# *Quality Assurance Project Plan*

**Removal of Phragmites and Lyme Grass from WI Lake Michigan Shoreline**

**EPA Grant Funding Source:** Great Lakes Restoration Initiative **GL-00E00570**

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**Prepared by:**
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**Date: August 19, 2011 - Revision 2**

**Approvals:**

Heidi Springborn, WDNR Project Coordinator — 8-19-2011 Date

Mark Martin, WDNR Project Officer — 8-19-2011

Donalea Dinsmore, Great Lakes Funding and Quality Assurance Coordinator — 8-19-2011

Louis Blume, GLNPO Quality Manager

Jennifer Conner, GLNPO Project Officer

## A.2 Table of Contents

## A.3
## Distribution List

**Wisconsin Department of Natural Resources, Bureau of Endangered Resources**

Lance Potter (Grant File)
Mark Martin
Heidi Springborn

**Wisconsin Department of Natural Resources, Office of the Great Lakes**

Donalea Dinsmore (SWIMS copy*)

* By attaching the document to the project in SWIMS, the QAPP will be available to any DNR staff that need to consult it.

**U.S. Environmental Protection Agency/GLNPO** Jennifer Connor
Louis Blume

**Grant Partners**

| | |
|---|---|
| Brown County Land Conservation Department | Jim Jolly |
| Door County Land Trust | Jodi Miliske |
| Door County Soil & Water Conservation Department | Greg Coulthurst |
| Marinette County Land | Greg Cleereman |
| | Robert Ruleau |
| Oconto County Land Conservation Department | Ken Dolata |
| The Ridges Sanctuary | Marne Kaeske |
| | Steve Leonard |
| Woodland Dunes Nature Center | Jim Knickelbine |
| U.S Fish & Wildlife Service | Gary VanVreede |
| | John Riens |

## A.4
## Project/Task Organization

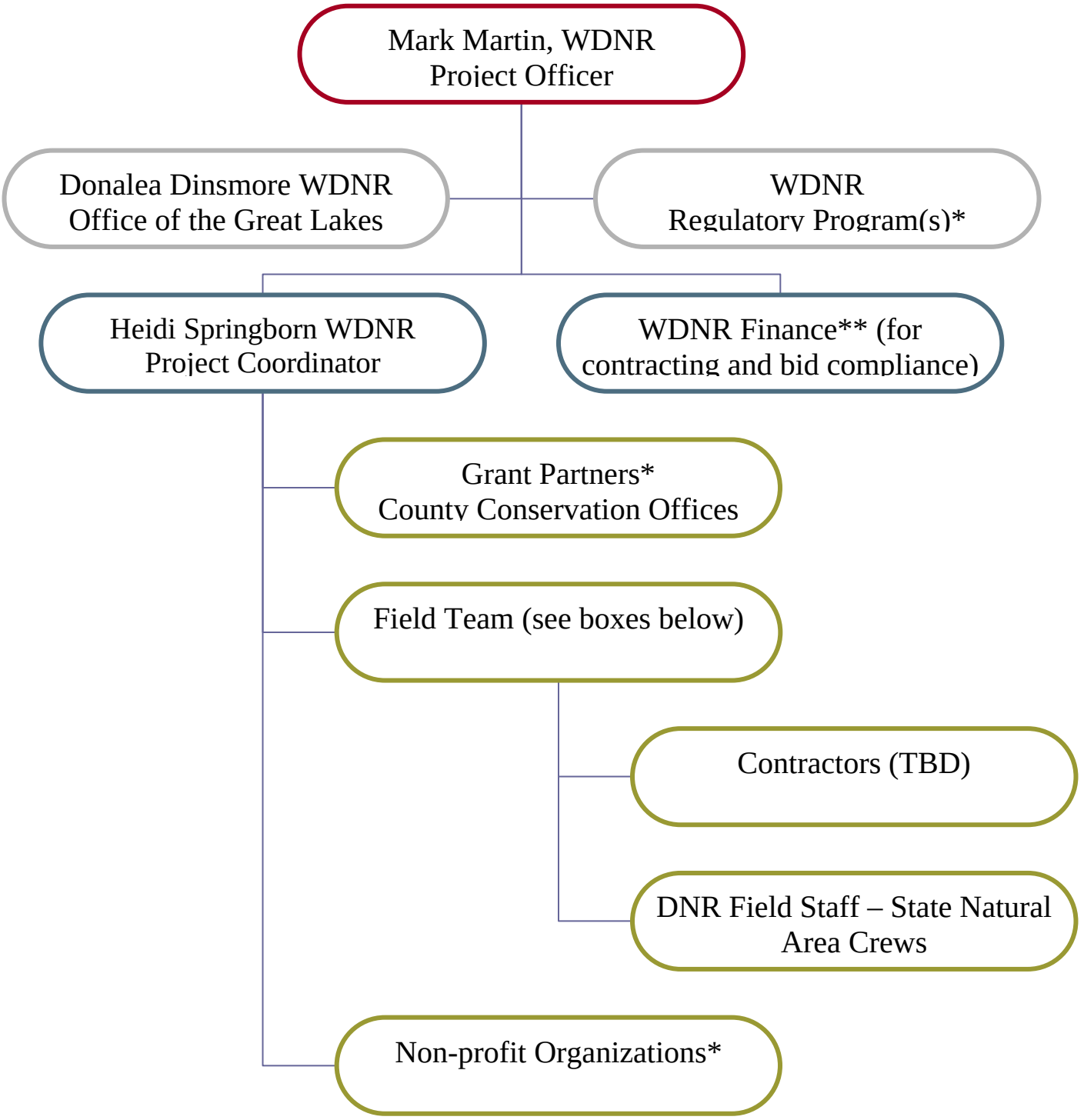
| **Key Individual(s)** | **Roles & Responsibilities** |
|---|---|
| Heidi Springborn, WDNR Project Coordinator | × Overall project management<br>× Monitors study progress<br>× Ensures project completion<br>× QAPP preparation & distribution, and overall project QA/QC<br>× Ensures QAPP is followed<br>× Project reporting in SWIMS database |
| James Doperalski, WNDR Regional Environmental Analysis and Review Specialist | × Environmental Impact Statement Support |
| Greg Sevener, WDNR Regional Watershed Specialist | × Provides guidance on permit requirements for the Green Bay West Shores |
| Mary Gansberg, WDNR Regional Water Resources Management Specialist | × Provides guidance on permit requirements for Door County, Manitowoc and Sheboygan Counties |
| Mark Martin, WDNR Natural Areas Specialist - Project Officer | x Natural Areas Specialist with the Bureau of Endangered Resource's State Natural Area program. Mark has worked in the natural resource field since 1971 and has worked on Phragmites control efforts for eight years.<br>x Provide project coordination and supervision. |
| Joe Henry, WDNR Regional Ecologist | × Ecologist in the Northeast Region for the Wisconsin Department of Natural Resources.<br>× Joe has worked in the natural resources field for the past 12 years and has a broad knowledge of the stewardship of natural communities and the management challenges facing resource management agencies.<br>× Provides management recommendations for minimizing threats to E/T species, biotic inventory work, assisting with property master plan development, granting writing and land management and invasive species control.<br>× Assist project coordinator with method development, vegetation survey support, endangered resources protocols and general project support |
| Brown County LWCD<br>Jim Jolly, Program Manager | × Will aid in private landowner point of contact, coordinate receiving permission for treatment, send mailings, |
| Door County Land Trust<br>Jodi Milske | × Staff time and volunteer assistance with mapping invasive species locations in Door County. |
| Door County SWCD<br>Greg Coulthutst, Conservationist | × Will aid in private landowner point of contact, coordinate receiving permission for treatment, send mailings GPS points, acreages, permissions |
| Marinette County LWCD<br>Greg Cleereman<br>Robert Ruleau | × Will aid in private landowner point of contact, coordinate receiving permission for treatment, send mailings<br>× Supply GPS data on Phragmites locations and acreages<br>× Assistance with control<br>× Provide matching funds |
| Oconto County LCD<br>Ken Dolata | × Gather perimeter data / acreage of *Phragmites* located in Oconto County from the ordinary high water mark out into the Bay of Green Bay using GPS equipment, Arc View and 2010 aerial photos<br>× Provide data to project coordinator. |

| | |
|---|---|
| | × Generate landowner address list and make initial contacts with landowners.<br>× Aid in helping monitor test plots within Oconto County and follow up information for second and third year of grant. |
| Point Beach State Forest | × Provide cash match |
| The Nature Conservancy | × Staff time and volunteer assistance with mapping invasive species locations in Door County. |
| The Ridges Sanctuary<br>Marne Kaeske | × Staff time and volunteer assistance with mapping invasive species locations in Door County.<br>× Aid with development of educational materials<br>× Help with training workshops; coordinating and instructing |
| Woodland Dunes Nature Center<br>Jim Knickelbine | × GPS points, acreages, permissions |
| Jennifer Conner, GLNPO<br>Project Officer<br>Environmental Projection Agency | × Review project information and reporting in Great Lakes Accountability System (GLAS).<br>× Assist the Project Manager in defining project milestones. |
| Donalea Dinsmore,<br>Great Lakes Funding and Quality Assurance Coordinator<br>Office of Great Lakes<br>Wisconsin DNR | × Provide guidance on project planning<br>× Approve QAPP<br>× Ensure that the approved QAPP is uploaded into SWIMS database<br>× Project reporting on Great Lakes Accountability System (GLAS) |

State Natural Area Crews from Wautoma, Madison, and LaCrosse will lead backpack spraying efforts for DNR. They may be supplemented by trained volunteers that meet qualifications and training requirements.

Contractor for aerial spraying and some on the ground spraying will be hired based on a competitive bid process.

**Organization Chart**




*See table for specific people or entities included in this box
** Actual individual involved may change based on workload distribution in Finance

**A.5**

## Problem Definition

Invasive species are one of the most serious and persistent threats to native species and ecosystems. Given the right conditions, non native, invasive species can rapidly spread into natural areas, causing significant negative ecological impacts to native plant and animal communities. Once established, invasive species can disrupt ecosystem patterns and processes, such as hydrology, nutrient cycling, frequency and intensity of wildfires, natural succession, and soil erosion. Invasive species can cause also cause a wide range of economic consequences, including impacts to agriculture, tourism, fisheries, and outdoor recreation industries. In response, land managers spend significant amounts of time and money to control these invaders. However, the most significant and long-lasting damage is often overlooked or unaccounted for – which is that of the simplified ecosystem. The services provided by intact ecosystems, such as clean water, shelter, medicine, and food, are what ultimately sustain life itself; human, plant, and animal alike.

During the past 15 years, Lake Michigan water levels have dropped to near record historic low levels. The receding water levels have exposed thousands of acres of new lakebed, a significant amount of which has been colonized by non-native *Phragmites* and Lyme Grass. The presence of these two species has resulted in habitat degradation and loss of the vegetative diversity in coastal wetlands and Great Lakes dunes and beaches. However, in many of these areas both species are in the early stages of infestation and can be successfully controlled if treatments are initiated now.

The Green Bay West Shore area, comprised of Marinette, Oconto and Brown Counties has been significantly impacted by *Phragmites*. Hundreds of riparian residences are in close proximity to extensive *Phragmites* infestations. In Door County, riparian areas have also been invaded, in some cases resulting in near-monotypic stands of Phragmites grass. The sheer size of *Phragmites* often eliminates scenic views and recreational access to the waters of Green Bay and Lake Michigan for property owners. Additionally, when the above ground portions of the plant die back each year, a significant fire hazard is created. These cumulative conditions are lowering property values in an already damaged housing market.

This project seeks to address the *Phragmites* and Lyme grass problems within designated Conservation Opportunity Areas (COA) along the shoreline of the seven county project area. In addition to the negative impacts it produces along the Lake Michigan shoreline, the large infestation of *Phragmites* serves as a seed source, spreading to wetland areas further inland. Eliminating this seed source will minimize the ecological impacts for numerous wetland areas and thousands of private landowners in other parts of northeastern Wisconsin. Lyme grass infestations, while just beginning to become established, can likewise present significant ecological threats to the beach and dune communities of Lake Michigan. As a result of this project, Lyme grass will be eliminated from the targeted areas, allowing native vegetation to become re-established.

# A.5
# Background

## Phragmites


Since 2003, the Wisconsin DNR has been actively engaged in controlling *Phragmites* and has successfully utilized three main methods of herbicide application, including; 1) aerial spraying large, dense clones 2) bundle, cut, and treat on small clones, 3) foliar "ground" application of scattered patches. Herbicide application has proven to be the most efficient control method both economically and ecologically, for several reasons. Ground applications are made with backpack sprayers, which can be succinctly targeted, producing minimal impacts to desirable native vegetation. All participating crew members have been state-certified to use herbicides over water, and are trained in the identification of both Phragmites and also native plant species. Additionally, nearly 100% control can be achieved with herbicide applications over a two year period. First year results yield >95% kill with the second year follow-up treatments yielding almost 100% control.

## Lyme grass

In 2006, the Department discovered the non-native Lyme Grass on several state-owned properties along Lake Michigan. Subsequent conversations with adjoining lake states revealed that Lyme Grass was distributed around much of Lake Michigan, and becoming one of the most significant threats to the plant communities of its dunes and beaches. In 2007, DNR ecologists established experimental control plots at Point Beach State Forest and Kohler Andrae State Park to determine the effectiveness of different herbicides on Lyme grass. The three treatments consisted of a treatment with Rodeo®, Clear Cast®, and Habitat® herbicide applications. Mowing the dune vegetation was not feasible as loose sand is difficult to navigate with vehicles. Post treatment results indicated that Habitat herbicide was most effective treatment. In plots sprayed with Habitat®, 98% control was achieved. Follow up treatments were made in 2008 and 100% control was achieved. As a result, Habitat® will be used for Lyme grass treatments during the course of this projects, using backpack sprayers. As is the case with Phragmites, Lyme grass has a distinctive growth form, and all crew members are trained to identify this species.

