How Ohio's Three Large Landscape Prairies Persisted into Modern Times

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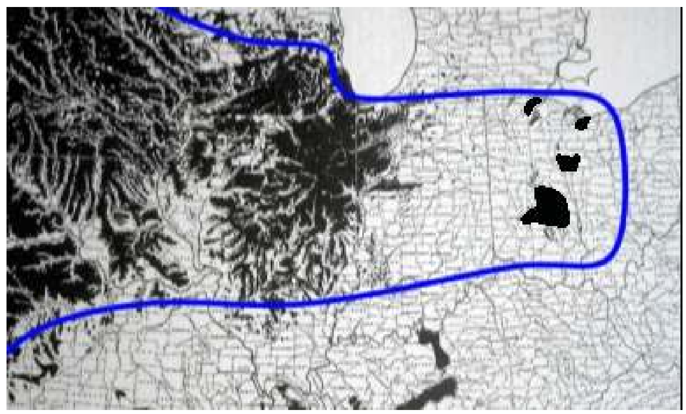
The imputed factors that (a) first caused the appearance of massive, landscape-scale tallgrass prairies in Ohio (and elsewhere in the more humid portions of the Midwest), and (b) the factors that then maintained those giant prairies, have been contentious and poorly substantiated for many decades. The origin and persistence of upland herbaceous vegetation in the more arid portions of the Midwest and Central Plains are not in much dispute. In Nebraska, Wyoming, and other arid states there is, for the most part, simply insufficient precipitation to support large woody plant communities, whether shrub/scrub or forest communities. The prairie vegetation of these arid regions is decidedly controlled by subdued annual precipitation.



But in the Prairie Peninsula, from Iowa to Ohio, the core of classic tallgrass prairies in the Midwest, two major questions arise.

The first question, the origin of the historic Midwestern tallgrass prairies, from the Missouri River to central Ohio, is no longer in great contention. Transeau and others have shown conclusively that an approximate 4000yr interval of much drier climatic conditions, from about 8000 BP to 4000 BP, suppressed trees and shrubs in the region, allowing more drought-resistant grasses and forbs to predominate. The palynological evidence (archeological pollen records) for this Xerothermic Interval is abundant and well studied. Consequently, the climatological causes of the incursion of tallgrass prairie eastward into the otherwise damp and forested portions of Illinois, Indiana, and Ohio, are no longer in contention. For a lengthy period of time the cogent portions of the Midwest were simply too dry to support eastern deciduous forest trees, in spite of adequate annual precipitation to the north and south of the Prairie Peninsula. In the peninsula proper, chronic arid conditions stressed woody plants, allowing more drought-tolerant herbaceous grasses and forbs to dominate.

As mentioned, this has been well-studied and described, and will not be deliberated here. Tallgrass prairies came into Ohio because of the lengthy Xerothermic Interval, when the climate was simply much hotter and drier than today in the Prairie Peninsula. Trees couldn't proliferate. Prairie grasses and forbs could.

But the second, bigger question will be addressed: How did Ohio's three massive landscape-scale tallgrass prairies persist over such large land masses *after* the Xerothermic Interval, when annual precipitation returned and persisted in amounts that would spontaneously support eastern deciduous forest communities?

Specifically, how did the approximate 100 sq mi of the Firelands Prairie, the approximate 700 sq mi of the Sandusky Plains prairies, and the approximate 1100 sq mi of the Darby Plains tallgrass complex (a total of 1900 sq mi; about 4.6% of the land area of Ohio) remain forest-free for 40 centuries?

One crucial fact must be kept in mind for this discussion. The entire matter centers on the following ecological truth: **Prairie plants are shade-intolerant and cannot persist in the shade caused by invading shrubs or trees.** Shrubs and trees suppress and eliminate prairies. What factors, then, could have kept woody plants from growing in and shading out large tallgrass prairies in Ohio? This has perplexed tallgrass prairie observers from the beginning.

The first to confront the issue (unsuccessfully) were the early Europeans who encountered Midwest tallgrass prairies, French traders in the 16th and 17th centuries. As trappers and traders of beaver and other animal skins and trade-goods, the early French explorers and entrepreneurs had no interest in ecological accuracies. They had no cultural imperative to explain the persistence of the large grasslands they encountered, or why there were no trees there. They merely had to give these open landscapes a name: “prairie,” French for meadow. Not forest. Not shrub/scrub. Not wetland. “Prairie,” meadow, as a descriptor, was sufficient. But the term “prairie” describes the vegetational aspect of this unique plant community. It offers no explanation of the community’s historic persistence, of how trees were kept out for several thousand years after the Xerothermic.

