ELEMENT STEWARDSHIP ABSTRACT
for

Lonicera japonica

Japanese Honeysuckle

Authors of this Abstract:
Victoria Nuzzo, Natural Area Consultants, 1 West Hill School Road, Richford, NY 13835

The Nature Conservancy
Element Stewardship Abstract
For *Lonicera japonica*

SCIENTIFIC NAME (GNAME)
Lonicera japonica Thunb.

The common name "Japanese honeysuckle" refers to the species *Lonicera japonica* Thunb. including the more aggressive cultivar *Lonicera japonica* var. halliana, also known as Hall's honeysuckle and the less common *Lonicera japonica* var. chinensis (P.W. Wats.) Baker. The original Latin name of the species was *Nintooa japonica* (Gleason and Cronquist 1963), but the species has been referred to as *Lonicera japonica* since at least 1889 (Wood and Willis 1889).

The genus name *Lonicera* refers to German naturalist Adam Lonitzer (1528-1586), the species epithet *japonica* to Japan, and the variety name *halliana* to Dr. George Hall, who introduced the variety to the United States in 1862 (Coombes 1991).

COMMON NAME

JAPANESE HONEYSUCKLE is the name most commonly used to refer to *Lonicera japonica* and its varieties, *L. japonica* var. halliana (Hall's Japanese honeysuckle) and *L. japonica* var chinensis. Hall's Japanese Honeysuckle is more common and aggressive than the species. In old floras *Lonicera japonica* was occasionally referred to as "woodbine" (Lounsbury 1899) and "Chinese honeysuckle" (Wood and Willis 1889; probably *L. japonica* var. chinensis).

DESCRIPTION (DIAGNOSTIC CHARACTERISTICS)

Lonicera japonica is a perennial trailing or climbing woody vine of the honeysuckle family (Caprifoliaceae) that spreads by seeds, underground rhizomes, and aboveground runners (USDA 1971). It has opposite leaves that are ovate, entire (young leaves often lobed), 4-8 cm long, with a short petiole, and variable pubescence. In the southern part of the range the leaves are evergreen, while in more northern locales the leaves are semi-evergreen and fall off in midwinter (Fernald 1970). Young stems are reddish brown to light brown, usually pubescent, and about 3 mm in diameter. Older stems are glabrous, hollow, with brownish bark that peels in long strips. The woody stems are usually 2-3 m long, (less often to 10 m). *Lonicera japonica* creates dense tangled thickets by a combination of stem branching, nodal rooting, and vegetative spread from rhizomes.

Lonicera japonica (including the varieties) is easily distinguished from native honeysuckle vines by its upper leaves and by its berries. The uppermost pairs of leaves of *Lonicera japonica* are distinctly separate, while those of native honeysuckle vines are connate, or fused to form a single leaf through which the stem grows. *Lonicera japonica* has black berries, in contrast to the red to orange berries of native honeysuckle vines. The fruits are produced September through November. Each contains 2-3 ovate to oblong seeds that are 2-3 mm long, dark-brown to black, ridged on one side and flat to concave on the other.

The fragrant white (fading to yellow) flowers of *Lonicera japonica* are borne in pairs on solitary, axillary peduncles 5-10 mm long, supported by leaflike bracts. The species has white flowers tinged with pink and purple. Individual flowers are tubular, with a fused two-lipped corolla 3-4(-5) cm long, pubescent on the outside. Flowers are produced late April through July, and sometimes through October. *Lonicera japonica* var. halliana may be distinguished from the species by its pure white flowers (fading to yellow; Dirr 1983) and more vigorous growth. *Lonicera japonica* var. *chinensis* has purple, essentially glabrous leaves, red flowers, and a more limited range than the species, occurring north to New Jersey and Pennsylvania (Fernald 1970), with an outlier in southern Illinois (Mohlenbrock 1986).

This description was derived from Gleason and Cronquist (1991) and Fernald (1970). Excellent illustrations of *Lonicera japonica* are contained in USDA (1971).

STEWARDSHIP SUMMARY

Lonicera japonica invades fields, forest edges and openings, disturbed woods, and floodplains, in eastern North America, where it spreads rapidly and outcompetes native vegetation by vigorous above- and below-ground competition. Once established, the vine may literally engulf small trees and shrubs, which collapse under the weight, and few plants survive beneath the dense canopy. It has also escaped cultivation at scattered locations in California and in Hawaii where it has the potential to become a severe pest in mesic and wet forest areas.

Lonicera japonica has few natural enemies in North America and is difficult to control once established. Thus, the best and most effective control method is to prevent its establishment by surveying a site for its presence regularly and immediately destroying every plant located. Unfortunately *Lonicera japonica* is difficult to locate when small and without careful attention may go unnoticed until it is well established.

Because Japanese honeysuckle is so difficult to control once established, an appropriate control program goal is 100% kill of all plants in the target area. Removing above-ground stems by cutting pulling or burning will temporarily weaken, but not kill, *Lonicera japonica* as it will resprout from subterranean buds and roots, and from cut branchlets.

In northern states, *Lonicera japonica* retains some leaves through all or most of the winter (semi-evergreen or evergreen), when most native plants have dropped their leaves. This provides a windows of opportunity from mid-autumn through early spring when it is easier to spot and treat with herbicides, fire or other methods without damaging native species. The most effective treatment is a foliar application of glyphosate herbicide (trade names Roundup, Rodeo or Accord; 1.5 v/v), applied after native vegetation is dormant and when temperatures are near and preferably above freezing. Applications within 2 days of the first killing frost are more effective than applications later in the winter. *Lonicera japonica* is less susceptible to herbicides after the first hard frost (-4^{o}C). Combining fire and herbicides may prove to be more effective than either method by itself if late autumn or winter burns are used to reduce Japanese honeysuckle biomass and all resprouts are then treated with a foliar application of glyphosate about a month after they emerge. Prescribed burns may also be used to help prevent spread of Japanese honeysuckle because seedlings and young plants are most susceptible to fires. Soil disturbance should be avoided in infested areas to minimize germination of seed in the seedbank.

IMPACTS (THREATS POSED BY THIS SPECIES)

Lonicera japonica damages natural communities it invades by outcompeting native vegetation for both light (shoot competition [Thomas 1980, Bruner 1967]) and below-ground resources (root competition [Dillenburg et al. 1993a, 1993b, Whigham 1984]), and by changing forest structure (Sasek and Strain 1990, 1991). *Lonicera japonica* grows very rapidly, sending out numerous runners that give rise to still more runners. The vines overtop adjacent vegetation by twining about, and completely covering, small trees and shrubs. Dense Japanese honeysuckle growth can topple trees and shrubs due to its weight alone (Williams 1994, McLemore 1981). As Lonicera japonica becomes established in forest openings it forms a dense blanket that excludes most shrubs and herbs (Oosting 1956). Few tree seedlings can penetrate the mat and those that do are often quickly overgrown and bent down by the vine, and consequently die (Slezak 1976, Thomas 1980). Forests invaded by *Lonicera japonica* gradually lose their natural structure as canopy openings are invaded, and understory herbs shrubs and replacement trees suppressed and killed by thick mats of honeysuckle. This results in a simplified, increasingly open understory. *Lonicera japonica*, in turn, becomes even more vigorous with the increased light (Thomas 1980). These openings also promote further invasion by other non-native species including aggressive vines like kudzu (*Pueraria lobata*) and English ivy (*Hedera helix*) (Miller 1985; Thomas 1980).

