# Site Assessment and Four-Year Restoration Plan for Upland Portions of the Hartland Marsh-Bark River Preserve

Waukesha County, WI


**Integrated Restorations, LLC**

Ecological Restoration & Land Management Services

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# Site Assessment and Four-Year Restoration Plan for Upland Portions of the Hartland Marsh-Bark River Preserve

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## Context

Historically, more than 6.9 million acres of Wisconsin was covered by oak savanna and open oak woodland (Curtis 1959) and Wisconsin led the Midwest in total acreage of these plant communities (WDNR 1995). Although Curtis (1959) operationally defined oak savanna as having greater than one oak tree per acre but less than 50% total tree canopy cover, the distinction between oak savanna and open oak woodland is largely subjective from a restoration and management perspective (c.f., Cottam 1949). Generally speaking, oak-dominated plant communities are characterized by 1) a preponderance of white, burr, black, red, pin, and/or Hill's oak, often with shagbark hickory as a principal subdominant species, 2) a midstory and groundlayer of fire-tolerant native shrubs and herbaceous vegetation, and 3) a history of periodic fire. At the landscape scale, topographic factors and gradients of soil characteristics and light also influence the composition of oak communities (Pruka 1994; Leach and Givnish 1998; Annen and Lyon 1999). Oak savanna and oak woodlands require a periodic stabilizing disturbance (in the form of fire) to maintain their structure and diversity; the frequency and intensity of historical fire regimes influenced the acreage of oak-dominated plant communities during any given time period, and the extent of these communities expanded and contracted in response to climatic changes that influenced fire behavior during the past 12,000 years (Anderson 1998). In the absence of fire, oak-dominated communities are quickly replaced by mesic forest or a novel mixture of non-native shrubs and fire-intolerant softwood trees.

Remnant oak savanna is presently considered one of the most threatened plant community types in the Midwestern United States. In 1995, the Wisconsin DNR reported that no more than 500 acres of undisturbed, high-quality oak savanna were listed in Wisconsin's Natural Heritage Inventory, less than 0.01% of their original acreage. Most oak savanna remnants are in highly degraded condition and occur as isolated islands within a landscape that has been highly fragmented by commercialization and urban expansion. Tree and shrub encroachment in the absence of periodic fire regimes, clearing and conversion to row crop agriculture, intensive livestock grazing, and species invasions have all contributed to loss of oak savanna acreage. Leach and Givnish (1998) suggested that degraded oak savanna remnants are more prevalent that conventionally thought, and proposed three criteria for identifying highly restorable oak savanna remnants in Wisconsin: 1) presence of oaks displaying an open growth form, 2) a history of fire within the previous ten years, and 3) a groundlayer of native species from both full-sun and shaded microsites. However, to date no one has used these criteria to reassess the total acreage of oak savanna remnant in Wisconsin. Regrettably, our knowledge of the biology and ecology of historical oak savanna and open oak woodlands is less than complete; much of the original

acreage had already been degraded by the time the University of Wisconsin Plant Ecology Laboratory (PEL) first made efforts to quantify their structure and composition (as summarized in Curtis 1959). In fact, several sources suggest that the original groundlayer composition of oak savanna is largely unknown (e.g., Pruka 1994; WDNR 1995). The present rarity of remnant oak savanna and open oak woodland communities underscores the need for conservation, protection, management, and scientific investigation of these plant community types and the array of wildlife they support.

