

ELEMENT STEWARDSHIP ABSTRACT
for

Lonicera maackii (Rupr.) Maxim (Amur honeysuckle)
Lonicera morrowii A. Gray (Morrow's honeysuckle)
Lonicera tatarica L. (Tatarian honeysuckle)
Lonicera x bella Zabel (Bell's honeysuckle)

The Bush honeysuckles

To the User:

Element Stewardship Abstracts (ESAs) are prepared to provide The Nature Conservancy's Stewardship staff and other land managers with current management related information on species and communities that are most important to protect or control. The abstracts organize and summarize data from many sources including literature and from researchers and managers actively working with the species or community.

We hope, by providing this abstract free of charge, to encourage users to contribute their information to the abstract. This sharing of information will benefit all land managers by ensuring the availability of an abstract that contains up-to-date information on management techniques and knowledgeable contacts. Contributors of information will be acknowledged within the abstract.

For ease of update and retrievability, the abstracts are stored on computer at The Nature Conservancy. Anyone with comments, questions, or information on current or past monitoring, research, or management programs for the species described in this abstract is encouraged to contact The Nature Conservancy's Wildland Invasive Species Program.

This abstract is a compilation of available information and is not an endorsement of particular practices or products.

Please do not remove this cover statement from the attached abstract.

Author of this Abstract: Michael S. Batcher and Shelly A. Stiles, Consulting Ecologist and Environmental Planner, 1907 Buskirk-West Hoosick Road, Buskirk, NY 12028, e-mail: mbatcher@netheaven.com.

THE NATURE CONSERVANCY

4245 North Fairfax Drive, Arlington, Virginia 22203-1606 (703) 841-5300

SCIENTIFIC AND COMMON NAMES

<i>Lonicera maackii</i> (Rupr.) Maxim	Amur honeysuckle
<i>Lonicera morrowii</i> A. Gray	Morrow's honeysuckle
<i>Lonicera tatarica</i> L.	Tatarian honeysuckle
<i>Lonicera x bella</i> Zabel	Bell's honeysuckle

DESCRIPTION AND DIAGNOSTIC CHARACTERISTICS

Exotic bush honeysuckles are upright, multi-stemmed, oppositely branched, deciduous shrubs that range in height from 2 m to 6 m. The opposite leaves are simple and entire, and paired, axillary flowers are showy with white, pink, or yellow corollas. The fruits of *Lonicera* spp. are red, or rarely yellow, fleshy berries (Gleason and Cronquist 1991).

In flower, exotic bush honeysuckles can be distinguished from all native bush honeysuckles except swamp fly-honeysuckle (*L. oblongifolia*) by their hirsute (hairy) styles. In fruit, the red or rarely yellow berries of the exotics separate them from the blue- or black-berried natives waterberry (*L. caerulea*) and bearberry honeysuckle (*L. involucrata*) (Gleason and Cronquist 1991). The exotic bush honeysuckles also generally leaf-out earlier and retain their leaves longer than the native shrub honeysuckles (Trisel and Gorchoff 1994).

Within the exotic bush honeysuckles, *L. maackii* alone has acuminate, lightly pubescent leaves (Luken and Thieret 1995) that range in size from 3.5 to 8.5 cm long (Gleason and Cronquist 1991) and peduncles generally shorter than 6 mm (Pringle 1973). Its flowers are white to pink, fading to yellow, 15-20 mm long. Its berries are red or with an orange cast. Height ranges to 6 m (Luken and Thieret 1995).

In North America, there has been considerable confusion regarding the correct identification of *L. morrowii*, *L. tatarica*, and *L. x bella*, their hybrid. The literature contains a number of references to plants called by the name of one of the parents, but described as having characters more like those of the hybrid. *L. x bella*. The hybrid therefore, may be more common than the literature would indicate (Barnes 1974, Wyman 1977), and accurate field identification may be similarly problematic.

The two parent species of *L. x bella*, however, are dissimilar. *L. morrowii* has leaves that are elliptic to oblong gray-green, soft-pubescent beneath, and are 3-6 cm long. Its flowers are pubescent, white fading to yellow, 1.5-2 cm long, on densely hairy peduncles 5-15 mm long. The fruits are red. The height ranges to 2 m (Gleason and Cronquist 1991, Rehder 1940, Wyman 1977). *L. tatarica* has leaves that are ovate to oblong, glabrous, and are 3-6 cm long. Its flowers are glabrous, white to pink, 1.5-2 cm long, on peduncles 15-25 mm long. The fruits are red or rarely yellow. Height ranges to 3 m (Gleason and Cronquist 1991).

