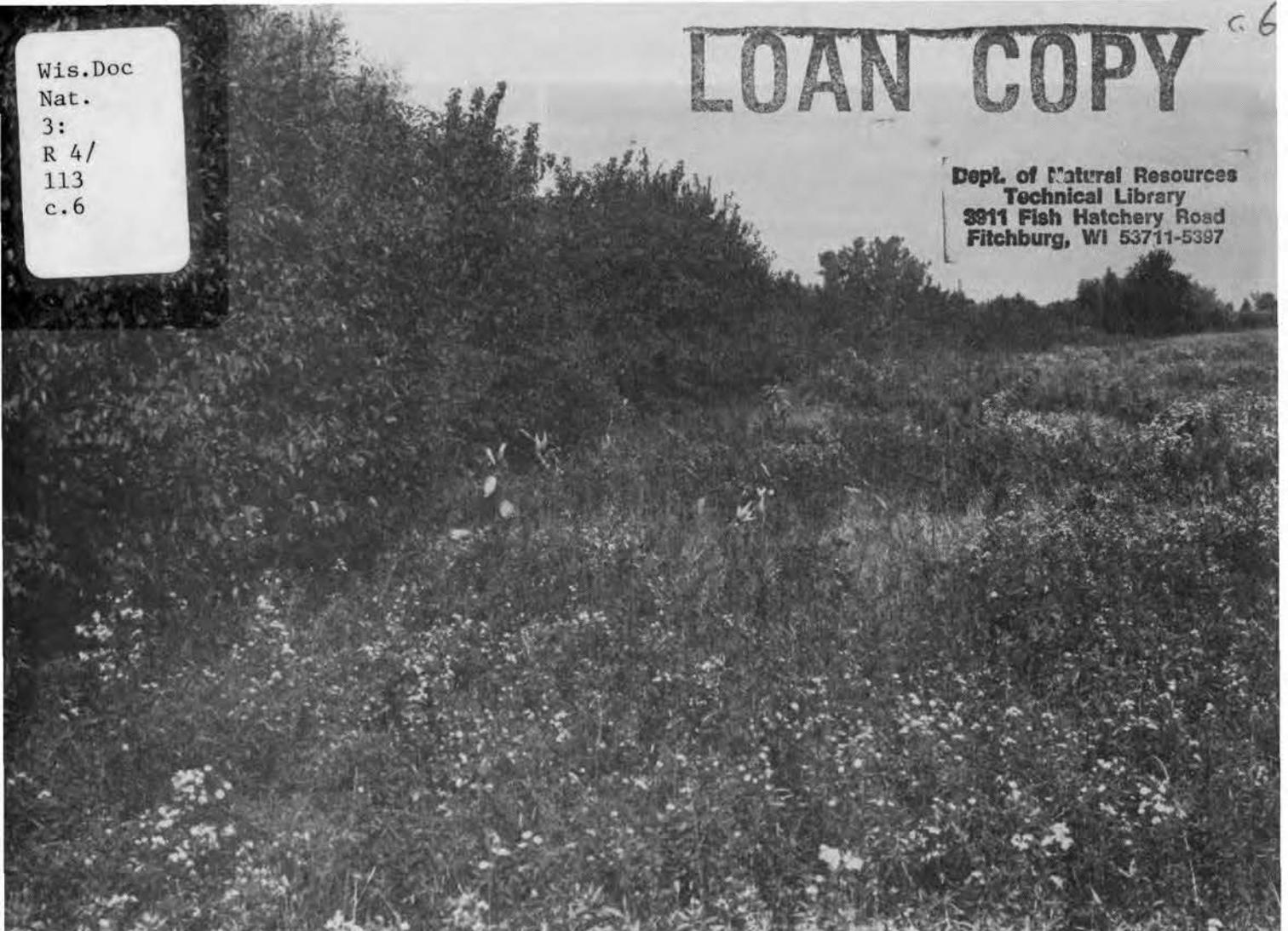


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RESEARCH

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HEDGEROW ESTABLISHMENT AND MAINTENANCE FOR FARM WILDLIFE

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ABSTRACT

At a time when hedgerows are rapidly disappearing from the landscape, it becomes increasingly important to establish new hedgerows on state and private lands to supplement the cover needs of farm wildlife. This report, based on observations made on the Waterloo Wildlife Area and the Marshall Quail Management Area, provides an insight into the basics of new hedgerow establishment, cultural methods, postplanting management, maintenance, and costs. An Appendix provides the characteristics of many shrubs planted and evaluated in Wisconsin.



The establishment and maintenance of hedgerows brings many advantages to both wildlife and people: food, cover, travel lanes, windbreaks, natural barriers, and beauty and diversity.



Undisturbed grass-forb cover adjacent to a hedgerow.

Tree and shrub planter.

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PURPOSE OF THIS REPORT

This report provides (1) a summary of the values inherent in hedgerows, (2) guidelines for establishing and maintaining woody plantings, and (3) descriptions of important shrub species, based principally on observations at the Waterloo Wildlife Area and the Marshall Quail Management Area by the authors and their colleagues. State and private land managers should find this document useful in gaining an elementary understanding of hedgerows. Additional references are given at the end of this report.

The Waterloo Wildlife Area is a 6,600-acre public hunting ground in Dodge and Jefferson counties. Topography of the area is characterized by recessional moraines, and large tracts of canary grass and shrub carr grow on the lowlands. Hedgerows were planted in association with retired croplands, wetlands and odd corners. The Marshall Quail Management Area is a 60-mile² block of private lands in Richland County. An experimental habitat development project targeted to bobwhite quail was undertaken during 1975-80. Topography of the area is rather abrupt with a complex of narrow valleys and broad ridges. Land use is characteristic of southwest Wisconsin's driftless area. Over 50 miles of hedgerows were established in a series of food and cover complexes (Dumke 1981).

Shrub stock for both projects consisted of native and exotic species grown at Department of Natural Resources nurseries, particularly the Wilson State Nursery, Boscobel, or at the U.S. Soil Conservation Service Plant Materials Center, Rose Lake, Michigan. The Waterloo study was designed to evaluate plant materials and cultural practices, so hand equipment was often used and small plots were created for test purposes. The Marshall Area project applied currently accepted practices on a large scale. Tree planters were used to establish most of the trees and shrubs so less attention was given to individual stems than on the Waterloo project.

INTRODUCTION

Hedgerows in southern Wisconsin are rapidly disappearing from the landscape. Prior to 1940, shrubs, vines, and trees were more commonly seen along roadsides, fencelines and field borders, around rural homesteads, and where irregular topography made cultivation difficult. The use of larger, more efficient agricultural machinery and herbicides beginning in the late 1940's were two primary factors contributing to the loss of countless miles of hedgerow cover. Fortunately, some woody fencelines and roadsides still persist, but their future appears tenuous except in relatively few locations where their presence is recognized for its practical or aesthetic value.

Hedgerows take on various identities in different geographic areas. They assume the intended function of a planted and trimmed field border as seen most often in northern European countries. In the Great Plains region of the United States, windbreaks are planted in the vicinity of farmsteads to lessen the impact of strong winds and drifting snow. Deciduous trees provide shade in summer, while trees and some shrubs provide nuts and fruits for human consumption. Shelter belts lessen the impact of winds and associated erosion of cultivated fields, and serve as snow traps to help replenish soil moisture.

But hedgerows, in general, whether purposely planted or resulting from natural plant succession along field edges or roadsides, came about essentially with human convenience as their main objective. Wildlife was not, in most situations, an intended beneficiary of the shrubs and trees planted around farmhouses or field borders. As these woody plantings matured however, they increasingly supported a growing diversity of small mammals, songbirds, gamebirds and mammals, and predators. Hedgerows became important sources of food and cover as well as travel lanes for wildlife.

IMPORTANCE OF HEDGEROWS

Wildlife Values

Food. Hedgerows serve one or more functions depending on age, species composition, and plant density. Food production for wildlife is an important value of developing hedges. While new hedgerows may bear fruit as early as the third year under ideal growing conditions, fruit production should not be anticipated before the fifth year.

The primary seed or fruit sources on planted hedgerows are the introduced species. Species selection is partly based on the persistence of fruit into the winter. However, the relative palatability or preference for shrub species is difficult to assess. Preference is associated with the abundance of the plant species, the availability of alternate food choices, and the distribution of local populations of birds and mammals that may consume fruits. Martin et al. (1951) summarized the use of shrub fruit and seed by birds and mammals by regions of the United States.

Wild plum ripens in August, drops by early September and rapidly decomposes. Use, if any, by wildlife is rarely recorded (Martin et al. 1951). Plum establishes easily, grows slowly and spreads from the root system into thickets. It is used as winter cover by pheasants and cottontails. Occasional cottontail or small mammal browse is seen only on the younger stems. Based solely on the use of fruit, wild plum would not usually be recommended.

Gray, silky, and red-osier dogwood produce 2 crops of fruit annually, first in June and again in September. Migrating flocks of robins and grackles converge on these species in late September and October and consume large quantities of fruit. Martin et al. (1951) noted that ruffed grouse, ring-necked pheasant, wild turkey, prairie chicken, and bobwhite quail consumed dogwood fruits. In addition, 26 species of songbirds were reported to eat dogwood fruits in the prairie and northeastern regions of the United States. Unfortunately, dogwood fruits do not persist past late fall or early winter. Since dogwood is a highly preferred species, the seasonal decline in fruit abundance may be attributed to heavy utilization.

Autumn olive produces exceptional crops of fruit in some years. Certain selections (Michigan 777) are marginally hardy in southern Wisconsin and the less hardy specimens tend to be poor fruit producers in years after partial winterkill has occurred. Autumn olive fruits ripen in early September and remain in good condition until severe frosts in late October. Thereafter, the fruits shrivel, but some are still present in late December. Alan and Steiner (1965) identified 27 bird species that use autumn olive. Hamor (1971) reported 15 species. A 7-year-old planting at Waterloo produced a heavy crop of fruit in 1976. These shrubs were checked 3 times between mid-September and early December to determine the rate of loss of fruit in the fall. During these observations, it steadily disappeared. Careful ground inspection showed only a few fruits beneath the plants. We concluded that the fruits were taken by birds and small mammals but did not identify species using the fruits.

Viburnums as a group produce fruit regularly but not in large quantity. Black-haw and nannyberry mature clusters of large fruit resembling small blue plums that are either consumed or dropped by early December. The hard, dry black fruits of the wayfaring tree persist into the winter but do not appear to be palatable. Highbush cranberry fruits are large and bright scarlet, and remain in excellent condition on the plants until late winter. Ruffed grouse, ring-necked pheasants, turkey and sharp-tails were listed by Martin et al. (1951) as users of the viburnums' fruit and 9 songbird species and 10 mammal species eat either fruit or parts of the shrubs.

Vines contribute numerous microniches in the brushy hedgerow. The 3 primary species, wild grape, bittersweet, and woodbine, are all utilized by birds and mammals. Wild grape is the most important species. The juicy, tart fruits were consumed by 5 species of gamebirds, 37 species of songbirds, and 9 species of mammals (Martin et al. 1951). The fruit ripens in mid-September and often persists through January. Bird droppings become reddish purple after wild grapes have been eaten and are particularly evident after snowfall.

Bittersweet fruit matures in October when the orange capsules split, exposing bright orange-red seeds. Fruits are retained until late December. Bobwhites, ring-necks, ruffed grouse, and turkeys eat bittersweet, but only 2 species of songbirds were reported by Martin et al. (1951). However, Hamor (1971) identified 12 bird species that use bittersweet.

The bright blue berries of woodbine ripen concurrently with the change of foliage color in mid-September and remain on the vine until November. While woodbine is not generally recognized as a food plant, Martin et al. (1951) listed 23 songbirds that ate the fruit. Vines may spread 50-60 ft laterally along a fence line or envelop a 60-ft tree. When growth of vines in some trees and shrubs becomes extensive and covers most of the canopy, the host plant vigor declines and it eventually dies.

Mixed crab fruits begin ripening in late summer and persist through early December. Annual yield is variable and some selections only produce good crops on alternate years. Because of varied genetic background, the fruit differs in size and color, but is usually 1/4-1/2 inch diameter and from rich yellow to deep reddish purple. Smith (1972) observed 40 wild crab selections in New York and found that selections or varieties producing the smallest individual fruits generally persisted through the winter. He recommended those varieties for wildlife plantings. Hamor (1971) noted 29 species of birds using crabs. Wild crab ranks highest as a cottontail browse species. Since branching of most crabs is normally low (at less than 3 ft) and the main trunk does not develop a rough or corky bark, the plants are exceedingly vulnerable to winter browsing by rabbits and mice. When high populations of cottontails or field mice occur, severe damage to crabs can be expected. If stems are completely girdled, the latent buds below the girdled section are stimulated into growth and the crab develops a multiple-stemmed shrubby appearance. Heavy browsing in consecutive years may kill the plant. During severe winters, deer browse was noted. Mixed crab and new shoots are frequently browsed throughout the summer.

Ninebark is not regarded as a food plant but seeds can be found in the capsules through early winter. Cedar waxwings, cardinals, and gray partridge have been observed eating the seeds.

In general, such winter food resources as fruits or seeds in hedgerows are not completely dependable each year. If winter food provision is a primary objective of shrub planting, the species or clones that hold fruits through late winter would be preferred. Migratory species utilize many of the late summer and early fall fruiting species and the diversity of food and cover provided by a mixed planting is preferred to a monotypic stand.

Auxiliary sources of food are often found in older hedgerows. Weedy annuals (foxtail or smartweed) associated with corn or small grain production appear along the edges of the woody cover. Foxtail seeds, which shed before winter, are readily consumed by small mammals, songbirds, ring-necked pheasants, and bobwhite quail. The persistence of annual species depends on continuous soil disturbance in adjacent fields. Viable seeds of these species rarely germinate in undisturbed grass-forb sod.

Bittersweet nightshade, a perennial vine, is frequently seen growing along old fencelines or along edges of hedgerows but is seldom noted in abundance in southern Wisconsin. This nightshade holds its fruit through much of the winter. Burdock, a biennial, persists in undisturbed sod. Seedheads develop at the tips of upper branches and usually remain above normal snow cover. Pheasants shred the seedheads and masses of burs clinging together can be seen beneath the plants after foraging.

Cover. The attractiveness of hedgerows for winter protection is evident during the period of snow cover in southern Wisconsin. Common winter birds such as cardinals, juncos, tree sparrows, and chickadees are frequently observed in deciduous hedgerows or brushy fencelines. Ring-necked pheasants, gray partridge and cottontails use portions of the woody cover that provide overhead protection. The overhead cover results from dense clusters of stems, branching habits of such species as ninebark, or a combination of shrubs and supporting vines such as wild grape, bittersweet, or woodbine.

Optimum protective winter cover comes from clustered conifers, notably the spruces. The relatively compact growth of Norway, white, or Colorado blue spruce intercepts a considerable percentage of the annual snow cover, allowing frequent or early exposure of bare ground through the winter, especially on south- or west-facing slopes. Relatively slow growth of conifers limits their effectiveness until about 5 years of age when they reach about 6 ft. Continuous spread increases their effectiveness for at least 30-40 years. As lower branches merge, the understory is replaced by a groundcover of needles. Eventually lower branches die as the canopy develops and the protection formerly provided close to ground level disappears for mammals such as cottontails. Natural loss of lower branches varies, depending on species composition, growth rates and spacing between individual plants. Generally, white and red pine will lose lower branches before the spruces. A walk through a 25- to 30-year-old pine plantation often reveals only dead branches and a decomposing mat of needles on the ground. Limited light penetration through the canopy restricts any further development of the understory until harvest or natural phenomena occur to break the overstory.

Brushy hedgerows function well as loafing or resting areas, particularly in the winter. Daily wintertime activity of some pheasant flocks at Waterloo included regular visits to woody hedgerows or fencelines. Birds were most frequently observed roosting in these sites between 10:00 a.m. and 3:30 p.m. with feathers fluffed out and with a minimum of activity or interaction between individuals. In late afternoon, the birds would move to standing corn or flush into heavier cover. When winter conditions remained relatively stable and when a dependable food supply and night roosting cover were also available nearby, pheasants were seen daily in the same section of brushy fenceline or hedgerow. This routine remained essentially unchanged until the onset of the breeding season or spring breakup. Evidence of night roosting by pheasants in winter was usually limited to a dense thicket associated with herbaceous and/or viny cover. A similar behavior pattern was noted for gray partridge in east central Wisconsin (Church et al. 1980).

Prior to incubation, breeding harems were also identified with segments of hedgerows. Pheasant brood use of hedgerows was seen on early August mornings after the second crop hay harvest and small grain harvest. After early morning feeding, pheasant broods, including adults, moved into hedgerows, especially those with an eastern or southern exposure, to preen feathers and dry off after exposure to early morning dewfall. On exceptionally wet mornings or following a summer rainfall, broods flew up into the branches to pick insects, preen or simply dry out.

Cottontails are commonly seen in hedgerows when snow obliterates much of the adjacent cover. Wintering songbirds use deciduous hedgerows with or without food resources, especially on sunny days when the shrubs offer protection from the wind. Flocks of cardinals estimated at 25-30 individuals were flushed several times from multiflora rose hedges at Waterloo.

Where herbaceous materials, dense branches or vines near the ground, or snow cover created a canopy, cottontails used hedgerows to conceal their forms.

During snow covered periods, there was little indication (based on presence, droppings, or forms) that any species used younger hedgerows for roosting.

Dense spruce trees in or near hedgerows or a coniferous windbreak around buildings attracted ring-necked pheasants and wintering songbirds. At Waterloo, 3 conifer hedgerows and one block planting of approximately 1 acre were used for winter roosting by pheasants. These stands were an estimated 10-15 years old. Each grove had at least 2 conifer species and several had 5 species (white cedar, white and red pine, white and Norway spruce). Distance between trees varied between 6 and 9 ft but all had developed essentially closed canopies. Pheasants usually roosted in the branches and continued to use these sites until spring breakup or the onset of the breeding season in late March. Flock sizes were estimated at 8-20 cocks and hens.

Juncos, field sparrows, mourning doves, cardinals, and chickadees also used conifers for roosting in late fall and winter. Examination of branches near the trunk or the needle duff on the ground showed accumulations of small bird droppings. Songbirds were often flushed from these sites after sunset. No estimates were made of the number of songbirds per tree or species but the abundance of droppings suggested that use was substantial. Colorado blue spruce, which develops the densest branching, appeared to be most heavily used. White spruce has branching nearly comparable in density to blue spruce but Norway spruce develops a more open and drooping form at maturity. Winter roosting of birds in conifer groves or hedgerows may deter nocturnal predation.

Hedgerows of deciduous shrubs, conifers, or both provide some degree of protection and security to nesting birds, cottontails, and small mammals. However, predatory species such as fox, raccoon, opossum, and skunk also utilize mature woody fencelines for den sites.

In southern Wisconsin early nesting species (e.g., mourning doves, grackles, and robins) showed a preference for conifers prior to the early- to mid-May leafing out of deciduous species. First nesting attempts of other summer resident passerines tended to coincide with leaf-out and increased insect populations.