This project will continue to build upon previous department successes in controlling *Phragmites* and Lyme Grass by using the techniques described above. All participating crewmembers are Aquatic-Certified herbicide applicators that are trained in the identification of Phragmites, Lyme grass and desirable native vegetation. An Aquatic Plant Management permit, required by the State of Wisconsin to apply herbicides over water, is currently in the process of being issued for all targeted treatment areas.

## A.6
## Project/Task Description

**Invasive Species Control**

**The goal** is to reduce Phragmites and Lyme grass populations to the degree that continued maintenance activities can keep these two invasives out of sensitive areas, and reduce the chance of re-introduction in the future. Successful control is better achieved with the involvement of adjoining landowners; invasive species do not restrict themselves to property boundary lines. Success requires management options that include cooperation from not only other agencies, but also reaching across those lines, and involving the public and landowner groups.

Most of the Phragmites along the Green Bay west shore will be sprayed with helicopters because it's tall, dense, and contains large areas that aren't accessible from the ground. In Door County, Manitowoc County, and Sheboygan County, different treatment methods will be utilized for Phragmites and also Lyme Grass including: backpack sprayers and the bundle and cut method, where applicable, and machine attachable boom sprayers.

Contractors will be hired to aerial spray, boom spray and to mow Phragmites along the Green Bay West Shores COA. The Department is required to accept the lowest bid. Aerial spraying is much faster and it is routine for 200-600 acres to be sprayed in one day under the right conditions. The cost per acre for aerial spraying is $32.50 per acre and $500 per acre for ground spot application plus herbicide. The cost per acre for ground spot application is higher because small patches are being sprayed over a large area.

Existing Department of Natural Resource (DNR) limited term employees (LTE's) will be used to spray (backpack and boom applications) much of the Phragmites and Lyme Grass in Door, Manitowoc, and Sheboygan Counties. Based on the department's previous years of experience controlling Phragmites, it is expected that the control plan outlined here is technically sound and realistic during a 30 month timeframe with the prescribed resources. Department LTE's are the most economical workforce available but because this project is so large, they will only account for approximately 25 percent of the proposed work. For example, in 2007 and 2008, twelve DNR LTE's were able to control Phragmites on 45 miles of shoreline and 100 acres of wetlands in Door County. Funds were limited and control work was limited to a two week period.

Coastal wetlands and shoreline in six counties and two Areas of Concern (Menominee River and Fox River Southern Green Bay) will be restored by controlling existing infestations of Phragmites and Lyme Grass and eliminating new infestations from expanding along the shoreline. Invasive species removal addresses priorities from the following strategic plans including; Objective 4.3 of Goal 4 from EPA's Strategic Plan, several long and short-term goals from the Wetlands and Coastal and Upland Habitats focus areas in the Great Lakes Regional Collaboration Strategy to Protect and Restore the Great Lakes, and the invasive species focus area of the Great Lakes Restoration Initiative

The Department will coordinate with partners including the Door County Land Trust, The Nature Conservancy, The Ridges Sanctuary, Wisconsin Wetlands Association, and Woodland Dunes Nature Center to disseminate information on goals and results, and the need to remove invasive species. Information will be disseminated through newsletters, press releases, and web sites.

## Implementation

The U.S. EPA – GLRI Removal of Phragmites & Lyme Grass from Lake Michigan shoreline, Invasive Species Control Grant supports the development a strategic approach to prevention and control activities in the Great Lakes ecosystem. We are using a multi-organizational approach to implementation, working with relevant governmental agencies, teaming up with the public, and establishing efforts that will hopefully continue beyond the project period.

This project will use methods, procedures, and protocols, which have proven effective in providing anticipated invasive species results and outcomes over time. Success will be measured by a change over time to the landscape. Certified aquatic applicators will be hired to assist with control efforts.

## Treatment Methods

Herbicide application will be used to achieve project objectives.

When tackling Phragmites, 'eliminating' Phragmites means killing its roots. Even when its seeds are viable, a Phragmites infestation spreads most aggressively via vegetative reproduction through root growth. For this reason, a thick, dense stand of Phragmites may be referred to as a 'clone'.
There is a variety of control techniques that can be utilized to combat Phragmites and Lyme Grass. The method selected for a given site will vary depending upon the location, size/stage of the infestation, site dynamics, the presence of any rare and/or threatened plant or animal species, and resources available.

Even though eradication is desirable with most invasive non-native plant problems, it is important to understand that control efforts will require a long-term commitment that over reaches past the period of this grant.

## Outcomes

Control of Phragmites and Lyme Grass will improve the quality of the wetland community and benefit plants and wildlife associated with the coastal wetlands especially the Species of Greatest Conservation Need (Table 2). An effective, efficient, and environmentally sound program of Phragmites and Lyme Grass management (identification of areas and eradication) is developed and implemented with all the partners and is consistent with existing fish, wildlife, and other ecosystem plans/strategies. This project

will also avert these invasives from further invading adjacent areas and negatively impacting coastal wetlands and associated species.

A Project Coordinator was hired in December 20, 2010 and is stationed at the Green Bay Wisconsin DNR office for 28 months. The coordinator will oversee the project, ensuring that permits are obtained, work is scheduled, support is provided to contractors (maps, GPS coordinates, etc.), land owner contacts are made, outreach and education materials are developed, provided, and assimilate information and prepare the final report for the project.

Phragmites and Lyme Grass will be reduced from 118 miles and 3,600 acres of Lake Michigan Shoreline along identified Conservation Opportunity Areas (COA's), which includes 25 State Natural Areas, 6 State Parks/Forests, and 3 State Wildlife Areas, and adjacent private lands below the ordinary high water mark (OHWM). The reduction of Phragmites and Lyme Grass from the identified areas will help prevent these non native invasives from expanding into other areas.

*By 2013 it is anticipated the following will be completed:*

| **Control Areas** | **Acres** | **Miles** |
|---|---|---|
| Green Bay West Shores (GBWS) | 3,315 | 55 |
| Door County | 240 | 50 |
| Manitowoc and Sheboygan Counties | 45 | 13 |
| **Project Total** | **3,600** | **118** |

- These acres are estimates, and will be updated as locations get verified.
- See Supplemental Information, Appendix for more information

## A.7
## Quality Objectives & Criteria

### Objectives

- ✓ Restore and conserve high quality wetlands and associated rare plant habitat along the Lake Michigan shoreline.
- ✓ Protect and maintain quality habitat for Wildlife Species of Greatest Conservation Need (SGCN) associated with dunes, beaches, and coastal wetlands (see Supplemental Information, Table 2).
- ✓ Significantly reduce the overall cover of *Phragmites* and Lyme grass in the seven county project area.
- ✓ Avert further inland spread and habitat conversion to monocultures of *Phragmites* or Lyme Grass.
- ✓ A visual identification and assessment of treatment areas, both prior and post application.

## Year 1

1. **Detection & assessment of non native Phragmites populations**.

   ✓ **Mapping** GPS/GIS technology is used to assess the level of infestation in the project area. See (Appendix reference) for specific mapping protocols.

   - Obtain shape files of Phragmites or Lyme grass infestations from county cooperators and partners
   - Verify that locational accuracy provided for large area infestations are within 1 meter (or sufficient accuracy for developing aerial spraying specifications) by surveying sites where the aerial photographs and the measurements provided suggest measurement error may exist
   - For areas suited for manual treatment with backpack sprayers, the locational information should be accurate to within approximately 10 meters (sufficient to locate Phragmites visually).

   ✓ **Treatment methods.** Based on site-specific conditions (infestation size, density), one of several treatment methods will be selected for initial treatment. .

   ✓ **Landowner permission**. A significant amount of the targeted areas are privately owned, requiring that written permission be granted prior to treatments.

   ✓ **Permitting.** An Aquatic Plant Management permit is acquired for all areas to be treated.

2. **Implement control methods**

   a. **Treatment.** Utilizing the results of the initial mapping protocol, apply herbicide to specifically targeted areas within the project boundaries. Treatments will take place in late summer and early fall, when this type of treatment has shown to be most effective. The treatment objective is to treat 100% of public lands and at least 90% of riparian areas adjacent to privately-owned land where landowner permission has been granted.

## Year 2, 3

3. **Adaptive Management Approach**

   ✓ **Monitoring** Utilizing the monitoring protocols in (Appendix), determine the success of the previous years' treatments. The objective is to determine which type of retreatment is appropriate for the location (extent of viable Phragmites or Lyme grass remaining and if observed, whether sensitive species are present).

   - Geo-locate clones of Phragmites that survived treatment to within approximately 10 meters (a distance where visual confirmation is possible)
   - In areas treated by aerial spraying in the first year, estimate the % cover range of Phragmites survival to provide input for the professional judgment about cost-effective and appropriate re-treatment strategies

- ✓ **Follow-up treatments** Re-visit the previous years' treatment areas, and apply herbicide to any areas that were missed, or otherwise continue to have the targeted invasive species present.

**4. Prevention / Awareness / Education**

- ✓ **Create educational information** The public will be kept informed throughout the project by the creation of a website. Information will be posted on the website to report on the results of each years' treatments, monitoring results and subsequent plans to re-treat areas. In addition, an educational brochure will be developed, dealing with Lyme grass ecology and the need to control this species.

## Regulatory Requirements

**Federal:**

| | |
|---|---|
| ATCP 29 | Pesticide Use & Control |

**State**

| | |
|---|---|
| NR 30 | Navigable Waters |
| NR 40 | Invasive Species ID and Control |
| NR 103 | Water Quality Standards |
| NR 107 | Aquatic Plant Management |
| NR 150 | Environmental Analysis and Review Procedures |
| Manual Code 4230.1 | Department Approval, Use and Reporting of Chemicals for Disease, Pests and Management |
| Manual Code 4221.1 | General Department Guidelines for Hazardous Materials |
| Manual Code 4831.1 | Procedure for Disposal of Department Generated Hazardous Waste |
| Manual Code 9187.8 | Helicopter Safety |
| Manual Code 9248.15 | Aircraft Usage: Passengers, Cooperators, Contracted, Charter Flights |

**Local**

**Private Land Treatments below the Ordinary High Water Mark (OHWM)**

Herbicide treatment on or adjacent to, private land will only occur after written permission is obtained from the landowner. Permission forms will be coordinated and held though the respective county Land Conservation Departments and Hard copies or PDF files of the permission forms will be provided to the Project Coordinator. These copies will be retained by the project coordinator for at least 3 years, or the end of the project, whichever comes first.

**Local Access:** Regardless of bed ownership, the general public must follow the law to legally gain access to public waters. Adjacent property owners have exclusive use of dry or exposed lakebed below the OHWM. Such areas may be posted, but not fenced. If private land surrounds a land-locked lake, the general public must obtain the landowners permission to enter. The

general public must gain access to a public stream or river or connected lake via a public access such as a public boat landing or a public highway that crosses the river or stream. Someone hunting or fishing on a lake or stream must keep their feet wet unless portaging a physical obstruction by the shortest possible route.

**General Spray Application Procedures:**
**Follow label guidelines** for standards of use. Also refer to Standard operating procedures for herbicide use (refer to appendix).

**Herbicide Use Protocols**
(refer to appendix)

**Herbicide Selection**
Only herbicides that control Phragmites and Lyme grass and approved for use over/near water will be used.

**Imazapyr & methylated seed oil mix.**

| | | |
|---|---|---|
| Imazapyr | | |
| Active Ingredient: | | 27.8% |
| Rate: | Initial Treatment: | 2 quarts per acre |
| | Follow up Treatment: | 1 quart per acre |
| Methylated seed oil: | | 1 quart per acre |

**Application Rate**
The herbicide label provides a range of acceptable application rates based on soil conditions and characteristics, time of year, and target species. Application rates on the label are given in terms of amount formulated in product per acre. The applicator may have to determine the pounds of active ingredient (ai) per acre to be applied at a given application rate.

*Example*:

| Product Formulation | x | Product / Acre | = | Active Ingredient (ai) / Acre |
|---|---|---|---|---|
| 2 lb/ai / Gallon | x | 0.5 gallon / acre | = | 1 lb/ai / acre |

**Application Technique**
The time, labor, and equipment required to implement the different application techniques required for the success of this project are influenced by the cost of herbicide application. Site specific application techniques will be determined and selected to minimize risks of exposure to the applicator and others who may be in the area during and after the herbicide application and that also minimize the offsite movement of the herbicide.