L. x bella has intermediate characteristics. The leaves are slightly hairy beneath. Flowers are pink fading to yellow, on sparsely hairy peduncles 5-15 mm. long. Fruits are red or rarely yellow. Height ranges to 6 m (Gleason and Cronquist 1991).

STEWARDSHIP SUMMARY

The exotic bush honeysuckles are increasingly common throughout much of the eastern and mid-western United States and south-central Canada where they have contributed to reduced richness and cover of native herb communities and to reduced tree regeneration in early to mid-successional forests. Although disturbance of some kind usually precedes invasion, the exotic bush honeysuckles are adapted to a wide variety of habitats. Reproduction is almost entirely by seed. Seed production and short-term seed viability

are consistently high, and seeds are readily dispersed by birds and, perhaps, small mammals. The group is relatively free of known significant diseases and insect or other predators. Mechanical controls include grubbing or pulling seedlings and mature shrubs, and repeated clipping of shrubs. Effective mechanical management requires a commitment to repeated treatments for a period of three to five years. Winter clipping should be avoided as it encourages vigorous re-sprouting. Repeated annual prescribed burns during the growing season will top-kill shrubs and inhibit new shoot production. Because exotic bush honeysuckles readily resprout, it may be necessary to re-burn every year or every other year for several years. Most managers report that treatment with herbicides is necessary to control the exotic bush honeysuckles. Water-soluble formulations of glyphosate (brand names Roundup, and for use near waterbodies, Rodeo), a non-selective herbicide, and formulations of triclopyr (brand names Garlon, Pathfinder, and others), a selective herbicide for broad-leaved plants, have been used as foliar sprays or cut stump sprays and paints with varying degrees of success. Both glyphosate and triclopyr should be applied to the foliage late in the growing season, and to cut-stumps from late summer through the dormant season. The flush of seedlings that sometimes follows herbicide treatments must also be controlled.

RANGE

L. maackii is native to central and northeastern China, Manchuria, Korea and, less commonly, Japan. It was introduced to Europe beginning in 1887 and to North America at the Dominion Arboretum in Ottawa, Canada in 1896 and the New York Botanical Garden in 1898 (Luken and Thieret 1995). It is now naturalized in twenty-four states of the eastern and central United States and in Ontario, Canada (Trisel and Gorchoff 1994). Reported occurrences of *L. maackii* in North America include: Arkansas, Delaware, District of Columbia, Georgia, Illinois, Indiana, Kansas, Kentucky, Maryland, Massachusetts, Michigan, Mississippi, Missouri, New Jersey, North Dakota, Ohio, Ontario, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

L. morrowii is native to Japan and was introduced to North America circa 1875 (Rehder 1940). It is now common in southeastern and south-central Canada, and in most northeastern and mid-Atlantic states and in some midwestern states. Reported occurrences of *L. morrowii* in North America include: Arkansas, Colorado, Connecticut, District of Columbia, Illinois, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Brunswick, New Hampshire, New Jersey, New York, North Carolina, Ohio, Ontario, Pennsylvania, Quebec, Rhode Island, Saskatchewan, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming.

L. tatarica is native to western and central Russia (Barnes 1974) and was introduced to the United States as early as 1752 (Rehder 1940). It is common in southeastern and south-central Canada, and in most northeastern and mid-Atlantic states and in some midwestern and western states. Reported occurrences of *L. tatarica* in North America include: Alberta, California, Colorado, Connecticut, Delaware, District of Columbia, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Manitoba, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nebraska, New Brunswick, New Hampshire, New Jersey, New York, North Dakota, Nova Scotia, Ohio, Ontario, Pennsylvania, Quebec, Rhode Island, Saskatchewan, South Dakota, Utah, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming.

L. tatarica and *L. morrowii* hybridize to form *L. x bella*, which is widely naturalized from Alberta, Canada, east to Maine, south to northern North Carolina, west to Missouri, and north through Kansas, eastern Nebraska, and the Dakotas (Barnes 1974). Reported occurrences of *L. x bella* in North America include: Connecticut, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Brunswick, New Hampshire, New Jersey, New York, North Carolina, Ohio, Ontario, Pennsylvania, Quebec, Rhode Island, Saskatchewan, South Carolina, Vermont, Virginia, Wisconsin, and Wyoming.

