

# Invasive Plant Management Plan for the Oak Ridge Reservation



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Oak Ridge National Laboratory

**INVASIVE PLANT MANAGEMENT PLAN FOR THE OAK RIDGE RESERVATION**

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## ACRONYMS AND ABBREVIATIONS

APHIS	Animal and Plant Health Inspection Service
ARC	Appalachian Regional Commission
CSC	Certified Services Company
DOE	U.S. Department of Energy
EMS	Environmental Management Systems
EO	Executive Order
ESD	Environmental Sciences Division (ORNL)
EPA	U.S. Environmental Protection Agency
ETTP	East Tennessee Technology Park (formerly K-25 Gaseous Diffusion Plant)
FICMNEW	Federal Interagency Committee for the Management of Noxious and Exotic Weeds
F&O	Facilities and Operations Directorate (ORNL)
FR	Federal Regulation
FY	Fiscal Year
GPS	global positioning system
IPC	Invasive Plant Control, Inc.
ISMS	Integrated Safety Management System
MOU	memorandum of understanding
NA	Natural Area (Research Park)
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PSO	Program Secretarial Offices
RA	Reference Area (Research Park)
RM	Reservation Management (DOE Contractor Overhead Funding)
TDEC	Tennessee Department of Environment and Conservation
TN EPPC	Tennessee Exotic Pest Plant Council
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
USDA	U.S. Department of Agriculture
UT	University of Tennessee
WAPA	Western Area Power Administration
Y-12	Y-12 National Security Complex



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## 1. INTRODUCTION

The U.S. Department of Energy (DOE) takes seriously its responsibility for addressing invasive plant and noxious weed issues (DOE 2002). DOE has active programs at many of its sites to control problem plant species, often in cooperation with state and federal agencies (DOE 1998, 1999, 2000, 2001; WAPA 1999). These programs affirm DOE's continued commitment to, and proactive stance toward, control of invasive and noxious plant species. The regulatory requirements on which DOE sites base their programs for dealing with undesirable plants include federal laws, executive orders (EO), Presidential memos, contracts, agreements, and other requirements described in more detail in Sect. 2.

The DOE Oak Ridge Reservation (ORR) is composed mostly of native eastern deciduous forest with large blocks of mature interior forest, extensive areas of undisturbed wetlands, open water, and riparian vegetation, and several hundred acres of grass meadow. Three developed facility areas are surrounded by approximately 25,000 acres of fairly unfragmented, undeveloped area. Most of this undeveloped area is within the DOE Oak Ridge National Environmental Research Park. Numerous DOE contractors have responsibilities for land management of various portions of the 33,749-acre reservation. Multiple land uses for the DOE mission include security; research; utility corridors; access roads; grounds maintenance; protection of rare plants, animals, and special habitats; preservation of cultural resources; cleanup and remediation of contaminated areas; new facility construction; and monitoring. This multiplicity introduces challenges for effective invasive species prevention and management.

Protected and relatively undisturbed for the past 60 years, the landscape surrounding the DOE facilities has changed considerably since 1942 when it was acquired as part of the Manhattan project. Aerial photos indicate that about half of the land was cleared at the time of federal acquisition. These cleared and cultivated areas have returned to forest through planted seedlings and natural succession, with about 70% of the reservation now in mature or maturing native forest. ORR forests are mostly oak-hickory (*Quercus-Carya*) or pine. Communities are generally characteristic of the intermountain regions of Appalachia. Oak-hickory forest, which is most widely distributed on ridges and dry slopes, is the dominant association. Minor areas of other hardwood forest cover types include northern hardwoods, a few small natural stands of hemlock (*Tsuga canadensis*) or white pine (*Pinus strobus*), and floodplain forests (Mann et al. 1996). Ecological communities found within the larger framework of mixed hardwood and pine forests on the reservation include cedar barrens, river bluffs, and wetlands. These areas include species and habitats now absent or uncommon in areas surrounding the reservation. As a result of a couple of severe outbreaks of the southern pine beetle in the 1990s, a considerable acreage of pine plantation has been destroyed. Invasive plants, however, have also increased as they have spread out from old home site plantings, well-intentioned erosion control efforts, and wildlife forage enhancement projects.

### 1.1 INVASIVE PLANTS NATIONAL PERSPECTIVE

Government agencies, such as the Department of Transportation and the Bureau of Land Management, began to import invasive plants in the 1950s for various reasons, including erosion control along highways and public beaches. Many species were also introduced intentionally by individuals (e.g., gypsy moth for silk production) or accidentally (e.g., brought to this country by animals or with other imported goods). It was not until the late 1980s that the terrible effects of invasive exotic plants in natural areas were noticed. Seemingly harmless plants such as kudzu, spotted knotweed, and Amur bush honeysuckle were only beginning a silent biological invasion of natural and agricultural areas. At least 4,200 species of introduced plants (about 8.4% of the total introductions) have escaped from cultivation and established populations in the United States since the beginning of European colonization. Of that total, at least 675 species (15%) are harmful, causing severe damage. In economic terms, 79 species, or 12% of total

harmful species, caused documented losses of \$97 billion from 1906 to 1991 according to Dr. Randy Westbrooks, Invasive Plant Coordinator for the U.S. Geological Survey. Currently, the Weed Science Society of America recognizes about 2,100 plant species as weeds in the United States and Canada. These numbers do not include the hundreds of new species that have become established in the United States in recent decades (Westbrooks 1998).

A list published by the Tennessee Exotic Pest Plant Council (TN EPPC) with input from experts across the state includes 104 species listed as invasive exotic pest plants in Tennessee (TN EPPC 2002). Of these, 76 are considered severe or significant threats to natural communities. Watch lists (species that are problems in surrounding areas but not yet seen in Tennessee) include an additional 34 species. The TN EPPC Plant list is in Appendix A.

## **1.2 ORR INVASIVE PLANT MANAGEMENT PLAN DEVELOPMENT**

As a result of federal and state recognition of the impacts of invasive plants on operations and natural areas, this plan has been prepared to evaluate the situation on the ORR and discuss strategies to address the problem while also meeting the intent of the Executive Order 13112 on invasive species. Several components were integrated in the development of an invasive plant management plan for the ORR, including

- prioritizing situations for invasive plant management;
- ascertaining what invasive plants occur on the ORR;
- identifying regulations for management of invasive plants;
- increasing awareness of ORR invasive plants;
- determining the extent of the problem on the ORR;
- selecting appropriate treatments and timing;
- locating specific sites for initiating treatments;
- leveraging resources for treatment;
- developing and maintaining a database of information;
- sponsoring or facilitating research on invasive species;
- restoring treated areas, as needed;
- preparing guidelines to prevent or minimize spread of invasive species; and
- evaluating results and adapting approach.

Details of these various components of invasive plant management are discussed in the following sections of this document. As part of the plan development, a National Environmental Policy Act (NEPA) review was conducted by the Oak Ridge National Laboratory (ORNL) staff. The situations where treatment would be considered and possible impacts were evaluated. A NEPA categorical exclusion was issued in September 2003 to cover all invasive plant work on the ORR.

## **1.3 PRIORITIES FOR INVASIVE PLANT MANAGEMENT**

A number of priorities for invasive plant management specific to the ORR were identified with input from DOE and contractors (including subcontractors) at the ORNL, the Y-12 National Security Complex (also called Y-12), and the East Tennessee Technology Park (ETTP). These priorities include

- early detection (removal of an invasive before it becomes a problem);
- natural areas (e.g. protecting rare species and special habitats);
- areas where removal can be integrated with other tasks;
- corridors that encourage movement of invasive species (e.g., roads, streams, fences);
- rights-of-way infrastructure;
- wildfire fuel accumulation;
- contaminant transport;



- research areas;
- restoration/remediation sites;
- safety (e.g., breeding sites for mosquitoes, overgrowth in areas that could hide hazards, imminent safety hazards that should be addressed immediately);
- compliance and monitoring sites;
- security concerns;
- high visual impact;
- wildlife habitat;
- cultural resources;
- boundary areas; and
- wetlands and hydrologic regime impacts.

These priorities have been incorporated into the rating and ranking discussed in this Plan for Management of Invasive Plants (Sect. 5).

#### **1.4 INVASIVE PLANTS OCCURRING ON THE ORR**

Over 1,100 vascular plant species are found on the reservation. Of these, 168 plant species are nonnative, 54 of which have been identified as aggressive. The nonnative, aggressive species are listed in Table 1.1. Of these, the 18 most problematic species for natural areas (ORR habitats with rare plants or wildlife) were ranked (Drake et al. 2002). The ranking system, developed by the U.S. Geological Survey, uses species characterization information as well as attributes of the invaded site or community. Ranking for the top 18 problematic species are listed in Table 1.2 (Drake et al. 2002; 2003). Ongoing field characterizations and data collections add to the species list and may result in changes in priorities.

#### **1.5 BENEFITS OF INVASIVE PLANT MANAGEMENT**

Several benefits, in addition to addressing legal requirements, can be recognized for the ORR as a result of comprehensive invasive plant management planning.

Invasive plants present significant challenges for maintenance of power-line corridors and other rights-of-way on the reservation. Dense stands of certain invasive species form an impenetrable barrier, presenting significant issues for access for maintenance of the ROW or utility line. Climbing species, such as kudzu, are particularly problematic for utility lines, causing arcing and increasing the potential for fires. Both the degree of difficulty and the time required to maintain these areas can be significantly increased by well-established thick stands of invasive woody plants. Eradication of these species followed by establishment of native species (e.g., native grasses) results in more manageable maintenance requirements.

The ORR supports a diversity of game and nongame wildlife species that benefit from the diverse habitats currently found on the reservation. The Tennessee Wildlife Resources Agency (TWRA) is involved in statewide efforts to control and manage invasive plants impacting wildlife habitat. Significant gains can be made by the elimination of invasive plants and the establishment of native species that provide much higher quality wildlife habitat.

Active management to keep invasive plants out of sensitive areas, such as wetlands or rare plant habitats, will help prevent disruptions of hydrologic regimes or displacement of native plants that cannot compete. Management of invasive plants can help protect the high-quality forest blocks so significant on the ORR and important to migratory songbird populations.

**Table 1.1 Nonnative aggressive plant species on the ORR**

Scientific nomenclature	Common name
<i>Ailanthus altissima</i> (Mill.) Swingle	Tree of heaven*
<i>Albizia julibrissin</i> Durz.	Mimosa
<i>Allium vineale</i> L.	Field garlic*
<i>Amaranthus retroflexus</i> L.	Green amaranthus
<i>Ampelopsis brevipedunculata</i>	Porcelainberry
<i>Arthraxon hispidus</i>	Hairy jointgrass
<i>Celastrus orbiculata</i>	Oriental bittersweet
<i>Cirsium vulgare</i> (Savi) Ten.	Bull thistle*
<i>Coronilla varia</i> L.	Crown vetch*
<i>Dioscorea batatas</i>	Chinese yam*
<i>Echinochloa crus-galli</i>	Barnyard grass
<i>Elaeagnus umbellata</i> Thunb.	Autumn olive*
<i>Elaeagnus pungens</i> Thunb.	Thorny-olive
<i>Euonymus alata</i> (Thumb) Sieb	Burning bush
<i>Euonymus fortunei</i> (Turcz.) Hand.-Mazz.	Winter creeper
<i>Festuca arundinacea</i> Schreb.	Tall fescue
<i>Festuca pratensis</i> Huds.	Meadow fescue
<i>Glechoma hederacea</i> L.	Gill-over-the-ground, ground ivy
<i>Kummerowia striata</i> (Thunb.) Schindl.	Japanese clover
<i>Lespedeza bicolor</i> Turcz.	Bicolor lespedeza, shrubby bushclover
<i>Lespedeza cuneata</i> (Dum.-Cours.) G. Don	Sericea lespedeza*
<i>Ligustrum sinense</i> Lour.	Chinese privet*
<i>Ligustrum japonicum</i> Thunb.	Japanese privet
<i>Ligustrum vulgare</i> L.	Common privet
<i>Lonicera japonica</i> Thunb.	Japanese honeysuckle*
<i>Lonicera maackii</i> (Rupr.) Maxim.	Amur bush honeysuckle
<i>Lonicera morrowii</i> A. Gray	Morrow's bush honeysuckle
<i>Lonicera tatarica</i> L.	Tartarian honeysuckle, twinsisters
<i>Lonicera x bella</i> Zabel	Bush honeysuckle
<i>Lysimachia nummularia</i> L.	Moneywort, creeping Jenny
<i>Lythrum salicaria</i> L. [all varieties and cultivars]	Purple loosestrife
<i>Mahonia bealei</i> (Fortune) Carriere	Oregon grape
<i>Mentha x piperita</i> L.	Peppermint
<i>Mentha spicata</i> L.	Spearmint*
<i>Microstegium vimineum</i> (Trin.) A.	Camus Nepalgrass, Japanese grass*
<i>Myriophyllum spicatum</i> L.	Eurasian water milfoil
<i>Nasturtium officinale</i>	Watercress*
<i>Paulownia tomentosa</i> (Thunb.) Sieb. & Zucc. ex Steud	Princess tree*
<i>Poa pratensis</i>	Kentucky bluegrass
<i>Plantago major</i>	Common plantain
<i>Polygonum cuspidatum</i> Seib. & Zucc	Japanese knotweed, Japanese bamboo
<i>Polygonum hydropiper</i> L.	Smartweed
<i>Potamogeton crispus</i> L.	Curly pondweed
<i>Pueraria montana</i> (Lour.) Merr.	Kudzu*
<i>Rosa multiflora</i> Thunb.	Multiflora rose*
<i>Rumex conglomeratus</i> Murray	Clustered dock
<i>Sorghum halepense</i> (L.) Pers.	Johnson grass*
<i>Urtica dioica</i> L.	Stinging nettle
<i>Verbascum thapsus</i> L.	Common mullein
<i>Veronica arvensis</i>	Corn speedwell
<i>Veronica officinalis</i>	Common speedwell
<i>Veronica serpyllifolia</i> L.	Thyme-leaved Speedwell
<i>Vicia villosa</i>	Hairy vetch
<i>Vinca minor</i> L.	Common periwinkle*

\* Most problematic on the ORR.

