

ELEMENT STEWARDSHIP ABSTRACT
for

Robinia pseudoacacia

Black Locust

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The Nature Conservancy
Element Stewardship Abstract
For *Robinia pseudoacacia*

I. IDENTIFIERS

Common Name: BLACK LOCUST

General Description:

Black locust is a large deciduous tree and sometimes a shrub, growing up to 25 m tall (Fernald 1950). Narrow brittle branches form a round or oblong head (Sargent 1947). Older trees have furrowed dark brown bark with flat-topped ridges (Stephens 1973). Leaves are alternate, pinnately compound and have 7 to 21 leaflets (Barnes and Wagner 1981). The thin leaflets are elliptic or rounded with a mucronate tip, and are dark green above, pale beneath. Fragrant white flowers have a yellow blotch on the uppermost petal, and are born in drooping racemes. The glabrous pods are 5 to 10 cm long, and contain four to eight seeds (Stephens 1973). Seedlings and sprouts exhibit juvenile growth characterized by rapid growth and heavy thorns (Fowells 1965). More description is provided in Fernald (1950), Stephens (1973), and Barnes and Wagner (1981).

II. STEWARDSHIP SUMMARY

III. NATURAL HISTORY

Habitat:

Range: "The natural range of black locust is in two discontinuous parts. The eastern part is in the Appalachian Mountains from central Pennsylvania south to northern Alabama and Georgia and includes parts of West Virginia, Maryland, Virginia, Kentucky, Tennessee, North Carolina, and South Carolina. It is also in southern Ohio and southeastern Indiana. A few outliers extend into central Georgia. The western part is in the Ozark region of southern Missouri, north and west central Arkansas, and eastern Oklahoma. Locally it is in southern Illinois and southwestern Indiana." (Fowells 1965)

Black locust is also planted and naturalized north to Nova Scotia, Quebec and Ontario (Steiermark 1977) and is cultivated throughout the world.

Most of the following habitat, and a portion of the life history descriptions is taken directly from (Fowells 1965). His citations have been omitted.

"Climate: Black locust grows naturally in regions of humid climate, where the average annual precipitation varies from 40 to 60 inches per year and warm-season precipitation (April to September) averages 20 to 30 inches. The tree has been planted and apparently has become naturalized over a much wider area and in drier regions. It has been introduced to many parts of the world where the climate is much drier than its native habitat, as, for example, in Israel and Cyprus.

The average July temperature over the original botanical range varies from 70 degrees to 80 degrees F with an average annual extreme high of 95 degrees to 100 degrees. Average January temperatures are from 35 degrees to 45 degrees with an average annual extreme low of 10 degrees

to -10 degrees. In West Virginia, where black locust develops best, the highest recorded temperature was 110 degrees and the lowest was -30 degrees.

The average number of frost-free days per year is 140 to 220 days in the natural range.

Soils and Topography: Black locust will grow in a variety of soils, except that excessively dry or compact plastic soils are undesirable. Limestone soils are especially favorable, and soils without pronounced subsoil development are best. It survives better on very acid spoil banks than any other species planted there, except perhaps European alder.

The growth of black locust in Central States plantations was found to be correlated with properties of the subsoil that influence drainage and aeration - plasticity, compactness, and structure. The amount of mineral nutrients present and differences in soil reaction between pH 4.6 and pH 8.2 did not seem to affect growth. However, in fertilization experiments on sticky, yellowish-brown clay, growth of black locust increased as pH was raised from 4.3 to 6.9. Growth decreased as the pH was further raised to 7.7. But when only phosphorus fertilizer was added, the seedlings grew best at pH 4.3.

On poorly drained sites, with compact plastic subsoil, growth is slow, especially if the surface soil is shallow (less than 14 inches to subsoil). Excessively dry soils common to coarse, sandy moraines, or where the depth of soil to bedrock is less than 24 inches, are also poor sites for this tree. Yellow, brown, or reddish-brown subsoils without pronounced mottling are better than gray, bluish-gray, or yellow subsoils mottled any color. Silt loams, sandy loams, and the lighter textured soils are superior to clay, silty clay loams, and the heavier soils.

Within its original range, black locust occurs naturally in the Appalachian Mountains below an elevation of 3,500 feet. Singly or in small groups, it occurs on the slopes, coves, and borders of the forest. In West Virginia, it is more common on south and west slopes than on north and east slopes or in coves.