Attractiveness of nesting cover to individual bird species changed with growth and maturity of the shrubs and successional stages of understory grasses, weeds and forbs. Red-winged blackbirds commonly used shrubs up to about 4 ft tall, especially when surrounded with grassy cover. Goldfinches selected shrubs from 3 to 6 ft tall for nest sites, yet neither redwings nor goldfinches used hedgerows after a closed canopy developed. Increasing density of the shrub border apparently attracted robins, cardinals, catbirds, and brown thrashers. Stokes (1954) found that pheasants nested frequently under the spreading branches of fragrant sumac on Pelee Island. Ground nesting species at Waterloo, particularly sparrows, located nests in the grassy cover of recently planted shrub seedlings. Other songbirds used the hedgerows for singing perches, but nested elsewhere in the vicinity.

Cover types adjacent to the hedgerow may also contribute to attracting nesting birds. Greater numbers of individual birds and nests were present along segments of Indiana highways bordered by trees and shrubs than were found along segments bordered only by grass and forbs (Machan 1975).

Grass-forb strips adjacent to and between rows of conifers and shrubs may increase the attractiveness of hedgerows to birds. Although small grains are relatively unimportant as pheasant nesting cover in Wisconsin (Gates and Hale 1975), pheasant broods are often seen in small grain fields and use nearby hedgerows as travel lanes and resting areas. Gray partridge in east central Wisconsin preferred residual cover, particularly fencelines, for prenesting and nest site cover (Church 1980, Church et al. 1980). However, postfledged broods demonstrated preference for residual cover with oats.

Because of rotational farming practices throughout southern Wisconsin, cover types adjacent to hedgerows often change annually. This may alter the annual hedgerow use by wildlife. Also, a diversity of shrub species within the hedgerow may attract more species than monotypic plantings. For example, more nests are built under a dense canopy than in an open type, and nests are seen more frequently on shrubs that have horizontal branching (e.g., crabapple) as opposed to shrubs with predominantly upright branching (e.g., lilac). Some species of crabapple develop into densely branched specimens with nearly parallel branching. Common lilac, however, matures into a clone containing literally hundreds of nearly upright stems that only branch near the top at acute angles to the main stem.

Comparable nest densities occur in white and blue spruce, which branch at wide angles to the main stem, but white cedar grows more compact with abundant upright branching.

Fruiting or seed production of shrubs or conifers does not appear to be a factor in attracting nesting birds. The earliest fruiting dogwoods or buffaloberry do not bear ripe fruit until early to mid-July when the reproductive activity of many bird species is declining. The goldfinch is a notable exception. Their peak nesting occurs when thistles mature--the down is used almost exclusively to line their nests, while the seeds are an important item in the diet.

In the early stages of shrub growth, the hedgerows and their dominant grass cover understory are used by cottontails, ground squirrels, and small mammals for burrow and nest sites if cultivation or herbicides were not used to control the cover.

Pills and Martin (1978) suggested that woody vegetation along fencelines may influence fox den selection. Selection of woody cover for den sites was significantly greater than expected. On Horicon Marsh, foxes utilized a ninebark hedgerow as a den site for at least 3 consecutive years (J. March, pers. comm. 1978). Hedgerows appear to function both as travel lanes and reproductive sites for foxes.

Travel. Once hedgerows reach a growth stage where the canopy of branches offers some overhead protection, ring-necked pheasants will move along or through the woody cover to reach another part of the same field or an adjacent habitat. These movements were observed in early spring, late summer (broods), in the fall (to avoid hunters), and during the winter in the course of their undisturbed daily activity. Pheasants and partridge frequently fly into nearby hedgerow cover when flushed.

Songbirds present in woody fencelines often fly ahead when one walks nearby. They will flit between the branches after short flights along the edge of the hedgerow and continue to move in this manner until they reach the end of the row. Then they fly to other cover types or circle back to the hedgerow from which they were flushed. They seem reluctant to leave the more or less continuous cover provided by the hedgerow.

At Waterloo, fox tracks were seen within or along hedgerows during periodic winter checks for wildlife activity. There was an occasional sign of mouse predation, but no evidence of bird predation. The frequency or intensity of fox and other small carnivore use of hedgerows is not well known. Ease of movement by predators through or along the edge of brushy fencelines may be facilitated where fewer stems or lighter herbaceous vegetation have resulted from excessive competition. Occasional skunk tracks were observed in Waterloo hedgerows following several warm days in winter. Additional predator use would be anticipated throughout the year. Whether losses of game birds, songbirds, or cottontails are increased by the use of hedgerows as predator travel lanes is not known.

Fox and gray squirrels were commonly observed using brushy fencelines or hedgerows when traveling between a den tree or woodlot and standing corn in winter. Corncobs were always carried from the field to a nearby tree or back to the woodlot. Judging from the quantity of cobs and degerminated kernels found at the base of their trunks, some individual trees appeared to be used throughout the winter for squirrel feeding.

Based on observations of individuals, tracks, droppings, nests, and evidence of browse, the hedgerow serves differing needs year-round, providing food, protection, resting, reproduction, and travel between nearby habitat types for many resident and migratory species.

Aesthetic Values

Shrub plantings or hedgerows offer a variety of aesthetic values. Leaf or bark color, leaf shape and/or modifications such as thorns are characters often differing between genera or species. Seasonal changes, especially those occurring in the fall, are readily distinguishable even to the casual observer. Dramatic color changes from rich green to brilliant rose red are typical of the viburnums and sumacs. Not only is the fall color remarkable but it extends from September to late October in southern Wisconsin. Earliest color changes can be seen in smooth sumac as the large compound leaves begin to show reddish coloration in late August. By mid-September sumac leaves have become a striking deep red to reddish purple. Current year's growth turns color almost a month later and tends to develop deeper purple tints. Hard frosts, rain, and strong winds hasten leaf drop. Sumac is one of the first shrubs to drop its leaves in the fall.

Gray dogwood develops a rich reddish purple foliage when grown in full sun. In addition, individual plants remain more compact than when grown under the canopy of larger trees. Ninebark plants range in shade through yellow, orange, copper and brown, often showing all colors at the same time on the same plant. Exceptional among native shrub species, its fruiting capsules become a rich rosy red following bloom in early to mid-June. Shredding light tan bark on the older stems distinguishes ninebark from other shrub species after leaves have dropped in late fall. Flowering crabs are generally not distinguished for fall leaf coloring. "Mixed" crabs available for wildlife plantings usually are derived from a mixed or hybrid background resulting in variations of flowers, fruits, leaf shape and color, growth rates, and general conformation. Generally crab foliage tends to yellow or simply drop off after hard frosts without much color change. Autumn olive leaves remain green through mid- to late October, eventually fading to yellow and then dropping rapidly following the first sharp freeze when temperatures dip to the low 20's (°F).

Species susceptible to fungus infections often show moldy discolorations or blotches on the leaves. Lilacs never develop fall leaf color but are often affected by powdery mildew which in severe cases completely covers the upper leaf surface with a dull, moldy gray color.

Parent stock of "mixed crabs" was originally selected for bloom and to some extent for fragrance and for fruits. Seedlings grown from this source produce a myriad of blossom colors, ranging from predominantly white to deep rose. Mature trees are covered with blossoms for about 5-10 days from mid- to late May. Honey bees are often abundant in crab blossoms. Fruit size and color is highly variable. Mature fruits range from yellow to purplish red and from 1/2-1 inch in diameter. In general flowering crab blooms abundantly each year after the third or fourth growing season. Blossoming period varies annually depending on average spring temperatures. Cool, calm days favor longer bloom. Retention of fruit is a highly variable character among individual trees. Sharp freezes in November alter the natural color and cause gradual drying or shrinkage of the fruit. Certain varieties drop all fruit by November, while other varieties (e.g., sargents or bobwhite) hold most of the fruit through March.

Wild plum blossoms earlier than all other shrub species used for wildlife plantings. Flowering frequently occurs in late April and the pale pink flowers persist only 2 or 3 days. Fruit set is most unreliable, probably related to weather at pollination time. In years of good fruit production, the moderately large red and yellow plums begin to color in early August, are ripe by late August, and drop shortly thereafter. Fruits rapidly decompose after falling and wildlife use is limited. Fruits harvested at peak condition make excellent jams, jellies, pies and wines. Human use of the fruit crop does not conflict with wildlife use because of the short period of availability and apparently low utilization by wildlife at a period when many other food items are readily available.

Autumn olive flowers about mid-May, usually very abundantly. The small, clear, greenish-yellow flowers are lightly scented and attract numerous insects, including honey bees. Small, oblong, purplish red fruits mature in early September and persist through late October. Thereafter the fruits slowly begin to shrivel and drop, although a few can still be found on the stems in late December. Bird and mammal use appears to heavy throughout the fall. Autumn olive fruits are very satisfactory for making jellies and wines. Heavy fruit set often causes branches to bend. The dense foliage does not show color in the fall, but leaves are usually retained through early November.

Thornapples occur statewide. Fassett (1976) estimated 100 species in Wisconsin although he only lists 16. He also stated that the taxonomy is difficult because of frequent natural hybridization. While thornapples are more often regarded as small trees than shrubs, they are included as a hedgerow plant because of their reliable annual fruit production, small size, fairly dense lateral branching, and natural occurrence in old hedgerows or fencelines. Abundant pure white flowers appear from early to late May. Orange to orange-red fruits mature in late August and gradually drop off through the fall. In years of heavy fruit production, the ground may be a solid carpet of orange pomes about 1/2 inch in diameter. Fall foliage colors are variable, tending to fade to full yellows or yellow-greens and often showing effects of annual fungus infections or blights. Aged trees occasionally develop gnarled, twisted trunks.

Elderberries bloom from early to mid-July and the clusters of blue-black fruits ripen about mid-September. This is one of the more popular native fruits used in local wine-making and pies. Migratory songbirds consume most of the fruits, which are usually gone by late October.

Highbush cranberry is perhaps best known among the viburnums for its annual long-lasting, bright orange-red fruits. The persistent fruits retain their color most of the winter, an unusual characteristic among wildlife shrubs. Nannyberry and black-haw produce prune-like, edible fruits which persist through late fall. Palatability of these fruits seems low, based on their presence on the plants and conspicuous size and color.

Another acknowledged value of shrub plantings, though difficult to assess, is their use by honey bees. Flowering crabs and autumn olive are used extensively by honey bees throughout the blossoming period. It is possible other species are also of some value for nectar and pollen.

Hedgerows also function as natural snow fences and windbreaks, prevent soil erosion, and cushion potential damage to vehicles and passengers in off-the-shoulder accidents. They serve, too, as natural barriers to environmentally impoverished and unscentic areas such as disposal sites, salvage yards, industrial operations and areas generating noise pollution. At potential planting sites, these useful functions should be considered to make hedgerows serve a dual purpose.

ESTABLISHING NEW HEDGEROWS

Site Selection

Relationship to Cropland. Because of the permanency of woody cover, planting sites should be carefully reviewed to assess their relative value to wildlife species and the competition or encroachment that may develop with adjacent croplands. A slight to moderate reduction in grain, hay, or vegetable crop yields can be anticipated on cropland 5-20 ft from hedgerows. The size of a planting, the density of a hedge, and the distance from the edge of the hedgerow to the field influence crop yield. Row crops, especially corn, show the greatest effects of close planting to established woody cover, while hay crops appear to tolerate the competition for light, moisture and nutrients better.

Fields larger than 10-15 acres could be divided by establishing a central woody strip parallel to the long axis. Maintaining long fields is an important consideration if the land is to remain in agricultural production. On hilly or rolling lands, a hedgerow should follow the contour of the land where possible, particularly where tillage is planned for the adjacent land. Where proposed hedgerows cross a natural waterway, the planting must be either interrupted by dense grass and forb cover or the woody plantings should be spaced to allow for development of a vigorous grass-forb understory. In waterways, selection of the woody species should be limited to those developing a single or multiple stem which do not spread by root sprouts. Flowering crab is a good species to plant in this situation.

A mature, dense hedgerow growing at right angles to a slope exceeding 3-4% may present some soil erosion problems if the understory is completely shaded, or if the land adjacent to the shrub planting is cultivated in row crops. While the shrub branches and foliage will intercept driving rain, the umbrella effect of leaves will divert some of the precipitation to the edges of the hedgerow, creating heavier downhill runoff on a limited area. Thus, maintaining a sodded border extending at least 6-7 ft from the dripline can help avert a serious washout. Spring or late winter snow melt is definitely slowed by shading from all woody species, a positive attribute.

Exposure. The primary consideration governing exposure for the hedgerow planting is the wildlife benefits derived during periods of stress. Pheasants, quail and songbirds are frequently seen within the canopies of windbreaks or brushy fencelines with southerly or eastern exposures during midwinter. Woody or coniferous cover reduces the impact of winds when the birds seek exposure to the sun on bright, cold winter days. South-facing slopes should be given priority for planting woody cover, with the second choice being either east- or west-facing slopes. If plantings are to be made on leveled ditchbanks, the north and western edges are preferred. Where large fields are to be divided, exposure to the southeast, south, or east should be considered in that order.

Soils and Moisture. Mesic sites offer optimum soil and moisture conditions for the establishment of nearly all shrub species. Mineral soils ranging from sandy loams through clay loams are the preferred soil types. Sandy soils with low fertility and poor water retention capacity are generally not suitable for deciduous shrubs. Several species of oleaster and plum or cherry, adapted to drier conditions, are the possible exceptions. Clay soils are satisfactory, though difficult to plant unless soil moisture is moderate. Wet, poorly drained soils associated with wetlands are difficult to plant and chemical weed control is not effective. Organic soils dominate these areas and plant adaptability is usually limited to native species occurring naturally. Undisturbed wetlands dominated by grass, sedge, or forbs are often invaded by native shrub and tree species. Red-osier and silky dogwood grow well on these sites.

Spoilbanks in wetlands are good locations for planting woody cover, assuming waterfowl nesting cover is not a major objective. Often the spoil of leveled ditchbanks has improved drainage, permitting somewhat greater flexibility in the selection of species to be planted, compared with the nearby muck or poorly drained mineral soils.

In order to insure reasonable establishment and sufficient growth to be functional, it is important to select shrub species based on the soils and exposure of each site. Since nearly all readily available shrub species are adapted to mesic sites, proposed hedgerow development should concentrate on these locations, but not necessarily be restricted to them if critical habitat components exist and hedgerows would enhance their use.

Odd Corners or Areas. Throughout many of the intensively farmed regions of Wisconsin there are a variety of small land areas, sometimes isolated between blocks of regularly tilled fields. Examples of these are steep stony outcrops, hilltops, soil hardpan, wet spots, farm disposal sites, cutover woodlots, gullies, gravel pits, and abandoned farmsteads. These sites offer real potential for wildlife plantings with minimal interference to existing farming operations.

In southern Wisconsin, conifer plantations, some 30 years old or more, are evident on many such locations. These small groves represent the effort of 4-H members, Future Farmers of America groups, sportsmen's clubs, farmers, and others. Isolated woody plantings of these "odd acres" has been an accepted practice for several decades. With changing livestock management, some additional nontillable sites may be available for similar plantings. One precaution should be taken, however: nontillable areas may be rich in native grass and herb species and each site should be appraised for their presence. If native species are abundant, or endangered or threatened species are found, the area should remain undisturbed.

Relationship to Existing Permanent Cover. Well-developed hedgerows have only limited wildlife value if the surrounding cover consists solely of cropland, particularly row crops. Ideally the hedgerow should complement undisturbed grassy or herbaceous cover. Not only will grassy or herbaceous cover serve as a relatively secure nesting, brood-rearing, and roosting cover, but the diversity of grass-forb species will support a wide variety of insect food items for both adults and young. Cottontail rabbits will also benefit from surrounding grassy cover. On intensively cultivated lands the planted hedgerow should serve as a connecting link between permanent undisturbed cover units.

Field borders adjacent to wetlands are another appropriate site for hedgerows, unless the wetlands are already dominated by woody species. Soils near the wetland edges are often deep and fertile from years of eroded soil deposition including fertilizer from crop fields.

Site Preparation.

The single most important problem in establishing a new hedgerow will be the competition either from existing trees, shrubs, forbs, and grass or from weeds in crop fields and borders nearby. Desirable trees or shrubs already growing on a proposed site should be left undisturbed, but all species regarded as weedy or too competitive must be eliminated, preferably a year before planting. Oak, hickory, and cherry saplings are easily controlled by cutting during the summer or by using a herbicide applied basally. Some woody species will tend to resprout from rootstocks or basal buds after cutting. Aspen, box elder, sumac, prickly ash, locusts, and willows easily recover after cutting, especially if cut when dormant.

First-year regrowth from plants that resprout after cutting can reach 5-6 ft on fertile soils, and 2-8 sucker sprouts can be anticipated from each stem cut off. Removing the sucker sprouts once or twice during the growing season will help in permanent control, although some additional thinning may be necessary in the second year. Nearby seed sources of unwanted trees and shrubs should also be removed to eliminate reseeding of those species. Individual site preparation depends on the prevailing type of plants, soils, topography, exposure and the availability of equipment and labor. Treatment of the site will depend on whether a machine planter or planting spuds are used to set the stock. In general, eliminating or reducing competition is essential to successful establishment. Each potential location for a hedgerow planting should be evaluated according to the type of competition present and the best means of its control.

Croplands. Corn stalks are usually left on the field after grain harvest. Stalks and other debris should be field chopped or disced prior to fall plowing. Turning the stalks under in the fall will allow some decomposition of the organic matter and provide a firmer seedbed the following spring. All fall-plowed fields should be left rough to hold moisture and limit spring runoff. Before planting shrubs, the fields or strips should be disced for a relatively smooth seedbed. If soil-incorporated herbicides are used, they should be applied before discing unless the site is too rough. When using soil-incorporated herbicides, a disc, cultivator, or tiller must be used to work the chemical into the soil. If herbicides are not used, either cultivation or mulching is needed for first-year weed control.

Relatively clean corn fields harvested for silage already have a smooth surface and shrubs can be planted directly. Chemical weed control would then consist of a granular herbicide, applied to the soil surface prior to or at planting time.

On corn lands subject to soil erosion, the stalk residue can be reduced by using a flail chopper. The chopped debris will serve as a mulch and reduce the germination of annual weed seeds. Since mulch slows evaporation from the soil surface, this method is beneficial in dry seasons but will be a detriment in wet springs since tree planters do not work well in wet soils.

Most small grain fields develop a substantial late summer weed growth after harvest; foxtail, fall panicum, and small ragweed are the more common species. Tall stubble or abundant weed growth should be fall plowed, preferably before weed seeds mature. If erosion potential exists, the site should be field chopped or cut with a rotary mower before the weed seeds ripen. In short stubble fields, relatively clear of annual weeds or debris, shrubs can be planted directly. Hayfields and pastures should be mowed about mid-October and the residue removed if abundant.

Odd Corners, Gullies, Stony Lands, Woodland Borders. Site preparation on untillable lands is limited to herbicide treatment or scalping. Machine planting is difficult or impossible on these sites. Fall application of granular herbicides is the most practical approach. These herbicides are difficult to apply at the usual recommended rates on small areas, so extra caution is advised. Scalping should be done at planting time. Most machine planters have scalping blades or can be equipped with them. Planting with spuds necessitates manual scalping. A sharpened round shovel or a sod cutter works best in removing grass and/or forb sod. An area approximately 18 inches in diameter (or strip 18 inches wide) and 2 inches deep should be scalped. This will normally include the aboveground plant parts capable of growth and a high percentage of dormant annual weed seeds. Additional weed control in the year of establishment on scalped areas is usually not required. Ingress of perennials from surrounding sod is slowed sufficiently to give the shrub seedling time to become established in the first growing season.

