

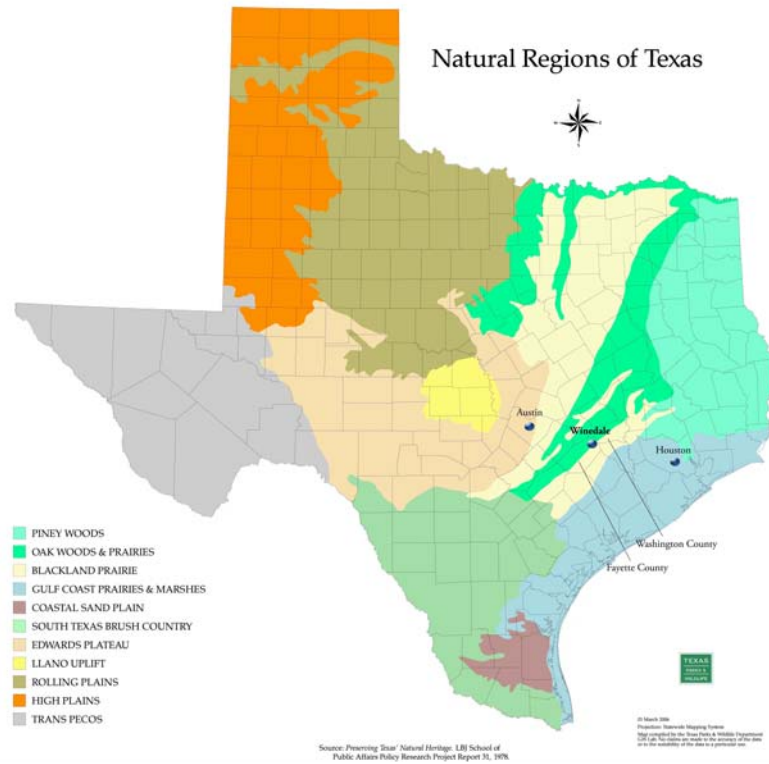
VI. WINEDALE RESTORATION PLAN

1. Introduction

Winedale is situated in an ecologically unique area, where both the Blackland Prairie and Post Oak Savanna (also known as Oak Woods and Prairies or Central East Texas Savanna) ecological regions intermingle. Ecological regions are areas of similar geologic and environmental conditions in which characteristic biological communities have emerged (Damude & Bender 1999). Although distinct boundaries between ecological regions are rare in the natural world, stark contrasts in soil can provide one situation in which distinct boundaries occur. Winedale has five different soils, with two being distinctly unique—typical examples of each of the two surrounding ecoregions—while the other three are gradations between the two distinct soil types. The Blackland Prairie soil is several feet of heavy clay while the Post Oak Savanna soil, in contrast, is several feet of sandy loam with an underlying shallow clay pan (USDA-NRCS, 2009). These different soils tend to favor similar, yet different, plant communities as will be described in Section 2.

The goal of this project is to restore these endangered ecosystems to how they appeared 150 years ago to serve as a living historical demonstration of the landscape that settlers at Winedale first encountered. Due to past agricultural practice there is currently very little of these original plant communities still evident. The restored site will not only serve as a demonstration of an historic landscape but also provide a refugium for native species whose populations are in decline. After restoration is complete, the resulting spectrum of plant communities viewed from the proposed nature trail will represent the region's structural diversity, from tallgrass prairie to savanna to woodlands (Figure 3).

Figure 3: Natural Regions of Texas



2. Winedale’s Principal Ecoregions

2.1 Blackland Prairie

Approximately only 5,000 acres of the original 12 million acres of Blackland prairie remain in Texas due primarily to this regions suitability for agricultural production, making this ecological region one of the most threatened landscapes in Texas (TPWD 2005). What acreage was not plowed for agriculture is often ecologically degraded due to past and current land management (such as overgrazing or fire suppression). Additionally problematic is that the majority of remaining native prairie is isolated into small parcels, increasing vulnerability to exotic species invasion, lowered genetic diversity in local populations, and increased extinction rates (Martin 1993, Steinauer and Collins 1996).

In addition to destruction, degradation, and fragmentation of the North American Prairie, many historical disturbance forces, such as wildfire or grazing by bison, common before European

settlement have been either eliminated or greatly modified. The ecology of the North American prairie was once dependent on fire and grazing as well as regulated by temperature and precipitation extremes (Risser et al. 1981, Madson 1982, Diamond and Smeins 1985, Leach and Givnish 1996, Steinauer and Collins 1996). Fire has been all but eliminated from most prairies, and the episodic but intense grazing of bison has primarily been replaced by the year-round grazing of domestic cattle. Studies show elimination of periodic grassland fires can lead to an annual loss of 0.45% to 1.03% of the original vegetation species (Leach and Givnish 1996). Loss of historical disturbance factors resulted in a downward spiral in the ecological integrity of prairie ecosystems and a general encroachment of woody plant species, particularly those able to withstand periodic droughts common to the Great Plains. In addition to exotic herbivores, the past 200 years have brought a variety of exotic plant species to the prairie. In east-central Texas, exotics grasses were introduced for purposes of increased grazing production or as a hay crop (Luken 1997, Diggs et al. 1999).

Blackland Prairie has different historical vegetative climax sub-communities throughout its range. Aside from bottomland hardwood forests and some wetlands, all of these sub-communities are dominated by tall grasses, such as little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), and Indiangrass (*Sorghastrum nutans*). There are many other species of mid and short grasses, as well as forbs, in this diverse and dynamic ecosystem.

2.2 Post Oak Savanna

Post Oak Savanna has soils that range from sands and sandy loams in the uplands to clays and clay loams in the bottomlands, with a dense clay pan under all of the soils. This clay pan is nearly impervious to water, which can limit plant growth. The region's average annual temperatures range from 60° F to 70° F and the average precipitation is between 35 and 45 inches per year.

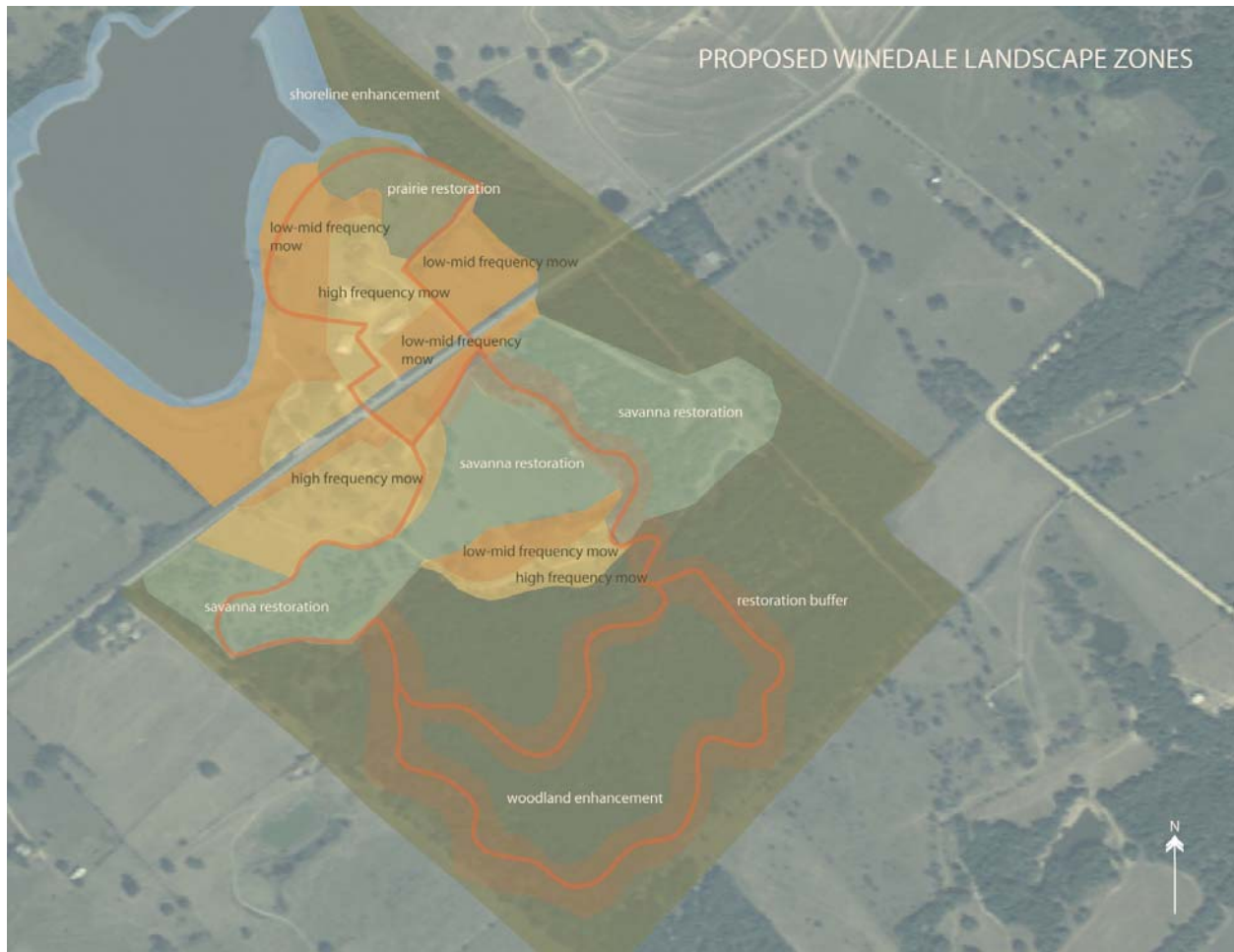
Historically, the region was likely characterized by tallgrass prairie dotted with scattered clumps of oaks, such as post oak (*Quercus stellata*) and blackjack oak (*Quercus marilandica*). Important native tallgrass species included little bluestem, Indiangrass, and upland switchgrass (*Panicum virgatum*). Low intensity but frequent ground fires maintained the open characteristics of this ecosystem by preventing small trees from reaching maturity. However, the patchy nature of fire often resulted in some trees escaping fire altogether, allowing them to grow to maturity. Once mature, the surviving

oak tree or oak mottes' canopies would be spaced far enough apart from groupings of trees that canopy fire would not spread to other trees or mottes.

The structure and function of what was once Post Oak Savanna has been greatly altered by humans. Two examples of these alterations are evident at Winedale. First, areas were seeded with non-native invasive species such as bahiagrass (*Paspalum notatum*), King Ranch bluestem (*Bothriochloa ischaemum*), or perennial rye (*Lolium perenne*) to support continuous grazing. Secondly, dense woodlands developed as a result of fire suppression, leading to an increasing density of common woody species such as post oak, blackjack oak, eastern red cedar (*Juniperus virginiana*), mesquite (*Prosopis glandulosa*), black hickory (*Carya texana*), live oak (*Quercus virginiana*), cedar elm (*Ulmus crassifolia*), hackberry (*Celtis* spp.) and yaupon (*Ilex vomitoria*) (TPWD 2005). As these woody species matured, they shaded out the native tallgrass component of the savanna. This shading further reduced the likelihood of fire and competition with woody plants. Due to these human alterations, the complexity and richness of this historic fire-climax plant community is being lost.

3. Introduction to Ecological Restoration at Winedale

The planned restoration will help transform the landscape from non-native pasture grasses to native tallgrass prairie; encroaching woodland to post oak savanna; and dense woodland with an impenetrable understory to an open park-like environment underneath the canopy of a gallery woodland. Lake Winedale's shoreline will as be enhanced to create a wetland-type atmosphere. Even high visibility areas near the road and buildings, which are actively managed with mowing already, can begin a precise timed mowing or prescribed fire regimen to encourage abundant seasonal wildflower displays and reduced mowing frequency. A general comparison of the labor, cost, establishment rate and preparation time for each ecological restoration type at Winedale can be found in Appendix B.

Figure 4: Restoration Zones, Trail Development & Mowing Regime

3.1 Restoration Process at Winedale

It is often beneficial for restoration to occur incrementally so that the vagaries of climate do not overwhelm a significant investment or effort. Additionally, the incremental approach will allow for fine tuning the restoration methods to what works best on site with the most effective staff and volunteer effort. Initial efforts should begin in high priority areas visible from the proposed trail which travels throughout the entire site. Combining the restoration areas with the trail locations on both the historical and non-historical side of the property will increase accessibility, facilitate monitoring, and add to the interpretive and educational experience of the trail (please see Figure 2 on page 27). In certain portions of the trail, the restoration efforts work in tandem with the trail development. For example, it is possible to use the cut woody debris for trail surfacing after chipping within the woodland enhancement area. The intent of this report, however, is not to be

overly prescriptive but to allow Winedale staff and volunteers to discern where priority areas are located and where time can be most efficiently directed.

In section 5 of this document, entitled *Restoration and Management Recommendations and Guidelines*, this report delineates where and how the initial, priority projects should be conducted as well as describes the supporting (or secondary) restoration projects and zones (Figures 4-12).

3.2 Prairie Restoration

The initial Blackland Prairie restoration is planned for approximately one acre of intensive restoration, and three to four acres of remnant prairie enhancement and invasive species control adjacent to this intensive restoration area. The site was chosen due the dark, rich Frelsburg clay soils—typical soil for Blackland Prairie—which are already adjacent to the existing trail. This area has a mix of native tallgrass species and non-native invasives. Prairie restoration efforts will preserve these existing prairie species while adding some native species diversity, and restoring a native fire regime through the use of prescribed burns. For the intensive restoration to be successful, efforts will need to focus first on removal of the invasive species, followed by the establishment of Blackland Prairie plant species. Using this approach, restored prairie can be expanded bit by bit, and the already existing remnant prairie can be enhanced with more biodiversity native to this ecoregion.

