

Invasive Species Phenology¹ and Treatment Recommendations²

Central Jersey Invasive Species Strike Team

Prepared by: Melissa Almendinger (Invasive Species Coordinator, URWA), Rachel Mackow (Land Steward, FoHVOS), and Michael Van Clef, Ph.D. (Stewardship Director, FoHVOS)

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| period of flowering |
| period of flowering and fruiting |
| period of ripe fruit availability |

| Scientific Name | Species Code | Common Name | See "Field Data Sheet" for codes | | | | ED/RR Action Code | January | February | March | April | May | June | July | August | September | October | November | December | Control Methods ^{3,4,5} |
|--------------------------------------------|--------------|--------------------------|----------------------------------|---------------------------|-------------|---|-------------------|---------|----------|-------|-------|-----|------|------|--------|-----------|---------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| | | | CJISST Search Grouping | Current Distribution Code | Threat Code | | | | | | | | | | | | | | | |
| <i>Aralia elata</i> (Miq.) Seem. | AREL | Japanese angelica tree | 3 | Stage 3 | High | 2 | | | | | | | | | | | | | Options: BB,FS,HS; Species has great potential to re-sprout; Glyphosate recommended for foliar applications; Triclopyr recommended for non-foliar applications | |
| <i>Artemisia stelleriana</i> Bess. | ARST | oldwoman | 3 | Stage 0 | Moderate | 1 | | | | | | | | | | | | | Options: FS,MO; Species has an extensive root system and pulling is ineffective; Glyphosate recommended for foliar applications. | |
| <i>Berberis vulgaris</i> L. | BEVU | common barberry | 1 | Stage 2 | Moderate | 1 | | | | | | | | | | | | | Options:BB,FS,CS, MO, PU; Glyphosate recommended for all methods except BB, where triclopyr is recommended | |
| <i>Buddleja davidii</i> Franch. | BUDA | orange eye butterflybush | 3 | Stage 0 | Moderate | 1 | | | | | | | | | | | | | Options: BB, FS,CS,MO,PU; Glyphosate recommended for all methods except BB, where triclopyr is recommended | |
| <i>Cardamine impatiens</i> L. | CAIM | narrowleaf bittercress | 1 | Stage 3 | High | 2 | | | | | | | | | | | | | Options: FS,CS,MO; Species is biennial--treatment recommended early in season before seed set. Glyphosate recommended. | |
| <i>Clematis terniflora</i> DC. | CLTE | Japanese clematis | 2 | Stage 3 | High | 2 | | | | | | | | | | | | | Options: FS; Species has an extensive root system and pulling is ineffective; Glyphosate recommended for foliar applications; Triclopyr recommended for non-foliar applications | |
| <i>Conium maculatum</i> L. | COMA | poison hemlock | 4 | Stage 1 | Moderate | 1 | | | | | | | | | | | | | Options: FS,CS,MO; Species is biennial--treatment recommended early in season before seed set. Glyphosate recommended. | |
| <i>Cynanchum louiseae</i> Kartesz & Gandhi | CYLO | black swallowwort | 2 | Stage 2 | High | 1 | | | | | | | | | | | | | Options: FS,PU; Species has an extensive root system and pulling is difficult; Glyphosate recommended for foliar applications | |
| <i>Dioscorea oppositifolia</i> L. | DIOP | Chinese yam | 2 | Stage 0 | Moderate | 1 | | | | | | | | | | | | | Options: BB,CS,FS; Species has extensive root system; Species reproduces by seed and bulbils (aerial potato-like structures)--use BB when bulbils are present; Glyphosate recommended for FS; Triclopyr is recommended for BB and CS | |

