Kudzu (Puerarial obata) continues to spread unabated in the South. To assist in kudzu control and containment efforts 15 herbicide treatments were tested in 1981 on a Piedmont site in Alabama using replicated plots, with retreatments applied a year later when needed. After 2 years, treatments that gave comparable control to the standard prescription of Tordon 10K at 50 lb/acre were Tordon 101 at 1 and 2 gal/acre, Banvel 720 at 3 and 4 gal/acre, Spike 80W at 6 and 10 lb/acre, and Spike 20P at 20 and 30 lb/acre. The Tordon and Banvel herbicides are currently registered for forest land site preparation and Spike 80W for fence rows and noncroplands. Spike 20P is an experimental compound. Tordon 101 at 1 gal/acre and Banvel 720 at 3 gal/acre were the most cost-effective compounds when two broadcast applications were made in successive years. Tordon 101 and the Spike herbicides also aided in controlling blackberry (Rubus spp.) and Japanese honeysuckle (Lonicera japonica). Round up and Brushkiller’s 4-41 and 10-51 were ineffective in controlling kudzu.

Multiflora rose was defoliated completely 320 days after spring foliar application of metsulfuron. Metsulfuron and 2,4-D plus dicamba spring foliar applied controlled multiflora rose equally. Metsulfuron applied to soil using a spotgun at 20 mg per m diam of multiflora rose in the spring resulted in 95% control 320 days later in one study but only 50% control in another. Control was less when lower rates of metsulfuron were soil-applied with a spotgun. Tebuthiuron spring soil-applied completely controlled multiflora rose. All spring-applied foliar and soil applications seemed to control multiflora rose better than fall treatments.

In the development of novel strategies for control of invasive plant species,

researchers might first consider plant performance throughout a range of habitats and then

concentrate management activities in habitats where plants are least resilient. We determined

the relative resilience of forest- and open-grown populations of the invasive shrub

*Lonicera maackii* (Caprifoliaceae) growing in northern Kentucky. Resilience was assessed

by imposing a clipping regime (once each year from 1986 to 1989) during which shrub

resprouting abilities were measured. Habitat-specific population regeneration from seeds

in the seed bank was also measured. Forest-grown *L. maackii* shrubs were less resilient

than open-grown shrubs when stressed by repeated clipping, due presumably to exhaustion

of stored reserves in shrub bases. This suggests that forests are secondary habitats for *L.*

*maackii.* However, resprouting potential and seed production in forests appear sufficient

to regenerate populations after most common disturbances. The ability to modify sprouting

patterns while maintaining resprouting ability and some seed production over a wide range

of habitats is an important adaptation of this invasive shrub. Management suggestions for

shrub eradication are provided.

Garlic mustard [Alliaria petiolata (Bieb.) Cavara & Grande] is a naturalized European obligate biennial herb that invades forest communities in the midwestern and northeastern United States and southeastern Canada. Three potential control methods (prescribed fire, 3% v:v glyphosate, cutting) were tested in a densely infested oak forest in northern Illinois. Spring treatment with either glyphosate or mid-intensity fire reduced garlic mustard adult (rosette) density and seedling frequency, while fall treatment creased rosette density only. Low-intensity fire did not affect garlic mustard presence. successful treatments produced cascading effects observable one to two years after treatment. Treating seedlings in spring reduced adult density the following year, and treating adults in either spring or fall resulted in lower seedling frequency two years later. Cutting flowering plants at ground level resulted in 99% mortality and reduced seed production to virtually zero; cutting at 10 cm above ground level produced 71% mortality and reduced total seed production by 98%. Recommended management is to prevent seed production until the seed bank is exhausted by repeated applications of fire, herbicide, cutting on an annual basis until garlic mustard is absent from the site for a minimum of three years.

Field studies were conducted to evaluate the efficacy of selected herbicides to control the noxious weed mile-a-minute (Polygonum perfoliatum L.). The effectiveness of pre- and postemergence applications of the herbicides Oust, Velpar L, Arsenal, AAtrex, Pursuit, and Pursuit Plus and postemergence application of Roundup were evaluated. Preemergence applications of most of the herbicides were more effective in controlling mile-a-minute than postemergence applications. Low preemergent rates of Oust, Velpar L, Arsenal, AAtrex, Pursuit, and Pursuit Plus were highly effective in controlling mile-a-minute; Roundup and Arsenal provided the best postemergence control.

