Tree/Shrub Site Preparation

490 Wisconsin Guidance Document

DEFINITION

Treatment of sites to enhance the success of natural or artificial regeneration of desired trees and/or shrubs.

PURPOSE

- Manage soil conditions, naturally available water, and seasonally high water to favor tree and shrub establishment, survival, and growth
- Modify the habitat of weeds, pests, and diseases to reduce pressure on naturally or artificially regenerated trees and shrubs
- Facilitate the establishment, survival, and growth of tree and shrub species

PLANNING CONSIDERATIONS

Methods: The following information is from the WI Department of Natural Resources (DNR) Silviculture Handbook, with some alterations to make it more applicable to NRCS planners.

Site preparation is the creation of a favorable growing environment for tree seeds or seedlings. The main objective is to establish plant communities of desired quantity (number of trees/acre) and quality (species and form). A successful regeneration establishment depends on accurate assessment of the site, biotic and abiotic factors, and the site-specific prescription.

Plants are affected by sunlight, relative humidity, foliage and soil temperatures, soil moisture, fertility, bulk density, animals, and plant pests. Site preparation has the potential to address all of the plants requirements and influences which factors will ultimately affect survival and growth. Site preparation must create sufficient numbers of suitable, strategically spaced growing sites without causing excessive soil disturbance. Site preparation should also be done in a manner which facilitates subsequent management and achieves results at the lowest cost.

Effective site preparation often will alter residual vegetation and slash load (from logging or other disturbance) and expose mineral soil to increase root zone temperature, increase oxygen in the soil, and enhance nutrient availability. Effective site preparation should reduce the risk of frost damage and insect damage, and reduce competing vegetation. When site preparation is done incorrectly it can cause increased soil erosion and water quality degradation, increased soil compaction, create landslides, aggravate moisture problems,

and negatively impact biodiversity and wildlife habitat.

When choosing a method of site preparation, stacking treatments can quickly become expensive. There is a need to keep costs reasonable without impairing the seedling's chances of surviving. If you are planning to do site preparation after a harvest, consider making the site preparation part of the logging activities. For example, the skidding of large trees can expose mineral soil and drop seed. Combining the activities can reduce total expense, but it does require increased planning, development of contract specifications and requirements to meet objectives, an experienced labor force, and possible reduced timber sale revenue.

If seedlings are not provided a proper microsite through site preparation they can be vulnerable to short-term changes in their environment. If conditions are severe, just a few hours of certain conditions can be damaging, especially immediately after planting.

It is crucial that you get the right number of quality planting spots per acre or the result will be an understocked stand that may not have the form you desire (e.g., branchy stems that have poor timber value). Understand the site characteristics and match the site preparations accordingly. Check the operator's work daily. You have to communicate your desires for all aspects of the operation.

Costs are variable depending on the site and operator's skill.

There are many different types of site preparation including manual, mechanical, chemical, and burning. Manual is rarely used as it is appropriate for only the smallest plantings or most difficult sites. The method and extent of site preparation can leave long lasting effects which can impact future management decisions.

When implementing site preparation follow guidelines in the WI Forestry Best Management Practices for Water Quality manual. The current version of the manual has sections on chemicals, mechanical site preparation, and prescribed burning. More information can be found at https://dnr.wisconsin.gov/topic/forestmanagement/bmp, or if the link is broken by searching “WI Forestry Best Management Practices”.

Mechanical Site Preparation

Mechanical site preparation includes blading, raking, plowing, ripping, mixing, chopping, scalping, mounding, dragging, trenching and rotovating. These techniques are timed to coincide with seedfall of desirable species for natural regeneration or completed by the fall of the year prior to planting the next spring.

1. Blading is the use of an angled blade to scarify the soil prior to a harvest or to clear a path through slash and small residual trees after a harvest. The process is best on boulder-free flat terrain. Rocks protruding from the soil bend and dull the blade edges making it ineffective. Depending on the management objective, the process may expose mineral soil. For scarification purposes, blading works best in frost free conditions. For shearing purposes, blading works best in cold weather (better shearing ability) and when there are < 250 trees/ac. and trees are < 10 in. DBH. Blading may produce scarified patches, windrows and nicely prepared strips depending on management objectives. For scarification work in a forest understory, the process requires a skilled operator and a large prime mover (270 HP). Windrows on treated sites can be attractive to rabbits which feed on seedlings. Blading prepares the site for planting but does little for competition. Depending on the depth of blading, the action does not deter sprouting of sheared stems.

Example of blading in action.

Photo by WI DNR.

2. Raking removes brush and medium-heavy slash loads and can be used on slopes. Some mineral soil exposure is possible depending on the skill of the operator. Production can be slowed by the teeth getting clogged with vegetation.

Root rake dozer used to scarify the ground to improve acorn regeneration.

Photo by WI DNR

3. Plowing is the use of a front mounted V-plow on a prime mover. Plowing controls competing vegetation, removes slash, and exposes mineral soil. It works to prepare for hand planting or it can coincide with mechanical planting. It works on level to slightly rolling sites. It is good with medium-heavy slash loads. Sites with large residual trees, shallow soils, and thin humus layers should be avoided. Wet sites should also be avoided as the furrows may fill with water. Furrows should follow natural contours to minimize erosion. It can be difficult to regulate the depth of scarification with plowing.

4. Ripping is used to rehabilitate compacted skid trails, roads, landings, or agricultural land. Hydraulic mounted tines with wings rip through the soil reducing bulk density. A large (D7-D9) prime mover and a skilled operator are required. Ripping should be done with the contours and can be done when the ground is frozen, but not if the soil is wet. Soil moisture must be less than 50% available water capacity at the deepest depth of disturbance to implement ripping. Use the NRCS “feel and appearance” test to determine soil moisture. Instructions are found as an appendix to this document. Consult with a NRCS soil scientist as needed.

Ripping Operation to Increase Rooting Depth in a Compacted Agricultural Field.