The immediate question bedeviled virtually every first-time European prairie visitor. What’s this giant patch of meadow doing out there, with inordinately tall grasses and dense forbs, surrounded by more normal, expected, and understood deciduous forest?

From the start, and until today, there are only a few reasonable explanations for the chronic persistence of un-forested tallgrass prairie landscapes in the humid Midwest, especially Ohio. These explanations include (but are not restricted to) the following, enumerated factors.

1. The prairie vegetation was too thick to allow the growth of woody plants.
(Explanation One — Prairie Vegetation Out-competed Woody Vegetation)

Upon first examination of a mature tallgrass prairie, it can seem obvious that the density of tallgrass prairie stems and leaves simply preclude the growth of woody plants. The tallgrasses and forbs shade seedling woody plants attempting to germinate and grow in a tallgrass prairie; and below ground the extensive occupying mass of prairie roots and rhizomes seem to further favor the existing herbaceous grasses and forbs. Both above ground, by shading, and below ground by competition, tallgrass prairies appear to effectively suppress woody plant growth from the seedling stage. Germinated acorns and the seeds of other woody plants in a thick, mature, tallgrass prairie would appear unable to establish and grow sufficiently in the shading density and underground competition of a mature tallgrass prairie. No one would intelligently plant a seedling deciduous tree in a mature tallgrass prairie and expect it to be able to eventually grow above the shading and competitive tallgrasses and forbs.

But, in fact, this occurs in the three large prairie areas of Ohio, *without exception*, where various disruptions of normal tallgrass prairie growth do not occur. Readers are encouraged to discover a mature native tallgrass prairie in any of the Big Three Ohio prairie areas that if left for five to ten years of normal, un-disrupted growth that does not soon become invaded by brush and trees. There are no such prairies.

The density of stems, leaves, and roots of the herbaceous vegetation of any Ohio tallgrass prairie simply *does not* prevent woody species from colonizing and eventually dominating the site's vegetation.

In every case, experience has shown that landscape-scale tallgrass prairies in Ohio are not self-sustaining "climax" plant communities. Without disturbance, whether natural or anthropogenic, these Ohio tallgrass prairies will succeed from a solely herbaceous plant community to one dominated by shading woody species, at first shrubs; and then later, trees.

In summary, the shading density of stems and leaves, and the below-ground density and competition of prairie roots and rhizomes simply do not preclude invasion and eventual site-capture by woody brush and trees. ***Large tallgrass prairie landscapes in Ohio are not self-sustaining climax communities.*** Without disturbance that suppresses shrubs and trees, they are soon invaded and taken over by woody species. The shade of the woody plants kills the shade-intolerant prairie plants and the prairie is lost. It fails to persist.

2. The site was too wet for trees to grow.
(Explanation Two — Hydric Soils Prohibited Trees)

Another explanation for the millennial persistence of Ohio's large prairies is that they occur on poorly drained topography, with perennially wet soils. It is presumed by this prairie-persistence explanation that (a) there are many prairie species adapted to persistently wet soils (such as *Spartina pectinata*, prairie cordgrass, among many others), and (b) the soils are simply too wet for the establishment and persistence of shading woody vegetation. The presumption is that shading trees and shrubs simply can't persist in perennially wet soils.

This is an error, as evidenced by Ohio's largest (now drained) wetland, the massive Black Swamp of northwest Ohio. The utterly flat, lacustrine soils of this original Ice Age lake bed remained wet for most or all of most years. Nonetheless, virtually the entire region was wooded — with trees that actually thrive in wet, inundated soils, such as several species of *Fraxinus* (ash) and *Ulmus americana* (American elm).

To explain the persistence of landscape-scale wet prairies by exclusion of woody species suppressed by wet soils is simple ecological inaccuracy. There are any number of trees and shrubs that grow well and dominate in perennially wet soils, not only in the great Black Swamp, but throughout the Ohio Big Three prairie areas.

In summary, wet soils simply do not preclude the growth and eventual shading dominance of shrubs and trees in the landscape-scale prairies of Ohio.

