Old Field Vegetation As An Inhibitor Of Tree Vegetation

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Reprinted from:
Power Lines and the Environment

Pages 78 – 88

Edited by
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Containing Proceedings of the Colloquium "Biotic Management Along Power Transmission Rights-of-way" held at the American Institute of Biological Sciences annual meeting Amherst, Massachusetts, June 21, 1973.

September 1973
THE CARY ARBORETUM OF THE NEW YORK BOTANICAL GARDENS,
BOX 609, MILLBROOK, NEW YORK, USA

Since the early years of forestry, a major activity of amateur and professional foresters in the Northeast has been planting trees on old fields abandoned from agriculture. It was quickly learned that old field herbaceous communities severely retard the establishment of many of our favorite trees, forcing planters to settle mostly for easily planted rugged pioneer species and stimulating a mass of tree establishment research. However, over the last century, much of the northeastern landscape has shifted from open field to predominantly forest cover, mostly from natural reforestation but aided by tree planters. While this forest cover is highly valued for a variety of reasons, many people now feel that in a least some areas frees are beginning to cover too much for optimum diversity and values from our landscape. Mass tree planting activity is now declining, and increasing forestry effort is devoted to fighting back tree invasion to maintain open land for roadsides and other rights of way, vistas, "people-pasture", and the like.

This paper arises from 18 years research and practice in reforestation of old fields in New York, which began by preoccupation with tree establishment and has now shifted to interest in a variety of vegetation communities for our diverse needs and values. In short, my efforts to overcome old-field vegetation have made me something of an old-field apologist. Widely, maligned when widely pre-sent, old fields deserve greater consideration as they become more scarce. We might start by suggesting a more positive image with a term accurately descriptive as well as a euphemistic – "perennial meadow".

The widely observed stability of perennial meadows without mowing or other treatment after agricultural abandonment has been documented by many ecological studies. A repeatedly studied field in southeastern Michigan maintained essentially constant Species presence and total plant mass for over 30 years, although internal changes in dominance – especially a decreasing grass component – have occurred over time (Wiegert and Evans, 1964). The field site for much of my research in central New York successfully resisted invasion of trees from the adjacent woods for over 25 years without any treatment before I interfered with its successional stability. I would partly take issue with the statement of Egler (1958) that "in most cases shrub communities retard reforestation more successfully than do grasslands." While very dense shrub cover effectively inhibits tree invasion, sparser shrub cover often aids such invasion into old fields. I believe there is a much greater acreage of success-fully stable meadow than shrub-land in the Northeast and that stable meadow is easier to establish over a variety of conditions.

Perennial meadow in the Northeast is an extremely complex community, combining an agriculture legacy of long-lived important cool-season hay grasses, and accidentally introduced associated perennial "weeds" with native meadow species that have found niches in the mix. The rich result presents a strong element of change over the growing season as each species has its time. Year after year, the dominance of cool season grasses and forbs in early summer is followed by a progression of later species ending with late blooming aster and goldenrod species in the fall.

Such meadows also are far from "faunal deserts", but rather, are the unique habitat of many meadow-oriented birds, small mammals and insects. While we could take this for granted when meadows were everywhere, it is something to value as they become more scarce. They are also good people habitat; easily traversed and offering a diverse biotic system at our feet while providing open space and views above to salve our increasingly enclosed lives. For these reason, the idea of minimum-maintenance "people-pastures" appears to be gaining support across the country.

Perennial meadows do have some disadvantages. Unfortunately, many of the imported and native cool-season grasses – timothy, orchardgrass, bluegrass, and others – are serious hay fever agents, and important consideration in populous areas with high incidences of respiratory ailments, but, most of the perennial meadow forbs apparently are not serious agents, including the much maligned goldenrod (Wodehouse, 1945), and when establishing new meadows near people, we might also select grass species that are less serious in this respect. This includes many of our native warm-season grasses.

