Using tree-ring dating in hedgerow management at Homestead National Monument of America

By Richard K. Sutton

A few minutes past midnight on New Year's Day 1863, when the Homestead Act of 1862 took effect, Daniel Freeman filed one of the first claims at the Brownville, Nebraska, Land Office (Land and Community Associates 2000). He wisely selected his 160-acre plot, which is now part of Homestead National Monument of America, for its wood and water—resources often lacking on the prairie (Dale 1948). However, the wooded banks along Cub Creek, west of Beatrice, Nebraska, did not have enough timber for all his needs (e.g., buildings, fuel, and wooden fences). Hence, Freeman, like so many prairie settlers (Baltensperger 1987), adopted hedge culture as a way to demarcate property boundaries, control livestock, block wind, and provide fuel wood and fence posts (Hewes and Jung 1981). The historic Osage-orange (*Maclura pomifera*) hedgerow planted by Daniel Freeman is one of the few structures left from the time of his original land claim (Sutton 2005). One-half mile (805 m) of Osage-orange lines the southern boundary of Homestead National Monument of America and creates a backdrop to the nation's second oldest tallgrass prairie restoration (fig. 1). Managed by the National Park Service, the 244-acre (99 ha) national monument celebrates and preserves the history of settlement of the Great Plains during the era of the Homestead Act (1863–1986).

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Earlier settlement of the Prairie Peninsula in Illinois had spawned the use of hedges featuring Osage-orange (fig. 2, page 58). This tough, thorny tree was collected by Lewis and Clark near St. Louis, Missouri, but was more common to northeastern and southwestern Arkansas, northwestern Louisiana, and southeastern Oklahoma. Touted by pioneer planters in Illinois, Osage-orange grew quickly on dry, windy sites and responded to hedging in which sprouts are encouraged then pruned and woven into an impenetrable barrier using a technique called plashing (Overman 1858). Billed as a plant to make "horse-high, bull-strong, and pig-tight" hedges, the likeness of Osage-orange to the barbed wire of the 1880s in Illinois—where it was invented, patented, and manufactured—is no mere coincidence. Ironically, many Osage-orange hedgerows continue to provide rot-resistant posts onto which barbed wire is strung.

Park managers speculate that the age of the hedgerow at the national monument is about 135 years old. However, the original planting date is unknown, as are Freeman's actual uses and management of the hedge. The surmised age of the hedge suggests that the hedgerow trees may be reaching the end of their lifespan, though at least one Osage-orange specimen in Virginia, growing more than 1,000 miles (1,609 km) from its native range, is thought to be more than 300 years old. Loss or decline of the hedgerow represents an unacceptable historical and visual impact to the

Figure 1. Osage-orange hedgerow provides a historically significant backdrop for the tallgrass prairie restoration efforts at Homestead National Monument of America.

site and runs counter to the management policy to preserve and interpret these homestead resources for future generations. Hedgerows still grow nearby, but each year brings losses as a result of widening of roads and fields by county road engineers and farmers who covet the space that hedges occupy in the rural landscape (Sutton 1985).

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Based on recommendations of a cultural landscape report (Land and Community Associates 2000) and to verify the age of the hedgerow for the purpose of interpretation and cultural resource management, park managers contracted the University of Nebraska–Lincoln to study and draft a plan that (1) reviewed and analyzed the recommendations in the cultural landscape report; (2) focused on preserving the historic hedgerow's structure; (3) inventoried individual plants in the hedgerow to ascertain their condition, size, age, and location; (4) proposed a tree monitoring protocol and timetable; and (5) examined impacts of adjacent land use. The study recommended procedures, practices, and scheduling of hedgerow maintenance and proposed alternatives that addressed ecological and sustainable management. The study also identified potential interpretation of the hedgerow and opportunities for its connection to a proposed new heritage center.

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Figure 2. Prairie settlers used the thorny Osage-orange for live fencing, posts, and fuel. Pawnee and Omaha-Ponca prized it for bows (bois d'arc), arrows, and war clubs. Though inedible to humans, squirrels eat the fruit, and deer browse the leaves and young shoots until deterred by thorny stems.

