HISTORICAL FIRE REGIMES AND FOREST STRUCTURE, FISHLAKE NATIONAL FOREST

FINAL REPORT ON A PILOT STUDY

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INTRODUCTION

Twentieth century fire exclusion has profoundly changed forest structure across the western US (e.g., Covington et al. 1997, Swetnam et al. 1999). However, fire exclusion has not affected all forests uniformly because fire regimes, and their effects on forest structure, were not uniform across landscapes. Rather, fire regimes varied across landscapes in response to factors such as topography, land use, forest type and regional climate. While we understand the influence of some of these factors on current fires regimes, we do not fully understand their influence on historical fire regimes. Consequently, we cannot accurately estimate historical fire regimes in one area by extrapolating from other areas. For example, fires in the same plant association were historically more frequent in the southern than the northern Blue Mountains in Oregon because there is a gradient in precipitation across that region, a finding that surprised local forest managers (Heyerdahl et al. 2001). Furthermore, the *effects* of historical fires and fire exclusion on forest structure also vary across the landscape. For example, fire exclusion has resulted in greater changes in ponderosa pine (*Pinus ponderosa* Laws. var. *scopulorum* Engelm.) forests that sustained frequent surface fires than in either high-elevation mixed-conifer forests, that sustained infrequent mixed-severity fires, or low-elevation pinyon-juniper forests that sustained infrequent moderate to high severity fires (Veblen 2000). Consequently, local fire and forest histories are critical physical evidence of change and are required to assess the need for management of these forests, e.g., fuel treatment, wildland fire use or prescribed fire, but also to justify management plans for specific forests to land management agencies and the public. However, only by understanding the drivers of fire regimes through time and space can we predict how such local fire and forest histories can be extrapolated across broader regions.

Our objective was to reconstruct several local histories of fire and forest structure across landscape-scale gradients in forest types and topography in the Beaver (RBC), Indian Creek (INC) and Upper Freemont River (UFR) drainages, Utah (Figure 1, Table 1), as a pilot study for a broader reconstruction of regional variation across Utah and eastern Nevada. We used the methods and preliminary results from this pilot study to successfully obtain funding from the Joint Fire Science Program to expand our work to 13 watersheds. In addition the pilot study, we reconstructed fire history from one plot on Old Woman Plateau (OWP) and crossdated samples collected in a previous study on Monroe Mountain (MON).

STUDY AREA

Early Euro-American land-use within the study area included caravan travel through Beaver County, en route to Nevada and California in the 1830s and 1840s (Bradley 1999). The Iron Mission of Mormon settlers established residence in Beaver Valley in 1851. The town of Beaver was established in 1857, with more than a hundred settlers, and logging along the Beaver River. In 1859, there were three sawmills near Beaver and Harris Canyons, and by 1870 there were four sawmills operating in the area (Bradley 1999). Early settlements in the Fremont River valley were established in the 1870's. Settlement in towns around the Sevier Valley began about 1864. A number of mining districts were created in Beaver County in the 1870's (Bradley 1999). Early Euro-American settlers throughout central and southern Utah were Mormon converts from the eastern United States and Europe. The settlement and associated livestock husbandry models they followed was unique for the western United States (Young et al. 1979). Small groups of settlers were sent by their leader, Brigham Young, to establish agriculture-based communities wherever water, forage, and timber resources could be found to sustain them. Most

of these original settlers owned only a few cows, horses, or sheep. Efficient herding was accomplished by uniting livestock into community herds during the day and returning animals to the safety of the community at night. Subsequently, forage resources close to the communities were often degraded and those at some distance used lightly, if at all. Although livestock numbers and the incidence of private herds increased steadily after settlement, this general pattern of livestock dispersal persisted until after the end of the Black Hawk War in the late 1860s (Nielson 1953). After this time, significant expansion of livestock into mountain pastures occurred. When railroad service expanded in the late 1880s, livestock numbers, especially sheep, increased dramatically. Locally owned herds competed with those brought in by outside interests. By 1890 forage on the mountains and high plateaus of southern and central Utah was severely depleted.

METHODS

We reconstructed fire and forest histories in three gridded watersheds (RBC, UFR and INC, Figures 1-4), collected and crossdated sections from a few fire-scarred trees on Old Woman Plateau (OWP), and crossdated fire-scarred sections collected from Monroe Mountain (MON) in a previous study.

Sampling design for gridded watersheds

We sampled one complete gridded watershed (RBC) and two partial gridded watersheds (UFR and INC). At these sites, we sampled grids of plots (45, 15, and 6 plots, respectively) with 0.3 mile spacing, covering 3153, 1075 and 610 acres, respectively (Figures 1-4). At each plot, we measured slope, aspect, elevation and location. We took four photographs, determined slope shape (convex, concave or straight), slope position (valley bottom, lower, middle, upper, or ridge), ground cover (as percentage of rock, litter, bare ground, forbs, grasses and shrubs) and recorded the presence of major understory species. We assigned each plot to a vegetation type according to the classifications developed for LANDFIRE and by the Fishlake National Forest (Table 2, Appendix B).

Topography at gridded watersheds (RBC, UFR)

To evaluate whether the topography of the sampled plots at the RBC and UFR sites is representative of those sampling areas as a whole, we compared the distribution of plots among three topographic parameters (elevation, slope and aspect) to that of land area in the sampling grid. The topographic parameters for the study area were derived from digital elevation models (30 m resolution; Utah AGRC 2004). At Inc, we did not sample enough plots to conduct this analysis.

Tree density at gridded watersheds (RBC, UFR and INC)

We computed the change in forest composition through time as the difference in density of trees (>6" dbh) at each plot, by species from 1880 to 2000.

History of tree recruitment at gridded watersheds (RBC, UFR and INC)

To reconstruct the history of tree recruitment at each plot, we used an n-tree density-adapted sampling method (Jonsson et al. 1992, Lessard et al. 2002). Specifically, we removed samples from those trees that were closest to plot center but within a radius of ≈100 feet, up to a maximum of ≈30 trees. Consequently, the plots varied in size with tree density, and some plots

did not include any trees (4 plots). Plot size ranged from 0.07 to 0.82 acres (average 0.27 acres) and was computed as the area of a circle with radius equal to the distance between plot center and the tree sampled farthest from plot center (range 31 to 107 feet, average 59 feet). For each of these trees, we determined species, diameter at breast height (dbh, 4.5 feet) and diameter at sampling height (≈6 inches). From live trees, we removed increment cores ≈ 6 inches above the ground. From dead trees that were sound enough to crossdate, we used a chain saw to remove a section, including the pith, from what would have been ≈6 inches above the ground. We did not remove a section from dead trees that were not sound enough to crossdate, but tallied them instead. All cores and sections were sanded and crossdated using the methods described below for fire-scarred sections. We estimated the recruitment date of each tree as its pith date at coring height. Most increment cores (66%) did not intersect the pith. To estimate the pith date of these trees, we estimated the number of years to pith from the curvature of the innermost rings sampled (average years to pith: 5 years; Applequist 1958, Duncan 1989) and subtracted this estimate from the innermost ring date.

We identified cohorts of early seral trees (ponderosa pine and aspen (*Populus tremuloides* Michx.)), as groups of trees with similar recruitment dates that are near one another within the watershed, using spatial statistics (spatial autocorrelation and cluster analysis; Duncan and Stewart 1991, Heyerdahl et al. 2001). However, we could complete this analysis only for RBC, the watershed for which we had a sufficient number of recruitment dates of early seral species.

History of surface fires at gridded watersheds (RBC, UFR and INC)

To reconstruct a history of surface fires, we searched for fire-scarred trees within a radius of ≈260 feet (corresponding to ≈5 acres) of each plot center, and used a chain saw to remove one to several scarred sections per tree (139 trees sampled in plots, Arno and Sneck 1977). In addition, we removed sections from 82 fire-scarred trees that we encountered between plots.

We sanded and crossdated all samples using standard dendrochronological methods, until the cell structure was visible with a binocular microscope, and assigned calendar years to tree rings using a combination of visual crossdating of ring widths and cross-correlation of measured ring-width series (Holmes 1983).

We identified the calendar year in which each scar formed, to determine the year of fire occurrence, and the position of each scar within the ring (ring boundary, earlywood, latewood or unknown), as an indication of the season of fire occurrence (Dieterich and Swetnam 1984). In addition to fire scars, we obtained a small amount of supporting evidence of surface fires (5% of number of scars) from abrupt changes in the width of annual rings. However, because factors other than surface fires can cause abrupt changes in cambial growth, we used such a change in a given sample as evidence of a surface fire only when it was synchronous with a fire scar in other samples in the same watershed. In the northern hemisphere, the season of cambial dormancy (i.e., the period corresponding to the ring boundary) spans two calendar years: from the time the cambium stops growing in the fall of one year until it resumes in the spring of the following year. For this study, we assigned ring-boundary scars to the *following* calendar year because modern fires in southern Utah generally burn early in the cambial growing season in Utah (Swetnam 1990, Kitchen and McArthur 2003; Figure 5). However, scars from a given fire can have a range of intra-annual positions because the timing of radial growth varies across the landscape (Fritts 1976). For some fire years, some scars occurred in the late earlywood or latewood of most trees but on the ring boundary of some. We inferred that the scars in both positions were created by a single fire burning late in the growing season and therefore assigned

the ring-boundary scars (21 scars) to the preceding calendar year, i.e., the same year as the earlywood scars. We were unable to determine the intra-ring position of some scars (29%) because they were obscured by rot or insect galleries, or the rings were narrow.

To compute plot fire intervals, we composited the fire dates from all trees sampled at a plot into a single fire chronology for that plot (composited over ≈5 acres; Dieterich 1980), and computed the intervals between years in which a fire was recorded on at least one tree. We limited our analysis to dates recorded on more than one tree to minimize the inclusion of scars that might appear to have been created by fire but were created by other process, such as lightning or frost. We assumed that these non-fire processes are unlikely to scar more than one tree in a given year. We split watershed RBC into upper (URBC, plot 12D and above) and lower (LRBC, plot 12C and below) for analysis because they differed in forest type. We report composite plot fire intervals for the period after which 25% of the plots in each watershed had recorded at least one fire (1508 lower RBC, 1813 upper RBC, 1626 UFR, 1423 INC, and 1654 MON) and before the cessation of surface fires (1880). We computed composite plot fire intervals only from trees that we sampled within plots.

We reconstructed fire size for a given year as the area of the smallest convex polygon containing all the plots or trees with evidence of fire in that year.

History of surface fires at Old Woman Plateau (OWP) and Monroe Mountain (MON)

We used a targeted sampling design (Baker and Ehle 2001) to reconstruct surface fire history at Old Woman Plateau (OWP). The forest at this site is mainly old-growth ponderosa pine and we searched the mesa top for trees with multiple fire scars. The mesa is relatively flat and bounded by steep canyons and cliffs to the east, north, and south. A total of 17 trees were collected over an area of 49 acres (Figure 1, Table 1).

In a previous study (Chappell 1997), fire-scarred and recruitment-date sections were removed from ≈40 trees at ≈16 locations on Monroe Mountain (Figure 1). Of these, we crossdated fire-scarred sections from 12 trees (8 ponderosa pine, 2 Douglas-fir (*Pseudotsuga menziesii* (Mirbel) Franco var. *glauca* (Beissn.) Franco), 1 quaking aspen and 1 pinyon pine (*Pinus edulis* Engelm.).

RESULTS

Topography at gridded watersheds (RBC, UFR)

The topography and vegetation of the plots we sampled at the gridded watersheds (RBC and UFR, Figure 6) are similar to that of the entire sampling area for each watershed.

Tree density at gridded watersheds (RBC, UFR and INC)

The density of trees (>6" dbh) changed between 1880 and 2000 (Figure 7). However, these changes varied among species and potential vegetation types. In the dry potential vegetation types (lower RBC and INC), Douglas-fir, white fir (*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr. var. *concolor*) and ponderosa pine all increased in density. Aspen density didn't change at lower RBC but increased at INC. In contrast, in the mesic potential vegetation types (UFR and upper RBC), the density of Douglas-fir did not change, although the density of aspen, Engelmann spruce (*Picea engelmannii* Parry ex *Engelm.*) and subalpine fir (*Abies lasiocarpa* (Hook.) Nutt. var. *lasiocarpa*) increased.

History of tree recruitment at gridded watersheds (RBC, UFR and INC)

To determine tree recruitment dates at RBC, UFR and INC, we removed samples (increment cores or sections) from 22 to 32 trees per plot (30 on average) for a total of 1332, 447 and 182 trees, respectively (Table 1). In addition, we tallied 641 trees that were too decayed to crossdate. At RBC, most (163 trees, or 84%) of the early seral trees (aspen and ponderosa pine) occurred in one of two cohorts; one around 1855 (40% of early seral trees) and the other around 1888 (44% of early seral trees). Recruitment dates range over 30 years within each cohort and there is no temporal overlap between the 2 cohorts, although they do overlap spatially (Figure 8, Appendix D).

History of surface fires at gridded watersheds (RBC, UFR and INC)

We removed fire-scarred sections from a total of 251 trees in the three gridded watersheds. Of these, we sampled 139 fire-scarred trees in the 34 of our 70 plots that contained such trees. We sampled the remaining 82 fire-scarred trees between plots. Overall, 42% of the fire-scarred trees we sampled were Douglas-fir, 41% ponderosa pine and 17% were other species (white fir, Engelmann spruce, subalpine fir and aspen). Most were logs, snags or stumps (71%), with the rest live trees. We were unable to crossdate sections from some of the sampled trees (15%). Those that we did crossdate yielded 807 fire scars, and 81 injuries or abrupt changes in ring width (1200 to 2004; Figure 9, Figure 10, Figure 11; Dieterich 1980). We were able to assign an intra-ring position to 70% of the fire scars. Most of these were created by fires burning when the cambium was growing (72% of assigned scars, 1200-2003, Figure 12, Figure 13, Figure 14).

The composite plot fire intervals that we reconstructed varied both within and among watersheds (Figure 15). Fires burned in the sampled plots in lower RBC on average every 15 years (range, 1 to 100 years) during the analysis period (1508 to 1880). Fires burned in the sampled plots in the upper portion of the site on average every 19 years (range, 2 to 33 years) during the analysis period (1813 to 1880). The surface fires we reconstructed for RBC burned from 12 to 1402 acres within the study area (Appendices C and D). The surface fires we reconstructed for UFR burned from 12 to 163 acres of the total study area (Appendices C and D), and burned the sampled plots on average every 57 years (range, 6 to 129 years), during the analysis period (1626 to 1880). However, we found fire-scarred trees in only 4 plots at UFR. At INC, surface fires burned from 3 to 232 acres of the total study area (Appendices C and D), and burned the sampled plots on average every 29 years (range, 4 to 72 years) during the analysis period (1423 to 1880). After approximately 1880, surface fires ceased abruptly at all our study sites.

History of surface fires at Old Woman Plateau (OWP) and Monroe Mountain (MON)

We crossdated fire-scarred sections from 17 and 12 trees at OWP and MON, respectively. Most of these were ponderosa pine (86%), and the rest were Douglas-fir (7%) or other species (7%). Most were logs, snags or stumps (97%). We were able to crossdate the samples from all but 1 tree. These yielded 132 fire scars, and 13 injuries or abrupt changes in ring width (1490 to 2003 at OWP and 1654 to 1994 at MON; Dieterich 1980; Grissino-Mayer 1995, 2001; Figure 16, Figure 17). We were able to assign an intra-ring position to 73% of the fire scars (Figure 18, Figure 19). Of these, less than half were created by fires burning when the cambium was growing (41% of assigned scars in earlywood or latewood). Over the 49 acre sampling area at OWP, fires burned at on average once every 27 years (range: 6 to 62 years) during the analysis

period (1576 to 1880). After approximately 1880, surface fires ceased abruptly at both OWP and MON.

DISCUSSION

Including the RBC watershed reported here, we have sampled complete grids (i.e., approximately 30 plots each) in 11 watersheds and will sample two additional watersheds in early summer 2005. By late fall 2005, we will draft a manuscript containing methods, raw data and data summaries for each of these 13 watersheds, which we will publish on CD as a Rocky Mountain Research Station general technical report. From these data, we will prepare several manuscripts, which we submit to peer-reviewed journals. We will make oral presentations of our work in Utah in spring 2006, with final completion of the project by August 2006. We have posted a map of the sites we have sampled and updates on analysis and reporting for this broader project to our web site (http://www.rmtrr.org/Utah/ Utahfirehistory.html).

Our reconstructions of fire size are limited by the small size covered by the sampled grids. Most of the fires that we reconstructed intersected the boundary of the sampling grids and therefore we cannot reconstruct the distribution of actual fire size but rather only the distribution of fire size *within* the grids.

Our understanding of the drivers of cohorts of early seral trees in ponderosa and mixed conifer forests is evolving rapidly (e.g., Brown and Wu, in press). These cohorts may result from a set of interacting factors that include climate, the timing of surface fires and moderate- and high-severity fires. We report cohorts from RBC for this report but are unable to fully determine the driver of these cohorts because the influence of climate on cohorts is likely to be evident only at regional spatial scales. Consequently, much of our analysis of the cohorts we reconstruct in Utah will occur in the context of the GTR and journal articles, with the full dataset of recruitment dates from all 13 watersheds.

We have too little data, and all of it from targeted samples, to confidently report fire regimes parameters from Monroe Mountain or Old Woman Plateau. However, these fire-scar dates will be included in our analysis of the drivers of temporal variation in historical fire regimes in Utah.

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TABLES

Table 1. Amount of data collected to reconstruct forest and fire histories, by watershed. Watersheds sampled in this report were Upper Fremont River (UFR), Beaver Creek (RBC), Indian Creek (INC), Old Woman Plateau (OWP), and Monroe Mountain (MON). UFR, RBC and INC were sampled on grids (Figure 2, Figure 3, and Figure 4). OWP and MON were not sampled on grids.

site	UFR	RBC	INC	OWP	MON
size of sampled area (acres)	1074	3152	610	49	-
number of plots sampled	19	44	6	1	-
number of crossdated trees (total)	319	1037	165	16	12
for fire scars	20	165	25	16	12
for recruitment dates	299	872	140	-	-
number of fire scars dated	32	619	156	95	37
number of injuries dated	3	29	9	0	1
number of abrupt changes in ring width dated	1	17	22	0	12
earliest ring date	1503	1451	1200	1490	1515

Table 2. Distribution of plots by two vegetation classifications at each sampling site. URBC and LRBC refer to upper RBC and lower RBC (above and below plot 12C, respectively, Figure 2). Four letter cover code definitions are as follows: ARTR big sagebrush (*Artemesia tridentata*), POTR quaking aspen (*Populus tremuloides*), PIPO ponderosa pine (*Pinus ponderosa*), CELE mountain mahagony (*Cercocarpus ledifolius*), ARPA greenleaf manzanita (*Arctostaphylos patula*), ARCA silver sagebrush (*Artemesia cana*).

	UFR	**URBC**	**LRBC**	**INC**	**OWP**
		number of plots			number of trees
LANDFIRE PVT					
spruce-fir	16	30			
big sagebrush (ARTR)	3				
white-fir		5	4	4	5
pinion / juniper / gambel oak			3	1	
pinion / juniper / big sagebrush			2		
pinyon / juniper					
ponderosa pine					11
Aspen				1	
total	19	35	9	6	16
Fishlake Soils Inventory, Current Veg Coverage					
mixed conifer / POTR	13	20	8	1	
POTR / perennial grasses			1		
mixed conifer	3	14		3	
PIPO/CELE/ARPA					16
perennial grasses		1			
riparian	1				
ARCA / perennial grasses	2				
mountain mahogany				2	
total	19	35	9	6	16

FIGURES

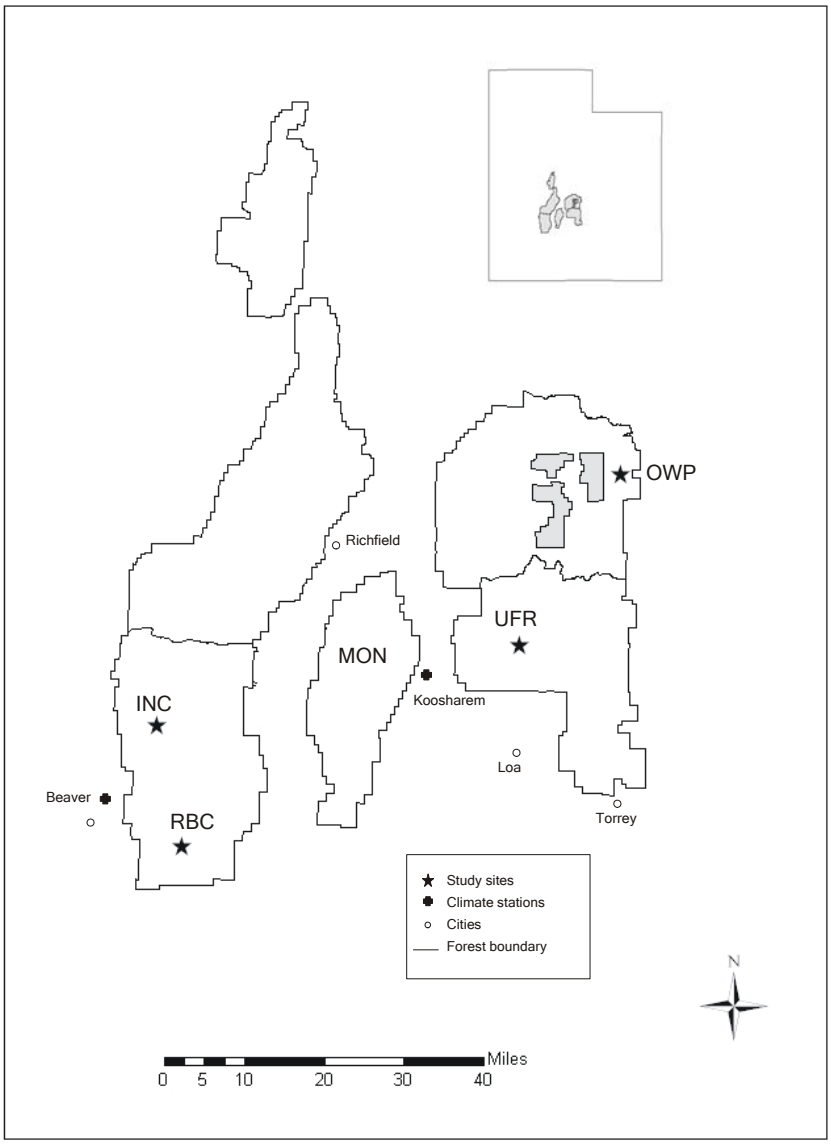


Figure 1. Location of watersheds on the Fishlake National Forest (Upper Fremont River (UFR), Beaver Creek (RBC), Indian Creek (INC), Old Woman Plateau (OWP), and Monroe Mountain (MON)). Samples from Monroe Mountain were collected over the entire Monroe Mountain Demonstration Area for a previous study (Chappell 1997), we lack exact locations for these trees. The gray area is land not managed by the USDA Forest Service.

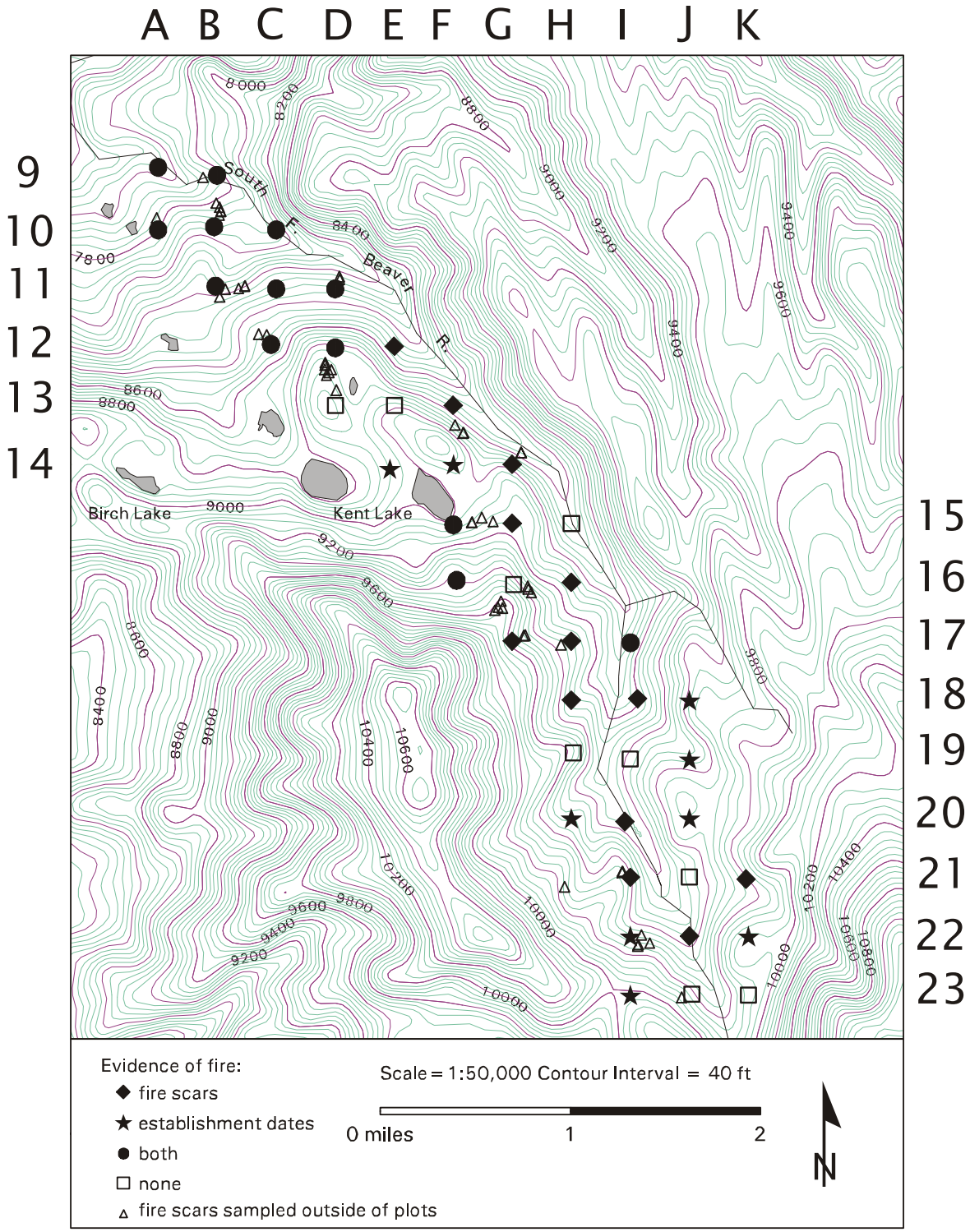


Figure 2. RBC watershed, showing location of plots and type of evidence collected at each.

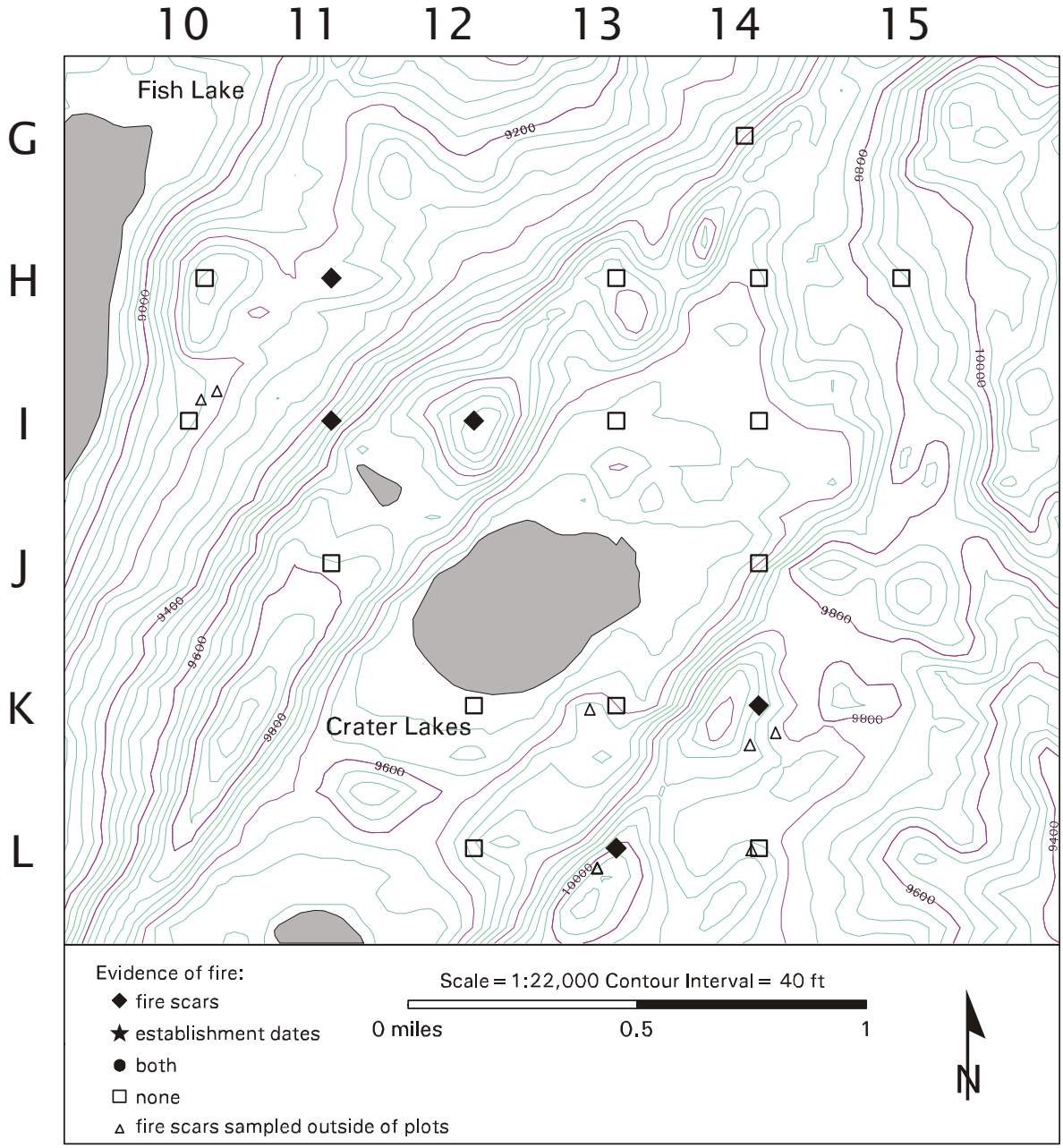


Figure 3. UFR watershed, showing location of plots and type of evidence collected at each.