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| | | | CJISST Search Grouping | Current Distribution Code | Threat Code | | | | | | | | | | | | | | | |
| <i>Dipsacus laciniatus</i> L. | DILA | cutleaf teasel | 4 | Stage 1 | Moderate | 1 | | | | | | | | | | | | | Options: FS,CS,MO; Species is biennial--treatment recommended early in season before seed set. Foliar spray recommended early in season before stems reach full height and become difficult to spray. Glyphosate recommended. | |
| <i>Elaeagnus angustifolia</i> L. | ELAN | Russian olive | 3 | Stage 0 | High | 1 | | | | | | | | | | | | | Options: BB, FS,CS,MO,PU; Glyphosate recommended for all methods except BB, where triclopyr is recommended | |
| <i>Eleutherococcus sieboldianus</i> (Makino) Koidz. | ELSI | fiveleaf aralia | 1 | Stage 0 | High | 1 | | | | | | | | | | | | | Options: BB,FS,MO,PU; CS is impractical due to thinness of stems; Glyphosate recommended for all methods except BB, where triclopyr is recommended | |
| <i>Eragrostis curvula</i> (Schrud.) Nees | ERCU | weeping lovegrass | 3 | Stage 2 | High | 1 | | | | | | | | | | | | | Options: FS,MO; Species has extensive root system - pulling is ineffective; Glyphosate recommended | |
| <i>Euonymus europaea</i> L. | EUEU | European spindle tree | 1 | Stage 1 | Moderate | 1 | | | | | | | | | | | | | Options: BB,FS,CS,PU; Glyphosate recommended for all methods except BB, where triclopyr is recommended | |
| <i>Euonymus fortunei</i> (Turcz.) Hand.-Maz. | EUFO | winter creeper | 1 | Stage 1 | Moderate | 1 | | | | | | | | | | | | | Options: BB,FS,CS,MO; Species has an extensive root system and pulling is ineffective; Glyphosate recommended for CS; Triclopyr is recommended for BB and FS (due to foliage's waxy cuticle). Cutting climbing stems from trees prevents fruiting. | |
| <i>Frangula alnus</i> P. Mill. | FRAL | glossy buckthorn | 4 | Stage 2 | High | 1 | | | | | | | | | | | | | Options: BB, FS,CS,MO,PU; Glyphosate recommended for all methods except BB, where triclopyr is recommended | |
| <i>Hedera helix</i> L. | HEHE | English ivy | 2 | Stage 1 | Moderate | 1 | | | | | | | | | | | | | Options: FS,MO,PU; Foliar application is most practical; Spraying may occur in non-growing season because species is evergreen; Triclopyr is recommended for FS (due to foliage's waxy cuticle). Cutting climbing stems from trees prevents fruiting. | |

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| | | | CJISST Search Grouping | Current Distribution Code | Threat Code | | | | | | | | | | | | | | | |
| <i>Heracleum mantegazzianum</i> Sommier & Levier | HEMA | giant hogweed | 3 | Stage 0 | Moderate | 1 | | | | | | | | | | | | | | Options: FS, CS; HANDLE WITH CAUTION - CAUSES SEVERE CONTACT DERMITITUS. Foliar spray recommended early in season before stems reach full height and become difficult to spray. Glyphosate recommended. |
| <i>Humulus japonicus</i> Sieb. & Zucc. | HUJA | Japanese hop | 2 | Stage 3 | High | 2 | | | | | | | | | | | | | | Options: FS,PU; species may behave as an annual or a perennial - recommend spraying before seed set; Glyphosate recommended |
| <i>Humulus lupulus</i> L. var. <i>lupulus</i> | HULU | common hop | 2 | Stage 2 | Moderate | 1 | | | | | | | | | | | | | | Options: FS; Species has an extensive root system and pulling is ineffective; Glyphosate recommended for foliar applications; Triclopyr recommended for non-foliar applications |
| <i>Iris pseudacorus</i> L. | IRPS | paleyellow iris | 4 3 | Stage 2 | High | 1 | | | | | | | | | | | | | | Options: FS,PU; PU is only effective for young individuals that have not yet become deeply rooted; Glyphosate recommended; in wetlands, seek aquatic application permit and use wetlands appropriate herbicides |
| <i>Lespedeza cuneata</i> (Dum.-Cours.) G. Don | LECU | sericea lespedeza | | Stage 3 | High | 2 | | | | | | | | | | | | | | Options: FS,MO; Species has an extensive root system and pulling is ineffective; Glyphosate recommended for foliar applications. |
| <i>Lonicera caprifolium</i> | LOCA | Italian honeysuckle | 1 | Stage 0 | Moderate | 1 | | | | | | | | | | | | | | Options: PU,MO,FS,CS; Most effective when manual control is combined with chemical. FS may be done in winter if green leaves are present. Glyphosate recommended. (Note: For penetration of waxier leaves, triclopyr may be used.) |
| <i>Lonicera fragrantissima</i> | LOFR | fragrant honeysuckle | 1 | Stage 0 | Moderate | 1 | | | | | | | | | | | | | | Options: PU, FS, CS. Vigorous regrowth after a single cutting. Multiple cuttings may significantly weaken plants. Glyphosate recommended. |
| <i>Marsilea quadrifolia</i> L. | MAQU | European watercress | 5 | Stage 0 | High | 1 | | | | | | | | | | | | | | Options: PU. Non-flowering; non-fruiting. Highlighted red period indicate presence of reproductive spores. |

