Natural History along the Natchez Trace Parkway

On-Site Lesson:

Alien Invasion: (code PAIB)

- **Grade Level:** High School
- **Subject Areas:** Biology, Environmental Science
- **Setting:** One period on a trail. One period in classroom.
- **Duration:** Two class periods.
- **Skills:** Observation, explanation, research and evaluate, graphing data, prediction, summarization
- **MS Objectives:** Intro to Bio: 3b,d Bio: 1 3c Environ Sci: 2c,d,e,f, 3 a,b,c
- **Vocabulary:** Invasive, non-native, diversity population, community, competition.

Summary: On a National Scenic Trail students will investigate how privet, a non-native plant species, out-competes and affects native plant species diversity.

Materials Needed: For each group of students: 4 plot markers. A meter stick or meter-long piece of string. Data Collection Sheets 1 and 2, results and conclusion. Appropriate Scenic Trail map available from www.nps.gov/natt or by calling 662-680-4027 or 800-305-7417

Instructional Information

Mississippi Objectives:
Intro to Bio: 3b. Analyze and explain the interactions among organisms for each level of biological organization. 3d. Predict the impact of human activities.
Biology 1: 3c. Examine and evaluate the significance of natural events and human activities on major ecosystems.
Environmental Science: 2c. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. 2d. Develop a logical argument explaining the relationships and changes within an ecosystem. 2e. Explain the causes and effects of changes in population dynamics. 2f. Research and explain how habitat destruction leads to the loss of biodiversity. 3a,b,c: Discuss the impact of human activities on the environment, conservation activities and efforts to maintain and restore ecosystems.

Learning Objective: The student will 1) learn how population dynamics are affected by the introduction of a non-native plant species 2) develop observation skills, 3) use prediction and inference to develop conclusions.

Teacher Set: The students will visit a National Scenic Trail and investigating the impact of non-native privet shrub on the native plant populations on the trail. It is highly recommended that the teacher visit the trail area prior to taking the students to the trail.

Teacher Overview: Invasive non-native plants are spreading across our country. Without the natural checks that exist in their indigenous areas, they often spread and out-compete native plants, reducing diversity and sometimes creating a virtual monoculture. In the southeast, one of the most common invasive and most difficult to control non-native plants is privet. See the attached USDA handout for more information.

What is an invasive plant? According to the Alabama Invasive Plant Council (AIPC) an invasive plant species is one that displays rapid growth and spread, establishes over large areas, and persists. Invasiveness is characterized by robust vegetative growth, high reproductive rate, and longevity. Even some native plants can become invasive under the right conditions.

Student Instruction: The students will need to be able to identify Chinese privet plants. An example from an unprotected area should be brought into the classroom. The USDA brochure should be made available to each student.

