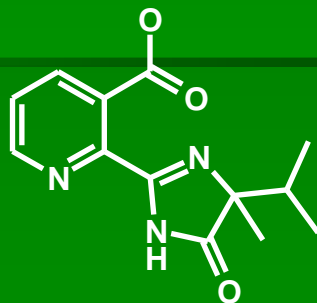
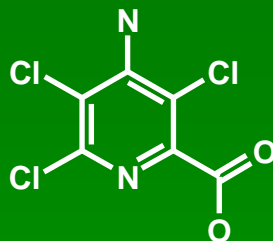


Invasive Weed Invaders from the North



Picture courtesy of Brian Armel



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Steps for Optimal Invasive Weed Control

- Accurate identification
- Extent of the infestation
- Selection of appropriate control measures
- Implementation of control measures
- Revisit and reassess
 - Apply similar technique
 - Adjust strategy

Identification of Vegetation Found Along the Tennessee Roadways

- A contract between UT and TDOT
- Mapping the vegetation in over 60 locations throughout the state
 - Herbaceous vegetation is counted in 3 meter squared locations in each location
 - Prominent woody species are recorded for each location
- Primary goal of the project is to assess current control strategies and to find ways of augmenting these measures to improve weed control.

Most prolific Herbaceous Weeds Found Along Tennessee Roadways in Region 2

common name	botanical name	# per m ²
Tall Fescue	<i>Schedonorus phoenix</i>	46.84444444
Hop Clover	<i>Trifolium campestre</i>	39.2
Creeping Red Fescue	<i>Festuca rubra</i>	12.73333333
Sweet Clover	<i>Trifolium pratense</i>	11.97777778
Field Madder	<i>Sherardia arvensis</i>	9.86666667
Mouse-Ear Chickweed	<i>Cerastium fontanum</i>	9.53333333
Corn Speedwell	<i>Veronica arvensis</i>	9.33333333
Buckhorn Plantain	<i>Plantago lanceolata</i>	8.6
Cornsalad	<i>Valerianella locusta</i>	4.22222222
Lyre-Leaf Sage	<i>Salvia lyrata</i>	3.2
Japanese Honeysuckle	<i>Lonicera japonica</i>	2.88888889
Cutleaf Geranium	<i>Geranium dissectum</i>	2.6
Smooth Crabgrass	<i>Digitaria ischaemum</i>	2.24444444
Broomsedge	<i>Carex scoparia</i>	2.11111111
Common Fleabane	<i>Erigeron philadelphicus</i>	1.88888889
Wild Carrot	<i>Daucus carota</i>	1.62222222
Orchardgrass	<i>Dactylis glomerata</i>	1.35555556
Cheatgrass	<i>Bromus secalinus</i>	1.22222222
Bermuda Grass	<i>Cynodon dactylon</i>	1.13333333
Yellow woodsorrel	<i>Oxalis stricta</i>	1.04444444
Hairy Vetch	<i>Vicia villosa</i>	1.02222222
Goldenrod	<i>Solidago canadensis</i>	0.73333333
Wild Garlic	<i>Allium vineale</i>	0.68888889
Oxeye Daisy	<i>Leucanthemum vulgare</i>	0.46666667
Dandelion	<i>Taraxacum officinale</i>	0.24444444

Do you recognize any of these species?

Woody Species Found in Region 2

- American Elm
- American Holly
- Autumn Olive
- Beech
- River Birch
- Black Cherry
- Black Locust
- Black Willow
- Blackberry
- Blackjack Oak
- Boxelder
- Bush Honeysuckle
- Callery Pear
- Chinese Privet
- Cottonwood
- Crabapple
- Crossvine
- Devil's Walkingstick
- Dogwood
- Eastern Red Cedar
- Golden Bamboo
- Green Ash
- Greenbriar
- Hackberry
- Hemlock
- Hickory
- Honey Locust
- Japanese Honeysuckle
- Juniper
- Maple
- Mimosa
- Mulberry
- Multiflora Rose
- Paulownia
- Persimmon
- Pin Oak
- Poison Ivy
- Post Oak
- Red Maple
- Red Oak
- Redbud
- Sassafras
- Shagbark Hickory
- Shortleaf Pine
- Silver Maple
- Spruce
- Staghorn Sumac
- Sweetgum
- Sycamore
- Tree of Heaven
- Trumpet Creeper
- Tulip Poplar
- Virginia Creeper
- Walnut
- Water Oak
- White Oak
- White Pine
- White Poplar
- Wild Grape
- Winged Elm
- Yellow Buckeye

* Invasive species

Chinese Privet is Everywhere!



