

# Destroying a Path to the Past – the Loss of Culturally Scarred Trees and Change in Forest Structure along Allmunvägen, in Mid-West Boreal Sweden

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The tradition to blaze trees to mark trails and boundaries is very old in northern Scandinavia. The disappearance of culturally modified trees (i.e. trees with trail blazes) and changes in forest structure along a section of an old bridle trail in boreal Sweden was analyzed using historical maps and forest surveys from the period 1876 to the year 2000. Remaining blazed trees were located during a field study and selected scars were dated. In total 104 scarred living and dead trees were found. The scars originated from the early 1500s to the early 1900s. Analysis of the forest surveys showed that the forest along the trail was dominated by older trees, and that the majority of the scarred trees probably were present, throughout the 19<sup>th</sup> century. By the mid 20<sup>th</sup> century logging had begun to affect the tree age along the trail and in 1974 no stands older than 180 years were present. A conservative estimate shows that around 90% of the original blazed trees have vanished. The trail was interpreted as have being lined for centuries with scarred trees which gradually have been destroyed during the 20<sup>th</sup> century. Culturally modified trees constitute an unique source of information for understanding pattern of old trails as well as of past human land use and movement in the landscape prior to the 20<sup>th</sup> century. This biological archive have to a large extent been destroyed by forestry activities and it is therefore very important to survey, recount and protect the trees that are still present.

**Keywords** blazed trees, culturally modified trees, dendroecology, forest trails, forest history, tree age structure

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## 1 Introduction

*“Veistä pilkut pitkin maita, rastit vaaroihin rakenna, jotta tunnen, tuhma, käyvä, äkkiouto, tien osoan etsiessäni ereä, antia anellessani !”\** (Kalevala 1964)

Trees modified by human hand can convey and reveal information about cultural history in forest ecosystems. In pre-industrial times, trees had a wide range of uses and were not used only as a source of raw material (Mobley and Eldridge 1992, Vilkuna 1992, Östlund et al. 2002). For example, as in the lines cited above from the Finnish epic poem Kalevala, boundaries and trails were marked with scarred trees for orientation. Furthermore, certain trees were used for medical, religious and mythological purposes. Also, they were commonly used for a range of more practical applications. Resin, sap and inner bark were extracted from trees. Living trees were modified to provide material for tools. Trees were utilized as lookout towers for hunting and guarding cattle. Carved handles and wedges were cut into trees for certain purposes. Traces of these past activities can still be found in a variety of scars and markings in dead and living trees. Interpretation of these biological artefacts can reveal information about earlier land use and human movement in forested landscapes (Mobley and Eldridge 1992, Zackrisson et al. 2000, Östlund et al. 2002).

Only 100 years ago the movement of goods and people in northern Sweden differed enormously from today. The pre-industrial economy of the forested parts of Sweden was primarily based on animal husbandry, fishing and hunting, all of which required large areas for sustainability. The population density was very low and grazing areas, winter fodder grounds, fishing and hunting territories, judicial districts, churches and market-places were situated far apart (Campbell 1936). Travelling between different locations through vast forest areas was therefore imperative for both peasants and the authorities alike. Human movements, in both forested and agricultural

districts, were probably extensive by medieval times as well as in later centuries (Myrdal 1979, Harrison 1998).

The roads used before the 20<sup>th</sup> century in northern Sweden can be classified in four categories (Mannerfelt 1936). Adjacent summer and winter roads were used for daily work in the immediate surroundings of the village. Long-distance summer and winter roads connected villages or districts for trade, postal, ecclesiastical or judicial purposes. In western parts of the province of Dalarna, in central inland Sweden, there were about 180 kilometers of “long distance roads” and about 280 kilometers of “adjacent roads”, in an area of approximately 2400 km<sup>2</sup> (0.2 km road per km<sup>2</sup>) with a population density between 0.4–0.9 people per km<sup>2</sup> in the late 17<sup>th</sup> century (Veirulf 1935, 1936). In the river valleys the length of the road network could have reached 0.5 km road or more per km<sup>2</sup> in upper Dalarna in the 17<sup>th</sup> century (Friberg 1975). The pre-industrial road system in inland boreal Sweden consisted almost exclusively of footpaths and bridle trails that were impassable by cart. The footpaths or bridle trails were as far as possible laid out on dry upland, avoiding mires and wetlands. Exceptions were roads to very important places, larger villages and mining districts, for example the road to the “Nasa-mountain silver mine” situated on the Norwegian border in the province of Norrbotten (Hoppe 1945). Such roads were often fairly well constructed and maintained, for example boulders in the road were removed or split using fire, and over mires an about 3 meter wide road surface was built out of small Scots pine (*Pinus sylvestris* L.) trunks (Burman 1902, Hoppe et al. 1996). Elsewhere, just the trees were removed and there were no ditches or man-made road surfaces. Winter roads, which out of preference were laid out on frozen mires and lakes, were passable using sledges. Important winter roads were marked with shrubs or sticks on lakes and mires (Hoppe 1945).

The volume of traffic varied greatly between trails. Also, seasonal variations on the same trail were commonplace. A trail could therefore lie unused for long periods. Naturally, it was essential to mark the direction of the trails. In forested areas both winter and summer trails were commonly marked with scars in trees along the path, often

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\*“Blaze a trail across the country, And set guideposts on the hills, That I stupid man may follow, Uiter stranger find his way, While he’s hunting down the quarry, Scouring through the forest for it.”