Agricultural or Pasture Sod. Planting sites in hayfields or sodbound pastures should be fall plowed if the field has a history of tillage and no serious erosion potential exists. Permanent pastures should not be worked because their soils are generally thin, easily eroded, and stony. Weedy or grassy competition is best controlled with limited herbicide use.

Several additional alternatives may be considered. Rotovating incorporates surface debris with the soil and develops a satisfactory seedbed after only one treatment. A field cultivator used several times on old sods will also tear them apart and eliminate the need to plow and disc. Occasionally seedbeds are worked 3 to 4 times the previous year to destroy perennials and to stimulate annual weed seed germination and thereby reduce the competition for the shrub seedlings the following season. This is advisable if no chemical weed control is planned. Tillage operations break up and destroy the roots and rhizomes of perennial species and decomposition releases some nutrients.

However, plowed or rotovated planting sites have potentially negative features that should be weighed against the benefits. The disturbed soil has trapped air and the roots of newly planted shrubs may be subjected to excessive drying unless the soil is properly packed. Elimination of the grass-forb vegetation occasionally encourages the spread of undesirable woody species growing nearby. If species such as prickly ash, box elder, and locust adjoin the new planting, a narrow-band herbicide application along each shrub row should be employed instead of a hedgerow-wide plow-strip. Disturbed soil is also prone to erosion; therefore, hedgerows oriented at right angles to the contour on slopes greater than 10% should be established with herbicides or mowing to minimize disruption of the sod.

Burning residual vegetation is recommended in stands of heavy cover or when a thick duff is present. Spring burning of cool-season perennial grasses such as quackgrass or bluegrass (after new growth exceeds 8 inches in height) will set back regrowth and generally prevent flowering that season. Where site restrictions preclude burning, rotary mowing of residual vegetation improves transplant operations. The mower should be adjusted to cut as close to the ground as possible. If residual cover is comparatively light, a sickle-bar mower can be used. The cut material remains on the surface, partly curbing regrowth and temporarily limiting competition to the shrub stock.

Species Selection

Single vs. Multiple Species. Establishment of a new hedgerow offers a chance to develop a multiple-use woody planting with wildlife as a primary benefactor. During the 1950's and 1960's, when multiflora rose was popular, single species plantings were usually grown. One or 2 rows of shrubs became the arbitrary standard. There was a reluctance to plant more than 2 rows because of the competition for space, nutrients and water with adjoining cropland. On fertile, upland soils a single row of multiflora rose was capable of meeting its well-publicized stockproof reputation. The arching canes provided a protective haven for small mammals, songbirds and game species. Edible, long-lasting fruits followed a bright, attractive display of scented white flowers. However, gradual appearance of volunteer rose plants along roadsides and other relatively undisturbed areas disenchanting many former proponents.

The decline in popularity of multiflora rose raised other questions on the merits of single-species plantings. In an 8-year study in Michigan (Gysel and Lemmien 1964), the annual productivity of fruits or seeds was determined for 10 species of shrubs common to the area. Seed production for each species was highly variable between years. The study suggested that a mixed-species planting is preferable to a single-species stand since a mixture of species in a hedgerow will provide a diversity of food resources over a maximum time period. It is possible that the range of microenvironments will attract a larger number of wildlife species and provide some assurance against the occasional catastrophe in loss of shrubs from insects, disease or climatic extremes.

Availability of shrub fruits or seeds for wildlife is shown in Table I. Annual variations in production and availability can be expected. All species listed will grow satisfactorily on average soils of moderate fertility. Those species adapted to drier or wet sites are also indicated. Winter hardiness is not absolute. In severe winters when cold temperatures drop below -20 F, all varieties adapted to the southeastern third of Wisconsin will probably show evidence of winter injury the following growing season. In large plantings individual variation in freeze damage will also be evident. For greater detail on species characteristics, see Appendix C.

Nuisance Status

Whenever perennial plants are successfully established, there is a risk of spreading naturally in the immediate vicinity vegetatively or by seed, or more extensively as the result of bird or mammal activity. Normally, the appearance of shrubby species in other habitats or even their extension beyond the original hedgerow boundary is regarded as weedy invasion. All species are capable of spreading, but the probability is highly variable between species and between years. The amount of seed or fruit production, the number of wildlife species consuming the fruits or seeds, condition of soil surface where seeds are deposited, and length of growing season influence the capacity of individual species to reestablish. No problem exists on regularly tilled croplands. Pastures and many types of relatively undisturbed lands, such as fencelines, roadsides, ditchbanks, wildlife areas, woodlots, and building foundations, are likely locations where volunteer shrubs may appear.

In southern Wisconsin, the honeysuckles and multiflora rose have demonstrated the most serious potential for spreading although their wildlife values are among the best. Native woody species such as box elder, soft maple, American elm, aspen, cottonwood, and ash frequently spread, especially in the vicinity of seed-producing trees. In perspective, most woody plants can and do spread naturally and the shrubs as a group are neither more nor less capable of reestablishing than most native trees. Control measures, when required, are essentially the same as eradicating undesired trees. Chemical or mechanical means are the best methods of eliminating unwanted plants.

Establishing hedgerow cover on desired locations should not be discarded merely because some species may spread. Rather, each site should be evaluated and carefully matched to suitable shrub species to reduce the probability of future maintenance or control problems. Generally, if natural spreading does occur, volunteer plants do not appear until 5-10 years after planting and seedlings develop slowly in undisturbed grass cover. Prompt control measures can minimize problems with unwanted volunteer plants if they appear.

Desirable Shrub Characteristics for Wildlife Plantings. (1) Winter hardiness. Plants should be completely hardy including floral buds and should not be stimulated into growth the first warm days of spring. Unfortunately, the highly desirable species autumn olive and Washington hawthorn will show winter injury in some years, although individual variation is common.

(2) Site adaptability. Plants should grow well on moderately drained (mesic) sites with average fertility. Some highly desirable shrubs such as native blueberries and holly only thrive under wet, acid, bog-type conditions and therefore are excluded from general consideration. However, most species adapted to dry sites grow well on mesic sites. Also some wetland species such as silky and red-osier dogwood can adapt to mesic sites.

(3) Growth forms. Multiple-stemmed plants that develop an arching, heavy-branched form and do not spread readily by rootstocks or seeds are preferred. Some selections of ninebark show this character. At the other extreme is elderberry, which branches only slightly.

(4) Longevity. Individual plants should grow slowly and remain productive and useful for at least 25 years. Most species suggested will survive this long barring exceptional environmental catastrophes such as insect outbreaks or severe weather. On wet sites, species that withstand short-term flooding should be the first choice.

(5) Ease of establishment. Given a suitable environment, all shrubs recommended in Table I will grow. Under moisture stress or excessive weed competition some species will thrive better than others. Autumn olive and ninebark have consistently grown well and maintained high seedling survival despite the lack of weed control. However, shrub plantings should not be made unless they can be given proper care and management in the year of establishment.

(6) Availability of shrub stock. Not all desirable shrub species are consistently available through DNR or private nurseries. Plants like Washington hawthorn and other thornapple species are not offered on a regular basis.

TABLE 1. Availability of fruits or seeds and the characteristics of shrubs important to wildlife.

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	Hardiness	Soil Adapt.	Protection	Fruit Prod.
Amur maple				→						3		2	2
Amur privet		→	→	→						1		1	2
Autumn olive			→	→	→	→	→			2	D	1	1
Buffalo berry		→	→	→	→	→				2	D	2	2
Crab, Mixed			→	→	→	→	→	→	→	2		2	1
Dogwood, Gray		→	→	→	→					3		3	2
Dogwood, Red-osier		→	→	→	→					3	W	2	2
Dogwood, Silky		→	→	→						3	W	1	2
Hawthorn, Washington				→	→	→	→	→	→	1		3	1
Hazel				→	→					3		2	2
Lilac, Common or Late			→	→	→	→				3		2	3
Multiflora rose			→	→	→	→	→	→	→	1		1	2
Ninebark				→	→	→	→			3		1	2
Plum, American			→	→						3		2	3
Siberian pea shrub	→	→								3	D	2	3
Thornapple		→	→	→	→	→	→	→	→	3		2	2
Viburnums - Black-haw				→	→	→	→			1		3	3
Viburnum - Highbush cranberry				→	→	→	→	→	→	2	W	2	2
Viburnum - Nannyberry				→	→	→	→	→	→	3		3	3
Viburnum - Wayfaring-tree				→	→	→	→	→	→	2		2	3
Vine - Bittersweet				→	→	→	→	→	→	3		3	2
Vine - Wild grape				→	→	→	→	→	→	3		2	2
Vine - Woodbine			→	→	→	→	→	→	→	3		3	3

Hardiness Ratings	Soil Adaptation	Protection	Fruit Producers
1 - Southeast 1/3 of Wis.	D - Dry	1 - Best	1 - Best
2 - Southeast 1/2 of Wis.	W - Wet	2 - Moderate	2 - Moderate
3 - Statewide	All will grow on mesic sites	3 - Poor	3 - Poor

(7) Production, availability and persistence of fruit. Emphasis on bird use of fruit is often cited in nursery catalogs as a feature of multiple-use shrubs (wildlife and landscaping). Bird use has been documented by food habit studies or summaries (Martin et al. 1951, Gill and Healy 1974). Ideally the shrub should mature fruits in September and retain them in palatable condition through January or February. Highbush cranberry is the best example of a fruit producer that holds fruit until late winter. This persistence may reflect a low wildlife preference; however, in periods of stress these fruits serve as a survival item. The fruits of autumn olive and wild grape desiccate by winter and possibly decline in palatability also. No single species appears to have the capability of producing an abundant, highly palatable, nutritious, persistent fruit.

(8) Freedom from insect pests and/or plant diseases. Resistance to major pests is a goal of plant breeders involved in developing new varieties. Most shrub species discussed here are host to plant diseases and insects but none are considered vulnerable enough to warrant their exclusion as desirable plants (Append. C). Infestations of foliar diseases fluctuate annually and normally do not constitute a serious threat to commercial or agricultural crops.

The mixed or flowering crabs are hybrids of native and/or exotic species. Disease resistance varies among the numerous selections now available. When selecting crabs for wildlife plantings, varietal choice should consider resistance to apple scab, cedar-apple rust, and fire blight. Mixed crabs produced at Wilson Nursery, Boscobel have not been evaluated for their relative disease resistance but tentative field observations suggest at least moderate resistance to those diseases.

(9) Limited natural spreading from seed or rootstock. Some shrub species with many positive wildlife values occasionally become a nuisance because of their aggressive growth characteristics. Notorious for its unwanted natural spreading is the once-favored multiflora rose. This problem is most acute in Indiana, Ohio and the middle Atlantic states (Scott 1965), although volunteer multiflora rose plants began appearing on the Waterloo Wildlife Area in 1968. The oldest multiflora rose hedgerows were planted between 1955 and 1960 in single rows. Many of the volunteer plants were in the immediate vicinity of the old hedgerows although some rose canes on roadsides, idled pastures, and undisturbed uplands were up to 3 miles from established hedges. Spreading is believed to be from bird or mammal ingestion. Except in the immediate vicinities of old multiflora rose hedges, the number of volunteer rose plants is small. Seedling growth in old sod is slow and the young plants may be heavily browsed by small mammals and cottontails.

Bristly locust, a native of southeastern United States was grown experimentally at 2 sites at Waterloo. This species produces rhizomes extending 12-24 ft from the original plant. Bristly locust has been marginally hardy in southern Wisconsin but is a good example of the unwanted spreading characteristic of some species. Routine tillage operations usually destroy the extensions of species capable of spreading vegetatively.

Red osier dogwood can establish naturally on former upland pastures and undisturbed former hayfields. Autumn olive has demonstrated a tendency to spread from older plantings in Wisconsin. Since the species is exotic, particular attention has been given to monitoring natural spreading at potential problem sites.

(10) Aesthetic values. Certain plant characteristics appeal to the aesthetic tastes of most people. Commonly included are showy or fragrant blossoms, edible or colorful fruits, attractive fall coloration, and bark coloration. Many shrub species exhibit one or more of these characteristics, which may guide landowners to their selection in hedgerow plantings. These are discussed under "Aesthetic Values" in the "Importance of Hedgerows" section and under single species accounts in Appendix C.

Source of Seeds or Planting Stock. Cash outlay needed for the purchase of shrub stock may discourage private individuals from establishing a wildlife hedgerow. Enterprising people can collect seed along public thoroughfares or on public lands, or may obtain permission from private landowners to harvest seed from native species and then grow their own shrubs for hedgerow planting. Also, seed from either native or exotic species can be purchased from some seed specialists at a fraction of the cost of 1-year seedlings. Some species can be propagated from cuttings of small branches. Two recommended references are the USDA Handbook #450, Seeds of Woody Plants in the United States, available through the Superintendent of Documents, Washington, D.C. (and possibly in local libraries), and the Proceedings of the International Plant Propagators Society, published annually and available for reference through university or college agricultural libraries.

In rural areas, landowners may purchase seedlings through the Department of Natural Resources if the planting site is approved by the local forester. Minimum orders of 500 stems consisting of at least 100 stems per species and "wildlife packets" containing trees and shrubs were available for purchase at the time of this writing. A number of private nurseries offer small wildlife packets of 25 shrubs made up of several species. Some nurseries specifically note the birds attracted to the shrubs for the benefit of prospective customers. Generally, nursery stock offered through retail catalogs consists of branched plants at least 2 years old which range in size from 18 to 36 inches and costs substantially more than 1-year seedlings. Several wholesale nurseries offer 1-year shrub seedlings in quantities of 25 each, usually with a minimum order in quantity or cost. Interested landowners should consider pooling shrub orders to secure a lower cost per unit. Horticulture and/or garden periodicals contain advertisements for nurseries offering shrubs for wildlife plantings. A partial list of sources is presented in Appendix B.

CULTURAL METHODS

Nursery Stock

Shrub stock produced from seed at nurseries is raised under intensive management, including seed scarification, fumigation of nursery beds, high-level soil fertility, water regulation, and chemical weed and insect control. Dormant stock is lifted in late fall or early spring, sorted, graded and bundled. One-year-old field-run stock may vary in size from several inches to several feet. For ease of planting and to insure better survival, only seedlings 6+ inches tall should be planted. Plants with roots and stems exceeding 18 inches require pruning to facilitate hand or machine planting. Root systems should be kept at 8-12 inches but tops can be trimmed to 6 inches when necessary. Pruning shears, grass clippers or a sharp hatchet work satisfactorily in cutting back the top or root systems.

Shrub stock lifted in the fall is kept under controlled temperature and humidity to retain maximum vigor for spring growth. Lifting of seedling stock in spring is preferred if temperatures remain cool enough to prevent growth. Nursery stock sold for wildlife plantings are 1- and 2-year seedlings bundled in sphagnum, excelsior, or other moisture-retaining media. Sealed plastic-lined bags have also been used successfully in recent years to ship nursery stock without the packing material.

Handling Nursery Stock Prior to Planting. After the bundles of shrubs are received from the nursery, care should be taken to avoid drying out or excessively soaking the stock. Upon arrival, the shrub bundles should be opened and checked for damage and moisture. If dry to the touch, the packing material should be watered, with the excess drained off. Packages should be retied and kept in a cooler unless planting can be completed within 7 days. Shrubs keep safely in a cooler (34-40 F) with this treatment for at least 4 weeks. An alternative is to repack the shrubs in closed plastic bags without moisture-retaining materials. Small numbers (up to 600-700) can be stored in an old refrigerator. Large quantities of shrubs will require a walk-in cooling facility, where the temperature should be maintained within the recommended range and shrubs should be routinely checked to determine moisture conditions. Because of the uncertainty of favorable planting conditions in early spring, arrangement for adequate cold storage should be made before shrubs arrive.

Another common method used to temporarily store stock is to heel-in shrubs or trees in a cool, shaded location. Separate and line out the individual stems in a trench and cover the roots with soil packed or tamped down to limit drying out. A tarpaulin or snow covering will help keep temperatures down. On a short-term basis, heeling-in is preferred to keeping the shrub bundles packaged in a shaded area. Cool

daytime temperatures of less than 40 F will limit new growth, but maximum spring temperatures often exceed 40 F and will trigger bud expansion and root growth. Prompt transplanting to permanent sites cannot be overemphasized. Shrub stock that has been heeled-in should be checked daily to insure that there is adequate moisture in the temporary bed.

Transplanting

Once shrubs are removed from the cooler or heeling-in bed, the roots should be prevented from drying out. Most tree planters have holding boxes which should be kept partly filled with water. If hand planting, keep the shrubs in a large pail half-filled with water. Transplant stock should be covered and kept shaded and as cool as possible after removal from the cooler or heeling-in bed. Only lift the number of plants that will be transplanted each day.

Machine planting

Tree planters commonly used in Wisconsin have a specially designed plowshare that opens a narrow trench in which the shrub/tree roots are placed. A coulter is mounted ahead of the plow to cut the sod and packing wheels behind the trencher press the sod against the roots. A seat is positioned above the packing wheels for the person who is planting the stock. Holding boxes are mounted on the sides of the planter for stock that is separated and ready for planting.

Tree planters can be pulled by a tractor or caterpillar; some models are mounted in the 3-point hitch. Herbicide attachments are customary on rigs used in Wisconsin and the PTO drives the pump for liquid applications. Dual nozzles are desirable for shrub planting because they can be adjusted to avoid spraying the chemical directly on the newly planted stock.

Machine planting is suitable for most sites but careful attention should be given to packing the trench on uneven terrain and stony soils. The roots may dry out if the soil is not packed tightly. Tree planters are not well adapted for use on cohesive soils and wet soils often cling to the plowshare resulting in a poorly formed trench. Excessively dry soils crumble and pack very poorly. Machine planting rates tend to vary according to site, type of equipment, and experience of the workers. Approximately 5,000 shrubs or trees can be planted daily under average working conditions.

Hand Planting

A spud, round shovel, narrow spade, hoe, or even a trowel can be used to plant shrubs by hand. The spud is most frequently used. Whether on prepared beds, sods, or stubble fields, each tool works best when the soils are moist--not too wet or too dry. A clean, scoured surface on any tool makes planting easier. If the tool surfaces are rough or rusty they should be buffed down to a bright metal surface. Hand planting should be considered on small areas, in stony locations, on rough or hilly sites, or in replacement planting on established hedgerows where machine planting is impractical.

Hand planting rates tend to be highly variable. Under good planting conditions, 1 person can plant about 500 stems in 8 hours, or about 1 stem/minute. Scalping sod reduces the planting rate by about 60%. The soil type and moisture condition can slow planting; wet clay loams are difficult to work, while sandy loams are usually not troublesome.

Poor shrub survival can be expected if little or no moisture falls within 2 weeks after planting. The ability of planted stock to withstand prolonged dry conditions depends on planting at the proper depth and compacting soil around the root system. Extra care should be taken to pack the soil tightly around the roots with a boot heel.

