PROMOTING PLANT GERMINATION AND GROWTH

TECHNICAL GUIDANCE DOCUMENT

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INTRODUCTION

After vegetation is planted a combination of weed control and ensuring sufficient water is essential to ensure plant germination and growth. Weed control efforts often include combinations of mowing, spot herbicide application and hand weeding. Watering activities can range from from ATV mounted watering systems to the use of water control structures for wetlands. In most cases the first several years of restoration projects are summarized in a project schedule that lists when certain maintenance activities will be conducted.

Gas powered mower behind an ATV

Mowing can be an effective method to control annual and biennial weeds and to prevent perennial weeds from setting seed and allowing for effective herbicide control. Recently restored uplands and wetlands can be invaded by annual and biennial weeds such as foxtail, velvet leaf, lambsquarter, nut sedge, and ragweed, among other species. Seeds of these species blow in from surrounding areas or were part of the soil seed bank. Mowing is typically conducted several times the first year and one or two times the second year. Mowing will prevent weed seeds from establishing and will give native plants sufficient light as they establish. A study in Iowa found that areas left un-mowed after planting had eight species while areas that were mowed had 27 species, stressing the importance of mowing to facilitate seedling establishment (Kurtz, 2001).

Flail mowers or stalk choppers are typically used to mow upland plantings and wetland edges. Flail mowers and stalk choppers cut material into finer particles than sickle bar mowers. Spot treatment with herbicide is a typical practice for both upland and wetland areas to remove undesirable perennial species that will not be controlled through mowing. Sufficient herbicide should be applied to target species to cover leaves to the extent possible.

Equipment for herbicide application includes boom sprayers mounted on trucks and tractors, backpack sprayers and herbicide wands.

Hand weeding is a labor-intensive technique that is not cost-effective for large areas but is a viable option when attempting to minimize herbicide use. Hand weeding can be useful for the management of small populations of invasive species and to aid the establishment of competition-sensitive species.

Gloves and eye protection are typical equipment for hand weeding. Tools such as trowels and dandelion diggers can be useful to loosen large roots. Equipment such as Weed Wrenches and Weed Talons are used for pulling woody material. Tractor mounted platforms have been developed to increase hand weeding efficiency.

Ensuring sufficient water for new plants is an essential step in the restoration process. This can involve watering with hoses, buckets, or irrigation systems. Most plants need one-inch of water per week from rainfall or subsequent watering. The timing of planting when there is good soil moisture or beneficial rainfall can aid establishment.

Water control structures play an important role in the management of open water wetlands. Appropriate water level management can promote the establishment and growth of desirable plants and discourage the establishment of undesirable species. Water control structures allow for managing shallow water or moist soil conditions during the vegetation establishment period and can help prevent wetland seed from floating to the surface and moving to the water's edge in a narrow band. With the use of water control structures, seed will tend to stay in place and cover the bottom of the wetland instead of just the fringe (Hoag 2000). Water control structures can aid in the establishment of sedge and wet meadow communities by maintaining saturation near the ground surface. Water control structures can also help control invasive species by allowing for the drainage of open water and the subsequent use of non-aquatically certified herbicides.

APPLICATION

Mowing - Newly seeded prairies and wetland margins are typically mowed two to three times the first year to around six to eight inches in height. Additional mowing in years two and three may also be necessary. Weedy annual and biennial species that may establish in wetlands often do not pose as much of a problem as upland weeds. Standing water eliminates common weeds such as foxtail (Bohnen and Galatowitsch, 1999). However, wetlands that are not inundated may have significant competition from weeds and should be mowed as long as equipment will not create ruts in the substrate. Invasive species such as Canada thistle should be mowed before seeds are fully formed. Mowing of Canada thistle and reed canary grass during the growing season can keep the plants green and actively growing into the fall so they can be more effectively controlled with herbicide.

Example Mowing Maintenance Regime for upland and wetland areas as soil moisture allows	
Year 1	Mow (6-8 inches) – every 30 days after planting until September 30; spot spray thistle and other problematic weeds.
Year 2	Mow (6-8) inches one time between June 1 – August 15 before weeds set seed. Conduct additional mowing as needed.
Year 3	Spot spray perennial weeds if necessary.
Future Maintenance	Continue spot treatment of weeds and conduct burning on upland areas on a 3-5 year rotation.

