Evaluating Vegetation Management Practices for Woody and Herbaceous Vegetation

October 2016
Project Team

ODOT Planning and Research
  Jill Martindale

ODOT Technical Advisory Committee
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How Did We Get Here?

Challenged with managing vegetation along nearly 50,000 lane miles throughout Ohio’s diverse landscapes, ODOT sought to improve and expand its integrated vegetation management (IVM) program.

ODOT’s Office of Statewide Planning and Research with a Technical Advisory Committee developed a research project and solicited assistance through a request for proposal.

Davey Resource Group, a division of The Davey Expert Company, was selected to complete the research project.
Project Description and Goal

Implement New and Improved Vegetation Management

Increase Efficiency, Effectiveness, and Reduce Costs

- Decrease the amount of noxious and problem weeds on the ROW
- Better safety for workers and traveling public
- Extend maintenance cycles for herbaceous and woody vegetation
- Make use of new and more effective chemical methods for vegetation management
- Utilize better mechanical methods for vegetation management
- Improve the abilities of workers to utilize equipment and herbicides properly
Phase I to Phase II

Phase I
Evaluate, Research, Assess, and Recommend IVM Methods
August 2013 – February 2014

Phase II
Test Recommended IVM Methods
May 2014 – November 2016
Project Scope

**TASK 1**
Field Days and Technical Briefs

**TASK 2**
Guide for Roadside IVM of Prohibited Noxious Weeds in Ohio

**TASK 3**
Field Testing of Mechanical and Chemical Methods
Task 1. Field Days and Technical Briefs

Conducted nine field days and presented technical briefs to share the project’s goals, implementation, and successes with ODOT staff.

Agenda

- Meet at ODOT County Garage
  - Davey Presentation of Project
- Visit Test Site and Review Test Fact Sheet
  - Davey Overview of Test Goals and Implementation
  - ODOT Staff Demonstrate Equipment and Provide Feedback
Field Days
Technical Briefs

Created for each test and includes:

- Objective
- Recommended Method
- Standard Operating Procedure
- Goals
- Study Area
- Equipment, Materials, and Herbicides
- ODOT Fieldwork Time
- Evaluation Factors
- Measurements

Recommend controls for managing noxious weeds along state maintained rights-of-way.

- Noxious Weed Identification and Control
- Applicator Guidance
- Definitions
Chapter 901:5-7 of the Ohio Administrative Code Noxious Weeds

- Apple of Peru (*Nicandra physalodes*)
- Canada thistle (*Cirsium arvense* L. (Scop.))
- Cressleaf groundsel (*Senecio glabellus*)
- Giant hogweed (*Heracleum mantegazzianum*)
- Grapevines (*Vitis* spp.)
- Japanese knotweed (*Polygonum cuspidatum*)
- Johnsongrass (*Sorghum halepense* L. (Pers.))
- Kochia (*Bassia scoparia*)
- Kudzu (*Pueraria montana* var. *lobata*)
- Marestail (*Conyza canadensis*)
- Mile-a-minute weed (*Polygonum perfoliatum*)
- Musk thistle (*Carduus nutans*)
- Oxeye daisy (*Chrysanthemum leucanthemum* var. *pinnatifidum*)
- Palmer amaranth (*Amaranthus palmeri*)
- Poison hemlock (*Conium maculatum*)
- Purple loosestrife (*Lythrum salicaria*)
- Russian thistle (*Salsola kali* var. *tenuifolia*)
- Shatter cane (*Sorghum bicolor*)
- Wild carrot (Queen Anne’s-lace) (*Daucus carota* L.)
- Wild mustard (*Brassica kaber* var. *pinnatifida*)
- Wild parsnip (*Pastinaca sativa*)
Musk Thistle (Carduus nutans)

**Description**
Musk thistle, or nodding thistle, is a biennial or winter annual weed. Mature plants can reach up to 6 feet tall with multiple erect stems that bolt from a basal rosette. Leaves are spiny tipped with hairs only on the broad central leaf veins. The flower is a round 2" flower that tends to bend or "nod".

