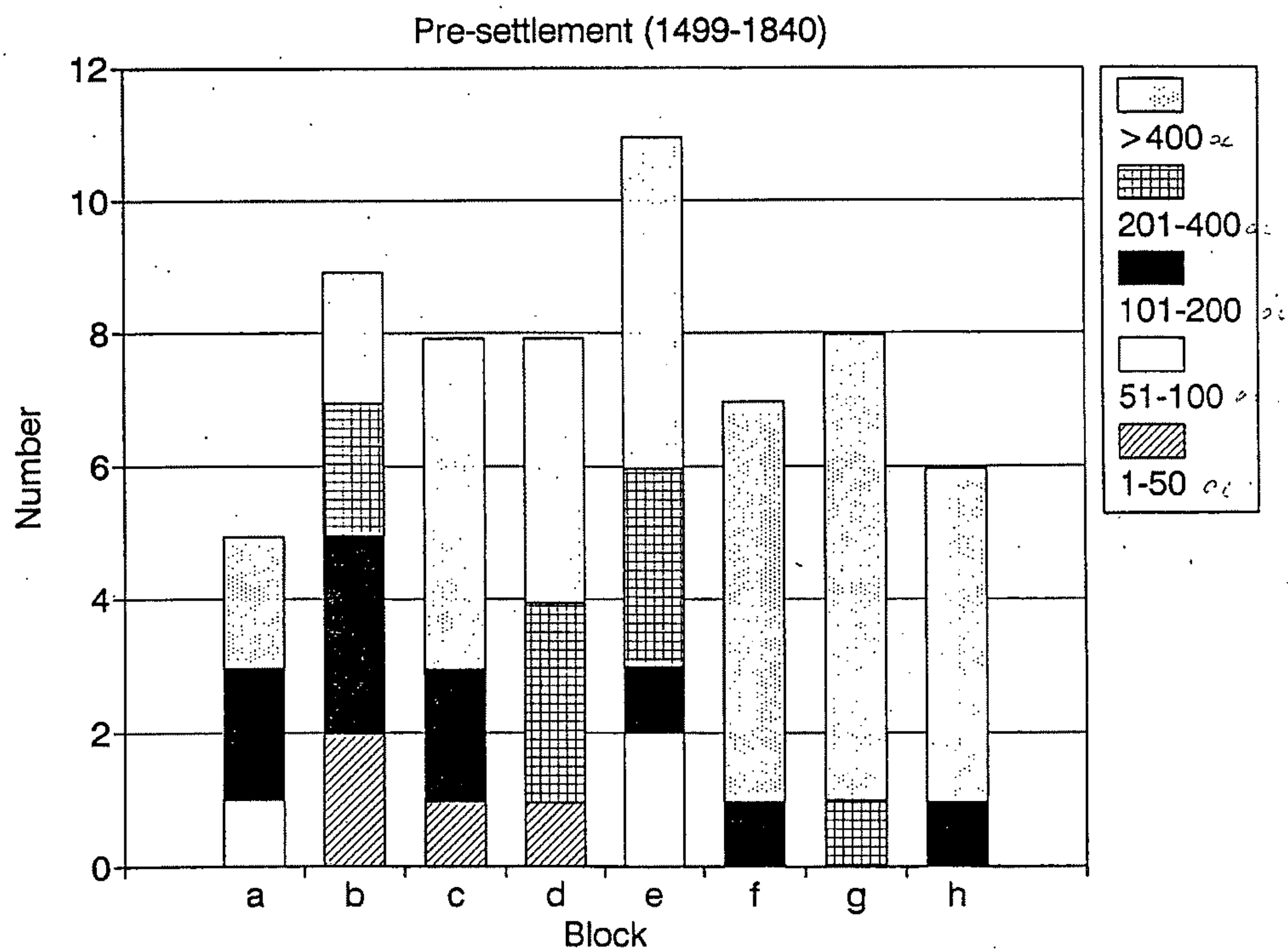
"Evt_Orig" = 1991 - ((1991 - "Act_Dt") + "Event")

Where:

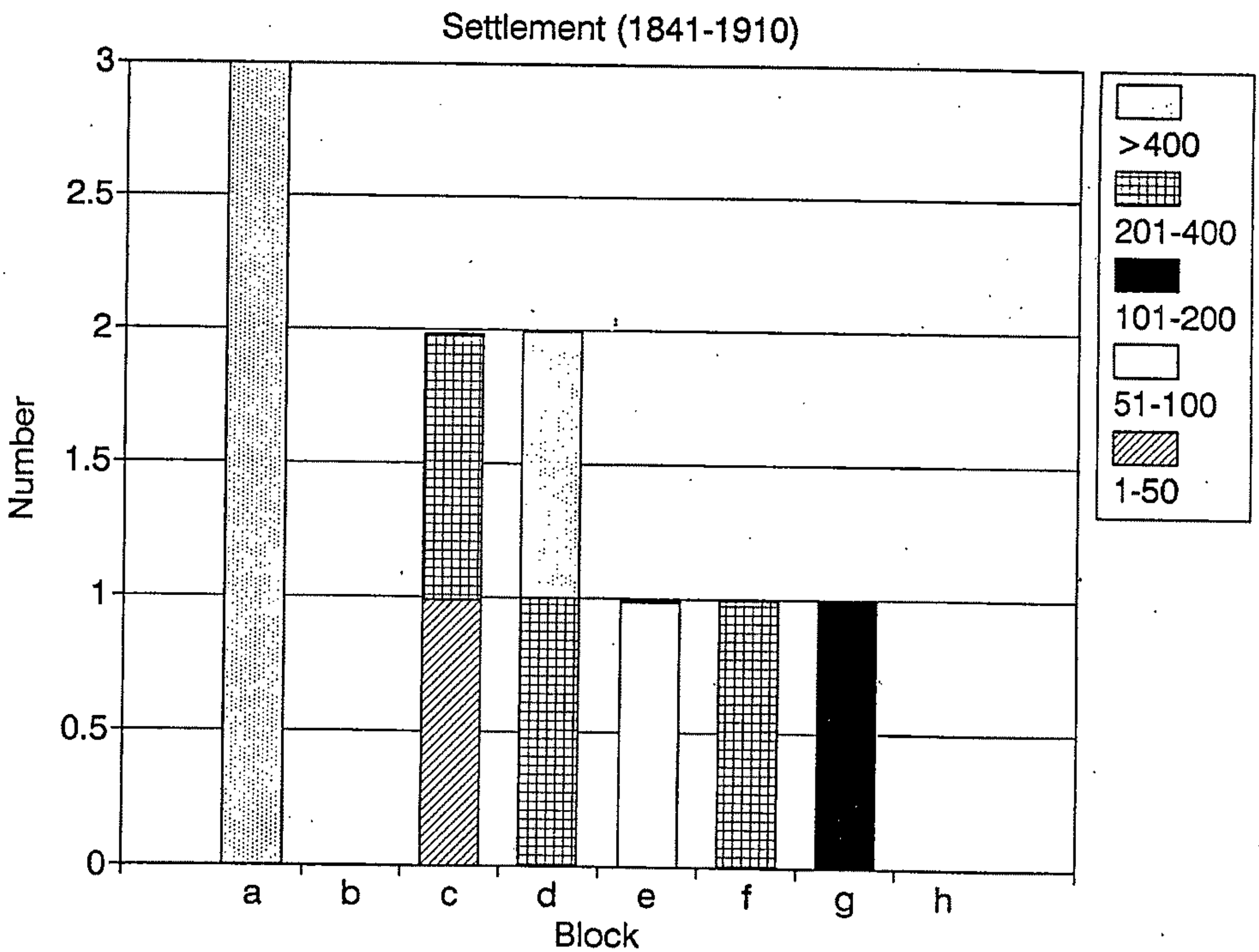
"Evt_Orig" = The year a particular fire event occurred (ie. 1887).

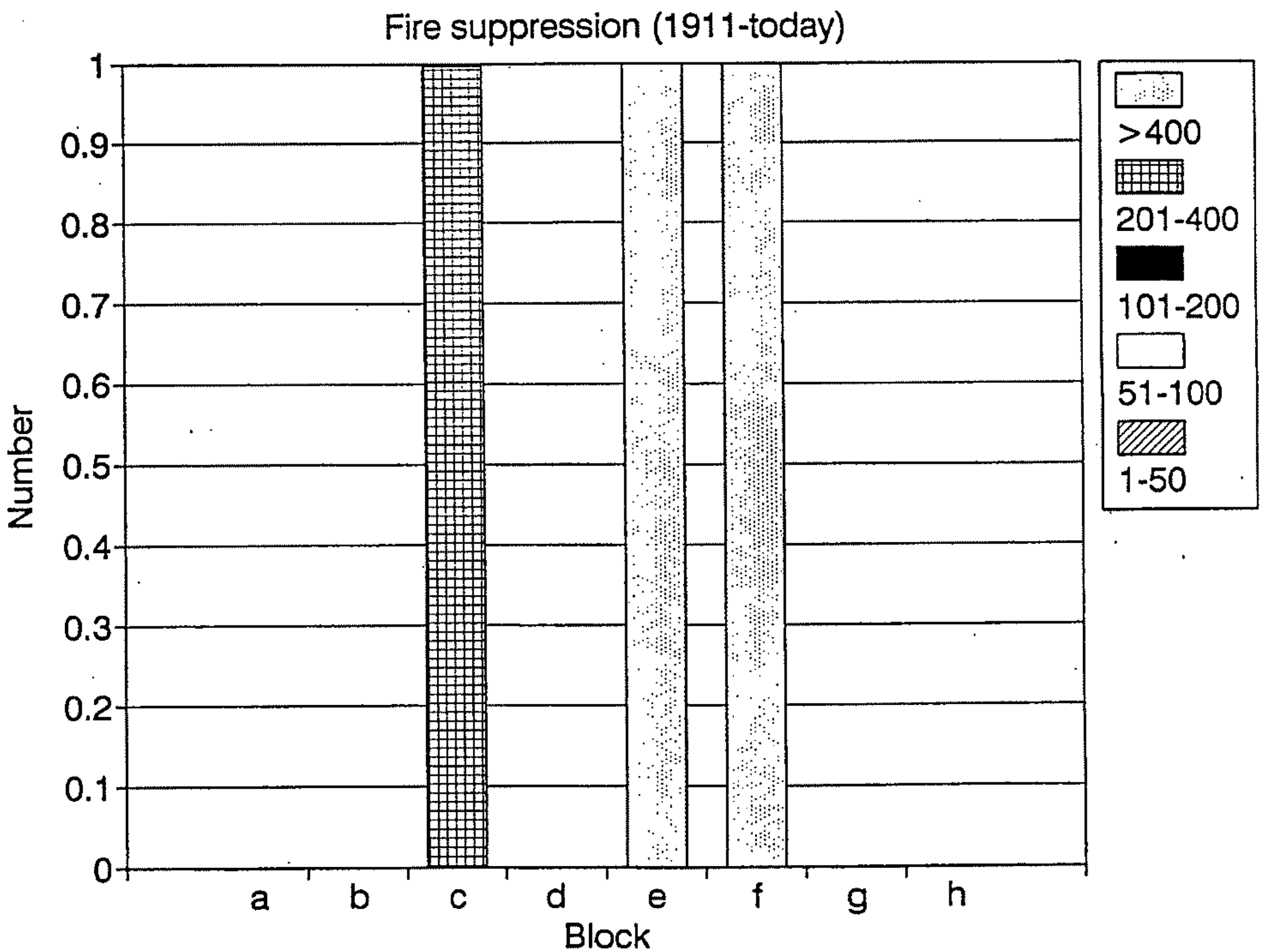
"Act_Dt" = Typically the year of harvest for a sample tree. For live trees (core samples), a value of 1991 was entered so all data could be adjusted to the year that fire evidence occurred.