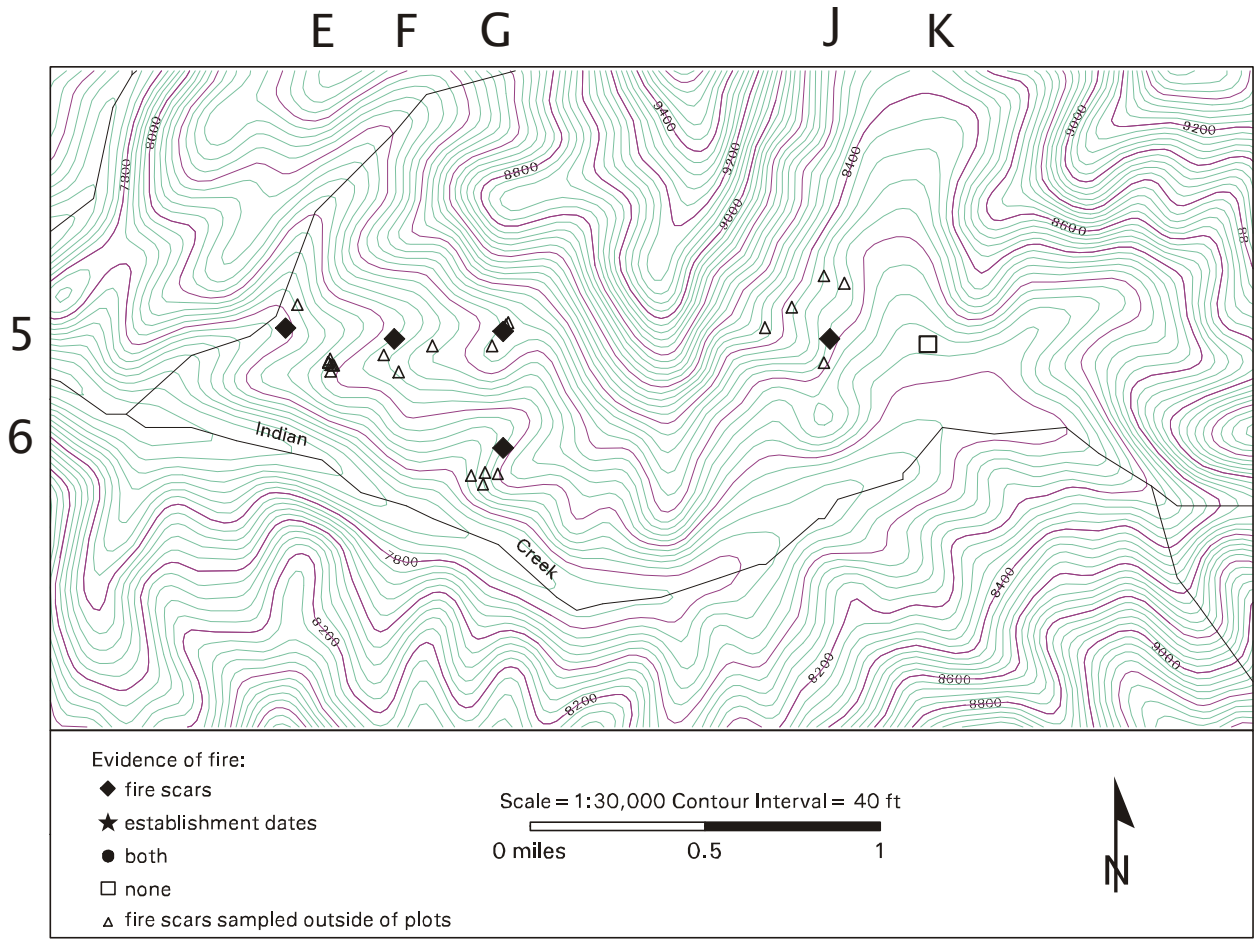


Figure 4. INC watershed, showing location of plots and type of evidence collected at each.

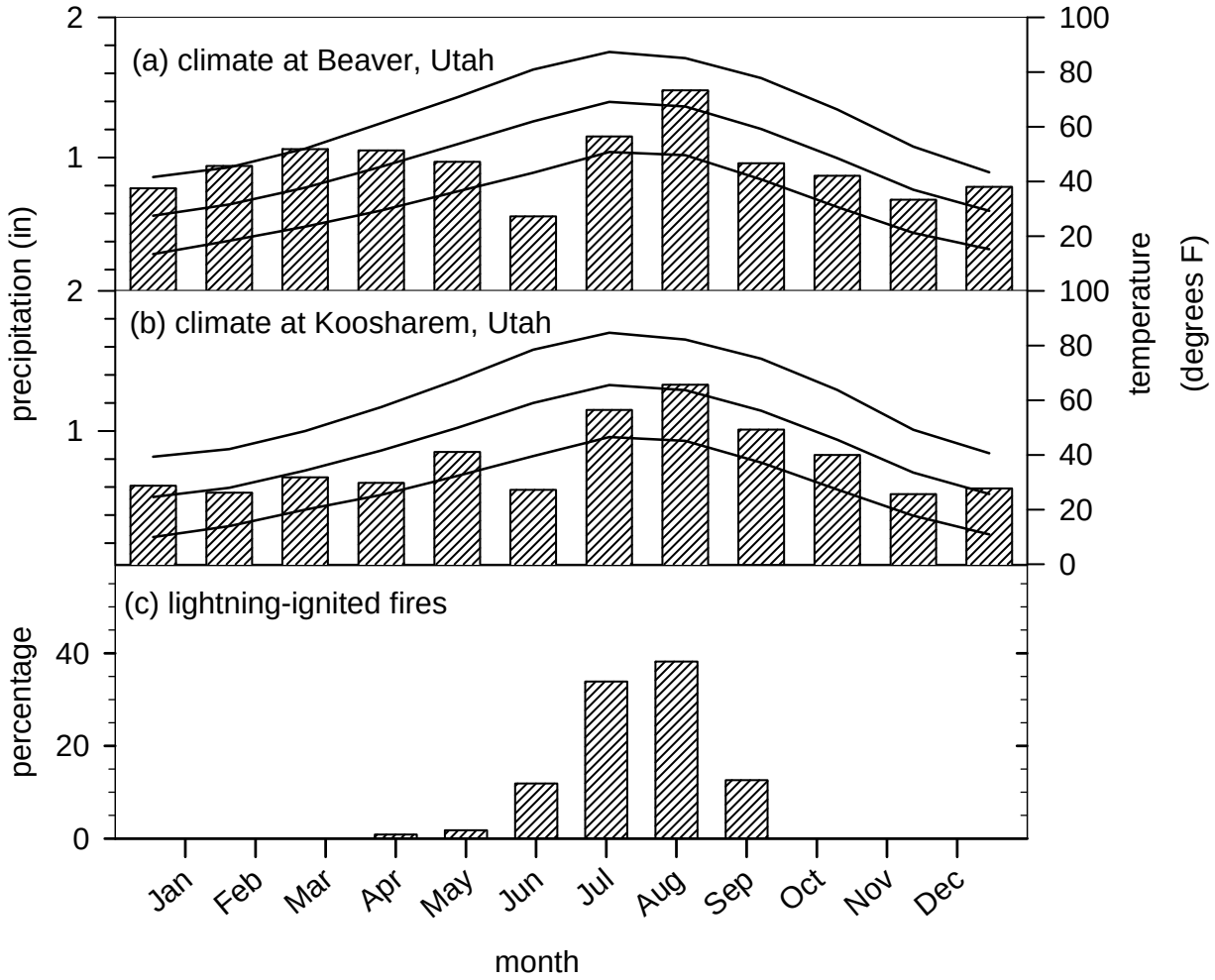


Figure 5. Climate at (a) Beaver, Utah and (b) Koosharem, Utah (1890 to 1990; Western Regional Climate Center 2001; Figure 1; monthly precipitation (bars) and monthly minimum, maximum and mean temperature (lines)); (c) seasonal distribution of lightning-ignited fires on the Fishlake National Forest (1970-2001; Fishlake National Forest 2001).

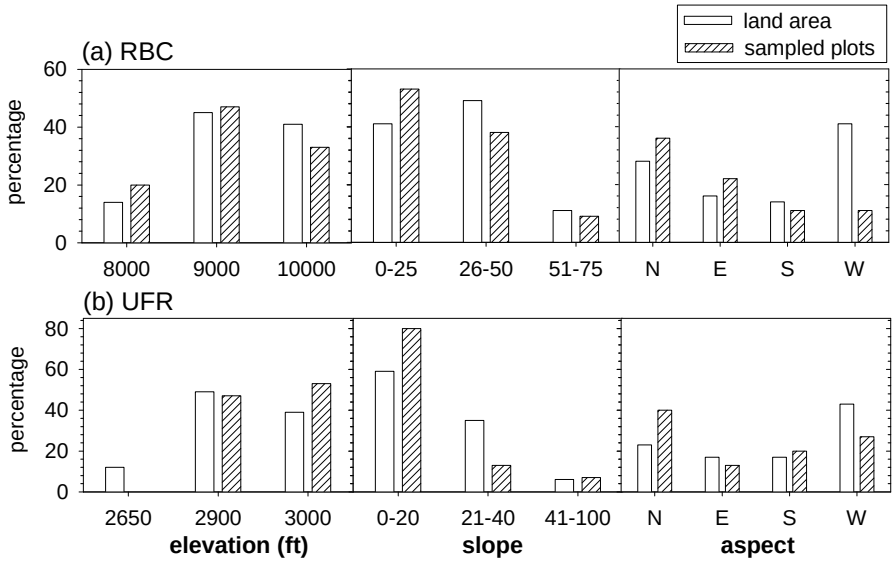


Figure 6. Comparison of topography at sampled plots to that of land area in at RBC and UFR. Elevation labels are midpoints of the range plotted.

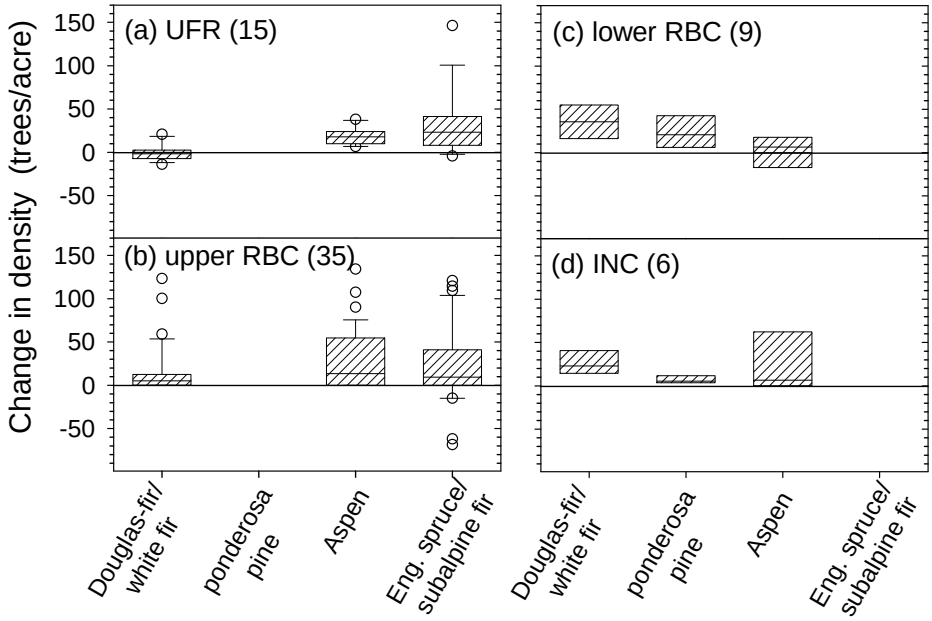


Figure 7. Change in density of live trees (>6" dbh) from 1880 to 2000, by species, with number of plots in parentheses. The boxes enclose the 25th to 75th percentiles and the whiskers enclose the 10th and 90th percentiles of the distribution of plots. The horizontal line across each box indicates the median, and the values falling outside the 10th to 90th percentiles are shown as circles. UFR and upper RBC are of similar potential vegetation types as are lower RBC and INC (Table 2).

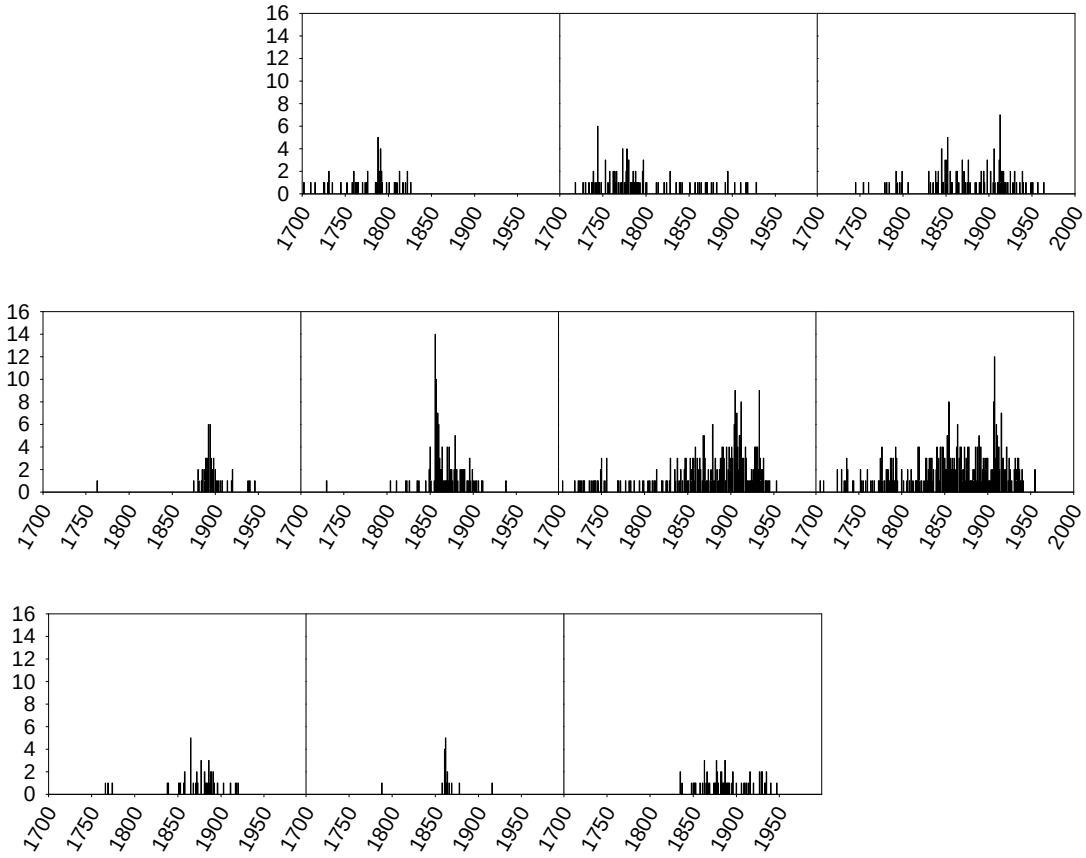


Figure 8. Recruitment dates of trees (>6" dbh), by species at the gridded watersheds (UFR, RBC and INC).

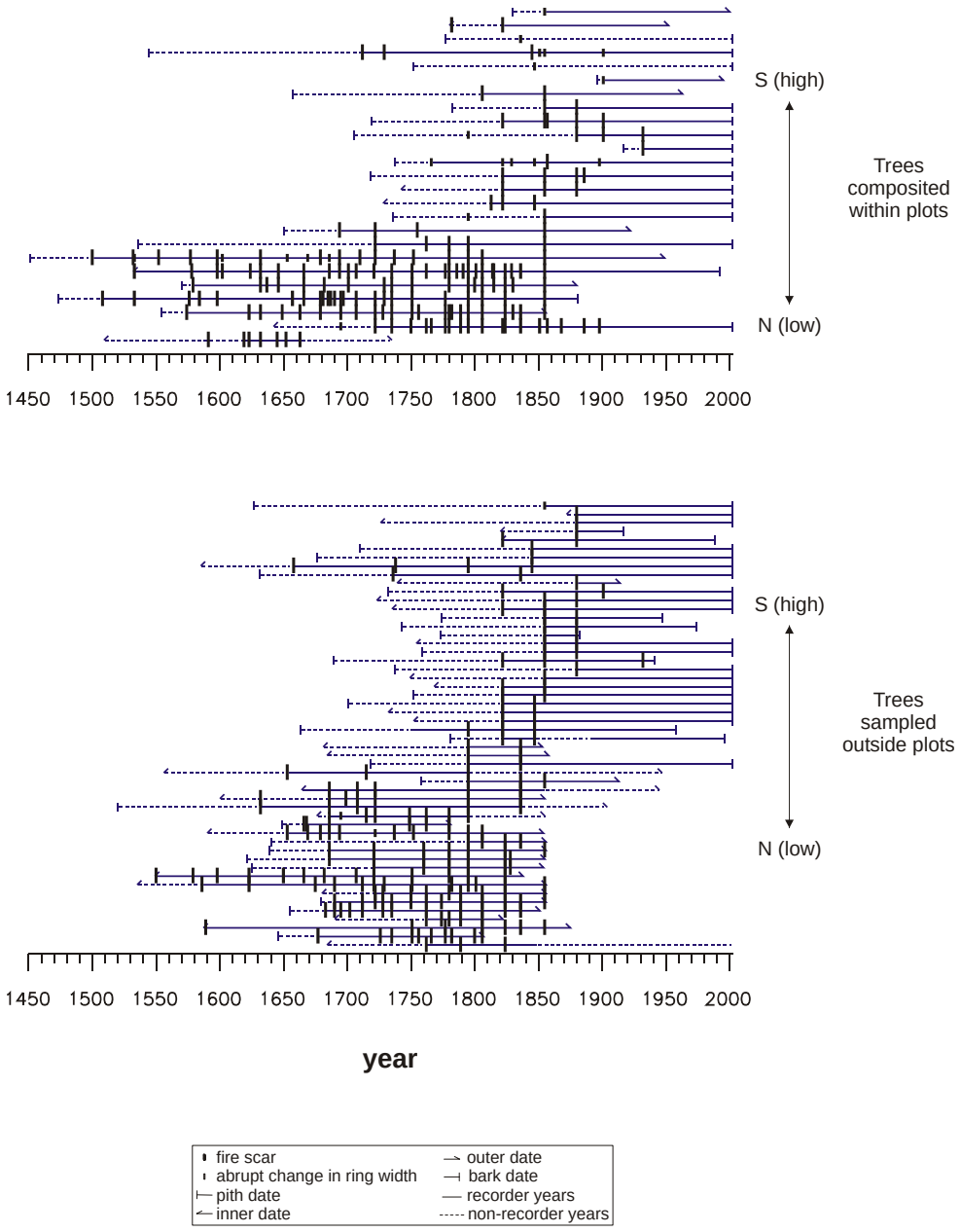


Figure 9. RBC fire charts showing samples composited at each plot (upper figure) and samples from outside of plots (lower figure). Each horizontal line shows the fire records composited at the plot through time (Grissino-Mayer 1995). Recording years generally follow the first scar on each tree. Non-recorder years precede the formation of the first scar on each tree but also occur when a period of the fire record was consumed by subsequent fires or rot. Inner and outer dates are the dates of the earliest or latest rings sampled from trees where pith or bark was not sampled.

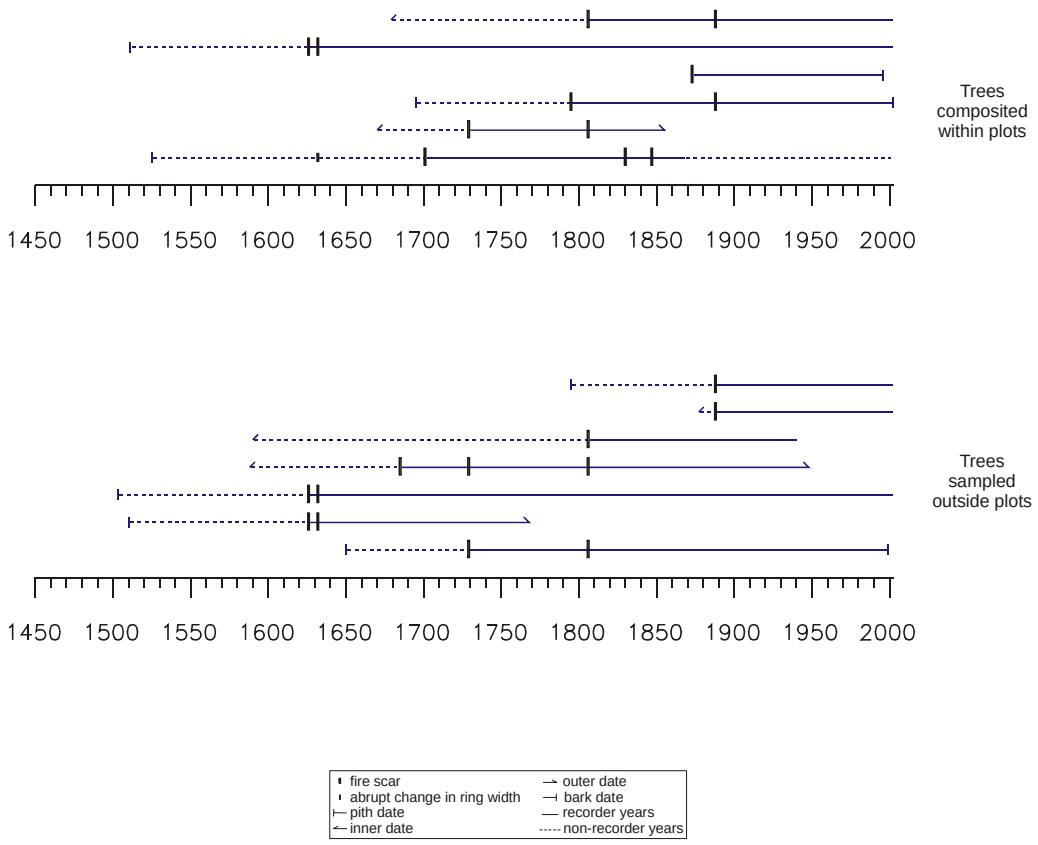


Figure 10. UFR fire charts showing samples composited at each plot (upper figure) and samples from outside of plots (lower figure). Each horizontal line shows the fire records composited at the plot through time (Grissino-Mayer 1995). Recording years generally follow the first scar on each tree. Non-recorder years precede the formation of the first scar on each tree but also occur when a period of the fire record was consumed by subsequent fires or rot. Inner and outer dates are the dates of the earliest or latest rings sampled from trees where pith or bark was not sampled.

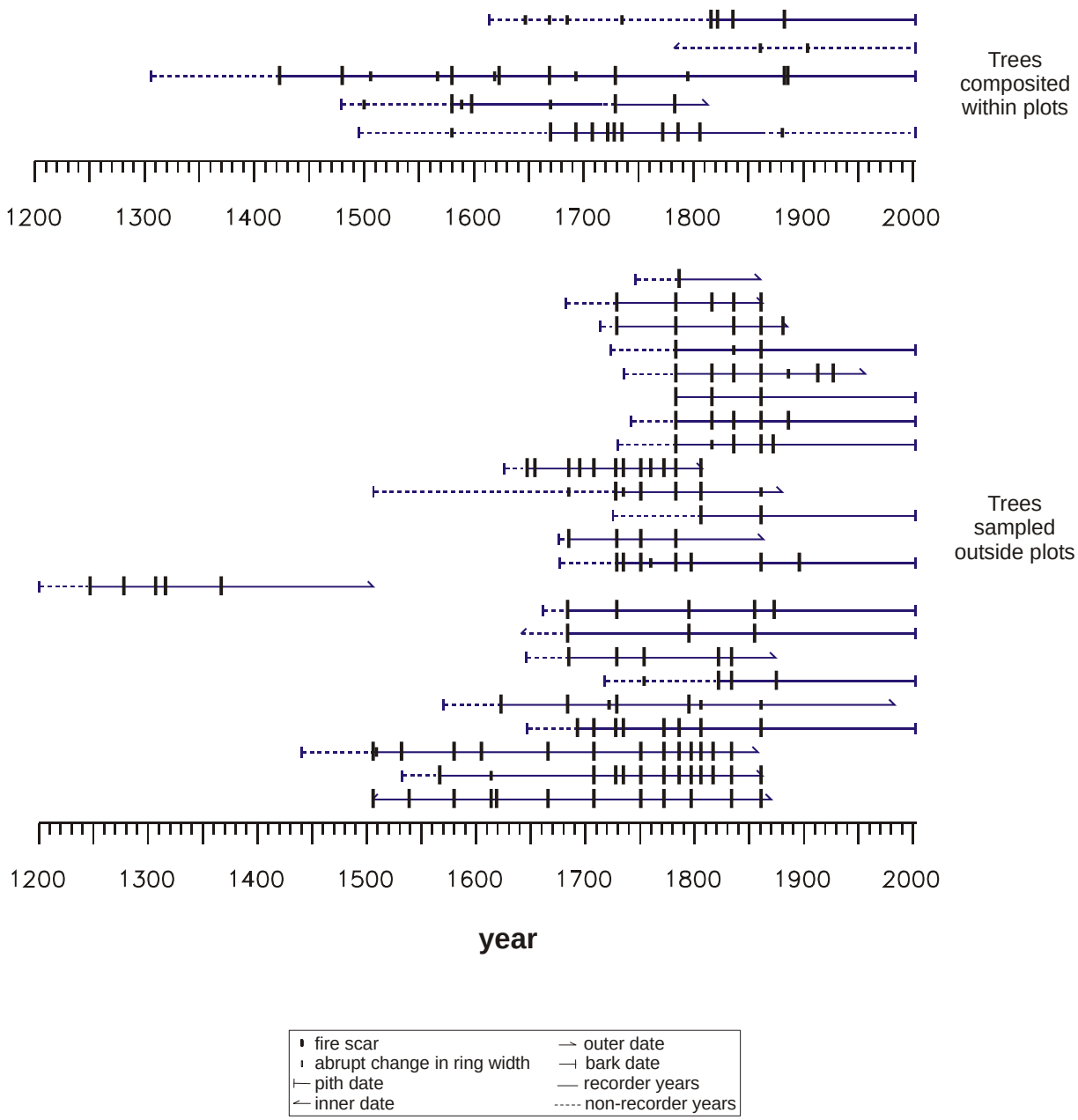


Figure 11. INC fire charts showing samples composited at each plot (upper figure) and samples from outside of plots (lower figure). Each horizontal line shows the fire records composited at the plot through time (Grissino-Mayer 1995). Recording years generally follow the first scar on each tree. Non-recorder years precede the formation of the first scar on each tree but also occur when a period of the fire record was consumed by subsequent fires or rot. Inner and outer dates are the dates of the earliest or latest rings sampled from trees where pith or bark was not sampled.

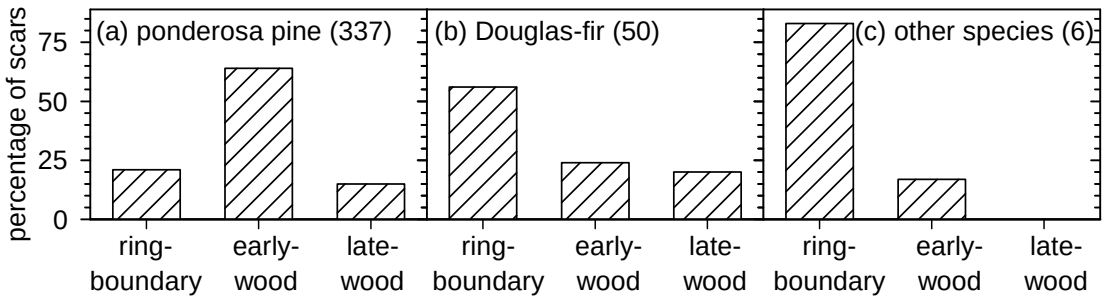


Figure 12. Intra-ring position of fire scars at RBC, by tree species, for scars with season determined (70%; 1508-1880). Number of scars is given in parentheses. Other species are subalpine fir (5 trees) and white fir (1 tree). Ring-boundary scars were formed by fires that burned between cambial growing seasons, when the cambium was dormant, whereas earlywood and latewood scars were formed by fires that burned during the cambial growing season.

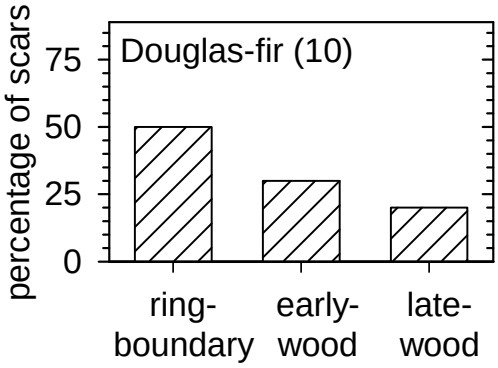


Figure 13. Intra-ring position of fire scars at UFR, for scars with season determined (43%; 1626-1880). All fire scars were sampled from Douglas-fir trees. Number of scars is given in parentheses. Ring-boundary scars were formed by fires that burned when the cambium was dormant, whereas earlywood and latewood scars were formed by fires that burned during the cambial growing season.

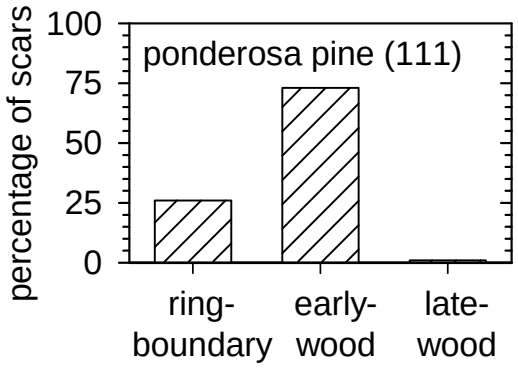


Figure 14. Intra-ring position of fire scars at INC, for scars with season determined (78%; 1423-1880). Number of scars is given in parentheses. Most fire scars were sampled from ponderosa pine trees. However, fire scars were sampled from 3 Douglas-fir and 2 white fir trees (not shown here). Ring-boundary scars were formed by fires that burned between cambial growing seasons, when the cambium was dormant, whereas earlywood and latewood scars were formed by fires that burned during the cambial growing season.