**Table 1.2 Ranking of the 18 most problematic ORR invasive plants for natural areas**

<b>Rank</b>	<b>Common name</b>	<b>Scientific name</b>
1	Japanese grass	<i>Microstegium vimineum</i>
2	Japanese honeysuckle	<i>Lonicera japonica</i>
3	Chinese privet	<i>Ligustrum sinense</i>
4	Kudzu	<i>Pueraria Montana</i>
5	Multiflora rose	<i>Rosa multiflora</i>
6	Lespedeza	<i>Lespedeza cuneata</i>
7	Chinese yam	<i>Dioscorea batatas</i>
8	Tree-of-heaven	<i>Ailanthus altissima</i>
9	Field garlic	<i>Allium vineale</i>
10	Autumn olive	<i>Elaeagnus umbellata</i>
11	Oriental bittersweet	<i>Celastrus orbiculatus</i>
12	Princess tree	<i>Paulownia tomentosa</i>
13	Johnsongrass	<i>Sorghum halepense</i>
14	Periwinkle	<i>Vinca minor</i>
15	Spearmint	<i>Mentha spicata</i>
16	Watercress	<i>Nasturtium officinale</i>
17	Bull thistle	<i>Cirsium vulgare</i>
18	Crown vetch	<i>Coronilla varia</i>

Management of invasive plants around field research sites can prevent impacts on environmental, energy, and remediation studies. Effectiveness of monitoring and remediation areas is less likely to be compromised by overgrowth with preventive maintenance of invasives.

Improvement in ORR aesthetics is an additional benefit. The growth pattern of many invasive plant species results in the establishment of monoculture stands of vegetation that choke out more attractive native species. This results in vast areas that provide very little visual appeal. Proper management of these areas for more appealing native plant species results in more pleasing landscapes that can highlight regionally native species.

Restoration of rare plant communities can be an important outcome of invasive species management and control. On the ORR, invasive plant control, used in conjunction with follow-on planting programs and other management strategies, can restore locally and regionally rare plant communities. A prime example is the re-establishment of native grasslands that had been historically common in the region. This not only benefits wildlife, but because of reduced maintenance requirements, can result in cost savings.

Invasive plant encroachment is a national issue that impacts vast areas of public and private lands, including other DOE facilities. The knowledge gained from the ORR invasive plant species program can serve as an important model for application to other areas in need of management.

## 2. REQUIREMENTS FOR MANAGEMENT OF INVASIVE PLANTS

### 2.1 MANAGEMENT OF UNDESIRABLE PLANT SPECIES ON DOE SITES

DOE has active programs at many of its sites to control problem plant species, often in cooperation with state and federal agencies (DOE 1998, 1999, 2000, 2001; WAPA 1999). These programs demonstrate DOE's commitment to the control of invasive and noxious plant species.

The regulatory requirements on which DOE sites base their programs for dealing with undesirable plants include the following:

- federal laws, executive orders (EO), and Presidential memos (see Sect. 2.3);
- land withdrawal orders;
- contracts for managing DOE sites;
- state weed-management laws;
- state noxious weed lists;
- county noxious weed-management legislation;
- county noxious weed lists; and
- compliance agreements and memoranda of understanding (MOU).

### 2.2 TENNESSEE ACTS, AGENCIES, AND AUTHORITIES

The Tennessee Plant Pest Act (Tenn. Code Ann. § 43-515 et seq.) is implemented by the state U.S. Department of Agriculture (USDA). Two plants have been listed under it as pest plants: purple loosestrife (*Lythrum salicaria*, *L. virgatum*, and related cultivars) and tropical soda apple (*Solanum viarum*). The USDA is considering expanding the Tennessee noxious weed list.

The ORR straddles two Tennessee counties, Roane and Anderson. Neither one has a county list of noxious weeds.

**The Tennessee Exotic Pest Plant Council (TN EPPC)** has published, with input from experts across the state (e.g., botanists, land managers, citizens), a list of invasive plant species that may cause damage to native plant communities. The list provides useful information to help guide agencies in making responsible decisions about plant use and management. The list is included in Appendix A. The TN EPPC has recommended that all plant species listed on the Tennessee Invasive Plant List as Rank 1: Severe Threat and Watch List A be added to the Tennessee Noxious Weed List.

### 2.3 FEDERAL ACTS, AGENCIES, AND AUTHORITIES

Information on the most significant laws or other authorities related to undesirable plants, which could be applicable to DOE as identified by sites that have programs to control such species, are discussed in this section.

**Federal Noxious Weed Act (1974).** Most of the content of the Federal Noxious Weed Act has been incorporated into the Plant Protection Act of 2000. However, § 2814, *Management of Undesirable Plants on Federal Lands*, was amended and remains in effect. This section mandates in *subsection (a)* that each federal agency

- designate an office or person to develop and coordinate an undesirable plants-management program for control of such plants on federal lands under the agency's jurisdiction;
- establish and adequately fund an undesirable plants-management program;
- complete and implement cooperative agreements with state agencies regarding the management of undesirable plant species on federal lands under the agency's jurisdiction; and

- establish integrated pest-management systems to control or contain undesirable plant species targeted under cooperative agreements.

“Undesirable plants” are defined to include, but are not limited to, noxious weeds. (See definitions, Appendix B.)

*Subsection (c)* allows federal agencies, as appropriate, to enter into cooperative agreements with state agencies to coordinate the management of undesirable plant species on federal lands.

*Subsection (d)*, titled *Exception*, states, “A Federal agency is not required under this section to carry out programs on Federal lands unless similar programs are being implemented generally on State or private lands in the same area.”

**Presidential Memorandum: Environmentally and Economically Beneficial Practices on Federal Landscaped Grounds (1994).** The presidential memorandum was signed on April 26, 1994, and guidance to assist federal agencies in implementing it was published in the *Federal Register* (FR) on August 10, 1995 (60 FR 40837). This memo was replaced in 2000 by EO 13148 (see below) that incorporates its provisions and the guidance implementing it. The guidance focuses on five guiding principles:

- use regionally native plants;
- design, use, or promote construction practices that minimize adverse effects on the natural habitat;
- seek to prevent pollution;
- implement water- and energy-efficient practices; and
- create outdoor demonstration projects.

The guidance encourages the use of landscape management products and practices (e.g., using trimmings as composted material, mulches, and landscape amendments) to help inhibit weed growth. Barriers to the use of native plants that are identified in the guidance include the more prevalent use of exotic species in landscaping and the spread of invasive exotics.

**Memorandum of Understanding for the Establishment of a Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW) (1994).** FICMNEW was established under an MOU signed by 17 federal agencies, including DOE. It is responsible for coordinating a federal government effort to manage noxious and exotic weeds on federal lands in an ecological and integrated manner. FICMNEW is charged with coordinating the identification of the extent and impacts of noxious and exotic weeds for the Secretaries of the involved Departments through the appropriate Assistant Secretaries. Under the MOU FICMNEW provides information about agency needs and makes recommendations to departmental leadership on research, technology transfer, and management actions pertaining to invasive plants. The federal agencies are cooperating to achieve the advancement of knowledge and skills, good land stewardship practices, and public awareness of noxious weed issues and management (<http://environment.fhwa.dot.gov/guidebook/vol1/doc9c.pdf> )

**Executive Order (EO) 13112, Invasive Species (Clinton 1999).** This EO directs all federal agencies to address invasive species concerns and refrain from actions likely to increase invasive species problems. It defines invasive species as “any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem.” It creates an interagency National Invasive Species Council to coordinate and improve the invasive species programs of 23 federal agencies and work closely with state and local governments and private organizations on this critical

economic, environmental, and health issue. The Council is co-chaired by the Departments of Agriculture, Commerce, and Interior and includes seven other federal departments and agencies. The EO also calls for development of a National Invasive Species Management Plan to better coordinate federal agency efforts. The plan was completed in January 2001 (National Invasive Species Council 2001).

One product of the Management Plan is the *National Early Warning and Rapid Response System for Invasive Plants in the United States* that poses a framework of public and private partners at all levels to address new invasive plants through (FICMNEW 2001)

- early detection and reporting;
- identification and vouchering;
- verification;
- archival of new records in databases;
- rapid assessment; and
- rapid implementation of control if plants are determined to be invasive.

**EO 13148, Greening the Government Through Leadership in Environmental Management (2000).**

This EO, published in the *Federal Register* on April 26, 2000 (65 *FR* 24595), is implemented by DOE O 450.1. The EO replaced the 1994 Executive Memorandum on Environmentally and Economically Beneficial Practices on Federal Landscaped Grounds. It requires agencies to incorporate the guidance generated by the landscaping memorandum into their landscaping practices and calls for that guidance to be updated, if necessary. *Section 207* states that each agency shall strive to promote the sustainable management of federal facility lands through the implementation of cost-effective, environmentally sound landscaping practices and programs to reduce adverse impacts to the natural environment. (Appendix C contains portions of this EO.)

**DOE O 450.1 (2003).** The objectives of DOE's *Environmental Management Program* (DOE O 450.1) are stated as follows:

To implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by Department of Energy (DOE) operations and by which DOE cost effectively meets or exceeds compliance with applicable environmental; public health; and resource protection laws, regulations, and DOE requirements. This objective must be accomplished by implementing Environmental Management Systems (EMSs) at DOE sites. An EMS is a continuing cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental goals.

While there are no DOE orders or other DOE-wide requirements that specifically call for control and management of invasive plants and noxious weeds, the objectives of this DOE order cannot be fully met without invasive plant management. A commitment to manage undesirable species would ensure that sound stewardship practices are developed and implemented to protect DOE land and natural resources. Thus, management of undesirable species could be incorporated into EMSs to achieve environmental goals.

The order assigns the Assistant Secretary for Environment, Safety and Health (EH-1) the responsibility of developing or revising, as needed, existing DOE environmental protection directives, policies, guidance, requirements, and procedures in order to promote the protection of the environment, efficient compliance with environmental requirements, and enhanced environmental performance in the conduct of DOE operations. (Appendix D contains portions of this DOE order.) Development of explicit guidance for dealing with undesirable plant and animal species would be a valuable way to meet this responsibility.

**Plant Protection Act (2000).** This law, Title IV of the Agriculture Risk Protection Act of 2000, consolidates and modernizes all major statutes pertaining to plant protection and quarantine (e.g., Federal Noxious Weed Act, Plant Quarantine Act). (See Federal Noxious Weed Act for information on amendments to it that remain in effect.) The act permits the USDA's Animal and Plant Health Inspection Service (APHIS) to address all types of weed issues, increases the maximum civil penalty for violations, and authorizes APHIS to take both emergency and extraordinary emergency actions to address incursions of noxious weeds.

### **3. AWARENESS AND EDUCATION**

Actively battling pest plants is not a new issue for those with grounds, forestry, and facility maintenance responsibilities. However, for other types of resource management (such as natural area, wetland, and cultural resource protection), management that was once passive in nature (identify and protect the area from disturbance) now requires active management to maintain the integrity of the habitat or ecosystem. Invasives (both plants and wildlife) also damage "typical" landscapes as well as natural areas, and education can serve to reduce the impact of invasives across the entire landscape. The increase in the number of types and species of invasive plants throughout the region also impacts the frequency and types of treatments needed for ORR infrastructure, compliance monitoring, and wildland fire prevention. The requirements to maintain skills for identification of current and watch-list invaders, share methods of effective treatment, and find funding sources provide constant challenges.

#### **3.1 PUBLIC ANNOUNCEMENTS, ARTICLES, AND WEB SITES**

Outreach to the general public, and residents of the DOE facilities will be a continuing part of the Invasive Plant Management program. Postings onsite, short notices in facility communications, and articles in local newspapers will increase awareness and continue to highlight the value of the invasive plant control activities. Many in the general public are unaware that common plants, such as privet or honeysuckle, are not native species and pose a problem to native ecosystems. Volunteer outreach efforts could possibly involve local citizens in eradication efforts. A Research Park brief on ORR invasive species is available on the web at: <http://www.esd.ornl.gov/facilities/nerp/biobriefs.html>. Links to sites with additional information on invasive plant management and photos are located at: <http://www.samab.org/Focus/Invasive/about.html>. A section on invasive plant species is being added to the Research Park web site at: [http://www.esd.ornl.gov/facilities/nerp/invasive\\_plants.html](http://www.esd.ornl.gov/facilities/nerp/invasive_plants.html).