"Event" = The value recorded on the field data sheets as years ago for a particular fire event (ie. 114 years ago).

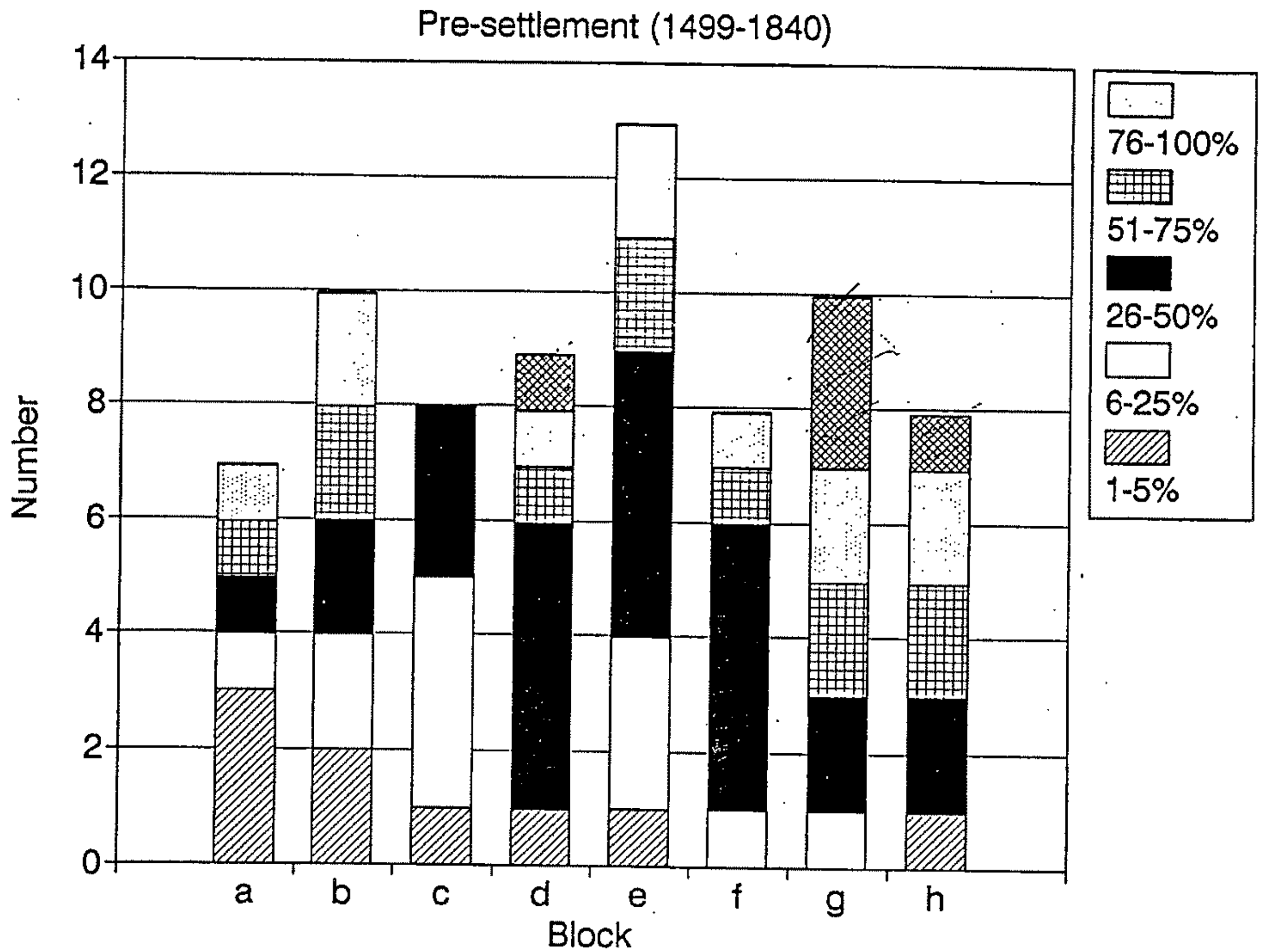


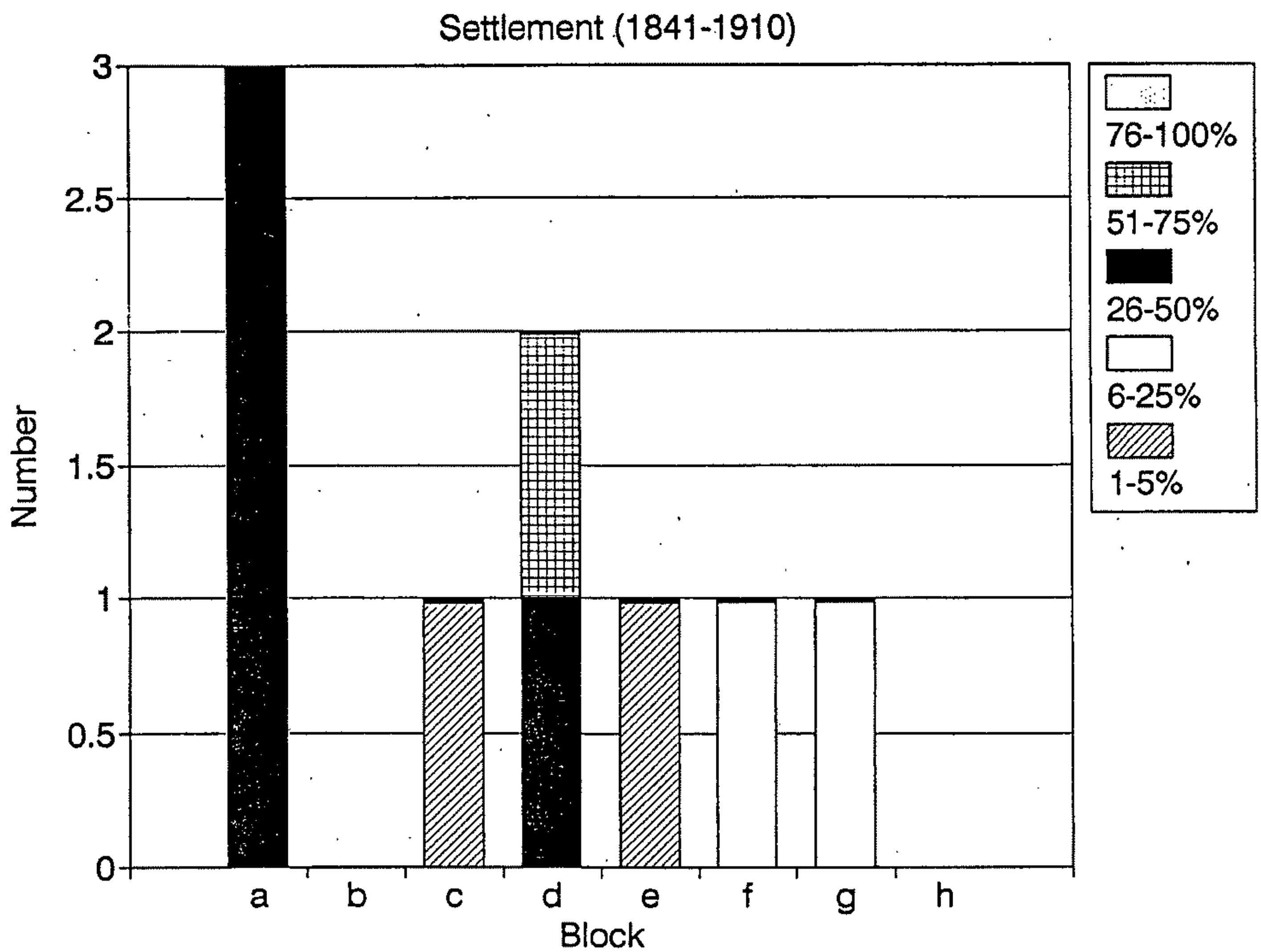
Pre-settlement (1499-1840)
Number
Block
0
2
4
6
8
10
12
a
b
c
d
e
f
g
h
>400
201-400
101-200
51-100
1-50

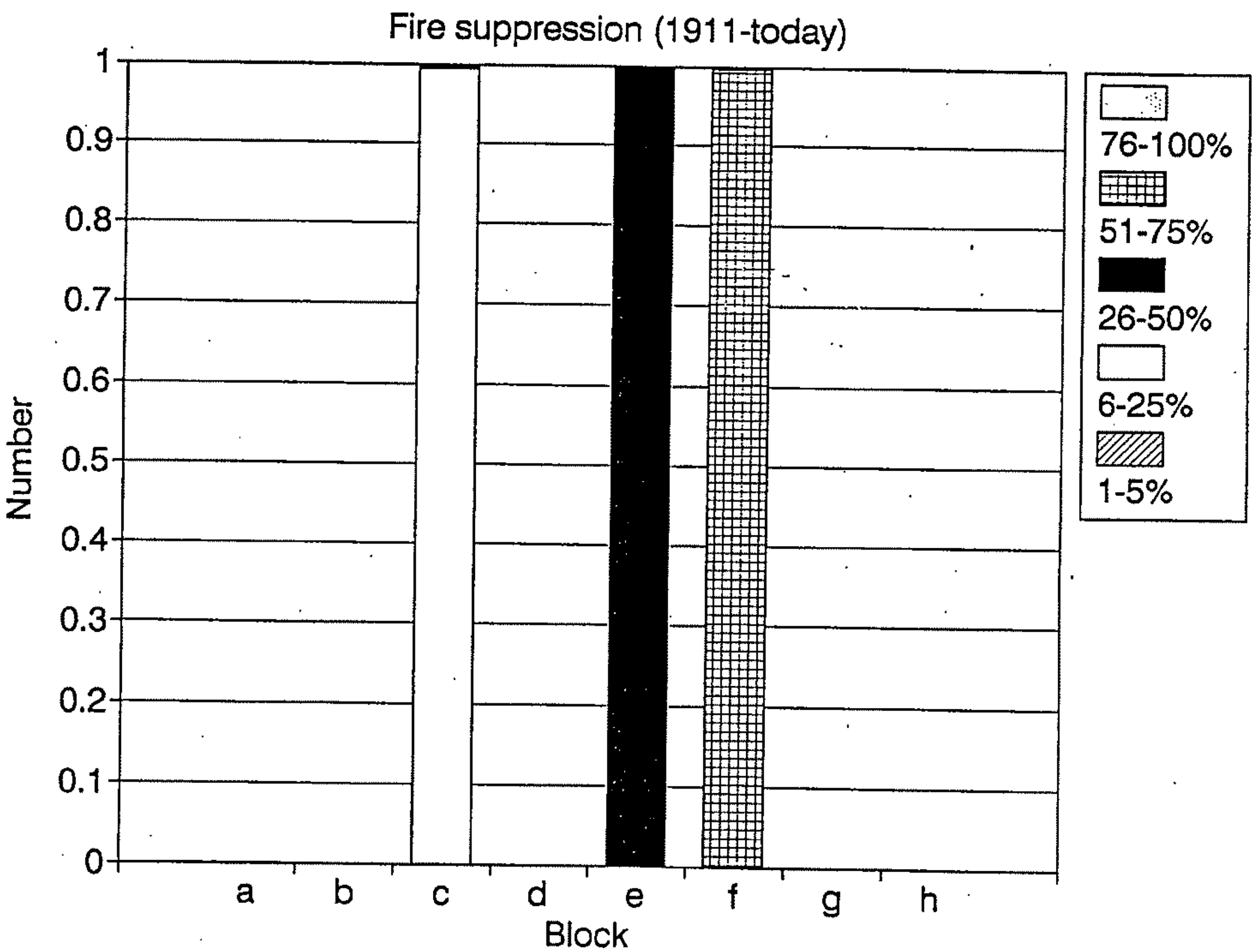

Settlement (1841-1910)
Number
3
2.5
2
1.5
1
0.5
0
a
b
c
d
e
f
g
h
Block
>400
201-400
101-200
51-100
1-50