One strategy to control hybrid cattail and phragmites involves cutting leaves close to the ground in the fall or winter when water levels are low and the cutting can be done on the ice. When water levels rise with the spring thaw, the air supply to the rhizomes will be eliminated, killing or weakening the plant. Cutting can also be conducted when the plants are flowering if they are cut

below the water level (Payne, 1992). Mowing can also be used to decrease the height of vegetation before water levels are increased to remove undesirable plants such as reed canary grass. Mowing will decrease the amount of oxygen available to plants through leaves and stems that extend above the water's surface.

Spot Herbicide Treatment –Herbicide treatment is conducted with different types of equipment including broadcast applicators, backpack sprayers, wands, and wicks, as well as other types of spot treatment equipment. Spot spraying is an effective control technique for perennial invasive species that will persist in a restoration. Timing of application and the herbicide used will depend on the target species. In some cases, areas of native species may need to be sprayed at the same time as invasive species and later reseeded. Canada thistle and reed canary grass may require mowing earlier in the season to prevent seed production and herbicide application in the fall when treatment is most effective.

It is common to use broad spectrum herbicides while conducting spot treatment but grass specific or broad-leaf specific herbicides can be used to cause less impact on non-target species. If large areas of desirable species are removed during spot treatment, re-seeding may be necessary.

Herbicide applications over large areas can be conducted during the establishment phase but should be well planned to minimize impact to non-target species.

Certain herbicides cannot be used near water due to toxicity to aquatic organisms. This is true for the grass specific herbicides Assure II (Quizolofop P-Ethyl) or Poast/Vantage (Sethoxydim) as well as Roundup, a non-aquatically certified glyphosate product. Project specifications and label recommendations must be followed for herbicide application.

Hand-held wand applicators can be used for spot treatment as they allow the application of herbicide to specific plants without spraying the surrounding vegetation. Larger versions of wand applicators are mounted on Tractors, ATVs or Marsh Masters.

The following are general guidelines for herbicide use:

- Herbicide applicators must follow label recommendations
- Herbicide applicators must have commercial herbicide applicators certification
- Appropriate gear should be worn according to label directions
- Non-target species should be identified and protected from application
- Wind speeds should be less than 10 mph during application to minimize drift
- In public places, notices should be posted for all treated areas
- Herbicides must be labeled appropriately
- Herbicides must be stored appropriately
- Herbicide containers should be thoroughly cleaned and rinse water must be disposed of according to EPA Guidelines
- Animals and people should be prevented if possible from entering areas of recent herbicide application

Grass specific herbicides are increasingly popular for controlling reed canary grass during vegetation establishment. See Appendix 5-B of the *Minnesota Wetland Restoration Guide* for recommendation on their use for controlling reed canary grass.

Effectiveness of grass specific herbicides can be increased by following label recommendations related to time of use, surfactants, and other additives. The following information provides recommendations for the use of grass specific herbicides

Early Spring Spraying in Uplands – Early spring applications of glyphosate is a strategy that is sometimes used in upland prairies to remove cool-season weeds such as Kentucky bluegrass and smooth brome. Sprays are conducted around early to mid-April before warm season prairie species are active. This strategy is most useful in stands that are dominated with warm season grasses, as it will remove cool-season native grasses and forbs.

Control of Specific Invasive Species – Herbicides can be sprayed over large areas of infestation when non-target species are dormant. Other herbicides specifically target grasses or broad-leaved weeds. Spot herbicide application helps to control many invasive species.

Appendix 5B of the Minnesota Wetland Restoration Guide includes control information for the following invasive species:

Hybrid cattail (Typha glauca)
Narrow-leaf cattail (Typha angustifolia)
Purple loosestrife (Lythrum salicaria)
Reed canary grass (Phalaris arundinacea)
Common buckthorn (Rhamnus cathartica)
Glossy buckthorn (Frangula alnus)
Common reed grass (Phragmites australis, syn. P. communis)
Canada thistle (Cirsium arvense)
Crown vetch (Coronilla varia)
Bird's foot trefoil (Lotus corniculatus)
Sweet clover (Melilotus officinalis and M. alba)
Wild parsnip (Pastinaca sativa L.)
Spotted knapweed (Centaurea maculosa)

Hand Weeding - Hand weeding can be effective for small populations of shallow rooted plants and can be an effective non-herbicide method of control. Efforts should be made to avoid the disruption of the soil during weeding, which could provide conditions for the establishment of additional weeds or invasive species. Weeding should be conducted when the soil is moist because the weeds are much easier to pull and it will cause less disruption to the surrounding soil. Weeding is beneficial in wetlands where young cattail plants are invading an area. If cattails can be pulled before extensive rhizomes have developed, their establishment can be slowed or prevented. Hand weeding cattail seedlings along with the establishment of native vegetation will often control cattail invasions (Hild 1999). Weeding is also effective for eradication of small populations of invasive species. In the case of purple loosestrife, plants can be pulled out of the ground when they are young. Older plants develop dense root systems, making them difficult to pull.