Images 1 and 2: Current Winedale Prairie Areas



Remnant Prairie showing swale (Zone A)



Invasive Species Dominant Area (Zone A)

Images 3 and 4: Examples of Successful Prairie Areas



Fall Prairie



Summer Prairie

3.3 Savanna Restoration

Savanna restoration is planned initially for a swath of land extending north of the McGregor house west to F.M. 2714 and south to the property fence, excluding the mowed areas immediately surrounding the historic buildings (identified in Figure 9). The process of restoration will use all the tools in the restoration toolkit to open woodlands, selectively remove undesirable species amidst rare native plants, and completely replace invasive pasture grasses with native tallgrass in other areas. The proposed trail (Figure 5) will travel through the savanna restoration areas where some of most rare and interesting plants exist at Winedale and by the gravesite of the great naturalist Gideon Lincecum. The trail will then continue into the northwest portion of the savanna restoration zones further exposing the visitor to the beauty of Winedale’s native tallgrass savanna.

Images 5 and 6: Current Savanna Area at Winedale



Zones I & S



Remnant Savanna: Zone P

Images 7 and 8: Examples of Successful Savanna



Live Oak Savanna with Bluebonnets



Oak/Cedar Savanna with wildflower mix

3.4 Woodland Enhancement

A significant amount of the Winedale property has become dense woodland. As mentioned above, this is due to a lack of fire. In areas where this relatively dense canopy will remain, enhancing the species composition in these areas can help create a more inviting space. Two trails have been suggested in the plan, allowing users the option to determine the length of hike they would prefer through the woodland area (Figures 5 and 10).

Activities for woodland enhancement will be based upon Winedale’s long-term management goals. It is possible to restore all the woodlands to Post Oak Savanna; it is also possible to leave the woodlands as they are, with a trail to guide visitors through a shaded adventure; or it is possible to keep the woodland canopy while altering and opening to a park-like understory, also known as a gallery woodland.

Images 9 and 10: Current Woodland Areas at Winedale



Winedale Cedar Dominated Woodland



Winedale Woodland Canopy

Image 11: Example of Successful Woodland



3.5 Mowed Areas/Wildflower Meadow Enhancement

Regular mowing over the last thirty years has kept grasses short and woody vegetation from encroaching on pastures. Some of these areas already provide good wildflower displays, while others are dominated by non-native invasive grasses which outcompete wildflowers and inhibit their displays. Precisely timed mowing or prescribed burn schedules along with selective use of herbicide can greatly enhance wildflower displays in the open areas near the buildings and along F.M. 2714.

Image 12: Winedale High Frequency Mow Area



Campus area between Visitor Ctr. and Pavilion

Image 13: Preferred Winedale Wildflower Area



Field in front of Meadows building

Images 14 and 15: Examples of Successful Wildflower Displays



Bluebonnets along dirt road



Combination of mowed & flowering area

3.6 Trail Enhancement

Trail development is recommended throughout the Winedale site, connecting the historical and non-historical sides and meandering past the historical structures, the lake, and through the prairie and savanna restoration and woodland enhancement zones. It is important to note that trail development should be intentional and deliberate for two reasons: to limit environmental impacts, and to provide the trail user with an interesting and unique experience. While the proposed trail in the woodland area travels near the riparian corridor (drainage) on the southwestern portion to showcase one of the more beautiful areas in the woodland, the trail minimizes access to this area to protect this ecologically sensitive region. In addition, too many trails throughout the woodland will interfere with the overall ecological integrity of this area. In the savanna and woodland portions of the site, the trail will contain a buffer delineating the immediate areas for woodland thinning and will allow visitors to observe restoration techniques. It is recommended that this buffer be 15 feet wide on either side of the trail (Figures 4 and 6-12 demonstrate the buffer). Trail development should also be implemented in conjunction with interpretive concepts, which the user will experience through signage and exposure to specific plant communities, restoration points, and historical markers.¹

It is recommended that Winedale investigate the possibility of adding a crosswalk across F.M. 2714 to connect the two sides of the property and provide a fluid, safe place for trail connections.

¹ For trail development techniques which address all the above issues, the book “With People in Mind: Design and Management of Everyday Nature” written by Rachel Kaplan, Stephen Kaplan, and Robert L. Ryan is an excellent reference.

Figure 5: Trail Enhancement Areas



3.7 Shoreline Enhancement

The water level of the lake at Winedale is constantly fluctuating and often varies significantly depending upon rainfall patterns. The fluctuating water level offers both challenges and opportunities. To ensure that this zone is established, the water’s edge should be planted with tall grass wetland species and edge recreational activities such as fishing should be discouraged. This would assist in protecting the lake’s water quality as well as provide habitat for waterfowl and other birds. Mowing in this zone is restricted to reduce the disruption of habitat and to allow the growth of taller wetland/shoreline plants as listed in Tables 4 and 11. However, some invasive species currently exist along the water’s edge and as discussed in section 5.5.1 of this chapter, mowing can be one approach to control cattails and woody species along the shoreline. It is also recommended

that Winedale continue to mow the trail area along the Lake as demonstrated in Image 18. A more detailed shoreline mowing plan is found in Section 4.4.

Images 16 and 17: Current Lake Winedale Shoreline



Image 18: Mowed Trail Along Winedale Lake Shoreline



Image 19: Example of Successful Shoreline with Aquatic and Terrestrial Plants



4. Restoration and Management Techniques

This section provides general guidelines that illustrate the concepts behind landscape restoration and management decisions. Many of the restoration techniques will be used in multiple ecosystem types (i.e. prairie, savanna, and woodland). For example, prescribed fire is specifically listed and described as a method under prairie restoration (Section 4.1), but will also be useful, if not essential, as a method for restoration of other ecosystem types. Additionally, the listed target invasive species (Section 5) will most likely occur in more than one ecosystem type. These target invasive species should be treated wherever they are found.

4.1 Prairie Restoration

Native prairies are highly diverse and productive communities. This diversity cannot be recreated over a short time period. Prairie restoration projects strive to replace the prairie's basic components through seeding, transplanting, and modification of soil conditions so that the prairie can begin to

heal itself under continual management supervision. In time, the diversity will increase as additional species become established.

Ecological restoration is a process dependent on a number of key variables: controllable variables (seed addition, prescribed fire, grazing, mowing); partially controllable variable (seed bank, soil conditions); and some variables beyond the control of the restoration manager (climate, immigrant seed). Any one of these uncontrollable variables can effectively trump active management events, or can impede some or all of the aforementioned variables. To increase the chance of success it is important to adopt an integrated management plan that constantly monitors the progress toward the target state and can direct the management accordingly. Therefore, although this plan provides an outline of the expected actions, events may force further input of resources or delay the process.

4.1.1 Fundamental Approaches

Two broad approaches to prairie restoration can be utilized: the agricultural approach and the interseeding approach (Packard & Mutel 1997). Both approaches have advantages and disadvantages, and most restoration plans incorporate aspects of both approaches.

Agricultural Approach

The agricultural approach entails complete replacement of the vegetation on the site. Prior to seeding, the existing vegetation is removed via herbicide treatment or physical removal in order to minimize invasive species competition with seedlings. Invasive species competition with seedlings significantly reduces seedling establishment and poses a serious obstacle to prairie restoration projects. Invasive non-native species such as johnsongrass (*Sorghum halepense*), bahiagrass (*Paspalum notatum*), and King Ranch bluestem (*Bothriochloa ischaemum*) cause ecological harm by displacing native species. Reducing weed competition can dramatically increase native seedling establishment and vigor (Kline 1997).

The agricultural approach is often highly effective and establishes a young prairie community fairly quickly. However, it is labor intensive, reduces any remaining desirable native species at the site along with non-native species and encourages erosion while the soil is bare. This approach is best suited for projects where little native vegetation exists on the site, as is the case with agricultural fields.

Interseeding Approach

Interseeding calls for seed to be sown among existing plants; this can be done with a seed drill on a tractor or by spreading seed by hand and raking (more in Section 4.1.2 C). The interseeding approach is most appropriate for use when erosion is an issue and when existing natives should be protected. Very little soil preparation is necessary, though spot application of herbicide to existing invasive species prior to seeding is recommended. This approach preserves existing native diversity, requires less work and is less likely to cause significant erosion from the site. For the first several years, competition from weed species will be more intense than it would be with the agricultural approach. More invasive species control will be necessary with this approach, but eventually the plant community will become more resistant to invasion and competition from invasive species.

4.1.2 Methods

A. Invasive Species Management

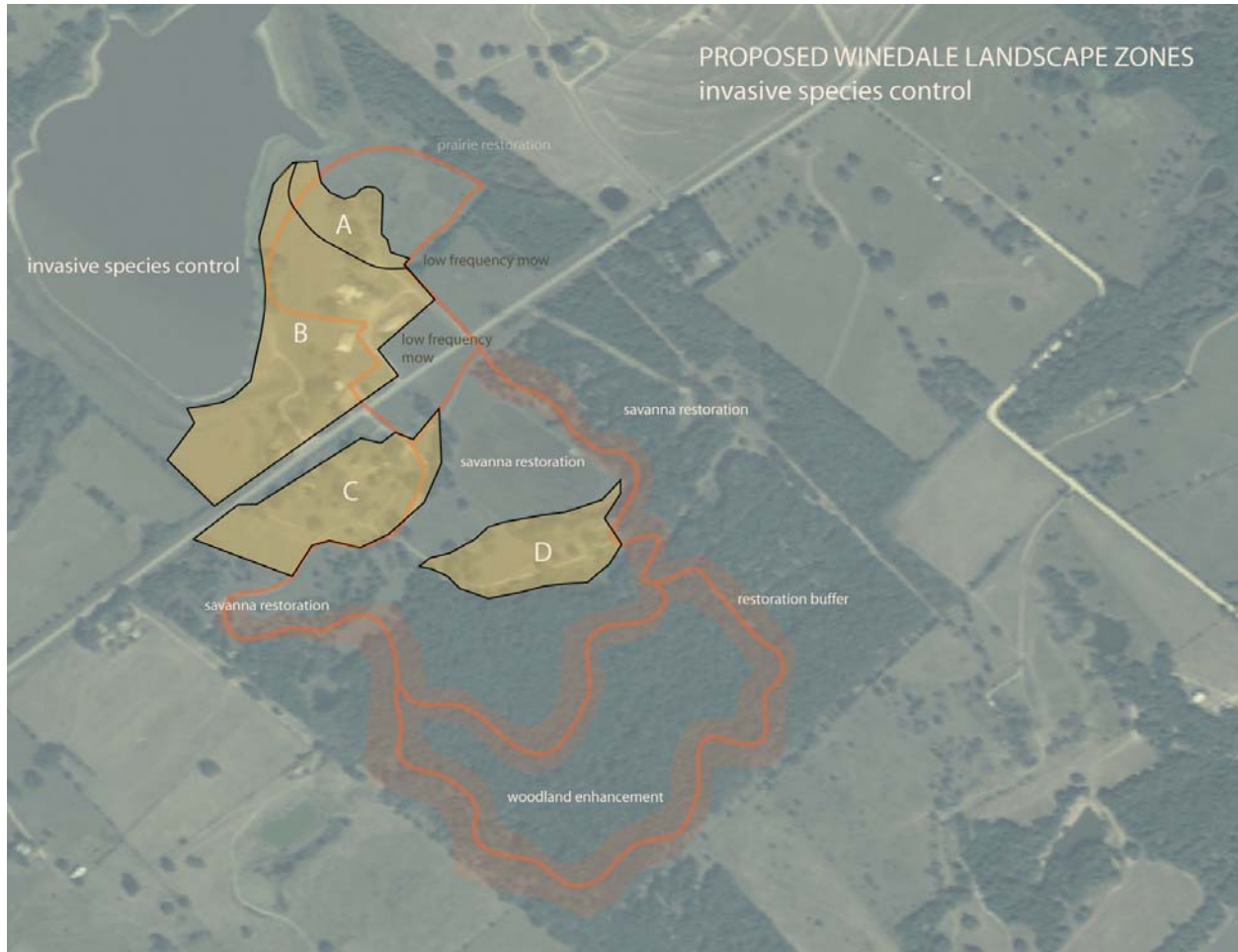
Invasive species are non-native species that cause economic or environmental harm. Invasive species generally harm natural communities by displacing native species (specifics on target invasive species at Winedale in Section 5; Figure 6 below identifies target invasive areas). This process reduces the community's species diversity and simplifies the vegetative community structure. These simplified systems are able to support fewer forms of life and are less able to recover from damaging events.

Healthy plant communities are usually fairly resistant to invasion by non-native species. They can be invaded, however, if the community is disturbed or stressed. Once in place, these species can reproduce rapidly, competing with existing natives for resources and often reducing desired seedling germination and survival. Invasive species are particularly problematic on small sites because invasive plant seed entering from the edges can easily reach any point within the site.

Invasive species management is critical to the success of most restoration projects. Invasive species can be managed through a program of chemical and mechanical removal, prescribed fire, and through efforts to increase the general health of the community. During the early phase of a restoration project, the preferred method of invasive species control tends to be chemical. Mechanical removal of individual plants is labor intensive and can cause soil damage. Prescribed fire

is better suited for use as a long-term management tool. Additionally, herbicide can be selectively applied to target species with only minimal adverse effect on nearby desired species.

Figure 6: Target Invasive Areas



A. Herbicide

Herbicides can be applied in a number of ways: broadcast, spot application, “wicking,” or by cut stump treatment. Broadcast application tends to apply the most herbicide by dispersing a broad mist over the entire area using either suspended sprayer on a tractor, or through aerial application. Spot application uses less herbicide as it selectively sprays herbicide within a field, targeting only a subset of the plants in the area. Wick application uses a saturated media (typically a rope or sponge) to put a small amount of herbicide on the target plant. Cut stump treatment uses mechanical removal of the upper plant material combined with herbicide application to the newly exposed

cambium of the freshly cut bark of a woody plant using either a spray wand, a paintbrush, or a chemical wash bottle.

Most weed management can be done within the scope of this project can be done with two herbicides: glyphosate and fluazifop. Glyphosate is the active ingredient found in such products as Round Up® and Eraser®. Glyphosate is a broad spectrum herbicide that can be used for control of a wide range of plants. Fluazifop is a grass-specific herbicide, meaning that it does not typically harm shrubs, forbs, or trees. Fusilade® is a common brand name herbicide with fluazifop as the active ingredient. If used correctly the benefits of these two chemicals are significant.