Methodology

The researcher selected tree coring and dendrochronology as the methodology to address park management needs. The difference in seasonal growth of most woody plants leaves a concentric pattern of annual tree rings, which can be counted to determine the specimen's age. Dendrochronologists have conducted tree-ring dating for about 80 years, during which time the method has developed into a sophisticated archaeological and ecological tool (Stokes and Smiley 1968) that reveals general precipitation and temperature trends (Briffa et al. 2002), periods of drought (Dean 2001), and fire histories (Allen et al. 1995; Swetnam et al. 1999).

During the inventory of individual plants in the hedgerow, the researcher selected several large-diameter specimens, which likely represented some of the oldest trees. Six trees were sampled with a 12-inch increment borer. The use of the borer causes no harm to the tree because growth of the tree's cambium layer closes in the small-diameter hole within a year or two. However, one mishap occurred while taking sample 3: the bore tube snapped off inside the tree abruptly concluding sampling. Osage-orange wood, even when green, is extremely hard, and this contributed to the damaged bore tube. The large diameters of the sample trees coupled with the difficulty of tapping all the way to the trees' center piths led to incomplete (but useable) core samples.

After extraction, core samples were dried and glued into grooves cut into blocks of wood (fig. 3). The blocks/cores were then sanded with very fine sandpaper to reveal the annual growth rings. To make the best estimates of tree age, each growth ring was measured, and dated backward from 2004, the year of sampling. Counting and measuring was done on 600 dpi (dots per inch) scanned images of each sanded core. Ring width was averaged for the sample and used to extrapolate and predict the number of annual rings that would lead to the center of each sample tree. This method does have some problems: trees have a growth curve that may be faster in young trees; that is, the young growth rings tend to be larger than the older ones. The estimate did not account for this and represents a straight line rather than an S-shaped growth curve.

Results

Each sample was analyzed with a test of homogeneity of variances using Bartlett's test (SAS 1985). A common scientific practice to establish a rough estimate of a tree's age is dividing half of a tree's diameter by the average

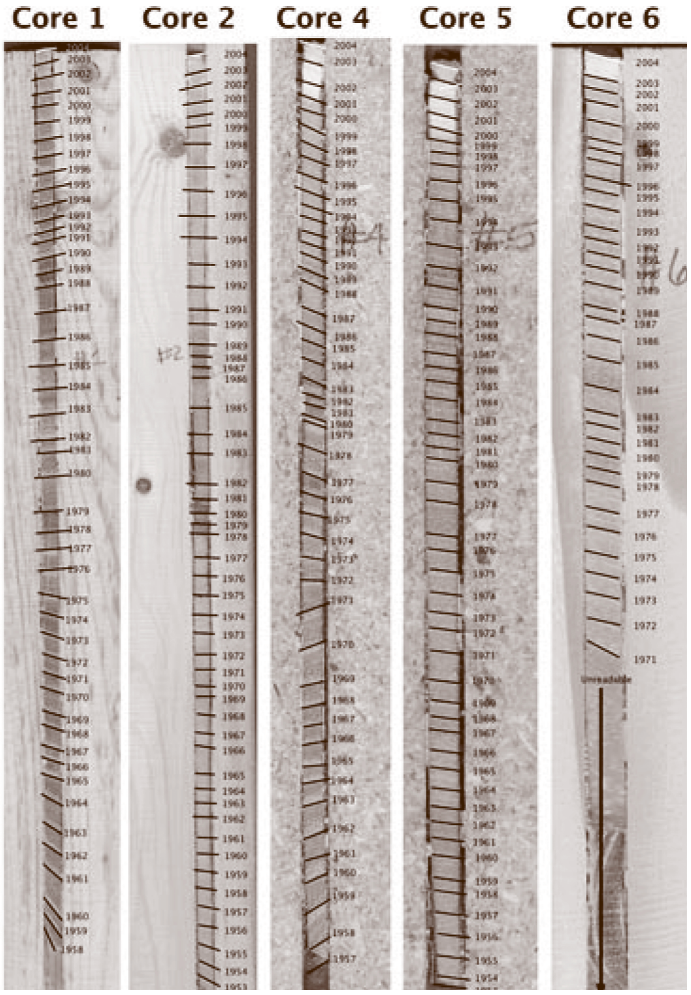

Figure 3. The researcher analyzed five cores from large Osage-orange specimens to estimate the age of the hedgerow. Coring of sample 3 ended abruptly when the bore tube snapped off in the hard Osage-orange wood. COPYRIGHT RICHARD K. SUTTON