So where do these invasive species come from and how to we predict the next invasion.....

Non-native ornamentals sold in the Tennessee

Common Name	Latin Name	Common Name	Latin Name
<u>Chinese privet</u>	<u><i>Ligustrum sinense</i></u>	<u>bush honeysuckle</u>	<u><i>Lonicera</i> spp.</u>
<u>tree of heaven</u>	<u><i>Ailanthus altissima</i></u>	<u>Chinese wisteria</u>	<u><i>Wisteria sinensis</i></u>
<u>mimosa</u>	<u><i>Albizia julibrissin</i></u>	<u>English ivy</u>	<u><i>Hedera helix</i></u>
<u>Callery pear</u>	<u><i>Pyrus calleryana</i></u>	<u>golden bamboo</u>	<u><i>Phyllostachys aurea</i></u>
<u>princesstree</u>	<u><i>Paulownia tomentosa</i></u>	<u>wintercreeper</u>	<u><i>Euonymus fortunei</i></u>
Chinese silvergrass	<i>Miscanthus sinensis</i>	Japanese bloodgrass	<i>Imperata cylindrica</i>
periwinkle	<i>Vinca minor</i>	burning bush	<i>Euonymus alata</i>
butterly bush	<i>Buddleja davidia</i>		

Identified in non-cultivated areas along Tennessee roadsides

•60 locations across the state; 3-5 miles long

Mile-a-minute - *Persicaria perfoliata*



Photos by: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Mile-a-minute - *Persicaria perfoliata*- History

- Native of Asia...first records in North America are from Portland, Oregon (1890) and Beltsville, Maryland (1937)
- Both of these sites eliminated or did not establish permanent populations of the species
- Introduction of mile-a-minute in the late 1930's to a nursery site in York County, Pennsylvania produced a successful population of this plant (rhodendron shipment)
- The distribution of mile-a-minute has radiated from the York County site into neighboring states
- In the past 70 years, the range for this plant in the United States has expanded more than 300 miles from its PA origin.

Mile-a-minute - *Persicaria perfoliata*- Distribution

- PLANTS database lists mile-a-minute present in:
 - New York
 - Pennsylvania
 - Maryland
 - New Jersey
 - Ohio
 - Oregon
 - Virginia
 - West Virginia
- Spotted in recent survey in Tennessee
- Will grow in any area where 8 weeks are under 46°F.

Mile-a-minute - *Persicaria* *perfoliata*- Key Facts

- Mile-a-minute weed grows rapidly over shrubs and other vegetation, shading them out
- Weight and pressure of the vine can distort the stems and branches of covered plants
- Mile-a-minute weed can smother tree seedlings
- It has the potential to be a problem to nursery and horticulture crops that are not regularly tilled as a cultivation practice
- Contains spines on leaves and stems that hinders predation and manual removal

Mile-a-minute - *Persicaria perfoliata*- Control

- Mile-a-minute can be controlled with triclopyr and glyphosate in most situations
 - Time applications prior to seed formation
- Mowing can reduce flowering

Swallowwort - *Cynanchum rossicum*



Photos by: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Pale Swallowwort - *Cynanchum rossicum*- History

- Likely introduced for ornamental purposes
- First collected in Monroe and Nassau counties in New York State in 1897
- Subsequent records of occurrences include:
 - Massachusetts (1919)
 - Pennsylvania (1927)
 - New Jersey (1938)
 - Connecticut (1942)
 - Indiana (1961)
 - New Hampshire (1979)
 - Michigan (1985)
 - Missouri (?)
 - Wisconsin (?)
- Indications of naturalized populations include records of collections from roadsides (1897, 1917) and natural areas (1918, 1919, and 1921) in New York State