Photo by David J. Moorhead, University of Georgia, Bugwood.org

5. Mixing is the mechanical blending of mineral and organic soil layers. It controls competing vegetation and exposes mineral soil but does not mend compacted soil. Mixing provides an excellent growing environment for seedlings. It provides good soil aeration and lowered bulk density for root development and better soil/water relations, while nutrients are retained in proximity to the seedling.

   Coarse mixing involves large (1,500-2,000 pound) discs and heaps the mixture in a raised bed which is drier, has better aeration, and is warmer. It works best on flat loams and fine textured soils that are dry or slightly frozen. It does not work on rocky sites, sites with slash larger than 3", or sites with fresh stumps. Slopes greater than 20% can be difficult for this equipment. A large (D6-D9) prime mover is required. It provides vegetation control that lasts, but it is expensive and has low productivity, especially if a prior treatment (e.g., root rake) is required. Equipment is also limited and requires high maintenance.

Disc Trencher Creating Rows of Mixed Soil.

Photo by WI DNR

   Finer mixing chops surface vegetation and mulches it with mineral and organic soil. It produces a high quality product, but the process requires a large prime mover and can be expensive depending on production rates. A salmon-blade is an example of fine mixing. Salmon-blades can be difficult for operators as the attachment can be hidden behind the dozer blade and difficult to see. It is less likely to clog with vegetation as compared to a root rake, and overall is effective.

Salmon-blade Mixing for Increased Acorn Germination.

Photo by WI DNR.

   Spot mixing uses an implement on a boom such as an auger screw to produce individual planting sites. This can be used on a wide variety of sites and can be highly productive. It works best with dry to lightly frozen soil. A skilled operator is needed who knows the microsite needed. Treatments may need to be followed with herbicide to control competing vegetation.

6. Chopping is the cutting or flattening of brush, shrubs, and small trees. Chopping is best

done on even terrain with loamy or sandy soils that are not wet or thin because it requires heavy equipment. Chopping is most effective at breaking stems in cold temperatures with frozen ground. Chopping is limited on sites where the residual trees or stumps are large or where large rocks/exposed bedrock are present. Chopping is not appropriate for aspen regeneration because the blades reduce sucker vigor, but if the objective is to increase stand diversity by reducing the aspen component, then a roller chopper used in spring or summer would be an appropriate site preparation treatment.

The Marden roller chopper is equipped with cutting blades and partially filled with water (the sloshing effect provides more effective cutting action). The Marden roller chopper is pulled by a prime mover.

Single Drum Roller Chopper Used for Site Preparation with Frozen Ground.

Photo by MN DNR

The 2-drum roller features opposed rolling drums for better chopping action. It is best when used on vegetation that is a few years old so that it doesn't spring back easily. This chopper is not very maneuverable, can only be turned in one direction and is best on large tracts.

Marden 2-Drum Roller Chopper.

Photo by WI DNR.

These rolling brush cutters reduce slash and competing brush to facilitate use of planting machines or as scarifiers of sod for hand planting. Rolling brush cutters are often used where slash or residual brush is medium to heavy, rocks are absent, stumps are low, residual stems over 6 in. DBH are few, and on areas where seed or fire hazard reduction are needed.

7. Scalping or patch scarification is the creation of intermittent patches of exposed soil for direct tree planting or manual seeding. Scalping provides access to layers of both mineral and organic soil and leaves unused land unaffected. Scalping works well on dry sites with thin humus layers. Scalps must be of good size or competing vegetation will take over. Wet sites should be avoided to prevent the submersion of seedlings. It is preferable to scalp in the late summer or fall preceding planting and allow the scalp to

stabilize over winter.

The Bracke scarifier is an example of a scalper. It works best on flat to rolling hills with <25% slope and can handle light/medium slash. Stumps and heavy slash cause problems because the scalper will ride above the soil. Thick duff can also reduce penetration. The Bracke is rugged, creates regular patches and mounts easily. Unfortunately it is not maneuverable and wheel slippage can disrupt scalp spacing. The Bracke scarifier needs a 90-130 HP prime mover with rubber tires or a JD450. It has a productivity range of 2-4 acres/hour. Its good in areas where erosion may be a problem because the scalps do not create a continuous channel for water to travel.

Bracke 2-Row Scarifier Attachment and Post-Implementation Results.

Photos by WI DNR

The Leno scalper mounts directly to a 160-180 HP prime mover and is highly maneuverable and compact. The scalping action is independent of the prime mover. It produces a shallow scalp and is highly productive. It also requires regular maintenance. Patch size should be monitored closely. It is not for use on rocky terrain, shallow soils, thick organic matter, heavy clay, frozen soils, contours with >30% slope, or on sites with a high water table. The Leno works in light to medium slash.

Leno Scarifier in Action.

Photo by WI DNR.

Other implements may also produce patch scarification, such as tined options that can be attached to smaller prime movers. Scalps are created through the periodic raising and lowering of the tines. It works wherever the prime mover can go. Thin soils, rocks, and stumps do cause problems. A skilled operator is necessary, but these implements are usually portable, easy to mount and relatively maintenance free.

8. Mounding is the production of raised intermittent mounds with deeper pits and higher mounds than scalps. They make good planting sites in cold moist environments or on soils with thick organic matter. The mounds are aerated, above the water table and handle competing vegetation if they are high enough. Permits are required to implement this technique in wetlands.

   This technique works well for wetland areas with extensive emerald ash borer mortality where the absence of tree transpiration has resulted in an elevated water table.

Mounding should be done with an excavator (backhoe) for larger plantings or can be done by hand for small plantings. The operator inserts the excavator bucket into the ground and flips the bucketful of soil over to create the mound. Mounds are typically 1-3 feet in diameter and 6-12 inches in height. When using mechanical equipment in wetland/riparian settings, it is important to work only when soil conditions are dry to avoid rutting and compaction (generally late summer). The mounds provide a better-drained and warmer planting spot which is beneficial for seedling establishment. Mounds mimic natural processes in wetland forests where trees are tipped over by wind, partially pulling the roots out and above the ground surface and resulting in a depression where the roots used to be. As the roots decompose and attached soil sloughs off, mounds are formed next to the depressions. These natural mounds should also preferentially be used as planting spots.