Grazon P+D® is the recommended brand name of herbicide for treating Macartney's rose (*Rosa bracteata*). Grazon P+D® is a combination of two active ingredients: picloram and 2,4 D. The unique herbicide requirement for this one species is described in more detail in section 5.2.1.

Adjuvants, such as methylated seed oil (MSO), should be used with the herbicides, if not already added by the manufacturer. Adjuvants are important because they help the herbicide to stick to the plant surface and thus be absorbed more effectively into the plant. This greatly increases the effectiveness of herbicides. Be cautious with the use of adjuvants however, because they can have environmental toxicity issues greater than the herbicide itself. Be sure to follow the manufacturer's guidelines found on the label whenever using herbicide.

B. Prescribed Fire

The terrestrial ecosystems of east-central Texas are fire-controlled ecosystems, meaning they have been shaped by fire. As described previously, when fire is removed from these ecosystems, there is a greater likelihood that species not adapted to fire can increase to the detriment of the native species. Intensity of fire and seasonality of fire episodes are coming to be understood as important factors in the vegetative community's response to a fire. Fire events any time of year will reduce woody species, but the species by species effects of fire are quite variable. These vary based on how wet or dry of a year it has been, how hot the fire burned, and the season the fire occurred. While winter prescribed fires are more common in agricultural practice and often more acceptable to regulatory authorities, summer fires were probably a greater influence in the evolution of these vegetative communities and tend to be most effective for restoring diversity of native species as part of a long term management strategy.

In the process of preparing for prescribed burns it may require the accumulation of decadent vegetation in areas currently kept mowed at a low frequency. In the short term, this could pose a slightly greater threat to buildings on the site. To mitigate for this it will be important to maintain short turfgrass around the buildings. In times of drought it will be necessary to water these turfgrasses to keep them green and create a safety zone extending thirty feet from the building.

In woodland areas where there is a lot of litter (i.e. leaves, dead branches, mulch) already on the ground, it will be necessary to create fire lines. A fire line can be created by raking or using a gas powered leaf blower to make a border free of fuel at least five feet wide.

Burning brush piles is an alternative practice to deal with accumulation of woody material. This will be most relevant for the thinning of woodlands for either woodland enhancement or savanna restoration. While burning brush piles is not as complex as performing a prescribed burn it is important to give thought to brush pile burning. The leading cause of wildfires in Texas is from escaped brush pile burns. Burning in open areas where the burn pile is surrounded by grass is typically more dangerous than burning piles within a woodland. This is because grass is a receptive, fine fuel that can dry quickly and spread fire quickly, whereas the canopies of many woodland trees are not a receptive fuel under moist conditions. Burning brush piles should only be done under wet (recent rain event) conditions with high humidity (50% or higher). In a dense woodland a hot fire may burn branches above it and open a hole in the canopy, but under moist conditions it is quite unlikely it will cause a fire that can spread.

Always exercise caution when using fire as a management tool.

To get started with prescribed burning, it will be important to have the assistance of knowledgeable and experienced people. Two recommended resources for assistance with planning and implementing prescribed burns are: Texas Parks and Wildlife's Oak-Prairie Wildlife District's District Leader, David Forrester; and the Texas Nature Conservancy's State Fire Manager, Larry Belles. Mr. Forrester is located at 111 E. Travis, Suite 200; La Grange, TX 78945. He can be reached by telephone at (979) 968-3501. Larry Belles is located at 506 Hayter Street; Nacogdoches, TX 75965. He can be reached at his office telephone, which is (936) 462-1294, or also at his business mobile phone, which is (936) 615-0295.

C. Seeding

As a general rule, forbs should be sown in the fall/late summer, and grasses in the spring. However, if only one seeding time is available, all of the seed can be sown in the fall.

Processed seed, as is obtained from a commercial seed company, can be very effectively planted with either a no-till drill or a Brillion seeder. Alternatively, seed can be hand broadcast and raked in by hand or with a tractor-drawn harrow to achieve good soil-seed contact. Several distributors have developed versions of seeding machines adapted for native seed by incorporating three separate seed bins for the three main types of seed: light fluffy seed, small hard seed, and large hard seed. By using this type of range seeding equipment, all of the seed can be planted in one pass. Most seed companies will ship seed already mixed and bagged for a 3-bin seeder if requested.

It is recommended that seed be sown across two distinct events: one in the fall to synchronize with fall rains, the second to coincide with spring rainfall the following year. Many grasses will not germinate in the fall and may be lost to predation or rotting over the winter. A fall sowing of forbs and some rapidly establishing grasses will help to fill the ecological niche opened by fire and reduce the chance of invasion by undesirable grasses.

D. Seed Collecting

Oftentimes the dominant species of a plant community will be available commercially, while many of the less common species are not. Hand collected seeds can be used to add diversity to a seed mix for restoration of native plant communities. Furthermore, locally collected seeds ensure that the plants are adapted to that locale. Seeds grown in a different part of the state or country, even if they are the same species found locally, may not be ideally adapted to the new locale's climate, soil, et cetera. Beyond that, the genetics of the imported plant can cross pollinate with the local stock, changing the genetics of the local population.

When collecting seed, it is important to ensure that seeds are ripe before you collect them. Cues to determine if seeds are ripe enough to pick vary from species to species. Therefore, it is valuable to utilize the help of an expert seed collector if at all possible. Michael Eason of the Lady Bird Johnson Wildflower Center has offered to come out to Winedale and lead seed collecting demonstrations. Michael's e-mail address is michael.eason@wildflower.org.

A list of suggested desirable species to hand collect is attached in Restoration Appendix A.

E. Irrigation

Irrigation will increase initial seedling germination and survival significantly, and if used, will need to be continued until the new plantings are established—typically one year. The amount of irrigation required varies with species, amount of rainfall received, and water storage capacity in the soil. Water requirements will be highest immediately after plants are installed and will decrease as the plants' root systems develop. Grass seed will not germinate unless it receives at least 0.5 inches, preferably in more than one rain event over several days, to retain sufficient soil moisture. Following germination, survival is enhanced if the top 3 inches of soil are kept moist with a minimum application of 0.5 inch a week for the first month. Thereafter, during the first growing season these areas should receive a minimum of 2 inches a month.

Temporary aboveground PVC pipe irrigation systems can be installed in high visibility areas where rapid success is important. In areas where a slower establishment of prairie is acceptable, irrigation should not be necessary.

4.2 Savanna Restoration

Post Oak Savanna restoration is just like prairie restoration, aside from two major factors: trees and sandy soils. All of the methods above can be utilized, but with different target invasive species to control, different plant species to restore, and also brush and trees to thin.

Savanna restoration is dependent upon whether or not restoration is occurring near trees. Savanna by definition has trees, but they are scattered amongst a grass dominated landscape. The trees in a savanna plant community will typically be spread apart enough so that a canopy fire in one tree would not spread to the canopy of another tree. Surface fires maintain an open grassland system. Where trees are present, they may need to be thinned so the remaining trees are spaced apart enough that a canopy fire could not spread. It is important to realize that a few oak mottes are natural, but as a general rule the tree components of the plant community should be spaced adequately as described above.

Where there are widely-spaced trees it is possible to use the agricultural or interseeding approaches (Section 4.1.1). Disking and plowing however, should not be done near desired trees as these methods could damage tree roots. Interseeding will be most effective if done after chemically treating invasive plants or after a growing season prescribed fire.

Selectively using herbicide in areas where there are patches of perennial rye and/or johnsongrass, will be an important measure to reduce those invasive species (Section 5.1.1).

4.2.1 Methods

A. Mechanical Thinning

Mechanical thinning is the physical cutting and removal or break down of woody plant material. When thinning, there are two major factors: 1) how to thin; and 2) what to do with the thinned material. Below are some strategies to consider for mechanical thinning.

Hand crews with loppers and chainsaws can mechanically thin brush or small trees. A skid steer with a hydraulic shears attachment can quickly cut through small to mid-sized full grown trees. The woody material will oftentimes need to be extricated out of the canopy by hand crews. Then hand crews can either leave woody material in place or pile it up nearby. Slash piles can be burned (see Section 4.1.2 B) at a later date or left in piles (preferably away from public view). Slash piles in woodlands serve as good wildlife habitat. If left in place it should be in preparation for a prescribed burn.

If thinned wood is left on the ground, it could take a long time to decompose. A way to deal with that is to mulch the woody material. Mulching can be accomplished most easily with a Seppi attachment on a large skid steer. A Seppi can be driven over areas of dense brush and the material will be mulched in place. Light mulching is fine, as it will break down along with the leaf litter. However, when the mulch load becomes heavy it will not break down for a very long time and will provide additional challenges if prescribed fires are ever used.

Herbicide treatment (see Section 4.1.2 A.a) can be used along with mechanical thinning by painting the inner bark, or cambium, of the stump immediately after the individual is cut. This is important

for species which will resprout from cut stumps, such as yaupon holly, but not necessary for non-resprouting species such as eastern red cedar.

If manpower is limited, it may be desirable to have a timber harvester remove the trees you want and pay you for the lumber. A timber harvester will tend to select the largest trees for harvesting, which may be the most ecologically valuable. Though oftentimes, it will be necessary to cut many mature trees to thin to target objectives. It would be important to save some of the tallest and oldest, because they will tend to survive fire better, but also leave a few younger trees for age class diversity. Otherwise, when all the old trees die there will be no others to replace them.

Finally, it is important to consider that using mechanical thinning without also burning will create superficial versions of natural savanna or woodland ecosystems.

4.3 Woodland Enhancement

Woodland is 80% or less canopy cover as opposed to forest which is 80-100%. Woodland enhancement requires a combination of mechanical thinning of trees and understory brush, herbicide use, and possibly prescribed fire. These methods can be used in an intensive fashion to transform the woodland into a savanna or less intensively to maintain canopy cover while opening up the understory.

4.4 Mowed Areas/Wildflower Meadows Management Plan

Because most of the restoration efforts encourage the growth and establishment of “tall” native grasses, it might be necessary and beneficial to speak with visitors and the community about these new maintenance practices. Due to historical land management practices as discussed in the beginning of this chapter, general perception of restoration processes and established prairie is that the land may appear to some as neglected and unkempt. It is anticipated that there will be a need to have an open dialogue with the community and visitors regarding these perceptions, providing an educational opportunity to discuss the material culture of the landscape. To assist in restoration communication, physical indicators can be implemented to illustrate care. One way to do this would

be to mow a 5' buffer, or the width of a mower, around tall grass/restoration areas. Creating needed mowed routes through the grass communicates the management is intentional and maintained while also communicating where to walk and where not to walk. However, it is not necessary to mow borders between contiguous management areas, or between a management area and an adjacent wooded area. The perception that restoration areas look 'messy' has been widely discussed in both academic and applied fields pertaining to landscape ecology. Communicating Winedale's restoration goals and processes to the public, through signage, mowing, educational tours, or conversation, can help change this perception from 'messy' to managed. (Appendix H contains an article by Joan Nassauer on this topic.)

There are three proposed mow intensities as illustrated in Figure 7: high, medium and low. High frequency is at a rate deemed necessary by staff to maintain a formal aesthetic, concurrent with present maintenance practices. Medium (Mid) frequency is defined as regular mowing *except* from February to late July, during which time the majority of spring wildflowers grow and set seed. Low frequency mows will be once or twice a year in the winter (December through February) and/or in late summer (July through August). The low frequency mowing is meant to encourage late summer and fall wildflowers such as gayfeather (*Liatris* sp.) and goldenrod (*Solidago* sp.) as well as tallgrass species by not mowing them before their seeds have set and ripened. The low frequency mowing also greatly reduces total labor costs associated with mowing. The objectives of the mowing regimens will also be enhanced through use of fluazifop, a grass-specific herbicide, in accordance to manufacturer's label on non-native grass patches. Prescribed fire during the growing season should also help encourage wildflower displays for the following year. Section 4.4.1 below describes the mowing plan in more detail, including preferred mowing schedules by location.

If areas are to be mowed, equipment will need to be cleaned (typically by blowing all mud, debris or cut material off all portions of the tractor and mowing rig with an air compressor) after mowing areas dominated by non-native species (the high mow areas) before the equipment is used on the restoration areas. Failure to clean this equipment will result in further invasive species problems.

Figure 7: Mowing Frequency and Locations



4.4.1 Mowing Plan

Definition of Terms:

Low Frequency Mow: Mowing once or twice a year in winter (December through February) and/or summer (July through August).

Mid Frequency Mow: Periodic mowing all year as needed to achieve aesthetic goals **except** between February and July.

High Frequency Mow: Mowing as much as desired to achieve aesthetic goals.

Prairie

A low frequency mow regime should be implemented pre-restoration for the prairie areas. During the restoration process, burning or mowing treatments should be delayed until newly established vegetation is well established. After restoration, the mowing regime is dependent on the implemented restoration technique. If the prairie area is to be managed by mowing, a low-frequency mowing regime should be used, with mowing occurring in winter, after warm season grasses have gone dormant. It is not necessary to mow every year, but occasional mowing or burning is necessary to maintain this system. If area is to be managed by prescribed burning, the mowing schedule should be suspended to allow herbaceous growth to accumulate for at least one growing season until sufficient fine fuel has accumulated to support the desired fire. Mowing is not recommended if it is to be managed by fire. There should be an interval of several years between burns.

Savanna

For pre-restoration, a low-frequency mowing regime is recommended with limited mowing along the area's edges to make the area look intentional and inviting. If more extensive mowing is necessary, it should be done only in February or late July to encourage late spring or fall wildflower displays. As with the prairie areas, the mowing regime during restoration depends on the restoration technique. If the area is being converted from a wooded area, the clearing, mowing/burning regime should begin immediately. If the area is being created from grassland, young trees should be protected from mowing or burning (before burning, surrounding herbaceous vegetation should be cut and raked away from young trees to be protected). Burning or mowing treatments should be delayed until newly established vegetation is well established. After restoration, if the area is to be managed by mowing, a low-frequency mowing regime should be used. If the area is to be managed by prescribed burning, it should not be mowed. Herbaceous growth should be allowed to accumulate for at least one growing season until sufficient fine fuel has accumulated to support the desired burn.