yearly ring width then subtracting that number from the year of sampling. The mean tree-ring size was not significantly different across samples ($P>.895$), so the tree-ring widths were pooled and used for calculating age estimates (table 1). The pooled tree-ring width mean was 0.1688 inches (4.29 mm). The mean width of the annual rings of sample 1 was 0.1688 inches (4.29 mm); for sample 2, the mean width was 0.1776 inches (4.51 mm). The mishap during coring of sample 3 resulted in no data. For sample 4, the mean width was 0.1768 inches (4.49 mm), 0.1776 inches (4.51 mm) for sample 5, and 0.1692 inches (4.30 mm) for sample 6.

Interpretation

The core samples establish that the sampled trees postdate the original plantings of Osage-orange (table 1). Simply put, the present hedgerow consists of at least second-growth stump sprouts. This interpretation is supported by NPS photos taken in the early 1940s, which show thin, short wisps of suckering Osage-orange trees in a spindly hedge with large gaps (fig. 4, page 60). The data suggest that all or some sections of the hedge were cut for fence posts just prior to the National Park Service acquiring the land in 1936. This interpretation corresponds to the practice of harvesting trees during the Great Depression, which was common in Gage County, where the national monument is located.

At several places in the hedgerow, large Osage-orange trunks spring from the periphery of old stumps (fig. 5, page 60). The larger of these stumps range from 1.5 feet to 2.0 feet (0.5 m to 0.6 m) in diameter, which is about the size of the larger live trunks within the hedge, which sprouted between 1934 and 1938 (table 1). The stumps are most likely the remnants of Freeman's original Osage-orange plantings. Because Osage-orange wood is rot resistant, stumps may have survived many years past harvest. The only method to examine the stump's age would require digging out the stump and carefully sawing a section through it. This destructive sampling would not be easy because Osage-orange wood of that age would resist most saws. Furthermore, digging out a stump would damage the stump's roots and the intertwined roots of neighboring trees, which are most likely alive with the potential to resprout and should be preserved.

Application to management plan

The hedgerow is a significant social, historical, and cultural feature at Homestead National Monument of America. Settlers adapted and adopted plants, animals, technology, and social systems to survive and prosper on the Great Plains. Osage-orange hedgerows are one of the best examples of the integration of all of these accommodations. Though "historical," that is representing a moment in time, hedgerows cannot simply be preserved in a static state but must also be managed as a dynamic,

Table 1. Estimated ages of selected Osage-orange stems at Homestead National Monument of America

Tree	Diameter / 2 inches (mm)[1]	Estimated date of sprouting[2]	Age in 2004
Sample 1	11.64 (295.66)	1935	69
Sample 2	11.82 (300.23)	1934	70
Sample 3	No data		
Sample 4	11.12 (282.45)	1938	66
Sample 5	8.64 (219.46)	1953	51
Sample 6	8.10 (205.74)	1956	48

[1]Rounded to nearest 100th.

[2]Based on pooled tree-ring width (0.1688 inches [4.29 mm]).

living resource. Individual trees are managed to bring about the favorable growth, development, visual character, and interpretation of the hedge. The hedgerow serves as wildlife habitat and a corridor, connecting bottomland and upland, and provides erosion and wind control. These are benefits that most often fall under the province of natural resource management. In this case, the hedgerow serves multiple purposes and functions: it is part of a cultural landscape requiring natural resource management to preserve and science to understand.