Pale Swallowwort - *Cynanchum rossicum*- Key Facts

- Pale swallow-wort can form extensive patches that crowd out plant species and have various impacts on birds and insect populations
 - Highly poisonous to insects like the Monarch butterfly
- In New York, pale swallowwort is displacing the federally listed Hart's tongue fern (*Asplenium scolopendrium*), mosses, and lichens
- Pale swallow-wort modifies the soil microbial community, displacing native plant species that are adapted to the unique microbial associations of alvar (limestone pavement barrens supporting unique plant communities)
- Wind disseminates 2000 polyembryonic seeds per square yard

Pale Swallowwort - *Cynanchum rossicum*- Control

- Foliar applications of glyphosate at 43 oz ai/A has been effective when applied after flowering.
- Cut-stem application with a 50% solution of glyphosate
- Mowing before seed formation may reduce spread
- Digging up crowns may help prevent re-sprouts

Giant Hogweed - *Heracleum mantegazzianum*



Terry English, USDA APHIS PPQ,
Bugwood.org



Donna R. Ellis, University of Connecticut,
Bugwood.org



Donna R. Ellis, University of Connecticut,
Bugwood.org

Giant Hogweed - *Heracleum*

mantegazzianum- History and Distribution

- Native of the Caucasus Mountains and southwest Asia.
- Introduced as a garden plant in the United States, Europe, Canada and the United Kingdom in 1917
- It was reported in Canada in southern Ontario around 1950.
- It has been reported in:
 - Washington
 - Oregon
 - Illinois
 - Michigan
 - New York
 - Pennsylvania
 - Maine
 - Vermont
 - Massachusetts
 - Connecticut

Giant Hogweed - *Heracleum mantegazzianum*- Habitat

- Can be found in:
 - Floodplain forests
 - River or Stream
 - Roadside
 - Vacant Lot
 - Yard or garden
 - Prefers rich, moist soil in semi-shaded areas

Giant Hogweed - *Heracleum mantegazzianum*- Key Facts

- May cause increased soil erosion
 - Shallow rooting coupled with competition
- The sap contains furano-coumarin compounds which makes the skin very sensitive to UV radiation, causing blistering and severe burns
- Removing it manually becomes very difficult because of the danger caused by its sap

Giant Hogweed - *Heracleum mantegazzianum* - Control

- Apply a preemergence treatment of 32 to 128 oz ai/A dichlobenil or postemergence foliar treatment of 15.6 oz ai/A glyphosate, or 1 lb ai/A triclopyr

Wavyleaf basketgrass - *Oplismenus hirtellus ssp. Undulatifolius*



Wavyleaf basketgrass - *Oplismenus hirtellus ssp.* *Undulatifolius*- History and Distribution

- Discovered in Maryland in 1996
- It was found in 2005 at two sites approximately 2 and 22 miles from the original location
- In September 2007, Wavyleaf basketgrass had spread from several small patches (<15m across) in its original locations, to densely cover 150 acres and be scattered throughout as much as 1000 acres
- Scattered, small patches were reported from two additional Maryland watersheds in 2007
- Has spread to Northern Virginia and down the I-81 corridor

Wavyleaf basketgrass - *Oplismenus hirtellus ssp. Undulatifolius*- Key Facts

- It occurs in the same habitats as Japanese stiltgrass, *Microstegium vimineum*
- Wavyleaf basketgrass is perennial, remains green later in the season, has a highly effective seed dispersal mechanism, and appears to be more competitive than *Microstegium vimineum*
- The seeds secrete a sticky substance which attaches to passing animals and makes it easier for the seeds to disperse

Wavyleaf basketgrass - *Oplismenus hirtellus ssp.* *Undulatifolius*- Control

- Currently, many herbicides are being evaluated for control of wavyleaf basketgrass, but no data is currently available
- Handpulling has been successfully used as a control method, but is not practical on large scale infestations

Oriental Bittersweet - *Celastrus orbiculatus*



Leslie J. Mehrhoff, University of Connecticut, Bugwood.org



Shawn Askew – Virginia Poly Tech.