## General Site Description and Location

The 178-acre Hartland Marsh-Bark River Preserve (refer to map at the end of this document) is located west of Cottonwood Drive within the Village of Hartland, T7N R18E, in Waukesha County, Wisconsin, and is also bordered by the City and Township of Delafield. The Hartland Marsh-Bark River Preserve consists of a habitat mosaic of oak savanna, open oak woodland, shrub-carr, sedge meadow, and riparian communities, all of which are in a slightly degraded but highly restorable condition. The Bark River flows through the Preserve from NE to SW, and approximately 1.5 miles of a spur and loop of the Ice Age Trail meanders through the site. Boardwalks have been installed over the wetland portions of the site to allow access to the oak savanna islands that occur on high points within the wetland. Presettlement vegetation in the area consisted of a mosaic of prairie and oak savanna, with wetland communities in the lowlands of the Bark River floodplain. The present landscape consists of remnant oak savanna-open oak woodland and wetland communities within a matrix of commercial and residential developed land.

## Assessment of Restoration Potential

The beta (habitat) diversity of the Hartland Marsh-Bark River Preserve along a wetland-to-upland gradient offers an opportunity for conservation of numerous species across multiple trophic levels. The present composition and structure of native relic vegetation suggests that the Preserve has high natural area potential, and public use of these hiking trails presents the possibility to educate local residents about habitat conservation in general and the importance of oak savanna and oak woodland remnants specifically. Although the preliminary site analysis (conducted by Ann Hasselkus) did not detect the presence of any species of conservation concern, supplementary in-depth surveys might reveal the presence of at-risk species inhabiting the Preserve, particularly following implementation of restoration and management initiatives. Management action should be undertaken within the next five years to

preserve this remnant and curtail any further degradation of its structural and compositional integrity and prevent local species loss; if the present trend is allowed to continue for more than five years, species invasions and successional changes will be increasingly difficult and expensive to reverse, and will require a longer time commitment to accomplish. Fortunately, previous efforts by IATA (Ice Age Trail Alliance) and WCLC (Waukesha County Land Conservation) volunteers have already placed this site on a trajectory toward recovery, and capitalizing on these efforts can be accomplished within a three-year time period with a routine level of management intensity. The only foreseeable challenge this site poses is its urban location and obtaining permission and public acceptance of the use of prescribed fire as a management tool.

The 37 acres of oak savanna and open oak woodland remnants of the Hartland Marsh-Bark River Preserve are presently in highly recoverable condition; the majority of the mature oaks present possess an open canopy growth form, oak and hickory regeneration is occurring in all but the seedling age classes, native groundlayer sedges, grasses, and forbs are present in at least some locations, and the depth and composition of litter is conducive to application of prescribed fire. In the absence of periodic fire, this upland oak savanna and open oak woodland remnant is tracing a new trajectory toward replacement by trees and shrubs, although at present this trend is still reversible on a practical time scale. The primary immediate threat to the ecological integrity of this site arises from non-native invasive species, principally buckthorn. A variety of size classes of box elder, white mulberry, American cherry, and honeysuckle are also present throughout the uplands at lower density. Brambles are common in places, and may expand following initial management. Also present are garlic mustard, Japanese hedge parsley, with scattered Canada thistle and burdock.

Incidentally, the wetland areas are also largely in recoverable, remnant condition and display high restoration and habitat potential, although specific management recommendations for the Preserve's wetlands are not covered in this report.

## Restoration Plan

Refer to the map at the end of this document; this report summarizes restoration tasks for the 37 acres of upland habitat outlined with yellow, green, and purple polygons.

**A. Short-term management initiatives should focus on three general priorities:**

1) Tree and shrub removal,
2) Invasive species suppression, and

3) Reintroduction of prescribed fire to the site.
4) Reintroduction of additional groundlayer species that are characteristic of presettlement oak savanna and open oak woodlands. Brian Pruka (1994) provided a list of savanna indicator species that can serve as a starting point for this effort. Additional lists of savanna groundlayer species can be found at http://oaksavannas.org/savanna-forbs.html#Packard

**B. Longer-term management initiatives** *THESE INITIATIVES ARE NOT COVERED IN THIS REPORT BUT WE CAN PROVIDE GUIDELINES ONCE RESTORATION REACHES THIS PHASE:*

1) Creation and installation of habitat structural elements for wildlife use (e.g., bird and bat houses, den logs, plum thickets, hazelnut, nurse logs, basking logs, hard- and softwood snags).
2) Maintenance of a habitat mosaic to maximize the Preserve's biodiversity potential and provide wildlife with habitat refuge, as most of the surrounding area will not support oak savanna and open oak woodland habitat specialists.