Groundlayer response to prescribed fire was monitored in a central Illinois sand forest between 1990 and 1994. The first of three annual fires resulted in a significant increase in richness and cover of herbaceous species, and a minor decrease in woody cover. Successive fires maintained or slightly increased herb richness and cover, but did not change woody cover. Before burning, the forest understory was dominated by dense shrubs (74- 89% cover) over a sparse herb layer (4-18% cover). After the first fire, herb cover increased over fourfold to 48-57%, and to 65-66% after the second fire. Fire nonsignificantly reduced woody cover by some 20%, primarily due to a reduction in Parthenocissus quinquefolia (Virginia creeper), but did not affect frequency of woody vegetation. Species richness increased over 50% after the first fire, from 6.2-7.0/M2 to 9.8-10.8/M2, due to the increased frequency of herbaceous, and especially annual, species. Most of the postfire increase in herbaceous cover was due to Eupatorium rugosum (white snakeroot), which increased from <5% cover preburn to 23-36% cover after the first fire, and 50-55% cover after the second fire. Following a fire-free year, herbaceous cover decreased slightly but remained >3X higher than preburn levels. The alien biennial Alliaria petiolata was maintained in a reduced condition by repeated fires, but in the absence of fire doubled in cover every 2 yr, from 4.6% in 1990 to 8.6% in 1992 to 17.0% in 1994.

Experimental control of *Alliaria petiolata* was conducted in three sites over two years,

testing three herbicides at various concentrations, and monitoring response of both *A.*

*petiolata* and groundlayer flora. Glyphosate (trade name Roundup) significantly reduced

*A. petiolata* by >93% when applied at 1% and 2%, but not at 0.5%, concentrations.

Glyphosate at all concentrations had little effect on herbaceous species, which were

primarily dormant at the time of application, but at 0.5% concentration significantly

reduced cover of sedges (*Carex jamesii* and *C. laxiflora*) from a pretreatment mean of

13.1% to a post-treatment mean of 2.2%. Bentazon (trade name Basagran) nonsignificantly

reduced *A. petiolata* cover by >90% (compared to a 70% reduction in the

control plots) when applied at 0.56 kg and 1.12 kg AI/ha. Bentazon did not affect cover

of groundlayer species, nor species density. Acifluorfen (trade name Blazer) killed all *A.*

*petiolata*, inhibited *A. petiolata* seedling germination, and significantly reduced cover of

native herbs by >70%, and appeared to have a strong soil residual.

The response of the understory herbaceous flora to fire management was studied in a degraded woodland in northern Illinois. The site contains a rapidly expanding population of Alliaria petiolata, a non-indigenous plant that is highly invasive in forests. Three treatment units (March fire, May fire, and unburned) were sampled in 1991, prior to fire treatments. Following prescribed fire, plots were sampled annually from 1992 to 1994, inclusive, to track the response of the vegetation to the fire treatment. The purpose of the experiment was to assess the impact of fire on (1) A. petiolata populations, (2) the native herbaceous flora, and (3) shrubs and saplings. The initial impact of fire on A. petiolata, understory forbs, shrubs, and saplings was strongly negative in the growing season burn unit and moderate in the dormant season burn unit. After three years, A. petiolata had not recovered to preburn densities in the growing season burn unit. Likewise, densities and richness of native herbaceous species remained below preburn values in the growing season burn unit after three years. Dormant season and growing season burns equally and strongly reduced shrub and sapling densities relative to the control unit.

Rose rosette disease, lethal to multiflora rose and indigenous to North America, has been proposed as a biocontrol agent for multiflora rose, a noxious weed in the central and eastern United States. Studies in experimental plots showed that the disease can be intensified by grafting infected shoots onto plants in established stands (i.e., augmentation). The rate of disease spread in augmented plots was significantly faster compared to epidemics in nonaugmented plots at 5 locations. Augmentation provided effective control 3 to 5 yr after implementation. Risk to ornamental rose seems to be low under conditions of this study. Plots to assess risk of the disease to ornamental roses, located at distances greater than 100 m from augmentation sites, showed no infection during the 3 yr of this study.

We studied the utility of gap formation and soil disturbance as methods to enhance establishment of plant species in the understory of a northern Kentucky forest where Lonicera maackii (Amur honeysuckle) produced dense thickets. In May 1994, gaps (5 m diameter) were cut in the shrub thicket. In adjacent areas, the shrub canopy remained intact. Subplots were established where soil was either turned with a spade to a depth of 15 cm or not disturbed. We monitored plant establishment for three growing seasons (1994, 1995, and 1996). Shrub removal increased light availability to about 10% of full sun. Gap formation had a significant (p < 0.05) and positive influence on total plant density (exclusive of

L. maackii), and soil disturbance did not (p > 0.05). After three growing seasons, the most important species were L. maackii, Alliaria petiolata, Parthenocissus quinquefolia, Vitis vulpina, and Acer negundo. Of these species, only V. vulpine showed significantly (p < 0.05) higher densities in gaps. Other less important species such as Phytolacca americana, Campsis radicans, and Eupatorium rugosum occurred almost exclusively in gaps. Of the 44 taxa observed in this study, most were generalist species that also occur in early successional habitats. Long-term dominance of the understory by L. maackii has likely modified system attributes with corresponding effects on community development. Shrub removal provides a window of establishment for various plant species, but successful restoration may require

further management to augment species availability and to control new invaders.