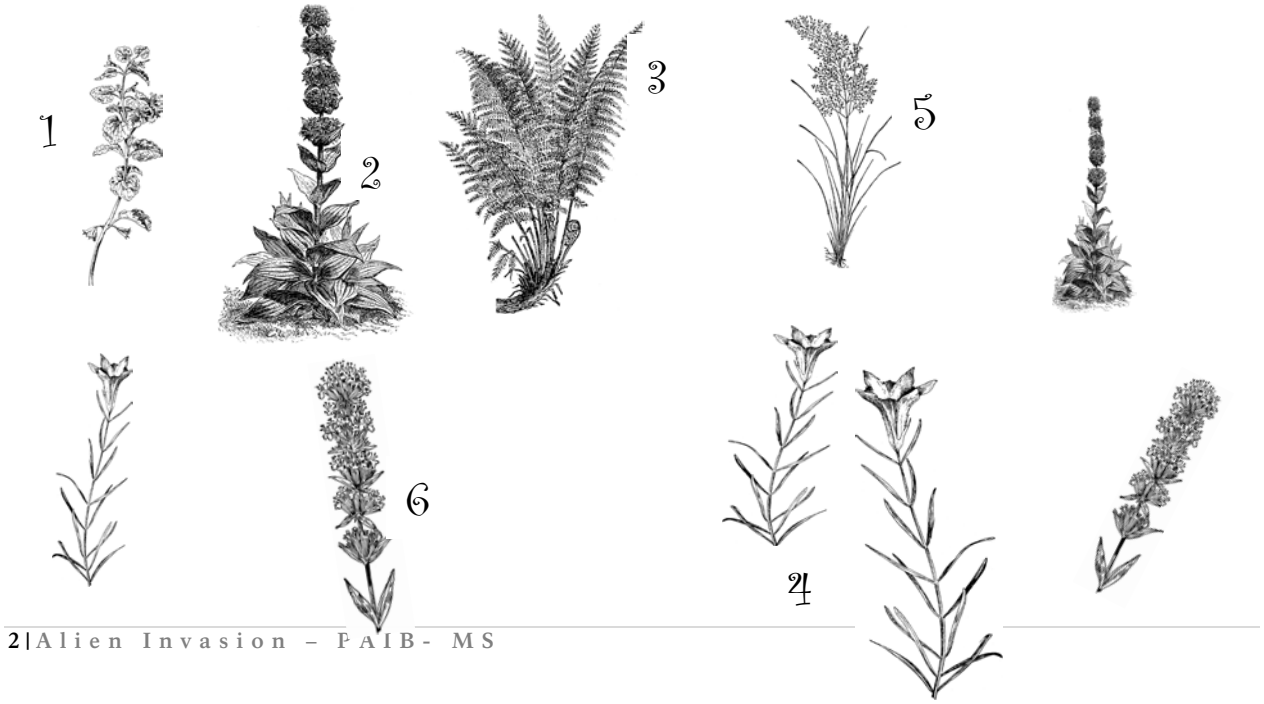
The students will be comparing three plots along a National Scenic Trail. The first plot will be a "no privet plot". The second will be a "privet plot" and the third will be a plot between the privet and no privet plots. They will be counting the number of different plant species within each plot. They may also count the population of each species in each plot but that is not necessary. They need only recognize one plant species by sight, Chinese Privet. If students are good at plant identification, then the plant number in each plot could represent the same plant, but that is not necessary. Another option is to have the students subjectively label the plants, Rare, Common or Abundant. See the example for how they might list plants.

Examples of different ways to count and enter plant data from a plot

Plant Number	How Many
1	1
2	2
3	1
4	3
5	1
6	2

Plant Number	Here?
1	✓
2	✓
3	✓
4	✓
5	✓
6	✓

Plant Number	Abundance
1	R
2	C
3	R
4	A
5	R
6	C



Student Task: See study procedure.

Teacher Closure: Explain to the students that Chinese privet is only one kind of invasive non-native plant. Plants are imported into different areas in many different ways. Modes of introduction may range from seeds stuck on shipping boxes from other continents to seeds stuck to a bumper traveling from Canada to Mexico. In the right (wrong) place, without competition, a non-native species may take over.

The students may be interested in engaging in a class debate about what should be considered non-native and what should be done about non-natives. See the Discussion Stimulator sheet.

Student Assessment: Participation in the activities, accuracy and completion of data sheets and report.

Suggestions for re-teaching: Relate this study to other topics when lessons include subjects such a species distribution, competition and populations.

Extension: The students could research other non-native plants and develop reports or displays. The students might investigate the "Saltcedar Study" in the American Southwest. http://www.usgs.gov/newsroom/article.asp?ID=2451

The Effects of Privet on Diversity in a Plant Community

Hypothesis:_____

_____

Materials: Four plot markers, data collection sheet, pencil, measuring stick

Procedure: On a Scenic Trail Section _____ (trail name) locate an area with a well established growth of privet. You will be able to tell a well established growth by the size of the plants. Find an area with the tallest privet plants. Those will probably be among the oldest plants so therefore the most established. Find the edge of the privet plot to set up the first plot.

Not disturbing any plants, AVOIDING poison ivy and looking CAREFULLY where you put your feet and hands, put one marker in the ground within the privet growth. Using that marker as one corner, measure a one meter square, marking the corners with the other plot markers. Try to not include the entire trunks of trees. Plants overhanging the plot may be included as being in the plot.

Look carefully to differentiate between different types of plants. Write the number of DIFFERENT types of plants in the correct place on the data table. Estimate the number of each type of plant and enter that data in the correct column. You may not need to use all of the blocks provided.