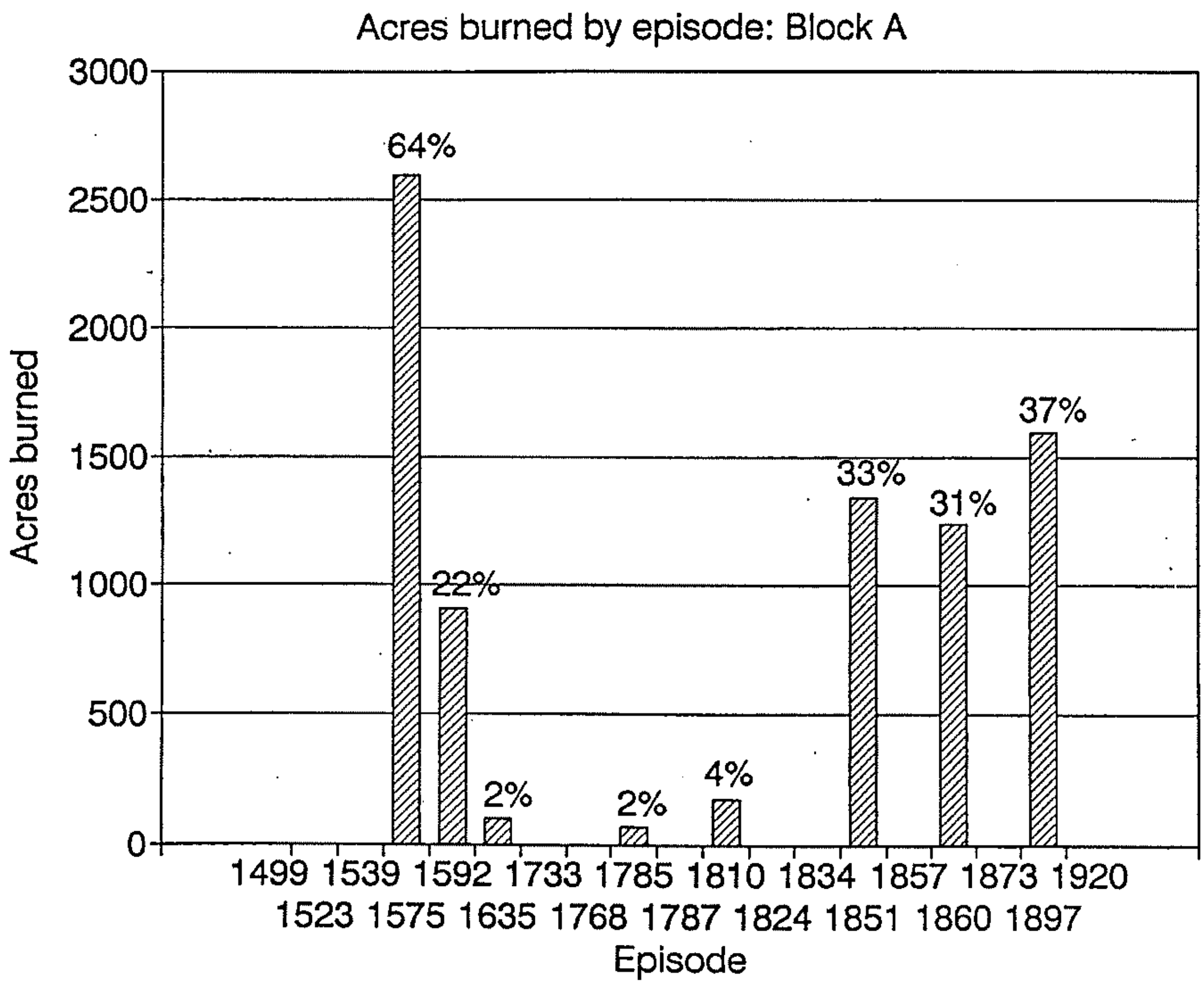


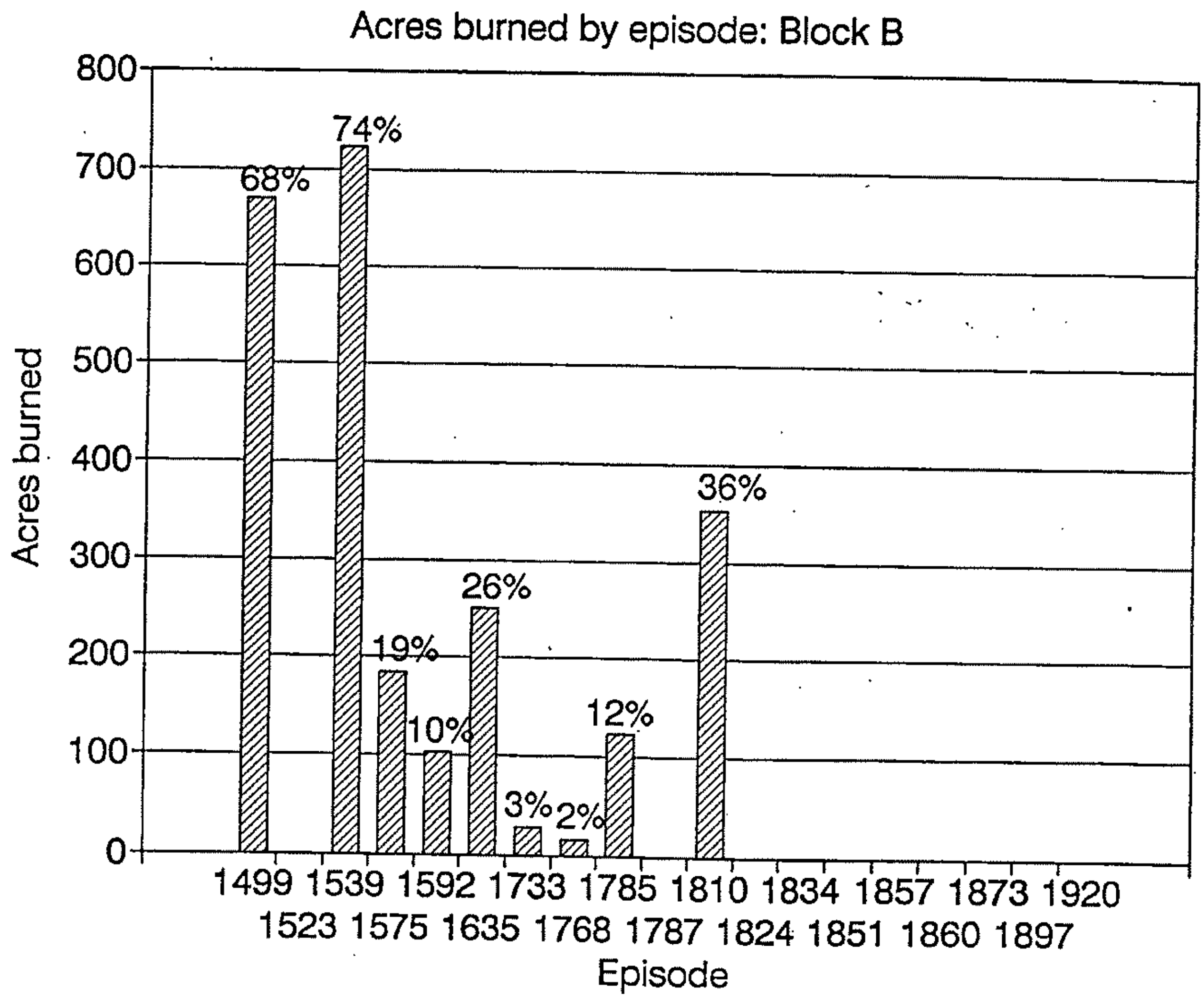
Fire suppression (1911-today)
Number
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
a
b
c
d
e
f
g
h
Block
>400
201-400
101-200
51-100
1-50