**Summary of Specific Management Objectives:**

1. **Reverse buckthorn invasion.**
2. **Remove subdominant trees and additional invasive shrubs; retain native shrubs for wildlife use.**
3. **Suppress garlic mustard, Japanese hedge parsley, burdock, and Canada thistle.**
4. **Conduct spring burns in the uplands annually for 3 – 5 consecutive years.**
5. **Reestablish herbaceous vegetation in the groundlayer.**

**Specific Management Objectives:**

1. **Reverse buckthorn invasion.** Buckthorn is the most abundant invasive species in the oak savanna and open oak woodland remnants (Figure 1). Owing to previous management efforts that focused on buckthorn removal, a single age-class cohort of ca. four year-old buckthorns (≈ ¾ to 1-inch basal diameter) has populated much of the remnant wooded portions of the Preserve. This population probably arose following increased light penetration to the buckthorn seedbank after initial buckthorn removal, commensurate with the lack of fire to curtail shrub establishment and expansion. This cohort has begun to reach reproductive maturity (Figure 2, note the presence of black berries growing from the axils of the upper branches), is already capable of suppressing oak regeneration (the seedling and small sapling age-classes of oaks are

nearly absent), has altered the open character of oak savanna habitat (concomitantly reducing habitat suitability to many wildlife species), and has likely altered the site's ability to carry a fire in some places. ***This threat should be addressed immediately upon implementation of active management.***

**Figure 1. Buckthorn invasion following initial buckthorn removal (2014).**

**Figure 2. Reproductively mature buckthorn producing berries (2014).**

**Specifications:** Approximately ⅔ of the area covered by buckthorn at high density occurs on relatively flat ground and can be forestry mowed by agency staff (refer to the management timeline section of this document for specific timing windows). Mowing should be performed during the early winter months once the ground is well frozen (to limit soil disturbance) and the dense buckthorn shrubs have lost most of their leaves, enhancing visibility for the mower operator to avoid damaging equipment on the array of quartzite glacial erratics and occasional downed trees that are distributed throughout the site. Mowed areas should be foliar-treated by a contractor with a mixture of 3% (v/v) water-soluble triclopyr (Element 3A®, Garlon 3A®) and 2% (v/v) methylated seed oil-nonionic surfactant blend (MSO-NIS) during the peak of the subsequent growing season, after resprouts have achieved full leaf-out. Considering the buckthorn population is already releasing propagules, it is strongly recommended that a minimum of two mowing and three foliar treatment iterations are performed to limit subsequent buckthorn reinvasions, simultaneous with annual imposition of prescribed fire to the areas under active management (refer to the management timeline section of this document for specific timing windows). The remaining ⅓ of the buckthorn population occurs on sloping ground and will need to be manually removed by a contractor. During manual removal, freshly cut stumps should be treated with a 50% (v/v) solution of water-soluble triclopyr (Element 3A®, Garlon 3A®) or a 21% (v/v) mixture of oil-soluble triclopyr (Element 4®, Garlon 4®, or Garlon RTU®) and bark oil diluent (refer to the management timeline section of this document for specific timing windows). The southeast corner of the site (near the parking lot and chimney structure) supports larger buckthorn shrubs that should also be removed and chemically treated by a contractor to prevent the spread additional propagules throughout the remainder of the Preserve. Slash should be piled and burned by a contractor in winter when there is adequate snow cover on the ground.