**Table 1.** Unpublished sources.

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|----|---|
| A. | National road museum, Borlänge, Sweden.<br>Nils Fribergs collections:<br>1. Kopparbergs Länstyrelse. Landskansliet, E XI. no 1. 1663–1846, fasc 6, vägdelning 1710, no 1.<br>2. Älvdalens kyrkoarkiv 1:1. |
| B. | Krigsarkivet, Stockholm, Sweden.<br>L 13232: KA, Sveriges krig, Roten skans 1676, Dalarna, Generalkartor.   |
| C. | Stifts och Landsbiblioteket i Västerås arkiv, Västerås, Sweden.<br>Daniel Herweghr collections, 25:3.   |
| D. | The state forest archive, Falun, Sweden.<br>Forest inventories (Älvdalen district) from the years: 1876, 1893, 1920, 1938, 1952, 1974   |
| E. | Sveaskog, Älvdalen district, Sweden.<br>Forest inventory register the year 2000.  |
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on two sides of the tree, to indicate the direction of the trail (Levander 1935, Ågren 1983). Blazes in trees was also used to allocate maintenance obligations when dividing a road between local farmers (Table 1 A:1). The tradition to mark trails with blazes is ancient in Scandinavia and is even mentioned in the old saga literature (Kalevala 1964, Snorre Sturlason... 1900). The practice was also followed in both Siberia and North America (Berg 1930, Merell 1998). For example native american tribes crossing the Rocky Mountains used sophisticated markings in trees to direct and warn the traveller (Flanagan 2001).

Preserved scarred trees are an often neglected and unique source of information in the exploration of old trails and the movement of people in forested landscapes. For example, in a dissertation on roads in northern Sweden, it is presumed that there are no traces left of the so-called “Judges’ trail” (Hoppe 1945). However, in a later study, 143 trees with blazes dating from 1644 to 1880 were revealed on an about 1000 meter long uncut section of the trail (Ågren 1983). Through ignorance of this biological archive many of the remaining scarred trees are felled or destroyed by forestry activities (Alldredge 1995). It is therefore important to survey, recount and protect the trees that are still present. They constitute both natural and cultural legacies of the historical movement of people and their relationship with the forest landscape.

## 1.1 Aim of the Study

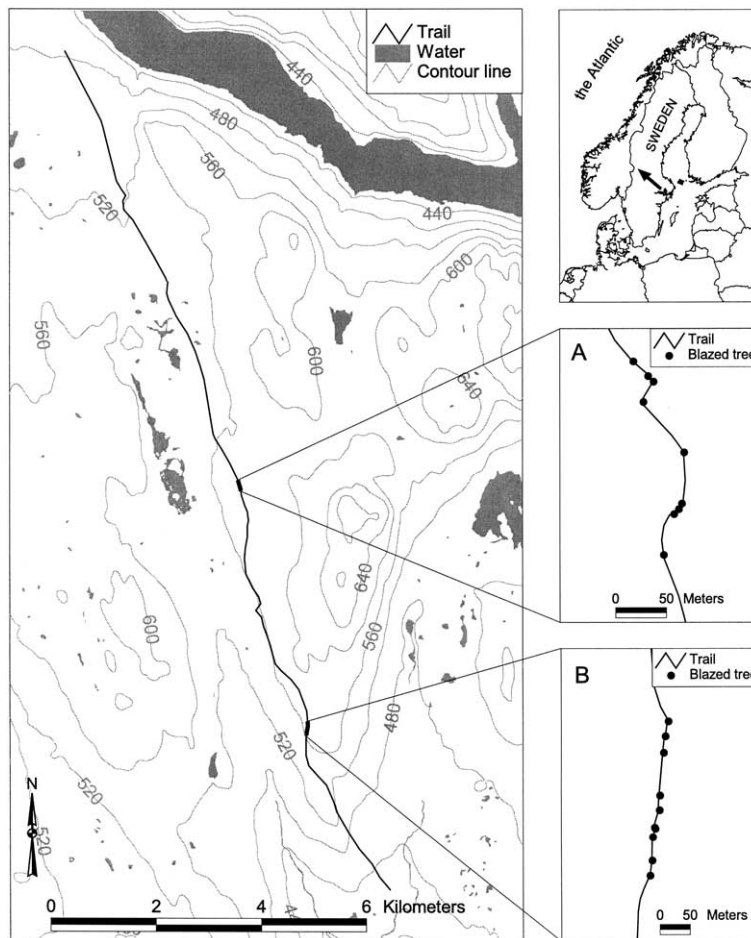
The aim of this study was to analyze part of an old bridle trail in boreal Sweden by studying scarred trees. We set out to 1) analyze and date remaining trees with scars along the trail, 2) analyze changes in the forest structure along the trail during the last 100 years by using historical maps and forest surveys, 3) interpret the disappearance of trees bearing scars. Our hypothesis is that important trails were lined with scarred trees until the onset of the industrial use of the forest in the late 19<sup>th</sup> century and that the vast majority of such trees have been cut during the 20<sup>th</sup> century.

The trail we have studied was a very important path to remote villages in the Fennoscandian mountains. We have selected this particular part of the trail because it runs in a relatively remote forest area and is one of few stretches of the path that can still largely be traced. Also, the forest surrounding this part of the trail has been treated by regulated forestry by a single owner (the Swedish state) since the latter part of the 19<sup>th</sup> century and consequently has been subject to systematic forest inventories.