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| | | | CJISST Search Grouping | Current Distribution Code | Threat Code | | | | | | | | | | | | | | | |
| <i>Polygonum sachalinense</i> F. Schmidt ex Maxim. | POSA | giant knotweed | 4 | Stage 1 | High | 1 | | | | | | | | | | | | | Options: CS,FS,PU; PU is only effective for young individuals that have not yet become deeply rooted;Species resprouts from root fragments; Glyphosate recommended for foliar applications; Triclopyr recommended for non-foliar applications; in wetlands, seek aquatic application permit and use wetlands appropriate herbicides | |
| <i>Pueraria montana</i> (Lour.) Merr. var. <i>lobata</i> (Willd.) Maesen & S. Almeida | PUMO | kudzu | 2 | Stage 0 | High | 1 | | | | | | | | | | | | | Options: BB,FS,CS; Species has an extensive root system and pulling is ineffective; Glyphosate recommended for foliar applications; Triclopyr recommended for non-foliar applications | |
| <i>Pyrus calleryana</i> Dcne. | PYCA | Callery pear | 3 | Stage 2 | High | 1 | | | | | | | | | | | | | Options: BB,FS,HS,CS,GI,PU; Glyphosate recommended for all methods except BB, where triclopyr is recommended | |
| <i>Rhamnus cathartica</i> L. | RHCA | common buckthorn | 1 | Stage 2 | High | 1 | | | | | | | | | | | | | Options: BB,FS,HS,CS,PU; GI is not recommended due to the potential of re-sprouting; Glyphosate recommended for foliar applications; Triclopyr recommended for non-foliar applications | |
| <i>Rhodotypos scandens</i> (Thunb.) Makino | RHSC | jetbead | 1 | Stage 2 | High | 1 | | | | | | | | | | | | | Options: BB, FS,CS,MO,PU; Glyphosate recommended for all methods except BB, where triclopyr is recommended | |
| <i>Ribes rubrum</i> L. | RIRU | garden red current | 1 | Stage 1 | Moderate | 1 | | | | | | | | | | | | | Options: BB, FS,CS,MO,PU; Glyphosate recommended for all methods except BB, where triclopyr is recommended | |
| <i>Robinia hispida</i> L. var. <i>hispida</i> | ROHI | bristly locust | 3 | Stage 1 | Moderate | 1 | | | | | | | | | | | | | Options: FS; Clonal species with several individual stems. Pulling results in significant sprouting. Glyphosate recommended. | |
| <i>Rorippa nasturtium-aquaticum</i> (L.) Hayek | RONA | white watercress | 5 | Stage 3 | High | 2 | | | | | | | | | | | | | Options: FS, PU; Species is aquatic and requires special treatments (i.e., harvesting, application of herbicide by trained lake management professionals). Small quantities can easily be removed by hand. | |

