

United States Department of the Interior



FISH AND WILDLIFE SERVICE

Ecological Services
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711 Stadium Drive, Suite 252
Arlington, Texas 76011
January 29, 2009

21420-2008-FA-0248

Colonel Christopher Martin
District Engineer
Attn: William Haferkamp
Environmental Resource Specialist
U.S. Army Corps of Engineers
P.O. Box 17300
Fort Worth, Texas 76102-0300

Dear Colonel Martin:

This letter provides our planning assistance on the Brazos Systems Assessment – Interim Feasibility Study Phase II, Aquilla Lake Storage Reallocation. It is intended to assist the U.S. Army Corps of Engineers (Corps) in the planning and evaluation of options available for the proposed reallocation of storage capacity within Aquilla Lake.

The Corps initiated this supplementary feasibility study based on the findings of the November 7, 2005, Brazos River Basin Systems Assessment Interim Feasibility Study which was a cooperative effort by the Corps and the non-Federal sponsor, Brazos River Authority. The Brazos River Basin Systems Assessment Interim Feasibility Study is a basin-wide effort focusing on the portion of the basin which includes, or is impacted by, the nine Federal reservoirs owned and operated by the Corps. This basin-wide study was initiated as a partial response to House and Senate resolutions by the committee on Public Works, United States Senate, 83rd Congress, adopted August 12, 1954.

The purpose of our report was to identify and describe existing fish and wildlife resources within a study area cooperatively delineated by the Corps, Texas Parks and Wildlife Department (TPWD), and U.S. Fish and Wildlife Service (Service) and to recommend preliminary measures for resource protection. This planning assistance is provided to the Corps, pursuant to the Fish and Wildlife Coordination Act (48 Stat, 401, as amended) (FWCA). This information does not represent a final report of the Secretary of the Interior within the meaning of Section 2(b) of the FWCA. A complete FWCA report will be prepared by the Service to accompany the feasibility report after all available pertinent information, including review comments from TPWD and proposed project alternatives, has been received and reviewed.

We appreciate the opportunity to participate in the planning of this project. If you have any questions or comments concerning this report, please contact Mr. Sean Edwards of my staff at (817) 277-1100.

Sincerely,

A handwritten signature in cursive script that reads "Tom Cloud".

Thomas J. Cloud, Jr.
Field Supervisor

enclosure



U.S. Fish & Wildlife Service
Arlington, Texas, Ecological Services

**EXISTING HABITAT CONDITIONS PLANNING AID REPORT
FOR THE
BRAZOS SYSTEMS ASSESSMENT – INTERIM FEASIBILITY STUDY
BRAZOS RIVER BASIN PHASE II
AQUILLA LAKE STORAGE REALLOCATION**



Prepared by:
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Region 2



EXECUTIVE SUMMARY

This planning aid report describes existing fish and wildlife resources within the Brazos Systems Assessment – Brazos River Basin Interim Feasibility Study Phase II, Aquilla Lake Storage Reallocation study area in Hill County, Texas. It is intended to assist the U.S. Army Corps of Engineers (Corps) in their planning efforts. A list of preliminary resource protection recommendations is also included in the report. The Brazos River Basin Interim Feasibility Study was initiated to assess the portion of the basin which includes, or is impacted by the nine Federal reservoirs owned and operated by the Corps. The current Phase II is being conducted to perform a detailed investigation of the reallocation of storage capacity within Aquilla Lake. U.S. Fish and Wildlife Service (Service), Texas Parks and Wildlife Department (TPWD), and Corps personnel cooperated in collecting the habitat field data required to complete this report.

The Aquilla Lake study area encompasses the entire Corps-owned property surrounding Aquilla Lake and its floodplain, which includes the reservoir formed by the impoundment of Aquilla Creek downstream of its former confluence with Hackberry creek, and various terrestrial habitats.

The terrestrial data collected were analyzed using the Service's *Habitat Evaluation Procedures* (HEP) to describe the various existing habitats in the study area. Spatial data depicting habitat cover maps utilized in the analysis and evaluation were provided by the Corps.

The study area contains approximately 2,802 acres of upland forest (27.3% of the study area), 2,042 acres of shrubland (19.9%), 1,199 acres of grassland (11.7%), 366 acres of savanna (3.6%), 334 acres of bottomland hardwood (3.3%), and 113 acres of wetlands (1.1%). All have overall habitat values ranging from below average to good. The remaining 33.2% of the study area consists of open water (2,927 acres) and structures/disturbed areas (468 acres) which were not evaluated for habitat quality. Due to the character of the habitats observed within the study area, it is unlikely that any federally listed threatened or endangered species would be present.

The Aquilla Lake study area has been subjected to minimal adverse environmental impacts since its acquisition by the Corps and the filling of the reservoir began in April, 1983. Currently, the Corps leases an area near the dam for hay harvest and leases several other areas for very limited grazing. Fishing and other recreation is minimal; only two boat ramps are currently in operation and no other permanent recreation facilities exist. Impacts from agricultural practices during prior ownership are evident in certain areas. Overall, wildlife habitats appear largely intact. Previously disturbed areas have begun succession to a more natural state but could benefit from restoration efforts to improve habitat diversity and quality, promoting a variety of resident and migratory wildlife species.

ACKNOWLEDGEMENTS

The U.S. Army Corps of Engineers (Corps), Fort Worth District, Planning, Environmental and Regulatory Division provided the U.S. Fish and Wildlife Service (Service) the information necessary for completing this report. William Haferkamp, Environmental Resource Specialist with the Corps Fort Worth District, assisted with field work, reviewed data, and provided the information required for completing this document. Whitney Lake Corps Office staff members Brady Dempsey, Brad Ellis, and Elizabeth Anderson assisted with field work and data collection. Corps Geographical Information Specialists also provided the GIS layers and other relevant spatial data.

Tom Heger of the Texas Parks and Wildlife Department assisted in the planning and development of this project and aided with field work.

Several Service biologists assisted with this report. Carol Hale (former lead for this project) planned and conducted all field work with assistance from Sid Puder. Jacob Lewis assisted with the GIS information provided by the Corps. Tom Cloud, Field Supervisor, reviewed this document and provided insightful guidance necessary to complete this report.

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**EXISTING HABITAT CONDITIONS PLANNING AID REPORT
FOR THE
AQUILLA LAKE WATER REALLOCATION INTERIM FEASIBILITY STUDY
(BRAZOS RIVER BASIN SYSTEMS ASSESSMENT INTERIM FEASIBILITY
STUDY, PHASE II)**

INTRODUCTION

The purpose of this report is to describe existing fish and wildlife resources within the Aquilla Lake Water Reallocation Interim Feasibility Study area (study area) and to recommend preliminary measures for resource protection. This planning assistance is provided to the U.S. Army Corps of Engineers (Corps), pursuant to the Fish and Wildlife Coordination Act (FWCA) (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*). This information does not represent a final report of the Secretary of the Interior within the meaning of Section 2(b) of the FWCA. A complete FWCA report will be prepared by the U.S. Fish and Wildlife Service (Service) to accompany the feasibility report after all available pertinent information, including review comments from the Texas Parks and Wildlife Department (TPWD) and proposed project alternatives, has been received and reviewed.

The Corps initiated this supplementary feasibility study based on the findings of the November 7, 2005, Brazos River Basin Systems Assessment Interim Feasibility Study which was a cooperative effort by the Corps and a non-Federal sponsor, the Brazos River Authority (BRA). The Brazos River Basin Systems Assessment Interim Feasibility Study is a basin-wide effort focusing on the portion of the basin which includes, or is impacted by the nine Federal reservoirs owned and operated by the Corps. This basin-wide study was initiated as a partial response to House and Senate resolutions by the committee on Public Works, United States Senate, 83rd Congress, adopted August 12, 1954, as quoted below:

Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be and is hereby requested to review the report of the Chief of Engineers printed in House Document Numbered 181, Seventy-second Congress, first session, and other reports on the Brazos River and tributaries, Texas, with a view to determining whether any modification of the recommendations contained therein should be made at this time.

The current Phase II Aquilla Lake Storage Reallocation study is intended to investigate the reallocation of storage capacity within Aquilla Lake and prepare an Integrated Interim Feasibility Report and Environmental Assessment.

The Corps property encompassing the entire study area has largely been undisturbed since its acquisition, completion of the dam, and the filling of the reservoir which began April 29, 1983. Aside from the approximately 468 acres containing structures or other

ongoing disturbances, the entire 6,857 acres of remaining land are designated as Wildlife Management Areas affording some measure of protection from impacts.

STUDY AREA

Location

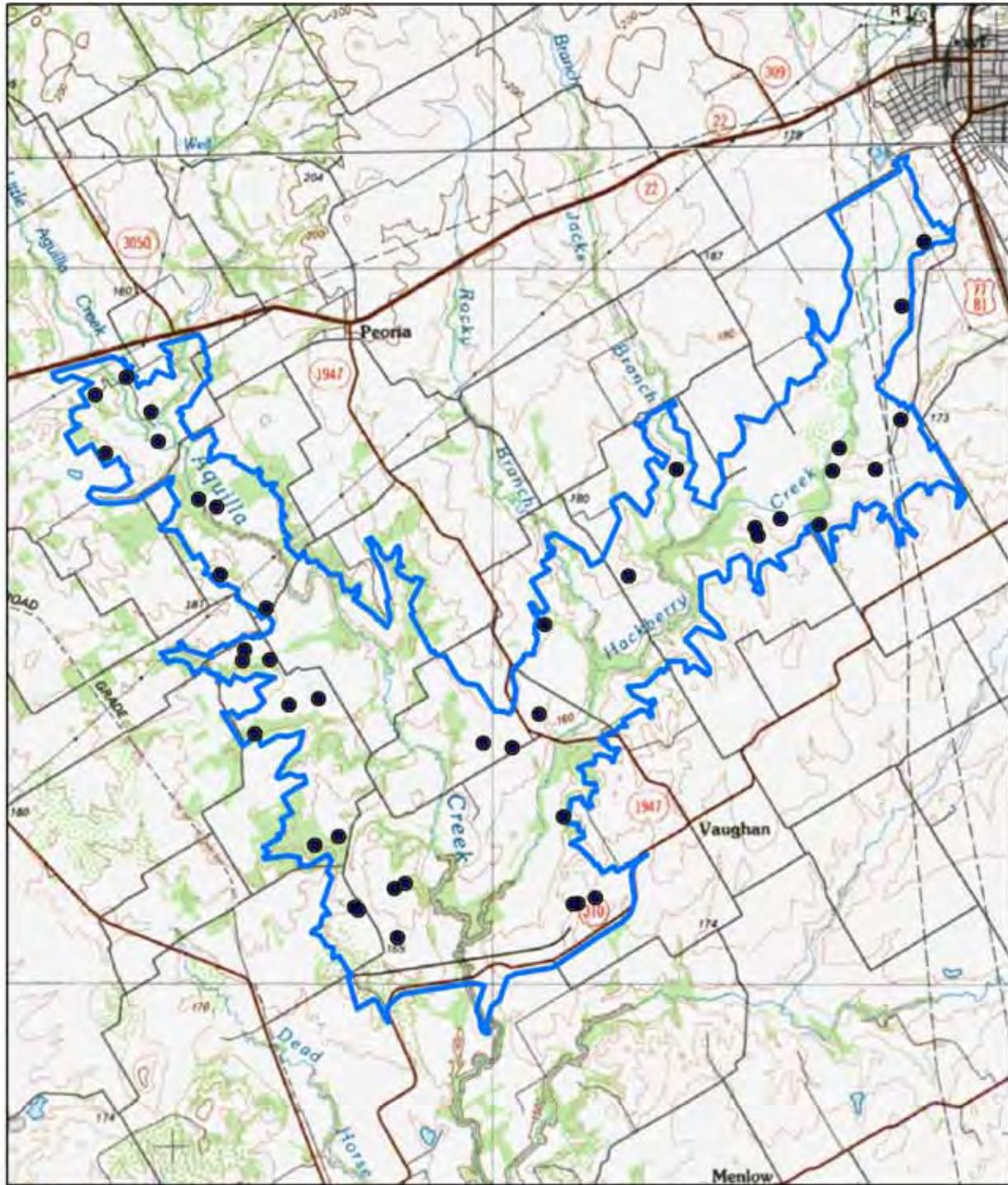
The environmental study area within the Aquilla Lake vicinity was delineated as the entirety of the Corps property surrounding the reservoir. Spatial data provided by the Corps indicate that the study area encompasses approximately 10,253 acres located immediately southwest of the City of Hillsboro, Hill County, Texas and is bordered to the north by SH 22, and to the south by FM 310 (Figure 1).

The study area is located within the floodplain of the Brazos River and the reservoir was formed by the impoundment of Aquilla Creek just downstream of its former confluence with Hackberry Creek. Little Aquilla Creek, Rocky Branch, Jacks Branch, as well as numerous other unnamed tributaries also empty into the reservoir. Below the dam's spillway, Aquilla Creek resumes flow and ultimately empties into the Brazos River approximately 24 miles downstream.

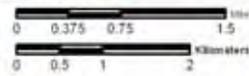
Climate, Topography, and Ecology

The climate of Hill County is humid subtropical with hot summers and mild winters, with an occasional front of extremely cold temperatures. The average low and high temperatures range from 35°F in January to 97°F in August. The lowest minimum recorded temperature is -5°F and the highest maximum 112°F. Annual precipitation also varies considerably, ranging from less than 20 inches to more than 50 inches, with an average of 33.7 inches (NOAA, 2008). The terrain consists of rolling hills and occasional bluffs and drainages ranging from 460 to 880 feet (140 to 268 m) in elevation, generally sloping to the south and southeast.

Hill County contains portions of the Cross Timbers and Prairies and the Blackland Prairies ecological areas of Texas (Gould, 1962) and the study area lies with the East Cross Timbers natural vegetational area (Diggs et al., 1999). The East Cross Timbers is characterized historically as a narrow band of woody vegetation between the Blackland Prairie and the Grand Prairie occurring largely on sandy soil formations. Vegetation composition is variable ranging from open savanna with oak overstory to dense brush. Woody overstory consists primarily of post oak (*Quercus stellata*) and blackjack oak (*Quercus marilandica*). In addition to the characteristic oaks, other woody species commonly found include cedar elm (*Ulmus crassifolia*), hackberry (*Celtis* spp.), pecan (*Carya illinoensis*), juniper (*Juniperus* spp.), and mesquite (*Prosopis grandulosa*). Common grasses include hairy gramma (*Bouteloua hirsuta*), side-oats gramma (*Bouteloua cirtipendula*), tall dropseed (*Sporobolus composites*), switch grass (*Panicum virgatum*), Canada wildrye (*Elymus canadensis*), and Texas winter grass (*Nassella*



U.S. Fish & Wildlife Service
 Arlington, Texas, Ecological Services Field Office
 Projection: UTM Zone 14N, NAD 1983, GRS 1980
 Production Date: 1/22/2009



- HEP_Sites
- Corps boundary

Figure 1: Aquilla Lake study area with HEP sites

Leucotricha) (Correll & Johnson 1970). Past mismanagement and cultivation have caused many uplands to be currently populated by scrub-type oak, mesquite, and juniper with mid- and short-grasses beneath (Hatch et al. 1990)

The study area largely contains sandy soil derived from rocks of the Woodbine formation (Hill 1901) principally made up of ferruginous, argillaceous sands. These Woodbine sands are often unconsolidated and rather loose. The post oak-blackjack oak vegetation typical of the East Cross Timbers does well on the deep loose soils developed from these unconsolidated layers (Diggs et al., 1999). Due to differences in soil formations, vegetation at Aquilla Lake differs substantially from that found at nearby Whitney Lake which lies within the Lampasas Cut Plain distinguished by Edwards limestone features more typical of the Texas Hill Country.