## 2 Material and Methods

### 2.1 Area Studied

The area studied is situated in Älvdalen parish in the county of Dalarna in central Sweden (Fig. 1). The full 60 kilometer extension of the bridle trail “Allmunvägen” originally connected the village of Älvdalsåsen with the communities of Särna, Hede and Idre. Connecting roads ran from Idre to the cities of Röros and Trondheim in Norway. The extension to the part of the trail studied, an approximately 20 km long strip measuring a few meters wide, runs from 61°22′N, 13°36′E to 61°31′N, 13°31′E. The trail rises from an altitude of 415 m.a.s.l. in the south to approximately 480 m.a.s.l. in the north. The trail passes mostly through dry, forested moorland and the dominant tree species is Scots pine. In the depressions Norway spruce (*Picea abies* (L.) Karst.) is to be found mixed with birch (*Betula* spp.). The ground cover consists of an almost unbroken layer



**Fig. 1.** Map of the study site showing the extension of the investigated section of the road “Allmunvägen”. Small inserted map of Scandinavia showing location of the studied area in Sweden. Inserted maps A and B, showing the parts with aggregated blazed trees.

of lichen (*Cladina rangiferina* (L.) Nyl., *Cladina arbuscula* (Wallr.) Hale & Culb., *Cladina alpestris* (L.) Nyl. and some *Cetraria islandica* L.). Also interspersed are mosses such as *Pleurozium schreberi* (Brid.) Mitt. and *Dicranum scoparium* L. *Calluna vulgaris* L. occurs abundantly in the ground vegetation mixed with *Empetrum nigrum* L., *Vaccinium vitis-idaea* L. and some *Vaccinium myrtillus* L. The bedrock consists of an even layer of porphyry with few notable slopes. The porphyry is covered with glacial deposits often forming north to south running ridges.

## 2.2 History of the Trail

The first historical indication of the trail's existence is from a demarcation document between Sweden and Norway dating from 1403. In this document the creek Rödhällan is mentioned as a demarcation point. It is very likely that this creek actually marks the trail where it crossed the border (Friberg 1947). Travel through northern Dalarna occurred in medieval times, both for trade and pilgrimages to Nidaros (Trondheim) in Norway (Bull 1919, Nergaard 1921, Steen 1929). The first time the trail is clearly depicted on a document is

from the 1670s war between Sweden and Denmark when defence maps of this area were drawn (Table 1 B). In one of these maps the trail is drawn more or less correctly even though the map is not very detailed. Friberg (1956) speculates on behalf of this map that the trail might have changed route slightly in the 18<sup>th</sup> century. Some years earlier, in 1644, Sweden had conquered the villages of Särna, Hede and Idre, taking them from Norway. In 1673 the peasants in Älvdalen complained about having to carry mail without compensation, for the crown and the bishop, along the long path (Table 1 A:2). In a “Guide to all the Towns and Famous Places in Sweden and the Grand Duchy of Finland”, published for the first time in 1743, the trail is mentioned as a “bridle path” along with distance markers (Buurman 1776). During this time, in 1755, the inhabitants of Särna and Älvdalsåsen call attention, in a written complaint, to the fact that their horses get ruined when taking travellers along the trail, with no opportunity to change horses, through “*a heavy road with rocky hills and swampy marshlands*” (Table 1 A:2).

The Swedish botanist and explorer Carl Linnæus travelled the path in the summer of 1734 and is the first person to leave a written report of the trail’s physiognomy (Gullander 1980). He also describes the blazes on the trees and emphasizes the advantages of this marking system, since the trail remains visible even when the ground is covered with snow. After Carl Linnæus, several other early travellers passed along the trail and recorded their impressions (Hülphers 1957, Table 1 C., von Hallberg-Broich 1820, von Unge 1831, Engström 1835, Lamm 1944). Jointly, they describe the trail as desolated in an often severely burned, barren forest terrain. “*Our only guidance were the blazes in the trees and sometimes some cattle tracks*”, says for example Otto Sebastian von Unge when he passes the forest in 1826.

During the 1850s the trail gradually lost its importance as a major road, when a parallel, prepared cart-road was constructed (Murelius 1931). This new highway, which was completed in 1855, did not follow the windings of the old trail. And since the path was left intact and many activities took place in the surrounding forest, parts of the trail were used for more than half a century to come. Grazing, collection of winter fodder, hunting and fishing still took place in the

forest along the trail (Malmström 1963). Also the start of the timber industry resulted in increased movement in the forest towards the end of the 19<sup>th</sup> century. In the course of the first decades of the 20<sup>th</sup> century, forestry gravel roads were constructed in the vicinity, and the importance of the old bridle path gradually diminished.

The first attempt to preserve one section of the old trail was made in 1925, when a local forester took the initiative to mark the blazed trees with red paint (Lindberg 1970, 1971). By 1939 the markings had already partly faded and more red paint was applied, this time as circles on trees along the same section. Once again the paint faded and in 1957 a longer section was marked in white and, within clearings, white-coloured sticks were pegged out. Once again, in August 1966, the trail was marked, this time with yellow paint (Olle Larsson Lövnäs, personal communication). In the 1960s a reservoir for a power plant was constructed which partly (about 15 km) submerged the trail. During a number of summers in the 1950s and 1960s a philologist, Lindberg (1970, 1971), walked the entire 60 kilometer trail with local guides, studying place-names. His report is extremely detailed about the trail’s twists and turns, and his notes have been an important source of information for this study in order to position the trail in the field.

### 2.3 Historical Sources

We have used forest inventory maps with stand descriptions from the years 1876, 1893, 1920, 1938, 1952, 1974 and 2000 to trace the trail, to reconstruct the past forest structure and to analyze past logging activities along the trail (Table 1 D and E). In addition, diaries from early travellers who used the trail in the 18<sup>th</sup> and 19<sup>th</sup> centuries were used.

