Tree/Shrub Planting Recommendations

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The following recommendations about planting trees and shrubs are based on scientific research, bulletins published by agency personnel and university professionals who have specific expertise in planting trees and shrubs, and my own experiences planting trees and shrubs and measuring survival as part of research projects and private sector planting projects in Michigan, Indiana, and Florida. The focus of this document is recommendations for planting deciduous trees, coniferous trees, and shrubs, for timber and wildlife habitat. Orchard management and Christmas tree plantation management are separate disciplines so are not discussed here. Regardless of your objective(s), it is important to consult with professionals prior to designing and implementing a tree planting project. Finally, it is important to note that many of the following topics are debated and still researched, meaning that in some cases there is no single correct answer. It is therefore important to use the best evidence available prior to making a decision about which trees and shrubs to plant and how to plant them.

Site and Species Selection

First and foremost, **DEFINE YOUR OBJECTIVES AND WORK WITH A PROFESSIONAL TO UNDERSTAND WHAT IS REALISTIC BASED ON THE CONDITIONS AT YOUR PARCEL**. Are you interested in planting trees for ornamental purposes? Are you interested in a forest plantation for timber production? Are you interested in providing food and cover for certain wildlife species? Are you trying to control erosion or stabilize the bank of a lake, river, or stream? These are important questions to ask. Different species of trees and shrubs are suitable for different purposes (Lantagne and Koelling 1997; Ochterski et al. 2009; Table 1).

It is also important to match the appropriate species to the soil type on your property. Please visit the Web Soil Survey at ***https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm*** to examine your parcel for soil types. Refer to Lantagne and Koelling (1997) and Ochterski et al. (2009) for a list of common tree and shrub species and where they grow, in the Midwest and Eastern U.S. For example, certain tree and shrub species are best adapted to sandy soils whereas other species are better adapted to damp, heavy soils (Table 1).

Table 1. A tree selection table, from Ochterski et al. (2009). Please note that for the category "Deer browse likely", a species rated as Good is not as susceptible to being browsed as species rated as Fair and Poor.

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Tree Selection Table

	SOIL			LOCATION / USE					Deer browse likely	Pioneer species	Shade / understory planting
	Damp / heavy	Loamy	Sand / gravel	Windbreak / screen	Timber or lumber	Wildlife	Christmas tree	Streambank / riparian buffer			
Native conifers / evergreens											
White pine (*Pinus strobus*)	F	G	P	G	P	G	G	P	G	G	P
White cedar (*Thuja occidentalis*)	G	G	F	G	P	G	P	G	P	G	F
Eastern red cedar (*Juniperus virginiana*)	F	G	G	G	F	G	P	P	G	G	P
White spruce (*Picea glauca*)	G	G	F	G	P	F	G	P	G	G	P
Canadian hemlock (*Tsuga canadensis*)	P	G	P	F	F	F	P	G	P	P	F
Balsam fir (*Abies balsamea*)	F	G	F	P	P	F	F	F	P	P	F
Red pine (*Pinus resinosa*)	P	G	G	G	P	F	P	F	F	G	P
Native hardwoods											
White ash (*Fraxinus americana*)	G	G	P	F	G	F	P	G	F	P	F
Green ash (*Fraxinus pennsylvanica*)	G	G	F	F	F	F	P	G	F	F	F
White birch (*Betula papyrifera*)	F	G	G	G	P	F	P	F	F	G	P
Black cherry (*Prunus serotina*)	P	G	G	F	G	G	P	F	F	F	F
Red (Soft) maple (*Acer rubrum*)	G	G	F	F	F	F	P	G	F	F	F
Sugar (Hard) maple (*Acer saccharum*)	P	G	F	P	G	G	P	F	P	P	G
Red oak (*Quercus rubra*)	P	G	G	F	G	G	P	F	P	F	F
White oak (*Quercus alba*)	P	G	G	F	G	G	P	F	P	F	F
American chestnut (*Castanea dentata*)	P	G	G	F	F	G	P	F	P	F	G
American sycamore (*Platanus occidentalis*)	G	G	F	P	P	F	P	G	F	F	P
Yellow poplar (*Liriodendron tulipifera*)	P	G	F	P	F	F	P	F	P	F	G
Black walnut (*Juglans nigra*)	P	G	P	P	G	G	P	F	F	F	F
Butternut (*Juglans cinerea*)	P	G	G	F	F	F	P	G	F	F	F
Redbud (*Cercis canadensis*)	P	G	F	P	P	F	P	G	P	F	G
Flowering dogwood (*Cornus florida*)	P	G	F	P	P	G	P	F	P	P	G
Trembling aspen (*Populus tremuloides*)	G	G	F	G	P	F	P	G	F	G	P
Big-toothed aspen (*Populus grandidentata*)	G	G	F	G	P	F	P	G	F	G	P
Cottonwood (*Populus deltiodes*)	G	G	F	G	P	F	P	G	F	G	P
Sweetgum (*Liquidambar styraciflua*)	G	G	P	P	P	F	P	G	F	F	F
Water tupelo (*Nyssa sylvatica*)	G	G	P	P	P	F	P	G	F	F	F
Hawthorn (*Crataegus* sp.)	G	G	G	F	P	G	P	F	F	G	F
American plum (*Prunus americana*)	F	G	G	F	P	G	P	F	F	F	F
Black locust (*Robina pseudoacacia*)	F	G	F	G	F	F	P	G	F	G	P
Hazlenut (*Corylus americana*)	F	G	F	F	P	G	P	G	F	F	G