The study area is used by both resident and migratory wildlife species, likely including those typically intolerant of human activity. Migratory waterfowl and shorebirds utilize the reservoir, its tributaries, and local herbaceous wetlands for foraging and brood rearing. The woodlands are used by a variety of migratory and resident passerine, owl, and hawk species. Common bird species that may be observed in the study area are sparrow, northern mockingbird (*Mimus polyglottos*), American robin (*Turdus migratorius*), northern cardinal (*Cardinalis cardinalis*), blue jay (*Cyanocitta cristata*), Carolina chickadee (*Parus carolinensis*), scissor-tailed flycatcher (*Tyrannus forficatus*), downy woodpecker (*Picoides pubescens*), common crow (*Corvus brachyrhynchos*), American kestrel (*Falco sparverius*), barred owl (*Strix varia*), and red-tailed hawk (*Buteo jamaicensis*). Mammal species that may utilize habitat in the study area include raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), opossum (*Didelphis virginiana*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), eastern cottontail (*Sylvilagus floridanus*), fox squirrel (*Sciurus niger*), and small rodents. Various species of frogs and turtles may be found within the reservoir and wetlands, while lizards and snakes can be found throughout the study area. A list of faunal species that were observed during field investigations in the study area is included on each site observation sheet in Appendix B. Fish species within the reservoir include largemouth bass (*Micropterus salmoides*), blue catfish (*Ictalurus furcatus*), channel catfish (*Ictalurus punctatus*), crappie (*Pomoxis nigromaculatus*), white bass (*Morone chrysops*), and various sunfish species (*Lepomis* spp.) (TPWD 2008).

EXISTING TERRESTRIAL HABITATS AND WILDLIFE RESOURCES

Habitat Evaluation Methods

An interagency biologist team, including the Corps, TPWD, and the Service, was convened to conduct a habitat evaluation of the study area. The Service's *Habitat Evaluation Procedures* (HEP) (U.S. Fish and Wildlife Service 1980) were used to analyze and describe the various existing habitats in the study area.

The biologist team collected field data on July 14 – 17, 2008. Forty-three survey sites were randomly selected within the six terrestrial habitat types in the study area: riparian woodlands, grasslands, upland deciduous woodlands, shrubland, savanna, and herbaceous wetlands. HEP data were collected in 42 of these sites. Figure 1 displays the locations of the data sites that were recorded using a Trimble GeoXT handheld unit. These sites are also depicted on aerial maps in Appendix D and their Geographical locations are listed in Appendix C. Spatial data depicting habitat cover maps utilized in analysis and evaluation were provided by the Corps and are illustrated in Appendix E, pages E-1 through E-3.

Thirteen wildlife indicator species were selected to represent the wildlife communities that use the six habitats evaluated. The raccoon, fox squirrel, Carolina chickadee, barred owl, wood duck (*Aix sponsa*), and downy woodpecker were selected to represent those species that use riparian woodlands. The raccoon, green heron (*Butorides striatus*), and wood duck were selected to represent the wildlife community in herbaceous wetlands. The eastern meadowlark (*Sturnella magna*), eastern cottontail, fox squirrel, scissor-tailed flycatcher, and American kestrel were selected to represent the wildlife communities in the savanna. The eastern cottontail, scissor-tailed flycatcher, northern bobwhite, and racer (*Coluber constrictor* [snake]) were selected to represent the wildlife communities in shrubland. The downy woodpecker, raccoon, Carolina chickadee, barred owl, and fox squirrel were selected to represent the upland deciduous forest community. The eastern meadowlark, eastern cottontail, and American kestrel were selected to represent the wildlife communities in grasslands.

HEP requires the use of Habitat Suitability Index (HSI) models developed for each indicator species that use the habitats. The HSI models contain a list of structural habitat composition variables that are contained in optimum habitat. All the variables for each species representing each habitat are compiled and measured in the field (Appendix F). Eighteen variables were evaluated for the riparian woodlands (Table F-1). There were 12 variables measured for herbaceous wetland habitat (Table F-2), 18 savanna variables (Table F-3), 15 shrubland variables (Table F-4), 12 grassland habitat variables (Table F-5) and 16 upland forest habitat variables (Table F-6). These variables were measured or estimated within a tenth-acre data plot within the habitat they represent. They are used as indicators of habitat condition or value.

Baseline habitat conditions are expressed as a numeric function (HSI value) ranging from 0.0 to 1.0, where 0.0 represents no suitable habitat for an indicator species and 1.0 represents optimum conditions for the species. HSI values ranging from 0.01 to 0.24 are considered “poor” habitat, 0.25 to 0.49 are considered “below average” habitat, 0.50 to 0.69 are “average” habitat, 0.70 to 0.89 are “good” habitat, and 0.90 to 1.00 are considered “excellent” habitat. Habitat units are calculated by multiplying the HSI for each habitat by the amount of acres of the same habitat.

A complete list of plant species observed during the surveys is included in Appendix A. Appendix B includes the individual site observation sheets that contain a description of each site, photographs taken in each compass direction from the center of each survey site, and a list of plants and animals observed at the site.

Habitat Descriptions and Suitability Index Values

Six terrestrial wildlife habitats types are present within the study and were evaluated for habitat suitability: approximately 2,802 acres of upland forest (27.3% of the study area), 2,042 acres of shrubland (19.9%), 1,199 acres of grassland (11.7%), 366 acres of savanna (3.6%), 334 acres of bottomland hardwood (3.3%), and 113 acres of wetlands (1.1%). The study area also contains approximately 2,927 acres of open water (28.5% of the study area) and 468.4 acres (4.6%) of permanent structures and/or ongoing disturbance, both of which were not evaluated for habitat suitability.

Table 1 displays the HSI values and habitat units for each habitat in the study area per indicator species. The HSI values for each habitat within the study area ranged from 0.48 for grassland to 0.74 for upland forest.

The study involved three multi-cover type species: American kestrel, eastern cottontail, and wood duck. There are five cover types within the study area that the American kestrel may utilize; riparian woodland, upland deciduous forest, savanna, shrubland, and grassland. Each of these cover types contributes to the life requisites required by the American kestrel. Individual HSI scores for each cover type evaluated for the American kestrel are weighted within an overall, shared HSI value across cover types. The overall HSI value (0.43) for all cover types evaluated for American kestrel indicates below average habitat. The limiting factors for the each species are discussed in the appropriate cover type section below.

The eastern cottontail has an overall HSI of 0.46. The cottontail is a multi-cover type species and may use all of the available cover types within the study area, except wetlands. However, this species was used to assess only three: grasslands, shrublands, and savanna. Each cover type contributes to the life requisites required by the cottontail.

The wood duck utilizes riparian woodland and herbaceous wetland cover types within the study area. The overall HSI value is 0.03 for both cover types indicating poor suitability.

The limiting factors for the wood duck are discussed under the herbaceous wetland and riparian woodland sections below.

- 1) Riparian Woodlands** (334.4 acres) – Riparian woodlands are typically bottomland hardwoods, however, the study area contains some riparian woodlands that could be classified as upland influenced by an adjoining stream. The HEP defines the bottomland hardwood cover type as wetland areas dominated by deciduous trees, usually along streams, and that are occasionally

Table 1. HSI Values for each Cover type per Indicator Species within the Aquilla Lake Study Area.

Indicator Species	Cover type					
	Riparian Woodland (334.40 ac)	Upland Forest (2802.40 ac)	Herbaceous Wetland (112.98 ac)	Grassland (1198.96 ac)	Deciduous Shrubland (2042.94 ac)	Savanna (365.46 ac)
Barred owl	0.71	0.45				
Carolina Chickadee	0.95	0.93				
Raccoon	0.71	0.80	0.71			
Wood Duck ¹	0.03		0.03			
American Kestrel ¹				0.43		0.43
Fox Squirrel	0.61	0.55				0.00
Downy Woodpecker	1.00	0.95				
Green Heron			0.87			
Eastern Cottontail ¹				0.46	0.46	0.46
Scissor-tailed Flycatcher					1.00	1.00
Eastern Meadowlark				0.54		0.85
Racer					1.00	
Northern Bobwhite					.09	
HSI Totals	0.67	0.74	0.54	0.48	0.63	0.54
Habitat Units	224.05	2073.78	61.01	575.50	1287.05	197.35

¹ Multi-cover type species: suitability values for each cover type are weighted within an overall study area value

flooded. In optimum conditions, this cover type provides food, cover, nesting habitat, and living space to riparian forest dependent species. Large trees are important as nesting habitat for the fox squirrel, wood duck, and barred owl, and escape cover for raccoons, wood ducks, and passerines. Large mast producing trees and shrubs provide food for the fox squirrel. Brush piles and snags provide necessary food, cover, and shelter for the raccoon and passerines. The close proximity to water is important for the raccoon and wood duck. Riparian forest habitats are essential in maintaining biodiversity and providing important wildlife travel corridors.

Riparian woodlands make up approximately 3.3 percent of the study area and are primarily located along the various inflows to the reservoir. Many of these woodlands are periodically flooded and are predominately composed of cedar elm, green ash (*Fraxinus pennsylvanica*), pecan, black willow (*Salix nigra*), and box elder (*Acer negundo*). Other trees species present include bur oak (*Quercus macrocarpa*), red mulberry (*Morus rubra*), honey locust (*Gleditsia triacanthos*), cottonwood (*Populus deltoids*), and sugar hackberry (*Celtis laevigata*). Considering the relative newness of the reservoir (1983), it is likely that areas along the shoreline will develop further riparian woodland characteristics as vegetation matures.

There are seven data sites in riparian woodlands in the study area: Site 14, 23, 25, 26, 32, 36, and 39. Sites 25 and 26 are located within a single, large patch. Most of the riparian sites are dominated by overstory trees that are at the lower extent of that which would be considered optimal (≥ 12 inches dbh); however, over half of the data sites scored within this range.

The most limiting factor for raccoon habitat was the temporal availability of water in three of the data plots. The winter food requisite was the most limiting factor for fox squirrels. The required number of mast producing trees greater than 10 inches dbh needed for optimum fox squirrel habitat was absent in four of the seven data sites and grain availability was too low in all of the data sites.

Each of the life requisites was well above average or excellent for the Carolina chickadee. This was consistent across each of the data sites.

The value of this cover type was poor for the wood duck and below average throughout the study area due to the low number of potentially suitable nest cavity trees and the lack of brood and winter cover across all cover types.

The overall HSI value for the riparian woodland within the study area is 0.67 (average habitat value) with 224.05 HUs.

2) Upland Deciduous Forest (2,802 acres) – Deciduous forests are upland hardwood areas dominated by trees and with a minimal tree canopy cover of 25%. Upland forests provide food, cover, nesting habitat, and living space to upland forest dependent species. Five species were utilized to represent the upland forest guild: barred owl, raccoon,

Carolina chickadee, fox squirrel, and downy woodpecker. Large trees are important as nesting habitat for the fox squirrel and barred owl. White-tailed deer (*Odocoileus virginianus*), small mammals, turkey (*Meleagris gallopavo*), bobwhite quail (*Colinus virginianus*), and many other species of birds utilize these stands for food and/or cover.

Upland forest makes up 27.3% of the study area and six data sites were evaluated: 7, 9, 11, 15, 19, and 30. Cedar elm, post oak, and hackberry dominate this cover type. Other tree species associated with this forest type include mesquite, eastern red cedar (*Juniperus virginiana*) and blackjack oak. The shrub layer consists of gum bumelia (*Bumelia lanuginosa*), hackberry, cedar elm, post oak, red mulberry, deciduous holly (*Ilex decidua*) and coralberry (*Symphoricarpos orbiculatus*).

The HSI values for each species for this cover type range from below average for the barred owl, average for the fox squirrel, good for the raccoon, to excellent for the Carolina chickadee and downy woodpecker. The most limiting factors in this cover type are (1) the lack of large trees required by the fox and barred owl; (2) tree canopy closure required by the barred owl, and (3) a lack of mast producing trees required by the fox squirrel.

The overall upland deciduous forest HSI value within the study area is 0.74 (good habitat value) with 2073.78 HUs.

3) Herbaceous Wetlands (112.9 acres) – Herbaceous wetlands are wetland areas dominated by non-woody vegetation. Wetlands provide food and cover for fish, resident and migratory birds, small mammals, invertebrates, and the predators that feed on these species. Wetlands are important nesting habitat for wading birds and waterfowl.

This cover type makes up only 1.10% of the study area. It is comprised primarily of rushes, sedges, wetland grasses, and aquatic plants located along the edges of the reservoir and creeks, and in seasonally flooded areas. Some of these wetlands are permanent, but most are likely seasonal.

There were eight data sites in herbaceous wetlands: Sites 6, 8, 12, 18, 22, 29, 35, and 38. The three species representing the herbaceous wetland cover type are the raccoon, green heron, and wood duck. HSI values ranged from good for the green heron and raccoon to poor for the wood duck. Poor cover and the number of potential nest cavities for the wood duck were the limiting factors in this cover type. The most limiting factor for the raccoon was the seasonable availability of water.

The overall herbaceous wetland HSI for the study area is 0.54 (average habitat value) with 61.01 HUs.

4) Grasslands (1,199.0 acres) - Grasslands are dominated by grasses, native or introduced, that are not regularly planted or mowed, and have a minimal canopy cover of

25%. Grasslands provide open space, a food source for passerines and the eastern cottontail, and cover for escape and nesting by means of tall grass, scattered brush piles and shrubs for a variety of animals. Red-tailed hawks hunt for prey in open grasslands. Grasslands make up 11.7% of the study area.

Much of the grassland within the study area would be classified as unmanaged grasslands when considering the residual effects of prior agricultural uses. Unmanaged grasslands are fallow fields also containing a combination of native and introduced grasses, forbs, and trees, but the composition is different from those in native short grass areas. The grass species found in the data plots were coastal bermuda (*Cynodon dactylon*), little bluestem (*Schizachyrium scoparium*), inland seaoats (*Chasmanthium latifolium*), Canada wildrye, switchgrass (*Panicum virgatum*), panic grass (*Dichanthelium* sp.) Johnsongrass (*Sorghum halepense*), and sideoats gramma (*Bouteloua cirtipendula*).