Associated Trees: The Black Locust Type (Type 50) may include many species of hardwood trees and hard pines. It is a temporary type, spotty in occurrence but widely distributed because black locust has been extensively planted on old fields and lands stripmined for coal. Black locust frequently becomes established on burned-over land, and the tree reproduces naturally on old fields in parts of West Virginia, western Maryland, Ohio, and eastern Kentucky." (Fowells 1965)

Reproduction:

"Reproduction and Early Growth: Flowering and fruiting: Black locust flowers appear in May and early June, about a month after the leaves. Flower buds occur mainly at the ends of branches. Thus, if shoots from the end of branches are used as scions, grafted stock may flower the year of grafting. Pollination is carried out by insects, especially bees. The fruit is a pod which ripens in September and October. Each pod contains 4 to 8 seed whose hard outer coats are relatively impervious to water.

Seed Production and Dissemination: Black locust is a good seed producer, with heavy seed crops at 1- or 2- year intervals and light crops in the intervening years. Best seed crops occur when the trees are between 15 and 40 years of age, but some trees will bear at 6 years and some as late as 60 years. An exception is the shipmast variety (*Robinia pseudoacacia* var. *rectissima*) which, on Long Island, produces few if any seed. In the Central States, though, shipmast bears seed prolifically.

Seed pods open while on the tree during the winter and early spring. There are 16,000 to 35,000 seed per pound.

Seedling Development: Despite frequent heavy seed crops, black locust seedlings are rare; few seed germinate because of the impermeable seedcoat. The seedcoat can be softened by treatment with sulfuric acid, soaking in hot water, or scarification.

Although black locust will tolerate a wide range of site conditions, it will not grow well in competition with other trees, vines, or grasses, nor will it grow well on poorly drained, heavy-textured soils.

In several instances fertilizer supplements, especially phosphates, applied at the time of planting have increased height, diameter, and root growth of seedling black locust. No response to nitrogen was detected when the total nitrogen supply of the soil exceeded about 2,000 pounds per acre.

Early height growth of seedlings is rapid. For the first 10 years it averages 1-1/2 feet per year on sites that are below average quality, and on good sites (site index 90 or more) annual height growth averages 4 feet or more.

Average annual diameter growth of seedlings is from 1/6 inch on poor sites to 1/2 inch on good sites, and sprout stands grow even faster.

On 957 old-field plots in Ohio, annual height growth of black locust exceeded that of all other trees except sycamore on 1 plot and poplar on 4 plots." (Fowells 1965)

Asexual Reproduction: Most natural reproduction of black locust is vegetative by means of root suckering and stump sprouting (Sterrett 1962). Root suckers originate from endogenous adventitious buds in the roots (Sterrett and Chappell 1967). Sprouts arise from dormant buds at the root crown, or on the lower portion of the trunk (Sterrett 1962).

Root Suckering: Black locust reproduces most frequently and vigorously by root suckering. Root suckers can arise spontaneously from the extensive fibrous root system of trees as young as four or five years old. Most suckers originate where branch roots emerge from older roots (Sterrett and Chappell 1967), but also form elsewhere on one or two year old fibrous roots (Fowells 1965). In propagation experiments, root cuttings between 1/4 inch (0.64 cm) and one inch (2.54 cm) in diameter of the previous year's growth yielded the most suckers (Swingle 1937).

Productivity of root suckers is influenced by injury, temperature, and seasonal physiological changes. Physical damage to the roots increases root suckering (Sterrett et al. 1968). In a Romanian forest root suckers developed one year after trees were harvested by grub felling (roots were cut during harvest) (Tanasescu 1970). More suckers are produced in full sun (Sterrett et al. 1968), in open areas (Larsen 1935) and in sandy loam soil (Swingle 1937) than in shade, dense brush and heavy soil. In one case, the number of suckers arising from roots stumps in full sun was 77% of the original number of stems; as compared to 2% in shade (Sterrett et al. 1968). Suckering is stimulated in open areas possibly because day and night temperature fluctuations are greater than in shade, whereas suckering decreases under constant temperatures (Sterrett et al. 1968).

Seasonal variations in carbohydrate and auxin concentrations affect sucker formation. Carbohydrate and auxin levels are highest near shoot apices when shoot growth is most active in June (Sterrett et al. 1968, Digby and Wareing 1966). Sterrett et al. (1968) showed that root suckers are formed less frequently on root cuttings taken in June than during other months probably because high auxin levels suppress sucker initiation, and root carbohydrate reserves are low. 6% of root cuttings in June produced suckers as compared to 61% in August, 89% in November and 94% in March (Sterrett et al. 1968). As active growth and auxin levels decrease, root suckering resumes rapidly, because residual auxin concentrations that inhibit root suckering, are inactivated by an auxin oxidase present in the roots. This oxidizing system also would be activated following root injury allowing root sucker initiation (Sterrett and Chappell 1967).

