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Lake Aquilla - Habitat Survey Hill County, Texas

Kevin Philley and Michael P. Guilfoyle

August 2017

Environmental Laboratory

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Final report

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Lake Whitney Project Office
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Under Project 448608, “Lake Aquilla Terrestrial Habitat Survey”

Abstract

This study surveyed and mapped the plant communities at Lake Aquilla, Hill County, Texas. The condition of the communities and their potential for future applications of selected restorative practices were also evaluated. Emphasis was placed on locating potential Texas Blackland prairie remnants, shrublands that may support the federally threatened Black-capped vireo (*Vireo atricapilla* Woodhouse), and oak-juniper woodlands that may support the federally endangered Golden-cheeked Warbler (*Dendroica chrysoparia* P. L. Sclater and Salvin). Data was collected using a combination of plots and transects. All vascular plant species were recorded, as well as their abundance and growth form. Plant community classifications were adapted from those developed by the National Vegetation Classification System for the state of Texas.

Two-hundred and twenty-seven species of vascular plants were recorded from 27 sample locations. Remnant patches of Texas Blackland prairie degraded by fire suppression and previous land use practices were identified in the survey area. Shrublands suitable for the black-capped vireo, and oak-juniper woodlands suitable for the golden-cheeked warbler were not detected in the survey area. Restorative practices that include management of undesirable woody vegetation and application of prescribed fire were recommended for the grasslands, and oak woodlands and forests at Lake Aquilla.

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Preface

This study was conducted for the U.S. Army Corps of Engineers, Fort Worth District under Project 448608, "Lake Aquilla Terrestrial Habitat Survey."

The work was performed by the Ecological Resources Branch (EE-E) and the Wetlands and Coastal Ecology Branch (EE-W) of the Ecosystem Evaluation and Engineering Division (EE), U.S. Army Engineer Research and Development Center, Environmental Laboratory (ERDC-EL). At the time of publication, Dr. Jennifer Seiter-Moser was the Branch Chief (CEERD-EE-E), Ms. Patricia Tolley was the Branch Chief (CEERD-EE-W), Mr. Mark Farr was Chief (CEERD-EE), and Dr. Al Confrancesco, (CEERD-EM-W) was the Technical Director. The Deputy Director of ERDC-EL was Dr. Jack Davis and the Director was Dr. Beth Fleming.

The authors thank Dr. Jacob Berkowitz and Dr. Nathan Beane for providing peer review. Dr. Charles Bryson is thanked for providing confirmation of selected Cyperaceae species determinations.

The Commander of ERDC was COL Bryan S. Green and the Director was Dr. David W. Pittman.

Unit Conversion Factors

Multiply	By	To Obtain
acres	4,046.873	square meters
feet	0.3048	meters
hectares	1.0 E+04	square meters
inches	0.0254	meters
miles (nautical)	1,852	meters
miles (U.S. statute)	1,609.347	meters
square feet	0.09290304	square meters

1 Introduction

The purpose of this survey was to conduct a botanical inventory and generate a map of vegetation types found on project lands owned and operated by the U.S. Army Corps of Engineers (USACE) - Fort Worth District at Lake Aquilla, TX. This report is intended to provide support for ongoing and future management decisions, and identify opportunities for habitat restoration. While conducting the survey, emphasis was placed on locating remnant patches of Blackland Prairie habitat and Oak-Juniper (*Juniperus ashei* J. Buchholz) woodlands, determining their suitability for potential restoration efforts that could support the federally threatened and endangered Golden-cheeked Warbler (*Dendroica chrysoparia* P. L. Sclater and Salvin), and the Black-capped vireo (*Vireo atricapilla* Woodhouse).

This survey is not intended to provide a comprehensive flora, and therefore, does not describe or account for every plant species that occurs at Lake Aquilla. Comprehensive floras, while valuable, require substantial inputs of time and effort in locating and identifying as many species as possible, making other mission objectives secondary in nature (this does not meet the project objectives as outlined in this section).

1.1 Site Description

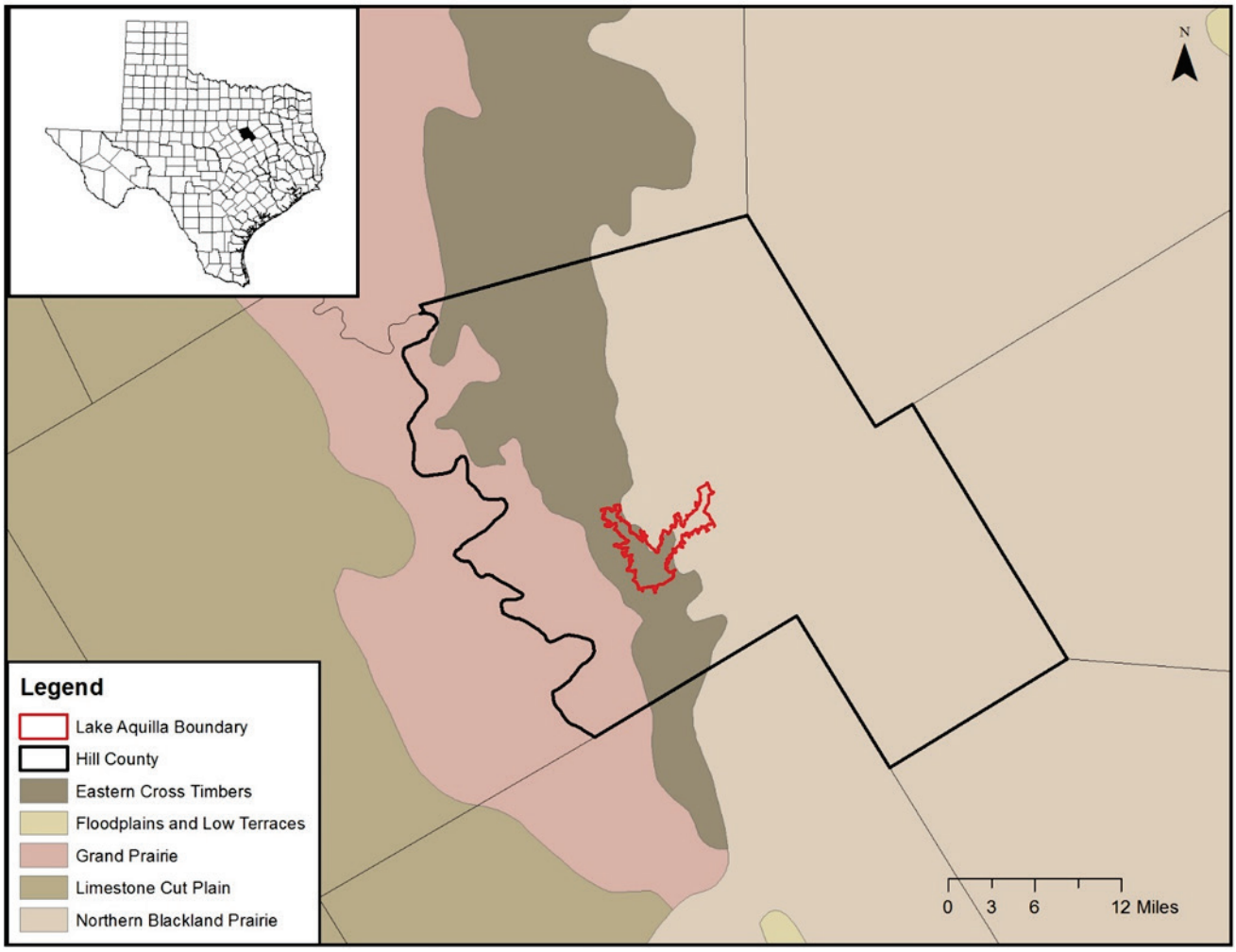
Lake Aquilla is located in southwestern Hill County, Texas, and was constructed in 1983 by damming Aquilla Creek for the primary purposes of flood control, surface water supply, and recreation. The total managed area is approximately 4,151 ha (10,257 acres), with the conservation pool occupying 1,330 ha (3,260 acres). Most of the USACE-managed land consists of retired agricultural fields and grazing land, intermixed with areas of upland forests, bottomland forests, wetlands, and grasslands.

1.1.1 Ecoregions

The lake is situated along an ecoregion division, with the eastern portion in the Northern Blackland Prairie region and the western portion in the Eastern Cross Timbers region according to Omernick's Level IV Regions of Texas (TPWD 2016a) (Figure 1). Ecoregions do not always occur along easily observable boundaries and often grade into each other; therefore,

inclusions of different regions can be expected. However, the east and west portions of the lake display the general soils and vegetation characteristics of the regions they are designated as (K. Philley*, pers. obs.).

Figure 1. Ecoregions of north-central Texas near Hill County and Lake Aquilla (TPWD 2016a).



The Blackland Prairie of Texas is often considered the southern tip of the North American Tallgrass Prairie. The flora and fauna of this ecoregion has experienced a regime of disturbances from extensive grazing by herbivores, frequent fires that varied in seasonality and intensity, droughts, and extreme variations in temperature. These fluctuating patterns of disturbance over time and space reduced or eliminated dominance by any one or few species, allowing for the development of highly heterogeneous communities (Helzer 2010). This ecosystem has

* U.S. Army Environmental Laboratory, Vicksburg, MS.

since experienced a 97% reduction in area since European settlement, mainly as a result of conversion to cereal crops and rangeland. Within the Texas Blackland Prairie region, approximately one percent remains of the original 6.8 million hectares (16.8 million acres), mostly occurring as small scattered remnants degraded by overgrazing and fire suppression (Diamond and Smeins 1993). As a consequence, many species of wildlife that depend on these prairies have declined significantly, and several species of grassland birds are now listed as species of conservation concern (Brennan and Kuvelsky 2005). Preserving these prairie remnants and restoring converted areas back to functioning prairies remains a priority for federal and state agencies, and non-government organizations such as The Nature Conservancy (Diamond and Smeins 1993).

This ecoregion was originally dominated by a variety of warm-season grasses and forbs that include the bluestems (*Andropogon gerardii* and *Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), blanketflowers (*Gaillardia sp.*), tickseeds (*Coreopsis sp.*), and blazingstars (*Liatris sp.*). Lower, more mesic areas were dominated by switchgrass, or gama grass (*Tripsacum dactyloides* (L.)L.), with several species of sedges (*Carex sp.* and *Cyperus sp.*) co-occurring (Sinha et al. 2010).

The Eastern Crosstimbers, a sub-region of the greater Crosstimbers region, is a relatively narrow strip of forest type that extends north and south in central Texas, bordering the Blackland Prairie and Grand Prairie regions. The greater Crosstimbers region forms a transitional area, or ecotone between the forests of eastern North America and the southern Great Plains, supporting a wide variety of wildlife and plant species (Bragga et al. 2012). The name is believed to have derived from settlers heading westward who had difficulty crossing the area compared to the open prairies to the east, and farther west. They described the crosstimbers as a mosaic of savannas, open woodlands, and forests with thick undergrowth dominated by post oak (*Quercus stellata*) and blackjack oak (*Quercus marilandica*). Washington Irving's *A Tour of the Prairies* (1835) gave the following account:

> "The whole tract may present a pleasant aspect in the fresh time of the year, when the ground is covered with herbage; when the trees are in their green leaf, and the glens are enlivened by running streams. I shall not easily forget the

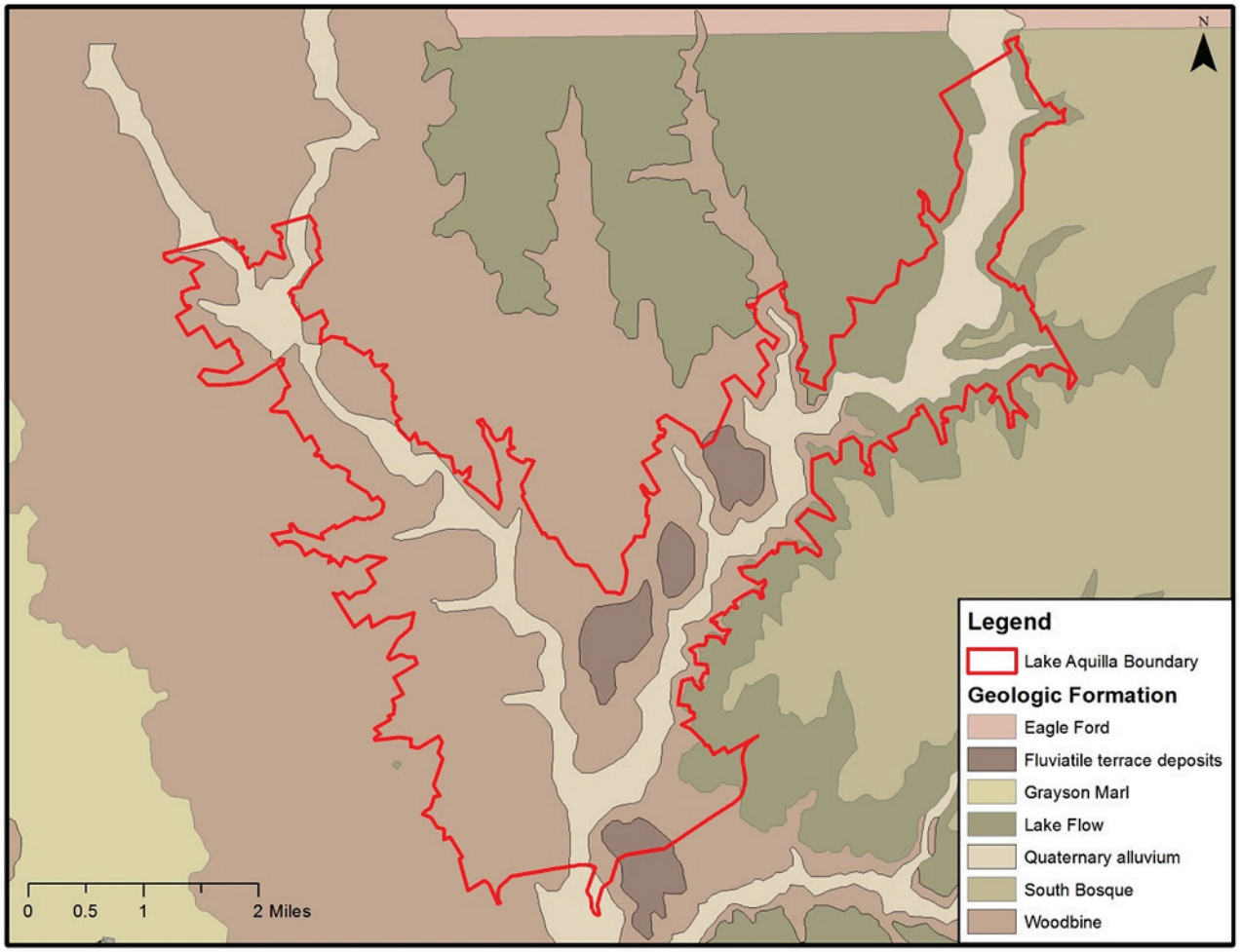
> mortal toil and vexations of the flesh and spirit that we underwent occasionally, in our wanderings through the Cross Timber. It was like struggling through forests of cast iron."

Much of the crosstimbers is now highly fragmented due to conversion to grazing land or suburban and urban development. Fire suppression has also allowed the understory in many stands to become well-developed, with multiple strata of sub-canopy trees, shrubs, and vines. Although these types of stands are accounted for in some historical records, the mosaics of oak savannas with widely spaced trees and open woodlands with a robust herbaceous layer that early settlers described are largely absent or degraded. Many of these stands also display poor oak recruitment due to insufficient light reaching the understory (ACTC 2016).

1.1.2 Geology

The geology of the Lake Aquilla area is occupied by five major formations (Figure 2) (Brooks 1978). The majority is underlain by the Woodbine formation, which forms a belt adjacent to Aquilla Creek. It is composed of friable sandstone that transitions to clay and shale to the south. The terrain is generally hilly or rolling compared to adjacent areas. Quaternary alluvium occurs along Aquilla and Hackberry Creeks, as well as their tributaries, and consists of relatively recent floodplain deposited sediments of sand, silt, and clay. Much of this alluvium is now covered by water, with most of the exposed areas near the northern portions of the lake. Fluviate deposits occur just above the confluence of major streams. These deposits are mainly sand and gravel remnants of older alluvium that was deposited before the contemporary floodplains of these streams formed. The South Bosque and Lake Flow formations occur primarily along the eastern portion of the lake area and are predominately composed of shale, with the Lake Flow formation having interbedded limestone units (Brooks 1978). The Eagle Ford and Grayson Marl formations occur just outside of the lake area.

Figure 2. Surface geology of Lake Aquilla, Texas (TNRIS 2016).



1.1.3 Soils

The soils of Lake Aquilla are made up of three main groups, the prairie soils, the woodland soils, and the alluvial/floodplain soils (Figure 3) (USDA-NRCS Web Soil Survey 2016). The clayey, alkaline prairie soils are dominated by Vertisols, including the Altoga, Ferris, Heiden, and Houston Black series. These soils account for approximately 24.3 percent of the land area or about 684.3 hectares (1,691 acres). The loamy prairie soils are Alfisols including the Crockett, Normangee, and Wilson series. These soils range from mildly acidic to slightly alkaline, and occupy approximately 9.3 percent of the land area or about 261.8 hectares (647 acres). The sandy and loamy clay woodland soils are Alfisols including the Bastsil, Crosstell, Gasil, Konsil, Silstid, and Travis series. They occupy approximately 16.6 percent of the land area or about 467.6 hectares (1,155.6 acres). The loamy and clayey alluvial soils are Pursely and Tinn series (Mollisols and Vertisols respectively), occupying approximately 20.1 percent of the land

area or about 567.8 hectares (1,403 acres). The remaining area is composed of several minor soil components. All soil series represented in the area are shown in Figure 4. A general description of each series and total area occupied can be found in Appendix A.

Figure 3. Major soil groups of Lake Aquilla (USDA-NRCS 2016).

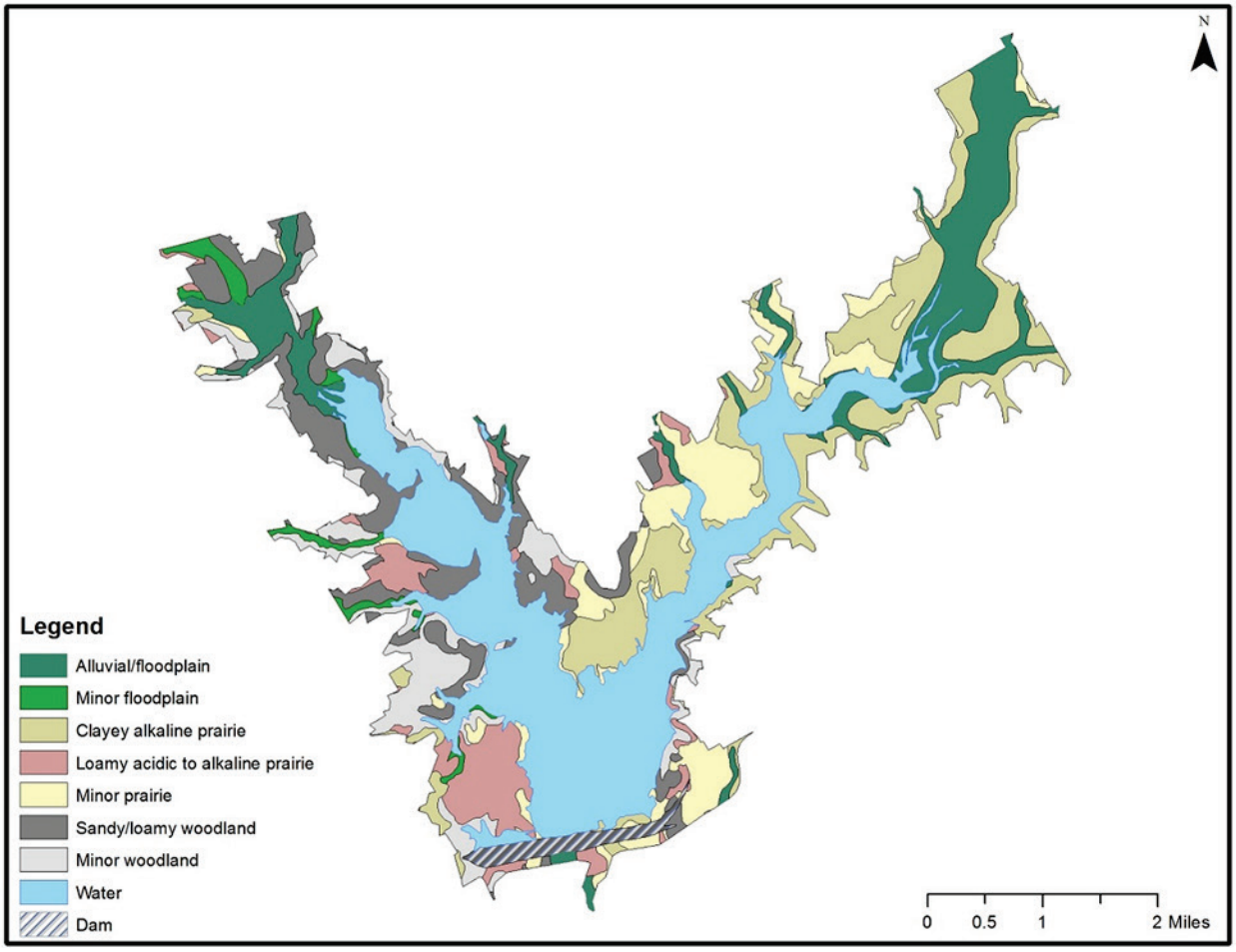
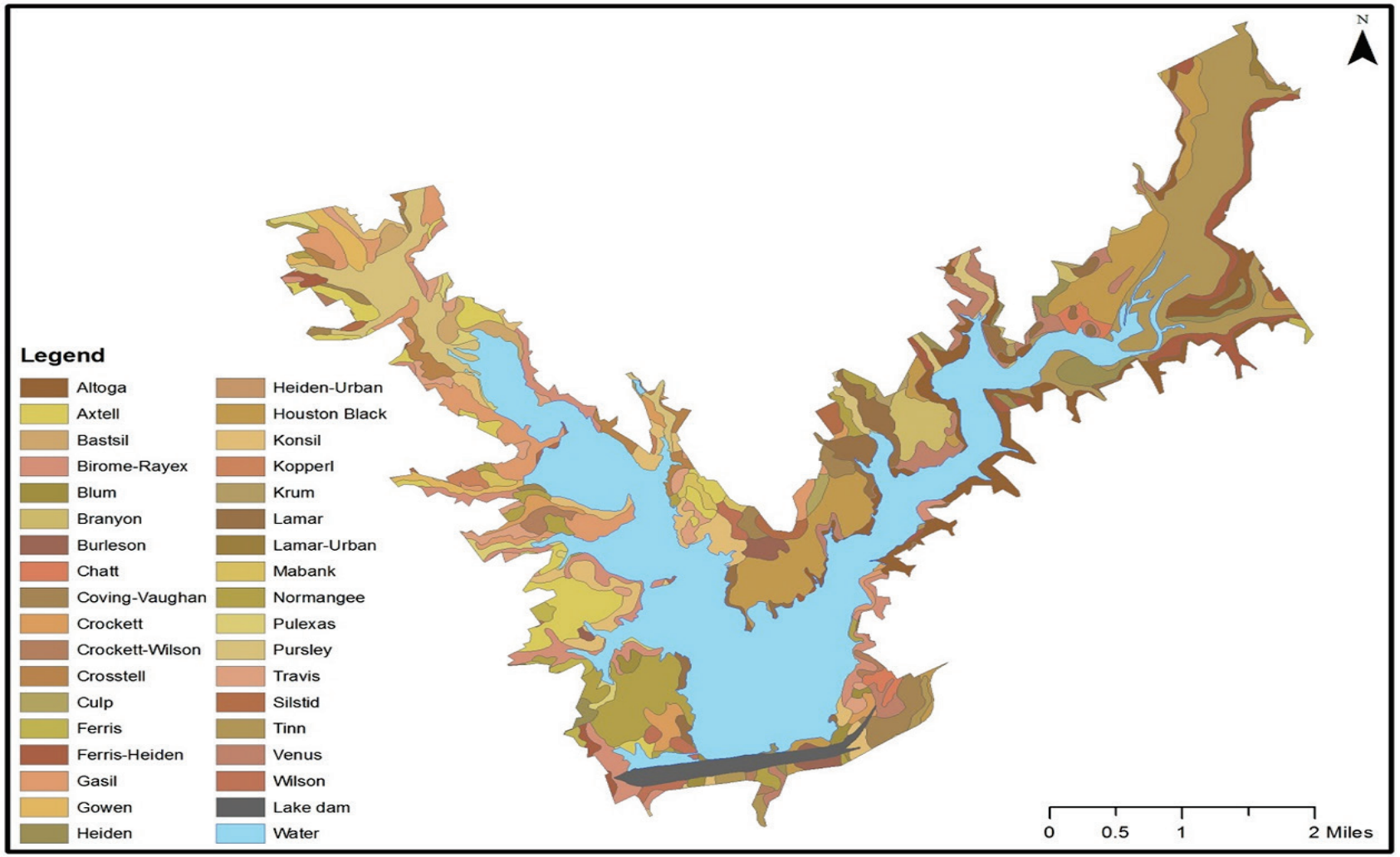


Figure 4. Soil series of Lake Aquilla (USDA-NRCS 2016).



2 Methods

Mr. Kevin Philley and Dr. Michael Guilfoyle conducted field data collection. Local Fort Worth District personnel, Mr. Bailey Gaines and Mr. Jared Tadsen, provided assistance with accessing the sites, and provided background information on land use, management, disturbance, etc. Surveys were conducted May 16th–20th and October 3rd–7th, 2016, to capture late spring/early summer and late summer/early fall flowering peaks. This survey may not represent all plant species occurring within the study area, including species most readily detectable and identifiable in early spring, mid-summer, and late fall flowering periods.

Variable length transects were randomly allocated in survey locations. Dominant vegetation was recorded along each transect based upon visual observations and estimates of absolute percent cover (USACE 2010). Additionally, a minimum of one sample plot was established at representative locations within a given plant community. Twenty-seven sample plots were established during the survey. At each sample plot, investigators recorded species richness, abundance, and structure. The vegetation type occurring at each survey area determined the size of the plot utilized. For example, sites dominated by woody vegetation were sampled using an 11.3 m (37 ft) radius plot; this equates to a 0.04 ha area (1/10th acre). A five m (16 ft) radius plot was used for communities dominated by herbaceous vegetation. The reduction in plot size for these communities that typically have higher species richness than closed canopy forested areas, was required to maintain sampling efficiency, while retaining an adequate sample size to capture the inherent variability of each particular area (USACE 2010). In narrow or elongate plant communities, plot shapes and sizes were modified to capture the vegetation present without overlapping other distinct communities. All species present within each plot were recorded along with their absolute percent cover. Absolute cover requires counting of overlapping vegetation, therefore, it is possible for a sample location to exceed one hundred percent cover (USACE 2010).