Design and Spacing

After sites and species are selected for hedgerow planting, spacing between plants and rows must be determined. At times it is difficult to envision a mature hedge with a continuous canopy developing from the spindly one-year seedlings most frequently used for transplanting. Spacing at 6 ft intervals may seem excessive but for most species this will allow for adequate development to function as protective cover and permit regular production of seeds and/or fruits. The site selection generally dictates the type of hedgerow to be developed compatibly with other land in the area. Where adjacent lands are cropped annually, only a single row of shrubs may be permitted along existing field borders or fencelines. Two or 3 rows of shrubs are preferred and 4 rows are ideal along existing field borders or fencelines. Spacing between plants is not critical and can be varied somewhat for added diversity, including expected breaks in the canopy at maturity. At times, canopy openings result from poor survival of some species in the establishment year. Intentional breaks in the hedgerow are suggested on slopes wherever natural runoff flows or on any slope vulnerable to soil erosion that will be further aggravated by reduction of the understory due to shading.

Mature woodlot edges may be cut back from the fenceline to reduce overhang and competition to crops for light and moisture. Establishing 1 or 2 rows at the edge of the woodlot creates added diversity and may reduce re-establishment of less desirable species.

On open land of 40 acres or more, the presence of shrubby cover may enhance wildlife use. Block, rectangular, or any conformity grouping can be adapted to individual sites. A minimum of 4 rows approximately 30 ft long should be spaced similarly to suggested hedgerow planting at approximately 6 ft intervals. Shrub establishment in odd corners will be largely dictated by size and presence of other vegetation. Again, a minimal size unit of 4 rows of 30 ft each is suggested. Except for shrub carr, natural upland shrub communities do not exist. Occasionally cutover woodlots temporarily revert to an unplanned shrub-dominated vegetation which is usually replaced by tree seedlings or stump sprouts within a few years.

Where hedgerows are established to also function as farm windbreaks, native conifer species can be planted alone or in combination with shrubs. Depending on space limitations, 1-3 rows of conifers (white, blue, or Norway spruce or white cedars are preferred) are planted at intervals of 8 ft between plants and rows. Shrubs can be planted on the interior or lee side of the conifers. Uniform spacing of the conifers is preferred to achieve maximum effect as a windbreak. Conifer transplants under the best cultural conditions require at least 6 years before effective cover is developed. Each additional year's growth improves the quality of the cover. The conifer windbreak will continue to serve its purpose for at least 50 years under average growing conditions.

Throughout southern Wisconsin isolated conifer groves are evident on many farms. Most are small, less than 1 acre, and are located on shallow soils, moderately steep slopes, gullies, or occasionally, fencelines. Because most are located away from buildings the objective of the cover is uncertain.

In past decades, planting stock was made available to rural youth groups (FFA, 4-H, etc.) and these maturing stands are testimony to their efforts. At Waterloo, four small conifer groves consistently attracted pheasants during the winter. Cottontail use was also heavy while lower branches provided cover. Although pheasants are generally ground-roosting birds, they frequently used the conifer groves for roosting at night. Presumably this behavior tended to reduce the incidence of loss through predation.

A basic approach in determining the size and shape of plots and species of shrubs and/or conifers planted for wildlife is to use existing cover as part of the habitat development program, incorporating new stock to provide maximum protection and diversity for the target species. While the minimal size of unit is purely arbitrary, potential cover consisting of 4 rows of plants 30 ft long is preferred to a single row 120 ft long.

Time of Planting

Early spring is the ideal time to plant shrubs. Leaf-out on many species occurs naturally in late April or early May. Planting early in April allows better establishment of root systems while soil temperatures are still cool, moisture supply is often adequate and weed competition is temporarily low. If planting is delayed until mid-May or later, supplemental watering may be needed if soil conditions are generally dry. Cloudy days are preferred to bright sunny days if a choice can be made. If shrubs have started to leaf out, planting should not be done on warm (75 F), clear, windy days between 11:00 a.m. and 3:00 p.m., if possible. Soil conditions and maximum daytime temperatures will govern what course of action is desirable. Heeled-in stock can rarely be held later than mid-May with reasonable survival, while stock kept nearly dormant under controlled temperatures in a cooler may be safely planted until mid-June. Survival rates of late-planted seedling shrubs normally diminish unless added attention is given to soil moisture, dormancy of the stock, weed control and planting techniques.

Fall planting of bare root shrub seedlings is not recommended. The small plants may be browsed by deer, cottontails or field mice, and the root systems can become exposed to excessive drying by alternate freezing and thawing of soil in late winter. Early spring planting helps insure successful establishment.

POSTPLANTING MANAGEMENT

Weed Control

Successful establishment of shrub or conifer seedlings or transplants on former agricultural lands is greatly improved by effective weed control during the first and second year. Weed control is most often accomplished with herbicides, but cultivation, mulches, clipping, and hand weeding are effective alternatives. Tables 2 and 3 list and describe commonly used herbicides. Only a few of the herbicides listed in Table 3 were used on new or established shrub plantings on the Waterloo and Marshall areas, but they have been tested extensively throughout the midwest and are recommended and labeled for weed control in nursery planting.

TABLE 2. Herbicides for planting shrubs and conifers.

Trade Name	Application Rate	Time Of Application	Tolerant Plants
Princep	2 - 4 lb/acre	Pre-emergent	Conifers, and selected shrubs
Roundup	2 - 3 lb/acre	Rapid growth stage for weeds	None
Treflan	2 pints EC or 20 lb 5-G	Incorporated pre-plant	Conifers and shrubs
Casaron	150 lb/acre	Late fall or early spring	Conifers and shrubs

TABLE 3. Additional herbicides labeled for nursery use.

Pre-emergent Types (Annuals)	Systemics (Annuals or Perennials)
Amiben	Amitrol- T
Betasan	Amizine
Dachtal	Dowpon
Dymid	Kerb
Eptan	
Ronstar	
Surflan	

Herbicides. Careful herbicide use permits greater latitude in the selection of planting sites and one application may provide long-term protection, depending on the character of weed problems. Effective weed control depends on proper use of the herbicide. Some herbicides, like Casaron, can be applied either in late fall or in early spring, whereas cultivation is restricted to the period when weeds are small and vulnerable to soil disturbance. Effective control by either method depends on timing; with the herbicide, application rate and weather are also important factors. Herbicides may not be more economical but they often result in better and longer control.

Some chemicals like Treflan control a wide spectrum of broad-leaved and grassy annuals but do not control perennials. But Treflan must be worked into the soil after application to secure optimum results. Under some types of hedgerow plantings, Treflan could not be used effectively. Thus, herbicide advantages and disadvantages should be understood and the selection made according to site, probable weed species present, and types of shrubs or trees to be planted.

Equally important to selection of the herbicide is the proper use and accurate calibration of equipment, especially if the operator has not used the equipment before. Calibrate the machine for water-incorporated herbicides by placing a jar under 1 nozzle and driving a prescribed distance at a constant speed. (When calibrating equipment, only water is used to make necessary adjustments in speed, pressure or nozzle opening.) Granular application equipment is calibrated using the actual herbicide and collecting it in plastic containers. Hand-operated cyclone spreaders are often used to apply granular herbicides. Coordination is required in walking speed, cranking speed, rate of flow of the granules, and the area covered in each pass. Because of variation among individuals, each person must calibrate the equipment separately. Gandi-spreaders, sometimes used behind tree planters, must be adjusted with the tractor speed. The proper herbicide application rate is important because sometimes there are narrow limits between weed control and injury to the planting stock. The economics of using the proper amount of herbicide is also important. Several herbicides are quite costly and their value can be lost through sloppy or improper application. Before applying any herbicide, the label should be carefully read and understood. Any questions should be referred to recognized herbicide specialists. County agricultural agents, herbicide company representatives, or University herbicide specialists can be consulted on these problems.

The following herbicides are recommended for weed control in establishing new hedgerows:

(1) Simazine or Princep (4-G or 80W). Simazine is a triazine herbicide related chemically to Atrazine. Two forms are available: granular (4-G), and wettable powder (80W). Recommended application rates range from 2 to 4 lb/acre active ingredient. The lower rate is for control of annuals only as a pre-emergence application. To control perennials, grasses in particular, the higher rate is recommended.

Simazine is one of the best and most economical herbicides to use on new and established conifer plantings. The disadvantage of Simazine is that some deciduous shrubs are sensitive to it. Only dogwoods and Siberian pea trees have label clearance to date. Our trials indicated that ninebark, autumn olive, highbush cranberry, nannyberry, hazel, and wild crab also tolerated Simazine at 2-4 lb/acre. Special care should be taken to avoid excessive application or spraying the planting stock when using Simazine to establish deciduous shrubs.

The granular form can be applied through a hand-spreader attached to a tree planter. The wettable powder is applied with a hand sprayer or tank attachment on the tree planter. Applications are generally made in early spring, which coincides with tree and shrub planting. At the higher application rates, annuals and many perennials are controlled for most of the growing season. Simazine is not recommended on mucks or sands.

(2) Casaron G-4. Two forms of Casaron (Dichlobenil) are available, W-50, a wettable powder, and G-4, a 4% granular formulation. Casaron inhibits germination and the growth of new sprouts of many perennial weeds, including quackgrass. Because the chemical is highly volatile the granular form should only be applied when air temperatures are less than 40 F, unless the chemical can be worked into the soil promptly.

Casaron works best on established plantings where perennial weeds are seriously competing with the shrubs. Normally, the granular form is applied in late fall or early spring before growth starts. The recommended rate is 6 lb/acre of active ingredient, or 150 lb/acre of total material. Weed control persists until early July when annuals, primarily grasses, begin to germinate. Breakdown of the chemical also permits some ingress of perennial grasses from the edge of the treated area. The extent of germination of weedy annuals in midsummer is related to the amount of duff or residual cover on the ground. If relatively good cover exists, germination will be low but will become increasingly severe in relation to the percentage of lightly covered or bare ground present. Casaron can also be used as a pre-plant herbicide for new hedgerows, but our data show that soil disturbance after treatment reduces its effectiveness in the area where the shovel or planting bar made the cut to plant a stem.

Casaron appeared to depress growth of all transplants despite excellent weed control. Autumn olive showed a definite negative response to Casaron. Most of its spring growth appeared chlorotic with the edges of new leaves turning yellow. The second summer growth did not show the effect.

On established stands we did not detect any effects on the shrub. Release from weedy competition and the apparent decomposition of the vegetation stimulated the growth of all shrub species.

(3) Treflan (E.C. or 5G). Treflan (Trifluralin) provides excellent control of many grassy and broad-leaved annual weeds but will not control any perennials. It is necessary to incorporate either form of the chemical into the soil within 8 hours after application for maximum control. Unless a conventional seedbed is prepared or the soil is worked between rows, Treflan cannot be used. Failure to incorporate the herbicide properly into the upper 2 or 3 inches of soil will result in erratic control. Treflan controls weeds such as foxtail, lambsquarters, pigweed, and smartweed up to 4 months after application.

Treflan is applied in granular form at 20 lb/acre or as an emulsion of 2 pints in 20 gal water/acre. A field cultivator, disc, or rototiller is used to mix it into the soil. A disc or cultivator should be run over the treated area twice, preferably at different angles. This herbicide should be restricted to fields or plots that can be tilled and to sites containing annual weeds. Treatment the second year is recommended if winter annuals appear in the first fall and the shrubs need additional help in the second growing season. Application in the second year is made while the shrubs are still dormant.

(4) Roundup. Roundup is a nonselective contact herbicide that controls annuals and most perennials. It has some application for weed control in shrub plantings.

Roundup should be applied during the rapid growth stage of perennials. For cool-season grasses, including quackgrass, this could be either in early spring about the time the grass has reached 10-12 inches, or during the flush of growth in the fall, usually mid-September. It should also be applied at least 3 days before planting. Treatment time for broad-leaved perennials depends on growth state. Dandelions grow very early and should be sprayed earlier than the preferred time for quackgrass, whereas Canada thistle would be treated when buds first appear about late June.

Roundup is very effective on nearly all annual weed seedlings but has the disadvantage of having no residual carryover. After the initial treatment, additional seedlings are apt to germinate. Roundup works best on old pasture sod that usually contains only a small population of annual weed seeds. It can also be used with discretion in established shrub stock when applied before new growth appears and is directed specifically on the weeds. At present, Roundup is not labeled for this use.

Additional herbicides labeled for use in nursery or shrub plantings are listed in Table 3. Each herbicide has some limitations and their labels should be carefully read before use is considered.

Cultivation. A minimum of 1 cultivation is necessary if weeds are to be controlled by mechanical means. Repeat cultivations may be required in the first season for annuals and winter annuals which do not germinate until late summer. The winter annuals are not competitive the first year but grow very rapidly in the second growing season. Use of most conventional tillage equipment would limit plantings to straight rows. The one exception is the small, hand-operated rototiller. Cultivation around individual stems or between plants in the same row requires caution to avoid damaging to the plants or roots. Any severe weed competition immediately next to seedlings or transplants must be removed by hand.

Cultivation by any means is most effective when the weed seedlings are less than 6 inches high. Tillage on a bright sunny day and subsequent drying of the topsoil and exposed root systems kills nearly all annual weeds on the same day with the possible exception of purslane (*Portulaca oleracea*). Large top-growth often means large root systems, and severing the entire root system by mechanical means is difficult. Many weeds, especially the grassy annuals, can survive if the roots are not completely cut or exposed or may recover following a summer shower on the day of cultivation. Soil disturbance as a result of cultivation also exposes additional weed seeds to the germination zone of the top 1/2-inch of soil. Additional weed seed germination may require a second cultivation.

Mulches. Several alternatives to weed control may be considered. After planting, a mulch of poor quality hay, straw, chopped cornstalks, or wood chips can be spread between plants and/or rows. Spread mulch by hand to insure even distribution. Low quality hay can be purchased locally at harvest time in wet years at a nominal cost. In some instances, the material may be free for the hauling. Most waste hay will be relatively free of weed seeds; if spread approximately 2-3 inches thick it provides good weed control throughout the first growing season, and slows surface evaporation and soil erosion from summer thundershowers.

Mulches are most effective on prepared seedbeds where annual weeds are anticipated. Perennial grasses and forbs are retarded in early spring by mulches but gradually recover during the growing season. Exercise care in applying mulches around shrub seedlings to keep excessive materials from around the stems. A mulch depth up to 6 inches can be left between rows if ample supplies are available. If shrub growth the first growing season is normal, no additional weed control will be required.

While mulching is a good practice, the labor input is high. This should be recognized before the effort is expended to secure materials. Local marsh hays are very satisfactory, but the cost will be higher than that of other types (\$1-\$2 per bale). Occasionally, sawdust or wood chips are available at minimal cost from local sawmills, city forestry departments, or private tree-trimming companies. Again, these sources have to be sought out and availability will vary locally. Plastic strips and surplus cardboard have also been used with reasonable success. Both types require considerable anchoring and have the disadvantage of diverting rainfall, plus they are not aesthetically appealing.

Mulching with biodegradable materials should be considered if an adequate supply is available, the price is right, the use of chemicals for weed control is objectionable or impractical, and manpower is available to handle the mulching job.

Clipping. Perennial weeds resistant to herbicides or newly germinated annuals that prove highly competitive to shrub or conifer plantings can be mowed or clipped if appropriate equipment is available, although this is less satisfactory than herbicides, mulching, or cultivation. Weeds should be clipped or mowed as close to the ground as the equipment will permit. Generally tractor-powered rotary or sickle-bar mowers cannot be operated close enough to individual stems without injuring the shrub stock. Hand-operated rotary mowers are useful around individual stems where the soil surface is relatively smooth and free of stones. Small gasoline- or battery-powered nylon weed cutters or battery-powered grass shears are very useful for cutting around individual stems. Except for mowing between straight rows with tractor-powered rotary mowers, the clipping procedures are time-consuming and require careful hand labor.

Clipping should be done as soon as the dominant weedy growth is the same height as the average shrub seedling. Because most weeds recover rather fast after close clipping, a second mowing is often needed when regrowth again equals the average shrub height. Mowing or clipping in the second growing season is recommended if shrub growth lags and weeds become too competitive.

Hand Weeding. When mechanical or chemical weed control cannot be employed, hand weeding may be the last resort to insure establishment. A minimum circular area of 8 inches in radius around each stem should be cleared of weeds to reduce the competitive effect. If done before the weed growth exceeds 6 inches, an ordinary garden hoe can be quite effective. Over 6 inches, most weeds have developed a sizable root system calling for deeper hoeing, which could partly damage the shrubs' new root system.

Hand-pulling all weeds immediately adjacent to the shrub stem reduces possible damage to the shrub root system and the stems. Careful removal of all weeds within the 16-inch diameter (or larger) area of the shrub usually eliminates the need for a second hand weeding even though the canopy from uncontrolled weeds may completely enclose the shrub. The 16-inch diameter area is absolutely minimal. The larger the area weeded the greater the advantage to the shrub or conifer. If surrounding weeds can be mowed prior to maturing seeds, the potential weed population for the second growing season is substantially reduced and the mowed plant residue can function as a mulch.

The need for post planting weed control and the most appropriate control measure depend on the judgment of the property manager. Generally weed control will benefit seedling shrub survival and growth if the potential height and density of the weeds might develop into a complete canopy over the individual stems. At this point the shrub or conifer cannot successfully compete for light, moisture and nutrients.

Prevention of Mammal or Bird Damage

Animal damage to young shrub plantings can be anticipated in some situations. Potential problems of this nature should be considered prior to planting. For example, planting a hedgerow adjacent to or in a wetland, woodlot, or undisturbed grassy cover, or near existing fencelines or field borders creates a potential for detrimental browsing by field mice, cottontails, or white-tailed deer. Wildlife populations and damage may vary greatly between years and prevention is usually an emergency action. It is important to recognize problems promptly so appropriate control measures can be taken. Effective weed control reduces the probability of mouse and rabbit damage in the winter.

Generally mouse damage is the most severe since mice often completely girdle the main stem. Since this damage usually occurs under snow cover, it is the most difficult to recognize. Rabbit browse can be seen first in early to mid-November. The first year's succulent growth is most susceptible. If cottontail populations are high, persistent browsing can be anticipated throughout the winter. Box traps are effective in reducing the cottontails if the trap lines can be checked daily and the traps can be built cheaply or rented.

Where trapping is not feasible, the use of a repellent is advised. One commercial product that has proven very effective contains Thiram as an active ingredient. It is manufactured by Science Product Company and sold under the "Science" label as rabbit and deer repellent. This product is mixed with equal parts water and applied with a hand sprayer. The spray is directed at the stem and branches within normal reach of the browsing animals. It leaves a white residue that persists through the winter. Protection for the first 2 years is most important; thereafter, shrub species can endure some browsing and still make a satisfactory recovery. However, persistent heavy browsing for several years tends to seriously weaken most plants and also makes them susceptible to bacterial or fungal infections.

Deer occasionally nip early new growth of deciduous shrubs. This is normally not serious on established plants if it does not recur in successive years. Control or preventive measures have to be judged individually. The harvest of nuisance wildlife by legal hunting is the preferred method of curbing problem browsing. Where this cannot be accomplished, chemical or mechanical repellents are the second alternative.