There were seven data sites in grasslands in the study area: Sites 1, 4, 17, 21, 27, 34 and 37. Three indicator species represent the grassland guilds: eastern meadowlark, American Kestrel, and the eastern cottontail. The HSI values per species ranged from 0.43 for the kestrel, 0.46 for the eastern cottontail, to 0.54 for the eastern meadowlark.

The American kestrel is a multi-cover type species and the value of each cover type applicable to this species is weighted within an overall value for the species within the entire study area. The HSI value in grassland alone was 0.96, considerably higher than the overall study area-wide value of 0.43. Likewise, the eastern cotton tail is a multi-cover type species. The HSI value for eastern cottontail in grassland alone was 0.64, somewhat higher than the overall study area-wide value of 0.46. However, HSI values for multi-cover type species must be expressed as a single value giving appropriate weight to each of the cover types present which may be utilized by that species.

The most limiting factor for cottontails in grasslands throughout the study area is insufficient cover, such as shrubs, trees, or persistent herbaceous plants. An insufficient number of large nest and perch trees are the most limiting factors for the eastern meadowlark. Each of these deficiencies may be at least partially due to the prior agricultural use and slow recovery time of these now fallow fields.

The overall HSI value for grasslands within the study area is 0.48 (slightly below average habitat value) with 575.50 HUs.

5) Deciduous shrublands (2,042.9 acres) –Shrublands are defined as non-wetland areas dominated by shrubs and with a minimal shrub canopy cover of 25 percent. Shrublands provide open space, a seed and insect food source for passerines, forage for cottontails, and cover for escape and nesting by means of tall grass, scattered brush piles, and shrubs for a variety of animals. Red-tailed hawks hunt for prey in shrublands.

Shrublands make up 19.9% of the study area. The grass species found in the data sites are Johnsongrass, coastal bermuda, Canada wildrye, panicgrass, and switchgrass. The

predominant shrub species are mesquite, cedar elm, hackberry, gum bumelia, eastern red cedar, Chickasaw plum, and western soapberry.

There were seven survey sites in shrublands: Sites 2, 5, 13, 20, 28, 40, and 42. Four indicator species represent the shrubland guild: northern bobwhite, scissor-tailed flycatcher, racer and eastern cottontail. The deciduous shrubland HSI values per species ranged from poor for northern bobwhite (0.21) to optimal for scissor-tailed flycatcher (1.0), eastern cottontail (1.0), and racer (1.0).

The overall HSIs for multi-cover type species evaluated in shrublands total 0.09 for northern bobwhite and 0.46 for eastern cottontail. The shrubland HSI value for both of these species was higher than the overall value of all cover types utilized by these species within the entire study area.

The most limiting factors for northern bobwhites within shrublands are the lack of bare open ground allowing access to seeds while foraging, and the lack of canopy cover of woody shrubs less than 2 meters in height needed for cover.

The overall HSI for deciduous shrubland was 0.63 (average value) with 1,287.05 HUs.

7) Savanna (365.5 acres) –savanna is a non-wetland area with a shrub and/or tree canopy cover between 5-25 percent, but with a total canopy cover of all vegetation greater than 25 percent. The area between the trees and shrubs is typically dominated by grasses or other herbaceous vegetation. Savannas provide open space, a food source for passerines and the eastern cottontail, and cover for escape and nesting by means of tall grass, scattered brush piles, and shrubs for a variety of animals.

Savanna makes up 3.6% of the study. There are seven data sites in this cover type: Sites 3, 10, 16, 24, 31, 33, and 41. Unmanaged savannas such as those within the study area typically consist of fallow fields also containing a combination of native and introduced grasses, forbs, and trees, but the composition is different from those in the short grass areas. The grass species found in the data plots were Johnsongrass, little bluestem, Canada wildrye, coastal bermuda, switchgrass, sideoats gramma, and three awn. Tree and shrub species found within the savanna sites include mesquite, hackberry, hawthorne (*Crataegus* sp.), gum bumelia, coralberry, Mexican plum (*Prunus Mexicana*), honey locust, and deciduous holly.

Five indicator species represent the savanna guild: eastern meadowlark, American kestrel, fox squirrel, scissor-tailed flycatcher, and the eastern cottontail. The HSI for this cover type was optimal (1.0) for scissor-tailed flycatcher, good (0.85) for eastern meadowlark, and below average for eastern cottontail (0.46) and kestrel (0.43).

The overall HSIs for multi-cover type species evaluated in savannas total 0.46 for northern bobwhite and 0.64 for eastern cottontail. The savanna HSI value for kestrel was

higher than the overall value of all cover types utilized by this species within the entire study area.

However, the limiting factor for savannas throughout the study area is the insufficient persistent herbaceous plants which provide essential winter cover for cottontails.

The overall savanna HSI is 0.54 (average habitat value) with 197.35 HUs.

Threatened and Endangered Species and Birds of Conservation Concern

The federally listed threatened or endangered species known to occur in Hill County include the endangered whooping crane (*Grus americana*) black-capped vireo (*Vireo atricapilla*), and golden-cheeked warbler (*Dendroica chrysoparia*). Two candidate species for listing, the smalleye shiner (*Notropis buccula*) and sharpnose shiner (*Notropis oxyrinchus*) have also been recorded in Hill County.

Endangered whooping cranes may be encountered in any county in north central Texas during migration. Autumn migration normally begins in mid-September, with most birds arriving on the wintering grounds at Aransas National Wildlife Refuge between late October and mid-November. Spring migration occurs during March and April. Whooping cranes prefer isolated areas away from human activity for feeding and roosting, with vegetated wetlands and wetlands adjacent to cropland being utilized along the migration route. Foods consumed usually include frogs, fish, plant tubers, crayfish, insects, and waste grains in harvested fields. It is possible that whooping cranes may temporarily utilize habitats present within the study area during their annual migration but an encounter would be a rare occurrence. It is unlikely that any of the current activities or an increase in pool rise would have an adverse impact on this species

The golden-cheeked warbler's habitat is generally described as mature (at least 12 feet tall) oak-juniper woodlands, with 50 percent or greater canopy cover, although warblers have been found in habitat with as little as 30 percent canopy cover. Steep, narrow canyons, with deciduous trees located along the drainage bottoms and juniper on the side slopes, provide an ideal mix of vegetation for this species. However, suitable habitat may also occur on hilltops or other relatively flat areas. Ideal habitat areas have a diverse mixture of juniper and hardwood trees, including oaks, hackberry, sycamore, and cedar elm.

The black-capped vireo is a habitat specialist, nesting in mid-successional brushy areas (i.e., before the area develops into a mature woodland) where the dominant woody species are oaks, sumacs, persimmon, and other broad-leaved shrubs. Juniper may be common in vireo habitat, but juniper prominence is not essential or even preferred by the birds. Typical nesting habitat is composed of a shrub layer extending from the ground to about six feet covering about 35-55% of the total area, combined with a tree layer that may reach to 30 feet or more. Open, sometimes grassy spaces separate clumps of trees

and shrubs. The vireo also depends on broad-leaved shrubs and trees, especially oaks, which provide insects on which the vireo feeds.

The habitat evaluation team did not encounter any habitats that appeared suitable for nesting golden-cheeked warblers or black-capped vireos. Therefore, it is unlikely that either species would be present within the study area.

The bald eagle (*Haliaeetus leucocephalus*) was formerly listed in Hill County but was removed from the federal threatened and endangered species list effective August 8, 2007. However, bald eagles are still afforded safeguards under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. We recommend all activities be conducted in accordance with the Service's National Bald Eagle Management Guidelines which may be accessed at <http://www.fws.gov/migratorybirds/issues/BaldEagle/NationalBaldEagleManagementGuidelines.pdf>.

The smalleye and sharpnose shiners are candidate species with no current federal protections; however, we recommend that potential impacts to these species be considered during project planning. Our records indicate that both of these species historically occurred in Hill County within the Brazos River area now occupied by Whitney Lake. We have no current records of either species' presence within the study area.

The Service published the *Birds of Conservation Concern 2002* (BCC) in December 2002. "The overall goal of the BCC is to accurately identify the migratory and non-migratory bird species (beyond those already designated as Federally threatened or endangered) that represent our highest conservation priorities and draw attention to species in need of conservation action" (U.S. Fish and Wildlife Service 2002).

Copies of the *Birds of Conservation Concern 2002* may be obtained by writing to the Chief, Division of Migratory Bird Management, U.S. Fish and Wildlife Service, 4401 North Fairfax Drive, Mail Stop 4107, Arlington, VA 22203-1610, ATTN: BCC 2002. It is also available for downloading on the Division of Migratory Bird Management's web page at <http://migratorybirds.fws.gov>.

The following are 23 species on the BCC lists that may utilize the habitat types within the study area:

- little blue heron (*Egretta caerulea*) - inlands marshes and ponds
- northern harrier (*Circus cyaneus*) - marshes, prairies, and savannas
- peregrine falcon (*Falco peregrinus*) - generalist
- American golden-plover (*Pluvialis dominica*) - prairies, and savannas
- long-billed curlew (*Numenius americanus*) – open water, prairies, and savannas
- Hudsonian godwit (*Limosa haemastica*) - inlands marshes
- buff-breasted sandpiper (*Tryngites subruficollis*) - prairies, margins of lakes
- red-headed woodpecker (*Melanerpes erythrocephalus*) - woodlands

scissor-tailed flycatcher (*Tyrannus forficatus*) – prairies, savannas, and open shrubland
 loggerhead shrike (*Lanius excubitor*) – open savanna, shrubland
 Bell’s vireo (*Vireo bellii*) - dense thicket
 Sprague’s pipit (*Anthus spragueii*) - short grass prairie
 prothonotary warbler (*Protonotaria citrea*) – riparian woodland
 worm-eating warbler (*Helmitheros vermivorus*) - woodlands
 Swainson’s warbler (*Limnothlypis swainsonii*) - riparian woodland
 Kentucky warbler (*Oporornis formosus*) - riparian woodland
 field sparrow (*Spizella pusilla*) – old fields, scrubland, forest edge
 Henslow’s sparrow (*Ammodramus henslowii*) – grasslands with scattered shrub
 Le Conte’s sparrow (*Ammodramus caudacutus*) – thick, damp grassy areas, wetlands
 Harris’ sparrow (*Zonotrichia querula*) - scrub, undergrowth in open woodlands and savanna, thickets, brushy fields, and hedgerows
 Smith’s longspur (*Calcarius pictus*) – short grassland
 chestnut-collared longspur (*Calcarius ornatus*) - shortgrass prairie, plowed field, overgrazed pasture
 painted bunting (*Passerina ciris*) - riparian and thorn forest, oak woodlands, savanna, brushy pastures, and hedgerows

PRELIMINARY PLANNING RECOMMENDATIONS

Our habitat analysis indicates the following specific measures could restore natural habitats impacted by prior use within the study area. These recommendations are intended to address a future without project scenario. Recommendations specific to the implementation of the proposed pool rise will be offered in subsequent Planning Aid Reports.

1. Loss of wetland habitat is the most serious threat facing North America’s waterfowl. Additional herbaceous wetlands could be created adjacent to the inflowing streams and along the shoreline of the reservoir where seasonal flooding would inundate low-lying areas. These additional wetlands could provide several benefits that contribute to water quality improvements including water quality function through solids settling, nutrient transformation, and biological uptake. Further, because they provide a fairly large surface area, wetlands provide floodwater storage and serve to collect peak flood flows known to carry most of the polluted runoff from nonpoint sources. Finally, wetlands provide diversity in the landscape and supply a unique habitat for many plant and animal species.
2. We recommend planting locally available native aquatic plants and shrubs around the water edges including sedges, water willow (*Justicia americana*), softstem bulrush (*Schoenoplectus tabernaemontani*), water pennywort (*Hydrocotyle umbellata*), switch grass, smartweeds (*Polygonum sp.*), and buttonbush (*Cephalanthus occidentalis*).

3. If hay harvesting is permitted near an existing or newly created wetland, we recommend that the surrounding area not be mowed to maintain habitat function and minimize disturbance. Any mowing schedule that may be developed should promote tall grass growth, but not interfere with tall-grass nesting birds. The grassland should not be mowed until after July 15.
4. Provide brush and log piles in all existing habitats where needed to provide cover for small mammals. This may be especially true within and adjacent to wetlands where essential brooding and wintering cover for wood ducks and other species was lacking.
5. Place wood duck nest boxes at wetlands on public land where there is an insufficient number of trees with potential nest cavities. TPWD's management guidelines for proper placement and use of wood duck nest boxes may be accessed at http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_1045.pdf.
6. Restore native grasslands where possible throughout the study area to replace fallow fields containing largely coastal bermuda grass, Johnsongrass, and switchgrass monocultures. We recommend planting native grass and forb species appropriate for the soils. Little bluestem, big bluestem, Indian grass, side-oats grama, vine-mesquite, Illinois bundle-flower (*Desmanthus illinoensis*), Maximilian sunflower (*Helianthus maximilian*), and Engelmann's daisy (*Engelmannia peristeri*) are excellent forage and seed producing species to consider. Plant a few shrub mottes and briar thickets in grasslands, and shrub and tree savannas, but maintain them to only about 5 percent canopy cover.
7. The use of prescribed fire is an essential tool in grassland restoration and management and its feasibility should be explored. Because Aquilla Lake has far fewer adjacent homes than typical lakes (Grapevine, Lewisville, Whitney) the use of prescribed fire for grassland enhancement would likely be less difficult.
8. Grassland areas may also be converted to higher-priority resource category habitats such as savanna, shrubland, or upland deciduous forests. These cover types are very likely the original state of some of the existing fallow fields within the study area.
9. Due to past clear cutting for agricultural use, riparian corridors along the inflows to the reservoir are likely narrower than conditions will actually support. Widen the riparian woodland corridors along these creeks and tributaries as much as possible by planting native mast producing trees and shrubs. Riparian buffer zones provide several benefits for aquatic resources. First, riparian zones stabilize eroding banks by absorbing the erosive force of flowing water while roots hold soil in place. Second, riparian zones filter sediment, nutrients, pesticides, and animal waste runoff. Finally, riparian zones provide shade, shelter, and food for fish and other aquatic organisms. Native mast producing trees and shrubs, such as pecan, bur oak, red oak, black walnut (*Juglans nigra*), wild plum (*Prunus mexicana*), sumac (*Rhus sp.*), hawthorne (*Crataegus sp.*), and coral-berry, should be planted in the expanded portion of the riparian woodland to improve canopy cover and food base. Plant 70 percent woody

stems, with no more than 25 percent soft mast producers. Shrubs should be planted at no more than 30 percent stems. Maintain some scattered open spaces for fox squirrel movement.