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| | | | CJISST Search Grouping | Current Distribution Code | Threat Code | ED/RR Action Code | January | February | March | April | May | June | July | August | September | October | November | December | | | | | | |
| <i>Viburnum plicatum</i> Thunb. | VIPL | Japanese snowball viburnum | 1 | Stage 0 | High | 1 | | | | | | | | | | | | | | | | | | Options: BB, FS,CS,MO,PU; Glyphosate recommended for all methods except BB, where triclopyr is recommended |
| <i>Viburnum setigerum</i> Hance | VISE | tea viburnum | 1 | Stage 0 | High | 1 | | | | | | | | | | | | | | | | | | Options: BB, FS,CS,MO,PU; Glyphosate recommended for all methods except BB, where triclopyr is recommended |
| <i>Viburnum sieboldii</i> Miq. | VISI | Siebold's arrowwood | 1 | Stage 2 | High | 1 | | | | | | | | | | | | | | | | | | Options: BB, FS,CS,MO,PU; Glyphosate recommended for all methods except BB, where triclopyr is recommended |
| <i>Wisteria floribunda</i> (Willd.) DC. | WIFL | Japanese wisteria | 2 | Stage 2 | High | 1 | | | | | | | | | | | | | | | | | | Options: BB,FS,CS; Species has an extensive root system and pulling is ineffective; Glyphosate recommended for foliar applications; Triclopyr recommended for non-foliar applications |

¹Phenology information collected from Hough (1983), MOBOT (2007), PFAF (2007), Rhoads and Block (2007) or Brand (2007) and is intended to guide timing of control efforts.

²Treatment recommendations from Zerbe et al. (2003), multiple websites, personal experiences of colleagues and author.

³Optimal treatment methods vary by size of individual plants and extent of infestation in selected treatment areas. See "Control Methods" for additional information.

⁴For bark applications, triclopyr should be used in its ester form (e.g., Garlon 4). See "Control Methods" for additional information.

⁵See below for a sample of invasive species control and species information websites:

- Plants for a Future <http://www.pfaf.org/index.html>
- Flora of North America http://www.efloras.org/flora_page.aspx?flora_id=1
- USDA PLANTS <http://plants.usda.gov/index.html>
- Invasive Plant Atlas of New England <http://nbi-nin.ciesin.columbia.edu/ipane/icat/catalogOfSpecies.do>
- Plant Conservation Alliance - Alien Plant Working Group <http://www.nps.gov/plants/alien/fact.htm>
- Plant Invaders of Mid-Atlantic Natural Areas <http://www.invasive.org/weeds.cfm>
- The Nature Conservancy's Global Invasive Species Initiative <http://tncweeds.ucdavis.edu/control.html>
- National Invasive Species Information Center <http://www.invasivespeciesinfo.gov/plants/control.shtml>

Broad Control Method Categories

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| Control Method | Description | Pros | Cons | Notes |
|----------------|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Biological | Introduction of a biocontrol agent (e.g., insect, pathogen) from the invasive species' native range | Dramatic reduction in abundance with minimal costs; Minimal site accessibility issues | Limited number of invasive species have agents; Potential for unintended consequences if the biocontrol agent 'switches' to non-target species | Requires extensive time and effort to provide effective host-specific agents; Numerous federal regulations provide significantly reduced risk of impacts to non-targets species |
| Mechanical | Physical removal of all or portions of an invasive species | No requirement for specialized training; Can be performed by volunteers | Very labor intensive; May require specialized equipment; Site accessibility issues, impractical for large infestations; Re-sprouting or further invasive species dissemination may occur | Common techniques include mowing, cutting, pulling and girdling |
| Chemical | Application of herbicide to all or portions of a plant | Most effective and efficient method in most cases; Staff can be assisted by volunteers | Labor intensive; Site accessibility issues; Requires specialized training/license and equipment; May require repeated applications for more difficult species | Common applications include foliar, cut stump, basal bark and injection; Mechanical and chemical controls may be combined for cut stump and hack-and-squirt methods |
| Cultural | Removal of invasive species through broad land use activities | Very cost effective | Does not apply well to forest habitats | Primarily applies to agricultural systems, but may apply to the maintenance of early successional natural systems including grasslands; Techniques include prescribed fire and prescribed grazing |
| Ecological | Allowing natural ecological processes (e.g., competition for light and soil resources) to reduce invasive species over time | Very cost effective; Utilizes natural processes | May not occur in many systems due to persistent or continuing human impacts (e.g., overabundant deer, continual physical disturbance, habitat fragmentation, etc.) | Primarily applies to forest systems; As an example, very strong anecdotal evidence suggests that overabundant deer facilitate infestations by Japanese stiltgrass and other invasive species in forests. |