Shading under the extensive and rapid aerial growth of *Lonicera japonica* poses the most obvious threat to native species. However, Dillenburg et al. (1993a, 1993b) demonstrated that in the early stages of invasion, below-ground competition by *Lonicera japonica* reduced tree growth, particularly leaf size and expansion rate, significantly and more than above-ground competition. After two growing seasons, *Lonicera japonica* root competition significantly reduced growth of young sweetgum trees (*Liquidambar styraciflua*) and greatly exceeded root competition from the native vine *Parthenocissus quinquefolia* (Dillenburg et al. 1993b). The combined effects of above- and below-ground competition can suppress growth or result in direct mortality of trees and seedlings (Whigham 1984). Bruner (1967) documented that after five years of co-occurrence, 33% of yellow-poplar seedlings were dead, 22% were overwhelmed, and 45% were heavily draped with *Lonicera japonica* that germinated from seed in the first year.

Lonicera japonica has an additional competitive edge as it grows during part or all of the winter, when many native species are dormant (Carter and Teramura 1988a). This evergreen or semi-evergreen character allows *Lonicera japonica* to photosynthesize at winter temperatures and light levels. The shade it casts during early spring may inhibit ephemeral herbs that complete their life cycle in the six weeks prior to deciduous tree leaf-out.

Alteration of forest understory and overstory structure by *Lonicera japonica* may lead to a decline or alteration in songbird populations (Nyboer 1990). However, no studies have been conducted on interactions between *Lonicera japonica* and native animals, with the exception of white-tailed deer (*Odocoileus virginianus*) which favors *Lonicera japonica* leaves as food (Handley 1945, Harlow and Hooper 1971). In fact, wildlife managers in some states actively promoted growth of this aggressive vine to provide winter forage for deer (Dyess et al. 1994; Segelquist and Rogers 1975, Stransky 1984). Japanese honeysuckle foliage is most digestible and nutritious in spring, but it is still relatively high in nutritional value in winter (Blair et al 1983) when other food sources are less available to deer (Dyess et al. 1994). Seeds and leaves are eaten by cottontail rabbits, as well as birds (Dyess et al. 1994), and the tangled thickets provide cover for birds and small mammals.

Lonicera japonica is a severe threat in the southeastern and eastern states (Florida to Texas, north to Kansas, Missouri, central Illinois and New York), and a severe potential threat in northern states outside the current (1995) range. On the northern edge of the range, *Lonicera japonica* flower production is inhibited by winter temperatures (Swink and Wilhelm 1994), and the vine is thus a moderate threat. For example, in Illinois, *Lonicera japonica* is not a serious pest in the colder, northern third of the state, but is increasingly common in the central part of the state (Nyboer 1990). *Lonicera japonica* continues to spread gradually northward (Wagner 1986), possibly due to increasing cold tolerance, or to warm winters, or to other factors.

As of 1995 *Lonicera japonica* northern range was limited by winter temperatures, and its western range by drought-induced stress at the seedling stage (Sasek and Strain 1990). If atmospheric CO_2 concentrations increase as predicted, resulting in a 3^oC increase in average and minimum winter temperatures, the northern range of *Lonicera japonica* is predicted to shift up to 400 km north (Sasek and Strain 1990). Further westward expansion may be limited by decreased summer precipitation, although *Lonicera japonica* has improved water use efficiency and increased drought tolerance at higher CO_2 levels (Sasek and Strain 1990). *Lonicera japonica* is also predicted to become a more serious competitor of native trees at higher CO_2 levels, as it experiences much greater growth rates at higher CO_2 levels than do native woody erect species (Sasek and Strain 1991).

Virginia and Illinois have produced honeysuckle control circulars (Williams 1994, Nyboer 1990). Minnesota ranks the species as a severe potential threat (MN DNR 1991).

GLOBAL RANGE

Lonicera japonica is native to east Asia, including Japan and Korea (Gleason and Cronquist 1991, Lee et al. 1990). From this native range it has spread to Hong Kong (Thrower 1976), England (Clapham et al. 1962), Wales (Martin 1982), Portugal (De Baceler et al. 1987), Corsica (Jeanmonod and Burdet 1992), Hawaii (Wagner et al. 1989), Brazil, (Bove 1993), Argentina (Bonaventura et al. 1991), possibly the Ukraine (Panova 1986), and the continental United States, primarily by way of horticultural introductions.

The species was introduced into the U.S. in 1806 on Long Island, NY (Leatherman 1955), and the similar but more aggressive variety halliana was introduced to the country in 1862 in Flushing, N.Y. As with many invasive species, Japanese honeysuckle initially had a very gradual rate of spread, primarily to the south and east. *Lonicera japonica* was not included in Chapman's Flora of the Southern States (1884; in Hardt 1986) but in 1889 Wood and Willis included the variety *chinensis* in their flora of the eastern United States and a decade later Britton and Brown (1898) reported that the species ranged from New York and Pennsylvania to North Carolina and West Virginia. In 1899 *Lonicera japonica* was described in a wildflower book as the most widely planted of the honeysuckles (Lounsbury 1899). *Lonicera japonica* was reported from Florida in 1903, and from Texas in 1918 (Hardt 1986). By 1912, it had "escaped from cultivation", and ranged from Connecticut to Florida (Atkinson 1912), and within a few years was identified as an invasive problem species from the Gulf of Mexico to Massachusetts, creating "a network of tangled cords that covers the ground wherever this ruthless invader gets a foot hold" (Andrews 1919).

Lonicera japonica now occurs throughout the eastern half of the United States, south of a line extending from Massachusetts west to Lake Michigan, Illinois, and Missouri, and then southwest through Texas to Mexico, an area encompassing 26 states (USDA 1971, Leatherman 1955). The northern range limit coincides with maximum 30-year winter temperatures of -25^{o}C (Sasek and Strain 1990). The area of greatest infestation is in the center of this range, where annual precipitation averages 100-120 cm, and 30 year low temperatures are -8^{o}C to -15^{o}C (Sasek and Strain 1990). *Lonicera japonica*'s range is limited to the north by severe winter temperatures, and to the west by insufficient precipitation and prolonged droughts which limit seedling establishment (Sasek and Strain 1990). At the northern edge of the range, plants have reduced growth due to a shorter growing season, and produce few or no flowers (Swink and Wilhelm 1994). *Lonicera japonica* continues to spread northward, however, possibly due to increasing cold tolerance or warmer winters (Wagner 1986). It may spread up to 400 km north if global temperature increases 3^{o}C (Sasek and Strain 1990).

Japanese honeysuckle sporadically escapes from cultivation in California where it is present in scattered locations, primarily below 1000 m elevation (Hickman 1993). It has also escaped cultivation in scattered locations in the Hawaiian islands, particularly in mesic to wet forest in Kokee State Park on Kauai and near Volcano on the island of Hawaii (Wagner et al. 1990). It apparently does not produce seed at most locations in Hawaii and will likely become a much more serious pest there if fertile strains develop. Unfortunately, most plants in an escaped population in Manoa Valley on Oahu reportedly set seed (Wagner et al. 1990). A recent report from Kauai also indicates the Japanese honeysuckle population there may be spreading and has potential to become a severe pest in the Kokee area (Flynn, personal communication).