3. The site was too dry for trees to grow.
(Explanation Three — Xeric Soils Prohibited Trees)

A converse explanation for the persistence of some tallgrass prairies in Ohio is that they are on very dry, xeric soils — too dry for the growth of dominating trees and shrubs.
But experience in the Big Three prairie areas shows this explanation to be in error. The driest soils in Ohio are composed of porous sand, with ample examples in the Oak Openings region west of Toledo. Yes, the Oak Openings have a few presently un-vegetated moving sand dunes. Ostensibly, these poorly-vegetated sand dunes and expanses appear to support the explanation that utterly dry sand soils do, indeed, preclude woody plant growth.

At NASA's Plum Brook Station, in the Firelands Prairie, several hundred acres of beach-ridge sand support a prairie-oak savanna complex. But the oaks (and now, other tree species) are rapidly overtaking and shading out the herbaceous prairie species of the site, coincident with the termination of mowing and burning by NASA in the 1970s. The photo shows the oaks growing on a sand ridge of the site. The bare sand in the foreground resulted from sand excavation. Small trees, mostly oaks, are slowly re-invading the bare sand. In a generation, the entire sand hill will once again be (as in the un-excavated rear area) oak savanna or forest.

It should be noted that precipitation in Ohio falls in rather uniform amounts in all seasons of the year. Ohio does not have a consistent or prolonged “dry season.” Instead, one to five centimeters typically falls in each Ohio month. Pure sand substrates simply are not left without precipitation for lengthy periods of time. Were this so, woody species would probably be precluded from pure sand soils in Ohio. But in every case of xeric soils in the Big Three prairie areas of Ohio, trees and shrubs will eventually grow and capture such sites, as the historical record shows.

In summary, there are no Ohio soils in Ohio’s landscape-scale prairies persistently too dry to preclude woody plant growth. The even, consistent month-to-month precipitation patterns of Ohio climatology maintain enough moisture in even the driest sands to support eventual woody plant growth and dominance.

Too-dry soils do not explain the persistence of Ohio’s large prairies since the end of the Xerothermic Interval approximately 4000 years ago.

4. The soils were too dense or rocky for tree roots to grow sufficiently.

(Explanation Four — Dense or Rocky Root-zone Prohibited Trees)

Another edaphic (soil environment) explanation for the persistence of Ohio prairies (and the local absence of woody plants) is that some prairie sites had soils so rocky that even with consistent precipitation insufficient moisture was retained or available for woody plant growth; thereby allowing xeric prairie plants to persist.

In fact, this *is* an explanation for at least one Ohio prairie, the Marblehead Peninsula prairie in Ottawa County. Most of this site has been quarried away for the high-quality limestone that existed at the surface, with little or no overlying soil.

Contemporary examination of the vegetation growing in the Marblehead quarry will show that, indeed, large expanses of exposed limestone are void of all vegetation. But historical accounts note that before the limestone was quarried, there was a very thin, localized topsoil that supported *Schizachyrium scoparium,* little bluestem; *Bouteloua curtipendula*, sideoats gramma, and a few other xeric prairie species.

This explanation for the persistence of prairie in Ohio is accurate — but only for a very few, select sites, such as the former Marblehead Peninsula prairie in Ottawa County, and perhaps a few rocky hillside prairie sites in Ohio, particularly a few of those in Adams County. It is nowhere an ecological factor in the Ohio Big Three prairie areas.

5. The soils were too infertile for woody plants to grow.
(Explanation Five — Nutrient-Poor Soils Prohibited Trees)

Another plausible explanation for the historical persistence of some tallgrass prairies in Ohio would be that many were located on nutrient-poor soils that could not otherwise support the growth of shading woody plants.

Again, there simply are no cases of soils in Ohio's Big Three prairie areas so nutrient-poor that no woody vegetation can grow on them. The presumption here would be that trees require more nutrients to grow than prairie plants; that prairie plants are adapted to and thrive on nutrient-poor soils. There is no evidence for this notion whatsoever.

Nutrient-poor soils do not explain the persistence of Ohio's large tallgrass prairies from their origin during the Xerothermic Interval. Shading trees can grow on all the soils of Ohio.

6. The site was too windy and woody plants dried out.
(Explanation Six — Drying Winds Killed Trees)

This is an explanation used to explain dry prairies on windy bluffs above the Mississippi and Missouri rivers and elsewhere to the west of Ohio. There is some evidence that hot, dry, summer winds wafting across high river bluffs can sufficiently suppress woody plant growth so that drought-adapted prairie plants can persist.

But the landscapes of Ohio's Big Three prairie regions are markedly flat, without wind-concentrating bluffs.