Good	Fair	Poor
G	F	P

Table developed by Shavonne Sargent Morin.

Northeastern Tree Planting & Reforestation

Site Preparation

Preparing the site is a critical step to maximize the survival and growth of tree seedlings (Dickman and Stuart 1983; Ashby 1997; Lantagne et al 1997; Neumann 2001a).

Mechanical site preparation methods include using hand tools or larger equipment to kill or clear competing vegetation. Hoeksema and Peterson (2001) recommend a 24-inch wide area (where the seedling is planted in the center) be scalped (i.e., competing vegetation is mechanically removed with hand tools) prior to planting. Ochterski et al. (2009) suggest, if mowing and/or brush hogging methods are used to clear competition, these practices should be implemented in August and again in October the year prior to the spring when seedlings are planted, and only in the zones where seedlings will be planted.

Herbicides can be used to chemically control competition. Beheler and Michler (2013) provide a clear description of the different types used in tree/shrub planting projects: "Pre-emergent herbicides are applied before weed seeds germinate. Post-emergent are applied to plants that are actively growing. Some chemicals translocate, which means they move within the plant; these are known as systemic herbicides. Other chemicals only affect what they touch; these are known as contact herbicides. Chemicals like glyphosate are non-selective, meaning they are not specific to any species and will kill trees if applied incorrectly. Selective herbicides affect only some plant types or species—some just kill grasses, some only kill broadleaved plants. The label will help identify how the specific chemical works, how and when it should be applied, and what conditions to avoid to prevent damage to your trees." When using herbicides, please remember that THE PESTICIDE LABEL IS THE LAW! Refer to Lantagne et al (1997), Neumann (2001b), and Randall (2013) for common herbicides used in Christmas tree plantations (many conifers planted as Christmas trees are also planted for forestry and wildlife purposes) and forestry plantations (Table 2).

Table 2. Some herbicides recommended for site preparation for deciduous and conifer seedlings. Table taken from Neumann (2001a).

Herbicides recommended for site preparation for hardwood and conifer tree seedlings.[1, 2]

For both hardwood and conifer regeneration:	**Quantity**
Accord, Glypro, Roundup Pro[3]	3/4 to 4 quarts/acre
Garlon 3A	1/4 to 3 gallons/acre
For conifer regeneration only:	
Velpar DF	1.3 to 6.6 pounds/acre (site preparation only)
Velpar L	4 to 10 quarts/acre (for conifer site preparation only)
Arsenal	1/4 to 2.5 pints/acre (summer applications)
2,4-D ester (2,4-D LV4)	1.5 to 4 quarts/acre (between full leaf development to two weeks before first frost)
Patron 170	1 to 2 gallons/acre (between full leaf development to two weeks before first frost)
Vanquish (Dicamba)	1 pint to 2 gallons/acre (between full leaf development to two weeks before first frost)
Garlon 4	3 to 6 quarts/acre (wait 1 to 2 months after application before planting)

[1]For site preparation on sites with minor patches of woody brush, spot spray with Garlon 4 or a concentrated Roundup solution per the label instructions.