Shoreline Area

To maintain taller grasses along the shoreline, which is preferred for waterfowl, mowing may be completely eliminated. The periodic mowing regime (mentioned in 5.5) is recommended only to control woody invasives if necessary.

Visitor Grounds

These areas can implement a high frequency mowing regime in order to maintain Winedale's current formal aesthetic around the historical structures, and on the north side of the property.

Wildflower Areas

Pre-restoration, a low-frequency mowing plan can be implemented. If a mowing regime is implemented, it is recommended that section A2 of Figure 10 not to be mowed as this area is best treated with prescribed fire given the dominance of King Ranch bluestem. During restoration, low-intensity mowing coupled with burns and herbicide are recommended. After restoration, the area can begin a low intensity regime of mowing for 1-2 times a year between December and February and July and August if desired. If the area is to be managed by prescribed burning, it should not be mowed. Herbaceous growth should be allowed to accumulate for at least one growing season until sufficient fine fuel has accumulated to support the desired burn.

Roadside Ditches

The roadside ditch areas are mowed by TxDOT in July and September. Additional mowing as necessary before public events in the summer and the fall is not detrimental to the overall land management plan. However, if wildflower establishment is desired in this area, it is recommended that mowing be limited to TxDOT's mowing regime.

Grassland Enhancement

The grassland areas are those locations adjacent to restoration areas yet not part of the high-mow visitor grounds area. These grassland areas should maintain a low to mid frequency mowing regime.

5. Restoration and Management Recommendations and Guidelines

Ecological restoration is oftentimes quite complex; subtleties can ultimately determine the success or failure of a project. Therefore, it is important to recognize that ecological restoration is a fluid, adaptable process that evolves as observations are made over time.

The most efficient way to begin a large restoration project is by first focusing on the highest priority areas. The lessons learned and skills obtained from the first projects will inform second phase projects and so forth. As the need for the labor and resources utilized on the first projects undertaken begins to wane, they can be reallocated to the next projects. It is critical to account for continuing maintenance and invasive species control of already restored or enhanced projects when reallocating those resources.

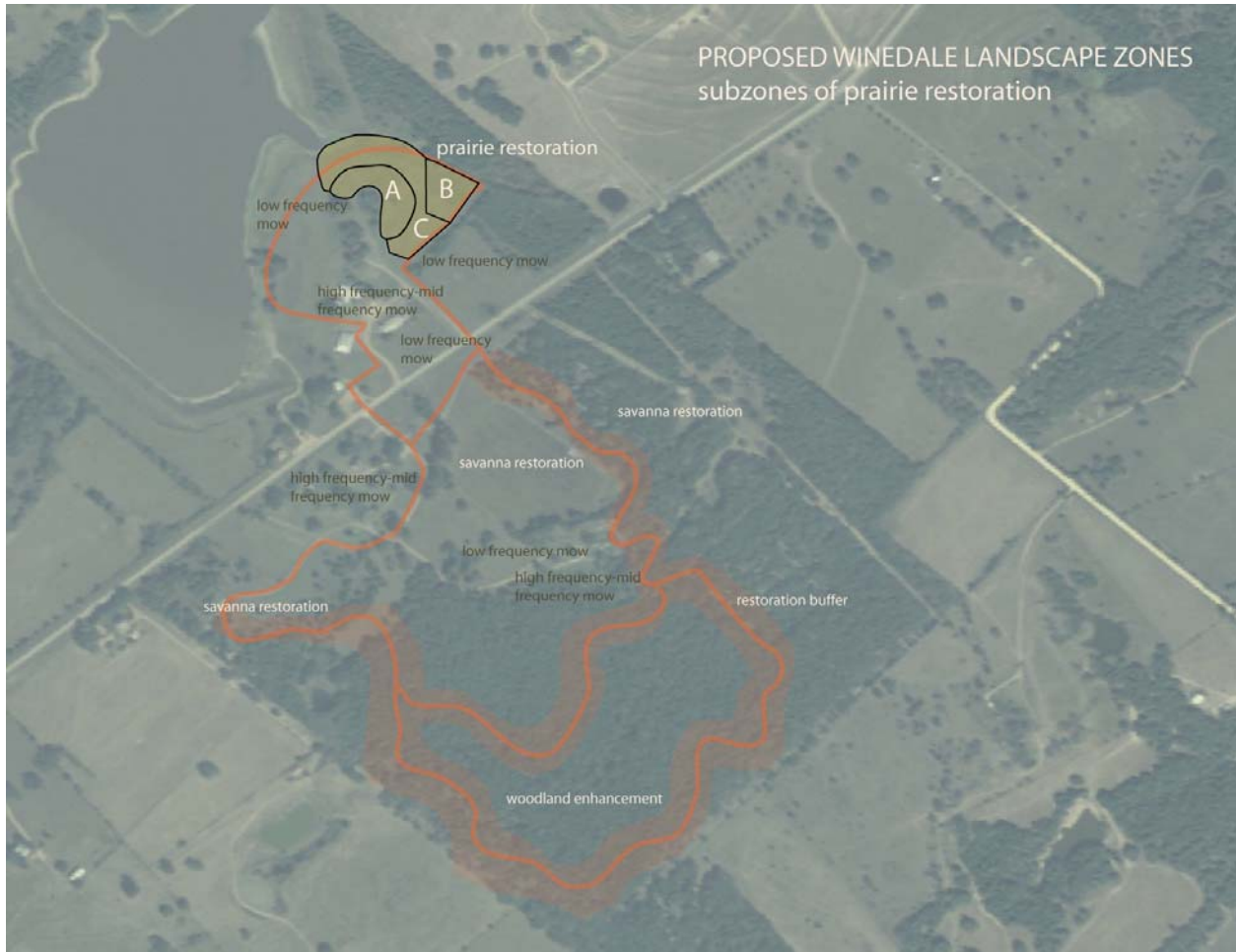
This section is intended to give recommendations and guidelines for implementation of restoration tasks. Each ecosystem type is divided into subzones that are prioritized by alphabetical order. For instance subzone 'A' is higher priority than subzone 'B' and so on. Attention could be paid to only one ecosystem type at a time, or attention can be given to only 'A' priority subzones in each ecosystem type. Most likely however, the most effective way to begin will be to select a combination of those two approaches.

Target invasive species are included within the first ecosystem type they apply to, but it is very important to treat them wherever they are found on site where they directly conflict with management goals. For example, johnsongrass is listed as a Blackland Prairie target species, but also exists elsewhere on the site.

5.1 Prairie Restoration

Prairie ecosystem restoration will consist of three subzones.

Figure 8: Prairie Restoration Areas



- A.** Subzone A is to be restored prairie using the agricultural approach to restoration. It is predominantly covered with two non-native invasive species: perennial rye (*Lolium perenne*) and bur-clover (*Medicago* spp.) (More detail in Section 5.1.1). Implementation is described in detail as Example Project #1 (Section 5.1.2).

Subzone A can also be restored using another less intensive method of removing the invasive species and clearing the seed bank. In the fall of the first year the area to be restored is mowed short. In February, when the vegetation is beginning to grow back, but has not yet begun to flower, will be the ideal time to broadcast spray glyphosate. Monitor the area that

has been sprayed to ensure the vegetation is dying. At the same time ensure that any nearby areas, especially uphill, where little bur-clover and perennial ryegrass (*Lolium perenne*) are growing are kept from flowering and producing seeds. This can easily be achieved by mowing. When new seeds begin to sprout in subzone A broadcast spray once again with glyphosate.

At this point, follow the directions from the Example Project #1, where it describes the seeding process (Section 5.1.2 paragraph 2).

- B.** Subzone B is a relatively intact block of remnant prairie consisting of a native vegetative community dominated by little bluestem grass. Management will focus on optimizing and enhancing the health of subzone B with the use of interseeding and prescribed fire. Implementation is described in detail as Example Project #2.
- C.** Subzone C will need to be managed to restrict the spread of invasive species into subzone A, and prepare the area for later restoration with either the agricultural or interseeding methods. Treat for target species and interseed with seed mix #2. Eventually this area will connect the restored prairie of subzone A with the remnant prairie of subzone B.

5.1.1 Blackland Prairie Target Invasive Species

- **Johnsongrass**

Johnsongrass (*Sorghum halepense*) reproduces easily from seed, or vegetatively from an aggressive rhizomatous root system. It was introduced from the Mediterranean region around 1800 as a potential forage crop and is now considered one of the ten worst invasive species of the world. The species thrives in heavily disturbed environments and often takes over patches of bare dirt exposed during construction. It is commonly spread between development sites by construction equipment and mowers. Once established, johnsongrass often grows tall and dense, inhibiting the growth of other grasses and many other herbaceous species.

Johnsongrass seed can remain dormant in the soil years before germination, enabling the plant to continue to be a problem several years after control methods have been implemented. Many factors such as available moisture, soil type, and management influence

the growth of rhizomes. Johnsongrass rhizomes typically grow to a depth of 10 to 20 inches (25 to 50 cm) if the soil is not compacted. However, if moisture and nutrients are not limiting factors, rhizomes can penetrate deeper reaching depths of 2 to 3 feet (60 cm to 100 cm). Rhizomes are produced most extensively after johnsongrass forms seedheads. To effectively control johnsongrass the plant should be managed from multiple angles: combating the seed, rootstock, and underground rhizomes. Johnsongrass can be successfully controlled with a program of mechanical removal and foliar herbicide application of glyphosate or fluazifop.

- **Bur-clover**

Little bur-clover (*Medicago* spp.) is an annual legume whose seeds are dispersed by attaching to the fur or clothing of a passerby. It is very widespread and should be spot treated in areas where it is dense, or is directly conflicting with a management goal. Bur-clover is a cool season non-native species that is best treated with glyphosate or disked early in the spring before its tiny yellow inflorescences emerge.

- **Perennial Rye**

Perennial rye (*Lolium perenne*) is often used for rapid revegetation of bare earth. It is effective at quickly holding soil and preventing erosion during the cool season, but during the warm season it leaves a biologically depauperate void. It tends to grow in patches almost in monocultures, where it excludes the native vegetation. Spot spraying with a grass specific herbicide, such as fluazifop, in these patches of perennial rye will allow forbs to establish. It is important to spray as early as possible, or disk into the soil, once a positive identification of the species is made. Late winter-early spring is the best time to spray. Fluazifop is slow acting, so it is important to spray before this species begins going to seed. Glyphosate can work more quickly than fluazifop, but should only be used when non-grass species are targeted for control as well.

5.1.2 Example Project #1: Agricultural Method: Subzone A

As already discussed, the agricultural method for prairie restoration requires significant site preparation before seed is introduced. It is important that invasive species control measures occur during winter and early spring when perennial rye and bur-clover are actively growing, but before

their seed crop can mature. It may be most effective if these control efforts were maintained for two successive years before restoration begins. In February of year 1, broadcast spray the area to be restored with glyphosate. One to two weeks after the initial herbicide application, use a tractor to create berms on the upslope and downslope borders of subzone A to minimize erosion from later tillage of the planting area, and to reduce weed seed from outside the plot from migrating into the area. After berms are in place, disk the entire area of Subzone A to remove all vegetation and disturb the seed bed. Weed seeds will begin to sprout in the turned soil after rainfall. Once this occurs, glyphosate should be used again to kill the germinating seeds, and the soil should also be disked again. This process of cleaning the seed bank in the soil can continue for quite some time, but is typically sufficient after spraying and disking two to three times between February and the end of May. A cover crop such as sorghum or alfalfa can be grown to hold the soil in place through the summer while the remaining weeds are selectively treated. The cover crop can either be harvested or disked back into the soil to stimulate the soil microbial community. If weed control is sufficient, seed can be installed in the fall of year 1. If significant pressure from undesired weeds continues to be evident during the summer, then repeat this process in year 2.

Once the seed bank is clear of weed seed, desired species can be added. Seeding can be done either once in the fall, or in both the fall and the spring as described previously. Table 3 provides the seed application rate for each recommended species. If irrigation is used follow irrigation guidelines (Section 4.1.2 E). Hand gathered seed can be added as it becomes available (Section 4.1.2 D and Restoration Appendix A). Adding these species immediately after they have been gathered will reduce complications that can arise when trying to store seed over a long period.

As the native vegetative community becomes established it will be important to vigilantly monitor for and control invasive species. This will typically require repeated spot applications of herbicide or mechanical removal (shovel/hoe) multiple times during the growing season over the first 3 to 5 years.

Subzone A should have enough fuel for a prescribed fire after the third growing season. Remove any above ground irrigation that may have been installed before instigating the prescribed fire. If the density of desired species was not optimal before the prescribed fire, consider overseeding with the seed mix in Table 4 or a reduced rate of the seed mix in Table 3 immediately following the fire and

before the first rain. Seed can be hand broadcast where needed directly into the ash, or drill seeded over the entire field. Invasive species should be controlled by ongoing spot spraying or hand pulling.

5.1.3 Example Project #2: Interseeding Method: Subzone B

The vegetative community in Subzone B is somewhat altered from historic species concentrations due to long-term mowing. However, the vast majority of the present species are native, so spot application of herbicide in the invasive species areas, while augmenting with missing species, should result in the most efficient establishment of a healthy native prairie on site.

Suggested treatment is to reduce patches of non-native plants, by targeted herbicide application. Grass specific herbicide, such as fluazifop, should be used during the winter on non-native cool season grasses while the majority of native grass species are dormant.

Interseeding method should be done with seed mixes and rates specified in Table 4, which are designed to enhance species diversity at the site. Mowing should precede seeding efforts. To replicate the historic fire frequency, prescribed fires should be installed every 4 to 7 years, primarily in the growing season (June to October), however it can be beneficial to initially burn more frequently (every 2 to 3 years) until all invasive species are under control and desired species are established.

5.2 Savanna Restoration

Savanna ecosystem restoration is proposed for five subzones—two of which are higher priority and identified as subzones A1 and A2.