HABITAT

Lonicera japonica is native to east Asia. In Korea, *Lonicera japonica* is part of the understory in later successional forests dominated *Carpinus cordata, Fraxinus rhynchophylla* and *Cornus controversa* (Lee et al. 1990).

In North America, *Lonicera japonica* primarily occurs in disturbed habitat, including successional fields, roadsides, forest edges, and fencerows (Williams 1994). It is common in dry-mesic to wet-mesic upland forest, floodplain forest, and southern pine stands, and particularly common in forest openings created by disturbance, such as treefall, logging, or disease. *Lonicera japonica* continues to be planted for landscape purposes in gardens and along highways.

Lonicera japonica grows most vigorously in full sun and on rich soil, but is shade and drought tolerant and therefore able to grow in a wide variety of habitats (Leatherman 1955). It develops high frequency and cover in young forests while densely shaded, mature forests support fewer, and smaller, colonies (Robertson et al. 1994). *Lonicera japonica* usually invades disturbed communities and rarely colonizes deeply shaded, mature forests unless canopy openings are created by human disturbances or natural processes (disease, wind throw, drought, etc.) (Slezak 1976; Thomas 1980). In Virginia *Lonicera japonica* quickly invaded a former forest site destroyed by avalanche (Hull and Scott 1982), and it grew vigorously in a forest opening in Arkansas (McLemore 1981). This species can persist in low numbers in relatively undisturbed forest and then "break out" following disturbances that open the canopy, e.g.; windthrow, ice storm, disease, scouring flood, or drought. Once established, *Lonicera japonica*'s dense canopy inhibits establishment of later successional species (Myster and Pickett 1992). *Lonicera japonica* rarely invades deeply shaded, mature forests unless the canopy is somehow opened (Robertson et al. 1994).

In Pennsylvania, *Lonicera japonica* is a major component of the third stage of succession in old fields, increasing after fields have been abandoned for four years (Keever 1989). In New Jersey *Lonicera japonica* invaded an oldfield 13 years after abandonment, and was present for at least 18 years (Myster and Pickett 1992). In Virginia *Lonicera japonica*, is most abundant in the piedmont and coastal plant forests (Williams 1994). In Illinois *Lonicera japonica* grows where overstory canopy provides filtered light, especially oak forests, cedar glades, and barrens, and along the banks of streams where the natural break in canopy creates a light opening (Nyboer 1990). Plants then spread into adjacent shaded forest. *Lonicera japonica* has been found on Michigan sand dunes (Wagner 1986), and persists near abandoned homesites in the Chicago region (Swink and Wilhelm 1994). In Indiana, *Lonicera japonica* is abundant in urban forest preserves, but is absent from woodlots isolated by agricultural fields and distant from urban areas (Brothers and Springarn 1992).

BIOLOGY-ECOLOGY

Lonicera japonica is a strong competitor due to wide seed dispersal, rapid growth rate, extended growing season, ability to capture resources both above- and below-ground, wide habitat adaptability, and lack of natural enemies. Some of these factors have received considerable study, while others have been given little or no attention.

Lonicera japonica blooms most prolifically in full sun (Leatherman 1955), and decreases flowering activity as light decreases; in 8% of full light no flowers are produced (Blair 1982, Robertson et al. 1994). The blooming period extends from April to December in Georgia (Andrews 1919), late May to October in Kentucky (Sather, personal communication), May to June in Illinois (Mohlenbrock 1986), and June in Michigan. Flowers open a few hours before sunset, and remain open for approximately three days (Roberts 1979). In Wales, the majority of flowers are pollinated the day after opening by bumblebees (*Bombus lucorum* and *B. pascuorum*). Other bee species may be potential pollinators, as nectar is available to species with tongues ≥ 4 mm long (Roberts 1979). Flowers remain open at night, indicating the possibility for moth pollination (Roberts 1979). In the United States *Lonicera japonica* is probably pollinated by a variety of insects, due to its extended blooming season and wide geographical range.

Relatively few studies have documented seed production, seed viability, germination requirements, or seedling establishment.

The inconspicuous black berries contain 2-3 seeds (USDA 1971). Fruit production is much higher in full sun than in shade (average 222 vs. 11 g seeds per plant, respectively) in Texas (Halls 1977). Fruit production decreases as soil nitrogen increases (Segelquist and Rogers 1975). Seed viability is highly variable. Leatherman (1955) determined that 85% of seed were viable, and obtained 63% germination. Haywood (1994) attempted to study long-term seed viability, but seed was unsound when collected. This variation is typical of the *Lonicera* genus, which is characterized by having variable seedcoat dormancy, embryo dormancy, and/or no dormancy both within and among species (Hartmann and Kester 1968). Bruner (1967) reported rapid growth from seed in South Carolina, and Carter and Teramura (1988b) stated that *Lonicera japonica* reproduces abundantly from seed. Berries are consumed by a number of birds including robin, turkey, quail, bluebird, and goldfinch (Martin et al. 1951, Jackson and Cooper 1974), which then disseminate the seeds (Nyboer 1990).

Rate of growth from the seedling stage is not known; most researchers and nurseries propagate *Lonicera japonica* from stem cuttings, particularly the var. halliana, which forms roots "wherever the canes touch moist ground" (Hartmann and Kester 1968). Leatherman (1955) suggested that seedlings likely photosynthesize shortly after germination, due to the low food reserves in each seed. Seedlings are known to establish in shaded understories, which implies that light may not be necessary for seed germination. Seedling growth is apparently slow for the first two years (Little and Somes 1967). *Lonicera japonica* is drought sensitive, particularly at the seedling stage (Sasek and Strain 1990). Biomass appears to decline with summer drought (Faulkner et al. 1989).

Once established, *Lonicera japonica* is capable of extremely vigorous growth. In a moist bottomland forest vines overtopped a 4.5 m tree in one year (Bruner 1967), although growth rates of 1.5 m/year may be more typical (Leatherman 1955). Bell et al. (1988) recorded a maximum shoot elongation of 4.6 mm/day in Maryland. This rapid growth rate allows *Lonicera japonica* to outcompete native trees; In one year, *Lonicera japonica* overtopped three-year old sweetgum (*Liquidambar styraciflua*) trees (Dillenburg et al. 1993a). *Lonicera japonica* vines spread both vertically and horizontally (Williams 1994).

Individual vines have numerous long vegetative runners; the combined length of lateral and sublateral runners from one sprout in one year exceeded 15 m (Little 1961). Vines in high light have been recorded with $\geq$ 7 runners, each over 60 cm long (Slezak 1976). The runners develop roots at nodes in contact with soil, and thus form dense mats. If the above ground parts are severed, each new root system develops into a separate, but genetically identical, plant. The root system has been recorded at up to 3 m across and 1 m deep (Leatherman 1955). Roots are highly competitive with native species (Carter and Teramura 1988a, 1988b).