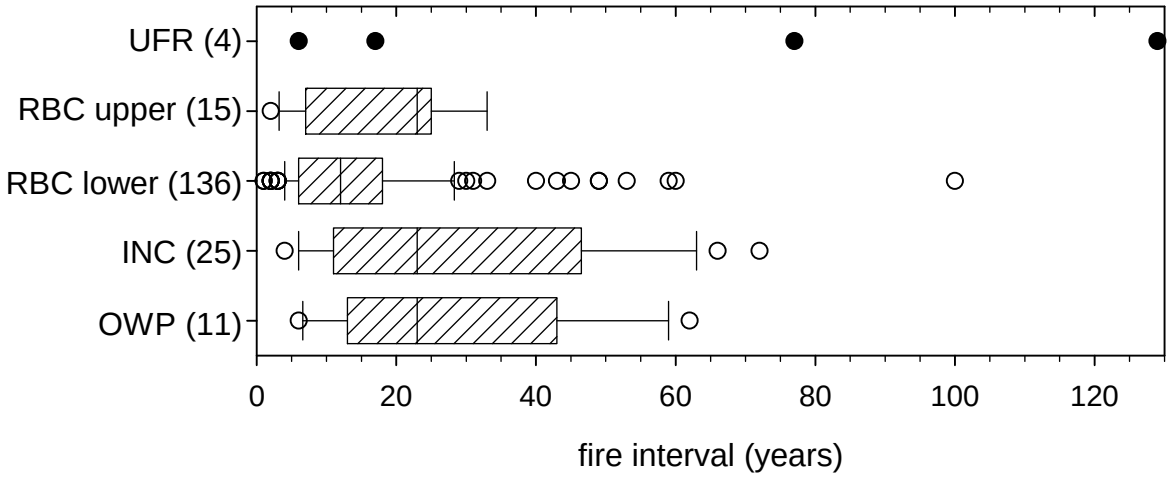


Figure 15. Composite surface fire intervals at plots, with the number of intervals in parentheses. The boxes enclose the 25th to 75th percentiles and the whiskers enclose the 10th and 90th percentiles of the distribution of intervals. The vertical line across each box indicates the median, and the values falling outside the 10th to 90th percentiles are shown as circles. We could not create a boxplot for UFR because we reconstructed only 4 fire intervals there, rather we plotted the actual intervals. UFR and upper RBC are of similar potential vegetation types as are lower RBC and INC (Table 2).

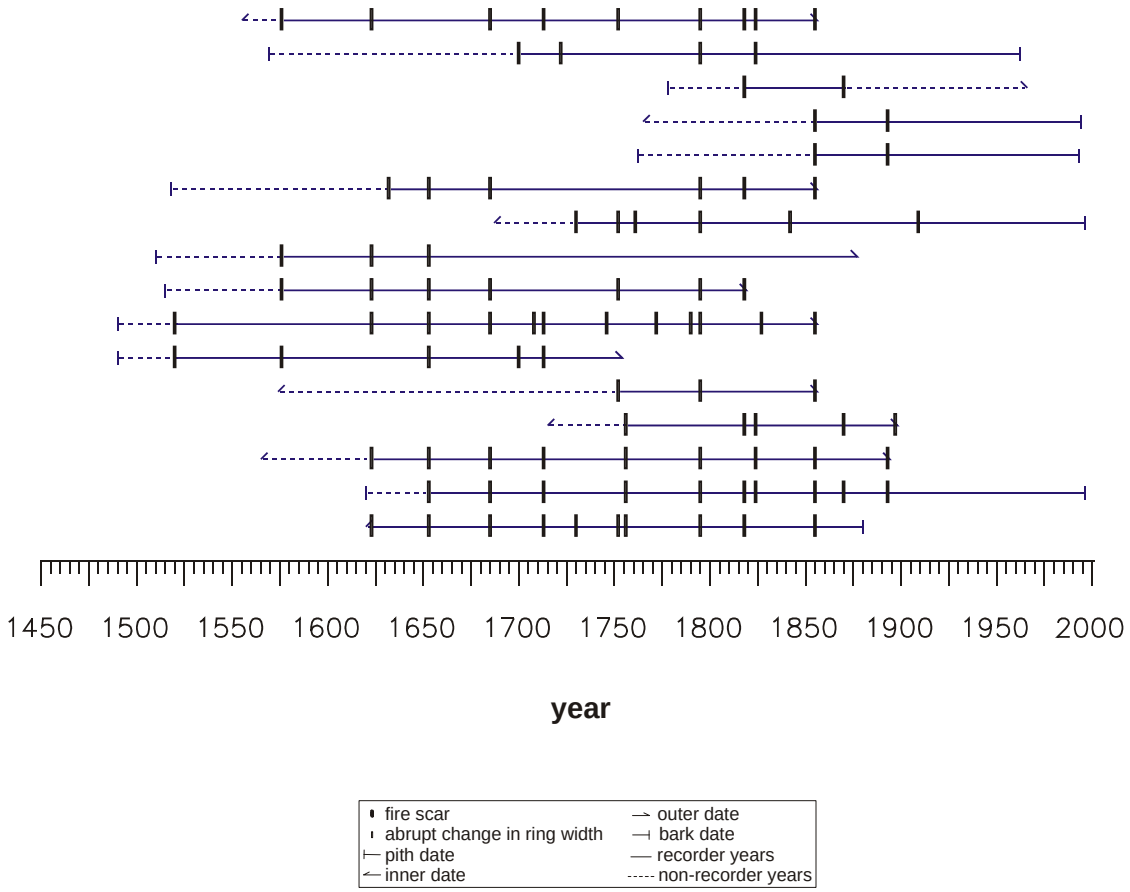


Figure 16. OWP fire chart. Each horizontal line shows the fire records composited at the plot through time (Grissino-Mayer 1995). Recording years generally follow the first scar on each tree. Non-recorder years precede the formation of the first scar on each tree but also occur when a period of the fire record was consumed by subsequent fires or rot. Inner and outer dates are the dates of the earliest or latest rings sampled from trees where pith or bark was not sampled.

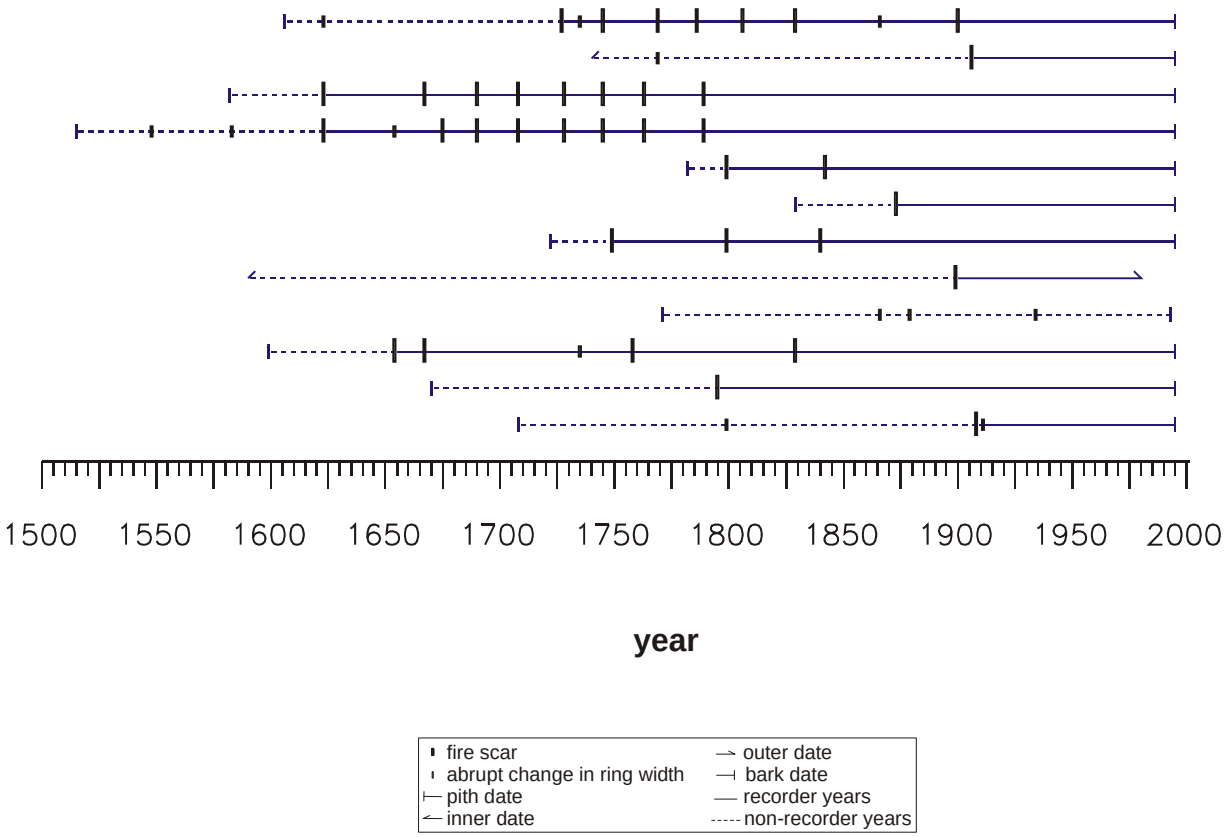


Figure 17. MON fire chart showing all crossdated samples. Each horizontal line shows the fire records composited at the plot through time (Grissino-Mayer 1995). Recording years generally follow the first scar on each tree. Non-recorder years precede the formation of the first scar on each tree but also occur when a period of the fire record was consumed by subsequent fires or rot. Inner and outer dates are the dates of the earliest or latest rings sampled from trees where pith or bark was not sampled.

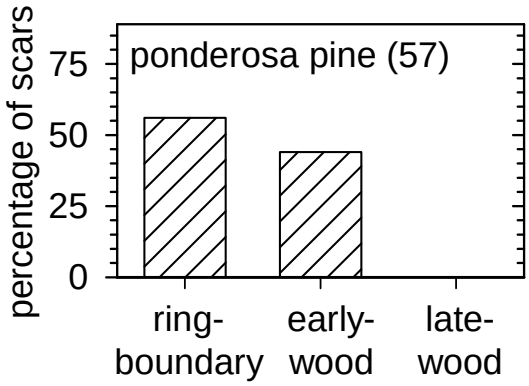


Figure 18. Intra-ring position of fire scars at OWP, for scars with season determined (66%; 1576-1880). Number of scars is given in parentheses. All fire scars from this site were sampled from ponderosa pine trees. Ring-boundary scars were formed by fires that burned between cambial growing seasons, when the cambium was dormant, whereas earlywood and latewood scars were formed by fires that burned during the cambial growing season.

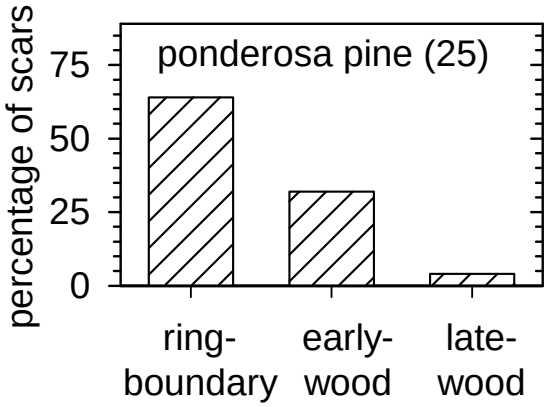


Figure 19. Intra-ring position of fire scars at MON, for scars with season determined (90%; 1654-1880). Number of scars is given in parentheses. Most fire scars were sampled from ponderosa pine trees. Ring-boundary scars were formed by fires that burned between cambial growing seasons, when the cambium was dormant, whereas earlywood and latewood scars were formed by fires that burned during the cambial growing season.

APPENDIX A: PLOT CHARACTERISTICS

Plot level measurements from individual watersheds. Note that plots in the grids that did not contain trees are not included here and that the table for RBC stretches over two pages.

Plot ID	UTM-E	UTM-N	Elev (ft)	Aspect	Slope (%)	Slope position	Slope shape	sampled trees	undatable samples	crossdated samples
UFR14G	443450	4271000	9721	139	14	val. bottom	concave	30	10	20
UFR10H	441555	4270500	9249	363	7	middle	convex	30	13	17
UFR11H	442000	4270500	9209	358	16	middle	straight	30	9	21
UFR13H	443000	4270500	9691	26	30	middle	straight	31	2	29
UFR14H	443500	4270500	9669	229	10	middle	straight	31	19	12
UFR15H	444000	4270500	9810	237	21	upper	convex	31	10	21
UFR10I	441500	4270000	9186	322	12	middle	straight	30	6	24
UFR11I	442000	4270000	9439	314	65	middle	straight	30	2	28
UFR12I	442500	4270000	9829	228	4	ridge	straight	30	20	10
UFR11J	442000	4269500	9774	354	15	middle	straight	28	17	11
UFR13K	443000	4269000	9590	23	14	lower	straight	31	7	24
UFR14K	443500	4269000	9905	74	10	upper	convex	22	11	11
UFR12L	442500	4268500	9649	307	14	middle	concave	32	9	23
UFR13L	443000	4268500	9970	325	14	ridge	straight	30	5	25
UFR14L	443500	4268500	9810	360	11	middle	straight	31	8	23

Plot ID	UTM-N	UTM-E	Elev (ft)	Aspect	Slope (%)	Slope position	Slope shape	sampled trees	undatable samples	crossdated samples
RBC9A	4235380	370650	7737	24	47	Middle	Straight	30	5	25
RBC9B	4235313	371149	7880	56	16	Lower/Ridge	Straight	30	24	6
RBC10A	4234850	370650	7933	265	56	Middle	Straight	30	4	26
RBC10B	4234877	371124	8025	305	18	Upper	Concave	30	6	24
RBC10C	4234850	371650	7960	30	45	Middle	Straight	31	6	25
RBC11B	4234373	371136	8180	319	10	Upper	Concave	31	5	26
RBC11C	4234350	371650	8390	142	24	Ridge	Concave	30	9	21
RBC11D	4234350	372150	8460	45	30	Middle	Concave	30	10	20
RBC12C	4233879	371606	8722	338	23	Upper	Convex	30	5	25
RBC12D	4233850	372150	8842	115	10	Lower	Concave	31	17	14
RBC12E	4233850	372650	8594	40	6	Middle	Convex	31	7	24
RBC13D	4233350	372150	8770	174	13	Upper	Straight	30	7	23
RBC13E	4233350	372650	9060	121	21	Upper	Straight	29	6	23
RBC13F	4233350	373150	8747	14	30	Middle	Concave	31	6	25
RBC14E	4232813	372613	8966	12	2	Valley Bottom	Straight	28	9	19
RBC14F	4232850	373150	9060	208	5	Ridge	Straight	30	20	10
RBC14G	4232850	373650	9141	63	35	Upper	Straight	30	5	25
RBC15F	4232350	373150	9249	20	23	Middle	Straight	31	14	17
RBC15G	4232350	373650	9260	80	38	Middle	Straight	31	13	18
RBC15H	4232350	374150	8954	20	23	Middle	Straight	30	18	12
RBC16F	4231879	373178	9420	325	54	Middle	Concave	31	4	27
RBC16G	4231833	373662	9638	118	45	Upper	Straight	30	3	27
RBC16H	4231850	374150	9040	370	20	Lower	Concave	30	10	20

Plot ID	UTM-N	UTM-E	Elev (ft)	Aspect	Slope (%)	Slope position	Slope shape	sampled trees	undatable samples	crossdated samples
RBC17G	4231350	373650	9620	62	16	Middle	Convex	31	7	24
RBC17H	4231350	374150	9247	135	45	Middle	Convex	32	7	25
RBC17I	4231350	374650	9285	273	34	Middle	Straight	30	13	17
RBC18H	4230850	374150	9419	332	34	Upper	Straight	30	6	24
RBC18I	4230863	374711	9420	327	51	Middle	Straight	30	6	24
RBC18J	4230850	375150	9626	218	18	Upper	Convex	31	14	17
RBC19H	4230402	374167	9357	123	22	Lower	Straight	30	22	8
RBC19I	4230350	374650	9500	257	49	Upper	Straight	30	8	23
RBC19J	4230350	375150	9669	17	5	Upper	Straight	31	12	19
RBC20H	4229850	374150	9588	62	33	Middle	Straight	30	17	13
RBC20I	4229821	374603	9399	47	32	Lower	Concave	30	10	20
RBC20J	4229850	375150	9461	187	18	Middle	Straight	30	17	13
RBC21I	4229350	374650	9632	112	40	Middle	Straight	32	7	25
RBC21J	4229350	375150	9610	284	11	Upper	Straight	30	18	12
RBC21K	4229334	375630	9799	347	32	Upper	Convex	30	4	26
RBC22I	4228850	374650	9696	350	11	Middle	Straight	30	6	24
RBC22J	4228850	375150	9648	29	30	Lower	Convex	30	11	19
RBC22K	4228850	375650	10009	140	22	Middle	Straight	30	12	18
RBC23I	4228350	374650	10098	253	21	Middle	Concave	30	13	17
RBC23J	4228360	375171	9910	36	55	Middle	Concave	30	9	21
RBC23K	4228350	375650	9969	325	35	Middle	Concave	30	19	11

Plot ID	UTM-E	UTM-N	Elev (ft)	Aspect	Slope (%)	Slope position	Slope shape	sampled trees	undatable samples	crossdated samples
INC5E	367664	4254246	7757	312	14	ValleyBottom	Concave	30	10	20
INC5F	368164	4254196	8040	337	47	Upper	Straight	31	2	29
INC5G	368664	4254231	8262	-999	56	Upper	Straight	30	3	27
INC5J	370164	4254196	8156	63	60	Lower	Straight	31	7	24
INC5K	370614	4254172	7840	156	7	ValleyBottom	Straight	30	19	11
INC6G	368664	4253696	7906	318	55	Middle	Straight	30	1	29

APPENDIX B: FOREST COVER TYPE BY PLOT

Plot cover types from individual watersheds. Note that plots with no samples are not included here. Cover type sources are: Cover class (Fishlake) – vegetation communities within the Fishlake National Forest, derived from soil resource inventory data. GAP (Fishlake) – vegetation types on the Fishlake National Forest derived from land satellite classification. PVT (Landfire) – Potential natural vegetation layer from Landfire project derived using predictive landscape models based on reference data, satellite imagery, biophysical gradient layers, and classification and regression trees. Current Cover (Landfire) – Existing vegetation layer from Landfire project derived using predictive landscape models based on reference data, satellite imagery, biophysical gradient layers, and classification and regression trees.

	Cover class	GAP	PVT	Current Cover
Plot ID	(Fishlake)	(Fishlake)	(Landfire)	(Landfire)
UFRG14	Mix Con / POTR	spruce-fir	spruce-fir	spruce-fir
UFRH10	Mix Con / POTR	spruce-fir	spruce-fir	spruce-fir
UFRH11	Mix Con / POTR	spruce-fir	spruce-fir	spruce-fir
UFRH13	Mix Con / POTR	spruce-fir	spruce-fir	spruce-fir
UFRH14	Mixed Conifer	spruce-fir	spruce-fir	spruce-fir
UFRH15	Mix Con / POTR	spruce-fir	spruce-fir	spruce-fir
UFRI10	Mix Con / POTR	spruce-fir	spruce-fir	spruce-fir
UFRI11	Mix Con / POTR	spruce-fir	spruce-fir	spruce-fir
UFRI12	Mix Con / POTR	spruce-fir	spruce-fir	spruce-fir
UFRJ11	Mix Con / POTR	spruce-fir	spruce-fir	spruce-fir
UFRK13	Mix Con / POTR	spruce-fir	spruce-fir	spruce-fir
UFRK14	Mix Con / POTR	spruce-fir	spruce-fir	spruce-fir
UFRL12	Mixed Conifer	spruce-fir	spruce-fir	spruce-fir
UFRL13	Mix Con / POTR	spruce-fir	spruce-fir	spruce-fir
UFRL14	Mixed Conifer	spruce-fir	spruce-fir	spruce-fir

	Cover class	GAP	PVT	Current Cover
Plot ID	(Fishlake)	(Fishlake)	(Landfire)	(Landfire)
INC5E	Mixed Conifer	ponderosa pine	pinyon-juniper	pinyon-juniper
INC5F	CELE	ponderosa pine	white-fir	aspen
INC5G	Mixed Conifer	mtn. shrub	lodgepole pine	white-fir
INC5J	Mixed Conifer	mtn. shrub	white-fir	white-fir
INC5K	Mix Con / POTR	ponderosa pine	white-fir	white-fir
INC6G	CELE	ponderosa pine	white-fir	white-fir

	Cover class	GAP	PVT	Current Cover
Plot ID	(Fishlake)	(Fishlake)	(Landfire)	(Landfire)
RBC9A	Mix Con / POTR	Mountain fir	Pin / Jun / QUGA	Pinyon-juniper
RBC9B	Mix Con / POTR	Mountain fir	Pin / Jun / ARTR	pinyon-juniper
RBC10A	Mix Con / POTR	Mountain fir	Pin / Jun / QUGA	pinyon-juniper
RBC10B	Mix Con / POTR	Mountain fir	Pin / Jun / QUGA	white-fir
RBC10C	POTR / Per. Grass	Mountain fir	Pin / Jun / ARTR	pinyon-juniper
RBC11B	Mix Con / POTR	Mountain fir	White-fir	white-fir
RBC11C	Mix Con / POTR	Mountain fir	White-fir	white-fir
RBC11D	Mix Con / POTR	Mountain fir	White-fir	white-fir
RBC12C	Mix Con / POTR	Aspen / conifer	White-fir	white-fir
RBC12D	Mix Con / POTR	Mountane fir	White-fir	white-fir
RBC12E	Mix Con / POTR	Aspen / conifer	White-fir	white-fir
RBC13D	Mix Con / POTR	Aspen / conifer	Spruce - fir	spruce-fir
RBC13E	Mix Con / POTR	Aspen / conifer	Spruce - fir	spruce-fir
RBC13F	Mix Con / POTR	Aspen / conifer	White-fir	white-fir
RBC14E	Mix Con / POTR	Aspen	Spruce - fir	aspen
RBC14F	Mix Con / POTR	Aspen	Spruce - fir	aspen
RBC14G	Mix Con / POTR	Aspen / conifer	White-fir	white-fir
RBC15F	Mix Con / POTR	Aspen / conifer	Spruce - fir	aspen
RBC15G	Mix Con / POTR	Aspen / conifer	Spruce - fir	aspen
RBC15H	Mix Con / POTR	Mountain fir	White-fir	white-fir
RBC16F	Mix Con / POTR	Aspen / conifer	Spruce - fir	aspen
RBC16G	Mix Con / POTR	Aspen / conifer	Spruce - fir	aspen
RBC16H	Mix Con / POTR	Aspen	Spruce - fir	aspen
RBC17G	Mixed Conifer	Spruce-fir	Spruce - fir	aspen
RBC17H	Mixed Conifer	Aspen	Spruce - fir	aspen
RBC17I	Mixed Conifer	Spruce-fir	Spruce - fir	aspen
RBC18H	Mixed Conifer	Aspen	Spruce - fir	aspen
RBC18I	Mixed Conifer	Spruce-fir	Spruce - fir	aspen
RBC18J	Mix Con / POTR	Spruce-fir	Spruce - fir	aspen
RBC19H	Mixed Conifer	Spruce-fir	Spruce - fir	aspen
RBC19I	Mix Con / POTR	Spruce-fir	Spruce - fir	aspen
RBC19J	Mix Con / POTR	Spruce-fir	Spruce - fir	aspen
RBC20H	Mixed Conifer	Spruce-fir	Spruce - fir	aspen
RBC20I	Perenial grasses	Spruce-fir	Spruce - fir	aspen
RBC20J	Mix Con / POTR	Spruce-fir	Spruce - fir	aspen
RBC21I	Mixed Conifer	Spruce-fir	Spruce - fir	aspen
RBC21J	Mix Con / POTR	Spruce-fir	Spruce - fir	aspen
RBC21K	Mix Con / POTR	Spruce-fir	Spruce - fir	aspen
RBC22I	Mixed Conifer	Spruce-fir	Spruce - fir	aspen
RBC22J	Mixed Conifer	Spruce-fir	Spruce - fir	aspen
RBC22K	Mixed Conifer	Spruce-fir	Spruce - fir	aspen
RBC23I	Mixed Conifer	Spruce-fir	Spruce - fir	spruce-fir
RBC23J	Mixed Conifer	Spruce-fir	Spruce - fir	spruce-fir
RBC23K	Mixed Conifer	Spruce-fir	Spruce - fir	spruce-fir

APPENDIX C: STATISTICS OF INDIVIDUAL FIRE YEARS

Fire interval and area statistics for entire sampled area for RBC, including only years for which at least two trees were scarred.

Fire Year	Total Scars	Total Other	Total Injuries	Recorder Trees	Percent Scarred	Fire Interval	Area burned (ac)
1532	2	0	2	3	67	.	33
1533	2	1	3	3	100	1	112
1579	2	0	2	6	33	46	30
1598	4	1	5	8	63	19	117
1623	4	0	4	8	50	25	76
1632	10	0	10	14	71	9	46
1646	2	0	2	11	18	14	68
1653	2	1	3	13	23	7	35
1657	2	0	2	14	14	4	36
1663	2	0	2	15	13	6	25
1666	11	0	11	21	52	3	122
1679	8	2	10	25	40	13	87
1681	2	0	2	26	8	2	36
1682	2	0	2	26	8	1	30
1685	6	0	6	30	20	3	36
1686	9	2	11	34	32	1	36
1690	7	0	7	36	19	4	58
1694	4	0	4	38	11	4	128
1695	9	2	11	40	28	1	84
1701	2	0	2	42	5	6	68
1702	2	0	2	42	5	1	-999
1707	19	0	19	44	43	5	100
1708	3	0	3	44	7	1	58
1712	4	0	4	45	9	4	25
1715	2	0	2	45	4	3	25
1721	6	0	6	46	13	6	93
1722	30	3	33	59	56	1	247
1728	4	0	4	56	7	6	32
1729	4	0	4	56	7	1	114
1735	28	1	29	57	51	6	145
1737	4	0	4	58	7	2	35
1749	2	0	2	57	4	12	38
1750	5	0	5	58	9	1	22
1751	24	0	24	60	40	1	161
1752	6	1	7	61	11	1	35
1755	2	0	2	61	3	3	51
1756	2	0	2	60	3	1	29
1760	3	0	3	60	5	4	30
1762	14	0	14	63	22	2	169
1766	2	1	3	62	5	4	152
1774	2	0	2	59	3	8	13

Fire interval and area statistics for entire sampled area for RBC (cont.)

Fire Year	Total Scars	Total Other	Total Injuries	Recorder Trees	Percent Scarred	Fire Interval	Area burned (ac)
1777	17	0	17	60	28	3	122
1780	21	0	21	58	36	3	261
1782	4	0	4	57	7	2	77
1789	8	0	8	58	14	7	57
1795	51	2	53	69	77	6	57
1800	2	0	2	60	3	5	38
1801	2	0	2	60	3	1	58
1806	33	0	33	61	54	5	300
1815	2	0	2	59	3	9	68
1822	21	2	23	76	30	7	552
1824	26	0	26	75	35	2	221
1828	2	0	2	75	3	4	13
1830	3	0	3	75	4	2	41
1836	17	1	18	75	24	6	218
1845	4	0	4	75	5	9	71
1847	8	11	19	76	25	2	282
1855	54	7	61	84	73	8	1402
1857	3	0	3	66	5	2	258
1880	31	0	31	77	40	23	940
1886	2	0	2	74	3	6	47
1901	4	2	6	76	8	15	286
1932	3	0	3	72	4	31	101

Fire interval and area statistics for entire sampled area for UFR.

Fire Year	Total Scars	Total Other	Total Injuries	Recorder Trees	Percent Scarred	Fire Interval	Area burned (ac)
1626	5	0	5	5	100	.	65
1632	4	0	5	6	83	6	77
1685	1	0	1	7	14	53	22
1701	1	0	1	8	13	16	12
1729	3	0	3	10	30	28	53
1795	1	0	1	7	14	66	27
1806	5	0	5	9	56	11	163
1830	1	0	1	9	11	24	12
1847	1	0	1	9	11	17	12
1873	1	0	1	8	13	26	100
1888	4	0	4	11	36	15	118

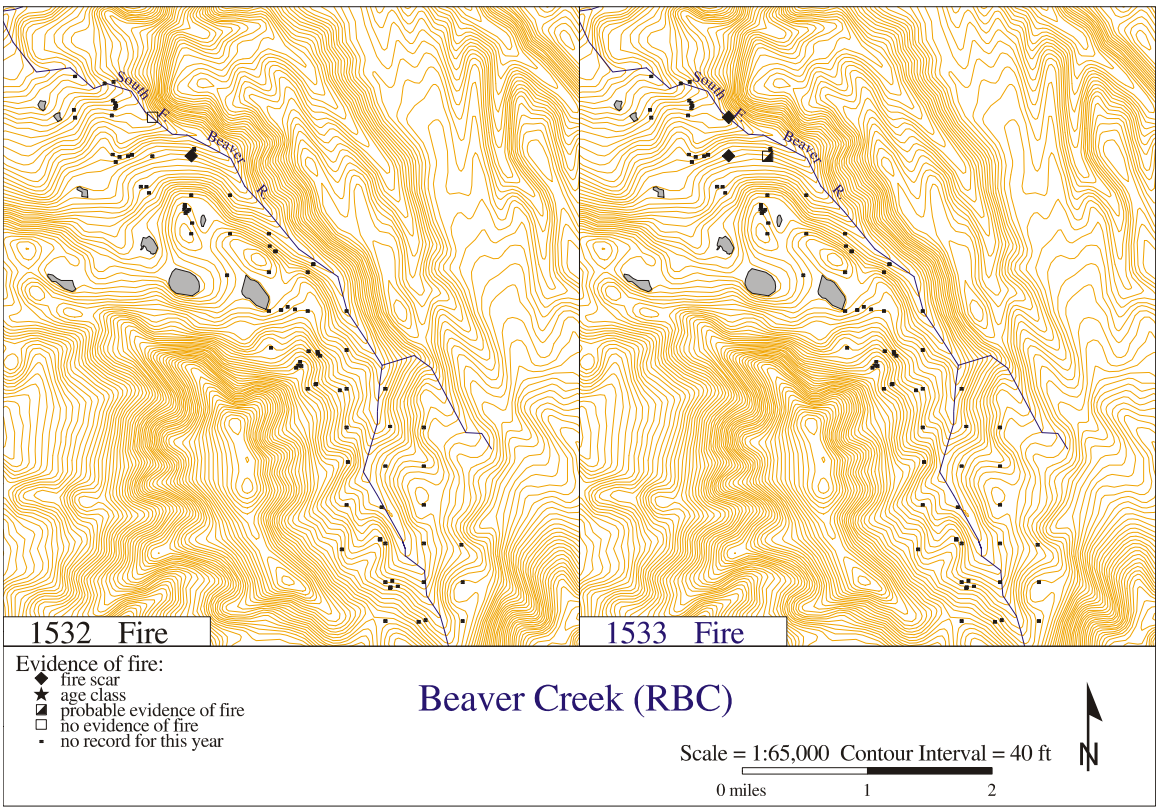
Fire interval and area statistics for entire sampled area for INC, including only years for which at least two trees were scarred and only after 1500.