## Chart of Application techniques

| METHOD | STAND CHARACTERISTICS | SITE CONDITIONS | TREATMENT TECHNIQUE | ADVANTAGES | PRECAUTIONS |
|---|---|---|---|---|---|
| **Aerial** | Dense,<br>Monotypic stands. | ~ Weather conditions are the limiting factor.<br>~ Use on low wind days to mitigate drift to non-target areas.<br>~ Fly low. Flow Slow. | ~ Spray from helicopter with attached boom using proper droplet size, boom length, and nozzle type.<br>~ Calibrate equipment per label instructions. | ~ Extremely cost-effective.<br>Good for very large scale, remote or areas not easily accessible by foot or vehicle.<br>~ GPS provides guide to identify spray and treatment areas.<br>~ Switch inside turns off herbicide. | ~ Weather conditions limiting factor in application.<br>~ Using a skilled pilot is imperative.<br>~ Large broadcast applications may affect adjacent plant communities. |
| **Mechanical** | Dense,<br>Monotypic stands. | ~ Weather conditions should be considered.<br>~ Use on low wind days to mitigate drift to non-target areas. | ~ Spray from boom mounted sprayer | ~ Used as site preparation for herbicide applications and helps make herbicide applications more effective. | ~ Consider weather conditions<br>~ Overspray possible<br>~ Large broadcast applications may affect adjacent plant communities.<br>~ Equipment costs and resources needs. |
| **Backpack** | Isolated/Scattered<br><br>Moderately dense stands. (Height dependent) | ~ Use on low wind days to mitigate drift outside the treatment area.<br><br>~ Try to avoid native plants. | ~ Spray close to leaves using low pressure.<br><br>~ Maintain constant pressure to achieve good coverage of plant.<br><br>~ Do not over saturate. | ~ Ideal for isolated and/or scatted patches.<br>~ Much quicker than bundle-cut-treat (B-C-T) method.<br>~ Effective, with minimal follow up.<br>~ Utilize different spray patterns/nozzles (ex. Flat fan) to minimize non-target exposure | ~ Overspray – impacts on desirable species, exposure to applicator.<br>~ Dye marking may fade; treatment areas hard to identify.<br>~ Slow activity of chemical, effects may not be seen until following growing season.<br>~ Water needs when treating larger clones; Debris may clog nozzles.<br>~ Tall, dense clones hard to treat.<br>~ Equipment costs and resources needs. |
| **Boom** | Dense stands.<br>Greater than 1 acre | ~ Use on low wind days to mitigate drift.<br>~ Use carefully to avoid native plants. | ~ Attach low pressure boom sprayer to an ATV or tractor. | ~ Cover large areas<br>~Quicker than backpack<br>~ More targeted | ~ Calibrate equipment.<br>~ Check/maintain nozzle pressure, watch for pulled lines/hoses. |
| **B – C – T (Bundle-Cut-Treat)** | Scattered dense<br><br>Moderately dense<br><br>Dense stands | ~ Useful when complete eradication of all other plants is not desired | ~ Use pre-cut strands of a bio-degradable twine, tie up clump of stems.<br>~ Cut stems above the twine.<br>~ Apply herbicide to cut surface of stems. | ~ Little to no spray drift or overspray<br>~ Reduces collateral damage.<br>~ Safe for applicators.<br>~ Easy to track what has been treated.<br>~ Can treat any height of stems.<br>~ Minimal re-treatment/follow up. | ~ Can only treat moderately dense to dense clones.<br>~ Single stem are only cut and treated.<br>~ Slow going.<br>~ Labor intensive. |
| **Wick** | Moderately dense<br><br>Dense stands | ~ Targets taller plants.<br>~ Useful when complete eradication of all other plants is not desired. | ~ Saturate absorbent material with low pressure sprayers attached to an ATV or tractor. | ~ Targets taller vegetation.<br>~ Direct herbicide contact to plant.<br>~ Minimizes overspray to desirable/non-target species. | ~ In dense areas, double application may be needed.<br>~ Herbicide may not reach rhizomes.<br>~ Stems damaged by equipment break, bend and may affect non-target species. |

## Application Timing

Herbicide application timing refers to the time of year, time of day, and sequence of application relative to other management activities or events (rainfall). The timing of the application can depend upon the target species, herbicide mode of action, growth stage of the plant and/or environmental conditions (drought, low water levels).

Herbicide applications will be timed to maximize favorable weather conditions. To mitigate drift and potential non target impacts, herbicide should not be applied when winds speeds exceed 12mph, or as deemed safe by an experienced, qualified, certified applicator. Other weather conditions that will influence herbicide effectiveness are temperature, moisture, and humidity. Warm conditions are usually favorable for chemical application, although hot, dry conditions can slow plant metabolism, and can make plants less susceptible to the herbicide.

The length of time required between herbicide application and rainfall, referred to as the rain-fast period, varies for different herbicides; refer to the product specific label for guidelines.

### Factors Affecting Herbicide Effectiveness

| Biological | Environmental | Technical | Logistical |
|---|---|---|---|
| **time of application** seedling vs. mature | **weather conditions** wind, precipitation, temperature | **application technique** foliar, wick, cut stump | **treatment location** accessibility to site, high use public areas |
| **plant life cycle** annual, biennial, perennial | **soil characteristics** texture, pH, organic matter | **application timing** pre/post emergence | **application method** aerial, ground |
| **growth activity** actively growing vs. dormant, | | **application rate** recommended rates on label, proper calibration of equipment | **application accuracy** equipment, personnel training and experience, technique |
| **plant morphology** grass vs. broadleaved | | | |

http://www.fws.gov/invasives/staffTrainingModule/methods/chemical/practice.html

## Timeline

| *2011* | JANUARY TO MARCH | APRIL TO JUNE | JULY TO OCTOBER | OCTOBER TO DECEMBER |
|---|---|---|---|---|
| | ✕ Gather and create information a<br>✕ Develop/create information/edu<br>✕ Develop permission forms; sen<br>✕ Initiate landowner contact(s)<br>✕ Seek permission to spray on ex<br>✕ GBWS, OHWM boundary dete<br>✕ Site inspections, map infestatio<br>✕ Continue with landowner conta<br>✕ Initialize process to secure prop NR 107 | ✕ Continue with landowner conta<br>✕ Collect permission to spray in<br>✕ Map shoreline; gather baseline<br>✕ Finalize RFP's; bids for project<br>✕ Post signage at treatment sites,<br>✕ Establish, set up monitoring loc<br>✕ Natural Heritage Inventory Rev<br>✕ Initiate public information meet<br>✕ Secure permits<br>✕ Organize field activities, interna | ✕ Collect permission letter<br>✕ Finalize spray sites<br>✕ Finalize NHI<br>✕ Hire crews through bid<br>✕ Finalize monitoring locatio<br>✕ Wrap-up with public inforn<br>✕ Finalize baseline GPS data<br>✕ Finalize posting sites<br>✕ Finalize permits<br>✕ Organize & finalize field a<br>✕ Spray notification to public<br>**SPRAYING (to start in August )** | ✕ Evaluate treatment areas.<br>✕ Organize data provided by<br>✕ Follow up/check in June<br>✕ Plan for 2012<br>**OCTOBER 30**<br>LAST POSSIBLE SPRAY DAY |
| *2012* | JANUARY TO MARCH | APRIL TO JUNE | JULY TO OCTOBER | OCTOBER TO DECEMBER |
| | ✕ Continue with landowner conta<br>✕ Verify landowner permission<br>✕ Initialize process to secure prop NR 107 | ✕ Continue with landowner conta<br>✕ Finalize permission<br>✕ Post signage at treatment sites,<br>✕ Check monitoring locations, co<br>✕ Public information meeting (s)<br>✕ Secure permits<br>✕ Organize field activities, interna | ✕ Organize & finalize field a<br>✕ Treat areas not done in 201<br>✕ Follow up treatments to sit<br>✕ Wrap-up with public inforn<br>✕ Finalize posting site, if nee<br>✕ Finalize permits<br>✕ Spray notification to public<br>**SPRAYING** | ✕ Evaluate treatment areas.<br>✕ Organize data provided by<br>✕ Follow up/check in June<br>Plan for 2013<br>**OCTOBER 30**<br>LAST POSSIBLE SPRAY DAY |
| *2013* | JANUARY TO MARCH | APRIL TO JUNE | JULY TO OCTOBER | OCTOBER TO DECEMBER |
| | ✕ Initialize process to secure prop NR 107 | ✕ Check 2011 & 2012 treatment<br>✕ Coordinate crews | ✕ Retreat (if necessary) sites<br>**SPRAYING** | ✕ Evaluate treatment areas.<br>✕ Organize data provided by<br>✕ Final report |

# A.8
# Special Training/Certification

## Herbicide Applicators

All workers; DNR, contractors, and/or any volunteer who mixes, stores, transports, and/or applies herbicides will be required to have the appropriate Commercial Pesticide Applicator Licenses.

Category: 5.0 – Aquatic & Mosquito

9.9 – Aerial Operations (only for aerial applications)

**Internal DNR Staff and volunteers:**

The Project Coordinator will work with DNR staff and volunteers to make sure they become licensed. Obtaining a license includes reading a self-study manual and passing a test.

For information on pesticide certification and licensing, contact:
**Wisconsin Department of Agriculture, Trade, and Consumer Protection**
Commercial Pesticide Applicator Training (PAT)
*P.O. Box 8911, Madison, WI 53708*
*Phone: (608)262-7588*
*FAX: (608) 262-5217*
*E-mail: PAT-program@wisc.edu*
http://datcp.wi.gov/Plants/Pesticides/index.aspx

**Suggested training;**
To minimize any potential health and safety risks related to field sampling conducted as part of this project, surveyors need to be physically able to conduct field work under demanding conditions and be well prepared to handle contingencies or emergencies. The following training sessions are recommended for all field survey personnel:

- Recent CPR training,
- Recent first aid training,
- Completion of a satisfactory interview about health and safety aspects of the project with the Project Leader, including routine safety precautions and a discussion of actions to be taken in the event of an emergency.

Surveyors will refer to WDNR Manual Code 9187.91 Employees Working Alone for additional information about safety during the field work.

## A.9
## Documents and Records

**Project Records**
The WDNR, GLRI Grant Project Coordinator will retain a copy of the QAPP and will provide the document to contractors upon hire, and make it available to all stakeholders and the public. All parties will be notified of any revisions and updates that occur throughout the project period. All revisions will be saved as separate documents, and retained for a period no less than the project term. Where possible, data will be maintained in electronic format and backed up on a pre-determined schedule. Hard copies will be available upon request.

All training will be documented and records will be in the project file, stored and maintained by the project coordinator. A report will be prepared each year that summarizes the progress of the inventories and documents key decisions in the process, such as specific objectives, habitat delineation, and the sampling frame and layout of sampling plots or transects.

**Reporting/Recordkeeping Requirements**

**EPA (Environmental Protection Agency)**
- ✓ Semi-annual Progress Reports

**GLAS (Great Lakes Accountability System)**
- ✓ Quarterly Reporting on acres treated

**WDNR**
- ✓ Natural Heritage Inventory (if new locations of rare species are located)
- ✓ Chemical Use /Approval
- ✓ Herbicide Use/Treatment Records

**ALL Herbicide Applicators: (Contactors and Field Crews)**
Prepare a report in Microsoft Word and/or Excel format that describes the work in enough detail that another person could conduct the inventory based on the written report and associated GIS products. This information is important in evaluating the project's success, improving methodology, and identifying mistakes. In addition, it documents the procedure for future site management decisions to be made by the project coordinator.

Refer to the required herbicide treatment record indicated below for items to include.

**Herbicide Treatment Records**
When using herbicides it is required by law to keep detailed records of all relevant information. At the time of application, all herbicide applicators will take detailed notes of the following:
- Name of applicator(s)
- Date of application
- Time of application
    - Time start and time stop

- Application method used
  - Air
  - Ground
- Location of target species
  - To be recorded as Latitude/Longitude coordinates expressed in decimal degrees
  - GPS points should be collected using the WGS/NAD84 datum otherwise the projection needs to be noted.
- Type and concentration of the herbicide
  - Chemical(s) used
  - Application rate
- Weather conditions
  - Wind speed and direction ***(before and after herbicide application***)
  - Temperature
  - Relative Humidity
  - Cloud cover/sun exposure (use a percentage)
- Performance outcomes
  - Acres or miles treated
  - Overlaps and/or skips noted
  - Corrective actions taken
- Any other observations made during application.
  - Pesticide formulation problems
  - Equipment malfunctions

**Field Surveys:**
The surveyor of natural communities and invasive plants will supply the following records and documents:

1. GPS coordinates documenting the locations and extent of populations. GPS points should also be used to document places where photographs were taken. GPS points should be provided using the WGS/NAD84 datum and Decimal Degrees in electronic (e.g. comma-delimited) format, as well as hardcopy. GPS waypoint numbers corresponding to features being documented should be written on forms to allow cross-reference between the tabular data and the waypoints.
2. If necessary, voucher specimens may be collected for ID purposes, which will become the property of the WDNR.
3. Photographs of the surveyed invasive plant populations, or other documented features such as disturbances or threats. Digital photos should be provided as a jpg or tif.
4. For each monitoring site selected, provide an invasive plant reporting form for each invasive plant population; and future inventory needs and considerations.
5. GPS points may also be used to document locations of unique features, representative portions of natural communities, shifts in community attributes, or changes in community types. This should be recorded as a side note.

**If rare plants are found:**

1. Wisconsin Natural Heritage Inventory (NHI) Rare Plant Field Report forms (Form 1700-049, see Appendix C.8) for each of the rare plant populations. Rare plants must be identified to the appropriate taxon level (i.e., species, subspecies, or variety) as listed on the Wisconsin Natural Heritage Working List (see Appendix C.3 and http://www.dnr.state.wi.us/org/land/er/wlist/). Method(s) of identification must be indicated on the rare plant reporting forms.

2. A description of the vegetation community in which the rare species was observed. The description should include a list of all observed plants, the dominant vegetation, and a brief assessment of the site condition (degraded, pristine, etc,) and any associated threats to species or surrounding habitat.

All field data sheets will be scanned and saved electronically as Portable Document Format (PDF) files. If possible, these will be uploaded to the WDNR Surface Water Integrated Monitoring System (SWIMS). ArcView will be used to process the GIS data. All data added will go through a quality control process to ensure their validity and accuracy. All data sheets will be held by the project coordinator.

A **Final Report** will be completed for this segment of the project. This report will be uploaded into the GLAS and if possible, the SWIMS databases and will include:

- Discussion of methods used
- Discussion of QA/QC, including results of QA checks and any corrective actions
- All data collected
- Summary of results

Natural Heritage Inventory (NHI) data are exempt from Wisconsin's Open Record Law. All data collected under this project become part of this inventory and should be treated as sensitive data. Any requests for this data should be directed to the WDNR project coordinator. Publication of data by surveyors is permitted if locations of element occurrences are generalized to prevent harm to the elements. The surveyor can distribute reports that do not contain precise locations of element occurrences. A list tallying where these records are distributed will be held by the project coordinator.