**Where to Find:**
Typically musk thistle is found in dry areas particularly slopes around gravel roads and in difficult to mow areas. It can be found in most counties in Ohio but is most prominent in the southern region.

**When to Find:**
Midsummer to early fall is the easiest time of year to identify musk thistle. Look for vivid pink-orange colored, globe-shaped flowers.

**Seasonal Identification**
- **Spring Identification - Difficult**
  - Annual rosettes can be found as low-growing mounds. At the rosette stage, distinguishing musk thistle from other thistles can be difficult. The key to identifying musk thistle is its broad whitish central leaf veins. A new growth stage can be observed in late spring as musk thistle begins to grow vertical stems. This growth stage is known as the bolting phase.
  - **Summer Identification - Moderate to Easy**
    - After stem elongation (bolting), rosette, round, globe-shaped flower heads develop during early summer and may be confused with bull thistle. Seeds form one month after flowering.
  - **Fall Identification - Easy to Moderate**
    - Fully mature plants begin to decline. Look for remnant, fluffy seed heads, fully formed multiple stems, and smooth, spiny-tipped, winged leaves. As musk thistle declines and wildfires become more difficult to distinguish from bull thistle.

**Winter Identification - Difficult**
Musk thistle is difficult to locate in mowed areas. Unmowed areas are easier to locate dead weed skeletons. Revisit in spring to determine the level of seed distribution and germination. Reserves that germinate in warmer late fall and early winter can be found growing in winter.

**Control Recommendations**
Mowing also helps reduce seed head development. Mow musk thistle during flowering but before seed form.
- Foliar herbicide application is best applied during midsummer to prevent seed distribution. Dime, cabendazim should be treated with high-volume sprays using a shield sprayer and boom run. Mixed herbicide solutions should be applied at 10 gallons per acre rates.
- Light infestation should be treated with backpack sprayers.
- Selective herbicides to preserve grasses:
  - 2,4-D
  - Imazapyr

**Similar Looking Species:**
- **Canada thistle (Cirsium arvense)**
  - Flowers are purple. Their stems are smooth with no hairs or spines.

**Additional Infestation Points:**
- **Spring:** Rosette is identified by leaf and white center mid-vein.
- **Early Summer:** Young developing flower develops as globe-shaped balls with lime shaped flower heads.
- **Summer:** Stems are hairless near flower head, but have winged spikes on the lower stems. Leaf has winged spike tips, but is hairless on leaf surfaces.
- **Summer:** Mature flowers are pink-orange colored and tend to bend or nod.
- **Late Summer:** Mature flowers develop into fluffy seed heads.
- **Fall:** Identified by the nodding seed head which is dispersed by the wind.
Applicator Guidance

Calibration Guidance for Spray Truck Broadcast Herbicide Applications

When planning a broadcast application with a spray truck, equipment calibration is needed to properly maintain the equipment's accuracy. This is done by ensuring the nozzle settings are accurate.

Calibration Guidance for Spray Truck Broadcast Herbicide Applications

Use the One-Acre Conversion Chart to determine how fast to move the truck at a fixed nozzle width and how fast it will take to spray 1 acre based on the actual width and ground speed. These charts will help with consistent nozzle width and spray distances. For example, one can estimate the amount of time it will take to spray a certain area.

One Acre Conversion - Lane Width Based on Nozzle Width

<table>
<thead>
<tr>
<th>Nozzle Width (inches)</th>
<th>Lane Width (feet)</th>
<th>Time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>2</td>
<td>10</td>
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<tr>
<td>18</td>
<td>4</td>
<td>5</td>
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<tr>
<td>24</td>
<td>6</td>
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Calibration Guidance for Directed Herbicide Applications

The following chart can be used to determine the average time to spray 1 acre. To complete the worksheet, the user will need to determine the average spray pattern width, total ground speed (depth of spray width), and the total time to spray the area. This worksheet is designed for reference only. The actual time will vary with the nozzle width and speed.