Specific Control Method Types

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| Method Name | Method Category | Method Code | Typical Herbicide Concentrations | Typical Herbicide | Target Type(s) | Time of Year | Basic Technique | Pros | Cons | Notes |
|--------------------|-------------------------------|-------------|----------------------------------|-----------------------|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| biological control | Biological Control | BC | N/A | N/A | few selected species | dependent on released species | Release of approved biological control agents that attack | Method can provide effective control and is cost effective | Most species do not have an available biological control agent. | A biological control agent for garlic mustard is under development and may be ready for release in the near future. |
| pulling | Mechanical Control | PU | N/A | N/A | small woody plants and herbaceous species, shallowly rooted species | Perennials: Year round. Annuals & biennials: before setting seed (see phenology tab) | Removal of entire plant by hand or use of specialized tools such as a "Weed Wrench" | Method can provide effective control; Method can be performed by volunteers | Method is extremely time consuming and ineffective when root system cannot be completely removed; Method creates soil disturbance that stimulates germination of invasive species such as garlic mustard and Japanese stiltgrass | Bag, compost or "hang up" species that can re-root or set seed |
| mowing | Mechanical Control | MO | N/A | N/A | many species | Perennials: Year round. Annuals & biennials: before setting seed (see phenology tab) | Cutting tops of plants using a mower, brush cutter or weed whacker | as a pre-treatment for herbicide application. Follow with cut stump application (immediate) or foliar application (to re-sprouts) using a backpack sprayer | Without herbicide follow-up, method is ineffective for most species because of re-sprouting ability | Japanese stiltgrass can sustain itself as a "lawn" by producing seeds on plants that are two inches or smaller |
| foliar spray | Chemical Control | FS | 1-3% | glyphosate, triclopyr | Any plant less than 4 feet tall | Deciduous-during growing season. Annuals & biennials-before setting seed. Evergreen-year round. Avoid rain, extreme heat or wind. | Application of herbicide using a backpack sprayer to wet all leaves. Plants may be cut and allowed to resprout before treatment. | Method provides effective control and is cost effective | Method has potential to injure non-target species and cannot be used on taller plants due to increased risk to applicator and non-target species (i.e., spraying upward increases risk of drift); Method can be sensitive to weather conditions (e.g., heat may dry spray before effective absorption) | Foliar applications generally include use of a backpack sprayer (Recommend use of Thinvert system ¹). Some foliar application methods include wipe-on applications (e.g., "bloody glove"), but these methods are not recommended because they are extremely time consuming and increase likelihood of exposure to the applicator. The use of boom applications is not recommended, but may be useful in the establishment of native warm season grasses where all existing vegetation must be removed prior to seeding. |
| cut stump | Chemical & Mechanical Control | CS | 20 - 25% | glyphosate, triclopyr | woody species | Year round-avoid spring sap rise. Avoid wet weather or snow on ground. Optimal time is during fall. | Cutting stems just above ground level followed by targeted application of herbicide to cut stems | Method provides effective control; Volunteers can assist with stem cutting | Mechanical removal of stems is very time consuming | Cutting is performed by loppers, handsaws or chainsaws depending upon size of stems. Herbicide applied with a squirt bottle, paint brush or backpack sprayer. Herbicide should be applied immediately after cutting. |