[2]Reference to commercial products or trade names does not imply endorsement by the MSU Department of Forestry or the MDNR Forest Management Division, or bias against those not mentioned.

[3]Roundup Pro is registered for landscape and ornamental uses. Accord concentrate and Accord SP are labeled for forestry site preparation.

Containerized or Bareroot Seedlings?

The question of "containerized versus bareroot" is a hotly debated topic, as is the "type of bareroot".

What do the numbers mean with bareroot stock? Bareroot seedling stock is available in a variety of ages. You will often see numbers such as 1-0, 2-0, 3-0, 2-1, and 2-2 next to seedling names. The first number indicates the number of years a seedling was grown in the nursery seedling bed and the second number indicates the number of years the seedling was grown in a transplant nursery bed (Lantagne and Koelling 1997). For example, a 2-0 seedling was grown for 2 years on the nursery seedling bed and never grown on a transplant bed. Conversely, a 2-2 seedling was grown for 2 years on the nursery seedling bed and 2 additional years on a transplant bed. Seedlings such as 2-2 seedlings are referred to as transplant stock, which are taller and have more robust root systems than seedlings that were grown only on the nursery seedling bed. Survival and growth tend to be better with transplant stock as compared to smaller seedlings, but transplant stock is more expensive and take more time to plant (Lantagne and Koelling 1997).

What about containerized seedlings? In general, seedlings grown in containers are less susceptible to transplant shock than bareroot seedlings because the roots are not disturbed on containerized seedlings when out-planted (Lantagne and Koelling 1997). This often translates to higher survival rates for containerized seedlings (Walter et al. 2013). Containerized seedlings can also be planted during a wider window of the growing season as compared to bareroot stock. However, containerized seedlings are also more expensive (McRae and Starkey 2000) and require more space to transport (e.g, 1,000 containerized seedlings in flats will take up more space than 1,000 bareroot seedlings in a bundle). From an economic perspective, it is important to compare the cost of planting containerized seedlings with a higher initial survival rate to the cost of planting bareroot stock with a lower survival rate followed by a re-planting. In some cases it is still cheaper to plant and re-plant a certain number of bareroot stock (to make up for mortalities during the first planting) to achieve the same level of survival as a single planting of containerized stock.

Spring or Autumn?

Like the question of "containerized versus bareroot", the question of "spring or autumn planting" is a hotly debated topic. Iowa Department of Natural Resources (2003) recommend that trees/shrubs be planted during the spring, from when the frost is out of the ground to the end of May, or in the autumn from October until the ground is frozen. Ochterski et al. (2009) indicate that deciduous and evergreen seedlings are best planted in the spring in the Northeastern U.S. Lantagne and Koelling (1997) suggest that spring is the best time to plant, particularly on heavy loam or clay soils. Lantagne and Koelling (1997) indicate that autumn planting, particularly on heavy soils, can result in higher mortalities due to frost heaving, dry winter winds, and higher levels of damage from rodents. Koelling (2006) indicated that nearly 90% of trees planted for Christmas trees or other purposes are planted in the spring. In spite of this statistic, Koelling (2006) suggests that autumn tree planting may be an advantage because of the expected precipitation that occurs in the autumn, which can translate to higher survival during years when a summer drought follows a spring planting; however, he also emphasizes the importance of planting larger stock and early enough in the autumn (to allow for more root growth) to ensure survival.