The first inventory (1876) does not cover the whole area but was used to get a general picture of the forest structure before any significant logging occurred in the area. The following inventories describe the forest along the entire stretch of the trail studied: the trail is marked on the maps from 1893 and 1920 and partly marked on the maps from 1938 and 1952. All silvicultural data from the stands alongside the trail were noted from

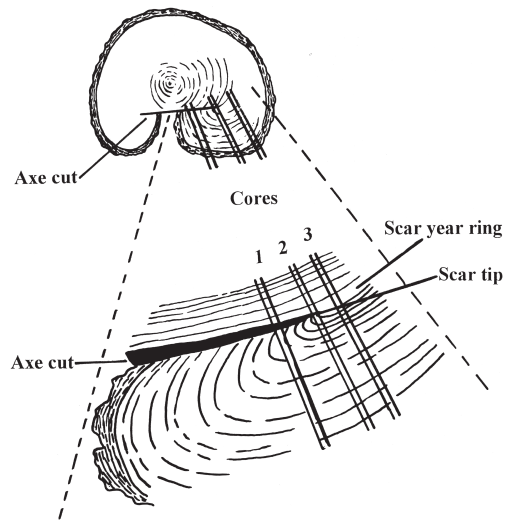


the description of the stands in each of the given years. Where the trail was not marked on the map, that particular stretch was reconstructed from the older maps.

## 2.4 Mapping and Sampling of Scarred Trees

A field study was carried out in the summer of 2000 to find the trail and to identify remaining blazed trees. The trail was searched for in the field with the aid of the earliest forest inventory maps and other written sources. All parts found were tracked with a GPS (Global Positioning System) receiver (Garmin 12 XL). Also, all trees with blazes were positioned with the GPS, using the averaging function to increase the precision. The digital data were processed using a GIS (Geographic Information System) program (Arc View 3.0) to produce maps showing the locations of the findings. Blazes were found on living, dead standing and downed trees. The DBH, i.e. diameter at breast height, of the blazed trees was measured with a calliper. The visible number of times every tree had been blazed was registered and the length of each scar was measured. Also, the position of the blaze in relation to the trail's direction was noted. A subjective selection of the blazed trees was made, based on the estimated age of the tree and condition of the wood around the area of the scar. Many trees were severely decayed in the area of the scar and therefore an objective sampling was impossible to achieve. The sampled trees were cored with an increment borer to date the time the blazes were inflicted (see below). Samples were also taken with a chainsaw from dead felled logs that showed blaze marks. A further reason for not sampling all the available trees is that these trees constitute an unique cultural heritage and we were very cautious about taking samples that might cause damage to the trees. The selection was made to acquire a wide age-span of the trees examined.

When a tree is injured by for example an axe cut, the surrounding cambium starts a periclining division between the dead and living tissue (Fig. 2). New wood forms and grows over the scar tip thus conserving the year-ring which was damaged. By counting the year-rings formed outside the scar, it is thus possible to date the year



**Fig. 2.** Hypothetical cross section of a single scarred tree trunk illustrating the core boring method used to determine the years when the scars (axe cuts) were inflicted on the sampled living trees along "Allmunvägen" bridle path.

when the scar was inflicted. However, if a scar was inflicted before radial growth has started or after radial growth has ceased the single calendar damage year is not possible to determine.

The scars from the blazes on living trees were dated with methods described by Barrett and Arno (1988). An increment borer was used to core samples from the outer bark through the healing lobe adjacent to the scar towards the estimated location of the scar tip (Fig. 2). Sometimes several cores had to be taken in order to hit the scar tip. If the scar tip itself was missed three times, an estimate of the year when the scar was inflicted was made with the help of the width of the adjoining rings from the one best sample which hit closest to the scar tip. When more than one scar was found on the same tree the same procedure as described above was undertaken for each scar. The samples were taken into the laboratory and examined with a microscope, counting the year rings from the last ring developed (the year 2000) into the scar tip thus determining the year when the blaze was inflicted. In addition, established dendrochronological pointer-years valid for the region were used for crossdating, to doublecheck the datings

according to methods described by Niklasson (1998). The pointer-years used in this case were for example 1832, 1868, 1889, 1890, 1901, 1902, 1914, 1959. This was done to determine possible missing or false year-rings (cf. Niklasson 1998). Missing year-rings seems to be extremely rare in this region (Kalela-Brundin 1999). Year-rings which are sometimes missing in the area is the year-rings of 1741 and 1928. Determination of the season of cambial damage from the inflicted scars was not done (cf. Niklasson et al. 1994). Even though the scar tip itself was hit, an uncertainty within two calendar years were added, in case the scar had been inflicted during the dormant season (see above).

To date the dead down-logs with unknown age, traditional crossdating was used. This method compares the variation of the width of the tree rings from a wood sample with the variation of the width of the tree rings from a known chronology thus matching the sample into a known time span. Scars in discs taken from dead down-logs were crossdated in the laboratory using local chronologies in the dendrochronological software program CATRAS, the width of the tree-rings was measured with the ANIOL measuring-device (Aniol 1983).

The ages of the blazes on the trees not sampled were subjectively classified as young living (0–100 years), old living (101+ years), dead standing and dead down-logs.

## 3 Results

### 3.1 The Trail According to Maps and Field Study

The total investigated length of the trail was 19.1 km. For 8.8 km (46%), the surface of the trail was destroyed by either scarification or roads for forestry operations. For 5 km (26%), the roadway was still visible and for 5.3 km (28%) of the investigated length the roadway was overgrown and invisible, but not otherwise physically affected.

### 3.2 Current Number of Scarred Trees along the Trail

In total 104 scarred trees were found along the part of the trail investigated (Table 2). Eighty-two trees were classified as having been blazed before the year 1900 (i.e. blazes were older than 100 years); 38 of these were dead, including both downed logs and standing snags (Fig. 3). Blazes classified as younger than 100 years were found on 22 trees. Mean diameter at breast height on the 82 old trees was about 30 centimeter and the mean length of the blazes on these trees was about 95 centimeter. On average these trees had been scarred 1.5 times. The 22 “young” trees had a mean diameter of about 25 centimeter. These trees were on average scarred 1.05 times and the mean length of the blazes was about 33 centimeters.

