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Culturally Scarred Trees in the Bob Marshall Wilderness, Montana, USA – Interpreting Native American Historical Forest Use in a Wilderness Area

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ABSTRACT: Wilderness areas are primarily set aside to protect natural ecosystems and processes. However, most protected areas have a long history of native peoples' land use predating their protection. The general paucity of evidence in the form of historical records, in combination with romantic views of native peoples' effects on nature, often leads to their impact being underestimated. The analysis of culturally modified trees in protected old-growth forests has increasingly been recognised as an important tool for analyzing long-term trends in native peoples' land use. The aim of this study was to gather evidence of native peoples' use of the ponderosa pine forest in the South Fork Valley of the Bob Marshall Wilderness area, Montana, USA, by analyzing trees with bark-peeling scars (the result of past inner bark collection) and then using written historical and ethnographic records (as far as possible) to corroborate the information obtained. The method used (peeling) to collect the inner bark did not kill the trees, thus leaving live trees with characteristic scars, which can be dated by using dendrochronology. We studied 138 bark-peeling scars on trees at four sites within this wilderness area, and the results show that Native American tribes visited the area regularly in the spring to collect ponderosa pine inner bark at specific sites. The majority of the scars were from the 1800s, the oldest scar was from 1665 and the youngest from 1938. Between 20% and 25% of the old ponderosa pines at the studied sites had such scars. These results indicate that analysis of culturally modified trees can provide a detailed temporal and spatial record of the presence of native peoples in a remote wilderness area and can be used to analyze important aspects of historic human land use.

Index terms: bark peeling, bark-peeled trees, culturally modified trees, forest history, ponderosa pine

INTRODUCTION

Wilderness areas, national parks, and other nature reserves are primarily designated to protect features and processes of natural ecosystems. The areas selected were usually less affected by contemporary forms of human disturbance (e.g., logging, hydroelectric dams, and roads) than most other areas; and the original reason that such locations were included was the desire to protect "pristine" environments, to maintain natural biodiversity, and to provide scope for outdoor recreational activities. A common denominator for most protected areas, even those considered "pristine," is that they had a long history of human use prior to being protected (Östlund et al. 2003, Robertson and Hull 2003). Historical and pre-historical use by native peoples was very different from modern land use, but it still shaped the ecosystems to some extent.

Since humans have played an active and integral role in most ecosystems, historical knowledge of the ways native peoples have used and changed ecosystems is of considerable interest for future management and restoration of nature reserves (cf. Östlund et al. 2002, Robertson and Hull 2003). The effects of land use by native peoples on ecosystems are usually difficult to discern since there is little historical documentation. Evidence provided by ethnological

records and paleoecological methods, such as pollen analysis and dendrochronology, may help interpret the role of native peoples on ecosystem dynamics (Whitney 1994, Kaye and Swetnam 1999, Zackrisson et al. 2000). Another biological archive (one that has been exploited to a limited extent by researchers to date) is the stock of old trees carrying an anthropological legacy, so called "culturally modified trees" (Mobley and Eldridge 1992). In northern, forested ecosystems, human-made marks on living trees have increasingly been acknowledged as important tools for interpreting native peoples' land use (Swetnam 1984, Mobley and Eldridge 1992, Alldredge 1995, Merrell 1998, Kaye and Swetnam 1999, Zackrisson et al. 2000, Östlund et al. 2002, Östlund et al. 2004). Unique temporal and spatial information relating to the movements of native peoples and their utilization of land in the past can be acquired from this archive. Throughout the northwestern parts of the United States and Canada, specific recording programs for culturally modified trees have been developed, such as the one described in the CMT handbook (Eldridge 1997, Stryd 1997).

The inner bark, sap layer, cambium, or more accurately the "cambial zone (Ford-Robertson 1983), in various pine (*Pinus*) species comprised an important food and nutrient source for many native peoples (Kunkel 1984). In North America, the in-

ner bark of several pine species was used in a wide range of ecosystems by native tribes (Thwaites 1905, White 1954, Martorano 1981, Ferris 1983, Swetnam 1984, Barrett 1985, Mobley and Eldridge 1992, Alldredge 1995, Merrell 1998, Kaye and Swetnam 1999). It was usually collected when the sugary sap was running in spring. Bark sheets were cut from trees using specific tools made from wooden sticks flattened at one end or from rib bones of elk. Then the inner and outer bark was separated using scrapers made from sheep horns or metal. The bark could be eaten fresh or rolled into balls, which could be stored for prolonged periods (Ahlberg 2001). One of the most commonly used species was ponderosa pine (*Pinus ponderosa*), which is found in drier habitats throughout much of western North America from Mexico to southern Canada. Features that seem to have been shared by native peoples across the northern hemisphere who used pine inner bark as food were that they lived in sharply seasonal environments and primarily depended on animal protein in their diet (Speth and Spielmann 1983, Östlund et al. 2004). Pine inner bark could provide important carbohydrates during critical periods of the year, important food fibers that moderated the potentially adverse effects of a protein-rich diet, and vitamin C (Ahlberg 2001, Östlund et al. 2004). The inner bark was peeled in patches by native peoples without girdling or otherwise killing the tree. These bark-peeled or cambium-stripped trees belong to one of a number of recognized types of Culturally Modified Trees (CMT's; Mobley and Eldridge 1992). Surviving trees were left with a distinctive bark-peeling scar. In North America, these scars were called Indian scars. The Sami people made similar scars in northern Scandinavia. These scars offer direct evidence of native peoples' use of forest ecosystems (Zackrisson et al. 2000, Östlund et al. 2003). Since bark-peeling scars can be dated, they also provide a unique opportunity to analyze temporal uses of resources by native peoples (Kaye and Swetnam 1999).