A second problem is that unmowed grassland is quite flammable at least for a period in spring and fall in our region. This precludes its use close to structures and facilities, but should not prevent its use in low fire hazard areas where a grass fire would cause not great crisis. Grassland actually benefits from occasional burning, and one might hope we could develop enough environmental sophistication to discern between burning dumps and burning grass and, in less populous areas, permit care-fully controlled use of fire as an occasional tool to rejuvenate meadows. I do not think fire is as important for maintaining meadows in the Northeast as it is for prairie in the central states, but I have found a controlling burn every five years or so very helpful in maintaining a meadow near my in the Catskills.

The process of secondary succession form bare soil to eventual forest in our region is a highly variable one both in stages encountered and in rates of community change at various stages. That nature abhors a vacuum is evident in the rapid re-vegetation of most bared ground bared ground if not actively eroding, and in the invasion of new plants whenever an existing plant community is not fully using available resources. Thus the farmer of annual crops and the ROW maintenance crew fighting tree invasion on cleared sites face a constant struggle against succession. On the other hand, communities such as perennial meadow make rather full use of their re-sources and are therefore quite resistant to displacement. These can be maintained indefinitely by minimal maintenance directed at reinforcing their mechanisms for stability. By turning our extensive tree planting experience around, we can identify the most effective pressure points for holding perennial meadows against unwanted invasion of trees.

ELEMENTS INVOLVED IN MEADOW STABILITY

The growth and composition of perennial meadows varies greatly with local soil and other environmental conditions. The significance of various elements in meadow stability likewise varies with these conditions.

SOIL MOISTURE AND NUTRIENT COMPETITION

For sites periodically short on moisture during the growing season, due either to soil conditions (shallowness or coarse texture), or topography (ridges and steep south or west slopes), competition for soil moisture is probably the dominant mechanism inhibiting invasion of tree seedlings into meadows. Because water also carries nutrients into plants, this is best viewed as a complex of moisture and nutrient competition. In this competition, grass species appear to be especially effective for at least two reasons: 1) The dense fibrous root systems characteristic of grass facilitate rapid and effective moisture absorption. 2) Grasses can draw moisture down to and endure a greater soil moisture stress than most woody plant seedlings. (Lane and McComb, 1948). Tree seedlings do not have to be overtopped to suffer severe moisture competition, and seldom are overtopped on droughty sites where such competition is most severe. My studies on controlling oldfield vegetation around planted spruce, sugar maple, white ash, paper birch and other species in central New York indicate that moisture/nutrient competition is the most important inhibiting mechanism on dry sites supporting a moderate to relatively sparse perennial meadow community. Woody plant establishment is favored by removal of perennial grass and forbs even when herbaceous plants quickly reinvade because the invaders are much less competitive than the well established meadow community. On sites in central New York wit more favorable moisture and fertility conditions, moisture/nutrient competition is a less significant element inhibiting tree invasion (Richards, 1968). In the slightly less humid climate of lower Michigan, White (1960) has found moisture/nutrient competition to be very severe on most sites, and therefore advocates more complete control of herbaceous vegetation for planted trees than I have found necessary in New York.

SHADING

Dense herbaceous cover can shade out seedlings of intolerant trees such as pine, birch, and apple. This is most effective as a control mechanism on moist fertile sites where herbaceous growth is vigorous but moisture/nutrient competition less critical. However, even fairly dense herbaceous cover probably lets in more light than a closed forest canopy, so shade tolerant tree species are not likely to be shaded out by the average oldfield cover. Also, unlike moisture/nutrient competition shading is no longer effective once a tree or shrub gets above the herbaceous cover. On the contrary, because most old-field vegetation is quite in-tolerant, shading is probably the prime means by which trees and shrubs increase their advantage over meadows plant once they have gotten above them.

BURYING

Heavy herbaceous cover lodging in winter can flatten and bury small woody seedlings. Especially on wet sites, mortality of buried seedlings can be high, probably due to excessively humid, anaerobic condition for buds and leaves. However, once seedlings have strong enough stems to resist flattening, they are no longer subject to this control mechanism.