Plants formed from suckers are interconnected by fibrous roots to form groves of trees with the oldest plants in the center, and the youngest on the periphery. In an Ohio study, black locust expansion rate ranged from 3.3 feet (1.0 meter) to 10 feet (3.0 meters) per year as measured from the center of a grove to the youngest tree on the edge. Larsen (1935) found that area covered by black locust spread increased geometrically. Two years after clearcutting a black locust stand in Pennsylvania, seedlings and suckers ranged in height from three to nine feet (0.9 m to 2.7 m) (McIntyre 1929).

Sprouts: Stump sprouts are most noticeable when the tops of black locust are removed by fire, wind, cutting, disease, etc. Hardest sprouts follow late fall and winter cutting on trees younger than 60 years (McIntyre 1929). Stump sprouts inhibit the formation of root suckers because of apical dominance (high auxin levels) (Sterrett and Chappell 1967). However, high auxin levels do not significantly reduce stump sprouting. Sterrett and Chappell (1967) showed that exogenously applied auxin applied to root stubs inhibited root sucker formation, but the same concentration did not inhibit stump sprouting. Cut stumps produce from one to ten sprouts (McIntyre 1929) that are capable of growing ten feet (3.0 m) in one season (Nyboer 1983). In a clear cut site, stump sprouts average 14.4 feet (4.4 m) tall and 1.1 inches (2.8 cm) in diameter three years after cutting (McIntyre 1929).

Maintenance: "Black locust attains a height of 40 to 100 feet and a diameter of 1 to 3 feet. When forest-grown it produces a clear, straight bole; in the open it tends to fork and be crooked and limby. Some of this tendency may be inherited.

Black locust is a legume. Nitrogen-fixing bacteria associated with nodules on the roots increase nitrogen content of the soil in which the tree grows. Soil calcium, magnesium, potassium, nitrates, and pH increase with decomposition of locust litter. This litter decomposes rapidly and releases soluble nitrates (60 pounds per acre per year under closed stands) that are readily available to other plants. Nitrogen increases totaling 600 pounds per acre occurred in the top 20 inches of soil under 16- to 20-year old locust stands, although there was no increase under stands 5 to 10 years old. However, the effect of locust on associated vegetation resulted principally from high annual turnover of nitrogen from limbs and litter rather than from increased total nitrogen in the soil. An annual turnover of 50 pounds per acre per year was estimated, twice the amount of turnover in other forest types.

Reaction to Competition: Black locust is intolerant, and is not found in dense woods except as a dominant tree. Where it has room to grow, its rapid growth rate enables it to compete successfully with more tolerant trees. Erosion-control plantings on uncultivated, grassy areas adjacent to gullies have often failed because of competing grasses. In Iowa grass reduced the soil moisture

below the wilting point of black locust. Soil moisture probably is the critical factor in the establishment of black locust on sod.

Principal Enemies: Black locust is normally a shallow-rooted species that does not produce a taproot. Thus, it is sensitive to soil conditions that produce excessive aeration and drainage, or that impede aeration and drainage; and its growth is adversely affected by water-logged soils or compaction due to heavy grazing. Even if the tree survives under these conditions, root nodulation is poor and its nitrogen-fixing properties are reduced.

Of several insects attacking the tree, the locust borer (*Megacyllene robiniae*) causes the most severe damage. Its larval tunnels weaken the tree, resulting in wind breakage, and make the wood unfit for most commercial uses. Slow-growing trees are most susceptible to borer attack. However, rapidly growing trees older than 10 years are not usually attacked. Selection of good quality sites for planting and stimulation of growth by release or fertilization are recommended methods for minimizing borer damage.

Maintaining heavy shade on the locust boles or planting locust in mixtures with other hardwoods also seem to reduce borer damage, especially on the better sites. This may be due to a lower rate of oviposition by the borer due to lower temperatures in shaded stands. On spoil banks in Ohio, heavy borer attack often occurs when locust plantings are 5 to 12 years old. The trees are killed back to the roots but sprout vigorously. The sprouts are usually attacked and killed.

The locust leaf minor (*Chalepus dorsalis*) attacks the leaves of black locust in early spring. By late summer or early fall trees suffering heavy attack have a conspicuous "burned" appearance and a loss occurs in seasonal growth.