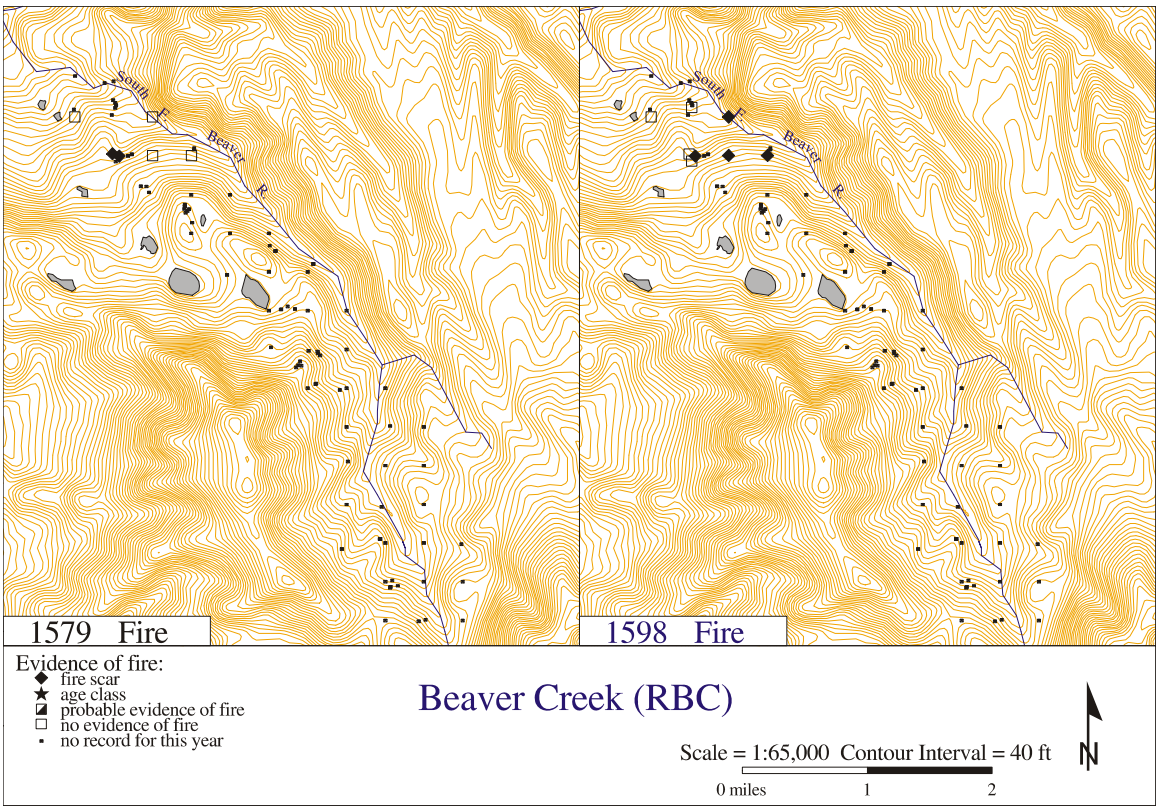
Fire Year	Total Scars	Total Other	Total Injuries	Recorder Trees	Percent Scarred	Fire Interval	Area burned (ac)
1506	2	1	3	3	100	26	25
1567	1	1	2	4	50	28	18
1580	4	2	6	5	120	13	117
1614	1	1	2	5	40	9	11
1619	1	1	2	5	40	5	25
1623	2	0	2	6	33	4	90
1647	1	1	2	7	29	24	20
1666	2	0	2	7	29	12	9
1669	1	1	2	7	29	3	18
1670	1	1	2	8	25	1	92
1684	3	0	3	10	30	14	84
1685	3	2	5	12	42	1	58
1693	3	1	4	14	29	8	125
1708	6	0	6	13	46	13	139
1722	1	1	2	12	17	14	158
1728	5	0	5	14	36	6	150
1729	9	0	9	19	47	1	187
1735	5	2	7	19	37	6	211
1751	7	0	7	19	37	16	113
1754	1	1	2	19	11	3	131
1760	1	1	2	19	11	6	76
1772	6	0	6	19	32	12	139
1783	12	0	12	24	50	11	122
1786	5	0	5	25	20	3	117
1795	3	1	4	25	16	9	100
1797	4	0	4	25	16	2	70
1806	7	1	8	26	31	9	232
1816	5	1	6	24	25	10	15
1817	2	0	2	24	8	1	3
1822	3	0	3	25	12	5	133
1834	5	0	5	24	21	12	143
1836	6	1	7	24	29	2	16
1855	2	0	2	24	8	19	10
1861	12	3	15	21	71	6	224
1881	1	1	2	14	14	6	84
1883	2	0	2	15	13	2	18
1886	2	1	3	15	20	3	19

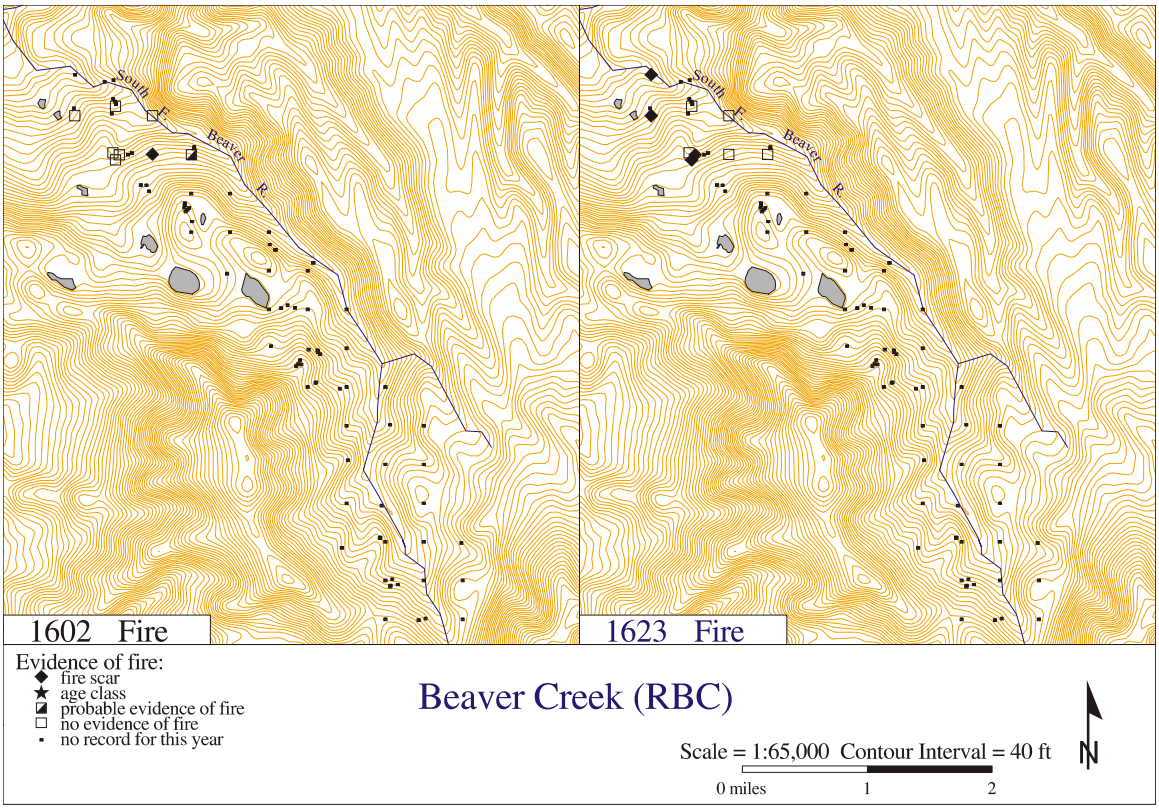
APPENDIX D: MAPS OF SURFACE FIRES AND RECRUITMENT-DATE COHORTS

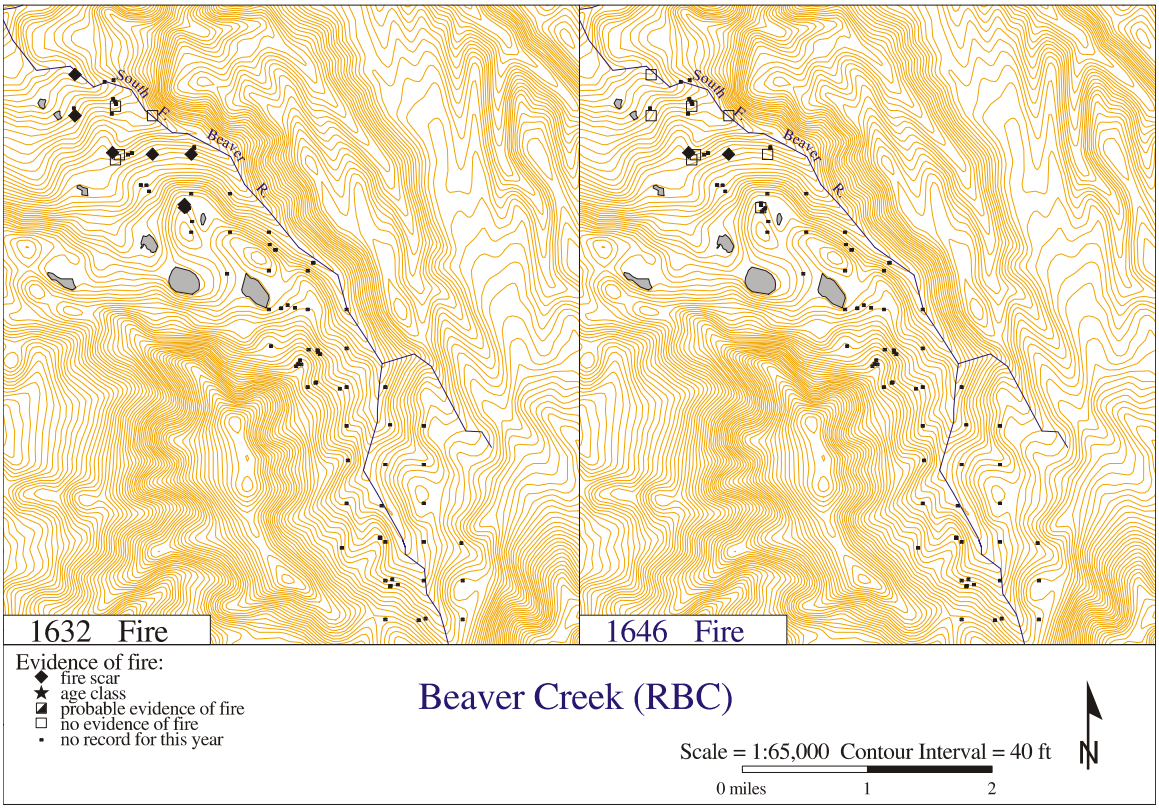
The following maps show evidence of surface fires and recruitment data cohorts (only at RBC) for each fire year in our watersheds where 2 or more samples had evidence of fire. Each point on the maps represents either a composite of fire events within 80 meters of a plot, or a tree outside of plots with fire evidence, as indicated by symbols defined in the legends. Evidence of fire noted on these map legends is as follows:

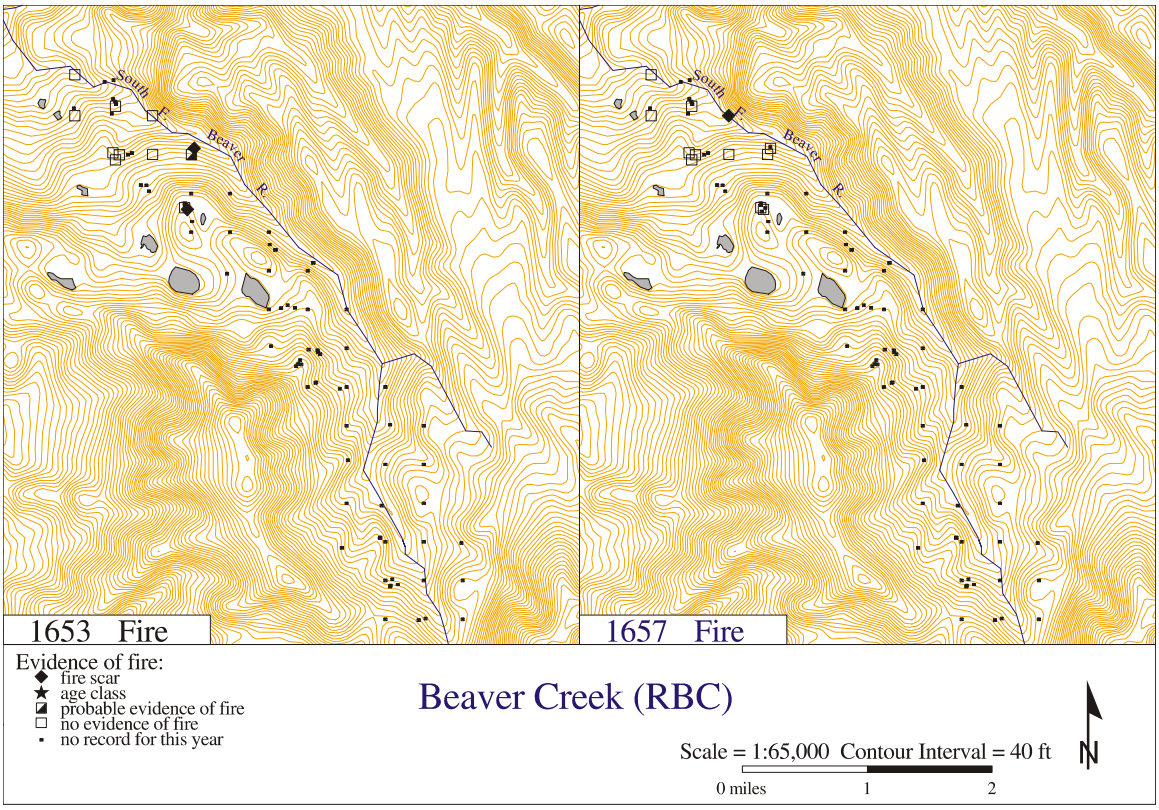
- fire scar: a fire scar date at this location
- age class: recruitment-date cohort that synchronous with a fire scar date for this date at this location
- probable evidence of fire: an injury or abrupt change in ring width that matches a fire scar date at this location
- no evidence of fire: no sample at this date at this location
- no record for this year: we sampled this plot but no trees were alive during this year as potential recorders, we consider this plots to be unsampled for these years.

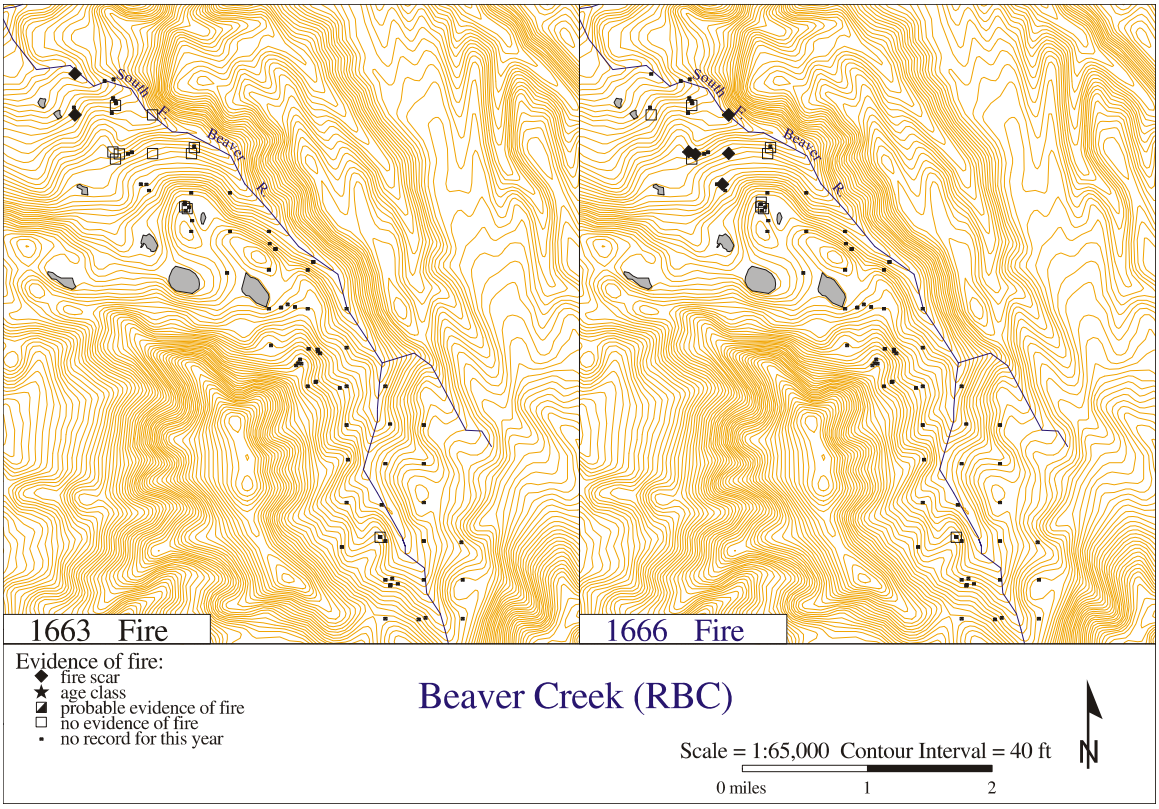

South F
Beaver R
1532 Fire
South F
Beaver R
1533 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

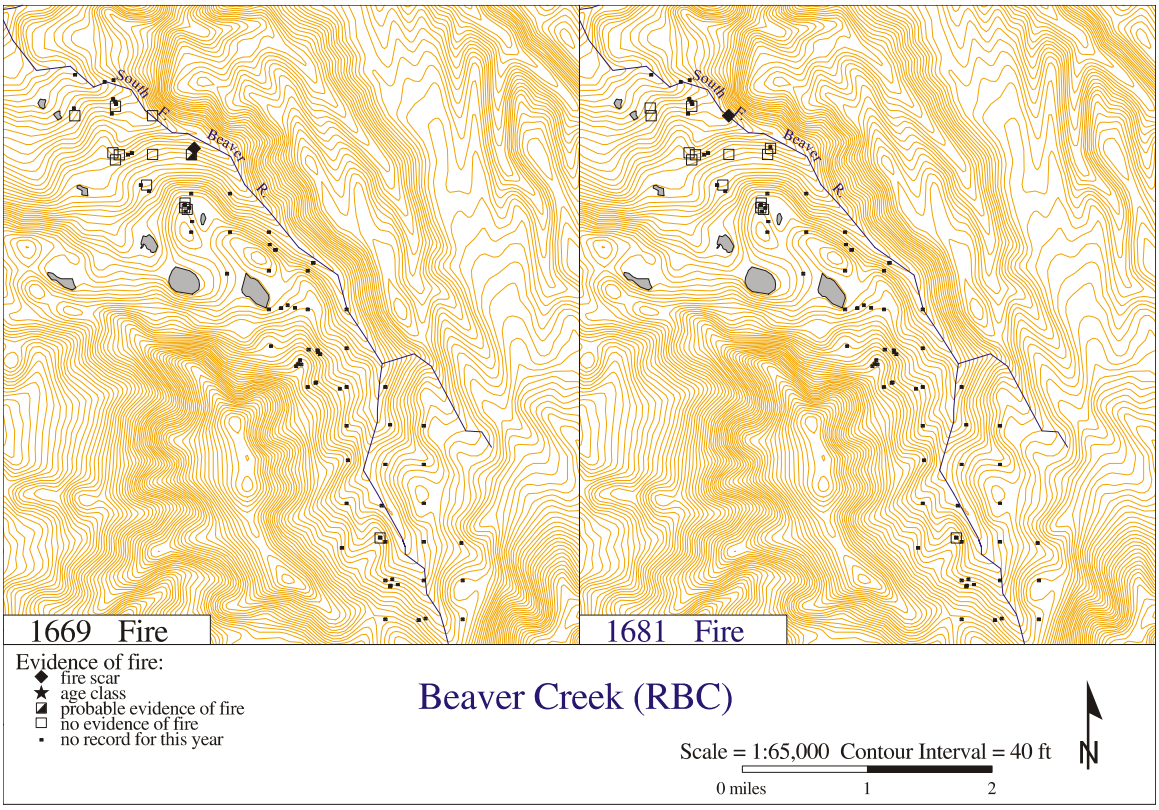

South F
Beaver R
1579 Fire
South F
Beaver R
1598 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

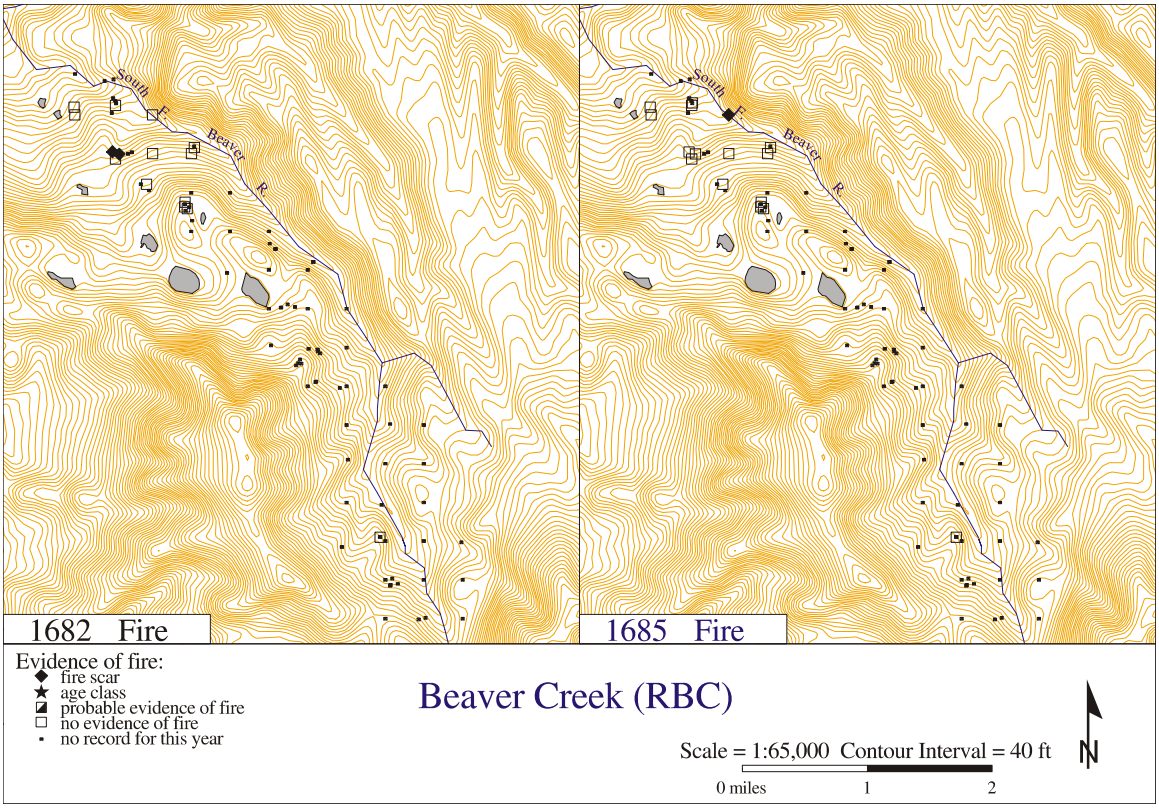

South F. Beaver R.
1602 Fire
South F. Beaver R.
1623 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

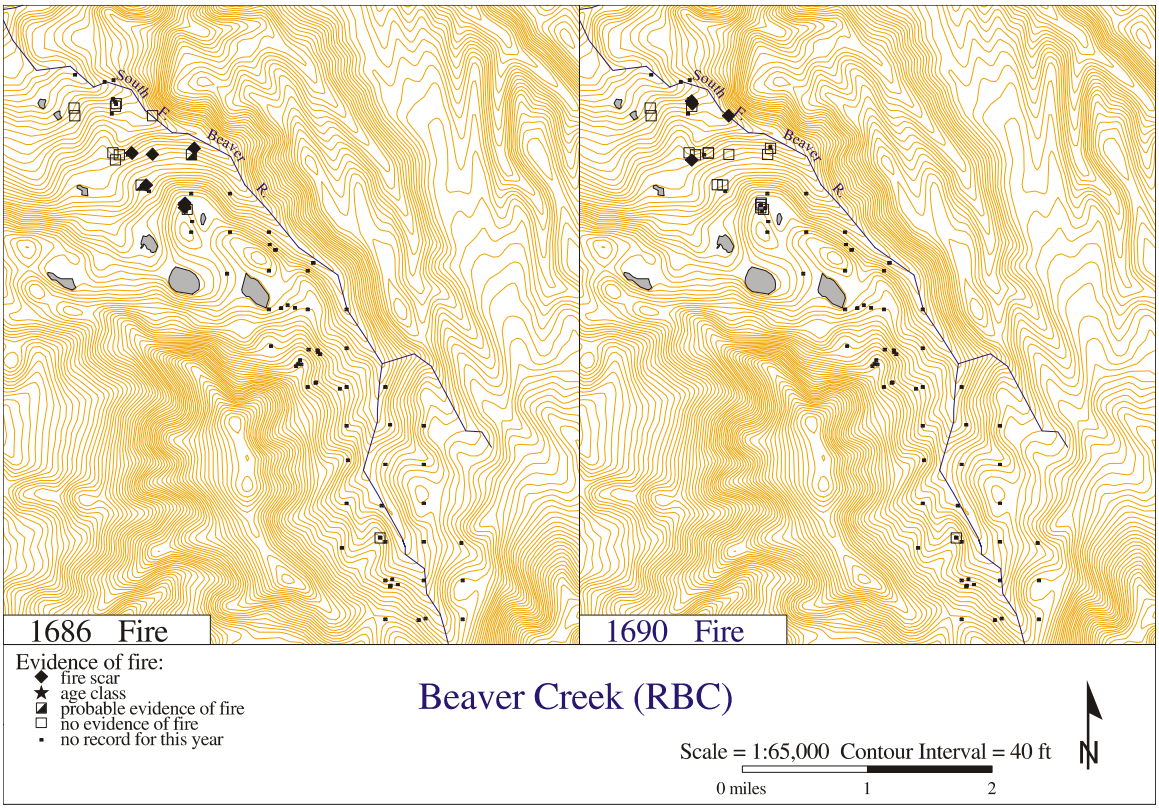

South F. Beaver R.
1632 Fire
South F. Beaver R.
1646 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

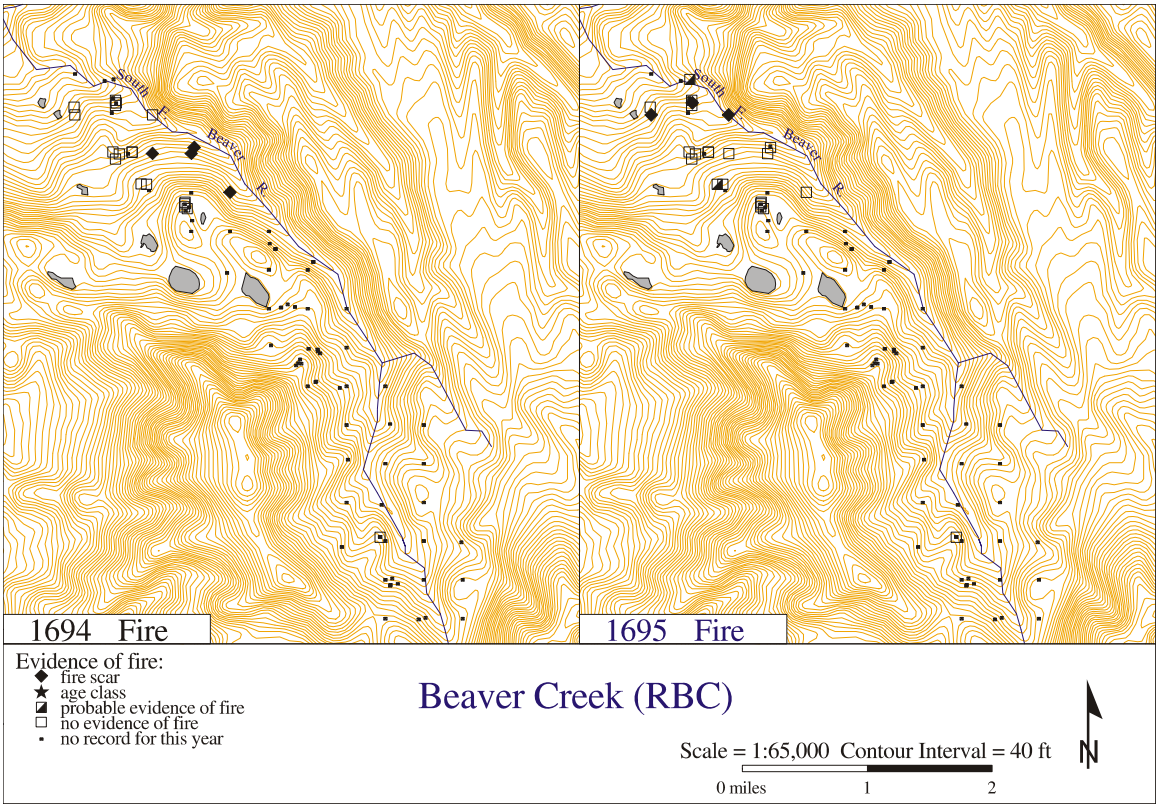

South F.
Beaver R.
1653 Fire
South F.
Beaver R.
1657 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