Tartarian honeysuckle and buckthorn can be removed by pulling with weed wrenches, tools specifically designed for pulling invasive shrubs. When using weed wrenches, it is recommended to lop the shrubs at waist height before pulling so that branches will not be directed toward the face. Gloves and eye protection should be worn. After shrubs are removed, their roots should be shaken to remove any soil and disturbed soil should be tamped by foot to prevent the germination of weeds or more invasive shrubs.

Watering and Water Level Control - Most new plantings need approximately one inch of water a week from rainfall or other methods. The most efficient method of watering involves taking advantage of rainfall around the time of planting. In some cases, water control structures can be used to retain rainfall. If water control structures are not available, other options may include water trucks, ATV mounted tanks, pumps, and irrigation.

The water needs of individual plant species may vary. For example, dry prairie species generally require less watering than woodland plants or wetland species that are exposed to dry conditions. Soil types can also have a big influence on the water needs of plants. Plants growing in organic rich wetland soils may require water less often than plants growing in a sandy upland soil. The amount of competition for water from other plants and the amount of mulch or duff layer at the soil surface will also influence the need for watering.

It is helpful to flag newly installed plants so they can be found later for watering and other maintenance activities. It is also beneficial to mulch around herbaceous and woody plants during the planting process to retain water during dry periods. The amount of mulch applied for projects often depends on project budgets, availability of mulch materials and staff or volunteer availability. Watering is most commonly conducted with hoses and sprinklers for relatively small plantings, or water trucks or tanks and hoses mounted on trucks or ATVs for larger or more remote areas. For wetland sites, water control structures may be used to manage water levels to promote plant growth.

Plants that have been grown in nurseries are particularly succeptable to drying as it takes some time for them to be accustomed to their new site conditions. Upon installation plants should be thoroughly watered and should be watered consistently in following weeks if there is not sufficient rainfall. After they have adapted to site conditions their watering needs will likely decrease. The water needs of containerized or bare-root woody plants are similar to herbaceous species, they should be watered thoroughly during the planting process and receive sufficient water after planting.

Species that have been seeded into prairies typically germinate and grow when conditions are favorable and most prairie species are relatively drought tolerant. In many cases it is not practical to water large prairie plantings, though it may be possible to water a seeded planting that is part of a bioretention area, lakeshore, or the edges of a retention basin. When watering these areas during dry periods it is beneficial to add about one-inch of water during each application and to apply the water with equipment that will not dissipate the flow of water so that seedling plants are not displaced. Applying too much water may help out weed species more than prairie grasses and flowers.

For woody plants it is often helpful to insert hoses (if available) into the ground after planting holes are filled but before they are packed to ensure that sufficient water is reaching the entire planting hole. After water starts coming out of the surface the plant should be thoroughly watered. If buckets are being used for watering it is often useful to fill half of the hole with soil, add water, followed by adding the rest of the soil and then adding additional water.

For wetlands with water level controls and sufficient water flowing into the site it may be possible to retain water to provide sufficient moisture for plants. In many cases water levels are raised within wetlands as plants increase in height. In some cases, it may be possible to use irrigation systems or water pumps if there is a suitable water source. It is important that appropriate permits are obtained if water will be pumped from nearby waterbodies. Regardless of the watering method, it is important that water levels are not raised above the height of seedlings as they cannot survive when submerged. The seed of most wetland species can sit dormant for many years until conditions are favorable, so in cases where a sufficient water source is not available, it may be better to wait until conditions are naturally favorable for plant growth rather than providing periotic watering that may allow for germination but may not be enough water to sustain growth.

The most successful wetland plant establishments, whether through the use of native seedbank in the soil substrate, or supplemental wetland seeding tend to occur when the most suitable hydrologic conditions are present in the wetland. For most wetland plant species, these conditions are achieved by establishing shallow water or a moist soil environment as these plants are germinating and start growing. Care must be taken during the initial establishment of these wetland species to avoid deep water conditions or flooding, as plant growth will be inhibited by these conditions. Many undesirable plant species such as reed canary grass and narrow-leaf cattail will thrive under these conditions as they are best adapted to sites with high water level fluctuations. Many native wetland plants, including most sedge species, will not tolerate rapid water fluctuations.