9. Dragging of chains or drums across a site is used to control brush, expose mineral soil (if the organic layer is not too thick) and to crush older slash. Dragging works on flat to rolling terrain and is not limited by rocks or soil depth. It is often used with raking and can enhance natural regeneration.

Example of a chain used for site preparation.

Photo by WI DNR.

Sharkfin barrels are an effective piece of dragging apparatus which create trenches or patches of mineral soil. They do require a more powerful (150 HP) prime mover and are limited to sandy sites. These barrels may also have the capability of being filled with and dispersing seed as they scarify.

10. Rotovating produces a continuous band of tilled soil and is generally used on old agricultural sites. Sites should be rotovated in the fall prior to planting the following spring to allow for the soil to settle, as air introduced into the soil by rotovating can cause seedling desiccation. Avoid heavy soils, rocky areas, wet soils, and areas with slash. Rotovators come in varying sizes, ranging from 18 inches to 6 feet in width. The type of tractor required to power a rotovator is dependent on the size of the rotovator.

Chemical Site Preparation

The use of chemicals in site preparation does not alter the slash load or expose mineral soil the way mechanical site preparation does, but it can be an effective means to control competing vegetation and improve tree growth. The use of herbicides for weed removal will increase the amounts of sun and water available to seedlings. It will stimulate growth by increasing foliar and root zone temperatures. Herbicides will also kill plants that may be providing shelter for seedling- feeding pests thereby reducing tree mortality and disease.

Note that NRCS employees cannot make chemical recommendations. There are sources of

information to help landowners make herbicide decisions. WI DNR foresters and Technical Service Provider foresters may be able to make recommendations based on local experience. See the WI DNR website https://dnr.wisconsin.gov/topic/foresthealth/herbicides for information on effectiveness of herbicides on different classifications of competing vegetation (or search "WI DNR herbicides for forest management" if the link is broken). The tables on this website contain large amounts of information on herbicides labeled for forestry uses. In these tables, the plant needing to be controlled should show as "S" for susceptible for the herbicide chosen. For information on invasive species, UW-Extension fact sheets are good sources on the effectiveness of different treatment methods and herbicides. These fact sheets can be found at https://fyi.extension.wisc.edu/wifdn/learn/invasive-species-i-d-and-impacts/, or by searching for "UW Extension invasive species fact sheets" if the link is broken. When using these fact sheets, the herbicide chosen should have greater than 50% efficacy the season after treatment. Landowners must follow label directions of the herbicide chosen, as the label is the law.

Chemical site preparation can be used alone (e.g., foliar band-spraying rows to be planted in an old field) or in combination with mechanical site preparation (e.g., cutting woody vegetation with a chainsaw and treating the stumps to prevent re-sprouting). Another example is mechanical site preparation used to scarify soil combined with foliar herbicide application to reduce existing competing vegetation.

Choosing an herbicide and application technique should be done carefully with consideration for selectivity, timing, and areas that may be sensitive to herbicide exposure. If available and effective, using an herbicide that is selective for the plant requiring control will reduce damage to nearby desirable plants. Seasonal timing of application is important for maximum effectiveness. Timing is also important from a weather standpoint. Herbicides typically require a certain amount of drying time to be resistant to washing off from rain. High temperatures can volatilize some herbicides, making them more susceptible to drift. Dry and hot conditions can cause plants to become dormant, which will reduce uptake of foliar applied herbicides. The WIN-PST tool should be used to evaluate potential negative effects of herbicides, except for those not needing review as listed in Table 2 of the 314-Brush Management guidance document "Hazard Rating Quick Reference Guide for Commonly Used Forestry Herbicides". Mitigation measures may be needed, as described in Table 1 of 595-Pest Management Conservation System guidance document "Pest Management in Conservation Planning". Aquatic formulations of herbicides should be used if application takes place near water features.

It may take days or weeks for results of the herbicide application to become apparent. Information on timing of results should be in the label directions. Plants can develop resistance to some herbicides. To counteract this, rotate use of herbicides that have different modes of action or use other control methods on the resistant plants.

Below are common application methods for herbicides. For most of these methods, adding a dye to the herbicide mix will help the applicator keep track of what has already been treated. Where water is used to mix herbicide, water conditioner adjuvants may be needed for "hard" water to prevent loss of effectiveness. Use adjuvants according to herbicide label directions.

- Foliar – Herbicide is applied directly to leaves of the plant. This can be done using hand-sprayers, backpack sprayers, or equipment such as mist blowers mounted on machinery. The application can be somewhat targeted with hand-sprayers and backpack sprayers. Equipment-mounted sprayers are typically a less targeted broadcast application. Timing is during the active growing season. This method uses a large amount of herbicide mix, however concentrations of herbicide in the mix are usually low. Drift to non-target areas needs to be carefully considered with this method, and application avoided on excessively windy days. Drift retardant adjuvants can be added to the mix to increase the range of wind conditions suitable for application. Surfactant adjuvants are commonly added to the mix in this method to increase uptake by the leaves. Follow herbicide label directions when choosing and mixing adjuvants.