Figure 9: Savanna Restoration Areas

- A. Subzones A1 and A2, located on the edge of woodlands and along the trail, are recommended to be thinned and restored to savanna. Subzone A1 can serve as a fire line, where initial thinning can occur as described in Example Project #3. More sunlight reaching the ground will encourage tallgrass species to establish more densely. These grasses can serve as a fuel to ignite a head fire when conducting a prescribed burn in subzone B. Gravel (crushed limestone, pea gravel, decomposed granite) is a much better option in areas to be burned. In subzone A2 trees need to be removed in order to open the canopy, however some tall trees with large canopies should be protected to create areas of shade along the trail. The trail surface should be treated the same as for A1. Wood that is thinned can be dragged into open areas to be consumed in a later prescribed burn. Avoid piling all woody debris in any one area.

- B.** Subzone B is perhaps the most ecologically significant location at Winedale and serves as an important reservoir for many remnant species that are rare or absent from other onsite areas. Restoration of Subzone B is described in Example Project #3.
- C.** Subzone C is mostly woodland that will need to be intensively thinned as described in Example Project #3. Wood currently being stacked near power lines should be relocated, if it is to be burned. When slash is piled for later burning or chipping, areas dominated by invasive species should be selected for placement of piles, to minimize impact on desirable species.
- D.** There are many options for the management of Subzone D. This area could be treated with the agricultural method or the interseeding method. Some attempts at restoration of this location, led by Bob Pickens and Texas A&M University in the late 1990s, have not evidenced much success in terms of change in species dominance at the site.

The agricultural method, similar to that described in Example Project #1, might have the highest probability of success, but should be seasonally altered so that efforts to control bahiagrass occur during warm seasons when it is actively growing. The seed mix given in Table 5 should be used for this approach. Control through soil disturbance is most effective during times of heat and drought, but chemical controls should occur when the bahiagrass is actively growing.

Areas not targeted for the agricultural method can be managed with less intensive methods. One possible low-input option would be to allow the grass to grow, without mowing, for a year. Cleared trees can be spread about with the grass growing up amongst it. A hot summer prescribed fire can be used to burn the downed wood and weaken the non-native grass. Then interseeding could happen using the seed mix in Table 5. Some of the native species in that mix may come in quickly and start to compete with the bahiagrass. If another summer burn is done as soon as fuel will allow (typically 15 to 24 months later), it would further suppress the bahiagrass and favor the native species. If these positive changes are happening and bahiagrass is becoming less and less abundant, then continued management using summer fire and additional overseeding with the seed mix in Table 6 will promote further tallgrass species development. If results with the interseeding method are unsatisfactory, it

may be necessary to aggressively attack the bahiagrass with the agricultural method, incrementally reclaiming portions of the field, as resources allow.

5.2.1 Post Oak Savanna Target Invasive Species

- **Bahiagrass**

Bahiagrass (*Paspalum notatum*) is often used as a pasture grass, where it tends to become a dominant species, as is the case in Subzone D (Section 5.2 D). There is some evidence that summer fire can reduce Bahiagrass. Resprouts can be sprayed and killed with glyphosate or fluazifop after a prescribed burn. After herbicide treatment begins to show its effects, disking can be used to break up the below ground rhizomes and root system.

- **Macartney's Rose**

Macartney's Rose (*Rosa bracteata*), has been found on the site and can be difficult to control. It currently occurs primarily in the southwest corner of the property. If this species spreads into any of the restoration areas, the most effective treatment is to spot apply Grazon P+D herbicide (a combination of picloram and 2,4 D). Fire should then be used a minimum of one year after spraying to clear dried Macartney's Rose plants. It is important to give grasses time to grow around and into the rose bush to help spread the fire and eliminate the rose plants. After it has been burned you can look for persisting resprouts to respray with the Grazon P+D if necessary (personal comm. Hanselka, 2009).

5.2.2 Example Project #3: Thinning the Canopy and Burning: Subzone B

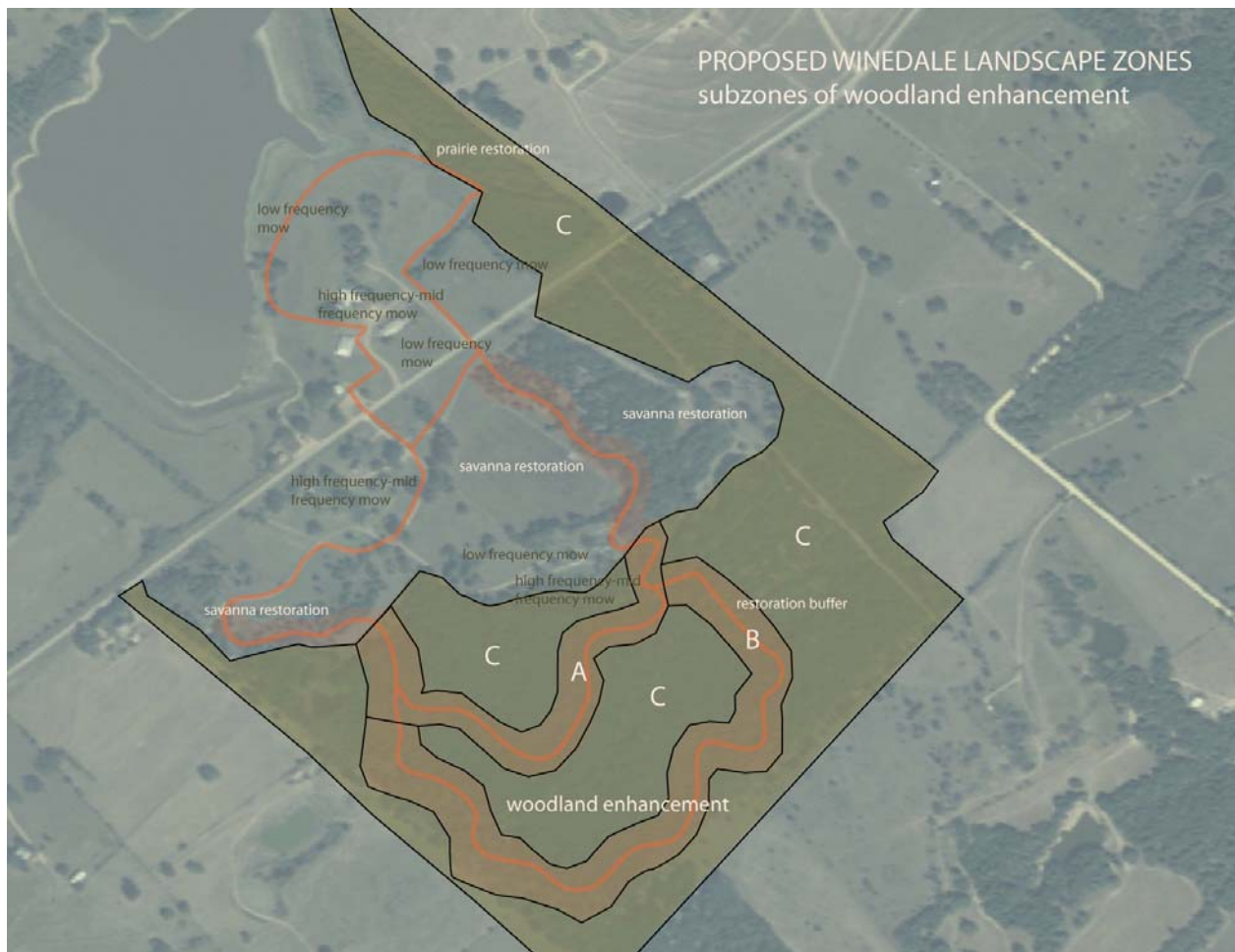
Subzone B can be restored by thinning the canopy, spot treating invasive species, and eventually installing prescribed fire. Macartney's rose is a major target species here that should be treated as described above (Section 5.2.1). Trees will need to be mechanically cut by a skid steer with hydraulic shears, a hydro axe or manually with chainsaws (see Section 4.2.1 A). Special effort should be made to establish workable firelines along or near the boundary fences. The wood should be piled into burn piles no higher than 6 feet near where they are cut. Trees within subzone B should be thinned to achieve approximately 15% canopy cover in the subzone. Mowing in the area should cease in

order to allow the growth of vegetation such that a prescribed fire can be conducted. Rather than interseeding with commercial seeds, it is recommended that local native genestocks be preserved and encouraged in this area through proper management. The area of highest value and concern is the western corner, bounded by the parking lawn and the road to the Biegel house.

5.3 Woodland Enhancement

The subzones for woodland enhancement are based on trail construction. Trail placement within the woodlands are important (refer to Section 3.6). Creating a thinned buffer along the trails can, in places, open the view for visitors. It will be important not to reduce the canopy around the trail, as daylighting the trail will reduce the amount of users during hot summer days. Trails can be mulched with woody material that is being cleared for trail construction.

Figure 10: Woodland Enhancement Areas



The implementation of enhancement strategies in the woodland area will be different from work in other areas. In woodland areas, it is acceptable to work in a patchy manner rather than a consistent and ubiquitous way.

Refer to Section 4.2.1 A for specific strategies to thin the woodland area.

5.3.1 Woodland Enhancement Target Species

- **Eastern Red Cedar**

Eastern red cedar (*Juniperus virginiana*) is a native species which quickly becomes dominant in a woodland system that lacks fire. It should not be eliminated, but reduced to open up the canopy and understory simultaneously. This tree can simply be cut down near the ground, and it will not resprout. Thus there is no need to use herbicides if mechanically thinning this species.

- **Yaupon Holly**

Yaupon holly (*Ilex vomitoria*) is a native species that tends to dominate the understory in woodland systems that lack fire. Mechanical thinning and use of glyphosate on the cambium of a freshly cut stump will ensure resprouting does not occur.

5.3.1 Example Project #4: Thinning the Understory and Burning: All Subzones

The method described here is appropriate for any of the subzones within the Woodland Enhancement area. Follow the steps outlined in the section on mechanical thinning (Section 4.2.1 A). Mulched trails are compatible with fire in this area because fire will spread through the understory more than on the ground. Mulch will need to be checked for smoldering after a prescribed fire, but it is not incompatible as it is in the savanna restoration.

Treat Macartney's rose (see Section 5.2.1) in addition to the yaupon holly and eastern red cedar, as it is also a key target invasive species in the woodland areas.

Seeding can be done by hand with desirable shade adapted species such as inland sea oats (*Chasmanthium latifolium*) and tropical red sage (*Salvia coccinea*).

5.4 Wildflower Meadow / Mowed Area Enhancements

There are several techniques recommended for enhancing wildflower displays in the current mowed areas. There are four different subzones—two of which are subzone A. High intensity mowing areas are not included in this section because they are not intended to have wildflower displays. These subzones are focused on low intensity mowing areas or an equivalent treatment with prescribed fire.

Figure 11: Wildflower Enhancement Areas



- A.** Subzones A1 and A2 can serve as interesting demonstrations. The goal is to increase wildflower displays in both of them, but with different methods. A1 will follow the low intensity mowing prescriptions and also treat for invasive non-native species using herbicide as described above. The grass specific herbicide fluazifop, properly timed with growing

seasons, can be used to knock back non-native grasses. Cool season grass perennial rye is of particular concern (see Section 5.1.1). This treatment will reduce competition between grasses and wildflowers.

We recommend that A2 not be mowed, however herbicide may be used, but as the primary invasive species is King Ranch bluestem, and this species has been shown to be adversely affected by growing season fire, we recommend using this treatment to control King Ranch Bluestem and promote wildflower dominance.

- B.** Subzone B can be enhanced with seed mix in Table 8 and managed using a low intensity mowing regime.
- C.** Subzone C is heavily infested with target invasive species, particularly bur-clover (see Section 5.1.1). The agricultural method is suggested as described in Project Example #1. After clearing seed bank, use the seed mix in Table 3.

5.4.1 Mowed Areas/Wildflower Meadows Target Invasive Species

- **Bermudagrass**

Native to Africa, bermudagrass (*Cynodon dactylon*) is a common turfgrass widely used across Texas. It is a relatively short (4 to 18 inches; 10 to 50 cm), sod-forming grass, adaptable to a broad range of conditions, and is difficult to eliminate once established. Bermudagrass reproduces easily both vegetatively and from seed, with the seed being highly transferable. Even if the living plant material and the seed bank can be eliminated from a given area, bermudagrass will swiftly recolonize from any surrounding stock. This may be a significant problem for high public-accessibility areas where the reintroduction of bermudagrass would be accelerated by high foot and vehicular traffic in addition to maintenance equipment. Bermudagrass often overtakes native shortgrasses, particularly in deeper, mesic soils. However, native grass communities can compete more effectively with bermudagrass in areas with low nutrient inputs subject to frequently arid conditions. Native tallgrasses are typically very competitive with bermudagrass because they are better able to compete for light resources. Unlike johnsongrass, project goals would not be compromised if bermudagrass were not completely eliminated. Bermudagrass does typically allow desired native species, particularly spring wildflowers and taller grasses, to grow through it. This

species can tolerate both grazing and fire; therefore, recommended treatment is repeated foliar application of glyphosate or grass-specific herbicide such as fluazifop.

- **King Ranch Bluestem**

King Ranch bluestem (*Bothriochloa ischaemum*) is an Asian midgrass species widely used across Texas as a pasture grass and for general revegetation. King Ranch bluestem's typical growth form is a bunchgrass, but will form a dense sod under mowing or intense grazing. In its sod form, King Ranch bluestem tends to form a monoculture, out-competing most other herbaceous species.

Significant earthwork or soil disturbance tends to kill living plants but causes germination of the seed bank. Because this species forms dense, monoculture stands, it can be effectively controlled using targeted spray applications of a non-specific herbicide, such as glyphosate or glufosinate-ammonium on the affected area. Repeated applications are often necessary. In areas where large patches of bare earth will remain after the invasive bluestem is removed, reseeding the area with appropriate native grasses and forbs is recommended. Due to the King Ranch bluestem's documented sensitivity to growing-season fire, an initial prescribed fire, and subsequent spot foliar herbicide application of herbicide, will greatly reduce this species' population. However, periodic spot treatment and/or episodic growing season prescribed fire will likely be necessary.