For plot 2, you may move all markers or you may move only two plot markers to make another one meter square still using one side of the original square. Move the markers to stay within the privet growth. If they cannot safely move the markers, they may just "eyeball" the plot. Enter the number of species in this plot.

Next locate closest area with similar habitat but with roughly no more than half of the plants being privet. Set up the plots in the same manner as in the privet plots, entering data on Middle Plot spaces on the collection sheet each time.

Third, find a similar habitat with no privet and repeat the procedure entering data in the No Privet columns.

Chinese Privet
Ligustrum sinense

Leaves are opposite and usually less than 1" long. Stem is woody. Shrub can grow about 30' tall.

Data Collection Sheet Plot 1 Alien Invasion

Privet Plot		Middle Plot		No Privet Plot	
Plant Number	How Many?	Plant Number	How Many?	Plant Number	How Many?
Privet		Privet		Privet	0
1.		1.		1.	
2.		2.		2.	
3.		3.		3.	
4.		4.		4.	
5.		5.		5.	
6.		6.		6.	
7.		7.		7.	
8.		8.		8.	
9.		9.		9.	
10.		10.		10.	
11.		11.		11.	
12.		12.		12.	
13.		13.		13.	
14.		14.		14.	

Data Collection Sheet Plot 1

Privet Plot		Middle Plot		No Privet Plot	
Plant Number	How Many?	Plant Number	How Many?	Plant Number	How Many?
15.		15.		15.	
16.		16.		16.	
17.		17.		17.	
18.		18.		18.	
19.		19.		19.	
20.		20.		20.	
21.		21.		21.	
22.		22.		22.	
23.		23.		23.	
24.		24.		24.	
25.		25.		25.	
26.		26.		26.	
27.		27.		27.	
28.		28.		28.	
29.		29.		29.	

Data Collection Sheet Plot 2 Alien Invasion

Privet Plot		Middle Plot		No Privet Plot	
Plant Number	How Many?	Plant Number	How Many?	Plant Number	How Many?
Privet		Privet		Privet	0
1.		1.		1.	
2.		2.		2.	
3.		3.		3.	
4.		4.		4.	
5.		5.		5.	
6.		6.		6.	
7.		7.		7.	
8.		8.		8.	
9.		9.		9.	
10.		10.		10.	
11.		11.		11.	
12.		12.		12.	
13.		13.		13.	
14.		14.		14.	

Data Collection Sheet Plot 2

Privet Plot		Middle Plot		No Privet Plot	
Plant Number	How Many?	Plant Number	How Many?	Plant Number	How Many?
15.		15.		15.	
16.		16.		16.	
17.		17.		17.	
18.		18.		18.	
19.		19.		19.	
20.		20.		20.	
21.		21.		21.	
22.		22.		22.	
23.		23.		23.	
24.		24.		24.	
25.		25.		25.	
26.		26.		26.	
27.		27.		27.	
28.		28.		28.	
29.		29.		29.	

Data Collection Sheet Plot 3 Alien Invasion

Privet Plot		Middle Plot		No Privet Plot	
Plant Number	How Many?	Plant Number	How Many?	Plant Number	How Many?
Privet		Privet		Privet	0
1.		1.		1.	
2.		2.		2.	
3.		3.		3.	
4.		4.		4.	
5.		5.		5.	
6.		6.		6.	
7.		7.		7.	
8.		8.		8.	
9.		9.		9.	
10.		10.		10.	
11.		11.		11.	
12.		12.		12.	
13.		13.		13.	
14.		14.		14.	

Data Collection Sheet Plot 3

Privet Plot		Middle Plot		No Privet Plot	
Plant Number	How Many?	Plant Number	How Many?	Plant Number	How Many?
15.		15.		15.	
16.		16.		16.	
17.		17.		17.	
18.		18.		18.	
19.		19.		19.	
20.		20.		20.	
21.		21.		21.	
22.		22.		22.	
23.		23.		23.	
24.		24.		24.	
25.		25.		25.	
26.		26.		26.	
27.		27.		27.	
28.		28.		28.	
29.		29.		29.	