Rhamnus frangula L. (glossy buckthorn) is an aggressive introduced species that has become a serious problem in wetlands in the upper midwestern States. Three mechanical control methods were tested for effectiveness during the Both cutting and girdling were ineffective as control methods when applied December through March; neither method caused any mortality in these trials. followed by an application of glyphosate herbicide to the cut stump, resulted to 100% kill of buckthorn individuals in four trials during the same December March period.

An assumption of weed science and conservation biology is that small populations are more vulnerable to elimination and extinction than large populations. We tested this with the invasive biennial garlic mustard (*Alliaria petiolata*). We compared 61 experimental populations from which every flowering plant was removed for 4 years, with 56 control populations. Whereas the majority of the control populations continued to expand in size over the 4 years, experimental populations showed a strong experimental effect, remaining stable in size, declining in size, or going extinct. Small populations were far more vulnerable to extinction than large populations: 43% of small experimental populations (initially fewer than 10 individuals) went extinct, but only 7% of large populations (initially more than

50 individuals). However, some small experimental populations persisted, and in a few cases, larger experimental populations continued to expand even though every flowering individual had been removed. These results and a simple population model suggest the importance of buried seeds in allowing this species to persist despite attempts to eradicate it.

Negative effects on native plant populations are often attributed to invasions by exotic plants, but experimental evidence is lacking to support many of these claims. *Lonicera* *maackii,* an exotic shrub with long leaf phenology, has become naturalized throughout the eastern United States. This study investigated the effects of *L. maackii* on demography of *Galium aparine, Impatiens pallida* and *Pilea pumila,* native annual herbs in differing phenological categories. These interactions were examined in two Ohio forest stands. One stand has a history of logging, burning and grazing and a higher *L. maackii* density, whereas the other stand has little anthropogenic disturbance and a lower *L. maackii* density. Three types of experimental plots were established: *L. maackii* removal, *L. maackii* present and, at the

less disturbed stand, *L. maackii* absent. Seedlings of the annuals were transplanted and monitored for 1 y for survival to reproductive age and fecundity. In the more disturbed stand, survival of *Galium aparine* and *Impatiens pallida* and fecundity of all three species were significantly greater in the removal treatment than where *Lonicera* *maackii* was present. In the less disturbed stand there was no treatment effect on survival, but fecundity of all annuals was greater in the removal treatment than where *L. maackii* was present. Also, fecundity of *I. pallida* and *Pilea pumila* was greater where *L. maackii* was absent than where it was present. At both sites fitness (estimated as the product of survival and

fecundity) was highest for each species in the removal treatment and lowest where *L. maackii*

was present. These results demonstrate direct effects of the invasive shrub *Lonicera maackii* on populations of annuals. They suggest that other annuals, particularly those that are shade-intolerant

or photosynthesize only in the early spring, will decline in the presence of shrubs with

early leaf expansion.

We examined vegetation change over time at managed and unmanaged oak woodland sites located in Cook County, Illinois, forest preserves. The managed site (Cap Sauers Holding) was dominated by red and white oak *(Quercus rubra* and *Q. alba)* in 1995, and density was 313 trees ha-'. Historical records indicate that white oak dominated the site and tree density was between 5 and 50 trees ha-'. Management initiated in 1989 included prescribed burning and woody plant removal. Vegetation was surveyed in 1988 and 1995. No significant change in total ground cover or in cover of native or exotic species (plants <1 m tall) was detected in 1995. However, herbaceous species as a percent of the total ground cover increased from 58% in 1988 to 81% in 1995. Woody species decreased from 42% of the total cover in 1988 to only 19% in 1995. Selected taxa—white snakeroot *(Eupatorium rugosum),* enchanter's nightshade *(Circaea lutetiana),* woodland knotweed *(Polygonum virginianum),* and oak species *(Quercus* spp.)—significantly in-creased in cover between the 1988 and 1995 surveys. Exotic shrubs decreased by 3139 stems ha-1, natives decreased by 2635 stems ha-', and the canopy cover of exotic and native shrubs decreased significantly. Tree canopy cover at the managed site did not change significantly between years. In contrast, at the unmanaged site (McClaughry Springs Forest Preserve), total ground cover (plants <1.4 m tall) significantly increased over four years, mostly due to increases in woody vegetation. Density of woody species in all size classes increased, and there was a significant increase in Virginia creeper *(Parthenocissus quinquefolia).* Invasive shrubs substantially increased in the suppressed (stems <1.4 m tall) and intermediate (stems >1.4 m tall but <11 cm dbh) layers. Management at Cap Sauers Holding, while not having a conclusive positive effect on herbaceous species, has substantially reduced the density and cover of invasive and exotic shrubs and maintained tree canopy cover, all of which increased at the unmanaged site. The results of this study indicate that management, in the form of prescribed burns and removal of woody species, achieved some restoration goals at this site.