Handling Seedlings

After seedlings are removed from the nursery bed and/or after they are purchased from a Conservation District, actions should be taken to avoid overheating, lack of moisture, and physical damage during the transportation of the seedlings. Regardless of what actions you take during transportation, seedlings should be given to you in packaging, with packing material, to help keep the roots moist and cool. Roots should not exhibit a whitish color that is indicative of being dried out, nor should they be over-saturated or waterlogged (Jamie L. Whitten Plant Materials Center 2002). The following actions can help (Wisconsin Department of Natural Resources 2006): 1) Leave gaps around boxes or bags of seedlings to minimize overheating and allow for ventilation. 2) Pick up your seedlings in the morning when temperatures are cooler. 3) If the sun is shining, cover seedlings with a tarp (but keep the air temperature cool!) to avoid excessive drying of the seedlings. 4) If possible, put seedlings in a cooler.

From the time the seedlings are removed from the ground at the nursery, it is best to store the seedlings at temperatures between 33 and 40 degrees Fahrenheit (Wisconsin Department of Natural Resources 2006). Jamie L. Whitten Plant Materials Center (2002) suggest the ideal storage temperatures are between 33 and 35 degrees Fahrenheit. Seedlings can tolerate being stored in temperatures as high as 50 degrees, but storage temperatures higher than this can result in seedling damage due to hot temperatures that cause the root hairs to dry out, making it more difficult for seedlings to absorb water and nutrients once in the ground. Likewise, storage temperatures below 33 degrees can result in freeze damage (Wisconsin Department of Natural Resources 2006).

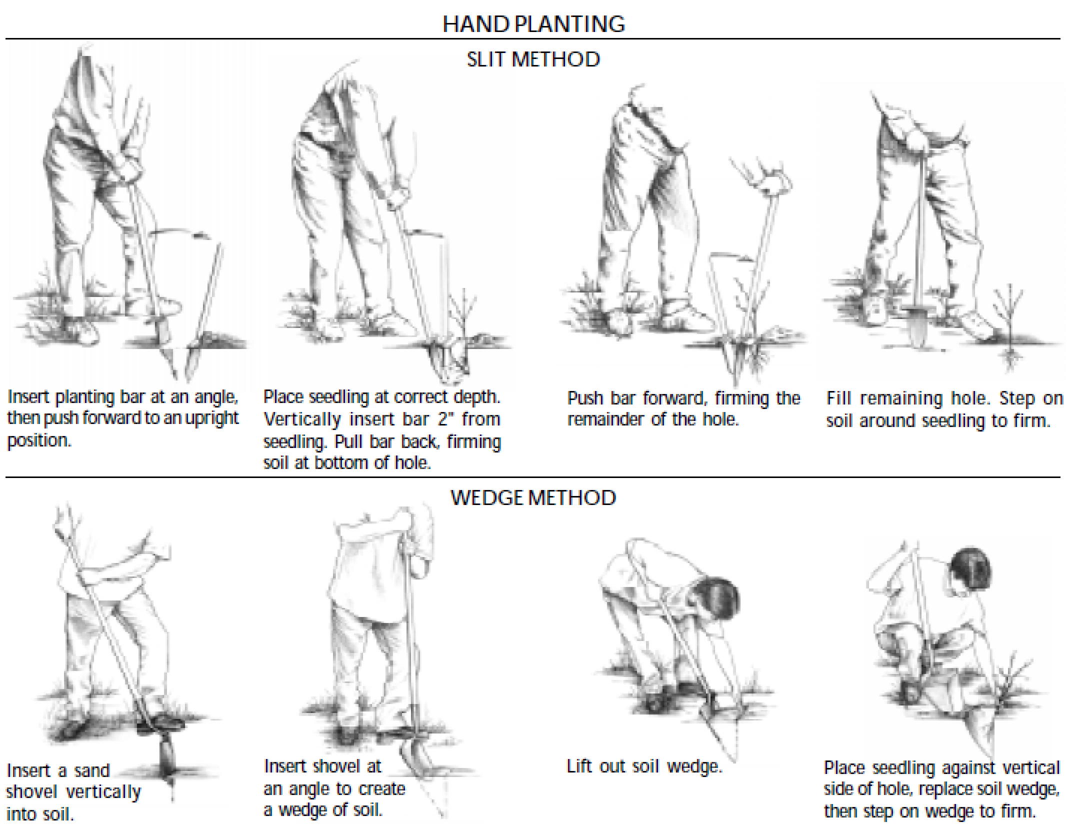
Seedlings should be planted within 72 hours of being taken out of cold storage (Jamie L. Whitten Plant Materials Center 2002). For longer term storage, "heeling in" the seedlings is an option, whereby seedlings are placed in a trench, covered in soil, and watered until ready to be planted. It is important to note that "heeling in" causes additional stress to the seedlings as compared to planting them right away so "heeling in" should only be used as a last resort for storage of seedlings (Jamie L. Whitten Plant Materials Center 2002).