#### **3.2 TRAINING, WORKSHOPS, AND SAFETY**

An invasive plant workshop was held at ORNL in April 2003 for individuals who make land management decisions or provide management actions on the ORR. The workshop featured many speakers, including staff from Invasive Plant Control, Inc. (IPC), an expert firm dealing with control issues in the southeast; a professor from the University of Tennessee with expertise in invasive plants; and, a nurseryman from middle Tennessee with expertise in use of native plants in landscaping. The workshop included identification of invasive species, treatment approaches, and field demonstrations. Approximately 50 individuals from 11 different agencies and organizations involved with ORR land management participated. Follow-up small group meetings were held at each of the sites to discuss needs specific to the ETPP, Y-12, and ORNL areas.

Training sessions are needed on a regular basis for reservation users and caretakers to provide information on how to identify ORR invasive species, inform them about potential invasive threats, and discuss new treatment options. Invasive plant experts will be brought in to lead workshops and field sessions. Training workshops were initiated during the summer of 2004.

An important part of any invasive plant management program is an integrated safety assessment. Because a wide variety of chemical and mechanical tools may be used to treat invasive plants, the potential hazards of these tools must be considered. Also, treatment will occur at sites with other potential hazards such as contamination, steep or uneven terrain, and poisonous plants or animals. Treatment may occur when temperature extremes are possible, so heat and cold stress must be addressed. Therefore, all activities conducted under this plan have been described and evaluated in a Research Safety Summary. The Research Safety Summary is updated at least annually and is required reading for all ORNL participants in the invasive plant management program. Contractors must demonstrate that a health and safety plan is in place, and all ORNL subcontracts include a safety checklist review.

### **3.3 DEMONSTRATION PROJECTS**

As part of the awareness effort for management of invasive plants on the ORR, a series of small projects were initiated in 2002–2004 to serve as demonstrations. These projects spanned the varying types of activities possible for implementation on the ORR. They also were generally located where they would be visible to the DOE and contractor staff. Several of these projects were also included in the invasive plant treatment workshop conducted by IPC.

#### **3.3.1 First Creek Project**

First Creek is a small tributary that flows through the west end of ORNL. It served as a site for a DOE Environmental Management Program wetland enhancement project (as mitigation for disturbance of a wetland in clean-up actions elsewhere on the ORR) in the 1990s and resulted in many native wetland plants being planted in the stream riparian area. However, several years following planting, the site became severely compromised by invasive plants such as fescue (*Festuca spp.*), Japanese honeysuckle (*Lonicera japonica*), crown vetch (*Coronilla varia*), and privet (*Ligustrum spp.*). During the summer of 2003, IPC treated most of the privet by cut and spray techniques, and treated the crown vetch and some fescue using a foliar spray. Because the area was sensitive to erosion, plugs of native grasses and wildflowers were added to the site post-treatment. Follow-up treatment is planned for 2004 to deal with any remaining honeysuckle, privet, fescue, and crown vetch.

#### **3.3.2 Fifth Creek Project**

Fifth Creek is a small tributary that flows through the center of ORNL. Areas along this stream were also treated by IPC in the summer of 2003. Target species included privet, autumn olive (*Elaeagnus umbellata*), honeysuckle, creeping euonymus (*Euonymus fortunei*), and porcelainberry (*Ampelopsis brevipedunculata*). Follow-up treatments in 2004 will focus on removing the euonymus and some limited restoration.

#### **3.3.3 Raccoon Creek Cedar Barrens (RA 8) Project**

Raccoon Creek Cedar Barrens Reference Area (RA 8) is a unique area that borders the Clinch River west of ORNL. The vegetation in the barren represents a valuable resource for the ORR. In the summer of 2003, roadside areas were treated to remove *Sericea lespedeza* (*Lespedeza cuneata*). Some of the interior areas were treated for privet, fescue, and Johnson grass (*Sorghum halepense*). As part of the demonstration project, boom applicators and weed wands were used to see how effective these might be for controlling large areas. Crews inexperienced in invasive plant management were used in order to evaluate the level of training needed for various aspects of treatment.

#### **3.3.4 Bethel Valley Kudzu Project**

Several areas along Bethel Valley Road are infested with kudzu (*Pueraria montana*). During the summer of 2003, a small patch of kudzu, just east of the west ORNL portal was treated by Certified Services Company (CSC) using a power sprayer. This is a highly visible area, and the resulting control of this well-known invasive will be useful in educating employees and guests about the impacts of invasive plant management. Follow-up treatments are scheduled with CSC for 2004.



### **3.4 GUIDELINES TO PREVENT OR MINIMIZE THE SPREAD OF INVASIVES**

Preventative measures to avoid or minimize introduction and spread of invasive plants can reduce impacts to reservation resources. Actions have been initiated to incorporate many of the following guidelines into routine operating activities.

- prohibit purchases or acquisition of plants identified as invasive in Tennessee (per TN EPPC Plant List) for use on the ORR, including around facilities, for remediation, or for wildlife management. Special exceptions must be approved;
- require nurseries or agencies providing plant material to inspect and certify that their shipments do not accidentally contain plants identified as invasive in Tennessee;
- purchase or acquire seed only from dealers who assure a high degree of seed purity;
- educate individuals who work in the field to identify invasive plants, spot new ones, and map locations;
- report invasives sighted in the field to the ORNL area manager;
- provide a list of appropriate alternative native or noninvasive species for planting;
- conduct annual spring and fall surveillance and monitoring to spot new invasive plants or detect new hot spots;
- perform road maintenance when invasives are less likely to be spread (before germination or prior to seed set);
- clean tires, vehicles, and equipment carefully after they have been in an area where invasive plants occur;
- evaluate the potential to spread invasive plants in project reviews;
- require a follow-up plan to deal with invasive plants following completion of field projects that may open areas or result in areas vulnerable to spread of invasive species; and
- continue to educate employees, reservation users, and public (especially boundary neighbors) about invasive plants.

## **4. DETERMINING THE EXTENT OF THE PROBLEM ON THE ORR**

The occurrence of invasive plants on the reservation has been recognized for years, especially in areas where they have impacted management (e.g., forestry, maintenance). However, documentation of types and frequency of invasive plants in specific locations has begun only recently.

### **4.1 SURVEYS OF OAK RIDGE RESERVATION**

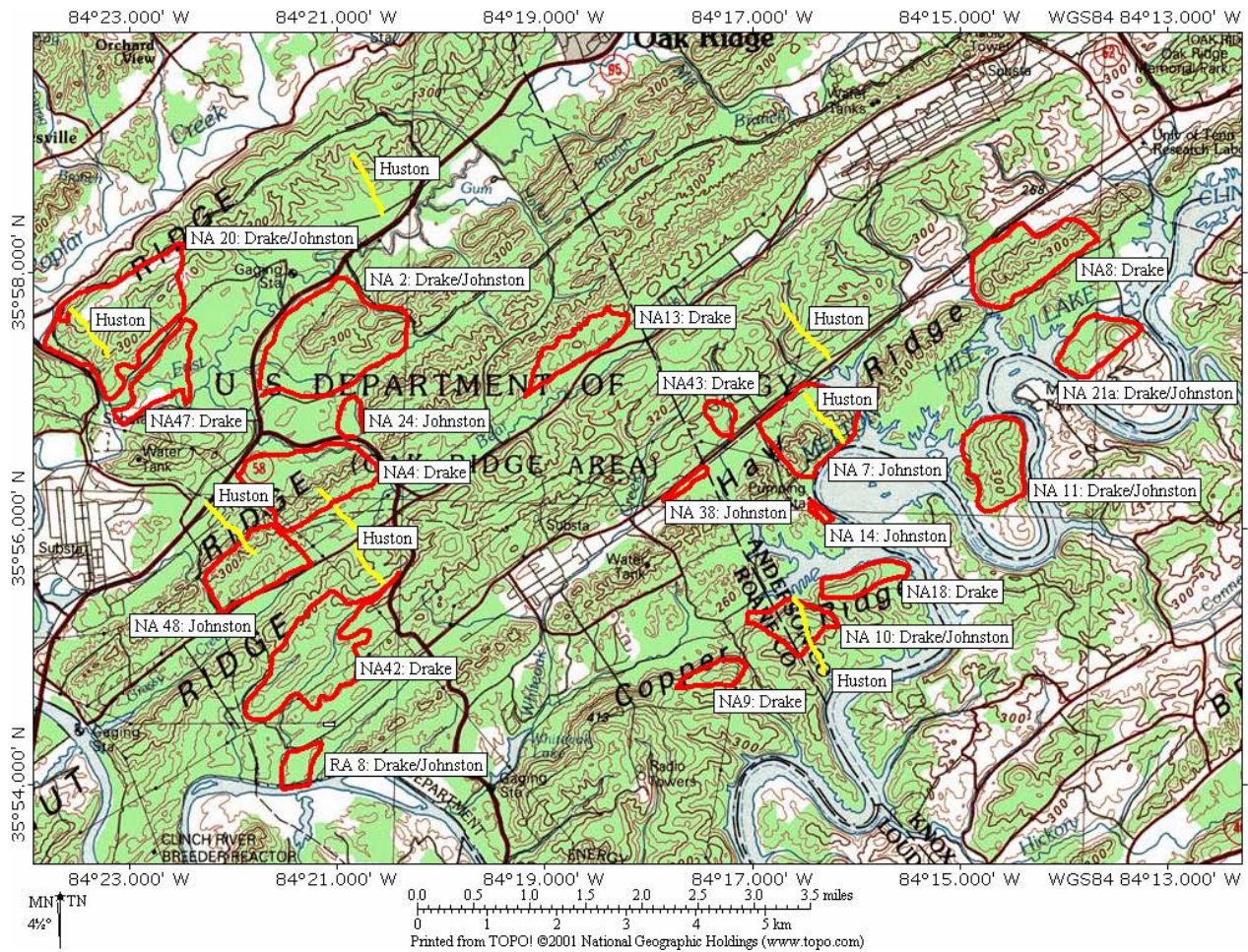
In 2000, Sara Drake (University of Tennessee) generally characterized invasive plants within and adjacent to 16 Research Park Natural Areas (Drake et al. 2002). In 2002, locations of kudzu (visible from the road) were recorded using global positioning system (GPS) data. (See Appendix E.) A project to predict the distribution and dominance of exotic species in the Southern Appalachians, funded by the U.S. Environmental Protection Agency (EPA) National Center for Environmental Research, included numerous permanent plots on the ORR that provided additional data on invasive plants within ORR forested areas (Michael Huston personal communication to Pat Parr 2003). A more rigorous characterization of invasive species within Research Park Natural Areas was begun in 2003 (Johnston 2003) and will continue in 2004. The Tennessee Department of Environment and Conservation (TDEC) established invasive plant monitoring plots within an area designated for conservation easement on Black Oak Ridge in 2003. The primary areas surveyed for invasive species on the ORR are shown in Fig. 4.1.

### **4.2 DATABASES FOR INVASIVE PLANT MANAGEMENT**

Information gathered from surveys documenting locations and abundance of invasive plants was combined with treatment efforts. Currently, abundance data is available for 18 of the approximately 90 Research Park Natural or Reference Areas and for a select number of species (kudzu and oriental

bittersweet). The information is generally recorded on topographic map software, with GPS coordinates for some data. The occurrence of invasive plants also can be correlated with areas where they are likely to spread. These areas include routes of dispersal such as road ways or areas where disturbance has occurred, such as pine plantations devastated by outbreaks of southern pine beetle.

A database is under construction that documents the particulars of major treatment efforts. This database tracks where the treatment occurred, when it began, the target species, the treatment technique, who did the work, the GPS coordinates, and, when possible, a digital image history of before and after photos that indicate the degree of success. Quantitative measurements of invasive density before and after may be available for some sites, but is not a routine measurement. The database is set up in an Excel spreadsheet, but is able to be shifted to a more advanced data management format in order to link up with national data sets being created to help manage invasive species at a larger scale.



**Fig. 4.1** Areas of the ORR that have been surveyed for invasive plant species. Areas in red are Natural Areas (NA), yellow lines are research transects, and labels indicate primary researcher.

## 5. PLAN FOR MANAGEMENT OF INVASIVE PLANT SPECIES

### 5.1 MANAGEMENT APPROACH OPTIONS

Three primary approaches to invasive plant treatments are recommended for the ORR. These approaches are (1) targeting control to manage an individual species regardless of where it occurs, (2) targeting control to manage multiple species in specific areas, and (3) targeting control to the corridors or routes of dispersal and invasion. The approach used would depend on factors such as the likelihood for success, associated cost, and priority for controlling the target species or protecting the specific area. Because of the size of the ORR and the variety of problems presented by invasive plants, the judicious application of all three techniques, at least initially, offers the best route for success. In many situations, treatment of specific invasive problems will fit more than one of the treatment approaches.

#### 5.1.1 Target Invasive Plants by Species

Targeted species management focuses treatment on a single, invasive plant species. This can be effective in areas where this species has crowded out other species, is just getting started, or is the only species of invasive plant interspersed with desirable plants.