- Cut Stump – In this method stems of the target plant are cut low to the ground, and herbicide is applied to the stump surface to prevent re-sprouting. Stumps should be cut flush with a horizontal surface. This will provide a flat surface for herbicide application, as well as reduce safety hazards. Herbicide is usually applied using a hand-sprayer or backpack sprayer, although some logging equipment is capable of both cutting the stem and applying herbicide to the stump. Timing is best in late summer/early fall, as this is the time when plants are pulling nutrients into the roots. It is important for the herbicide to translocate into the roots to prevent sprouting. This is a very targeted application, as only the stump surface is treated. This method uses a small amount of herbicide mix compared to foliar, however the concentration of herbicide in the mix is usually high to make up for the small surface area treated.
- Basal Bark – This method applies herbicide (typically mixed with an oil penetrant) to the lower stem of target plants. Stems less than 6" in DBH (diameter at 4.5' above ground level) will be most susceptible due to having thin bark. The bottom 12-24" of the stem should be sprayed completely, including the root collar of species that will sprout from roots. This is usually done with a backpack sprayer. Timing is best in the fall for the herbicide to translocate into the root system. This is a somewhat targeted application. WIN-PST evaluation will be influenced by the oil chosen as carrier. Specially formulated basal oils are generally good choices. This method uses a moderate amount of herbicide mix with a moderate to low concentration of herbicide.
- Girdle/Frill/Hack'n'Squirt – This method applies herbicide through cuts into the stem's inner bark, where it is then translocated throughout the plant. The cuts are usually made with girdling tools or hand axes/hatchets. Cuts are made every 3-4" around the stem at the same level (the level should be from 6-18" above the ground), chopping downward into the bark so the cut will hold the herbicide mix. Herbicide mix is applied only to the cuts or girdle, usually with a hand sprayer or backpack sprayer. Specialty hatchets are available that apply herbicide directly into the cuts. This technique can be applied most times of year except for periods of heavy sap flow that pushes the herbicide out of the cuts, usually in spring. Some herbicides may lose effectiveness in freezing temperatures, and drought-induced summer dormancy will also reduce effectiveness. This is a targeted herbicide application. This method uses a small amount of herbicide mix, however the concentration of herbicide in the mix is usually high to make up for the small surface area treated.

Prescribed Fire as a Site Preparation Tool

Site preparation burns can be an effective treatment for regeneration of some species. Prescribed burning prepares a suitable seedbed by reducing organic layers, reducing slash, and potentially reducing competing vegetation. The soil nutrient regime is often temporarily positively affected through increased levels of cations and accelerated mineralization rates, and soil temperature is increased through altered surface albedo and reduction in the insulating organic layers. Burning of dead grasses on farm fields can be helpful in controlling mouse and meadow vole habitat and reducing the girdling of planted seedlings. Burning may need to be combined with other methods of site preparation to adequately set back competing vegetation.

See the Prescribed Burning Decision Matrix tool in Section 3 of the Field Office Technical Guide for guidance on when prescribed burning is appropriate for financial assistance. Use the Prescribed Burning standard (Code 338) to plan a prescribed burn.

Do not plant sites immediately after burning them. Soil temperatures at the ground line near the seedling can be significantly higher than the ambient air temperatures due to the absorption of heat by the ash. This can lead to increased seedling mortality on these sites if daily air temperatures exceed 90 degrees shortly after planting. To avoid this problem, burn in the fall or at minimum a month prior to planting seedlings.

Prescribed burning is a regular occurrence in the regeneration of several species. Jack pine, with its serotinous cones, is adapted to regeneration following fire. However, do not burn jack

pine slash and expect to regenerate the site using the seed contained in the cones on the slash. The cones and seed are also burned up in the prescribed fire. Possible alternatives include to prescribe burn the site and then direct seed jack pine afterwards or to mechanically scarify the site lightly to expose mineral soil and scatter the jack pine slash uniformly across the site. Prescribed burning has been used to stimulate oak regeneration, while temporarily controlling species not adapted to fire disturbance. Burning should be done in May when understory and mid-story competing tree species are leafing out for greatest mortality of these competitors. Burning should not harm mature oak trees. The mineral soil seedbed and reduced organic layers provided by burning provides excellent conditions for natural regeneration of oak. However, it may take several prescribed burns over a decade-long period to successfully develop adequate numbers of advance oak regeneration and set back competitors, especially on nutrient-rich sites. Other methods may produce faster results.

Prescribed burning is a tool but is not a cure-all for forest management problems. It requires extensive training and experience to effectively plan, implement and control prescribed fires. A major disadvantage associated with prescribed fire includes the risk of fire escape. In areas where fire has not historically played a natural role, its use may be inappropriate and detrimental.

Cover Crops

Cover crops are appropriate for afforestation sites such as crop fields. Cover crops can reduce establishment of competing vegetation and provide erosion control.

When selecting a cover crop, choose a species that will not adversely affect the growth and development of trees. Grasses can compete fiercely with trees. Legumes such as clovers have advantages that can benefit seedlings.

Legumes add nitrogen to the soil, increasing the fertility level; conserve moisture and nutrients; improve the soil physical condition; build up the soil organic matter; enhance microbial activity; decrease erosion; and provide a mulching effect. Most legumes have shallow roots that are not as finely branched as grasses making them less able to compete with tree roots for water and nutrients. Cool season legumes complete most of their growth during the early spring before moisture becomes limiting. Stems and leaves then form a mulch during the summer, conserving moisture and releasing nutrients. Avoid legumes that grow tall enough to overtop planted seedlings.

Small grain crops such as winter wheat, rye and oats can be useful cover crops. Generally, these grain crops can be seeded directly with tree seedlings at time of planting.

Old Field Site Preparation (Afforestation)

1. Grass fields

   The more intense site preparation you use the less weed control will be necessary immediately following planting. Plowing, disking, and herbicide application are often used in combination for sod and woody vegetation control. The site preparation chosen will depend on the composition of the soil, topography, accessibility, density and composition of the existing cover, and cost.

   For spring planted areas a proven method of site preparation consists of vegetation eradication in the autumn of the year prior to the planting year, with herbicide (e.g., glyphosate) followed by plowing or disking 1 to 2 weeks after spraying. This kills deep rooted perennials, improves soil aeration and water movement and stimulates microbial activity while incorporating organic matter into the soil. It is important that the site be plowed in the fall, not the spring. Spring plowing can create excessive soil aeration just prior to planting causing seedling mortality. Fall plowing allows the soil to settle through the winter and provides for excellent planting conditions in the spring. A pre-emergent

herbicide can be used in the spring to complete the site preparation, if compatible with tree seedlings. Cover crops may also be used instead of a pre-emergent herbicide to suppress competing vegetation.