The Bob Marshall Wilderness area in northwestern Montana covers a large area (>300,000 ha) that has not been subjected to logging, ranching, settlement, road

construction, or other forms of development. However, the Salish, Kootenai, and Blackfoot tribes used this area for hunting and other subsistence activities as late as the early 20th century (Cheff 1993). The "South Fork Valley," along the South Fork of the Flathead River, is the largest valley within the wilderness, and it contains small populations of ponderosa pine trees occupying some of the driest sites on river terraces (Arno et al. 2000). Forest types that are typical of cold, moist environments surround these isolated occurrences of ponderosa forest. The South Fork valley is relatively high (1300 to 1400 m), lying near the pine's northern range and elevational limits, and it has a short frost-free season. In most of the area it occupies in the South Fork Valley, ponderosa pine is subject to competitive (successional) replacement by more abundant and frost-hardy conifers, including inland Douglas fir (*Pseudotsuga menziesii* var. *glauca*), Engelmann spruce (*Picea engelmannii*), and lodgepole pine (*Pinus contorta* var. *latifolia*). The survival of ponderosa pine appears to have depended on frequent fire, as indicated by the presence of multiple fire scars on the trees (Arno et al. 2000).

A major problem when studying bark-peeled or other culturally modified trees is that remaining scarred trees represent scattered remnants of the original population (Swetnam 1984, Östlund et al. 2002). Relatively few old-growth ponderosa pine trees now remain in the surrounding region, where most of the original forest has been logged during the past 130 years, as is the case in most of the northwestern United States. Under such circumstances, it is impossible to determine the original pattern of bark-peeled trees or the structure of the forest in which they occurred. The setting provided in the Bob Marshall Wilderness, by contrast, allows scarred trees to be studied in a landscape where evidence of past use by native peoples has not been destroyed by logging or development.

AIMS OF THE STUDY

The aims of this study were to interpret native peoples' use of the ponderosa pine forest in the South Fork Valley by analyz-

ing trees with bark-peeling scars and then using written historical and ethnographic records (as far as possible) to corroborate the information obtained. Our goals were to identify temporal and spatial patterns of the collection of ponderosa pine inner bark by native peoples and to compare these findings with the results of studies that have focused on other sites in North America and Scandinavia. We also wanted to assess both the wider ecological and archaeological context of the bark-peeled ponderosa pines and the implications of the findings for attempts to maintain the "naturalness" of this wilderness area.

PROJECT LOCATION

Geography and history of the area

The South Fork Valley in the Bob Marshall Wilderness is located just west of the Continental Divide in the Rocky Mountains in northwestern Montana in a transition area between the Intermountain Plateau and the Northwestern Great Plains Native American culture groups. The groups that are known to have used this area are the Salish (Pend d'Oreille, Kalispel, and Flathead), living primarily to the west of the Bob Marshall Wilderness, the Kootenai to the northwest, and the Blackfoot (Bloods and Piegan) on the plains to the east (Flanagan 2001). There is very little detailed information about uses of the South Fork Valley or other specific areas in the higher mountains by native peoples (Flanagan 2001), although it is known that the Salish tribe used this area for hunting and fishing in historical times (Shaw 1967, Fredlund and Fredlund 1971, Gabriel 1976) and several different trail routes were used to pass through the mountains (Johnson 1969, Fredlund and Fredlund 1971, Flanagan 2001). When the Flathead Indian Reservation was created in 1854, the South Fork Valley and surrounding mountains became an important hunting area for the Salish tribe. The Kootenai also used this area, accessing it from the north, according to historical sources. A frequented summer camp was established near Spotted Bear about 50 km downstream from Big Prairie (Fredlund and Fredlund 1971). The South Fork Valley was included in the Lewis and

Clark Forest Reserve created in 1897; and shortly thereafter, a survey provided general information about forest resources and the ubiquitous role of forest fires (Ayres 1900). In 1908, the South Fork drainage area was incorporated into the Flathead National Forest. In 1931, a large “primitive area” was designated here, followed in 1964 by the establishment of the Bob Marshall Wilderness (McKay 1994).

Vegetation and forest types in the studied area

A montane forest occupies the valley and ranges from the moist subalpine fir/clintonia (*Abies lasiocarpa/Clintonia uniflora*) habitat type to the xeric ponderosa pine/rough fescue (*Festuca scabrella*) habitat type. The latter is restricted to some of the driest gravelly terraces that also support isolated dry grasslands (Arno et al. 2000). At the time of our field study (2000-2001), most of the ponderosa pine was mature

to very old, with few trees younger than 70 years, and large areas of former open ponderosa pine forest were being replaced successional by Douglas fir and lodgepole pine (Arno et al. 2000). This is a result of fire suppression that has interrupted the historical pattern of frequent surface fires (Arno et al. 2000).

METHODS AND MATERIALS

Sampling of trees and selection of sites

Methodologically, we essentially followed protocols in the CMT handbook (Eldridge 1997, Stryd 1997) in this study, but focused on one specific type of CMT – rectangular bark-strip scars on ponderosa pine (called bark-peeling scars hereafter). We also carefully dated the scars. The first step was to undertake a “level one” reconnaissance survey, in which a minimal

amount of site information was recorded, providing a basic inventory of the area on a broad scale. The area covered by the isolated occurrences of ponderosa forest was surveyed at this basic level in order to identify appropriate sites for higher-resolution investigation. After a reconnaissance survey of the ponderosa pine and bark-peeling scar occurrence in the South Fork Valley, four sites (described below) with relatively high densities of bark-peeling scars were selected for more detailed, level two, recording. The groves of bark-peeled trees were situated on gentle slopes in the valley bottom (Figure 1).