# SECTION B – DATA GENERATION & AQCUISITION

## B.1 & B2
## Sampling Process Design (Experimental Design) & Methods

Success of the project will be determined by sampling from within the treated areas, following the initial herbicide application. The basic unit of measurement to be used is percent cover of the invasive species, determined by making visual assessments in combination with established photo points. Depending on the size and density of the infestation, either aerial (helicopter or airplane) or on-the-ground sampling will be taken. In year 1, the sampling will provide the data necessary to determine which treatment type will be used (aerial or ground application). In years 2 and 3, sampling will determine which areas will need to be visited for follow-up treatments.

Invasive plant surveys will be performed in the COA's and its riparian corridor to ground-truth and verify location data is accurate within 1 meter. Data generated from these surveys will be used to do the following: 1) Assess the overall health of natural communities and extent of invasive species' populations in the COA's; 2) Provide baseline population data which will be used to make management decisions, and 3) measure success and rate performance.

At each site, the surveyor will record the GPS coordinates of the site to be represented in Latitude and Longitude coordinates expressed in decimal degrees. The surveyor will also take pictures of each selected monitoring site to use as vouchers. These photos may also be used to document other features such as high-quality natural communities, disturbances, or future threats.

Sampling locations will be determined by the surveyor, using criteria agreed upon with project staff, prior to the beginning of the inventory period. The surveyor will utilize his or her knowledge of this landscape, aerial photos and topographical maps of the project area, various GIS layers, and the habitat requirements of target species. The surveyor will focus on habitats that have the potential to support high-quality natural communities and rare species. The sampling will be done within the project area on properties approved for surveys. It is expected that these areas of high-quality habitat will be small and that the surveyor will be able to visit all of them.

The number of survey sites will be determined by how much money is available, the amount and quality of habitat available, and access granted to private property. Timing of the surveys will be determined by the surveyor, using his or her professional judgment. As this is a one-time assessment rather than a monitoring study, each site will be surveyed only once during the project

* *Note that exact survey locations have not yet been selected.*

Data collected for each sample point will included a description of the vegetation, a map or sketch of vegetation distribution, digital photographs, GPS location, and estimated GPS accuracy. A variety of methods of obtaining data will be utilized and based on resources and

funding availability. Data will be obtained from a variety of methods to include: Aerial photography; comparisons of yearly vegetation changes, ground truth knowledge of invasives locations by DNR staff qualified in plant identification, and by collecting geo-reference (GIS) data with a handheld GPS unit; accuracy will require a 30 ft minimum.

**Survey objectives** include the following:

1. Verify pre-existing data on invasive species locations within the COA
2. Collect GPS data; verify data collected from volunteers
3. Survey for and document invasive plants along the Lake Michigan shoreline, within the COA's.
4. Select sites for monitoring

Geographic Information System (GIS) technology has proven to be a powerful and useful tool for organizing, displaying, analyzing, and integrating natural resource information, and many people routinely use GIS in management. All pre-existing GIS data will be analyzed by the project coordinator. Observations will be done in the field. .

## B.3
## Sampling Handling & Custody

Not applicable.

## B.4
## Analytical Methods

Not applicable for this project

## B.5
## Quality Control

The data collected by this project will be used to identify and prioritize habitat restoration actions within the Lake Michigan Coastal Conservation Areas of Concern. It will be used for planning and management decisions.

**Resource monitoring** will be conducted specifically to:

(1) Determine compliance with environmental standards; or (2) evaluate impacts of management activities. Quality monitoring systems are being developed to measure physical, chemical, and biological parameters.

The purpose of a natural resource ecological monitoring system is to provide a rational basis for taking management actions. Actions based on sound scientific data from monitoring will provoke a higher level of confidence and will better ensure that natural resources and ecosystem functions remain unimpaired for future generations. In short, use of monitoring information will increase confidence in managers' decisions and improve their ability to manage resources.

See appendix for Monitoring Protocols.

**Digital Photo Points**

Digital photos will be utilized as a monitoring tool. A GPS point will be taken to ensure a constant photo point for the 3 year monitoring protocols. Photos will be taken at eye level. The photographer will indicates on the field notes which cardinal direction the photo was taken; North, South, East, or West. To avoid confusion about which site the photo depicts, a photo will also be taken of the sites data sheet before the habitat shots are captured.

See appendix for Monitoring Protocols.

## B.6 & B7
## Instrument/Equipment
## Testing, Inspection, Maintenance, Calibration and Frequency

**GPS Units**

The primary instrument needing testing and maintenance will be the Global Positioning System (GPS). The Project Coordinator will provide surveyors with a handheld GPS unit. The surveyors will be responsible for maintaining the GPS unit and keeping it in operable condition, referring to the owner's manual as needed. Any problems with the GPS unit should be resolved by the Project Coordinator. Surveyors will carry extra batteries, check specific unit used for size needed.

**Backpack Sprayer:**

The Project Coordinator will be responsible for inspection and maintenance.
*See appendix for Backpack Calibration Guidelines.*

**Other equipment** necessary for these assessments include:
Keys (field identification guides) for plant identification, a digital camera, measuring devices (meter stick, tape measure), a portable plant press, and scissors or knife for voucher collection. The surveyor will check that all items are present and in good condition before sampling.

## B.8
## Inspection/Acceptance of Supplies & Consumables

**Herbicide Purchase Requirements**

The Department will purchase the herbicide for the ground applications to confirmed lands, both public and private.

The aerial Contractor will provide the herbicide for the aerial, broadcast application to confirmed private lands, both public and private.

**Confirmed vs. Unconfirmed (Definitions)**

A portion of the land that the Department wishes to spray is private land. The Department is in the process of obtaining permission to spray on this private land. The acres sprayed on the

Department public lands will not need to obtain permission to spray herbicide, these are defined as "confirmed" lands. The Confirmed land will definitely be sprayed for this project. The Unconfirmed land may be sprayed if the Department received permission to do so from the landowner. The Department wishes to spray all private land acres identified but it will only be able to spray the land where we have received permission to do so.

## Herbicide Chemical Requirements

Below are the chemical requirements for spraying for the term of the project; December 2011-December 2013. The rate for follow up treatment may change. Contact the project coordinator for application rates.

| **Herbicide rates (Foliar):** | | **Aerial Applications** | **Ground** |
|---|---|---|---|
| Imazapyr 27.8% | | | |
| | Initial: | 2 quarts per acre | 1.5 ounces per gallon of water |
| | Follow up: | 1 quart per acre | 1.5 ounces per gallon of water |
| MSO (surfactant) | | 1 quart per acre | 1.5 ounces per gallon of water |

| **Herbicide rates (Cut Stem):** | **Ground** |
|---|---|
| Imazapyr 27.8% | |
| | 6.5 ounces per gallon of water |
| MSO (surfactant) | 6.5 ounces per gallon of water |

**Imazapyr** (the active ingredient in Habitat, Polaris, and Arsenal) is an anionic, organic acid that is non-volatile, and is both persistent and mobile in soil. It may be applied by broadcast application to aquatic freshwater sites to control floating or emergent aquatic vegetation. Adults and children may be exposed when swimming in treated water bodies following application of Imazapyr. Imazapyr does not bioconcentrate in fish; photolysis is the only identified aquatic route of degradation.

A non-selective herbicide used for the control of a broad range of weeds including terrestrial annual and perennial grasses and broadleaved herbs, woody species, and riparian and emergent aquatic species. It controls plant growth by preventing the synthesis of branched-chain amino acids. Imazapyr is a non-selective broad-spectrum systemic herbicide, absorbed by the foliage & roots, with rapid transfer to the xylem and phloem to the meristematic regions, where it accumulates and causes disruption of protein synthesis. This leads to interference in DNA synthesis and cell growth of the plants.

27.8% **Isopropylamine** salt of Imazapyr. The aquatic use approved herbicide; Imazapyr will be applied by certified applicators. Methods of application will be made by air and ground. Aerial applications will be made with a helicopter with an attached boom sprayer. Ground applications will be site specific and will include a variety of methods to include: spraying with backpack, from ATV or machines mounted boom sprayers. The bundle-cut-treatment of stems may also be used.

All herbicide label formulations are listed as percent active ingredient (a.i.); also referred to as the chemical name, this is the chemical that kills the plant. When an herbicide is purchased it will contain a certain amount of active ingredient.

**MSO** is a vegetable oil that is mixed with Imazapyr to aid in breaking the waxy surface tension of the leaves, which results in better contact of the herbicide to the plant material. MSO (methylated seed oil), is the surfactant required to mix with the Imazapyr due to its drift reduction capabilities. The MSO surfactant will make the smaller driftable droplets of the straight herbicide larger, which result in the droplets being heaver and less likely to move around in the air before making contact with the target species. MSO is designed for use with post-emergent herbicides. Methylated seed oil is not a pesticide.

## B.9
## Data Acquisition Requirements for Non-Direct Measurements

**Aerial Photography & Coordinate Data**
Air photos of varying years ranging from 2008 – 2010 used as preliminary information to identify where invasive species populations exist.

These photos are also used to ground truth and verify the coordinate data received from the County Partners identifying the location of the Phragmites infestations within the OHWM. This data was generated through a range of on the ground surveys done with GPS units with at least 1m accuracy. Additionally, these counties also coordinated identify the riparian landowners adjacent to the exposed lakebed of these Phragmites infestations to be treated. A verification and review process has been incorporated into the project plan to ensure all data is compatible.

## B.10
## Data Management

Data will be generated by the Project Coordinator and project partners using a combination of electronic devices (GPS units, digital cameras), and field notebooks. GPS waypoints will be downloaded and made into GIS shapefiles with an associated attribute table. All field notes (size and density of infestations) taken at waypoints will be integrated into the attribute table, to maintain accuracy and consistency of the data collected. The shapefiles will be used to create hardcopy maps of the project areas, which will be critical to the planning phase of the project.

**Computer hardware and software**
GPS units used on this project consist of both (name) and Trimble (name). Arcview 9.3 will be used to organize GPS data and create shapefiles.

**Data Storage**
GPS/GIS data created throughout the course of the project will be stored both electronically, on the project coordinator's hard drive, and also on an external hard drive as back up. Additionally, spreadsheets will be created in order to track the results of the monitoring phase of the project. These will also be stored both in electronic form, and in hardcopy, with copies to be retained throughout the duration of the project.

**Chemical use reports**
All herbicide use on both DNR lands and also private lands below the ordinary high water mark will be documented using the Chemical Use Report, DNR Form #4200-008, with a copy retained by the Project Coordinator for a minimum of 3 years.

**Data Analysis and Evaluation**
Using a combination of information collected from targeted field sampling, an evaluation will be done to determine whether the goal of 95% removal of species has been reached, and whether additional sampling is needed to meet site objectives for the inventory. Conduct preliminary analyses of the data to determine where additional sampling is needed. For species for which only presence/ absence or abundance category information is needed, GIS databases will be developed to record and monitor progress

**Database Development and Reporting**
A report will be prepared each year that summarizes the progress of the field monitoring inventories and to document key decisions in the process, such as site-specific objectives, habitat delineation, and the sampling frame and layout of sampling plots or transects. At the end of the project, the project coordinator will prepare a report in Microsoft Word format that describes the work in enough detail that another person could conduct the inventory based on the written report and associated GIS products.

All GIS products should be in a format compatible with Arcview GIS software, and metadata compatible with FGDC standards should be prepared and/or provided by the project coordinator.

**Acceptance Criteria for GIS Data Sharing**

**DNR Projection**:
The DNR standard: WTM83/91 ArcGIS projection file ("NAD 1983 HARN WTM83-91)

**Geo-referenced data**. Treatment zones, sampling points, plots, or transects must have accurate coordinates in latitude/longitude or UTM coordinates.

**Mapping Software.** While it is possible to produce simple maps by hand, the most common Windows-based programs used to calculate such maps are ARC-GIS. If this software is not unavailable as a resource option, data may also be stored in a Microsoft Excel spreadsheet.

**Data Storage, Sharing and Handling Criteria**

**Shapefiles**
A ShapeFile is a format developed by the Environmental Systems Research Institute (ESRI) for storing non-topological geometry and attribute information. ShapeFiles are usually used in conjunction with ESRI software products, but the format may be created and used by anyone. See ESRI whitepaper (pdf)</A

A shapefile is a simple, non-topological format for storing the geometric location and attribute

information of geographic features. Geographic features in a shapefile can be represented by points, lines, or polygons (areas). More simply, a shapefile is a data file format for storing points, lines, polygons, and associated attribute information. This is a very simple, openly published format defined and supported by ESRI—originally for use in ArcView.

The ESRI shapefile format specification can be found at http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf.

## Copying/Transferring Shapefiles

### Shapefile file extensions

The shapefile format defines the geometry and attribute information of geographically referenced features in six files with specific file extensions that should be stored in the same project workspace. They are:

- **.shp**—The main file that stores the feature geometry; required.
- **.shx**—The index file that stores the index of the feature geometry; required.
- **.dbf**—The dBASE table that stores the attribute information of features; required.
- **.sbn** and **.sbx**—The files that store the spatial index of the features.
- **.prj**—The file that stores the coordinate system information; used by ArcGIS.
- **.xml**—Metadata for ArcGIS—stores information about the shapefile.

Each file must have the same prefix, for example, roads.shp, roads.shx, and roads.dbf. When viewing shapefiles in ArcCatalog (or any ArcGIS program), you will only see one file representing the shapefile; however, you can use Windows Explorer to view all the files associated with a shapefile. *When copying shapefiles, it is recommended that you do so in ArcCatalog or by using a geo-processing tool.*

***However, if you do copy a shapefile outside ArcGIS, be sure to copy all the files that make up the shapefile.***

**Metadata**Most items have a description that relates what the item is. This description is technically referred to as the item's metadata. *This will be required to be provided along with the shapefile of geo-spatial data. Refer to information in above section.*

You can record whatever information is important for your organization. This might include information about how accurate and recent the item is, restrictions associated with using and sharing the item, important processes in its life cycle such as generalizing features, and so on. A metadata standard is a document identifying content that should be provided to describe geospatial resources such as maps, map services, vector data, imagery, and relevant non-spatial resources such as tables and tools.