HABITAT

In its native habitat, *L. maackii* is found in mixed forests in association with oaks, elms and other hardwoods, and with softwoods such as fir, spruce, and hemlock; in floodplain forests; and in scrub communities. It is often found in calcareous soil (Luken and Thieret 1995; Luken et al. 1995a). In Japan, *L. morrowii* is often associated with mesic sites and acidic soils (Barnes 1974). In Eurasia, *L. tatarica* occurs in dry, relatively cool semi-desert locations (Barnes 1974). The group as a whole favors disturbed sites and forest edges or openings (Barnes 1974; Luken et al. 1995b), but in a New England study of the *L. tatarica*-*L. morrowii*-*L. x bella* group, it also invaded the interior of intact forests (Woods 1993).

In North America, *L. maackii* is often found in urban forests or in forests with histories of fragmentation, grazing, or woodcutting (Luken and Thieret 1995), and in semi-shaded fencerows, weedy thickets, and brushy groves (Cochrane 1995). It is especially aggressive on calcareous soils (Cochrane 1995; Luken and Goessling 1995). In North America, *L. morrowii*, *L. tatarica*, and their hybrid *L. x bella* occupy a wide range of sites. They are most often found on forest edges and in forest interiors but are also found in lacustrine (lakeside) and riparian habitats and in a variety of waste places such as abandoned agricultural land and road and railroad rights-of-way (Barnes 1974; Woods 1993). They grow in soils ranging from poorly to well drained and non-calcareous to limey and tolerate low nutrient availability (Barnes 1974; Woods 1993). A 1998 survey of The Nature Conservancy's land managers documented *L. maackii* and/or *L. tatarica* in a number of habitats and communities, including mesic woodlands, old-growth northern hardwood forests, oak woodlands, floodplain forests, maritime forests, shale barrens, shrub fens, maritime shrublands, dry prairie, grasslands, and serpentine grasslands (Randall and Meyers-Rice, unpublished).

BIOLOGY AND ECOLOGY

Flowering and Fruiting

Reproduction of the bush honeysuckles is almost entirely by seed (Converse 1985), although greenwood and hardwood cuttings have been used extensively in their commercial propagation (Wyman 1977). *L. maackii* and *L. tatarica* (and perhaps the others as well) consistently produce abundant annual seed crops (Schopmeyer 1974). *L. maackii* may first fruit when as young as three to five years (Luken and Thieret 1995). *L. maackii* seeds ripen September through November; *L. morrowii* and *L. tatarica* seeds, June through August (Schopmeyer 1974).

Seed Germination

Horticultural recommendations for germination of bush honeysuckle seeds call for a three-month stratification at 40° degrees F. (Wyman 1977), but in a greenhouse experiment, *L. maackii* seeds collected in November began to germinate in just 18 days and continued to germinate three months from planting. Light promoted but was not necessary for germination; germination rates at the end of 88 days ranged from 50% in dark to 80% in light (Luken and Goessling 1995).

Seed Dispersal

Seeds of bush honeysuckles are dispersed by birds and perhaps by small mammals. *L. tatarica* and *L. maackii* fruits, which persist on the plants into the middle of the winter, are often consumed by a variety of birds (Ingold 1983; White 1992). Bird dispersal contributes to germination success by increasing the likelihood that seed will be dropped in lighted tree fall gaps and other openings rather than in shaded settings (Hoppes 1988). Bird dispersal also increases germination success where allelopathy is present, as has been suggested for some *Lonicera* species (Converse 1985).

Phenology

In a study conducted in three northeastern forest stands, *L. tatarica* was the earliest deciduous plant to leaf-out, with leaf break beginning two weeks earlier than for co-occurring trees. It also retained its leaves longer than any other woody plant (Woods 1993). In Wisconsin, *L. x bella* showed a wide adaptability to

different light regimes (Barnes 1975). Although *L. maackii* (and perhaps the others) are not unusually shade tolerant (Luken et. al. 1995b), their unusually long photosynthetic period may help explain their competitiveness. The competitive success of *L. x bella* may also be due in part to hybrid vigor (Barnes 1974).

ECONOMIC USES

Lonicera spp. have been widely used in ornamental plantings. *L. tatarica* has also been used in mine reclamation (Wade 1985).

IMPACTS AND THREATS POSED BY EXOTIC *LONICERA* SPP.