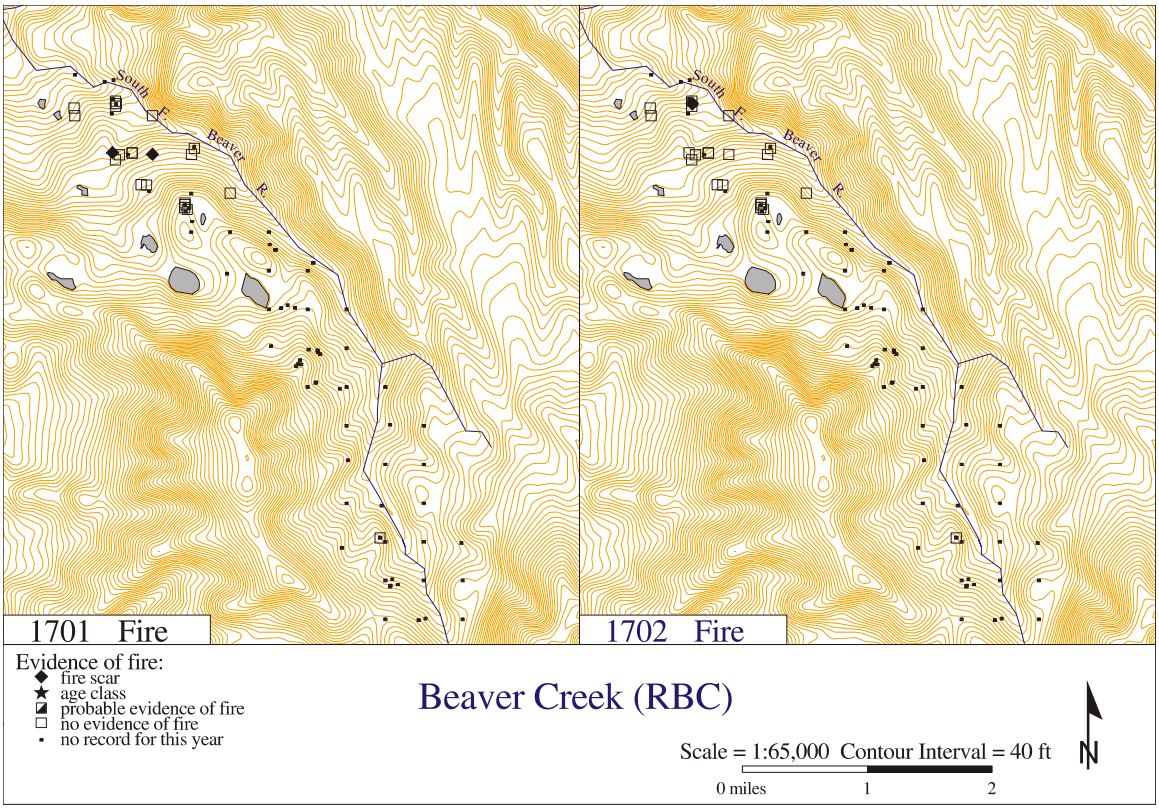

South F.
Beaver R.
1663 Fire
South F.
Beaver R.
1666 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

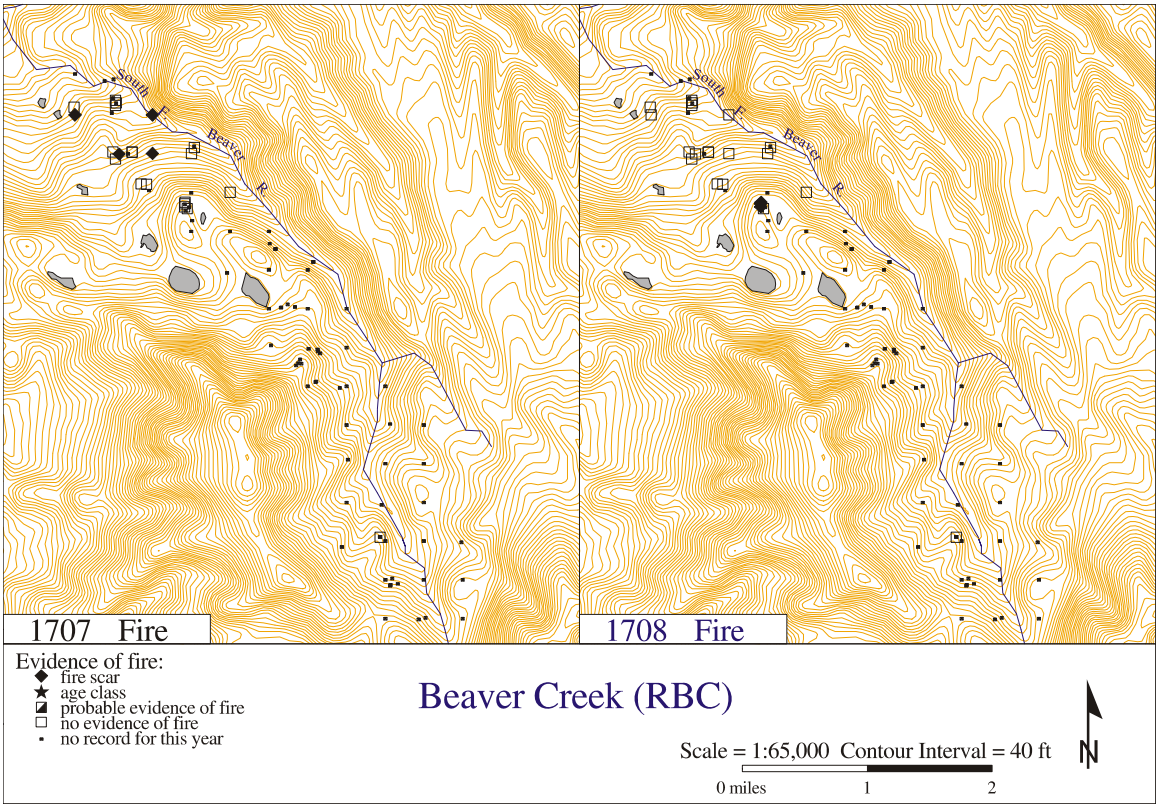

South F.
Beaver R.
1669 Fire
South F.
Beaver R.
1681 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

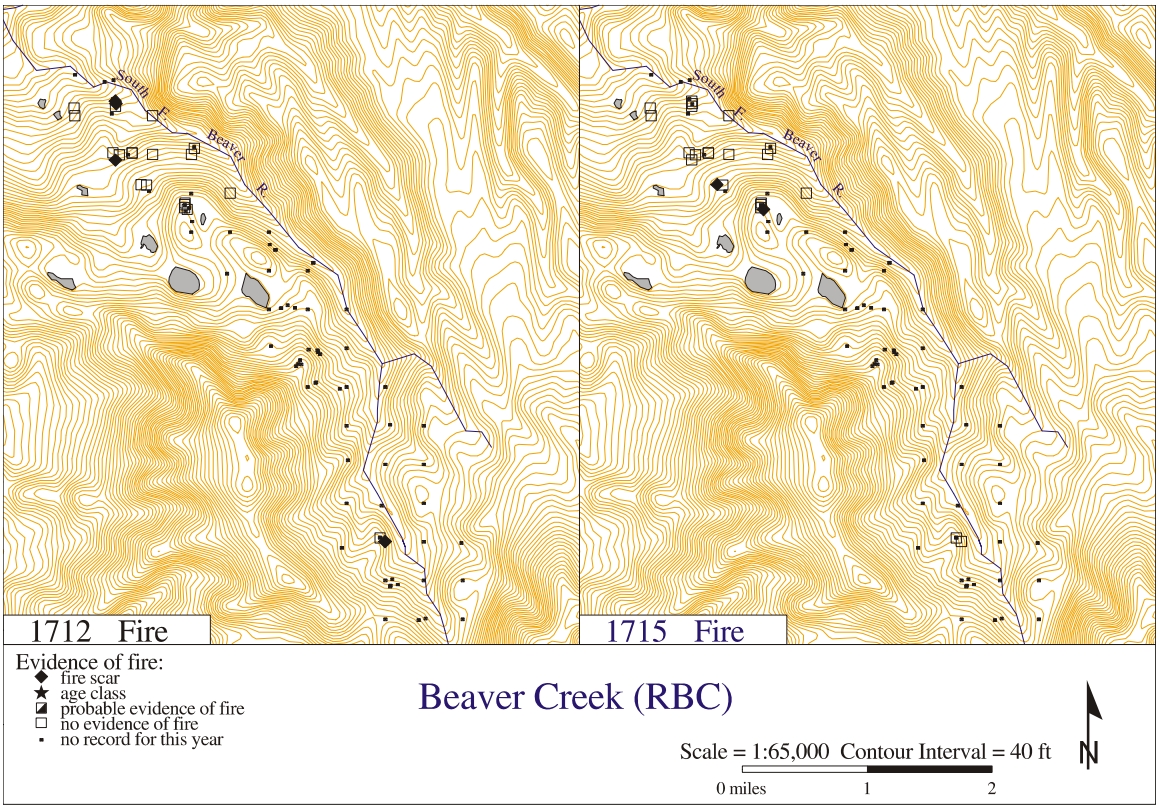

South F.
Beaver R.
1682 Fire
South F.
Beaver R.
1685 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

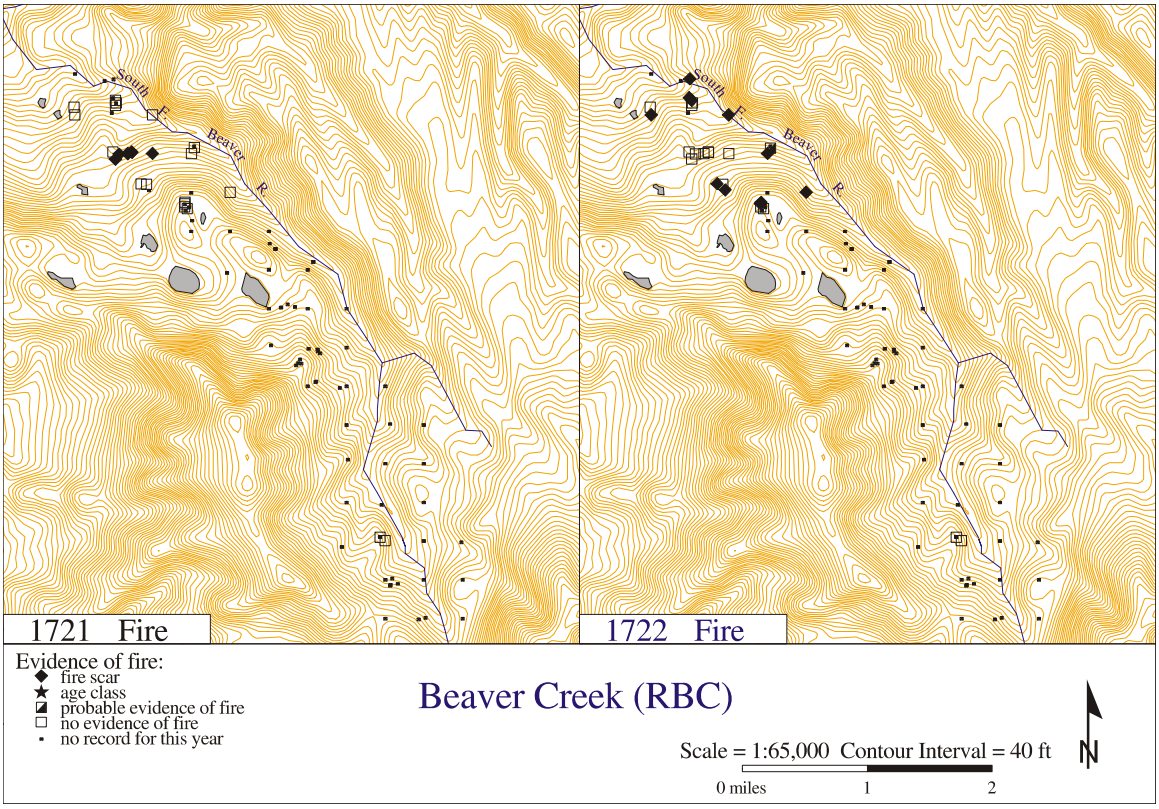

South F.
Beaver R.
1686 Fire
South F.
Beaver R.
1690 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

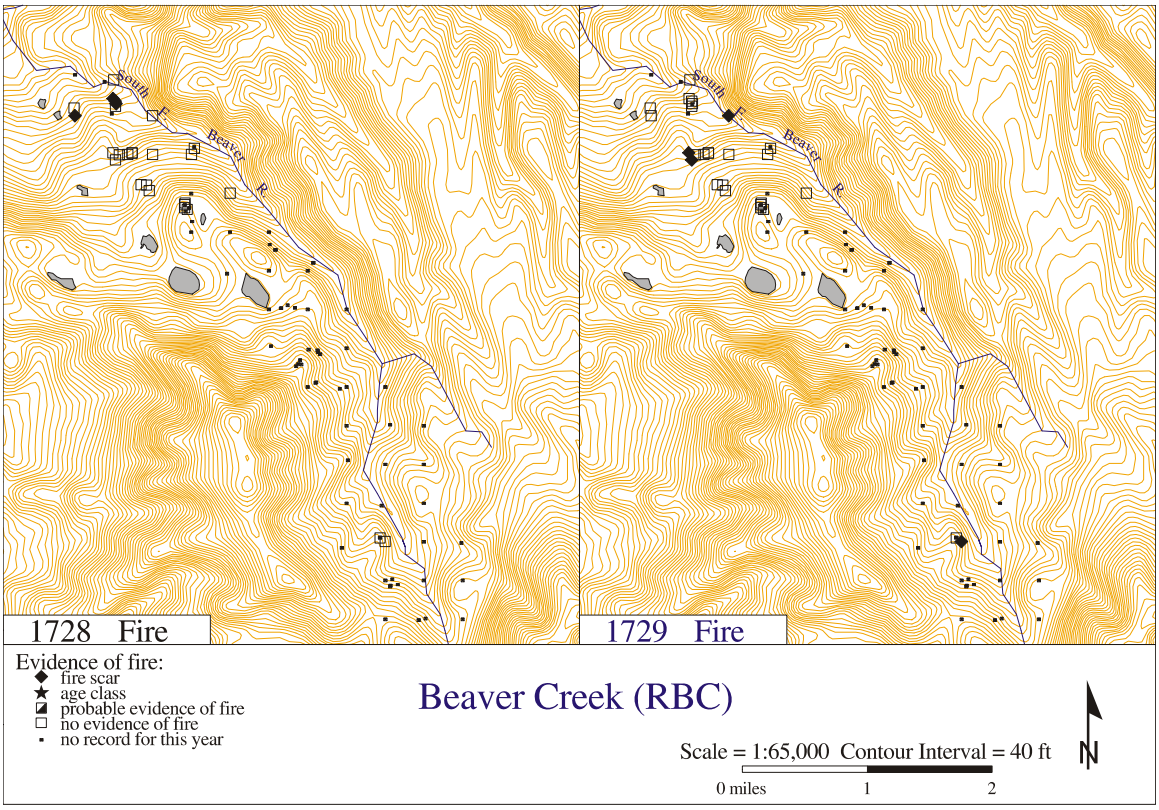

South F.
Beaver R.
1694 Fire
South F.
Beaver R.
1695 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

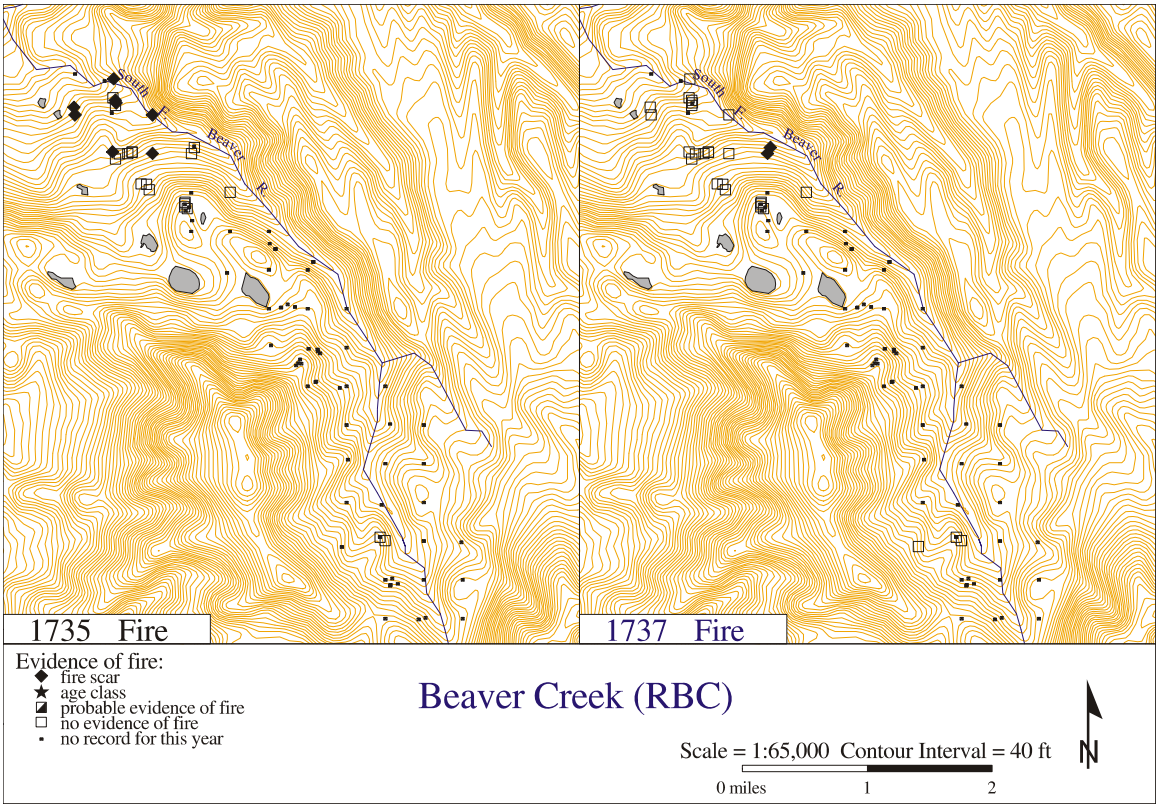

South F.
Beaver R.
1701 Fire
South F.
Beaver R.
1702 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

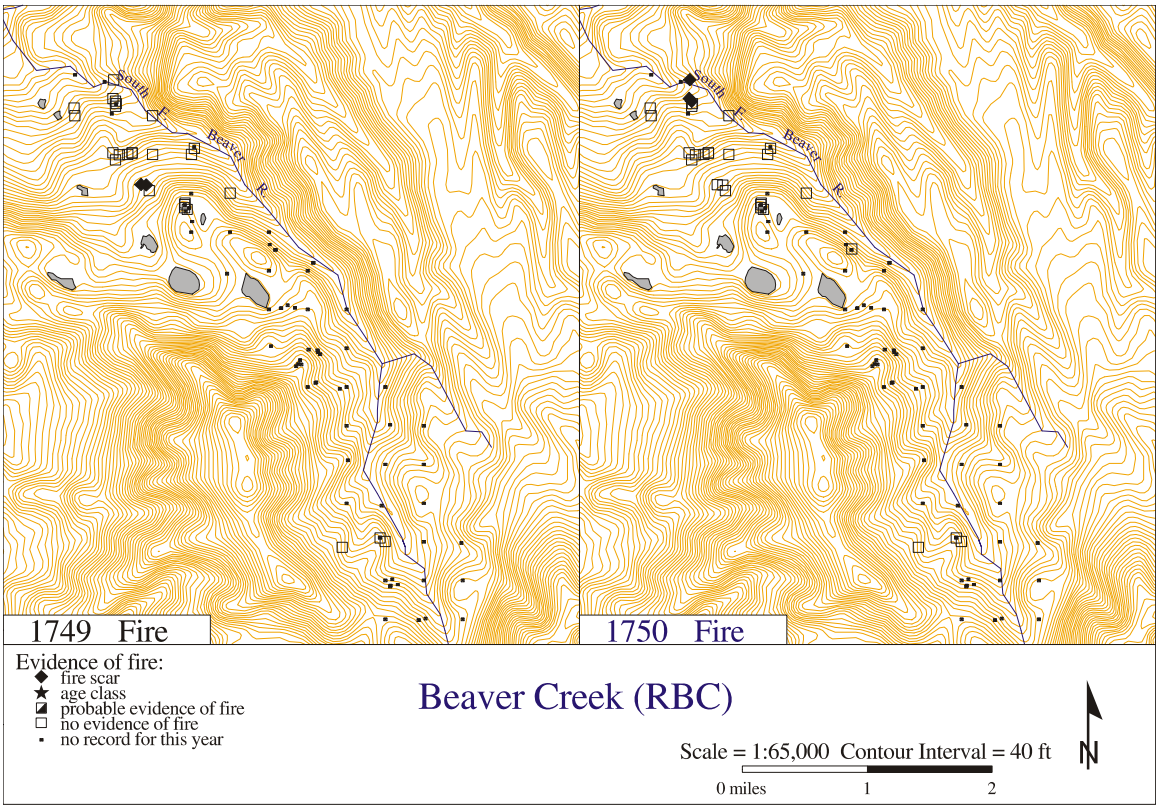

South F.
Beaver R.
1707 Fire
South F.
Beaver R.
1708 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

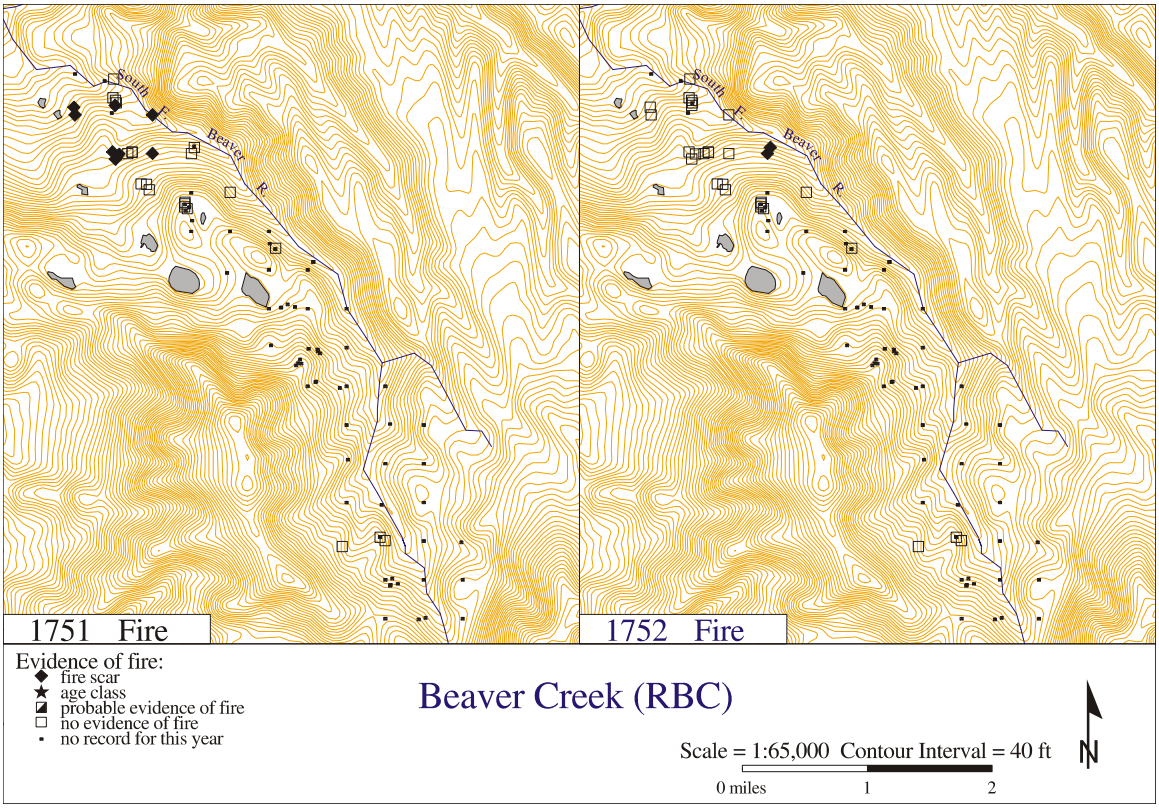

South F.
Beaver R.
1712 Fire
South F.
Beaver R.
1715 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

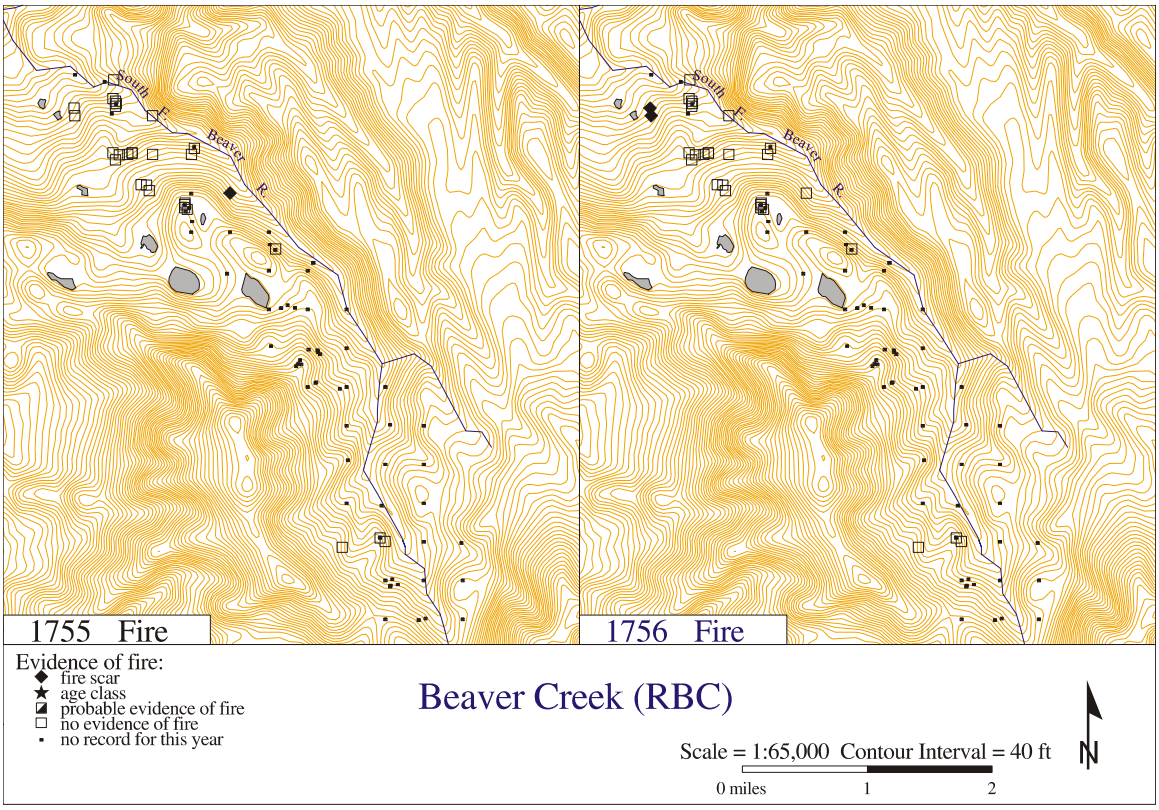

South F.
Beaver R.
1721 Fire
South F.
Beaver R.
1722 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

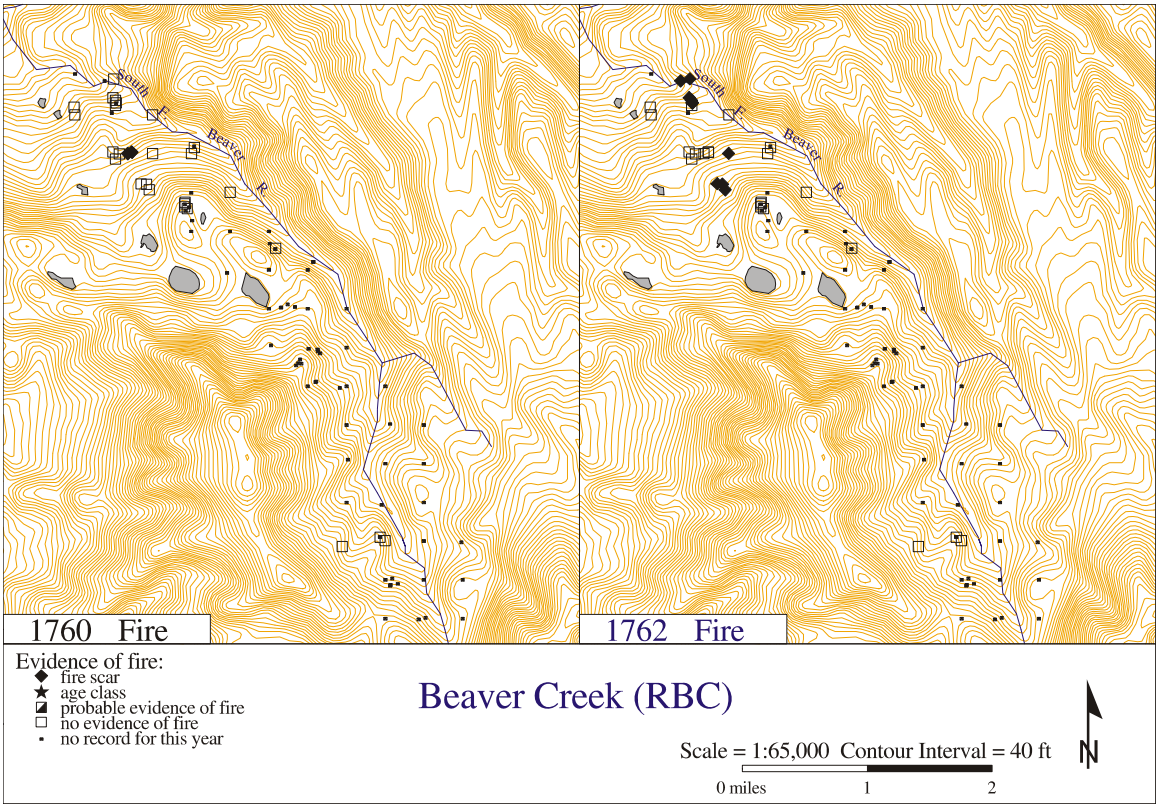

South F.
Beaver R.
1728 Fire
South F.
Beaver R.
1729 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