Individual plants were assigned to a stratum based on height and growth form; therefore, it is possible for a single species to be recorded in multiple strata. Trees were defined as woody vegetation, excluding vines, ≥7.6 cm (3 inches) in diameter at breast height (DBH) and >6.1 m (20 feet) in total height. The tree strata were defined as emergent canopy (T1), canopy (T2),

and sub canopy (T3). Shrubs were defined as woody vegetation between 0.5m and 6.1 m in height, and recorded as tall shrub (S1; ≥3 m), medium shrub (S2; <3 m but ≥1 m), and dwarf shrub (S3; <1m but ≥0.5 m). Herbaceous plants were defined as any non-woody species, and woody species <0.5 meter in height regardless of size, excluding vines. Vines included woody and non-woody vine species regardless of size or height.

Plant species that could not be readily identified in the field were collected and identified using *Shinner's and Mahler's Illustrated Flora of North Central Texas* (Diggs et al. 1999). Due to nomenclatural changes that have been made since publication, the survey applied the currently accepted name found in Flora of North America (http://floranorthamerica.org/), and Integrated Taxonomic Information System (http://www.itis.gov). Remaining plant specimens collected during sampling were donated by U.S. Army Engineer Research and Development Center-Environmental Laboratory (ERDC-EL) to the Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas.

Representative site photos were taken at each plot center facing due north. Data regarding location information (latitude/longitude), soils, soil texture, aspect, and hydrology were also recorded for each sample location. All data sheets are included in Appendix B, and location information for each plot in Appendix C. The National Vegetation Classification System (NVCS) was used to classify the sample sites, providing a basis for mapping project lands vegetation types. Due to the scale of the project area and time required for sampling, inclusions of differing vegetation types can be expected in areas designated with a particular classification. Local resource managers have the ability to modify or update these features as needed, based on additional data from field observations.

3 Results

The section below provides an overview of the data collected at each sample plot within the Lake Aquilla (LA) survey area. Information includes study plot location, land use, dominant plant species, and representative landscape photos. Selected photos of individual plant species or species assemblages are also provided. A total of 227 species were documented from the 27 plots that were established, and represented 62 families and 177 genera (Appendix D). Approximately 9.3 percent (21) of these species are considered non-native to North America, have an uncertain nativity, or occur as a mix of native and non-native genotypes or varieties. Thirty-one species were previously undocumented in Hill County, and are represented by a voucher specimen.

Large colonies of the non-native, invasive giant reed (*Arundo donax L.*) were encountered near N 31.92584° W 97.19610° and N 31.89567° W 97.20164°. This species is typically planted near homesteads and over time expands forming large colonies. In riparian situations, it can spread rapidly from rhizomes that detach and disperse by water, or by layering when culms are pushed to the ground by water and debris during high flow events (Boland 2006).

Plot LA01 was located near N 31.90711° W 97.22397°, in a fairly level area currently managed as part of a grazing lease (Figure 5). The plot had high densities of honey mesquite (*Prosopis glandulosa*) as both trees and shrubs, and high cover of non-native grasses such as field brome (*Bromus arvensis*) and perennial ryegrass (*Lolium perenne*). Lower areas along drains and swales were dominated by honey-locust (*Gleditsia triacanthos*) and cedar elm (*Ulmus crassifolia*). Native forbs such as western horse-nettle (*Solanum dimidiatum*), silver-leaf nightshade (*Solanum elaeagnifolium*), and Carolina desert-chicory (*Pyrrhopappus carolinianus*) occurred at low levels of cover. This sample area appears to be degraded due to invasion by woody species, and the introduction of non-native grasses

Figure 5. Site photo from plot LA01, Lake Aquilla, Texas, demonstrating high densities of honey mesquite and high cover of non-native grasses.

Plot LA02 was located near N 31.904778° W 97.222083°, in a level area similar to LA01 that is currently managed as part of a grazing lease (Figure 6). This plot also exhibited high densities of honey mesquite in both the tree and shrub strata, and high cover of non-native herbaceous vegetation such as field brome and perennial ryegrass. Native graminoids and forbs such as kidneyshaped sedge (*Carex reniformis*), pinebarren flatsedge (*Cyperus retrorsus*), Heller's rosette grass (*Dichanthelium oligosanthes*), Texas thistle (*Cirsium texanum*), and green antelopehorn (*Asclepias viridis*) occurred at low levels of cover. This sample area appears to be degraded due to invasion by woody species, and the introduction of non-native grasses.

Figure 6. Site photo from plot LA02, Lake Aquilla, Texas, demonstrating high densities of honey mesquite and high cover of non-native grasses.

Plot LA03 was located near N 31.901222° W 97.212528°, along the shoreline of Lake Aquilla. The area is open to grazing and exhibited some soil disturbance and compaction from cattle (Figure 7). The tree stratum was dominated by cedar elm and honey mesquite. The small tree and shrub strata were dominated by honey locust and gum bumelia (*Sideroxylon lanuginosum*), respectively. A large portion of the plot was non-vegetated and covered by gravel and small rocks.

Figure 7. Site photo from plot LA03, located along the shoreline of Lake Aquilla, Texas.

Plot LA04 was located near N 31.900556° W 97.214278°, in a low swale, within an area that is open to cattle grazing. Honey mesquite cover was relatively low in this area, likely due to greater soil moisture content relative to higher and drier areas nearby (Figure 8). Grasses such as gaping grass (*Steinchisma hians*) and sedges such as Britton's sedge (*Carex tetrastachya*), tapertip flatsedge (*Cyperus acuminatus*), and Baldwin's flatsedge (*Cyperus croceus*) replaced the brome and ryegrass that were dominant in higher, drier sites such as LA01 and LA02.

Figure 8. Site photo from LA04, Lake Aquilla, Texas, demonstrating high cover by gaping grass along a swale.

Plot LA05 was located near N 31.930083° W 97.241056°, in a level grass/forb dominated opening, abutting an access point and parking area (Figure 9). The area is relatively small yet exhibited high species richness with over 30 species recorded in a five meter radius plot. The site is likely maintained by periodic mowing since it is located next to an access gate and parking area.

Indian paintbrush (*Castilleja indivisa*), Texas star (*Sabatia campestris*), and Texas wintergrass (*Nasella leucotricha*) dominated the area. Texas wintergrass was originally a minor component of most prairies but is now much more common due to disturbance (Figure 10.) (Diggs et al. 1999). Its dominance in the plot may be indicative of past land use practices and reduced habitat quality compared to other herbaceous communities at Lake Aquilla where its cover is lower. Other common plants in this area included Lady Bird's centaury (*Centaurium texense*), Carolina larkspur (*Delphinium carolinianum*), and Texas vervain (*Verbena halei*).

Figure 9. Site photo from LA05, Lake Aquilla, Texas, with Indian paintbrush and Texas star in the foreground.

Figure 10. Texas wintergrass (*Nasella leucotricha*), (Strickland 2004; http://www.wildflower.org/gallery/result.php?id_image=28164).

Plot LA06 was located near N 31.93191° W 97.22757°, in a level grass/forb dominated area, with scattered clumps of trees and shrubs (Figure 11.). Annual ragweed (*Ambrosia artemissifolia*), lemon beebalm (*Monarda*

citriodora), field brome, and Heller's rosette grass were dominant species within the plot. Winecup (*Callirhoe involucrata*), Texas thistle, Britton's sedge, grass-leaf rush (*Juncus marginatus*), and Texas bullnettle (*Cnidoscolus texanus*) occurred as minor components. A sounder of approximately 15 feral hogs (*Sus scrofa* Linnaeus) was encountered near this site while performing the survey.

Figure 11. Site photo from plot LA06, demonstrating grass and forb dominated areas with scattered clumps of trees and shrubs, Lake Aquilla, Texas.

Plot LA07 was located near N 31.92744° W 97.23889°, in a riparian forest along an unnamed tributary to Aquilla Creek (Figure 12.). Post oak and cedar elm dominated the canopy tree stratum, and Eastern red-cedar (*Juniperus virginiana*) and white ash (*Fraxinus americana*) dominated the sub-canopy tree stratum. Several species of vines occurred at this site including anglepod (*Gonolobus suberosus*), poison-ivy (*Toxicodendron radicans*), Virginia creeper (*Parthenocissus quinquefolia*), and saw

greenbrier (*Smilax bona-nox*). Riveroats (*Chasmanthium latifolium*) and Heller's rosette grass dominated the herbaceous stratum, with many other species occurring as minor components such as Eastern woodland sedge (*Carex blanda*), false hair sedge (*Carex bulbostylis*), Canadian snakeroot (*Sanicula canadensis*), and Pennsylvania pellitory (*Parietaria pensylvanica*). This was the only plot that contained a population of limestone adder's-tongue fern (*Ophioglossum engelmannii*), and established a new species record for Hill County.

Figure 12. Site photo from plot LA07, near an unnamed tributary to Aquilla Creek, Lake Aquilla, Texas.

Plot LA08 was located near N 31.92783° W 97.23226°, on a well-drained north facing slope. Post oak dominated the tree stratum with cedar elm and white ash occurring as minor components (Figure 13.). The shrub stratum was composed of several species, including skunk-bush sumac (*Rhus trilobata*), Mexican plum (*Prunus mexicana*), gum bumelia, elbowbush (*Forestiera pubescens*), coralberry (*Symphoricarpos orbiculatus*), sugarberry (*Celtis laevigata*), and eve's necklace (*Styphnolobium affine*).

This was the only plot that contained bluntlobe cliff fern (*Woodsia obtusa*), and established a new species record for Hill County. Its distribution is predominately in eastern North America, and typically found growing on or near calcareous rock or scree. It approaches the southwestern limit of its known distribution in central Texas.

Figure 13. Site photo from plot LA08, located on a north facing slope, Lake Aquilla, Texas.

Plot LA09 was located near N 31.936682° W 97.234554°, in a poorly drained area that is frequently inundated by Lake Aquilla (Figure 14.). The understory was sparse due to frequent and prolonged inundation during high lake levels. Pecan (*Carya illinoinensis*), cedar elm, green ash (*Fraxinus pennsylvanica*), honey-locust, and black willow (*Salix nigra*) dominated the tree stratum. A small depression in the plot that appears to hold water for prolonged periods of time contained lesser duckweed (*Lemna aequinoctialis*), a free-floating aquatic plant not typically encountered while conducting terrestrial vegetation inventories.

Osage-orange (*Maclura pomifera*) occurred sporadically at this site. Its native range is often stated as the Red River Valley of Texas, Oklahoma, Arkansas, and Louisiana (Radford, et al. 1968; Weakley 2015). However, evidence suggests that Osage-orange and six other species of *Maclura* were widely distributed in North America up until the Pleistocene epoch. Their extinction, or in the case of *M. pomifera*, a contraction in distribution, is believed to have coincided with the extinction of mammalian megafauna that may have been their primary seed dispersers (Estes et al. 2007; Janzen and Martin 1982).

Figure 14. Site photo from plot LA09, Lake Aquilla, Texas. The understory in this area is sparse due to frequent and prolonged inundation.

Plot LA10 was located near N 31.93688° W 97.23633°, in a fairly level area that has recently been retired from grazing and has been invaded by cedar elm (Figure 15.). The trees here are small, typically less than 10 cm (four inches) in diameter at breast height, and occur at high densities (>1600 trees per hectare in some locations). Wild-rye (*Elymus canadensis*), marsh-elder (*Iva annua*), and gaping grass dominated the herbaceous stratum, with clasping coneflower (*Dracopis amplexicaulis*), Carolina foxtail grass (*Phalaris caroliniana*), and poison-ivy occurring as minor components.

Figure 15. Site photo from plot LA10, with high densities of young cedar elm trees, Lake Aquilla, Texas.

Plot LA11 was located near N 31.94858° W 97.22959°, along a well-drained south facing slope (Figure 16.). The soil here is a well-drained sandy loam, frequently with surface strewn rocks. Post oak dominated the canopy tree stratum with Texas ash (*Fraxinus texensis*) and cedar elm occurring as minor components. Eastern red-cedar dominated the sub-canopy tree stratum at this plot to the exclusion of all other species, which may suggest a long history of fire-suppression. Eastern red cedar, post oak, and skunk-bush sumac dominated the shrub stratum, with Mexican plum and coralberry occurring as minor components. The herbaceous stratum was sparse, likely due to shading by the large amounts of eastern red-cedar; however, yellowfruit sedge (*Carex annectans*) and western rough goldenrod (*Solidago radula*) were frequently encountered.

Figure 16. Site photo from plot LA11, in a post oak dominated forest with large amounts of eastern red-cedar, Lake Aquilla, Texas.

Plot LA12 was located near N 31.94821° W 97.22789°, along a gravelly shoreline of Lake Aquilla (Figure 17.). Switchgrass dominated the plot, and was frequently observed around the lake's shoreline on areas that were moderately well-drained to somewhat poorly drained. Buttonbush (*Cephalanthus occidentalis*) occurred along the water's edge and in small shallow coves. Large portions of the area were sparsely vegetated, and covered with small rocks and gravel.

Figure 17. Site photo from plot LA12, along the shoreline of Lake Aquilla, Texas.

Plot LA13 was located near N 31.96105° W 97.25469°, on the side slope of a well-drained ridge, near an old stock pond (Figure 18.). Honey mesquite and eastern red cedar dominated the tree startum, with eve's necklace and cedar elm occurring as minor components. Honey mesquite and gum bumelia dominated the shrub stratum, with sugarberry and post oak occurring as minor components. Field brome and perennial ryegrass dominated the herbaceous stratum; however, several native herbaceous species occurred here, such as Heller's rosette grass, Texas vervain, Pennsylvania pellitory, Indian paintbrush, western horse-nettle, and southwest bedstraw (*Galium virgatum*).

Figure 18. Site photo from plot LA13, demonstrating dominance by honey mesquite and non-native grasses, Lake Aquilla, Texas.

Plot LA14 was located near N 31.96068° W 97.25405°, on a well-drained ridge near LA13. Smooth brome and perennial ryegrass dominated the plot; however, several species of native grasses and forbs were identified, including little bluestem (visible in the center of Figure 19.), Arkansas yucca (*Yucca arkansana*), green antelopehorn, tulip prickly-pear (*Opuntia phaeacantha*), and Texas star. Engelmann's daisy (*Engelmannia peristenia*) occurred here which is often said to be an "ice-cream plant" preferentially grazed by cattle, resulting in its absence from the landscape under typical grazing regimes (Diggs et al. 1999).

Figure 19. Site photo from plot LA14, with little bluestem located in the center, Lake Aquilla, Texas.

Plot LA15 was located near N 31.96518° W 97.26043° in a gently sloping grass and forb dominated area (Figure 20 A and B). Honey-mesquite at this plot was relatively low in density and appears to have only recently invaded the area, or the site has received some treatment such as prescribed fire or herbicide, as many of the trees and shrubs have thin crowns, and retain dead lower limbs.

The spring survey indicated that this plot was high in species richness with over 40 species documented in an 11.3 m radius plot. Despite this, cover of native species such as blanketflower (*Gaillardia pulchella*) and Texas wintergrass (*Nasella luecotricha*) were high, and dominated most of the area. The fall survey indicated that the site was dominated by silver beard grass (*Bothriochloa laguroides subsp. torreyana*), prairie tea (*Croton monanthogynus*), common broomweed (*Amphiachyris dracunculoides*), and snow-on-the-prairie (*Euphorbia bicolor*). This was the only plot where prairie Brazosmint (*Warnockia scutellarioides*), a native prairie species, was encountered (Figure 25.).

Figure 20. (A) Site photo from plot LA15, taken 16 May 2016, Lake Aquilla, Texas, demonstrating high cover by Texas wintergrass. (B) Site photo from plot LA15, taken 6 October 2016, Lake Aquilla, Texas, demonstrating low cover by native warm season grasses.

Figure 21. Prairie Brazosmint (Warnockia scutellarioides), at plot LA15, Lake Aquilla, Texas.

Plot LA16 was located near N 31.96999° W 97.25258°, in an area formerly used as agricultural or pasture land (Figure 26.). The site was dominated almost exclusively by non-native grasses such as field brome and perennial ryegrass, with low cover of native species such as Carolina geranium (*Geranium carolinianum*), smallflower groundcherry (*Physalis cinerascens*), and Britton's sedge. Based on the evidence of remnant ditches and berms, the area exhibits disturbance to the original vegetation and the local hydrology. Tree cover was low, likely due to continuous and/or recent use as grazing land; however, cedar elm and honey locust appear to be invading the core area.

Figure 22. Site photo from plot LA16, demonstrating high cover by non-native grasses, Lake Aquilla, Texas.

Plot LA17 was located near N 31.97027° W 97.25767°, in a well-drained grass and forb dominated area (Figure 27.). This site is generally lower in cover relative to other herbaceous communities that were surveyed. The vegetation here is also fairly low in stature, otherwise, occasional clumps of switchgrass and shrubs dot the area. Switchgrass, blanketflower, western horse-nettle, Texas flax (*Linum medium*), field brome, rosemary

sun-rose (*Helianthemum rosmarinifolium*), annual hairgrass (*Aira caryophyllea*), and blackeyed Susan (*Rudbeckia hirta*) were dominant. Texas star, juniperleaf (*Polypremum procumbens*), little quakinggrass (*Briza minor*), largebracted plantain (*Plantago aristita*), and tulip pricklypear were minor components.

Figure 23. Site photo from plot LA17, demonstrating dominance by low-statured herbaceous vegetation, Lake Aquilla, Texas.

Plot LA18 was located near N 31.933528° W 97.207028°, in a fairly level area dominated by switchgrass (Figure 28.). This site was more mesic compared to most other herbaceous communities that were surveyed. Giant goldenrod (*Solidago gigantea*) and dewberry (*Rubus trivialis*) were common, with grassleaf rush, Texas vervain, little bluestem, and showy evening-primrose (*Oenothera speciosa*) occurring as minor components. Woody vegetation was sparse, although it appeared to be colonizing the core area, and will likely expand in coverage without management. Some areas nearby occurred as a matrix of switchgrass dominated patches and patches of honey mesquite, field brome, perennial ryegrass, and wild-rye.

Figure 24. Site photo from plot LA18, dominated by switchgrass, Lake Aquilla, Texas.

Plot LA19 was located near N 31.93475° W 97.210861° in an area similar to LA01 and LA02 (Figure 30. (A)). This plot contained high densities of honey mesquite and high cover of non-native herbaceous vegetation such as field brome and perennial ryegrass. Portions that were lower and had higher soil moisture content displayed higher densities of honey-locust, and herbaceous plants such as Britton's sedge. This sample area appears to be degraded due to invasion by woody species and the introduction of non-native grasses.

Figure 25. Site photo from plot LA19, demonstrating dominance by honey mesquite and non-native grasses, Lake Aquilla, Texas.

Plot LA20 was located near N 31.94075° W 97.178806°, in a forb/grass dominated community just downslope from a switchgrass dominated area (Figure 26). This site appeared to be periodically inundated by the lake during high water events; therefore, the community had a higher percentage of species that are typical of areas that receive periodic natural disturbances. Canada goldenrod (*Solidago altissima*) and switchgrass dominated the site with clasping coneflower, giant ragweed (*Ambrosia trifida*), cocklebur (*Xanthium strumarium*), smallflowered milkvetch (*Astragalus nuttallianus*), and beaked cornsalad (*Valerianella radiata*) occurred as minor components.

Figure 26. Site photo from plot LA20, demonstrating dominance by Canada goldenrod and switchgrass, Lake Aquilla, Texas.

Plot LA21 was located near N 31.96575° W 97.176889°, in a floodplain forest dominated by pecan and sugarberry, with cedar elm, green ash, and Osage-orange occurring as minor components (Figure 31.). Wild-rye and riveroats dominated the herbaceous stratum, with rogue-plant (*Rivina humilis*), poison-ivy, and giant ragweed occurring as minor components. A small clump of cultivated common oat (*Avena sativa*) occurred in this plot, and was likely washed in as seed from a nearby field upstream. This plot contained the only population of dwarf stinging nettle (*Urtica chamaedryoides*) encountered during the survey, and established a new record for Hill County, TX.

Figure 27. Site photo from plot LA21, demonstrating dominance by pecan, sugarberry, riveroats, and wild-rye, Lake Aquilla, Texas.

Plot LA22 was located near N 31.99525° W 97.1425° in a low, poorly drained area that is semi-permanently flooded, only drying out during late summer or after prolonged droughts (Figure 32.). Green ash and sugarberry dominated the canopy tree stratum, the sub-canopy tree stratum, and the shrub stratum. Water primrose (*Ludwigia peploides*) and Britton's sedge, dominated the herbaceous stratum, with pale dock (*Rumex altissimus*), ravenfoot sedge (*Carex crus-corvi*), and turkey tangle frogfruit (*Phyla nodiflora*) occurring as minor components.

Figure 28. Site photo from plot LA22, Lake Aquilla, Texas. Water primrose dominates the foreground to the exclusion of most other species.

Plot LA23 was located near N 31.988639° W 97.137861°, in a riparian area along an intermittent stream (Figure 33.). Sugarberry and eastern red-cedar dominated the canopy tree stratum. Black willow occurred as a minor component growing in the stream channel. Sugarberry and soapberry (*Sapindus saponaria*) dominated the sub canopy tree stratum.

The trees in this area were relatively dense and small in diameter, suggesting that the site was part of a larger agricultural field or pasture that was retired within the past 15–30 years. The herbaceous stratum was typical of local riparian features and contained a mix of native and non-native species that are adapted to the natural disturbance regime along stream corridors that occurs as a result of scouring and deposition of sediment by floodwaters.

Figure 29. Site photo from plot LA23, demonstrating the abundance of sugarberry in the area, Lake Aquilla, Texas.

Plot LA24 was located near N 31.98825° W 97.135725°, in a fairly level forb and grass dominated area along the USACE property boundary (Figure 30 A and B). During the spring survey, blanket flower, blazing star (*Liatris sp.*), prairie bishop (*Bifora americana*), and Texas grama (*Bouteloua rigidiseta*) dominated the plot. Lemon beebalm, Leavenworth's eryngo (*Eryngium leavenworthii*), southwest bedstraw, and knotweed leaf-flower (*Phyllanthus polygonoides*) occurred as minor components. During the fall survey, silver beard grass and King Ranch bluestem dominated the plot.

Figure 30. (A) Site photo from plot LA24, taken 20 May 2016, with blanketflower dominating the foreground, Lake Aquilla. (B). Site photo from plot LA24, taken 5 October 2016, with silver beard grass and King Ranch bluestem dominating the area, Lake Aquilla, Texas.

Plot LA25 was located near N 31.951167° W 97.156056°, on a moderately sloping area in a small prairie remnant (Figure 31). Species richness was high, with more than 40 species recorded within a five-meter radius plot. This community extends across the USACE managed boundary onto private property. In total, it appears to be about 0.65 hectares (1.6 acres), with approximately half of it inside the USACE boundary. During the fall survey, the privately owned portion appeared to have a diminished warm season grass component relative to the USACE owned portion.

Several species of native forbs were only encountered in this area, including wild foxglove (*Penstemon cobaea*) (Figure 32), a large and showy native prairie species. If the undesirable woody vegetation is left unmanaged, it will likely continue to expand in cover and diminish the size of this already small prairie remnant, as well as the species richness present.

Figure 31. Site photo of plot LA25, demonstrating low cover by undesirable trees and shrubs within the prairie remnant, but with high densities of woody vegetation encroaching the perimeter, Lake Aquilla, Texas.

Figure 32. Wild foxglove (Penstemon cobaea) documented in plot LA25, Lake Aquilla, Texas.

Plot LA26 was located near N 31.91927° W 97.23002°, in a post oak and blackjack oak dominated woodland (Figure 33). This plot had less tree canopy when compared to other oak forest/woodland types present at Lake Aquilla. The shrub strata was also reduced but dominated by young oaks. Although the ground surface appeared to receive adequate sunlight for oak recruitment, the herbaceous stratum was patchy to sparse, and dominated by little bluestem, slim-spike threeawn (*Aristida longespica*), tulip prickly-pear, and common broomweed. Green antelopehorn, jumping cactus (*Clylindropuntia leptocaulis*), western rough goldenrod, composite dropseed (*Sporobolis compositus*), and yellow-puff (*Neptunia lutea*) occurred here as minor components. The non-vegetated substrate was predominately bare soil and surface strewn sandstone. Areas such as this may be important habitat for native wildlife that require open rocky areas and bare ground for basking, feeding, etc. Striped bark scorpions (*Centruroides vittatus Say*) were encountered in the area.

Figure 33. Site photo from plot LA26, demonstrating the sparsely vegetated patches that are common in this area of oak woodlands, Lake Aquilla, Texas.

Plot LA27 was located near N 31.95757° W 97.13915°, in an area of gently sloping rangeland invaded by Ashe's juniper (Figure 34). The junipers occurred most frequently on areas of eroded and bare soil. The shrub stratum was sparse with gum bumelia and cedar elm occasionally occurring. Little bluestem, common broomweed, prairie tea, and King Ranch bluestem dominated the herbaceous stratum. Pasture heliotrope (*Heliotropium tenellum*), Leavenworth's eryngo (*Eryngium leavenworthii*), false bone-set (*Brickellia eupatoriodes*), silver beard grass, Arkansas yucca, and giant ragweed occurred as minor components.

Figure 34. Site photo from plot LA27, an area of rangeland invaded by Ashe's juniper, Lake Aquilla, Texas.

4 Discussion

Lake Aquilla contains a diverse range of vegetation community types and species as reflected in the site photos and species recorded in Appendix D. The majority of lands surveyed were rangelands that vary widely in their condition; however, most were impaired for wildlife usage by historical alterations to the species composition that favored non-native grasses and invasion by undesirable broadleaf trees (e.g., honey mesquite, honey-locust, cedar elm). Several areas were identified as prairie remnants. However, those areas occurred as small scattered fragments, much like the remaining Blackland Prairie of central Texas. A subset of the prairie remnants lacked a native warm season grass component, but otherwise were well-stocked with native cool season grasses and forbs.

Oak forests and woodlands occurred primarily along the western side of Lake Aquilla, which is predominantly mapped as the Eastern Crosstimbers ecoregion. The best examples were located on well-drained slopes, landscape positions too difficult to convert to grazing land, or unsuitable for agriculture. Several areas of forested wetlands occurred, typically along the upper reaches of the streams that flow into the lake. The riparian forests associated with those streams displayed intact, healthy plant communities composed of pecan, sugarberry, and cedar elm stands typical for the region.

4.1.1 Black-capped vireo

Black-capped vireo (“vireo”) breeding habitat in central Texas consists of low shrubs and small trees that are irregular in height, and have adequate cover to conceal the nest, which is typically situated about one meter from the ground (Grzybowski 1995). These shrublands are a product of climate in the arid western portion of the bird’s range, where shrubs represent the climax community. In the more mesic eastern portion of its range where woodlands represent the climax community, shrublands are created and maintained by disturbance patterns (McFarland et al. 2013).