**Table 2.** Mean figures from 104 investigated blazed trees along the “Allmunvågen” bridle path.

Type of blazed tree <sup>a</sup>	Number of trees	dbh <sup>b</sup> (cm)	Length of blazes (cm) alongside <sup>c</sup>	Length of blazes (cm) inwards <sup>d</sup>	Mean scar year <sup>e</sup>	Times scarred <sup>f</sup>
Young	22	25	33 (n=26) <sup>g</sup>	32 (n=6)	1911 (n=4)	1.05 (n=22)
Old	44	33	93 (n=81)	56 (n=20)	1847 (n=27)	1.5 (n=45)
Dead	23	30	96 (n=39)	78 (n=13)		1.6 (n=23)
Downed	15	30	102 (n=19)	40 (n=1)	1765 (n=17)	1.5 (n=15)

<sup>a</sup> Young = living trees estimated to have been blazed since the year 1900. Old = living trees estimated to have been blazed before the year 1900. Dead = standing dead trees. Downed = dead downed trees.

<sup>b</sup> Mean diameter in centimeter at breast height.

<sup>c</sup> Mean length in centimeter of blazes pointing in the paths direction.

<sup>d</sup> Mean length in centimeter of blazes pointing inwards the path.

<sup>e</sup> Mean year when the blazes were made; only a selection of trees were age determined.

<sup>f</sup> Mean times the tree have been blazed.

<sup>g</sup> Sample size; blazes were found on one, two or three sides of the trees.



**Fig. 3.** Old snag (*Pinus sylvestris*), which repeatedly have been scarred, along “Allmunvägen” bridle path.

The scarred trees found were not evenly distributed along the investigated part of the trail (Fig. 1). Eighteen of the 82 old scarred trees were found on two separate 200 meter long sections (A and B in Fig. 1). This means that 22% of these trees were located on 2% of the investigated distance, making an average of 4.5 scarred trees per 100 meters on these sections.

### 3.3 The Age of Blazes on Trees Lining the Trail

A total of 20 living trees with 31 blazes in all were cored for to determine the age of the scars (Table 3). Scars from the period around 1800 to 1930 were found on the living trees. Sawn wood samples from six dead downed trees with 17 blazes altogether were also dated (Table 3). One of the samples had 223 dateable year-rings (1438–

**Table 3.** Scar years from 48 blazes made in 26 investigated trees along “Allmunvägen” bridle path.

idnr	Scar year 1 <sup>a,b</sup>	Scar year 2	Scar year 3
149	1527/28 <sup>c</sup>		
72	1711/12	1736/37	
26	1722/23	1748/49	1756/57
58	1742/43	1793/94	1804/05
	Scar year 4: 1815/16	Scar year 5: 1823/24	
6	1778/79	1788/89	1812/13
80	1794/95	1820/21	1836/37
47	1800(10)	1820(10)	1845(5)
84	1823(10)	1847(5)	1885(10)
35	1825(10)	1830(5)	1844(5)
100	1829(5)	1846(5)	1867(5)
104	1830(10)	1846(10)	
98	1840(5)		
63	1840(10)		
23	1844/45		
82	1845(10)		
89	1850(5)		
25	1850(5)		
70	1851(5)		
19	1851(5)		
77	1855(10)		
83	1865(10)		
91	1870(10)	1880(10)	
33	1880(20)		
66	1896/97		
87	1905(5)	1934(5)	
9	1910/11		

<sup>a</sup> Oldest detected scar. Many trees were scarred several times.

<sup>b</sup> Samples where the scar year ring was detected two calendar years is noted because if a scar was inflicted before radial growth has started or after radial growth has ceased the single calendar damage year is not possible to determine. Samples where the scar year ring was not detected, the noted year is followed by a parenthesis. In this cases an estimate of the year when the scar was inflicted was made with help of the width of the sampled year rings adjoining the scar year ring (see Fig. 2). Figures within the parentheses represent the appraised uncertainty of the age determination.

<sup>c</sup> Severely decayed, uncertain finding difficult to interpret.

1660), with the scar dated to the years 1527/28. However, this sample was severely decayed, making it difficult to interpret the origin of the scar. The other five disks with 16 obvious blazes dated from the years 1711/12 to 1836/37. Over half (56%) of the blazes, including both the living and dead trees, were dated to the period 1800 to 1860. One of the trees had five different blazes dating from the years 1742/43 to 1823/24.



**Table 4.** Tree ages in forest stands along “Allmunvägen” bridle path from forest inventories compiled between the years 1893 to 2000.

Inventory year	Stand age <sup>a</sup>			
	0–59	60–119	120–179	180–
1893	22 <sup>b</sup>	0	31	47
1920	14	19	26	41
1938	3	22	21	54
1952	14	26	29	31
1974	47	17	36	0
2000	67	18	15	0

<sup>a</sup> Figures from oldest tree-layer in stand mentioned in the different forest inventories.

<sup>b</sup> Percentages of investigated distance.

**Table 5.** Volume in forest stands along “Allmunvägen” bridle path from forest inventories compiled between the years 1893 to 2000.

Inventory year	Stand volume <sup>a</sup>				
	0–25	26–50	51–75	76–100	101–
1893	22 <sup>b</sup>	38	7	28	5
1920	5	69	10	15	1
1938	24	29	43	2	2
1952	10	32	17	28	13
1974	36	11	32	13	8
2000	51	8	12	6	23

<sup>a</sup> Cubic meter per hectare.

<sup>b</sup> Percentages of investigated distance.