Name_____

Results:

Group Number	Number of Species in Privet Plot 1	Number of Species in Middle Plot 1	Number of Species in Non-Privet Plot 1

Group Number	Total Number of Plants in Privet Plot 1	Total Number of Plants in Middle Plot 1	Total Number of Plants in Non-Privet Plot 1

Group Number	Number of Species in Privet Plot 2	Number of Species in Middle Plot 2	Number of Species in Non-Privet Plot 2

Group Number	Total Number of Plants in Privet Plot 2	Total Number of Plants in Middle Plot 2	Total Number of Plants in Non-Privet Plot 2

On a sheet of graph paper, or using computer software, make a graph that represents the different amounts of species for each plot. Compare your group's results with the rest of the class.

Conclusion: Answer the following question.

1. **What happen to the diversity of the community when privet was present?**

2. **Why do you think the privet out-competes native plants?**

3. **Do you think the native community will change permanently? Why or why not?**

   Do you think there are any inherent problems with having non-native invasive plants growing on a National Scenic Trail? Why or why not?

4. **How much responsibility do you think ordinary citizens of this country should take in dealing with non-native invasive plants or animals?**

Discussion Stimulators… answers are not necessarily right or wrong.

1. **If an animal carries a seed from one place to another it is considered expansion of the plant or natural transportation. If people carry seeds from one continent to another, we consider the resulting plants as non-native. What do you think about these designations?**
   Consider:
   a. **Transportation of imports and exports**
   b. **Agricultural materials**
   c. **Vehicles**
2. **Is it a good idea to use non-natives (plants/insects) to combat "problem" species? (Like fighting fire with fire?**
   a. **What dangers might this pose?**
   b. **What benefits?**
3. **If you are landscaping your property, is it a good thing to use only native plants even though they may not be as pretty as non-native plants?**
4. **How damaging can a non-native species be to the environment?**
   a. **Could it actually change the habitat?**
   b. **Could any changes be good?**
5. **Counting the Cost:**
   Consider:
   a. **Is it worth it to try to get rid of a non-native invasive?**
   b. **Labor/Supplies? How much is "worth it?"**
   c. **Lost recreational value?**
   d. **Effects on other species, plant and animal.**
   e. **Other costs?**
      i. **Emotional**
      ii. **Educational loss**
6. **Assuming the same capacity for "carrying", would a non-native plant have a better chance at establishing itself in a new area if it was moved by a migrating arctic bird or a migrating human traveling east and west? Why? What geographical features need to be considered?**
7. **Which species of plants or animals have the best chances of establishing themselves worldwide? Specialist plants like cactus/ tropical vines or polar bears/orangutans OR species that can survive in a wide variety of habitats like armadillos or Chinese privet?**
8. **Brain storm all of the different ways plants and/or animals can be transported long distances.**

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Guide

CHINESE PRIVET

Ligustrum sinense Lour.

Plant Symbol = LISI

Contributed by: USDA NRCS National Plant Data Center & Louisiana State University-Plant Science; partial funding from the US Geological Survey and the US National Biological Information Infrastructure

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USDA, NRCS, NPDC

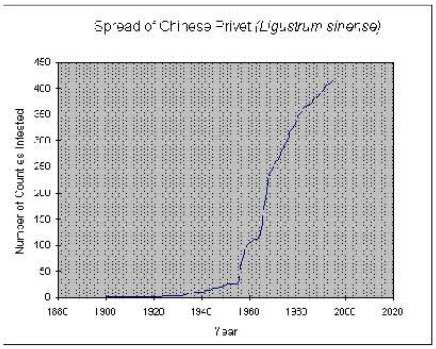
Uses

Weed (**very invasive in the southern US**), ornamental

Noxiousness

Chinese privet was introduced into the United States from China for ornamental planting. Having escaped from cultivation, it is now naturalized throughout the southeastern United States. The greatest threat posed by this species is large-scale ecosystem modification due to its ability to successfully compete with and displace native vegetation. Chinese privet plants mature rapidly and are prolific seed producers. They also reproduce vegetatively by means of root suckers. Once established, Chinese privet is difficult to eradicate because of its reproductive capacity.