The shrubland communities at Lake Aquilla were largely represented by rangeland that has been invaded by honey mesquite and other native broadleaf trees. These communities are transient and soon become uniform stands, with little to no branching structure near the ground and likely are unsuitable for vireos. Several large patches of Chickasaw plum

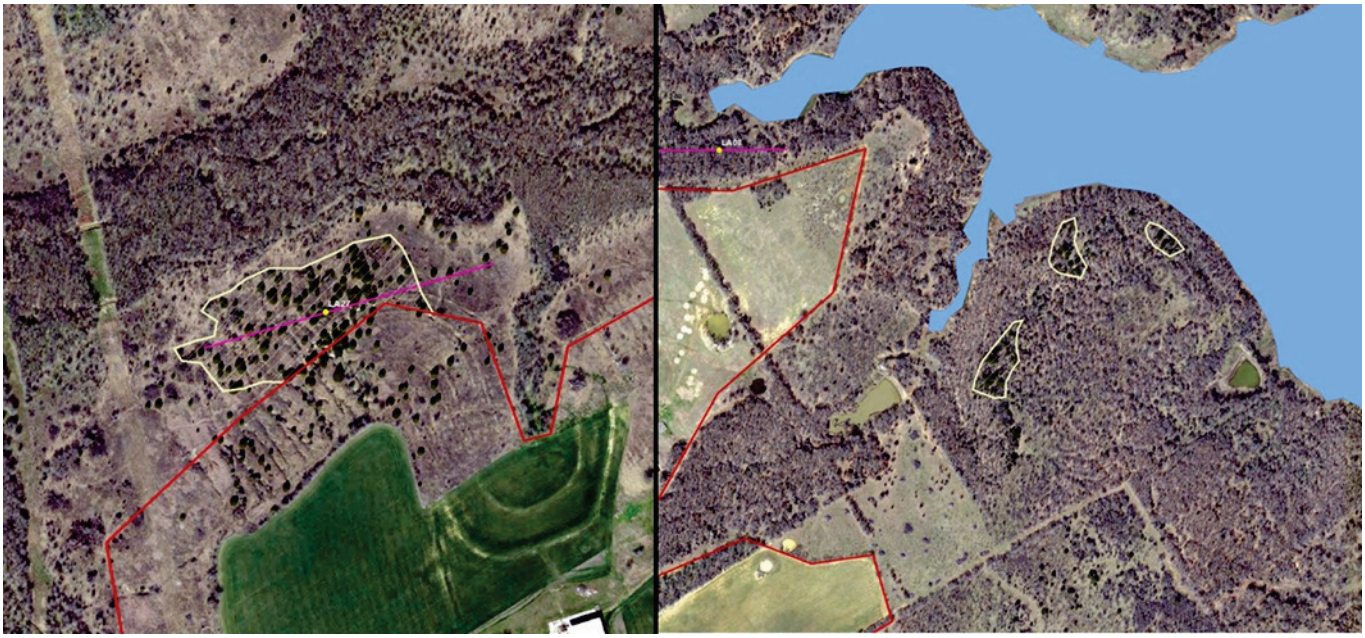
(*Prunus angustifolia Marshall*), a native thicket forming shrub, were encountered in open grazing lands. These patches may be suitable in structure, but generally occur as small islands when viewed on a landscape scale, making them unlikely to be colonized by breeding vireos.

Based on extensive surveys, vireos appear to cluster near each other on the landscape, possibly due to conspecific attraction (Cimprich and Kostecke 2006). This suggests that creation or restoration of suitable habitat may not be successful in attracting vireos unless they are already located nearby, although this has not been substantiated (McFarland, et al., 2013). Recent detections of vireos in adjacent Bosque County to the west by McFarland, et al. (2013) indicates that habitat improvements should probably be focused near eastern portions of Lake Whitney, and upon successful recruitment of breeding birds, they may be implemented at western portions of Lake Aquilla with a greater likelihood of success.

4.1.2 Golden-cheeked Warbler

Emphasis was placed on locating Oak-Ashe's Juniper woodlands at Lake Aquilla, in association with potential habitat for the federally listed Golden-cheeked Warbler. Considerable effort was spent visiting sites with *Juniperus sp*. visible on aerial photographs. Ashe's juniper was encountered occasionally as scattered individuals, sometimes co-occurring with eastern red-cedar, and as small patches at two locations. The patches were up to 2.02 hectares in size but typically much smaller, and are shown in Figure 35. Remaining areas with a dominant or co-dominant *Juniperus sp*. component appear to be represented by eastern red-cedar, and likely do not constitute suitable warbler habitat, as Ashe's Juniper is required for nesting material, and is a preferred foraging substrate during the later portion of the breeding season (Marshall et al. 2013). The patches were small, embedded within other communities, and may be difficult for warblers to locate on the landscape. If they were to utilize the area near LA27 they would likely be susceptible to high levels of nest parasitism from brown headed cowbirds (*Molothrus ater Boddaert*) because of the large amount of edge (Figure 35).

Figure 35. (A) Ashe's juniper stands (yellow crosshatched polygons LA27). (B) Areas near N 31.92593° W 97.22677° on the right located at Lake Aquilla, Texas.



4.1.3 Blackland prairie remnants

Texas Blackland Prairie remnants are important for wildlife habitat and maintaining the biodiversity of an imperiled ecosystem. Most are degraded by lack of fire, overgrazing, and alterations to site hydrology. Natural resource managers should seek to maintain the size and species composition of these areas at a minimum. Ideally, sites can be improved, expanded, and connected to other areas.

Remnants are normally affected on some level by woody vegetation, both native and non-native, that encroaches the perimeter and/or invades the core area. Over time, this results in changes to the community composition, and diminishes the biomass of the herbaceous stratum (Limb et al. 2014). The first step in rehabilitating these prairie remnants is to remove and control the woody competition. This can be achieved with a variety of methods; however, care should be taken to limit disturbance or damage to native, desirable vegetation. Prescribed fire is a necessary tool in the long-term management of these areas when applied at an appropriate interval, but may only provide top-kill for small trees and shrubs, and unless applied at the correct timing and with enough intensity, it may not control mature trees. There is concern over the use of prescribed fire for these communities, and its impact on their potential remnant fauna. It is suggested that these areas should not be burned in

their entirety, but burned in thirds or halves, in alternating years, and if practicable, during non-repeated seasons for a given burn unit (Packard and Mutel 1997).

4.1.4 Oak forests and woodlands

The oak woodlands and forests located at Lake Aquilla appear to have experienced a relatively long period of fire-suppression. The majority of stands have a sub-canopy that is well-developed with many fire-intolerant species, while the herbaceous stratum is reduced or sparse due to deep shading. Oaks cannot regenerate successfully in full shade, consequently, most of these areas have very low recruitment. Without a disturbance such as fire, these areas will eventually transition to some other forest type. The loss of oaks will have negative consequences for many species of wildlife that depend on them as both a structural component of the ecosystem as well as a food source. Many species of oak are fire-tolerant, in that they are capable of resprouting vigorously after being top-killed by a fire that might otherwise cause mortality to other young tree species. In fire prone environments, they often persist as "grubs" in the herbaceous stratum until a sufficient fire-free period allows them to develop bark that is thick enough to protect them from top-kill, and are eventually recruited to the tree stratum (McShea and Healy 2002). Tree core data from eight representative oak trees at two locations indicated that they originated 60 to 80 years ago. This time period may indicate the end of frequent fire on the local landscape. A tree core from a representative sized eastern red-cedar found in one of the crosstimbers stands was aged at 25 years old. Because eastern red-cedar is fire-intolerant, the age of its establishment may indicate the minimum amount time since the site has experienced fire.

The management activity that would most benefit these forests and woodlands is the periodic application of prescribed fire. However, many stands have a dense sub-canopy of eastern red-cedar, which under certain conditions, can become highly flammable and has the potential to cause severe crown scorch or even mortality of desirable trees. Stands such as this may require felling of red-cedar trees and larger saplings prior to the application of prescribed fire to diminish this risk. Undesirable woody vegetation that is aggressive and not easily controlled by prescribed fire should be removed/controlled prior to initiating a burn regime, or soon thereafter. Failure to do so may promote these species.

Woodlands and forested areas are sometimes used as part of grazing leases and can lead to competition with native wildlife. If possible, these areas should be excluded from cattle during the summer months and late winter when food resources may be scarce (TPWD 2016b).

4.2 Vegetation classifications

The section below describes the vegetation classification scheme utilized herein, forming the basis for the associated vegetation community maps generated in conjunction with this report. The vegetative community types represent 11 series classifications according to the National Vegetation Classification System (NVCS) (2016). Each vegetation class is described below.

4.2.1 Forest and Woodland Communities

Ashe's Juniper Ruderal Forest (CEGL004159) occurred as four small stands embedded within other vegetation types, with a total coverage of approximately 2.9 hectares (7.14 acres). It is believed that the development of these stands is a result of poor grazing practices, previous land-clearing, and/or fire-suppression. Areas of bare soil were frequently encountered underneath the junipers.

Cedar Elm - Pecan - Sugarberry / Longleaf Woodoats - Cherokee Sedge Floodplain Forest (CEGL002388) occurred on level to slightly sloping areas near streams that receive periodic overbank flooding and/or have saturated soils, and occupied approximately 387 hectares (956.3 acres). This type appeared to be adventive in some moderately drained areas, likely due to fire-suppression. If local hydrology has been altered to increase drainage in bottomland areas, restoring it may potentially increase the area occupied by this community. Green ash and cottonwood (*Populus deltoides Bartram ex Marshall*) frequently occur with this type.

Crosstimbers Post Oak - Blackjack Oak Forest (CEGL002074) occurred on approximately 478.1 hectares (1,181.5 acres) of ridges and slopes, mostly along the western portions of Lake Aquilla on loamy/rocky soils. These stands typically had a closed canopy with multiple, well developed, woody sub-canopy strata, and a sparse herbaceous stratum, indicative of a relatively long fire-free period. Periodic application of fire may convert these stands to Post Oak - Blackjack Oak / Little Bluestem woodland

(CEGL002147), with open canopy, and sparse sub-canopy woody vegetation.

Crosstimbers Post Oak - Blackjack Oak Woodland (CEGL002147) occurred on approximately 76.3 hectares (188.7 acres) of ridges and slopes, along western portions of Lake Aquilla, and had reduced canopy cover and shrub strata compared to the Crosstimbers Post oak – Blackjack Oak forest. Shallow soils, grazing, and/or periodic fire are responsible for maintaining the open canopy.

Crosstimbers Ruderal Post Oak - Red-cedar Forest (CEGL004935) occurred as a result of fire suppression and subsequent invasion by eastern red-cedar on approximately 77.7 hectares (192 acres). Periodic application of prescribed fire may convert these stands to Post Oak - Blackjack Oak / Little Bluestem woodland (CEGL002147).

Green Ash - Cedar Elm - Sugarberry Floodplain Forest (CEGL004618) occurred on 367.2 hectares (907.5 acres), mostly near the upper reaches of Lake Aquilla on level to slightly sloping areas near streams that receive periodic overbank flooding and have poorly drained soils. It was more predominant in the eastern portions of Lake Aquilla, especially near Hackberry Creek, which has more level topography compared to Aquilla Creek to the west. If local hydrology has been altered to increase drainage in bottomland areas, restoring it may potentially increase the area occupied by this community. Pecan and cottonwood frequently occur with this type.

Honey Mesquite - Cedar Elm / Texas Wintergrass Riparian Ruderal Woodland (CEGL004180) occurred on 842.5 hectares (2,081.9 acres) of rangeland where honey mesquite, cedar elm, and honey locust have invaded due to fire-suppression and poor grazing practices. Eastern red-cedar was often present at sites where cedar elm was dominant. This NVCS classification lacks accuracy as applied here because no ruderal upland mesquite-broadleaf tree classification currently exists. If a more appropriate classification is adopted in the future, these areas should be reclassified. Removal of non-desirable woody vegetation and conversion to various grassland types appropriate for the region is recommended.

4.2.2 Grassland, Prairie, and Herbaceous Communities

Annual Marsh-elder - (Rough Cocklebur) Ruderal Wet Meadow (CEGL004124) occurred near the upper reaches of Lake Aquilla, occupying approximately 93 hectares (229.8 acres), where frequent and/or prolonged inundation from high water events precludes most other plant species from becoming established. Giant ragweed, smartweeds (*Persicaria sp*.), and several sedges (*Cyperaceae*) often co-occurred. Some of these sites may have historically been dominated by floodplain forests but were cleared for agriculture, and have since been retired.

Gamagrass - Switchgrass Tallgrass Prairie (CEGL002217) occurred on approximately 318.2 hectares (786.3 acres) and appears to be an artifact of previous grassland restoration efforts (W.W. Haferkamp*, pers. comm.) Most stands have experienced long periods without the disturbance regimes that are necessary for the development and maintenance of diverse tallgrass prairies. They were dominated almost exclusively by switchgrass, and did not contain other characteristic species at more than marginal levels of cover. Incorporating prescribed fire and appropriate grazing regimes would likely reduce the dominance of switchgrass, recruit more herbaceous species, and increase structural heterogeneity.

Giant Reed Riverbank Ruderal Wet Meadow (CEGL004101) occurred as a 1.9 hectare (4.9 acre) stand near the outlet channel of Lake Aquilla, and as small patches scattered around the lake. The non-native giant reed (*Arundo donax*) forms large monospecific stands excluding other vegetation, and should be controlled/removed if possible.

Little Bluestem - Indiangrass - Big Bluestem - Prairie Bishop Vertisol Grassland (CEGL004027) occurred as small fragments embedded within other vegetated communities on vertisols. These areas are less than one acre in size, occur as a mosaic and could not be mapped at the scale used for this effort, except for two small patches totaling 0.42 hectares (1.03 acres). Several species of forbs were only recorded in this community type (LA25).

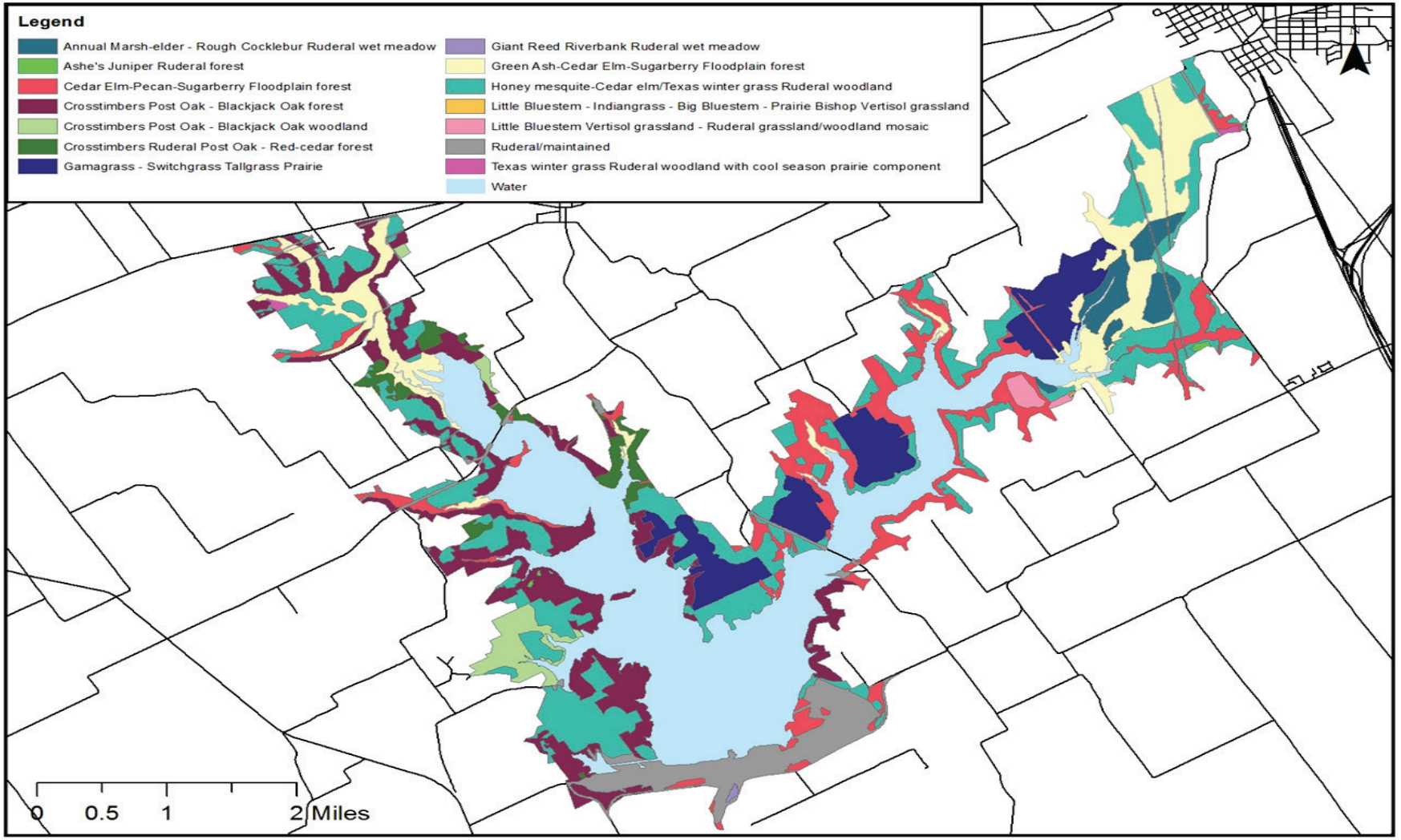
The vegetation type map is shown in Figure 36. The delineated areas do not always contain every designated species component, and often will

* Environmental Stewardship BLM, Three Rivers Regional Project Office, Fort Worth District, Clifton, Texas

have inclusions of other types that are not mapped at the scale used for this effort. Also, some vegetation types are not well documented and may not have a classification that best describes the species composition and general landform characteristics. Areas that were maintained, frequently mowed, planted, highly disturbed, or occupied by man-made structures were delineated as “ruderal/maintained” and occupied approximately 254.3 hectares (628.4 acres). Vegetation types that occurred as a mosaic or as a subset with a seasonal component are provided.

The vegetation classifications provided herein describe current conditions. Succession, disturbance, and management activities often alter the floristic composition of a given area over medium (<5 year) to long (>20 year) timescales, requiring periodic updates to maps and datasets. Collection of periodic on-site survey data is recommended prior to initiating any management activity driven by mapped vegetation resources.

Figure 36. Vegetation classification of Lake Aquilla, Texas.

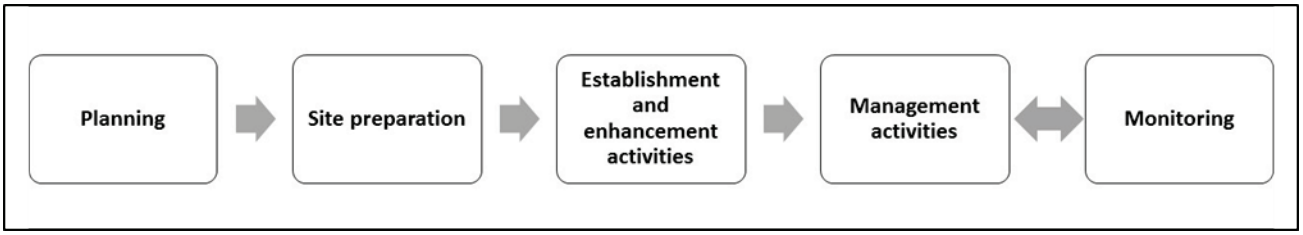


4.3 Restoration

The primary objectives of the current report included identifying restoration potentials for the vegetation community types found at Lake Aquilla. Most successful restoration efforts begin with planning, and proceed through a sequence of steps (Figure 37) including site preparation, establishment and/or enhancement activities, management activities, and monitoring. The planning phase includes determining target sites, target conditions, success criteria, preferred methods, and costs (Packard and Mutel 1997). An inventory, such as this, is an important planning component that allows managers to be aware of the resources that are present as well as their condition, improving plan development and overall likelihood of success.

Site prep represents the first physical alterations of a site that facilitate subsequent activities, altering the trajectory of the existing site condition to the target condition. Site prep activities can include herbicide applications, prescribed fire, land clearing, and land resurfacing. Establishment and enhancement activities generally involve augmenting the existing species composition of a site, or in some cases replacing them altogether. For grasslands this typically involves application of seed or planting of seedlings to achieve the desired species mix. Management activities can include prescribed fire, mowing, control and removal of undesirable or invasive vegetation, and potentially grazing for grassland communities. Most monitoring efforts center on evaluating the site and comparing the findings to the success criteria developed in the initial planning phase. It is an integral and ongoing part of the process that provides the necessary feedback for decision-making that drives continuing management activities.

Figure 37. Basic components of habitat restoration and management.



4.3.1 Site Preparation

If a chosen restoration site exhibits alterations such as ditching and draining, resource managers often restore the original hydrology before

initiating planting by filling ditches and/or removing drainage (Packard and Mutel 1997). The resultant change potentially decreases the ability of some target species to become established, requiring the selection of mesic or wet-mesic prairie species in lower, poorly drained areas. Managers should consider potential impacts of hydrologic restoration to adjacent property owners, and requirements of federal, state, and local permitting procedures.

Undesirable woody vegetation can affect a wide variety of plant communities. A relatively inexpensive procedure that provides high levels of woody vegetation control, while minimizing damage to desirable resources is the cut-and-spray method (Packard and Mutel 1997). This method requires cutting of woody vegetation at ground level, and the immediate application of an herbicide mixed with a surfactant, to the stump. This method is easily carried out with a two-person team, one cutting vegetation and the other applying the herbicide. Utilizing a dye that is mixed prior to application can help the applicators identify which stumps have already been treated. Small woody vegetation (less than six feet in height) can be effectively treated with a foliar spray, taking care not to allow wind-drift or drips onto non-targeted vegetation. Basal bark application is another method used on small trees, where the herbicide is mixed with an oil and applied to the base of the stems (Packard and Mutel 1997). Trees that are difficult, dangerous, or time consuming to fell can be treated with the hack-and-squirt method, where a hatchet is hacked into the cambium, and an herbicide is sprayed into the cut (Texas Invasives 2016). The number of hacks per tree depends on the diameter, as larger trees require a higher dosage to cause mortality. Most herbicides have their highest mortality rate in the last half of the growing season through fall, when the chemical is easily transported to the target plant's root system.

Honey mesquite is a significant invader of prairies and rangeland throughout central Texas. If left unmanaged, it can form expansive areas, degrading habitat and available forage. Areas of mesquite shrubland with an herbaceous layer dominated by non-native grasses and forbs provide opportunities to completely reestablish native prairie vegetation, and often on a relatively large scale. These sites first require the removal of mesquite and other woody broad-leaf invaders via chemical and/or mechanical removal. Large areas would likely require aerial application of Sendero®, or some other triclopyr-based herbicide, in order to be time and cost effective. Any remaining woody vegetation can be effectively controlled via

cut-and-spray methods or potentially with hack-and-squirt treatments, mentioned previously. If successful, these large sites may be most beneficial to wildlife that are obligate prairie species that are negatively affected by large amounts of edge found at smaller sites (Beck et al. 2016).

Plowing and disking prior to replanting has been used since the earliest days of prairie restoration efforts (Packard and Mutel 1997). However, it should be reserved for sites that have low cover of native grasses and forbs and with no rare species present, otherwise it may cause severe damage to these desirable resources. Sites occurring on slopes are not good candidates for disking, as high levels of soil disturbance initiate erosion problems. Disking should also be avoided near desirable trees to prevent damage to their roots. Undesirable, weedy perennial vegetation (e.g. Eurasian grasses) may have to be disked several times over the course of a year in order to prepare a site. Each pass brings dormant seeds to the upper soil profile, and must be exhausted prior to planting of desirable species. This method requires a substantial labor investment preparing the site. Additionally, disking eliminates habitat for almost all wildlife species until vegetation is reestablished (Packard and Mutel 1997). Shallow disking, with the blades oriented to the direction being pulled can be used to reduce the vigor of native plants (e.g. switchgrass) that are dominating a site to the exclusion of most other species, without severely disturbing the soil (Helzer 2010).

An alternative to plowing and disking is the application of herbicides to the entire target site. These can be applied as selective (e.g., effective only on grasses) or broad-spectrum (effective on a wide-variety of vegetation) depending on the site conditions. As with plowing and disking, this should be reserved for sites that lack rare species, and have low cover of desirable native vegetation. Because there is little to no soil disturbance, herbicides are especially recommended for sites that occur on slopes, where mechanized site preparation can lead to severe erosion (Packard and Mutel 1997). Much like disking and plowing, several applications over the course of a growing season may be necessary if persistent, aggressive, weedy perennial vegetation is present on site.

A relatively new alternative to the methods described above that has been used for small restoration sites, requires covering the target area with heavy duty black plastic for an entire growing season (Packard and Mutel 1997). This method should only be used on sites with few desirable species

as all vegetation and seeds near the soil surface are destroyed by lack of light and high temperatures trapped underneath. The benefits of this method belie the simplicity of applying a plastic covering and passively waiting eight to twelve months. When combined with no till methods, it reduces cost and time spent on site preparation, reduces erosion potential, increases soil moisture content by maintaining dead sod as a covering, maintains any potentially weedy seedbank deep in the soil profile, and reduces opportunities for weeds to invade and compete with desirable vegetation (Packard and Mutel 1997). This method should be considered for suitable areas where purchasing sufficient amounts of plastic and applying them is not prohibitive. If so, applying it to smaller sequential sections of a target site over a period of years may be a suitable alternative.

4.3.2 Seeding

Sites that have been suppressed by woody vegetation for long periods of time or have low cover of native grasses and forbs usually cannot be restored through prescribed fire alone, and require seeding in order to achieve a desired species composition (Eldridge et al. 2011). The method of seeding depends on the size and condition of the site after all site prep has been performed. Small sites can be applied by hand spreaders while larger sites may require a specialized native seed drill. Sites that have been disked can be applied using a standard mechanical broadcaster. Soil packing is an important step that must be done after broadcasting seed on a tilled site (Packard and Mutel 1997).

Each plant species is adapted to a particular range of conditions, and the target site should be matched appropriately with species that are native to the area. Seed sources should be acquired from populations that are as local as possible (e.g., adjacent site, nearby population, same ecoregion). Importing seed from other states and ecoregions risks bringing unfavorable genotypes (e.g., inadequate drought tolerance) into the local populations (Packard and Mutel 1997). A list of commercial seed sources and additional information on restoration planting can be found on the Native Prairies Association of Texas website (http://texasprairie.org/index.php/manage/restoration_entry/planting_a_tallgrass_prairie_what_to_plant/).

Seeds should be planted at site locations that best fit their ecological niche, based on soils, drainage, topography, aspect, etc. Developing a planting map that denotes the intended locations of planted species across the

target site is useful during the planting process and during site monitoring to determine if success criteria have been met. Planted species of tall grasses can often dominate a site in the immediate years after planting. An alternative to overcome this, is to plant shorter grass species the first year, postponing tall grass species until the second year or plant taller grass species on downslope and downwind areas from shorter and intermediate height grasses (Packard and Mutel 1997).

Grasses tend to dominate most planted areas, to the detriment of forbs, which are an important component of most communities. They provide essential food sources for insects that in turn provide a critical food source for many species of wildlife, but especially birds (Packard and Mutel 1997). Consider planting a mix that includes a considerable amount of forbs (e.g., 50%), or choose designated areas for separate seed mixes (Packard and Mutel 1997). The period of active growth and anthesis of a target plant species is also important to consider. These attributes affect wildlife that depend on them as resources for particular phases of their life cycles. If possible, select an appropriate mix of forb species with varying flowering periods that correspond to all portions of the growing season.