Lonicera japonica's climbing architecture is adapted to early successional forest (Carter and Teramura 1988a), which typically has small diameter trees and a dense understory. The vines twine about vegetation in closely spaced spirals, thus creating a strong support structure that permits them to remain upright after the host tree is killed. Individual shoots may be very long, but due to the numerous spirals, a vine's height above the ground may not be great. Japanese honeysuckle vines typically climb stems <15 cm diameter (Andrews 1919). Larger stems are rarely used as hosts, as *Lonicera japonica* cannot climb wide boles unless small branches or other vines are present to provide support (Andrews 1919).

Longevity of individual plants has not been measured. As *Lonicera japonica* reproduces vegetatively, life span of individual stems or roots is not a measure of genet longevity.

Lonicera japonica is adapted to growing in 25-100% of full light, and grows vigorously in full sun. Stem density is greatest in full light, and decreases with increasing shade: In Pennsylvania, Robertson et al. (1994) recorded mean stem densities of 25.4/m^2 in an oldfield, 15/m^2 in a thicket, 13.6/m^2 in a woodland, and 8.6/m^2 and 8.1/m^2 in riparian forest and upland mature forest, respectively. Stem density was similarly high in both oak and maple associations (Robertson et al. 1994). In Washington D.C. *Lonicera japonica* produced good growth at 47% of full sun (Thomas 1980). In this location winter light measurements in closed forest range from 49% to 86% of full light. *Lonicera japonica* is able to persist in deciduous forest at low summer light intensities, and put on growth in winter, or when canopy gaps occur.

Lonicera japonica tolerates low light conditions, and may spread vegetatively, but rarely produces flowers or fruits under low light (25% of full light; Robertson et al. 1994). Honeysuckle plants are severely stressed in low light, and lose substantial amounts of aboveground biomass after long periods of low light: Blair (1982) reported that leaf biomass declined 94% after two years at very low light (8% of full sunlight), and plants suffered stem dieback and leaf loss, but did not die. Leatherman (1955) similarly reported that half of her experimental cuttings survived at 10% of full light, and the majority survived at 25% of full light. Once established, *Lonicera japonica* can persist at low light levels with little or even negative growth, and respond to winter sun and canopy openings with more vigorous growth (Carter and Teramura 1988a). Interestingly, as a twining vine *Lonicera japonica* is less physiologically adapted to low light levels than native tendril climbing vines, such as *Parthenocissus quinquefolia* (Carter and Teramura 1988a), which can rapidly climb up supporting trees to reach higher light levels.

Lonicera japonica has a long photosynthetic season due to its evergreen nature and its ability to grow in cold temperatures. *Lonicera japonica* shoots grow until the first frost, apparently because they are able to lignify rapidly, which gives them greater cold-hardiness than more tender species (Panova 1986). In southern locales *Lonicera japonica* retains its old leaves over winter (Schierenbeck and Marshall 1993) permitting year-round photosynthesis. In these areas, *Lonicera japonica* leaves are physiologically active during the winter and can grow when minimum predawn air temperatures are at or above -3^{o}C. At these temperatures, net photosynthetic rates on warm winter days are comparable to those in summer (Carter and Teramura 1988b). The presence of old leaves during the period of new-leaf formation (January - March), combined with the higher photosynthetic rates in new leaves, increases total carbon gain and thereby growth rate and invasiveness (Schierenbeck and Marshall 1993). Shoots produce an early burst of growth in spring, before native species leaf out (Dillenburg et al. 1993a).

In the northern states *Lonicera japonica* retains its leaves until late December or January (semi-evergreen), while native trees lose their leaves in October. The vines continue to photosynthesize for several months after overstory trees have dropped their leaves, which allows them to maintain presence in low light communities (Robertson et al. 1994, Carter and Teramura 1988a). In Maryland, *Lonicera japonica* is physiologically active for 9 weeks after native deciduous vines have gone dormant (*Parthenocissus quinquefolia* and *Vitis vulpina*) (Bell et al. 1988). In spring *Lonicera japonica* begins growth some two months earlier than native species, from the period when temperatures are above freezing, until deciduous trees produce new leaves (Hardt 1986). Thomas (1980) calculated that in the Washington D.C. area there are an average of 52 days/year between first and last frost when temperature and light conditions in closed canopy forests are adequate for *Lonicera japonica* photosynthesis.

Lonicera japonica leaves are unaffected by minimum temperatures of -0.6^{o}C, and continue to function, at lower efficiency, until temperatures drop below -3.0^{o}C (Carter and Teramura 1988b). The relatively high rate of leaf gas exchange in autumn, winter, and spring indicates that carbon gain during this period may contribute substantially to *Lonicera japonica*'s rapid growth rate. Although *Lonicera japonica* leaves photosynthesize in winter, the lowered activity reduces effectiveness of foliar herbicides applied after the first frost (Regehr and Frey 1988). In Tennessee, defoliation occurred at -26^{o}C, but plants were not apparently killed (Faulkner et al. 1989).

Lonicera japonica is spread primarily by birds, which consume the fruits and pass the seeds, carrying them from landscape plantings to natural areas and disseminating them in forest openings and disturbance zones. Once established, *Lonicera japonica* can develop a large seedbank that germinates when the soil is disturbed. This attribute led to a dramatic increase in southern states in the 1950's, when timber companies promoted intensive site preparations (discing, burning, bush-hogging) to facilitate tree regeneration after clearcutting (Prine and Starr 1971). Honeysuckle grew so rapidly from both seedbank and top-killed plants that tree seedlings were outcompeted (Prine and Starr 1971). Consequently, forest companies have conducted much of the research to identify herbicides that control *Lonicera japonica* (Edwards and Gonzalez 1986, McLemore 1981).

Originally introduced as a landscape plant, *Lonicera japonica* is still considered a desirable species by some landscapers, highway designers, and wildlife managers. Wildlife managers promote increased growth of *Lonicera japonica* to provide winter forage, particularly for deer (Dyess et al. 1994). Landscape architects plant *Lonicera japonica* for its fragrant flowers and rapid growth (Georges et al. 1993, Nam and Kwack 1992, Bradshaw 1991), and highway designers use the plant for erosion control and bank stabilization (Stadtherr 1982, Hardt 1986).

In China *Lonicera japonica* is a valued medicinal herb that contains anti-complementary polysaccharides (Shin et al. 1992). Polyphenolic compounds isolated from *Lonicera japonica* inhibit human platelet activation and provide protection from cellular injury, and thus help maintain human vascular homeostasis (Chang and Hsu 1992). Aden I, a mixture of *Lonicera japonica* flower buds and parts of other plants, has both antibiotic and antiviral effects, comparable to results produced by standard antibiotics (Houghton et al. 1993). Leaves and flowers are used in the therapy of chicken pox (Luo 1989), and may be used as a food additive to increase productivity of broiler chickens in Korea (Cho 1992).

CONTROL

Prevention/Legislation
In Illinois, the sale and distribution of *Lonicera japonica* is prohibited under the Illinois Exotic Weed Act (1988).