During the planting stage, it is critical to keep the roots cool and moist until they are ready to be put in the ground (Jamie L. Whitten Plant Materials Center 2002). For example, do not open bundles of seedlings and allow them to sit in the sun as you are planting other seedlings. Likewise, do not store seedlings in buckets of water, causing excessive saturation (Jamie L. Whitten Plant Materials Center 2002). Instead, open one bundle at a time, and keep the roots moist and protected as you are putting the seedlings in the ground.

Planting Methods

If planting by hand, two common methods are the slit method with a planting bar, or the wedge method using a shovel (Wisconsin Department of Natural Resources 2006; Table 2).

Table 2. The slit method using a planting bar, and the wedge method using a shovel. Taken from Iowa Department of Natural Resources State Forest Nursery (2002). Illustrations and design by nita at *nitaupchurchstudio.com*.



According to Wisconsin Department of Natural Resources (2006), "Plant a seedling by placing the root collar at the soil line or no more than 1/2 inch deeper. The root collar is a spot located just above the roots identified by a change in color or slight swelling of the main stem. Make the planting hole or slit deep enough to accommodate the seedling's root system. The roots should hang freely in the planting hole and not be bent or twisted. Pack the soil firmly around the seedling to maintain good root-to-soil contact and eliminate air pockets." Also, it is important to root prune seedlings with excessively long root systems and be sure not to "J root" seedlings, which occurs when roots are placed in too small of a hole for the root system, resulting in roots growing upward and strangling themselves. Root pruning can be used to avoid "J-rooting" and should not negatively affect the survival or growth of the seedling (Simpson 1992). According to Wisconsin Department of Natural Resources (2006), "In general, seedlings can have their roots pruned 8 to 10 inches below the root collar. The root collar is the point on the main stem identified by a change in color or slight swelling in the stem. Larger seedlings (3-year-old or transplanted seedlings) require a larger root system, so don't over-prune these."

For larger, multi-acreage tree planting projects, machine planting is an option if the site conditions allow for it. As stated by Ochterski et al. (2009), "Mechanized planters are usually towed behind a tractor or large ATV. The seedlings are handled carefully and loaded into a covered hopper. Progressing through the prepared field, a small plow opens a furrow, and the seedling is inserted. Packing wheels drive the topsoil back into the hole, planting the tree. Mechanized tree planters are best operated on flat or gently sloping sites of well drained soil. Rocks, woody debris, and roots interfere with the mechanisms, so they must be removed first. Sites with poor drainage can be damaged by tree planting machines, so be sure to check soil conditions first."

Spacing

The spacing of planted seedlings depends on your objectives. If the objective is to plant conifers, such as red pine (*Pinus resinosa*) for timber, a spacing of 8 feet between rows x 7 feet within rows (~778 seedlings per acre) is typical (Lantagne and Koelling 1997). For deciduous trees, a 9 feet x 9 feet spacing (~538 seedlings per acre) or 10 feet x 10 feet spacing (~436 seedlings per acre) is typical. Shrubs can be planted at a tighter spacing (as close as 6 feet apart) than deciduous trees. For windbreaks, three staggered rows are recommended, with a minimum spacing of 10 feet between rows and between trees within a row.

Watering and Fertilizing

Seedlings, during the first two to three years after being planted, are not likely to survive excessive droughts such as two or three weeks of rain-free periods, so watering is necessary if these conditions are anticipated (Ochterski et al. 2009).