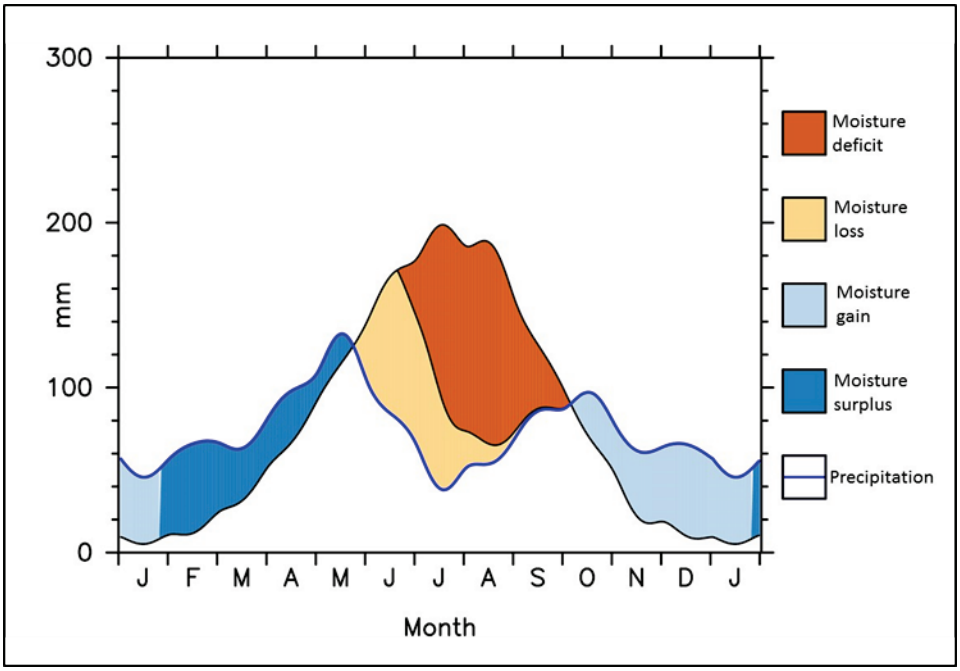
Interseeding involves planting seeds among existing vegetation, and can be accomplished by hand for small areas or single species, or by native seed drill for larger areas and species mixes. Its primary advantage is that it does not disturb existing desirable vegetation or soil, in contrast to plowing/disking, and subsequently seeding. This method is ideal for augmenting the species composition of a degraded prairie remnant, a site with slopes, and near desirable trees. As with all seeding methods, failure is likely if performed during a year of abnormally low rainfall that prevents seedlings from becoming established. Success using interseeding has been achieved at many restoration sites by simply broadcasting the seed on the ground surface, although it requires more seeds per unit area, increasing the cost for seed mixes (Packard and Mutel 1997).

Irrigation after seeding can boost the germination and success rate of planted seeds; however, it remains impracticable for most restoration areas, requiring specialized equipment, manpower, and/or a dedicated water source. Therefore, timing of planting is critical and should take advantage of maximum normal rainfall for the area. This information can be obtained from several sources such as the USDA National Water and Climate Center website

(http://www.wcc.nrcs.usda.gov/climate/wetlands.html) or the Web-based, Water-Budget, Interactive, Modeling Program (WIMP). These sources are based on long-term climate data and should be used for general planning purposes, in conjunction with short-term weather forecasts. The average annual water budget for the city of Hillsboro, Texas was generated from WIMP (2016) and is shown in Figure 38. Precipitation reaches its maximum in mid-May, with soil moisture loss beginning by the end of the month. By late June, a moisture deficit begins and lasts until the end of September with moisture gains through the fall and winter months. Based on this information, spring planting should take advantage of the moisture surplus and coincide with the beginning of the growing season. Fall plantings should take advantage of moisture gains if they take place no sooner than mid-October.

Applying fertilizer to a seeded area is not required but can help promote the establishment of seedlings. Low nitrogen content fertilizers are recommended as higher nutrient inputs promote undesirable weeds rather than the target species (Packard and Mutel 1997).

Figure 38. Average annual water budget for Hillsboro, Texas (WIMP 2016).



4.3.3 Prescribed Fire

Prescribed fire is used as a component of restoration efforts as well as continuing management practices (Packard and Mutel 1997). Historically,

the prairies, savannas, and woodlands of central Texas consisted of fire-dependent communities that burned periodically due to both natural and man-induced fires. The frequency and intensity of fires varied considerably from site to site, and contributed to the mosaic of communities that early explorers and settlers described. Historic fire regimes can be replicated by burning small stands and portions of larger stands on a periodic basis, and in varying seasons depending on existing site conditions and the desired target community. Most prescribed burns are carried out during the dormant season, which typically promotes warm season grasses and forbs, while growing-season fires promote cool season plants (Helzer 2010).

Much debate exists over what constitutes an appropriate prescribed fire interval; however, maintaining sufficient fuel loading to carry a fire remains the ultimate factor determining fire frequency. Wet-mesic and mesic sites are generally more productive than dry or xeric communities, and therefore, accumulate litter (fuel) at a faster rate, which influences their potential to burn at shorter intervals. It is recommended that new prairie restoration sites be burned frequently after the first year of planting, and less frequently after seeded species have become well established (Packard and Mutel 1997). Dendrochronology studies of trees in the tallgrass prairie region indicate that most areas burned every three to four years on average (Helzer 2010).

Firebreaks are a necessary component of carrying out a prescribed burn on the contemporary landscape. They are typically constructed by plowing a strip of bare earth around the perimeter of the burn unit. This method may not be desirable for prairie remnants where the total area of the community is relatively small. Also, there are anecdotal reports that some small animals may avoid these fire breaks, refusing to cross them (Noss 2013). An alternative method is to mow a strip around the perimeter on a low setting, followed by a multi-person team slowly applying fire while using fire flappers or water to contain the fire within the mown break.

4.3.4 Mowing

Mowing is an effective tool for managing areas where prescribed fire is prohibited, dangerous, or otherwise unwieldly, although not a direct replacement. Mowing during the growing season can have negative consequences for wildlife who may be utilizing the area, especially if it is mowed entirely. Leaving strips or blocks that are mowed in alternating

years on sites that are well-established can reduce this conflict by providing cover and feeding areas. (Helzer 2010).

If a site contains large amounts of weedy perennials, it may require mowing prior to seeding and soon thereafter to allow sunlight to reach small seedlings. Adjusting the mower to a high setting (i.e., no lower than six to eight inches) and mowing before vegetation becomes rank is recommended, otherwise the large clippings may produce more unwanted shade than the live standing leaves of the undesirable species. Repeated mowing may be required throughout the growing season for two to three years, or until seedlings become well established to compete with weedy species (Packard and Mutel 1997).

4.3.5 Grazing

Prior to European settlement, central Texas was home to free-roaming herds of ungulates that cropped the vegetation and created openings on the soil surface for seeds to germinate. These herds concentrated on recently burned areas where young, tender shoots of vegetation had emerged, and were present in low numbers on areas that had already been grazed, or had not burned recently (Helzer 2010). Agriculture and rangeland stocked with domestic livestock dominates the contemporary landscape. If managed properly, grazing can be compatible with the objectives of natural resource management. This requires managers to determine the appropriate stocking rates for each area on a yearly basis and rotate livestock to allow each site to have adequate time to rest (TPWD 2016b). Cattle are often allowed to graze too long or too frequently on a given parcel, and over time the plant community becomes degraded and dominated by only a few species that are less preferred. This predicted outcome of range degradation often leads to managers excluding grazing from managed prairies, even though it is recognized as an important component of their development and maintenance (Helzer 2010). However, it is recommended that livestock be excluded from seeded areas until seedlings have become established (typically two to three years).

Mob grazing or high intensity low frequency (HILF)-grazing has become popular as an attempt to mimic the grazing patterns of wild herds, where ranges are highly stocked but allowed to graze for only a small portion of the year; however, most of the claimed benefits (e.g., increased soil carbon) have not been substantiated (Taylor et al. 1993). Wild herds would have likely demonstrated preferential foraging as they moved across the

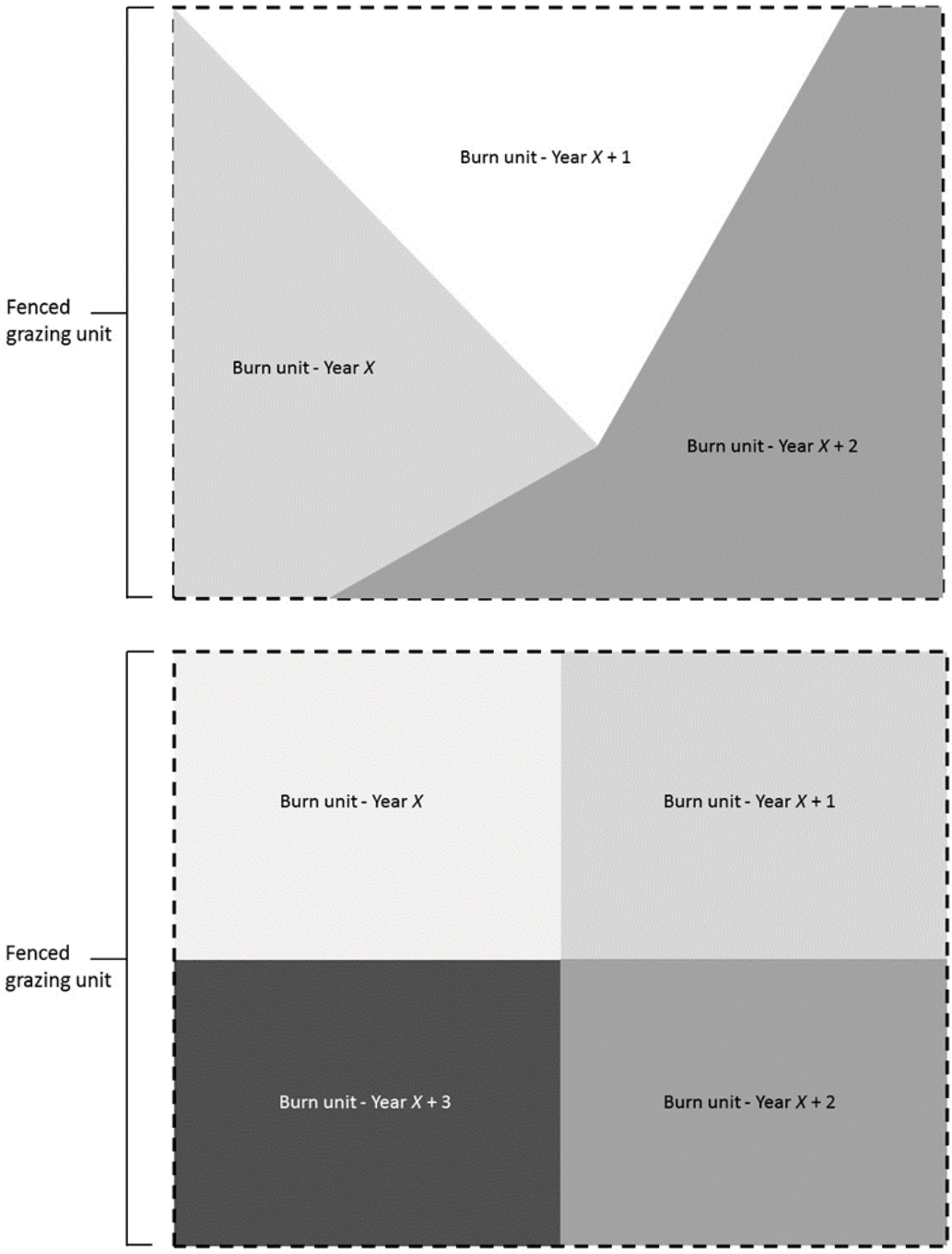
landscape, whereas, animals that are confined to an enclosure will generally do the same until they exhaust all preferred foods and then begin consuming whatever forage remains (Helzer 2010).

Many areas of rangeland at Lake Aquilla are very high in cover of non-native, cool season grasses. An option worth investigating may be to allow cattle to repeatedly and intensively graze these areas in the cooler months over many repeated seasons, and exclude them through the summer and fall months. This repeated grazing pattern over time would likely diminish undesirable cool-season grasses, allowing native warm-season grasses and forbs an opportunity to expand their cover. Using this approach during the summer months for a few seasons could be effective for areas that are currently dominated almost exclusively by warm-season grasses such as switchgrass.

Patch-burn grazing is a method used to manipulate the movement and grazing patterns of bison and cattle using prescribed fire, rather than fences or driving animals to enclosures, and was first employed by the Nature Conservancy to mimic the natural events of fire followed by grazing (Helzer 2010). Grazers concentrate on areas that have burned most recently, and in small numbers periodically on the previous year's burn area, where easily digestible, nutrient rich shoots are abundant. Under the proper stocking rate, areas that have not been burned within the past two years are not likely to be visited by grazers at all, allowing the vegetation to have sufficient time to recover. If livestock visit these unburned areas and persist grazing, then stocking is most likely too high (Helzer 2010).

An example of the patch-burn technique is shown in Figure 39 (A) where each burn unit is given two years of rest between the application of prescribed fire and subsequent grazing, and Figure 39 (B), where each burn unit is given three years of rest. Studies have shown that this technique results in greater plant species richness and grassland bird diversity compared to other treatment methods when livestock are managed at the appropriate stocking rate (Duchardt et al. 2016; Helzer 2010). Stocking rates that are too low can reduce the effectiveness of this method, and must be adjusted year to year depending on range conditions (Duchardt et al. 2016).

Figure 39. (A) Example of a patch-burn grazing regime with a two year rest. (B) Example of a patch-burn grazing regime with a three year rest.



4.4 Monitoring

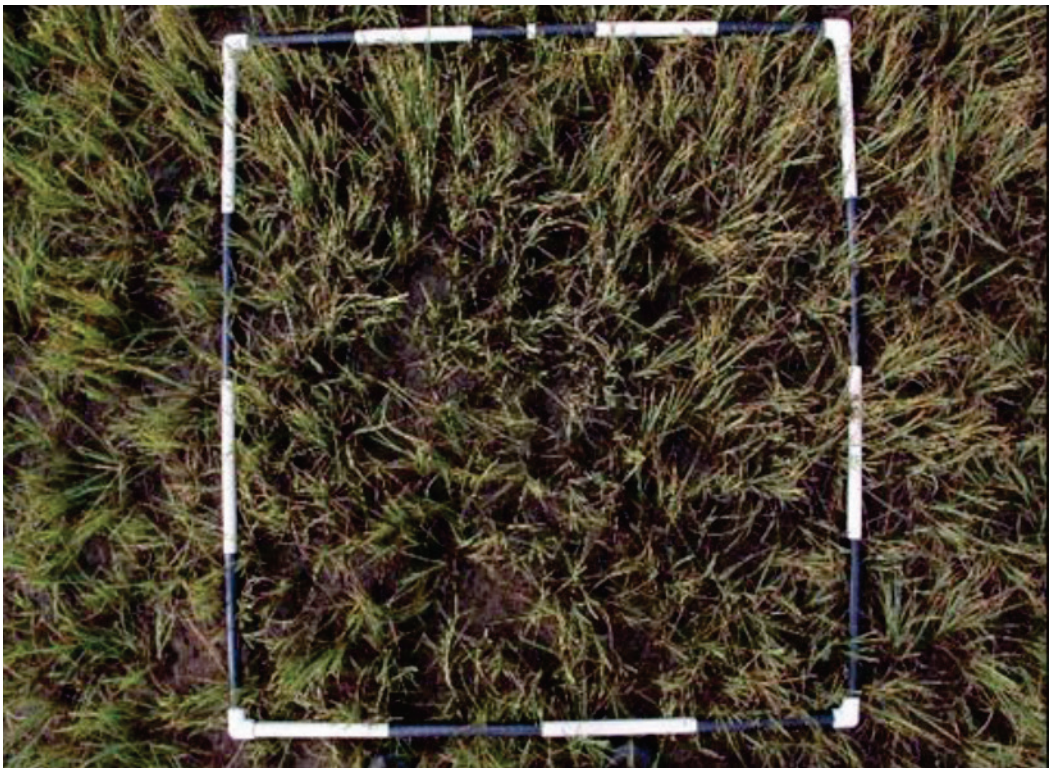
After a restoration project has been initiated, resource managers must determine if the applied treatment(s) was successful, and if any corrective measures or changes in management regime are necessary. Metrics or success criteria that guide these decisions should be incorporated into the

restoration plan during the planning phase, and augmented as the restoration process continues. Assessing the structural features of an ecosystem is a common method used by many disciplines of natural resource management and by agencies with regulatory/policy authority. Common structural features of a prairie could include abundance of native grasses (percent cover), abundance of native forbs, density of woody vegetation (trees or shrubs per unit area), plant species richness (total species), and faunal species richness (e.g., herptofauna, Lepidoptera, small mammals). The structural features being assessed should reflect the desired target condition for the site (e.g., greater abundance of native grasses, decrease in shrubs per acre, greater abundance of Monarch butterfly caterpillars).

Most prairie restoration monitoring efforts focus solely on the vegetation to determine the effects of management activities. If feasible, sampling should be done in the spring and repeated in the fall to capture as much of the potential flora as possible. Quadrat sampling, plots, and transects are the most common methods used for sampling herbaceous vegetation (Packard and Mutel 1997). Common vegetation measurements and calculations include relative frequency (frequency of species *A* ÷ frequency of all species recorded), relative cover (percent cover of species *A* ÷ percent cover of all species recorded), and relative density (number of trees per acre of species *A*).

Quadrats (Figure 40) are usually square units made of tubular PVC designed to occupy a predetermined area (e.g., 0.25 m^2, 1.0 m^2), and are thrown randomly or placed in a systematic manner along a transect line at a given interval. The species present inside the quadrat are recorded as well as their abundance (percentage of the sample occupied by that species). Each subsample is then averaged to represent the overall community. It is important to determine the adequate number of samples needed, as too few samples may provide inaccurate interpretations of what is present and lead to erroneous conclusions about what should be done to the site. Sampling too many quadrats requires additional time sampling and processing data.

Figure 40. Example of a one square meter quadrat, with an estimate of 65 percent cover of a single species (remaining percent is bare ground). Photo credit Nathan R. Beane, 2015.



Plots are established sample areas of square feet, square meters, acres, or hectares, and can be square, rectangular, or circular. They can be allocated randomly or systematically based on a designed grid or according to landscape variables (e.g., topography, soils, elevation). Permanently established plots are helpful on restoration sites because they allow repeated measures of the same area, and its features over time. This may reduce the number of plots that are needed to obtain an accurate representation of the overall site conditions. Installing a section of galvanized metal conduit in the ground is a fast and inexpensive method for permanently marking plot centers or corners.

Transects are linear sampling designs that are especially effective on sites that have gradients in species composition. Typically, the species present is recorded at a predetermined distance interval along the established transect lines. This information tells you the frequency that each species was encountered and where they are located on the landscape.

Floristic Quality Indices (FQI) are used to determine the quality of a particular habitat based on the concept of conservatism ratings, or *C*

values for each plant species, usually rated from 0–10. (Freyman et al. 2016). A species rated zero represents degraded or disturbed sites dominated by undesirable species (i.e. weeds), while a species rated ten occupies only high quality sites. These values may not be available for all areas or species assemblages in question and may have to be developed by an experienced botanist. FQI is typically calculated by multiplying mean C by the square root of the total number of species (n) recorded (FQI = average $C \sqrt{n}$). A site that has an increasing FQI over time, indicates increasing habitat quality.

Keeping detailed records of management activities performed on a restoration site and results of monitoring efforts provides valuable insight for resource managers. Restoration projects often require multiple years to reach the target conditions, even for grassland communities that develop on a much shorter time scale than forested areas. In the early years after project initialization, ruderal or weedy species may dominate the site until desirable vegetation establishes and expands in cover. Some years may show fluctuations in desirable species, due to severe drought or other weather-related phenomena. The resultant conditions should not be immediately interpreted as a failure, the beginning of a downward trend, or allowed to induce panic or abandonment of the original plan.

4.5 Outreach

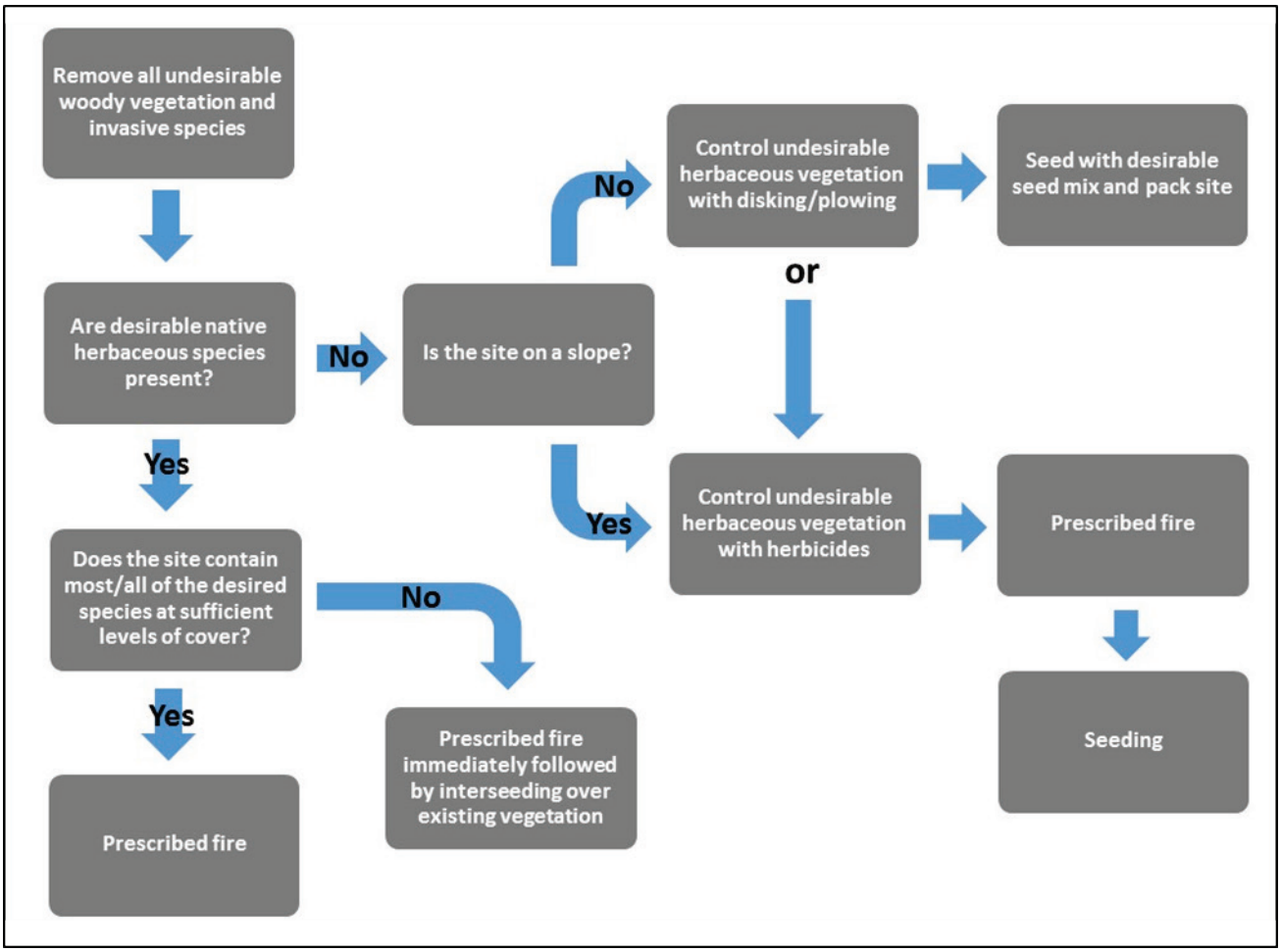
Incorporating education and outreach with local schools and non-profit groups into restoration plans provides opportunities for volunteer work that would otherwise be prohibitively expensive or time consuming (e.g., hand seed collecting). Consider notifying the public of the anticipated or desired outcomes of projects by installing signage, especially in highly visible areas where ongoing activities may appear negative (e.g., tree cutting, burning). Following restoration success, installation of interpretive signage, trails, boardwalks, etc., increases the public's opportunities to engage and learn about the plant and animal communities that are under threat, but also being protected, rehabilitated, and restored.

4.6 Prospective Restoration Concepts

Combinations of the methods described in the current report can be utilized to restore most areas of degraded rangeland, woodlands, and prairie remnants at Lake Aquilla. Figure 41 summarizes these methods in basic sequences of primary activities, based on observed site conditions.

The information in the figure is highly generalized and intended for broad-scale planning purposes only. The section below identifies restoration opportunities at Lake Aquilla and provides specific recommendations on restorative techniques for portions of the survey area.

Figure 41. Decision diagram of primary activities associated with prairie restoration.