The Brownstone Creek site (Figure 2) covers approximately 40 ha and is centered on a small creek that frequently dries out in the late summer. This site borders a large, luxuriant meadow to the south. In terms of the plant assemblage, the main habitat type at this site is Douglas fir/snowberry (*Symphoricarpos albus*), dominated by Douglas

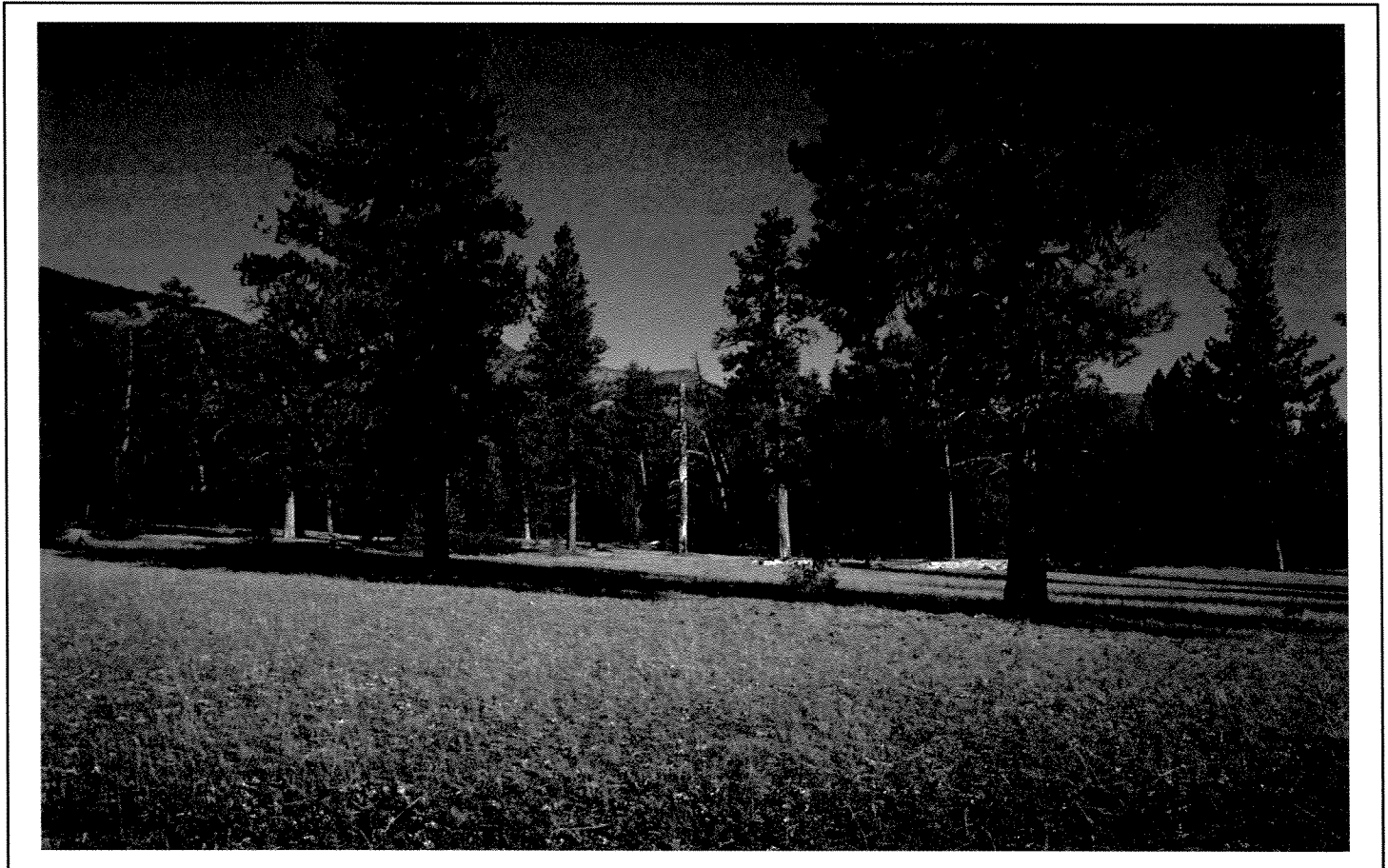


Figure 1. Open old-growth ponderosa pine forest at the site North White River Park, upper terrace. (Photo Lars Östlund)