Impact/Vectors: *Ligustrum sinense* is native to China and was introduced into the United States in 1852 for use as an ornamental shrub. It is used for hedge and mass plantings, and sometimes as single specimens for its foliage and its profusion of small white flowers (Dirr 1990; Wyman 1973). It continues to be widely sold in the nursery and gardening industry. The foliage of Chinese privet is also used, presumably, for cut-flower arrangements. This horticultural introduction has been cultivated for a relatively long time in the United States. Wyman (1973) reports that this species is still growing as a hedge on the old Berkman's Nursery grounds in Augusta, Georgia, where it was planted in the early 1860's. It was planted on the Chickamauga and Chattanooga National Military Park after it came under the control of the Secretary of War in 1890. Present day plants are descendants of those early plantings (Faulkner et al. 1989). According to Small (1933), the species was escaping from cultivation in southern Louisiana by the 1930's. A survey of appropriate herbaria reveals collection records from Georgia as early as 1900. Based on herbarium records the species has become naturalized and widespread in the southeast and eastern U.S. during the 1950's, 60's, and 70's. Taylor et al. (1996) notes the rapid, recent spread of *Ligustrum sinense* in Oklahoma.



Plant Materials <http://plant-materials.nrcs.usda.gov/>
Plant Fact Sheet/Guide Coordination Page <http://plant-materials.nrcs.usda.gov/intranet/pfs.html>
National Plant Data Center <http://npdc.usda.gov>

The species is a major threat to natural landscapes. An example of Chinese privet's ability to push a native species closer to extinction is noted in the recovery plan for Schweintz's sunflower (*Helianthus schweinitzii*). This endangered species is known from about 16 populations on the piedmont of the Carolinas. Residential and commercial development and the invasion of aggressive exotics, such as *Ligustrum sinense*, represent the greatest threats for this species (U.S. Fish and Wildlife Service 1992). Similar observations about the competitive characteristics of Chinese privet have been noted in various Nature Conservancy reports in the Southeast. Removal of Chinese privet from natural areas is problematic and essential for their restoration (News from Volunteers of the Nature Conservancy, North Carolina Chapter and the Louisiana Chapter, pers. comm. 1997).

In addition to the privet's impact on natural landscapes, it can be directly harmful to humans. All introduced species of *Ligustrum* produce fruit toxic to humans that cause such symptoms as nausea, headache, abdominal pain, vomiting, diarrhea, weakness, and low blood pressure and body temperature. Where Chinese privet occurs in abundance, floral odors may cause respiratory irritation (Westbrooks & Preacher 1986). Chinese privet is sold in nurseries and is often included on recommended planting lists or other literature produced by cooperative extension services without mention of its invasive nature. Named cultivar selections have been developed (Bailey and Bailey 1976).

Chinese privet grows in a wide variety of habitats and can tolerate a wide range of soil and light conditions, but it grows best in mesic soils and abundant sunlight but can tolerate lower light conditions (Thomas 1980; Bailey & Bailey 1976). Few woody plants offer an easier test of gardeners' skills.

© L. Urbatsch
Leaves with developing fruit.

The species persists on abandoned home sites and can readily invade abandoned lots and farmlands where it forms impenetrable thickets. It becomes especially abundant along fencerows, stream, bayou, and forest margins, and it has the ability to invade forests (Godfrey 1988).

Chinese privet reproduces by sexual and vegetative means. Seeds, produced in great abundance, are spread by birds (McRae 1980). Landscape plantings provide seed sources for establishment in disturbed habitats. Soil disturbances of all sorts such as forest clearing, abandoned agricultural lands, and fence construction provide opportunities for colonization by Chinese privet. Natural disturbances for example tree falls, erosion, animal excavations, etc. provide similar colonization opportunities. The plants also have the ability to reproduce vegetatively from root suckers. Once established, Chinese privet is difficult to control because of the huge seedbank and the need to remove underground parts as well. Because of these characteristics, the major impact of Chinese privet is its ability to displace native species and disrupt various terrestrial ecosystems.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description

General: Olive Family (Oleaceae). Chinese privet is a shrub or small tree that may grow to as much as 30 feet tall although its typical height ranges from 5 to 12 feet. If flowering, its blossoms are very aromatic. Its root system is shallow but extensive. Suckers are readily produced and the plants can spread vegetatively in this fashion. The plants branch abundantly and the branches typically arch gently downward. Its twigs are usually densely hairy (pubescent) when young, and the plant hairs (trichomes) spread at right angles from the twig surface. Raised, tan-colored lenticels are also evident on the twig's surface. Chinese privet leaves are evergreen to semi-deciduous and are oppositely arranged (two leaves per node) along the stem on nodes that are usually less than one inch apart. The leaf stalk (or petiole, shown below) is about one-