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| Method Name | Method Category | Method Code | Typical Herbicide Concentrations | Typical Herbicide | Target Type(s) | Time of Year | Basic Technique | Pros | Cons | Notes |
|--------------------|------------------------------------------------------------|-------------|----------------------------------|-----------------------|--------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| basal bark | Chemical Control | BB | 20 - 25% | triclopyr | woody species | Year round. Avoid rain or snow, wet bark or snow covering near treatment. | herbicide within a 6-12 inch band around entire stem approximately 12 inches above | Method provides effective control and is cost effective | Some suggested oil diluents are not environmentally friendly, but vegetable or citrus oils with triclopyr can be effective (Rathfon 2006) | Herbicide application is performed using a backpack sprayer. Method used for woody stems ≤ 6" in diameter. This method should be considered an important control technique. |
| hack-and-squirt | Chemical & Mechanical Control | HS | 20 - 25% | glyphosate, triclopyr | woody species | Year round. | Make downward cuts with a hand axe (one cut per inch of diameter) | Method provides effective control and is cost effective; Volunteers can assist | Stem cutting may be difficult for thick-barked plants | Herbicide applied with squirt bottle or paint brush. Herbicide should be applied immediately after cutting. |
| stem injection | Chemical & Mechanical Control | SI | 20 - 25% | glyphosate, triclopyr | woody species | Year round. | E-Z-Ject Lance loaded with herbicide pellets | Method provides effective control | Equipment is difficult to operate under field conditions; Injection for thick-barked trees requires significant force; Equipment is expensive | None. |
| girdling | Mechanical Control (may be combined with Chemical Control) | GI | N/A | N/A | woody species | Year round. | Cutting and removing a ≥ 3 inch band of bark from a trunk | Method can provide effective control; Method can be assisted by volunteers | Method may be ineffective on species with re-sprouting ability; Method is time consuming and difficult for thick-barked species; Method cannot be utilized where the risk of standing dead trees is unacceptable | Method may be combined with chemical control (i.e., apply herbicide to girdled area); Do not attempt on species such as black locust, tree-of-heaven or Japanese angelica tree, which will vigorously re-sprout multiple stems in response to girdling (hack-and-squirt may be effective on these species) |
| pre-emergent spray | Chemical Control | PS | 1-3% | imazapic | herbaceous species | Spring, before germination of plants. | Application of herbicide to prevent seed germination | Method can provide effective control | Requires a broad application in areas known or suspected to contain invasive species; Timing of application can vary between years for targeted species; Suppresses germination of all species | None. |
| prescribed fire | Cultural Control | PF | N/A | N/A | many species | In NJ, the burn season is October- April. Regulated by the Forest Fire Service. | Should follow a site-specific Prescribed Burning Plan that is part of a comprehensive Grassland Management Plan | Method provides effective control and is cost effective | Requires highly trained personnel; Insurance requirements may restrict application to an outside contractor; Requires public outreach to neighbors and public officials | Prescribed fire is most effective for grasslands with dense stands of native warm season grasses that provide ample fuel to eliminate woody seedlings; Prescribed fire may be utilized to remove dense thatch before application of herbicides (e.g., common reed, reed canary grass) in wetland habitats. The effectiveness of prescribed fire to control invasive species in forest habitats is currently uncertain. |