10. Once a pool level is established, efforts should also be made to reestablish any lost riparian zones and to encourage the establishment of further riparian areas to full potential.
11. Thin portions, but not all, of the existing riparian corridor and upland deciduous forest under mast producing trees where the understory is too dense in order to improve fox squirrel habitat and to open the stands as preferred by woodpeckers.
12. We recommend planting mast producing trees and shrubs in the existing woodlands where they are lacking to improve the canopy cover and food base. The thick overstory and/or understory may need to be thinned and cleared around the young trees to provide space and sunlight. Leave snags standing and let downed logs remain. Existing mast producing trees should be allowed to mature and increase in size.
13. We recommend that the direct, indirect, and cumulative impacts and conservation needs of the *Birds of Conservation Concern 2002* (BCC), be considered during the planning and development of the Aquilla Lake Storage Reallocation project accounting for potential habitat loss or alteration.
14. We recommend that a biological analysis be conducted every few years using the same habitat evaluation technique to monitor and quantify habitat impacts of the restoration sites. Such an analysis would provide good information for adaptive management and for future habitat restoration planning projects.

SUMMARY

The Aquilla Lake study area has been minimally impacted since the acquisition of the land and the inundation of the reservoir in 1983. However, the past alteration of the land from agricultural practices is evident throughout the study area. Natural succession would eventually reverse the effects of these past impacts; however, restoration and management of these areas could ensure that this process is effective and more rapid. Because the study area faces few imminent threats from development or recreational use, it represents a unique opportunity to improve habitats essential to migratory and resident wildlife in which long lasting benefits would likely be assured.

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APPENDIX A

PLANT SPECIES BY COMMON AND SCIENTIFIC NAMES

Appendix A
Aquilla Lake Water Reallocation Project
 Plants by Common Name in Alphabetical Order

<u>Common Name</u>	<u>Scientific Name</u>
American elm	<i>Ulmus americana</i>
annual marsh elder	<i>Iva annua</i>
annual sunflower	<i>Helianthus annuus</i>
arrowhead	<i>Sagittaria sp.</i>
basketflower	<i>Centaurea americana</i>
coastal bermudagrass	<i>Cynodon dactylon</i>
barnyardgrass	<i>Echinochloa crus-galli</i>
beggar's lice	<i>Desmodium canadense</i>
bindweed	<i>Convolvulus equitans</i>
blackjack oak	<i>Quercus marilandica</i>
black willow	<i>Salix nigra</i>
bois d' arc	<i>Maclura pomifera</i>
box elder	<i>Acer negundo</i>
broomweed	<i>Amphiachyris sp.</i>
brown-eyed susan	<i>Rudbeckia triloba</i>
buttonbush	<i>Cephalanthus occidentalis</i>
Canada wildrye	<i>Elymus canadensis</i>
Carolina horsenettle	<i>Solanum carolinense</i>
cattail	<i>Typha sp.</i>
cedar elm	<i>Ulmus crassifolia</i>
Chickasaw plum	<i>Prunus angustifolia</i>
cocklebur	<i>Xanthium strumarium</i>
coralberry	<i>Symphoricarpos orbiculatus</i>
cottonwood	<i>Populus deltoides</i>
cow itch vine	<i>Campsis radicans</i>
croton	<i>Croton sp.</i>
deciduous holly	<i>Ilex decidua</i>
dodder	<i>Cuscuta sp.</i>
duckweed	<i>Lemnaceae sp.</i>
eastern red cedar	<i>Juniperus virginiana</i>
elbowbush	<i>Forestiera angustifolia</i>
Engelmann's daisy	<i>Engelmannia peristenia</i>
Eve's necklace	<i>Sophora affinis</i>
frogfruit	<i>Lippia sp.</i>
frost weed	<i>Helianthemum sp.</i>

gayfeather
giant ragweed
goldenrod
green ash
gum bumelia
hawthorn
honey locust
hoptree
horsemint
Illinois bundleflower
Indian blanket
inland sea oats
ironweed
johnsongrass
Leavenworth's eryngo
little bluestem
maximilian sunflower
mesquite
Mexican plum
Mexican primrose-willow
milkweed
milkweed vine
muscadine grape
muskgrass
panicgrass
partridge pea
pecan
peppervine
pigeonberry
pigweed
pink evening primrose
poison ivy
post oak
prairie parsley
prickly-pear cactus
privet
rattlebush
red mulberry
roughleaf dogwood

Liatris sp.
Ambrosia trifida
Solidago sp.
Fraxinus pennsylvanica
Sideroxylon lanuginosum
Crataegus sp.
Gleditsia tricanthos
Ptelea trifoliata
Monarda citriodora
Desmanthus illinoensis
Gaillardia pulchella
Chasmanthium latifolium
Vernonia texana
Sorghun halepense
Eryngium leavenworthii
Schizachyrium scoparium
Helianthus maximiliani
Prosopis grandulosa
Prunus mexicana
Ludwigia octovalvis
Asclepias sp.
Matelea reticulata
Vitis rotundifolia
Chara sp.
Dicanthelium sp.
Chamaecrista nictitans
Carya illinoensis
Ampelopsis arborea
Rivina humilis
Amaranthus L.
Oenothera speciosa
Toxicodendron radicans
Quercus stellata
Polytaenia nuttallii
Opuntia sp.
Ligustrum sp.
Sesbania sp.
Morus rubra
Cornus Drummondii

sago pondweed
saw greenbrier
sensitive briar
sideoats gramma
silverleaf nightshade
skunkbush sumac
smartweed
southern dewberry
snailseed vine
spikerush
sugar hackberry
sumpweed
sweetscent
switchgrass
teal lovegrass
Texas bluebells
Texas persimmon
Texas winter grass
thistle
threeawn
unknown rush
unknown sedge
Virginia creeper
western ragweed
western soapberry
yellow passion flower

Potamogeton pectinatus
Smilax bona-nox
Mimosa L.
Bouteloua curtipendula
Solanum elaeagnifolium
Rhus trilobata
Polygonum sp.
Rubus enslenii
Cocculus carolinus
Eleoagrostis sp.
Celtis laevigata
Cyclachaena xanthifolia
Pluchea odorata
Panicum virgatum
Eragrostis hypnoides
Eustoma grandiflora
Diospyros texana
Nassella leucotricha
Cirsium sp.
Aristida sp.
Juncus sp.
Carex sp.
Parthenocissus quinquefolia
Ambrosia psilostachya
Sapindus saponaria
Passiflora lutea

Plants by Scientific Name in Alphabetical Order

<u>Scientific Name</u>	<u>Common Name</u>
<i>Acer negundo</i>	box elder
<i>Amaranthus L.</i>	pigweed
<i>Ambrosia psilostachya</i>	western ragweed
<i>Ambrosia trifida</i>	giant ragweed
<i>Ampelopsis arborea</i>	peppervine
<i>Amphiachyris sp.</i>	broomweed
<i>Aristida sp.</i>	threeawn
<i>Asclepias sp.</i>	milkweed
<i>Bouteloua curtipendula</i>	sideoats gramma
<i>Campsis radicans</i>	cow itch vine
<i>Carex sp.</i>	unknown sedge
<i>Carya illinoensis</i>	pecan
<i>Celtis laevigata</i>	sugar hackberry
<i>Centaurea americana</i>	basketflower
<i>Cephalanthus occidentalis</i>	buttonbush
<i>Chamaecrista nictitans</i>	partridge pea
<i>Chara sp.</i>	muskgrass
<i>Chasmanthium latifolium</i>	inland sea oats
<i>Cirsium sp.</i>	thistle
<i>Cocculus carolinus</i>	snailseed vine
<i>Convolvulus equitans</i>	bindweed
<i>Cornus Drummondii</i>	roughleaf dogwood
<i>Crataegus sp.</i>	hawthorn
<i>Croton sp.</i>	croton
<i>Cuscuta sp.</i>	dodder
<i>Cyclachaena xanthifolia</i>	sumpweed
<i>Cynodon dactylon</i>	coastal bermudagrass
<i>Desmanthus illinoensis</i>	Illinois bundleflower
<i>Desmodium canadense</i>	beggar's lice
<i>Dicanthelium sp.</i>	panicgrass
<i>Diospyros texana</i>	Texas persimmon
<i>Echinochloa crus-galli</i>	barnyardgrass
<i>Eleoagrostis sp.</i>	spikerush
<i>Elymus canadensis</i>	Canada wildrye
<i>Engelmannia peristenia</i>	Engelmann's daisy
<i>Eragrostis hypnoides</i>	teal lovegrass
<i>Eryngium leavenworthii</i>	Leavenworth's eryngo

<i>Eustoma grandiflora</i>	Texas bluebells
<i>Forestiera angustifolia</i>	elbowbush
<i>Fraxinus pennsylvanica</i>	green ash
<i>Gaillardia pulchella</i>	Indian blanket
<i>Gleditsia tricanthos</i>	honey locust
<i>Helianthemum sp.</i>	frost weed
<i>Helianthus annuus</i>	annual sunflower
<i>Helianthus maximiliani</i>	maximilian sunflower
<i>Ilex decidua</i>	deciduous holly
<i>Iva annua</i>	annual marsh elder
<i>Juncus sp.</i>	unknown rush
<i>Juniperus virginiana</i>	eastern red cedar
<i>Lemnaceae sp.</i>	duckweed
<i>Liatris sp.</i>	gayfeather
<i>Ligustrum sp.</i>	privet
<i>Lippia sp.</i>	frogfruit
<i>Ludwigia octovalvis</i>	Mexican primrose-willow
<i>Maclura pomifera</i>	bois d' arc
<i>Matelea reticulata</i>	milkweed vine
<i>Mimosa L.</i>	sensitive briar
<i>Monarda citriodora</i>	horsemint
<i>Morus rubra</i>	red mulberry
<i>Nassella leucotricha</i>	Texas winter grass
<i>Oenothera speciosa</i>	pink evening primrose
<i>Opuntia sp.</i>	prickly-pear cactus
<i>Panicum virgatum</i>	switchgrass
<i>Parthenocissus quinquefolia</i>	Virginia creeper
<i>Passiflora lutea</i>	yellow passion flower
<i>Pluchea odorata</i>	sweetscent
<i>Polygonum sp.</i>	smartweed
<i>Polytaenia nuttallii</i>	prairie parsley
<i>Populus deltoides</i>	cottonwood
<i>Potamogeton pectinatus</i>	sago pondweed
<i>Prosopis grandulosa</i>	mesquite
<i>Prunus angustifolia</i>	Chickasaw plum
<i>Prunus mexicana</i>	Mexican plum
<i>Ptelea trifoliata</i>	hoptree
<i>Quercus marilandica</i>	blackjack oak
<i>Quercus stellata</i>	post oak

<i>Rhus trilobata</i>	skunkbush sumac
<i>Rivina humilis</i>	pigeonberry
<i>Rubus enslenii</i>	southern dewberry
<i>Rudbeckia triloba</i>	brown-eyed susan
<i>Sagittaria sp.</i>	arrowhead
<i>Salix nigra</i>	black willow
<i>Sapindus saponaria</i>	western soapberry
<i>Schizachyrium scoparium</i>	little bluestem
<i>Sesbania sp.</i>	rattlebush
<i>Sideroxylon lanuginosum</i>	gum bumelia
<i>Smilax bona-nox</i>	saw greenbrier
<i>Solanum carolinense</i>	Carolina horsenettle
<i>Solanum elaeagnifolium</i>	silverleaf nightshade
<i>Solidago sp.</i>	goldenrod
<i>Sophora affinis</i>	Eve's necklace
<i>Sorghum halepense</i>	johnsongrass
<i>Symphoricarpos orbiculatus</i>	coralberry
<i>Toxicodendron radicans</i>	poison ivy
<i>Typha sp.</i>	cattail
<i>Ulmus americana</i>	American elm
<i>Ulmus crassifolia</i>	cedar elm
<i>Vernonia texana</i>	ironweed
<i>Vitis rotundifolia</i>	muscadine grape
<i>Xanthium strumarium</i>	cocklebur

APPENDIX B
OBSERVATION SHEETS: HEP SITES
WITH PHOTOS

HEP Site Observations for the Aquilla Reservoir Project

HEP Site #:1

Location: 31.906261, -97.187168

Date: 07/14/2008

General Description: grassland within emergency spillway, scattered mesquites, site occasionally controlled burned

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
	mesquite	costal bermudagrass	western ragweed
			horsemint
			Illinois bundleflower
			pink evening primrose
			silverleaf nightshade

Wildlife Species Observed: great blue heron, mourning dove, fire ants

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP Site #: 2

Location: 31.905608, -97.189773

Date: 07/14/2008

General Description: shrubland, mesquite with giant ragweed

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
cottonwood	cedar elm	johnsongrass	giant ragweed
	mesquite		beggar's lice
	hackberry		partridge pea

Wildlife Species Observed: eastern cottontail, northern cardinal

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 3

Location: 31.90551, -97.190466

Date: 04/24/2002

General Description: tree savannah, primarily hawthorn and mesquite over costal Bermudagrass

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
	mesquite	costal bermudagrass	basketflower
	hawthorn	johnsongrass	horsemint
		little bluestem	giant ragweed
			snailseed vine
			western ragweed

Wildlife Species Observed: none

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 4 **Location:** 31.905581, -97.222718

Date: 07/14/2008

General Description: grassland, grass/forb patch surrounded by mesquite

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
post oak	mesquite	little bluestem	western ragweed
		coastal bermudagrass	Illinois bundleflower
			prickly pear cactus
			brown-eyed susan
			broomweed
			begger's lice
			sumpweed
			milkweed

Wildlife Species Observed: unidentified rodent

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP Site #: 5

Location: 31.905161, -97.22223

Date: 07/14/2008

General Description: shrubland, primarily regenerating mesquite over coastal bermudagrass, level site

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
mesquite	mesquite	Canada wildrye	western ragweed
	honey locust	coastal bermudagrass	giant ragweed
	hackberry	sedge sp.	goldenrod
		three awn	milkweed

Wildlife Species Observed: Rodent tunnels in matted grass

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 6 **Location:** 31.901691, -97.216482

Date: 07/14/2008

General Description: emergent wetland, small stock tank approximately 60 ft diameter, bare banks resulting from receding water, submerged vegetation consists of alga and muskgrass, surrounded by mesquite shrubland

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
	mesquite	sedge sp.	sumpweed
		spikerush sp.	croton sp.
			frogfruit
			cocklebur
			western ragweed
			cattail sp.
			muskgrass

Wildlife Species Observed: mosquitofish, deer tracks, raccoon tracks

Views:



North



South

Unavailable
East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 7 **Location:** 31.907853, -97.216812

Date: 07/14/2008

General Description: upland deciduous forest, hackberry woodland, undersory consists of Canada wildrye and coralberry

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
hackberry	coralberry	Canada wildrye	milkweed vine
mesquite	cedar elm		frostweed
			saw greenbier