Spray Truck Workload Calibration Worksheet

1. 3.56 (square feet per) _______ = Equipment spray pattern width _______ (feet) 
2. X = (total gallons) _______ / (total nozzle size) _______ = Gallons per hour _______ / minute _______ 
3. _______ gallons = 1 barrel _______ = Gallons per hour _______ / minute _______ 
4. _______ hours = 1 day _______ / _______ minutes = 1 day _______ / _______ minutes 
5. _______ gallons per _______ = _______ (gallons per minute / hour)

Hand Carts or Backpack Calibration Worksheet - Determining Flow Rate Gallons per Minute (GPM) and Time to Spray Area

1. _______ (seconds) _______ time to fill 1 gallon with head gear or backpack
2. _______ (seconds) _______ time to fill 1 gallon _______ (GPM) flow rate
3. _______ (seconds) _______ time to fill 1 gallon _______ (GPM) flow rate
4. _______ (seconds) _______ time to fill 1 gallon _______ (GPM) flow rate
5. _______ (seconds) _______ time to fill 1 gallon _______ (GPM) flow rate

Applicator Practice Chart - Time per Acre

1. _______ (minutes) _______ time per acre _______ (minutes) _______ / (gallons per minute / hour)
2. _______ (minutes) _______ time per acre _______ (minutes) _______ / (gallons per minute / hour)
3. _______ (minutes) _______ time per acre _______ (minutes) _______ / (gallons per minute / hour)
4. _______ (minutes) _______ time per acre _______ (minutes) _______ / (gallons per minute / hour)
5. _______ (minutes) _______ time per acre _______ (minutes) _______ / (gallons per minute / hour)
Task 3. Field Test of Mechanical and Chemical Methods

Seven Districts participated in a total of 25 tests

**District 3**
- Maintain Turf under Guardrail or Cable Rail with Spray Truck and Boomless Nozzle

**District 4**
- Maintain Turf in Open Areas Spray Truck and Boomless Nozzle
- Maintain Turf on Slope or over Guardrail with Spray Truck and Boomless Nozzle
- Maintain Bare Ground under Guardrail or Cable Rail with Spray Truck and Boomless Nozzle
- Maintain Vegetation under Guardrail or Cable Rail
- Maintain Turf at Road Edge, no Rail with Spray Truck and Boomless Nozzle

**District 7**
- Brush Control > 1” with Forestry Mulcher and Herbicide Application
- Brush Control < 1” with Flail Mower and Herbicide Application
- Brush Control with Rotary WetBlade™ System
- Maintain Vegetation under Guardrail or Cable Rail
- Maintain Turf or General Vegetation Maintenance on Steep Slopes with Slope Mower

**District 8**
- Maintain Turf with Batwing WetBlade™ System

**District 10**
- Noxious Weed Control (Johnsongrass, Japanese Knotweed, Poison Hemlock, Kudzu)
- Autumn Olive Control with Foliar Application
- Selective Brush Control with Foliar Application
- Selective Brush Control with Basal Bark Application
- Tree-of-Heaven Control with Basal Bark Application

**District 11**
- Tree Maintenance, Equipment On-Road
- Tree Maintenance, Equipment Off-Road
- Tree Maintenance with Foliar Application
- Tree Removal, Equipment On-Road
- Tree Removal, Equipment Off Road
Equipment Purchased

- GM-60 Spider Guard Rail Mower with John Deere 6115 R Tractor
- Skid Sprayer with Boomless Nozzle
- 15” Flexing WetBlade™ PTO
- 50” Rotary Boom Mower WetBlade System
- Bandit 1850 Whole Tree Chipper with Cab and Loader
- LRV60 Articulating Over-center Type Tree Trimming Aerial Device
Vegetation Management Zone Goals

Zone One: Eliminate or Reduce Mechanical Removal
Zone Two: Reduce Mowing
Zone Three: Remove Noxious Weeds and Brush, and Prevent Regrowth
Zone Four: Remove Trees and Prevent Regrowth
Zone One - Vegetation Free Zone

