# Mid-Brazos River Watershed Riparian Wildlife Habitat Evaluation

*U. S. Fish and Wildlife Service*
*Region 2*

Arlington Ecological Services Field Office
Arlington, Texas

July 2004

Prepared by:
Carol S. Hale, Senior Staff Biologist

Reviewed by:
Tom J. Cloud, Jr., Field Supervisor

Filename: C:\Documents and Settings\HALEC\My Documents\Documents\Documents\USACE\Brazos\draft3.wpd

# Executive Summary

The purpose of this report is to document existing riparian conditions within the proposed Middle Brazos River Aquatic Ecosystem Restoration project area in Erath and Hamilton Counties, Texas, and recommend preliminary measures for resource protection and restoration. It provides baseline data with which future impacts (anthropological and natural), with and without restoration, can be compared. The U.S. Army Corps of Engineers initiated this study at the request of the Brazos River Authority, the local sponsor, due to water quality and sediment concerns identified in the 1999 Middle Brazos River Basin Reconnaissance Study.

An interagency assessment team was formed to provide expert advice for riparian habitat restoration or enhancement potential. The team consisted of representatives from the Natural Resource Conservation Service, Texas State Soil and Water Conservation Board, Texas Farm Bureau, Tarleton State University, BRA, USACE, private landowners, and Service. Vegetative and hydrological riparian habitat data were collected in 27 plots on 23 early project participant lands during two interagency site visits on June 14-15 and July 13-14, 2000.

Six private landowners located within the Green Creek, Duffau Creek, Meridian Creek, Honey Creek watersheds, and on the shores of the North Bosque River 14 miles from the town of Hico, are currently participating in the project. This report provides detailed information and recommendations for the bottomland hardwood habitat located on their lands only. A tract level analysis has not been computed for any of these areas, but a preliminary calculation was made to get an estimate of the HSI and HUs for each participant's land.

Although the riparian corridors located on the 6 participating private lands have many good riparian forest attributes, they are considered poor quality because they are narrow, fragmented strips, void of interior forest attributes. A discussion of the habitat model used for the evaluation is included in the report, as well as preliminary recommendations to the USACE and the landowners for enhancing and managing the fish and wildlife riparian habitat at each project site.

There are 4 endangered, 2 threatened, and one candidate wildlife species known to occur in Erath and Hamilton Counties. There is no designated critical habitat for any of these listed species in Erath or Hamilton County. An evaluation of the proposed projects potential effects to these listed species should be conducted.

Enhancement and reforestation of the riparian corridors will improve riparian species diversity and quality in all 6 the project areas, benefiting a variety of resident and migratory wildlife species.

# Table of Contents

Executive Summary .....ii

Table of Contents .....iii

List of Tables ..... iv

List of Figures .....v

Acknowledgements..... .....vi

Introduction .....1

Background Information .....1

Methods.....3
- Study Area .....3
- Habitat Evaluation Model .....3
- Data Collection .....5
- Plot Variables.....6
- Plot Suitability Indices.....9

Results.....9
- Overall Plot Variable Descriptions .....9
- Plot Suitability Indices.....13
- Detailed Description of Plots on Participating Lands.....17
- Threatened and Endangered Species and Birds of Conservation Concern.....20

Recommendations.....23

Conclusion .....25

Literature Cited .....26

Appendices:
- Appendix A. Structural Habitat Composition Attributes in Each Plot
- Appendix B. Presence of Mature Forest Elements in Each Plot
- Appendix C. Presence of Ground Layer Elements in Each Plot
- Appendix D. HEP Sites Observation Sheets
- Appendix E. Plants Found in the Study Plots
- Appendix F. Maps
- Appendix G. Photographs

# List of Tables

Page

Table 1. Data Plot Locations.....6

Table 2. Structural Habitat Composition of
All Data Plots in the Mid-Brazos Watershed.....10

Table 3. Number of Plots Containing Each Mature Forest Element .....11

Table 4. Number of Plots Containing Each Ground Layer Element .....13

Table 5. Habitat Plot Data on the Duffau and Little Duffau Creeks.....14

Table 6. Habitat Plot Data on Green Creek .....14

Table 7. Habitat Plot Data on Other Sites.....15

Table 8. Suitability Indices for Plots on Duffau and Little Duffau Creeks .....15