For smaller seedlings, fertilizers are typically not needed given that the proper species should be matched to your soil type. Applying fertilizers in this case will often create a loss of nutrients due to leaching or favor competing, non-native, weedy vegetation (Ochterski et al. 2009). Polomski et al. (2004) indicate that too much fertilizer can result in weakened plant growth, making the seedling more susceptible to being damaged from drought, cold weather, and pests and diseases. Furthermore, Jacobs and Timmer (2005) indicate that improper fertilization can result in chemical changes that prevent the roots from taking in water and nutrients. Having said that, more research is needed on this topic given that fertilizers, when applied according to the recommendations of a soil test, can result in increased growth of seedlings (Polomski et al. 2004).

Planting gel, in the form of hydrogels such as Terra-sorb®, can be used to dip bareroot seedling roots and increase the water-holding capacity of such roots prior to planting. More research is needed to determine under which circumstances this provides a significant advantage in terms of seedling survival. In one study, Apostol et al. (2009) found that northern red oak (*Quercus rubra*) seedlings treated with Terra-sorb® had 80% higher root moisture content than seedlings not treated.

Protection from Herbivory

Tree tubes (i.e., tree shelters) provide an excellent way to protect seedlings from being browsed by white-tailed deer (*Odocoileus virginianus*) and other herbivores. As indicated by Ochterski et al. (2009), "Tree tubes reduce deer browse and create a favorable growing environment immediately around the seedling. The translucent material allows sunlight to pass through while reducing wind stress, increasing warmth, and protecting the young tree from sudden changes in temperature. They provide mowing protection and make young trees easy to spot in the field." It is also important to note that tree tubes require maintenance. As indicated by Ochterski et al. (2009), "Maintenance and monitoring of tree shelters are necessary. Tree shelters are not a 'stick it and forget it' operation. Tree tubes can tip, become weedy, and fail due to incorrect installation. Landowners should inspect each tree shelter seasonally to make sure it is providing the desired protection. If you cannot monitor the shelters at periodic intervals, it is not worth installing them in the first place."

Fencing is another option. As indicated by Ochterski et al. (2009), "One of the most successful tactics to limit the impact of deer is exclusion with fencing. Numerous types of fencing are available depending on deer density, cost, and aesthetics. An 8-foot high fence should be sufficient in most situations. Although deer can jump this high, they are unlikely to take the risk, especially when other food sources are available. It is imperative that the fence goes close to ground level as deer are as likely to crawl under a fence as they are to jump over the fence."

Numerous types of repellents are available to prevent herbivores from browsing and killing tree and shrub seedlings. Wagner and Nolte (2001) examined 20 types of repellents and found that fear-based repellents were more effective than taste or pain-based repellents. See ***https://www.plantskydd.com/articles/field-trials/forestry-field-trials*** for a list of forestry field trials conducted using Plantskydd®, a fear-based repellent made from organic dried blood.

Follow-up Competition Control

Hoeksema and Peterson (2001) recommend using mechanical practices such as mowing or smothering competition with mulch, and/or application of herbicides. They suggest that applying herbicides is the most efficient approach. Ochterski et al. (2009) also suggest these practices, as well as synthetic weed mats. With mulching, Ochterski et al. (2009) suggest a 2-inch thick layer in a 12-inch radius circle around each seedling. They also suggest not allowing the mulch to contact the stem of the seedling directly as this can result in the creation of micro-habitat for voles that can and will kill seedlings by girdling the stems.

Follow-up Monitoring for Pests and Diseases

Look for browsed shoot tips, withered shoot tips and/or leaves, excessively eaten leaves, and abnormal discoloration of leaves (Hoeksema and Peterson 2001). While these may be caused by pests and/or diseases, environmental factors such as drought could also be the culprit so it is important to contact a professional if you are noticing issues.

Invasive Species

It is important to avoid planting non-native invasive species! Simply put, non-native (i.e., exotic) species are organisms that are not native to a particular ecosystem and/or geographic area. Such species, when re-located, can and do cause significant ecological and economic harm to the environment and therefore to humans. Non-native invasive species are the second-most important threat to biodiversity (habitat destruction is first; Wilcove et al. 1998, Mack et al. 2000). Some of the native species that suffer may have economic value (e.g., important merchantable tree species), medicinal value, aesthetic value, cultural value, etc. Annual economic costs incurred by invasive species in the U.S. may be as high as $120 billion (Pimentel et al. 2005). Some native species may have important values that have not been discovered.