Forest regeneration following disturbance can be severely impeded by these species. The group is widely considered an aggressive, highly successful weedy complex (Barnes 1974; Luken and Thieret 1996; Woods 1993 and others). In a survey of Ohio forests, tree seedling density, tree seedling species richness, and herb cover were all inversely related to *L. maackii* cover, and tree regeneration appeared to have been inhibited (Hutchinson 1997). In a study in New England, the *L. tatarica*-*L. morrowii*-*L. x bella* complex reduced the richness and cover of herb communities and the establishment of new seedlings. Seedlings that predate *L. tatarica* establishment were more tolerant of its presence. Annual herbs were entirely suppressed. (Woods 1993).

The *L. tatarica*-*L. morrowii*-*L. x bella* complex is an aggressive invader of lower elevation forests throughout the northeastern United States (Woods 1993). *L. maackii* becomes a dominant shrub in a large variety of plant communities growing on calcareous soils (Luken and Goessling 1995) and is increasingly common in a variety of disturbed, early to mid-successional forests throughout the eastern and central United States and south-central Canada (Luken and Thieret 1996). In a study conducted in the Oxford, Ohio area, *L. maackii* moved outward from its urban point of origin at a rate of from 0.1 to 0.5 km/year. Agricultural land can act as a barrier to *L. maackii* spread while greater forest cover and connectivity facilitates its extent, presumably due to the relationship between cover type and dispersal by birds (Hutchinson 1998).

Schmidt and Whelan (1999) studied nest predation on American robins (*Turdus migratorius*) and wood thrushes (*Hylocichla mustelina*) for 6 years in a 200 ha woodland fragment near Chicago. They found that robin nests in *Lonicera maackii* and another non-native, invasive shrub, *Rhamnus cathartica*, experienced higher predation rates than nests in similar native shrubs (*Crataegus*, *Viburnum*) and in native trees. Part of this difference was due to nests in *L. maackii* being built closer to the ground. The authors speculate that absence of thorns on the exotics and a branch structure that facilitates movement of predators like raccoons may also help explain the difference. Robin use of *Lonicera* increased sharply during the 6-year study and the authors suggest this may be due to the exotic shrub's early leaf-out. If so, higher predation rates early in the season may also help explain the difference between nest success in exotic and native plants. Predation on wood thrush nests in native and exotic plants was not significantly different. High proportions of thrush nests were in *L. maackii* and as use of *L. maackii* by robins increased, predation rates on thrushes increased. The authors caution that these results are specific to a single site and to the two bird species followed and that it is not known whether they will be applicable to other sites or species. But they note that if higher nest predation rates are found in exotic shrubs elsewhere, restoring native shrubs would serve several conservation goals simultaneously.

The exotic bush honeysuckles may provide an important source of winter food for birds in areas where it is abundant and few other shrubs survive (Whelan and Dilger 1992). In a study of New Jersey frugivores, *L. tatarica* was one of two introduced species used most by birds during the winter sampling period, after high-quality native fruit sources had been exhausted (White 1992). Despite their low fat content and extreme bitterness, *L. maackii* fruits, which persist into the middle of the winter in Ohio, are also consumed by a variety of birds (Ingold 1983). In a study undertaken in southwestern Ohio, deer mice

(*Peromyscus maniculatus*) were found to be the major small mammal consumers of *L. maackii* fruits (Williams et al. 1992).

The bush honeysuckles have been promoted for decades by the U.S. Department of Agriculture and by commercial nurseries for their wildlife, shelterbelt, and ornamental value. Many state and private nurseries still sell them, although less widely than previously (Luken and Thieret 1996). Commercial sources continue to introduce *Lonicera* spp. to areas not already colonized, but most future invasions will originate in naturalized populations of the shrubs. Only cropland and large, closed canopy forests, where bush honeysuckles remain relegated to the edge (Luken and Thieret 1996), will be secure from invasion (Barnes 1974; Hutchinson and Vankat 1998).

MANAGEMENT

Potential for Restoration of Invaded Sites

Lonicera spp. annually produce large numbers of viable seed that are readily dispersed by birds and germinate at high rates in a wide range of conditions. The different species are extremely adaptable and have successfully invaded a wide range of habitats and communities in North America. Manual and mechanical, environmental/cultural, and chemical methods are all useful to varying degrees in controlling *Lonicera* spp. The use of prescribed fire may be effective in some cases where the density of *Lonicera* spp. is low and sufficient fuels are available. Restoration potential is likely to be lowest where *Lonicera* spp. occur in high densities and there is a high likelihood of continued dispersal of seeds into the restoration area. *Lonicera* spp. have a high degree of reproductive vigor, a wide range of adaptability, and few pests and predators in North America. The potential for large-scale restoration of unmanaged natural areas or wildlands infested with *Lonicera* spp. is probably low. Restoration potential for managed natural areas or wildlands infested *Lonicera* spp. is probably moderate. If attacked during the early stages of colonization, the potential for successful management is high.