2. **Remove subdominant trees and additional invasive shrubs; retain native shrubs for wildlife use.** Trees that are not characteristic of historical oak savanna and additional invasive shrubs (principally honeysuckle, barberry, white mulberry, black cherry, and box elder) have also become established in the absence of fire. These species occur at lower density than buckthorn, probably as a result of competitive interference by buckthorn, and will likely expand once buckthorn removal occurs.

   **Specifications:** Shrubs and tree seedlings occurring in the flat areas should be forestry mowed along with the buckthorn, while larger trees (which are interspersed throughout the uplands)

and those trees and shrubs occurring in sloped areas should be manually removed by a contractor. It is recommended that a minimum of two foliar treatments are conducted on honeysuckle and black cherry resprouts since neither is completely eradicated by a single foliar treatment (both species have a leaf anatomy that provides a measure of physical tolerance to triclopyr foliar treatments). The southeast corner of the site consists of a ca. ¾-acre stand of large trees (along with several large mature buckthorn shrubs) that are not characteristic of historical conditions and should be manually removed by a contractor. Slash should be piled and burned in winter when there is adequate snow cover on the ground. Chemical treatment recommendations and specific timing windows for this objective are the same as for buckthorn.

3. **Suppress garlic mustard, Japanese hedge parsley, burdock, and Canada thistle.**

   **Specifications:** Garlic mustard and Japanese hedge parsley: Scout and spot treat garlic mustard and Japanese hedge parsley plants with 0.8 grams per gallon wettable-granule metsulfuron methyl (Escort XP®) with 1% methylated seed oil-nonionic surfactant blend (specific tank mixing instructions can be found in appendix A of this document). Any small shrubs or brambles that are leafing out during this initial pass can also be treated with this mixture. Canada thistle and burdock: Scout and spot treat populations of Canada thistle and burdock with a 0.5% (v/v) mixture of clopyralid (Transline®, Stinger®) with 1% (v/v) biodegradable organic fatty acid-based sticking agent and acidifier (Induce pH®) and 1% (v/v) MSO-NIS in mid- to late June (optimally, before flowering and seed production). The sticking agent will cause the herbicide to physically adhere to treated surfaces and retard spray drift and leaf wash, thereby minimizing the risk of collateral damage to non-target species and decreasing the volume of herbicide necessary to achieve herbicide performance. Treatments should be repeated for at least three growing seasons to ensure complete eradication.

4. **Conduct spring burns annually for 3 – 5 consecutive years.** Fire is necessary to maintain the open character and species composition of oak savannas and open oak woodlands. Moreover, in terms of the long-term threat posed by the buckthorn invasion, the allelopathic metabolites released by buckthorn are sequestered by electrostatically-charged activated charcoal that results from frequent low-intensity burn events. Periodic fire is also necessary for mast production and oak and hickory regeneration. One possible response to fire management is an initial increase in the abundance of invasive species. Fire effects (litter removal and seed scarification) can affect a flush of invasive species seed banks, particularly of legumes and biennial species, although the severity of invasive outbreaks typically diminishes with time. The

optimal time to eradicate an invasive species is during the initial establishment phase of its expansion; therefore, the site should be annually scouted for the presence and distribution of invasive species, especially during the initial recovery period and after fire management events.

**Specifications:** The upland portions of the site should be burned annually for at least three to five consecutive years by experienced IATA and Waukesha County Land Conservation volunteers. Volunteers should also coordinate firebreak construction and maintenance activities with burn leaders (refer to the management timeline section of this document for specific timing windows).

5. **Reestablish herbaceous vegetation in the groundlayer.** Volunteers should plant plugs (live plants) and seeds of sedges, grasses, and forbs characteristic of oak savanna and open oak woodland vegetation communities. Brian Pruka (1994) provided a list of savanna indicator species that can serve as a starting point for this effort. Additional lists of savanna groundlayer species can be found at http://oaksavannas.org/savanna-forbs.html#Packard. This will additionally help to make the oak savanna and open oak woodland remnants more flammable during burns, which will in turn enhance the effects of fire management on species invasions (refer to the management timeline section of this document for specific timing windows).