Oriental Bittersweet - *Celastrus orbiculatus*- History and Key Facts

- Introduced into the U.S. in the 1860s as an ornamental plant
- Still widely planted and maintained as an ornamental vine
- Reproduces prolifically by seed, which is readily dispersed to new areas by many species of birds including mockingbirds, blue jays and European starlings
- It also expands through root suckering

Oriental Bittersweet - *Celastrus orbiculatus*- Distribution and Habitat

Oriental bittersweet
currently occurs in

- Connecticut
- Delaware
- Illinois
- Indiana
- Kentucky
- Massachusetts
- Maryland
- Maine
- Michigan
- Missouri
- North Carolina
- New Hampshire
- New Jersey
- New York
- Pennsylvania
- Rhode Island
- Tennessee
- Virginia
- Vermont
- Wisconsin
- West Virginia

Will infest:

- forest edges,
- woodlands,
- fields,
- hedgerows,
- coastal areas and
- salt marsh edges,
- tolerance for shade allows oriental bittersweet to invade forested areas.

Oriental Bittersweet - *Celastrus orbiculatus*- Competition

- Smothers vegetation which may die from excessive shading or breakage
 - Oriental bittersweet is displacing our native American bittersweet (*Celastrus scandens*) through competition and hybridization
-

Oriental Bittersweet - *Celastrus orbiculatus*- Control

- Apply 2,4-D at 14 to 56 oz ai/A or triclopyr to the foliage.
- Multiple applications may be required

Garlic mustard - *Alliaria petiololata*



Shawn Askew – Virginia Poly Tech.



Shawn Askew – Virginia Poly Tech.



Randy Prostak – University of
Massachusetts – Amherst

Garlic mustard - *Alliaria petiolata*- History and Key Facts

- First recorded in the United States about 1868, from Long Island, New York
- Likely introduced by settlers for food or medicinal purposes
- A single plant can produce thousands of seeds, which scatter as much as several meters from the parent plant
- Depending upon conditions, garlic mustard flowers either self-fertilize or are cross-pollinated by a variety of insects
- Long distance dispersal is most likely aided by human activities and wildlife
- White-tailed deer prefer native plants to garlic mustard, large deer populations may help to expand garlic mustard populations by removing competing native plants and exposing the soil and seedbed through trampling

Garlic mustard - *Alliaria petiolata*- Distribution and Habitat

- Garlic mustard occurs in moist, shaded soil of:
 - River floodplains
 - Forests
 - Roadsides
 - Edges of woods
 - Trails edges
 - Forest openings
- Disturbed areas are most susceptible to rapid invasion and dominance
- Does not tolerate high acidity

Currently occurs in:

- Arkansas
- Connecticut
- Delaware
- Georgia
- Iowa
- Idaho
- Illinois
- Indiana
- Kentucky
- Maine
- Maryland
- Missouri
- North Carolina
- North Dakota
- New Hampshire

- New Jersey
 - New York
 - Pennsylvania
 - South Carolina
 - Tennessee
 - Virginia
 - West Virginia
 - Vermont
- And many other western states.*

Garlic mustard - *Alliaria petiolata*- Competition

- Garlic mustard threatens a rare native insect, the West Virginia white butterfly (*Pieris virginiensis*)
 - Several species of spring wildflowers known as "toothworts" (*Dentaria*), also in the mustard family, are the primary food source for the caterpillar stage of this butterfly
 - Invasions of garlic mustard are displacing toothworts, and allelopathy in garlic mustard may be toxic to the eggs of the butterfly

Garlic mustard - *Alliaria petiolata*

- Apply metsulfuron at 0.5 oz ai/A, or imazapic at 0.95 to 1.4 oz ai/A to dormant rosettes in late fall or early spring
- Late fall is a preferred timing, as most native species go dormant before garlic mustard

Japanese Knotweed - *Polygonum cuspidatum*



Shawn Askew – Virginia Poly Tech.

Stephen L. Solheim



Japanese Knotweed - *Polygonum cuspidatum*- History

- Japanese knotweed was probably introduced to the U.S. in the late 1800's
- First introduced as an ornamental and has also been used for erosion control
- Japanese knotweed spreads primarily by vegetative means with the help of its long, stout rhizomes.
- It is often transported to new sites as a contaminant in fill dirt or as discarded cuttings.
- Seeds are sometimes distributed by water, and carried to a lesser extent by the wind

Japanese Knotweed - *Polygonum cuspidatum*- Distribution and Habitat

- Japanese knotweed currently occurs in 36 states, including:
 - Tennessee
 - Mississippi
 - Georgia
 - North and South Carolina
 - Kentucky
 - Virginia
- Japanese knotweed can tolerate
 - full shade
 - high temperatures
 - high salinity
 - drought
- It is found near water sources, such as along streams and rivers, in low-lying areas, etc.