5.5 Shoreline Enhancement

For the shoreline area, a 'no' to 'low' mowing regime is recommended. If a taller vegetative screen is desired, then the area can thrive with no mowing at all. However, in areas where no woody establishment is desired, it is possible to mow once every few years to reduce the proliferation of these species. The timing of these infrequent mows can be dictated by the management plan of adjacent lands, and coupled with an understanding of the desired shoreline habitat establishment (for nesting and/or visiting species). Herbicide treatment (see Section 4.1.2 A.a) can be used for invasive woody species at the water's edge by painting the inner bark, or cambium, of the stump immediately after the individual is cut. This is important for species which will resprout from cut stumps, but not necessary for non-resprouting species.

For herbaceous invasive species, an initial treatment of invasive species is required depending upon the degree of dominance and the determined establishment method. If the native species are established by seed, a more aggressive initial invasive treatment is required. However, if the native species are established from container stock, less aggressive treatment will be necessary. The larger native grasses such as switchgrass and bushy bluestem are large in size and will typically shade out invasive species with shorter stature. The types of plants that perform best in these dynamic situations are opportunistic disturbance species which can respond quickly to changing conditions. For establishing the area from seed, it is suggested that the area be planted with a wetland fringe mix of wildflowers and switchgrass. Bushy bluestem is another ideal grass species. Though available commercially, bushy bluestem is expensive, and available amounts are sometimes limited. If establishing by seed, it is recommended that this species be collected in the field during the fall from surrounding low lying areas and then incorporated into the seed mix (Please see Table 9). A higher establishment rate, and potentially higher survival rate, may be achieved if planting is augmented with container stock in addition to some seed. However, this method is significantly more expensive and more labor intensive.

5.5.1 Shoreline Areas Target Invasive Species

- **Bermudagrass**

See Section 5.4.1

- **Cattails**

An aquatic perennial herb, the common cattail is predominantly found in freshwater aquatic zones, though can often also be found in marsh areas with slight salinity. Depending on the variety, cattails can grow between 5 to 10 feet tall, and have large creeping rhizomes. Cattails grow well in mineral and organic soils, and can grow in either permanently wet or periodically dry zones. Cattails are considered a pest species because they form large, dense colonies which exclude other desirable plants. They can withstand drying, burning and long-term flooding up to 4 feet in depth, thus, controlling cattails can be done through mowing where possible or through the application of herbicides.

Figure 12: Shoreline Enhancement Areas



While the enhancement of Lake Winedale’s shoreline is primarily focused on the terrestrial establishment, aquatic restoration is also recommended. Though beneficial to enhance the ecological function, habitat, and visual aesthetic of the lake, aquatic restoration is a more involved and costly restoration process.

A typical pond’s profile has differing plant types in relation to both the height of the water level and the ponds topography resulting in three different planting zones: deep water zone, marsh zone plants, and pond edge plants. The deep water zone has submerged, oxygenators, and floating plants from 12” to 36” below the permanent pool level. The marsh zone plants are located from 12” to 3” below the permanent pool level and the pond edge plants are located 3” below and 6” above the pool level. Table 10 provides a comprehensive list of potential aquatic plants that are recommended for the varying water zones. However, we do not recommend using all of these plants for

restoration efforts. Modifications and further planning will be necessary before any aquatic planting begins. To further develop, maintain and protect the Winedale Lake Shoreline, further planning and research is needed. This would be an ideal course for students with the support and resources of the local Master Naturalist whom have expressed interest in the water's ecological habitat.

6. Seed & Plant Mixes, Restoration Timelines & Restoration Comparisons

Table 3: Winedale -Blackland Prairie Tallgrass Seed Mix - Agricultural Method

| Winedale -Blackland Prairie Tallgrass Mix - Agricultural | | | | | | | | |
|--|-----------------------|-----------------|------------------|-------------|------------|--------------------|----------|---------|
| Acres seeded: | | 1 | | | | | | |
| Flowers | | | | | | | | |
| Species | Common name | Planting Season | Ideal lbs needed | Cost/lb NAS | Cost/lb WS | Preferred Provider | NAS Code | WS Code |
| <i>Gaillardia pulchella</i> | Indian blanket | F | 2.00 | \$20.00 | \$20.00 | WS | 1005 | 3220 |
| <i>Monarda citriodora</i> | Horsemint | F | 0.50 | \$20.00 | \$20.00 | WS | 1006 | 3314 |
| <i>Coreopsis tinctoria</i> | Plains coreopsis | F | 0.25 | \$19.00 | \$20.00 | WS | 1003 | 3212 |
| <i>Rudbeckia hirta</i> | Black-eyed Susan | F | 0.25 | \$24.00 | \$25.00 | WS | 1007 | 3239 |
| <i>Engelmannia pinnatifida</i> | Engelmann daisy | F or Spr | 2.00 | \$34.00 | x | NA | 1014 | |
| <i>Lupinus texensis</i> | Bluebonnet | F | 2.00 | \$29.85 | ? | WS | 1002 | 3228 |
| <i>Centaurea americana</i> | American basketflower | F | 1.00 | \$39.00 | x | NA | 1010 | |
| <i>Rudbeckia (Dracopis) amplexicaulis</i> | Clasping coneflower | F | 0.25 | \$19.00 | \$20.00 | WS | 1013 | 3238 |
| <i>Desmanthus illinoensis</i> | Illinois bundleflower | F | 1.00 | \$24.00 | x | NA | 3075 | |
| <i>Helianthus maximiliani</i> | Maximilian sunflower | F | 0.25 | \$49.00 | \$30.00 | WS | 1018 | 3329 |
| <i>Chamaecrista fasciculata var. fasciculata</i> | Partridge pea | F | 1.00 | \$24.00 | \$24.00 | NA | 1016 | 3202 |
| <i>Ipomopsis rubra</i> | Standing cypress | F or Spr | 0.25 | \$59.00 | \$59.00 | WS | 3082 | 3223 |
| Grasses | | | | | | | | |
| Species | Common name | Planting Season | Ideal lbs needed | Cost/lb NAS | Cost/lb WS | Preferred Provider | NAS Code | WS Code |
| <i>Leptochloa dubia</i> | Green sprangletop | F or Spr | 1.00 | \$13.25 | x | NAS | 2010 | |
| <i>Andropogon gerardii</i> | Big bluestem | F or Spr | 2.00 | \$12.85 | x | NAS | 2002 | |
| <i>Panicum virgatum (Upland)</i> | Upland switchgrass | F or Spr | 1.00 | \$17.32 | x | NAS | 2034 | |
| <i>Schizachyrium scoparium</i> | Little bluestem | F or Spr | 2.00 | \$59.00 | x | NAS | 2003 | |
| <i>Sorghastrum nutans</i> | Yellow Indian Grass | F or Spr | 1.00 | \$15.58 | x | NAS | 2006 | |
| <i>Bouteloua curtipendula</i> | Sideoats grama | F or Spr | 1.00 | \$9.95 | x | NAS | 2004 | |
| Blackland Prairie Mix | Grasses and forbs | F | 1.00 | \$11.00 | x | NAS | 2800 | |
| <i>Elymus virginicus</i> | Virginia wildrye | F | 1.00 | \$21.00 | x | NAS | 2035 | |
| <i>Tripsacum dactyloides</i> | Eastern gamagrass | F | 1.00 | \$19.13 | x | NAS | 2011 | |
| <i>Buchloe dactyloides</i> | Buffalograss | F or Spr | 2.00 | \$13.72 | x | NAS | 2001 | |

Table 4: Winedale -Blackland Prairie Tallgrass Seed Mix – Interseeding/Enhancement

| Winedale -Blackland Prairie Tallgrass Mix - interseeding/enhancement | | | | | | | | |
|---|-----------------------|------------------------|-------------------------|--------------------|-------------------|---------------------------|-----------------|----------------|
| Acres seeded: | | 1 | | | | | | |
| Flowers | | | | | | | | |
| <i>Species</i> | <i>Common name</i> | <i>Planting Season</i> | <i>Ideal lbs needed</i> | <i>Cost/lb NAS</i> | <i>Cost/lb WS</i> | <i>Preferred Provider</i> | <i>NAS Code</i> | <i>WS Code</i> |
| <i>Monarda citriodora</i> | Horsemint | F | 0.25 | \$20.00 | \$20.00 | WS | 1006 | 3314 |
| <i>Rudbeckia (Dracopis) amplexicaulis</i> | Clasping coneflower | F | 0.25 | \$19.00 | \$20.00 | WS | 1013 | 3238 |
| <i>Helianthus maximiliani</i> | Maximilian sunflower | F | 0.25 | \$49.00 | \$30.00 | WS | 1018 | 3329 |
| <i>Engelmannia pinnatifida</i> | Engelmann's daisy | F or Spr | 1.00 | \$34.00 | | NA | 1014 | |
| <i>Centaurea americana</i> | American basketflower | F | 0.50 | \$39.00 | | WS | 1010 | |
| <i>Ipomopsis rubra</i> | Standing cypress | F or Spr | 0.25 | \$59.00 | | ? WS | 3082 | 3223 |
| <i>Desmanthus illinoensis</i> | Illinois bundleflower | F | 0.25 | \$24.00 | | NA | 3075 | |
| <i>Chamaecrista fasciculata var. fasciculata</i> | Partridge pea | F | 0.25 | \$24.00 | \$24.00 | NA | 1016 | 3202 |
| Grasses | | | | | | | | |
| <i>Species</i> | <i>Common name</i> | <i>Planting Season</i> | <i>Ideal lbs needed</i> | <i>Cost/lb NAS</i> | <i>Cost/lb WS</i> | <i>Preferred Provider</i> | <i>NAS Code</i> | <i>WS Code</i> |
| <i>Sorghastrum nutans</i> | Yellow Indian Grass | F or Spr | 1.00 | \$15.58 | | NA | 2006 | |
| <i>Panicum virgatum (Upland)</i> | Upland switchgrass | F or Spr | 0.50 | \$17.32 | | NA | 2034 | |
| <i>Andropogon gerardii</i> | Big bluestem | F or Spr | 1.00 | \$12.85 | | NA | 2002 | |
| Blackland Prairie Mix | Grasses and forbs | F | 0.50 | \$11.00 | | NA | 2800 | |
| <i>Tripsacum dactyloides</i> | Eastern gamagrass | F | 0.50 | | | NA | 2011 | |
| <i>Bouteloua curtipendula</i> | Sideoats grama | F or Spr | 0.25 | \$9.95 | | NA | 2004 | |
| <i>Elymus virginicus</i> | Virginia wildrye | F | 0.25 | \$21.00 | | NA | 2035 | |

Table 5: Winedale -Post Oak Savannah Sandy Loam Tallgrass Seed Mix - Agricultural method

| Winedale -Post Oak Savannah Sandy Loam Tallgrass Mix - Agricultural method | | | | | | |
|---|-----------------------|------------------------|-------------------------|--------------------|-------------------|---------------------------|
| Acres seeded: | | 1 | | | | |
| Flowers | | | | | | |
| <i>Species</i> | <i>Common name</i> | <i>Planting Season</i> | <i>Ideal lbs needed</i> | <i>Cost/lb NAS</i> | <i>Cost/lb WS</i> | <i>Preferred Provider</i> |
| <i>Gaillardia pulchella</i> | Indian blanket | F | 2.00 | \$20.00 | \$20.00 | WS |
| <i>Monarda citriodora</i> | Horsemint | F | 0.50 | \$20.00 | \$195.00 | WS |
| <i>Coreopsis tinctoria</i> | Plains coreopsis | F | 0.25 | \$19.00 | \$20.00 | WS |
| <i>Rudbeckia hirta</i> | Black-eyed Susan | F | 0.25 | \$24.00 | \$25.00 | WS |
| <i>Chamaecrista fasciculata</i> var. <i>fasciculata</i> | Partridge pea | F | 2.00 | \$24.00 | \$24.00 | NA |
| <i>Lupinus texensis</i> | Bluebonnet | F | 2.00 | \$29.85 | x | WS |
| <i>Centaurea americana</i> | American basketflower | F | 1.00 | \$39.00 | | NA |
| <i>Rudbeckia (Dracopis) amplexicaulis</i> | Clasping coneflower | F | 0.25 | \$19.00 | \$20.00 | WS |
| <i>Desmanthus illinoensis</i> | Illinois bundleflower | F | 1.00 | \$24.00 | | NA |
| <i>Helianthus maximiliani</i> | Maximilian sunflower | F | 0.25 | \$49.00 | ? | WS |
| <i>Engelmannia pinnatifida</i> | Engelmann daisy | F or Spr | 1.00 | \$34.00 | | NA |
| <i>Ipomopsis rubra</i> | Standing cypress | F or Spr | 0.25 | \$59.00 | ? | WS |
| Grasses | | | | | | |
| <i>Species</i> | <i>Common name</i> | <i>Planting Season</i> | <i>Ideal lbs needed</i> | <i>Cost/lb NAS</i> | <i>Cost/lb WS</i> | <i>Preferred Provider</i> |
| <i>Sorghastrum nutans</i> | Yellow Indian grass | F or Spr | 2.00 | \$15.58 | | NA |
| <i>Panicum virgatum</i> (Upland) | Upland switchgrass | F or Spr | 1.00 | \$17.32 | | NA |
| <i>Andropogon gerardii</i> | Big bluestem | F or Spr | 2.00 | \$12.85 | | NA |
| Eastern Savannah Grass Mix | Grass mix | F or Spr | 1.00 | \$39.00 | | NA |
| <i>Bouteloua curtipendula</i> | Sideoats grama | F or Spr | 1.00 | \$9.95 | | NA |
| <i>Eragrostis trichodes</i> | Sand lovegrass | F or Spr | 0.25 | \$16.67 | | NA |
| <i>Schizachyrium scoparium</i> | Little bluestem | F or Spr | 1.00 | \$59.00 | | NA |
| <i>Leptochloa dubia</i> | Green sprangletop | F or Spr | 0.25 | \$13.25 | | NA |
| <i>Sporobolus cryptandrus</i> | Sand dropseed | F or Spr | 0.12 | \$14.95 | | NA |
| <i>Elymus canadensis</i> | Prairie wildrye | F | 1.00 | \$15.95 | | NA |
| <i>Tridens flavus</i> | Purpletop | F or Spr | 1.00 | \$43.00 | | NA |