**For more information on metadata**:
http://sco.wisc.edu/wisclinc/metatool
http://www.fgdc.gov/metadata/iso-metadata-editor-review

**For more information on ESRI protocols and programming interfaces:**
http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//00r90000009t000000.htm

# SECTION C – ASSESSMENT AND OVERSIGHT

## C.1
## Assessments and Response Actions

### Eradication vs. Control

For the term of this Grant, ***eradication*** will mean a 95% ***reduction*** of target species (Phragmites and Lyme grass) from the landscape, measured as a change over time. However, it is expected that some areas will have less than 95% reduction in target species following the initial herbicide application.

During years 2 and 3, the proposed monitoring protocols (see attachment) will be used to identify specific sites that have less than 95% reduction of target species, and identify an appropriate re-treatment technique (backpack or aerial spraying, depending on the size and density of the infestation).

Contractors and field crews will be made aware of the 95% eradication standard, and the need to re-treat certain areas if less than 95% reduction of the targeted species is achieved. Accommodations will also be made for those participating landowners whom express concern about the initial herbicide application. The Project Coordinator (or designee) will conduct site visits with these landowners to address any concerns.

### Performance Requirements and Corrective Actions

Corrective actions will be taken if any aspect of the sampling event differs from that planned. Under circumstances where corrective action is needed, the Project Coordinator will be notified and the situation will be researched and a decision will be made. Corrective actions should only be implemented after approval by the Project Coordinator. Corrective actions will be documented in the field log or data report at the time of decision, and will accompany all reports after analytical results are returned. The Project Coordinator is ultimately responsible for any corrective actions and appropriate documentation of those actions.

Weather conditions may affect survey results, but there will be enough time throughout the field season to coordinate survey effort so that optimal weather conditions can be met. If there is any question about the affect of the weather on survey results, the surveyor should consult with the Project Coordinator before proceeding with the survey.

Since much of the land within the COA, project boundary is privately owned, access could be an issue. Due to Wisconsin's Public Trust Doctrine, surveyors can legally use and perform surveys in all sections of the lake itself, but they cannot cross private lands or conduct surveys on private lands and riparian areas below the ordinary high water mark without landowner permission. Gaining such permission should not be a problem for these surveys.

The Project Coordinator and the partners will ensure that landowner permission is granted before any work is done on private property and riparian areas. If necessary, alternative survey sites will be found. (1,200 letters were sent to property owners and 95% have replied with permission to control phragmites in the riparian area adjacent to their property.)

Donalea Dinsmore, the Great Lakes Funding and Quality Assurance Coordinator will perform at least one project evaluation during the course of the project to determine whether the project is proceeding

according to plan, with appropriate documentation of deviations from the plan. Mark Martin will evaluate overall project progress by review of quarterly reports and site visits as deemed necessary.

## C.2
## Reports to Management

**Reporting the Results of Treated Areas:**
Each quarter a report will be prepared to include:

- Acres of Phragmites and Lyme Grass Surveyed
- Acres of Phragmites and Lyme Grass treated
- Amount and type of Herbicide used

**Reporting the Results of Monitoring**
The broad-based, scientifically sound information obtained through natural resource monitoring has multiple applications for management, decision-making, research, education, and promoting public understanding.

The primary audience for the results of the monitoring is resource managers. This will provide the data needed to make management decisions and to work with others for the benefit of the Resource. However, other key audiences for monitoring results include Resource planners, interpreters, researchers and other scientific collaborators, and the general public. To be most effective, monitoring data must be analyzed, interpreted, and provided at regular intervals to each of these key audiences in a format they can use, which means that the same information needs to be packaged and distributed in several different formats.

The scientific data we need to better understand how systems work and to better manage them will come from many sources. In addition to new field data collected through site visits, other data to help us assess and keep track of the condition of the resources will come from other projects and programs, other agencies, and from the general scientific community (Figure 1).

To the extent that staffing and funding is available, this project will collaborate and coordinate with these other data collection and analysis efforts, and will promote the integration and synthesis of data across projects, programs, and disciplines.

**Reporting Requirements**

**EPA (Environmental Protection Agency)**

- ✓ Semi-annual Progress Reports

**GLAS (Great Lakes Accountability System)**

- ✓ Quarterly Reporting on acres treated

**WDNR**

- ✓ Natural Heritage Inventory (if new locations of rare species are located)
- ✓ Chemical Use /Approval

- ✓ Herbicide Use/Treatment Records

## SECTION D – DATA VALIDATION AND USABILITY

### D.1, D.2
### Data Review, Verification, and Validation

The Project Coordinator will be responsible for coordinating the review, verification and validation of all data collected during the course of the project. Data will be collected by partners, field crews, and the Project Coordinator.

**Year 1**
Locational data for *Phragmites* was received from each of the three counties in the GB West Shores project area, in the form of a shapefile. This data was verified and validated by the Project Coordinator, by conducting an aerial 'truthing' of the County-specific shapefile data, via aircraft.

Phragmites and Lyme grass locational data has been collected by field staff for the remaining four counties, in areas where on-the-ground data collection was most practical. This data will be verified and validated by the Project Coordinator and field crews while herbicide applications are taking place.

Waypoints and field notes will be taken by aerial spray contractors and field crews, denoting the location of herbicide treatments. These will be downloaded and entered into GIS, eventually forming a shapefile with associated attribute table. The Project Coordinator will compare the original locational data to the herbicide treatment data in order to quantify the number of acres treated.

**Year 2, 3**
The Project Coordinator will conduct aerial and on-the-ground surveys to determine the effectiveness of the Year 1 herbicide treatments, using the proposed monitoring protocols (see attachment). Spreadsheets will be developed in order to ensure that all necessary data collection occurs and is recorded.

Review and revision of objectives will include an assessment of the overall administration and coordination of the *Strategy*, and perhaps even more importantly, it will evaluate and report the success of the conservation actions implemented, and the restoration of their habitats.

This review and revision of objectives will follow the principles of Adaptive Management, an approach to continuous improvement that incorporates the results of monitoring and evaluation into management actions in order to adapt and learn over time (Figure 1-1). We are planning to monitor several locations in, at approximately 1-year intervals over the course of 3 years; the life of the Project.

## Adaptive Management

**Figure 1-1. Strategy for adaptive management including the role of monitoring.**

Monitoring is a key part of what has been termed "adaptive management," in which monitoring measures progress toward or success at meeting an objective and provides the evidence for management change or continuation (Holling 1978; Ringold et al.1996). In practice, most monitoring measures the change or condition of the resource; if objectives are being met, management is considered effective.

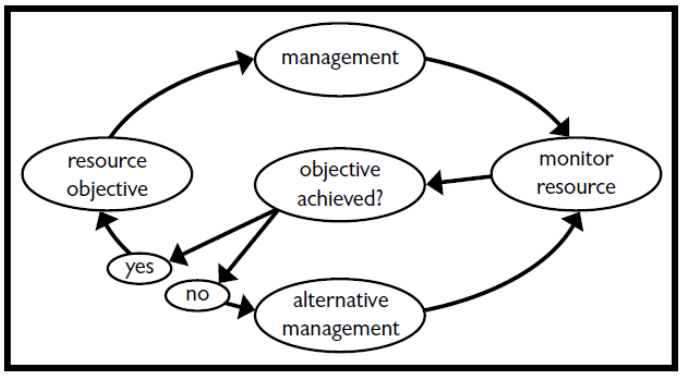



FIGURE 1.1. Diagram of a successful adaptive management cycle. Note that monitoring provides the critical link between objectives and adaptive (alternative) management.

The adaptive management cycle is illustrated in Figure 1.1:

1. Objectives are developed to describe the desired condition;
2. Management is designed to meet the objectives, or existing management is continued
3. The response of the resource is monitored to determine if the objective has been met; and
4. Management is adapted (changed) if objectives are not reached.

Lead responsibility for the review and revision of the objectives and its components will lie with the Department of Natural Resources' Endangered Resources program. Endangered Resources staff will coordinate the full 3-year review and revision, to include experts from throughout the Department of Natural Resources and its conservation partners.

This project is planned to run for three years with two rounds of chemical treatment in all areas. Past Department experience indicates about 95% control of invasive species after each round of treatment. After two years the target invasive species should be substantially reduced.

**Year 1 – Initial Treatment**

Herbicide application to 3600 acres of Phragmites and Lyme Grass in designated locations along the Lake Michigan shoreline.

Follow up on treatment locations to pre-determined monitoring areas to measure how much Phragmites and Lyme Grass is left alive within treatment zones.

The post treatment data results obtained from monitoring areas will determine the acreage to be treated in the subsequent year.

**Year 2 – Follow up Treatment**

Round two, herbicide application to Phragmites and Lyme Grass in the same designated locations as the previous year.

A follow up treatments will take place to the same areas(s) as the previous year, but the size of what is sprayed will be much less, this follow-up treatment is to 1) address any missed or skipped areas not treated in year 1, 2) to spray any new regeneration in the same areas, but the size of the population treated will be much smaller; only live vegetation will be targeted for treatment.

The post treatment data results obtained from monitoring areas will determine the acreage to be treated in the subsequent year.

**Year 3 – Follow up Treatment**
A third year of follow up treatments will entirely be funding dependant.

A follow up treatments will take place to the same areas(s) as the previous years, but the size of what is sprayed will be much less, this follow-up treatment is to 1) address any missed or skipped areas not treated in year 1, 2) to spray any new regeneration in the same areas, but the size of the population treated will be much smaller; only live vegetation will be targeted for treatment.

## D.3
## Reconciliation with User Requirements

This project has an initial three year timeframe, with herbicide treatments to take place during all three years. However, both the second and third years will also contain an element of monitoring/assessments of the previous years' work, in order to refine and focus the re-treatments. The proposed monitoring plan (see attached) is designed to inform the Project Coordinator of specifically where treatments took place, how successful each of the first two years' treatments were, and where future treatments should occur. One limitation of this project is that there is a significant amount of potential acreage to treat on private land, where permission must be gained prior to any treatments taking place. It is already known that certain property owners within the project areas did not grant permission, leaving their property untreated.

The goal of this project is to reduce the Phragmites population by 95% in the target areas. Extensive data has been gathered on the specific locations of Phragmites and Lyme grass infestations. These data will be used to direct both field crews and contractors to specific sites within the larger project area. It is within these areas that we have a target of reducing infestations by 95%. It is possible that the non-participating landowners will cause our actual reduction to fall short of 95%. Additionally, there will be areas within the treated area which are missed, or otherwise under-treated. Both of these elements will be accounted for during the final round of assessment surveys, and stated in the final report.

The monitoring program promotes communication, collaboration, and coordination with other programs and agencies to reach the overall goal of understanding, protecting, and restoring natural resources. The content and amount of detail included in the various products of the monitoring program will differ depending on the intended audience for each report.

Scientific data for assessing and keeping track of the condition of natural resources will come from multiple sources, and will be managed, analyzed, and distributed to multiple audiences in several different formats in order to make the results more available and useful.

**Outcomes** of this project are to learn how many acres were treated, specifically where those sites are, and whether or not the 95% reduction standard is met. These will be gained by following the proposed monitoring protocol, which calls for establishing monitoring plots, photo points, and conducting aerial surveys during the growing season following treatments.

**Uses of Collected Data**
With the development of training, protocols, and quality assurance/quality control, collected data will have the potential to contribute to the following:

- Identify impaired lands
- Gather data concerning population trends
- Assess distribution, range, and habitat requirements
- Assess habitat conditions, ecosystem health, and population status
- Establish, review, and revise management decisions
- Evaluate management (protection/restoration) effectiveness

**Reporting the Results of Treated Areas:**
Each quarter a report will be prepared to include:

- Acres of Phragmites and Lyme Grass Surveyed
- Acres of Phragmites and Lyme Grass treated
- Amount and type of Herbicide used

## *Abbreviations and Acronyms*

| | |
|---|---|
| **AOC** | Area of Concern |
| **ArcView** | ESRI Software used to process GIS data |
| **BMP** | Best Management Practice |
| **COA** | Conservation Opportunity Area |
| **DATCP** | Department of Agriculture, Trade, and Consumer Protection |
| **DCIST** | Door County Invasive Species Team |
| **EPA** | Environmental Protection Agency |
| **ER** | Endangered Resources |
| **ESRI** | Environmental Systems Research Institute |
| **GBWS** | Green Bay West Shores |
| **GIS** | Geographical Information System |
| **GPS** | Geographical Positioning System |
| **GLAS** | Great Lakes Accountability System |
| **GLNPO** | Great Lakes National Program Office |
| **GLRI** | Great Lakes Restoration Initiative |
| **LCD** | Land Conservation Department |
| **LWCD** | Land and Water Conservation Department |
| **MSDS** | Material Safety Data Sheets |
| **NHI** | Natural Heritage Inventory |
| **OGL** | Office of the Great Lakes |
| **OHWM** | Ordinary High Water Mark |
| **PPE** | Personal Protective Equipment |
| **QA** | Quality Assurance |
| **QAPP** | Quality Assurance Project Plan |
| **QC** | Quality Control |
| **SGCN** | Species of Greatest Conservation Need |
| **SOP** | Standard Operating Procedure |
| **SNA** | State Natural Area |
| **SWA** | State Wildlife Area |
| **SWCD** | Soil and Water Conservation Department |
| **SWIMS** | |
| **TNC** | The Nature Conservancy |
| **WDNR** | Wisconsin Department of Natural Resources |
| **WWAP** | Wisconsin Wildlife Action Plan |