##### 5.1.1.1 Most Likely To Be Controlled

Some invasive species can be easier to control than others, and thus merit individual attention. Trees and some shrub species take longer to mature and thus, have a somewhat slower rate of invasion than vine or forb species that usually produce seeds within the first few growing seasons. Attacking these comparatively slower growing species before they reach reproductive age results in a better chance of controlling them. On the ORR, several species fall into this category. Princess tree (*Paulownia tomentosa*), mimosa (*Albizia julibrissin*), and tree-of-heaven (*Ailanthus altissima*) are trees that can become significant problems, and thus, would warrant a specific treatment effort. Three shrub species, autumn olive, privet, and thorny olive (*Eleagnus pungens*) also take a few years to reach fruit-bearing stages and might be worth targeting. However, all of these species are already very abundant on the ORR and may require extensive effort to control. Significant control is recommended before the species population reaches a size where it can reproduce faster than it can reasonably be controlled.

##### 5.1.1.2 New or Recurrent Invasive Species

Another category where targeting individual species is particularly useful is the case in which the species occurs only singly or at limited locations. The best time to control an invasive is when it first appears on the ORR, a method that has previously had some limited success. Oriental bittersweet (*Celastrus orbiculatus*) was observed in NA2 and has been controlled by an intensive treatment approach over 3 years. Another population of bittersweet was found in the 2003 natural areas survey. Renewing the effort to control this species while its numbers are low would likely be a successful strategy. For this strategy to be useful, partial surveys of the ORR should be conducted on an annual basis so that the majority of the reservation is checked every about every five years. Increased awareness of potential new invaders will make early treatment more likely.

##### 5.1.1.3 Species Occurring at High Densities

Targeting an individual species can be very successful when the species occurs at very high densities in a few locations. By their nature some invasive species spread slowly at first, becoming locally abundant, before they become a more widespread problem. By targeting areas with high-density infestations, these species may be controlled more efficiently. Control of two such high-density species was initiated in 2003 on the ORR. Kudzu is a fast growing vine that spreads locally by rhizomes and extended vines more often than seed dispersal. Although quite tenacious, a control effort that is repeated for several years can produce significant reductions. In 2003, two small patches of kudzu (less than 1 acre each) were sprayed. Follow-up treatments are scheduled for 2004. Additional areas will also be targeted in 2004. Autumn

olive also occurs at extremely high densities on the ORR, and a cooperative treatment program involving Tennessee Valley Authority (TVA), Tennessee Wildlife Resources Agency (TWRA), and ORNL was started in 2003. This treatment process will definitely be a multiyear effort, because unlike kudzu, autumn olive produces large quantities of berries that are more widely spread. Other species, such as Japanese grass (*Microstegium vimineum*) can occur in very high densities, but because control methods are less successful on this annual species, treatment efforts on this invasive may not be among the higher priorities.

### **5.1.2 Target Invasive Plants by Areas**

In many cases, multispecies management in specific areas is needed when a variety of invasive plants grow in a particular area. This treatment can be a labor-intensive, requiring careful selection of the plants to treat (to avoid treating the ones being protected from the invasive plants). Different species may require treatment at different times of the year, and different types of treatment may be effective (see Sect. 6). The ability to identify the wide range of possible invasive species is a necessary skill targeting specific plants.

Targeting invasive species by area is also important in known areas of disturbance. The ORR has endured a couple of recent attacks by the southern pine beetle (Roy et al. 2001). These attacks killed pine trees covering about 2100 ha. The devastation of primary cover opens many of these areas to invasive plants. By treating these areas, negative impacts of the pine loss can be reduced or minimized, and native plants can revegetate the areas.

#### **5.1.2.1 Environmentally Sensitive Areas and Aesthetic Resources**

A multispecies approach is often necessary to protect sensitive or special-value areas. In these cases, eliminating the primary invasive species may not meet the goal of protecting rare species or unique habitats. Also, an effort to target multiple species at one time can be more cost efficient if the method of treatment is the same for all target species. In 2003, a multiple-species treatment effort was initiated in Raccoon Creek Barren. At this site, the primary invasive was sericea lespedeza (*Lespedeza cuneata*), but other invasive plants were present, including Johnson grass (*Sorghum halepense*), fescue, privet, multiflora rose (*Rosa multiflora*), bull thistle (*Cirsium vulgare*), and Japanese honeysuckle. All these species were treated with the same herbicide used to target the lespedeza, so a multiple-species treatment was practical and efficient.

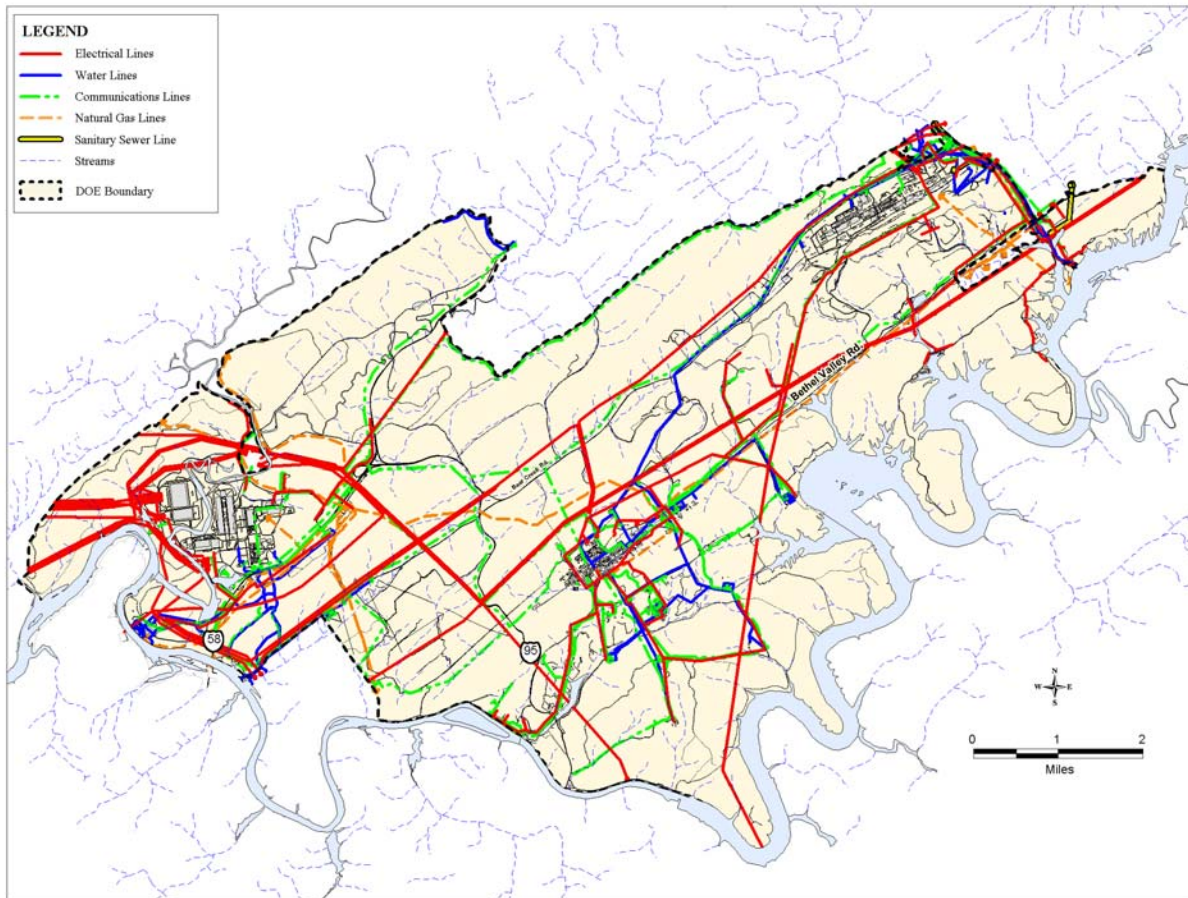
#### **5.1.2.2 Target Operational Areas**

In addition to treatment efforts concentrated on sensitive and unique areas, an area approach can also be used based upon the responsible land manager or facility. Because there are several major facilities within the ORR, the responsibility for some of the acreage is divided among these users. One useful strategy for managing invasive plants may be to work with the operational organizations of these facilities to treat problems in their areas. If regular grounds crews are scheduled to clear or trim in an area that also contains invasive plants, with a little guidance they can achieve multiple objectives with the same effort. Further, these efforts can provide leverage (labor, supplies, follow-up treatment) to gain even more treatment on invasive plants.

### **5.1.3 Target Routes of Dispersal and Invasion**

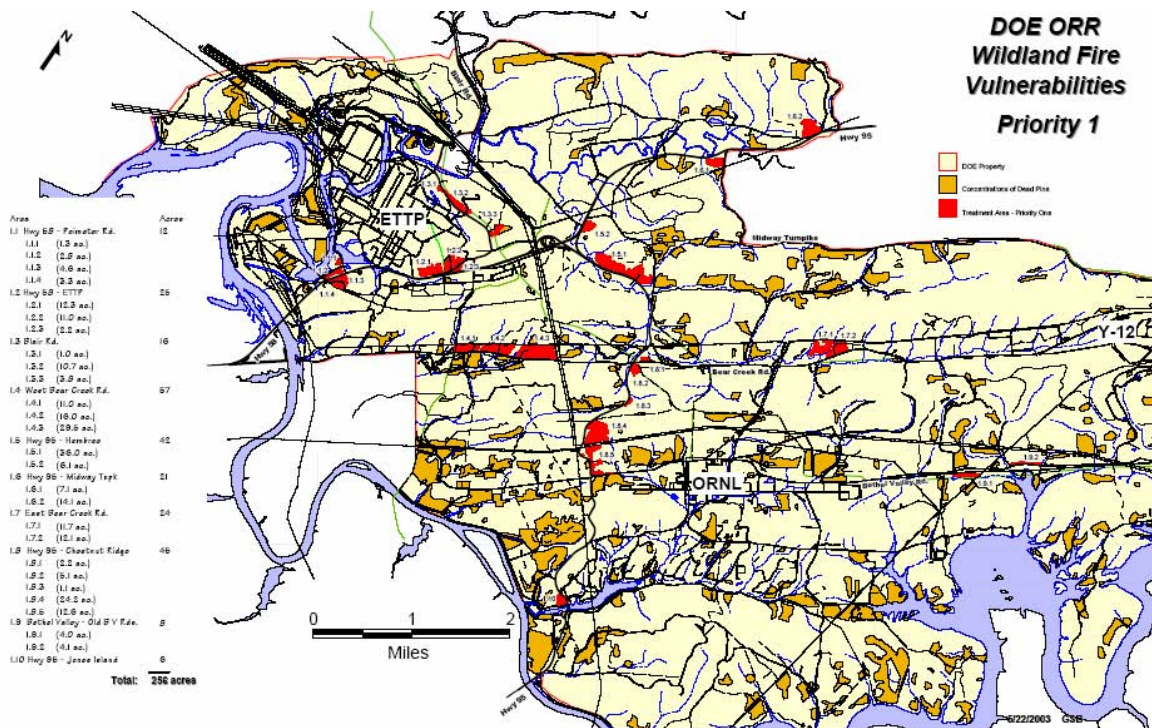
The third major approach to treatment of invasive species is to attack their routes of dispersal or invasion. Most invasive plants become established first along corridors of disturbance and in areas that have open canopies exposed to full sunlight. These routes of dispersal/invasion (Fig. 5.1) include roads, utility rights-of-way, streams and riparian buffers, and fenced perimeters. By managing invasive species in these corridors, not only are individual invasive plants eliminated, but their ability to spread further throughout the ORR is limited. For each type of dispersal corridor, implementation of slightly different control approaches is needed. For riparian areas, a highly selective treatment is recommended to minimize loss of





**Fig. 5.1 Location of major routes of dispersal for invasive plants on the ORR.** Routes include roadways, streams, and utility rights-of-way.

vegetative cover that helps control erosion and stabilize stream banks. For roadsides, the treatment can be broader in spectrum because the invasive plants often form a thicker monoculture along the edges of a road. Treatment can also be more mechanical because of the easy access roads provide. The right-of-way treatments along streams is also easy except in cases where steep slopes present a problem. Areas damaged by pine beetles are difficult to treat because of their. These areas are particularly vulnerable to invasion by nonnative species on the ORR because they represent a large portion of the reservation (Fig. 5.2). Pine-beetle ravaged areas should be monitored or treated to help control the invasive plant problem on the ORR.