Another common method of site preparation is mowing in mid-July and again in mid-August, followed by a fall foliar application of a broad-spectrum herbicide. An application of a pre-emergent herbicide in the spring immediately following planting completes the treatment. It is important to make sure the pre-emergent herbicide will not harm the newly planted tree seedlings. This technique reduces soil disturbance.

A strip herbicide treatment works well on steeper slopes where soil erosion is an important consideration. The advantages of strip treatments are the reduction of erosion on sloping fields and the reduction in amount of herbicide required when compared to broadcast applications. This has proven an effective treatment when incorporated with between row maintenance (e.g., mowing) to prevent annual weed problems. The major disadvantage is the eventual encroachment by perennial weed species from the neighboring un-sprayed strips.

Knowledge of herbicide dosage is critical because too much herbicide can cause injury to seedlings while too little won't control vegetative competition. Always read the label and material safety data sheet (MSDS) before purchasing or handling any pesticide. Pesticide labels have the force of federal law and directions must be followed precisely.

2. Former row crop fields (in crops the previous year)

Site preparation on fields that were in row crop production (e.g. corn, soybeans) the previous year involves the use of a pre-emergent herbicide following a spring tree planting. Generally, the site will be bare soil with crop residue on the surface. Additional items that should be considered when planting trees on fields that were in agricultural production the previous year include the presence of a plow layer (hardpan) at 8 to 9 inches deep, topsoil erosion patterns, soil fertility levels, soil pH, and the presence of weeds. Site preparation possibilities to deal with these items include soil ripping to break up hardpans; sowing a cover crop to stabilize soil, prevent soil erosion and reduce weed invasions; and the addition of soil amendments to the site prior to tree planting to adjust fertility and pH.

Potential logistical issues on former row crop fields include muddy loam and clay soils in the spring. Mechanical tree planting may not be possible on these soils early in the planting season. When scheduling tree planting, consider planting these agricultural fields with heavier soils towards the end of the tree planting season. Additionally, on agricultural fields formerly treated with atrazine, some pre-emergent herbicides may not be effective due to resistant weed populations, if the herbicide has a similar mode of action to atrazine. Anticipate the potential of a late summer annual weed problem and consider mowing to control the weeds. Cover crops may also be used in the spring instead of a pre-emergent herbicide to try to suppress weeds in this situation.

3. Alfalfa fields

Alfalfa can be an extreme competitor with young seedlings for moisture and nutrients. It grows to about three feet in height and can completely shade out young seedlings. More importantly, alfalfa lives many years and develops a deep, heavy root system which makes it difficult to control with conventional herbicides.

In order to control alfalfa the root system must be killed. Moldboard plowing and rototilling are effective site preparation treatments for controlling alfalfa, but these mechanical methods can expose the site to soil erosion. Herbicides are effective on

alfalfa when applied during the active growing season when the plant is translocating nutrients to the root system. Ideally, the tops of the alfalfa should be greater than 6 inches in height and in the early bud to flower stage. Alfalfa that has already reached the stage where seed has been set should be harvested and allowed to resprout prior to treatment. Additionally, alfalfa that is growing slowly because of stress from environmental conditions (e.g., drought) will not be effectively controlled by herbicide applications. In droughty conditions alfalfa has little translocation occurring, and even though the top will dieback and the plant will look dead the root system will still be alive and resprout vigorously.

Test results have shown late summer (mid-September in southern Wisconsin) applications of herbicides are effective in controlling alfalfa. Several herbicides formulated for broadleaf weed control are effective at controlling alfalfa (e.g., glyphosate, dicamba).

Site Preparation Planning for Pests and Diseases

There are several insects and diseases that can build up in live trees or in post-harvest slash material. Consult with a WI DNR Forest Health Specialist to plan projects to treat slash to prevent insect or disease outbreaks. Plan these using the Woody Residue Treatment standard (Code 384), or planning can be built into a project for Tree-Shrub Site Preparation if the area needs to be prepped for regeneration. Below are the insects and diseases of most cause for concern during regeneration.

Conifer Bark Beetles

There are several species of bark beetles that may pose issues in slash after logging.

Ips bark beetles, also called pine engravers, attack and kill weakened pine and spruce trees, including those suffering from transplant shock. The best way to avoid mortality is to ensure trees are adapted to the planting site and manage at healthy stocking levels through the life of the planting. Slash greater than 2” in diameter infested with Ips beetles should be chipped or burned to destroy the bark beetle larva. An alternative option is to use equipment to drive over the slash to break up the bark so it will dry out more quickly, reducing suitable habitat for this beetle. Slash can then be left on site. These treatments are especially important when slash-producing cutting occurs in March – August, the active period of these bark beetles.

Diplodia Shoot Blight

Diplodia shoot blight primarily affects red pine trees, although it can also affect jack pine and white pine. Seedlings and saplings of pine trees are most likely to experience mortality from this disease. If a regeneration harvest has occurred in an affected stand and will be re-planted to red pine, treat all slash greater than 3” diameter by burning or removal from the site.

Armillaria Root Disease

Armillaria is a fungus that commonly occurs in many forest types. It is rarely a severe problem, mostly decaying already dead or dying trees. It can also infect weakened trees and kill them. Where Armillaria is causing severe problems in a regeneration area, remove the stumps of cut trees and delay planting a year to reduce seedling mortality. Stump removal is expensive, not feasible at large scales, and causes excessive disturbance. This treatment should be used with caution and infrequently.