Wildlife Species Observed: Carolina chickadee

Views:

Unavailable
North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 8

Location: 31.90848, -97.21516

Date: 07/14/2008

General Description: emergent wetland, pond, deep in appearance, abundant muskgrass and sago pondweed

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
black willow	mesquite	Canada wildrye	muskgrass
	hackberry		sago pondweed
			duckweed
			annual marsh elder
			giant ragweed

Wildlife Species Observed: cricket frogs, drangonfly sp., raccoon tracks, deer tracks, beaver or nutria chew signs

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 9 **Location:** 31.913455, -97.228453

Date: 07/14/2008

General Description: upland deciduous forest, approximately 20 degrees slope, rocky clay soil, has trees on slope but not on flat area, wetter area below slope

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
post oak	cedar elm	Canada wildrye	saw greenbrier
cedar elm	skunkbush sumac	Texas wintergrass	
	coralberry		
	hoptree		
	elbowbush		
	hackberry		
	opunita sp.		
	gum bumelia		
	Mexican plum		
	deciduous holly		

Wildlife Species Observed: American crow

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 10 **Location:** 31.914535, -97.224901

Date: 07/14/2008

General Description: tree savannah, grass with forbs and scattered mesquite, approximately 2 degrees of slope, many dewberry plants growing through mat of grass, thick mat of last season's grass present

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
mesquite	mesquite	sedge sp.	western ragweed
		Canada wildrye	pigweed
		coastal bermudagrass	annual marsh elder
		johnsongrass	southern dewberry
			cocklebur
			giant ragweed

Wildlife Species Observed:

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 11 **Location:** 31.916565, -97.191679

Date: 07/15/2008

General Description: upland deciduous forest, on 40-50 degree slope just above reservoir, forest starts at the top of the cut bank and proceeds upslope to fence

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
cedar elm	coralberry	Canada wildrye	poison ivy
post oak	cedar elm	sedge sp.	Virginia creeper
	green ash		saw greenbrier
	privet		cow itch vine
	hackberry		southern dewberry
	gum bumelia		sensitive brier
	eastern red cedar		yellow passionflower
	skunkbush sumac		

Wildlife Species Observed: Carolina chickadee, great blue heron

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 12 **Location:** 31.938125, -97.23838

Date: 07/15/2008

General Description: emergent wetland, pond with fallen black willow, black willow also growing around shoreline, max dbh: 5.5”

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
black willow	bois 'd arc	Canada wildrye	Mexican primrose-willow
			giant ragweed
			annual marsh elder
			cocklebur
			smartweed
			goldenrod
			southern dewberry
			sweetscent

Wildlife Species Observed: Many signs of nutria or beaver chews, pig wallow evident

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 13 **Location:** 31.936769, -97.238695

Date: 07/15/2008

General Description: shrubland, mesquite with ragweed, mostly level with slight depression

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
	mesquite	rush sp.	broomweed
	prickly pear cactus	switchgrass	partridge pea
			giant ragweed
			annual marsh elder
			beggar's lice
			western ragweed
			frog fruit
			sensitive brier

Wildlife Species Observed:

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 14 **Location:** 31.936892, -97.234634

Date: 07/15/2008

General Description: bottomland hardwood; black willow (mostly very tall and straight), pecan, green ash dominant; many downed limbs; little groundcover, signs of long-term standing water, saturated soil

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
black willow	honey locust		poison ivy
cedar elm	green ash		muscadine grape
	pecan		saw greenbrier
	hackberry		snailseed vine
	cedar elm		giant ragweed
			cocklebur
			southern dewberry

Wildlife Species Observed: predated turtle nest

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 15 **Location:** 31.92764, -97.237054

Date: 07/15/2008

General Description: upland deciduous forest, cedar elm dominant near hilltop, varying approximately 10-30 degrees in slope, relatively open canopy and understory, signs of fire several years ago

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
cedar elm	cedar elm	switchgrass	saw greenbrier
post oak	hoptree		southern dewberry
eastern red cedar	deciduous holly		muscat grape
	eastern red cedar		elbowbush
	blackjack oak		Virginia creeper
	prickly pear		
	hackberry		
	gum bumelia		

Wildlife Species Observed: turkey vulture, red-tailed hawk

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 16 **Location:** 31.931242, -97.231957

Date: 07/15/2008

General Description: tree savannah, small opening of shorter grasses within large field of tall switchgrass, a few mesquites of shrub and tree size present on one side, no slope

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
mesquite	mesquite	switchgrass	annual sunflower
	prickly pear	panicgrass	western ragweed
	hawthorn sp.	rush sp.	partridge pea
		little bluestem	goldenrod
			snailseed vine

Wildlife Species Observed:

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 17 Location: 31.931938, -97.227592

Date: 07/15/2008

General Description: grassland, coastal bermudagrass with widespread mesquite encroachment, abundant western ragweed

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
	mesquite	coastal bermudagrass	western ragweed
		rush sp.	goldenrod
		little bluestem	

Wildlife Species Observed: red-tailed hawk

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 18 **Location:** 31.943394, -97.235053

Date: 07/15/2008

General Description: emergent wetland, small pond, abundant filamentous algae, bare shore due to water level drop

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
		barnyardgrass	Mexican primrose-willow
		rush sp.	smartweed
			annual marsh elder
			cocklebur

Wildlife Species Observed: no signs of fish activity

Views:



North



West



South

Unavailable
East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 19 **Location:** 31.947694, -97.241788

Date: 07/15/2008

General Description: upland deciduous forest, largely open understory with little groundcover, abundant leaf litter and seedling poison ivy

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
cedar elm	hackberry	inland sea oats	saw greenbrier
hackberry	cedar elm		poison ivy
	post oak		southern dewberry
	red mulberry		Virginia creeper
	gum Bumelia		

Wildlife Species Observed: deer scat

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 20 **Location:** 31.963223, -97.258435

Date: 07/15/2008

General Description: shrubland, grass and forb field invaded by mesquite

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
	mesquite	panicgrass	western ragweed
	prickly pear cactus		prairie parsley
	gum bumelia		broomweed
	hackberry		snailseed vine
	eastern red cedar		southern dewberry

Wildlife Species Observed: Carolina chickadee, cottontail, northern cardinal, tufted titmouse, egret, downy woodpecker, crow, Bewick's wren.

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 21 Location: 31.97058, -97.259801

Date: 07/15/2008

General Description: grassland, switchgrass dominant with openings of forbs and short grass

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
	mesquite	switchgrass	annual marsh elder
		panicgrass	giant ragweed
		rush sp.	western ragweed
			annual sunflower
			Carolina horsenettle

Wildlife Species Observed:

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 22 **Location:** 31.972723, -97.255154

Date: 07/15/2008

General Description: emergent wetland, small pond entirely covered by duckweed, surrounded by upland woods

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
black willow	Mexican plum	switchgrass	goldenrod
cottonwood	eastern red cedar		annual marsh elder
	hackberry		cocklebur
	Texas persimmon		western ragweed
	honey locust		saw greenbrier
	mesquite		duckweed

Wildlife Species Observed: bullfrogs, abundant dragonfly sp.

Views:



North



West



South

Unavailable
East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 23 **Location:** 31.968333, -97.251576

Date: 07/15/2008

General Description: bottomland hardwood, moderately wet ground, abundant downed limbs washed into piles, bare ground due to inundation and hog activity

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
hackberry	deciduous holly	Canada wildrye	poison ivy
pecan	pidgeonberry	inland sea oats	saw greenbrier
bur oak	hackberry		southern dewberry
cottonwood	boxelder		Virginia creeper
green ash			muscadine grape
cedar elm			

Wildlife Species Observed: abundant hog signs, carp skull and skeleton

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 24 Location: 31.964642, -97.250584

Date: 07/15/2008

General Description: tree savannah, predominantly johnsongrass and giant ragweed, also contains a few mixed trees and shrubs

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
hackberry	pecan	johnsongrass	giant ragweed
honey locust	gum bumelia	Canada wildrye	annual marsh elder
	cedar elm	switchgrass	
		sedge sp.	

Wildlife Species Observed: northern cardinal

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 25 Location: 31.956245, -97.242141

Date: 07/16/2008

General Description: bottomland hardwood; bare mudflat with trees; primarily willow and boxelder; appears to be a delta with signs of frequent, long inundation; new coat of sediment deposited

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
black willow	green ash		frostweed
boxelder	boxelder		smartweed
green ash	hackberry		
	pecan		
	American elm		

Wildlife Species Observed: unidentified hummingbird

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 26 **Location:** 31.957241, -97.244785

Date: 07/16/2008

General Description: bottomland hardwood, riparian forest, located between main creek and a side channel on natural creek berm, frequently inundated and mostly bare, dead cedar trees present

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
cedar elm	pecan	Canada wildrye	poison ivy
boxelder	green ash		saw greenbrier
green ash	roughleaf dogwood		southern dewberry
	cedar elm		Virginia creeper
	deciduous holly		peppervine
	hackberry		
	bur oak		

Wildlife Species Observed: beaver signs, eastern phoebe

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 27 **Location:** 31.925335, -97.199047

Date: 07/16/2008

General Description: grassland, primarily switchgrass with interspersed short grass areas, forb component minimal although diverse in species, signs of cattle activity present

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
		switchgrass	milkweed sp.
		sideoats gramma	annual sunflower
			bluebells
			western ragweed
			broomweed

Wildlife Species Observed:

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 28 **Location:** 31.926041, -97.203332

Date: 07/16/2008

General Description: shrubland, grass and forb field invaded by mesquite, level slope

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
	mesquite	johnsongrass	annual marsh elder
			bluebells
			dodder
			western ragweed
			snailseed vine
			brown-eyed susan
			Illinois bundleflower
			giant ragweed

Wildlife Species Observed: bobwhite quail

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 29 **Location:** 31.92955, -97.195011

Date: 05/22/2002

General Description: emergent wetland, pond above small cove of main lake surrounded by trees, shrubs; several snags and downed limbs near and in edge of water; bare area three meters wide around shoreline

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
pecan	roughleaf dogwood	switchgrass	saw greenbrier
hackberry	Eve's necklace		poison ivy
cedar elm	honey locust		ironweed
	deciduous holly		cocklebur
			southern dewberry
			arrowhead
			milkweed sp.

Wildlife Species Observed:

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 30 **Location:** 31.940732, -97.193939

Date: 07/16/2008

General Description: upland deciduous forest, 20-30 year growth woodland with heavy leaf litter, largely open understory, midstory predominantly cedar elm, overstory predominantly oak sp., level slope

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
blackjack oak	gum bumelia		saw greenbrier
post oak	cedar elm		southern dewberry
cedar elm	deciduous holly		yellow passionflower
	Mexican plum		western ironweed
	coralberry		

Wildlife Species Observed: Carolina chickadee

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 31 **Location:** 31.946636, -97.18149

Date: 05/22/2002

General Description: tree savannah, switchgrass with invading mesquite and cedar elm, sparse short-grass patches present, level slope

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
mesquite	mesquite	johnsongrass	western ironweed
	hackberry	switchgrass	broomweed
	cedar elm	sideoats gramma	giant ragweed
	gum bumelia		annual sunflower
	coralberry		goldenrod
	Mexican plum		brown-eyed susan
			poison ivy
			snailseed vine
			maximillian sunflower

Wildlife Species Observed:

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 32 **Location:** 31.960002, -97.174116

Date: 07/16/2008

General Description: bottomland hardwood above bank of permanent stream; frequently flooded by lake; flood debris, dead cedar, and bare ground observed as flooding signs

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
pecan	boxelder		saw greenbrier
boxelder	buttonbush		western ragweed
honey locust	honey locust		
	hackberry		

Wildlife Species Observed:

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 33 **Location:** 31.951466, -97.162238

Date: 07/16/2008

General Description: tree savannah, grass with invading mesquite at top of shallow knoll, scattered cedars present

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
mesquite	mesquite	johnsongrass	gayfeather
	cedar elm	little bluestem	western ragweed
		threeawn	maximillian sunflower
			Indian blanket
			horsemint

Wildlife Species Observed:

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 34 **Location:** 31.952514, -97.162686

Date: 07/16/2008

General Description: grassland composed primarily of switchgrass, sparse short-grass areas present

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
	eastern red cedar	johnsongrass	ironweed
		switchgrass	thistle sp.
		sideoats gramma	yellow passionflower
			western ragweed
			horsemint

Wildlife Species Observed: yellow-billed cuckoo, northern cardinal, yellow swallowtail butterfly.

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 35 **Location:** 31.953535, -97.158894

Date: 07/16/2008

General Description: emergent wetland, old creek channel inundated by lake, exposed during low lake levels, broad flats of rattlebush monoculture

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
			rattlebush
			Mexican primrose-willow

Wildlife Species Observed: blue-winged teal, double-crested cormorant, snowy egret, gambusia sp.