Biological Controls

There are no known biological controls of *Lonicera* spp. The aphid *Hyadaphis tataricae* (Aizenberg) is an obligate feeder on the tips and shoots of *L. tatarica* and perhaps *L. morrowii* and *L. x bella*. The resulting "witches brooming" may somewhat reduce flowering (Voetglin and Stoetzel 1988) and therefore fruiting. *Hyadaphis* is present throughout the northern U.S. and southern Canada, as are a number of native ladybug beetles that prey on it. (Nyboer 1992).

Mechanical Control

Mechanical controls include grubbing or pulling seedlings and mature shrubs, and repeated clipping of shrubs. Effective mechanical management requires a commitment to cut or pull plants at least once a year for a period of three to five years (Virginia Natural Heritage Program, no date). Grubbing or pulling by hand (using a Weed Wrench or a similar tool) is appropriate for small populations or where herbicides cannot be used. Any portions of the root system not removed can resprout (Tennessee Exotic Pest Plant Council 1997). Because open soil can support rapid re-invasion, managers must monitor their efforts at least once per year and repeat control measures as needed (Nyboer 1992). Mature *L. maackii* shrubs growing in shaded forest settings can be eradicated by clipping once a year, during the growing season, until control is achieved (Luken and Mattimiro 1991). Other bush honeysuckles growing in more open settings can be managed by clipping twice yearly, once in early spring and again in late summer or early autumn. Winter clipping should be avoided as it encourages vigorous re-sprouting (Virginia Natural Heritage Program, no date). Mature honeysuckle wood is tough and easily dulls power-tool blades (Nyboer 1992).

Prescribed Burning

Repeated annual prescribed burns during the growing season will top-kill shrubs and inhibit new shoot production. Because exotic bush honeysuckles readily resprout, it may be necessary to re-burn every year or every other year for several years to achieve good control (Nyboer 1992).

Herbicides

Most managers report that treatment with herbicides is necessary for the control of *L. maackii* populations growing in full sun and may be necessary for all large bush honeysuckle populations. Formulations of glyphosate (brand names Roundup, and for use near waterbodies, Rodeo) and formulations of triclopyr (brand names Garlon, Pathfinder, and others), have been used as foliar sprays or cut stump sprays and paints with varying degrees of success (Nyboer 1992). Glyphosate is a non-selective herbicide which kills both grasses and broad-leaved plants while triclopyr is a selective herbicide that kills broad-leaved plants but does little or no harm to grasses. A survey of The Nature Conservancy land managers undertaken in 1998 found that most used glyphosate, and used it as a cut stump treatment, to control *L. maackii* and/or *L. tatarica* (Randall and Meyers-Rice, unpublished). For cut stump treatments, 20-25% solutions of glyphosate or triclopyr can be applied to the outer ring (phloem) of the cut stem. 2% solutions of glyphosate or triclopyr can be used for foliar treatments. Both glyphosate and triclopyr should be applied to the foliage late in the growing season, and to the cut stumps from late summer through the dormant season (Tennessee Exotic Pest Plant Council, 1997; Virginia Natural Heritage Program, no date). The subsequent flush of seedlings following all herbicide treatments must also be controlled (Luken and Mattimiro 1991).

EXAMPLES OF *LONICERA* SPP. CONTROL ON TNC PRESERVES

Exotic bush honeysuckles have been reported from TNC preserves in Kentucky, Indiana, Wisconsin, Vermont, Maryland, Massachusetts, Minnesota, Ohio, and in New York. Garth Fuller reported that prescribed fires are useful in controlling *Lonicera* spp. in Minnesota, but only if the fires are hot and repeated at regular intervals. Steve Richter of Wisconsin similarly reported that fire is useful in controlling the growth of small seedlings.

All preserves reported that pulling is effective for smaller plants, but is labor intensive. Cutting the shrubs was also effective, especially if the herbicide glyphosate (tradename RoundUp and others) is applied to the cut-stump immediately after cutting. Margaret Shea of the Kentucky preserves and Ross Lebold of Ohio reported positive results using the cut-stump method. David Banks of Indiana, however, reported that results from cutting were poor without an herbicide application. Garth Fuller (of Minnesota) added that the cut-stump technique using glyphosate or triclopyr (tradename Garlon and others) was effective if applied in fall, but not effective if applied in spring.