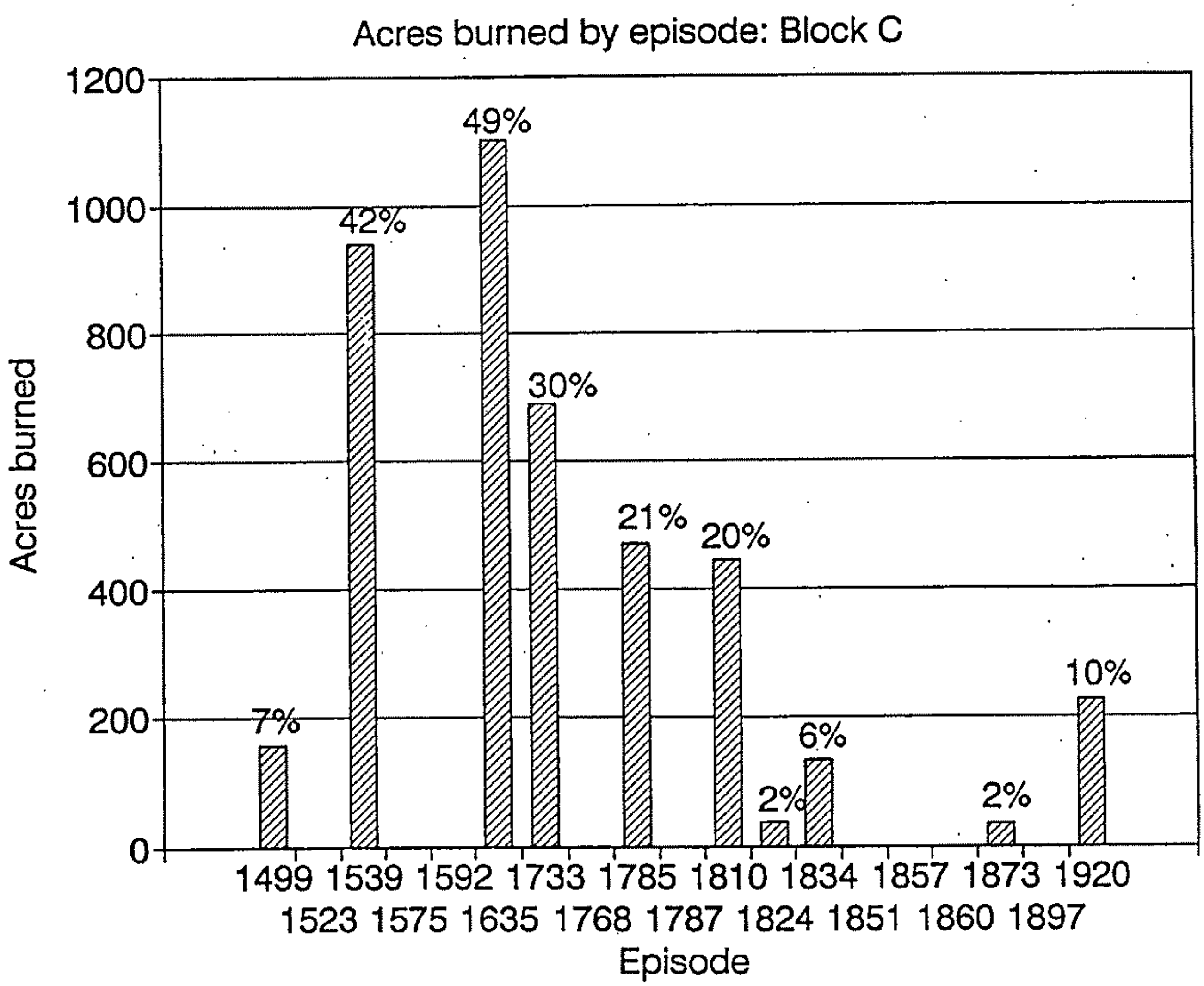

Pre-settlement (1499-1840)
Number
Block
0
2
4
6
8
10
12
14
a
b
c
d
e
f
g
h
76-100%
51-75%
26-50%
6-25%
1-5%


Settlement (1841-1910)
Number
3
2.5
2
1.5
1
0.5
0
a
b
c
d
e
f
g
h
Block
76-100%
51-75%
26-50%
6-25%
1-5%

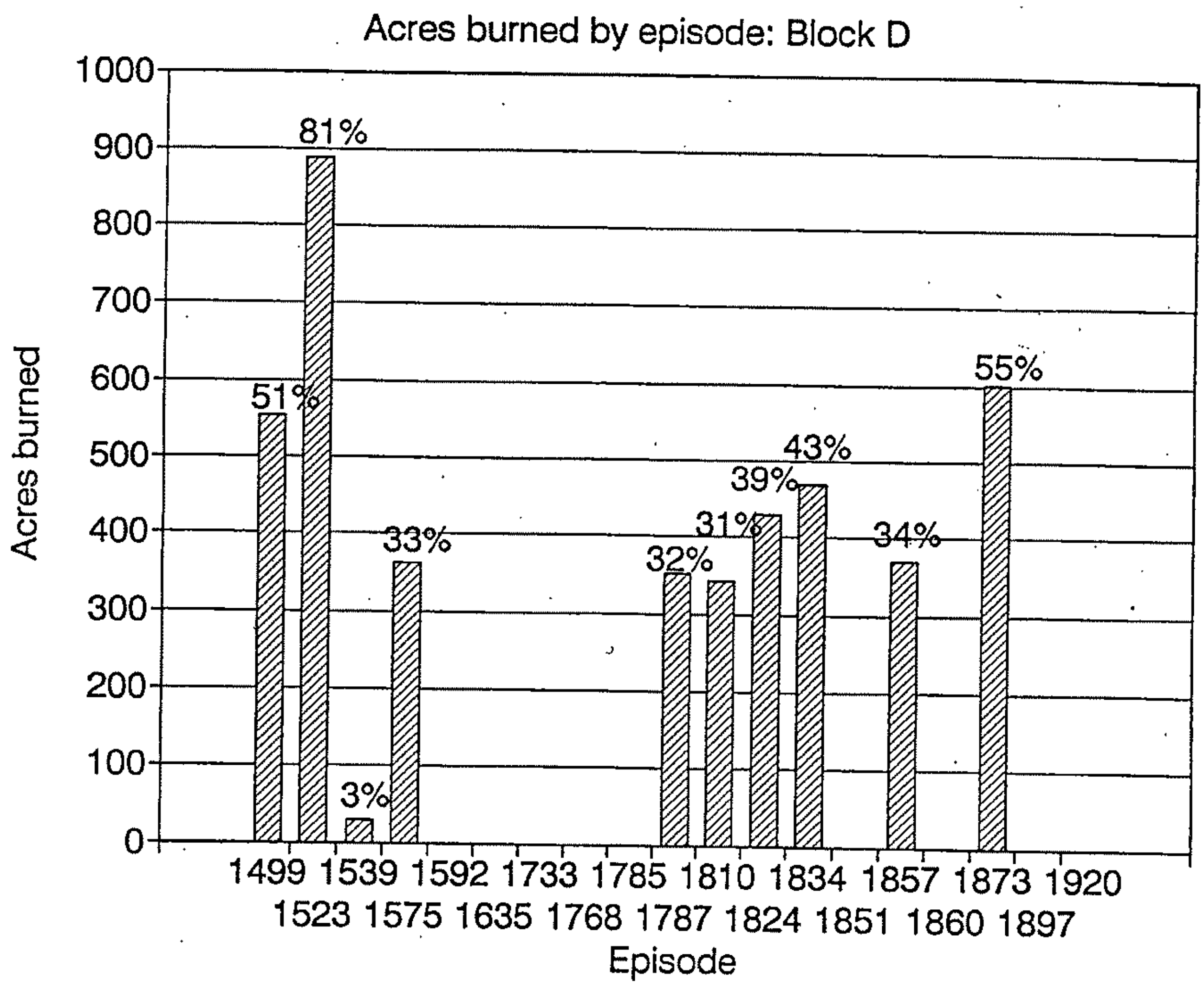

Fire suppression (1911-today)
Number
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
a
b
c
d
e
f
g
h
Block
76-100%
51-75%
26-50%
6-25%
1-5%

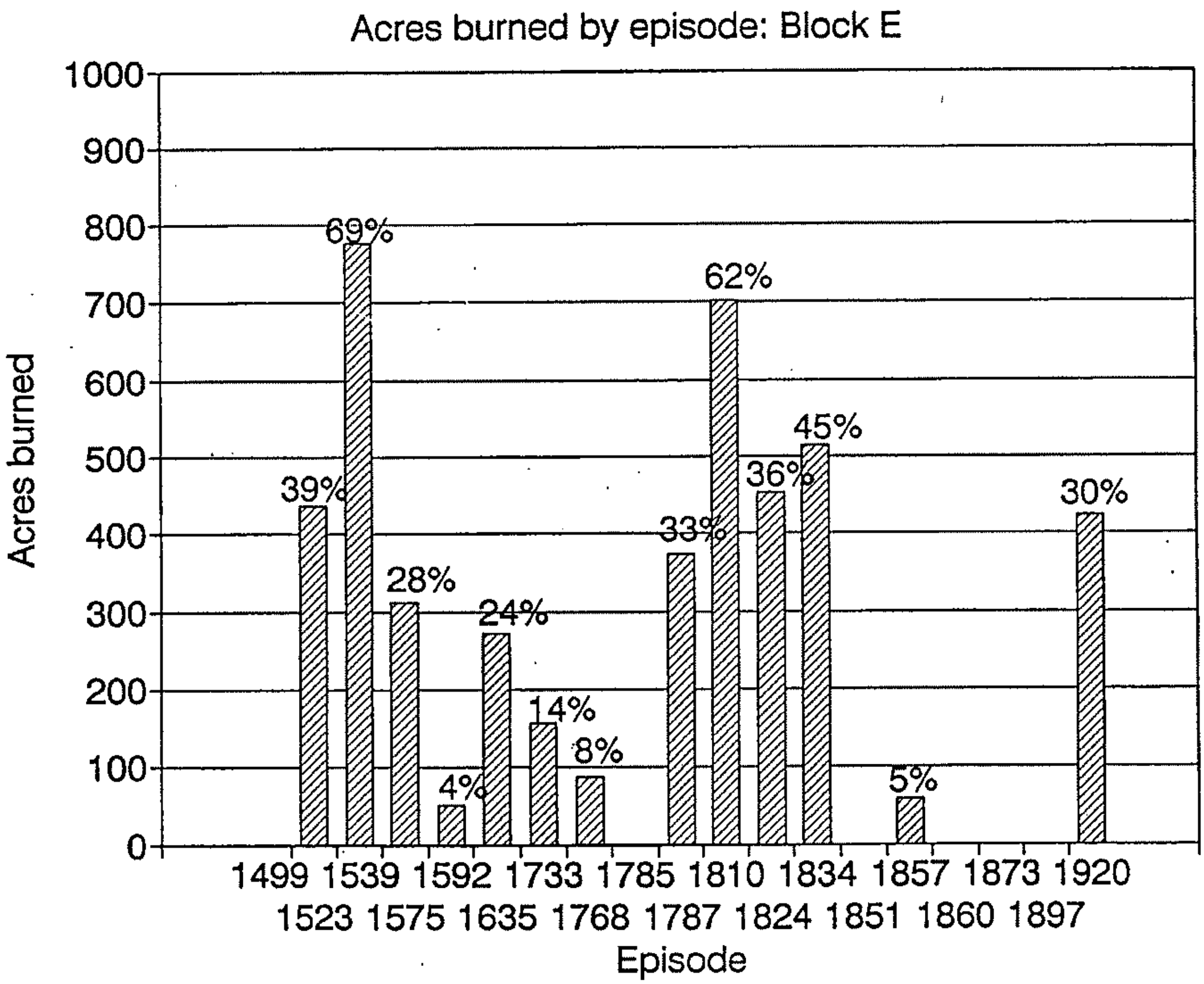

Acres burned by episode: Block A
3000
2500
2000
1500
1000
500
0
Acres burned
64%
22%
2%
2%
4%
33%
31%
37%
1499 1539 1592 1733 1785 1810 1834 1857 1873 1920
1523 1575 1635 1768 1787 1824 1851 1860 1897
Episode


Acres burned by episode: Block B
Acres burned
0
100
200
300
400
500
600
700
800
68%
74%
19%
10%
26%
3%
2%
12%
36%
1499 1539 1592 1733 1785 1810 1834 1857 1873 1920
1523 1575 1635 1768 1787 1824 1851 1860 1897
Episode