### 3.4 Analysis of Forest Survey Records

The first forest inventory from 1876 covers the forest surroundings of roughly 25% of the investigated length of the trail. At this time about 15% of the forestland was classified as unforested. The forest had approximately 65 trees ha<sup>-1</sup> larger than 27 cm at breast height constituting approximately 48 m<sup>3</sup> ha<sup>-1</sup>. Windfalls and dead trees at a density of approximately 4.5 m<sup>3</sup> ha<sup>-1</sup> were present. No mean age was mentioned in the inventory. However, it is stated in the plan that the trees needed 180 years of growth to reach timber quality and approximately 16 such trees ha<sup>-1</sup> were present. In this inventory it is pointed out that the forests “suffer” frequently from forest fires and are therefore sparse and the trees are unevenly distributed. It is also mentioned in the plan that grazing occurs in the forest from early spring and can cause damage to seedlings.

The forest inventories from 1893, 1920, 1938, 1952, 1974 and 2000 cover the whole section of the trail investigated and contain comparable silvicultural data. According to the forest surveys of 1893, 1920 and 1938 the forest along the trail was dominated by older trees (Table 4). From 1893 to 1938 over 40% of the forest stands along the trail contained tree layers older than 180 years. Stands along the trail with a density between 76–100 m<sup>3</sup> ha<sup>-1</sup> decreased from 28% in 1893 to 2% in 1938 (Table 5). The proportion of the trail covered by thin stands of 0–25 m<sup>3</sup> ha<sup>-1</sup> decreased at the turn of the century, from 22% in 1893 to 5% in 1920 and then increased to 24% by 1938.

By the mid 20<sup>th</sup> century logging had begun to affect the mean tree age along the trail. In 1952 about 30% of the stands contained a tree layer older than 180 years. Stands with a density greater than 100 m<sup>3</sup> ha<sup>-1</sup> had increased to cover over 10% of the stretch.

By 1974 a major change had occurred and stands with a tree layer older than 180 years had disappeared. At this time young stands (0–59 years) covered almost half of the area investigated. This development was even more pronounced by the year 2000 when tree ages had decreased further, and the proportion of young stands had increased to almost 70%. This structural change also reflects changes in stand densities. Stands with a density of 0–25 m<sup>3</sup> ha<sup>-1</sup> increased from 36% to 51% between the years 1974 to 2000 and stands with a density exceeding 101 m<sup>3</sup> ha<sup>-1</sup> also increased during this period.

## 4 Discussion

The “Allmunvägen” bridle path is a very old trail that probably has been in use since medieval times. It is characterised by its terrain, running smoothly and strikingly on dry land and ridges (Fig. 4). Depressions have formed in the soil on the hillsides and ravines it crosses thanks to centuries of travelling hoofs and feet. Like ancient monuments, old pines with blazes can be seen on a few remaining parts of the trail (Fig. 5). The numerous, large scars, up to about a meter long, have caused characteristically large bulges on the tree trunks. Today, the majority of the scarred trees



**Fig. 4.** On some dry sections not clearcut, the roadway of “Allmunvägen” is still visible, even though all the blazed trees are logged.

are gone and most of the trail’s surface is barely visible. This is mostly due to forestry activities, such as logging, scarification and road building. Other human activities have also destroyed parts of the trail, for example damming of the nearby river for a hydroelectric power station.

#### 4.1 The Number of Scarred Trees along the Trail

The scarred trees lining the trail are today the key to understanding the route. Without the aid of blazed trees one could not distinguish the main road from, for example, a crossing game trail. The frequency of blazed trees had to be sufficiently high that a stranger could follow the trail without getting lost. “*The road was designated with markings in the trees, that an unacquainted man in this wilderness would not lose his way.*”, says for example Daniel Herweghr, during his trip along the trail in 1763 (Table 1 C). But how many scarred trees were there on an ordinary forest trail? In theory the distance between each scarred tree should not exceed the traveller’s view at any given moment. The highest frequency we found in our study area was 4.5 blazed trees per 100 meter trail, equivalent to slightly more than 20 meters



**Fig. 5.** Like ancient monuments, old pines (*Pinus sylvestris*) with blazes can be seen on a few remaining parts of the trail “Allmunvägen”. The multiple large scars, have caused characteristically large bulges on the tree trunks.

between each scarred tree. This frequency was found on two 200 meters sections, in the stands which were least affected by modern forestry. These sections are not located in completely unaffected stands, but in stands which have been exposed to only light, selective logging. Some scarred trees might thus have disappeared even on these sections. But whether this frequency should be seen as a minimum figure for this type of trail is nevertheless questionable. Depending on the structure and density of the forest and the trail's curvature, the frequency of scarred trees naturally varied. From the first forest inventories one can learn that large parts of the forest were severely affected by fires. Along some parts of the trail there might even have been a shortage of trees suitable for scarring. Indications of this could be seen during the field study as some scarred trees were situated quite far (5–10 m) from the roadway. Ågren (1983) found 143 scarred trees on a 1000 meter section of the so-called "Judges' trail" in Norrbotten. But this was a winter road and such roads often changed routes (Levander 1953). The blazed trees occurred in a wide zone and not along a specific roadway. But when only counting trees which had been scarred several times, representing the most likely course, an approximately 50 meter wide section appeared with a frequency of about six scarred trees per 100 meters. Along a summer path in a forest reserve in the coastal region of northern Sweden, Andersson and Östlund (2002) found an average of six blazed trees per 100 meters (about 17 meters between trees) and they report that the next scarred tree in line was almost invariably in sight when walking the trail.