Simply, in all of the Big Three areas there are no tallgrass prairie sites where invading woody vegetation is kept out by long-lasting dry winds that kill or suppress woody vegetation. Drying winds do not explain the persistence of tallgrass prairies in Ohio's three large landscape-scale prairie areas.

7. Large animals over-grazed and suppressed shading woody vegetation.
(Explanation Seven — Herbivores Suppressed Trees)

In presettlement Ohio, there were two large grazing animals that might have selectively eaten woody shrubs and trees invading tallgrass prairies: *Odocoileus virginianus,* the white-tailed deer, and *Cervus canadensis*, the elk. Deer are preferential browsers, eating woody bark and stems. Elk both browse and graze (eat herbaceous vegetation).

Evidence that either deer or elk can suppress woody plant invasion into Ohio tallgrass prairies is limited. Elk, of course, no longer exist in the wild in Ohio; but contemporary white-tailed deer populations are large. Because of their preferred browsing habits, deer would be the greater ecological factor in the putative suppression of woody plant invasion of large tallgrass prairies.

A number of contemporary large Ohio tallgrass prairies have large white-tailed deer populations, and there is no evidence that deer adequately consume and suppress woody plants in these prairies. A classic case of this is the large NASA Plum Brook Station in Erie County, located on the original Firelands Prairie. White-tailed deer populations at the Station have been large since at least the 1970s, when annual controlled hunts were initiated to help control the expanding deer populations.

Irrespective of the large resident deer populations at Plum Brook Station, woody brush has simply overtaken every herbaceous landscape where mowing, prescribed fires, or other brush-suppressing measures have not been undertaken.

At no prairie site in Ohio's large prairies is there evidence that deer (or elk) populations originally or presently suppress shading woody plant invasions. The stripping of a seedling dogwood's leaves and bark in summer by deer browsing does not kill the shrub; it merely prunes the plant which regrows from the un-browsed and un-harmed root crown. At no known Ohio site are deer populations so dense that browsing of re-growth actually kills seedling and small trees and brush.

In summary, there is no evidence, historical or contemporary, that herbivore browsing of woody stems and leaves adequately suppresses invasion of landscape-scale tallgrass prairies by woody species.

8. Windstorms or tornadoes felled local trees, allowing herbaceous vegetation to dominate the site in the absence of tree shade conditions.

(Explanation Eight — The Windfall and Open Sky Factor)

This explanation for the persistence of tallgrass prairies in Ohio presumes that (a) prairies were first excluded by the shade of existing trees, and that (b) when the shade was removed by the storm windfall of the trees, prairie seeds in the forest soil could quickly utilize the intense, unshaded sunlight and grow faster and more competitively than woody species.

This explanation fails on two accounts. It fails to explain how a viable prairie seed reservoir might have accumulated and persisted for centuries under a shading forest canopy. Secondly, it presumes (incorrectly) that seedling prairie grasses and forbs are able to grow quickly and rapidly overtake the concomitant growth of shrub and tree seedlings. There is no evidence for either of these essential suppositions.

Even if the forest windfall hypothesis were locally valid, it would fail to explain the magnitude of Ohio's several large prairie landscape areas alluded to, all of which are hundreds of square miles in size. Tornados and windstorms simply don't leave swaths of fallen timber of such sizes or shapes. Lastly, tornados and windstorms happen rather randomly across the state. Tallgrass prairies, however, did not; they were most prevalent in the large prairie areas. The windfall hypothesis fails to explain the location, size, or shape of Ohio's tallgrass prairies.

9. Guano from passenger pigeon nest colonies killed all vegetation.
(Explanation Nine — Pigeon Guano Killed Trees)

There are records of large bald spots that persisted in the forest for decades where large nesting colonies of passenger pigeons had been established. But as with the forest windfall explanation, the passenger pigeon excrement explanation fails to account for sufficient prairie seeds in the quano-killed areas. Clearly, passenger pigeons did not eat the seeds of Ohio prairie grasses or forbs (they ate forest mast), so the birds themselves did not seed the bald areas. And quano-killed forest areas simply were never the size of Ohio's landscape tallgrass prairies.

10. Lightning-caused fires suppressed woody plant growth.
(Explanation Ten — Lightning-caused Fires Killed Trees)

There is abundant evidence that tallgrass prairies re-grow with vigor and density following a burn. It is now universally understood that large tallgrass prairies in Ohio are fire-adapted and thrive and persist with the frequent occurrence of fires — so much so that many have proposed that the only plausible explanation for the millennial persistence of big prairies in Ohio since the end of the Xerothermic Interval could have been solely by frequent lightning-caused fires in those prairie areas.