CONTACTS

David Banks and Jeffrey Maddox
The Nature Conservancy
Indiana Field Office
1330 West 38th St.
Indianapolis, IN 46208
(317) 923-7547
davbamls@aol.com

Garth Fuller
328 Central Avenue
Faribault, MN 55021
(507) 332-0525
gfuller@tnc.org

Donnelle Keech or Doug Samson

The Nature Conservancy
Maryland Field Office
Chevy Chase Metro
(301) 656-8673
dkeech@tnc.org

Ross Lebold
The Nature Conservancy
6375 Riverside Dr. Ste. 50
Dublin, OH 43017
(614) 717-2770
rlebold@tnc.org

Randy Nyboer
Division of Natural Heritage
Illinois Department of Conservation
2612 Locust St.
Sterling, IL 61081
815 625-2968

Rose Paul
The Nature Conservancy
Vermont Field Office
27 State St.
Montpelier, VT 05602-2934
(802) 229-4425
rpaul@tnc.org

Steve Richter
633 W. Main St.
Madison, WI 53703
(608) 251-8140
srichter@tnc.org

Kay Sadighi
The Nature Conservancy
Berkshire Program Office
404 LeGeyt Rd.
P.O. Box 268
Sheffield, MA 01257
(413) 229-0232
KayTrees@aol.com

Margaret Shea
The Nature Conservancy
Kentucky Field Office
642 West Main St.
Lexington, KY 40508
(606) 259-9655
margaret@mis.net

Tennessee Exotic Plant Pest Council
c/o Friends of Warner Parks
50 Vaughn Road
Nashville, TN 37221

Virginia Native Plant Society
PO Box 844
Annandale, VA 22003

Virginia Department of Conservation and Recreation
Division of Natural Heritage
1500 East Main St., Suite 312
Richmond, VA 23219

MONITORING

Control efforts must be repeated and monitored for three to five years following the initial treatment (Virginia Natural Heritage Program, no date). In natural areas management, monitoring programs will likely combine assessing changes in abundance of exotic bush honeysuckles with changes in abundance of species or changes in community attributes that are the targets of management. Such programs should be designed to meet certain minimum confidence levels (for example, a 90% confidence level that changes of 20% and more will be accurately captured). And such programs should have explicit objectives that can be measured and that are meaningful from both a biological and management standpoint. These objectives may vary depending on the abundance of exotic bush honeysuckles and other invasives. For instance, in a forest that currently has 40% cover of exotic bush honeysuckles an appropriate management objective might be to reduce honeysuckle cover to 20%; In a forest that currently has just 10% honeysuckle cover, an appropriate management objective might be to prevent honeysuckle cover from increasing by more than 10% (total honeysuckle cover 20%). In addition, increasing the regeneration and abundance of native species may be an important objective. Monitoring the status of other conservation targets, such as invertebrates dependent on specific nectar sources, may be more important than tracking invasive plant species abundance. In general, the objectives of monitoring should track those of management.

In terms of effort (number of plots established and monitored), transects or long, linear plots are generally more effective in providing sufficient statistical power to determine change than square or broadly rectangular or otherwise regularly shaped quadrats. Analyses of plant species composition and abundance can be simplified by (1) collecting data on abundance of dominant species; (2) collecting data on all species and pooling data on less abundant species; and (3) pooling data on species by placing them in guilds (invasive grasses, invasive legumes, native grasses, etc.).

While generally a research technique, measuring change, or lack thereof, in control (unmanaged) areas can be an effective way of assuring that changes seen in treated areas are actually the result of management actions and not due to other factors. In forest communities that are in early successional stages or recently disturbed, declines in abundance of the exotic bush honeysuckles may occur over time without management.

RESEARCH NEEDS

Among the research topics suggested in the literature are: 1) What are the mechanisms of exotic honeysuckle invasion and spread in a variety of fragmented forest landscapes? (Brothers 1992); 2) What is the light environment of disturbed forests and bush honeysuckle's corresponding tolerance limits for critical life history events? (Luken et al. 1995b); 3) What can comparisons between invasives and native congeners (or other less prolific non-native congeners) tell us about those traits that are most likely responsible for successful invasion and establishment versus those that are merely coincident with them? (Schierenbeck et al. 1994); and 4) What are the effects of bush honeysuckle invasions on herb layer species? (Hutchinson and Vankat 1997).

White tailed deer are a major influence on the composition of forest communities in the midwest and northeast . No information exists on the relationship between high deer populations and the abundance of the exotic bush honeysuckles. To what extent selective browsing by deer is important to the abundance of the exotic bush honeysuckle as a forest invader, is an important area of research.