Biological control
The only technique that could control *Lonicera japonica* on a regional scale is biological control, but as of 1997 no formal program had been established. Interestingly, in China, a biocontrol program using *Sclerodermus* spp. was established to protect *Lonicera japonica* from the cerambycid *Xylotrechus grayi* (Tian et al. 1986). *Lonicera japonica* is utilized by some insects in its native habitat and the U.S. In Sichuan, China, *Lonicera japonica* growing near cottonfields is an early spring host for aphids that feed on crops later in the growing season (Li and Wen 1988). In North Carolina, the two-spotted spider mite (*Tetranychus urticae*), an agricultural pest in corn and peanut fields, overwinters on *Lonicera japonica* growing on field margins (Margolies and Kennedy 1985). *Lonicera japonica* is also a suitable host for the cicadellid cotton pest (*Empoasca biguttula*) in Hunan, China (Chen et al. 1987), and may be a host for tobacco leaf curl virus, which was detected in the horticultural variety *Lonicera japonica* var. aureo-reticulata (Macintosh et al. 1992). The vine is susceptible to honeysuckle latent virus (Brunt et al. 1980), and to tobacco leaf curl bigeminivirus (TLCV) transmitted by whiteflies (MacIntosh et al. 1992).

Burning
Fire removes above-ground vegetation, and reduces new growth, but does not kill most *Lonicera japonica* roots, and surviving roots produce new sprouts that return to pre-burn levels of cover within a few years (Oosting and Livingstone 1964). A single spring fire reduced Japanese honeysuckle cover 50% in Illinois (Nyboer 1990). Two sequential fires topkilled *Lonicera japonica*, reducing crown

volume (m^3/ha) by 80%, but new growth from root sprouts maintained *Lonicera japonica* as a dominant groundcover species in North Carolina (Barden and Matthews 1980). In Virginia burning is used to reduce abundance of *Lonicera japonica*, and inhibit spread for 1-2 growing seasons (Williams 1994). Prescribed burning significantly reduced *Lonicera japonica* biomass in Tennessee, by 93% when burned in October, and by 59% when burned January - March (Faulkner et al. 1989). Top-killed honeysuckle resprouted in spring (March - April), apparently from roots or runners just below the unburned litter layer. In this situation, follow-up application of 2% glyphosate in spring, 2 - 6 months after burning, appeared to control honeysuckle better on unburned than burned plots, possibly because tall herbaceous vegetation that grew up after the fire on the burned plots intercepted the herbicide before it could reach the shorter honeysuckle resprouts (Faulkner et al. 1989). In Texas, burning in February removed all above ground foliage, but did not kill plants (Stransky 1984). However, burned plants produced fewer and shorter runners than unburned plants, and fire therefore reduced total vegetative growth (Stransky 1984).

Combining fire and herbicides may prove to be more effective than either method by itself if late autumn or winter burns are used to reduce Japanese honeysuckle biomass when most native species are dormant and all resprouts are then treated with a foliar application of glyphosate about a month after they emerge (Johnson, personal communication). Prescribed burns may also be used to help prevent spread of Japanese honeysuckle because seedlings and young plants are most susceptible to fires (Richter, personal communication) .

Chemical

The evergreen and semi-evergreen nature of *Lonicera japonica* allows application of herbicides when many native species are dormant. Timing of application is critical to effectiveness; in general, applying herbicide shortly after the first killing frost, and before the first hard frost (ca. -4.0^{o}C) is most effective. Herbicide effectiveness can be reduced in areas where large stones or fallen logs protect root crowns from soil-active herbicides (Miller 1985) or where overtopping vegetation intercepts foliar herbicides (Faulkner et al. 1989). Many herbicides produce a short-term reduction in foliar coverage, but do not kill the plant and buds left undamaged by the herbicide can produce new growth that often exceeds growth from untreated plants within a year (Prine and Starr 1971). A foliar application of 1.5% glyphosate shortly after the first frost appears to be the most effective treatment. Treated plants should be re-examined at the end of the second growing season, as plants can recover from herbicide application (McLemore 1981).

GLYPHOSATE (brand names include: Roundup, Rodeo, Accord)

• October applications of 0.75% and 1.5% v/v glyphosate killed 99% of treated *Lonicera japonica* within six months in Delaware, and few plants resprouted within 30 months of treatment (Regehr and Frey 1988). The two application rates were equally effective. The same experiment conducted in December resulted in 68% mortality at the lower concentration, and 86% mortality at the higher concentration, and regrowth from buds was much greater than in plants treated in October. The authors concluded that timing of application was critical; applying glyphosate within 2 days of the first frost resulted in very high mortality. After the first frost, higher concentrations of glyphosate were needed to achieve somewhat lower mortality. Defoliation after glyphosate treatment was very slow; only 5-15% of leaves were gone one month after treatment, although 78-90% of stems were dead.

• A mid-August application of 2.2 kg/ha glyphosate controlled 83% of actively growing *Lonicera japonica* in North Carolina; control was reduced under drought conditions (Younce and Skroch 1989). Glyphosate (2 lb active ingredient/gal) at 1 to 1.5 gallons/acre controlled "most" *Lonicera japonica* in Alabama (Miller 1985).

• In Arkansas, a 6.72 kg active ingredient/ha application resulted in 85% control after one growing season, and 80% control after two growing seasons (McLemore 1981). Lower application rates were less effective two years after treatment.

• Effectiveness of glyphosate increased linearly with increasing herbicide concentration (0.48-4.8% w/w), but no concentration gave complete control with one application; repeated treatment with 4.8% glyphosate produced complete shoot necrosis in only 50% of plants (Ahrens and Pill 1985).

• Efficacy of glyphosate was not increased by addition of surfactants (Younce and Skroch 1989, Regehr and Frey 1988).

DICHLORPROP + 2,4-D

• Dichlorprop mixed with 2,4-D at 3.6 grams active ingredient/liter (1.5% v/v) resulted in 94% mortality when applied within two days of the first frost in October, but only 46% mortality when applied in December. Thirty months after treatment, 14% of stems sprayed in October resprouted, and 75% of stems sprayed in December produced new growth (Regehr and Frey 1988).

2,4-D + PICLORAM (brand names include: Tordon)

• Picloram is a restricted use soil-active herbicide that is prohibited in California, as it is relatively persistent and subject to leaching.

• Tordon 101 (4:1 2,4-D amine + picloram, at 1 to 2 gal/acre) "reduced existing honeysuckle to a few surviving crowns" (Miller 1985). Tordon 10K at 50 lb/acre had similar effectiveness (Miller 1985).

• Tordon 101 at 10 gal acre reduced foliage by 72.5% one year after treatment; a second application of Tordon 101 reduced foliage by a total of 90% one year after re-treatment (Prine and Starr 1971)

• A foliar spray of Tordon 101 at 2.8-8.4 kg/ha gave 84-94% control in a pine stand (McLemore 1982), similar to control provided by amitrole at 2.24 and 4.48 kg/ha. (McLemore 1982).

TEBUTHIURON (brand names include: Spike)

• Spike 80W (80% tebuthiuron) and Spike 20p (20% tebuthiuron) provided very effective control when applied at 4-5 lbs active ingredient/acre, "resulting in essentially bare plots with yellowing sprigs of vegetation" (Miller 1985).

DICAMBA (brand names include: Banvel, Brushkiller)

• Banvel 720 (2 lb 2,4-D and 1 lb dicamba) was very effective when applied at 4 gal/acre, but had only partial effectiveness at 3 gallons/acre (Miller 1985).

• Lower rates of Dicamba, as in Brushkiller 4-41 and 10-51, resulted in limited or no mortality (Miller 1985). In fact, *Lonicera japonica* growth was stimulated by application of Brushkiller 10-51 (Miller 1985).