The locust twig borer (*Ecdytolopha insticiana*) is also important. It attacks only new growth, working inside the twigs and forming an elongate gall 1 to 3 inches long. This retards growth and distorts the limbs.

The most damaging disease of black locust is a heart rot (*Fomes rimosus*). It often follows borer attack, especially in older trees.

In nursery beds black locust is highly susceptible to chlorosis and damping off.

Prolonged drought, especially on normally moist soils, causes a reduction in growth rate and vigor in locust and provides conditions favorable for infestations of the locust borer. Spring drought, in particular, results in a great increase in borer attack. During periods of extreme drought, effects of borer attack are most severe because the larvae tend to feed only on phloem instead of feeding on both phloem and heartwood as they normally do. The result is an increase in the frequency of complete girdling among the infested trees.

Black locust is moderately frost hardy in the southern and central Plains. However, glaze damage, frost damage, and frost heaving in plantations have occurred in the colder parts of its range.

Because of its thin bark and shallow root system, black locust is very susceptible to fire damage, especially when young." (Fowells 1965)

IV. CONDITION

V. MANAGEMENT/MONITORING

Management Requirements:

Black locust is a management problem because it aggressively invades dry prairies, sand prairies, and savannas where it shades desirable plant species. Undisturbed sand prairies can be invaded by black locust (Anderson and Brown 1980, Henderson 1984). Reasons for this problem include:

1. Its natural range has been expanded by planting for erosion control windbreaks, afforestation, and mine reclamation beginning in the early 1900s.
2. It tolerates dry sites probably because of an extensive fibrous root system.
3. It grows and propagates most vigorously in full sun and where herbaceous vegetation is sparse.
4. It most frequently reproduces by rapid vegetative growth and colonial spread. Vegetative growth is more rapid than seedling growth (Kellogg 1939).
5. Vigor of suckers and sprouts usually increases following top removal by fire, cutting, dozing, etc.

No present techniques provide effective control of black locust mostly because of its resprouting ability. Cutting or burning generally increases sucker and sprout productivity (Prescott 1961, Anderson and Brown 1980). Most management has concentrated on use of chemical control with variable success because apparently killed plants can resprout several years after treatment (Henderson 1984). Some results are summarized below.

Chemical:

Glyphosate

1. In Maryland studies, glyphosate applied in September as a band or directed spray at .77 kg/ha or as a mist at 2.27 kg/ha completely killed black locust by the next fall (Gouin 1979). In Illinois, foliar application in July of 2.5 to 3% aqueous solution on resprouts arising following a late April burn resulted in top dieback (Lampa 1984). Saplings sprayed in the summer in Wisconsin were controlled by a 12.5% solution (Liegel 1983). In a later Wisconsin study, saplings sprayed with glyphosate in a 1:8 solution with water resulted in 100% resprouting the following year (Liegel 1984). Immediate application of 10 to 15% solution to cut stumps in the spring following bud break controlled black locust in Illinois (Nyboer 1983). In Wisconsin, Marty (1983) sprayed stumps in the summer with a 6.25% solution for good to excellent control. A later Wisconsin study employed glyphosate in a 1:16 solution with water. Stumps were sprayed with herbicide in August 1983; 63% resprouted (Liegel 1984).

Picloram

2. In trial studies of picloram, 10% pellets have provided excellent control when applied to the soil at 60 lbs/A in April following cutting in February. However, on slopes of 15-45 degrees, phytotoxicity to vegetation growing within 50-75 feet downhill from the treated area was observed following heavy rain (Wiltse 1964). In Illinois, picloram in a ready to use formulation provided 100% control when applied in frills in May and June (McClain 1983). In similar treatments in Wisconsin, an estimated 80% of treated black locust were killed using a ready to use formulation of 3% acid equivalent picloram and 11.2% acid equivalent 2,4-D (Pauly 1984a, 1984b). McClain

(1983) suggests using an injection of picloram to uncut trees. In similar treatments in Wisconsin, an estimated 80% of (treated) black locust were killed (Pauly 1984).

AMS

3. AMS applied in August at a rate of 3.5 lbs/gal. water in overlapping frills (on trees less than 1" diameter breast height) provided 100% kill by the following July in a Virginia study (Trumbo and Chappell 1960). In Pennsylvania, an AMS mixture, 30% by weight in water applied to freshly cut stumps in June resulted in more root suckers than original number of plants. However, after two more successive August applications as a foliar spray there were no resprouts (Bramble and Worley 1952).