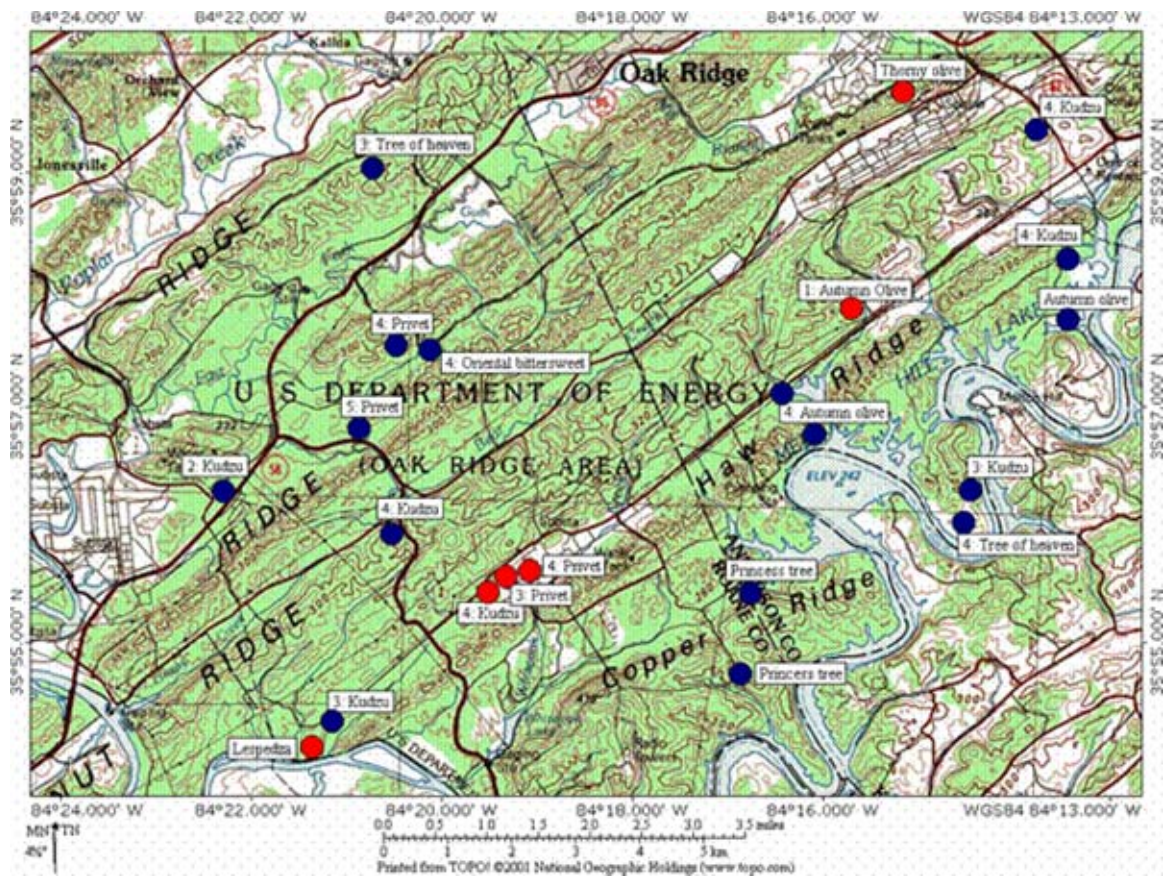


**Fig. 5.2. Areas damaged by southern pine beetle that have the potential for infestation by nonnative invasive plant species on the ORR.**

## 5.2 PRIORITIZING OPTIONS

Priorities must be set when selecting a specific approach and locations for management of invasive plants on the ORR. The scale of the ORR is large enough that currently available labor and funding will not allow all existing problems to be addressed immediately. The prioritization involves looking at the previously discussed approaches, examining the impact of specific invasive, determining applicable treatment techniques (see Sect. 6), and identifying available resources to handle the possible treatments. The priority rankings will vary from year to year, depending on progress in some areas, discovery of new species on the ORR, funding changes, and availability of new research options. For 2003, targets were identified subjectively, based on the management options outlined in this report. Projects are shown in Fig. 5.3.





**Fig. 5.3** Locations of invasive plant management demonstration areas in 2003 (red) and scheduled for 2004 (blue). Labels indicated relative priority and target species.

For 2004, the rankings indicated an emphasis on several areas. A prioritization procedure was developed (Table 5.1) that blended all three major approaches and other relevant data. Target species and areas are identified in Table 5.2, which shows the ranking for each species and how it was selected. Locations are shown in Fig. 5.3.

**Table 5.1 Priority rating procedure to determine which target invasive species and/or areas to treat on the ORR**

**Total Rating.** The priority assessment is a 12-metric evaluation to define what target species and locations should be treated first. Each metric is rated from 1 to 3, so 12 is the highest rating, indicating targets to treat first; 36 is the lowest rating, suggesting a less urgent need to treat. Generally, a target will include a species and location, e.g., kudzu-RA 8, or privet-Bethel Valley Road.

**1. Drake Survey Rating.** Based on Drake et al. (2002) survey rating for rankings of 18 species; those ranked 1–9 = 1; ranked 10–18 = 2; unranked = 3.

1 = Japanese grass, honeysuckle, privet, kudzu, multiflora rose, lespedeza,

Chinese yam, tree-of-heaven, field garlic

2 = autumn olive, oriental bittersweet, princess tree, Johnson grass, periwinkle, spearmint, watercress, bull thistle, crown vetch

3 = unranked species

**2. Johnston Survey Rating.** Based on Johnston (2003) survey that ranked species and NA areas.

1 = kudzu, tree-of-heaven, princess tree, mimosa, autumn olive, privet

2 = honeysuckle, oriental bittersweet, lespedeza, and Japanese grass

3 = others

**3. TNEPPC Threat Rank.** Based on threat ranking assigned plants by TN EPPC (2001; see Appendix A).

1 = severe threat

2 = significant threat

3 = lesser threat or watch list

**4. Natural Area/Reference Area Rating.** Based on NA/RA rating using priorities assigned by Parr and Pounds (personal communication, 2003).

1 = Priority 1 and 2 NAs, aquatic NAs, and aquatic RAs

2 = Priority 3 NAs, and RAs

3 = ORR areas that are not classified as RA or NA

**5. Control Rating.** Based on judgment of reproductive capacity and growth cycle of plant.

1 = plant takes several years to mature or has low seed production

2 = plant is early maturing perennial with moderate seed production

3 = plant is an annual or perennial with high seed production

**6. Density Rating.** Based on how thick the target species has covered an area, using a qualitative judgment.

1 = >75% coverage or monoculture

2 = >25 to 75% coverage

3 = <25% coverage

**7. Dispersal Corridor Rating.** Based on occurrence of target species in dispersal corridors.

1 = includes roads, rights-of-way, and stream areas

2 = includes 2 of 3 dispersal areas

3 = includes 1 or fewer dispersal areas



**Table 5.1, Cont.**

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**8. New Occurrence Rating.** Based on whether target is a new infestation.

- 1 = new occurrence or previously exterminated on ORR
- 2 = limited occurrence at five or fewer locations
- 3 = widespread occurrence

**9. Operational Priority Rating.** Based on whether control of target meets any or all of the following priorities: security, fuel buildup, contaminant transport, research/monitoring/compliance area, safety, visual impact, cultural resource, wildlife habitat, wetland, restoration/remediation site.

- 1 = five or more of the priorities
- 2 = three to four of the priorities
- 3 = two or fewer of the priorities

**10. Owner Rating.** Based on who is responsible for the target area.

- 1 = ETPP or Y-12 area of responsibility
- 2 = ORNL area of responsibility (i.e., most of ORR outside of facilities)
- 3 = TWRA, TVA, leased, or commercially owned area

**11. Treatment History Rating.** Based on whether site has been treated for invasive plants before, with the assumption that once treatment has been initiated at a site, it would be best to finish it before starting any new areas.

- 1 = treated more than once before
- 2 = treated once before
- 3 = not treated previously

**12. Help Rating.** Based on the amount of support for work in an area with the assumption that the more funds/labor that are leveraged for a site the better.

- 1 = help from two or more agencies/departments to cover cost/labor
  - 2 = help from one agency/department to cover cost/labor
  - 3 = no help from others
-

**Table 5.2 Priority ranking of selected target invasive plant species and areas for treatment on the ORR in 2004**

<b>Rank</b>	<b>Species</b>	<b>Site</b>	<b>Priority rating</b>
1	Autumn Olive	Bethel Valley Rd. at Mt. Vernon Rd.	19
2	Kudzu	Blair Rd. and Hwy. 58	21
3	Kudzu	Bull Bluff – NA 11	22
3	Kudzu	Raccoon Creek – RA 8	22
3	Tree-of-Heaven	Poplar Creek Cliff – NA 20	22
3	Privet	Walker Branch Barren – NA 7	22
3	Privet	First Creek	22
3	Privet	Fifth Creek	22
4	Kudzu	Bear Creek Rd. at Hwy. 95	23
4	Kudzu	Scarboro Rd.	23
4	Kudzu	Bethel Valley Rd. W of First Creek	23
4	Kudzu	Freels Bend Rd.	23
4	Autumn Olive	Walker Branch Barren – NA 7	23
4	Tree-of-Heaven	East Fork Ridge – NA 2	23
4	Oriental Bittersweet	East Fork Ridge – NA 2	23
4	Privet	East Fork Ridge – NA 2	23
4	Honeysuckle	First Creek	23
5	Kudzu	White Oak Ave.	24
5	Autumn Olive	Old Bethel Valley Rd.	24
5	Autumn Olive	Bull Bluff – NA 11	24
5	Princess Tree	East Fork Ridge – NA 2	24
5	Tree-of-Heaven	Bull Bluff – NA 11	24
5	Tree-of-Heaven	Lazy Beaver Forest – NA 10	24
5	Privet	Bull Bluff – NA 11	24
5	Privet	Hembree Marsh – NA 24	24
5	Privet	Lily Site at Hwy. 95 – NA 25	24
5	Privet	Sleepy Salamander – NA 48	24
5	Honeysuckle	East Fork Ridge – NA 11	24

### 5.3 IMPLEMENTATION AND SCHEDULE

Implementation of invasive plant management began informally in 2002–2003 in demonstration areas. The foundation for current efforts was laid out, and treatment was initiated in selected areas. Results of these efforts provided data used in the evaluation of how to proceed reservation-wide. The current schedule for implementation is based on the priorities listed in Table 5.1, using a relative scale that spans from 12 to 36 points. Based on resource expert knowledge of the ORR and invasive plant surveys, 60 potential target site/plant combinations were evaluated for treatment. The results of this analysis ranged from 19 to 30 points. The top 28 targets were broken down into five priorities (Table 5.2). These rankings were combined with the treatment requirements listed in Sect. 6 to determine potential schedules. Implementation will be achieved, within available funding constraints, by using contractor and subcontractor staff who specialize in treatment of invasive plants. Funds provided by the reservation management sitewide budget will be leveraged with resources from the other ORR facilities and interested agencies such as TVA and TWRA. Treatment locations where costs or labor can be shared with

other groups will be favored in the implementation. The 2004 schedule, based on this assessment of priorities, treatment options, and available funds, is given in Table 5.3.

#### **5.4 LONG-TERM PLANNING**

Beyond the next fiscal-year cycle, long-term goals are useful for management of the invasive plant problem on the ORR. Control of invasive species is recommended in areas identified as important — natural areas, security areas, remediation sites, or in areas where treatment efforts can make a difference. If a standard approach is used each year, achieving the overall goal of reducing invasive plants is possible. To meet this goal, we must revisit some of the treated areas for follow-up control or evaluation and modify the maintenance of rights-of-way areas to include treatment of invasive species. Working with TWRA to convert nonnative fescue areas to native grasses as part of the improvement of wildlife habitat complements long-term goals of invasive plant management. Because long-term efforts such as these span more than one fiscal year, appropriate budgeting is needed.

**Table 5.3 Target sites and invasive plant species to be treated in FY 2004 on the ORR\***

Site	Target species	Priority rank	Party performing work	Effort (\$)	Partner Agency /Division
Bethel Valley Rd. x Mt. Vernon Rd.	Autumn olive	1	CSC	2,000	TVA
Hwy. 58 x Blair Rd.	Kudzu	2	CSC	8,000	
Bethel Valley Rd. x First Creek	Kudzu	4	CSC	2,000	
Bethel Valley Rd. x First Creek	Kudzu	4	ORNL F&O	1,000	
Scarboro Rd	Kudzu	4	CSC	4,400	Y-12 Security
Hwy 95 x Bear Creek Rd.	Kudzu	4	CSC	8,800	
Raccoon RA 8	Kudzu	3	IPC	3,000	
Poplar Bluff NA 20	Tree of heaven	3	IPC	1,000	
Walker Branch NA 7	Autumn olive /privet	4/3	IPC	3,000	
East Fork Ridge NA 2	Privet/tree of heaven / princess tree	4- 5	IPC	4,000	
Bull Bluff NA 11	Kudzu	3	IPC	1,000	TWRA
Bull Bluff NA 11	Autumn olive/ privet / tree of heaven / princess tree	4-5	IPC	4,000	
Bull Bluff NA 11	Kudzu	3	TWRA	1,800	RM
Freels Bend Rd.	Kudzu	4	TWRA	1,800	
Freels Bend Rd.	Autumn olive / privet	NR	TWRA	1,100	RM
Bethel Valley Rd. x Mt. Vernon Rd.	Autumn olive	1	TVA	2,000	RM
Hembree Marsh NA 24	Privet / honeysuckle / autumn olive	5	RM (ESD)	1,600	
Fifth Creek/First Creek	Privet / honeysuckle	3 – 4	RM (ESD)	1,600	
East Fork Ridge NA 2	Oriental bittersweet	4	RM (ESD)	1,600	
Freels Bend Rd.	Autumn olive / privet	NR	RM (ESD)	4,800	TWRA
Total				58,500	

\* The sitewide reservation management (RM) budget provides FY 2004 funding for subcontractor (CSC, IPC) or contractor staff [Environmental Sciences Division (ESD), Facilities and Operations Directorate (F&O)]. Other sources of funding or labor include TVA and TWRA.