Pine Weevils (Pales Weevil)

Pales weevil are a native insect that can be a problem when an existing conifer forest is harvested and re-planted to conifers. Populations build-up on 1- to 2-year-old conifer stumps in the larval

stage, and adult feeding can cause mortality of conifer seedlings. Damage can be avoided by delaying planting for 2 years after harvest or by planting less preferred species. Site preparation should occur toward the end of the 2-year waiting period to control vegetation that has claimed the site during this time. Other options include treatment of stumps with insecticides, stump removal, or dipping the above-ground portion of seedlings in insecticide immediately before planting them. Stump removal is expensive, not feasible at large scales, and causes excessive disturbance. This treatment should be used with caution and infrequently.

Heterobasidion Root Disease

Heterobasidion root disease causes mortality of pine, spruce, balsam fir, and red cedar. Once heterobasidion root disease is present in a stand it is not feasible to remove it. No site preparation options exist to treat heterobasidion root disease. The site should instead be prepped with conventional methods and planted to hardwood species. Any equipment used should be cleaned of dirt and debris prior to moving to a different site.

Oak Wilt

When oak wilt exists in a stand that will be regenerated back to oak, chemical stump treatment of cut oaks may be recommended to prevent sprouting. Sprouts of infected oaks will keep the roots alive and maintain the potential for root grafting and disease spread with newly established trees or nearby un-infected oak trees. Chemical stump treatment must be done immediately after cutting as part of harvest operations. Follow WI DNR oak harvesting guidelines to prevent new infections of this disease (guidelines can be found HERE , or by doing a web search for “WI DNR Oak Harvesting Guidelines”).

White Grubs

White grubs are the larval stage of several beetles, most commonly June beetles. The grubs can feed on the roots of both conifer and hardwood seedlings, and cause extensive mortality where populations are high. They are most likely to be problems on sites with dense sods or weeds (old fields), or under agricultural crops and cover crops. When planting into these types of sites, survey the soil with a hand trowel or shovel for white grubs prior to planting. Populations of grubs greater than 1 grub/square foot should be treated prior to planting. Several insecticide choices are available to control grubs (options are listed in the UW-Extension publication “White Grubs on Christmas Trees”, HERE). They should generally be applied before rain is forecast so they will move down into the soil.

REFERENCES

Edge, G. and R. Lietz 2017. Scarification trial in red oak. WI DNR-Division of Forestry. Madison, WI. Accessed July 2022 from https://dnr.wisconsin.gov/sites/default/files/topic/ForestManagement/silvicultureTrials_Oak_scarifytrial_GE.pdf.

Liesch, P.J., and C. Williamson. 2013. White grubs on Christmas trees. University of Wisconsin Extension. Madison, WI. Accessed July 2022 from https://hort.extension.wisc.edu/articles/white-grubs-christmas-trees/.

Lof, M., D.C. Dey, R.M. Navarro and D.F. Jacobs. 2012. Mechanical site preparation for forest restoration. New Forests (2012) 43:825-848.

Londo, A.J. and G.D. Mroz. 2001. Bucket mounding as a mechanical site preparation technique in wetlands. Northern Journal of Applied Forestry. 18(1). Pgs. 7-13.

Mayfield III, A.E. (2012) White grubs. In M.M Cram, M.S. Frank, & K.M Mallams (Eds.), *Forestry nursery pests* (pp. 170-172). Washington DC: USDA Forest Service.

Micheler, C.H. and R. Rathfon. 2006. Site Preparation for Tree Planting in Agricultural Fields and Hardwood Forests. FNR-220. Hardwood Tree Improvement and Regeneration Center. Lafayette, IN.

Natural Resources Canada. 2017. "A Guide to Mounding". Cat. No. Fo4-116/2017F-PDF. Ottawa, ON, Canada. 4 pgs.

Pellitteri, Phil. 2011. Ips bark beetle. University of Wisconsin Extension. Madison, WI. Accessed July 2022 from https://hort.extension.wisc.edu/articles/ips-bark-beetle/.

Rajotte, E. 2017. Pales weevil. Penn State Extension of the Pennsylvania State University. State College, PA. Accessed July 2022 from https://extension.psu.edu/pales-weevil.

WI DNR-Division of Forestry. 2021. Armillaria Root Disease. DNR PUB-FR-622j 2021. Madison, WI. Accessed July 2022 from https://widnr.widen.net/view/pdf/2tldne12ae/undefined.

WI DNR-Division of Forestry. 2021. Conifer Bark Beetles. DNR PUB-FR-622c 2021. Madison, WI. Accessed July 2022 from https://widnr.widen.net/view/pdf/hs082iscqc/Conifer-Bark-Beetles-Factsheet.

WI DNR-Division of Forestry. 2020. Diplodia Shoot Blight and Canker. DNR PUB-FR-622g 2020. Madison, WI. Accessed July 2022 from https://widnr.widen.net/view/pdf/rhoxe2re4p/Diplodia-Factsheet---FR-622g.

WI DNR-Division of Forestry. 2022. Heterobasidion Root Disease. DNR PUB-FR-622d 2022. Madison, WI. Accessed July 2022 from https://widnr.widen.net/view/pdf/a1ylzqbr1h/Heterobasidion-Root-Disease-Factsheet.

WI DNR Division of Forestry and Wisconsin Council on Forestry. 2022. Oak Harvesting Guidelines to Reduce the Risk of Introduction and Spread of Oak Wilt. PUB-FR-560-2022. Madison, WI. 40 pp.

WI DNR-Division of Forestry. 2004. Silviculture Handbook-Chapter 22 Artificial Regeneration. HB24315.22. Madison, WI. Accessed July 2022 from https://dnr.wisconsin.gov/topic/forestmanagement/silviculture.