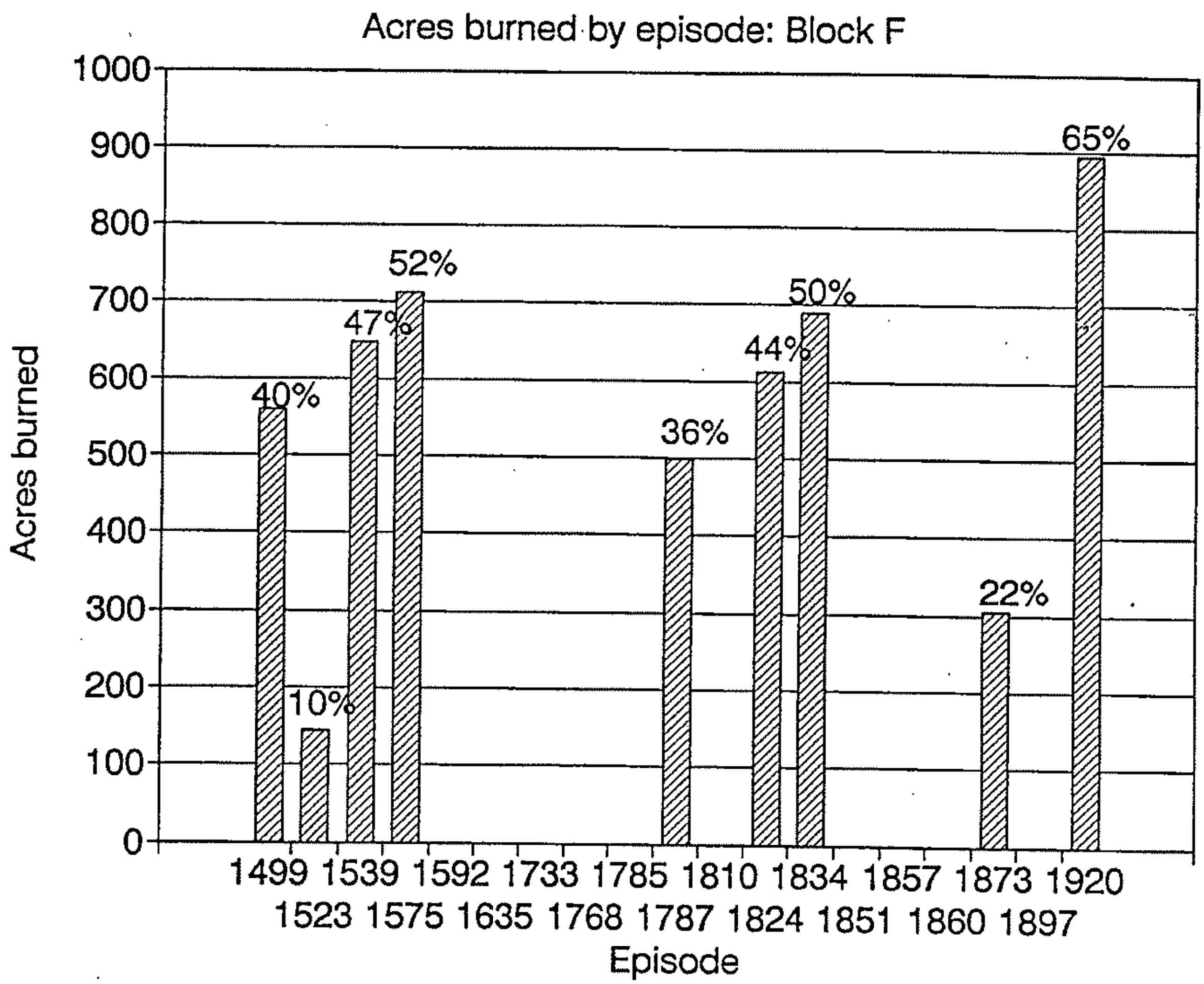


Acres burned by episode: Block C
1200
1000
800
600
400
200
0
Acres burned
49%
42%
30%
21%
20%
7%
6%
2%
2%
10%
1499 1539 1592 1733 1785 1810 1834 1857 1873 1920
1523 1575 1635 1768 1787 1824 1851 1860 1897
Episode

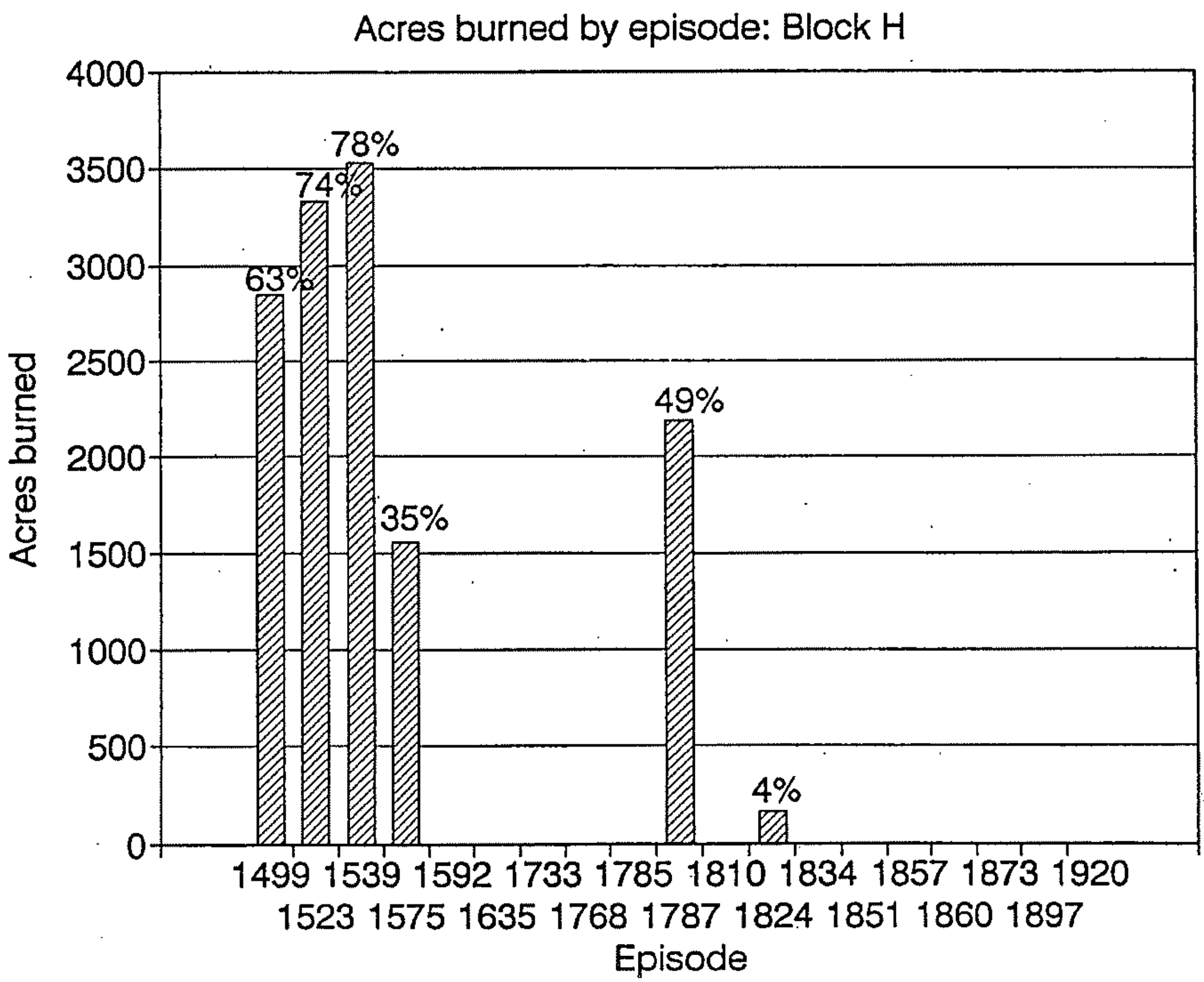

Acres burned by episode: Block D
Acres burned
1000
900
800
700
600
500
400
300
200
100
0
81%
51%
3%
33%
32%
31%
39%
43%
34%
55%
1499 1539 1592 1733 1785 1810 1834 1857 1873 1920
1523 1575 1635 1768 1787 1824 1851 1860 1897
Episode

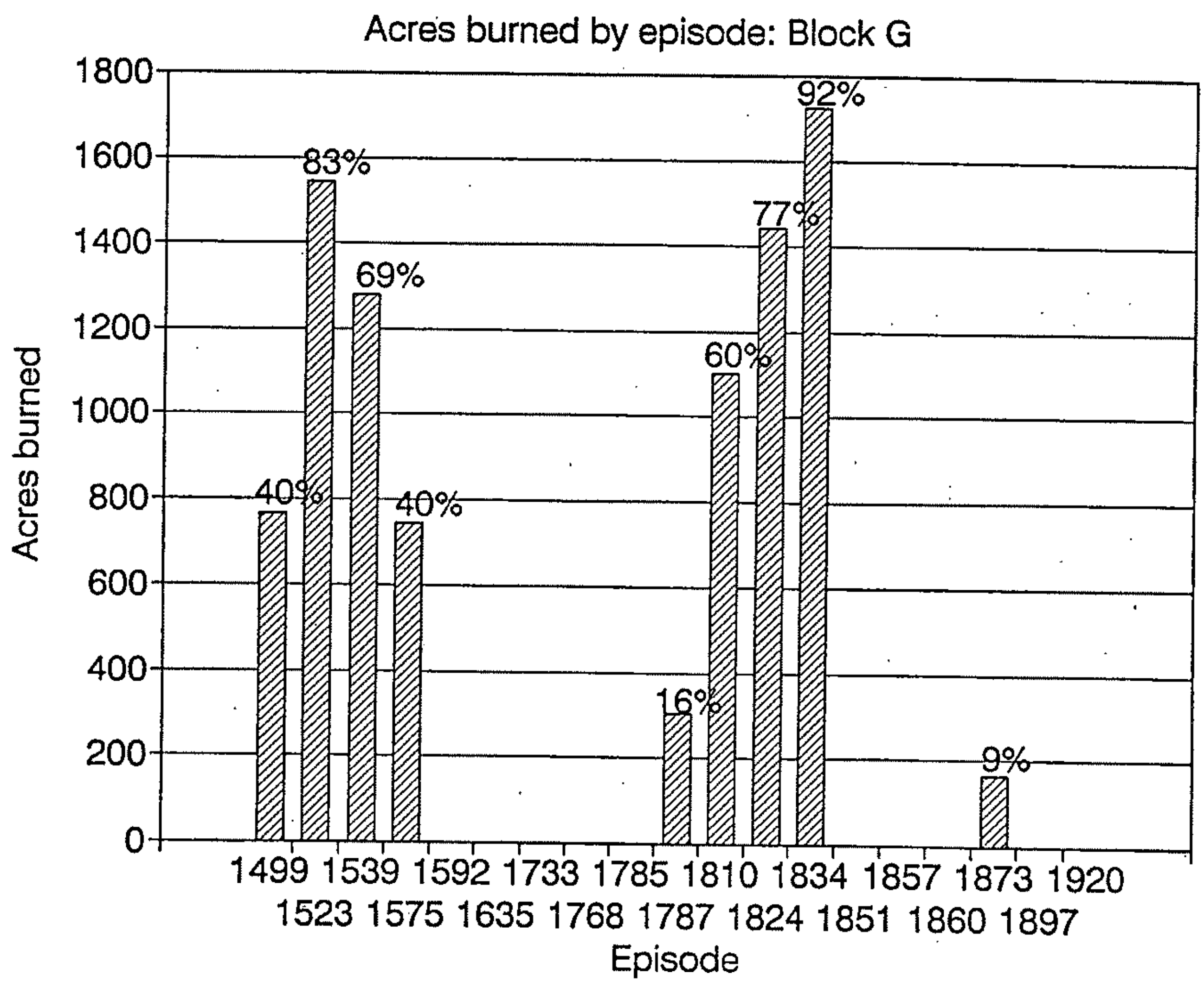


Acres burned by episode: Block E
1000
900
800
700
600
500
400
300
200
100
0
Acres burned
69%
62%
45%
39%
36%
30%
33%
28%
24%
14%
8%
4%
5%
1499 1539 1592 1733 1785 1810 1834 1857 1873 1920
1523 1575 1635 1768 1787 1824 1851 1860 1897
Episode