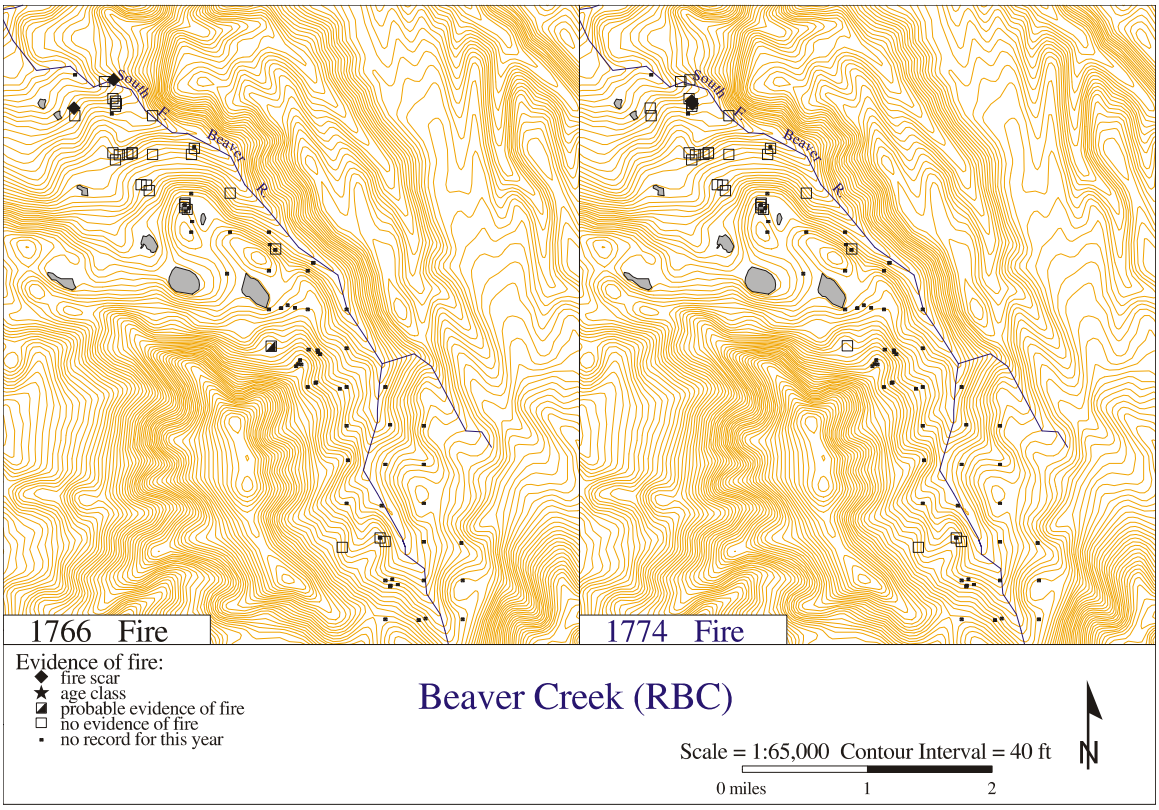

South F.
Beaver R.
1735 Fire
South F.
Beaver R.
1737 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

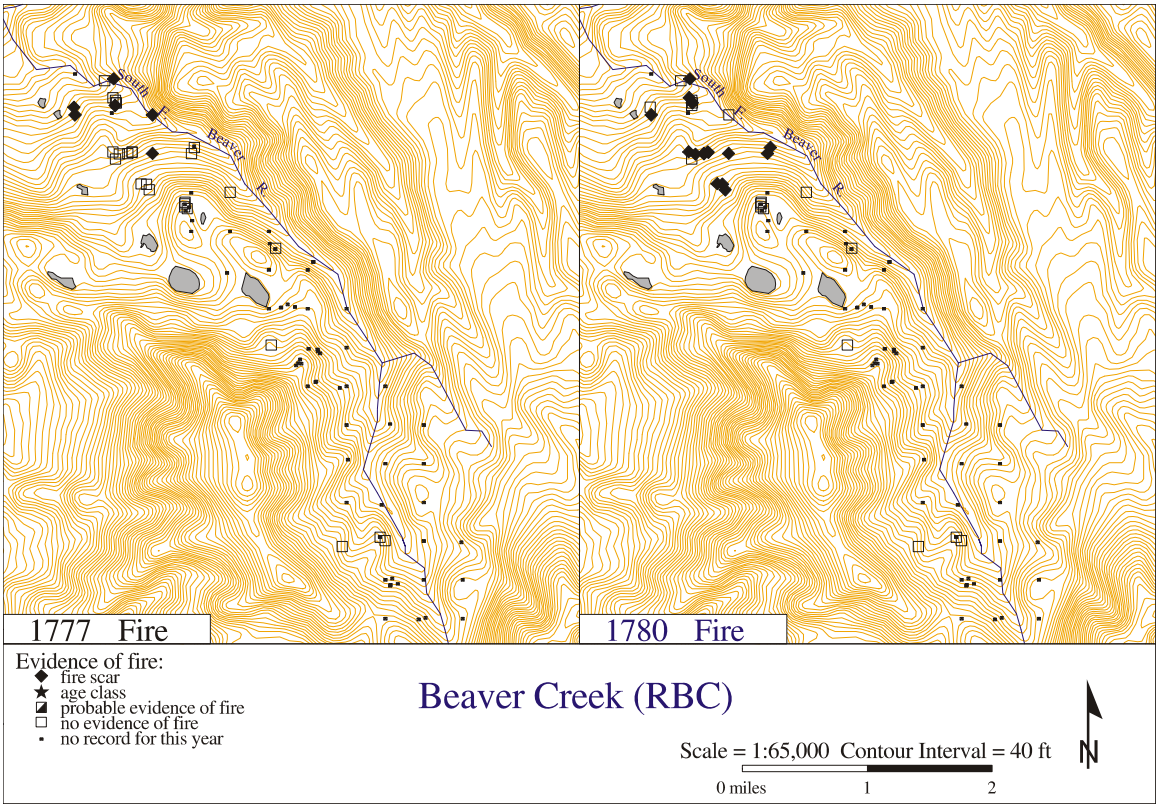

South F.
Beaver R.
1749 Fire
South F.
Beaver R.
1750 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

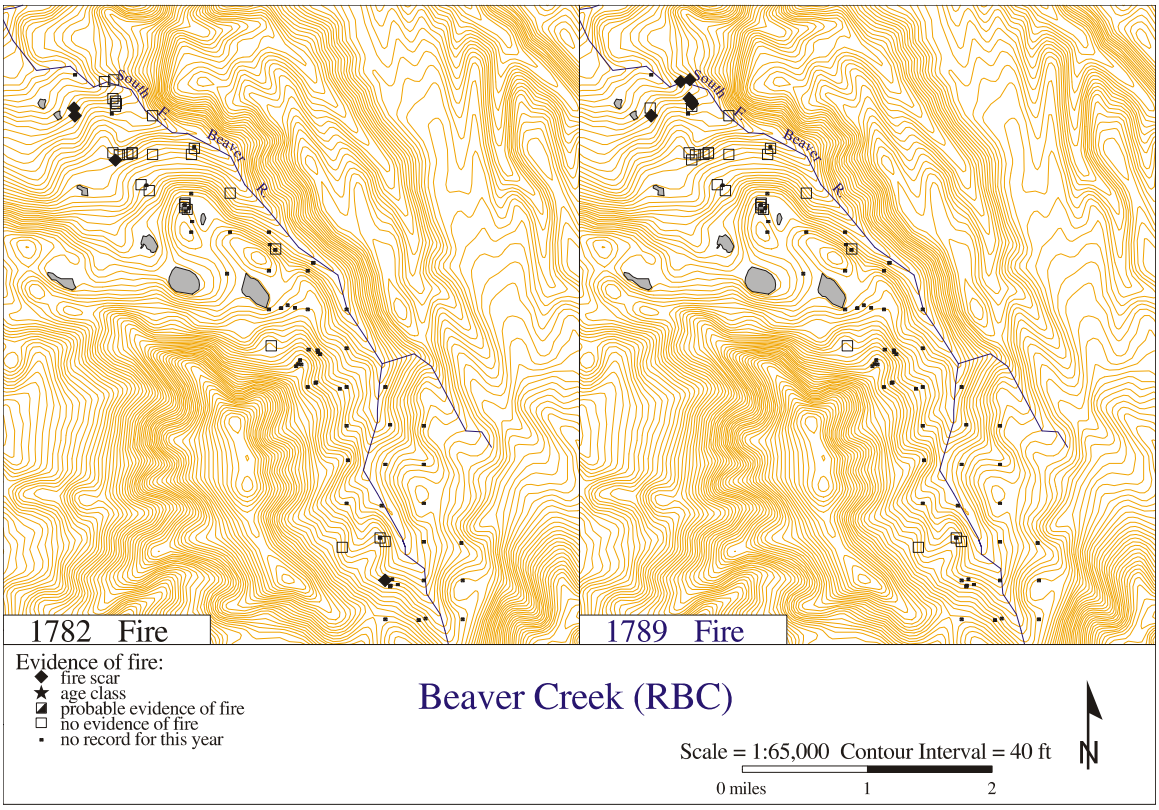

South F.
Beaver R.
1751 Fire
South F.
Beaver R.
1752 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

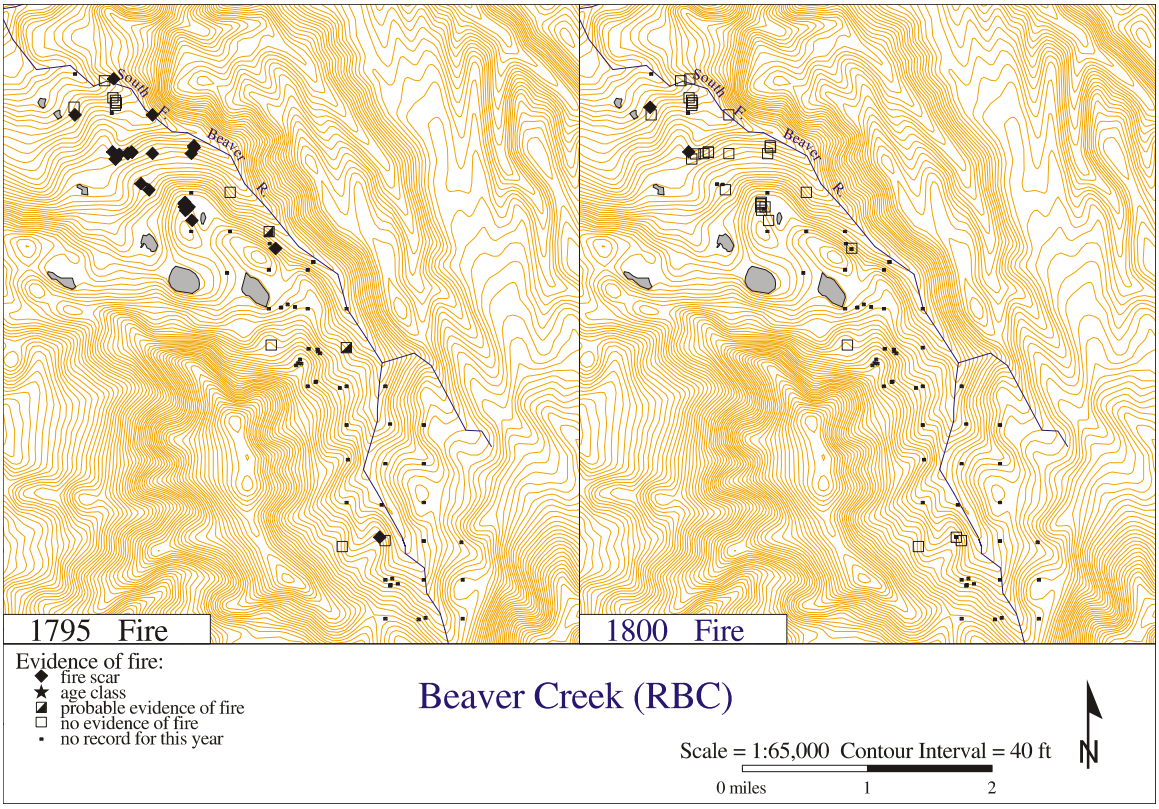

South F.
Beaver R.
1755 Fire
1756 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

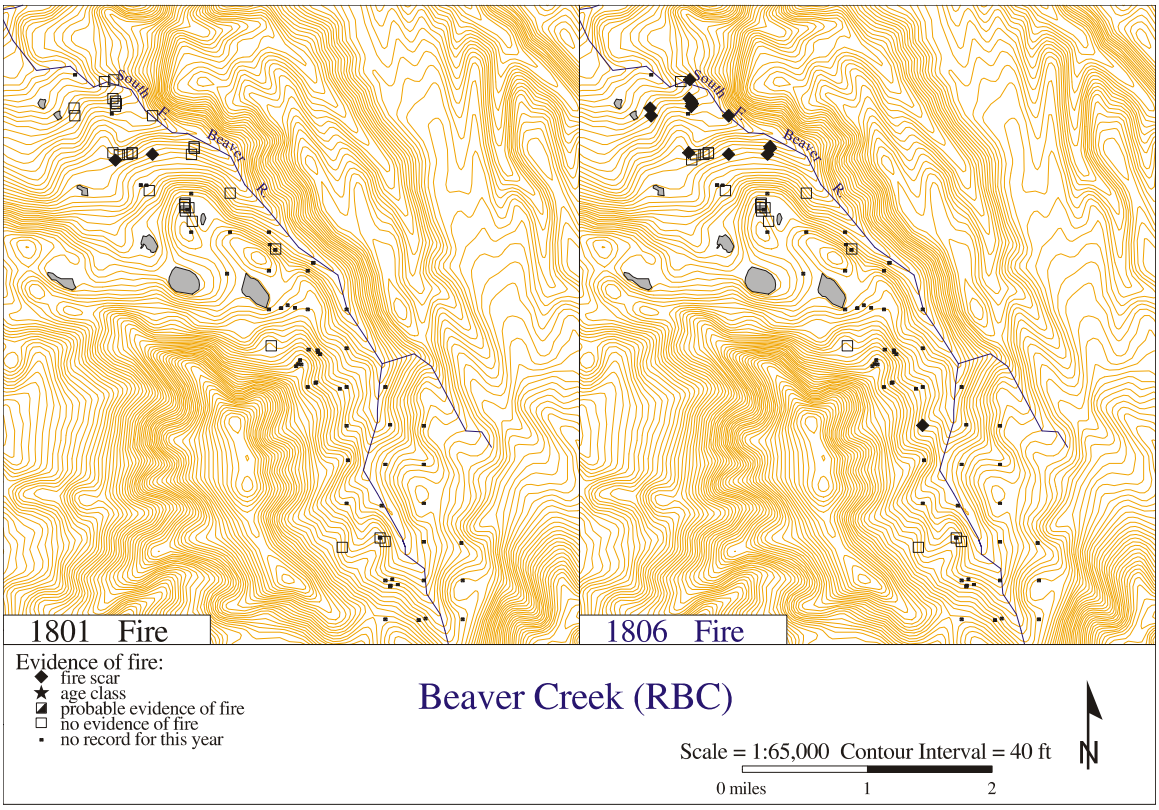

South F.
Beaver R.
1760 Fire
1762 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

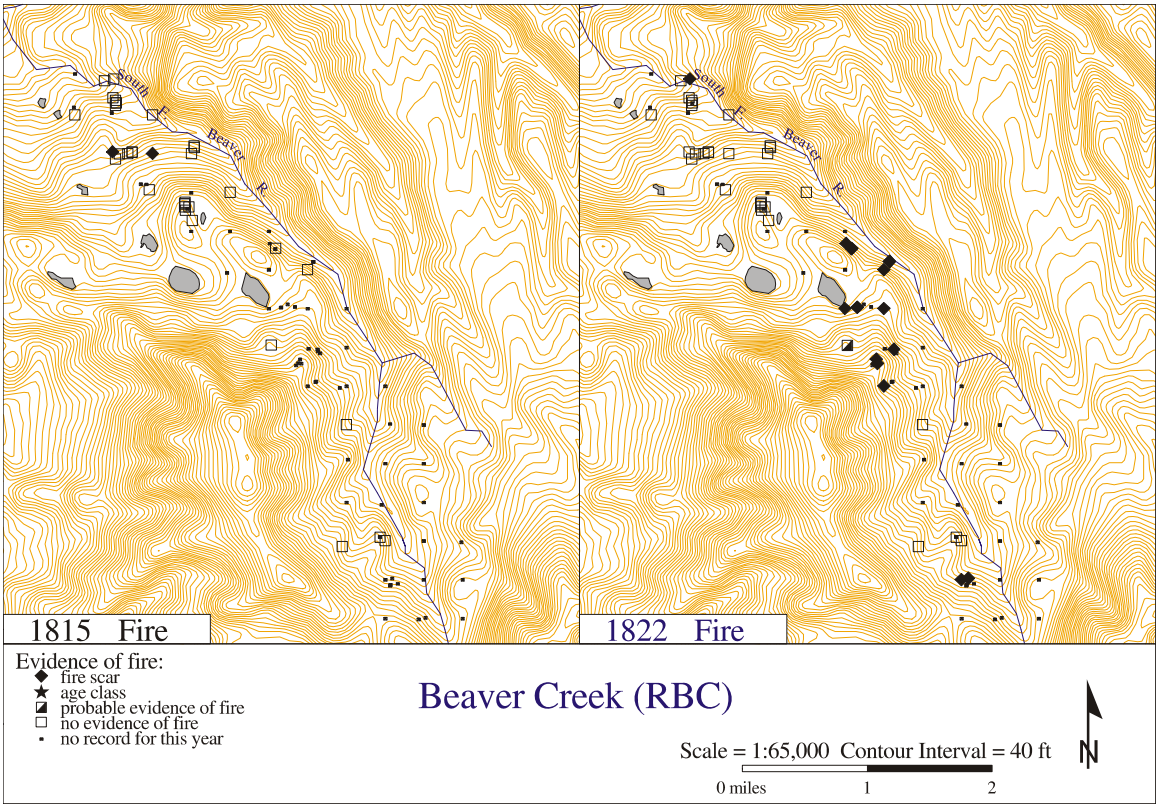

South F.
Beaver R.
1766 Fire
South F.
Beaver R.
1774 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

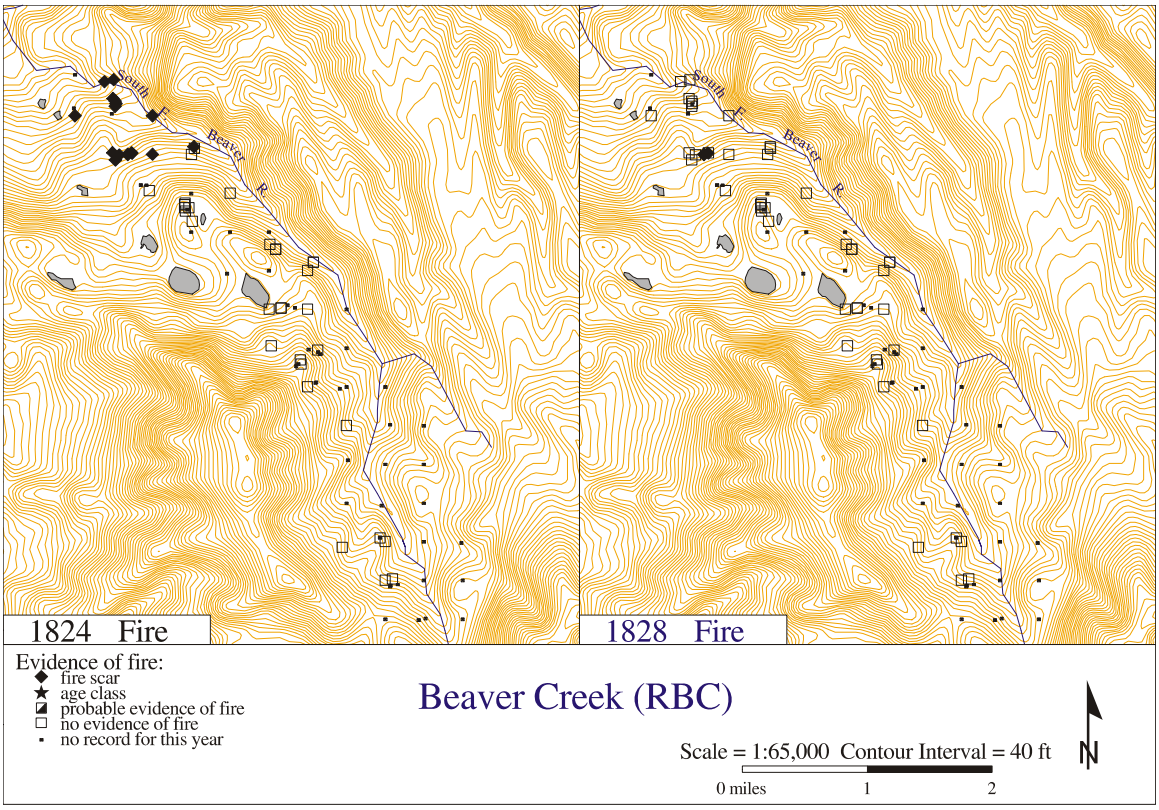

South F.
Beaver R.
1777 Fire
South F.
Beaver R.
1780 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

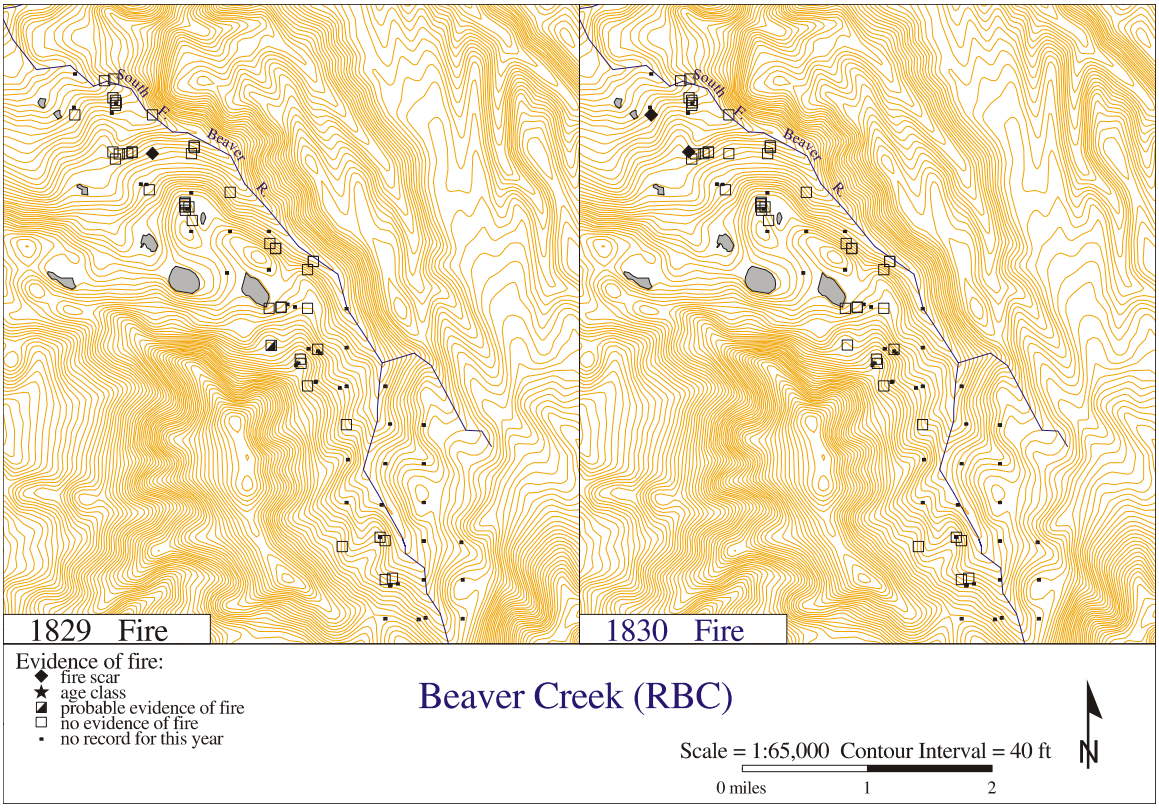

South F.
Beaver R.
1782 Fire
South F.
Beaver R.
1789 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

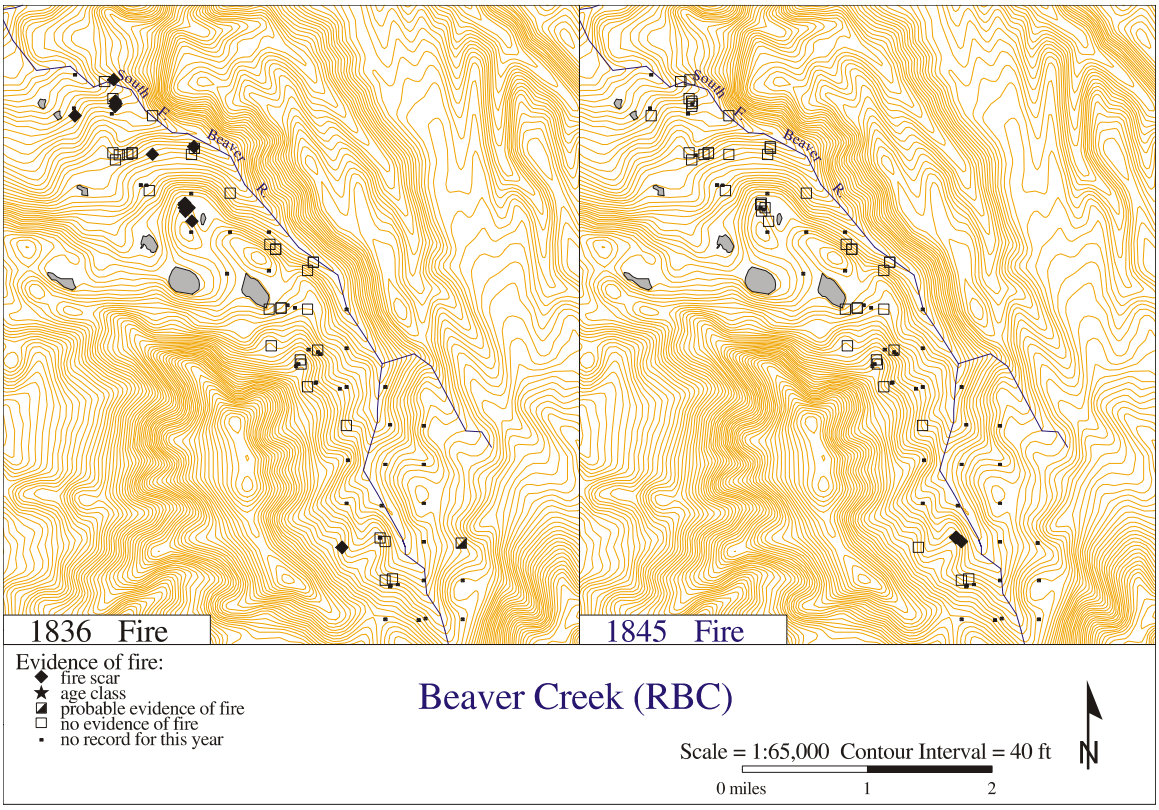

South F.
Beaver R.
1795 Fire
South F.
Beaver R.
1800 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

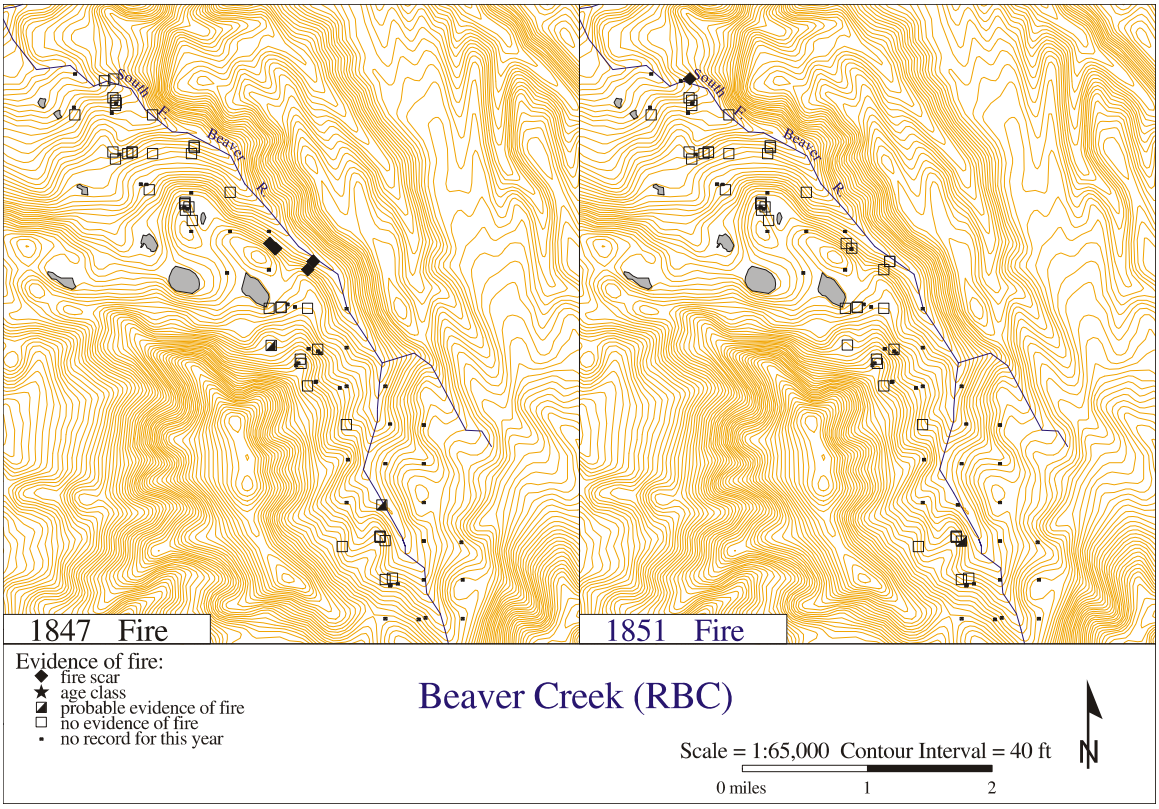

South F.
Beaver R.
1801 Fire
South F.
Beaver R.
1806 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

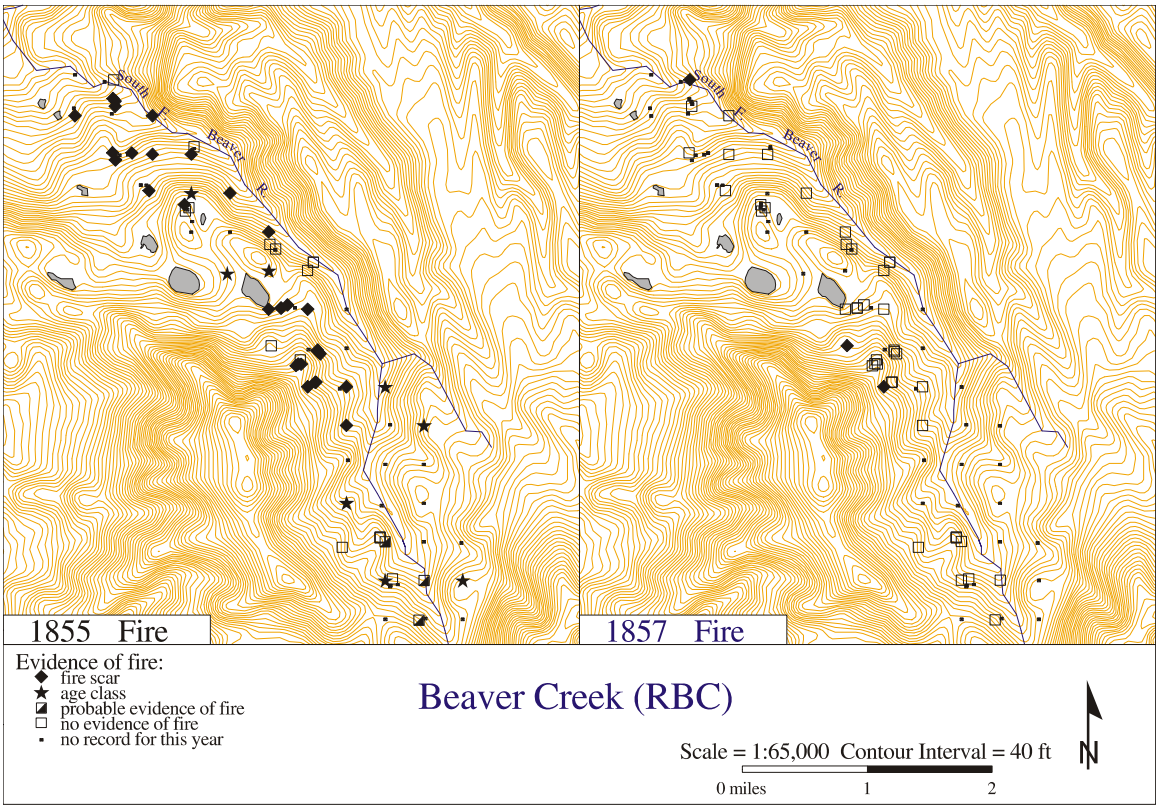

South F.
Beaver R.
1815 Fire
South F.
Beaver R.
1822 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