Table 9. Suitability Indices for Plots on Green Creek .....17

Table 10. Suitability Indices for Plots on Other Sites.....17

# List of Figures

Page

Figure 1. The Mid-Brazos River Riparian Habitat Study Area .....4

Figure 2. Distance from the Center of the Plot to a Major Topographical Change.....16

# Acknowledgments

The U.S. Fish and Wildlife Service would like to thank the 2000 Site Assessment Team for their assistance in data collection during the field visits: Gayle Haecker, Brazos River Authority; Dr. H.L. Self; Tony Huffman, USDA Natural Resources Conservation Service; Steve Jones, Texas State Soil and Water Conservation Board; Tim Jones, Texas Institute of Applied Environmental Research; and Dr. Hank Jarboe, U.S. Army USACE of Engineers. Ms. Haecker and Dr. Jarboe planned and coordinated the site visits and provided information required to complete this report. We would particularly like to thank Mr. Tim Jones for his assistance in collecting the Habitat Evaluation Procedure data and identifying plant species.

The Service would like the thank Jeffry Tripe, U.S. Army USACE of Engineers, Fort Worth District, for planning and coordinating the 2004 site visits and providing information.

# Introduction

The purpose of this report is to document existing riparian conditions within the proposed Middle Brazos River Aquatic Ecosystem Restoration project area and recommend preliminary measures for resource protection and restoration. It provides baseline data with which future impacts (anthropological and natural), with and without restoration efforts, can be compared. This planning assistance is provided pursuant to the Fish and Wildlife Coordination Act (FWCA)(48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). It does not represent a final report of the Secretary of the Interior within the meaning of Section 2(b) of the Act. A discussion of the habitat model used for the evaluation is included in the report, as well as preliminary recommendations to the USACE and the landowners for enhancing and managing the fish and wildlife riparian habitat at each project site. A complete FWCA report will be prepared by the U.S. Fish and Wildlife Service (Service) for the U.S. Army USACE of Engineers (USACE) to accompany the Detailed Project Report after all available pertinent information has been reviewed, including the comments from the Texas Parks and Wildlife Department (TPWD) during the planning process.

Authority for this feasibility study is contained in Section 206 of the Water Resource Development Act (WRDA) of 1996 (P.L. 104-303). The USACE initiated this study at the request of the Brazos River Authority, the local sponsor, due to water quality and sediment concerns identified in the 1999 Middle Brazos River Basin Reconnaissance Study in the Middle Brazos River Basin in Erath, Hamilton, and Bosque Counties, Texas.

The Service's role during this study is to assist the USACE in the identification of existing fish and wildlife resources and their needs, and potential ecosystem restoration alternatives.

# Background Information

Water is the "most precious natural resource" in the State of Texas (TWDB 1997). The state's economy and health depends on an abundance of clean water sources. Due to the rapidly growing human population in Texas, the demand for water is increasing. Texas rivers and streams provide water for human and livestock consumption and agricultural, recreational and industrial purposes (TWDB 1997). Riparian woodland corridors are critical in maintaining an abundance of quality water to meet future demands. They have several hydrological and biological functions, including flood control, surface water storage, ground water supply recharge, and biological diversity (Dickson 1989, Gregory 1991, Williams et al. 1997). Vegetation in riparian corridors act as a filter trapping sediment, organics, nutrients, and pesticides from surface runoff from agricultural fields and pastures, therefore improving water quality (Lowrance et al. 1984, Henley et al. 2000).

Riparian woodlands are complex ecosystems that contain unique habitats that are important to a variety of animals. The trees, shrubs, grasses, and forbs they contain provide food (Halls 1973), resting, migration and dispersal cover (Burk et al. 1990, Halls 1973), and breeding habitat for many fish, mammal, bird (Dickson and Huntley 1987), reptile and amphibian species (Rudolph and Dickson 1990, Brode and Bury 1984). Trees, branches, and leaves falling from riparian

corridors into the water provide food and cover for aquatic organisms (Cummins et al.1989, Flebbe 1999, Maser and Sedell 1994). Over hanging trees and shrubs provide shade that lowers the water temperature to a level required for healthy fish populations (Biro 1998, Cole 1983, Ringler et al. 1975, Young 1999).