Other research questions might include: 1) Which if any biocontrols are effective in the native ranges of the taxa?; 2) What role do logging and other forestry practices play in the successful spread of these taxa?; 3) How could forestry operations be carried out to prevent invasion by exotic bush honeysuckles?; 4) Which species replace honeysuckle when control succeeds?; 5) What is the effectiveness of prescribed burning on reducing or eliminating these species and encouraging regeneration of native species in forest types that are fire influenced?; and 6) What are the latitudinal limits of the species? Have they been reached in North America?

Work is also needed on more efficient control methods, especially where cutting is used. Standard tools such as weed whackers, brush hogs and other equipment are not designed for cutting this species or the kinds of habitat where work is needed.

REFERENCES

- Barnes, W.J. and G. Cottam. 1974. Some autecological studies of the *Lonicera x bella* complex. Ecology. 55(Winter): 40-50.
- Brothers, T.S. and A. Spingarn. 1992. Forest fragmentation and alien plant invasion of central Indiana old-growth forests. Conservation Biology. 6(1): 91-100.
- Cochrane, T.S. 1995. *Lonicera maackii* (Caprifoliaceae) naturalized in Wisconsin. The Michigan Botanist. 34: 79-82.
- Converse, C.K. 1985. Element Stewardship Abstract for *Lonicera tatarica*, *L. morrowii*, and *L. x bella*. The Nature Conservancy. Unpublished document.
- Gleason, H.A. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. 2nd edition. The New York Botanical Garden. Bronx, NY. 910 p.
- Hoppes, W.G. 1988. Seedfall pattern of several species of bird-dispersed plants in an Illinois woodland. Ecology. 69(2): 320-329.
- Hutchinson, T.F. 1998. Landscape structure and spread of the exotic shrub *Lonicera maackii* (Amur honeysuckle) in southwestern Ohio forest. The American Midland Naturalist. 139(2): 383-391.
- Hutchinson, T.F. and J.L. Vankat. 1997. Invasibility and effects of Amur honeysuckle in southwestern Ohio forests. Conservation Biology. 11(5): 1117-1124.
- Ingold, J.L. and M.J. Craycraft. 1983. Avian frugivory on honeysuckle (*Lonicera*) in southwestern Ohio in fall. Ohio Journal of Science. 83(5): 256-258.
- Kline, V. 1981. Control of honeysuckle and buckthorn in oak forests (Wisconsin). Restoration and Management Notes. 1(1): 18.
- Luken, J.O. 1988. Population structure and biomass allocation of the naturalized shrub *Lonicera maackii* (Rupr.) Maxim. in forest and open habitats. American Midland Naturalist. 119(2): 258-267.
- Luken, J.O. and N. Goessling. 1995. Seedling distribution and potential persistence of the exotic shrub *Lonicera maackii* in fragmented forests. American Midland Naturalist. 133(1): 124-130.
- Luken, J.O., L.M. Kuddes, T.C. Tholemeier and D.M. Haller. 1997. Comparative responses of *Lonicera maackii* (Amur honeysuckle) and *Lindera benzoin* (Spicebush) to increased light. American Midland Naturalist. 138 (2): 331-343.
- Luken, J.O. and D.T. Mattimiro. 1991. Habitat-specific resilience of the invasive shrub Amur honeysuckle (*Lonicera maackii*) during repeated clipping. Ecological Applications. 1(1): 104-109.
- Luken, J.O. and J.W. Thieret. 1995. Amur honeysuckle (*Lonicera maackii*; Caprifoliaceae): its ascent, decline, and fall. Sida. 16(3): 479-503.
- Luken, J.O. and J.W. Thieret. 1996. Amur honeysuckle, its fall from grace. BioScience. 46(1): 18-24.
- Luken, J.O., T.C. Tholemeier, L.M. Kuddes, and B.A. Kunkel. 1995a. Performance, plasticity, and acclimation of the non-indigenous shrub *Lonicera maackii* (Caprifoliaceae) in contrasting light environments. Canadian Journal of Botany. 73: 1953-1961.