Tests

• Maintain Bare Ground under Guardrail or Cable Rail with Spray Truck and Boomless Nozzle
• Maintain Vegetation under Cable Rail or Guardrail with Guardrail Mower
Zone Two – Operational Zone

Tests

• Maintain Turf in Open Areas with Spray Truck and Boomless Nozzle
• Maintain Turf under Guardrail or Cable Rail with Spray Truck and Boomless Nozzle
• Maintain Turf at Road Edge, no Rail with Spray Truck and Boomless Nozzle
• Maintain Turf with Batwing Wetblade™ System
• Maintain Turf on Slope or over Guardrail with Spray Truck and Boomless Nozzle
• Maintain Turf or General Vegetation Maintenance on Steep Slopes with Slope Mower
Zone Three – Transition Zone

**Tests**

- Noxious Weed Control
  - Johnsongrass
  - Japanese Knotweed
  - Poison Hemlock
  - Kudzu
- Selective Brush Control with Foliar Application
- Autumn Olive Control with Foliar Application
- Brush Control < 1” with Flail Mower and Herbicide Application
- Brush Control with Rotary Wetblade™ System
- Brush Control > 1” with Forestry Mulcher and Herbicide Application
- Selective Brush Control with Basal Bark Application
- Tree-of-Heaven Control with Basal Bark Application
Zone Four – Undisturbed Zone

Tests
- Tree Maintenance with Foliar Application
- Tree Maintenance, Equipment On-Road
- Tree Maintenance, Equipment Off-Road
- Tree Removal, Equipment On-Road
- Tree Removal, Equipment Off-Road
- Tree Removal with Tree Mulcher
Successes and Team Approach
Obstacles and Lessons Learned
Tom Corey
Deputy Director, Division of Operations
Chad Cline
Labor Relations Officer III, District 11
Joseph Parisi, II, P.E.
Transportation Engineer, District 11

Wild carrot

Poison hemlock
Table of Contents

• How to use this Guide
• Prohibited Noxious Weed Identification and Control
• Invasive Plant Identification and Control
• Applicator Guidance
• ODOT Forms
• Glossary
• Note Pages
Poison hemlock (Conium maculatum)

Plant Description:
Poison hemlock is a biennial weed that can be seen from early spring to midsummer as a tall, stout, upright, single-stemmed branching plant with silvery-white flower heads. Poison hemlock can also be found as spring or fall or a low-growing seeding or rosette. Colonies are easily spotted in late spring to early summer with silvery-white flower heads.

Leaves: Leaves are dark green, glossy, and deeply divided with nearly oblong to wide blades.

Stem: Stems are slightly zigzag, hollow, smooth, and often with purple spots.

Flowers: Upward-pointing white flowers emerge in early summer in a loose umbel-like formation in several clusters.

Seed: Seeds are yellow-green, small, and round with a white button.

Reproduction: The seeds function as the primary means of reproduction, germinating in both full and partial shade. Most seeds are dropped around the parent plant and can also be spread by animals, birds, or water.

Winter: Poison hemlock is highly toxic to humans if ingested. It may cause contact dermatitis, severe blistering, and even death, especially when combined with sun exposure.

Seasonal Identification:

Spring Identification: Moderate
Seedlings and seedlings can be found covering the ground, often in colonies growing under dead mature plants. The fern-like leaves are large, broad, dark green, and glossy.

Summer Identification: Easy
Mature poison hemlock features include zigzag, and smooth but hollow stems with purple bases and white umbel-like flower clusters at the ends of branches.

Fall Identification: Easy to Moderate
Mature poison hemlock plants have died off by the time leaving plant skeleton standing. Seedlings and seedlings can easily be found under dead mature plants by late fall. Seedlings and seedlings patches are usually dark green than most other vegetation at this time.