SULFOMETURON (brand names include: Oust)

- A February application of sulfometuron methyl in South Carolina at .25 lb/acre active ingredient, applied when vegetation is less than 30-45 cm high, is recommended for control of *Lonicera japonica* in loblolly pine stands (Michael 1985).
- In Georgia, *Lonicera japonica* was not controlled by a late application of Sulfometuron applied at 3 oz/acre (Withrow et al. 1983)
- *Lonicera japonica* was almost completely killed (99% mortality) by a May application of 2 oz metsulfuron-methyl + 0.25% surfactant in central Georgia (Edwards and Gonzalez 1986)

INEFFECTIVE

- In Illinois, herbicides that are not used by the Department of Conservation due to ineffectiveness or environmental persistence are: picloram; amitrole; aminotriazolel atrazine; dicamba; dicamba + 2,4-D; 2,4-D; DPX 5648; fenac; fenuron; simazine; and triclopyr (brand names for triclopyr include Garlon 3A, Garlon 4 and Brush-B-Gone) (Nyboer 1990).
- Hexazinone at 2.24 and 6.72 kg Active ingredient/ha was ineffective (McLemore 1981), as was application at 1 or 2 lb active ingredient/acre (Michael 1985). Hexazinone pellets at 8 lb active ingredient/acre reduced *Lonicera japonica* cover from 100% to 25% cover after three years, while a 2 lb/acre rate resulted in a decrease in cover from 100% to 52% over the same time period (Michael 1984).
- Oryzalin is apparently ineffective, as it is recommended for use in controlling weeds that threaten *Lonicera japonica* planted as a groundcover (Bowman 1983)
- Brushkiller 10-51 at 1.5 gal/acre "encouraged" growth of *Lonicera japonica* (Miller 1985). Brushkiller 170 resulted in a 45% decrease in foliar cover one year after June treatment (Prine and Starr 1971).
- June application of 2,4-D (4 lb active ingredient/acre at 10 gal/acre) increased foliar growth of *Lonicera japonica* by 48% one year after treatment (control plants increased by 0.9%) (Prine and Starr 1971).
- June application of Banvel resulted in increased foliar growth one year after treatment (Prine and Starr 1971).
- Triclopyr in both ester and salt formulations (3 and 4lb/gal, respectively) and as an ester combined with 2,4-D (1 and 2lb/gal respectively) failed to control *Lonicera japonica* one year after treatment (Dreyer 1988). However, in Illinois the latter formulation is reputedly effective (Nyboer 1990).

Mowing, Discing and Pulling

Removing the above-ground portion of *Lonicera japonica* reduces current-year growth but does not kill the plant, and generally stimulates dense regrowth. Cut material can take root and should therefore be removed from the site (not practical with most infestations).

Mowing is an ineffective control method, stimulating growth and encouraging formation of dense, albeit shorter, mats. Plants mowed in February formed a dense, 20 cm tall mat within two months, growing from cut stems and rooting from severed runners; by the following November (21 months later) mowed plants were 60 cm high (Stransky 1984). Twice-yearly mowing in Virginia slowed vegetative spread but increased stem density (Williams 1994).

Bush-hogging is an ineffective control, as *Lonicera japonica* re-invades within one growing season (McLemore 1985).

Discing is apparently an effective control method: McLemore (1985) reported that "control of the honeysuckle was still effective after two years". Discing depth was not indicated. Discing is a highly destructive procedure that destroys native groundlayer species, and may stimulate *Lonicera japonica* seed bank germination.

Hand-pulling is a time-consuming procedure with limited effectiveness, as the entire plant (roots and shoots) must be removed. Pulling may be a practical method to remove small patches of seedlings.

LITERATURE CITED

Ahrens, W.H. and W.G. Pill. 1985. Gel-incorporated glyphosate for perennial weed control. Hortscience 20:64-66.

Andrews, E.F. 1919. The japanese honeysuckle in the eastern United States. Torreya 19:37-43.

Atkinson, G.F. 1912. Practice key and flora of the eastern, northern and central states. Henry Holt and Co. New York, NY. 261 p.

Barden, L.S. and J.F. Matthews. 1980. Change in abundance of honeysuckle *Lonicera japonica* and other ground flora after prescribed burning of a piedmont pine forest. Castanea 45:257-260.

Bell, D.J., I.N. Forseth, and A.H. Teramura. 1988. Field water relations of three temperate vines. Oecologia 74:537-545.

Blair, R.M. 1982. Growth and nonstructural carbohydrate content of southern browse species as influenced by light intensity. Journal of Range Management 35:756-760.

Blair, R.M., R. Alcaniz, and A. Harrell. 1983. Shade intensity influences the nutrient quality and digestibility of southern deer browse leaves. Journal of Range Management 36:257-264.

Bonaventura, S.M., M.J. Piantanida, L. Gurini, and M.I. Sanchez-Lopez. 1991. Habitat selection in population of cricetine rodents in the region Delta (Argentina). Mammalia 55:339-354.

Bove, C.P. 1993. Systematic catalogue of arboreal plant pollen grains of southern Brazil: XXVII. Bombaceae, Caprifoliaceae, and Styracaceae. Revista Brasileira de Biologia 53:87-101.

Bowman, P. 1983. selected preemergence herbicides in groundcovers. Proceedings of the 35th Annual California Weed Conference p. 142.

Bradshaw, D. 1991. Climbing honeysuckles (Lonicera). Plantsman 13:109-110.

Brothers, T.A. and A. Springarn. 1992. Forest fragmentation and alien plant invasion of central Indiana old-growth forests. Conservation Biology 6:91-100.

Bruner, M.H. 1967. Honeysuckle-- a bold competitor on bottomland hardwood sites. Forest Farmer 26:9,17.

Brunt, A.A., S. Phillips, and B.J. Thomas. 1980. Honeysuckle latent virus, a carlavirus infecting *Lonicera periclymenum* and *Lonicera japonica* (Caprifoliaceae). Acta-Hortic 110:205-210.

Cain, M.D. 1992. Japanese honeysuckle in uneven-aged pine stands: problems with natural pine regeneration. Proceedings of the Southern Weed Science Society 45:264-269.

Carter, G.A. and A.H. Teramura. 1988a. Vine photosynthesis and relationships to climbing mechanics in a forest understory. American Journal of Botany 75:1011-1018.

Carter, G.A. and A.H. Teramura. 1988b. Nonsummer stomatal conductance for the invasive herbs kudzu and Japanese honeysuckle. Canadian Journal of Botany 66:2392-2395.

Chang, W.C. and F.L. Hsu. 1992. Inhibition of platelet activation and endothelial cell injury by polyphenolic compounds isolated from *Lonicera japonica* Thunb. Prostoglandins Leukotienes and Essential Fatty Acids 45:307-312.

Chapman, A.W. 1897. Flora of the southern United States. 3rd ed. American Book Co. New York.

Cho, S.K. 1992. Effect of addition of *Lonicera japonica* Thunberg on productivity and development of intestinal organs in broiler chickens. Korean Journal of Poultry Science 19:27-34.

Chen, Y.N., B.Z. Zhong and K.J. Zhou. 1987. A preliminary study on the sources of *Empoasca biguttula* Shiraki in Hunan Province. Insect Knowledge. 24:148-150.