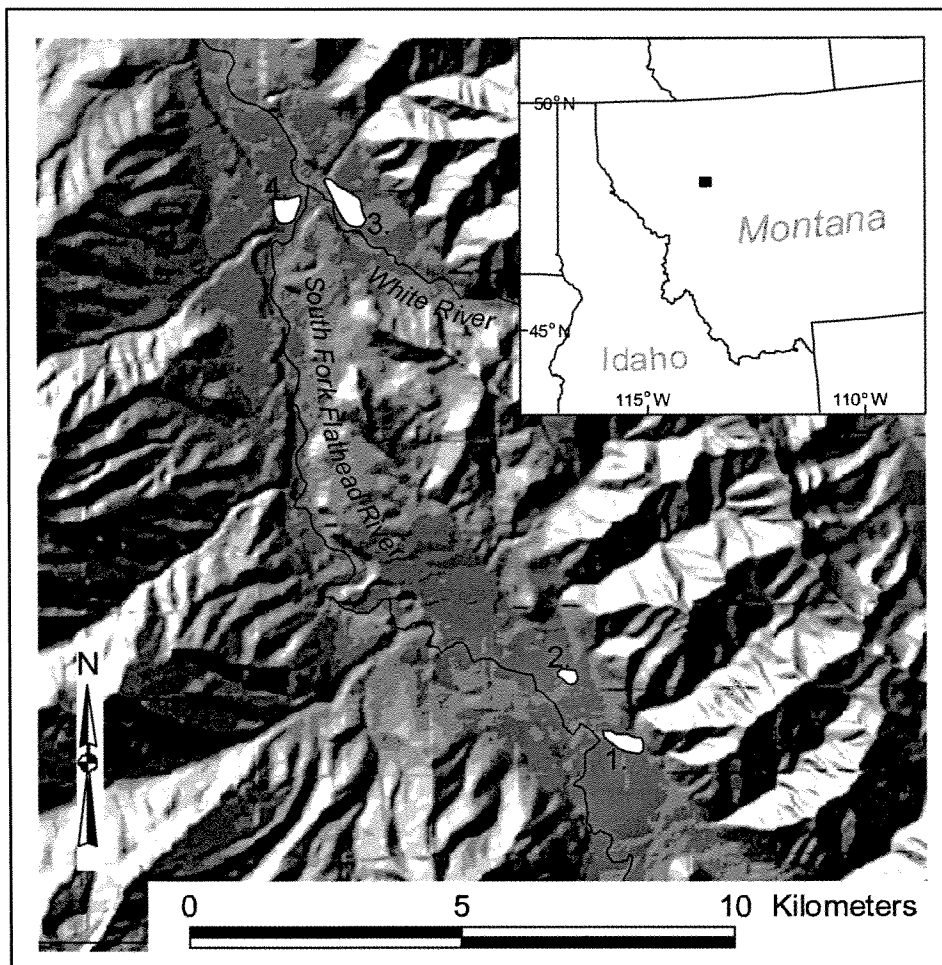


Figure 2. Relief map showing the upper part of the South Fork Flathead River Valley. White areas are the study sites and the numbers indicate the different sites: 1) Brownstone Creek, 2) Big Prairie, 3) North White River Park, 4) Murphy Flat. Insert map shows location of the study area.

fir, lodgepole pine, and ponderosa pine.

The Big Prairie site includes a 7 ha grove east of the ranger station, where a small creek enters the valley bottom (Figure 2). The forest cover is similar to that of the Brownstone Creek site. Also included in this study site is a small area west of the ranger station, near the river, where there are scattered open-grown ponderosa pine and patches of lodgepole pine mixed with grassland.

The North White River Park site covers 26 ha and is located on three terraces north of the White River near its junction with the South Fork (Figure 2). The two lower terraces consist of open ponderosa pine groves and small meadows, while there is a large, open meadow on the highest terrace, fringed by ponderosa pine with

patches of lodgepole pine.

The Murphy Flat site, which covers 17 ha, is located on the west side of the South Fork opposite the White River, and is also terraced (Figure 2). The lowest terrace is clearly close to the water table and its vegetation consists largely of scattered ponderosa pines and small groves of quaking aspen (*Populus tremuloides*). The higher terraces are characterized by dry meadows with scattered ponderosa pines and patches of encroaching lodgepole pine.

Mapping and sampling of scarred trees

Within each study site, details of every bark-peeling scar were intensively recorded, noting most of the information required when filling "level two" recording

forms (Stryd 1997). Some parameters were excluded, such as slope, and the main effort was put into sampling cores for dating. The variables recorded included position (geo-referenced with a global positioning system [GPS] receiver), measurements of the tree and scar, the compass orientation of the scar, and description of visible tool marks. Samples were also taken, with an increment borer (usually 12 mm diameter), to establish the year when the scar was made using the methods described by Barrett and Arno (1988), Zackrisson et al. (2000), and Ericsson et al. (2003). In addition, the diameter at breast height (1.3 m above ground) of all ponderosa pines larger than 30 cm (live, dead, standing, and down) was measured with a measuring tape and they were geo-referenced with a GPS receiver. The procedure used to collect samples for determining the age of the scars was designed to minimize the impact on the trees. Therefore, only two cores were taken from each tree, except occasionally when an additional core was taken because decay was encountered on one side of the bark peeling. The cored samples were dated in the laboratory using standard cross-dating procedures (see Zackrisson et al. 2000, Ericsson et al. 2003). A few samples were also taken from dead, down trees that exhibited bark-peeling scars. These samples were taken using a crosscut saw only when the down log was far from a hiking trail. The North White River Park site was selected for a further, more detailed geographic analysis. The positions of the scarred trees were put into a geographic information system (GIS), and a map was made in order to see if there was a spatial pattern of trees with bark-peeling scars of different ages.

RESULTS

The initial survey showed that the bark-peeled trees were mostly clustered in a few isolated locations within the ponderosa pine stands (Figure 2). Apart from these clusters, we found only a few scattered bark-peeled trees. Within the four study sites, 620 old ponderosa trees were recorded and 138 bark-peeling scars were sampled, 116 of which could be accurately dated.

Temporal patterns of bark-peeled trees

The oldest bark-peeling scar we sampled dated to 1665, and the youngest was from 1938 (Figure 3). The majority of bark-peeling scars were from the 19th century, with a peak in the period 1851-1875. The numbers of bark peelings made before and after this period declines with increasing time (towards the past and present, respectively) except for the period 1701-1725, during which more trees were peeled than in the subsequent period. Some representative scars are shown in Figure 4.

Orientation, size and special characteristics of scars

No consistent pattern was detected in the orientation of the scars, except for a slight possible bias in favor of a southerly or easterly rather than a northerly or westerly orientation (data not shown). Most scars now span less than half of the circumfer-

ence of the stem: originally, they would have been wider, but healing has reduced their size. Vertical dimensions are probably less affected by the lateral healing process, and ranged from 10 cm to 285 cm. Few scars were shorter than 50 cm in length, but three scars were only 10, 15, and 18 cm in length. The mean length of the scars was 129 cm (standard deviation 52 cm). A few scars still show typical tool marks (made by axe or knife) at the bottom (cf. White 1954, Alldredge 1995, Ahlberg 2001).

Temporal and spatial patterns of scarred trees at each study site

The Brownstone Creek study site had 136 ponderosa pine trees (living and dead) estimated to be more than 100 years of age. Of these, 33 (24%) had bark-peeling scars. There were 0.82 scars per hectare. Scar dates ranged from 1665 to 1938, and were well distributed throughout this period except for a gap during the mid 19th century (Figure 5).

The Big Prairie study site had 61 old ponderosa pine trees east of the ranger station, 13 (21%) of which had bark-peeling scars. There were 0.85 scarred trees per hectare. Additionally the isolated group of open-growing trees near the river west of the station consisted of four trees with a total of five bark-peeling scars (one tree had two separate scars). Altogether there were 18 bark-peeling scars at this site. The dates of the Big Prairie scars are scattered from 1672 to 1902, but only two are from the mid 19th century (Figure 5).