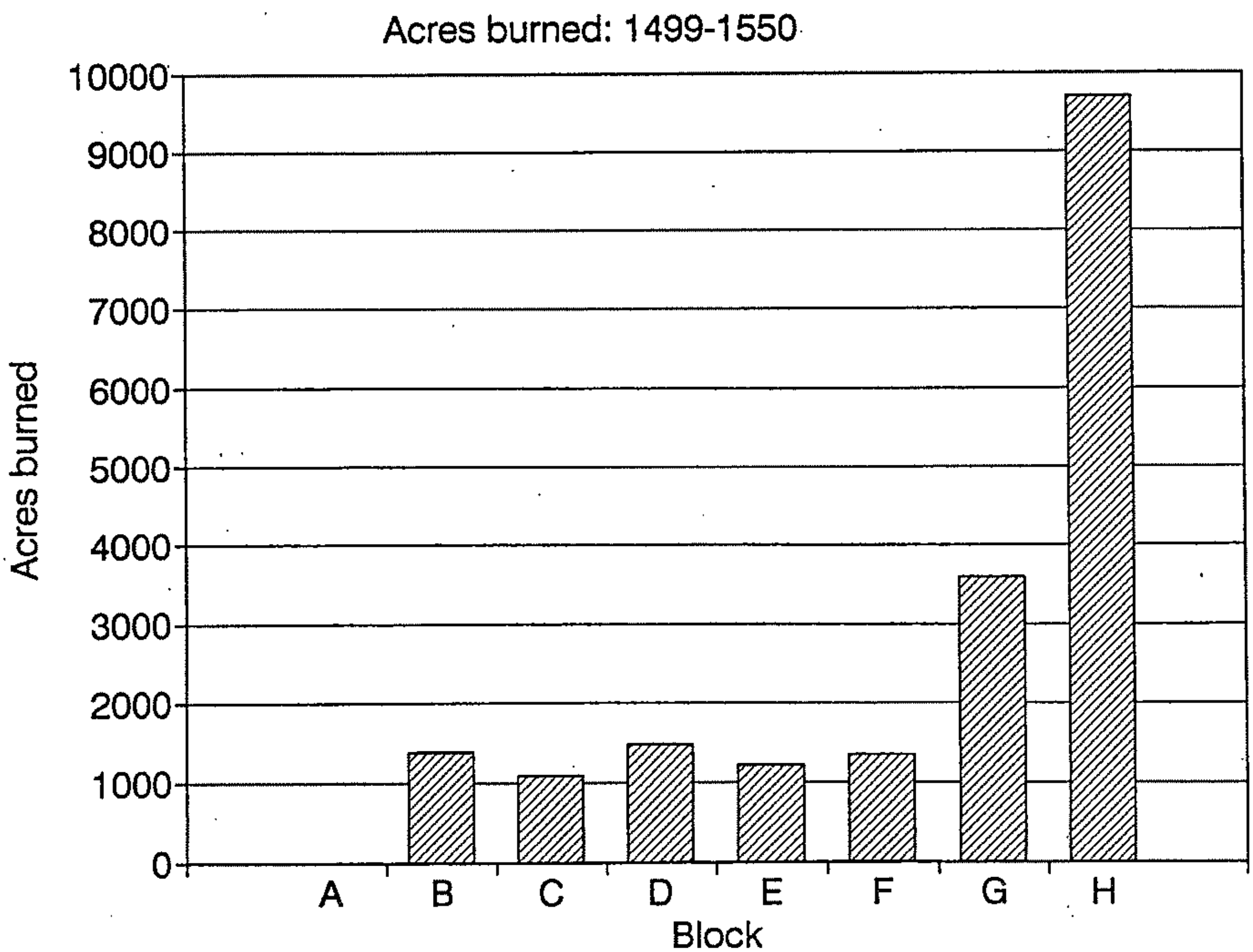


Acres burned by episode: Block F
Acres burned
1000
900
800
700
600
500
400
300
200
100
0
40%
10%
47%
52%
36%
44%
50%
22%
65%
1499 1539 1592 1733 1785 1810 1834 1857 1873 1920
1523 1575 1635 1768 1787 1824 1851 1860 1897
Episode

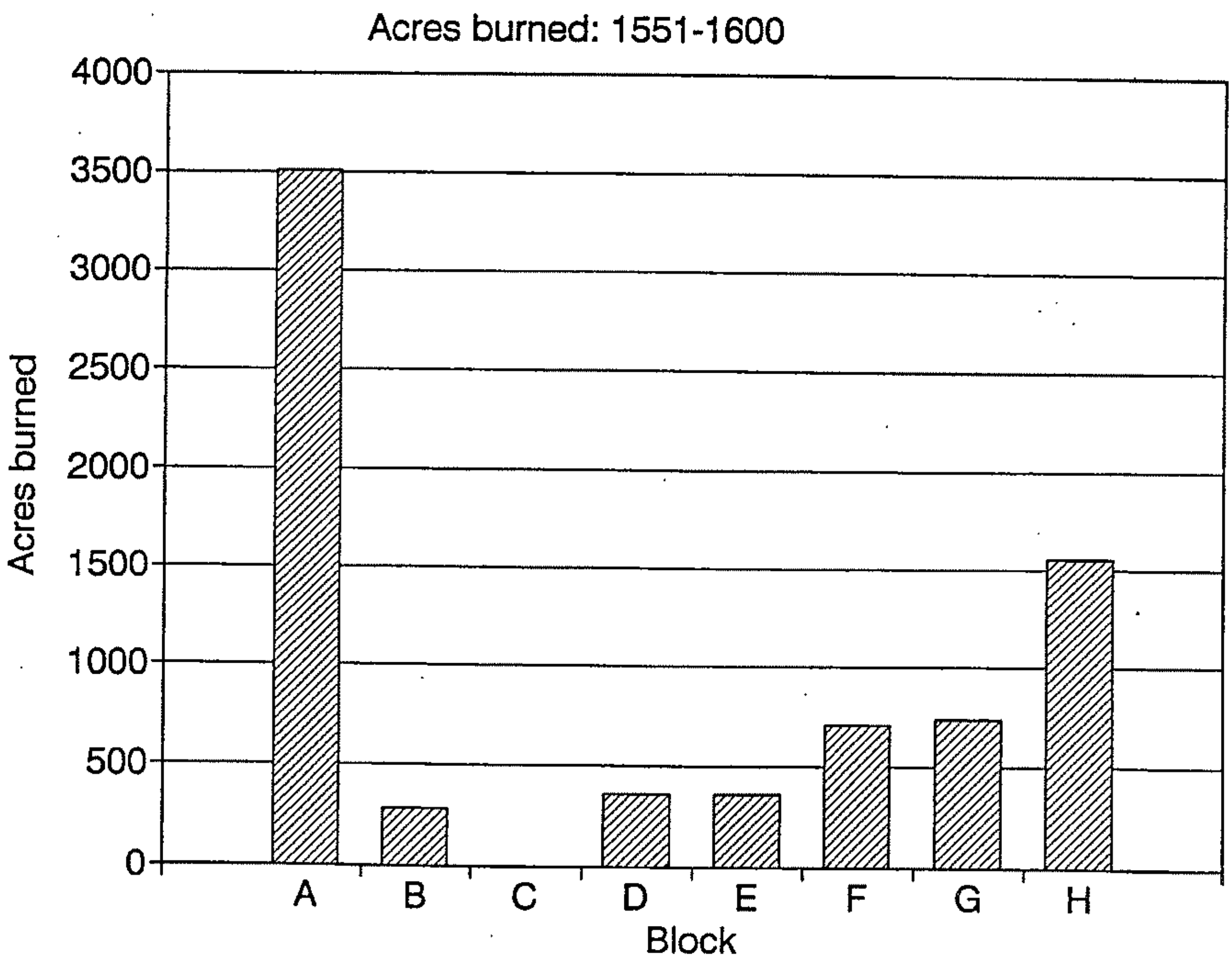

Acres burned by episode: Block H
Acres burned
4000
3500
3000
2500
2000
1500
1000
500
0
63%
74%
78%
35%
49%
4%
1499 1539 1592 1733 1785 1810 1834 1857 1873 1920
1523 1575 1635 1768 1787 1824 1851 1860 1897
Episode