The role of lightning in the cause of frequent landscape fires in the West is well understood. Lightning storms in the West commonly occur with little or no rain, so fuels can be ignited without the fire suppression of concurrent rain.

But this is not the case in Ohio. Clearly, lightning does cause fires in Ohio — but almost never in forests, prairies, or other natural Ohio wildlands; only in fire-prone structures, for several reasons. First, ground-striking lightning in Ohio almost always occurs with storm rains, which dampen fuels and prevent the ignition of wild fuels. Secondly, lightning in Ohio tends to occur from late spring through late summer and early fall, when prairies and other Ohio vegetation communities are green and in growth. A lightning bolt into an Ohio prairie in June through September, even in the absence of rain, will fail to create a large landscape-scale prairie fire. Green, wet, growing prairie vegetation simply cannot support a spreading fire of any cambium-killing heat or intensity.

The prairie-fire-by-lightning explanation fails because lightning in Ohio most frequently occurs with dousing rains, and most frequently in periods when the prairie vegetation is moist. Those who have conducted prescribed prairie fires in Ohio are familiar with the inability of green and moist fuels to sustain a fire. Green, growing, wet prairie vegetation simply does not burn, even if struck by lightning.

The final difficulty with the lightning explanation for the persistence of tallgrass prairies in Ohio since the Xerothermic Interval is the isolated and localized locations of the prairies in the state. Lightning storms occur randomly and without pattern or exclusion across Ohio — but prairies are markedly localized. They did not appear as randomly and dispersed as thunderstorms. If lightning were the prime explanation for the persistence of Ohio prairies, why, then, did large prairies persist only in the Firelands Prairie in northern Ohio, the Sandusky Plains prairie area in north-central Ohio, and the Darby Plains prairie area in west central Ohio? If lightning were the primary persistence factor in Ohio prairies, prairies should have occurred randomly and evenly throughout the state. They do not. Interestingly, a freedom of information request detailing the contemporary occurrence of lightning-caused Ohio fires that were suppressed by local fire departments supports the understanding that lightning in Ohio is incapable of starting sufficient prairie fires to maintain them for the centuries following the end of the Xerothermic Period.

Ohio fire departments are required to report to the State Fire Marshal telling all cogent information regarding fires the departments respond to. A request was made asking for the number, location, and nature of reported lightning-caused fires in Ohio landscapes, particularly in herbaceous vegetation, such as crop fields, pastures, and meadows. There were almost none. There are few, if any, modern records of lightning-caused wildfires in herbaceous vegetation in Ohio, whether in natural vegetation, or agricultural. In Ohio, lightning simply does not often strike in herbaceous fuels, and when it does, it seldom ignites those fuels which are most often moist from normal growth or rainfall.

The explanation of the persistence of Ohio tallgrass prairies in the humid climatological conditions following the Xerothermic by natural lightning-set landscape fires is without a shred of evidence of this ever happening.

11. Humans frequently set landscape fires that killed or suppressed woody plant growth.

(Explanation Eleven — Anthropogenic Fires Killed Invading Brush and Trees)

One final explanation for the persistence of large Ohio tallgrass prairies remains: that for centuries Native Americans consistently and deliberately set afire Ohio's big prairies. This is the only explanation with abundant evidence and plausibility.

A detailed reading of the pre- and early-settlement literature describing landscape conditions in the 18th and 19th centuries in Ohio will reveal many dozens, if not hundreds, of specific accounts of landscape fires ignited by Native Americans across the state. These fires were frequent and annual; with only weather-suppressed short intervals of fire absence.

Some of the best early accounts of these fires are in the historic literature of the Firelands Prairie in Erie and Huron Counties in northern Ohio. With the opening of the Erie Canal in 1825, a massive migration of New Englanders into the fertile lands of the Connecticut Western Reserve in northeast Ohio began. These settlers were literate and articulate, and frequently recorded their early-settlement, pioneer experiences. Prominently, in Erie and Huron Counties the Firelands Historical Society was formed in 1857, deliberately to record the written accounts of settlement experiences earlier in the century. From these, recorded in the *Firelands Pioneer*, are specific accounts of the annual fires on the large Firelands

Prairie, with details on their anthropogenic (Native American) origins.