The North White River Park site contained 241 old ponderosa pine trees, 54 (22%) of which exhibited bark-peeling scars. Two trees had double scars. The number of scars per hectare of forest was 2.1. Scar dates ranged from 1714 to 1930, and they were well distributed through this period (Figure 5). The spatial distribution of scars of different ages showed no strong correlation to any specific place within this site. However, most of the pre-19th century scars were located on the lowest terrace close to

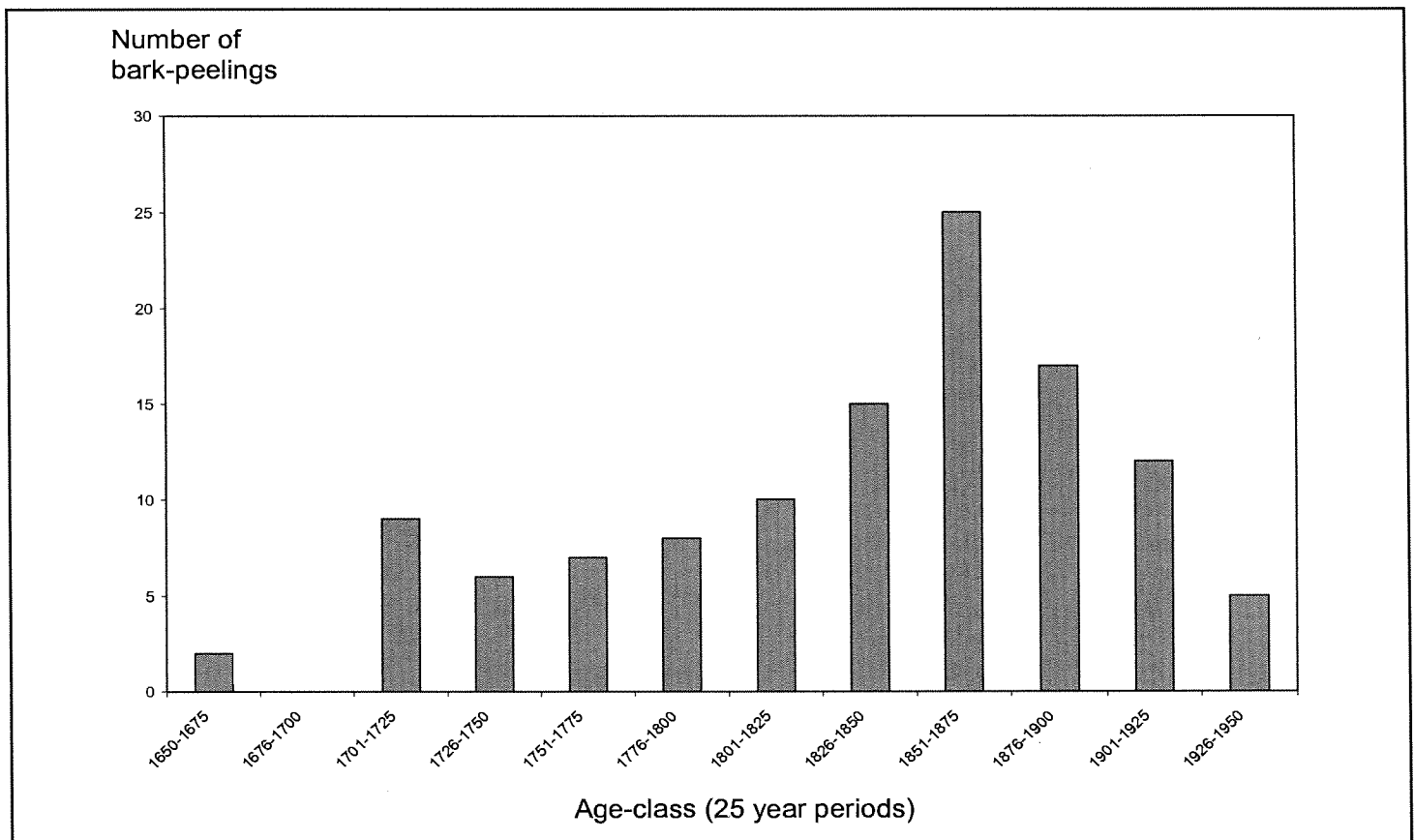


Figure 3. Number of dated bark-peeling scars per 25 year-period from 1650 to 1950.