Clapham, A.R., T.G. Tutin and E.F. Warburg. 1962. Flora of the British Isles. Cambridge University, London.

Coombes, A.J. 1991. Dictionary of plant names. Timber Press. Portland, OR. 205 p.

De Bacelar, J.J.A.H, A.I.D. Correia, A.C.S Escudeiro, A.R.P.D. Silva, and C.M.A. Rodrigues. 1987. News concerning the flora of Sintra (Portugal). Boletim da Sociedade Broteriana 60:147-162.

Dillenburg, L.R., D.F. Whigham, A.H. Teramura, and I.N. Forseth. 1993a. Effects of vine competition on availability of light, water, and nitrogen to a tree host (*Liquidambar styraciflua*). American Journal of Botany 80:244-253.

Dillenburg, L.R., D.F. Whigham, A.H. Teramura, and I.N. Forseth. 1993b. Effects of below-and aboveground competition from the vines *Lonicera japonica* and *Parthenocissus quinquefolia* on the growth of the tree host *Liquidambar styraciflua*. Oecologia 93:48-54.

Dirr, M.A. 1983. Manual of woody landscape plants: their identification, ornamental characteristics, culture, propagation and uses. Stipes Publishing Co. Champaign, IL. 826 p.

Dreyer, G.D. 1988. Efficacy of triclopyr in rootkilling oriental bittersweet (*Celastrus orbiculatus Thunb.*) and certain other woody weeds. Proceedings, 42nd Annual Meeting. Northeastern Weed Science Society 120-121.

Dyess, J.G., M.K. Causey, and H.L. Stribling. 1994. Effects of fertilization on production and quality of Japanese honeysuckle. Southern Journal of Applied Forestry 18:68-71.

Edwards, M.B. and F.E. Gonzalez. 1986. Forestry herbicide control of kudzu and Japanese honeysuckle in loblolly pine sites in central Georgia. 39th Proceedings of the Southern Weed Science Society 272-275.

Faulkner, J.L., E.E.C. Clebsch, and W.L. Sanders. 1989. Use of prescribed burning for managing natural and historic resources in Chickamauga and Chattanooga National Military Park, USA. Environmental. Management 13:603-612.

Fernald, M.L. 1970. Gray's manual of botany. D. Van Nostrand. New York 1632 p.

Flynn, T. personal communication. National Tropical Botanical Garden. P.O. Box 340, Lawai, Kauai, HI 96765.

Georges, D., J.C. Chenieux, and S.J. Ochatt. 1993. Plant regeneration from aged-callus of the woody ornamental species *Lonicera japonica* cv. "Hall's prolific". Plant Cell Reports 13:91-94.

Gleason, H.A. and A. Cronquist. 1963. Manual of vascular plants of northeastern United States and adjacent Canada. New York Botanic Garden, New York, NY. 810 p.

Halls, L.K. 1977. Japanese honeysuckle/*Lonicera japonica* Thunb. pp 108-109 *in* Forest Service Technical Report-US Southern Forest Experiment Station.

Handley, C.O. 1945. Japanese honeysuckle in wildlife management. Journal of Wildlife Management 9:261-264.

Hardt, R.A. 1986. Japanese honeysuckle: from "one of the best" to ruthless pest. Arnoldia 46:27-34.

Harlow, R.F. and R.G. Hooper, 1971. Forages eaten by deer of the Southeast. Proc. Southeastern Assoc. Farm and Fish Commissioners 25:18-46.

Hartmann, H.T. and D.E. Kester. 1968. Plant propagation: principles and practices. Prentice-Hall. Englewood Cliffs, NJ.

Haywood, J.D. 1994. Seed viability of selected tree, shrub and vine species stored in the field. New. For. 8:143-154.

Hickman, J.C. (ed.) 1993. The Jepson Manual: higher plants of California. University of California. Berkeley, CA.

Houghton, P.J., B.X. Zhou, and X.S. Zhao. 1993. A clinical evaluation of the chinese herbal mixture Aden-I for treating respiratory infections. Phytotherapy Research 7:384-386.

Hull, J.C. and R.C. Scott. 1982. Plant succession on debris avalanches of Nelson County, Virginia. Castanea 47:158-176.

Jackson, L.W. 1974. Japanese honeysuckle. p 74-77 *in* J.D. Gill and W.H. Healy, (eds.) Shrubs and vines for northeastern wildlife. USDA-FS GTR NE-9.

Jeanmonod, D. and H.M. Burdet. 1992. Notes and contributions to the Corsican flora: VIII. Candollea 47:267-318.

Johnson, E. personal communication. The Nature Conservancy, New Jersey Field Office, 200 Pottersville Road, Chester, NJ 07930

Keever, C. 1979. Mechanisms of plant succession on old fields on Lancaster County, Pennsylvania. Bulletin of the Torrey Botanical Club 106:299-308.

Leatherman, A.D. 1955. Ecological life-history of *Lonicera japonica* Thunb. Ph.D. thesis. University of Tennessee. 97 pp.

Lee, K.J., J.C. Jo., B.S. Lee and D.S. Lee. 1990. The structure of plant community in Kwangnung (Korea) forest (I): Analysis of the forest community of Soribong area by the classification and ordination techniques. Journal of the Korean Forestry Society 79:173-186.

Li, Q.F. and Q. Wen. 1988. Observations on the relationship between aphids and braconids on early spring hosts and cotton. Insect Knowledge 25:247-277.

Little, S. 1961. Recent tests in controlling Japanese honeysuckle,. The Hormolog 3(1):8-10.

Little, S. and H.A. Somes. 1967. Results of herbicide trials to control Japanese honeysuckle. US Forest Service Northeast Forest Experiment Station Research Note 62:18.

Lounsbury, A. 1899. A guide to the wildflowers. Frederick A. Stokes Co. New York. 347 pp.

Luo, G. 1989. Therapy of chicken pox with leaves and flowers of Japanese honeysuckle (*Lonicera japonica*). Journal of Traditional Chinese Veterinary Medicine 2:20-21.

Macintosh, S., D.J. Robinson, and B.D. Harrison. 1992. Detection of 3 whitefly-transmitted geminiviruses occurring in Europe by tests with heterlogous monoclonal-antibodies. Annals of Applied Biology 121:297-303.

Margolies, D.C. and G.G. Kennedy. 1985. Movement of the twospotted spider mite *Tetranychus urticae*, among hosts in a corn (*Zea mays*) and peanut (*Arachis hypogaea*) ecosystem. Entomologia Experimentalis et Applicata 37:55-62.

Martin, A.C., H.S. Zim, and A.L. Nelson. 1951. American wildlife and plants: a guide to wildlife food habits. Dover Publications. New York. 500 p.

Martin, W.K. 1982. The new concise British flora. Ebury Press and Michael Joseph. London England. 247 p.

McLemore, B.F. 1981. Evaluation of chemicals for controlling Japanese honeysuckle. Proceedings of the 34th Annual Meeting Southern Weed Science Society 34:208-210.

McLemore, B.F. 1982. Comparison of herbicides for controlling hardwoods in pine stands. Proceedings of the 35th Annual Meeting Southern Weed Science Society 35:195-199.