Table 6: Winedale -Post Oak Savannah Sandy Loam Tallgrass Seed Mix - Interseeding/Enhancement

| Winedale -Post Oak Savannah Sandy Loam Tallgrass Mix - Interseeding/Enhancement | | | | | | | | |
|--|-----------------------|------------------------|-------------------------|--------------------|-------------------|---------------------------|-----------------|----------------|
| Acres seeded: | | 1 | | | | | | |
| Flowers | | | | | | | | |
| <i>Species</i> | <i>Common name</i> | <i>Planting Season</i> | <i>Ideal lbs needed</i> | <i>Cost/lb NAS</i> | <i>Cost/lb WS</i> | <i>Preferred Provider</i> | <i>NAS Code</i> | <i>WS Code</i> |
| <i>Monarda citriodora</i> | Horsemint | F | 0.25 | \$20.00 | \$195.00 | WS | 1006 | 3314 |
| <i>Desmanthus illinoensis</i> | Illinois bundleflower | F | 1.00 | \$24.00 | | NA | 3075 | |
| <i>Helianthus maximiliani</i> | Maximilian sunflower | F | 0.25 | \$49.00 | ? | WS | 1018 | 3329 |
| <i>Engelmannia pinnatifida</i> | Englemann daisy | F or Spr | 1.00 | \$34.00 | | NA | 1014 | |
| <i>Centaurea americana</i> | American basketflower | F | 0.50 | \$39.00 | | NA | 1010 | |
| <i>Chamaecrista fasciculata</i> var. <i>fasciculata</i> | Partridge pea | F | 1.00 | \$24.00 | \$24.00 | NA | 1016 | 3202 |
| <i>Ipomopsis rubra</i> | Standing cypress | F or Spr | 0.25 | \$59.00 | ? | WS | 3082 | 3223 |
| Grasses | | | | | | | | |
| <i>Species</i> | <i>Common name</i> | <i>Planting Season</i> | <i>Ideal lbs needed</i> | <i>Cost/lb NAS</i> | <i>Cost/lb WS</i> | <i>Preferred Provider</i> | <i>NAS Code</i> | <i>WS Code</i> |
| <i>Eragrostis trichodes</i> | Sand lovegrass | F or Spr | 0.25 | \$16.67 | | NA | 2009 | |
| <i>Sorghastrum nutans</i> | Yellow Indian grass | F or Spr | 0.50 | \$15.58 | | NA | 2006 | |
| Eastern Savannah Grass Mix | Grass mix | F or Spr | 0.50 | \$39.00 | | NA | 2805 | |
| <i>Bouteloua curtipendula</i> | Sideoats grama | F or Spr | 0.50 | \$9.95 | | NA | 2004 | |
| <i>Panicum virgatum</i> (Upland) | Upland switchgrass | F or Spr | 0.25 | \$17.32 | | NA | 2034 | |
| <i>Andropogon gerardii</i> | Big bluestem | F or Spr | 0.50 | \$12.85 | | NA | 2002 | |
| <i>Elymus canadensis</i> | Prairie wildrye | F | 0.50 | \$15.95 | | NA | 2014 | |
| <i>Tridens flavus</i> | Purpletop | F or Spr | 0.50 | \$43.00 | | NA | 2048 | |

Table 7: Shortgrass/Wildflower Seed Mix- Agricultural method

| Winedale-Shortgrass/Wildflower - Agricultural | | | | | | | | |
|--|--------------------|------------------------|-------------------------|--------------------|-------------------|---------------------------|-----------------|----------------|
| Acres seeded: | | 1 | | | | | | |
| Flowers | | | | | | | | |
| <i>Species</i> | <i>Common name</i> | <i>Planting Season</i> | <i>Ideal lbs needed</i> | <i>Cost/lb NAS</i> | <i>Cost/lb WS</i> | <i>Preferred Provider</i> | <i>NAS Code</i> | <i>WS Code</i> |
| <i>Gaillardia pulchella</i> | Indian blanket | F | 4.00 | \$20.00 | \$20.00 | WS | 1005 | 3220 |
| <i>Monarda citriodora</i> | Horsemint | F | 1.00 | \$20.00 | \$195.00 | WS | 1006 | 3314 |
| <i>Castilleja indivisa</i> | Indian paintbrush | F | 0.07 | x | x | WS | 1011 | 3202 |
| <i>Rudbeckia hirta</i> | Black-eyed Susan | F | 0.50 | \$24.00 | \$25.00 | WS | 1007 | 3239 |
| <i>Lupinus texensis</i> | Bluebonnet | F | 4.00 | \$29.85 | x | WS | 1002 | 3228 |
| <i>Phlox drummondii</i> | Drummond phlox | F | 2.00 | \$39.00 | \$39.00 | WS | 3059 | 3236 |
| <i>Engelmannia pinnatifida</i> | Engelmann daisy | F or Spr | 2.00 | \$34.00 | x | NA | 1014 | x |
| <i>Coreopsis tinctoria</i> | Plains Coreopsis | F | 0.25 | \$19.00 | \$20.00 | WS | 1003 | 3212 |
| <i>Ipomopsis rubra</i> | Standing Cypress | F or Spr | 0.50 | \$59.00 | ? | WS | 3082 | 3223 |
| <i>Salvia farinacea</i> | Mealy blue sage | F or Spr | 0.25 | \$120.00 | \$92.00 | WS | 1027 | 3302 |
| Grasses | | | | | | | | |
| <i>Species</i> | <i>Common name</i> | <i>Planting Season</i> | <i>Ideal lbs needed</i> | <i>Cost/lb NAS</i> | <i>Cost/lb WS</i> | <i>Preferred Provider</i> | <i>NAS Code</i> | <i>WS Code</i> |
| <i>Bouteloua curtipendula</i> | Sideoats grama | F or Spr | 4.00 | \$9.95 | | NA | 2004 | |
| <i>Buchloe dactyloides</i> | Buffalograss | F or Spr | 10.00 | \$13.72 | | NA | 2001 | |
| <i>Bouteloua gracilis</i> | Blue grama | F or Spr | 2.00 | \$13.00 | | NA | 2008 | |

Table 8: Shortgrass/Wildflower Seed Mix- Interseeding / Enhancement

| Winedale - Shortgrass/Wildflower - Enhancement/Interseeding | | | | | | | | |
|--|--------------------|------------------------|-------------------------|--------------------|-------------------|---------------------------|-----------------|----------------|
| Acres seeded: | | 1 | | | | | | |
| Flowers | | | | | | | | |
| <i>Species</i> | <i>Common name</i> | <i>Planting Season</i> | <i>Ideal lbs needed</i> | <i>Cost/lb NAS</i> | <i>Cost/lb WS</i> | <i>Preferred Provider</i> | <i>NAS Code</i> | <i>WS Code</i> |
| <i>Gaillardia pulchella</i> | Indian blanket | F | 2.00 | \$20.00 | \$20.00 | WS | 1005 | 3220 |
| <i>Rudbeckia hirta</i> | Black-eyed Susan | F | 0.25 | \$24.00 | \$25.00 | WS | 1007 | 3239 |
| <i>Monarda citriodora</i> | Horsemint | F | 0.25 | \$20.00 | \$195.00 | WS | 1006 | 3314 |
| <i>Phlox drummondii</i> | Drummond phlox | F | 0.50 | \$39.00 | \$39.00 | WS | 3059 | 3236 |
| <i>Ipomopsis rubra</i> | Standing Cypress | F or Spr | 0.25 | \$59.00 | ? | WS | 3082 | 3223 |
| <i>Salvia farinacea</i> | Mealy blue sage | F or Spr | 0.25 | \$120.00 | \$92.00 | WS | 1027 | 3302 |
| <i>Coreopsis tinctoria</i> | Plains Coreopsis | F | 0.07 | \$19.00 | \$20.00 | WS | 1003 | 3212 |
| <i>Engelmannia pinnatifida</i> | Engelmann daisy | F or Spr | 0.50 | \$34.00 | | NA | 1014 | |
| Grasses | | | | | | | | |
| <i>Species</i> | <i>Common name</i> | <i>Planting Season</i> | <i>Ideal lbs needed</i> | <i>Cost/lb NAS</i> | <i>Cost/lb WS</i> | <i>Preferred Provider</i> | <i>NAS Code</i> | <i>WS Code</i> |
| <i>Buchloe dactyloides</i> | Buffalograss | F or Spr | 4.00 | \$13.72 | | NA | 2001 | |
| <i>Bouteloua curtipendula</i> | Sideoats grama | F or Spr | 1.00 | \$9.95 | | NA | 2004 | |
| <i>Bouteloua gracilis</i> | Blue grama | F or Spr | 1.00 | \$13.00 | | NA | 2008 | |

Table 9: Shoreline Enhancement Seed Mix

| Winedale-Lake Shoreline Terrestrial | | | | | | |
|---|--------------------|------------------------|-------------------------|--------------------|-----------------|--|
| Acres seeded: 1 | | | | | | |
| Species | Common name | Planting Season | Ideal lbs needed | Cost/lb NAS | NAS Code | Estimated Seed Cost |
| Wetland Fringe Mix | Wetland Fringe Mix | F | 4.00 | \$44.00 | 1807 | \$176.00 |
| <i>Panicum virgatum</i> | Switchgrass | F/S | 2.00 | \$14.32 | 2005 | \$28.64 |
| total | | | | | | \$204.64 |
| Winedale-Lake Shoreline Aquatic Pricing | | | | | | |
| Acres planted: 1 | | | | | | |
| Estimated amount of container plants at 3% multiplier | | | | | | |
| 1,350 plants | | | | | | Estimated cost + installation \$9,500 |
| Total Estimated Cost | | | | | | \$9,704.64 |

Table 10: Shoreline Enhancement Area Desired Plant Species

Pond Edge Zone Plants

| Common Name | Latin Name | Desired Abundance | Growth Form | COE Zone | Ht. | Additional comments | Comments and Planting Information |
|-------------------|--|-------------------|------------------------------------|------------------|-------|--|---|
| Bushy bluestem | <i>Andropogon glomeratus</i> | 2 | | | 3' | Low wildlife values. | 0" to + 3", clump grass |
| Waterhyssop | <i>Bacopa monnieri</i> | 2 | Emergent | 1 | 10" | Important wildlife food--can dominate and exclude other plants. | (-3"to 6") emergent |
| Emory sedge | <i>Carex emoryii</i> | 2 | | | 2' | Most <i>Carex</i> have good wildlife value. | 0" to +6", grass-like foliage |
| Caric-sedge | <i>Carex tetrastachya</i> (<i>C. brittoniana</i>) | 1 | | | 2' | Most sedges have good wildlife values, weeds eaten by waterfowl birds, rodents. | -2"-0" |
| Buttonbush | <i>Cephalanthus occidentalis</i> | 3 | | | 6-12' | Might form dense woody thickets. Often looks scraggly due to dead stems. Used as roost site for rookeries. Seeds occasionally eaten. | (-3"-6") showy blooms attracts wildlife |
| Inland sea oats | <i>Chasmanthium latifolium</i> | 2 | | | 2' | | 0" to +3", grass, takes shade |
| Sawgrass | <i>Cladium mariscus</i> <i>ssp. jamaicense</i> | 3 | | | | Saw-toothed cutting edges on leaf blades. Small, hard seeds eaten by ducks. | |
| Flatsedge | <i>Cyperus odoratus</i> | 1 | | | 2' | Frequent, unshaded margins of impoundments . | -3" to +3" planting depth |
| Flatsedge | <i>Cyperus ochraceus</i> | | | | 2' | Frequent, unshaded margins of impoundments. | -3" to +3" planting depth |
| Tall burhead | <i>Echinodorus berteroi</i> | 3 | Emergent/floating-leaved/submersed | 1,2,3,4 | 3' | Occasional, streambanks. Low wildlife value. | (-3"-6") emergent, distinctive fruit |
| Burhead | <i>Echinodorus cordifolius</i> | 3 | Emergent | 1,2 | 2' | | 2' -3" to 0", foliage similar to Arrowhead |
| Spikerush (short) | <i>Eleocharis macrostachya</i> (<i>palustris</i> , <i>montevidensis</i>) | 1 | Emergent | 1 (macrostachya) | 1' | <i>E. palustris</i> and <i>E. macrostachya</i> are taxonomically confusing, are frequent on pond edges. <i>E. montevidensis</i> is common. Eaten by ducks and geese. | -3" to +3", colonizes for shoreline erosion control |
| Horsetail | <i>Equisetum hyemale</i> , <i>E. laevigatum</i> | | | | | Often invasive and hard to control. Reproduces by rhizomes and spores. No known wildlife values, but interesting foliage. Dragonflies like to perch on stems. | |
| Umbrella sedge | <i>Fuirena simplex</i> | 1 | | | 2' | Common on pond edges. | -3" to 0", ornamental sedge |
| Mallow | <i>Hibiscus lasiocarpus</i> (<i>laevis</i>) <i>Kosteletzkya virginica</i> | 3 | | | 3' | Showy flowers. Seeds eaten by ducks and songbirds. Rose mallow (<i>H.lasiocarpus</i>) is rare, others found further east. | -3" to 0", pink flowers |
| Inland rush | <i>Juncus interior</i> | see comments | | | 4' | <i>Juncus interior</i> is the common rush here---poor wildlife values | -3" to +3", evergreen clump |
| Cardinal flower | <i>Lobelia cardinalis</i> | 2 | | | 3' | Very showy blooms, good hummingbird plant. Prefers to grow on perennial stream margins, but is commonly planted around ponds. | -3" to 0", red flowers |