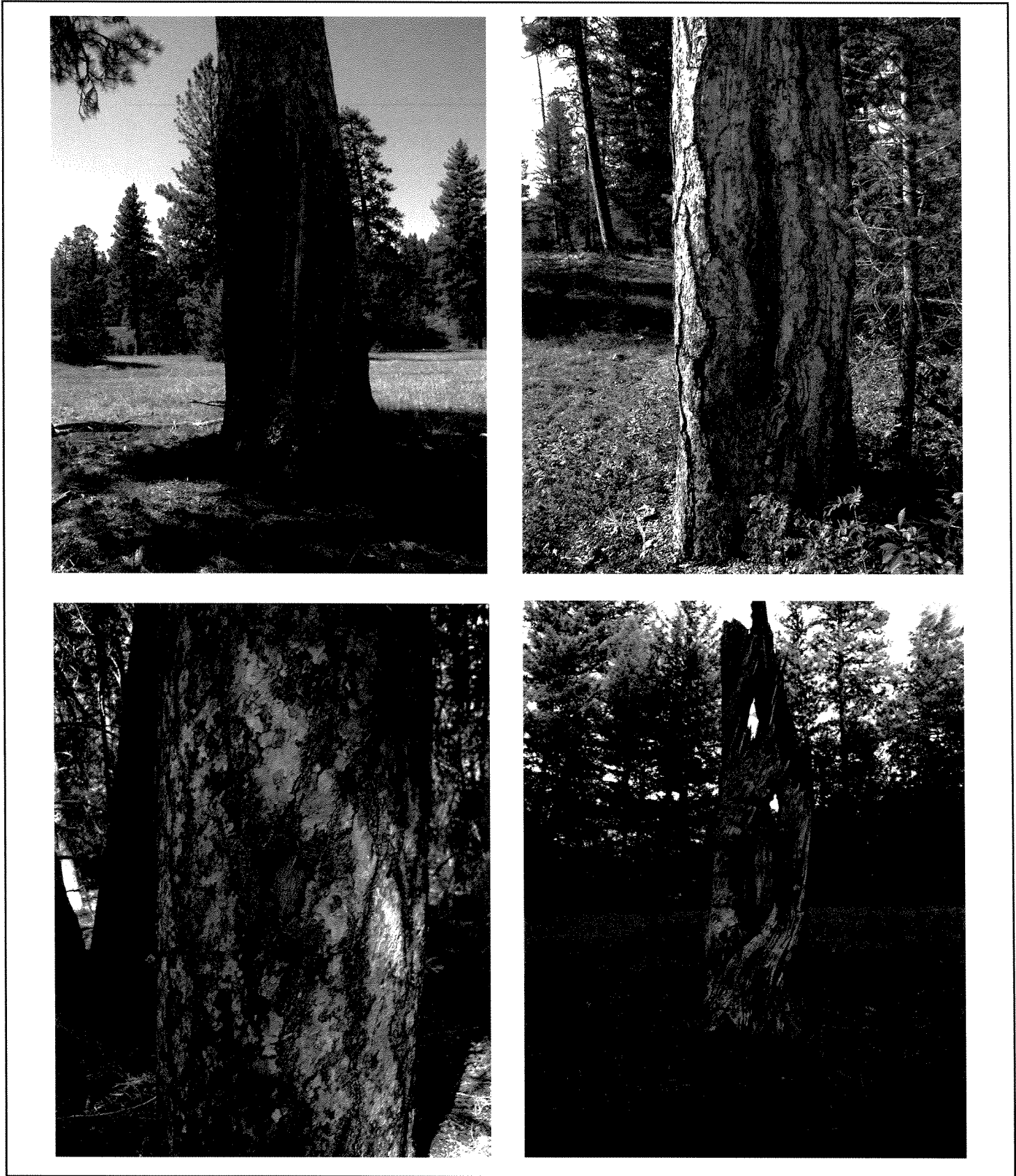


Figure 4. Bark-peeling scars on ponderosa pine trees. Upper left, large scar (height 257 cm) on live tree dated to 1861 at the Murphy Flat site. Upper right, almost fully encroached scar dated to 1717 at the North White River Park. Lower left, small scar (height 18 cm) interpreted as “taste scar” dated to 1896 at the North White River Park. Lower right, scar on standing dead snag at the Murphy Flat site, not dated.

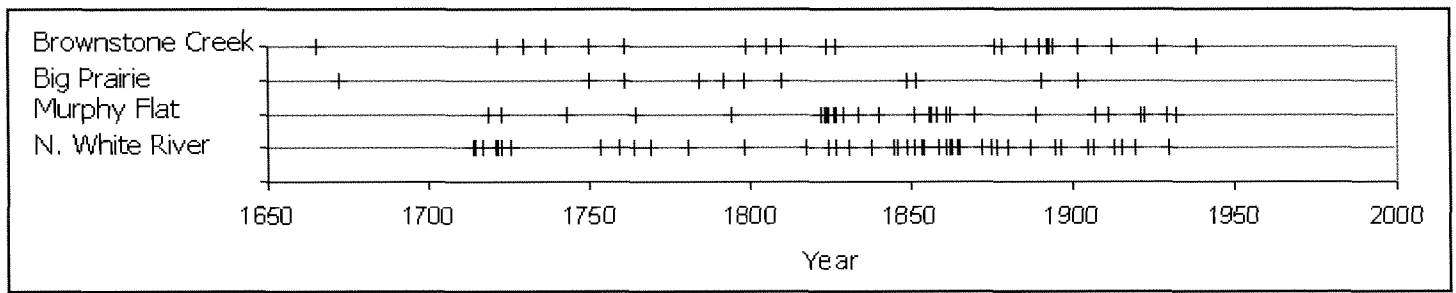


Figure 5. Age of the bark-peeling scars at each site. Each line crossing the time-line equals one dated scar.

the river (Figure 6).

The Murphy Flat site contained 182 old ponderosa pine trees, 33 (18%) of which had bark-peeling scars. The number of scars per hectare of forest was 1.9. Scar dates ranged from 1719 to 1932 (Figure 5). A few scattered scars were made in the 18th century and there were clusters of scars dating from the 1820s, 1850s, and early 1860s.

DISCUSSION

Spatial distribution, size, and orientation of scarred trees

The bark-peeling scars on our study sites are located primarily in clusters, each of which has about 20-25% of the old pines scarred. The clusters of scarred trees are located at positions where stream water was readily available, adjacent to meadows on gentle slopes favorable for campsites. These areas were “traditional use areas” which provided a stable low risk and high yield food resource. No clusters of trees with the same scar date appeared within the sites (Figure 6). Peeling trees, and the preparation of the cambium for consumption, was arduous, time-consuming work, so probably this work was primarily done near the campsites (cf. White 1954, Alldredge 1995). The large number of bark-peeled trees on the north bank of the White River might also be related to the attractiveness of the site’s food resources, since there is evidence indicating that fishing in this tributary was considered particularly good (Fredlund and Fredlund 1971).