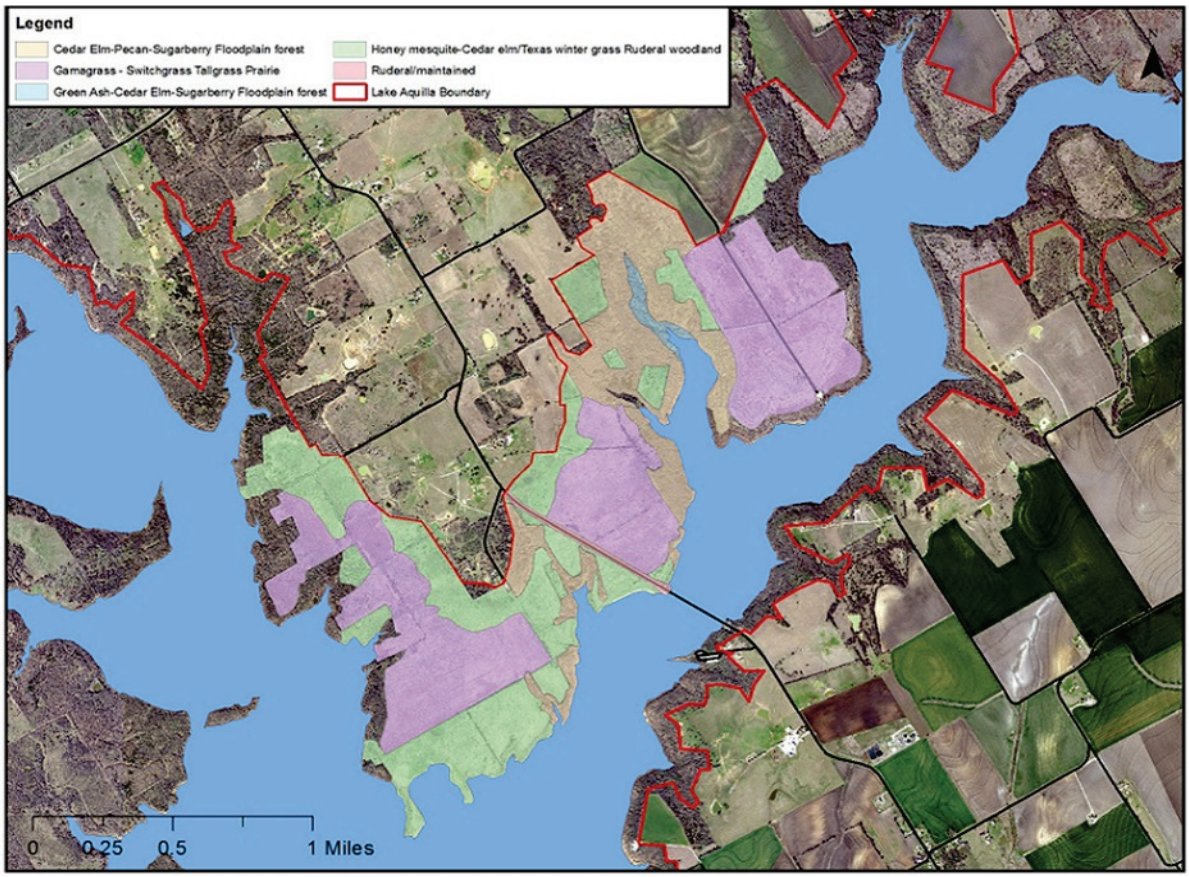


4.7 Contiguous/adjacent prairie

The greatest opportunity to restore contiguous and/or adjacent tallgrass prairie occurs near the center of Lake Aquilla at the confluence of Aquilla Creek and Hackberry Creek (Figure 42). The area has approximately 206.5 hectares (510.4 acres) of switchgrass prairie established. Approximately 151.1 hectares (373.5 acres) of other adjacent vegetation types, mostly made up of degraded rangeland, could undergo restoration via removal of undesirable woody vegetation and subsequent seeding. Some of these areas are relatively small with high amounts of edge, but opportunities for connection with adjacent parcels exist through removal of undesirable

woody vegetation. Planting forbs and grasses other than switchgrass is recommended since this species dominates large areas, excluding other species in some locations. Periodic prescribed fire and an appropriate grazing regime would break down the dominance pattern of switchgrass.

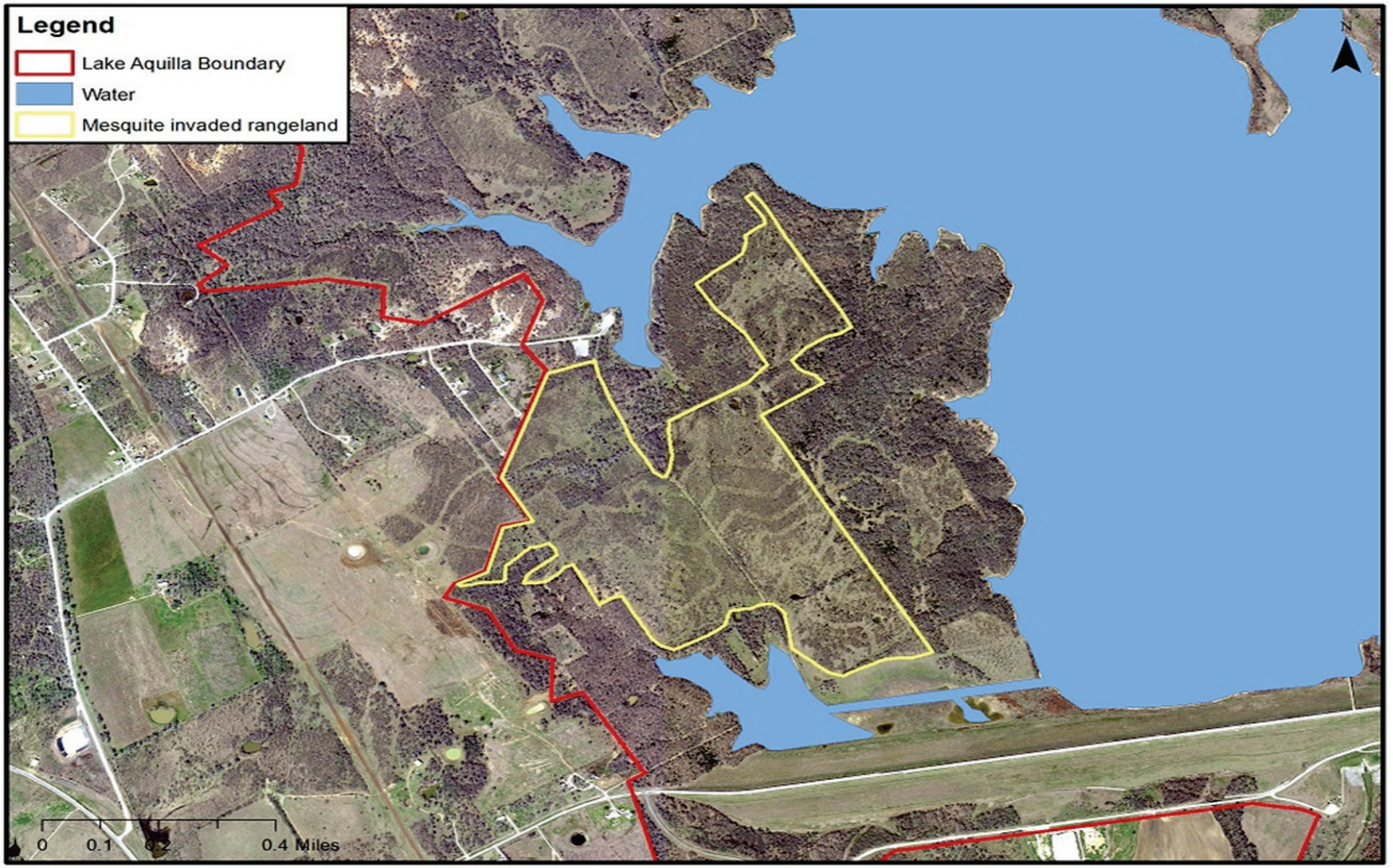
Figure 42. Areas of switchgrass prairie and potential adjacent restoration areas at Lake Aquilla.



4.8 Honey mesquite removal/prairie restoration with public access

A fairly level area of rangeland located northwest of the Lake Aquilla dam (Figure 43) displaying honey mesquite invasion provides the best opportunity to restore a large prairie (approximately 80.9 hectares) that is also readily accessible to the public. Plots LA01 and LA02 established in this area indicated dominance of honey mesquite and non-native grasses, with low cover of native desirable species. Controlling honey mesquite at this site would likely require an aerial application of herbicide such as Sendero®. Mechanical removal usually leaves stumps and roots that are capable of resprouting, and hand applications of herbicide likely remains too labor-intensive to be cost-effective for such a large area. Access to surface water from the lake for post-seeding irrigation purposes also appears to be feasible at this site.

Figure 43. Contiguous area of honey mesquite invaded rangeland, Lake Aquilla, Texas.

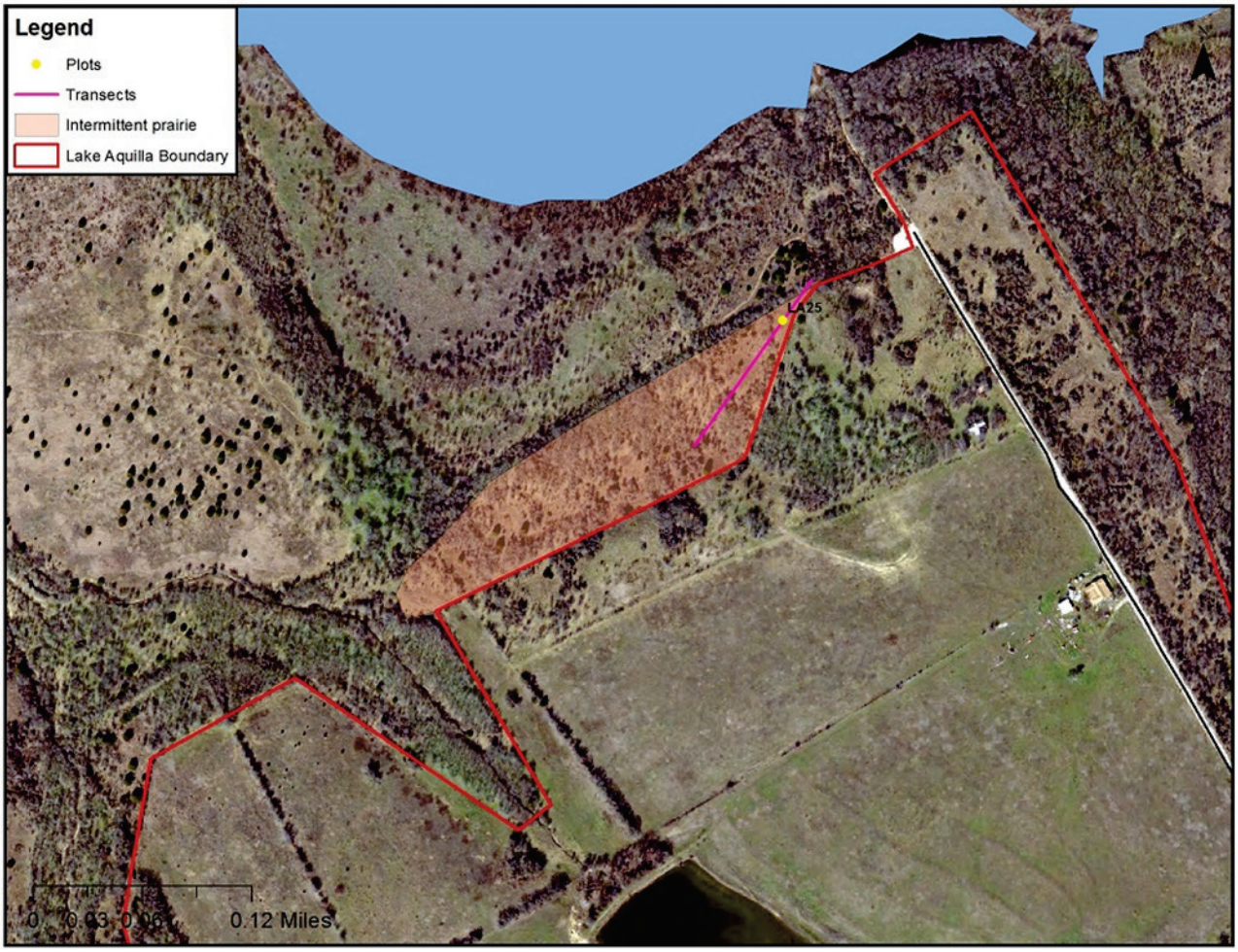


4.9 Prairie remnant expansion

A series of high quality prairie remnants are located near plot LA25 (Figure 44 and Figure 45). They occur as a mosaic of small patches, typically less than 0.4 hectare (one acre), embedded in an area that is dominated by native woody vegetation. Encroachment by woody plants will continue unless prescribed fire or other control measures are implemented. These patches could be connected by tree removal using the hack-and-spray method or cut-and-spray method, taking care not to place cut trees and brush into existing prairie patches. This area is on a slope and could develop erosion problems if mechanical removal is utilized. Removing the dominant woody vegetation increases available space and potential for weedy species. Planting a cover crop such as a native cool season grass (e.g., Virginia or Canada wild-rye) will prevent weeds from dominating these areas, depending on the timing of woody vegetation removal (Packard and Mutel 1997).

Figure 44. Little Bluestem - Indiangrass - Big Bluestem - Prairie Bishop Vertisol Grassland (LA25), Lake Aquilla, Texas.

Figure 45. Intermittent prairie remnants, Lake Aquilla, Texas.



4.10 Restore prairie – rangeland mosaic

An area of prairie-rangeland mosaic occurs near N 31.95131° W 97.16281° (Figure 46), and occupies approximately 14.9 hectares (37 acres). Patches of native forbs and grasses co-occur with patches of non-native grasses and honey-mesquite (Figure 47). Mapping conducted with a sub-meter accuracy GPS to identify desirable vegetation patches allows for restoration to native desirable vegetation and increased patch connectivity. The plastic cover/seeding method or herbicide/prescribed fire/seeding method could be used in this area. Upon successful site restoration, connection with the high quality prairie remnants located nearby within the boundary of Lake Aquilla or with any potential outside remnants becomes feasible.

Figure 46. Prairie-rangeland mosaic near N 31.95131° W 97.16281°, Lake Aquilla, Texas.

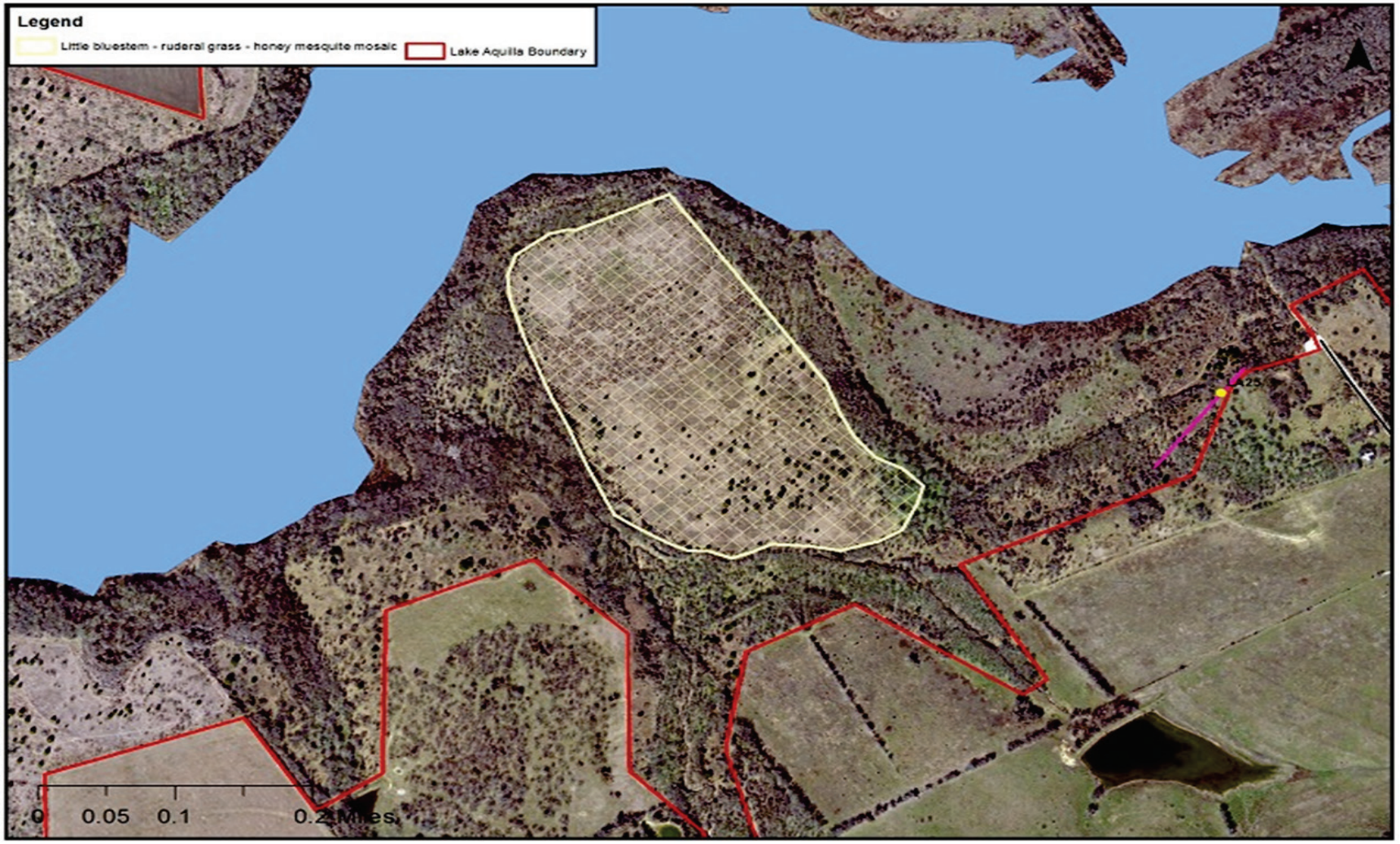


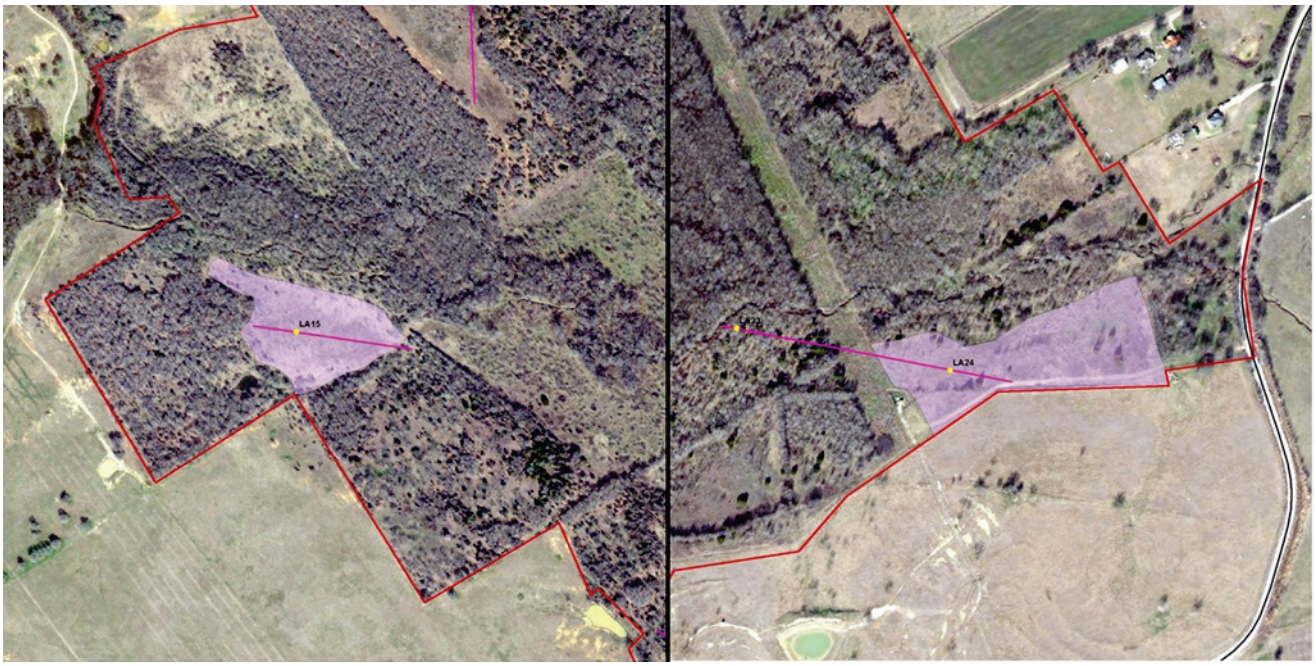
Figure 47. Mosaic of native grasses and forbs, non-native warm season grasses, and honey mesquite, Lake Aquilla, Texas.

4.11 Species assemblage augmentation of prairie remnants

Some areas at Lake Aquilla were initially labeled as high quality prairie remnants during the spring survey, displaying high species richness of native forbs and cool season grasses, with low cover of undesirable woody vegetation. Upon revisiting in the late summer/fall, it was noted that these areas lacked a dominant native warm season grass component, becoming dominated by non-native warm season grasses and/or ruderal forbs. This highlights the importance of examining sites across multiple seasons for determining appropriate classifications, monitoring efforts, and identifying components with restoration potential. Sites with missing components make good candidates for species augmentation rather than replacing the plant community entirely. LA15 and LA24 are examples of such sites, providing opportunities for prescribed fire coupled with immediate interseeding with warm season grasses (Figure 48). LA24

displays the lowest potential due to small size (approximately 1.9 hectares or 4.8 acres), linear shape (high amounts of edge), and lack of adjacent potential habitat, but could serve as a hand-collected seed source for certain species that are needed at other sites.

Figure 48. Communities with a native cool season grass/forb component (LA15 and LA24) but lacked a native warm season grass component, Lake Aquilla, Texas.



5 Summary

Lake Aquilla has a diverse assemblage of plant communities and provides essential habitat for wildlife in a landscape setting dominated by agriculture. Many of these resources have potential for improvement via application of selected restoration techniques described in this report.

The Blackland prairie remnants located at Lake Aquilla are part of an imperiled ecosystem. Active management through prescribed fire and woody vegetation control is recommended, otherwise these resources may further degrade or eventually disappear from the landscape.

Restorative techniques that work well for one area may not be equally effective at all other locations. Utilizing different treatments on smaller portions of an overall area can demonstrate which have the highest performance, and which are most cost effective, prior to applying a single overarching treatment. This approach can potentially result in long term cost savings, and reduce negative effects on wildlife and other natural resources.

Monitoring is a critical component of habitat restoration and must be accounted for in planning, post restoration, and long-term management. Annual monitoring intervals for prairie restoration areas and three to five year intervals for forested communities is recommended.

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Appendix A: Soils of Lake Aquilla

Soil Series	Texture	Landform	% Slope	% of Area	Acres
Altoga	clayey	uplands	2-8	5.10	522.8
Axtell	loamy	uplands	0-5	3.60	365.3
Bastsil	sandy loam	uplands	0-3	0.80	86.8
Birome-Rayex complex	sandy loam	uplands, shallow over sandstone	5-20	3.60	369.0
Blum	loamy	uplands	0-2	0.40	45.8
Branyon	clayey	calcareous terraces	0-1	1.50	149.6
Burleson	clayey	terraces	0-1	0.60	64.2
Chatt	clayey	terraces	1-3	0.60	66.1
Coving-Vaughan complex	sandy loam	drainageways	0-2	1.70	170.3
Crockett	loamy	uplands	1-3	1.10	112.3
Crockett-Wilson complex	loamy	uplands	0-2	0.60	61.3
Crosstell	loamy	uplands	5-12	1.20	118.7
Culp	loamy	uplands	1-3	0.20	21.4
Ferris	clayey	uplands	5-20	0.50	50.2
Ferris-Heiden complex	clayey	uplands	2-5	2.30	240.7
Gasil	loamy	uplands with interbedded sandstone	1-5	3.70	381.2
Gowen	loamy	bottomlands	0-1	1.00	100.4
Heiden	clayey	formed in marine sediments on uplands	1-3	1.50	155.7
Heiden-Urban land complex	clayey	uplands	3-8	0.01	3.3
Houston Black	clayey	uplands	0-3	7.00	721.4
Konsil	loamy	uplands	3-5	3.40	353.1
Kopperl	gravelly/loamy	terraces	1-3	0.30	29.6
Krum	clayey	terraces	0-1	0.20	22.5
Lamar	loamy	uplands	1-5	2.50	248.5
Lamar-Urban land complex	loamy clay	uplands	1-5	0.20	20.5
Mabank	loamy	uplands	0-2	0.50	47.0
Normangee	clayey	alkaline uplands	0-5	4.00	404.6
Pulexas	sandy	floodplains	0-1	0.80	84.1

Pursley	loamy	calcareous bottomlands	0-1	4.30	436.8
Silstid	loamy	uplands, with interbedded sandstone	1-5	0.70	66.0
Tinn	clayey	calcareous bottomlands	0-1	9.30	966.1
Travis	loamy	terraces	1-3	1.50	149.8
Venus	loamy	calcareous terraces	1-5	2.50	252.3
Wilson	clayey	alkaline uplands and terraces	0-3	0.60	68.8

Appendix B: Plot Datasheets

Site Name/Project: Lake Aquilla - Level II Survey					**Date:** 5/16/2016
City/County: Hill County		**State:** Texas			**Plot #:** LA01
Investigators: Kevin Philley / Bailey Gaines					
Latitude/Longitude: N 31.90711° W 97.22397°					**Datum:** WGS84
Plot Size/Shape: 0.04 hectare (1/10th acre), circular					
% Slope: 2		**Landform:** Convex		**Aspect:** Southeast	
Cowardin	**Hydrologic Modifiers**				
_X_ Upland	___ Semipermanently Flooded	___ Intermittently Flooded		Salinity/Halinity	
___ Estuarine	___ Seasonally Flooded	___ Permanently Flooded		___ Saltwater	
___ Riverine	___ Saturated	___ Permanently Flooded tidal		___ Brackish	
___ Palustrine	___ Temporarily Flooded	___ Tidally Flooded		___ Freshwater	
___ Lacustrine					
Surface Geology: Woodbine (Kwb)				**Soil Taxon:** Normangee clay loam	
Soil Texture					
___ sand	___ loamy sand	___ sandy loam	___ loam	___ silt loam	___ silt
_X_ clay loam	___ silty clay	___ clay	___ peat	___ muck	
Soil Drainage					
___ Rapidly drained		___ Well drained		_X_ Moderately well drained	
___ Somewhat poorly drained		___ Poorly drained		___ Very poorly drained	
Unvegetated Surface - % by cover class (see table)					
___ Bedrock		___ Small rocks (2 mm - 10 cm)		___ Wood (>1cm)	
___ Large rocks (> 10 cm)		___ Sand (0.1 - 2mm)		___ Litter	
___ Bare soil		___ Other:			
Leaf Phenology of dominant stratum			**Leaf Type of dominant stratum**		
Trees and shrubs	*Herbs*		_X_ Broad-leaved	___ Graminoid	
___ Evergreen	___ Annual		___ Needle-leaved	___ Forb	
_X_ Cold-deciduous	___ Perennial		___ Microphyllous	___ Pteridophyte	
___ Drought-deciduous					
Physiognomic Class					
___ Forest	___ Woodland	_X_ Shrubland	___ Dwarf shrubland		
___ Herbaceous	___ Nonvascular	___ Sparsely vegetated			

Strata	Height Class	Cover Class	Diagnostic Species (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub	04		*Prosopis glandulosa*
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass	02		*Lolium perenne*
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA01
Stratum	**Species name**	**% Cover (class)**
T2	*Prosopis glandulosa*	15 (03)
T2	*Gleditsia triacanthos*	10 (03)
T2	*Celtis laevigata*	5 (02)
S1	*Prosopis glandulosa*	15 (03)
S1	*Ulmus crassifolia*	5 (02)
S2	*Gleditsia triacanthos*	5 (02)
H	*Lolium perenne*	40 (04)
H	*Solidago altissima*	15 (03)
H	*Bromus catharticus*	10 (03)
H	*Medicago orbicularis*	5 (02)
H	*Oenothera speciosa*	5 (02)
H	*Pyrrhopappus carolinianus*	2 (02)
H	*Elymus canadensis*	2 (02)
H	*Tragia ramosa*	1 (02)
H	*Valerianella radiata*	1 (02)
H	*Carex reniformis*	1 (02)
H	*Rumex pulcher*	1 (02)
H	*Plantago rhodosperma*	2 (02)
H	*Cirsium texanum*	2 (02)
H	*Lathyrus hirsutus*	1 (02)
H	*Lepidium virginicum*	0.5 (01)
H	*Solanum dimidiatum*	0.5 (01)
H	*Solanum elaeagnifolium*	1 (02)
H	*Physalis cinerascens*	1 (02)
V	*Cocculus carolinus*	4 (02)