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 36 **Location:** 31.952734, -97.153101

Date: 07/16/2008

General Description: bottomland hardwood, small dry creek and adjacent floodplain, likely often inundated by lake, ground largely barren due to inundation, many downed limbs washed into lines

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
green ash	green ash		saw greenbrier
cedar elm	hackberry		bindweed
boxelder	boxelder		beggar's lice
black willow	cedar elm		
	pecan		

Wildlife Species Observed: northern flicker, abundant cicadas

Views:



North



West



South

Unavailable
East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 37 **Location:** 31.959627, -97.144719

Date: 07/17/2008

General Description: grassland, johnsongrass dominant, sparse mixed form and switchgrass patches, a few invading mesquites present

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
	mesquite	johnsongrass	ironweed
		switchgrass	giant ragweed
		sideoats gramma	gayfeather
			horsemint
			brown-eyed susan
			maximillian sunflower

Wildlife Species Observed:

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 38 Location: 31.959465, -97.151074

Date: 07/18/2002

General Description: emergent wetland, upper end of lake, complete cocklebur cover with additional wetland plants present, likely often inundated, line of spikerush approximately 25 m inland is probable normal waterline, upland woodland on adjacent slope east of site

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
			cocklebur
			peppervine
			teal lovegrass
			rattlebush

Wildlife Species Observed: armadillo sign

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 39 **Location:** 31.962363, -97.150023

Date: 07/17/2008

General Description: bottomland hardwood, overbank area of creek and backwater area of lake, many downed limbs and woody debris, largely barren of living vegetation, occasional dense saw greenbrier thickets extending from overhead branches to ground level

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
cedar elm	cedar elm		saw greenbrier
red mulberry	pecan		
green ash	boxelder		
hackberry			

Wildlife Species Observed: red-tailed hawk; northern cardinal; gulf coast toad; small, unidentified passerines abundant

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 40 **Location:** 31.965781, -97.140855

Date: 07/17/2008

General Description: shrubland, two plum thickets with interspersed mesquites on 20 degree slope, grassland at top and mixed woods with poison ivy at bottom of slope

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
	mesquite	coastal bermudagrass	ironweed
	eastern red cedar	sedge sp.	Illinois bundleflower
	Chickasaw plum		southern dewberry
			western ragweed
			poison ivy
			Carolina horsenettle
			Engelmann's daisy
			Leavenworth's eryngo
			horsemint

Wildlife Species Observed: northern cardinal, Carolina chickadee, American crow, turkey vultures

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 41 **Location:** 31.980089, -97.140452

Date: 07/17/2008

General Description: tree savannah, johnsongrass and giant ragweed field with interspersed honey locust, green ash, hackberry, cedar elm; bottom of slope slightly wetter due to seepage

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
hackberry	cedar elm	johnsongrass	giant ragweed
green ash	deciduous holly	sideoats gramma	annual marsh elder
	hackberry		poison ivy
	honey locust		peppervine
			ironweed

Wildlife Species Observed: abundant dicksissels

Views:



North



West



South



East

HEP Site Observations for the Aquilla Reservoir Project

HEP site #: 42 Location: 31.988186, -97.136944

Date: 07/17/2008

General Description: shrubland, regenerating hackberry in large forest opening; consists largely of dense giant ragweed and Canada wildrye groundcover creating a shaded, bare ground below

Plant Species Observed:

Tree:	Shrub:	Grass:	Vine or Forb:
hackberry	hackberry	Canada wildrye	giant ragweed
	eastern red cedar	johnsongrass	
	western soapberry		

Wildlife Species Observed: abundant dicksissels

Views:



North



West



South



East

APPENDIX C
HEP SITES GEOGRAPHICAL POSITIONS

APPENDIX C

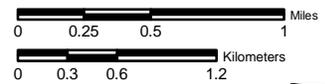
**Geographical Positions in Decimal Degrees of the HEP Sites in the
Aquila Lake Water Reallocation Project, Hill County, Texas**

Site #	Latitude	Longitude	Site #	Latitude	Longitude
1	31.906261	-97.187168	22	31.972722	-97.255154
2	31.905607	-97.189772	23	31.968332	-97.251576
3	31.905509	-97.190465	24	31.964642	-97.250584
4	31.905581	-97.222717	25	31.956244	-97.242140
5	31.905160	-97.222230	26	31.957240	-97.244784
6	31.901690	-97.216482	27	31.925334	-97.199047
7	31.907852	-97.216811	28	31.926041	-97.203332
8	31.908479	-97.215160	29	31.929550	-97.195011
9	31.913454	-97.228452	30	31.940731	-97.193939
10	31.914535	-97.224900	31	31.946636	-97.181490
11	31.916565	-97.191678	32	31.960002	-97.174116
12	31.938124	-97.238380	33	31.951465	-97.162237
13	31.936769	-97.238695	34	31.952513	-97.162686
14	31.936891	-97.234634	35	31.953535	-97.158894
15	31.927639	-97.237053	36	31.952733	-97.153100
16	31.931242	-97.231957	37	31.959626	-97.144719
17	31.931938	-97.227591	38	31.959464	-97.151073
18	31.943394	-97.235052	39	31.962362	-97.150022
19	31.947694	-97.241788	40	31.965780	-97.140854
20	31.963222	-97.258435	41	31.980088	-97.140452
21	31.970580	-97.259800	42	31.988185	-97.136944

APPENDIX D
AERIAL PHOTOGRAPHS



U.S. Fish & Wildlife Service
Arlington, Texas, Ecological Services Field Office
 Projection: UTM Zone 14N, NAD 1983, GRS 1980
 Production Date: 1/22/2009

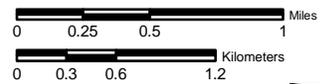


- HEP_Sites
- Corps boundary

Appendix D1: Aerial photograph Aquilla Lake study area with HEP sites, western half



U.S. Fish & Wildlife Service
Arlington, Texas, Ecological Services Field Office
 Projection: UTM Zone 14N, NAD 1983, GRS 1980
 Production Date: 1/22/2009

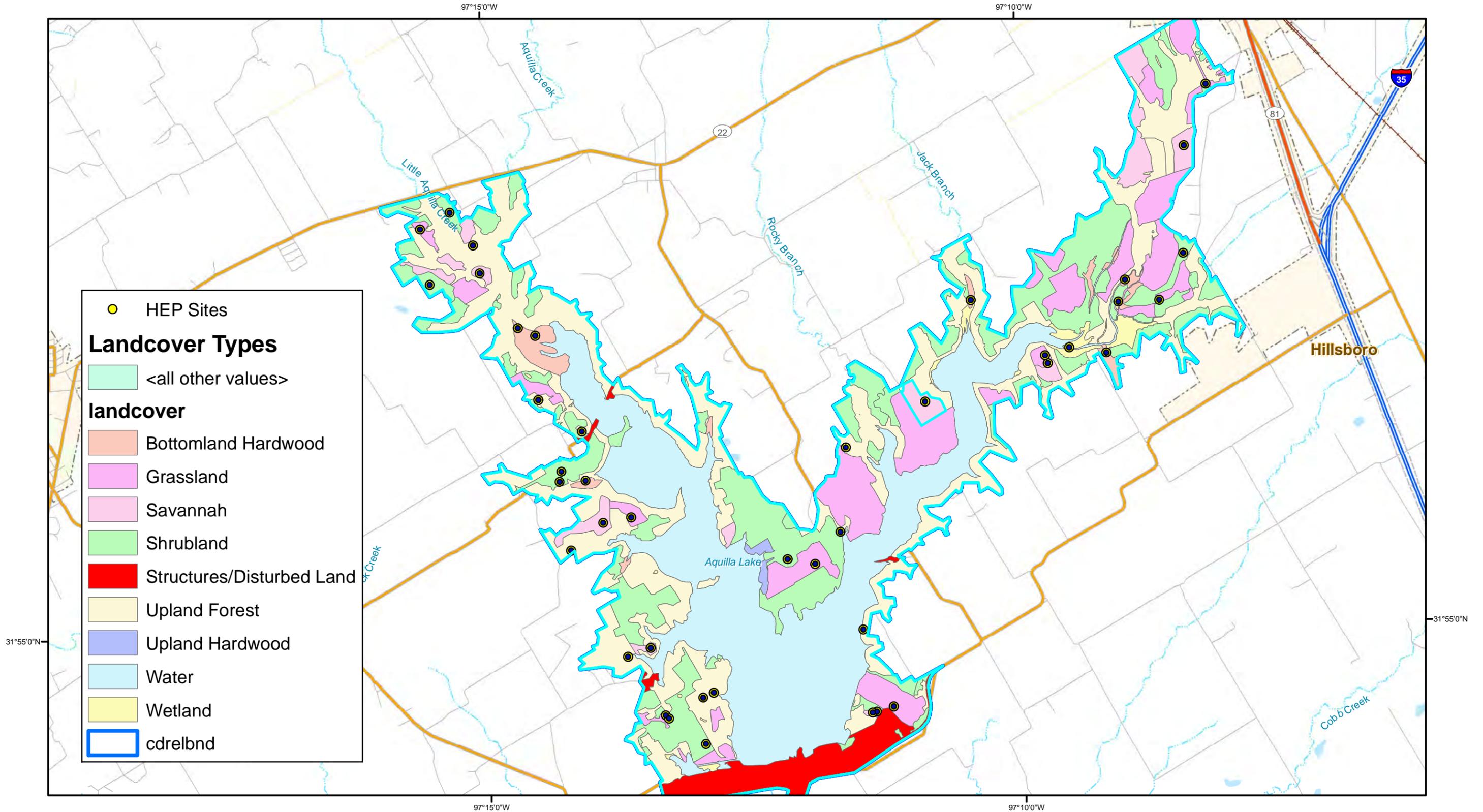


- HEP_Sites
- Corps boundary

Appendix D2: Aerial photograph Aquilla Lake study area with HEP sites, eastern half

APPENDIX E
COVER TYPE MAPS

Appendix E: Aquilla Lake study area landcover types

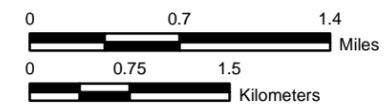


U.S. Fish & Wildlife Service

Arlington, Texas, Ecological Services Field Office

Projection: UTM Zone 14N, NAD 1983, GRS 1980

Production Date: 2/22/2009



APPENDIX F
HEP STRUCTURAL HABITAT
COMPOSITION PARAMETERS

Table F-1. Structural habitat composition parameters estimated at each Riparian Woodland survey site.

Parameter	Survey sites							
	14	23	25	26	32	36	39	Ave.
Percent tree canopy closure (%)	85	96	65	40	75	80	75	73.71
Percent tree canopy closure of mast producers \geq 10 in. dbh (%)	65	80	0	0	5	0	0	21.43
Percent canopy closure deciduous trees in stand (%)	85	96.5	65	75	75	80	75	78.79
Ave. dbh of overstory trees (in.)	12.3	13.5	12.2	10.3	10.7	ND	15.58	12.43
Ave. height of overstory trees (ft.)	50	50	35	65	45	60	50	50.71
Overstory forest size class: (A =<6"dbh, B =6-10"dbh, C =10-20"dbh, D =>20"dbh)	3	3	3	3	3	3	3	3
# of snags <10 in. dbh per acre	50	80	0	70	40	30	30	42.86
# of snags >6 in. dbh per acre	20	20	30	30	10	40	0	21.43
Percent shrub crown cover (%)	20	10	50	40	10	10	75	30.71
Number refuge sites per acre (#)	40	30	40	100	20	20	100	50
Distance to water (ft.)	145	250	60	30	50	360	60	136.43
Water regime: (A=Permanent, B=Semi-Permanent, C=None/Ephemeral)	3	2	2	1	1	1	1	1.57
# potential nest cavities per acre	10	20	40	20	10	20	0	17.14
# nest boxes per 0.4 ha (ac)	0	0	0	0	0	0	0	0
% water surface covered by logs, trees, or woody veg. within 1m	0	0	25	15	10	10	5	9.29
Basal Area; total dbh of all woody stems	70	80	80	130	50	110	110	90 / 44.16 sq.ft.
# trees \geq 12 dbh/ ac	30	40	80	20	60	80	70	54.29
Distance to available grain	9999	9999	9999	9999	9999	9999	9999	9999
Survey site cover type total area (acres)	11.48	163.14	42.91*	42.91*	8.99	20.79	18.8	Total evaluated area: 309.02 ac
								Total Riparian Woodland within study area: 334.40 ac

* HEP sites 25 and 26 are within a single Riparian Woodland patch encompassing 85.82 ac

Table F-2. Structural habitat composition parameters estimated at each Herbaceous Wetland survey site.

Parameter	Survey sites								
	6	8	12	18	22	29	35	38	Ave.
Distance to water (ft.)	0	0	0	0	0	0	0	1500	187.5
Water regime: (A=None/Ephemeral, B=Semi-Permanent, C= Permanent)	2	2	2	2	1	2	1	3	2
Water current: (A=still-slow, B=mod-slow, C=mod-fast, D=fast)	1	1	1	1	1	1	1	1	1
Number refuge sites per acre (no.)	50	80	100	40		100	10	10	55.71
Percent water area < 10 in. deep (ave. summer cond.) (%)	75	15	20	20	30	30	50	100	42.50
Percent emergent herbaceous cover in littoral zone (%)	2	25	10	0	0	0	10	100	18.38
Percent water surface covered by logs, overhang veg., etc. (%)	5	10	33	5	10	10	15	0	11
Aquatic substrate composition: (A=muddy, B=sandy, C=rocky)	1	1	1	1	1	1	1	1	1
Distance to forested/shrub wetland (large trees) (mi.)	1.51	.31	0	0	.14	0	.14	.06	.31
Number potential nest cavities per acre	0	0	5	2	10	20	10	20	8.38
Percent water area < 6 feet deep (%)	100	80	100	60	20	100	100	100	82.5
Number of nest boxes/ac.	0	0	0	0	0	0	0	0	0
Survey site cover type total area (acres)	.10	.58	.59	.46	.24	.32	15.85	1.40	Total evaluated area: 19.54 ac
									Total Herbaceous Wetland within study area: 112.98 ac

Table F-3. Structural habitat composition parameters estimated at each Tree Savanna survey site.								
Parameter	Survey sites							
	3	10	16	24	31	33	41	Ave.
% herbaceous canopy cover	95	100	85	90	85	95	95	92.14
Average height of herbaceous canopy in summer (centimeters)	30.5	45.72	76.2	91.44	60.96	35.56	71.12	58.79
Average height of herbaceous canopy in spring (centimeters)	15.25	22.86	38.1	45.72	30.48	17.78	35.56	29.4
Availability of weed, grass, grain seed: 1)abundant 2)Scattered 3) scarce	1	2	2	2	2	2	3	2
Composition of cover type: A) grasses dominant; B) legumes dominant; C) forbs dominant	1	1	1	1	1	1	3	1.29
% shrub (<16.5 ft height) canopy cover	5	15	10	15	10	5	5	9.29
% canopy closure of persistent herbaceous vegetation	50	100	100	60	40	30	70	64.29
Percent herbaceous canopy cover ≤ 12" tall	50	0	0	10	50	5	10	17.86
Distance (miles) to perch site (trees, fence post, utility post, and lines)	.0095	.0114	.0047	.00095	.00076	.0114	.0057	.00755
Availability of large lone trees > 12" dbh or groves < 1ac containing large trees w/in 1 mi: 1) Abundant; 2) Moderate; 3) Scarce to none	3	1	2	1	1	1	1	1.43
Avail. of cliff ledges, earth banks, or old abandoned buildings w/in 1mi: 1) Abundant; 2) Moderate; 3) Scarce to none	2	3	3	3	3	3	3	2.86
% tree canopy closure of mast producers ≥6" dbh	0	2	0	0	0	0	0	.29
Distance to available grain (meters)	2666.7	2666.7	600	533.33	500	1100	333.33	1200
% of herbaceous canopy that is grass	95	90	95	75	65	90	20	75.71
Distance to nearest deciduous trees	50	60	25	80	150	60	30	65
Ave. dbh of overstory trees	0	8	7	0	7	0	7	4.14
% tree canopy closure	0	0	5	0	15	5	5	4.29
# of deciduous trees per acre	0	10	10	10	10	10	10	8.57
Survey site cover type total area (acres)	3.70	10.71	48.16	13.20	51.36	19.87	40.90	Total evaluated area: 187.9 ac
								Total Savanna within study area: 365.46 ac

Table F-4. Structural habitat composition parameters estimated at each Shrubland survey site.