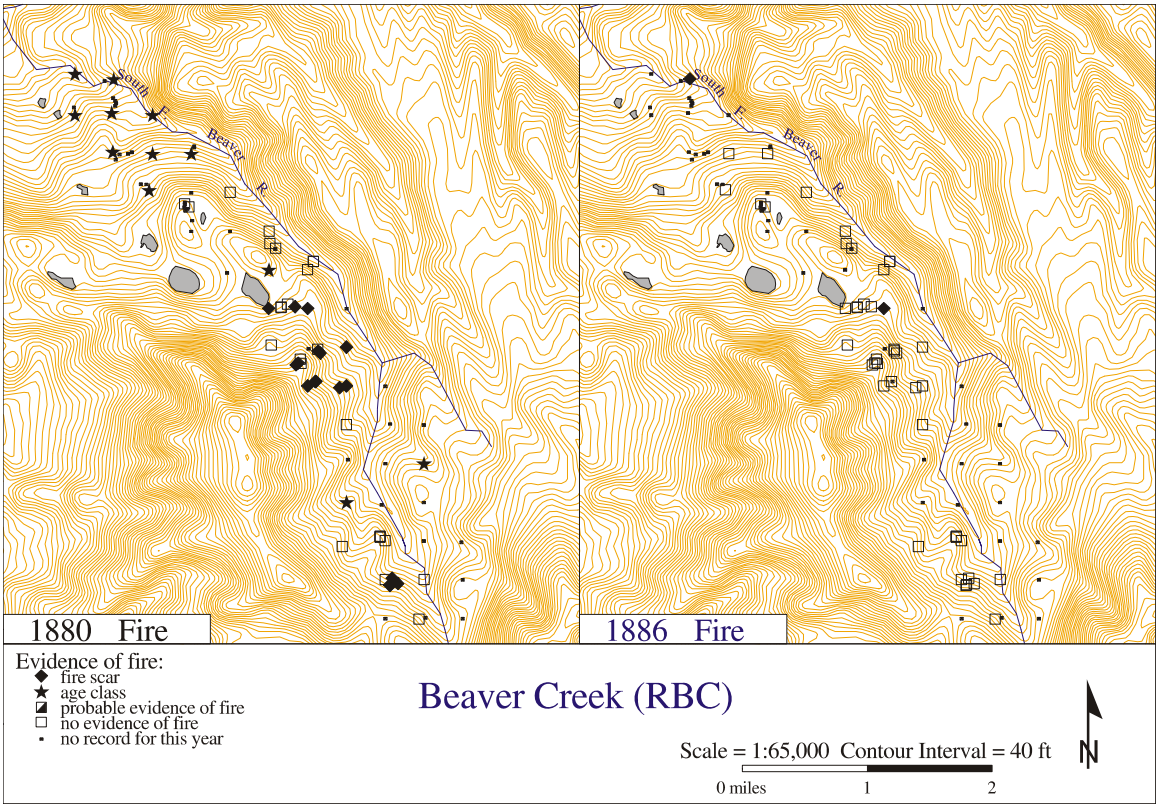

South F.
Beaver R.
1824 Fire
South F.
Beaver R.
1828 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

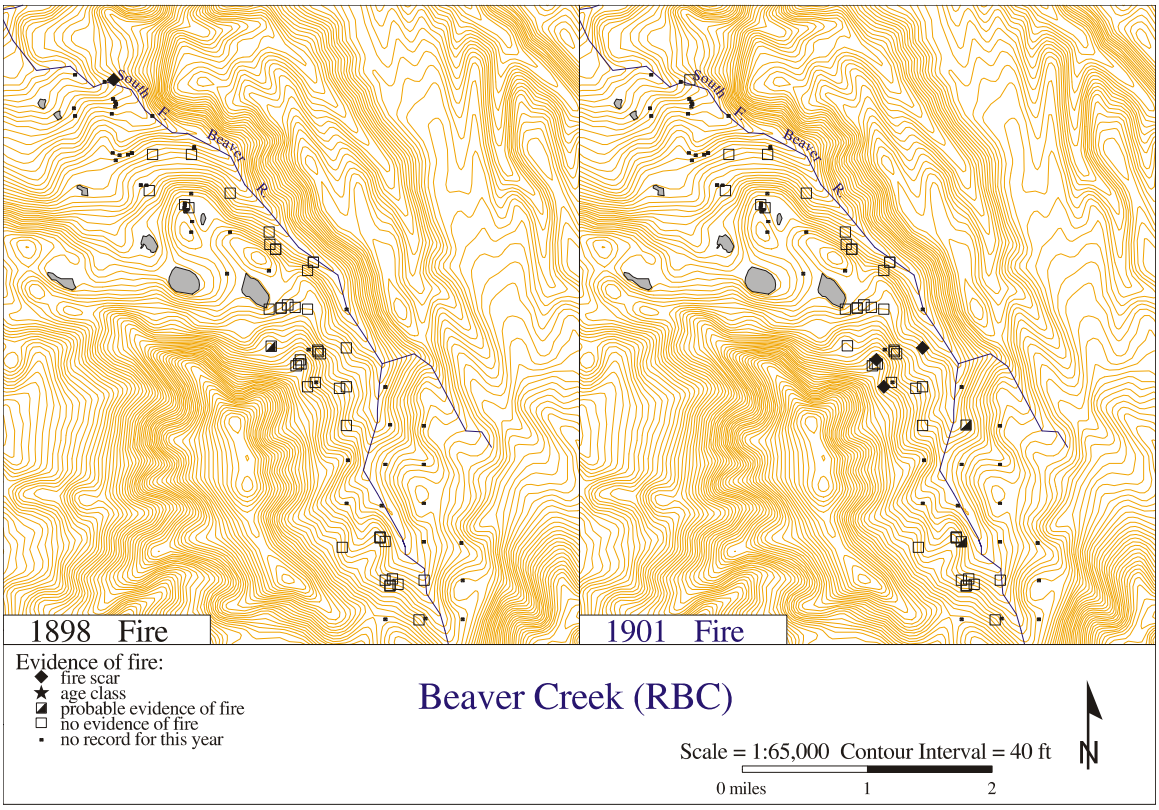

South F.
Beaver R.
1829 Fire
South F.
Beaver R.
1830 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

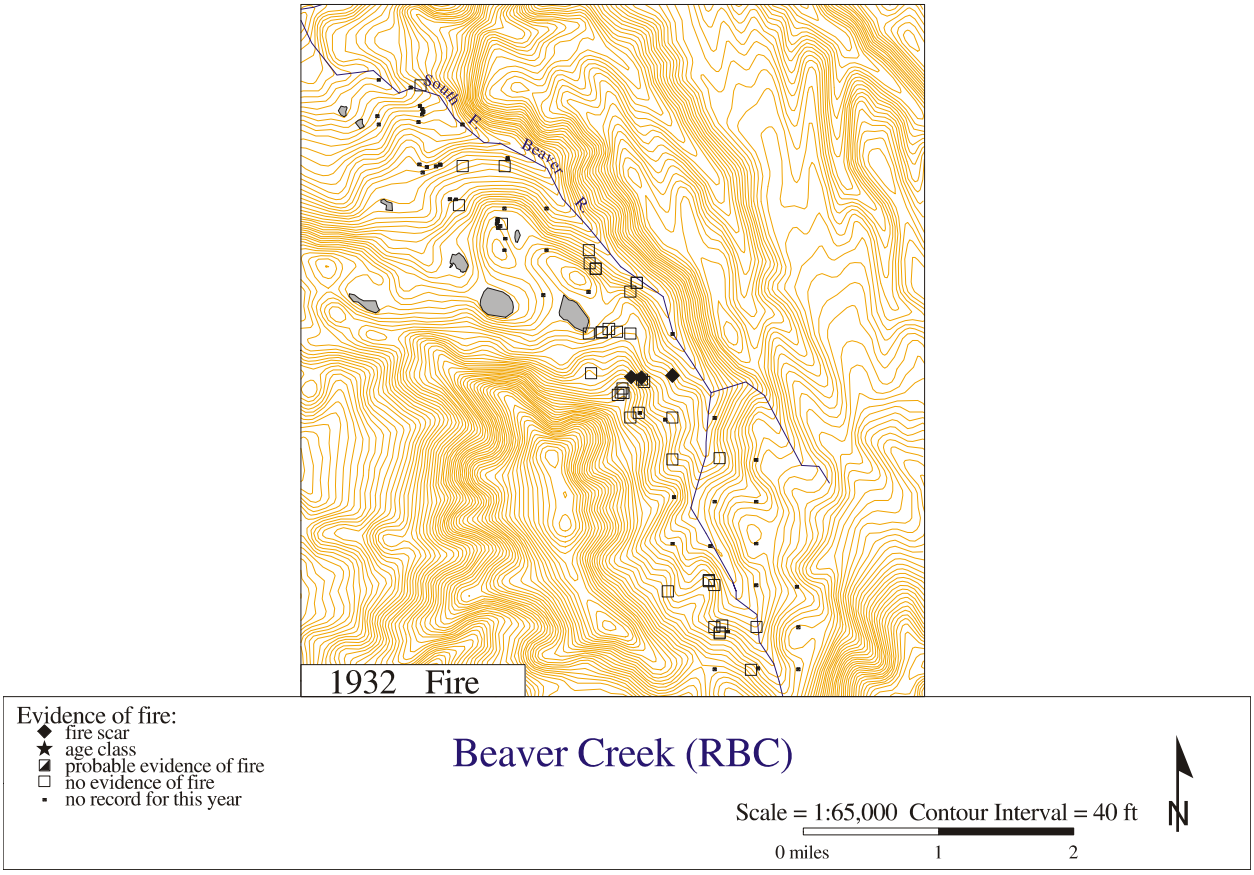

South F.
Beaver R.
1836 Fire
South F.
Beaver R.
1845 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

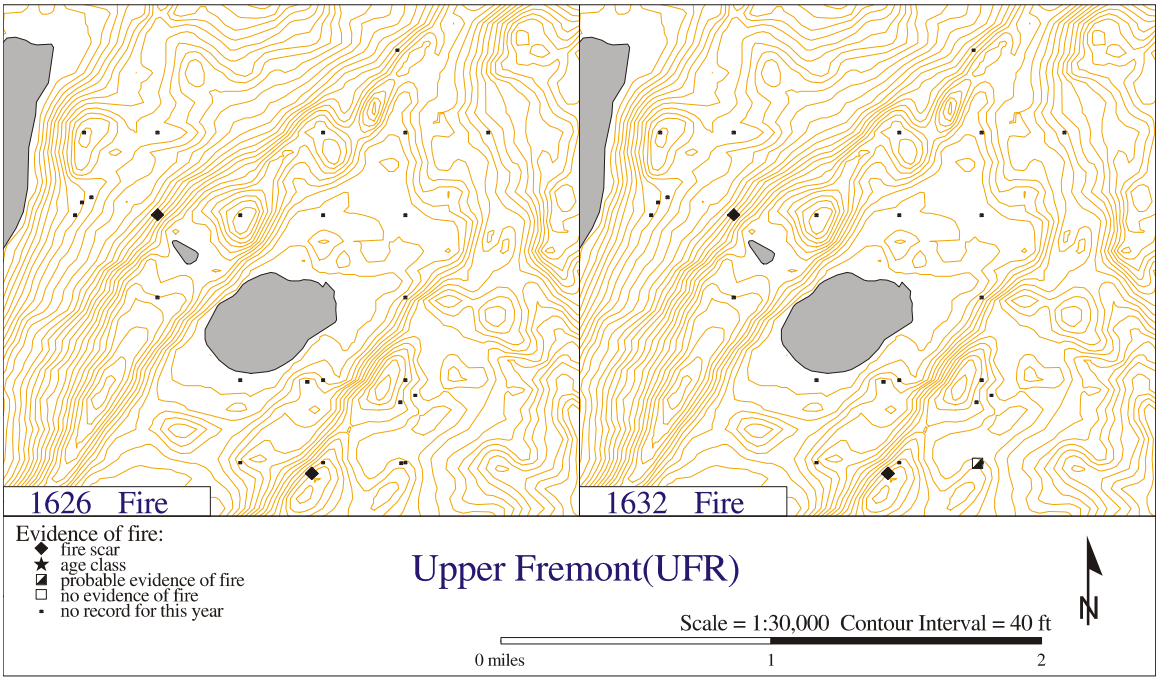

South F.
Beaver R.
1847 Fire
South F.
Beaver R.
1851 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

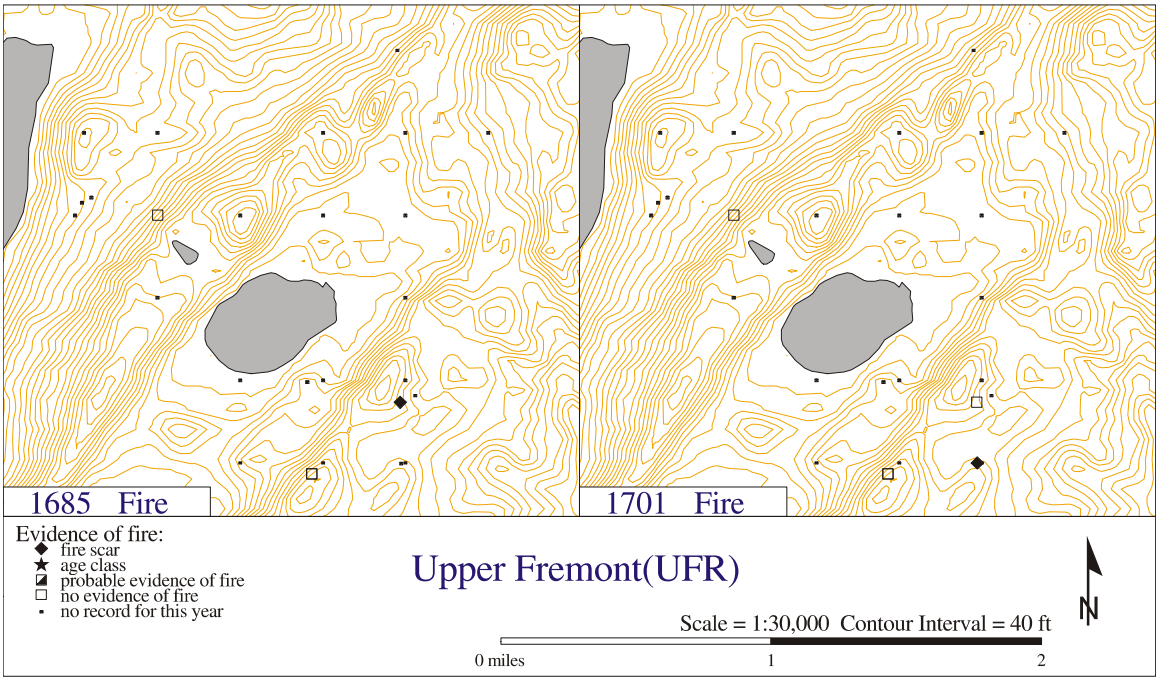

South F.
Beaver R.
1855 Fire
South F.
Beaver R.
1857 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

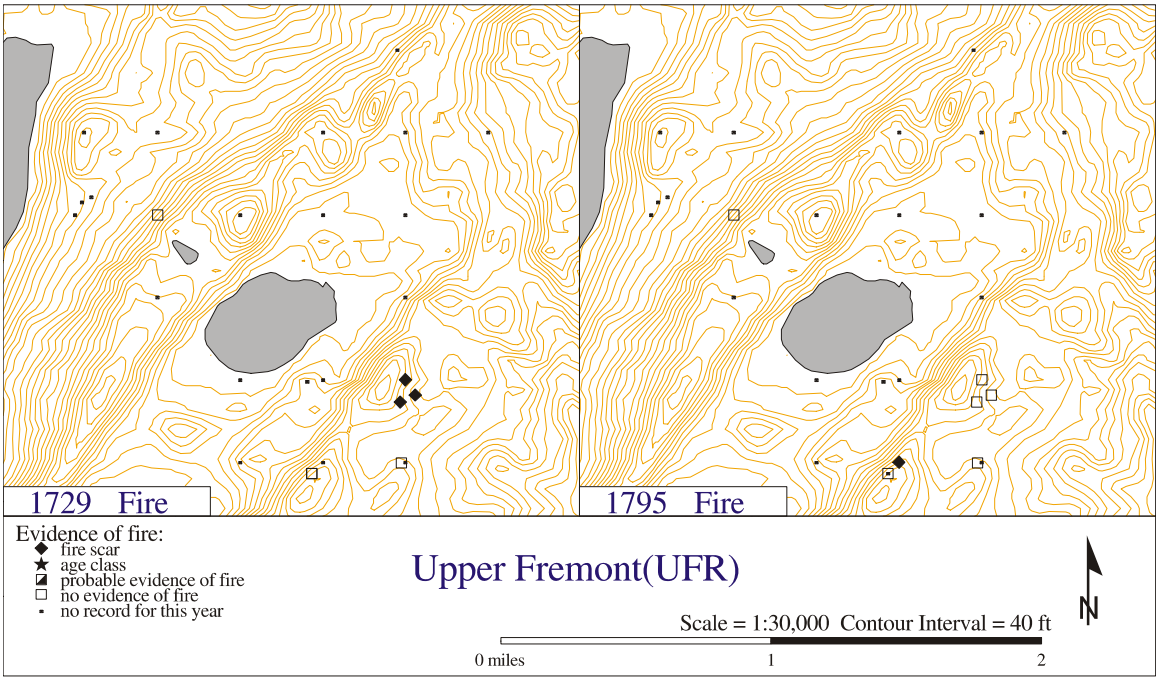

South F.
Beaver R.
1880 Fire
South F.
Beaver R.
1886 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

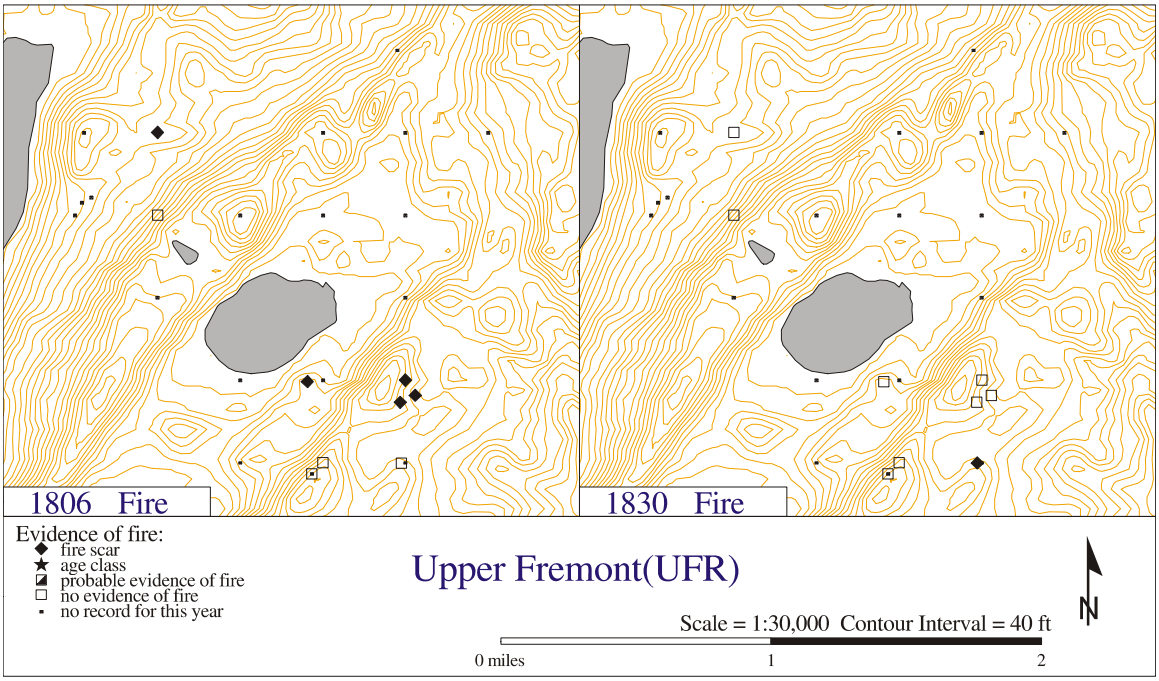

South F.
Beaver R.
1898 Fire
South F.
Beaver R.
1901 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

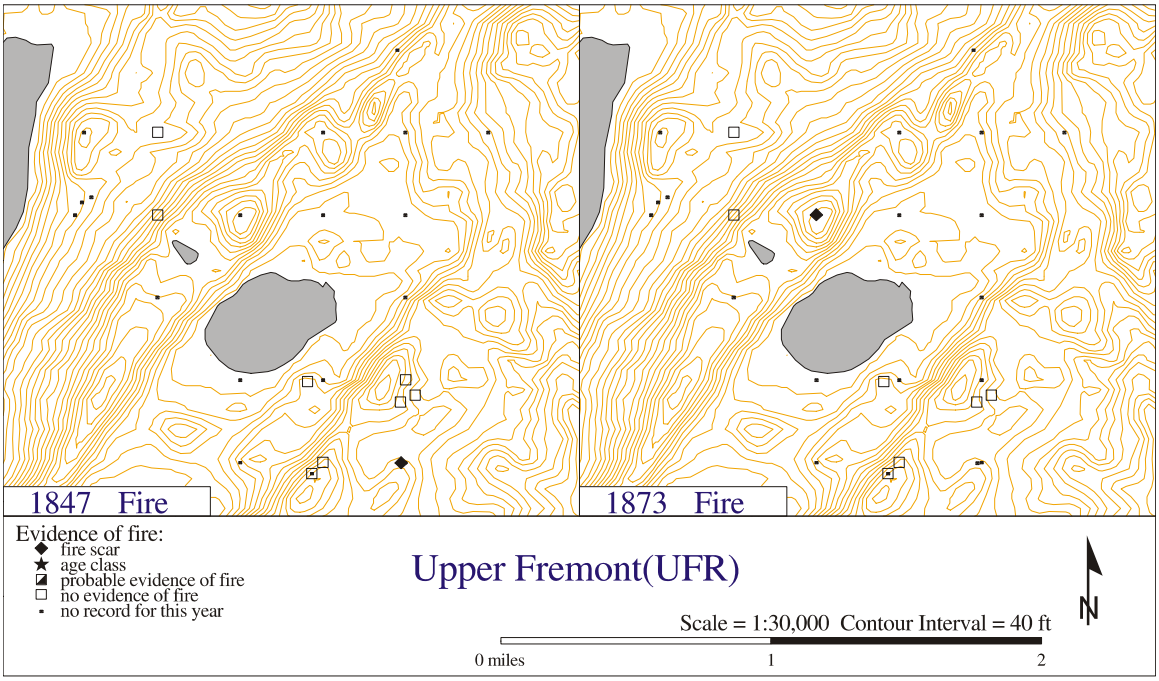

South F.
Beaver R.
1932 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Beaver Creek (RBC)
Scale = 1:65,000 Contour Interval = 40 ft
0 miles
1
2
N

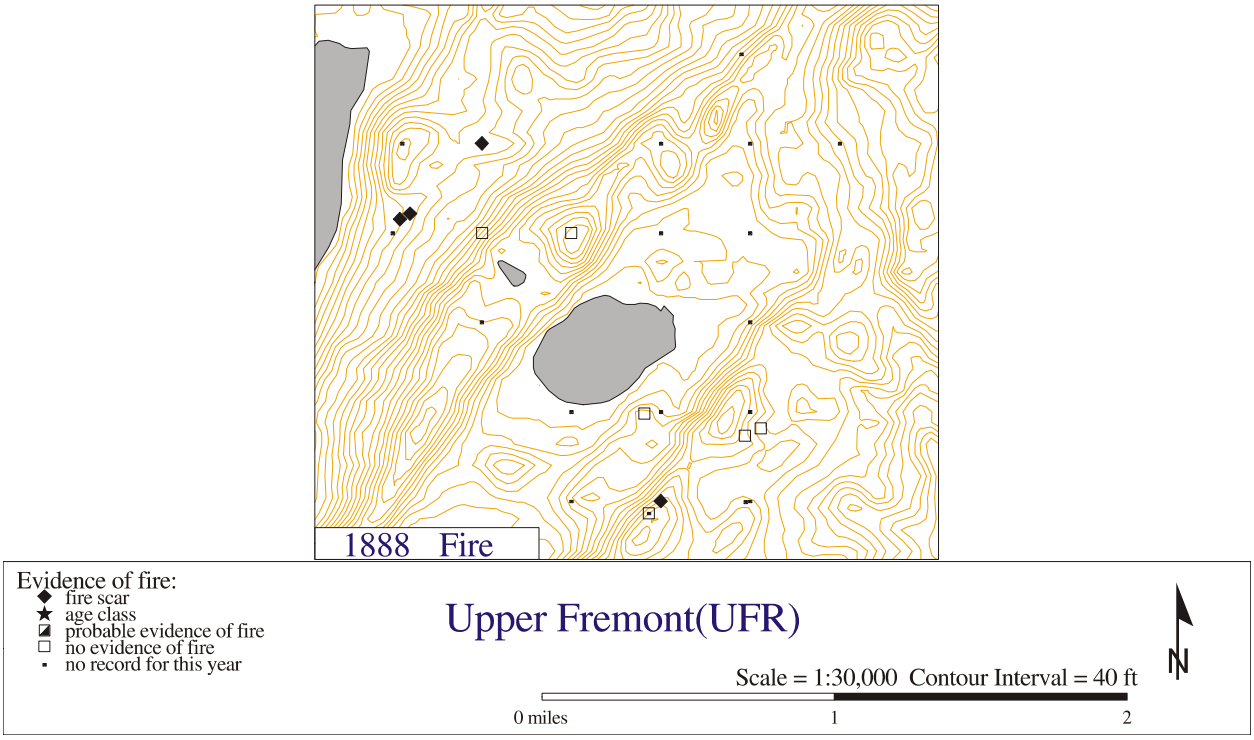

1626 Fire
1632 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Upper Fremont(UFR)
Scale = 1:30,000 Contour Interval = 40 ft
0 miles
1
2
N

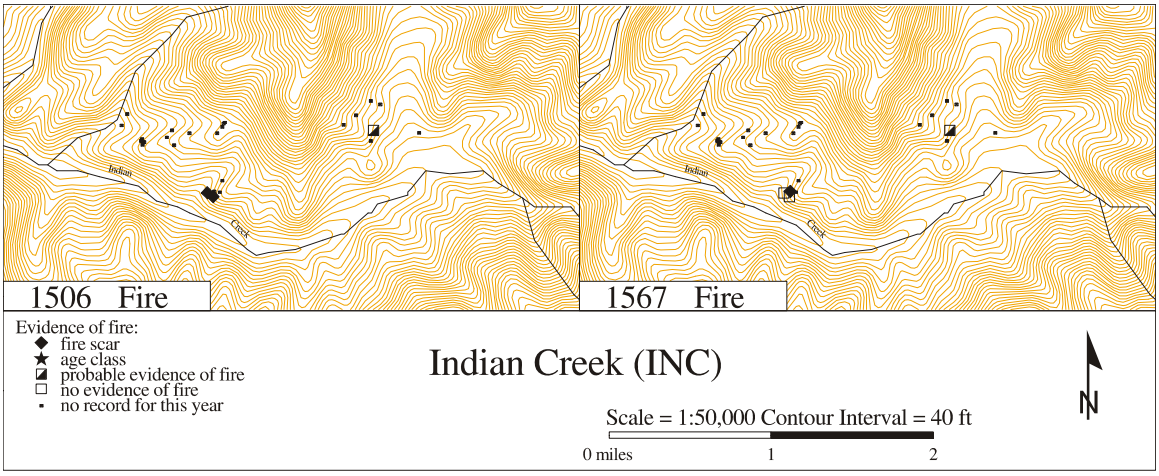

1685 Fire
1701 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Upper Fremont(UFR)
Scale = 1:30,000 Contour Interval = 40 ft
0 miles
1
2
N

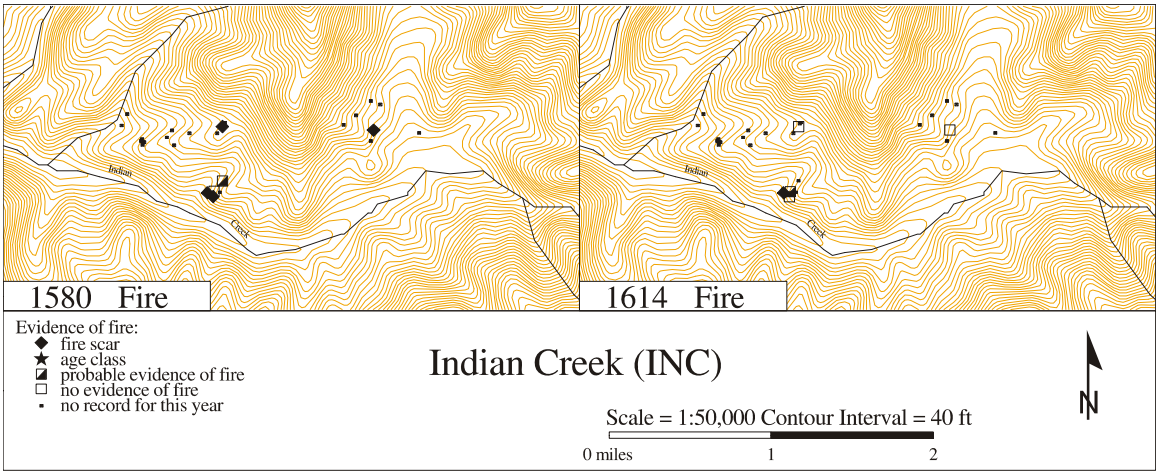

1729 Fire
1795 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Upper Fremont(UFR)
Scale = 1:30,000 Contour Interval = 40 ft
0 miles
1
2
N