When mammal browsing appears probable, shrub selection should be restricted to species normally not very palatable or a mixture of shrub species should be planted to assure some survival. Fencing may be an alternative, though a costly one. Planting a corn food patch nearby, but not adjacent to the shrub planting, may divert cottontails and deer from the shrubs.

Domestic livestock, cattle, horses, sheep, and goats can seriously damage a shrub planting. Fencing or removing the livestock are the most logical solutions to this problem.

Replacement Planting

In large scale developments, survival of planting stock will vary. Causes of failure are numerous--low soil moisture at planting or a prolonged dry spell following planting are frequently involved. Weed competition in the establishment year is another critical factor. Occasionally other problems arise such as rabbit or deer browsing, delayed planting, poor quality stock, and faulty planting techniques. A mid-summer or early fall field inspection will reveal the approximate survival.

Replacement planting should be considered if mortality exceeds 20%. Normally replacements are made the following season and invariably require hand planting. Care must be taken to use hand applied herbicides with precision to achieve recommended application rates. Hand weeding is another option if labor is available. Whenever possible, replacements should be made early in the spring. Avoid replanting any species that shows evidence of not adapting to a specific site. Replacements are rarely made more than once; failure to establish in 2 consecutive years, provided that good cultural techniques were practiced, may indicate a poor site or species selection.

MAINTENANCE OF ESTABLISHED HEDGEROWS

Once hedgerows are firmly established and begin to bear fruit (3-8 years), maintenance, if any, will be minimal for 10 years or longer. Growth rates decline as shrubs mature, and management should be directed toward keeping the hedgerow functional and within predetermined boundaries to reduce competitive effects on adjacent croplands.

Management needs are unpredictable. Physical injury, storm damage, insect infestation, plant diseases, or herbicide drift can develop into problems requiring some corrective action. Annual field checks allow the property manager to note any such difficulties and to treat them promptly.

Lateral Branching

Lateral branching may present some problems as the maturing shrubs develop a closed canopy and compete for light. Limb pruning or removal of individual plants may suffice. If overhanging branches are extensive, selective herbicide treatment may be more efficient. Krenite is an effective chemical pruner that only affects the portion of the plant treated with the herbicide. The untreated part of the shrub will continue to grow normally. One disadvantage is the variable susceptibility of individual shrub species. Carefully follow label instructions to insure best results.

Fertilization and Weed Control

Well-established hedgerows rarely need supplemental weed control or fertilization. Few weedy species thrive under the shady shrub canopy, and vigorous undisturbed grassy cover adjacent to hedgerows generally repels invasion of undesired species. On low fertility sites evidenced by relatively low growth rates, a general, all-purpose fertilizer such as 12-12-12 applied in early spring prior to leaf-out will stimulate growth for 1 or 2 seasons. Application can be made with a cyclone-type spreader at a predetermined rate.

Rabbit and Rodent Damage

Small mammal or cottontail populations occasionally reach high densities capable of resulting in severe browse damage. This is most apparent, however, in relatively young hedgerows before stems develop rough bark. McCabe (1945) found cottontails to be very selective in only browsing stems or branches of the current year's growth for numerous shrub species. Use of repellents on older hedgerows would be effective but the cost may not be warranted on a broad application. Wildlife use is the primary purpose of the hedgerow, and browsing once the plants are established should be regarded as a function, or at least a tolerable side effect, of the planting.

Disease and Insect Control

Occasional insect infestations or disease outbreaks may occur. Susceptibility of individual shrub species to diseases and insects is identified in Appendix C. Trees or shrubs seriously affected should be removed and burned, particularly if the rest of the hedgerow is threatened. Infestations of highly observable insect pests such as the eastern tent caterpillar are common and completely defoliate of the affected species. Severe outbreaks weaken the host but most plants recover. Objectionable insect nests and dead branches should be cut back and promptly burned. Branch or stem removal should be done with care and necessary cutbacks made in healthy wood to avoid contaminating tools and unintentionally spreading the disease vector.

If disease or insect problems are extensive or persistent, a specialist should identify them and prescribe treatment on the basis of severity, probable spread, and estimated costs of control. Normally the infection or infestation is allowed to run its course without further action, but each outbreak has to be appraised so that appropriate action can be taken if necessary.

Renovation

Older hedgerows may benefit by cutting out the older mature stems. Where this procedure is undertaken, approximately one-third of the old stems of each shrub should be removed at or near ground level. Many species will develop new sucker sprouts from the crown as a result. Topping may be desired to stimulate lateral bud development and increase canopy density. Occasionally, tall-growing species interfere with utility lines. Small chain saws or heavy-duty brush cutters capable of cutting branches up to 1 1/2 inches in diameter are most efficient for these pruning needs.

Renovation may prove to be a rather time-consuming and costly procedure if the hedgerow is particularly dense. It is important to appraise the objectives, needs, and results of such actions before they are undertaken. If complete removal is required, heavy equipment such as bulldozers with special blades may be necessary to accomplish the task.

Partial loss of plants in older hedgerows may be compensated for by hand planting new seedlings. This allows for some diversity in species composition, plant size and stage of maturity. However, only open spots which allow direct light penetration are suitable for underplanting.

Natural Spreading

All shrub species have the capacity to spread naturally after they become well established. When adjacent lands are managed for grass-forb-sedge vegetation and kept relatively undisturbed, small plants gradually appear at the edges of hedgerows. New shoots emerge from root sprouts or rhizomes of the original seedling at distances of approximately 1 ft to 10 or 15 ft from the original plant, regardless of the type of existing vegetation. Vegetative reproduction is common to American or wild plum, sumac, gray, and red-osier dogwood. Plum, sumac, and gray dogwood growing in full sun will develop moderately dense thickets after 10-20 years. The original plants eventually mature and annual growth rapidly declines whereas the younger plants continue vigorous growth at the periphery of the clone. Cropping at regular intervals will contain the natural extension of the hedgerow. Burning or mowing can temporarily control the natural expansion although most species will resprout from the crowns or root systems.

If control is desired on undisturbed herbaceous cover, the most expedient means of restricting spread will be the careful use of labeled herbicides. Broad-leaved perennial forbs tend to be sensitive to herbicides used for woody species. Use caution in selecting the most suitable herbicide for the species to be controlled without causing substantial loss to the understory. Foliar applications are the safest for controlling the woody vegetation while limiting damage to the understory grasses and sedges.

Some shrub species such as the viburnums do not spread vegetatively as readily as plum, sumac, and others. Long-range plans should recognize possible natural expansion and the occasional control measures required.

All shrub species are capable of spreading from seed, especially the smaller fruited types readily consumed by birds. The most notorious plant is probably the multiflora rose. On undisturbed lands, rose seedlings begin to appear about 10 years after establishment and often several miles from the original planting. Shrub seedlings are easily destroyed by cropping. Dense sod cover inhibits natural establishment from seed. Cautious use of selected herbicides is the best choice for control of scattered unwanted plants.

Invasion of Other Weedy Species

The recently established hedgerow is most vulnerable to invasion of other woody species early in development. Woody plants likely to be found are box elder, soft maple, black cherry, honeysuckle, buckthorn, or American elm. Seed sources are usually nearby and should be removed to prevent recurring problems. If undesired species are present in the seedling stage, hand removal is the safest way to eradicate them. After two growing seasons, a sharp grub hoe may be required to sever the stem slightly below ground level to prevent recovery from other stem sprouts. Where foliage of the shrubs does not overlap with the weedy species, carefully directed herbicide will also control the unwanted species.

TABLE 4. Cost of establishing 1 mile of hedgerow in 1981.

Item	Shrubs	Conifers
Stock*		
Seedling	\$260	\$180
Transplants	---	422
Herbicide**		
Casaron 4-G	263	343
Simazine 4-G	136	176
Simazine 80W	24	24
Plow-disc-harrow ¹	50	62
Planting		
Machine ²	169	127
Hand ³	141	106

Median cost (range) \$588 (425-692) \$601 (310-892)

*Based on 4 rows with 6 x 6 ft spacing for shrubs (3,520 stems/mile) and 8 x 8 ft spacing for conifers (2,640 stems/mile) and costs for shrub seedlings - \$74, conifer seedlings - \$68; and conifer transplants - \$160.

**Based on 20 ft strip for shrubs and 26 ft strip for conifers. Simazine 80W applied in bands so only 1/2 the total area is treated.

¹Based on custom rates for plowing - \$10/acre, discing - \$5/acre, and harrowing - \$5/acre.

²Based on \$40/1,000 for tractor plus operator, and \$8/1,000 for tree planter.

³Based on \$40/1,000 for hand labor.

COSTS

The approximate cost of establishing 1 mile of hedgerow was \$600 including planting stock, herbicides and equipment operation (Table 4). Costs for planting stock were taken from 1981 DNR price lists. Initial costs from independent nurseries are generally more, but stock is usually sold in larger size classes with associated higher prices. Commercial nurseries may also give a limited guarantee on survival the first growing season and/or offer a discount for large quantity orders or direct pickup from the nursery.

Conifer expenses depend on species and age of stock. Seedling stock is the most economical but should only be used on sites with low potential weed competition or on sites treated with the appropriate herbicide. Transplants are a better choice on sod or in locations where tillage is not practical. Spruces are preferred for wildlife plantings. A 4-row conifer windbreak and wildlife planting with approximately 8-ft intervals between plants and rows would cost \$180/mile using 3-year seedlings or \$422/mile with 2-2 transplants. Combinations of shrubs and conifers may better suit individual circumstances including soils, slope, exposure, or personal preference.

Additional anticipated costs are transportation from the nursery to planting sites, seedbed preparation, herbicide application or cultivation the year of establishment, tractor operating costs, and fencing, plus hired labor if shrubs or trees are hand planted. A tree planter or planting spud can usually be rented from the county for a small fee. Reservations should be made early if large quantities (over 1,000 stems) are scheduled for planting.

Machine operating costs will vary from one locality to another if any or all operations require custom work. Operating costs for landowners who have their own equipment will be considerably lower than costs for those having all field work done commercially. Rental units are frequently available through implement dealers, and this possibility should be checked if difficulty is encountered in securing a custom operator.

Postplanting costs often cannot be anticipated, but they are sometimes incurred. Fencing may be necessary to protect a planting against domestic livestock. Electric fencing can be erected rapidly and is by far the most economical to set up if the livestock problem is expected to be temporary.

SUMMARY

Hedgerows are important for wildlife habitat, windbreaks and erosion control and aesthetic values. Land managers can establish new plantings to replace extensive areas lost in recent years to changing land use priorities.

New hedgerows should be located where they will connect other wildlife habitats such as woodlots and wetlands, along natural field borders and roads, and around farmsteads. Many deciduous and several conifer species offer a variety of wildlife uses - for food, cover, nesting, shelter from wind and the like. Planting a mixture of species helps insure that each of these wildlife needs will be supplied, while minimizing effects of any single species failure to survive.

Planting methods vary with the size, location, and topography of the site, but include both pre-plant plowing and no-till methods, and hand and machine planting. Weed control is necessary for establishment in the first year or two and also varies according to the site and species planted. Hand weeding, cultivation, mowing, mulching, and chemical weed control are options.

Shrubs vary in their susceptibility to insects, diseases, and animal browse. These characteristics and their growth form, size, palatability, and appearance are important to consider when planning a hedgerow planting.

Costs for establishing the hedgerow also vary by site and species, but in this 1981 project were around \$600/mile of hedgerow.

APPENDIX A: Scientific and Common Names of Shrubs Mentioned in This Report

<u>Scientific Name</u>	<u>Common Name</u>
<u>Acer ginnala</u>	Amur maple
<u>Arctium minus</u>	Burdock
<u>Caragana arborescens</u>	Siberian pea shrub
<u>Celastrus scandens</u>	Bittersweet
<u>Cornus amomum</u>	Silky dogwood
<u>Cornus racemosa</u>	Gray dogwood
<u>Cornus stolonifera</u>	Red-osier dogwood
<u>Corylus americana</u>	American hazel
<u>Crataegus spp.</u>	Thornapple
<u>Crataegus phaenopyrum</u>	Washington hawthorn
<u>Elaeagnus umbellata</u>	Autumn olive
<u>Ligustrum amurense</u>	Amur privet
<u>Parthenocissus inserta</u>	Woodbine or
<u>P. quinquefolia</u>	Virginia creeper
<u>Physocarpus opulifolius</u>	Ninebark
<u>Picea spp.</u>	Spruce
<u>Picea abies</u>	Norway spruce
<u>Picea glauca</u>	White spruce
<u>Picea pungens</u>	Colorado blue spruce
<u>Pinus resinosa</u>	Red or Norway pine
<u>Pinus strobus</u>	White pine
<u>Polygonum spp.</u>	Smartweed
<u>Prunus spp.</u>	Plum cherry
<u>Prunus americana</u>	Wild plum
<u>Pyrus spp.</u>	Crabapples
<u>Pyrus sargentii</u> , and	Sargeant's crab (Flowering Crab)
<u>P. zumi calocarpa</u>	Cultivar Bobwhite (Flowering Crab)
<u>Rhus aromatica</u>	Fragrant sumac
<u>Robinia hispida</u>	Bristly locust
<u>Rosa multiflora</u>	Multiflora rose
<u>Setaria spp.</u>	Foxtail
<u>Shepherdia argentea</u>	Buffaloberry
<u>Solanum dulcamara</u>	Bittersweet nightshade
<u>Syringa spp.</u>	Lilac
<u>Syringa villosa</u>	Late lilac
<u>Syringa vulgaris</u>	Common lilac
<u>Thuja occidentalis</u>	White cedar
<u>Viburnum lantana</u>	Wayfaring-tree
<u>Viburnum lentago</u>	Nannyberry
<u>Viburnum prunifolium</u>	Black-haw
<u>Viburnum trilobum</u>	Highbush cranberry
<u>Vitis riparia</u>	Wild grape

APPENDIX B: Sources of Wildlife Shrub Species

ILLINOIS

LaFayette Home Nurseries, Box 1A, R#1, LaFayette, IL 61449
King Nursery, 1036 Benton St., Aurora, IL 60505

INDIANA

Krider Nursery, Middlebury, IN 46540
Simpson Orchard Nursery, Inc., 1504 Wheatland Rd., Vincennes, IN 45791

IOWA

Earl Farris Nursery, 811 Fourth St. NE, Hampton, IA 50441
Earl May Seed & Nursery Co., North Elm St., Shenandoah, IA 51603
Henry Field Seed and Nursery Co., 407 Sycamore St., Shenandoah, IA 51602
Interstate Nursery, Hamburg, IA 51640
Mount Arbor Nurseries, Inc., 400 N. Center St., Shenandoah, IA 51601
Sherman Nursery Co., 1300 W. Grove St., P.O. Box 579, Charles City, IA 50616
Smith Nursery Co., P.O. Box 515, Charles City, IA 50616

MICHIGAN

Armin Trout's Evergreen Nursery, Rt. #7, 2815 113th Ave., Allegan, MI 49010
Burgess Seed and Plant Co., P.O. Box 3000, Galesburg, MI 49053
Dutch Mountain Nursery, Augusta, MI 49012 (catalog 25¢)
Emlong Nurseries, Stevensville, MI 49127
Light's Landscape Nurserymen, 9153 East D Ave., Richland, MI 49083
Michigreen Nursery, 12531 N. Cedar Dr., Grand Haven, MI 49417
Needlefast Evergreens, Route #2 Hansen Rd., Ludington, MI 49431
Van's Pines Inc., 0-7550 144th Ave., West Olive, MI 49460
Wavecrest Nurseries, 2509 Lakeshore Dr., Rt. #2, Fennville, MI 49408

MINNESOTA

Bachman's Inc., 6010 Lyndale Ave. South, Minneapolis, MN 55423
Bailey Nurseries, Inc., 1325 Bailey Rd., St. Paul, MN 55119
Farmer Seed and Nursery Co., Rt. #60, Fairbault, MN 55021
Orchid Gardens, 6700 Splithand Rd., Grand Rapids, MN 55744

MISSOURI

Forest Keeling Nursery, Elsberry, MO 63343

NEBRASKA

Hills Sod, Trees and Landscaping, Box 208, O'Neil, NE 68763
Marshall Nurseries, 205 North 2nd, Arlington, NE 68002
Plumfield Nurseries, Inc., P.O. Box 410, Fremont, NE 68025

NEW HAMPSHIRE

Charles H. Bickford - Exeter Wild Flower Gardens, P.O. Box 510, Exeter, NH 03833

PENNSYLVANIA

Musser Forest, P.O. Box 340, Indiana, PA 15701

SOUTH DAKOTA

Gurney Seed and Nursery Co., Yankton, SD 57078

WISCONSIN

Christom Farms Nursery, 1746 Hwy. 73, Cambridge, WI 53523
Evergreen Nurseries, Route #3, Sturgeon Bay, WI 54235
Game Food Nurseries, Box V, Omro, WI 54963
Jungs Seed Co., Inc., 335 S. High Street, Randolph, WI 53956
McKay Nursery, Waterloo, WI 53594

*From "Sources of plants and related materials". Am. Assoc. of Nurserymen, 230 Southern Bldg., Washington, D.C., 20005. 70 pp. For additional nation-wide listing see "Sources of Native Seeds and Plants" available through the Soil Conservation Society of America, 7515 Northeast Ankeny Rd., Ankeny, Iowa 50021 (price \$2.00).

APPENDIX C: Characteristics of Important Shrub Species

CONTENTS

Varieties Evaluated in Wisconsin

* <u>Acer ginnala</u>	Amur maple	<u>Parthenocissus inserta/</u>	Woodbine/
* <u>Caragana arborescens</u>	Siberian pea shrub	<u>P. quinquefolia</u>	Virginia creeper
<u>Celastrus scandens</u>	Bittersweet	<u>Physocarpus opulifolius</u>	Ninebark
<u>Cornus amomum</u>	Silky dogwood	* <u>Picea abies</u>	Norway spruce
<u>Cornus racemosa</u>	Gray dogwood	* <u>Picea glauca</u>	White spruce
<u>Cornus stolonifera</u>	Red-osier dogwood	* <u>Picea pungens</u>	Blue spruce
<u>Corylus americana</u>	American hazel	* <u>Pyrus spp.</u>	Mixed crabs
<u>Crataegus spp.</u>	Thornapple	* <u>Pyrus sargentii and</u>	
* <u>Crataegus phaenopyrum</u>	Washington hawthorn	<u>P. zumi calocarpa</u>	Wild crab
* <u>Elaeagnus umbellata</u>	Autumn olive	* <u>Rosa multiflora</u>	Multiflora rose
* <u>Ligustrum amurense</u>	Amur privet	* <u>Shepherdia argentea</u>	Buffaloberry
		* <u>Syringa villosa</u>	Late lilac
		* <u>Syringa vulgaris</u>	Common lilac
		* <u>Thuja occidentalis</u>	Northern White Cedar
		* <u>Viburnum lentana</u>	Wayfaring-tree
		<u>Viburnum lentago</u>	Nannyberry
		<u>Viburnum prunifolium</u>	Black-haw
		<u>Viburnum trilobum</u>	Highbush cranberry
		<u>Vitis riparia</u>	Wild grape

Varieties Not Planted or Evaluated in Wisconsin

<u>Amelanchier arborea</u>		<u>Kolkwitzia amabilis</u>	Beauty bush
and <u>A. laevis</u>	Serviceberries	<u>Lonicera fatarica and</u>	
<u>Aronia melanocarpa</u>	Black and red	<u>L. Maacki</u>	Honeysuckles
and <u>A. rubra</u>	chokecherry	<u>Phytadelphus coronarius</u>	Mock orange
<u>Cephalanthus occidentalis</u>	Buttonbush	<u>Rhamnus frangula</u>	Alder buckhorn
<u>Cotoneaster acutifolius</u>		<u>Rhamnus cathartica</u>	Common buckhorn
and <u>C. multiflorus</u>	Cotoneasters	<u>Rhus glabra</u>	Smooth sumac
<u>Elaeagnus angustifolia</u>	Russian olive	<u>Rosa setigera</u>	Prairie rose
		<u>Spiraea vanhouttei</u>	Bridalwreath
		<u>Weigela florida</u>	Weigela

*Exotic to Wisconsin

Varieties Evaluated in Wisconsin

● Acer ginnala Amur maple

Range - Native to central and northern China, Manchuria and Japan.