Winter Identification: Moderate
Dead mature plants can persist into winter and can be identified by zigzag and hollow stems. Seedlings and seedlings stay green over winter but are dormant.

Wild carrot (Daucus carota) young plants look most similar, but leaves are more deeply lobed and not glossy. Hair, seed, and stem are the main differences. Flower heads are white and flat-topped.

Giant hogweed (Heracleum mantegazzianum) has similar umbrella-like flower heads, but they are flat-topped flower heads. The size of giant hogweed, especially the leaves, distinguish this plant from poison hemlock. Stems are purple with purple splashes but are covered in hair. All features of giant hogweed are generally much larger than those of poison hemlock.

Where to Find: Poison hemlock is quite common in Ohio, usually found in large patches or colonies in unaltered areas along Ohio roadways, local bird and quail habitats, and along the road. Poison hemlock does best in well-drained slopes with full sun, but can also tolerate wet soil and shaded areas along the edge of wooded environments.

Control Methods:
Mechanical: Mow or cut early from spring to early summer to maintain visibility or to reduce seed production. Hand pull with caution. Avoid any contact as it can cause severe lasting.

Chemical: Make directed applications from spring to early summer with selective herbicides. Selective applications before flowering. Fall applications to young plants can also provide control.

Cultural: Plant tall fence in early fall. Recommendation Summary: Poison hemlock is toxic. Germinates in spring, flowers in the fall season, and dies out in winter. In the second year, the mature plant produces seeds and flowers before dying. Accomplishing control is not difficult with many opportunities to prevent seed production. For best control results, make herbicide applications in spring or early summer. Fall applications to seedlings can also be effective. Follow directed applications because poison hemlock is usually found in dense patches. It is sporadic in large areas, use broadcast applications with selecticide herbicides before or after flowering, conversion to native seed production. Plant tall fence in early fall. Use caution when hand pulling to control or cutting to reduce risk of plant height. Place all fence in early fall and allow to grow tall in spring to compete for space and shade out seedlings. Failure to control poison hemlock will allow high toxic levels to grow tall and may contribute to new growth. Poison hemlock is toxic. Use caution when handling.

Fall Identification: Easy to Moderate
Falls from a distance, colonies in seed appear yellow. As mature poison hemlock plants begin to fade away for the year, the entire plant turns yellow.

Spring and Fall: Seedlings and seedlings can be found mingling patches in spring or fall. Note the thick, tall root and the poison hemlock in hedges.

Late Spring to Summer: Stems are smooth and yellow with purple splashes. The dried Corn Silk had to dry and were broad than wild carrot Kansas.

Early Summer: Poison hemlock flowers develop in rounded clusters in an umbel-like formation. Poison hemlock is commonly found on slopes and along unweeded areas in early summer.

Summer: Later blooming, much faster growing, but not all at once. Seeds are yellow-green, small, and round with a white button.

Fall: Poison hemlock flowers develop in rounded clusters in an umbel-like formation. Poison hemlock is commonly found on slopes and along unweeded areas in early summer.
Calibration Guidance for Directed Herbicide Applications

The following flow rate charts and worksheet are intended to help applicators calibrate directed applications to 100 gallons per acre (GPA). It is important to know what the gallons per minute (GPM) flow rate is to determine the time it takes to treat 1 acre. Proper calibration and understanding of equipment flow rates helps to avoid over application of herbicide. The charts below are quick guides to help with calibration activities. These charts should be used to verify the worksheet calculations are accurate. Use the worksheet and the time it should take to spray an area of 1,000 square feet. Once the worksheet is complete and time it should be timed, the next step is to practice with water and dye. The applicator should practice until the area can be covered in the worksheet below (Line 5 of worksheet). The photos below demonstrate how to set up a practice area.