## Three-Year Cost Estimate

$17,000 - $23,000 ($460 – $620/acre) for items in the task plan designated to the contractor (estimate includes all expendable supplies, including herbicides and additives).

*Hourly labor rate: $35/person*

*Hourly consulting rate: $50/consultant*

*Integrated Restorations, LLC and its staff are fully certified and licensed commercial pesticide applicators. Integrated Restorations, LLC carries active liability and worker's compensation insurance to protect its clients.*

## Management Timeline and Task Plan

This assessment and recovery plan focuses on management priorities for a 46-month time period.

| Timing Window | Activity | Task Assignment |
|---|---|---|
| | **Year 1** | |
| October-November | Forestry mow shrubs in flat areas | *Local government agency* |
| November-December | Thin canopy of trees not characteristic of oak woodlands | *Contractor* |
| December | Burn brush piles | *Contractor* |
| | **Year 2** | |
| January | Burn brush piles | *Contractor* |
| March-April | Install firebreaks and conduct prescribed burn | *Volunteers* |
| April-May | Scout and spot spray GM and JHP | *Contractor* |
| May-June | Scout and spot spray burdock and thistle | *Contractor* |
| June-July | Foliar spray brush resprouts in forestry mowed areas | *Contractor* |
| | Foliar spray brambles (as needed) | *Contractor* |
| October-November | Forestry mow shrubs in flat areas | *Local government agency* |
| | Manually remove shrubs from sloped areas | *Contractor* |
| November | Scout and spot spray GM and JHP | *Contractor* |
| | **Year 3** | |
| March-April | Conduct second prescribed burn | *Volunteers* |
| April-May | Scout and spot spray GM and JHP | *Contractor* |
| June-July | Foliar spray brush resprouts in forestry mowed areas | *Contractor* |
| | Foliar spray brambles (as needed) | *Contractor* |
| September-October | Collect local ecotype seed for savanna understory | *Volunteers* |
| November | Scout and spot spray GM and JHP | *Contractor* |
| | **Year 4** | |
| March-April | Conduct third prescribed burn | *Volunteers* |
| | Interseed local ecotype seed into burned areas | *Volunteers* |
| April-May | Scout and spot spray GM and JHP | *Contractor* |
| May-June | Scout and spot spray burdock and thistle | *Contractor* |
| June-July | Foliar spray brush resprouts in mowed areas | *Contractor* |

# References


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# Appendix A:
# Tank mixing instructions for herbicides and additives listed in this report
**(arranged by target species)**

## 1. Brambles (blackberry, red raspberry, black raspberry, dewberry)

***Herbicide:*** Element 3A® [44.4% a.i. stock solution of water-soluble triclopyr].
***Rate:*** 0.4% (a.i.) WS triclopyr, equivalent to 1.3 fluid ounces (37.7 mL) per gallon. This produces a 1% solution by volume (1% v/v).
***Solvent:*** Water (a conditioning agent is not required for this formulation).
***Additive:*** Dyne-Amic® (Helena Chemical Co.) organosilicone-based methylated seed oil + nonionic surfactant.
***Addition rate:*** 1% (v/v), equivalent to 1.3 fluid ounces (37.7 mL) per gallon.
***Tank mixing sequence:***

a. Add ⅔ of the desired total volume of water to tank
b. Add triclopyr
c. *q.s.* tank to desired final volume
d. Add MSO-NIS
e. Add spray pattern indicator dye
f. Replace tank lid, agitate, and apply
g. (Periodically re-agitate spray solution during application)

***Coverage for optimal performance:*** ≥ 85% of leaf surface area.

***Application Window:*** Late June – early July, preferably during periods of active growth and limited precipitation deficit. Brambles should be completely leafed out and actively growing.