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA02
Stratum	**Species name**	**% Cover (Class)**
T2	*Prosopis glandulosa*	30 (04)
T2	*Gleditsia triacanthos*	10 (03)
S1	*Prosopis glandulosa*	10 (03)
S1	*Gleditsia triacanthos*	10 (03)
S2	*Ulmus crassifolia*	5 (02)
S2	*Celtis laevigata*	5 (02)
S2	*Symphoricarpos orbiculatus*	5 (02)
H	*Asclepias viridis*	10 (03)
H	*Lolium perenne*	30 (04)
H	*Pyrrhopappus carolinianus*	2 (02)
H	*Rudbeckia hirta*	2 (02)
H	*Briza minor*	2 (02)
H	*Bromus catharticus*	10 (03)
H	*Valerianella radiata*	1 (02)
H	*Hordeum pusillum*	10 (03)
H	*Verbena halei*	1 (02)
H	*Torilis arvensis*	1 (02)
H	*Physalis cinerascens*	2 (02)
H	*Dichanthelium oligosanthes*	5 (02)
H	*Rumex hastatulus*	1 (02)
H	*Cyperus retrorsus*	1 (02)
H	*Cyperus acuminatus*	1 (02)
H	*Cyperus croceus*	1 (02)
H	*Plantago aristata*	1 (02)
H	*Lathyrus hirsuta*	1 (02)
H	*Carex reniformis*	1 (02)
H	*Paspalum dilatatum*	5 (02)
H	*Oenothera laciniata*	1 (02)
H	*Cirsium texanum*	2 (02)
H	*Krigia cespitosa*	0.5 (01)
H	*Dichanthelium acuminatum*	1 (02)
H	*Croton monanthogynus*	3 (02)
V	*Cocculus carolinus*	5 (02)
H	*Juncus marginatus*	3 (02)
H	*Polytaenia texana*	1 (02)

Site Name/Project: Lake Aquilla - Level II Survey					**Date:** 5/16/2016
City/County: Hill County			**State:** Texas		**Plot #:** LA03
Investigators: Kevin Philley / Bailey Gaines					
Latitude/Longitude: N 31.901222° W 97.212528°					**Datum:** WGS84
Plot Size/Shape: 0.04 hectare (1/10th acre), circular					
% Slope: 2		**Landform:** Convex		**Aspect:** East	

Cowardin	**Hydrologic Modifiers**		
___Upland	___Semipermanently Flooded	_X_Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
_X_Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Lamar clay loam

Soil Texture					
___sand	___loamy sand	___sandy loam	___loam	___silt loam	___silt
_X_clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage		
___Rapidly drained	___Well drained	_X_Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)		
___Bedrock	04_Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	_X_Broad-leaved	___Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
_X_Cold-deciduous	___Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class			
___Forest	___Woodland	_X_Shrubland	___Dwarf shrubland
___Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy	04		*Prosopis - Ulmus crassifolia*
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA03
Stratum	**Species name**	**% Cover (class)**
T2	*Ulmus crassifolia*	25 (04)
T2	*Prosopis glandulosa*	10 (03)
S2	*Sideroxylon lanuginosum*	10 (03)
T3	*Gleditsia triacanthos*	5 (02)
H	*Cynodon dactylon*	15 (03)
H	*Iva annua*	10 (03)
S2	*Symphoricarpos orbicularis*	5 (02)
H	*Panicum virgatum*	5 (02)
H	*Verbena halei*	2 (02)
V	*Cocculus carolinus*	2 (02)
H	*Pyrrhopappus carolinianus*	1 (02)
H	*Sabatia campestris*	1 (02)
H	*Phalaris caroliniana*	5 (02)
H	*Mimosa strigillosa*	1 (02)
H	*Lolium perenne*	5 (02)
H	*Geranium carolinianum*	1 (02)
H	*Ipomoea lacunosa*	0.5 (01)
H	*Ambrosia artemissifolia*	5 (02)

Site Name/Project: Lake Aquilla - Level II Survey					**Date:** 5/16/2016
City/County: Hill County			**State:** Texas		**Plot #:** LA04
Investigators: Kevin Philley / Bailey Gaines					
Latitude/Longitude: N 31.900556° W 97.214278°					**Datum:** WGS84
Plot Size/Shape: 5 meter radius					
% Slope: 2		**Landform:** Convex		**Aspect:** South	

Cowardin	**Hydrologic Modifiers**		
_X_Upland	___Semipermanently Flooded	_X_Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	_X_Freshwater
___Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Wilson clay loam

Soil Texture					
___sand	___loamy sand	___sandy loam	___loam	___silt loam	___silt
_X_clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage		
___Rapidly drained	___Well drained	_X_Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)		
___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
02_Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	___Broad-leaved	_X_Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
___Cold-deciduous	_X_Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class			
___Forest	___Woodland	___Shrubland	___Dwarf shrubland
_X_Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA04
Stratum	**Species name**	**% Cover (class)**
T2	*Prosopis glandulosa*	5 (02)
H	*Steinchisma hians*	25 (04)
H	*Carex tetrastachya*	15 (03)
H	*Cyperus acuminatus*	10 (03)
H	*Carex blanda*	1 (02)
H	*Cynodon dactylon*	10 (03)
H	*Iva annua*	5 (02)
H	*Phyla nodiflora*	5 (02)
H	*Mimosa strigillosa*	1 (02)
H	*Anagallis minima*	5 (02)
H	*Ludwigia glandulosa*	1 (02)
H	*Cyperus croceus*	5 (02)
H	*Juncus marginatus*	5 (02)
H	*Juncus bufonius*	2 (02)

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 5/16/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA05
Investigators: Kevin Philley / Bailey Gaines		
Latitude/Longitude: N 31.930083° W 97.241056°		**Datum:** WGS84
Plot Size/Shape: 5 meter radius		
% Slope: 2	**Landform:** Convex	**Aspect:** Southeast

Cowardin	**Hydrologic Modifiers**		
_X_Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Travis fine sandy loam

Soil Texture

___sand	___loamy sand	_X_sandy loam	___loam	___silt loam	___silt
___clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage

___Rapidly drained	_X_Well drained	___Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)

___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	___Broad-leaved	___Graminoid
___Evergreen	___Annual	___Needle-leaved	_X_Forb
___Cold-deciduous	_X_Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class

___Forest	___Woodland	___Shrubland	___Dwarf shrubland
_X_Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA05
Stratum	**Species name**	**% Cover (class)**
H	*Castilleja indivisa*	12 (03)
H	*Sabatia campestris*	15 (03)
H	*Verbena halei*	5 (02)
H	*Daucus pusillus*	3 (02)
H	*Rudbeckia hirta*	3 (02)
H	*Delphinium carolinianum*	2 (02)
S3	*Ulmus crassifolia*	2 (02)
H	*Torilis arvensis*	1 (02)
H	*Cyperus retrorsus*	3 (02)
H	*Monarda citriodora*	5 (02)
H	*Paspalum dilatatum*	8 (03)
H	*Dichanthelium oligosanthes*	5 (02)
H	*Bromus catharticus*	8 (03)
H	*Ambrosia artemissifolia*	2 (02)
H	*Oxalis dillenii*	3 (02)
H	*Mimosa strigillosa*	2 (02)
H	*Cyperus croceus*	1 (02)
H	*Lolium perenne*	3 (02)
H	*Schizachyrium scoparium*	1 (02)
H	*Opuntia phaeacantha*	1 (2)
V	*Smilax bona-nox*	2 (02)
H	*Tragia ramosa*	2 (02)
H	*Nassella leucotricha*	10 (03)
V	*Cocculus carolinus*	1 (02)
H	*Galium virgatum*	1 (02)
H	*Eragrostis sessilispica*	3 (02)
H	*Aristida purpurea*	2 (02)
H	*Vulpia octoflora*	2 (02)
H	*Vicia sativa*	2 (02)
H	*Chaetopappa asteroides*	10 (03)
H	*Polypremum procumbens*	2 (02)
H	*Centaurium texense*	2 (02)
H	*Croton monanthogynus*	2 (02)
H	*Castilleja purpurea*	1 (02)
	Additional Species from October 6, 2016	
H	*Palafoxia callosa*	2 (02)
H	*Gutierrezia dracunculoides*	8 (03)

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 5/16/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA06
Investigators: Kevin Philley / Bailey Gaines		
Latitude/Longitude: N 31.93191° W 97.22757°		**Datum:** WGS84
Plot Size/Shape: Circular, 5 meter radius		
% Slope: 2	**Landform:** Convex	**Aspect:** Southwest

Cowardin	**Hydrologic Modifiers**		
_X_Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Crockett-Wilson complex

Soil Texture

___sand	___loamy sand	_X_sandy loam	___loam	___silt loam	___silt
___clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage

___Rapidly drained	_X_Well drained	___Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)

___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	___Broad-leaved	_X_Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
___Cold-deciduous	_X_Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class

___Forest	___Woodland	___Shrubland	___Dwarf shrubland
_X_Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA06
Stratum	**Species name**	**% Cover (class)**
H	*Ambrosia artemissifolia*	10 (03)
H	*Monarda citriodora*	10 (03)
H	*Rumex hastatulus*	2 (02)
H	*Cnidoscolus texanus*	2 (02)
H	*Triodanus perfoliata*	2 (02)
H	*Velerianella radiata*	3 (02)
H	*Oxalis dillenii*	2 (02)
H	*Bromus catharticus*	10 (03)
H	*Rubus trivialis*	5 (02)
H	*Juncus marginatus*	5 (02)
H	*Sabatia campestris*	5 (02)
H	*Cirsium texanum*	5 (02)
H	*Daucus pusillus*	2 (02)
H	*Carex tetrastachya*	3 (02)
H	*Callirhoe involucrata*	1 (02)
H	*Rudbeckia hirta*	5 (02)
H	*Mimosa strigillosa*	5 (02)
H	*Croton capitatus*	10 (03)
H	*Dichanthelium oligosanthes*	5 (02)
H	*Verbena halei*	5 (02)
H	*Croton monanthogynus*	10 (03)
H	*Lolium perenne*	5 (02)
H	*Oenothera laciniata*	2 (02)
H	*Tragia ramosa*	2 (02)
	Additional Species October 4, 2016	
H	*Tridens flavus*	5 (02)
H	*Heterotheca subaxillaris*	5 (02)
H	*Helenium amarum*	2 (02)

Site Name/Project: Lake Aquilla - Level II Survey					**Date:** 5/16/2016
City/County: Hill County			**State:** Texas		**Plot #:** LA07
Investigators: Kevin Philley / Bailey Gaines					
Latitude/Longitude: N 31.92744° W 97.23889°					**Datum:** WGS84
Plot Size/Shape: 0.04 hectare (1/10th acre), circular					
% Slope: 3		**Landform:** Convex		**Aspect:** East	

Cowardin	**Hydrologic Modifiers**		
_X_Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Pulexas

Soil Texture					
___sand	___loamy sand	_X_sandy loam	___loam	___silt loam	___silt
___clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage		
___Rapidly drained	_X_Well drained	___Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)		
___Bedrock	___Small rocks (2 mm - 10 cm)	01_Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	02_Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	_X_Broad-leaved	___Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
_X_Cold-deciduous	___Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class			
_X_Forest	___Woodland	___Shrubland	___Dwarf shrubland
___Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			*Quercus stellata/Ulmus crassifolia*
T3 Sub-canopy			*Juniperus virginiana*
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #: LA07**
Stratum	**Species name**	**% Cover (class)**
T2	*Ulmus crassifolia*	15 (03)
T2	*Quercus stellata*	20 (03)
T3	*Fraxinus americana*	10 (03)
T3	*Juniperus virginiana*	15 (03)
V	*Gonolobus suberosus*	5 (02)
H	*Dichanthelium oligosanthes*	10 (03)
H	*Chasmanthium latifolium*	20 (03)
H	*Opuntia phaeacantha*	1 (02)
H	*Oxalis dillenii*	1 (02)
V	*Smilax bona-nox*	4 (02)
H	*Elymus canadensis*	2 (02)
H	*Carex bulbostylis*	1 (02)
H	*Galium aparine*	2 (02)
H	*Plantago rhodosperma*	2 (02)
H	*Carex blanda*	1 (02)
H	*Lactuca ludoviciana*	1 (02)
H	*Torilis arvensis*	1 (02)
V	*Rubus trivialis*	1 (02)
H	*Tragia ramosa*	2 (02)
S2	*Symphoricarpos orbiculatus*	2 (02)
V	*Parthenocissus quinquefolia*	3 (02)
S2	*Forestiera pubescens*	3 (02)
H	*Sanicula canadensis*	5 (02)
H	*Ophioglossum engelmannii*	1 (02)
V	*Toxicodendron radicans*	3 (02)
S2	*Sideroxylon lanuginosum*	3 (02)
S2	*Celtis laevigata var. reticulata*	5 (02)
H	*Myosotis macrosperma*	0.5 (01)
H	*Parietaria pensylvanica*	0.5 (01)

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 5/16/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA08
Investigators: Kevin Philley / Bailey Gaines		
Latitude/Longitude: N 31.92783° W 97.23226°		**Datum:** WGS84
Plot Size/Shape: 0.04 hectare (1/10th acre), circular		
% Slope: 10	**Landform:** Convex	**Aspect:** North

Cowardin	**Hydrologic Modifiers**		
_X_ Upland	___ Semipermanently Flooded	___ Intermittently Flooded	Salinity/Halinity
___ Estuarine	___ Seasonally Flooded	___ Permanently Flooded	___ Saltwater
___ Riverine	___ Saturated	___ Permanently Flooded tidal	___ Brackish
___ Palustrine	___ Temporarily Flooded	___ Tidally Flooded	___ Freshwater
___ Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Birome-Rayex complex

Soil Texture

___ sand	___ loamy sand	___ sandy loam	___ loam	___ silt loam	___ silt
_X_ clay loam	___ silty clay	___ clay	___ peat	___ muck	

Soil Drainage

___ Rapidly drained	_X_ Well drained	___ Moderately well drained
___ Somewhat poorly drained	___ Poorly drained	___ Very poorly drained

Unvegetated Surface - % by cover class (see table)

___ Bedrock	05 Small rocks (2 mm - 10 cm)	___ Wood (>1cm)
05 Large rocks (> 10 cm)	___ Sand (0.1 - 2mm)	10 Litter
___ Bare soil	___ Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	_X_ Broad-leaved	___ Graminoid
___ Evergreen	___ Annual	___ Needle-leaved	___ Forb
_X_ Cold-deciduous	___ Perennial	___ Microphyllous	___ Pteridophyte
___ Drought-deciduous			

Physiognomic Class

_X_ Forest	___ Woodland	___ Shrubland	___ Dwarf shrubland
___ Herbaceous	___ Nonvascular	___ Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #: LA08**
Stratum	**Species name**	**% Cover (class)**
T2	*Quercus stellata*	40 (04)
T2	*Ulmus crassifolia*	15 (03)
T2	*Fraxinus americana*	10 (03)
S2	*Rhus trilobata*	5 (02)
S2	*Symphoricarpos orbiculatus*	5 (02)
V	*Smilax bon-nox*	5 (02)
S2	*Prunus mexicana*	2 (02)
S2	*Forestiera pubescens*	5 (02)
T	*Juniperus virginiana*	5 (02)
S1	*Sideroxylon lanuginosum*	5 (02)
V	*Toxicodendron radicans*	3 (02)
H	*Oxalis dillenii*	3 (02)
H	*Carex retroflexa*	5 (02)
H	*Myosotis macrosperma*	0.5 (01)
H	*Galium aparine*	1 (02)
H	*Torilis arvensis*	1 (02)
H	*Rubus trivialis*	5 (02)
S1	*Styphnolobium affine*	10 (03)
H	*Parietaria pensylvanica*	0.5 (01)
H	*Elymus canadensis*	2 (02)
H	*Chasmanthium latifolium*	2 (02)
H	*Gonolobus suberosus*	1 (02)
S1	*Celtis laevigata*	2 (02)
V	*Parthenocissus quinquefolia*	3 (02)
H	*Sanicula canadensis*	1 (02)
H	*Gamochaeta pensylvanica*	0.5 (01)
H	*Woodsia obtusa*	0.5 (01)
V	*Cissus trifoliata*	2 (02)
T3	*Quercus marilandica*	5 (02)

Site Name/Project: Lake Aquilla - Level II Survey					**Date:** 5/17/2016
City/County: Hill County			**State:** Texas		**Plot #:** LA09
Investigators: Kevin Philley / Bailey Gaines					
Latitude/Longitude: N 31.936682° W 97.234554°					**Datum:** WGS84
Plot Size/Shape: 0.04 hectare (1/10th acre), circular					
% Slope: 1		**Landform:** Flat		**Aspect:** n/a	
Cowardin	**Hydrologic Modifiers**				
___Upland	___Semipermanently Flooded		_X_Intermittently Flooded		Salinity/Halinity
___Estuarine	___Seasonally Flooded		___Permanently Flooded		___Saltwater
___Riverine	___Saturated		___Permanently Flooded tidal		___Brackish
___Palustrine	___Temporarily Flooded		___Tidally Flooded		___Freshwater
_X_Lacustrine					
Surface Geology: Woodbine (Kwb)				**Soil Taxon:** Mabank fine sandy loam	
Soil Texture					
___sand	___loamy sand	___sandy loam	_X_loam	___silt loam	___silt
___clay loam	___silty clay	___clay	___peat	___muck	
Soil Drainage					
___Rapidly drained		___Well drained		___Moderately well drained	
___Somewhat poorly drained		_X_Poorly drained		___Very poorly drained	
Unvegetated Surface - % by cover class (see table)					
___Bedrock		___Small rocks (2 mm - 10 cm)		01_Wood (>1cm)	
___Large rocks (> 10 cm)		___Sand (0.1 - 2mm)		01_Litter	
08_Bare soil		___Other:			
Leaf Phenology of dominant stratum			**Leaf Type of dominant stratum**		
Trees and shrubs	*Herbs*		_X_Broad-leaved		___Graminoid
___Evergreen	___Annual		___Needle-leaved		___Forb
_X_Cold-deciduous	___Perennial		___Microphyllous		___Pteridophyte
___Drought-deciduous					
Physiognomic Class					
_X_Forest	___Woodland	___Shrubland	___Dwarf shrubland		
___Herbaceous	___Nonvascular	___Sparsely vegetated			

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy	07		*Carya illinoinensis - Celtis laevigata - Fraxinus penn.*
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA09
Stratum	**Species name**	**% Cover (class)**
T2	*Salix nigra*	10 (03)
T2	*Carya illinoinensis*	25 (03)
T3	*Ulmus crassifolia*	15 (03)
T2	*Fraxinus pennsylvanica*	10 (03)
T3	*Gleditsia triacanthos*	10 (03)
T2	*Celtis laevigata*	5 (02)
S1	*Celtis laevigata*	5 (02)
S1	*Ulmus crassifolia*	5 (02)
S2	*Ilex decidua*	2 (02)
V	*Smilax bona-nox*	3 (02)
S1	*Fraxinus pennsylvanica*	10 (03)
H	*Lemna aequinoctialis*	1 (02)
V	*Vitis mustangensis*	10 (03)
V	*Toxicodendron radicans*	2 (02)
T3	*Maclura pomifera*	2 (02)

Site Name/Project: Lake Aquilla - Level II Survey					**Date:** 5/17/2016
City/County: Hill County			**State:** Texas		**Plot #:** LA10
Investigators: Kevin Philley / Bailey Gaines					
Latitude/Longitude: N 31.93688° W 97.23633°					**Datum:** WGS84
Plot Size/Shape: 0.04 hectare (1/10th acre), circular					
% Slope: 1		**Landform:** flat		**Aspect:** Southeast	

Cowardin	**Hydrologic Modifiers**		
___Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
_X_Palustrine	_X_Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Mabank fine sandy loam

Soil Texture					
___sand	___loamy sand	___sandy loam	___loam	___silt loam	___silt
_X_clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage		
___Rapidly drained	___Well drained	_X_Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)		
___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	05 Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	_X_Broad-leaved	___Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
_X_Cold-deciduous	___Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class			
___Forest	___Woodland	_X_Shrubland	___Dwarf shrubland
___Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			*Ulmus crassifolia - Carya illinoinensis*
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA10
Stratum	**Species name**	**% Cover (class)**
S1	*Prosopis glandulosa*	10 (03)
S1	*Ulmus crassifolia*	65 (05)
S1	*Carya illinoinensis*	3 (02)
V	*Cocculus carolinus*	2 (02)
H	*Iva annua*	10 (03)
H	*Dichanthelium acuminatum*	8 (03)
H	*Phalaris caroliniana*	5 (02)
H	*Sisrynchium minus*	8 (03)
H	*Ambrosia artemissifolia*	2 (02)
H	*Cyperus retrorsus*	3 (02)
H	*Steinchisma hians*	10 (03)
V	*Smilax bona-nox*	2 (02)
H	*Dracopis amplexicaulis*	0.5 (01)
S2	*Gleditsia triacanthos*	2 (02)
H	*Juncus bufonius*	2 (02)
H	*Rubus trivialis*	1 (02)
V	*Toxicodendron radicans*	2 (02)
H	*Elymus canadensis*	30 (04)
S1	*Diospyros virginiana*	2 (02)

Site Name/Project: Lake Aquilla - Level II Survey			**Date:** 5/17/2016
City/County: Hill County	**State:** Texas		**Plot #:** LA11
Investigators: Kevin Philley / Bailey Gaines			
Latitude/Longitude: N 31.94858° W 97.22959°			**Datum:** WGS84
Plot Size/Shape: 0.04 hectare (1/10th acre), circular			
% Slope: 5	**Landform:** convex	**Aspect:** South	

Cowardin	**Hydrologic Modifiers**		
_X_Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Birome-Rayex complex

Soil Texture

___sand	___loamy sand	_X_sandy loam	___loam	___silt loam	___silt
___clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage

___Rapidly drained	_X_Well drained	___Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)

___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
01 Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	05 Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	_X_Broad-leaved	___Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
_X_Cold-deciduous	___Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class

_X_Forest	___Woodland	___Shrubland	___Dwarf shrubland
___Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			*Quercus stellata*
T3 Sub-canopy			*Juniperus virginiana*
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA11
Stratum	**Species name**	**% Cover (class)**
T2	*Quercus stellata*	55 (04)
T2	*Fraxinus texensis*	10 (03)
T3	*Juniperus virginiana*	20 (03)
S1	*Juniperus virginiana*	10 (03)
S1	*Quercus stellata*	10 (03)
V	*Smilax bona-nox*	5 (02)
S2	*Prunus mexicana*	5 (02)
S2	*Rhus trilobata*	10 (03)
H	*Carex annectans*	2 (02)
H	*Opuntia phaeacantha*	1 (02)
S	*Ulmus crassifolia*	2 (02)
S	*Symphoricarpos orbiculatus*	2 (02)
V	*Toxicodendron radicans*	2 (02)
H	*Torilis arvensis*	1 (02)
H	*Solidago radula*	15 (03)
T2	*Juniperus virginiana*	5 (02)
T3	Quercus marilandica	5 (02)

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 5/17/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA12
Investigators: Kevin Philley / Bailey Gaines		
Latitude/Longitude: N 31.94821° W 97.22789°		**Datum:** WGS84
Plot Size/Shape: 5 meter radius		
% Slope: 2	**Landform:** convex	**Aspect:** South

Cowardin	**Hydrologic Modifiers**		
___Upland	___Semipermanently Flooded	_X_Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	_X_Freshwater
_X_Lacustrine			

Surface Geology: Quaternary alluvium (Qal)	**Soil Taxon:** Birome-Rayex complex

Soil Texture

___sand	___loamy sand	___sandy loam	___loam	___silt loam	___silt
_X_clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage

___Rapidly drained	___Well drained	_X_Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)

___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
04_Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	___Broad-leaved	_X_Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
___Cold-deciduous	_X_Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class

___Forest	___Woodland	___Shrubland	___Dwarf shrubland
_X_Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA12
Stratum	**Species name**	**% Cover - (class)**
S1	*Quercus stellata*	2 (02)
S1	*Fraxinus texensis*	2 (02)
S2	*Cephalanthus occidentalis*	5 (02)
H	*Panicum virgatum*	45 (04)
V	*Smilax bona-nox*	15 (03)

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 5/17/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA13
Investigators: Kevin Philley / Bailey Gaines		
Latitude/Longitude: N 31.96105° W 97.25469°		**Datum:** WGS84
Plot Size/Shape: 0.04 hectare (1/10th acre), circular		
% Slope: 3	**Landform:** convex	**Aspect:** Northeast

Cowardin	**Hydrologic Modifiers**		
_X_ Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Axtell fine sandy loam

Soil Texture

___sand	___loamy sand	___sandy loam	_X_ loam	___silt loam	___silt
___clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage

___Rapidly drained	_X_ Well drained	___Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)

___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	01 Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	_X_ Broad-leaved	___Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
_X_ Cold-deciduous	___Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class

___Forest	___Woodland	_X_ Shrubland	___Dwarf shrubland
___Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy	04		*Prosopis glandulosa*
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		Plot #: LA13
Stratum	**Species name**	**% Cover**
T2	*Prosopis glandulosa*	20
T2	*Juniperus virginiana*	15
S1	*Sideroxylon lanuginosum*	15
S1	*Prosopis glandulosa*	10
T2	*Styphnolobium affine*	5
S1	*Celtis laevigata*	3
H	*Cirsium texanum*	2
H	*Torilis arvensis*	3
V	*Cocculus carolinus*	2
S2	*Celtis laevigata*	5
H	*Physalis cinerascens*	2
H	*Tragia ramosa*	4
H	*Rubus trivialis*	5
H	*Opuntia phaeacantha*	10
H	*Lathyrus hirsutus*	5
H	*Bromus catharticus*	35
H	*Lolium perenne*	35
H	*Callirhoe involucrata*	1
H	*Asclepis viridis*	5
S2	*Gleditsia triacanthos*	2
T2	*Ulmus crassifolia*	2
H	*Stellaria media*	1
H	*Dichondra carolinensis*	1
H	*Parietaria pensylvanica*	1
H	*Solanum dimidiatum*	5
H	*Juncus marginatus*	8
H	*Castilleja indivisa*	2
H	*Plantago aristita*	1
H	*Dichanthelium olgigosanthes*	10
H	*Galium aparine*	1
H	*Daucus pusillus*	1
S2	*Quercus stellata*	1
H	*Pyrrhopappus carolinianus*	1
H	*Verbena halei*	2
H	*Hordeum pusillum*	5

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 5/17/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA14
Investigators: Kevin Philley / Bailey Gaines		
Latitude/Longitude: N 31.96068° W 97.25405°		**Datum:** WGS84
Plot Size/Shape: 5 meter radius		
% Slope: 2	**Landform:** convex	**Aspect:** Northeast

Cowardin	**Hydrologic Modifiers**		
_X_ Upland	___ Semipermanently Flooded	___ Intermittently Flooded	Salinity/Halinity
___ Estuarine	___ Seasonally Flooded	___ Permanently Flooded	___ Saltwater
___ Riverine	___ Saturated	___ Permanently Flooded tidal	___ Brackish
___ Palustrine	___ Temporarily Flooded	___ Tidally Flooded	___ Freshwater
___ Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Axtell fine sandy loam