In hardwood subtropical forests of southern Florida, nonnative vines have been hypothesized ro be

detrimental, as many species form dense "vine blankets" that shroud the forest. To investigate the

effects of nonnative vines in post­ hurricane regeneration, we set up four large (two pairs of 30 X

60 m) study areas in each of three study sites. One of each pair was unmanaged and the other was

managed by removal of nonnative plants, predominantly vines. Within these areas, we sampled

vegetation in 5 X 5 m plots for stems 2 cm DBH (diameter at breast height) or greater and in 2 X

0.5 m plots for stems of all sizes. For five years, at annual censuses, we tagged and measured

stems of vines, trees, shrubs and herbs in these plots. For each 5 X 5 m plot, we estimated percent

coverage by individual vine species, using native and nonnative vines as classes. We investigated

the hypotheses that: (1) plot coverage, occurrence and recruitment of nonnative vines were greater

than that of native vines in unmanaged plots; (2) the management program was effective at reducing

cover by nonnative vines; and (3) reduction of cover by nonnative vines improved recruitment of

seedlings and saplings of native trees, shrubs, and herbs. In unmanaged plots, nonnative vines

recruited more seedlings and had a significantly higher plot-cover index, but not a higher

frequency of occurrence. Management significantly reduced cover by nonnative vines and had a

significant overall positive effect on recruitment of seedlings and saplings of native trees,

shrubs and herbs. Management also affected the seedling community (which included vines, trees,

shrubs, and herbs) in some unanticipated ways, favoring early successional species for a longer

period of time. The vine species with the greatest potential to "strangle" gaps were those that

rapidly formed dense cover, had shade tolerant seedling recruitment, and were animal-dispersed.

This suite of traits was more common in the nonnative vines than in the native vines. Our results

suggest that some vines may alter the spatiotemporal pattern of recruitment sites in a forest ecosystem following a natural disturbance by creating many very shady spots very quickly.

Acer platanoides is an exotic, invasive tree in eastern deciduous forests of North America where past research shows it to thrive in the forest interior and to suppress understory diversity. To test the efficacy of restoration strategies and to probe dynamics of this tree's seedling bank, trees and seedlings of Acer platanoides were removed in 1997 from a mixed maple forest carpeted by an even mix of exotic Acer platanoides and native Acer saccharum seedlings. The treatments were removal of trees (height > 1.5 m) and removal of small seedlings (height < 1.5 m), using a crossed design with a total of 80 permanent plots, all sampled before removals and two years later. After two years, removal of Acer platanoides trees had caused an increase in native Acer saccharum seedling densities over those in control areas and had caused a decrease of new Acer platanoides recruitment. Conversely, removal of Acer platanoides seedlings initiated far more new Acer platanoides than Acer saccharum seedlings. The Acer platanoides seedling bank was partially, but not fully, replenished two years after its removal. Although removal of canopy trees appears effective as a restoration tool, other exotic species (especially Lonicera japonica, Alliaria petiolata, and Robinia pseudoacacia) proliferated where tree removals opened the canopy. Restoring the pre-invasion com- munity will thus require future intervention.

Eight herbicide treatments were applied by low volume basal applications and compared to hand cutting for the removal of *Ailanthus altissima.* Manual cutting of *Ailanthus* stimulated resprouting and increased overall stand density. Chemical control not only removed existing trees but also prevented resprouting. When evaluated 2 years after treatment, optimal control of *Ailanthus* was achieved with a combination of Garlon 4 and Tordon K herbicides. Garlon 4 at 20% v/v alone Garlon 4 combined with Stalker, or

Stalker herbicide alone controlled *Ailanthus* better than hand cutting but were not as effective as treatments containing picloram. Removal of *Ailanthus* resulted in a shift in herbaceous species to native species of the region without reseeding with naturally occurring herbs. Manual control of *Ailanthus* should be avoided in order to prevent proliferation. Herbicide control of *Ailanthus* is the preferred

method of control because it successfully kills the trees and prevents resprouting. Because major *Ailanthus* infestations occur near roadways, access with a backpack sprayer should be achievable.