How many scarred trees have disappeared along the bridle path "Allmunvägen"? Today's distribution, even in less affected stands, hardly reflects the former number of culturally scarred trees in the Swedish boreal forest (Östlund et al. 2002). We have nevertheless made a rough calculation that there may have been four scarred trees per 100 meters, on average. This adds up to an original total of roughly 760 blazed trees along the section investigated. We found 82 old blazed trees, 23 of which were standing dead trees and 15 were felled or down-logs and partly destroyed by forestry machinery. Sixty-seven trees remain in a natural and unaffected condition. A conserva-

tive estimate shows that around 90%, or 650–700 of the original blazed trees have vanished along the 19 kilometer stretch investigated. This part of the trail is also the most well preserved part of the entire 60 kilometer bridle path. The other sections have scarcely any trace of scarred trees and 15 kilometers run below the water level of a reservoir. On some stretches all the blazed trees had already been cut down in the late 19<sup>th</sup> century (Lindberg 1970, 1971).

Analysis of the forest surveys indicates that a majority of the scarred trees were probably still present throughout the 19<sup>th</sup> century. During the first logging period (about 1860–1890) only the largest pines of first grade quality were cut. But by the 1890s and during the first decades of the 20<sup>th</sup> century trees of poorer quality were harvested. Small and dry trees were cut for pulpwood and charcoal, also "inferior" trees were removed for "forestry" reasons (Malmström 1963). For example, by far the bulk of the timber felling proposed in the 1920s forest survey was designed for "cleansing" (trash logging) (Table 1 A). In the 1890s it was reported that a dry old pine, found at a resting-place along the trail and bearing carvings from the 18<sup>th</sup> century, was marked out to be cut by the forest ranger (Lindberg 1970, 1971). Stands containing old trees along the trail also decreased slightly in number in the forest inventories between 1893 and 1920 (Table 4). In the middle of the 20<sup>th</sup> century the impact of new logging methods, with clearance felling under seed trees, starts to be noticeable in the forest inventories with a higher percentage of younger stands. Many of the old blazed trees probably disappeared during this period. But the most dramatic decline of old trees is revealed in the forest inventories from the years 1974 and 2000, where no stands over 180 years are present. The age-class 0–59 years increases in proportion to 67% of the stands along the trail in the year 2000. This reflects the use of large-scale machine-based forestry with large clearings, together with subsequent scarification and seedling planting (Östlund et al. 1997, Ericsson et al. 2000). This development, involving large machinery in all phases of the logging and forestry operations, is problematic for the remaining culturally scarred trees. Even if a blazed tree is saved or, as in many cases, cut above the scar during the felling of the adjacent





**Fig. 6.** Blazed tree (*Pinus sylvestris*), along the “Allmunvägen” which has been scarred three times, in the years 1778/79, 1788/89 and 1812/13. The tree was cut above the scars and saved during the felling of the adjacent trees, but was later runned down by scarification machinery.

trees, it is often later run over or damaged by the machinery involved in transport of logs, planting or scarification (Fig. 6).

#### 4.2 The Age of Blazes on Trees Lining the Trail

It is very difficult to hit the scar tip when collecting samples with an increment borer and the method certainly produce some errors in the precision of dating. However, as stated earlier, we were very cautious about damaging these unique trees and therefore sampling with chainsaw was only done on dead trees and down-logs. Furthermore, the dating of the sampled scars were primarily done to get a overview of the time span when the blazes were inflicted and not to determine the single calendar year every tree was scarred. The 48 blazes in the 26 sampled trees lining the trail date from the early 1500s to the early 1900s. This indicates that the trail has been lined with scarred trees for at least 400 years. However, the single oldest dated scar (from the year 1527/28) is more difficult to interpret. This is a typical problem when studying culturally scarred trees, simply

because trees and wood deteriorate over time. Therefore the number of very old scars, as well as the possibility of interpreting them, does not reflect their former numbers (cf. Swetnam 1984, Alldredge 1995, Zackrisson et al. 2000). Also, the four youngest scars are shorter than most of the other scars. The mean vertical length of the blazes classified as “old”, i.e. scarred before the year 1900, were approximately three times longer than the blazes classified as “young”, i.e. scarred since the year 1900 (Table 2). Our interpretation is that as the importance of the trail gradually diminished, the blazes were made haphazardly and not in a consistent manner. When the trees were ordained to be blazed the scars were large, long and deep in order to last for a long time. But when made by an occasional hiker they were instead small, thin and shallow, probably with the intention of minimizing damage to the trees. Another indication of this is the fact that the “old” blazed trees were on average scarred about 1.5 times whereas the “young” trees were on average scarred about 1.05 times. One “old” tree had five blazes dating from 1742/43 to 1823/24. From medieval times the road maintenance was in principle obligated on the local peasants

(Montelius 2000). More regulated road maintenance was initiated at the beginning of the 17<sup>th</sup> century by the centralized Swedish royal power (Levander 1935). But even in the 16<sup>th</sup> century, several rulings were passed by local judges in northern Sweden concerning road maintenance (Friberg 1951). In a verdict from the year 1844, concerning the bridle path between Överkalix and Gällivare in Norrbotten, it is stated that the path should be carefully “marked out” (Hoppe 1945). The maintenance of the “Allmunvägen” road was also conducted by local farmers taking turns, up to the mid 19<sup>th</sup> century (Lindberg 1970, 1971). That over half of the sampled blazes dated from the period 1800 to 1860 is probably partly due to the fact that during this time the trail was still the main road to upper Dalarna. Another, simpler, reason is that preserved trees from before this time are very rare. Thus, determining the age of the blazes sampled cannot resolve the age of the trail, but it does support the theory that it was gradually abandoned towards the end of the 19<sup>th</sup> century and the first half of the 20<sup>th</sup> century. However, it is very likely that the trail is very old, probably dating from medieval times.