Soil Texture

___ sand	___ loamy sand	___ sandy loam	_X_ loam	___ silt loam	___ silt
___ clay loam	___ silty clay	___ clay	___ peat	___ muck	

Soil Drainage

___ Rapidly drained	_X_ Well drained	___ Moderately well drained
___ Somewhat poorly drained	___ Poorly drained	___ Very poorly drained

Unvegetated Surface - % by cover class (see table)

___ Bedrock	___ Small rocks (2 mm - 10 cm)	___ Wood (>1cm)
___ Large rocks (> 10 cm)	___ Sand (0.1 - 2mm)	___ Litter
___ Bare soil	___ Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	___ Broad-leaved	_X_ Graminoid
___ Evergreen	___ Annual	___ Needle-leaved	___ Forb
___ Cold-deciduous	_X_ Perennial	___ Microphyllous	___ Pteridophyte
___ Drought-deciduous			

Physiognomic Class

___ Forest	___ Woodland	___ Shrubland	___ Dwarf shrubland
_X_ Herbaceous	___ Nonvascular	___ Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA14
Stratum	**Species name**	**% Cover**
H	*Schizachyrium scoparium*	12
H	*Bromus catharticus*	30
H	*Lolium perenne*	25
H	*Asclepias viridis*	2
H	*Yucca arkansana*	5
H	*Engelmannia peristenia*	5
H	*Tragia ramosa*	5
H	*Opuntia phaeacantha*	10
H	*Torilis arvensis*	8
H	*Ambrosia artemissifolia*	5
H	*Daucus pusillus*	5
H	*Solanum dimidiatum*	5
H	*Pyrrhopappus carolinianus*	2
H	*Verbena halei*	2
H	*Castilleja indivisa*	2
H	*Briza minor*	2
H	*Desmodium sp.*	2
H	*Carex austrina*	8
S	*Sideroxylon lunuginosum*	1
H	*Vicia sativa*	3
H	*Valerinella radiata*	1
H	*Juncus marginatus*	5
H	*Lathyrus hirsutus*	1
H	*Galium aparine*	2
H	*Cyperus retrorsus*	2
H	*Croton monanthogynus*	5
H	*Sabatia campestris*	2
H	*Dichanthelium acuminatum*	8

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 5/17/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA15
Investigators: Kevin Philley / Bailey Gaines		
Latitude/Longitude: N 31.96518° W 97.26043°		**Datum:** WGS84
Plot Size/Shape: 0.04 hectare (1/10th acre), circular		
% Slope: 3	**Landform:** Convex	**Aspect:** East

Cowardin	**Hydrologic Modifiers**		
_X_Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Ferris-Heiden complex

Soil Texture

___sand	___loamy sand	___sandy loam	___loam	___silt loam	___silt
_X_clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage

___Rapidly drained	_X_Well drained	___Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)

___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	___Broad-leaved	_X_Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
___Cold-deciduous	___Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class

___Forest	___Woodland	___Shrubland	___Dwarf shrubland
_X_Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA15
Stratum	**Species name**	**% Cover**
S2	*Prosopis glandulosa*	10
S2	*Sideroxylon lanuginosum*	3
H	*Pyrrhopappus carolinianus*	2
H	*Nassella leucotricha*	50
H	*Gaillardia pulchella*	20
H	*Monarda citriodora*	10
H	*Centaurium texense*	2
H	*Warnockia scutellariodes*	2
H	*Lupinus texensis*	2
H	*Helianthemum rosmarinifolium*	1
H	*Physaria gracilis*	1
H	*Lindheimera texana*	2
H	*Galium virgatum*	3
H	*Torilis arvensis*	5
H	*Cirsium texanum*	2
H	*Centaruea americana*	5
H	*Achillea millefolium*	1
H	*Lathyrus hirsutus*	3
H	*Asclepias viridis*	5
H	*Lolium perenne*	5
H	*Bromus catharticus*	12
H	*Castilleja indivisa*	3
H	*Liatris pycnostachya*	3
H	*Triodanus perfoliata*	2
H	*Hedeoma hispida*	5
H	*Oenothera speciosa*	3
H	*Hordeum pusillum*	2
H	*Ambrosia trifida*	1
S	*Ulmus crassifolia*	1
H	*Valerianella radiata*	1
H	*Dichanthelium oligosanthes*	5
H	*Tragia ramosa*	2
H	*Polytaenia texana*	3
H	*Carex austrina*	5
H	*Croton monanthogynus*	2
H	*Elymus canadensis*	2
S	*Gleditsia triacanthos*	1
H	*Ambrosia artemisiifolia*	2
H	*Mimosa strigillosa*	1
H	*Chaerophyllum tainturieri*	1
H	*Linum medium var. texanum*	1
H	*Engelmannia peristenia*	2
H	*Euphorbia spathulata*	1
H	*Glandularia bipinnatifida*	1

Site Name/Project: Lake Aquilla - Level II Survey OCTOBER 6, 2016		**Plot #: LA15**
Stratum	**Species name (NOT RECORDED DURING SPRING SURVEY)**	**% Cover**
H	*Bothriochloa laguroides*	10
H	*Euphorbia bicolor*	10
H	*Croton monanthogynus*	35
H	*Gutierrezia dracunculoides*	30

Site Name/Project: Lake Aquilla - Level II Survey					**Date:** 5/17/2016
City/County: Hill County		**State:** Texas			**Plot #:** LA16
Investigators: Kevin Philley / Bailey Gaines					
Latitude/Longitude: N 31.96999° W 97.25258°					**Datum:** WGS84
Plot Size/Shape: 5 meter circular					
% Slope: 1		**Landform:** flat		**Aspect:** South	

Cowardin	**Hydrologic Modifiers**		
_X_Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Quaternary alluvium (Qal)	**Soil Taxon:** Gasil fine sandy loam

Soil Texture

___sand	___loamy sand	_X_sandy loam	___loam	___silt loam	___silt
___clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage

___Rapidly drained	_X_Well drained	___Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)

___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	___Broad-leaved	_X_Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
___Cold-deciduous	___Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class

___Forest	___Woodland	___Shrubland	___Dwarf shrubland
_X_Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA16
Stratum	**Species name**	**% Cover**
H	*Bromus catharticus*	70
H	*Geranium carolinianum*	10
H	*Ambrosia artemisiifolia*	8
H	*Rubus trivialis*	8
H	*Physalis cinerascens*	2
H	*Vicia villosa*	3
H	*Strophostyles lieosperma*	2
H	*Cnidoscolus texanus*	2
H	*Carex tetrastachya*	3
H	*Ipomoea lacunosa*	1
H	*Galium aparine*	1

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 5/17/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA17
Investigators: Kevin Philley / Bailey Gaines		
Latitude/Longitude: N 31.97027° W 97.25767°		**Datum:** WGS84
Plot Size/Shape: 5 meter, circular		
% Slope: 2	**Landform:** convex	**Aspect:** Southeast

Cowardin	**Hydrologic Modifiers**		
_X_Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Gasil fine sandy loam

Soil Texture

___sand	___loamy sand	_X_sandy loam	___loam	___silt loam	___silt
___clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage

_X_Rapidly drained	___Well drained	___Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)

___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	___Broad-leaved	_X_Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
___Cold-deciduous	_X_Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class

___Forest	___Woodland	___Shrubland	___Dwarf shrubland
_X_Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA17
Stratum	**Species name**	**% Cover**
H	*Panicum virgatum*	10
H	*Gaillardia pulchella*	10
H	*Castilleja indivisa*	5
H	*Sabatia campestris*	5
H	*Solanum dimidiatum*	10
H	*Verbena halei*	5
H	*Dichanthelium acuminatum*	15
H	*Mimosa strigillosa*	10
H	*Monarda citriodora*	5
H	*Opuntia phaeacantha*	5
H	*Asclepias viridis*	5
H	*Linum medium var. texanum*	10
H	*Bromus catharticus*	10
H	*Daucus pusillus*	5
H	*Lechea tenuifolia*	2
H	*Plantago aristita*	5
H	*Helianthemum rosmarinifolium*	12
H	*Aira caryophyllea*	10
H	*Rudbeckia hirta*	10
H	*Polypremum procumbens*	5
H	*Briza minor*	5
H	*Paspalum dilatatum*	5
H	*Juncus marginatus*	5
H	*Lespedeza sp.*	5
H	*Cyperus retrorsus*	1

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 5/18/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA18
Investigators: Kevin Philley / Jared Tadsen		
Latitude/Longitude: N 31.933528° W 97.207028°		**Datum:** WGS84
Plot Size/Shape: 5 meter radius		
% Slope: 1	**Landform:** Convex	**Aspect:** Southwest

Cowardin	**Hydrologic Modifiers**		
_X_Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Mabank fine sandy loam

Soil Texture					
___sand	___loamy sand	_X_sandy loam	___loam	___silt loam	___silt
___clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage		
___Rapidly drained	___Well drained	_X_Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)		
___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	___Broad-leaved	_X_Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
___Cold-deciduous	_X_Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class			
___Forest	___Woodland	___Shrubland	___Dwarf shrubland
_X_Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			*Panicum virgatum*
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		Plot #: LA18
Stratum	**Species name**	**% Cover**
H	*Panicum virgatum*	65
H	*Juncus marginatus*	2
H	*Juncus bufonius*	2
H	*Rubus trivialis*	20
H	*Daucus pusillus*	1
H	*Aira caryophyllea*	5
H	*Rudbeckia hirta*	2
H	*Solidago gigantea*	10
H	*Oxalis dillenii*	3
H	*Gernaium carolinianum*	1
H	*Plantago aristita*	1
H	*Sabatia campestris*	1
H	*Verbena halei*	1
H	*Oenothera speciosa*	1
H	*Monarda citriodora*	2
H	*Centaurium texense*	1
H	*Bromus catharticus*	2
H	*Valerianella radiata*	1
H	*Schizachyrium scoparium*	5
S2	*Prunus mexicana*	1
H	*Tragia ramosa*	1
H	*Cyperus retrorsus*	1
H	*Cirsium texanum*	2

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 5/18/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA19
Investigators: Kevin Philley / Jared Tadsen		
Latitude/Longitude: N 31.93475° W 97.210861°		**Datum:** WGS84
Plot Size/Shape: 0.04 hectare(1/10th acre), circular		
% Slope: 1	**Landform:** Convex	**Aspect:** Southwest

Cowardin	**Hydrologic Modifiers**		
_X_Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Axtell fine sandy loam

Soil Texture

___sand	___loamy sand	___sandy loam	_X_loam	___silt loam	___silt
___clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage

___Rapidly drained	___Well drained	_X_Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)

___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	_X_Broad-leaved	___Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
___Cold-deciduous	___Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class

___Forest	___Woodland	_X_Shrubland	___Dwarf shrubland
___Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		Plot #: LA19
Stratum	**Species name**	**% Cover**
S	*Prosopis glandulosa*	25
H	*Lolium perenne*	55
H	*Panicum virgatum*	2
H	*Ambrosia artemisiifolia*	10
H	*Lathyrus hirsutus*	5
H	*Juncus bufonius*	5
H	*Rudbeckia hirta*	1
H	*Juncus marginatus*	3
H	*Torilis arvensis*	1
H	*Briza minor*	3
H	*Pyrrhopappus carolinianus*	1
H	*Rubus trivialis*	5
H	*Bromus catharticus*	5
H	*Valerianella radiata*	2
H	*Gernaium carolinianum*	2
H	*Eupatorium serotinum*	2
H	*Croton monanthogynus*	5
H	*Hordeum pusillum*	3
H	*Cirsium texanum*	2
H	*Sabatia campestris*	1
H	*Medicago orbicularis*	2
H	*Cyperus sp.*	3
S2	*Ulmus crassifolia*	1
H	*Asclepias viridis*	1
H	*Plantago aristida*	1
H	*Oxalis dillenii*	5
H	*Elymus canadensis*	3
H	*Cyperus acuminatus*	2
H	*Dichanthelium oligosanthes*	2
H	*Carex retrorsus*	2

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 5/18/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA20
Investigators: Kevin Philley / Jared Tadsen		
Latitude/Longitude: N 31.94075° W 97.178806°		**Datum:** WGS84
Plot Size/Shape: 5 meter radius		
% Slope: 2	**Landform:** Convex	**Aspect:** Southeast

Cowardin

_X_Upland
___Estuarine
___Riverine
___Palustrine
___Lacustrine

Hydrologic Modifiers

___Semipermanently Flooded
___Seasonally Flooded
___Saturated
___Temporarily Flooded
___Intermittently Flooded
___Permanently Flooded
___Permanently Flooded tidal
___Tidally Flooded

Salinity/Halinity

___Saltwater
___Brackish
___Freshwater

Surface Geology: Woodbine (Kwb) **Soil Taxon:** Venus loam

Soil Texture

___sand ___loamy sand ___sandy loam ___loam ___silt loam ___silt
_X_clay loam ___silty clay ___clay ___peat ___muck

Soil Drainage

___Rapidly drained ___Well drained _X_Moderately well drained
___Somewhat poorly drained ___Poorly drained ___Very poorly drained

Unvegetated Surface - % by cover class (see table)

___Bedrock ___Small rocks (2 mm - 10 cm) ___Wood (>1cm)
___Large rocks (> 10 cm) ___Sand (0.1 - 2mm) 02_Litter
___Bare soil ___Other:

Leaf Phenology of dominant stratum

Trees and shrubs
___Evergreen
___Cold-deciduous
___Drought-deciduous

Herbs
___Annual
_X_Perennial

Leaf Type of dominant stratum

___Broad-leaved ___Graminoid
___Needle-leaved _X_Forb
___Microphyllous ___Pteridophyte

Physiognomic Class

___Forest ___Woodland ___Shrubland ___Dwarf shrubland
_X_Herbaceous ___Nonvascular ___Sparsely vegetated

Strata	Height Class	Cover Class	Diagnostic Species (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA20
Stratum	**Species name**	**% Cover**
H	*Panicum virgatum*	20
H	*Solidago altissima*	40
H	*Dracopis amplexicaulis*	4
H	*Centaurium texense*	2
H	*Oenothera speciosa*	2
H	*Monarda citriodora*	4
H	*Valerianella radiata*	5
H	*Astragalus nuttallianus*	5
H	*Daucus pusillus*	2
H	*Ptilimnium nuttallii*	2
H	*Ambrosia trifida*	5
H	*Plantago virginica*	2
H	*Triodanis perfoliata*	3
H	*Galium aparine*	3
H	*Vicia sativa*	5
H	*Teucrium canadense*	5
H	*Bothriochloa barbinodis*	2
H	*Croton monanthogynus*	5
H	*Tragia ramosa*	2
H	*Packera tampicana*	1
H	*Galium virgatum*	2
H	*Cocculus carolinus*	1
H	*Oxalis dillenii*	5
H	*Gaillardia pulchella*	1
H	*Xanthium strumarium*	1
H	*Limnodea arkansana*	5

Site Name/Project: Lake Aquilla - Level II Survey					**Date:** 5/18/2016
City/County: Hill County			**State:** Texas		**Plot #:** LA21
Investigators: Kevin Philley / Jared Tadsen					
Latitude/Longitude: N 31.96575° W 97.176889°					**Datum:** WGS84
Plot Size/Shape: 0.04 hectare (1/10th acre), circular					
% Slope: 1		**Landform:** Concave		**Aspect:** South	

Cowardin	**Hydrologic Modifiers**		
___Upland	___Semipermanently Flooded	_X_Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
_X_Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Pursley clay loam

Soil Texture					
___sand	___loamy sand	___sandy loam	___loam	___silt loam	___silt
_X_clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage		
___Rapidly drained	___Well drained	___Moderately well drained
_X_Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)		
___Bedrock	___Small rocks (2 mm - 10 cm)	02 Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	03 Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	_X_Broad-leaved	___Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
_X_Cold-deciduous	___Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class			
_X_Forest	___Woodland	___Shrubland	___Dwarf shrubland
___Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			*Carya illionoinensis/Celtis laevigata*
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA21
Stratum	**Species name**	**% Cover**
T2	*Carya illinoinensis*	25 (03)
T2	*Celtis laevigata*	25 (03)
T2	*Ulmus crassifolia*	8 (03)
T2	*Maclura pomifera*	5 (02)
T2	*Fraxinus pennsylvanica*	5 (02)
T2	*Acer negundo*	2 (02)
V	*Smilax bona-nox*	10 (03)
H	*Elymus canadensis*	30 (04)
H	*Lolium perenne*	0.5 (01)
H	*Allium canadense*	1 (02)
H	*Ambrosia trifida*	2 (02)
V	*Cocculus carolinus*	3 (02)
S	*Symphoricarpos orbiculatus*	2 (02)
V	*Toxicodendron radicans*	5 (02)
H	*Viola sororia*	0.5 (01)
V	*Parthenocissus quinquefolia*	2 (02)
H	*Chasmanthium latifolium*	10 (03)
H	*Galium aparine*	1 (02)
S	*Cornus drummondii*	2 (02)
V	*Passiflora lutea*	1 (02)
H	*Calyptocarpus vialis*	2 (02)
H	*Torilis arvensis*	1 (02)
H	*Sanicula canadensis*	1 (02)
H	*Rivina humilis*	2 (02)
H	*Avena sativa*	0.5 (01)
H	*Phytolacca americana*	1 (02)
V	*Vitis mustangensis*	10 (03)
H	*Myosotis macrosperma*	2 (02)
S	*Sapindus saponaria*	5 (02)
H	*Urtica chamaedryoides*	1 (02)
H	*Stellaria media*	0.5 (01)
H	*Carex blanda*	2 (02)

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 5/18/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA22
Investigators: Kevin Philley / Jared Tadsen		
Latitude/Longitude: N 31.99525° W 97.1425°		**Datum:** WGS84
Plot Size/Shape: 20 meters x 20 meters		
% Slope: 1	**Landform:** concave	**Aspect:** Southeast

Cowardin	**Hydrologic Modifiers**		
___Upland	_X_Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
_X_Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Quaternary alluvium (Qal)	**Soil Taxon:** Tinn clay

Soil Texture

___sand	___loamy sand	___sandy loam	___loam	___silt loam	___silt
___clay loam	___silty clay	_X_clay	___peat	___muck	

Soil Drainage

___Rapidly drained	___Well drained	___Moderately well drained
___Somewhat poorly drained	___Poorly drained	_X_Very poorly drained

Unvegetated Surface - % by cover class (see table)

___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
02_Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	_X_Broad-leaved	___Graminoid
___Evergreen	___Annual	___Needle-leaved	___Forb
_X_Cold-deciduous	___Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class

_X_Forest	___Woodland	___Shrubland	___Dwarf shrubland
___Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy	06	03	*Fraxinus pennsylvanica*
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb	01	07	*Ludwigia peploides*
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA22
Stratum	**Species name**	**% Cover**
T2	*Fraxinus pennsylvanica*	15
T2	*Celtis laevigata*	10
S1	*Fraxinus pennsylvanica*	10
S2	*Celtis leavigata*	5
H	*Ludwigia peploides*	60
H	*Carex tetrastachya*	10
H	*Iva annua*	5
H	*Phylla nodiflora*	2
H	*Polygonum hydropiperoides*	2
H	*Cyperus setigerus*	1
V	*Toxicodendron radicans*	5
H	*Ambrosia trifida*	1
H	*Rumex altissimus*	2
H	*Carex crus-corvi*	1

Site Name/Project: Lake Aquilla - Level II Survey					**Date:** 5/19/2016
City/County: Hill County			**State:** Texas		**Plot #:** LA23
Investigators: Kevin Philley / Jared Tadsen					
Latitude/Longitude: N 31.988639° W 97.137861°					**Datum:** WGS84
Plot Size/Shape: 0.04 hectare (1/10th acre), circular					
% Slope: 2		**Landform:** concave		**Aspect:** South	
Cowardin	**Hydrologic Modifiers**				
___Upland	___Semipermanently Flooded		_X_Intermittently Flooded		Salinity/Halinity
___Estuarine	___Seasonally Flooded		___Permanently Flooded		___Saltwater
___Riverine	___Saturated		___Permanently Flooded tidal		___Brackish
_X_Palustrine	___Temporarily Flooded		___Tidally Flooded		___Freshwater
___Lacustrine					
Surface Geology: Lake Waco (Klw)				**Soil Taxon:** Tinn clay, 0-1% slope	
Soil Texture					
___sand	___loamy sand	___sandy loam	___loam	___silt loam	___silt
___clay loam	___silty clay	_X_clay	___peat	___muck	
Soil Drainage					
___Rapidly drained		___Well drained		_X_Moderately well drained	
___Somewhat poorly drained		___Poorly drained		___Very poorly drained	
Unvegetated Surface - % by cover class (see table)					
___Bedrock		___Small rocks (2 mm - 10 cm)		___Wood (>1cm)	
___Large rocks (> 10 cm)		___Sand (0.1 - 2mm)		02_Litter	
___Bare soil		___Other:			
Leaf Phenology of dominant stratum			**Leaf Type of dominant stratum**		
Trees and shrubs	*Herbs*		_X_Broad-leaved		___Graminoid
___Evergreen	___Annual		___Needle-leaved		___Forb
_X_Cold-deciduous	___Perennial		___Microphyllous		___Pteridophyte
___Drought-deciduous					
Physiognomic Class					
_X_Forest	___Woodland	___Shrubland	___Dwarf shrubland		
___Herbaceous	___Nonvascular	___Sparsely vegetated			

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA23
Stratum	**Species name**	**% Cover**
T2	*Celtis laevigata*	40 (04)
T2	*Juniperus virginiana*	15 (03)
S1	*Sapindus saponaria*	10 (03)
H	*Ambrosia trifida*	15 (03)
H	*Torilis arvensis*	10 (03)
H	*Myosotis macrosperma*	1 (02)
H	*Dracopis amplexicaulis*	5 (02)
H	*Lolium perenne*	5 (02)
H	*Erigeron strigosus*	5 (02)
S1	*Ulmus crassifolia*	2 (02)
H	*Symphoricarpos orbiculatus*	2 (02)
V	*Toxicodendron radicans*	1 (02)
H	*Elymus canadensis*	5 (02)
H	*Vicia ludoviciana*	1 (02)
H	*Geranium texanum*	0.5 (01)
H	*Allium canadense*	3 (02)
H	*Carex tetrastachya*	1 (02)
H	*Iva annua*	1 (02)
T2	*Salix nigra*	3 (02)
H	*Carex texensis*	2 (02)
H	*Carex blanda*	3 (02)
H	*Dichondra carolinensis*	1 (02)
V	*Smilax bona-nox*	2 (02)
H	*Valerinella radiata*	0.5 (01)
H	*Medicago orbicularis*	0.5 (01)
H	*Mimosa strigillosa*	1 (02)
S1	*Celtis laevigata*	15 (03)
H	*Hypochaeris brasiliensis*	0.5 (01)

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 5/19/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA24
Investigators: Kevin Philley / Jared Tadsen		
Latitude/Longitude: N 31.98825° W 97.135725°		**Datum:** WGS84
Plot Size/Shape: 5 meter radius		
% Slope: 3	**Landform:** convex	**Aspect:** North

Cowardin	**Hydrologic Modifiers**		
_X_Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Lake Waco (Klw)	**Soil Taxon:** Ferris-Heiden Complex

Soil Texture					
___sand	___loamy sand	___sandy loam	___loam	___silt loam	___silt
_X_clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage		
___Rapidly drained	_X_Well drained	___Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)		
___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	___Broad-leaved	___Graminoid
___Evergreen	_X_Annual	___Needle-leaved	_X_Forb
___Cold-deciduous	___Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class			
___Forest	___Woodland	___Shrubland	___Dwarf shrubland
_X_Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		Plot #: LA24
Stratum	**Species name**	**% Cover (class)**
H	*Gaillardia pulchella*	15 (03)
H	*Monarda citriodora*	5 (02)
H	*Helianthus sp.*	5 (02)
H	*Castilleja purpurea*	3 (02)
H	*Erigeron strigosus*	2 (02)
H	*Linum rigidum*	5 (02)
H	*Medicago orbicularis*	3 (02)
H	*Bromus catharticus*	2 (02)
H	*Bifora americana*	15 (03)
H	*Bouteloua rigidiseta*	10 (03)
H	*Diaperia verna*	3 (02)
H	*Linum medium*	3 (02)
H	*Mimosa strigillosa*	5 (02)
H	*Castilleja indivisa*	5 (02)
H	*Desmanthus sp.*	1 (02)
H	*Solanum dimidiatum*	2 (02)
H	*Liatris sp.*	15 (03)
H	*Nasella leucotricha*	5 (02)
H	*Centaurium texense*	3 (02)
H	*Oenothera suffulta*	0.5 (01)
H	*Dalea purpurea*	2 (02)
H	*Eryngium leavenworthii*	1 (02)
H	*Solidago altissima*	3 (02)
H	*Sphenopholis obtustata*	5 (02)
H	*Galium virgatum*	0.5 (01)
H	*Galium aparine*	1 (02)
H	*Pyrrhopappus carolinianus*	2 (02)
H	*Phyllanthus polygonoides*	4 (2)
H	*Stenaria nigricans*	2 (02)
	Additional Species from October 6, 2016	
H	*Andropogon glomeratus*	1
H	*Eriochloa sericea*	2
H	*Solidago altissima*	10
H	*Liatris mucronata*	2
H	*Gutierrezia dracunculoides*	15
H	*Bothriochloa laguroides*	15
H	*Bothriochloa ischaemum*	20

Site Name/Project: Lake Aquilla - Level II Survey					**Date:** 5/19/2016
City/County: Hill County			**State:** Texas		**Plot #:** LA25
Investigators: Kevin Philley / Jared Tadsen					
Latitude/Longitude: N 31.951167° W 97.156056°					**Datum:** WGS84
Plot Size/Shape: 5 meter radius					
% Slope: 3		**Landform:** convex		**Aspect:** Northwest	

Cowardin	**Hydrologic Modifiers**		
_X_Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Lake Waco (Klw)	**Soil Taxon:** Altoga clay loam

Soil Texture					
___sand	___loamy sand	___sandy loam	___loam	___silt loam	___silt
_X_clay loam	___silty clay	___clay	___peat	___muck	