MICROCLIMATE EXTREMES

A dense mat of dead herbaceous tops, especially grass, forms a strong insulation layer in early spring that protects seedlings under it. But any woody plant projecting only a few inches above this layer is subjected to spring temperature extremes; high day temperatures stimulating early opening of buds and the common phenomenon of "grass frost" on clear cool nights subsequently damaging or killing these opening buds. In New York old fields, maple and ash seedlings are particularly susceptible to this effect. Any seedling that grows quickly enough to get a foot or more above the grass surface is past the most critical grass frost zone, but may still be damaged in frost pockets caused by topographic or vegetative impediments to cold air drainage. Irregular vegetation surfaces, due to a large component of tall strong-stemed forbs such as goldenrod, break up the zone of microclimatic extremes and provide greater protection for developing tree seedlings than does a uniform grass mat. And, of course, these microclimatic extremes are greatly moderated on oldfield edges adjacent to woods or hedgerows.

FAUNAL DAMAGE

Several animals take their toll on woody plant seedlings in meadows. In dense sod, meadow voles, Microtus pennsylvanicus, appear to be a very effective control element because of their typically high numbers and strong affinity for the bark of many woody species. Even fairly large seedlings that have escaped the other control elements in meadows often fall victim to this so-called "mouse-girdling".

Deer eat woody plants in old fields, but tend only to browse shoots above two feet after seedlings are well established, and then only to five or six feet in height. So, except where deer are quite numerous and other food scarce, they are a rather in-effective control mechanism. Rabbits also browse woody stems, but function best in the protective habitat of established brush, so tend to be too late to effectively retard woody plant establishment.

Below ground, white grubs or Junebug larvae (Phyllaphaga) can take a heavy toll on tree seedlings. Although they graze herbaceous and woody roots alike, the dense rooted herbs withstand this much better than do small woody seedlings, so high grub populations can be an effective control mechanism. However, white grub populations are quite cyclic, and well-established tree seedlings can readily survive their damage (Richards, 1968).

PHYTOCHEMICAL EFFECTS

Much has been written on observed and speculated allelopathic chemical effects between various plant species, but the subject is highly complex and controversial. At least one study concludes allelopathic effects of certain aster and goldenrod species on germination and early growth of tulip-poplar and Virginia pine (Haney, 1968). However, my observations of spruce root development in relation to established goldenrod and other oldfield species gave no evidence of chemical inhibition that could not be explained better in terms of moisture/nutrient competition. But, in comparison with all herbaceous species observed, other woody plant roots appeared to have a favorable effect on spruce root development (Richards, 1968). In greenhouse and field studies, Aird (1957) discounted allelopathy as a significant factor in grass competition effects on planted poplars. There is little doubt that many phytotoxins are produced by living and dead plants, but there are also many detoxifying mechanisms in nature and allelopathic effects are deeply complexed with other conditions.

There is, however, much evidence of indirect chemical effects through changes in micro-organism populations important for higher plant nutrition. There are several reports of tree seedlings failing upon introduction to new areas until their mycorrhizal organisms were also introduced, but it is generally felt that tree mycorrhizal organisms persist in any field that was once forested (Wilde, 1962). However, Rice (1964) has reported the inhibition of nitrogen fixing and nitrifying bacteria by certain grasses in Oklahoma, which might serve to discourage invasion of species with high nitrogen demands. And, from the forest side, Fisher and Stone (1969) have reported evidence of conifers increasing available soil nutrients in the adjacent field edge, apparently due to soil microorganism changes. To the extent this may prove more universal, it would support the already evident thesis of this paper that, for several reasons, old-field stability is lost once trees have begun to get established.

From all of these phytochemical complexities, a reasonable general hypothesis might be that the successional stability of oldfield vegetation depends on a vegetation system in homestasis with its resources, and successful invasion of woody plants depends on establishment of a viable woody vegetation system; not just the woody plants.