Parameter	Survey sites							
	2	5	13	20	28	40	42	Ave.
% herbaceous canopy cover	100	100	85	85	95	65	63	84.71
% of herbaceous canopy 6-24 inches tall	80	50	100	75	95	45	40	69.29
# refuge sites per acre	10	10	10	30	100	20	0	25.71
Ave. height of herbaceous veg (inches)	20	20	12	18	16	14	18	16.86
% shrub (<16.5 ft height) canopy cover	50	70	40	40	55	70	90	59.29
% canopy closure of persistent herbaceous vegetation	100	50	40	75	75	40	10	55.71
Distance to shrubby edges or shrub thickets (ft)	20	0	200	50	0	0	0	38.57
% canopy cover of preferred bobwhite food plants	80	70	40	20	60	30	10	44.29
% bare ground or covered w/light litter	0	0	5	10	5	5	37	8.86
Soil Moisture A) typically moist to saturated B) moderately dry to moist C) typically dry	3	3	2	2	3	2	2	2.43
% of herbaceous canopy that is grass	5	85	75	70	30	20	25	44.29
Distance to nearest deciduous trees (ft)	15	100	100	20	440	100	100	125
% tree canopy closure	10	0	0	40	0	12	25	12.43
# of deciduous trees per acre	10	0	0	10	0	30	30	11.43
% canopy cover of woody vegetation <2m in height	5	5	40	10	35	25	5	17.86
Survey site cover type total area (acres)	12.19	163.14	82.31	75.56	384.03	53.82	3.33	Total evaluated area: 774.38 ac
								Total Shrubland within study area: 2042.94 ac

Table F-5. Structural habitat composition parameters estimated at each Grassland survey site.

Parameter	Survey sites							
	1	4	17	21	27	34	37	Ave.
% herb. canopy cover	100	95	100	100	100	95	95	97.86
Ave. height herb. canopy in summer (inches)	17	14	18	36	12	18	14	18.43
Ave. height herb. canopy in summer (cm)	21.6	17.8	22.9	45.7	15.2	22.9	17.8	23.4
Ave. height herb. canopy in spring (cm)	10.8	8.9	11.45	22.85	7.6	11.45	8.9	11.7
% shrub canopy cover	2	5	0	2	0	0	5	2
% herb. canopy ≤ 12 in tall	100	100	100	30	85	50	65	75.71
Distance to perch site (tree, post, utility line) in feet	300	20	50	90	400	40	30	132.86
Avail. Of large, lone trees ≥ 12" dbh or groves 1ac in size containing large trees within a diameter of 1mi 1) Abundant; 2) Moderate; 3) Few	1	3	1	1	1	1	1	1.29
Avail. of cliff ledges, earth banks, or old abandoned buildings within 1 mi. 1) Abundant; 2) Moderate; 3) Scarce to none	2	2	2	3	2	3	3	2.43
% tree canopy closure	0	5	0	0	0	0	0	.71
% cc of persistent herb. veg.	100	85	100	100	60	50	75	81.43
% herb. cc that is grass	90	75	90	80	82	85	35	76.71
Survey site cover type total area (acres)	96.27	10.20	24.96	16.00	91.12	15.90	49.34	Total evaluated area: 303.79 ac
								Total Grassland within study area: 1198.96 ac

Table F-6. Structural habitat composition parameters estimated at each Upland Forest survey site.

Parameter	Survey sites						
	7	9	11	15	19	30	Ave.
% tree canopy closure	72	50	80	50	86.6	90	71.43
% tree canopy closure of mast producers ≥ 10 " dbh	0	35	33	40	85	75	44.67
% canopy closure deciduous trees in stand	72	50	80	50	86.6	90	70.60
% canopy closure of overstory trees	45	30	75	30	85	80	71.43
Ave. dbh of overstory trees	10	12	12.9	7.6	0	9.32	8.64
Ave. height of overstory trees	35	50	45	40	45	50	44.17
# snags <10" dbh/ ac.	100	40	40	50	20	40	48.33
# snags > 6" dbh/ ac.	5		20	10	50	0	17
% shrub crown cover	45		65	15	15	40	36
# refuge sites per ac.	40	30	30	40	20	10	28.33
Distance to water (feet)	750	100	80	1000	3500	1500	1155
Water regime: A-Perm. B-Semi-perm.(3 mos. April-Sept.) C-Semi-perm.(3-5mos.April-Sept.) D-None/ephemeral	1	1	1	1	1	1	1
# of trees ≥ 12 in. dbh/ ac	40	80	60	0	50	20	41.67
Overstory forest size class: 1-Saplings (<6 in dbh) 2- Pole timber (≥ 6 in to 10in dbh) 3- Sawtimber (≥ 10 in to 20 in dbh) 4- Mature trees (≥ 20 in dbh)	3	3	3	2	3	2	2.66
Distance to grain (meters)	8000	8000	600	700	8000	450	4292.7
Basal area; total dbh of all stems	50	60	160	80	90	80	86.67in / 40.95sq.ft.
Survey site cover type total area (acres)	213.36	112.75	90.28	103.54	18.52	132.28	Total evaluated area: 670.73 ac
							Total Upland Forest within study area: 2802.40 ac

**BASELINE FISHERIES SURVEY OF AQUILLA CREEK, JACK'S BRANCH,
AND HACKBERRY CREEK WITHIN THE PROPOSED AQUILLA LAKE
STORAGE REALLOCATION PROJECT AREA, HILL COUNTY, TEXAS**

Introduction

A fisheries survey was conducted on Aquilla Creek, Jack's Branch, and Hackberry Creek, tributaries of Aquilla Lake, Hill County, Texas, on August 23, 30, and 31, 2011, by U.S. Fish and Wildlife Service (USFWS) and U.S. Army Corps of Engineers (USACE) personnel. The purpose of this survey was to determine baseline fish-community structure within tributaries of Aquilla Lake that could be potentially impacted by stream modifications, development, and/or construction activities associated with the proposed Aquilla Lake Storage Reallocation Project.

Methods and Materials

Fish-community structure was assessed at one site on each tributary (Aquilla Creek, Jack's Branch, and Hackberry Creek) in Hill County, Texas by USFWS and USACE personnel to determine baseline conditions (Table 1 and Figure 1). The three sites were located in areas that would be directly impacted by activities associated with the proposed project; specifically, between the reservoir's current normal conservation pool elevation of 163.8 meters (537.5 feet) above sea level and the proposed 2-meter (6.5-foot) pool rise. Rocky Creek, a tributary of Aquilla Lake located approximately 2.5 kilometers (1.5 miles) southwest of Jack's Branch, was not sampled due to being completely dry during the sampling period.

Table 1. Aquilla Creek, Jack's Branch, and Hackberry Creek baseline fisheries survey sample sites, August 2011.	
Sample Site	General Description
Aquilla Creek	A 3rd order stream, approximately 700 meters (2300 feet) downstream of the Hill County Road 2415 bridge, a distance approximately 9 meters (30 feet), incorporating a portion of an isolated, stagnant pool habitat. Average stream width was 9 meters (30 feet) and water depth averaged 1 meter (3 feet). Substrate was dominated by clay and silt with areas of abundant organic debris.
Jack's Branch	A 1st order stream, approximately 970 meters (3182 feet) downstream of the Hill County Road 2431 bridge, a distance of approximately 15 meters (50 feet), incorporating an entire isolated, stagnant pool habitat. Average stream width was 5.5 meters (18 feet). Water depth averaged 1.2 meters (4 feet). Substrate was dominated by clay and silt with areas of abundant organic debris.
Hackberry Creek	A 3rd order stream, approximately 4 kilometers (2.5 miles) downstream of the State Highway 22 bridge, incorporating a portion of pool habitat. Average stream width was 7.6 meters (25 feet). Water depth averaged 1 meter (3 feet). Substrate was dominated by clay and silt with areas of abundant organic debris.

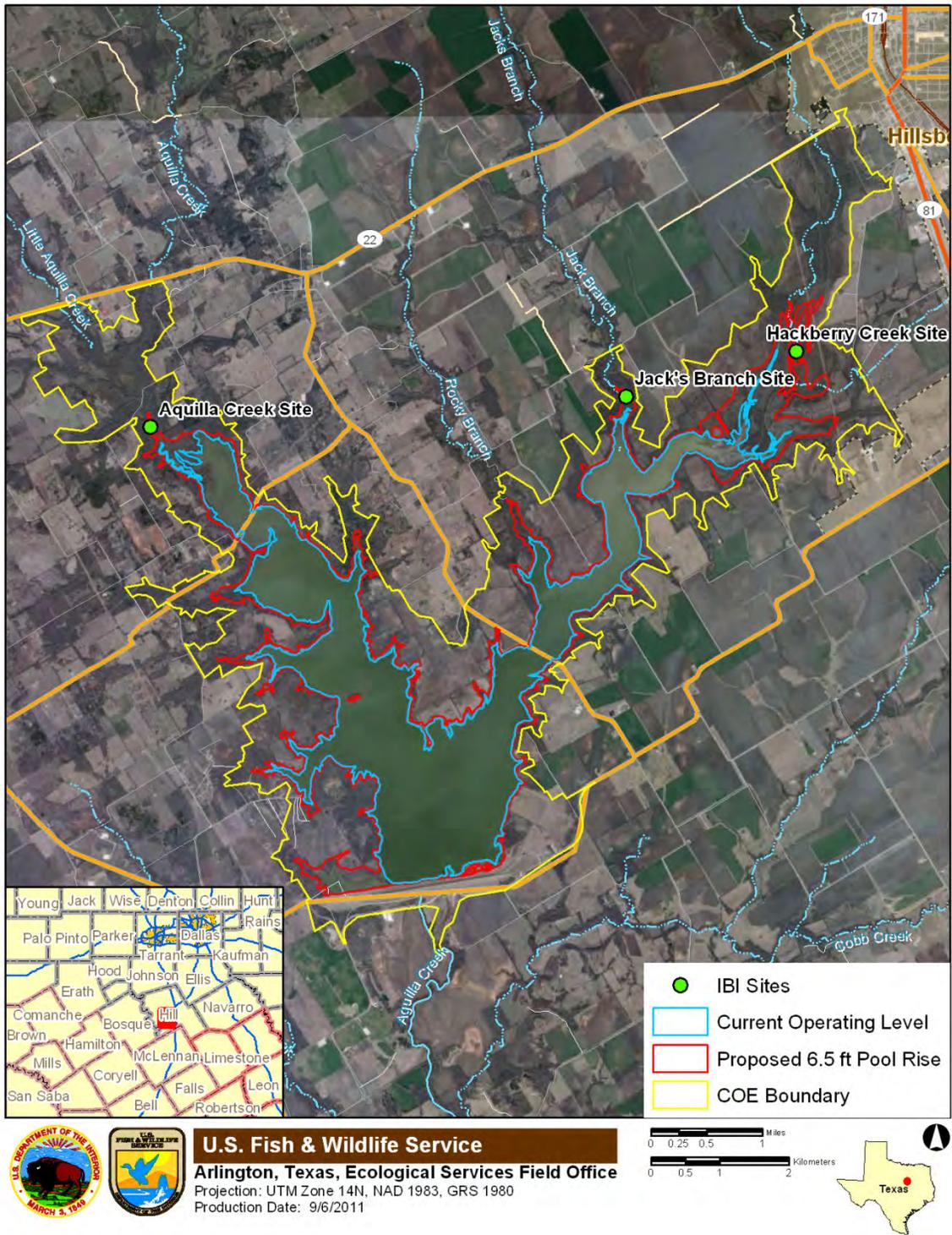


Figure 1: Location of Aquilla Creek, Jack's Branch, and Hackberry Creek sampling sites.

The drainage basin for the Aquilla Creek sampling site encompasses approximately 280 square kilometers (km²) [108 square miles (mi²)]. The Jack's Branch sampling site drainage basin encompasses approximately 25 km² (9.75 mi²). The Hackberry Creek sampling site drainage basin encompasses approximately 232 km² (89.5 mi²). Discharge at the Aquilla Creek and Jack's Branch sampling sites was negligible. Discharge at the Hackberry Creek sampling site was estimated at 0.028 cubic meters per second (1 cubic feet per second). In-stream habitat at the Aquilla Creek and Jack's Branch sites consisted of disconnected, stagnant pools, while the Hackberry Creek site in-stream habitat consisted of a long, continuous pool. No riffle or run habitat existed at any of the sampling sites. All sites had numerous in-stream obstacles, such as logs, fallen branches, and root wads. Each sampling site was located within bottomland hardwood habitat.

Fish were collected from all three sites using a 50 feet by 6 feet (15.2 meters by 1.8 meters) bag seine with 0.375 inch (9.53 millimeter) mesh. Six seine hauls were performed at the Aquilla Creek site, 4 seine hauls were performed at the Jack's Branch site, and 3 seine hauls were performed at the Hackberry Creek site. Water depth at all sites prevented the use of a backpack electrofisher as an effective means of collection. After collection, fish were identified to species using Robison and Buchanan (1988), Miller and Robison (2004), and Hubbs *et al.* (2008), counted, and any observed anomalies were recorded. All fish were then released back into the creek. The data resulting from this sampling effort were used to calculate aquatic life use values for each site employing the regional index of biotic integrity.

An index of biotic integrity (IBI) provides a means to assess aquatic life use within a given water body using multiple metrics. Accounting for the high variability in fish assemblages in aquatic systems between various ecological regions (eco-regions) in Texas, Linam *et al.* (2002) developed regionalized IBIs. The Aquilla Creek, Jack's Branch, and Hackberry Creek drainages are located in the region designated by Linam *et al.* (2002) as the Subhumid Agricultural Plains, which incorporates the variability of fish species inhabiting aquatic systems in Ecoregions 27 (Central Great Plains), 29 (Central Oklahoma/Texas Plains), and 32 (Texas Blackland Prairies). The regionalized IBI for this area consists of 11 metrics that define species richness, trophic composition, and abundance (Table 2 and Figure 2). Each one of these metrics is scored with values ranging from low (1) to high (5). In turn, aquatic life use values are determined by adding each metric score for a total score. These aquatic life use values can range from limited to exceptional.

Table 2. Regional index of biotic integrity scoring criteria for stream fish assemblages in the Subhumid Agricultural Plains (Ecoregions 27, 29, and 32). Total score for aquatic life use subcategories: >49 = Exceptional; 41-48 = High; 35-40 = Intermediate; and <35 = Limited (Linam *et al.* 2002).