Soil Drainage		
___Rapidly drained	_X_Well drained	___Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)		
___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
___Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	___Broad-leaved	_X_Graminoid
___Evergreen	___Annual	___Needle-leaved	_X_Forb
___Cold-deciduous	_X_Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class			
___Forest	___Woodland	___Shrubland	___Dwarf shrubland
_X_Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA25
Stratum	**Species name**	**% Cover (class)**
S	*Prosopis glandulosa*	10 (03)
S	*Celtis laevigata*	2 (02)
H	*Engelmannia peristenia*	3 (02)
H	*Asclepias asperula*	1 (02)
H	*Gaillardia pulchella*	10 (03)
H	*Centaurea americana*	2 (02)
H	*Delphinium carolinianum*	5 (02)
H	**Schizachyrium scoparium*	5 (02)
H	*Liatris mucronata*	15 (03)
H	*Castilleja indivisa*	3 (02)
H	*Penstemon cobaea*	1 (02)
V	*Matelea biflora*	1 (02)
H	*Bromus catharticus*	8 (03)
V	*Convolvulvus equitans*	1 (02)
H	*Yucca arkansana*	2 (02)
H	*Croton monanthogynus*	5 (02)
H	*Scutellaria drummondii*	1 (02)
H	*Cirsium texanum*	2 (02)
H	*Krameria lanceolata*	5 (02)
H	*Lindheimera texana*	2 (02)
H	*Mimosa strigillosa*	3 (02)
H	*Opuntia phaeacantha*	2 (02)
H	*Hybanthus verticillata*	2 (02)
H	*Tragia ramosa*	1 (02)
H	*Callirhoe pedata*	1 (02)
H	*Geranium carolinianum*	2 (02)
H	*Vicia sativa*	1 (02)
H	*Euphorbia missurica*	5 (02)
H	*Dichanthelium oligosanthes*	5 (02)
H	*Galium virgatum*	1 (02)
H	*Bupleurum rotundifolium*	1 (02)
H	*Physalis cinerascens*	1 (02)
H	*Dyschoriste linearis*	1 (02)
H	*Solanum dimidiatum*	1 (02)
H	*Cardiospermum halicacabum*	2 (02)
H	*Torilis arvensis*	5 (02)
H	*Eryngium leavenworthii*	1 (02)
H	*Coelorachis cylindrica*	5 (02)
H	*Medicago orbicularis*	1 (02)
H	*Asclepias viridiflora*	1 (02)
H	*Euphorbia spathulata*	1 (02)
H	*Linum pratense*	1 (02)
H	*Valerianella radiata*	1 (02)
H	*Carex planostachys*	2 (02)

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA25
Stratum	**Species name (Additional from October 2016)**	**% Cover**
H	*Helianthus maximiliani*	25
H	*Sporobolus compositus*	8
	**Schizachyrium scoparium* cover increased from 5 to 35	

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA26
Stratum	**Species name**	**% Cover**
T2	*Quercus stellata*	25
S2	*Quercus stellata*	10
S1	*Quercus stellata*	15
S2	*Quercus marilandica*	5
S1	*Quercus marilandica*	8
H	*Opuntia phaecantha*	5
H	*Schizacyrium scoparium*	15
H	*Aristida longespica*	10
H	*Gutierrezia dracunculoides*	5
H	*Liatris pycnostachia*	2
H	*Bothriochloa laguroides*	1
H	*Asclepias viridis*	1
H	*Carex sp.*	2
H	*Solidago radula*	2
H	*Sporobolus compositus*	2
H	*Opuntia leptocaulis*	2
H	*Linum medium var. texense*	1
H	*Neptunia lutea*	0.5

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 10/04/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA26
Investigators: Kevin Philley / Michael Guilfoyle / Bailey Gaines		
Latitude/Longitude: N 31.91927° W 97.23002°		**Datum:** WGS84
Plot Size/Shape: 0.04 hectare		
% Slope: 3	**Landform:** convex	**Aspect:** Southeast

Cowardin	**Hydrologic Modifiers**		
_X_ Upland	___ Semipermanently Flooded	___ Intermittently Flooded	Salinity/Halinity
___ Estuarine	___ Seasonally Flooded	___ Permanently Flooded	___ Saltwater
___ Riverine	___ Saturated	___ Permanently Flooded tidal	___ Brackish
___ Palustrine	___ Temporarily Flooded	___ Tidally Flooded	___ Freshwater
___ Lacustrine			

Surface Geology: Woodbine (Kwb)	**Soil Taxon:** Ferris clay

Soil Texture

___ sand	___ loamy sand	_X_ sandy loam	___ loam	___ silt loam	___ silt
___ clay loam	___ silty clay	___ clay	___ peat	___ muck	

Soil Drainage

_X_ Rapidly drained	___ Well drained	___ Moderately well drained
___ Somewhat poorly drained	___ Poorly drained	___ Very poorly drained

Unvegetated Surface - % by cover class (see table)

___ Bedrock	04 Small rocks (2 mm - 10 cm)	___ Wood (>1cm)
02 Large rocks (> 10 cm)	___ Sand (0.1 - 2mm)	___ Litter
04 Bare soil	___ Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	_X_ Broad-leaved	___ Graminoid
___ Evergreen	___ Annual	___ Needle-leaved	___ Forb
_X_ Cold-deciduous	___ Perennial	___ Microphyllous	___ Pteridophyte
___ Drought-deciduous			

Physiognomic Class

___ Forest	_X_ Woodland	___ Shrubland	___ Dwarf shrubland
___ Herbaceous	___ Nonvascular	___ Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Date:** 10/05/2016
City/County: Hill County	**State:** Texas	**Plot #:** LA27
Investigators: Kevin Philley / Michael Guilfoyle/ Bailey Gaines		
Latitude/Longitude: N 31.95757° W 97.13915°		**Datum:** WGS84
Plot Size/Shape: 0.04 hectare		
% Slope: 4	**Landform:** convex	**Aspect:** North

Cowardin	**Hydrologic Modifiers**		
_X_Upland	___Semipermanently Flooded	___Intermittently Flooded	Salinity/Halinity
___Estuarine	___Seasonally Flooded	___Permanently Flooded	___Saltwater
___Riverine	___Saturated	___Permanently Flooded tidal	___Brackish
___Palustrine	___Temporarily Flooded	___Tidally Flooded	___Freshwater
___Lacustrine			

Surface Geology: Lake Waco (Klw)	**Soil Taxon:** Altoga clay loam

Soil Texture

___sand	___loamy sand	___sandy loam	___loam	___silt loam	___silt
___clay loam	___silty clay	_X_clay	___peat	___muck	

Soil Drainage

___Rapidly drained	_X_Well drained	___Moderately well drained
___Somewhat poorly drained	___Poorly drained	___Very poorly drained

Unvegetated Surface - % by cover class (see table)

___Bedrock	___Small rocks (2 mm - 10 cm)	___Wood (>1cm)
___Large rocks (> 10 cm)	___Sand (0.1 - 2mm)	___Litter
03_Bare soil	___Other:	

Leaf Phenology of dominant stratum		**Leaf Type of dominant stratum**	
Trees and shrubs	*Herbs*	___Broad-leaved	___Graminoid
_X_Evergreen	___Annual	_X_Needle-leaved	___Forb
___Cold-deciduous	___Perennial	___Microphyllous	___Pteridophyte
___Drought-deciduous			

Physiognomic Class

___Forest	_X_Woodland	___Shrubland	___Dwarf shrubland
___Herbaceous	___Nonvascular	___Sparsely vegetated	

Strata	**Height Class**	**Cover Class**	**Diagnostic Species** (*if known*)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short shrub			
S3 Dwarf shrub			
H Herbaceous			
Grass			
Forb			
Fern			
N Nonvascular			
V Vine/liana			
E Epiphyte			

Site Name/Project: Lake Aquilla - Level II Survey		**Plot #:** LA27
Stratum	**Species name**	**% Cover (class)**
T2	*Juniperus ashei*	30
H	*Helianthus maximiliani*	5
H	*Schizachyrium scoparium*	10
H	*Agalinis heterophylla*	10
H	*Yucca arkansana*	5
H	*Gutierrezia dracunculoides*	15
H	*Ambrosia trifida*	3
H	*Sporobolus compositus*	5
H	*Eryngium leavenworthii*	5
H	*Liatris mucronata*	5
H	*Symphiotrichum ericoides*	2
H	*Solidago radula*	2
H	*Solidago altissima*	5
H	*Aristida oligantha*	2
H	*Croton monanthogynus*	10
H	*Mimosa strigillosa*	2
H	*Toxicodendron radicans*	2
V	*Smilax bona-nox*	2
S2	*Sideroxylon lanuginosum*	1
H	*Bothriochloa laguroides*	5
H	*Bothriochloa isachemum*	10
S1	*Ulmus crassifolia*	1
H	*Glandularia bipinnatifida*	1
H	*Paspalum dilatatum*	1
H	*Heliotropum tenellum*	0.5
H	*Melilotus indicus*	1
H	*Brickellia eupatoriodes*	1
H	*Eriogonum longifolium*	1

Appendix C: Plot Locations (WGS 84)

LA01	N 31.90711°	W 97.22397°
LA02	N 31.904778°	W 97.222083°
LA03	N 31.901222°	W 97.212528°
LA04	N 31.900556°	W 97.214278°
LA05	N 31.930083°	W 97.241056°
LA06	N 31.93191°	W 97.22757°
LA07	N 31.92744°	W 97.23889°
LA08	N 31.92783°	W 97.23226°
LA09	N 31.936682°	W 97.234554°
LA10	N 31.93688°	W 97.23633°
LA11	N 31.94858°	W 97.22959°
LA12	N 31.94821°	W 97.22789°
LA13	N 31.96105°	W 97.25469°
LA14	N 31.96068°	W 97.25405°
LA15	N 31.96518°	W 97.26043°
LA16	N 31.96999°	W 97.25258°
LA17	N 31.97027°	W 97.25767°
LA18	N 31.933528°	W 97.207028°
LA19	N 31.93475°	W 97.210861°
LA20	N 31.94075°	W 97.178806°
LA21	N 31.96575°	W 97.176889°
LA22	N 31.99525°	W 97.14250°
LA23	N 31.988639°	W 97.137861°
LA24	N 31.98825°	W 97.135725°
LA25	N 31.951167°	W 97.156056°
LA26	N 31.91927°	W 97.23002°
LA27	N 31.95757°	W 97.13915°

Appendix D: Summary of Plant Taxa

All species recorded from survey plots, with common names, arranged by major clade, and subsequently by alphabetical order after their particular family. Species that are considered non-native to North America are preceded by a dagger (†). Species that are considered native to North America, but not to Hill County, Texas are preceded with double daggers (‡). Species that have questionable nativity and/or occur as a mix of native and non-native genotypes are preceded with a darkened circle (●). Species that are new records for Hill County, and represented by a voucher specimen are preceded by a star (*).

Clade/Family/*Scientific name*	**Common name(s)**
Polypodiophyta	
Dryopteridaceae	
**Woodsia obtusa* (Spreng.) Torr.	Bluntlobe cliff fern
Ophioglossaceae	
**Ophioglossum engelmannii* Prantl	Limestone adders-tongue fern
Coniferophyta	
Cupressaceae	
Juniperus ashei J. Buchholz	Ashe's juniper
Juniperus virginiana L.	Eastern red-cedar
Magnoliophyta	
Acanthaceae	
Dyschoriste linearis (Torr. & A. Gray) Kuntze	Narrowleaf snakeherb
Agavaceae	
Yucca arkansana Trel.	Arkansas yucca
Amaryllidaceae	
Allium canadense L.	Field garlic
Anacardiaceae	
Rhus trilobata Nutt.	Skunkbush sumac
Toxicodendron radicans (L.) Kuntze	Poison-ivy
Apiaceae	
Chaerophyllum tainturieri Hook.	Hairyfruit chervil
Bifora americana Benth. & Hook. f. ex S. Watson	Prairie bishop
†**Bupleurum rotundifolium* L.	Hare's ear
Daucus pusillus Michx.	Wild carrot
Polytaenia texana (J.M. Coult. & Rose)	Texas prairie parsley

Mathias & Constance	
Ptilimnium nuttallii (DC.) Britton	Laceflower
Sanicula canadensis L.	Canadian snakeroot
†**Torilis arvensis* (Huds.) Link	Hedge-parsley
Asclepiadaceae	
**Asclepias asperula* (Decne.) Woodson	Antelope-horns
Asclepias viridiflora Raf.	Green comet
Asclepias viridis Walter	Green antelopehorn
Gonolobus suberosus var. *suberosus* (L.) Br.	Anglepod
**Matelea biflora* (Raf.) Woodson	Star milkvine
Asteraceae	
●*Achillea millefolium* L.	Common yarrow
Ambrosia artemisiifolia L.	Annual ragweed
Ambrosia trifida L.	Giant ragweed
Amphiachyris dracunculoides (DC.) Nutt.	Common broomweed
Brickellia eupatorioides (L.) Shinners	False boneset
†*Calyptocarpus vialis* Less.	Straggler daisy
Centaurea americana Nutt.	American star-thistle
Chaetopappa asteroides Nutt. ex DC.	Arkansas least daisy
**Cirsium texanum* Buckley	Texas thistle
Diaperia verna (Raf.) Morefield	Spring pygmy cudweed
**Dracopis amplexicaulis* (Vahl) Cass.	Clasping coneflower
Engelmannia peristenia (Raf.) Goodman & C.A. Lawson	Engelmann's daisy
Erigeron strigosus Muhl. ex Willd.	Prairie fleabane
Eupatorium serotinum Michx.	Lateflowering thoroughwort
Gaillardia pulchella Foug.	Blanket-flower
Gamochaeta pensylvanica (Willd.) Cabrera	Cudweed
Helenium amarum (Raf.) H. Rock	Bitterweed
Helianthus maximiliani Schrad.	Maximilian sunflower
Heterotheca subaxillaris (Lam.)	Camphorweed
†*Hypochaeris brasiliensis* (Less.) Benth. & Hook. ex Griseb.	Brazilian cat's ear
Iva annua L.	Marsh-elder
Krigia caespitosa (Raf.) K.L. Chambers	Weedy dwarf-dandelion
Lactuca ludoviciana (Nutt.) Riddell	Biannual lettuce
Liatris mucronata DC.	Narrow-leaf gayfeather
Liatris pycnostachya Michx.	Kansas gayfeather
Lindheimera texana A. Gray & Engelm.	Texas yellowstar
Packera tampicana (DC.) C. Jeffrey	Great Plains ragwort
Palafoxia callosa (Nutt.) Torr. & A. Gray	Small palafoxia

Pyrrhopappus carolinianus (Walter) DC.	Carolina desert-chicory
Rudbeckia hirta L.	Blackeyed Susan
Solidago altissima	Canada goldenrod
Solidago gigantea Aiton	Giant goldenrod
Solidago radula Nutt.	Western rough goldenrod
Symphyotrichum ericoides (L.) G.L. Nesom	White heath aster
Xanthium strumarium L.	Cocklebur
Aquifoliaceae	
Ilex decidua Walter	Deciduous holly
Boraginaceae	
**Heliotropium tenellum* (Nutt.) Torr	Pasture heliotrope
Myosotis macrosperma Engelm.	Largeseed forget-me-not
Brassicaceae	
Lepidium virginicum L.	Pepperweed
Physaria gracilis (Hook.) O'Kane & Al-Shehbaz	Spreading bladderpod
Buddlejaceae	
**Polypremum procumbens* L.	Juniper leaf
Cactaceae	
Cylindropuntia leptocaulis (DC.) F.M. Knuth	Jumping cactus, pencil cactus
Opuntia phaeacantha Engelm.	Tulip pricklypear
Campanulaceae	
Triodanis perfoliata (L.) Nieuwl.	Venus' looking glass
Cannabaceae	
Celtis laevigata Willd. *var. laevigata*	Sugarberry, Southern hackberry
Celtis laevigata Willd. *var. reticulata* (Torr.) L.D. Benson	Netleaf hackberry
Caprifoliaceae	
**Symphoricarpos orbiculatus* Moench	Coralberry
Caryophyllaceae	
†*Stellaria media* (L.) Vill.	Common chickweed
Cistaceae	
**Helianthemum rosmarinifolium* Pursh	Rosemary sun-rose
Lechea tenuifolia Michx.	Narrowleaf pinweed
Convolvulaceae	
**Convolvulus equitans* Benth.	Texas bindweed
Dichondra carolinensis Michx.	Ponysfoot

Ipomoea lacunosa L.	Whitestar
Cornaceae	
Cornus drummondii C.A. Mey.	Roughleaf dogwood
Cyperaceae	
Carex annectens (E.P. Bicknell) E.P. Bicknell	Yellowfruit sedge
**Carex austrina* (Small) Mack.	Southern sedge
Carex blanda Dewey	Eastern woodland sedge
**Carex bulbostylis* Mack.	False hair sedge
Carex crus-corvi Shuttlw. ex Kunze	Ravenfoot sedge
Carex planostachys Kunze	Cedar sedge
**Carex reniformis* (L.H. Bailey) Small	Kidneyshaped sedge
**Carex retroflexa* Muhl. ex Willd.	Reflexed sedge
**Carex tetrastachya* Scheele	Britton's sedge
Carex texensis (Torr.) L.H. Bailey	Texas sedge
**Cyperus acuminatus* Torr. & Hook. ex Torr.	Tapertip flatsedge
Cyperus croceus Vahl	Baldwin's flatsedge
**Cyperus reflexus* Vahl	Bentawn flatsedge
Cyperus retrorsus Chapm.	Pinebarren flatsedge
Cyperus setigerus Torr. & Hook.	Lean flatsedge
Ebenaceae	
Diospyros virginiana L.	Common persimmon
Euphorbiaceae	
Cnidoscolus texanus (M.ll.Arg.) Small	Texas bull-nettle
Croton capitatus Michx.	Woolly croton
Croton monanthogynus Michx.	Prairie tea
Euphorbia bicolor Engelm. & A. Gray	Snow-on-the-prairie
Euphorbia missurica Raf.	Prairie sandmat
Euphorbia spathulata Lam.	Warty spurge
**Phyllanthus polygonoides* Nutt. ex Spreng.	Knotweed leaf-flower
Tragia ramosa Torr.	Branched noseburn
Fabaceae	
Astragalus nuttallianus DC.	Smallflowered milkvetch
Dalea purpurea Vent.	Purple prairie clover
Galactia volubilis (L.)	Downy milk-pea
Gleditsia triacanthos L.	Honey-locust
†*Lathyrus hirsutus* L.	Caley pea
Lupinus texensis Hook.	Texas bluebonnet
†*Medicago orbicularis* (L.) Bartal.	Button-clover
†*Melilotus indicus* (L.) All.	Sour-clover
Mimosa strigillosa Torr. & A. Gray	Powderpuff

Neptunia lutea (Leavenw.) Benth.	Yellow-puff
Prosopis glandulosa Torr	Honey mesquite
Strophostyles leiosperma (Torr. & A. Gray) Piper	Slickseed fuzzybean
**Styphnolobium affine* (Torr. & A. Gray) Walp.	Eve's-necklace
Vicia ludoviciana Nutt.	Deer pea vetch
†*Vicia sativa* L.	Common vetch
†*Vicia villosa* Roth	Winter vetch
Fagaceae	
Quercus marilandica Münchh.	Blackjack oak
Quercus stellata Wangenh.	Post oak
Gentianaceae	
Centaurium texense (Griseb.) Fernald	Lady Bird's centaury
Sabatia campestris Nutt.	Texas star
Geraniaceae	
Geranium carolinianum L.	Crane's-bill
Geranium texanum (Trel.) A. Heller	Texas geranium
Iridaceae	
Sisyrinchium minus Engelm. & A. Gray	Dwarf blue-eyed grass
Juglandaceae	
Carya illinoinensis (Wangenh.) K. Koch	Pecan
Juncaceae	
Juncus bufonius L.	Toad rush
Juncus marginatus Rostk.	Grass-leaf rush
Krameriaceae	
Krameria lanceolata Torr.	Trailing ratany
Lamiaceae	
Hedeoma hispida Pursh	Rough false pennyroyal
Monarda citriodora Cerv. ex Lag.	Lemon beebalm
Scutellaria drummondii Benth.	Drummond's skullcap
Teucrium canadense L.	Canada germander
Warnockia scutellarioides (Engelm. & A. Gray) M.W. Turner	Prairie brazosmint
Lemnaceae	
Lemna aequinoctialis Welw.	Lesser duckweed
Linaceae	
Linum medium (Planch.) Britton *var. texanum* (Planch.) Fernald	Texas flax
Linum pratense (Norton) Small	Meadow flax

Linum berlandieri Hook.	Berlandier's yellow flax
Malvaceae	
Callirhoe involucrata (Nutt.) A. Gray	Winecup
Callirhoe pedata (Nutt. ex Hook.) A. Gray	Palmleaf poppymallow
Menispermaceae	
Cocculus carolinus (L.) DC.	Coralbead
Moraceae	
‡*Maclura pomifera* (Raf.) C.K. Schneid.	Osage-orange
Oleaceae	
Forestiera pubescens Nutt.	Stretchberry, Elbow-bush
Fraxinus americana L.	White ash
Fraxinus pennsylvanica Marshall	Green ash
Fraxinus texensis (A. Gray) Sarg.	Texas ash
Onagraceae	
Ludwigia glandulosa Walter	Cylindricfruit primrose-willow
●*Ludwigia peploides* (Kunth) P.H. Raven	Water primrose
Oenothera laciniata Hill	Cutleaf evening-primrose
Oenothera speciosa Nutt.	Showy evening-primrose
Oenothera suffulta (Engelm. ex A. Gray) W.L. Wagner & Hoch	Kisses
Orobanchaceae	
Agalinis heterophylla (Nutt.) Small ex Britton	Prairie false foxglove
Castilleja indivisa Engelm.	Entireleaf Indian paintbrush
Castilleja purpurea (Nutt.) G. Don	Downy Indian paintbrush
Oxalidaceae	
Oxalis dillenii Jacquin	Southern yellow wood-sorrel
Passifloraceae	
Passiflora lutea L.	Yellow passionflower
Phytolaccaceae	
Phytolacca americana L.	Pokeweed
**Rivina humilis* L.	Rogueplant

Plantaginaceae	
**Penstemon cobaea* Nutt.	Wild foxglove
**Plantago aristata* Michx.	Largebracted plantain
Plantago rhodosperma Decne.	Redseed plantain
Plantago virginica L.	Dwarf plantain
Poaceae	
†*Aira caryophyllea* L.	Annual hair grass
Andropogon glomeratus (Walter) Britton, Sterns, & Poggenb.	Bushy bluestem
**Aristida longespica* Poir	Slim-spike threeawn
Aristida oligantha Michx.	Prairie threeawn
Aristida purpurea Nutt.	Purple threeawn
†*Avena sativa* L.	Common oat
Bothriochloa barbinodis (Lag.) Herter	Cane bluestem
†*Bothriochloa ischaemum* (L.) Keng	King Ranch bluestem
Bothriochloa laguroides (DC.) Herter. *subsp. torreyana* (Steud.) Allred & Gould.	Silver beard grass
**Bouteloua rigidiseta* (Steud.) Hitchc.	Texas grama
†*Briza minor* L.	Little quakinggrass
†*Bromus arvensis* L.	Field brome
†*Bromus catharticus* Vahl	Rescue grass
Chasmanthium latifolium (Michx.) H.O. Yates	River oats
Coelorachis cylindrica (Michx.) Nash	Cylinder jointtail grass
†*Cynodon dactylon* (L.) Pers.	Bermudagrass
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark	Tapered rosette grass
Dichanthelium oligosanthes (Schult.) Gould	Heller's rosette grass
Elymus canadensis L.	Canada wild-rye
Eragrostis refracta (Muhl.) Scribn.	Coastal lovegrass
Eragrostis sessilispica Buckley	Tumble love-grass
Eriochloa sericea (Scheele) Munro ex Vasey	Texas cupgrass
Hordeum pusillum Nutt.	Little barley
**Limnodea arkansana* (Nutt.) L.H. Dewey	Ozark grass
†*Lolium perenne* L.	Perennial ryegrass
Nassella leucotricha (Trin. & Rupr.) Pohl	Texas wintergrass
Panicum virgatum L.	Switchgrass
†*Paspalum dilatatum* Poir.	Dallisgrass
Phalaris caroliniana Walter	Canarygrass
Schizachyrium scoparium (Michx.) Nash	Little bluestem
Sphenopholis obtusata (Michx.) Scribn.	Prairie wedgescale
Sporobolus compositus (Poir.) Merr.	Composite dropseed
Steinchisma hians (Elliott) Nash	Gaping grass
Vulpia octoflora (Walter) Rydb.	Sixweeks fescue

Polygonaceae	
Eriogonum longifolium Nutt.	Long-leaf wild buckwheat
Persicaria hydropiperoides (Michx.) Small	Swamp smartweed
Rumex altissimus Alph. Wood	Pale dock
**Rumex hastatulus* Baldw.	Heartwing sorrel
†*Rumex pulcher* L.	Fiddle dock
Primulaceae	
Anagallis minima (L.) Krause	Chaffweed
Ranunculaceae	
Delphinium carolinianum Walter	Carolina larkspur
Rosaceae	
Prunus mexicana S. Watson	Mexican plum
Rubus trivialis Michx.	Southern dewberry
Rubiaceae	
Cephalanthus occidentalis L.	Common buttonbush
Galium aparine L.	Catchweed bedstraw
Galium virgatum Nutt.	Southwest bedstraw
Stenaria nigricans (Lam.) Terrell	Diamond-flowers
Salicaceae	
Salix nigra Marshall	Black willow
Sapindaceae	
Acer negundo L.	Boxelder
†*Cardiospermum halicacabum* L.	Balloonvine
Sapindus saponaria L.	Wingleaf soapberry
Sapotaceae	
Sideroxylon lanuginosum Michx.	Gum bumelia
Smilacaceae	
Smilax bona-nox L.	Saw greenbriar
Solanaceae	
Physalis cinerascens (Dunal) Hitchc.	Smallflower groundcherry
Solanum dimidiatum Raf.	Western horsenettle
Solanum elaeagnifolium Cav.	Silver-leaf nightshade
Ulmaceae	
Ulmus crassifolia Nutt.	Cedar elm
Urticaceae	
Parietaria pensylvanica Muhl. ex Willd.	Pennsylvania pellitory
**Urtica chamaedryoides* Pursh	Dwarf stinging nettle

Valerianaceae	
Valerianella radiata (L.) Dufr.	Beaked cornsalad
Verbenaceae	
Glandularia bipinnatifida (Nutt.) Nutt.	Dakota mock vervain
Phyla nodiflora (L.) Greene	Turkey tangle frogfruit
**Verbena halei* Small	Texas vervain
Violaceae	
Hybanthus verticillatus (Ortega) Baill.	Babyslippers
Viola sororia Willd.	Common blue violet
Vitaceae	
Cissus trifoliata (L.) L.	Sorrelvine, Cowitch
Parthenocissus quinquefolia (L.) Planch.	Virginia-creeper
Vitis mustangensis Buckley	Mustang grape

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

This study surveyed and mapped the plant communities at Lake Aquilla, Hill County, Texas. The condition of the communities and their poten-tial for future applications of selected restorative practices were also evaluated. Emphasis was placed on locating potential Texas Blackland prairie remnants, shrublands that may support the federally threatened Black-capped vireo (Vireo atricapilla Woodhouse), and oak-juniper woodlands that may support the federally endangered Golden-cheeked Warbler (Dendroica chrysoparia P. L. Sclater and Salvin). Data was col-lected using a combination of plots and transects. All vascular plant spe-cies were recorded, as well as their abundance and growth form. Plant community classifications were adapted from those developed by the Na-tional Vegetation Classification System for the state of Texas.

Two-hundred and twenty-seven species of vascular plants were recorded from 27 sample locations. Remnant patches of Texas Blackland prairie degraded by fire suppression and previous land use practices were identi-fied in the survey area. Shrublands suitable for the black-capped vireo, and oak-juniper woodlands suitable for the golden-cheeked warbler were not detected in the survey area. Restorative practices that include management of undesirable woody vegetation and application of pre-scribed fire were recommended for the grasslands, and oak woodlands and forests at Lake Aquilla.

15. SUBJECT TERMS

Aquilla Lake (Tex.)
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Restoration ecology
Endangered species
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