## 6. TREATMENTS AND TIMING

The types and timing of treatments make a difference in the effectiveness of the results and the efficiency of the effort. Not all invasive species will respond to the same types of treatments, and a single type of treatment may not be appropriate for a site with multiple invasive species, especially if it is interspersed with desirable plants. The variety of pest management techniques described here are used on an integrated basis to enhance the effectiveness of the treatments. Land managers and researchers should continue to experiment with combinations of treatments, doses, and timing to meet site-specific needs. Treatment techniques include

- mechanical,
- biocontrol,
- chemical,
- prescribed burning, and
- other approaches.

The technique used for treatment should consider issues such as the existence of desirable species in the area, proximity to water, stage of the plant in the growing season, density of the population, and available manpower.

### 6.1 MECHANICAL TREATMENTS

Mechanical treatments include hand pulling, weed wrenching, cutting, and mowing. Mechanical treatments such as mowing have been extensively used on the ORR usually to meet management goals other than control of invasive vegetation, for example, to assure visibility along roads, and to control growth of woody vegetation that could interfere with power lines. These techniques can also be targeted specifically to invasive plants. Thickets of species such as privet and autumn olive can be mowed to remove surface growth. However roots are typically not killed, and mowing results in additional sprouts that require repeated mowing or chemical treatment for ultimate control. Mowing invasive species can be part of an effective control strategy for heavy infestations when cut surfaces are also chemically treated to control root masses. Similarly, invasive trees can be individually cut, and effectiveness can be enhanced through the use of chemical treatment to prevent root sprouts. Other mechanical methods, such as hand pulling and digging out roots, are also effective for control of certain species in selected settings, but are labor- and time-intensive for large infestations.

### 6.2 BIOCONTROLS

Biological control, or biocontrol, is the science of reconnecting invasive plants with the specialized natural enemies that often limit their density in their native ranges. This process consists of surveys in the plant's area of origin to discover candidate natural enemies, studies on their biology and host specificity and release and evaluation of their impacts on the target plant. In the eastern United States, projects have been targeted against aquatic, pasture, and forest weeds (Van Driesche et al. 2002). Results to date have been varied, with biocontrol showing promise for economic control of aquatic species such as Eurasian watermilfoil (Johnson and Blossey 2002) and pasture species such as multiflora rose (Amrine 2002). Because these methods are not yet as widespread as more conventional control methods, the cost is often high. In addition, the application of biocontrol agents can be time- and labor-intensive. No biocontrols have been introduced on the ORR, but when an appropriate setting for their use is found biocontrols can be evaluated as a management option.

### 6.3 PRESCRIBED BURNING

Fire has not been used on the ORR to treat invasive plants. However it has been used for "cleanup" of areas with pine beetle damage in preparation for restoration activities. Careful, controlled use of fire (i.e., prescribed burns) is often used for management of native warm-season grasses and understory vegetation

in forests. Published information on using fire to control invasive species suggests that the potential is very dependent on the invasive species and whether the native vegetation is fire-adapted (D’Antonio 2000, Wittenberg and Cook 2001). There seems to be as much potential to promote invasive growth as to control it when using fire. However, the literature reviews focus almost entirely on the western United states with little data available for eastern invasive species. The use of prescribed burns might be an approach that could be beneficial in controlling large infestations of invasive plants. In most cases, the burns would not be sufficient on their own to eliminate the plants, but if the burns were combined with follow-up chemical treatment, they could be very effective. The Nature Conservancy has experimented with the use of prescribed burns, but little published information exists on controlling invasive plants with burns. The use of prescribed burns is a potential area for research on the ORR.

## 6.4 CHEMICAL TREATMENTS

Chemical treatments are pesticide applications and have included herbicides that can be applied without certification and those that require special licensing for application. A primary goal of any invasive plant management program is selectivity of control—control of the invasive species without harming desirable, native vegetation that is often present in close proximity. Chemical treatments can offer such selectivity through application technique, timing, and chemical modes.

### 6.4.1 Application Techniques

Application techniques include handheld spraying, backpack spraying, high-volume truck container spraying with hoses, wicking, and basal bark treatments. Each of these techniques can be directed preferentially at a particular invasive species, while minimizing harm to its desirable neighbors. Table 6.1 describes the primary herbicide application techniques used on the ORR and includes notes about timing and selectivity. Selection of the appropriate herbicide depends in part on the chemical modes of action that kill a particular plant group, and the likelihood of not harming desirable groups of plants in the area. Table 6.2 describes the major herbicides used on the ORR and includes information on their selectivity and application techniques.

**Table 6.1 Application techniques for using chemicals to control invasive plants on the ORR**

<b>Technique</b>	<b>Description</b>	<b>Timing</b>	<b>Selectivity</b>
Foliage spray	Herbicide mixture is sprayed on plant foliage until wet	Whenever foliage is present	Spray can be directed to avoid desirable vegetation, selective herbicides can be used, application can be made to “evergreen” foliage when deciduous foliage is not present
Cut surface	Herbicide mixture is sprayed or painted onto cut stumps, or cuts (termed frill cuts) made into stems of plants to be killed	Year round except when freezing	Only target species are treated
Basal	Herbicide mixture in oil base is sprayed around stem wetting the lower 12 inches (the “base” hence basal)	Year round except when bark is frozen or wet	Spray can be directed to avoid desirable vegetation when present

## 6.4.2 Timing of Treatments

Susceptibility of particular plant species to chemical control depends on biological characteristics of the plant that are most often keyed to the annual growth cycle. For instance, control of deciduous species with foliage-active herbicides is possible only when foliage is present and typically works best when leaves are fully developed in summer. By contrast, evergreen species offer a wider foliage treatment window. Cut surface treatments can be performed year round on all woody species, as can basal treatments, although effectiveness varies with the season. Basal applications work best in late winter and early spring as the plant mobilizes energy to break winter dormancy.

The choice of an application technique for a particular species or group of species is limited by the period of the year in which it is possible to use the technique for that species. Next, the choice of a technique (from all techniques possible at whatever times of year) can be optimized based on considerations such as ease of application, opportunity for greater selectivity of application, and availability of labor and time. For instance, foliage applications can be made to evergreen species when nearby desirable deciduous species are without leaves thereby giving an extra margin of selectivity. Basal applications can be made in winter when foot travel through a forest is easier than in summer, thereby increasing the number of stems that can be treated per unit of time. Cut surface treatments can be made for woody species whenever labor is available, regardless of season of the year.

**Table 6.2 Herbicides used for control of invasive species on the ORR and information on their use**

<b>Product name<sup>1</sup></b>	<b>Chemical and formulaton</b>	<b>Selectivity</b>	<b>Technique: Typical rate (% in water, unless otherwise stated)</b>
Garlon 3A	44% triclopyr (amine)	Woody plants and broadleaf weeds; grasses unaffected	Foliage spray: 1–5% , cut surface: 25–100%
Garlon 4; Remedy	62 % triclopyr (ester)	Woody plants and broadleaf weeds; grasses unaffected	Basal: 1–30% solution of product with oil, cut surface: 20–30% solution of product with oil
Pathfinder II	62 % triclopyr (ester)	Woody plants and broadleaf weeds; grasses unaffected	Basal: premixed, used undiluted
Tordon K	24% picloram	Woody plants and broadleaf weeds; grasses unaffected; has soil activity	Foliage spray: 0.5–1% solution
Pathway	5.4 % picloram and 20.9% 2,4-D	Woody plants and broadleaf weeds; grasses unaffected; has soil activity	Cut surface: premixed, used undiluted
Roundup Glypro SP	41% glyphosate	Nonselective	Foliage spray: 2%, cut surface: 50–100%
Transline	41% clopyralid	Broadleaf weed and legumes; grasses unaffected; has soil activity	Foliage spray: 0.25–0.75%

<sup>1</sup>All chemicals manufactured by Dow Chemical, except for Roundup, which is manufactured by Monsanto.

For purposes of facilitating choice of application techniques and optimization of timing of treatments, the most problematic ORR invasive species have been grouped into eight categories based on relevant biological characteristics. These plant groups are deciduous trees, deciduous shrubs, deciduous vines, evergreen shrubs, evergreen vines, legumes, monocots, and herbaceous dicots (forbs). For each of these plant groups (and species in some cases) a determination has been made of which application techniques are possible during each month of the year (Table 6.3).

Within the table, a letter indicates the type of technique: ‘F’ for foliage spray, ‘C’ for cut surface, and ‘B’ for basal. If a letter(s) is present in a month, then the treatment is possible for that species at that time with that technique. If the letter(s) is in italic, then the associated treatment technique is optimal with respect to ease of application, enhanced selectivity, or efficacy as discussed previously. Table 6.3 can be used as an invasive plant control planning tool by noting seasonal overlaps of plant group optima. In addition, when locations of plant groups to be treated are determined and transportation to them is organized by cluster, further optimization of resources is possible.

While many invasive species can be controlled effectively throughout much of the year, others, such as the annual grass *Microstegium* (Japanese grass), have a much narrower window for effective control. For this species, mowing, burning, or herbicide applications early in the season do not control the plant; new seeds in the soil can germinate following such measures, and the resultant plants can still have time to set seed by the end of the season. Therefore, the most effective timing strategy is to kill or otherwise remove the foliage of *Microstegium* late in the season, but before seed has set, to avoid a new crop. This procedure must be followed for several years to give lasting control as seeds remain viable for 3 to 5 years.

## **6.5 OTHER APPROACHES**

Creative approaches to treatment can include other factors, such as tree harvesting, where it is cost effective. For example, a few large Paulownia trees have been identified on the ORR. Removal of these specific trees through a contract with specialty wood cutters would be a doubly positive approach because the wood is used in special products and the source of a problem plant species is eliminated for the ORR.

## **6.6 LEVERAGING RESOURCES FOR TREATMENT**

Because invasive plants are a nationwide problem, working (formally and informally) with other agencies within the region provides a mechanism to share and obtain regional resources. Agencies and organizations who have worked together both formally and informally include:

- Appalachian Regional Commission
- Bechtel Jacobs Corporation
- BWXT Y-12
- Certified Services Company
- GroWild (Native Plant Nursery)
- Invasive Plant Control, Inc.
- National Park Service (Great Smoky Mountains National Park)
- Native Gardens (Native Plant Nursery)
- Southeast Exotic Pest Plant Council
- Southern Appalachian Man and the Biosphere Cooperative
- Tennessee Department of Environment and Conservation (TDEC)
- Tennessee Exotic Pest Plant Council (TN EPPC)
- Tennessee Valley Authority (TVA)
- Tennessee Wildlife Resources Agency (TWRA)



- The Nature Conservancy
- University of Tennessee at Knoxville (UT)
- U.S. Department of Energy (DOE)
- U.S. Forest Service

A 2003 memorandum of agreement among UT-Battelle, TVA, TWRA, and DOE enabled the initiation of treatment of several acres of autumn olive, privet, bush honeysuckle, and other invasive plants within powerline rights-of-way and adjacent areas where they have spread. Recommended follow-up revegetation is native grasses and shrubs.

TWRA is responsible, through an agreement with DOE, for wildlife management on all of the ORR. Its goals to benefit wildlife include control of invasive species (plant and wildlife) and restoration using native grasses. TWRA has initiated treatment of invasive species in areas near the deer checking station on Bethel Valley Road, Gallaher Bend, and Solway, Gallaher, and Freels Bends.

University faculty and students have initiated research on invasive plants using study sites on the Research Park. Research has included analyses of moisture and shading on *Microstegium*, evaluating the impact of invasive plants on a small population of a state-listed orchid, determining factors that may inhibit invasive plant growth, and studying impacts of changes in climate and carbon dioxide on invasive plant growth. Results of these research projects are shared through open literature publications and conference presentations.

**Table 6.3 Timing of herbicide application techniques for invasive plants on the ORR**

Plant group	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Deciduous trees	CB	CB	CB	CB	CB	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	CB	CB
Deciduous shrubs												
Multiflora rose	CB	CB	<i>BC</i>	<i>BC</i>	<i>BFC</i>	FCB	FCB	FCB	FCB	CB	CB	CB
Autumn olive	CB	<i>BC</i>	<i>BC</i>	BC	CB	<i>FBC</i>	<i>FCB</i>	<i>FBC</i>	<i>FBC</i>	CB	CB	CB
Deciduous vines												
Chinese yam	CB	CB	CB	CB	CB	<i>FBC</i>	<i>FBC</i>	<i>FBC</i>	<i>FBC</i>	CB	CB	CB
Oriental Bittersweet	CB	CB	CB	CB	CB	FCB	FCB	FCB	FCB	CB	CB	CB
Evergreen shrub	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>
Evergreen vine	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>	<i>FCB</i>
Legumes												
Crown vetch						<i>F</i>	<i>F</i>	<i>F</i>	<i>F</i>			
Lespedeza					<i>F</i>	<i>F</i>	<i>F</i>	<i>F</i>	<i>F</i>			
Kudzu	<i>C</i>	<i>C</i>	<i>C</i>	<i>C</i>	<i>C</i>	<i>F</i>	<i>F</i>	<i>F</i>	<i>F</i>	<i>C</i>	<i>C</i>	<i>C</i>
Monocots												
Field garlic				<i>F</i>	<i>F</i>	<i>F</i>						
Microstegium								<i>F</i>	<i>F</i>			
Johnsongrass						<i>F</i>	<i>F</i>	<i>F</i>	<i>F</i>			
Herbaceous dicots				<i>F</i>	<i>F</i>	<i>F</i>	<i>F</i>	<i>F</i>	<i>F</i>			

Treatment types: F= foliar spray; C = cut surface (frill or cut stump); B = basal bark treatment. Abbreviations in a month indicate treatment is possible; italic letters indicate treatment is optimal for that type of treatment during that month.