Because Osage-orange is not a native plant, like those found in the monument's woodlands and prairies, the hedgerow's cultural and historical status assumes the primary reason for its management. The hedgerow planting is next to a prairie restoration area (not unplowed native prairie). To the south of the hedge is crop ground that has been in production since at least the time of Freeman's homestead. Osage-orange is not reproducing at a problematic rate, and neighbors of Homestead National Monument of America do not consider it a pest. In actuality, natural resource managers have a bigger problem with native wild plum (*Prunus americana*) and native smooth sumac (*Rhus glabra*) invading the prairie than with Osage-orange. Recently the Friends of the Homestead National Monument of America were instrumental in gaining funds for the purchase of a conservation easement along the south side of the Osage-orange hedgerow. This will allow control of the invasive, native eastern redcedar (*Juniperus virginiana*) now growing there and obviate hedge management difficulties.

The management plan recommends that the hedgerow be managed in permanently marked "units." Because harvesting has occurred in the hedgerow in the past, most likely in clear-cut sections (see fig. 4), use of sectional clear-cuts as management units would not be contrary to the historic scene. Moreover, dividing the hedgerow into management units would bring flexibility to planning yearly work and help identify and prioritize the uses, locations, and timing of hedging activities. The management plan proposes three spatial and temporal schemes for the preservation, rehabilitation, and scheduled maintenance of the historic hedgerow:

Scheme 1: Infill and rejuvenate

The simplest and most straightforward scheme for managing the hedgerow would be to propagate specimens and replant to fill its gaps, cut and rejuvenate certain key plants, and allow the hedge plants to continue growing and become trees. This management technique is now used with most hedgerows in southeastern Nebraska and eastern Kansas. While relatively simple to accomplish and less labor intensive over the long term,

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Figure 4. The National Park Service purchased Daniel Freeman's homestead in 1936. In 1941, when this photo was taken, the Osage-orange hedgerow was spindly and full of gaps. The lower, shrubby vegetation to the left of the largest gap (near the center of the photo) shows regrowth after cutting for posts several years earlier. NPS

Figure 5. The Osage-orange hedgerow at Homestead National Monument of America is a multifunctional resource with primarily cultural but also ecological values. The stump in the photo represents Freeman's original planting and serves as evidence of past harvesting activities. The tree trunks, which postdate the stump, represent sprouting that occurred around the time of the Great Depression, prior to NPS purchase of the site. COPYRIGHT RICHARD K. SUTTON

this scheme misses the opportunity to depict and interpret the hedgerow as a historic structure in the context of Freeman's homestead in particular and many eastern Great Plains homesteads in general.

Scheme 2: Mimic 1870s management techniques

One possible way to address the need for interpretation and facilitate long-term management of the hedgerow would be to follow Scheme 1 for most of its length, but establish a section of hedge using 19th century techniques of cutting, pruning, and plashing near the new homestead heritage center.

Scheme 3: Integrate management and expand interpretation

A more ambitious plan would be to focus a portion of the proposed homestead heritage center's interpretive space and adjacent landscape on the theme of hedgerows and their suitability to settling the eastern Great Plains. Scheme 3 would be in addition to Scheme 2.

Because Osage-orange will resprout after cutting, management units of the hedgerow can be cut and the harvested trees readily sold for posts. This sustainable harvesting is in keeping with previous techniques of management by the Freeman family during the Great Depression (see fig. 4). Also, such management techniques of Osage-orange hedgerows are in keeping with active interpretation in a living history setting.

Summary

The management plan for the Osage-orange hedgerow at Homestead National Monument of America incorporates a blend of natural and cultural resource considerations, where natural resource management can help achieve cultural goals. Ascertaining the age and growth rate for the hedgerow allowed the researcher to propose a dynamic rehabilitation and management plan that can be interpreted to the public. Such interpretation is important in explaining that Osage-orange hedgerows had a distinctive place in the 19th and 20th century agricultural landscape of the Great Plains, while still providing aesthetic, ecological, and economic benefits in the 21st century.

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About the author

***Richard K. Sutton**, PhD, a landscape architect by training, was the principal investigator of this study. Sutton is an associate professor at the University of Nebraska–Lincoln and can be reached at 402-472-1127 and rsutton1@unl.edu.*