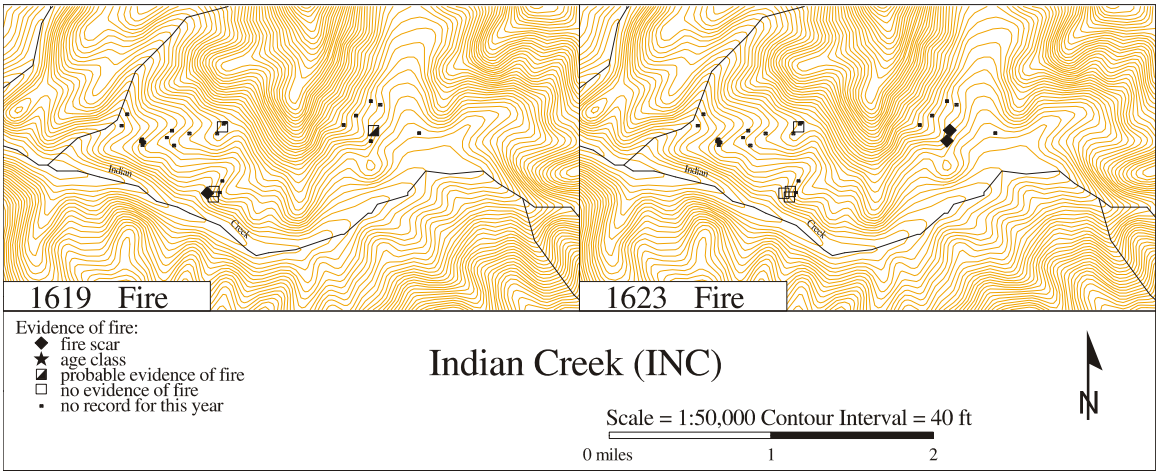

1806 Fire
1830 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Upper Fremont(UFR)
Scale = 1:30,000 Contour Interval = 40 ft
0 miles
1
2
N

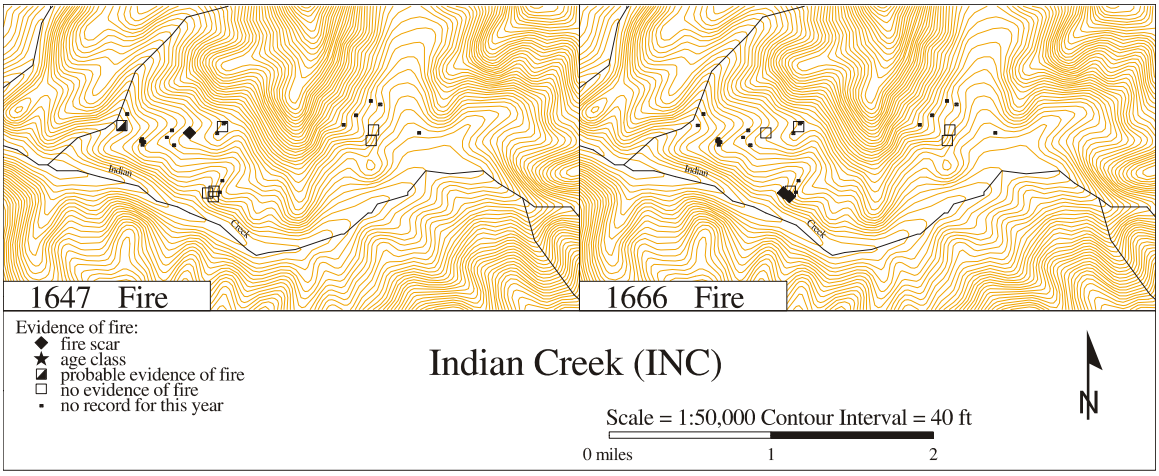

1847 Fire
1873 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Upper Fremont(UFR)
Scale = 1:30,000 Contour Interval = 40 ft
0 miles
1
2
N

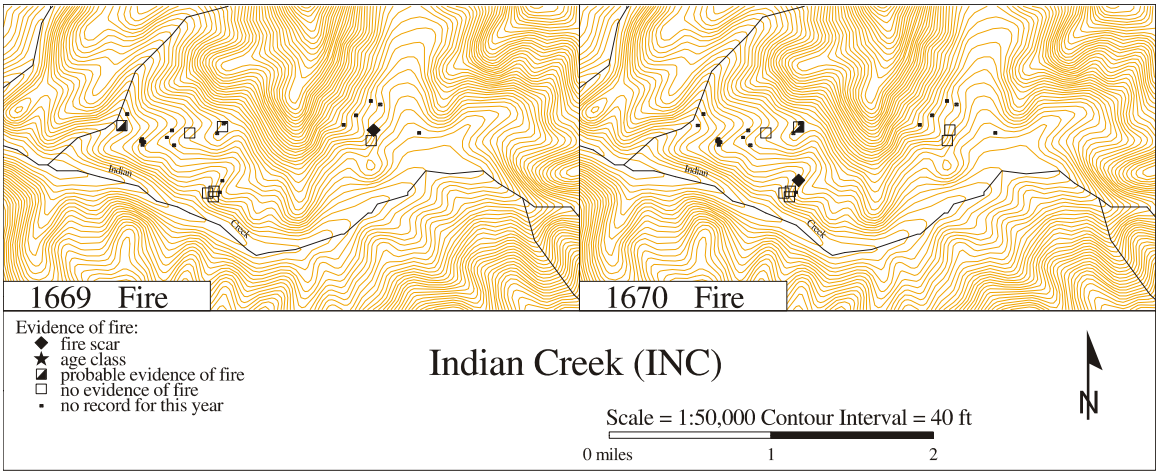

1888 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Upper Fremont(UFR)
Scale = 1:30,000 Contour Interval = 40 ft
0 miles
1
2
N

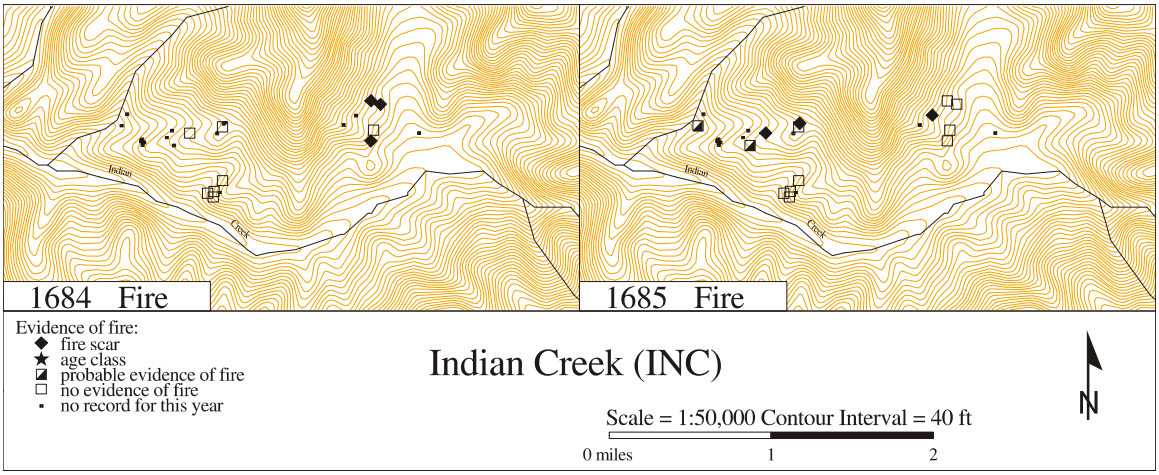

Indian
Creek
1506 Fire
1567 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N

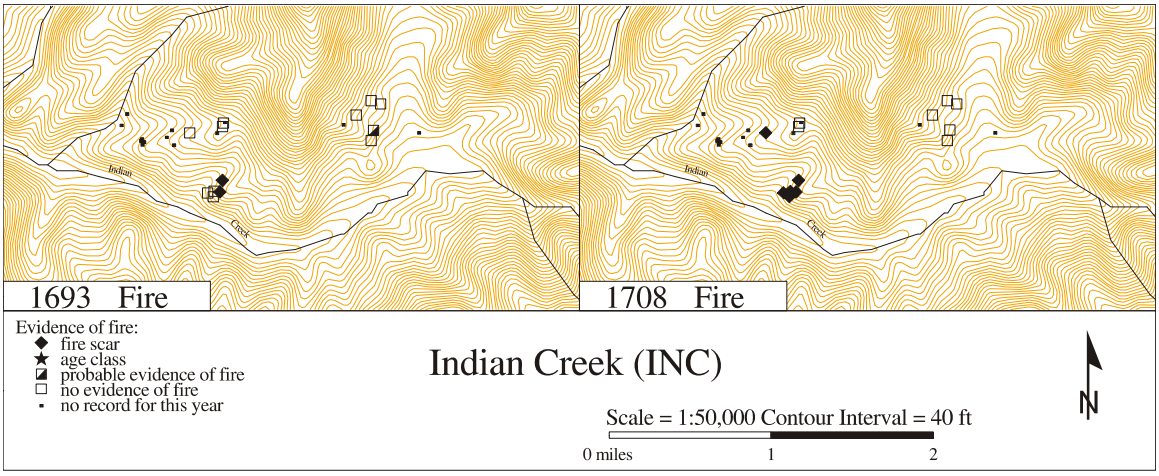

Indian
Creek
1580 Fire
1614 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N

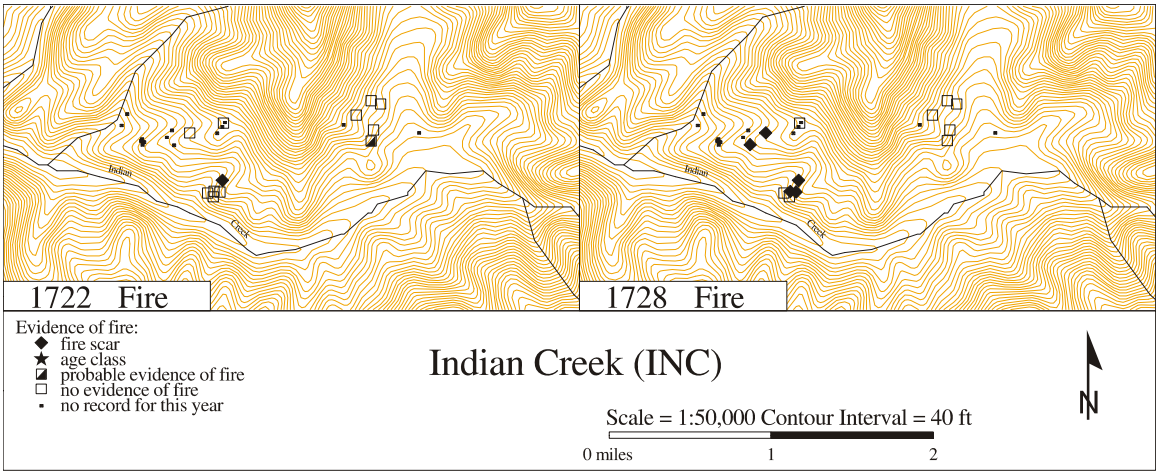

Indian
Creek
1619 Fire
1623 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N

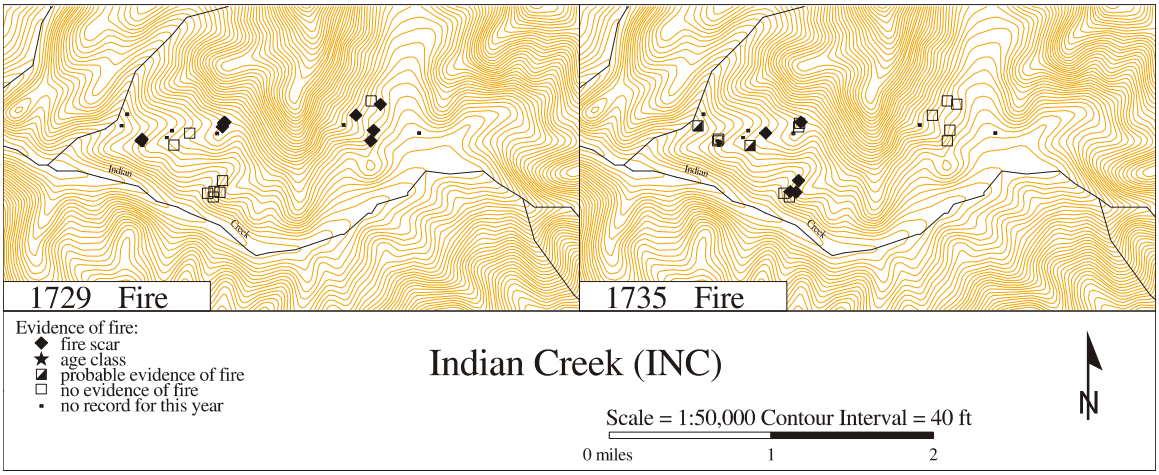

1647 Fire
1666 Fire
Indian
Creek
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N

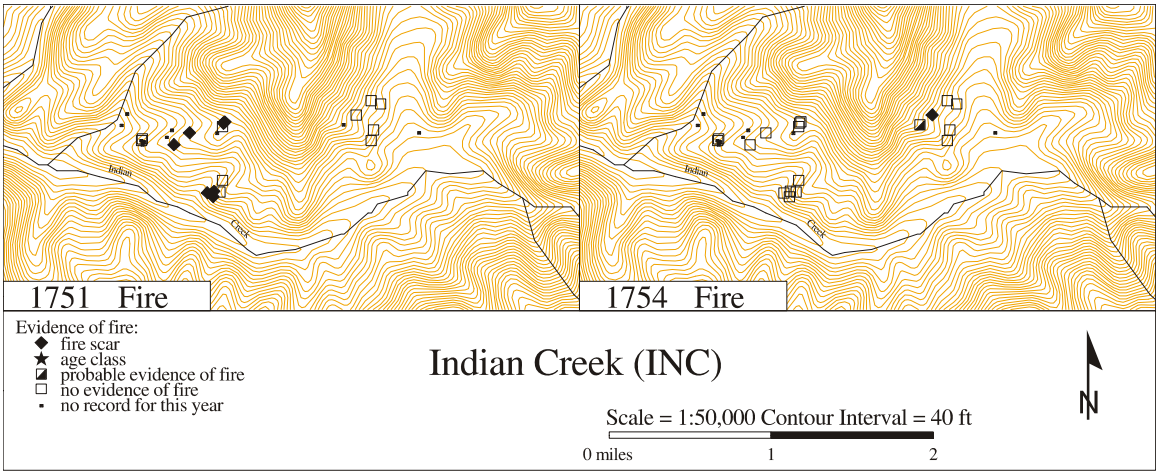

1669 Fire
1670 Fire
Indian
Creek
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N

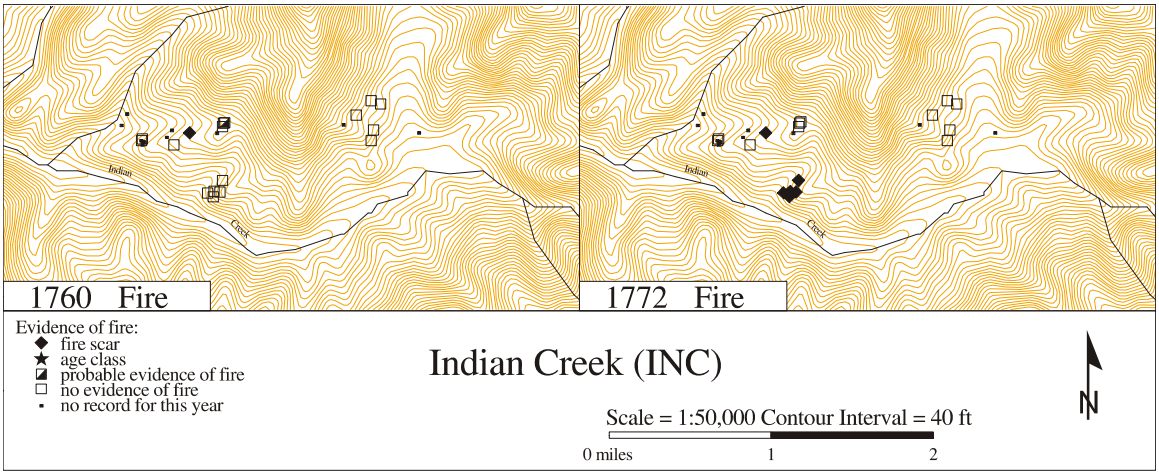

1684 Fire
1685 Fire
Indian
Creek
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N

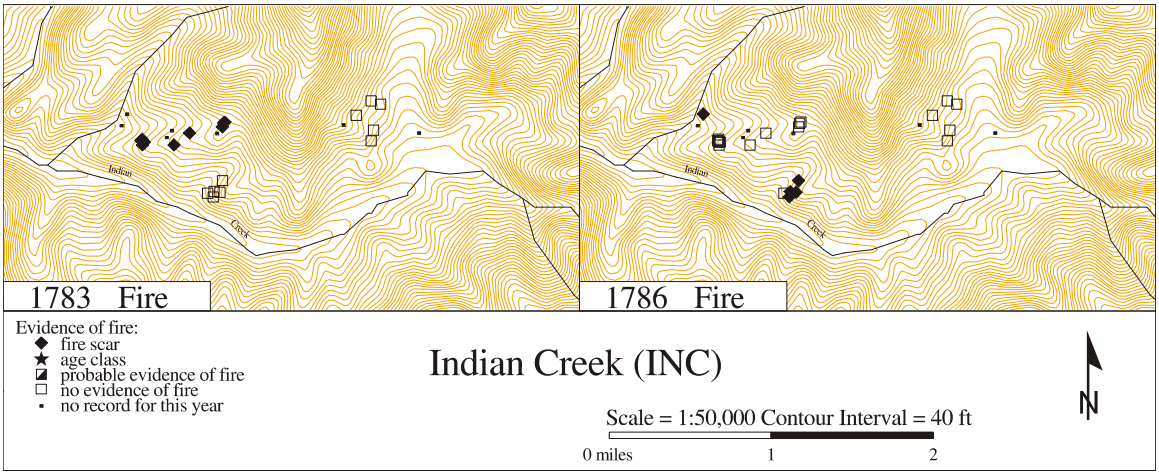

1693 Fire
1708 Fire
Indian
Creek
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N

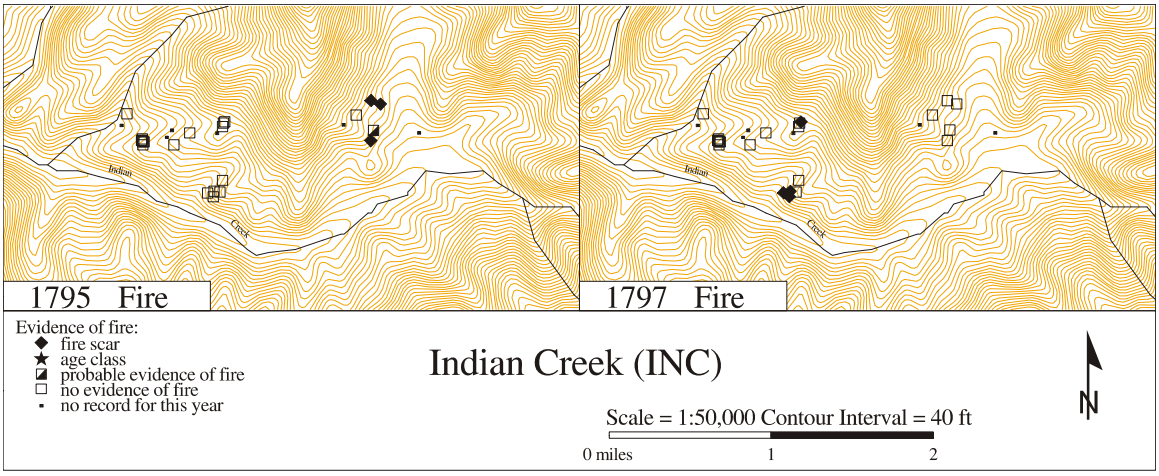

1722 Fire
1728 Fire
Indian
Creek
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N

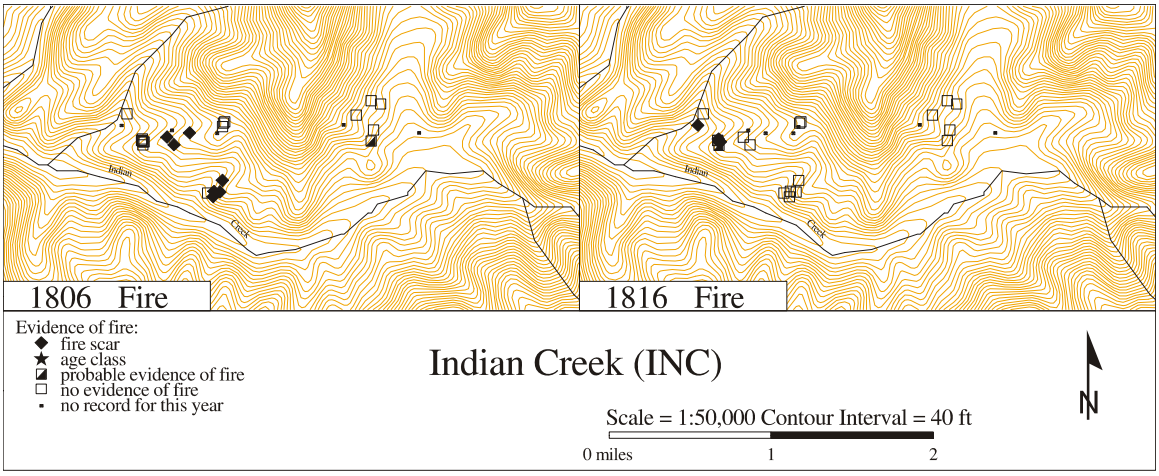

1729 Fire
1735 Fire
Indian
Creek
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N

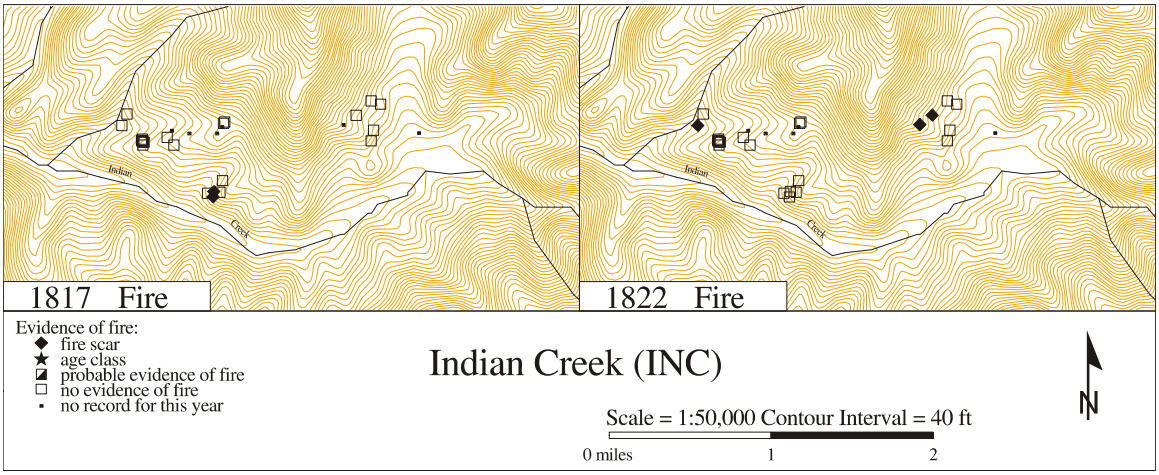

Indian
Creek
1751 Fire
1754 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N

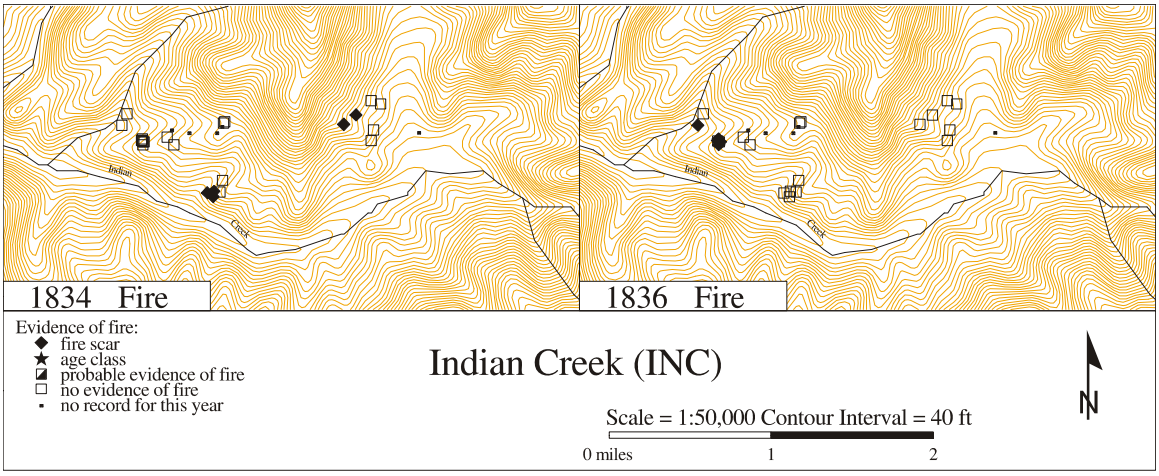

Indian
Creek
1760 Fire
1772 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N

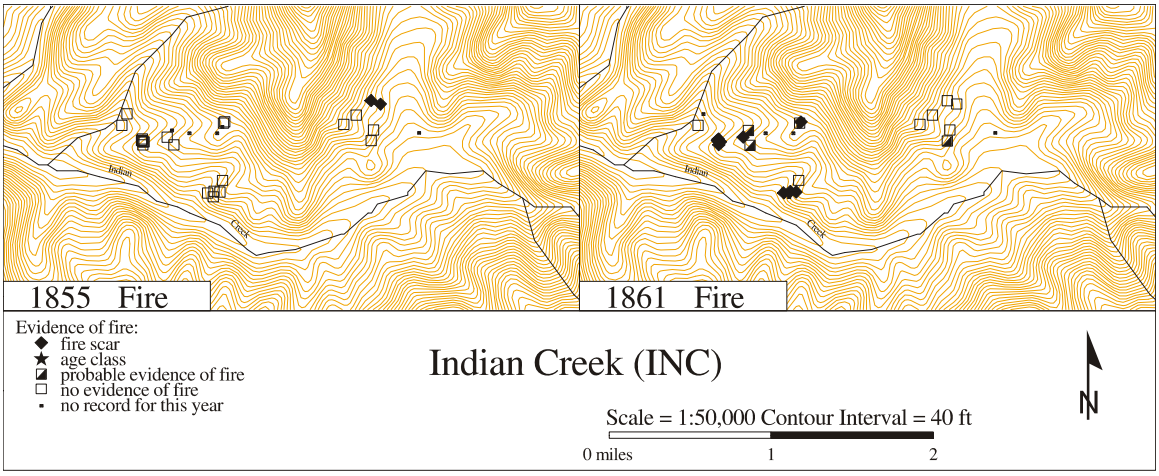

Indian
Creek
1783 Fire
1786 Fire
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N

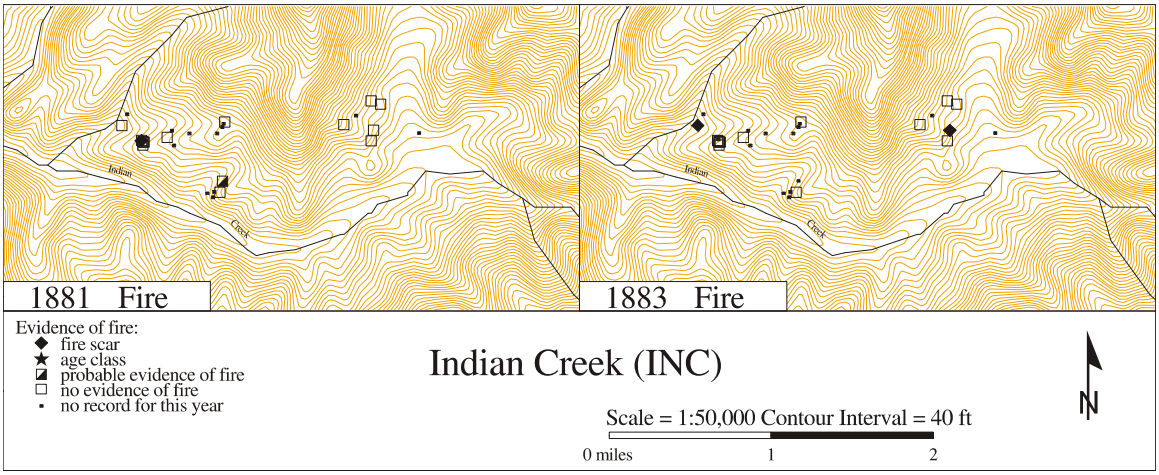

1795 Fire
1797 Fire
Indian
Creek
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N

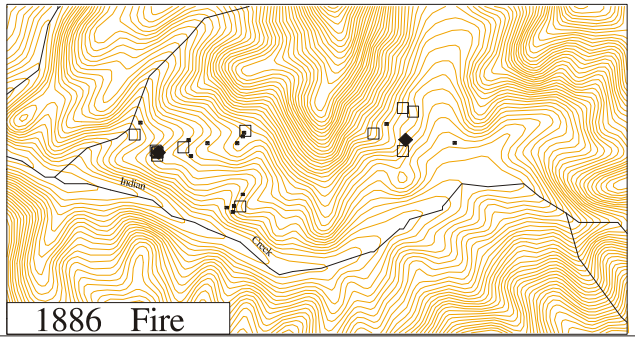

1806 Fire
1816 Fire
Indian
Creek
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N


1817 Fire
1822 Fire
Indian
Creek
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N


1834 Fire
1836 Fire
Indian
Creek
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N


1855 Fire
1861 Fire
Indian
Creek
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N


1881 Fire
1883 Fire
Indian
Creek
Evidence of fire:
fire scar
age class
probable evidence of fire
no evidence of fire
no record for this year
Indian Creek (INC)
Scale = 1:50,000 Contour Interval = 40 ft
0 miles
1
2
N



Evidence of fire:
- ◆ fire scar
- ★ age class
- ◪ probable evidence of fire
- □ no evidence of fire
- ▪ no record for this year

Indian Creek (INC)

Scale = 1:50,000 Contour Interval = 40 ft

0 miles 1 2

N