***Uptake:*** Element 3A® is rainfast in 4 hours. Addition of 2% (v/v) Dyne-Amic® to the mixture quadruples the rate of uptake, decreasing the rainfast period to 1 hour. Triclopyr is mildly decomposed by UV light.

***Posting Requirement:*** The Restricted Entry Interval (REI) of Element 3A® is 48 hours.

## 2. Buckthorn, honeysuckle, white mulberry, and black cherry resprouts

***Herbicide:*** Element 3A® [44.4% a.i. stock solution of water-soluble triclopyr].
***Rate:*** 1.3% (a.i.) WS triclopyr, equivalent to 3.8 fluid ounces (112 mL) per gallon. This produces a 3% solution by volume (3% v/v).
***Solvent:*** Water (a conditioning agent is not required for this formulation).
***Additive(s):*** Dyne-Amic® organosilicone-based methylated seed oil + nonionic surfactant, Induce pH® sticking agent. Both adjuvants are manufactured and distributed by Helena Chemical Company.
***Addition rate(s):*** Dyne-Amic—2% (v/v), equivalent to 2.6 fluid ounces (75.4 mL) per gallon; Induce—0.5% (v/v), equivalent to 0.65 fluid ounces (19 mL) per gallon.

***Tank mixing sequence:***

a. Add ⅔ of the desired total volume of water to tank
b. Add triclopyr
c. *q.s.* tank to desired final volume
d. Add MSO-NIS and sticking agent
e. Add spray pattern indicator dye
f. Replace tank lid, agitate, and apply
g. (Periodically re-agitate spray solution during application)

***Coverage for optimal performance:*** ≥ 95% of leaf surface area.

***Uptake:*** Element 3A® is rainfast in 4 hours. Addition of 2% (v/v) Dyne-Amic® to the mixture quadruples the rate of uptake, decreasing the rainfast period to 1 hour. Triclopyr is mildly decomposed by UV light.

***Height of target vegetation:*** ≤ 2½ feet tall (herbicide efficacy diminishes at heights greater than this).

***Application Window:*** Late June – Late July, preferably during periods of active growth and limited precipitation deficit. Resprouts should be completely leafed out and actively growing.

***Posting Requirement:*** The Restricted Entry Interval (REI) of Element 3A® is 48 hours.

### 3. Canada thistle and burdock

***Herbicide:*** Transline®, Stinger® [40.9% a.i. stock solution of water-soluble clopyralid].
***Rate:*** 0.2% (a.i.) WS clopyralid, equivalent to 0.5 fluid ounces per gallon. This produces a 0.4% solution by volume (0.4% v/v).
***Solvent:*** Water (a conditioning agent is not required for this formulation).
***Additive(s):*** Dyne-Amic® organosilicone-based methylated seed oil + nonionic surfactant, Induce pH® sticking agent.
***Addition rate(s):*** Dyne-Amic—1% (v/v), equivalent to 1.3 fluid ounces (37.7 mL) per gallon; Induce—0.5% (v/v), equivalent to 0.65 fluid ounces (19 mL) per gallon.
***Tank mixing sequence:***

a. Add ⅔ of the desired total volume of water to tank
b. Add clopyralid to tank and triple rinse measuring container.
c. *q.s.* tank to desired final volume
d. Add MSO-NIS and sticking agent
e. Add spray pattern indicator dye
f. Replace tank lid, agitate, and apply
g. This herbicide is infinitely soluble in water; it is therefore not necessary to periodically re-agitate spray solution during application.

***Coverage for optimal performance:*** Approximately 50% of leaf surface area; if target species are flowering, herbicide should also be applied to flowering portions of the plant.

***Uptake:*** Transline® and Stinger® are rainfast in about 15 minutes (the active molecule is small enough to be transported through plasmodesmata channels between adjacent plant cell walls and does not require phloem loading).

***Growth stage of target vegetation:*** Prior to seed development (herbicide efficacy diminishes when these species are treated post-anthesis).