### 4.3 Changes in the Forest Structure along the Trail

In the first forest inventory from 1876, 15% of the forest land was classified as unforested. These areas probably represented relatively recent burns. The value of timber had only recently assumed any significance in upper Dalarna and anthropogenic set fires to promote pasture were still common in the mid 19<sup>th</sup> century (Ericsson 1997). ‘Unforested’ should not necessarily be interpreted as completely bare but often merely as a sparse forest with scattered large old pines (Kohh 1975, Ericsson et al. 2000). The high fire frequency probably resulted in an age distribution with many very old trees mixed with large areas of young forest. In the inventory from 1893 this is clearly shown. Almost half of the stands along the stretch investigated were older than 180 years and over 20% of the stands were younger than 60 years (Table 4). Many pines were very old, and in the inventory from 1893, it is reported that 167 pines investigated were between 120

to 400 years old. Another result of the high fire frequency was that the forest was sparse, with 60% of the stands containing less than 50 m<sup>3</sup> ha<sup>-1</sup> in 1893 (Table 5). In the first decades of the 20<sup>th</sup> century the forest was subjected to selective logging and old and damaged trees were removed (Malmström 1963). The mean age decreased at the same time as forest fires were suppressed and the areas of juvenile forest on old burned terrain had a chance to mature (Table 4). Middle-aged stands increased in proportion, while the oldest and youngest stands decreased. But there were still a lot of old as well as middle-aged trees present, making the forest multi-layered. Large clearings with subsequent reforestation accompanied by thinning during the second half of the 20<sup>th</sup> century created a fairly rapid change in the forest structure towards younger even-aged single-layered stands. Modern forestry has also affected the trail surface. Almost half of the trail’s surface was destroyed by scarification or forestry roads. Although the old path naturally runs along dry ridges and other smooth, easily accessible sections of the terrain, tractor and gravel roads are for practical reasons often laid out in the same line, thus ruining the old roadway. Large parts have also been destroyed by scarification for planting seedlings. Some of these actions have been carried out in recent years despite the best protective intentions of the landowners. This is probably due to poor communication between the supervisors and the machine operators. Sections where the roadway was still visible were characterized by dry land with poor fertility and, consequently, sparse ground vegetation.

### 4.4 The Disappearance of Culturally Scarred Trees

The scarred trees formed a characteristic feature of the “Allmunvägen” road. Several of the early travellers noticed the blazed trees and commented on them. The fact that the bridle path was an extension of a cart-road, but still functioned as the main highway, made them a striking feature. These early travellers, most of them coming from urban areas, emphasize the use of the markings for guidance in a vast unknown wilderness. The practice must have been commonly used along



footpaths and bridle paths in forested areas in the Scandinavian countries as well as all around the northern hemisphere (cf. Berg 1930, Merell 1998, Flanagan 2001). For example, at the beginning of the 20<sup>th</sup> century, an environmentalist argues against the “..still ongoing bad practice of scarring trees with an axe to designate forest trails..”, and suggests marking with paint instead (Örtenblad 1916). The change in attitude towards trees in the wake of the introduction of modern forestry techniques can also be seen in a forestry magazine from the early 20<sup>th</sup> century. The author reports on the current bad practice of scarring trees for a number of different purposes (Ernberg 1907), for example in designating trails, marking trees and felling areas for forestry operations, searching for straight-split wood by cutting holes in trunks, etc. But he is also most indignant about the fact that the scarring of trees, in his opinion, occurred mischievously all over the forest. He even suggests prohibiting cattle-tenders from carrying axes. This reflects how common culturally scarred trees must have been in the pre-industrial forest landscape. It also shows how the practices resulting in culturally scarred trees ceased, not only because of a change in the way of life in the forest but also as a result of campaigning by foresters (cf. Leslie and Johnson 1992). The remaining blazed trees along “Allmunvägen” are part of a broader heritage in the form of diverse culturally modified trees in boreal Scandinavia. The majority of these trees, which characterised the forest landscape only 100 years ago are now gone (Östlund et al. 2002). They have also been common in other areas where traditional forest use as opposed to modern forest management has been prevalent (cf. Hicks 1985, Mobley and Eldridge 1992, Lewis and Mobley 1994, Merell 1998).

The vast majority of the blazed trees along “Allmunvägen” have been removed during the last hundred years. In our data from the forest inventories the decline of stands containing old trees along the trail is very clear. From the year 1893 until 1938 about 50% of the stretch contained tree layers over 180 years of age. For the years 1974 and 2000 the figure is zero (Table 4). The great majority of remaining culturally scarred trees are today found in forest reserves. Andersson and Östlund (2002) compared the occurrence

of culturally scarred trees in a reserve in coastal northern Sweden with the adjacent managed forest subjected to modern forestry. They found 5.4 pcs. ha<sup>-1</sup> in the reserve and 1.8 pcs. ha<sup>-1</sup> in the adjoining forest. Seemingly, the establishment of forest reserves in areas with a large number of old trees is one way to protect culturally scarred trees. But there is also a small number of such trees remaining scattered in regular, commercial forests. One way to protect these trees is to identify and position them with a handheld GPS as we have done in this study. The data could then be integrated in a GIS, accessible by forest companies and other interested parties (Merell 1998, cf. Axelsson 2001). Some forest machinery today already contains GPS-integrated monitors whereby the operators can very accurately identify their position in relation to computed objects on the ground. This development is likely to continue in the future and could be an important tool in the work to save and protect culturally scarred trees. Furthermore, also more efforts and practical actions should be undertaken to restore and maintain ancient trails, especially in forest reserves. As shown in this study preserving trails by marking them with rapidly disappearing paint is not very effective. Instead they should be marked with traditional blazes which are visible for many decades or more.

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