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| Method Name | Method Category | Method Code | Typical Herbicide Concentrations | Typical Herbicide | Target Type(s) | Time of Year | Basic Technique | Pros | Cons | Notes |
|--------------------|--------------------|-------------|----------------------------------|-------------------|----------------------------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| prescribed grazing | Cultural Control | PG | N/A | N/A | many species | Year round. | Rotational system using multiple livestock species; Should follow a site-specific Prescribed Grazing Plan that is part of a comprehensive Grassland Management Plan | Method may be effective; Method can be assisted by volunteers | Method requires significant expertise in selection of livestock species, density of animals per unit area and timing of grazing; Method requires installation of fencing; Method may spread some invasive species through feces; Trampling of vegetation may encourage invasive species | Implementation will require consultation with experts in the use of livestock for the purpose of eliminating invasive species; Method may be considered for shrub control in forest settings if native species are currently absent |
| soil tilling | Cultural Control | ST | N/A | N/A | herbaceous species and woody seedlings | Year round. | Turning of soil using typical farm equipment | Method may provide effective control and is cost effective | Method destroys native species along with invasive species; Method may increase invasive species through extensive soil disturbance | This is an extreme method with limited use in natural areas. Successive tilling events may be used to exhaust weed seed bank prior to re-planting pollinator meadows. |
| mulching | Cultural Control | MU | N/A | N/A | herbaceous species | Year round. | Application of a thick layer (3-4 inches) of organic materials | Method is effective for herbaceous species within cultivated garden beds or roadsides; Method can be assisted by volunteers | Method is not practical in natural areas where vehicle access is limited | Only effective on species with small seeds or weakly growing plants that cannot germinate/grow through the mulch. Japanese stiltgrass and garlic mustard are sensitive to heavy mulching. |
| solarization | Cultural Control | SO | N/A | N/A | herbaceous species | Year round. | Application of plastic sheeting over infested areas | Method may be effective in some situations; Method can be assisted by | Method may alter soil chemistry and biology more significantly than herbicides | Plastic sheeting increases soil temperature to kill seeds and plants. |
| hot foam spray | Mechanical Control | HF | N/A | N/A | herbaceous species | Growing season. | Rental of Waipuna Hot Foam System | No herbicides are required | System rental cost is \$700/month with a two-year lease commitment and there are other related equipment costs; system can only be used within 200 feet of a vehicle that carries the specialized hot foam generator, many herbaceous plants require multiple treatments | This is an innovative system, but has significant financial and practical limitations. |

¹Thinvert system involves use of specialized spray nozzles combined with a thin invert emulsion spray fluid (instead of using water to mix with herbicides). The primary advantage is less herbicide drift to non-target plants and an

Summary of Herbicide Characteristics

Central Jersey Invasive Species Strike Team

Prepared by: Melissa Almendinger (Invasive Species Coordinator, URWA), Rachel Mackow (Land Steward, FoHVOS), and Michael Van Clef, Ph.D. (Stewardship Director, FoHVOS)