Are all non-native species invasive? The Tens Rule published by Williamson and Fitter (1996) indicates that for every 1,000 species that are introduced to a new area, 100 will escape into the wild, 10 will become established, and one of those 1,000 species will actually become invasive. However, which of these species will be the one that becomes invasive is challenging to determine. It can also take many years for such an invasive species to become noticeable and by that point, it often becomes costly to control. It is therefore best to plant native species.

Introducing a non-native invasive species is not the same as slightly shifting the range of a native species already found in a particular region. Introducing non-native invasive trees and shrubs from one continent to another (e.g., introduction of non-native invasive shrubs from Asia to North America) or from one distinct eco-region to another (e.g., introduction of tree species from the Appalachian Mountains to the Midwest) can result in species becoming invasive. However, this is not the same as slightly shifting the current range of a species native to a particular region. For example, the probability is extremely low that planting a species in Northwest Michigan that is typically found in Southern Michigan, will result in that species becoming invasive, especially given that such a species is likely moving northward via other dispersal mechanisms.

A major debate that has persisted and will continue to persist is how to define “natural”. Some believe that humans should be excluded from this definition even though we are as much part of this world as any other species. As already mentioned, introducing non-native invasive trees and shrubs from one continent to another or from one distinct eco-region to another can result in species becoming invasive and interfering with the health of the ecosystems upon which we depend for our existence. This has less to do with “natural” versus “not natural” and more to do with environmental harm. However, species shifts not viewed as harmful and caused by "Mother Nature" within major geographic areas have been and are still often an effect of humans (e.g., increases in aspen [*Populus* spp.] and paper birch [*Betula papyrifera*] dominance in certain portions of Michigan due to the widespread logging across the state in the early 1900s). From an objective standpoint, humans as a dispersal mechanism is no less native than wind, water, mammals, or birds acting as dispersal mechanisms. There is a threshold that we must be mindful of, such as moving species such incredible distances as across continents or completely different ecosystems that the result is destruction of the native ecosystem. It is quite likely that Native Americans moved seed, such as acorns, long distances, and these additional propagules, combined with other activities such as planting and prescribed fire (Abrams and Nowacki 2008), resulted in some of the very ecosystems that folks call "natural", such as oak (*Quercus* spp.) savannahs and oak-hickory (*Carya* spp.) forests. Without the influence of humans, many of these areas in our part of North America are becoming dominated by maple (*Acer* spp.) and American beech (*Fagus grandifolia*) because of the lack of human-induced fire.

Case Study in Ogemaw County – Using Seedlings from the Manistee and Mason-Lake Conservation Districts

Since the spring of 2015, I have been purchasing tree and shrub seedlings from the Manistee and Mason-Lake Conservation District tree/shrub sales and planting seedlings at a family parcel in Ogemaw County, Michigan. A subset of these seedlings was used to initiate an experiment on seedling survival. Here are the results thus far:

Tree/Shrub Species	**Age and Type of Stock**	**Month/Year Planted**	**Soil Type**	**Site Preparation Method**	**Water and/or Fertilizer?**	**Planting Gel?**	**Total Number Planted**	**Experiment Description**	**Conclusion**
Red Pine (*Pinus resinosa*)	2-0; Bareroot	April/2015	Excessively Drained Rubicon Sand, 0 to 6 Percent Slope	I scalped a 3-feet diameter area using a spade, at the time of planting.	Seedlings were watered immediately after planting, but not again. No fertilizer was used.	Planting gel was not used.	25	I planted the seedlings and tracked survival.	As of the end of the growing season of 2017, 22 have survived (88% survival) and are growing.
White Oak (*Quercus alba*)	1-0; Bareroot	April/2015	Excessively Drained Rubicon Sand, 0 to 6 Percent Slope	I scalped a 3-feet diameter area using a spade, at the time of planting.	Seedlings were watered immediately after planting, but not again. No fertilizer was used.	Planting gel was not used.	10	I planted 5 seedlings and protected them from browsing using 5-feet tall tree tubes by Tree Pro. I did not protect the other 5 seedlings.	As of the end of the growing season of 2017, all 5 seedlings in tree tubes have survived and are growing (100% survival), whereas all 5 seedlings not protected have been repeatedly browsed by white-tailed deer (*Odocoileus virginianus*) and have died (0% survival)