***Application Window:*** Late May – mid-June, optimally prior to flowering.

***Posting Requirement:*** The Restricted Entry Interval (REI) of Transline® and Stinger® is 12 hours.

### 4. Garlic mustard and Japanese hedge parsley (first or second-year plants)

***Herbicide:*** Escort XP® [60% a.i. stock solution of metsulfuron methyl wettable granules].
***Rate:*** 0.4% (a.i.) metsulfuron methyl, equivalent to 0.8 grams per gallon. This produces a 0.6% solution by weight (0.6% w/v)
***Solvent:*** Water (an alkalinity agent such as ammonium hydroxide is required for this formulation).
***Additive(s):*** Dyne-Amic® organosilicone-based methylated seed oil + nonionic surfactant, Induce pH® sticking agent. Both adjuvants are manufactured and distributed by Helena Chemical Company.
***Addition rate(s):*** Dyne-Amic—1% (v/v), equivalent to 1.3 fluid ounces (37.7 mL) per gallon;
Induce—0.5% (v/v), equivalent to 0.65 fluid ounces (19 mL) per gallon.
***Tank mixing sequence:***

h. Add ⅔ of the desired total volume of water to tank
i. Add 1 cup (8 fluid ounces) household cleaning ammonia to increase tank solvent pH
j. Add 8 grams of metsulfuron methyl WG per gallon to sealable jar and agitate until all granules have dissolved.
k. Empty contents of sealable jar into tank and triple rinse, adding rinsate to tank.
l. *q.s.* tank to desired final volume
m. Add MSO-NIS and sticking agent
n. Add spray pattern indicator dye
o. Replace tank lid, agitate, and apply
p. (Periodically re-agitate spray solution during application)

➔ DO NOT use a non-ionic surfactant containing acetic acid or any similar chemical derivatives with metsulfuron methyl, as these mixtures are chemically incompatible and will result in diminished herbicide performance.

***Coverage for optimal performance:*** ≥ 85% of leaf surface area.

***Growth stage of target vegetation:*** Prior to seed development (herbicide efficacy diminishes when second-year biennials are treated post-anthesis).

***Application Window:*** Two windows are available for treating these biennials: April – early May and late October – early November. When employing autumn applications, be sure that native non-target species have senesced (typically occurs shortly after the first hard frost of the season).

***Posting Requirement:*** The Restricted Entry Interval (REI) of Escort XP® and MSM 90® is 4 hours.

**5. Trees and shrubs (manual removal followed by cut stump herbicide application)**

***Herbicide:*** Element 3A® [44.4% a.i. stock solution of water-soluble triclopyr] or Element 4® [Element 4 is sold as a ready-to-use (RTU) formulation].
***Rate:*** 22% (a.i.) WS triclopyr, equivalent to 64 fluid ounces per gallon. This produces a 50% solution by volume (50% v/v).
***Solvent:*** Water or windshield antifreeze if applying at air temperatures lower than 32°F (a conditioning agent is not required for this formulation).
***Additive(s):*** Spray pattern indicator dye (any color). Surfactants are not necessary for this type of cut stump treatment.
***Addition rate(s):*** To desired marking color.
***Tank mixing sequence:***

a. Add ⅔ of the desired total volume of solvent to tank
b. Add triclopyr
c. *q.s.* tank to desired final volume
d. Add spray pattern indicator dye
e. Replace cap, agitate and dispense into small capacity compression sprayer

***Coverage for optimal performance:*** 360° of outer cambium of cut stump.

***Uptake:*** Element 3A® is rainfast in 4 hours.

***Size of target vegetation:*** Irrelevant as long as herbicide is applied to the entire circumference of the cut stump's outer cambium.

***Application Window:*** September – March for most species, preferably during periods of low sap flow.

***Posting Requirement:*** The Restricted Entry Interval (REI) of Element 3A® is 48 hours. The REI of Element 4® is 12 hours.