## *Appendices*

Table 1. Green Bay West Shores & Lake Michigan COA's (from Grant)

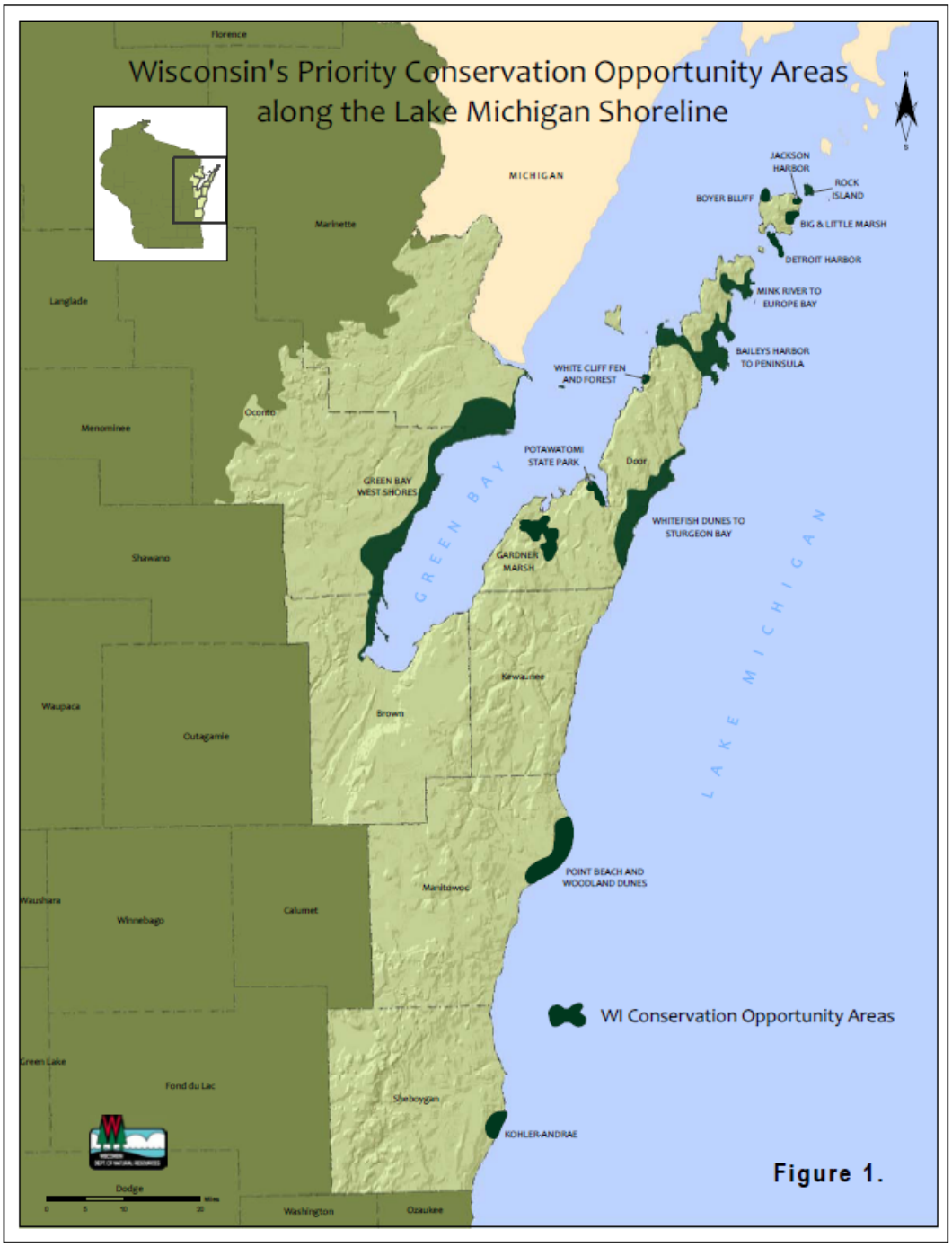



Figure 2: Phragmites clone

Figure 3. Aerial phragmites control

Figure 4: Joe Henry spraying phragmites

Table 2. Species of Greatest Conservation Need occurring on state lands within the project area (data from Wisconsin Natural Heritage Inventory)

| Taxon | Common Name | Scientific Name | Global Rank | State Rank | State Status | Federal Status |
|---|---|---|---|---|---|---|
| BIRD | American Golden-plover | *Pluvialis dominica* | G5 | SNA | | |
| BIRD | American Woodcock | *Scolopax minor* | G5 | S4B | | |
| BIRD | Black Tern | *Chlidonias niger* | G4 | S3B | SC/M | |
| BIRD | Black-billed Cuckoo | *Coccyzus erythropthalmus* | G5 | S4B | | |
| BIRD | Blue-winged Teal | *Anas discors* | G5 | S3S4B | SC/M | |
| BIRD | Canada Warbler | *Wilsonia canadensis* | G5 | S3B | | |
| BIRD | Caspian Tern | *Sterna caspia* | G5 | S1B | END | |
| BIRD | Common Tern | *Sterna hirundo* | G5 | S1B | END | |
| BIRD | Dunlin | *Calidris alpina* | G5 | SNA | | |
| BIRD | Forster's Tern | *Sterna forsteri* | G5 | S2B | END | |
| BIRD | Great Egret | *Ardea alba* | G5 | S1B | THR | |
| BIRD | Horned Grebe | *Podiceps auritus* | G5 | SNAB | | |
| BIRD | Piping Plover | *Charadrius melodus* | G3 | S1 | END | LE |
| BIRD | Short-billed Dowitcher | *Limnodromus griseus* | G5 | SNA | | |
| BIRD | Snowy Egret | *Egretta thula* | G5 | S1B | END | |
| BIRD | Whimbrel | *Numenius phaeopus* | G5 | SNA | | |
| BUTTERFLY | Two-spotted Skipper | *Euphyes bimacula* | G4 | S3 | SC/N | |
| DRAGONFLY | Hine's Emerald | *Somatochlora hineana* | G2G3 | S1 | END | LE |
| GRASSHOPPER | Lake Huron Locust | *Trimerotropis huroniana* | G2G3 | S1 | END | |
| MOTH | Phyllira Tiger Moth | *Grammia phyllira* | G4 | S3 | SC/N | |
| SALAMANDER | Four-toed Salamander | *Hemidactylium scutatum* | G5 | S3 | SC/H | |
| | | | | | | |
| PLANT | Alpine cottongrass | *Eriophorum alpinum* | G5 | S2 | SC | |
| PLANT | American sea-rocket | *Cakile edentula* | G5 | S3 | SC | |
| PLANT | Beautiful sedge | *Carex coccina* | G4G5 | S1 | THR | |
| PLANT | Bird's-eye primrose | *Primula mistassinica* | G5 | S3 | SC | |
| PLANT | Capitate Spikerush | *Eleocharis violacea* | G5 | S2 | SC | |
| PLANT | Common bog arrow-grass | *Triglochin maritima* | G5 | S3 | SC | |
| PLANT | Crawe's sedge | *Carex crawei* | G5 | S3 | SC | |
| PLANT | Death camas | *Zigadenus elegans var. glaucus* | G5T4T5 | S2S3 | SC | |
| PLANT | Dune goldenrod | *Solidago simplex var. gillmanii* | G5T3? | S2 | THR | |
| PLANT | Dune thistle | *Cirsium pitcheri* | G3 | S2 | THR | LT |
| PLANT | Elk sedge | *Carex garberi* | G5 | S2 | THR | |
| PLANT | Few-flowered spike-rush | *Eleocharis quinqueflora* | G5 | S2 | SC | |
| PLANT | Hair-like sedge | *Carex capillaris* | G5 | S2 | SC | |
| PLANT | Lake Huron Tansy | *Tanacetum huronense* | G5T4T5 | S1 | END | |
| PLANT | Lesser fringed gentian | *Gentiana procera* | G5 | S3 | SC | |
| PLANT | Low Calamint | *Calamintha arkansana* | G5 | S2 | SC | |
| PLANT | Many-headed sedge | *Carex sychnocephala* | G4 | S2 | SC | |
| PLANT | Marsh bedstraw | *Galium palustre* | G5 | S1 | SC | |
| PLANT | Marsh horsetail | *Equisetum palustre* | G5 | S2 | SC | |
| PLANT | Marsh willow-herb | *Epilobium palustre* | G5 | S3 | SC | |
| PLANT | Northern bog sedge | *Carex gynocrates* | G5 | S3 | SC | |
| PLANT | Ohio goldenrod | *Solidago ohioensis* | G4 | S3 | SC | |
| PLANT | Sand dune willow | *Salix cordata* | G4 | S1 | END | |
| PLANT | Sand Reedgrass | *Calamovilfa longifolia var. magna* | G5T3T5 | S2 | THR | |
| PLANT | Seaside crowfoot | *Ranunculus cymbalaria* | G5 | S2 | THR | |
| PLANT | Seaside spurge | *Euphorbia polygonifolia* | G5? | S2 | SC | |
| PLANT | Sheathed sedge | *Carex vaginata* | G5 | S3 | SC | |
| PLANT | Shore sedge | *Carex lenticularis* | G5 | S2 | THR | |
| PLANT | Slender bog arrow-grass | *Triglochin palustris* | G5 | S3 | SC | |
| PLANT | Slim-stem small reed grass | *Calamagrostis stricta subsp. inexpansa* | G5 | S3 | SC | |
| PLANT | Small-flowered grass of Parnassus | *Parnassia parviflora* | G4 | S1 | END | |
| PLANT | Thickspike wheatgrass | *Elymus lanceolatus var. psammophilus* | G5 | S2 | THR | |
| PLANT | Tufted bulrush | *Scirpus cespitosus* | G5 | S2 | THR | |
| PLANT | Tufted hairgrass | *Deschampsia cespitosa* | G5 | S2 | SC | |
| PLANT | Variegated horsetail | *Equisetum variegatum* | G5 | S3 | SC | |
| PLANT | Yellow screw-stem | *Bartonia virginica* | G5 | S3 | SC | |

Table 3. Ownership of Project Lands

| PROPERTY NAME | COUNTY | OWNERSHIP |
|---|---|---|
| Baileys Harbor Boreal Forest and Wetlands SNA | Door | DNR |
| Big and Little Marsh SNA | Door | DNR |
| Bloch Oxbow SNA | Marinette | DNR |
| Cana Island | Door | Door County |
| Cave Point-Clay Banks SNA | Door | The Nature Conservancy/Door County Land Trust |
| Charles Pond Wildlife Area and SNA | Oconto | DNR |
| Delta River Marshes SNA | Marinette | DNR |
| Detroit Harbor SNA | Door | Door County Land Trust |
| Gardner Swamp Wildlife Area | Door | DNR |
| Jackson Harbor Ridges SNA | Door | Town of Washington Island |
| Kohler Andrae State Park and SNA | Sheboygan | DNR |
| Little Lake SNA | Door | Door County Land Trust |
| Little Tail Point Wildlife Area | Brown | DNR |
| Long Tail Point Wildlife Area | Brown | DNR |
| Marshall's Point SNA | Door | Marshall's Point Association |
| Mink River Estuary SNA | Door | The Nature Conservancy |
| Moonlight Bay SNA | Door | DNR |
| Mud Lake Wildlife Area and SNA | Door | DNR |
| Newport State Park and SNA | Door | DNR |
| North Bay SNA | Door | The Nature Conservancy |
| Oconto Marsh Wildlife Area | Oconto | DNR |
| Peats Lake Wildlife Area | Brown | DNR |
| Pecor Point Wildlife Area | Oconto | DNR |
| Peninsula State Park | Door | DNR |
| Pensaukee Wildlife Area | Oconto | DNR |
| Peshtigo Harbor Lacustrine Forest SNA | Marinette | DNR |
| Peshtigo Harbor Wildlife Area | Marinette | DNR |
| Point Beach State Forest and SNA | Manitowoc | DNR |
| Potawatomi State Park | Door | DNR |
| Riebolts Creek Fishery | Door | DNR |
| Rock Island State Park and SNA | Door | DNR |
| Rush Point Wildlife Area | Oconto | DNR |
| Seagull Bar SNA | Marinette | DNR |
| Sensiba Wildlife Area | Brown | DNR |
| The Ridges Sanctuary | Door | The Ridges Sanctuary |
| Tibbett Suamico Wildlife Area | Oconto | DNR |
| Toft Point SNA | Door | UW-Green Bay |
| Two Creeks Buried Forest SNA | Manitowoc | DNR |
| White Cliff Fen and Forest SNA | Door | Door County Land Trust |
| Whitefish Dunes State Park and SNA | Door | DNR |
| Woodland Dunes SNA | Manitowoc | Woodland Dunes Nature Center |
| Exposed lake bed (private land) | Marinette | State of Wisconsin |
| Exposed lake bed (private land) | Oconto | State of Wisconsin |
| Exposed lake bed (private land) | Brown | State of Wisconsin |
| Exposed lake bed (private land) | Door | State of Wisconsin |
| Exposed lake bed (private land) | Manitowoc | State of Wisconsin |

Wisconsin State Rules & Regulations:

http://legis.wisconsin.gov/
http://legis.wisconsin.gov/rsb/code/nr/nr100.html

| | |
|---|---|
| NR 40 | http://legis.wisconsin.gov/rsb/code/nr/nr040.pdf |
| NR 103 | http://legis.wisconsin.gov/rsb/code/nr/nr103.pdf |
| NR 107 | http://legis.wisconsin.gov/rsb/code/nr/nr107.pdf |
| NR 150 | http://legis.wisconsin.gov/rsb/code/nr/nr150.pdf |
| | |
| ATCP 29 | http://legis.wisconsin.gov/rsb/code/atcp/atcp029.pdf |
| ATCP 30 | http://legis.wisconsin.gov/rsb/code/atcp/atcp030.pdf |