Japanese Knotweed - *Polygonum cuspidatum*

- Japanese knotweed spreads quickly to form dense thickets that exclude native vegetation and greatly alter natural ecosystems
- It poses a significant threat to riparian areas, where it can survive severe floods and is able to rapidly colonize scoured shores and islands
- Once established, populations are extremely persistent

Japanese Knotweed - *Polygonum cuspidatum*

- Apply 8 oz ai/A of glyphosate in the fall.
- Multiple years of treatment will be necessary for long-term control.

Types of Weed Control Measures- Which are practical?

- Sanitation
- Cultivation
- Soil solarization
- Mulching
- Hand weeding/Hoeing/pulling
- Fire/flaming
- Mowing
- Chemical- herbicides



http://images.google.com/imgres?imgurl=http://www.nps.gov/acad/parkmgmt/images/fire.jpg&imgrefurl=http://www.nps.gov/acad/parkmgmt/firemanagement.htm&usg=__i6S8E2A1PNdXdb7KptxaQJi0tPo=&h=300&w=556&sz=50&hl=en&start=6&um=1&itbs=1&tbnid=mr7VBEKYhtOK8M:&tbnh=72&tbnw=133&prev=/images%3Fq%3Dprescribed%2Bburns%26um%3D1%26hl%3Den%26tbs%3Disch:1



<http://www.cjasonspence.com/JD%204720%20Sprayer%20Serial%20Number%202939%20with%20690%20hours.jpg>

Choosing the Right Herbicide Product

- Things you need to know about a herbicide active ingredient.
 - Site/mode of action
 - Resistant weed management
 - Tank mix compatibility
 - Weed spectrum control
 - Timelines for control
 - Toxicology
 - Chemical properties
 - Volatility
 - Soil residual activity
 - Systemic vs. contact
 - Potential for off-target movement or movement to groundwater
 - Application rate and cost
 - Compare similar active ingredients

Major herbicide classes

- Plant growth regulators (PGR)
- Amino acid (protein) biosynthesis inhibitors
- Lipid biosynthesis inhibitors (ACCase)
- Seedling growth inhibitors
 - Root & Shoot and Shoot
- N-metabolism disrupter (GSI)
- Pigment inhibitors
- Photosynthesis inhibitors
 - Mobile and Nonmobile
- Cell membrane disrupters

Primary POST Herbicides Registered for Use in Invasive Weed Management

POST systemic with residual	POST systemic limited or no residual-blw	POST Contact only- Non-Selective	POST systemic limited or no residual-grass
Picloram	Dicamba	Glyphosate	Clethodim
Fluroxypyr	2,4-D	Diquat	Sethoxydim
Clopyralid	Triclopyr	Glufosinate	Fluazifop
Aminopyralid	Fosamine*	Pelargonic acid	Fexoxaprop
Hexazinone	<ul style="list-style-type: none"> ▪Mimic of indole-3-acetic acid (auxin or IAA) *Inhibitor of ACCase (fatty acids) ▪Inhibitors of acetolactate synthase (ALS) ▪Inhibitors of photosystem II at site A ▪Inhibitor of mitosis (dormancy initiation) ▪Inhibitor of EPSP synthase/aromatic amino acid synthesis ▪Inhibitor of phytoene desaturase (carotenoid biosynthesis) ▪Inhibitor of electron flow of photosystem I at ferredoxin ▪Inhibitor of photosystem II at site A different binding action ▪Inhibitor of glutamine synthetase ▪Cell membrane leakage and peroxidation (inhibition of linolenic acid degradation?) ▪Oxidation phosphorylation uncoupler (cessation of ATP production?) 		
Tebuthiuron			
Chlorsulfuron			
Sulfometuron			
Imazapyr			
Metsulfuron			

* Fosamine has little to no systemic activity in most species, but does have some limited residual activity in the soil.

Conclusions

- Several invasive species are moving south
- New products on the horizon, but new active ingredients with new modes of action will be limited
- Be vigilant....always return to treated sites to reassess control strategies.
- Questions??