Conversely, if the soils are kept too dry, invasive or other undesirable species will survive and compete with desired vegetation, reducing growth rates and inhibiting spreading and colonization.

When the project goal is to achieve a high level of wetland plant diversity, success is usually best achieved when hydrology is adequately managed in terms of both controlling the wetland "bounce" after runoff events and controlling water levels through manipulation of the planned outlet structure. Personnel responsible for establishing and managing wetland vegetation need to coordinate with the project engineers early in the design phase of the project to ensure the project goals, objectives and site constraints are clearly understood by all involved in the project.

The timing of the wetland plantings also needs to be coordinated with the return or introduction of hydrology to the site. This requires coordination with the project engineers. The planned construction schedule needs to be understood to ensure that the planned strategies for wetland vegetation establishment will be successful. For example, the return of hydrology to a wetland restoration project can occur immediately after construction is completed and if the planned seedings or plantings of wetland vegetation have not been completed, site conditions may prevent that work from occurring if drawdown capabilities are not available to the project.

Example schedule for water level control to establish emergent vegetation

April	Seeding and installation of wetland plugs along open water fringe
Early June (once seedlings reach 6 inches)	Raise water level 1 inch (water levels should not be raised over the top of establishing vegetation)
15-20 days later	Raise water level 1 inch
As plants reach a height of 1-2 feet	Raise water levels 3-4 inches
Future management	Fluctuate water levels to mimic natural variations

Wetland hydrology is best managed through the use of water control structures. Unfortunately, site conditions and project budgets often prohibit their use on every project. When water level management through the use of control structure is not available, other strategies for management need to be considered. This can include staging of construction activities in an attempt to introduce hydrology to the wetland in phases. For example, temporary wetland outlets that are set lower in elevation than the planned final outlet structure can be installed or utilized during the first season that vegetation is being established. Upon successful germination and growth of the wetland vegetation, the work on constructing the final outlet can be completed.

If water control structures have been installed, water levels can be raised periodically to inhibit invasive species. However, it is important that water levels are not raised over the height of the seedlings. Water levels

can gradually be increased as plant height increases. As plants reach a height of one to two feet in saturated soil, water levels should be raised a few inches for bulrushes, broad-leaved arrowhead, plantains, smartweeds, spikerushes, pickerelweed and arum. This increased water level is important because many wetland plants rely on buoyant structures and water pressure for physical support to grow in an upright manner (Hammer, 1992). Ultimately, water levels should be managed to maintain the target plant community. Some degree of water fluctuations are acceptable to mimic natural wetlands, which seldom have a constant water level (Hoag, 2000).

Water level control structure

Managers need to experiment with water levels to understand soil and water characteristics, patterns of water availability, seed stocks, response of vegetation, and chronology of wildlife use (Payne, 1992). Creating a diversity of plant and animal life is often a primary goal of water level manipulation. Wildlife species such as waterfowl often grow and benefit from active level management. For example, draw downs of Minnesota wetlands are conducted to promote emergent vegetation use by breeding waterfowl. In addition, drawdowns are used to promote the growth of annuals that are a food source for migrating ducks and geese.

OTHER CONSIDERATIONS

Mowing is most commonly used in uplands for the establishment phase and in wetlands as conditions allow. Mowing is used in combination with spot treatment to control weeds as a project establishes. Mowing is sometimes conducted prior to a burn as part of long-term maintenance if fuel levels are low to help carry the fire. Mowing may also be used in combination with water level control to reduce vegetation height before raising water levels to drown undesirable vegetation.

Spot treatment with herbicides is a common practice to control invasive species within plantings. It is commonly conducted simultaneously with other maintenance strategies such as mowing, burning, and biological control. Some species such as Canada thistle and reed canary grass may require mowing earlier in the season to prevent seed production and herbicide application in the fall when treatment is most effective and other species are dormant.

Hand weeding is conducted on small sites where the pulling of weeds is practical. Hand weeding can be done in combination with mowing, spot spraying, and biological control.

Planting dates can be adjusted to take advantage of natural moisture to maximize planting success if watering will not be possible.

Submersion of vegetation should be avoided in combination with biological control to ensure that biological control agents are not eliminated from the site.

COSTS

The per acre cost of weed control and watering can vary significantly depending on the method used and number of treatments or watering visits needed. Mowing tends to cost between $20-40 per acre, while herbicide application may cost $60-100 per acre. Watering costs can vary greatly depending on the equipment that is used. Costs associated with adjusting water control structures typically involve staff time and vehicle miles to visit the project site.

ADDITIONAL REFERENCES

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