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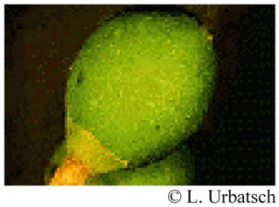
Petiole, axillary bud, stem with spreading

eighth inch long and covered with hairs. Leaf blades are elliptical in shape and are up to one inch wide and about two inches long. Leaf margins lack teeth (entire). The upper leaf blade surfaces are glabrous (without hairs) at maturity. Hairs occur along the midvein (see photo below) and sometimes on branch veins of the lower surfaces.

The flowers occur in numerous, cone-shaped, branching clusters (panicles) two to four inches long that profusely cover the shrub when flowering. A short, slender stalk (pedicel) supports each flower. The green calyx consists of four sepals fused to form a small, cup-like structure. Four white to off-white petals that are basally fused to one another make-up the corolla. Each flower has two stamens attached to the corolla, and they project beyond the corolla throat (exserted stamens). The flowers produce a somewhat disagreeable aroma. The single pistil in each flower matures into a blue-black, berry-like fruit. The fruit are ellipsoidal to nearly globose and are produced abundantly in persistent, pyramidal clusters.



© L. Urbatsch
Developing fruit & cuplike calyx of fused petals.

© L. Urbatsch
Midvein of lower leaf surface showing hairs.

Chinese privet is similar to Common Privet (*Ligustrum vulgare*), a European species that is naturalized in more temperate areas of the eastern United States. Chinese privet has evergreen to semi-evergreen leaves, densely hairy twigs and petioles, pubescent midveins on its lower leaf surfaces, and exserted stamens. In contrast, common privet is deciduous to somewhat evergreen with sparsely pubescent twigs, glabrous midveins, and included stamens (the tips of the anthers are shorter than the extended corolla lobes) (Gleason 1952).

© L. Urbatsch
Petiole, leaf base & margin.

Distribution: A survey of herbarium records shows that its present distribution includes an area extending from Florida to southern New England and westward to the eastern parts of Kansas, Oklahoma, and Texas. Chinese privet thrives in wet to dry habitats. It persists around old home sites and flourishes along fencerows, and stream and forest margins where it forms impenetrable, monocultural thickets. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Control

It is recommended that you contact your local agricultural extension specialist and/or county weed specialist for control measures pertinent to your area.

Various control measures have been reported for Chinese privet. For small areas and for relatively small plants, hand removal is effective. Digging tools such as a mattock are useful for removing underground parts. Broken root fragments need to be removed because of their ability to re-sprout. Repeated mowing and cutting will control the spread of privet, but will not eradicate it. For such treatment, stems should be cut as close to the ground as possible (Bartlow et al. 1997). Mechanical removal is especially effective in the early stages of an invasion when the numbers of plants are relatively small.

For larger natural areas where the use of chemical herbicides is inadvisable, enlisting numerous helpers to mechanically remove Chinese privet may be required. Using heavy equipment for large-scale removal may be appropriate in some locations, but the negative effects of soil disturbance and the potential for erosion need to be considered.

Herbicide treatments properly applied can selectively remove invasive species with minimal soil disturbance. Even slight soil disturbance may offer opportunities for re-invasion. When considering chemical control, local laws affecting herbicide use must be observed. Appropriate precautions in various habitats may be needed. Kline & Duquesnel (1996) point out that not all herbicides are appropriate for all areas. Some may damage non-target species. Herbicides will behave differently in different environments and under different conditions (Neal et al. 1986). For example, they may degrade more slowly in wetter, more anaerobic soils or move downward in sandier soils. A careful monitoring program is essential for evaluating herbicide use.

Randall & Marinelli (1996) report effective control of Chinese privet with glyphosate herbicides stating that foliage treatment is best for actively growing plants. Foliar spray methods should be used only where risk to non-target species is minimal. A 2% solution of glyphosate or 2% triclopyr with a one-half percent of

non-ionic surfactant is reportedly effective for treating Chinese privet (Bartlow et al. 1997).