Tree/Shrub Species	**Age and Type of Stock**	**Month/Year Planted**	**Soil Type**	**Site Preparation Method**	**Water and/or Fertilizer?**	**Planting Gel?**	**Total Number Planted**	**Experiment Description**	**Conclusion**
American Mountain Ash (*Sorbus americana*)	2-0; Bareroot	April/2015	Excessively Drained Rubicon Sand, 0 to 6 Percent Slope	I scalped a 3-feet diameter area using a spade, at the time of planting.	Seedlings were watered immediately after planting, but not again. No fertilizer was used.	Planting gel was not used.	10	I planted all seedlings and applied Plantskydd organic blood-based repellent to all 10 seedlings at the time of planting. I re-applied Plantskydd three more times during the growing season of 2015 and twice during the dormant season of 2015/2016 to 5 seedlings, and did not re-apply to the other 5 seedlings.	As of the end of the growing season of 2017, all 5 seedlings that received more than one application of repellent have survived and are growing (100% survival), whereas all 5 seedlings not protected have been repeatedly browsed by white-tailed deer (*Odocoileus virginianus*) and have died (0% survival)
Wild Crabapple (*Malus coronaria*)	2-0; Bareroot	April/2016	Excessively Drained Rubicon Sand, 0 to 6 Percent Slope	I scalped a 3-feet diameter area using a spade, at the time of planting.	Seedlings were watered immediately after planting, but not again. No fertilizer was used.	Planting gel was not used.	4	I planted the seedlings, protected all of them with 5-feet tall tree tubes by Tree Pro and tracked survival.	As of the end of the growing season of 2017, all 4 have survived (100% survival) and are growing.
Eastern White Pine (*Pinus strobus*)	2-0; Bareroot	April/2016	Excessively Drained Rubicon Sand, 0 to 6 Percent Slope	I scalped a 3-feet diameter area using a spade, at the time of planting.	Seedlings were watered immediately after planting, but not again. No fertilizer was used.	Planting gel was not used.	50	I planted the seedlings and tracked survival.	As of the end of the growing season of 2017, 40 have survived (80% survival) and are growing.

Tree/Shrub Species	Age and Type of Stock	Month/Year Planted	Soil Type	Site Preparation Method	Water and/or Fertilizer?	Planting Gel?	Total Number Planted	Experiment Description	Conclusion
Yellow Birch (*Betula alleghaniensis*)	1-0; Bareroot	April/2017	Somewhat Poorly Drained Soils (not mapped on the soil survey) between Rubicon Sand and a lake	I scalped a 3-feet diameter area using a Weasel Claw Pro garden tool, at the time of planting.	Seedlings were watered immediately after planting, but not again. No fertilizer was used.	Planting gel was not used.	10	I planted 5 seedlings and protected them from browsing using 5-feet tall tree tubes by Tree Pro. I did not protect the other 5 seedlings.	As of the end of the growing season of 2017, all 5 seedlings in tree tubes have survived and are growing (100% survival), whereas only 1 seedling not protected has survived (20% survival) and the other 4 have been repeatedly browsed by white-tailed deer (*Odocoileus virginianus*) and have died
Northern White-Cedar (*Thuja occidentalis*)	2-1; Bareroot	April/2017	Somewhat Poorly Drained Soils (not mapped on the soil survey) between Rubicon Sand and a lake	I scalped a 3-feet diameter area using a Weasel Claw Pro garden tool, at the time of planting.	Seedlings were watered immediately after planting, but not again. No fertilizer was used.	Planting gel was not used.	10	I planted 5 seedlings and protected them from browsing using 5-feet tall tree tubes by Tree Pro. I did not protect the other 5 seedlings.	As of the end of the growing season of 2017, all 5 seedlings in tree tubes have survived and are growing (100% survival), whereas all 5 seedlings not protected have been repeatedly browsed by white-tailed deer (*Odocoileus virginianus*) and have died (0% survival)

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