Habitat - Fernald (1950) reported Amur maple established locally from Maine and Connecticut to western New York. It performs best in full sun on moderately fertile soils to dry, sandy locations. Carroll (1973) reported poor growth on poorly drained or wet sites.

Growth form - Amur maple grows slowly and develops into a multistemmed, upright, spreading tall shrub reaching 15 ft at maturity. It has a well-developed, fibrous root system. One-year seedlings seldom exceed 12 inches, and weed control is essential for successful establishment.

Winter hardiness - Exceptionally winter hardy throughout Wisconsin.

Fruit and flower production - Even under good growing conditions, flowering and seed production (samaras) is seldom noted until the fifth growing season. Flowering is early, mid- to late April, and fruits ripen to a bright red color in early August, persisting until December.

Fall foliage - Leaves change to a rich red in autumn, rivaling the native red and sugar maples for fall color.

Insect pests and diseases - Relatively less vulnerable to wilts and insect pests that commonly attack the native maples.

Wildlife use - Amur maple is highly palatable to white-tailed deer and cottontail rabbits. If grassy weed growth is prevalent around the stems, mouse damage can be a serious problem. A rabbit repellent is recommended for young plantings, especially when fall populations are high. At Waterloo, deer heavily browsed Amur maple after it reached 5 to 6 ft in height. Although seeds persist into the fall, no observations were made on the species of wildlife eating the fruit. Martin et al. (1951) reported that 25 species consumed maples in the northeast.

Other uses - In addition to being used for wildlife plantings, Amur maple is sometimes used for screening.

● Caragana arborescens Siberian pea shrub

Range - Northeastern Asia: Siberia and Manchuria.

Habitat - Grows best on fertile soils in full sun. Caragana also performs well on droughty, sandy soils.

Growth form - A moderate-growing shrub developing into a broadly upright, coarse-stemmed plant reaching a height of 18-20 ft at maturity.

Winter hardiness - Extremely winter hardy throughout Wisconsin.



Siberian pea tree

Fruit and flower production - Bright yellow, pealike blossoms appear in late May, and the legume-type pods ripen by mid-July, soon spitting and dropping all their seeds. Seed pods are rarely present after early September.

Insect pests and diseases - Caragana is relatively free of serious insect pests and foliar diseases, leaf scorch and hairy root disease were reported by Pirone et al. (1970) as seldom severe enough to require treatment.

Nuisance status - There has been no indication of natural dispersal from seed or spreading from the root system.

Wildlife use - Specific wildlife associations are rarely recorded. Edminster (1950) listed Caragana along with 47 other species as not recommended for the northeastern states but did not give reasons for the status. At Waterloo, cottontails browsed moderately on Caragana. Ripening of seed in midsummer limited opportunities to make observations on seed consumption. Songbird nesting has not been noted in this species. However, it is a relatively minor species numerically, compared with autumn olive, wild plum, or ninebark. Hunt (1974) found extensive use of Caragana hedgerows for nesting by gray partridge in association with small grains in Saskatchewan.



Amur maple (right) Washington hawthorn (left)

● Celastrus scandens Bittersweet

Range - Southwestern two-thirds of Wisconsin. In North America, bittersweet is found from southern Quebec to southern Manitoba, east to New England, south to Georgia and west to Oklahoma.

Habitat - Frequently found in hedgerows, fence lines, open woods and remnant odd corners. This species tolerates a moisture gradient from wet mesic to dry mesic conditions.

Growth form - Always grows as a twining vine. The main stem wraps around the host plants, fences, buildings, machinery, and brush piles and may extend vertically or laterally 50-60 ft. Older plants develop many lateral branches that also twine around all forms of support, including the main stem and other adjacent branches. Individual vines are flexible but exceedingly tough and resilient and prove difficult to remove after several years. Bittersweet vines encircling the main stems or branches of trees or shrubs will eventually kill the host plant by girdling.

Winter hardiness - Completely winter hardy throughout Wisconsin.

Fruit and flower production - Bittersweet is dioecious and requires at least 2 separate plants for fruit production. Flowering occurs in late May and early June. The 3-valved fruit matures by late September or early October, turning a bright orange. By late October the valves split, exposing the bright, fleshy, reddish orange aril, each of which contains 2 seeds. Fruits are quite conspicuous after the leaves drop and apparently are readily consumed by birds. Some fruit is retained through late December.

Insect pests and diseases - Leaf spots and mildews infect bittersweet. Leaf spot caused by Ramularia celastris is the most common. The most significant insect pest is Euonymus scale (Unaspis euonymi) which attacks the stem and leaves.

Wildlife use - Bittersweet vines on fence lines or hedgerows provide supplementary protective cover throughout the reproductive season. Fruits are relished by ring-necked pheasants, bobwhites, wild turkeys, songbirds, and squirrels (Martin et al. 1951). Cottontails browse younger stems. Petrides (1942) reported bittersweet as "outstandingly acceptable for nesting hedgerow birds."

Human use - Bittersweet branches are a perennial favorite for rustic fall and winter decorations. Wild plants are frequently pruned for this purpose. Because the majority of fruit is produced at the extremities of the plant, human exploitation apparently does not seriously damage the plant.

● Cornus amomum Silky dogwood

Range - Southern Maine to southern Wisconsin, to South Carolina and Alabama. Fassett (1976) reports the range in Wisconsin as north to Waushara, Adams, and Pierce counties.

Habitat - Found in wetland habitats, including marshes and river banks. It also does well when planted on mesic sites but generally does not grow as large there as on organic soils.

Growth form - Silky dogwood grows faster than either gray or red osier and matures into a

multistemmed, upright-spreading, thickly branched shrub reaching 14 ft in height. In form, silky is similar to red osier but grows taller; the older branches develop a grayish red bark, compared to the bright red stems of red osier. The younger branches, however, are similar to those of red osier except that the pith of silky in 1- and 2-year-old stems is brown while the pith of red osier stems is white. Silky dogwood does not spread from stolons.

Winter hardiness - Winter hardy throughout the state although the natural distribution in Wisconsin extended only to the central part of the state.

Fruit and flower production - Silky dogwood flowers in late May and at irregular intervals thereafter. Lead blue fruits ripen in mid-August and persist through October. In southwest Michigan, fruit remained on the shrubs up to 90 days after ripening (Gysel and Lemmien 1955).

Insect pests and diseases - Silky dogwood is susceptible to scale insects and leaf spot common to other dogwoods. Generally, these infestations do not cause serious problems.

Nuisance status - Silky dogwood does not appear to spread as rapidly as either red osier or gray dogwood and is not regarded as a nuisance species.



Silky dogwood

Wildlife use - Ten wildlife species have been reported as using silky dogwood, including bobwhite, ring-necked pheasant, ruffed grouse, and wild turkey (Gill and Healy 1974). McCabe (1945) and Holweg (1964) indicate browsing by cottontails, although McCabe reported only slight browsing in a relatively severe winter. Songbirds nest in silky dogwood, and hedgerows of this species provide excellent year-round cover.

● Cornus racemosa Gray Dogwood

Range - A native dogwood occurring from Maine to southern Ontario to Minnesota, south to Oklahoma and east to West Virginia and Maryland.

Habitat - Occupies a wide range of habitats from wet mesic to dry mesic sites. Gray dogwood is

also moderately shade tolerant and is a common species in the understory of southern Wisconsin woodlots. It thrives in undisturbed fencelines, woodlot borders and roadsides.

Growth form - Gray dogwood grows upright to a maximum height of about 7 ft. In deciduous woodlots of southern Wisconsin it does not develop into the multiple-stemmed specimens characteristic of red osier or silky dogwood. By comparison it is rather spindly. Grown in full sun, gray dogwood develops into a more compact shrub and slowly spreads from underground stems, eventually forming thickets similar to American plum.

Winter hardiness - Gray dogwood is completely winter hardy throughout Wisconsin.

Fruit and flower production - Production of fruit may occur as early as the third season under good growing conditions. The white, berry-like fruit ripens in August and may remain on the red pedicels until early November. As in other *Cornus* species, the spring bloom takes place in late May and early June and flowers continue to appear irregularly throughout the summer. It is not unusual to find mature fruit and blossoms on the same specimen in early September.

Insect pests and diseases - Scale insects (*Chionaspis furfura*) frequently infest gray dogwood but usually do not cause serious or permanent damage.

Wildlife use - migrating songbirds consume the fruit rapidly during fall migration. Liscinsky (1974) reported gray dogwood to be an important cover plant for ruffed grouse. Woodcock utilize gray dogwood thickets throughout the reproductive period. McCabe (1945) noted moderate cottontail browsing on gray dogwood in comparison with only slight browsing on red osier, silky and alternate-leaved dogwood.

● *Cornus stolonifera* Red-Osier dogwood

Range - Newfoundland and southern Labrador to the Yukon, south to Nova Scotia, New England, Maryland, West Virginia, Ohio, Indiana, Illinois, Iowa, Nebraska, New Mexico, Arizona, and California.

Habitat - Red-Osier is one of the most common shrub species found on muck or peat soils throughout the glacial wetlands of Wisconsin. It also readily establishes on mesic sites, especially idled pastures near or adjacent to wetlands. Spreading into upland sites is believed to be by seed ingestion by birds.

Growth form - A multiple-stemmed, upright spreading shrub that matures at 10-12 ft, spreading from stolons. About mid-March, the red stems become particularly bright and noticeable from some distance.

Winter Hardiness - Extremely winter hardy throughout Wisconsin.

Fruit and flower production - Spring bloom occurs in late May, and rebloom on current season's growth is noted irregularly throughout the summer. Mature fruit, a white berry, and blossoms can frequently be found on the same plant simultaneously. Fruits remain on the shrubs until late November.

Insect pests and diseases - Infestation by scale insects (scurfy scale) appears to be common but

does not kill the host plant.

Nuisance status - Spreads rapidly into undisturbed wetlands and adjoining uplands, where it can be a problem. Invasion of red-osier into sedge meadows, wet prairies and idled grass-forb uplands is presumed to be from birds dropping seeds in these areas. On wildlife lands, some spread of red-osier may not be objectionable. Control by selected herbicides may be required on areas where it is not wanted. Fire temporarily sets it back, but vigorous stump sprouts emerge from the crown after winter or spring burn, growing 3-5 ft the first season.

Wildlife use - In southern Wisconsin, red-osier is frequently severely browsed by deer. Martin et al. (1951) reported dogwoods were used by 43 species in the northeastern United States. Red-osier was consumed by 93 bird species in New England (McKenny 1933). Korschgen (1960) found it to be a preferred food of pheasant and turkey in Missouri. Cottontails occasionally browse younger stems in severe winters (McCabe 1945). Red-osier is also an important winter cover species in wetlands for cottontails and pheasants.

● *Corylus americana* American hazel

Range - North America: from Maine to Saskatchewan, to Georgia, Missouri, and Oklahoma.

Habitat - Found in wooded and open habitats in locations ranging from mesic to dry-mesic.

Growth form - Generally upright, spreading outward at the extremity of the branches. Individual clones gradually become very dense, with closely packed stems. Matures at about 8 1/2 ft in height.

Winter hardiness - Completely winter hardy throughout Wisconsin.

Fruit and flower production - Small hazelnuts are produced within 2 broad, thick bracts. Upon ripening nutlets are exposed and drop out if not harvested by squirrels and chipmunks before completely ripe in early September. Use by squirrels and chipmunks seems to be extremely heavy, as few nuts are present on bushes by November. Catkins are an important food of ruffed grouse. Nut production is variable from year to year, and best production comes from clones or plants growing in full sun with limited competition.

Insect pests and diseases - Nuts are frequently infested by weevils, which destroy the embryo. Hazel foliage is generally resistant to other insect pests and foliar diseases. Older clones often have some dead stems near the center of the clump. Support from adjacent live stems prevents dead stems from falling to the ground, so that at first glance it may seem to have a pest problem. A close inspection usually indicates the younger outer stems of the hazel to be healthy; the gradual loss of stems from center appears to be a natural phenomenon.

Other *Corylus* species - The native *Corylus cornuta*, or beaked hazelnut, inhabits northern mesic and dry forests in addition to the boreal forest. European species and horticultural selections developed for commercial hazelnuts are rarely grown in Wisconsin because of questionable winter hardiness.

● Crataegus spp. Thornapple

Range - Approximately 200 species and varieties are reported for North America. The Crataegus genus is difficult taxonomically, and only the few identified species planted in southern Wisconsin will be discussed.

Habitat - Crataegus sp. in Wisconsin is most often found in open, mature, dry mesic to mesic woodlots. It is also commonly seen at edges of woodlots, fencelines, and roadsides. Thornapple is a good indicator of present or past livestock grazing and is frequently found on permanent upland pastures.

Growth form - Because there are numerous species and hybrids, physical characters naturally vary. Generally thornapple grows as a single-stemmed small tree with numerous laterally spreading thorny branches. However, multiple-stemmed specimens are not uncommon. Dense branching is usually characteristic, and mature height may reach 20-24 ft.

Winter hardiness - Winter hardy throughout Wisconsin.

Fruit and flower production - Blossoming usually occurs prior to leafout in early May. Mature trees are often completely covered by the white or cream-colored, sometimes fragrant blossoms. Honey bees are noted in abundance throughout the flowering period. Fruits start maturing about mid-August, with considerable variability in size and color. Individual fruits may range from 1/4 inch to 5/8 inch in diameter and from yellowish orange to deep red. Each fruit contains 1 to 5 very hard seeds or nutlets. The edible fruit

tends to be somewhat dry but has a distinctive flavor. Fruits usually drop after ripening in September, and trees are frequently bare of both fruit and leaves by mid-November. In years of heavy fruit production, the ground will be a mass of red-orange by late September. Some ornamental Crataegus hybrids hold fruit through midwinter.

Fall foliage - Crataegus leaves often yellow or become a mixture of faded greens and drab browns before falling.

Insect pests and diseases - Native Crataegus species are susceptible to the cedarapple rust caused by Gynosporangium juniperus. Severe infestation will cause some deformed leaves and the entire foliage will be covered with small yellow to orange spots about mid- to late June. Defoliation often results. A degree of control can be achieved by removing all junipers within 1/2 mile of Crataegus plantings. Thornapples are also susceptible to fireblight (Erwinia amylovora).

Nuisance status - Spreads slowly from seed but is not regarded as a problem species. May become a nuisance in pastures where it thrives because of unpalatability to cattle and other browsers.

Wildlife use - Martin et al. (1951) reported moderate use by songbirds, gamebirds and furbearers. Dense branching is very attractive to songbirds for nesting.

● Crataegus phaenopyrum Washington hawthorn

Range - Eastern United States; native from Pennsylvania to Florida, west to Arkansas and Missouri to Illinois.

Habitat - Found in thickets, fencerows and open woods on moist, rich soils.

Growth form - A tree form growing upright and spreading at the top. The slim branches give a rather open appearance. At maturity, the tree may reach 25 ft. Other cultivars develop into a multiple-stemmed, upright, slightly spreading large shrub.

Winter hardiness - Hardy only in southern Wisconsin.

Fruit and flower production - Fragrant blossoms appear in late May to early June, followed by many clusters of small but very bright scarlet fruits in September. Each fruit is about 3/8 inch in diameter and contains 3-5 nutlets. The fruit persists through midwinter.

Fall foliage - Foliage changes to shades of yellow and red before leaf drop in early to mid-October.

Insect pests and diseases - Washington hawthorn and related Crataegus species are subject to a wide range of plant diseases and insect infestations. Fire blight (Erwinia amylovora) affects most Crataegus species, and continued uncontrolled infection will eventually kill individual plants. Gradual dieback of outer branch tips in late spring or summer is typical of the infection. At times only a single branch may be affected, while susceptible species will have numerous infected branches appearing simultaneously. A leaf blight (Fabraea maculata) commonly occurs but seldom kills a plant. Nine species of rust fungi occasionally infect hawthorns, and 9 common leaf-spot diseases are reported (Pirone et al. 1970). Six species of aphids and four species of borers also infest Crataegus species. A hawthorn leaf skeletonizer (Hamerothrips puriana) and tent caterpillars (Macacosoma americana) can defoliate small specimens. Sharp (1965) concluded that native hawthorns were resistant to fire and leaf blight but the rust caused by Gymnosporangium clavipes was very destructive when the alternate host, red cedar (Juniperus virginiana) grew in the same area. Despite the vulnerability of hawthorns to numerous diseases and insect pests, they remain a highly desirable shrub for wildlife species.

Wildlife use - Zorb (1966) reported the fruits were eaten by cottontails, grouse, and deer. Wildlife managers in Michigan ranked Washington Hawthorn 6th out of 10 preferred species and confirmed fruit persistence into the winter months. This species is also a highly preferred browse species of cottontails and white-tailed deer. The broadly branched types offer relatively secure nesting sites for brown thrashers, bluejays, catbirds, robins, and mourning doves.

● Elaeagnus umbellata Autumn olive

Range - Eastern Asia: China, Korea and Japan.

Habitat - Autumn olive grows vigorously on wet mesic, mesic and dry mesic soils in full sun. It may tolerate partial shading such as is found on the eastern or western sides of woodlots. In a mixed shrub planting, it will develop more rapidly than most species.

Growth form - A spreading, upright shrub consisting of from several to 8 or 10 stems per plant. It matures at 10-14 ft and spreads from 6 1/2 to 10 ft at the top. Branching is alternating and the simple, small leaves are a distinct

silver-grey-green, quite unlike any other commonly grown shrubs except buffaloberry.

Winter hardiness - Autumn olive thrives in southern Wisconsin but appears to be subject to winter injury at minimum temperatures of -25 F. Severe cold temperatures of -10 to -24 F were recorded on 15 nights in January 1977 at Lake Mills, the recording station nearest Waterloo. Approximately 10% of all autumn olive shrubs 3-8 years old showed some winter injury in the spring and summer of 1977. Degree of damage to individual plants ranged from a single branch to about 90% of all top growth. In each case, vigorous sprouts developed from the base of affected plants. However, fruiting on all plants was reduced to about 10-20% of that noted in 1976. Loss of fruit production may also be attributable to hard frosts on May 9 and 10, 1976, following an exceptionally warm period over the previous 6 weeks. Waterloo results suggest that autumn olive can only be successfully established in southeastern Wisconsin. Continual observation after exceptionally severe winters may reveal certain individual plants that exhibit greater winter hardiness. Field checks did not reveal any observable difference in winter injury among the three cultivars planted.