**Websites**:

| | |
|---|---|
| Wisconsin DNR | http://dnr.wi.gov/ |
| Endangered Resources | http://www.dnr.state.wi.us/org/land/er/ |
| Invasive Species | http://www.dnr.state.wi.us/invasives/faq.htm |
| Wisconsin Wildlife Action Plan | http://dnr.wi.gov/org/land/er/wwap/ |
| Brown County SWCD | http://www.co.brown.wi.us/ |
| Door County SWCD | http://map.co.door.wi.us/swcd |
| Door County Invasive Species Team | http://map.co.door.wi.us/swcd/Invasive/index.htm |
| The Ridges Sanctuary | http://www.ridgessanctuary.org/ |
| Oconto County SWCD | http://www.co.oconto.wi.us |
| Marinette County SWCD | http://www.marinettecounty.com |
| Woodland Dunes | http://www.woodlanddunes.org |

Point Beach State Park
http://www.dnr.state.wi.us/org/land/parks/specific/pointbeach/
Kohler-Andrae State Park
http://www.dnr.state.wi.us/org/land/parks/specific/ka/
Wisconsin Wetlands Association
http://www.wisconsinwetlands.org/phragmites.htm

Strategic Plan to Manage Invasive Species, Courtney LeClaire
http://dnr.wi.gov/wnrmag/2010/04/invasives.htm

Wisconsin Council on Forestry (Invasive Species BMP's)
http://council.wisconsinforestry.org/invasives

Wisconsin Council on Invasive Species
http://invasivespecies.wi.gov/awareness/index.asp

Pesticide education Information, Clemson University
http://entweb.clemson.edu/pesticid/educatn.htm

ArcGIS Help Library
http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/Welcome_to_the_ArcGIS_Help_Library/00r90000001n000000

Standard Operating Procedures

1. Sampling Protocols
2. Backpack Calibration
3. Herbicide Use
4. Aerial Spray Guidelines
5. Pesticide Drift

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1) Sampling Protocols

# *Sampling Protocols*

## Monitoring Methods for Evaluating Control of Phragmites and Lyme Grass

Ryan P. O'Connor, Wisconsin DNR

### Introduction and Overview

Monitoring is an essential part of restoration and management activities, but time and funding are often limited. Different sizes and densities of invasive species require different methods of monitoring restoration progress. For example, large dense patches, small dense patches, large sparse patches, and small sparse patches of Phragmites and Lyme grass must be approached differently to maximize sampling efficiency. For large (hundreds of acres) patches of Phragmites, we propose a coarse-level method of estimating percent cover from the air (in a helicopter or airplane) that maximizes coverage of treatment areas and minimizes time spent accessing and traversing sites (described previously). For small dense patches of Phragmites, which range in size from a few square meters to one acre (approximately 200m by 200m), we propose using visual estimates in cover classes combined with photo points to visually depict chance over time. For large areas of sparse Phragmites and large areas of Lyme grass, we propose monitoring the degree of infestation by assessing the frequency (a surrogate for percent cover) of the invasive species in a series of quadrats arranged along a transect. Finally, for small, sparse areas, we propose a visual inspection to find any remaining stems and flag for retreatment if necessary. A summary of proposed monitoring methods are presented in Table 1.

Table 1. Monitoring methods for Phragmites and Lyme grass based on varying size and density of patches.

| Size and Density | Species Targeted | Monitoring Method |
|---|---|---|
| Large and dense (tens to hundreds of acres) | Phragmites | Coarse-level estimates of percent cover in each management unit from the air (helicopter or airplane) |
| Small and dense (less than one acre) | Phragmites | Coarse-level estimates of percent cover for each patch accompanied by a photo point |
| Large and sparse (typically spanning | Phragmites and Lyme grass | Frequency of occurrence (a surrogate for percent cover) in quadrats arranged along |

| | | |
|---|---|---|
| several hundred meters or more of shoreline) | | transects |
| Small and sparse (typically spanning 50 meters or less of shoreline) | Phragmites and Lyme grass | Visual inspection of site with any remaining stems flagged for retreatment |

These protocols do not require extensive botanical expertise, and are designed so that land managers and stewards can evaluate progress toward meeting restoration goals without relying on external botanists or ecological consultants. This protocol has been developed to fit the management and monitoring goals for Phragmites and Lyme grass control in areas of varying size and densities in the Green Bay West Shores region of northeast Wisconsin.

## General Methods

Small and Dense Patches

Small and dense patches of Phragmites will be monitoring using coarse-level estimates of percent cover for each patch accompanied by a photo point.

1. Map areas of small, dense Phragmites infestation with polygons (if large enough) or points. Randomly select ten percent of the polygons (or points) for more detailed monitoring. Create a GIS shapefile, and transfer polygons onto a handheld GPS unit and/or create hardcopy maps with the monitoring units overlaying a recent full-color, leaf-on aerial photo.
2. At each of the randomly selected sites, establish a photo point using standard methodology prior to treatment.
3. On the ground, perform a visual assessment of the randomly selected treatment units, estimating the percent cover of Phragmites. Estimates will be assigned to one of 6 cover classes (Daubenmire 1959, Braun-Blanquet 1965), which correspond to qualitative categories of habitat quality and restoration progress (Pearsall and Woods 2006) (Table 2). These cover classes and qualitative categories are designed to reflect ranges that are considered meaningful with respect to restoration progress.

Table 2. Cover classes and corresponding estimates of percent cover and qualitative habitat quality.

| Cover Class | Estimated Percent Cover | Qualitative Category |
|---|---|---|
| 1 | 0-1% | Very Good |
| 2 | 2-10% | Good |
| 3 | 11-25% | Fair |
| 4 | 25-50% | Fair |
| 5 | 50-75% | Poor |
| 6 | 75-100% | Poor |

It is recommended that the assessments be performed by at least two people familiar with Phragmites. Because these estimates are subjective, there will be variation among surveyors; however, using cover classes with a wide range rather than absolute

percentages significantly reduces subjectivity and observer bias (Elzinga et al 1998). Surveyors should discuss their estimates and come to an agreement on the cover class to be assigned to the monitoring unit.

4. Record the agreed upon estimated cover class on a field data sheet. In the office, transcribe cover classes into the attribute table of the GIS shapefile.
5. Progress toward meeting restoration goals can be assessed quantitatively by comparing the change in cover classes before and after treatments for each monitoring unit. Qualitative assessments can be conducted using the categories of habitat quality. Though the categories are subjective, assignment into a given category is objective and repeatable based on quantitative field data. These qualitative indices can be used to quickly assess and communicate restoration process to funders, agency partners, and the general public by color coding monitoring units based on before-treatment and after-treatment habitat quality.
6. Repeat photo points and sampling after treatment, at a similar time of year to the initial pre-treatment monitoring.

Large and Sparse Patches

Large and sparse patches of Phragmites and Lyme grass will be monitored by assessing frequency of occurrence (a surrogate for percent cover) in quadrats arranged along transects.

1. For large, sparse patches of Phragmites and Lyme grass (i.e., Kohler-Andre and Point Beach), determine the cardinal direction of the long axis of the infestation. Most likely, this will follow the shoreline and dune features.
2. Randomly select a starting point along the long axis of the infestation. From this starting point, run a 50 meter transect along the long axis of the infestation. Randomly select a starting distance along the transect between 0 and 5 meters, and place the corner of sampling frame on that number of the meter tape. The quadrat will be placed on the lake side of the transect. Continue placing quadrats every 5 meters for a total of 10 quadrats per 50 meters.

   Example: if 2.40 meters is randomly selected, the first quadrat will be placed at 2.4 meters, the next at 7.4, the next at 12.4, etc.

3. Quadrat size will be 1m2 for Phragmites and 0.25m2 for Lyme grass. This is to account for the different growth sizes and patterns of each species.
4. Establish up to a maximum of ten transects. The quadrat will be treated as the sampling unit, for a sample size of up to 100.
5. Data before and after treatment will be analyzed by comparing confidence intervals and may also be compared statistically using a Chi-square test.

Sparse and Small Patches

For sparse and small patches of Phragmites and Lyme grass, we propose to revisit treated sites and perform a visual inspection to search for surviving stems. Any stems found will be flagged and noted for follow up treatment. Due to the small, sparse nature of these

sites, this is deemed to be the most efficient means of monitoring the effectiveness of control and ensuring follow-up treatment if necessary.

**Supplies and Equipment**

- GPS unit (both for mapping unit boundaries and then relocating boundaries during field surveys)
- Aerial photographs depicting monitoring unit boundaries
- Several 50 meter sampling tapes
- Flagging tape
- Digital camera, 30-50 meter tape, compass with sighting mirror, and 1.5 meter tall black and white cover board for photo points
- Clipboards, data sheets and pencils

## Literature Cited

Braun-Blanquet, J. 1965. Plant sociology: the study of plant communities. Hafner Press, London.

Daubenmire, R.F. 1959. A canopy-coverage method. Northwest Science 33:43-64.

Elzinga, C.L., D.W. Salzer, and J.W. Willoughby. 1998. Measuring and Monitoring Plant Populations. BML Technical Reference 1730-1. Bureau of Land Management, Denver, CO. 477p. Available online at: http://www.blm.gov/nstc/library/pdf/MeasAndMon.pdf

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2) Backpack Calibration

## *Calibrating Liquid Hand Pump* and *Backpack Sprayers*

## How to calibrate manual sprayers

*When you calibrate a manual sprayer you should understand that, in part, you are calibrating the applicator.*

**Step 1.** Measure and mark off an area equal to 1,000 sq ft (such as 20 ft x 50 ft).

**Step 2.** Add a measured amount of water to the tank, spray the area and then measure the amount of water remaining in the tank. The difference between the amount in the tank before and after spraying is the amount used per 1,000 sq ft.

**Step 3.** Compare the measured rate with the intended or recommended rate, make necessary adjustments and recalibrate the sprayer.

**An alternative time method** is to record the time required to spray 1,000 sq ft and later catch and measure the spray from the nozzle (or nozzles) used for the same time period.

## *Tips for more uniform applications using manual sprayers*

**Manual sprayers** – hand pumps, hand cans and back packs — are designed for spot treatments and for spraying areas not suitable for power sprayers because of size of the area to be treated, site access, or other factors.

Most of these sprayers do not have pressure gauges or pressure controls unless you have a deluxe model or have purchased gauges separately. The pressure drops continuously in these sprayers as you spray. Therefore, you need to re-pressurize the tank at frequent intervals or with continuous pumping. When spraying, either hold the nozzle steady at a constant height and walk back and forth, or swing the nozzle in a steady, sweeping, overlapping motion. Maintaining a uniform nozzle height and walking speed are essential to keeping the application rate uniform throughout the spraying operation.

- For backpack sprayers, tie a weighted cord or chain to the wand near the nozzle. This serves as a height gauge to maintain a set distance from the nozzle. Or tie a cord to the wand near the nozzle, and tie the other end to the tank top.
- Walk a known space that should be covered by the sprayer. Practice until you can consistently spray this area with the correct amount of material. Use a ticking stop watch or timer to improve your pacing.
- For hand pump sprayers, attach a pressure gauge to the spray wand and check how fast the pressure drops. Count the number of seconds needed for the pressure to drop 10 psi. Count the number of pumps needed to return the pressure to the proper level.
- For backpack sprayers, attach a gauge to the spray wand and determine how fast you need to pump to keep the gauge pressure constant while spraying.

*Adapted in part from The Ohio State Extension Service Bulletin 817-00 Calibrating Turfgrass Chemical Application Equipment*

**Net Volume Method**

| Amount of water put in tank | Amount of water remaining in tank | Difference (Net) | Recommended rate/1000 sq ft (from label) |
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**Alternative Time Method**

| A<br>Time it takes to spray 1000 sq ft<br>(in seconds) | B<br>Amount of spray Collected from nozzle<br>(in A seconds) | Recommended rate/1000 sq ft<br>(from label) |
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3) Herbicide Use

## General Guidelines for Safe and Effective Herbicide Application

- Asses site conditions and level of infestation to determine if herbicide use is necessary and identify precautions applicator should take to minimize risk to non-target species.
- Select effective herbicides and application methods that are appropriate for the target species and site conditions.
- Use only EPA registered herbicides and use them in accordance with FIRFA, EPA, State laws and all other applicable authorities.
- "The label is the law". Follow all label requirements for mixing, loading, transporting, storing, and disposing of herbicides and containers to prevent soil and water contamination, and health risks to human, fish and wildlife.
- Ensure that staff that are mixing, using, and/or applying herbicides have training in all aspects of herbicide application procedures and spill clean up.
- Use personal protective equipment (PPE) as required by the herbicide label.
- Follow all federal, state, and local posting requirements for every herbicide application.
- Monitor before, during, and after herbicide application to assess performance, effects on target species, and non-target species.

- Make every attempt at limit access to entry of the treated area during the restricted entry interval (REI) which varies based on the herbicide. Refer to the label.
- Discontinue use of herbicides if application performance and/or chemical effectiveness are causing significant undesirable effects.
- Maintain legible, accurate, and continuous records on treated sites, application rates, and overall effectiveness. Report the type, amount, location, weather conditions, etc. on the form provided and submit to the project coordinator upon completing the application.

OSHA Standards 1910.120, .132, .133 and .134. Occupational Safety & Health Administration, U.S. Department of Labor.

## Standard Operating Procedure for Herbicide Use Regarding Aerial Spraying and the Phragmites Control Project in Northeast Wisconsin, 2011-2103

**Purpose**: To ensure the safety of all individuals participating in or affected by herbicide use, to minimize the Departments exposure to liability, to ensure the appropriate and effective application of herbicides as a management tool, and to minimize detrimental effects to the environment.

The Department uses herbicides when and where they contribute to the perpetuation of species, communities, and ecosystems targeted for conservation or when they provide the most efficient and/or environmentally compatible method for control of plants.