Simply stated, both on the Firelands Prairie and in the other two large Ohio prairie regions, copious historical documents describe how Native Americans set those prairies on fire each year, to (a) herd game to constrained killing points in late autumnal fires, (b) to clear invading brush from both prairies and forests, (c) to open long sight lines in prairie areas (to detect human incursions), and (d) to facilitate spring and early foraging for prairie onions, groundnuts, and other foods.

In presettlement times, Native Americans lived on the land, not on farms or in cities as with later European settlers. Native Americans knew first hand that if Ohio prairie areas were not annually burned, they quickly, in a few years (as we also see today), succeeded to thick, impenetrable brush. To allow a local prairie to ecologically succeed to brush would directly jeopardize Native American survival. Without ample reserves of dried and fruit-impregnated venison (pemican), survival through an Ohio winter would be questionable. Animal hides were also required for clothing. The artful use of flame fronts across an Ohio prairie in October or November herded and directed deer and elk toward constraining points where the ungulates could be slain by ataltls and spears. (Bows and arrows did not arrive in Ohio until the 7th century CE.)

The frequency (annual) of human-set fires on Ohio landscapes was not only on prairies. Native Americans also frequently set afire the leaf litter of the state’s forests, as revealed by the virtually universal settler accounts stating that early-settlement forests in Ohio were open and park-like — unlike the brush-laden forests of today, where brush-suppressing ground fires are absent.

Presettlement aboriginals needed to move across local landscapes with the greatest ease. Before horses came into human use, probably in the 16th or 17th centuries in Ohio, humans could move only by walking. This was greatly impaired or prohibited by the occurrence of brush in either forests or prairies. Annual fires, whether on the large prairies, or in the leaf litter of the forests, suppressed brush growth and allowed pedestrian mobility.

Today, wildfires are generally regarded as destructive of natural ecosystems. Native Americans, across the continent, never perceived wildfires in this regard. Contrarily, landscape fires were almost universally regarded as favorable to both humans and native vegetation communities. The only thing wildfires destroyed, whether human-set or by lightning (so infrequently in Ohio), was mobility-impairing brush patches.

In the chronic absence of Ohio landscape fires, Native Americans simply would not have been able to survive in prairie areas, as vegetation succeeded to massive, impenetrable brush areas, and thick brush would also impede mobility in forests. The slaying of sufficient ungulates (deer and elk) by mere stalking, without the assistance of game-driving smoke and fire lines would be improbable.

Deer were essential for Native American survival in all presettlement periods, for two purposes. Without ample stores of dried venison, winter protein sources were otherwise meager. Of equal or greater importance was the use of deer hides for clothing. Simply, deer had to be slain in appreciable numbers each year, and that would have been difficult if both forests and prairies were allowed to succeed to thick brush, as naturally occurs in most of Ohio in the absence of frequent fire.

Native Americans were unable to know the following physiology, but it also played a crucial role in deer killing and prairie fires. Modern research has shown that the grasses and forbs emerging from a burned tallgrass prairie have about twice the protein content of such herbaceous vegetation growing in years without a fall or spring burn. Burned prairies produce very nutritious vegetation, which was exploited by migrating deer and elk. Pregnant deer and elk migrated to burned prairie areas to produce ample lactation. Then, later in the autumn, human-set fires would drive these new ungulates to constrained killing points, providing aboriginals with venison and hides for the winter and following year.

A very detailed article could be written on all of this; but the matter of the millennial persistence of Ohio's large prairies following the Xerothermic into historical times is resolved. Only one explanation tells exactly why these giant Ohio prairies persisted, how shading trees were kept out: Each of them was burned frequently and persistently over centuries by Native Americans of every culture and period. The presumption that Ohio's aboriginals lived on the state's lands with no ability or desire to markedly impact large, landscape ecosystems or animal populations is mythical, an aberrant iteration of the "Noble Savage" concept. Instead, presettlement humans intelligently and artfully used their skills to favorably control vegetation and take game species for food and clothing. The deliberate and artful use of frequent landscape fires were at the center of this. **Without human-set landscape fires, no expansive tallgrass prairies would have persisted into modern times; they would have been shaded out by trees.**

Ohio's tallgrass prairie remnants are living natural artifacts of the state's many presettlement aboriginal cultures. To impugn the ecological value and historicity of human-set prairie fires, whether ancient or modern, is to demean the authentic intelligence and cultural achievements of Native Americans. Without them, without their deliberate and favorable use of frequent landscape fires, large tallgrass prairies in Ohio would have been only an un-persisting archeological happenstance of the ancient Xerothermic Interval.