| Water clover | <i>Marsilea macropoda (tenuifolia)</i> | 3 | | | 6" | Negligible wildlife values. <i>M. tenuifolia</i> is an obsolete synonym for <i>M. vestita</i> . | -3" to +6", clover-like fern |
|---------------------------------------|---|-------------------|--------------------|---------------------|------|---|---|
| Big muhly | <i>Muhlenbergia lindheimeri</i> | 2 | | | 3' | | 3' 0" to +6", clump grass |
| Obedient plant | <i>Physostegia angustifolia</i> | 2 | | | 4' | Showy blooms. Can aggressively colonize. | 0" to +3", pink flowers |
| Horned rush | <i>Rhynchospora corniculata</i> | | | | 18" | Overall wildlife value low. | -3" to 0", ornamental rush |
| Whitetop sedge | <i>Rhynchospora (Dichromena) colorata</i> | | | | | The most common <i>Rhynchospora</i> here, and it is uniquely attractive, but has little wildlife value. | |
| Palmetto | <i>Sabal minor</i> | 3 | | | 6' | Interesting foliage. | -3" to 0", tropical evergreen |
| Lizardstail | <i>Saururus cernuus</i> | | Emergent | 1 | | Doesn't typically occur this far west. No known wildlife value. Visually interesting. | |
| Water daisy | <i>Spilanthes americana</i> | 3 | | | 6" | Low wildlife values. | -3" to +6", yellow flowers |
| Easterngama grass | <i>Tripsacum dactyloides</i> | 2 | | | 4' | | 0" to +6", clump grass |
| Marsh Zone Plants | | | | | | | |
| Common Name | Latin Name | Desired Abundance | Growth Form | COE Zone | Ht | Additional comments | Comments and Planting Information |
| Canna lily (native) | <i>Canna flaccida</i> | 3 | | | 2.5' | Low wildlife value. Not native near here. | -3" to -12", yellow flowers |
| Spikerush (tall) | <i>Eleocharis (rostellata, quadrangulata, cellulosa)</i> | 2 | Emergent | 1,2 (quadrangulata) | 2.5' | High wildlife value. <i>E. quadrangularis</i> is most attractive, interesting, largest of these 3, | -3" to -12", colonizing evergreen |
| Slender spikerush | <i>Eleocharis acicularis</i> | 3 | Emergent | 1 | 7" | | 3"-12" emergent, sedge family |
| Pale spikerush | <i>Eleocharis macrostachya</i> | 1 | | | 3' | <i>E. palustris</i> and <i>E. macrostachya</i> are taxonomically confusing, are frequent on pond edges | 3"-12" emergent, birdnesting |
| Mudplantain | <i>Heteranthera limosa</i> | 3 | | | 6" | Low to moderate wildlife value. | 3"-12" emergent |
| Halberdleaf rosemallow (1-9E as well) | <i>Hibiscus laevis</i> | 3 | | | 6' | East and North-central Texas. | 3"-12" woody emergent, attracts butterflies |
| Crimsoneyed rosemallow (1-9E as well) | <i>Hibiscus moscheutos (H. militaris)</i> | 3 | | | 6' | East Texas. | 3"-12" woody emergent, blooms in summer attracts hummingbird wildlife |
| American waterwillow | <i>Justicia americana</i> | 2 | Emergent | 1,2 | 3' | | -3" to -12", forms solid mass |
| Arrow arum | <i>Peltandra virginica</i> | see comments | Emergent | 1 | 2' | Doesn't seem to be native to this area of state, low wildlife values, but attractive. Could be useful in shady areas. | 3"-12" emergent, yellow bloom in spring |
| Pickernelweed | <i>Pontederia cordata</i> | 1 | Emergent | 1,2 | 3' | Attractive blooms. Fruits eaten by waterfowl. | -6" to -12", flower spikes |
| Bulltongue | <i>Sagittaria graminea</i> | 3 | Emergent/submersed | 1,2,3,4 | 2' | Tubers of rosettes eaten by waterfowl. | 3"-12" woody emergent, flower shorter than leaves clumped together |
| Arrowhead* | <i>Sagittaria platyphylla (lanceifolia, latifolia, gramineae)</i> | 1 | Emergent | 1,2 (latifolia) | 2' | Tubers of rosettes eaten by waterfowl. | -3" to -12", wildlife value, white flowers |
| Hard-stem bulrush | <i>Schoenoplectus (Scirpus) acutus</i> | | | | 6' | West TX, not local | -3"-12" |

| Three-square bulrush, common three-square | <i>Schoenoplectus pungens</i> (<i>Scirpus americanus</i> var. <i>longispicatus</i>) | | | | | 4' | Seeds eaten by ducks. Geese and rodents consume bases and rhizomes. Prefers more mineral soils than <i>S. americanus</i> . | -3" to -12", triangular stems |
|---|--|-------------------|----------------------|---------------------|----|---------------------|---|--|
| Soft-stemmed bulrush | <i>Schoenoplectus (Scirpus) tabernaemontani</i> (= <i>Scirpus vallisus</i>) | 3 | | | | 4' - 6' | Seeds eaten by ducks. Rhizomes and shoots eaten by geese and rodents. Smaller and less invasive than <i>S. californicus</i> , the common one here. | |
| Horned pondweed (1-9G as well) | <i>Zannichellia palustris</i> | 2 | | | | 3' | Important waterfowl food. Likes clear water--might be too turbid. | 3"-12" submersed, delicate underwater branching perennial |
| Deep Water Zone Plants | | | | | | | | |
| Common Name | Latin Name | Desired Abundance | Growth Form | COE Zone | Ht | Additional comments | Comments and Planting Information | |
| Fanwort | <i>Cabomba caroliniana</i> | 3 | | | | 6' | May be too warm and turbid Common in San Marcos River. | Submergent oxygenator |
| Coontail | <i>Ceratophyllum demersum</i> | 2 | Non-rooted submersed | 2,3,4,5 | | 6' | Excellent wildlife food. | Submergent for nutrients |
| Muskgrass (macrophytic alga) | <i>Chara vulgaris</i> | see comments | Submersed | 2,3,4 | | | Will probably colonize on its own, but may be worthy of | |
| Water stargrass | <i>Heteranthera dubia</i> | 2 | Submersed | 2,3,4 | | 4" | Good for wildlife. | 12"-36" submersed yellow bloom attracts birds. Submergent oxygenator |
| American frog's bit | <i>Limnobium spongia</i> | see comments | Floating | 1,2,3,4,5 | | 6" | Fair to good wildlife values. Often mistaken for young water hyacinth. | 12"-36" Floating |
| Southern naiad, water naiad | <i>Najas guadalupensis</i> | 1 | Submersed | 2,3,4 | | 4' | Important for food and cover. Probably the most common submersed aquatic vascular plant in our area. | 12"-36" submersed |
| Water lily | <i>Nymphaea (odorata, elegans, mexicana)</i> | see comments | Floating-leaved | 3,4 | | 8' | Proceed with caution--can be invasive, especially <i>N. odorata</i> . <i>N. elegans</i> may be less so. <i>N. mexicana</i> can be especially invasive and troublesome. | Floating-leaved aquatic; 2 acre min. pond size |
| Floating hearts | <i>Nymphaoides aquatica</i> | | | | | | Grows in depths of 2-4 ft. Flowers white. Texas native range confined to E TX. Do not use <i>N. peltata</i> (yellow flowers), a European species naturalized in Texas. | |
| American pondweed | <i>Potamogeton nodosus</i> | 2 | Submersed | 2,3,4 | | 1-3' | Waterfowl food. | 12"-24" submersed/floating-leaved oxygenator |
| Pondweed | <i>Potamogeton pectinatus (nodosus, diversifolius, illinoensis)</i> . See <i>Stuckenia</i> . | 2 | Submersed | 3,4,5 (illinoensis) | | 4' | Waterfowl food. <i>P. illinoensis</i> is common in streams, prefers clear water. <i>P. nodosus</i> occasional in ponds. | Floating-leaved aquatic, benefits wildlife |
| Slender pondweed | <i>Potamogeton pusillus</i> | 1 | | | | 3" | Excellent wildlife food. Occasional in ponds. Limited by turbidity. | 12"-36" submersed |
| Delta Arrowhead | <i>Sagittaria</i> | 2 | | | | 3' | Tubers eaten by waterfowl. | 36" tubers = duck |

| | | | | | | | | |
|----------------------|---|--------------|----------|-----|--|---------|--|-------------------------------|
| Soft-stemmed bulrush | <i>Schoenoplectus (Scirpus) tabernaemontani</i> (= <i>Scirpus validus</i>) | | | | | 4' - 6' | Seeds eaten by ducks. Rhizomes and shoots eaten by geese and rodents. Smaller and less invasive than <i>S. californicus</i> , the common one here. | |
| Giant bulrush | <i>Schoenoplectus (Scirpus) americanus</i> | see comments | Emergent | 1,2 | | 4' | Native to Panhandle. Prefers more organic soils than <i>S. pungens</i> . Seeds eaten by ducks. Geese and rodents eat rhizomes and bases. | -3" to -12", triangular stems |
| Sago pondweed | <i>Stuckenia pectinata (Potamogeton pectinatus)</i> . | | | | | 1-3' | Occasional in ponds . Excellent wildlife food. See <i>Potamogeton</i> . | 12"-36" submersed |

| |
|-------------------------|
| 1 - a dominant |
| 2 - a sub-dominant, |
| 3 - trace to occasional |

COE (US Army Corps of Engineers) zones

Zone 1: waterline (shoreline) to a depth of 12-inches

Zone 2: from 12-inches to 18-inches deep

Zone 3: from 18-inches to 30-inches deep

Zone 4: from 30-inches to 48-inches deep

Zone 5: 48-inches and deeper: this zone should not be planted except under specific circumstances (e.g. constant water levels; low turbidity).

Restoration Timelines

Table 11: Overview of Maintenance Timeline for Prairie Restoration.

| Date | Action | Materials | Function |
|--|---|--|--|
| First year | Mow short and then broadcast spray herbicide or use disk the soil and spray germinating seeds | Glyphosate, Tractor with an offset disk | Removal of all plant life, in order to eliminate invasive species |
| First year | Set up temporary irrigation (optional) | | Increase germination of invasive species seeds during seed bank clearing phase and increase establishment success of prairie after seed planting |
| Second year | Continue to disk and spray (optional) | Glyphosate | Removal of all plant life, in order to eliminate invasive species |
| Second year--Fall | Plant seeds | Tractor with no till drill | Establish native tallgrass prairie flora |
| Third and Fourth years | Maintenance | Glyphosate; Water; | Hand pull or spot apply glyphosate to control invasives species. |
| Fifth year--Spring | Remove Temporary Irrigation if installed | | Prepare for prescribed fire |
| Fifth Year— Summer to early Fall | Prescribed fire | Fire Crew | Reduce King Ranch Bluestem. In Two-Phase method, this will facilitate planting of additional species. |
| Indefinite | Spot general herbicide | Glyphosate/ Fluazifop | Removal unwanted plants as necessary |

Table 12: Overview of Maintenance Timeline for Savanna Restoration.

| Date | Action | Materials | Function |
|--------------------------|---|---|---|
| First Year | Spray Macartney's Rose | Grazon P+D | Reduce Macartney's Rose |
| First Year | Stop mowing | | Allow grass to grow, to provide fuel for prescribed fire |
| Second Year--Late Summer | Prescribed fire | Fire Crew | Thin trees and reduce exotics, restore natural fire cycle |
| Second Year—Late Summer | Interseed | Hand broadcast or Tractor with no- till drill | Increase native components of vegetative community |
| Third Year | Respray Macartney's Rose | Grazon P+D | Eliminate any remaining Macartney's Rose |
| Indefinite | Repeat Previous actions, along with mechanical thinning | | Achieve/maintain savanna ecosystem |

Table 13: Overview of Maintenance Timeline for Woodland Restoration.

| Date | Action | Materials | Function |
|----------------------------------|---|---|---|
| First year and continued as able | Mechanically Thin | Loppers, chainsaw or skid steer with hydraulic shears or Seppi attachment | Initial thinning |
| Second Year or later | Prescribed fire or burn slash piles in woodlands when conditions are right (optional) | | Remove/reduce woody material in woodland area |
| Indefinite | Repeat above actions | | Achieve/maintain goals of either open woodland or savanna |

Restoration Appendix A: List of example plant species whose seeds can be collected on site and used to enhance the native diversity in restoration areas.

Splitbeard bluestem (*Andropogon ternarius*)

Gayfeather (*Liatris* spp.)

Indian paintbrush (*Castilleja* spp.)

Foxglove (*Penstemon cobei*)

Prairie parsley (*Polytaenia nuttallii*)

Green milkweed (*Asclepias viridiflora*)

Partridge pea (*Chamaecrista fasciculata*)

Indian plantain (*Arnoglossum plantagineum*)

Topeka purple coneflower (*Echinacea atrorubens*)

American basketflower (*Centaurea americana*)

Bluebonnet (*Lupinus texensis*)

Prairie larkspur (*Delphinium carolinianum* ssp. *virescens*)

Restoration Appendix B: Restoration Comparison

| | priority | labor | cost | establishment rate | preparation time |
|---------------------------|-----------------|---|------------------|---|---|
| mowing regime | high | low 1-2 people | low | change will be apparent within | establishment of mow areas; development of mowing technique to look intentional such as a mow line around the public fields |
| prairie | medium | low-medium 1 person to prepare the field, 10 people for burns | low (volunteers) | interseed 1 to 2 years; agriculture method from bare dirt 4-5 years | plan seed collection methods and commercial purchasing, equipment, labor, burn plan, maintenance plan |
| woodland | medium | high | low (volunteers) | results could be seen in one season; however, long term maintenance is needed. | labor, equipment, tree material strategy |
| savanna | medium | high | low (volunteers) | results could be seen in one season. long term maintenance is needed. prairie grass establishment ranges from 1 to 5 years depending on technique | labor, equipment, tree material strategy, seeding methods, burn plan |
| wildflower meadows | low | low 1 person | low | one season; however, needs to be repeated every year. The best time to spread seed is in the fall | ordering seeds and seeding in proper time frame |