- Luken, J.O., T.C. Tholemeier, B.A. Kunkel and L.M. Kuddes. 1995b. Branch architecture plasticity of Amur honeysuckle (*Lonicera maackii* (Rupr.) Herder): Initial response in extreme light environments. *Bulletin of the Torrey Botanical Club*. 122 (3): 190-195.
- Matlack, G.R. 1994. Plant species migration in a mixed-history forest landscape in eastern North America. *Ecology*. 75(5). 1491-1502.
- McClain, W.E. and E.A. Anderson. 1990. Loss of hill prairie through woody plant invasion at Pere Marquette State Park, Jersey County, Illinois. *Natural Areas Journal*. 10(2): 69-75.
- Nyboer, R. Vegetation Management Guideline: Bush Honeysuckles – Tatarian, Morrow's, Belle, and Amur Honeysuckle (*Lonicera tatarica* L., *L. morrowii* Gray, *L. x bella* Zabel, and *L. maackii* [Rupr.] Maxim.). *Natural Areas Journal* 12 (4): 218-219.
- Pringle, J.S. 1973. *Lonicera maackii* (Caprifoliaceae) adventive in Ontario. *Canadian Field-naturalist*. 8: 54-55
- Randall, J.M. and B.A. Meyers-Rice. unpublished. 1998 Weed Survey of The Nature Conservancy's land managers. Documents on file at TNC Wildland Invasive Species Program, Davis, CA.
- Rehder, A. Manual of Cultivated Trees and Shrubs, Second edition. MacMillan Publishing Company, New York. 1940. 996 p.
- Ruesink, A. 1998. Links between land use and *Lonicera*: patterns of honeysuckle invasion in a post-agricultural landscape. University of Vermont, Burlington. Master's thesis.
- Schierenbeck, K. A., R. Mack, and R. R. Sharitz. 1994. Herbivore effects on *Lonicera* growth and biomass allocation. *Ecology*. 75(6): 1661-1672.
- Schopmeyer. 1974. Seeds of Woody Plants in the United States. Forest Service, U.S. Department of Agriculture, Washington, D.C. 883 p.
- Schmidt, K.A. and C.J. Whelan. 1999. Effects of exotic *Lonicera* and *Rhamnus* on songbird nest predation. *Conservation Biology*, 13(6): 1502-1506.
- Tennessee Exotic Pest Plant Council and Great Smoky Mountains National Park. 1997. Tennessee Exotic Pest Plant Management Manual. Research Committee, Tennessee Exotic Pest Plant Council: 32-36.
- Todd, R. 1985. Honeysuckle controlled by hand pulling. *Restoration and Management Notes*. 3(1): 41.
- Trisel, D.E. and D.L. Gorchov. 1994. Regional distribution, ecological impact, and leaf phenology of the invasive shrub *Lonicera maackii*. *Bulletin of the Ecological Society of America* (supplement). 75: 231.
- Voegtlin, D. and M.B. Stoetzel. 1988. *Hyadaphis tataricae* (Homoptera: Aphididae): 10 years after its introduction into North American. *Proceeding of the Entomological Society of Washington*. 90(2): 256-257.
- Wade, G.L. 1985. Success of trees and shrubs in an 18-year old planting on mine soil. U.S. Forest Service, Northeastern Forest Experiment Station, Broomall, PA.
- Whelan, C.J. and M.L. Dilger. 1992. Invasive, exotic shrubs: a paradox for natural area managers? *Natural Areas Journal*. 12(2): 109-110.
- White, D.W. and E.W. Stiles. 1992. Bird dispersal of fruits of species introduced into eastern North America. *Canadian Journal of Botany*. 70: 1689-1696.
- Williams, C.E. no date. Virginia Natural Heritage Program Bush Honeysuckles Fact Sheet. Virginia Natural Heritage Program, Richmond, VA.
- Williams, C.E., J.J. Ralley, and D.H. Taylor. 1992. Consumption of seeds of the invasive Amur honeysuckle, *Lonicera maackii* (Rupr.) Maxim., by small mammals. *Natural Areas Journal*. 12(2): 86-89.)
- Woods, K. 1993. Effects of invasion by *Lonicera tatarica* L. on herbs and tree seedlings in four New England forests. *American Midland Naturalist*. 130(1): 62-74.
- Wyman, Donald. 1977. *Wyman's Gardening Encyclopedia*. MacMillan Publishing Co., New York. 1221 p.

AUTHORED BY: Michael S. Batchner and Shelly A. Stiles, Consulting Ecologist and Environmental Planner, 1907 Buskirk-West Hoosick Road, Buskirk, NY 12028, e-mail: mbatchner@netheaven.com.
 Authored: 8/2000.

EDITED BY: Mandy Tu and John M. Randall, The Nature Conservancy, Wildland Invasive Species Program, Dept. of Vegetable Crops & Weed Sciences, University of California, Davis, CA 95616, phone: (530) 754-8891.