## 7. RESTORATION OF TREATED AREAS

The restoration of any area formerly invaded by nonnative plants is the most important phase of final control (Miller 2003). In most cases on the ORR, successful removal of invasive species will allow the surrounding native vegetation to spread into the newly opened area and become reestablished. Successful removal consists of the initial killing of the invasive plant with no reestablishment from existing seed stocks or nearby root stocks. When this is the case, the treated area restores itself from the existing native vegetation. To ensure that this natural restoration is taking place, treated areas should be monitored for success and retreated for invasive species if needed. As experience is gained with treatment techniques and timing on the range of invasive species on the ORR, treatment strategies are continuously refined for maximum effectiveness.

In some cases, however, usually where extensive monocultures of a particular invasive species have become established, more extensive restoration efforts may be required. Successful treatment of invasive species such as kudzu, which can completely occupy extensive areas, may result in open areas so large that surface erosion can become a problem before native species have time to become reestablished. Where this is the case, revegetation is recommended, and planting native species will assist in meeting management goals. Surface preparation may be necessary. Slopes where kudzu is eradicated may be planted with native grasses to prevent further erosion problems, and it is possible the area beneath the kudzu is already eroded. Power line rights-of-way that have been acting as dispersal corridors for autumn olive may be reseeded with native grasses and low-growing shrubs after treatment by herbicides which remove the patches of autumn olive. Experience gained with reestablishment of native species where invasive species have been controlled has been valuable for efforts under way on the ORR. Native grassland areas are being established to replace higher maintenance lawn type areas and for restoration of areas affected by other stressors such as the pine bark beetle. Where such active restoration is employed, areas are monitored and maintained as necessary until native communities have become established. After native species are restored, these functional plant communities help prevent the establishment of invasive plants in what would otherwise be disturbed areas.

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## **APPENDIX A: TENNESSEE INVASIVE PLANT SPECIES LIST**

This appendix contains a reprint of “Invasive Exotic Pest Plants in Tennessee—2004” published by the the Tennessee Exotic Pest Plant Council (printed with permission).



# INVASIVE EXOTIC PEST PLANTS IN TENNESSEE – 2004

This is the first revision of the Invasive Exotic Pest Plants in Tennessee list, originally published in 1995. That list was initiated from the 'introduced taxa' portion of the Checklist of the Vascular Plants of Tennessee (pub. 1993 by B. E. Wofford and R. Kral), and was developed by the research committee of the Tennessee Exotic Pest Plant Council. The development of the list included reviews by professional and amateur botanists, ecologists, and resource managers. All comments were considered, and a consensus approach was accepted.

This revision followed a similar review process; however, a second step was initiated to review the plant list on a regional scale. First, the list was sent to professional and amateur botanists, ecologists, and resource managers for review of recommended changes, including additions, deletions, or changes to current species ranking. The second step established working subcommittees representing the three Grand Divisions of Tennessee: West, Middle, and East. The subcommittees reviewed the 1995 list, considered all reviewers' comments, and made their recommendations to the TN-EPPC Review Committee.

The TN-EPPC Review Committee was organized with at least one subcommittee representative from each region. The Review Committee included Dr. Scott Franklin, Ecologist, UT-Memphis; Kris Johnson, Resource Manager Specialist, Great Smoky Mountains National Park; Geoff Call, Resource Manager Specialist, Arnold Engineering and Development Center; Michele Webber, Botanist, Stones River National Battlefield; and Brian Bowen, Tennessee Department of Environment and Conservation's Division of Natural Heritage. The Review Committee made final additions, deletions, and changes in the species ranking based on consensus. Additions to the list include species discovered in Tennessee since 1995 that have been reported to cause ecological damage, species known to cause ecological damage elsewhere and are considered potential threats, and species that may have been overlooked during development of the 1995 list.

Nomenclature and authorship are taken from Kartesz, J., Synthesis of the North American Flora, August 1999.

The intent of this list is to: 1) rank exotics based on their invasive characteristics; 2) foster early detection of invasive exotics so that resource managers can implement a rapid response action to prevent them from becoming established and spreading; 3) educate the general public and resource managers in an effort to eliminate the use of invasive exotics in landscaping, restoration, and enhancement projects.

This list has no regulatory authority but provides useful information to help guide agencies and private landowners in making responsible decisions about plant use and management decisions. The Council acknowledges that most introduced species are harmless. However, it also realizes that many species do naturalize and have the potential to spread and become ecological disasters.



RON MCCONATHY

Autumn olive (*Elaeagnus umbellata*); Rank 1 – Severe Threat

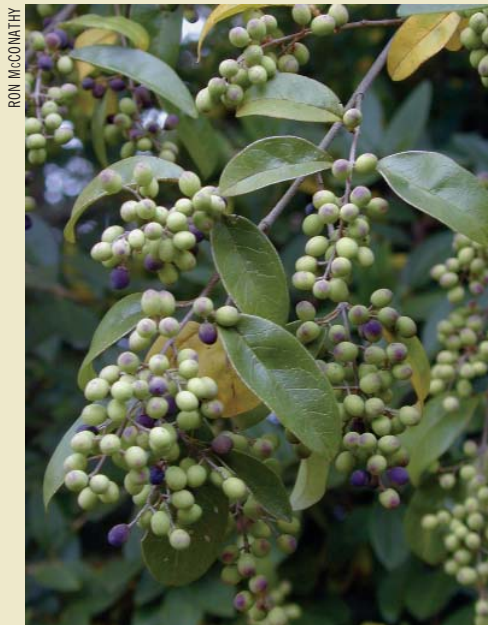


**Rank 1 – Severe Threat:** Exotic plant species that possess characteristics of invasive species and spread easily into native plant communities and displace native vegetation.

**Rank 2 – Significant Threat:** Exotic plant species that possess characteristics of invasive species but are not as easily spread into native plant communities

Scientific Name	Common Name
<i>Ailanthus altissima</i> (Mill.) Swingle	Tree of Heaven
<i>Albizia julibrissin</i> Durz.	Mimosa
<i>Alliaria petiolata</i> (Bieb.) Cavara & Grande	Garlic-mustard
<i>Celastrus orbiculata</i> Thunb.	Asian bittersweet
<i>Dioscorea oppositifolia</i> L.	Air-potato
<i>Elaeagnus umbellata</i> Thunb.	Autumn olive
<i>Elaeagnus pungens</i> Thunb.	Thorny-olive
<i>Euonymus fortunei</i> (Turcz.) Hand. – Mazz.	Winter creeper
<i>Hedera helix</i> L.	English ivy
<i>Lespedeza cuneata</i> (Dum.-Cours.) G. Don	Sericea lespedeza
<i>Ligustrum sinense</i> Lour.	Chinese privet
<i>Ligustrum vulgare</i> L.	Common privet
<i>Lonicera fragrantissima</i> Lindl. & Paxton	January jasmine
<i>Lonicera japonica</i> Thunb.	Japanese honeysuckle
<i>Lonicera maackii</i> (Rupr.) Maxim.	Amur bush honeysuckle
<i>Lonicera morrowii</i> A. Gray	Morrow’s bush honeysuckle
<i>Lonicera tatarica</i> L.	Tartarian honeysuckle; twin sisters
<i>Lonicera x bella</i> Zabel	Bush honeysuckle
<i>Lythrum salicaria</i> L. [all varieties and cultivars]	Purple loosestrife
<i>Microstegium vimineum</i> (Trin.) A. Camus	Nepalgrass; Japanese grass
<i>Myriophyllum spicatum</i> L.	Eurasion water milfoil
<i>Paulownia tomentosa</i> (Thunb.) Sieb. & Zucc. ex Steud.	Princess tree
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	Common reed
<i>Polygonum cuspidatum</i> Seib. & Zucc.	Japanese knotweed; Japanese bamboo
<i>Pueraria montana</i> (Lour.) Merr.	Kudzu
<i>Rosa multiflora</i> Thunb.	Multiflora rose
<i>Solanum viarum</i> Dunal	Tropical soda apple
<i>Sorghum halepense</i> (L.) Pers.	Johnson grass
<i>Spiraea japonica</i> L.f.	Japanese spiraea

Scientific Name
<i>Alternanthera philoxeroides</i> (Mart.) Griseb.
<i>Artemisia vulgaris</i> L.
<i>Arthraxon hispidus</i> (Thunb.) Makino
<i>Berberis thunbergii</i> DC
<i>Bromus commutatus</i> Schrad.
<i>Bromus japonicus</i> Thunb. ex Murray
<i>Bromus secalinus</i> L.
<i>Bromus tectorum</i> L.
<i>Carduus nutans</i> L.
<i>Centaurea biebersteinii</i> DC
<i>Cirsium arvense</i> (L.) Scop.
<i>Cirsium vulgare</i> (Savi) Ten.
<i>Clematis ternifolia</i> DC
<i>Conium maculatum</i> L.
<i>Coronilla varia</i> L.
<i>Daucus carota</i> L.
<i>Dipsacus fullonum</i> L.
<i>Dipsacus laciniatus</i> L.
<i>Euonymus alata</i> (Thunb.) Sieb.
<i>Festuca arundinacea</i> Schreb.
<i>Festuca pratensis</i> Huds.
<i>Hesperis matronalis</i> L.
<i>Hydrilla verticillata</i> (L.f.) Royle
<i>Lespedeza bicolor</i> Turcz.
<i>Ligustrum japonicum</i> Thunb.
<i>Lysimachia nummularia</i> L.
<i>Mahonia beali</i> (Fortune) Carriere
<i>Melilotus albus</i> Medik.
<i>Melilotus officinalis</i> (L.) Lam.
<i>Miscanthus sinensis</i> Andersson
<i>Murdannia keisak</i> (Hassk.) Hand. -Mazz.
<i>Myriophyllum aquaticum</i> (Vell.) Verdc.
<i>Nandina domestica</i> Thunb.
<i>Rorippa nasturtium-aquaticum</i> (L.) Hayek
<i>Polygonum caespitosum</i> Blume
<i>Populus alba</i> L.
<i>Potamogeton crispus</i> L.
<i>Setaria faberi</i> R.A.W. Herrm.
<i>Setaria italica</i> (L.) P. Beauv.
<i>Setaria pumila</i> (Poir.) Roem. & Schult.
<i>Setaria viridis</i> (L.) P. Beauv.
<i>Torilis arvensis</i> (Huds.) Link
<i>Tussilago farfara</i> L.
<i>Verbascum thapsus</i> L.
<i>Vicia sativa</i> L.
<i>Vinca minor</i> L.
<i>Wisteria sinensis</i> (Sims) DC
<i>Wisteria floribunda</i> (Willd.) DC
<i>Xanthium strumarium</i> L.



Chinese privet (*Ligustrum sinense*)



Nandina (*Nandina domestica*)

RON McCONATHY

KEN LANGELAND



plant species that possess characteristics not presently considered to spread as those species listed as **Rank 1**.

**Rank 3 – Lesser Threat:** Exotic plant species that spread in or near disturbed areas, and are not presently considered a threat to native plant communities.

**Common Name**

- Alligatorweed
- Mugwort, common wormwood
- Hairy jointgrass
- Japanese barberry
- Meadow brome
- Japanese brome grass
- Rye brome
- Thatch brome grass, cheat grass
- Musk thistle, nodding thistle
- Spotted knapweed
- Canada thistle
- Bull thistle
- Leatherleaf clematis
- Poison hemlock
- Crown vetch
- Wild carrot, Queen Anne's-lace
- Fuller's teasle
- Cutleaf teasle
- Burning bush
- Tall fescue
- Meadow fescue
- Dame's rocket
- Hydrilla, water thyme
- Bicolor lespedeza, shrubby bushclover
- Japanese privet
- Moneywort, creeping Jenny
- Oregon grape
- White sweet clover
- Yellow sweet clover
- Zebra grass, Chinese silver grass
- Asian spiderwort
- Parrot's feather, water milfoil
- Nandina, sacred-bamboo
- Watercress
- Bunchy knotweed, oriental ladies-thumb
- White poplar
- Curly pondweed
- Nodding foxtail-grass
- Foxtail-millet
- Yellow foxtail, smooth millet
- Green millet
- Spreading hedge-parsley
- Coltsfoot
- Common mullein
- Garden vetch
- Common periwinkle
- Chinese wisteria
- Japanese wisteria
- Common cocklebur

**Scientific Name**

- Allium vineale* L.
- Arundo donax* L.
- Bromus catharticus* Vahl
- Bromus inermis* Leyss.
- Broussonetia papyrifera* (L.) L'Her. ex Vent.
- Buglossoides arvensis* (L.) I.M. Johnston
- Cardiospermum halicacabum* L.
- Centaurea cyanus* L.
- Chrysanthemum leucanthemum* L.
- Chicorium intybus* L.
- Egeria densa* Planch.
- Elaeagnus angustifolia* L.
- Eschscholzia californica* Cham.
- Fatoua villosa* (Thunb.) Nakai
- Glechoma hederacea* L.
- Iris pseudoacorus* L.
- Kummerowia stipulacea* (Maxim.) Makino
- Kummerowia striata* (Thunb.) Schindl.
- Melia azedarach* L.
- Ornithogalum umbellatum* L.
- Pastinaca sativa* L.
- Polygonum persicaria* L.
- Rubus phoenicolasius* Maxim.
- Senna obtusifolia* (L.) H.S. Irwin & Barneby
- Tragopogon dubius* Scop.
- Tribulus terrestris* L.
- Urtica dioica* L.
- Xanthium spinosum* L.