McLemore, B.F. 1985. Comparison of three methods for regenerating honeysuckle-infested openings in uneven-aged loblolly pine stands. USDA-FS GTR Southern Forest Experiment Station 97-99.

Michael, J.L. 1984. Impacts of rate of hexazinone application on survival and growth of the loblolly pine. Proc. 37th Southern Weed Science Society. 37:210-213.

Michael, J.L. 1985. Growth of loblolly pine treated with hexazinone, sulfometuron methyl, and metsulfuron methyl for herbaceous weed control. Southern Journal of Applied Forestry 9:20-26.

Miller, J.H. 1985. Testing herbicides for kudzu eradication on a Piedmont site. Southern Journal of Applied Forestry 9:128-132.

Minnesota Department of Natural Resources. 1991. Report and recommendations of the Minnesota Interagency Exotic Species Task Force. unpublished report. 25 p + Appendices.

Mohlenbrock, R.H. 1986. Guide to the vascular flora of Illinois. Southern Illinois University,. Carbondale, IL.

Myster, R.W. and S.T.A. Pickett. 1992. Dynamics of association between plants in ten old fields during 31 years of succession. Journal of Ecology 80:291-302.

Nam, Y.K. and B.H. Kwack. 1992. Effects of different levels of light, gibberellin, nitrogen, potassium and phosphate applications on leaf-yellowing of *Lonicera japonica* var. aureo reticulata. Journal Korean Society Horticultural Science 33:54-61.

Nyboer, R. 1990. Vegetation management Guideline: Japanese honeysuckle (*Lonicera japonica* Thunb.). pp. 62-66 Vegetation Management Manual, Illinois Nature Preserves Commission.

Oosting, H.J. 1956. The study of plant communities. W.H. Freeman and Co. San Francisco CA 439 pp.

Oosting, H.J. and R.B. Livingstone. 1964. A resurvey of a loblolly pine community twenty-nine years after ground and crown fire,. Bulletin of the Torrey Botanical Club 91:387-395.

Panova, L.N. 1986. Adaptation of introduced woody plants to low temperatures in the steppe region of the southern Ukraine. Byulleten' -Glavnogo-Botanicheskogo-Sada 142:17-19.

Prine, E.L. and J.W. Starr. 1971. Herbicide control of Japanese honeysuckle in forest stands. Proc. 24th Annual Meeting Southern Weed Science Society 24:298-300.

Regehr, D.L. and D.R. Frey. 1988. Selective control of Japanese honeysuckle (*Lonicera japonica*). Weed Technology 2:139-143.

Richter, S. personal communication. The Nature Conservancy, Wisconsin Field Office, 333 West Mifflin, Suite 107, Madison, WI 53703

Roberts, A.V. 1979. The pollination of *Lonicera japonica*. Journal of Apicultural Research 18:153-158.

Robertson, D.J., M.C. Robertson and T. Tague. 1994. Colonization dynamics of four exotic plants in a northern Piedmont natural area. Bulletin of the Torrey Botanic Club. 121:107-118.

Sasek, T.W. and B.R. Strain. 1990. Implications of atmospheric carbon dioxide enrichment and climatic change for the geographical distribution of two introduced vines in the USA. Climatic Change 16:31-52.

Sasek, T.W. and B.R. Strain. 1991. Effects of carbon dioxide enrichment on the growth and morphology of a native and an introduced honeysuckle vine. American Journal of Botany 78:69-75.

Schierenbeck, K.A. and J.D. Marshall. 1993. Seasonal and diurnal patterns of photosynthetic gas exchange for *Lonicera sempervirens* and *L. japonica* (Caprifoliaceae). American Journal of Botany 80:1292-1299.

Segelquist, C.A. and M.J. Rogers. 1975. Response of Japanese honeysuckle (*Lonicera japonica*) to fertilization. Journal of Wildlife Management 39:769-775.

Segelquist, C.A., M.J. Rogers and F.D. Ward. 1976. Response of Japanese honeysuckle (*Lonicera japonica*) to management in the Arkansas Ozarks. 29th Proceedings Annual Conference Southeastern Association Game & Fish Commissioners 1975. p 370-373.

Shin, K.S., K.S. Kwon, and H.C. Yang. 1992. Screening and characteristics of anti-complementary polysaccharides from Chinese medicinal herbs. Journal of Korean Agricultural Chemical Society 35:42-50.

Slezak, W.F. 1976. *Lonicera japonica* Thunb., an aggressive introduced species in a mature forest ecosystem. M.S. Thesis. Rutgers Univ. New Brunswick, NJ 81 p.

Stadtherr, R.J. 1982. Ground covers for highway use. Combined Proc. International Plant Propagators Society 28:598-604.

Stransky, J.J. J.N. Hale, and L.K. Halls. 1976. Nutrient content and yield of burned or mowed Japanese honeysuckle [*Lonicera japonica*, leaf-browse]. 29th Proceedings Annual Conference Southeastern Association Game & Fish Commissioners 1975. p 403-406.

Stransky, J.J. 1984. Forage yield of Japanese honeysuckle after repeated burning or mowing [*Lonicera japonica*]. Journal of Range Management 37:237-238.

Swink, F. and G. Wilhelm. 1994. Plants of the Chicago region. 4th ed. Indiana Academy of Science. Indianapolis, IN. 921 p.

Thomas, L.K. 1980. The impact of three exotic plant species on a Potomac island. US National Park Service. Science Monograph Series, No. 13. 179 p.

Thrower, S.L. 1976. Hong Kong herbs and vines. Government Printer. Hong Kong. 114 p.

Tian, M.K., X.H. Meng, Z.J. Li, H.Z. Cheng, M.J. Lu, and Q.Z. Lin. 1986. Studies on the use of *scleroderma* spp. Chinese Journal of Biological Control 2:4,184.

USDA. 1971. Common weeds of the United States. Dover Publications. NY. 463 p.

Wagner, W.H., Jr. 1986. Japanese honeysuckle invasion. Michigan Botanist 25:124.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1989. Contributions to the flora of hawaii (USA): II. Begoniaeae-Violaceae and the monocotyledons. Bishop Museum Occasional Papers 29:88-130.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai'i. University of Hawaii Press/Bishop Museum Press, Honolulu.

Whigham, D. 1984. The influence of vines on the growth of *Liquidambar styraciflua* L. (sweetgum). Canadian Journal of Forest Research 14:37-39.

Williams, C.E. 1994. Invasive alien plant species of Virginia. Dept. Conservation and Recreation. Richmond, VA.

Withrow, K.D., P.D. Middlebrooks, and J.F. Miller. 1983. Control of roadside vegetation in Georgia with Oust. (abstract) Proceedings, Southern Weed Science Society 36th annual meeting

Wood, A. and O.R. Willis. 1889. The new American botanist and florist. American Book Co. New York. 449 p.

Younce, M.H. and W.A. Skroch. 1989. Control of selected perennial weeds with glyphosate. Weed Science 37:360-364.

LAST UPDATED 15 April 1997

AUTHORED BY
Victoria Nuzzo
Natural Area Consultants
1 West Hill School Road
Richford, NY 13835

EDITED BY
John M. Randall
The Nature Conservancy
Wildland Weeds Management & Research
Department of Vegetable and Weed Sciences
University of California
Davis, CA 95616