DEVELOPING AND MANAGING STABLE MEADOWS

From the foregoing, it is evident that perennial meadows involve a number of mechanisms that inhibit the establishment of woody plants: moisture/nutrient competition especially on moisture deficient sites, shading and burying especially on more moist and fertile sites, old field microclimate, fauna, and possible phytochemical effects operating in the inhibition complex. It is my observation that this inhibition complex is greater with perennial grasses than with perennial forbs, and that the most stable communities generally have a substantial grass component. Increasing dominance of perennial forbs over time appears to be part of the eventual deterioration of meadow stability and invasion of trees and shrubs. Given enough time, some trees sooner or later break through the complex of inhibitors. These scattered breakthroughs shade out the competing meadow vegetation, modify the microclimate, resist faunal attack, and may possibly change the biochemical environment to favor other trees. The keys to maintaining meadow stability thus appear to be:

1. The establishment and maintenance of fully stocked undisturbed perennial herbaceous cover with a dominance of grasses and,
2. Nipping all successful woody plant invaders in the bud.

For ROW strips and other areas to be so maintained, this requires that disturbed soil areas be quickly seeded with suitable perennial grasses and further disturbance be minimized after that, except to selectively remove any sprouting woody plant growth. The mainstays of most reasonably fertile old fields in New York are two longlived bunchgrasses; timothy (Phleum pratense) and orchardgrass (Dactylis glomerata), but when planting meadow from bare ground, it may be better to select more strongly rhizomatous sod-forming grasses for a more complete ground cover. Having only begun planting grasses for perennial meadow four years ago, I depend heavily on the U.S.D.A. Soil Conservation Service for advice.** So far, I am much impressed by red fescue (Festuca rubra) for moderately-well drained to dry soils with moderate fertility, because it forms a dense low mat without mowing. A promising species on moderately-drained and wetter soils, is creeping foxtail (Alopecurus arundinacea), which resembles timothy but forms a more continuous sod. But there are probably many other perennial sod-forming low-maintenance species useful for various meadow conditions. Most of the grasses used for agriculture and conservation in the Northeast are introduced cool-season species that grow mostly from early spring to early summer. There is now in-creasing interest in native warm-season grasses for minimum maintenance meadow or "people pasture". While grasses such as little and big bluestem (Andropogon scoparius and A. gerardi) and switch grass (Panicum virgatum) are most associated with the prairie, they are also native to the Northeast, but largely displaced by the agricultural grass imports. Although slow and difficult to establish in competition with the aggressive cool-season grasses, they may be worth trying on newly cleared sites. They grow throughout the summer if soil moisture permits, making efficient use of natural nutrient cycling, and therefore should be very effective inhibitors of tree seedlings.

Grass seedings commonly benefit from fertilization, especially phosphorus and potassium, but the need for nitrogen fertilization in establishing perennial low-maintenance meadow is less clear, except on very infertile soils. Cool-season grasses commonly respond well to nitrogen fertilization in early spring when cool, wet soils retard native nitrogen mineralization. But Goss (in Younger and McKell, 1972) provides some substantiation to the oft-heard view that heavy nitrogen fertilization stimulates grass top growth at the expense of root growth. (See Wilson*** foot note on recommended nitrogen fertilizer [on Page 87], at the end of this article.) Sentence**** in footnote should be inserted at this point in the text. My own work in old fields indicates that early spring fertilization favors the early grasses while fertilization later in spring or early summer is more favorable to tree seedlings. (Richards, 1969). On acid soils, liming is often beneficial for grass growth, primarily because it improves availability of native nutrients. In the Adirondacks, we have found dolomitic lime desirable to assure an adequate calcium/ magnesium balance.