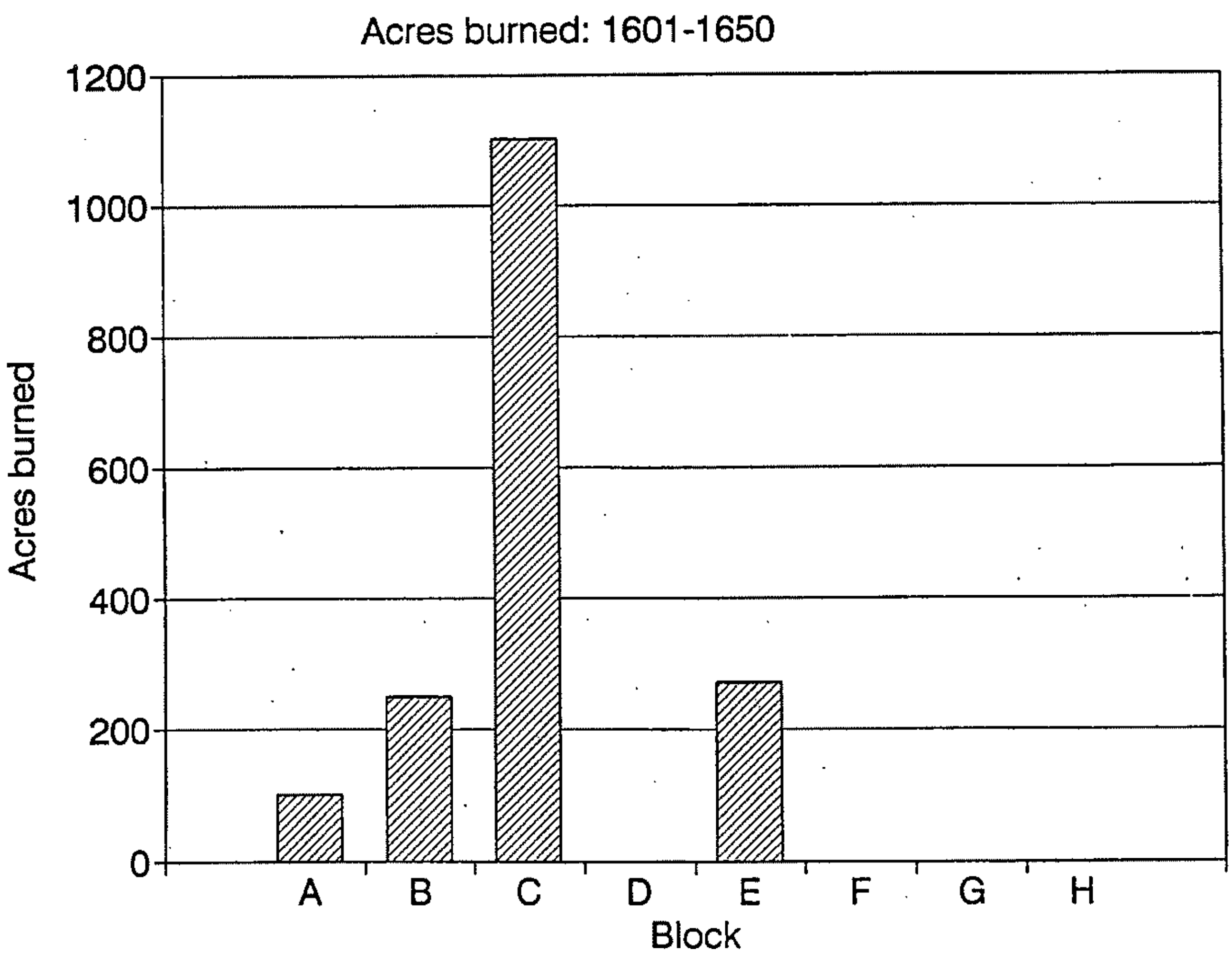
Acres burned by episode: Block G
1800
1600
1400
1200
1000
800
600
400
200
0
Acres burned
40%
83%
69%
40%
16%
60%
77%
92%
9%
1499
1523
1539
1575
1592
1635
1733
1768
1785
1787
1810
1824
1834
1851
1857
1860
1873
1897
1920
Episode

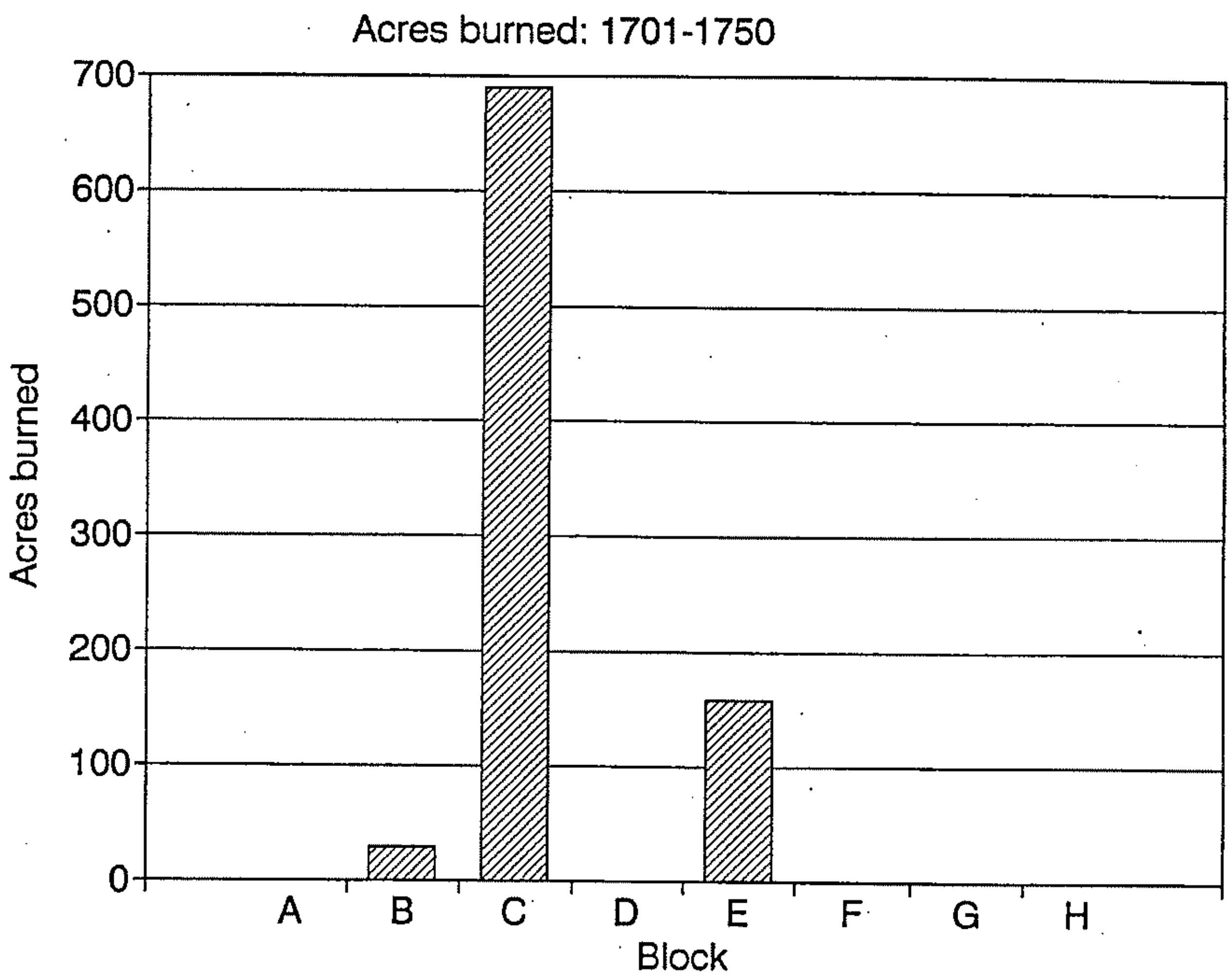


Acres burned: 1499-1550
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Acres burned
A
B
C
D
E
F
G
H
Block

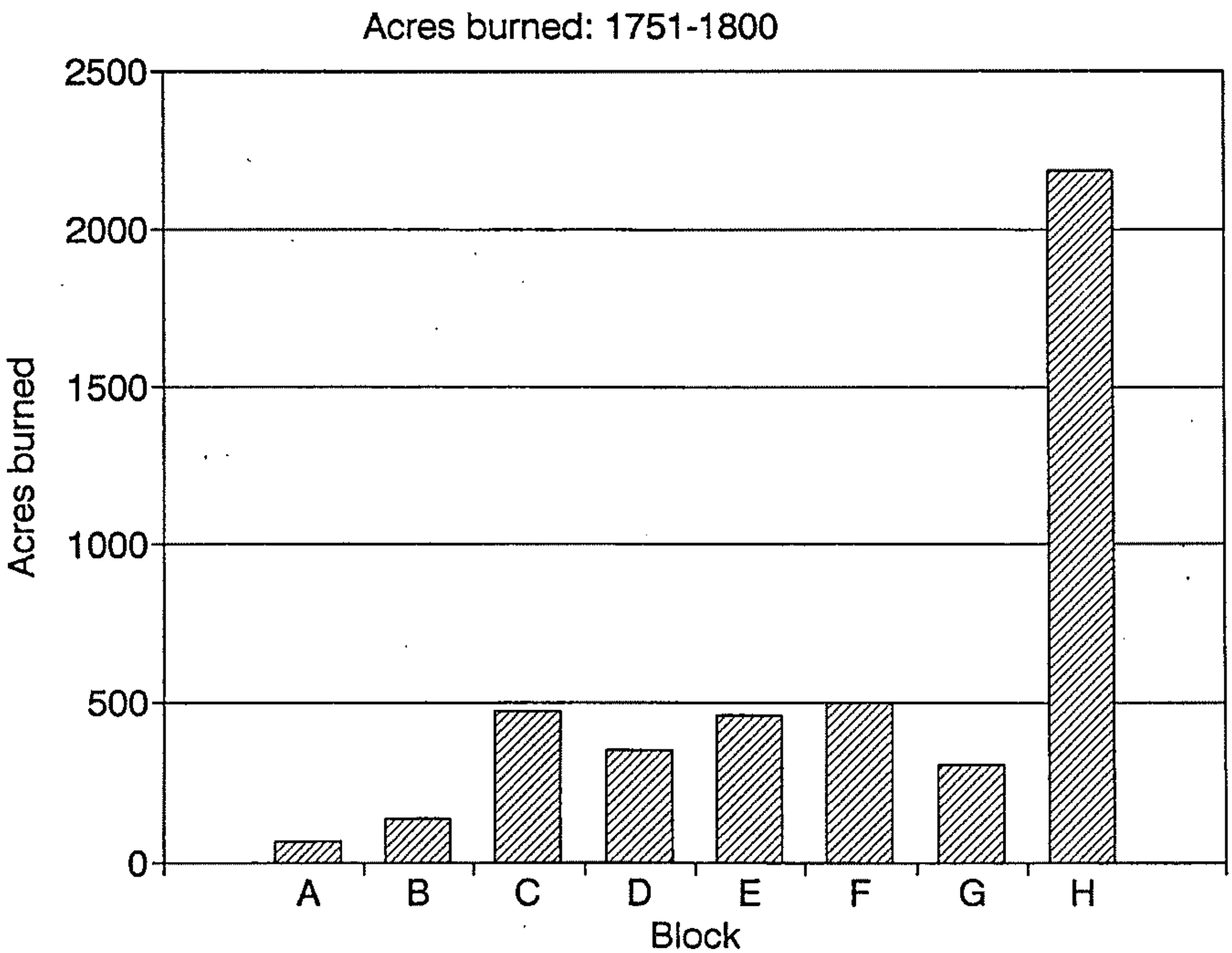


Acres burned: 1551-1600
Acres burned
4000
3500
3000
2500
2000
1500
1000
500
0
A
B
C
D
E
F
G
H
Block