**Additional Considerations**

**Safety:** Always wear recommended PPE from the herbicide and additive labels. **NEVER MIX UNDILUTED ADDITIVES WITH UNDILUTED HERBICIDES, particularly acidifiers with acidic herbicide formulations!**

**Equipment Maintenance:** With extended exposure, triclopyr is corrosive to brass and mildly corrosive to aluminum. It is also capable of physically degrading rubber seals, gaskets, and pump impellors. To extend the useful life of spray equipment, it is advisable to thoroughly flush and neutralize tanks and all sprayer components daily.

**Application Conditions:** If applying during morning hours when dew is present on leaf surfaces or on days when air temperatures exceed 80°F, increase addition rate of Induce or Induce pH to 1% (v/v), equivalent to 1.3 fluid ounces (37.7 mL) per gallon. It is not advisable to apply triclopyr at air temperatures exceeding 90°F or during a prolonged drought when leaves of target plants appear wilted or chlorotic at their margins. Under these conditions, target plants are quasi-dormant and herbicide uptake and translocation will be diminished. It is best to apply following a summer rainfall event when possible. It is not advisable to apply metsulfuron methyl at air temperatures below 20°F.

**Target Plant Resurgence:** When treating most buckthorn resprouts and all honeysuckle plants, anticipate the need for follow up applications for a minimum of two consecutive growing seasons. Buckthorn resprouts have stored carbohydrate reserves in their rhizome systems for regrowth, and honeysuckle leaves have a thick waxy cuticle that only allow herbicide uptake in non-lethal quantities, regardless of the additive system employed to enhance uptake. Follow-up applications are usually only necessary in heavily-infested bramble patches. Additionally, annual prescribed burns are recommended between applications to flush out the seed bank and burn off dead plant material, and also to expose obstacles (e.g. rock outcroppings) that can damage spray equipment and open up the native seed bank to light (assuming it has survived the invasion). Moreover, activated carbon resulting from annual burns has a slightly positive electrostatic charge that can sequester negatively-charged allelopathic inhibitors produced by buckthorn.

**Shelf life:** Stock solutions of the herbicides mentioned here are stable for 2 years if not subjected to freeze-thaw cycles. Mixtures of herbicide with MSOs are generally only stable for ≤ 72 hours. Therefore, it is recommended that applicators only mix as much herbicide as they plan on applying within a given day.

**BMPs for use near assets and non-target species:** Survey, locate, and flag all desirable or at-risk plants prior to applying herbicide. Using a reciprocating saw, remove the bottom from a plastic 5-gallon bucket. Place the bucket atop non-target species and spray around the outside of the bucket, directing spray as low as possible. To reduce the potential for herbicide drift, add Induce pH at a higher rate of 3 – 4% (v/v), equivalent to 3.8 – 5 fluid ounces (112 – 150 mL) per gallon.

**Technical Notes:** Dyne-Amic® is an organosilicone-based methylated seed oil-nonionic surfactant blend. MSOs dissolve leaf cuticles to enhance passive herbicide uptake by the target plant, and nonionic surfactants enable applied herbicide to spread evenly over a treated surface. Organosilicone-based additives have the additional advantages of lubricating sprayer components while resisting physical breakdown through pump-shear degradation, they render mixtures less vulnerable to chemical decomposition from UV light, and they don't dry as quickly on treated surfaces compared to inorganic silicone-based adjuvants. In addition, Dyne-Amic® is molecular-filtered and will not gel with insoluble calcium precipitates often present in mix water and jam nozzle filters when applied at air temperatures exceeding 80°F. Induce pH® is a blend of acidifiers, nonionic surfactants, and free fatty acids that function as sticking (drift control) agents. Mixtures containing this additive physically adhere to treated surfaces, and resist runoff from rewashing and evaporation of herbicides from leaf surfaces.

# IATA's Hartland Marsh