Worksheet for Preparing a Herbicide Mix

- Use the following worksheet to calculate herbicide mixtures. Decide if you are mixing by volume or by percentage solution by checking the product label.
- Measure the target area's length and width. Enter values in worksheet below to convert square feet to total acres.
- Identify target vegetation. Is the target vegetation grass, broadleaf, or woody? Determine if the goal is to achieve total vegetation control (broadleaf) or additive control to preserve some existing vegetation. Check herbicide label to see if product is appropriate for goal.
- Choose herbicide and check label for per acre rate.
- Always refer to product labels and safety data sheets (SDS) to determine appropriate rates and proper personal protective equipment (PPE).
- Never exceed the maximum allowable rate per acre per year.
- Use appropriate measuring devices for solid and liquid herbicides and adjuvants.
- Read the label to determine if tank mix partners or adjuvants are needed. Also, check the label to determine in what order water and the product should be mixed.

Determine Approximate Amount of Spray Solution (by volume):

- Confirm accuracy of units from the herbicide label for the herbicide and adjuvants.
- See the Volume Conversions and Mix Rates section to maintain common volume units throughout the worksheet.
1. \( \text{area width} \times \text{area length} = \frac{\text{square feet}}{\text{square feet}} \times \frac{\text{total acres}}{\text{total acres}} \)
2. \( \text{area width} \times \text{area length} = \frac{\text{square feet}}{\text{square feet}} \times \frac{\text{total acres}}{\text{total acres}} \)
3. \( \text{READ THE LABEL} \) to determine appropriate herbicide rate per acre \( \frac{\text{ounces/gallons}}{\text{gallons}} \times \frac{\text{total acres}}{\text{total gallons}} \)
4. \( \text{Determine approx. herbicide volume} \) \( \frac{\text{ounces/gallons}}{\text{gallons}} \times \frac{\text{total acres}}{\text{total gallons}} \)
5. \( \text{Check spray tank controls} \) to determine the per acre spray volume (GPA) for broadcast applications. Use 100 gallons per acre (GPA) for directed applications. Always calibrate before making applications with herbicide.
6. \( \text{Determine approximate amount of spray volume} \) \( \frac{\text{total acres}}{\text{total gallons}} \times \frac{\text{total gallons}}{\text{total gallons}} \)
7. \( \text{gallons} \) \( \frac{\text{total gallons}}{\text{total gallons}} \times \frac{\text{total gallons}}{\text{total gallons}} \)
8. \( \text{gallons} \) \( \frac{\text{total gallons}}{\text{total gallons}} \times \frac{\text{total gallons}}{\text{total gallons}} \)

Determine Approximate Amount of Spray Solution (by %):

- Confirm accuracy of units from the herbicide label for the herbicide and adjuvants.
- See the Volume Conversions and Mix Rates section to maintain common volume units throughout the worksheet.
1. \( \text{area width} \times \text{area length} = \frac{\text{square feet}}{\text{square feet}} \times \frac{\text{total acres}}{\text{total acres}} \)
2. \( \text{area width} \times \text{area length} = \frac{\text{square feet}}{\text{square feet}} \times \frac{\text{total acres}}{\text{total acres}} \)
3. \( \text{READ THE LABEL} \) to determine appropriate herbicide rate by percent solution: \( \% \) \( \text{rate} \)
4. \( \text{gallons} \) \( \frac{\text{gallons}}{\text{gallons}} \times \frac{\text{gallons}}{\text{gallons}} \)
5. \( \text{Calculate herbicide volume} \) \( \frac{\text{gallons}}{\text{gallons}} \times \frac{\text{gallons}}{\text{gallons}} \)
6. \( \text{Calculate herbicide volume} \) \( \frac{\text{gallons}}{\text{gallons}} \times \frac{\text{gallons}}{\text{gallons}} \)
7. \( \text{gallons} \) \( \frac{\text{gallons}}{\text{gallons}} \times \frac{\text{gallons}}{\text{gallons}} \)
Scott Lucas
Administrative Officer III,
Office of Maintenance Operations
Modified Spray Truck
Where we go from here?

Implementation

Short and Long Term Benefits
Final Results and Thoughts

Contact - Jill Martindale, Central Office Research

http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/Pages/default.aspx

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Questions?