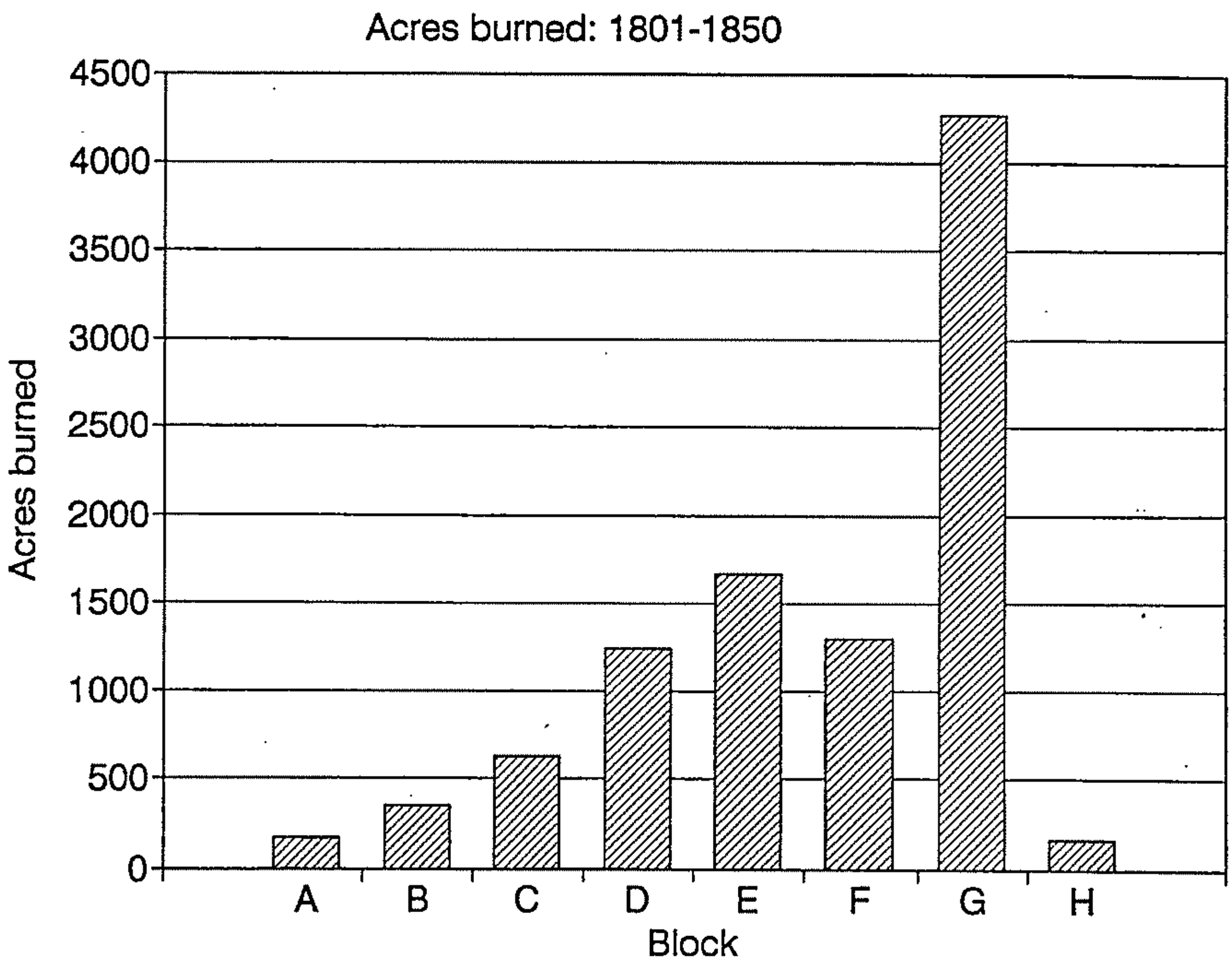

Acres burned: 1601-1650
1200
1000
800
600
400
200
0
Acres burned
A
B
C
D
E
F
G
H
Block



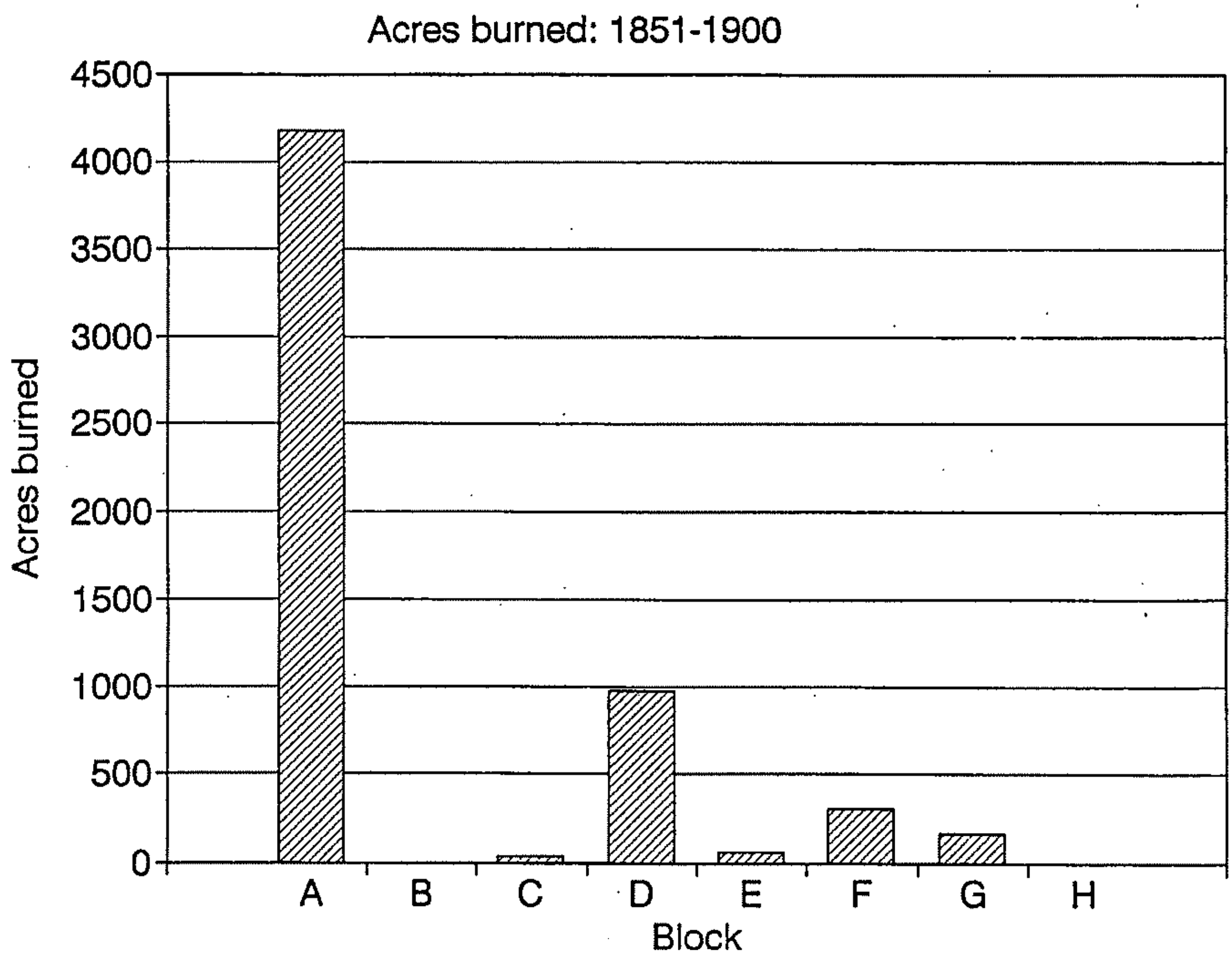
Acres burned: 1701-1750
Acres burned
700
600
500
400
300
200
100
0
A
B
C
D
E
F
G
H
Block

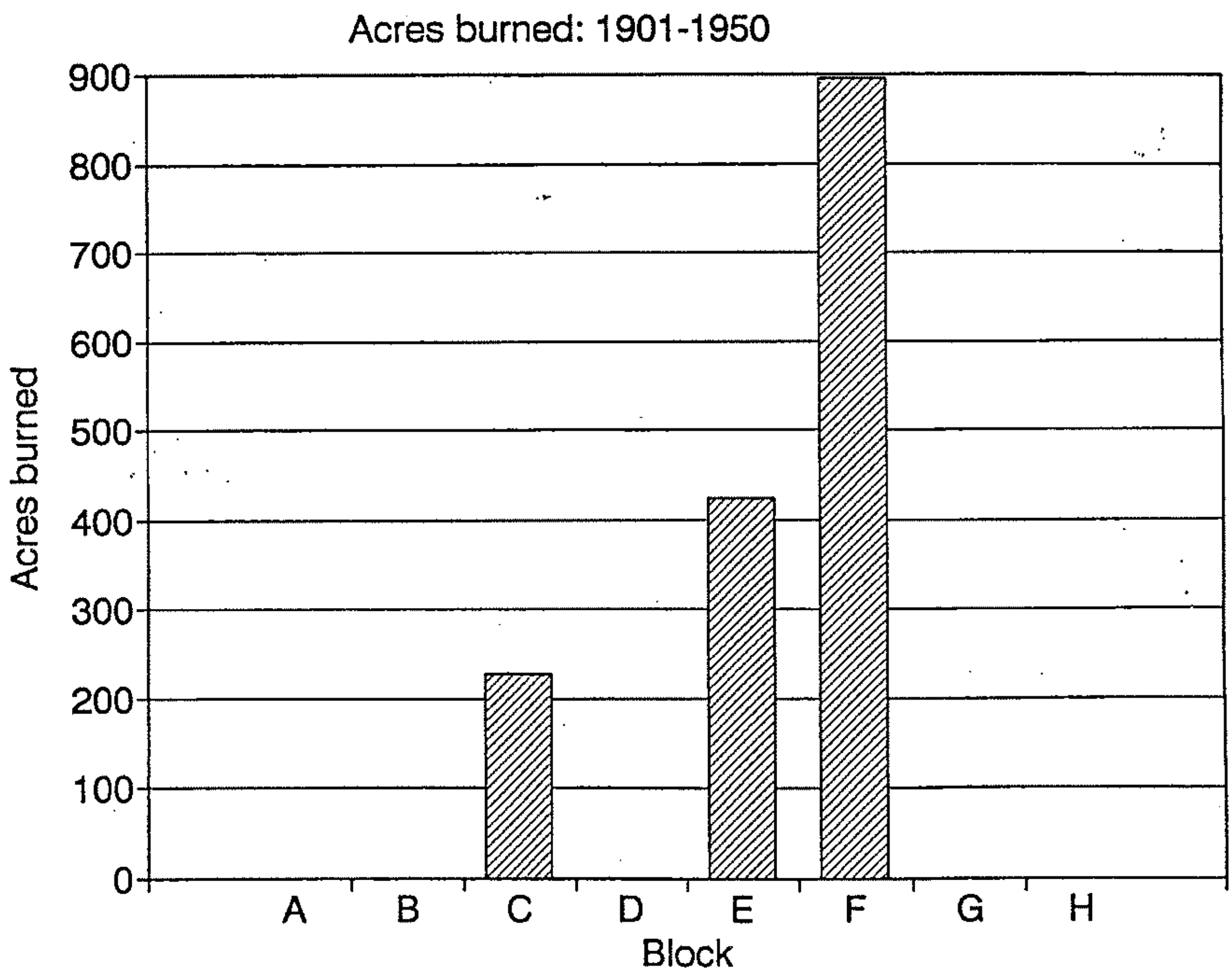


Acres burned: 1751-1800
2500
2000
1500
1000
500
0
Acres burned
A
B
C
D
E
F
G
H
Block



Acres burned: 1801-1850
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Acres burned
A
B
C
D
E
F
G
H
Block


Acres burned: 1851-1900
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Acres burned
A
B
C
D
E
F
G
H
Block


Acres burned: 1901-1950
900
800
700
600
500
400
300
200
100
0
Acres burned
A
B
C
D
E
F
G
H
Block