Kline & Duquesnel (1996) discuss various treatments for woody species including Brazilian pepper, Australian pine, Chinese tallow, and other tree-like species. They note that within mixed stands single stem treatments consisting of basal-bark treatments, cut-surface treatments (injection, cut-stump, or girdle), or direct foliar applications may be effective. A typical basal or cut-surface treatment consists of a 10-50% mixture of one of the following types of herbicides (glyphosate, hexazinone, imazapyr, or triclopyr) with an oil dilutant. They provide a table for use as a guide for selecting application methods and herbicides for various invasive plant species.

Brian Bowen, President of the Tennessee Exotic Pest Plant Council, reports success in controlling privet using 25% glyphosate/75% horticulture oil applied as a cut-surface treatment (personal communication, 1997). He advises against using this application as the plants break dormancy because upward movement of the sap reduces the treatment's effectiveness. The same herbicide preparation is effective when applied to cut stumps as long as the ground isn't frozen (Bartlow et al. 1997). For the basal bark method, applying a mixture of 25% triclopyr/75% horticultural oil to the basal parts of the shrub is reported (Bartlow et al. 1997). W. N. Kline, Senior Scientist, Dow Elanco, Duluth, Georgia, also favors basal-bark or cut-surface treatment over foliar application (pers. comm. 1997). The latter causes such rapid leaf drop that translocation of the herbicide in the plants is reduced, thereby lowering its effectiveness. Furthermore, he reports that disturbance (e.g., fire or mechanical) should be avoided for about one year following basal-bark or cut-surface treatments to allow translocation of herbicides. Disturbance of the plants or root system too soon after treatment may disrupt translocation and result in resprouting.

Fire is a naturally occurring phenomenon that is essential for certain native plant communities to exist. Its use in exotic pest plant control is being investigated. Faulkner et al. (1989) reported its effectiveness as a management tool in the Chickamauga and Chattanooga National Military Park for controlling *Ligustrum sinense* and other pest plants. Fire had the benefit of killing large privet stems, but the vigorous resprouting that followed burning offset this gain. Fall and winter burns had desirable aesthetic effects by considerably reducing the biomass of privet, but no long-term benefits were achieved since the species still remained.

Fire was also used as a herbicide pretreatment (Faulkner et al. 1989). In the spring following the fall and winter burns, foliar application of glyphosate damaged or killed a majority of the Chinese privet shoots. Burning facilitated foliar application of herbicide by reducing biomass. However, it did not increase the effectiveness of the herbicide compared to the unburned controls.

Privet has no known biological controls. A foliage-feeding insect native to Europe, *Macrophya punctumalbum*, is a known pest. Privet is also susceptible to a fungal leaf spot, *Pseudocercospora ligustri*, and a common root crown bacteria, *Agrobacterium tume-faciens* (Bartlow et al. 1997).

Illustrations and Photographs:

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Godfrey, R. K. 1988. *Trees, shrubs, and woody vines of northern Florida and adjacent Georgia, and Alabama*. The University of Georgia Press, Athens. 734 pp. (excellent line drawing showing flower and fruit in detail, p. 518).

Radford, A. E., H. E. Ahles, & C. R. Bell 1968. *Manual of the vascular flora of the Carolinas*. University of North Carolina Press, Chapel Hill, North Carolina. (small line drawing, p 831).

Randall, J. M. & J. Marinelli 1996. *Invasive plants, weeds of the global garden*. Brooklyn Botanic Garden, Handbook #149, Brooklyn, New York. 99 p. (photograph, plants in flower, p. 58)

Schopmeyer, C. S. 1974. *Seeds of woody plants in the United States*. USDA, Forest Service, Agricultural Handbook No. 450. (illustration of *L. sinense* seeds and seedlings of *L. vulgare*, a similar species, p. 500, 502).

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Prepared By
Lowell Urbatsch
Department of Plant Biology, Louisiana State University, Baton Rouge, Louisiana

Species Coordinator
Mark Skinner
USDA, NRCS, National Plant Data Center, Baton Rouge, Louisiana

Edited: 05dec00 jsp;03feb03ahv; 060802 jsp

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