Metric	Scoring Criteria		
	5	3	1
1. Total number of fish species	See figure 2		
2. Number of native cyprinid species	>3	2-3	<2
3. Number of benthic invertivore species	>1	1	0
4. Number of sunfish species	>3	2-3	<2
5. % of individuals as tolerant species (excluding western mosquitofish)	<26%	26-50%	>50%
6. % of individuals as omnivores	<9%	9-16%	>16%
7. % of individuals as invertivores	>65%	33-65%	<33%
8. % of individuals as piscivores	>9%	5-9%	<5%
9. (a) Number of individuals/seine haul	>87	36-87	<36
9. (b) Number of individuals/minute of electrofishing	>7.1	3.3-7.1	<3.3
10. % of individuals as non-native species	<1.4%	1.4-2.7%	>2.7%
11. % of individuals with disease or other anomaly	<0.6%	0.6-1%	>1%

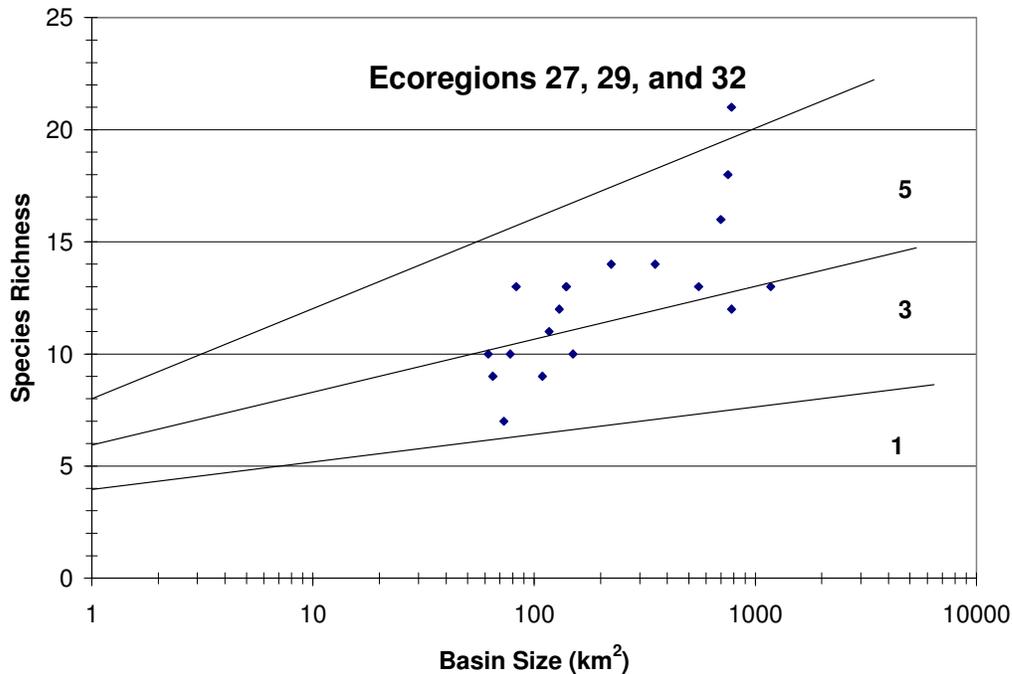


Figure 2. Fish species richness versus drainage basin size for the Subhumid Agricultural Plains (Ecoregions 27, 29, and 32) from Linam *et al.* (2002).

Results

A total of 935 fishes comprising 14 identifiable species from 8 families, were collected from the Aquilla Lake tributaries sampling sites (Table 3). Two species of sunfishes were unidentifiable to species level due to age (43 young-of-year juveniles) and hybridization (1 hybridized sunfish). Western mosquitofish (*Gambusia affinis*) represented 45.9% of the total number of fish collected from the three sites, followed by bluegill (*Lepomis macrochirus*, 23.1%), orangespotted sunfish (*Lepomis humilis*, 12.1%), gizzard shad (*Dorosoma cepedianum*, 5.2%), unknown juvenile sunfish (*Lepomis spp.*, 4.6%), white crappie (*Pomoxis annularis*, 4.5%), warmouth (*Lepomis gulosus*, 1.8%), and bigscale logperch (*Percina macrolepida*, 0.7%). Common carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), blackstripe topminnow (*Fundulus notatus*), green sunfish (*Lepomis cyanellus*), hybridized sunfish (*Lepomis spp.*), blackspot shiner (*Notropis atrocaudalis*), tadpole madtom (*Noturus gyrinus*), and river carpsucker (*Carpionodes carpio*) accounted for the remaining 2% of individuals captured.

Table 3. Fish collected by USFWS and USACE personnel from the Aquilla Creek, Jack’s Branch, and Hackberry Creek sampling sites, Hill County, Texas, August 2011.

Family	Species	Aquilla Creek	Jack’s Branch	Hackberry Creek	Total
Catostomidae (suckers)	<i>Carpionodes carpio</i> – river carpsucker	0	1	0	1
Centrarchidae (sunfishes)	<i>Lepomis cyanellus</i> – green sunfish	0	1	1	2
	<i>Lepomis gulosus</i> – warmouth	0	17	0	17
	<i>Lepomis humilis</i> – orangespotted sunfish	0	0	113	113
	<i>Lepomis macrochirus</i> – bluegill	46	138	32	216
	<i>Lepomis hybrid</i> – hybrid sunfish	0	0	1	1
	<i>Lepomis species</i> – unknown juvenile sunfish	0	24	19	43
	<i>Pomoxis annularis</i> – white crappie	0	7	35	42
Clupeidae (herrings)	<i>Dorosoma cepedianum</i> – gizzard shad	0	1	48	49
Cyprinidae (minnows)	<i>Cyprinus carpio</i> – common carp	0	5	0	5
	<i>Notropis atrocaudalis</i> – blackspot shiner	0	0	1	1
Fundulidae (topminnows)	<i>Fundulus notatus</i> – blackstripe topminnow	0	1	2	3
Ictaluridae (bullhead catfishes)	<i>Ictalurus punctatus</i> – channel catfish	0	4	1	5
	<i>Noturus gyrinus</i> – tadpole madtom	1	0	0	1
Percidae (perches)	<i>Percina macrolepida</i> – bigscale logperch	0	0	7	7
Poeciliidae (livebearers)	<i>Gambusia affinis</i> – western mosquitofish	9	215	205	429

Three separate species, representing 56 individuals, were collected at the Aquilla Creek sampling site. Ten species (excluding unidentifiable juvenile sunfishes), representing 414 individuals (including unidentifiable juvenile sunfishes), were collected at the Jack’s Branch sampling site. Ten species (excluding unidentifiable juvenile and hybridized sunfish), representing 465 individuals (including unidentifiable juvenile and hybridized sunfish), were collected at the Hackberry Creek sampling site. No indications of disease and/or other anomalies (such as tumors or lesions) were observed in any of the captured fish. Common carp were the only fish species collected at any of the three sites

considered non-native (Linam *et al.* 2002). The bigscale logperch and tadpole madtom were the only fish species collected at any of the three sites that were considered intolerant to limited water conditions (i.e., poor water quality, fluctuating water levels, reduced flow, etc.) by Linam and Kleinsasser (1998). In addition to fish, numerous odonate (dragonfly) larvae were observed at all sampling sites, two Mississippi map turtles (*Graptemys kohnii*) were captured at the Aquilla Creek sampling site, and several softshell turtles (*Apalone spp.*) and numerous freshwater shrimp (*Macrobrachium spp.*) were observed at the Hackberry Creek sampling site.

Designated tolerance levels (tolerant, intermediate, and intolerant) and associated trophic guilds (herbivore, invertivore, piscivore, and omnivore) for the species collected from all sampling sites were obtained from Linam and Kleinsasser (1998) and are presented in Table 4. Some sunfishes were unidentifiable to species level due to hybridization or age class, therefore a conservative assumption was made to classify those individuals as tolerant invertivores (Table 4). Results of the regionalized IBI calculations for all sampling sites, as well as the overall study area, are included in Tables 5 through 8.

Table 4. Fish species and their associated tolerance levels and trophic guilds collected from three sites within the Aquilla Lake drainage, Hill County, Texas, August 2011 (Linam and Kleinsasser 1998), where I = intermediate, N = intolerant, and T = tolerant. An asterisk (*) denotes the conservative assumption for categorizing unidentified hybrids and juveniles.			
Family	Species	Tolerance Class	Trophic Guild
Catostomidae (suckers)	<i>Carpoides carpio</i> – river carpsucker	T	omnivore
Centrarchidae (sunfishes)	<i>Lepomis cyanellus</i> – green sunfish	T	piscivore
	<i>Lepomis gulosus</i> – warmouth	T	piscivore
	<i>Lepomis humilis</i> – orangespotted sunfish	I	invertivore
	<i>Lepomis macrochirus</i> – bluegill	T	invertivore
	<i>Lepomis hybrid</i> – hybrid sunfish	T*	invertivore*
	<i>Lepomis species</i> – unknown juvenile sunfish	T*	invertivore*
	<i>Pomoxis annularis</i> – white crappie	I	piscivore
Clupeidae (herrings)	<i>Dorosoma cepedianum</i> – gizzard shad	T	omnivore
Cyprinidae (minnows)	<i>Cyprinus carpio</i> – common carp	T	omnivore
	<i>Notropis atrocaudalis</i> – blackspot shiner	I	invertivore
Fundulidae (topminnows)	<i>Fundulus notatus</i> – blackstripe topminnow	I	invertivore
Ictaluridae (bullhead catfishes)	<i>Ictalurus punctatus</i> – channel catfish	T	omnivore
	<i>Noturus gyrinus</i> – tadpole madtom	N	invertivore
Percidae (perches)	<i>Percina macrolepida</i> – bigscale logperch	N	invertivore
Poeciliidae (livebearers)	<i>Gambusia affinis</i> – western mosquitofish	T	invertivore

Table 5. Regional IBI Metric Calculations (IBI Score) for Aquilla Creek.			
1. Total # of fish species:	3 (1)	7. % of individuals as invertivores:	100 (5)
2. # of native cyprinid species:	1 (1)	8. % of individuals as piscivores:	0 (5)
3. # of benthic invertivore species:	1 (3)	9a. # of individuals/seine haul:	9.33 (1)
4. # of sunfish species:	1 (1)	9b. # of individuals/minute of electro-fishing:	na
5. % of individuals as tolerant species (excluding mosquitofish):	82 (1)	10. % of individuals as non-native species:	0 (5)
6. % of individuals as omnivores:	0 (5)	11. % of individuals with disease or other anomaly:	0 (5)
IBI Total Score: 33 (Limited)			

Table 6. Regional IBI Metric Calculations (IBI Score) for Jack's Branch.			
1. Total # of fish species:	10 (5)	7. % of individuals as invertivores:	91 (5)
2. # of native cyprinid species:	0 (1)	8. % of individuals as piscivores:	6 (3)
3. # of benthic invertivore species:	4 (5)	9a. # of individuals/seine haul:	104 (5)
4. # of sunfish species:	4 (5)	9b. # of individuals/minute of electro-fishing:	na
5. % of individuals as tolerant species (excluding mosquitofish):	46 (3)	10. % of individuals as non-native species:	<1 (5)
6. % of individuals as omnivores:	3 (5)	11. % of individuals with disease or other anomaly:	0 (5)
IBI Total Score: 47 (High)			

Table 7. Regional IBI Metric Calculations (IBI Score) for Hackberry Creek.			
1. Total # of fish species:	10 (3)	7. % of individuals as invertivores:	82 (5)
2. # of native cyprinid species:	1 (1)	8. % of individuals as piscivores:	8 (3)
3. # of benthic invertivore species:	1 (1)	9a. # of individuals/seine haul:	155 (5)
4. # of sunfish species:	4 (5)	9b. # of individuals/minute of electro-fishing:	na
5. % of individuals as tolerant species (excluding mosquitofish):	22 (5)	10. % of individuals as non-native species:	0 (5)
6. % of individuals as omnivores:	5 (5)	11. % of individuals with disease or other anomaly:	0 (5)
IBI Total Score: 43 (High)			

Table 8. Regional IBI Metric Calculations (IBI Score) for Overall Study Area.			
1. Total # of fish species:	14 (5)	7. % of individuals as invertivores:	87 (5)
2. # of native cyprinid species:	1 (1)	8. % of individuals as piscivores:	7 (3)
3. # of benthic invertivore species:	4 (5)	9a. # of individuals/seine haul:	72 (3)
4. # of sunfish species:	5 (5)	9b. # of individuals/minute of electro-fishing:	na
5. % of individuals as tolerant species (excluding mosquitofish):	36 (3)	10. % of individuals as non-native species:	<1 (5)
6. % of individuals as omnivores:	6 (5)	11. % of individuals with disease or other anomaly:	0 (5)
IBI Total Score: 45 (High)			

The regional IBI assessment results demonstrated a limited aquatic life use value for the fish community sampled at Aquilla Creek (score of 33) and a high aquatic life use value for the fish assemblages at Jack's Branch and Hackberry Creek (scores of 47 and 43,

respectively). The fish community within the overall study area was characterized as high (score of 45) and the mean IBI score for the three sites characterized the study area as high (mean score of 41).

Discussion

The fish community structure assessed within the Aquilla Creek, Jack's Branch, and Hackberry Creek drainages (tributaries of Aquilla Lake) in Hill County, Texas during August 2011, within an area that would be impacted by activities associated with the proposed Aquilla Lake Storage Reallocation Project, demonstrated a high overall aquatic life use value. Considering the limited flow conditions and lack of riffle or run aquatic habitat available at each site, the overall study area IBI score of 45, may be more representative of the actual aquatic life use value within the entire study area despite the Aquilla Creek sampling site being classified as limited (IBI score of 33).

It may be noted that reports provided to the Corps for projects such as this normally include mapping of "pool-run-riffle" sequences and further in-stream habitat discussions. This Aquilla Supplemental PAL does not include much in-stream habitat discussion because it was almost entirely absent. The reasons for this are:

- **Jack's Branch and Aquilla Creek-** Both were composed of disjunct, deeply incised pools. No runs or riffles were present. If it were not for migration from the reservoir, there would likely be almost no fish in these pools, certainly not as diverse a population. In essence, in-stream habitat was poorly represented, if at all. Raising the pool level could potentially connect these pools at times during the year, supporting more in-stream habitat.
- **Hackberry Creek-** This stream was not disjunct and will likely be continually connected to the reservoir considering that we observed it during very low-flow conditions. Hackberry Creek has continual flow is because it is fed by releases from an upstream wastewater treatment plant. A pool rise would likely only make it somewhat deeper, marginally affecting what is already a deeply incised channel. Typical "pool-run-riffle" in-stream habitat was not present and therefore missing from this Supplemental PAL.

Instream conditions at the Aquilla Creek sampling site may have negatively impacted sampling efficiency resulting in a low aquatic life use value. Obstacles, such as steep banks, undercut banks, slick substrate, deep channels (greater than 1.8 meters [6 feet] in depth), large fallen branches, submerged logs, and root wads, made effective seine hauls difficult to perform and excluded backpack electrofishing as a collection method. These conditions significantly restricted the size of the sampling area and may have impeded the collection of a representative sample of the existing fish community in Aquilla Creek.

The proposed project is expected to raise the normal operating level of Aquilla Lake as much as 2 meters (6.5 feet) and would result in the inundation of all sampling sites.

However, this is unlikely to negatively impact the assessed aquatic communities. Current conditions within the assessed tributaries exhibit limited flow, resulting in the lack of any riffle or run habitat, and the stagnation of isolated pools. It is the USFWS's opinion that any loss of aquatic life use value within each tributary will be mitigated by the increase of available pool habitat resulting from the proposed Aquilla Lake Storage Reallocation Project.

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