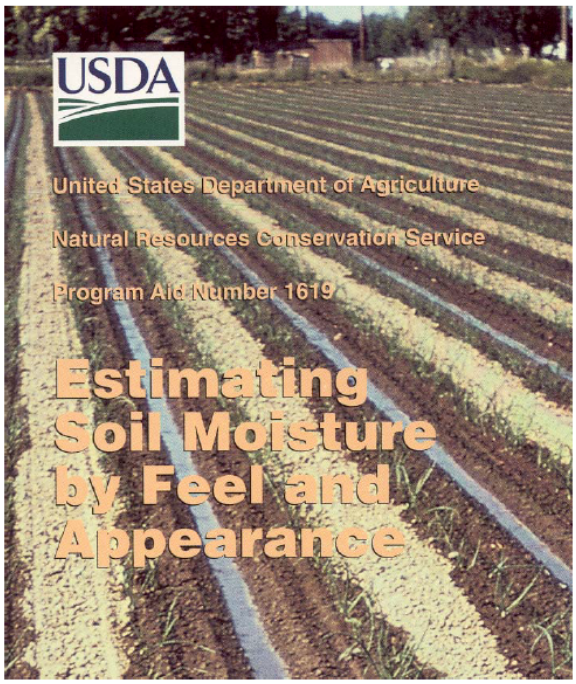
WI DNR-Division of Forestry. 2010. Wisconsin's Forestry Best Management Practices for Water Quality. PUB FR-093 2010. Madison, WI.

WI DNR-Division of Forestry. 2018. Wisconsin Forest Management Guidelines. DNR PUB-FR-226 2018. Madison, WI.

Appendix – Soil Feel Test to Determine Available Water Capacity

Estimating Soil Moisture by Feel and Appearance

Irrigation Water Management (IWM) is applying water according to crop needs in an amount that can be stored in the plant root zone of the soil.



The "feel and appearance method" is one of several irrigation scheduling methods used in IWM. It is a way of monitoring soil moisture to determine when to irrigate and how much water to apply. Applying too much water causes excessive runoff and/or deep percolation. As a result, valuable water is lost along with nutrients and chemicals, which may leach into the ground water.

The feel and appearance of soil vary with texture and moisture content. Soil moisture conditions can be estimated, with experience, to an accuracy of about 5 percent. Soil moisture is typically sampled in I-foot increments to the root depth of the crop at three or more sites per field. It is best to vary the number of sample sites and depths according to crop, field size, soil texture, and soil stratification. For each sample the "feel and appearance method" involves:

1. Obtaining a soil sample at the selected depth using a probe, auger, or shovel;
2. Squeezing the soil sample firmly in your hand several times to form an irregularly shaped "ball";
3. Squeezing the soil sample out of your hand between thumb and forefinger to form a ribbon;
4. Observing soil texture, ability to ribbon, firmness and surface roughness of ball, water glistening, loose soil particles, soil/water staining on fingers, and soil color. [Note: A very weak ball will disintegrate with one bounce of the hand. A weak ball disintegrates with two to three bounces;
5. Comparing observations with photographs and/or charts to estimate percent water available and the inches depleted below field capacity.

Example:

Sample Depth	Zone	USDA Texture	AWC*for Zone	Soil Moisture Delpetion**	Percent Depletion
6"	0-12"	sandy loam	1.4"	1.0"	70
18"	12-24"	sandy loam	1.4"	.8"	55
30"	24-36"	loam	2.0"	.8"	40
42"	36-48"	loam	2.0" 6.8"	.5" 3.1"	25

Result: A 3.1" net irrigation will refill the root zone.
** Available Water Capacity*
*** Determined by "feel and appearance method"*

Available Water Capacity (AWC) is the portion of water in a soil that can be readily absorbed by plant roots of most crops.

Soil Moisture Deficit (SMD) or Depletion is the amount of water required to raise the soil-water content of the crop root zone to field capacity.

Appearance of fine sand and loamy fine sand soils at various soil moisture conditions.

Available Water Capacity 0.6-1.2 inches/foot

Percent Available: Currently available soil moisture as a percent of available water capacity.

In/ft. Depleted: Inches of water currently needed to refill a foot of soil to field capacity.

0-25 percent available
1.2-0.5 in./ft. depleted

Dry, loose, will hold together if not disturbed, loose sand grains on fingers with applied pressure. (Not pictured)

25-50 percent available
0.9-0.3 in./ft. depleted

Slightly moist, forms a very weak ball with well-defined finger mark

50-75 percent available
0.6-0.2 in./ft. depleted

Moist, forms a weak ball with loose and aggregated sand grains on fingers, darkened color, moderate water staining on fingers, will not ribbon.

75-100 percent available
0.3-0.0 in./ft. depleted

Wet, forms a weak ball, loose and aggregated sand grains remain on fingers, darkened color, heavy water staining on fingers, will not ribbon

100 percent available
0.0 in./ft. depleted (field capacity)

Wet, forms a weak ball, moderate to heavy soil/water coating on fingers, wet outline of soft ball remains on hand. (Not pictured)

Appearance of sandy loam and fine sandy loam soils at various soil moisture conditions.

Available WaterCapacity 1.3-1.7 inches/foot

Percent Available: Currently available soil moisture as a percent of available water capacity.

In/ft. Depleted: Inches of water currently needed to refill a foot of soil to field capacity.

0-25 percent available 1 7-1.0 in/ft. depleted

Dry, forms a very weak ball, aggregated soil grains break away easily from ball. (Not pictured)

25-50 percent available 1.3-0.7 in/ft. depleted

Slightly moist, forms a weak ball with defined finger marks, darkened color, no water staining on fingers, grains break away.

50-75 percent available 0.9-0.3 in./ft. depleted

Moist, forms a ball with defined finger marks, very light soil/water staining on fmgers, darkened color, will not slick.

75-100 percent available 0.4-0.0 in./ft. depleted

Wet, forms a ball with wet outline left on hand, light to medium staining on fingers, makes a weak ribbon between the thumb and forefinger.

100 percent available 0.0 in./ft. depleted (field capacity)

Wet, forms a soft ball, free water appears briefly on soil surface after squeezing or shaking, medium to heavy soil/water coating on fingers. (Not pictured)

Appearance of sandy clay loam, loam, and silt loam soils at various soil moisture conditions.