**Common Name**

- Field Garlic
- Giant reed, elephant grass
- Brome grass, rescue grass
- Smooth brome grass
- Paper mulberry
- Corn gromwell
- Balloonvine, love-in-a-puff
- Bachelor's button, cornflower
- Ox-eye daisy
- Chicory
- Brazilian elodea, Brazilian water-weed
- Russian olive
- California poppy
- Hairy crabweed
- Gill-over-the-ground, ground ivy
- Pale-yellow iris
- Korean clover
- Japanese clover
- Chinaberry
- Star of Bethlehem
- Wild parsnip
- Lady's thumb
- Wineberry
- Sicklepod senna
- Yellow goat's-beard
- Puncturevine
- Stinging nettle
- Spiny cocklebur



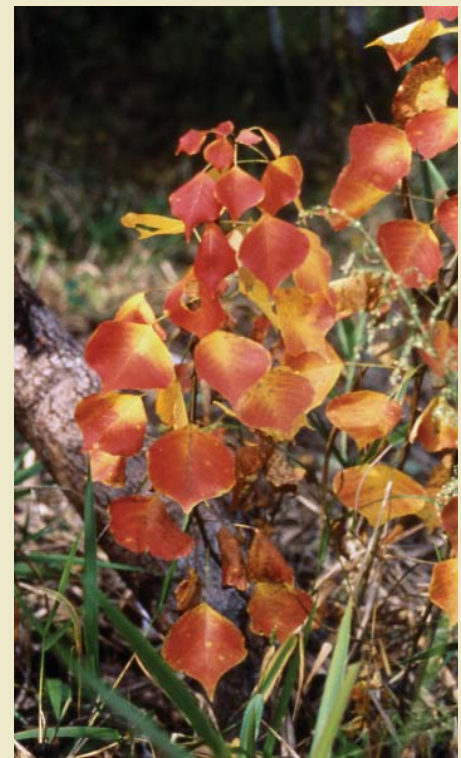
Chinaberry (*Melia azedarach*)



Japanese honeysuckle (*Lonicera japonica*)

**Watch List A:** Exotic plants that naturalize and may become a problem in the future; includes species that are or could become widespread in Tennessee. At this time more information is needed, and there is no consensus about their status.

Scientific Name	Common Name
<i>Agrostis stolonifera</i> L.	Weeping love grass
<i>Alnus glutinosa</i> (L.) Gaertn.	Sticky alder
<i>Bromus hordeaceus</i> L.	Soft brome
<i>Bromus sterilis</i> L.	Poverty brome
<i>Buddleia davidii</i> Franch.	Butterfly bush
<i>Bupleurum rotundifolium</i> L.	Hound's-ear, hare's-ear
<i>Cosmos bipinnatus</i> Cav.	Garden cosmos
<i>Cosmos sulphureus</i> Cav.	Sulphur cosmos
<i>Echium vulgare</i> L.	Viper's bugloss
<i>Hibiscus syriacus</i> L.	Rose of Sharon
<i>Hypericum perforatum</i> L.	Goatweed, St. John's-wort
<i>Mentha spicata</i> L.	Spearmint
<i>Mentha x piperita</i> L.	Peppermint
<i>Muscari atlanticum</i> Boiss. & Reut.	Grape hyacinth
<i>Muscari botryoides</i> (L.) Mill.	Common grape hyacinth
<i>Najas minor</i> All.	Water nymph
<i>Phalaris canariensis</i> L.	Canary grass
<i>Pyrus calleryana</i> Decne.	Bradford pear
<i>Rhamnus frangula</i> L.	Alder buckthorn
<i>Rhodotypos scandens</i> (Thunb.) Makino	Jetbead
<i>Senecio vulgaris</i> L.	Ragwort
<i>Seteria verticillata</i> (L.) P. Beauv.	Bur-foxtail
<i>Solanum dulcamara</i> L.	Bittersweet
<i>Stachys floridana</i> Shuttlew. ex Benth.	Hedge nettle



Chinese tallowtree (*Sapium sebiferum*) with fall foliage

PHOTOS BY KEN LANGE LAND

**Watch List B:** Exotic plant species that are severe problems in surrounding states but have not been reported in Tennessee.

Scientific Name	Common Name
<i>Ampelopsis brevipedunculata</i> (Maxim.) Trautv.	Amur peppervine
<i>Polygonum perfoliatum</i> L.	Mile-a-minute
<i>Rhamnus cathartica</i> L.	European buckthorn
<i>Rottboellia cochinchinensis</i> (Lour.) Clayton	Itchgrass
<i>Salvinia molesta</i> Mitchell	Aquarium water-moss
<i>Sapium sebiferum</i> (L.) Roxb.	Chinese tallowtree



Chinese tallowtree (*Sapium sebiferum*)

**What the TN-EPPC Does:**

- Raises public awareness about the spread of invasive exotic plants into Tennessee natural areas;
- Facilitates the exchange of information concerning management and control of invasive exotic plants;
- Provides a forum for all interested parties to participate in meetings, workshops, and an annual symposium, and to share the benefits from the information provided by TN-EPPC;
- Serves as an educational, advisory, and technical support council on all aspects of exotics;
- Initiates campaign actions to prevent further introductions

Please visit the TN-EPPC web site at [www.tneppc.org](http://www.tneppc.org)

## APPENDIX B: GLOSSARY

**Aggressive species:** “Aggressive species” are those that spread rapidly, persist, and have the greatest tendency to exclude native plant species, thus, becoming pests.

**Alien species:** “Alien species” means, with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem. [*From* EO 13112, Section 1. Definitions (a)]

**Biocontrol:** “Biological control,” or biocontrol, involves reconnecting invasive plants with the specialized natural enemies that usually limit their density in their native ranges.

**Integrated pest management:** “Integrated pest management” is the coordinated use of pest and environmental information with available pest control methods to prevent unacceptable levels of pest damage by the most economical means and with the least possible hazard to people, property, and the environment.

**Invasive plant species:** “Invasive species” means an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health. [*From* EO 13112, Section 1. Definitions (f)]

**Native:** A “native” (or indigenous) species is one that was not introduced into a geographical area by human actions.

**Nonnative:** A “nonnative” (or alien, exotic, foreign, introduced, or non-indigenous) species is one that occurs artificially in locations beyond its known historical natural range. Nonnative can refer to species brought in from other continents, regions, ecosystems, and even other habitats.

**Noxious weed:** A “noxious weed” is a species that is, or is liable to be, troublesome, aggressive, intrusive, detrimental, or destructive to agriculture, silviculture, or important native species, public roads or other property; and is difficult to control or eradicate. (*From*: WAPA 1999). The term “noxious weed” means any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment. [*From*: Title IV—Plant Protection Act. Public Law 106–224. June 20, 2000. Sec. 403. Definitions (10)]

**Pest plants:** Plant species, and parts thereof that might be used for propagation, which are injurious to the agricultural, horticultural, silvicultural, or other interests of the state [of Tennessee]. [*From*: Rules of the Tennessee Department of Agriculture, Division of Plant Industries. Chapter 0080-6-24, Pest Plant Regulations, 0080-6-24-.01 Definitions (1)].

**Problematic species:** “Problematic species” are those most likely to interfere with native species in natural areas.

**Restoration:** Return of an ecosystem to a close approximation of its presumed condition prior to disturbance.

**Undesirable plant species:** The term “undesirable plants” means plant species that are classified as undesirable, noxious, harmful, exotic, injurious, or poisonous, pursuant to State or Federal law. Species listed as endangered by the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) shall not be designated as undesirable plants under this section and shall not include plants indigenous to an area where control measures are to be taken under this section. [*From: Federal Noxious Weed Act Sec. 2814. Management of undesirable plants on Federal lands (e) Definitions (7)*]

**APPENDIX C: SELECTED PORTIONS OF EXECUTIVE  
ORDER (EO) 13112 AND 13148**

***EO 13112 Invasive Species***

**Sec. 2. Federal Agency Duties.**

(a) Each Federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law,

(1) identify such actions;

(2) subject to the availability of appropriations, and within Administration budgetary limits, use relevant programs and authorities to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them; and

(3) not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

(b) Federal agencies shall pursue the duties set forth in this section in consultation with the Invasive Species Council, consistent with the Invasive Species Management Plan and in cooperation with stakeholders, as appropriate, and, as approved by the Department of State, when Federal agencies are working with international organizations and foreign nations.

***EO 13148 Greening the Government Through Leadership in Environmental Management***

**PART 2—GOALS**

*Sec. 207. Environmentally and Economically Beneficial Landscaping.* Each agency shall strive to promote the sustainable management of Federal facility lands through the implementation of cost-effective, environmentally sound landscaping practices, and programs to reduce adverse impacts to the natural environment.

**PART 4—PROMOTING ENVIRONMENTAL MANAGEMENT AND LEADERSHIP**

*Sec. 405. Compliance Assistance.*

(a) Upon request and to the extent practicable, the EPA shall provide technical advice and assistance to agencies to foster full compliance with environmental regulations and all aspects of this order.

(b) Within 12 months of the date of this order, the EPA shall develop a compliance assistance center to provide technical assistance for Federal facility compliance with environmental regulations and all aspects of this order.

(c) To enhance landscaping options and awareness, the United States Department of Agriculture (USDA) shall provide information on the suitability, propagation, and the use of native plants for landscaping to all agencies and the general public by USDA in conjunction with the center under subsection (b) of this section. In implementing Part 6 of this order, agencies are encouraged to develop model demonstration programs in coordination with the USDA.

## **PART 6—LANDSCAPING MANAGEMENT PRACTICES**

### **Sec. 601. *Implementation.***

- (a) Within 12 months from the date of this order, each agency shall incorporate the Guidance for Presidential Memorandum on Environmentally and Economically Beneficial Landscape Practices on Federal Landscaped Grounds (60 Fed. Reg. 40837) [August 10, 1995] developed by the FEE into landscaping programs, policies, and practices.
- (b) Within 12 months of the date of this order, the FEE shall form a workgroup of appropriate Federal agency representatives to review and update the guidance in subsection (a) of this section, as appropriate.
- (c) Each agency providing funding for nonfederal projects involving landscaping projects shall furnish funding recipients with information on environmentally and economically beneficial landscaping practices and work with the recipients to support and encourage application of such practices on Federally funded projects.

*Sec. 602. Technical Assistance and Outreach.* The EPA, the General Services Administration, and the USDA shall provide technical assistance in accordance with their respective authorities on environmentally and economically beneficial landscaping practices to agencies and their facilities.

## **PART 7—ACQUISITION AND PROCUREMENT**

### **Sec. 704. *Environmentally and Economically Beneficial Landscaping Practices.***

- (a) Within 18 months of the date of this order, each agency shall have in place acquisition and procurement practices, including provision of landscaping services that conform to the guidance referred to in section 601 of this order, for the use of environmentally and economically beneficial landscaping practices. At a minimum, such practices shall be consistent with the policies in the guidance referred to in section 601 of this order.
- (b) In implementing landscaping policies, each agency shall purchase environmentally preferable and recycled content products, including EPA-designated items such as compost and mulch, that contribute to environmentally and economically beneficial practices.

**APPENDIX D: DOE ORDER 450.1**

**ENVIRONMENTAL MANAGEMENT PROGRAM**

5. RESPONSIBILITIES. All DOE elements ... are responsible for implementing the requirements specified in paragraph 4. ... Specific responsibilities for implementing this Order are set forth below.

a. Assistant Secretary for Environment, Safety and Health, in coordination with other DOE elements, must do the following.

(1) Develop or revise, as needed, existing DOE environmental protection directives, policies, guidance, requirements, and procedures to—

(a) provide guidance to Program Secretarial Offices (PSOs) and field organizations for ensuring site ISMSs provide for EMSs that promote the protection of the environment, efficient compliance with environmental requirements, and enhanced environmental performance in the conduct of DOE operations (guidance must include instruction for integration of EMS self-assessment requirements into ISMS self-assessment protocols);

...

d. DOE Operations/Field/Site Office Managers, in addition to the requirements in paragraph 5b and in coordination with their reporting sites and PSOs, must do the following. ...

(4) Incorporate, where appropriate, environmentally and economically beneficial landscape practices into all new landscaping programs, policies, and practices for facilities under their purview, in furtherance of compliance with Executive Order 13148.





**APPENDIX E: PRELIMINARY MAP OF OAK RIDGE RESERVATION**

**SHOWING KNOWN KUDZU INFESTATIONS (2002)**