Fosamine ammonium

4. Fosamine Ammonium provides effective control when applied within two months of leaf senescence as a foliar spray at 1 to 1.5 gal/ 100 gal water + a surfactant. The entire plant must be covered to prevent renewed vigor of some branches the next season (Gonzalez 1975). In Wisconsin, Pauly (as cited by Marty 1983) has used a 4% aqueous solution as a mist spray on seedlings up to 15 ft. in mid- to late summer for good control. For use in the motorized power mister, Pauly (1984b) prefers a 2% solution. At 100 gallons/ac, this provides better coverage. In another Wisconsin study, fosamine ammonium in a 1:24 solution with water was sprayed onto the foliage of black locust in early August; only 8% of the saplings resprouted (Liegel 1984).

Triclopyr

5. Triclopyr applied in July in Arkansas as a high volume spray at 2 and 4 lbs/100 gal resulted in 100% control with no permanent injury to grasses (Byrd et al. 1975).

2,4-D and 2,4-DP

6. Results from use of this chemical are erratic; control probably is most dependent on technique and timing of application.

Basal Spray: In Wisconsin, Kline (1982) sprayed bases of plants of 5 to 10 cm dbh in April with a 12.5% mixture of this herbicide in diesel fuel, resulting in kill of treated stems, but some were sprouts in the treatment area. Similar treatment of a grove of plants in July killed all treated shoots; but some resprouts required further treatment (Kline 1982). Plants treated with this basal spray in January when temperatures were above freezing had few resprouts (Kline 1982).

Cut Stump: In Wisconsin, Pauly (as cited by Marty 1983) painted a 4% aqueous or sprayed a 4% diesel mixture on stumps cut at ground level for excellent control. Saplings cut at the base and treated with a 4% or 6.25% solution in diesel fuel in August had fewer than 5% resprouts the same fall (Marty and Liegel 1983). Another treatment employed 2,4-D + 2,4-DP in a 1:25 solution with diesel fuel. Stumps were painted with the herbicide; one year later, 89% of the saplings had resprouted (Liegel 1984). A similar technique used a 1:16 solution with diesel fuel; 58% of the saplings resprouted (Liegel 1984). In another Wisconsin study, Henderson (1984) treated cut stumps with a 4% diesel fuel solution June through August and found that resprouts were reduced gradually with repeated treatments over four years. In Pennsylvania, freshly cut stumps treated with a 0.78% by volume 2,4-D ester in water increased root suckers the first year, but foliar sprays in August the next two years controlled resprouts (Bramble and Worley 1952). Kline (1982) found the stumps of trees 15 to 20 cm dbh cut in the winter and treated in April with 12.5% solution of 2,4-D + 2,4-DP in diesel fuel were completely killed. See picloram section, above, for results of a Wisconsin study using a ready to use formulation of 2,4-D and picloram applied in frills.

Girdles: Liegel et al. (1981-83) found that trees girdled in July followed by a 4.8% solution applied in the cuts wilted in two weeks, but resprouted vigorously the following year.

Basal Application: Kline applied a 12.5% diesel fuel solution to uncut bases of trees 3 to 5 cm dbh for good control (as cited by Marty 1983).

Physical Control

Dozing: In a Wisconsin site, locust cut by brush cutters was later dozed into piles and burned. Dozing removed most stumps, but some were sprayed with glyphosate resulting in 95% control (Liegel et al. 1983).

Cultural: Larson and Schwarz (1980) showed that black locust seedlings growth and nitrogenfixation is reduced allelopathically by several herbaceous species including *Solidago altissima*, and *Andropogon virginicus*.

VI. RESEARCH

Management Research Programs:

The Wisconsin Field Office is monitoring *Robinia pseudoacacia* at Schluckebier and Spring Green preserves. Areal extent of clones, density in clones, and stem height are being measured (Haglund 1983).

Evaluation of control measures using glyphosate, fosamine ammonium and 2,4-D + 2,4-DP were conducted in 1983 and continue in 1984 at the International Crane Foundation, Baraboo, WI (Liegel 1983).

Management Research Needs:

Timing, type, and technique (especially injection) of herbicide application for effective control need further study. Differences in response of juvenile and adult growth, and effects of herbicides on co-occurring high ranking elements needs study. Also needed are experiments with girdling of phloem for black locust control.

Some known active management of black locust continues in the following locations:

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VII. ADDITIONAL TOPICS

VIII. INFORMATION SOURCES

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IX. DOCUMENT PREPARATION & MAINTENANCE

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