A moderate invasion of perennial forbs into planted meadows is, in my opinion, quite acceptable because of the diversity they add. There is quite a lot of interest in meadow wildflowers and it would be nice to introduce attractive relatively non-aggressive species. Unfortunately, good wildflower seed is scarce and expensive, but it might be reasonable to make small seedings in visible areas and let them spread naturally, White daisy (Chrysanthemum leucanthemum), Black-eyed Susan (Rudbeckia hirta), Bergamot (Monarda didyma), Yarrow (Achillea millefolium), and New England Aster (Aster novae-anqliae) are a few of the ones I favor in New York.

MEADOWS - WOODS EDGES

In contrast with most old fields, ROW strips have a lot of edge per acre, and in the Northeast much of this edge is wooded. While woods-meadow edges are aesthetically and biotically attractive, they present problems for meadow maintenance because many meadow plants, especially grasses are adversely shaded and the edge microclimate favors tree establishment. The larger a meadow is, the easier it can be maintained in meadow vegetation, so for this reason as well as for visual effect in the landscape, I think scattered clearings larger than the minimum required for ROW purposes might well be considered on occasion. Nevertheless, several steps can be taken to hold meadows against edge encroachment.

A major means of woody plant invasion from edges is by clonal expansion, especially rootsprouting. Because rootsprouts gain sustenance from the parent trees, they are quite independent of the moisture/nutrient competition of their specific site, and by growing relatively rapidly, they quickly overcome the other inhibitory mechanisms in the meadow. Therefore, tree and shrub species capable of aggressive rootsprouting, such as aspen, black locust and alder, should be removed from the woods edge wherever possible.

A dense herbaceous cover can be maintained up to the woods edge by using shade tolerant grasses in the edge zone. In New York, red fescue is excellent for this purpose, and on Adirondack ski slopes it can maintain dense cover right up to the woods. Dense fern glades can also be encouraged to fill this zone. Bracken fern (Pteridium) especially is quite tolerant both of shade and infertile dry soils, and has long been noted by foresters for its inhibitory effects on tree establishment. Because it seldom invades dense sod, it can effectively fill the void between the field grasses and the woods.

The edge zone is also an excellent site for establishing stable shrub communities such as advocated by Niering and Egler (1953), who have reported on a highly stable Viburnum lentago community resisting tree invasion for several decades. The moderate microclimate and reduced grass competition of the edge zone make it a favorable site for planting shrub species that are otherwise difficult to establish in open fields. Desirable shrubs are those, such as several Viburnum and Cornus species, forming dense thickets that spread slowly out to dense meadow cover where they are inhibited by grass competition and vole girdling.

A legume that may have promise in the edge zone is flat pea (Lathyrus sylvestris), a vigorous, long-lived rhizomatous species with considerable shade tolerance. It is advocated for roadcut stabilization in the Northwest where it is reported that plants spaced six feet apart and fertilized with super-phosphate rapidly form a dense enough growth to retard brush invasion (Hafenrichter et. al., 1968). We have just begun testing it on logging roads in New York.

CONCLUSION

The high stability of perennial meadows due to their complex of elements inhibiting tree invasion, and their increasingly appreciated aesthetic and biotic values in the rapidly reforesting Northeast, warrant their use for minimum-maintenance cover on many ROW strips. By turning the tree planting experience of foresters around, we can reinforce the pressure points in meadows that inhibit unwanted tree invasion. But, because non-agricultural meadows have different values from agricultural ones, we also need the help of agronomists to direct their experience to these new needs. Some good pragmatic fieldwork is now required to determine species and techniques for establishing stable, minimum-maintenance meadows and edges under various conditions in the Northeast.

** Currently, Mr. Robert Slayback, Plant Materials Specialist (for New York and New England) U. S. Soil Conservation Service, Mid-town Plaza, 700 East Water Street, Syracuse, New York.

*** Mimeographed instructions from Jim Wilson, Wilson Seed Farms, Polk, Nebraska, who specializes in native warm season grasses.

**** Wilson does not recommend nitrogen fertilizer for establishing native warm season grasses because these grasses make good use of native nitrogen release through the warm season and added nitrogen stimulates invasion of cool season grasses and annuals.

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