Fruit and flower production - Prolific flowering usually begins about the fourth year and heavy annual blossoming occurs in late May. Yellowish, slightly fragrant flowers are borne in the leaf axils and are heavily worked by honey bees for about 10 days at full bloom. Clusters of edible fruit begin to ripen in early September. Individual berries are deep red at maturity and show a silvery, netted skin. Fruits are held in good condition through late fall. After sharp freezes of about 15 F, the berries gradually wither and drop, although some are still present in late December.

Insect pests and diseases - Autumn olive is relatively free of major insect pests and plant diseases. Occasionally, it may be infected with verticillium wilt (*Verticillium albo-atrum*), a soil-borne fungus that usually invades the host plant through wounds. Winter injury may be incorrectly identified as a disease, especially if only a portion of the upper branches is affected while the lower portion was protected by snow cover. Wilt, however, affects the plant during the growing season when the symptoms become evident.

Nuisance status - Only one Michigan wildlife manager reported autumn olive as spreading from the original planting (Zorb 1966). Pennsylvania is considering legislative action to restrict further distribution of autumn olive (Holtz 1981). At Waterloo, one volunteer plant was located that had reached fruiting stage and about 6 smaller seedlings were found in the vicinity of older plantings. All stems had established in undisturbed grass-forb vegetation. Systematic research studies, if any, documenting natural spreading of autumn olive have yet to appear in print. At present, potential weediness is a matter of conjecture and remains controversial.

Wildlife use - Autumn olive is highly regarded as a wildlife shrub because of its abundant fruit production and its growth form, which provides good overhead protection while allowing adequate movement at ground level for birds and mammals. Autumn olive ranked first with 28 experienced wildlife managers in Michigan in their mid-1960's appraisal of 21 species of wildlife shrubs. Fruits are eaten by grouse, pheasants, bobwhites,

and an undetermined number of songbird species. Cottontails browse on the young vegetative growth, and Michigan managers reported heavy deer browsing.



Autumn olive

In the fall of 1976, a year of exceptionally heavy fruit production, a planting of autumn olive at Waterloo was checked monthly from September through December to determine the disappearance of the fruit. Approximately 80% of the fruit disappeared by late November. Close inspection of the ground beneath the shrubs revealed very few fruit, but songbird droppings were abundant, suggesting use for feeding, roosting or both. Mammals may also have used the fallen fruits.

Human use - Autumn olive can be used for homemade wines and jellies. Branches with fruit are sold in Japanese markets (Alan and Steiner 1965).

● Ligustrum amurense Amur privet

Range - Northeastern Asia: Siberia.

Habitat - Introduced into the United States about 1860. Fernald (1950) reported amur privet naturalized in open woods from Virginia southward. It grows best on fertile, well-drained soils but is tolerant of partial shade and dry mesic conditions. Carroll (1973) indicated that Amur privet adapts to a wide range of soil conditions.

Growth form - Amur privet grows rapidly under good culture into a dense, slightly spreading, upright shrub reaching 15 ft at maturity. Foliage gradually changes to yellow and is not dropped until late October.

Winter hardiness - Fully winter hardy in the southern one-third of the state. It is probably winter hardy throughout Wisconsin but it is seldom grown in the northern part.

Fruit and flower production - White flowers in pyramidal clusters appear in May followed by small blue black fruits in early September. Fruits hold well until December.

Insect pests and diseases - Relatively free of insect and disease problems.

Wildlife use - Dense foliage provides excellent concealment attractive to songbirds. Edminster (1950) recommended this species for limited use in northeastern states. None of the earlier reports cited the fruit value for wildlife, and because the information would be of limited use in Wisconsin, we have not documented the merits of the fruit, either.

Habitat - Curtis (1959) reported ninebark as a plant of the exposed cliff plant community. Wyman (1961) noted a wide distribution throughout Wisconsin in open habitats ranging from very dry to very wet. Ninebark is also found in oak or maple woods, bluffs, riverbanks, sandy shores, sedge meadows, goat prairies, bogs, and marshes.

Growth form - Ninebark develops into a multi-stemmed, arching shrub about 10 ft tall at maturity. Bark on the older stems exfoliates, giving a shredded but rather distinct appearance. Some plants grow more upright without any notable arching of stems.

Winter hardiness - Completely winter hardy throughout Wisconsin.

Fruit and flower production - Numerous clusters of small white to pinkish flowers appear in late May, maturing to dry, brownish capsules in October. Small seeds about 1/16 inch long are produced in quantity. Capsules remain on the shrub throughout the fall and winter. A few seeds can be shaken out over much of the winter.

Fall foliage - Ninebark leaves change to a variety of subdued yellows, orange, copper, and reddish purple in midfall, often with all shades present on a single plant at one time. However, individual clones show considerable variation in fall color, and not all will develop the variety of shades that makes some clones stand out.

Insect pests and diseases - Ninebark is occasionally attacked by the common stem borer (*Papaipema nebris*). A single larva enters near the top of a new growth and tunnels through the pith, causing the new growth to collapse. This pest has not been serious, and only a few stems of each plant may be affected.

Nuisance status - Reported an escape, probably from landscape plantings (Fernald 1950), but there is no evidence that this is a problem in Wisconsin. Many small seedlings established on disturbed land adjacent to mature plants at Waterloo. Volunteer plants have not appeared in undisturbed dense sod.

Wildlife use - Seeds are eaten by winter migrant birds and cardinals. Gray partridge have been observed feeding on ninebark in winter (J. March, pers. comm. 1978). Cottontails use the cover but do not browse the stems. Mice have not been noted

● Parthenocissus inserta/P. quinquefolia
Woodbine or Virginia creeper

(These two species hybridize, since range and habitats overlap; ecotypes may also exist. Vigorous woodbine has been observed growing in dense shade in a mature oak forest and has also been observed growing very well on old fencelines in full sun.)

Range - Native throughout Wisconsin. Natural Range extends from southern Maine to Florida to Texas and Mexico, northward to Minnesota.

Habitat - Most frequently found in woodlots, along roadsides, fencelines and brushy field borders, and in undisturbed open areas. Tolerates a wide range of soil and light conditions, and is a vine that can maintain itself on the ground without secondary support. On fertile woodland soils, woodbine may be a dominant groundlayer species with 24-inch petioles supporting large palmate leaves. Along woodlot edges, woodbine will grow to the tops of the tallest trees, often causing a decline in vigor of the host tree, presumably from the shading of the woodbine leaves and gradual girdling by the very tough vines.

Growth form - A rugged vine capable of growing on the ground, along fencelines or hedgerows, or vertically on large trees into the uppermost branches. Tendrils develop adhesive discs which stick tenaciously to any kind of surface. In rich soils, growth is rapid, but vines tend to branch less than grape or bittersweet. Mature vines may reach 50-60 ft.

Winter hardiness - Woodbine is completely winter hardy throughout Wisconsin.

Fruit and flower production - Fruits form on a compound cyme and mature in late August into bright blue berries which persist up to 2 months after ripening.

Fall foliage - Some forms of Virginia creeper growing in full sun turn a rich brilliant red in early October.

Insect pests and diseases - Virginia creeper may be host to a variety of insect pests, such as scale insects, mites, and aphids. Occasional outbreaks of the eight-spotted forester larvae (*Alypia octomaculata*) may defoliate plants. Cankers, mildews and leaf spots infect this species; the most serious is downy mildew (*Plasmopara viticola*).

Wildlife use - Martin et al. (1951) reported that 24 species of songbirds plus red fox, cottontail and skunk consumed woodbine fruits.

● Physocarpus opulifolius Ninebark

Range - North America: Quebec to Hudson Bay, south to Wisconsin, south to Tennessee and North Carolina.



Ninebark

girdling the base. The arching character of ninebark stems in certain clones plus ease of establishment makes the species a high-priority plant for wildlife cover.

● Picea abies Norway spruce

Range - Native to northern and central Europe, but also planted extensively in the northeastern and upper midwest.

Habitat - Grows best on mesic to wet mesic soils. Partly shade tolerant although similar to other spruce in growing more compact where planted in full sun.

Growth form - Young trees appear similar to white spruce up to about 8 years; thereafter Norway spruce develop pyramidal form compared to the conical form typical of white and blue spruce. Lower branches grow wider, often horizontal or drooping. Branchlets become pendant as the tree matures.

Winter hardiness - Completely winter hardy throughout Wisconsin.

Insect pests and diseases - The eastern spruce gall aphid (*Adelges abietis*) infests new growth, producing the characteristic pineapple-shaped galls.

Wildlife use - The large cones are utilized by red and gray squirrels. Younger specimens provide excellent cover, but as the tree grows older, it becomes by open between whorls.

● Picea glauca White spruce

Range - Northern half of Minnesota, Wisconsin, Michigan, upper New York, New England, all Canadian provinces, Nova Scotia, and Alaska.

Habitat - Grows normally on low damp soils but not on persistently wet sites. It is moderately competitive with weeds on former agricultural lands. White spruce, although a northern species, grows very well on mesic to wet mesic soils in southern Wisconsin. It is somewhat shade tolerant.

Growth form - Produces dense, bright green to blue green lateral branching on typical conical form. It is comparable to blue spruce but with shorter needles and tends to be slightly less dense. Open grown specimens develop a denser growth form than plants grown in partial shade. It is wind and ice resistant.

Insect pests and diseases - Somewhat susceptible to eastern spruce gall aphid (*Adelges abietis*).

Wildlife use - Primarily used as cover, white spruce is an excellent windbreak, very resistant to breakage from snow or ice accumulation. White spruce windbreaks, hedgerows, or clump plantings provide excellent songbird nesting sites and winter roost cover. Pheasants use the species for loafing and roosting. After individual trees in groves begin to grow together, the lower limbs die, affording excellent overhead protection for all species. Ruffed grouse are frequently observed in the vicinity of white spruce throughout the winter, especially when trees are planted along deciduous woodlot edges or in open spaces in mixed woodlots. It is rarely browsed by deer, but squirrels and songbirds consume the seeds. White spruce is one of the best all around conifers to plant for attracting wildlife.

● Picea pungens Blue spruce

Range - The ever popular ornamental blue spruce is native to the Rocky Mountain region from Wyoming and Idaho south to Arizona and New Mexico.

Habitat - Adapted to wet mesic, mesic, and dry mesic soils and full sunlight, it performs exceptionally well on fertile agricultural silt loam soils.

Growth form - Remains conical in open-grown specimens to about 40 years and is wind and ice resistant. Rigid needles vary in shades of green and blue green.

Winter hardiness - Completely winter hardy throughout Wisconsin.

Insect pests and diseases - The cooley spruce gall aphid (*Adelges cooleyi*) infests blue spruce regularly, causing the typical pineapple gall at the base of new growth.

Wildlife use - Colorado blue spruce is an exceptional conifer with heavy needles and dense branching providing extremely good protective cover for roosting birds in all seasons. A variety of songbirds use the blue spruce for nesting, notably mourning doves and robins. Pheasants, cottontails, and bobwhites are attracted to it because of the protective cover quality. Squirrels eat the seeds.



Mixed crab

● Pyrus spp. Mixed crabs

The mixed crab stock offered through the DNR's Wilson State Nursery, Boscobel, originated from 20-30 unidentified varieties initially planted at DNR's Griffith State Nursery, Wisconsin Rapids. Seedlings from this collection were transplanted to the Wilson State Nursery in the late 1940's. This collection of crab trees now provides the seed source for the mixed crab distributed throughout the state for wildlife plantings. Due to the hybrid origin of this stock, the growth form, fruit size and color, and leaf shape and color are quite variable. The trees generally produce white blossoms, are very winter hardy, and produce a crop of fruit annually which has consistently good germination (Camp, pers. comm. 1977). Under moderate culture in field conditions

mixed crabs grow rapidly and compete fairly well when planted in grassy sod. Fruit retention is also variable, but most trees tend to drop their fruits by early winter. Like other crabs, the mixed group is highly susceptible to cottontail, field mice, and deer browsing.

● Pyrus sargentii

P. zumi calocarpa Wild crab

Range - P. sargentii and P. zumi calocarpa - Japan; various other Pyrus species are probably eastern Asia horticultural hybrids.

Habitat - Crabs do best in full sun on moderately fertile, well-drained locations. Satisfactory growth can be expected on a moisture gradient from wet mesic to dry mesic. One native species, Pyrus ioensis, the prairie crab, tolerates some shade and is often seen in the understory of deciduous southern Wisconsin woodlots. P. ioensis is also found along old woody fencelines, field borders and roadsides.

Growth form - Mixed or flowering crabs are generally classed as small trees and normally develop from a single trunk. Branching varies from lateral to near columnar; the majority of crabs considered for wildlife have a rounded or global shape at maturity. Sargent's crab (P. sargentii) is the smallest of a large group of species that grow only to 8 ft at maturity. Other crabs may attain a mature height of 12-16 ft.

Winter hardiness - All mixed crab (Wisconsin source) and P. sargentii and P. zumi calocarpa are hardy in southern Wisconsin.

Fruit and flower production - Crabs are widely known as flowering trees and shrubs used extensively for ornamental or landscape purposes. Flowering normally peaks about the middle of May, or about the same time as the common lilac. Blossoms differ in size and color, from 3/4 inch to 2 inches in diameter and from white to dark rose-red. Fragrance varies, but in general, most are fragrant and appealing to humans. Fruits mature between mid-August and late September and are highly variable in size, color and the length of time the fruit is retained on the branches. The species recommended are based on performance on wildlife areas. Smith (1972) found the smaller fruited varieties tended to hold fruit longer through the winter than the larger fruited selections.

Insect pests and diseases - Crabs in general are afflicted by numerous foliar, systemic diseases and a variety of insect pests. The susceptibility of clonal selections or species to the various pests varies considerably. The following are the most common insects and diseases that appear in the upper midwest. Fire blight (Erwinia amylovora) causes twig dieback and is noticeable

after the flush of spring growth and throughout the summer. Siberian crab (P. baccata) is moderately susceptible. Apple scab (Venturia inaequalis) affects many crab selections and ranges in severity from light to heavy infestation. Scab is most severe during cool, moist springs and will cause deformed fruits and premature leaf fall. Native crab species (P. ioensis) are very susceptible to cedar-apple rust (Gymnosporangium juniperi-virginianae). Tent caterpillars (Malacosoma americana) are among the most common insects attacking crabs. At irregular intervals, scale insects (Lepidosaphes ulmi) may infest the crabs. Pyrus species are extremely

vulnerable to rabbit and mouse browsing, particularly in the first 4-5 years.

Wildlife use - Extensive wildlife use has been recorded for the crabs. Cottontail use is regarded as negative because in browsing they often completely girdle of the main stem and lower branches, either killing the specimen or causing marked disfiguration. White-tailed deer browse is also common, but only the outer branches are affected and the tree is usually not killed unless repeated heavy browsing occurs annually. Deer also eat the fruit. In Ohio, Nixon and McClain (1966) found that crab ranked first in the diet of deer in the eastern part of the state. Martin et al. (1951) noted that 25 wildlife species, including the ring-necked pheasant, ruffed grouse, and bobwhite, ate the buds or fruit. In New York, Smith (1972) noted winter use of wild crab fruit by pheasants, squirrels, grouse, songbirds, cottontail, and deer. He further evaluated 103 crab selections for annual fruit production, fruit persistence into the winter, and winter wildlife use.

On the basis of this evaluation, 32 varieties were recommended for wildlife plantings in New York. Smith determined that the small-fruited varieties were best adapted for wildlife, as the fruit persisted from mid-December to mid-April.

● Rosa multiflora

Multiflora rose

Range - Eastern Asia.

Habitat - A vigorous plant once established. Multiflora rose grows best in full sun on mesic fertile soils but will tolerate wet mesic to dry mesic soils of moderately low fertility. It does not tolerate much shading.

Growth form - The long, densely thorned, arched canes reach a maximum height of about 5-1/2 ft in Wisconsin and mature plants may have a spread of 8-10 ft. Its growth form has proved highly desirable for many species of wildlife.

Winter hardiness - Only considered hardy in the southern third of Wisconsin. Because of the wide distribution of this species throughout the state, some local ecotypes have evolved. Stock from some sources shows apparent complete hardiness, while other types die in most winters. Plants from the same source exhibit varying degrees of winter hardiness. All plants that winterkill invariably resprout from the root system. Certain individual plants do not show winter injury for several years but die back drastically after a severe winter. This species is definitely not recommended for western, central, or northern Wisconsin. Judicious selection of seed from the most winter-hardy plants may improve this character.

Fruit and flower production - Multiflora rose produces an abundance of single fragrant white flowers in June. Fruits ripen in September and persist though midwinter.

Insect pests and diseases - Roses as a group are susceptible to a variety of leaf-spot diseases, insects that chew or mar the foliage, and stem borers and leaf miners; any of these problems can reach seriously damaging proportions. The multiflora rose is affected like other roses, but its insect and disease problems are tolerated because of its value to wildlife.

Nuisance status - Multiflora rose status has changed from an attractive living fence serving as

a source of food, nesting cover, and winter cover highly endorsed by many state agencies to the position of a noxious weed in numerous southeastern states. It lost appeal after volunteer seedlings appeared in fencelines, roadsides, permanent pastures, and open lands. Several states have now banned further distribution of the species. Apparently birds have been chiefly responsible for the natural spread. Although the species is controllable by judicious use of herbicides, the repelling nature of the thorny stems has undoubtedly helped warrant the objectionable status. Many volunteer plants are found at Waterloo in moderately heavy residual cover, usually in the vicinity of older plantings.

Wildlife use - Multiflora rose has probably had wider distribution and created more controversy than any single species of native or exotic shrub. Proponents of multiflora rose cite its value for wildlife, its attractive spring bloom, its red hips, and its all-purpose use as a living fence. Critical appraisal of established plantings reveal these recommendations to be essentially true. Brown thrashers, mourning doves and cardinals readily nest on top of or within the heavily spined branches. Cottontails and ring-necked pheasants frequently use the protective cover throughout the winter. Spiegel and Reynolds (1954) noted 85% frequency of multiflora rose hips in the winter pheasant diet in New York. One group of gamefarm pheasants was also penned and fed a diet of only multiflora rose hips for 2 months, and a second group received unlimited rose hips plus 1.5 lb of the gamefarm ration per week. In these trials, pheasants fed only rose hips lost an average of 4% of their starting weight, whereas controls gained about 3%. The tests proved that pheasants could be maintained during the critical winter period on rose hips as an emergency diet.

● Shepherdia argentea Buffaloberry

Range - North America: Manitoba to Alberta, south to Iowa, Kansas, and New Mexico.

Habitat - Streambanks. In Wisconsin, buffaloerry is reported as rarely escaping--only in Grant, Langlade, and Juneau counties (Fassett 1976).

Growth form - A spreading, upright form with a tendency towards lateral branching. Younger branches often develop short, dull thorns. The simple, small leaves are a very distinct grayish green. At maturity, buffaloerry attains a height of 16 ft. It spreads slowly from root sprouts.

Winter hardiness - Dependably hardy in southern Wisconsin.