These interpretations substantially agree with findings of Alldredge (1995), who

studied bark-peeled ponderosa pines in the Kootenai National Forest, Montana, about 150 km to the northwest. Bark peeling was done in late spring when the sap was running. The bark “slipped” and was relatively easy to peel. Marshall (2002) describes two different types of spatial distribution of bark-peelings on lodgepole pines in the native Carrier territory in British Columbia. “Trail type” peeled trees are found along commonly used trails, indicating that the bark was peeled for immediate consumption. In the South Fork Valley, there are some bark peelings, which may be of the trail type, but they appear to be quite rare. The explanation for the lack of the latter type may be that lodgepole pine, in contrast to ponderosa pine, is a smaller tree with a bark that is much easier to peel and thus more suitable for immediate consumption. The peelings we observed conform better to Marshall’s “harvest area type,” but the densities of peeled trees are much lower in our study area. The low number of scars per hectare found in our study may also be explained by the open forest in the investigated area, with relatively few trees, on average, per hectare.

The clustered pattern of peeled trees in the South Fork Valley agrees with interpretations from many other studies in both North America and northern Europe (c.f. White 1954, Swetnam 1984, Alldredge 1995, Zackrisson et al. 2000, Prince 2001, Marshall 2002, Östlund et al. 2003). In some places in the South Fork Valley, such as on the uppermost river terraces, ponderosa pines exhibit few (if any) peel scars. Plausible explanations include remoteness from potable water supplies, meadows, and, therefore, from traditional campsites.

There is a wide variation in the height of the bark-peeling scars. This is consistent with findings in other studies on pine species in western North America (see Ahlberg 2001), but conflicts with native peoples’ bark-peeling practices in northern Europe, where bark sheets with very precise sizes were taken (Zackrisson et al. 2000, Bergman et al. 2004). The great variation we found may be larger than the original size range, because, to varying degrees, healing has covered parts of the original scars. Occasionally, apparent bark-peeling scars in ponderosa pine become completely recovered with bark, and the only visible sign of their presence is a bark seam.

Variation in the original sizes of peeling scars could indicate that only the amount needed at any given occasion was taken, and possibly that material was taken for immediate consumption rather than harvesting for future use. In this study, we found several young, smaller scars located in areas where many trees had large bark peelings. We interpret these as “tasting scars” made to check the quality of the inner bark before a large sheet was taken. Ethnological documentation has verified that this was done (White 1954). However, due to their small size, only the youngest tasting scars are discernable today: older ones have healed over. This may also explain why a limited number of trees of the same age have been peeled at each site; only trees with the right qualities were used. There is a southerly/easterly bias in the orientation of the scars, but this seems to be random rather than intentional. In contrast, other studies of peeling, both in North America and northern Europe, have found that the northern side of trees was preferred, perhaps for spiritual reasons (Zackrisson et al. 2000, Marshall 2002,

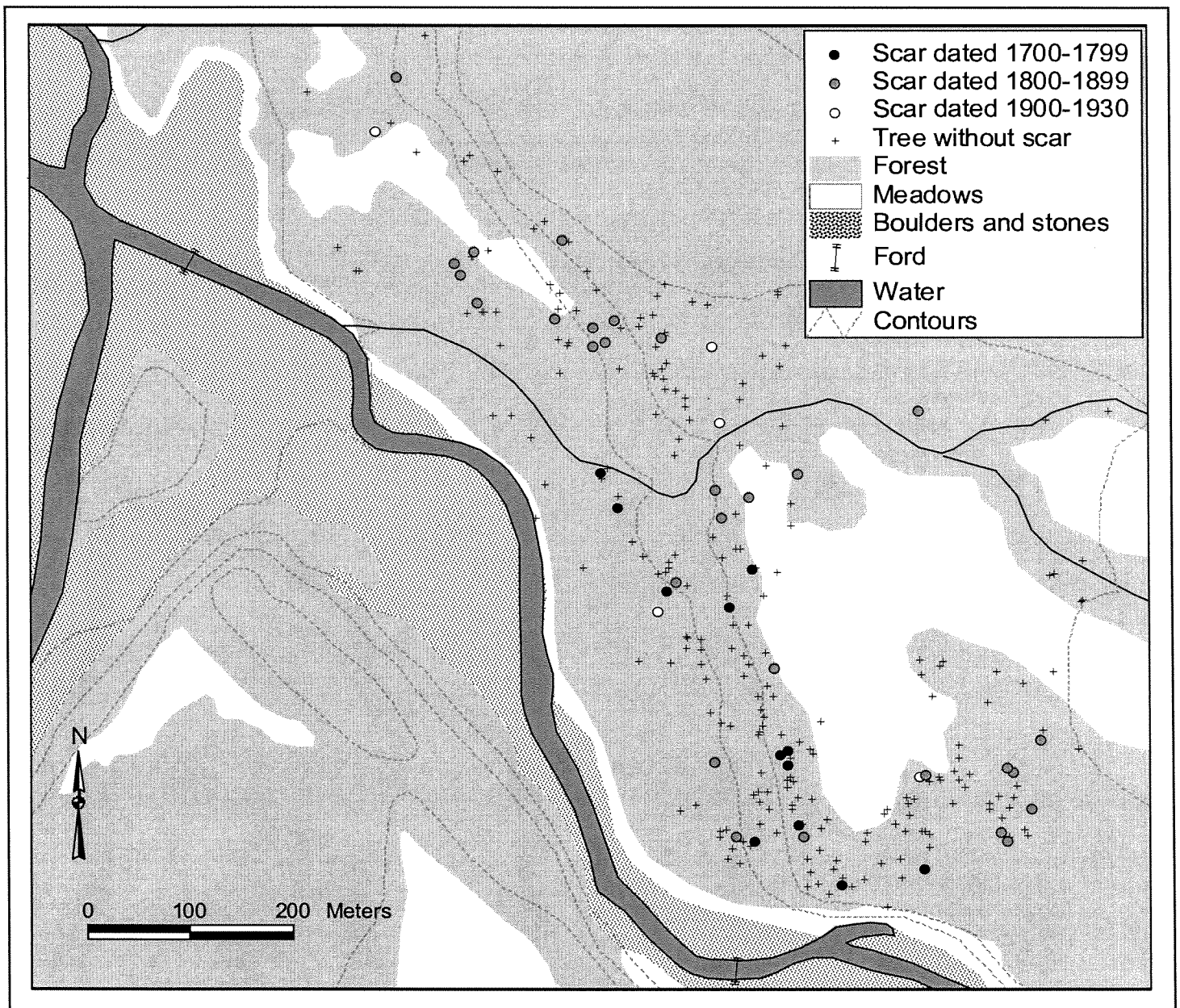


Figure 6. Map showing ponderosa pine trees with and without bark-peeling scars in age-classes at the North White River Park site in relation to topography and proximity to the river and open grasslands.