| Herbicide Common Name ¹ | Recommended Use Grouping ² | Target Species | Half-life in Soil (days) | Half-life in Water (days) | Estimated Cost per Gallon | Examples of Trade Names | Wildlife Risk Category | | Human Risk | |
|------------------------------------|---------------------------------------|-------------------------------------------------------------------|--------------------------|---------------------------|-----------------------------|---------------------------------------------------------------------------------------|------------------------------------------|-------------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------------|
| | | | | | | | Birds and Mammals | Aquatic Species | Signal Word ³ | Notes |
| Glyphosate ¹ | Typical | any plant | 47 | 12 days to 10 weeks | \$40 (Accord); \$80 (Rodeo) | Round-Up, Accord, Glypro, Glyphomax, Touchdown, Rodeo (approved for wetland use) | Low toxicity | Moderate toxicity ⁴ | Caution | Eye and skin irritant |
| Triclopyr | Typical | herbaceous broadleaf plants, woody plants (does not affect grass) | 30 | 4 days | \$130 (Garlon) | Garlon 4 Ultra, Remedy, Pathfinder II, Crossbow, Garlon 3A (approved for wetland use) | Slight toxicity | Slight toxicity | Caution or Danger | Garlon 3A can cause severe eye damage and is labeled "Danger"; Most other formulations are labeled "Caution" |
| Picloram | Typical | herbaceous broadleaf plants, woody plants | 90 | 2-3 days | \$120 (Tordon) | Tordon K, Tordon 22K, Grazon PC | Slight toxicity to practically non-toxic | Slight to moderate toxicity | Caution | Eye and skin irritant |
| Fluazifop-p-Butyl | Limited | grasses | 15 | stable | \$300 (Fusilade) | Fusilade DX, Fusion, Ornamec, Horizon 2000 | Slight toxicity to practically non-toxic | High toxicity | Caution | Eye and nasal irritant - toxic if inhaled |
| Fosamine | Limited | woody plants, some herbaceous broadleaf plants | 8 | stable | \$60 (Krenite) | Krenite S | Very slight toxicity | Low toxicity | Caution | Eye and skin irritant |
| Imazapyr ¹ | Limited | any plant | 24-141 | 2 days | \$410 (Arsenal) | Arsenal, Chopper, Stalker, Habitat | Low toxicity | Low toxicity | Caution | Eye and skin irritant |
| Sethoxydim | Limited | grasses | 5 | hours in sunlight | \$230 (Poast) | Poast, Torpedo, Ultima, Vantage, Conclude | Slight toxicity | Slight toxicity | Warning | Eye and skin irritant |
| 2,4-D ¹ | Infrequent | herbaceous broadleaf plants | 10 | hours to months | \$40 (Weed Ho) | Navigate, 2,4-D L.V.4 Ester, 2,4-D Amine 4, Aqua-kleen, Barrage | Moderately toxic | Not reported, but may bioaccumulate | Caution or Danger | Inconclusive evidence implicates 2,4-D as a potential endocrine disrupter; Eye and skin irritant |
| Clopyralid | Infrequent | herbaceous broadleaf plants | 40 | 8-40 | \$410 (Transline) | Reclaim, Curtail, Transline, Stinger, Lontrel | Practically non-toxic | Low toxicity | Caution or Danger | May cause serious eye damage |
| Hexazinone | Infrequent | herbaceous broadleaf plants, some grasses & some woody plants | 90 | 3 days to 9 months | \$95 (Velpar) | Velpar L | Low toxicity | Slight toxicity | Danger | May cause serious eye damage |
| Imazapic | Infrequent | some grasses, some herbaceous broadleaf plants | 120-140 | < 8 hours | \$350 (Plateau) | Plateau, Cadre | Low toxicity | Moderate toxicity | Caution | Eye and skin irritant |

¹ Denotes that some formulations of this herbicide are registered for aquatic applications.

² Groupings were based upon risks to humans or wildlife, relative cost compared to other similarly effective products and frequency of use by natural area managers.

³ Signal Words include "Danger" (highly toxic or highly corrosive), "Warning" (moderately toxic) and "Caution" (slightly toxic or relatively non-toxic). Please note that signal words are assigned to specific formulations and may vary within particular herbicide common names (CDMS 2007).

⁴ Glyphosate is essentially non-toxic when using aquatic formulations (e.g., Rodeo with a surfactant registered for aquatic applications).

Specific Control Techniques by Size Class

Central Jersey Invasive Species Strike Team

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| Plant Size Class | Suggested Treatment Techniques | Notes |
|-----------------------------------------------|--------------------------------------------------|-----------------------------------------------------------------------------------------|
| Large tree | Girdling or Harvesting | May be combined with herbicide application to girdled area |
| Large shrub / small tree | Basal bark, Hack-and-Squirt, Cut Stump, Girdling | Mowing may be used as a pre-treatment to reduce plant size prior to chemical treatments |
| Small shrub / tree sapling | Basal Bark, Foliar Spray, Cut Stump, Pulling | Mowing may be used as a pre-treatment to reduce plant size prior to chemical treatments |
| Large vines | Basal Bark, Cut Stump, Hack-and-Squirt | Many vine species have extensive root systems that require herbicide treatment |
| Forest herbs, woody seedlings and small vines | Foliar Spray, Pulling | Mulching may be utilized in garden beds or other human-modified areas |