Fruit and flower production - Sessile flower clusters develop in axils of branches, blooming in May and maturing fruit in August. Fruit clusters are bright red; individual fruits are round, 1/8-3/16 inch in diameter. Fruit is retained on branches until late fall, gradually losing its bright red color and shriveling and becoming brownish by early winter. Most fruit is dropped or consumed by early January.

Fall foliage - Leaves turn somewhat yellowish, then brown and drop by mid-October. Buffaloerry is sold by some nurseries for landscape purposes.

Insect pests and diseases - Minor leaf spot, powdery mildew and a rust were cited by Pirone et al. (1970) as unimportant for this species.

Nuisance status - Neither natural spreading nor escape from landscape planting has been reported. It has spread naturally from root sprouts at Waterloo in the vicinity of older established hedgerows.

Special adaptation - Adjusts well to rocky outcrops, dry soils, or alkaline situations. Buffaloerry should not be planted on wet sites. It has nitrogen-fixing capacity.

Wildlife use - Martin et al. (1951) indicated that buffaloerry was not sufficiently abundant to be of wildlife value. Fruits were consumed by valley quail, catbirds, brown thrashers, black bear and chipmunks. All wildlife use was reported in western states. Mouse browsing was noted on a few plants at Waterloo. No observations were made regarding use of the fruits, although some fruits persisted into early winter.

● Syringa villosa Late lilac
S. vulgaris Common lilac

Range - S. villosa: northeastern Asia. S. vulgaris: southeastern Europe.

Habitat - Lilacs thrive on wet mesic and mesic to dry mesic soils of moderate to high fertility. Organic soils or acid soils with a pH of less than 6.0 should be avoided. Lilacs tend to be shade tolerant, especially under large trees with spreading crowns. Better growth can be expected under conditions of full sun and limited competition.

Growth form - Common lilac grows upright, and all lateral branching also angles sharply upward. Late lilac develops a single stem or only a few root sucker sprouts. S. vulgaris can be seen frequently at old farm-butting sites. Many old lilac clumps consist of hundreds of small stems radiating from the center of the clump. At many locations, the original farm buildings have completely disappeared and the only evidence that buildings once were present is the broad, spreading lilac clump or occasionally the crumbling foundations of the original structures.

Winter hardiness - Both lilac species are completely hardy throughout Wisconsin.



Buffaloerry

Fruit and flower production - May is the month for lilac bloom. Old lilac clumps may be covered with bloom some years and produce relatively few panicles the following season. The fragrant, long-lasting bloom attracts honey bees and other insects. The seed apparently does not appeal to many species, although it persists into late fall.

Insect pests and diseases - Occasionally lilac borer (*Podocotesia syringae*) larvae will girdle the stems. Scale insects affect lilacs comparably to dogwoods. A bacterial blight (*Pseudomonas syringae*) that produces symptoms similar to fire blight appears in the spring but is not common. Powdery mildew (*Macrosphaera alni*) is frequently seen in late summer, particularly where lilacs are shaded or during a period of persistent damp weather. Severe infection causes premature leaf drop but will not ordinarily kill the plant.

Wildlife use - Lilacs are sometimes omitted from wildlife shrub listings because few, if any, species eat the seed and the stems or shoots are not often browsed. It is an excellent species for travel lanes and does provide some songbird nesting habitat. Cottontails occasionally browse off the previous seasons's root sprouts.



Wayfaring tree

● Thuja occidentalis Northern white cedar

Range - From western Minnesota to central Wisconsin, Michigan, southern New York, New England, and Canadian provinces. White cedar is also found in discontinuous locations in Illinois, Ohio, and higher elevations of Virginia and North Carolina.

Habitat - Adapted to a variety of sites from low wet poorly drained soils to dry mesic agricultural soils. White cedar is shade tolerant but plants grow thicker and denser if planted in full sun on fertile soils.

Growth form - Columnar to slightly conical.

Winter hardiness - Hardy throughout Wisconsin.

Insect pests and diseases - Generally not seriously affected by insects or foliar diseases.

Wildlife use - An excellent tree for windbreaks. Hedges provide some protective cover but generally not quite as much as the spruces. White cedar offers good concealment for nesting birds. Seeds are eaten by red squirrels, pine siskins, and red-polls. White cedar is a staple winter browse for white-tailed deer.

● Viburnum lantana Wayfaring-tree

Range - Wayfaring-tree is a native of Europe and western Asia and was introduced into the United States as an ornamental in colonial times (Wyman 1961). It is reported as an escape in New England along roadsides and fencelines (Fernald 1950). Fassett (1976) states that in Wisconsin it is sometimes found along railroad lines and woodland borders. Neither source mentions it as an aggressive weedy species.

Habitat - Best adapted to well-drained, fertile soils in full sun. It tolerates drier sandy loams and partial shade but develops at a slower rate under these conditions.

Growth form - Wayfaring-tree is noted for comparatively thick, heavy stems and branches,

which give the plant a rather stocky appearance. It grows broadly upright and reaches a height of 6 ft after 5 years (with grass competition). The rich green, oval leaves are slightly pubescent, stiff, and thick and turn a dark purplish red in the fall. Some plants retain their leaves into the winter.

Fruit and flower production - Some flowering occurs as early as the third year under good growing conditions and the relatively large fruits ripen in late August. As the fruits mature, they become a bright shiny red, gradually changing to blue-black. After killing frosts, the fruits shrivel to very hard drupes which remain on the plant through the winter.

Insect pests and diseases - Wayfaring-tree is relatively free of disease except for occasional infestation of scale insects.

Nuisance status - Volunteer plants have not been found at Waterloo, and the reported references to escapes do not indicate that wayfaring-tree is a problem species.

Wildlife use - Wyman (1961) reported the fruits consumed by birds. The dense foliage offers excellent concealment and protective cover for nesting songbirds and travel lanes or loafing cover for game birds and small mammals. No browsing by cottontails or deer has been observed at Waterloo.

● Viburnum lentago Nannyberry

Range - North America: western Quebec to Manitoba, south to Georgia, and west to Missouri and Colorado.

Habitat - In Wisconsin, nannyberry is associated with southern dry forests, particularly at edges or openings.

Growth form - At maturity, nannyberry may reach 25-30 ft. It is a tall, rather open, spreading shrub, consisting only of up to 6 or 8 individual stems. It is not as compact as other viburnums, although when grown in full sun, individual plants

are generally less rangy than those growing in the partial shade of woodlots. Gill and Healy (1974) reported nannyberry spreading extensively by root suckering in Connecticut.

Winter hardiness - Completely winter hardy throughout Wisconsin.

Fruit and flower production - Nannyberry flowers in May, and the relatively large drupes mature in rich, dark blue clusters in September. The fruit is edible, somewhat sweet but not very juicy. Retention of fruit is good if not consumed by birds, and dried fruit may frequently be noted at least through January. Apparently the dried fruit was responsible for another common name, "wild raisin".

Fall foliage - When growing in full sunlight, the entire plant changes to a rich, striking purplish red in October. Leaves drop gradually, with only the fruit remaining by mid-November.

Insect pests and diseases - Pirone et al. (1970) reported bacterial leaf spot (*Pseudomonas viburni*) as common and widespread. Aphids (*Anuraphis viburnicola*) occasionally infest this species.

Wildlife use - Martin et al. (1951) grouped all common viburnums and evaluated their use by wildlife as quantitatively limited. He noted, however, that use by ruffed grouse, white-tailed deer, brown thrashers, and cedar waxwings was most common. Longenecker (1958) stated that nannyberry was liked by cardinals. The use of nannyberry for nesting was not cited by any author.

● Viburnum prunifolium Black-haw

Range - A native of the eastern United States from Connecticut to Florida, west to Kansas, north to Iowa, Illinois to New York. Curtis (1959) did not include black-haw as a Wisconsin native, but Fassett (1976) reported it in Racine and Milwaukee counties.

Habitat - Natural habitats include woodland edges, streambanks, and open wetlands. Longenecker reported that black-haw was adapted to shade and dry sites but grew best under moist conditions.

Growth form - Black-haw is one of the larger viburnums, developing into a tall, upright, spreading, single or multiple-stemmed shrub similar to nannyberry. Properly pruned, it will also grow into a tree-like form.

Winter hardiness - Dependably hardy in southern Wisconsin.

Fruit and flower production - Edible fruits mature about mid-September. The large, bluish black drupes are produced abundantly on vigorous open-grown stock. In size, shape, and color, the fruit is similar to that of nannyberry. Within parts of its native range, black-haw fruits are used for making jams and preserves. As the fall season progresses, the black-haw berries shrivel but remain edible and are held on the cymes until early winter.

Fall foliage - Foliage changes to a rich red in the fall before leaf drop, making its color an outstanding character of the species.

Insect pests and diseases - Black-haw is relatively free of major plant diseases but is subject to scale insects.

Wildlife use - Longenecker (1958) reported that fruits were consumed by 28 species. Used with other shrub species black-haw improves diversity of hedgerow cover and travel lanes.

● Viburnum trilobum Highbush cranberry

Range - North America: Newfoundland to British Columbia, south to New England, Pennsylvania, northern Illinois, northeast Iowa to the Black Hills, South Dakota, Wyoming, and Washington.

Habitat - Reported by Curtis (1959) as found only in alder thickets or wet soils in northern Wisconsin. Highbush cranberry is used extensively for ornamental or landscape plantings throughout the state and grows well on mesic to wet sites.

Growth form - Develops into a branching and spreading upright shrub reaching 10-13 ft at maturity.

Winter hardiness - Hardy under extreme winter conditions throughout Wisconsin.

Fruit and flower production - Attractive flower clusters appear in May, followed by bright orange-red fruit in September. This species is noted for good retention of fruit throughout the fall and winter months, but, more important, the vivid color does not fade until late winter. The fruit is acid but edible and is frequently used in preserves.

Fall foliage - Highbush-cranberry foliage turns various shades of red or reddish purple in the fall.

Insect pests and diseases - Generally resistant or tolerant of insect infestation and foliar, stem, or root diseases except for susceptibility to scale insects.

Wildlife use - Longenecker (1950) reported the fruit readily eaten by cardinals. However, the persistence of the fruit through the winter suggests that it is not especially palatable to most birds. Dense foliage provides excellent cover through the growing season and provides songbird nest sites. When growing with other shrubs or trees, trilobum tends to be leggy and does not provide good escape cover. The European species *V. opulus* is similar and commonly offered by commercial nurseries. Fassett (1976) also notes *V. opulus* as an escapee in Wisconsin found from Grant to Winnebago Counties. Allegedly the European species is not palatable to birds and the highbush cranberries seen with fruit in midwinter are probably *V. opulus*. The native highbush cranberry (*V. trilobum*) is reputed to be very palatable to birds.

● Vitis riparia Wild grape

Range - Throughout Wisconsin; especially common in the southern half of the state.

Habitat - Roadsides, hedgerows, open woodlots, field borders, and occasionally undisturbed fields.

Growth form - A vine attaching to shrubs, trees, vacated machinery, and fences by very tough tendrils. In woodlots, a grapevine may climb to the top of a 60-ft tree. Older specimens may reach a stem diameter of 4-6 inches near ground level. At times several individual vines may

completely cover a shrub or small tree and eventually kill the host plant by girdling the trunk and/or enveloping the crown, competing for light.

Winter hardiness - Extremely durable and completely hardy throughout Wisconsin.

Fruit and flower production - Inconspicuous flowers appear in late May and early June and mature in late August. The very tart, juicy fruits remain on the panicles in good condition until sharp killing frosts, then slowly dehydrate, often persisting as raisins until winter.

Insect pests and diseases - Leaf spots and mildews infect wild grape. Downy mildew (*Plasmopara viticola*) and powdery mildew (*UmicTnula necator*) are the most serious fungi, causing damage by extensive leaf drop, especially in wet years.

Nuisance status - Native wild grapes are widely distributed throughout Wisconsin. Their common occurrence is believed to result from dispersal of the seeds of fruit eaten by birds and mammals. But wild grape seedlings are not at all competitive and often fail to establish. Except under unusual circumstances, the presence of wild grapes is not regarded as a nuisance.

Wildlife use - Martin et al. (1951) noted that wild grapes were used by 49 species of songbirds, gamebirds, and mammals. Squirrels frequently build nests in trees supporting grapevines and use the bark in construction of their leaf nests.

Human use - Native grapes are commonly used in home preparation of wines and jellies.

Varieties Not Planted or Evaluated in Wisconsin

Amelanchier arborea, A. laevis Serviceberry or Juneberry. These species of serviceberries are native to northeastern United States including Wisconsin. They are found on soils ranging from wetlands to dryer acidic sandy sites. Fruits ripen about midsummer and are consumed by a variety of birds and mammals (Larson 1974). Growth form is rather open.

Aronia melanocarpa, A. rubra. Black and red chokeberry. These medium height shrubs are native to North America. They mature at 5-7 ft and bear fruits that ripen in the fall. These species are adapted to wet and average soils and will tolerate partial shade.

Cephalanthus occidentalis. Buttonbush. This native, winter-hardy species is largely restricted to very wet soils and produces attractive flowers in midsummer.

Cotoneaster acutifolius, C. multiflorus. Cotoneaster. Cotoneasters are introduced species noted for bright shiny leaves. C. acutifolius is a spreading open shrub producing black fruits in late summer. Mature height is about 8 ft. C. multiflorus is a multi-stemmed widely spreading shrub that matures bright red fruits in the fall. These perform best on fertile soils.

- Elaeagnus augustifolia. Russian olive. An extremely hardy small tree native to Europe and Asia and noted for its grayish green foliage. Large olive fruits ripen in late summer. It is adapted to a wide range of soils.

- Kolkwitzia amabilis. Beauty bush. As the name implies, beauty bush produces a profusion of pink flowers in June followed by bristly brown seeds. Arching branches create excellent protective cover. It is winter hardy only in southern Wisconsin.

- Lonicera tatarica and L. Maackii. Honeysuckle. These exotic species and various cultivars are widely grown for landscape purposes. Rapid growth, winter hardiness, ease of establishment, and regular production of fruit are characteristic for both species. While each species is highly desirable from a wildlife standpoint, prospective owners should be aware that they spread rapidly into undisturbed areas and should be regarded as weedy. Exotic honeysuckle species and natural hybrids are shade tolerant and can be found in many southern Wisconsin woodlots.

- Philadelphus coronarius. Mock orange. Many horticultural selections are available that vary in mature size, growth habit, flower size, and fragrance. Their value for wildlife is primarily as a cover plant since they develop into fairly dense vigorous specimens and are relatively unpalatable to cottontails and mice. Mock orange flowers bloom in June with appealing fragrance. They are generally free of serious plant diseases and pests and grow well under various soil conditions. Most selections commonly available are hybrids of North American and European species. On choosing mock orange for wildlife plantings, exercise care to select only varieties known to be winter hardy in Wisconsin.

- Rhamnus frangula. Alder buckthorn. Alder buckthorn is not readily available but it is a good alternate choice for wildlife purposes because of its spreading habit, winter hardiness and ability to grow on a wide range of soils. The small fruits ripen over several months and are eagerly consumed by songbirds. Another species, Rhamnus cathartica (common buckthorn), is a small tree that can be found throughout southern Wisconsin. This latter species is often a serious weed in woodlots. Spread apparently occurs because the medium-sized black fruits are retained into the winter, consumed by birds when food resources are short, and disseminated through the droppings. Numerous seedlings can also be found in the vicinity of seed-bearing trees. Thus R. cathartica should be avoided to prevent additional unwanted establishment of the species.

- Rhus glabra. Smooth sumac. Smooth sumac is an extremely hardy native species and is noted for its brilliant red foliage in the fall. It is a good winter browse species for cottontails. Smooth sumac adapts to a wide range of soil conditions although it grows considerably taller on fertile soils. The disadvantage of smooth sumac is its spread from rhizomes. Within the hedgerow the extension is not objectionable, and adjacent to croplands invading plants are easily mowed off or plowed under. Control, however, is an annual problem where it exceeds the original planting area. Because of its growth form of primarily single, only slightly branched stems, smooth sumac does not offer much winter cover, although older clones become moderately dense, with individual stems approximately 1-3 ft apart. Quail consume the persistent fruits.

- Rosa setigera. Prairie rose. Except for multiflora rose, the relatively large number of species and hybrids available have not received adequate appraisal specifically for wildlife plantings. Therefore, any recommendations should be regarded as incomplete. In the past decade

multiflora rose has largely lost favor because of its propensity for spread to undisturbed open areas. Prairie rose is a native that should be considered as an alternative. It is a rank grower, producing many arching canes and is especially winter hardy. The 2-inch flowers appear in July. Its capacity to spread naturally at rates regarded as a nuisance is not determined.

- Spiraea vanhouttei. Bridalwreath. The common bridalwreath is seldom considered for a wildlife planting despite some highly desired characteristics. It is reliably winter hardy, produces many arching branched stems creating excellent year round cover, is very long-lived, and matures at a moderate height of 6-7 ft. There does not appear to be a problem from natural spreading and except for new shoots it is resistant to mouse and rabbit browse. This variety and possibly other species or hybrids should be grown more extensively for wildlife cover plants. In June the shrub is a mass of white blossoms, one of the characters contributing to its widespread popularity for home landscaping.

- Weigela florida hybrids. Weigela. This common horticultural shrub possesses several desirable attributes for a mixed deciduous hedgerow. Weigela grows rapidly on moderately fertile soils, developing into a multi-stemmed arching shrub about 7 ft tall. In form it is similar to bridalwreath, with fewer but heavier branches developing into a spreading arching habit. In June the shrub is covered with deep rose trumpet-shaped blossoms. A few blossoms appear throughout the summer and fall. The disadvantage of Weigela is partial winterkill in some winters. Selection of Weigela for hedgerows should be based on the known winter hardiness of the cultivar.

●
Shrubs recommended for wildlife plantings and/or hedgerows usually represent those species, hybrids

or named cultivars that possess physical attributes favoring use by local and migratory wildlife. Because each wildlife species has somewhat different habitat preferences or requirements, no single species of shrub is superior. A mixture of shrub species is preferred for greater diversity in structure and fruiting.

Few, if any, commercial nurseries will offer all the varieties in 1- or 2-year seedlings in wholesale lots--usually a minimum of 100 for each species. Alternate choice of varieties may be necessary to facilitate planting in a single year. Types of Rubus species were not included in this report even though fruits are widely accepted by birds and mammals. Native species are not available commercially, and domestic varieties are particularly susceptible to rabbit browsing. They also tend to be early woody invaders and die out as the canopy increases.

Prospective buyers of seedling shrubs should attempt to acquire stock locally if possible, or at least from sources in adjoining states. This is particularly important when considering varieties labeled for use only in southern Wisconsin. Marginally winter hardy species may incur partial winter injury in some years. In exceptional years certain species may die back to the crown.

Severe injury was noted to numerous selections of Autumn olive after the winter of 1978-79. Older specimens of 6-10 years were completely top killed although vigorous root sprouts developed in the spring and summer. Younger specimens of 2-4 years had mostly tip injury. Within most plantings for any age an occasional clone survived without observable damage, suggesting some genetic variation between individual plants. All desirable species suggested for southern Wisconsin only may also incur similar winter injury in some years. For native species widely distributed in North America preference should always be given to northern strains to assure winter hardiness and adaptability to local environments.

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