Bergman et al. 2004).

Interpretation of the temporal data – the long record of bark peeling

The analyses of the bark-peeling scars indicate that Native Americans used the ponderosa pine forest in the South Fork Valley of the Bob Marshall Wilderness repeatedly since at least the latter part of the 17th century. The majority of scars date from the 19th century, with a peak in the period 1851-1875 (Figure 3), af-

ter which the number of scars declined. This general temporal pattern coincides with findings from other studies both in this region (Alldredge 1995) and further south in the Rocky Mountains (Swetnam 1984, Kaye and Swetnam 1999). The bark peelings from 1665 and 1672 are the oldest yet recorded in ponderosa pine, and indicate that this tradition predates the introduction of horses in the region in about 1730 (Malouf 1969). Other studies from the northern hemisphere show that bark peelings represent traditions reaching

very far back in time. Dating living trees and snags cannot fully reveal the longevity this custom (Alldredge 1995, Zackrisson et al. 2000, Ahlberg 2001, Bergman et al. 2004). In northern Scandinavia, sub-fossil pine trees with bark-peeling scars have been dated to 2800 years B.P. (Östlund et al. 2004). The fact that the majority of the scars in this study are from the 19th century probably reflects a natural loss of older scarred trees through death and decomposition rather than an increase in bark-peeling activity during that century. Many of the

oldest scars, which were originally small, may have become completely covered with bark and are therefore undetectable.

The waning tradition of scarring ponderosa pines among the Nez Perce tribe in western Montana was noted by forest rangers in the early 20th century (Thompson 1944). Reasons for this cessation were that commercial sugar became available and that government foresters discouraged bark peeling, believing it reduced the value of trees for lumber (White 1954). The reason we found trees which were peeled as late as the 1930s is almost certainly because this area is in the midst of a large undeveloped wilderness which was never settled by European-American farmers and ranchers, and thus remained in traditional use by native peoples later than other areas in the region.

Implications of Native American use for the “naturalness” of a wilderness area

The bark-peeled trees in the Bob Marshall Wilderness provide direct evidence of site-specific land use by native peoples. The precise spatial and temporal data should help plan future archaeological investigations, which can focus on locations known to be used repeatedly. Many other uses of natural resources leave no permanent traces; and in many cases, very sparse documentary evidence of land use is available, and no written records. It is easy, therefore, to neglect and underestimate the scale of native peoples' land use and its effect on ecosystems (cf. Krech 1999, Stewart 2002). With scant evidence available, modern writers are often tempted to use speculative methods to bolster preconceived opinions about how important or unimportant native peoples were in shaping the ecosystem (Cronon 1996, Vale 1998).

Results presented in this study provide spatially precise data on native peoples' use of what is today a remote wilderness setting. The bark-peeling record indicates a regular, but not annual, presence in this area. The collection of inner bark was most likely not the main reason for occupation. Ponderosa pine forests are more extensive

in many other parts of this region. White (1953) suggests there is a strong connection between root gathering and the collection of inner bark. Berry picking and root gathering were not done communally, but in family groups which spilt from the main body after the spring ceremonials and dispersed across all of western Montana (Turney-High 1937). In May, the sweet sap of the pines was running perfectly for collecting the inner bark of the tree – “the suk'naukk” (Johnson 1969). The reasons why some, but not all, potential trees were peeled at the studied sites, and why there are large areas with no peeled trees, may be related to the relatively high elevation of this valley and the fact that high mountains almost completely surround it. Thus, it may have been visited infrequently during the spring period when the ponderosa pines could be peeled. An interesting observation is that inner bark was collected in such a way that the trees were not killed. This is typical of native peoples' bark peeling in different forest ecosystems across the northern hemisphere (Ahlberg 2001). In northern Europe, this has been interpreted as an indication that the trees had a spiritual value besides providing food (Bergman et al. 2004).

How should we interpret the human impact on the studied area based on the presence of bark-peeled trees? On one hand, we can conclude that people were present at these sites, which were repeatedly used in springtime in a secluded high valley in the Rocky Mountains. Most likely, we underestimate the impact of native peoples for two reasons. First, people did not always peel trees during their stay at these locations since bark peeling was an early-season activity. Second, probably a majority of the trees that were peeled before 1800 have disappeared due to fire, insect attacks, decay, and scar healing. We can also conclude that the impact of bark peeling on the forest was slight, since it did not kill or seriously weaken the trees. Related direct effects on the forest, due to activities such as horse grazing, hunting, collection of material for use as firewood and tent poles, etc., by relatively small groups also probably had a minimal impact on the ecosystems. A possible exception might be any substantial use of fire to clear

camping areas, travel routes, or stimulate forage or food plants (Barrett and Arno 1982, Boyd 1999).

Further archaeological and ecological studies are needed to examine relationships between the structure and function of the forests and historical land use patterns in this wilderness area. Another important task for the future is to develop methods to incorporate information on historical land use patterns in future management plans for wilderness areas (Egan and Andersson 2003). Such information is needed not only for maintaining desired ecosystem properties, but also for protecting an important cultural heritage contained in the forest ecosystem.

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Lars Östlund received his Ph.D. at the Faculty of Forestry at the Swedish University of Agricultural Sciences in Umeå, Sweden, and is now an Associate Professor in Forest Ecology at this University. His most recent research deals with interpretation of historical land use by native peoples in northern Europe, forest history and biodiversity, and long term changes of boreal forest ecosystems in relation to natural and anthropogenic disturbance by using dendrochronology and histori-

cal records.

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