Available WaterCapacity 1.5-2.1 inches/foot

Percent Available: Currently available soil moisture as a percent of available water capacity.

In/ft. Depleted: Inches of water currently needed to refill a foot of soil to field capacity.

0-25 percent available
2.1-1.1 in./ft. depleted

Dry, soil aggregations break away easily, no staining on fingers, clods crumble with applied pressure. (Not pictured)

25-50 percent available
1.6-0.8 in./ft. depleted

Slightly moist, forms a weak ball with rough surfaces, no water staining on fingers, few aggregated soil grains break away.

50-75 percent available
1.1-0.4 in./ft. depleted

Moist, forms a ball, very light staining on fingers, darkened color, pliable, forms a weak ribbon between the thumb and forefinger.

75-100 percent available
0.5-0.0 in/ft. depleted

Wet, forms a ball with well-defined finger marks, light to heavy soil/water coating on fingers, ribbons between thumb and forefinger.

100 percent available
0.0 in/ft. depleted (field capacity)

Wet, forms a soft ball, free water appears briefly on soil surface after squeezing or shaking, medium to heavy soil/water coating on fingers. (Not pictured)

Appearance of clay, clay loam, and silt clay loam soils at various soil moisture conditions.

Available WaterCapacity 1.6-2.4 inches/foot

Percent Available: Currently available soil moisture as a percent of available water capacity.

In/ft. Depleted: Inches of water currently needed to refill a foot of soil to field capacity.

0-25 percent available
2.4-1.2 in/ft. depleted

Dry, soil aggregations separate easily, clods are hard to crumble with applied pressure. (Not pictured)

25-50 percent available
1.8-0.8 in/ft. depleted

Slightly moist, forms a weak ball, very few soil aggregations break away, no water stains, clods flatten with applied pressure.

50 - 75 percent available
1.2-0.4 in./ft. depleted

Moist, forms a smooth ball with defined finger marks, light soil/water staining on fingers, ribbons between thumb and forefinger.

75-100 percent available
0.6-0.0 in./ft. depleted

Wet, forms a ball, uneven medium to heavy soil/water coating on fingers, ribbons easily between thumb and forefinger.

100 percent available
0.0 in./ft. depleted (field capacity)

Wet, forms a soft ball, free water appears on soil surface after squeezing or shaking, thick soil/water coating on fingers, slick and sticky. (Not pictured)

Guidelines for Estimating Soil Moisture Conditions

	Coarse Texture- Fine Sand and Loamy Fine Sand	Moderately Coarse Texture Sandy Loam and Fine Sandy Loam	Medium Texture - Sandy Clay Loam, Loam, and Silt Loam	Fine Texture- Clay, Clay Loam, or Silty Clay Loam
	Available Water Capacity (Inches/Foot)			
	0.6-1.2	1.3-1.7	1.5-2.1	1.6 -2.4
Available Soil Moisturre Percent	Soil Moisture Deficit (SMD) in inches per foot when the feel and appearance of the soil are as described.			
0-25	Dry, loose, will hold together if not disturbed, loose sand grains on fingers with applied pressure. SMD 1.2-0.5	Dry, forms a very weak ball, aggregated soil grains break away easily from ball. SMD 1.7 -1.0	Dry. Soil aggregations break away easily. no moisture staining on fingers, clods crumble with applied pressure. SMD 2.1-1.1	Dry, soil aggregations easily separate, clods are hard to crumble with applied pressure SMD 2.4-1.2
25-50	Slightly moist, forms a very weak ball with well-defined finger marks, light coating of loose and aggregated sand grains remain on fingers. SMD O.9-0.3	Slightly moist, forms a weak ball with defined finger marks, darkened color, no water staining on fingers, grains break away. SMD 1.3-0.7	Slightly moist, forms a weak ball with rough surfaces, no water staining on fingers, few aggregated soil grains break away. SMD1.6-0.8	Slightly moist, forms a weak ball, very few soil aggrega- tions break away, no water stains, clods flatten with applied pressure SMD 1.8-0.8
50-75	Moist, forms a weak ball with loose and aggregated sand grains on fingers, darkened color, moderate water staining on fingers, will not ribbon. SMD O.6-0.2	Moist, forms a ball with defined finger marks. very light soil/water staining on fingers. darkened color, will not slick. SMD O.9-0.3	Moist, forms a ball, very light water staining on fingers, darkened color, pliable, forms a weak ribbon between thumb and forefinger. SMD 1.1- 0.4	Moist. forms a smooth ball with defined finger marks, light soil/water staining on fingers, ribbons between thumb and forefinger. SMD I.2-0.4
75-100	Wet, forms a weak ball, loose and aggregated sand grains remain on fingers, darkened color, heavy water staining on fingers, will not ribbon. SMD O.3-0.0	Wet, forms a ball with wet outline left on hand, light to medium water staining on fingers, makes a weak ribbon between thumb and forefinger. SMD O.4-0.0	Wet, forms a ball with well defined finger marks, light to heavy soil/water coating on fingers, ribbons between , thumb and forefinger. SMD O.5 -0.0	Wet, forms a ball, uneven medium to heavy soil/water coating on fingers, ribbons easily between thumb and forefinger. SMD O.6-0.0
Field Capacity (100 %)	Wet, forms a weak ball, moderate to heavy soil/ water coating on fingers, wet outline of soft ball remains on hand. SMD 0.0	Wet, forms a soft ball, free water appears briefly on soil surface after squeezing or shaking,medium to heavy soil/water coating on fingers. SMD 0.0	Wet, forms a soft ball, free water appears briefly on soil surface after squeezing or shaking, medium to heavy soil/water coating on fingers. SMD 0.0	Wet, forms a soft ball, free water appears on soil surface after squeezing or shaking, thick soil/water coating on fingers, slick and sticky. SMD 0.0

April 1998