Specific required practices and general standard operating procedures, described below, are designed to ensure that the Department's project standards for use of herbicides meet or exceed the U.S. EPA's Worker Protection Standards for Pesticide Use.

**Specific Required Practices:**

1) Contractors must be certified/licensed by state and/or local regulations to apply herbicides. Copies of the licenses will be provided to the Project Coordinator before spraying begins.

2) Contractors will coordinate all herbicide application with the Project Coordinator and will provide the following data within one week of application to the Project Coordinator: date sprayed, type and amount of herbicide used, weather conditions, and GPS coordinates on area sprayed along with locations and size of area sprayed.

3) Disposal of containers (herbicide and surfactant):

a. If the contractor provides the herbicide/surfactant, the contractor will dispose of the herbicide/surfactant containers following label disposal instructions.
b. If the Department provides the herbicide/surfactant, the contractor will return the herbicide/surfactant containers to the Department. Containers will not be rinsed.

**Generalized Standard Operating Procedures When Transporting, Mixing, and Applying Herbicides:**

1. Pesticide users are required by law to review and comply with all the conditions set forth in the pesticide label.

2. Herbicide may be used only in compliance with all federal, state and local regulations, including those related to licensing and/or certification of applicators, use of protective and safety gear, and posting requirements.

3. Choose the correct herbicide and formulation to avoid misapplication, leaching, off-site drift, and carry over.

4. Follow standard safety practices for storage, mixing, transportation, and spill management.

5. All precautions should be taken to deliver herbicide to only the target species. In order to prevent or reduce drift, the spray boom should be at the lowest setting that will still produce a good pattern. A drift control agent *may* be added to the herbicide mix. Methylated seed oil makes larger droplet sizes and will be used as the surfactant.

6. Have a radio, first aid kit, spill response material, copy of the label, and emergency contact information including directions to the nearest emergency medical treatment facility on site when spraying.

7. Whenever possible, those who apply herbicides shall have access (within 15 minutes travel time or at the nearest vehicle access point, whichever is closest) to an eyewash kit and either a 1) shower or large sink, or 2) emergency decontamination and first aid kits.

8. Use the proper safety equipment. The label states what safety clothing and equipment are required. Pant legs should be left outside of boots. Remove clothing that is contaminated after a spill. (Protective clothing and equipment shall be decontaminated, cleaned, laundered, maintained or replaced as needed to maintain their effectiveness.)

9. Drink liquids to prevent dehydration during hot weather. Halt all activity if you experience respiratory difficulties and/or fatigue.

10. Extreme caution should be taken when handling herbicides. Never open a container at eye level. Never eat, drink, smoke, or use smokeless tobacco when handling herbicides and wash immediately if contact with a herbicide is made because some formulations can cause irritation, blisters, blindness and death.

11. Prior to moving or transporting any container, inspect it for leaks. Transport herbicide containers in an upright and secured position to prevent spillage. Transport in the bed of a truck or other off road vehicle not in the truck cab. Be sure to completely secure the containers, including backpack sprayers containing mixtures, to transport equipment and chemicals.

12. Keep current on weather conditions and forecast conditions. Do not apply herbicides in the rain or if rain is forecasted one hour before herbicide application. The herbicide needs one hour without be rained on to effective.

13. Always store herbicides in the original container in the locked herbicide area. Store any unused portions of herbicides mixtures in a clearly marked and closed container. Include the accumulation start date on the label. Refer to the label for the shelf life.

14. Thoroughly wash any vehicles used in the transportation or application process.

15. Inform the Project Coordinator of any problems however, minor.

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4) Aerial Spray Guidelines

## Aerial Spray Guidelines for the Phragmites Control Project in Northeast Wisconsin 2011 - 2013

The following guidelines were modified from the Aerial Herbicide Application for Noxious Weed Control in the Northern Region (Kulla, A. 2003). These guidelines are intended as a practical field guide for weed managers who may be considering use of aerial herbicide application as part of an integrated pest management program. The information and observations in this guide are specific to large droplet liquid herbicide applications and does not address pellet, insecticide or other fine droplet aerial application projects.

**Field Project Layout**
It is difficult to pre-determine the treatment day due to weed phenology, weather, and aircraft availability. It is recommended that aerial spray projects be prepped well in advance (2 to 4 weeks) of the anticipated treatment date.

It will be necessary for selection of a helibase (close to treatment area, good road access, near water source, open and free of obstacles, reviewed and OK'd by pilot)

Two copies of these aerial photos should be made, one copy for the Project Coordinator and one set for the application pilot to have on board the aircraft. When possible, geo-reference the aerial photo information in order to be able to give the pilot GPS location information.

**Drift Mitigation Measures***:* Drift mitigation measures may include:
- Use of a drift agent or a similar acting surfactant.

- Use of buffer areas next to sensitive resources
- On site weather monitoring
- Treatment next to sensitive areas when wind is lakeside and gentle
- No treatment during inversions
- No treatment when winds in the project area are greater than 12 miles per hour
- No treatment when weather forecasts predict rain in next 24 hours (This might also be lowered).

**Unit Marking Strategies:** In agricultural or residential settings treatment area boundaries are usually clearly defined by fences, roads and / or buildings. The Project Coordinator will identify treatment areas and be sure the application pilots know where treatment and no treatment areas are.

Unit marking strategies fall into two general categories:

1. Identification of specific treatment polygons and delineation of where *to treat* within a larger project area, or
2. Identification of the general project area and delineation of areas *not to treat*.

**Digital Unit and Treatment Marking**: GPS guided navigational devices are available that allow an aircraft to develop a digital treatment polygon file from either a recon flight or an on the ground unit layout. These digital shapes appear on a navigational screen in the aircraft and are used to guide the pilot to the units. GPS line files are collected for each spray swath and are displayed on the polygon on the screen during application. These swath lines can be printed after application to provide a digital map record of the treated area. The swath width can be loaded into the program to generate area treated based on swath length and width.

Data Requirements:

- A functioning GPS unit will be required in the helicopter
- Datum: NAD83
- Projection: WTM 83/91
- Accuracy of GPS unit: Sub-meter
- Ability to convert treatment data collected from flight into a shapefile
- Provide a treatment report and shapefile to the project coordinator within 1 week of finished job,

Large treatment areas that include many polygons and a mix of timbered and open areas may be difficult to mark and find from the air. If treatment units are large and there are only three to five in the project area it may be practical to mark each individual unit. If there are many units in a large area, it may be more efficient to mark the project area boundary and buffers and instruct the pilot *which areas not to treat* within the larger project area. The no treatment areas could include marked buffer areas (which would include waterways and wet areas), talus, rock and cliffs and areas with a closed overstory canopy.

All marking schemes will be coordinated with the application pilot.

## Pretreatment Recon Flight:

Before treatment occurs, the pilot should fly the project area with aerial photos in hand to review the treatment area, boundaries, and review if buffer zones will be required, decide on spray blocks, and locate loading and landing pads for the helicopter. The pilot will work with the Project Coordinator on a plan of treatment actions. The Project Coordinator or another DNR staff person may ride along if there is room in the recon flight.

### Equipment

Aerial applicators typically come with a mix truck equipped with aviation fuel tanks, water tanks, a mix tank and a mix master. . Applicator mix trucks are not typically suited to travel over rough or steep forest roads so it is recommended to select a mix site / helibase with relatively easy road and water access. Pump and hose fitting need to be compatible. Water should be clean or potable to avoid plugging up the spray system.

### Field Staffing and Operations

Commercial aerial spray operations are typically conducted with two people: a pilot and a mix master. For safety, cost and public relations, project managers should try to minimize the number of people in the project area during spray operations. Additional people increase exposure and may have nothing to do, creating a negative public perception. Spray contractors should be allowed to conduct the operation with a minimal amount of interruption from project staff. All on the ground project staff should have radio communication with each other and the pilot. Suggested staffing is shown below.

All project staff should be briefed on the project objectives, operations and duties prior to treatment day. Written briefs are suggested for traffic management staff and any others likely to encounter the public. Boxes or satchels should be prepared with all the necessary equipment and forms each person will need to do their job. Project staff will typically report to the office early the day of spraying to allow for travel to the project area, so it is suggested that everything organized and ready to go the day before.

| TABLE 1. SUGGESTED PROJECT STAFFING AND DUTIES Position | Duties | Location |
|---|---|---|
| **Project Coordinator** | Direct and oversee project;<br>Recon flight;<br>Answer pilot questions about the application;<br>Ensure project is within weather prescriptions;<br>Record loads, herbicide use and cycle times;<br>Maintain contract diary;<br>Monitor and document weather;<br>Review and approve invoices;<br>Ensure project mitigation measures are applied;<br>Maintain project file and complete the project report;<br>Answers questions, provides briefings on the project objectives and operations. | Helibase and throughout the project area<br><br>Or<br><br>Available by phone. |
| **Aerial Equipment Manager** | Oversee the flight operations;<br>Develop communication plan;<br>Review and brief pilot on Project Aviation Safety Plan;<br>Assist Project Coordinator with load and weather monitoring and documentation. | Helibase |

### Aerial Spray Recommendations

The treatment blocks will be marked with GPS coordinates to mark the block corners or be clearly described and reviewed with applicator. It will be required to have a GPS system on board to record helicopter swaths, position, and boom on and off times and location.

If local wind patterns are known they should be taken into account.

Avoid spray drift impacting non-target sites by taking the following steps:

- When treating next to sensitive areas spray in the morning. The specific time will need to be determined by real-time weather monitoring.
- Maintain boom pressure at less than 40psi.
- Monitor spray pressure during flight, since changes in pressure can change the application rates and may change the drop size.
- Use nozzles designed for medium to coarse droplet size (240 to 400 microns)
- Use drift agent to help maintain large droplet size.
- Check nozzles and review calibration with pilot.
- Begin the first swath 300 feet from any sensitive area.
- Mark boundaries so they are clearly understood by the pilot. Fly area with pilot prior to treatment to verify location. Use GPS to document boundaries and record treatment flight paths.

Monitor and record weather in the area. The weather should be monitored in real time for operational control and to help with the post-spray analysis. Strive for winds from 3 to 6 miles per hour or per label instruction. Do not treat if rain is predicted within one hour or if winds are over 12 miles per hour..

## Spray Rates for aerial Spraying:

- 2 quarts per acre of Imazapyr with an active ingredient of 27.8%
- 1 quart per acre of methylated seed oil (surfactant)
- Minimum of 5 gallons of water per acre.

Note: Herbicide rate for year 2 follow up will be a lower rate of 1 qt per acre.

*The Project Coordinator or DNR staff person will be present when aerial spraying is occurring. The Project Coordinator has the ability to stop the spraying due to weather forecast.*

**CONTENTS OF TREATMENT PROJECT FILE**

1. Name and location of the target pest
2. Treatment objectives
3. Date of treatment
4. Pesticide application
    a. Chemical(s) used
    b. Application rate
    c. Application timing
    d. Weather conditions
    e. Pesticide formulation problems
    f. Overlaps and/or skips noted
    g. Equipment malfunctions
    h. Treatment costs
5. Treatment success in terms of:
    a. Pest population reduction
    b. Acres covered
    c. % kill rate
6. Monitoring results
7. Recommendations for follow-up and/or future projects.
8. Start and stop times of aerial application.

**LOAD RECORD EXAMPLE**

**Aerial Spray Project Load Record**

**Contract Number: _____**
**Project Name: _____**

**Date: _____**

| Load # | Time Out | Time In | Unit | Prescription | Acres Treated | Amount Herbicide | Cycle Time | Comments |
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| Time | Location | Temp. | Wind/Direction | Rel. Humidity | Comments |
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5) Pesticide Drift

EPA's standpoint:
http://www.agdrift.com/Text%20pages/Spray%20Drift%20of%20Pesticides.htm

http://www.epa.gov/pesticides/

**How to reduce drift:**
http://entweb.clemson.edu/pesticid/saftyed/drift.htm
**(general):**

- Use as coarse a spray as possible and still obtain good coverage and control. For sprays, use formulations which give large diameter (150 - 200 microns or larger)

spray droplets. Droplet size is one of the most important factors affecting drift, however, addressing droplet size alone is not sufficient to reduce the probability of drift and potential damage.

- Don't apply pesticides with a wind speed over 12 miles per hour. **Read the label for specific instructions.**
- Choose an application method and a formulation that is less likely to cause drift. After considering the drift potential of a product/formulation/ application method, it may become necessary to use a different product to reduce the chance of drift.
- Apply pesticides early in the morning or late evening; the air is often more still than during the day.
- Only use herbicides that are approved to use near lakes, reservoirs, ponds, rivers, streams, marshes, etc. Read the label for specific instructions.
- Use a solid cone or fan spray nozzle. These produce larger droplet sizes than hollow cone nozzles.

- Be sure you are getting the spray deposition pattern you think you are; service and calibrate your equipment regularly.

- Check your system for leaks. Small leaks under pressure can produce very fine droplets.

- Determine wind direction and take this into account in determining application timing, equipment and whether or not to make an application. The wrong wind direction can cancel out everything else you have done to reduce drift.

**(ground applications):**

- For ground rigs and hand sprayers, use low pressure.

- Be careful of applications near other non-target species.

**(aerial applications):**

- Fly slow. Fly low. Slow speeds are combined with lower pump pressures to produce larger droplets. Herbicides should be applied at a lower height than other pesticides.
- Good coverage on initial spray runs

- Nozzle orientation affects wind shear across the nozzle face, and subsequently droplet size. Use a nozzle orientation that will give the desired droplet size.

- Boom length should be no more than 75% of the wingspan of fixed wing craft, or of the rotor diameter on helicopters to reduce drift caused by wingtip and rotor vortices.

- To mitigate drift to non target areas, use a methylated seed oil as the surfactant, this allows for a larger droplet size.