The Brazos River Authority (BRA) and local water districts expressed concern for the water quality of the Brazos River and its' tributaries due to the agricultural activities in the river basin. Much of the riparian woodland habitats along the tributaries of the Brazos River are gone and the remaining stands are fragmented, over grazed and trampled by cattle, leading to bank erosion, sediment loading, and a decrease in wildlife diversity and numbers. The Texas Natural Resource Conservation Commission's (TNRCC) 1998 water quality inventory designates several segments of the Brazos River Basin tributaries as impaired due to point and non-point source pollution and has placed several on the 1998 Section 303(d) list. The TNRCC also has determined that 75 miles along the North Bosque River, a tributary of the Brazos River, has periodic high bacteria levels that exceed the criterion established for safe contact recreation. The bacteria level is most likely due to concentrated cattle feeding operations in the area (TNRCC 1999).

In 1998, the Fort Worth District, USACE, conducted a reconnaissance study of the Middle Brazos River Basin to evaluate the ecological health of the basin and identify potential opportunities for ecosystem restoration and flood damage reduction. This study identified adverse impacts to the basin's riparian, prairie, and aquatic ecosystems as a result of intensive land use practices and water quality degradation due to nutrient loading from livestock facilities (USACE 1998). In support of the reconnaissance study, the Service conducted a fishery survey from June to September, 1998, to evaluate potential influences of water quality on fish populations and communities in the Middle Brazos River area. Fish samples were taken from tributaries of the Brazos River; the Bosque, Leon, and Lampasas rivers. The study found that the fishery in the Middle Brazos River Basin is substantially impacted by non-point source pollution from agricultural practices, point source pollution from wastewater treatment plants, high seasonal temperature, and low dissolved oxygen in tailraces below dams. The Service recommended a combination of riparian buffer zone restoration and off stream wetlands construction (USFWS 1998).

The USACE initiated a feasibility study in 2000 to further evaluate the initial findings of the reconnaissance study and define potential environmental restoration opportunities within the basin. A draft Interim Feasibility Report was scheduled to be completed by December 15, 2001 with a final report due in May, 2002. As part of this feasibility study, the USACE and the BRA, the non-federal sponsor, were to conduct a phased investigation within the Middle Brazos River Basin, with the North Bosque watershed scheduled as the first increment of the study. A pilot project was designed involving four tributaries of the Bosque River; the Green, Indian, Duffau, and Little Duffau creeks in Erath, Hamilton, and Bosque counties. An interagency planning team was formed to complete the study. The USACE and the BRA hosted a series of public workshops in Dublin, Stephenville, and Hico on April 13, 18, and 20, 2000, respectively, to present information on the watershed study, sponsored program, and encourage landowner participation. Twenty-three landowners, consisting of 21 private landowners and the cities of Stephenville and Meridian, expressed interest in participating by placing a dot on one of the program maps to indicate the location of their land. These sites are scattered along Green, Little

Duffau, and Duffau Creeks and the main stem of the North Bosque River. None were located in the Indian Creek watershed which was included in the original study plan (Figure 1). The project sites on Stephenville and Meridian city-owned lands have since been divided into separate projects and are no longer included in this project. Thirteen of the volunteer sites are clustered along Duffau Creek, presenting an opportunity for an evaluation of the existing riparian habitat conditions at a landscape scale in the Duffau Watershed. (See Appendix F, Page F-1.) An interagency assessment team was formed to visit the sites and provide expert advice on each site's habitat restoration or enhancement potential. The team consisted of representatives from the Natural Resource Conservation Service, Texas State Soil and Water Conservation Board, Texas Farm Bureau, Tarleton State University, BRA, USACE, private landowners, and Service. A Service biologist participated in the project planning, public meetings, and assessment team. The Service provided preliminary field data results and restoration recommendations to the USACE after the field work was completed. The USACE developed draft habitat restoration plans for each landowner, which included a 25-year conservation easement agreement.

The project was delayed for three years due to several issues. These included potential acquisition of less than fee simple lands, and less than perpetuity conservation easements, efforts to develop an interest in the project with the dairy farming community, and delays of funding. The feasibility study is now scheduled to be completed in December 2004. Currently, only 6 landowners located within the Green Creek, Duffau Creek, Meridian Creek, and Honey Creek watersheds and on the North Bosque River are participating in the project. However, this report includes the data collected at all the original 27 sites visited for the purpose of increasing the accuracy of the data analysis.

# Methods

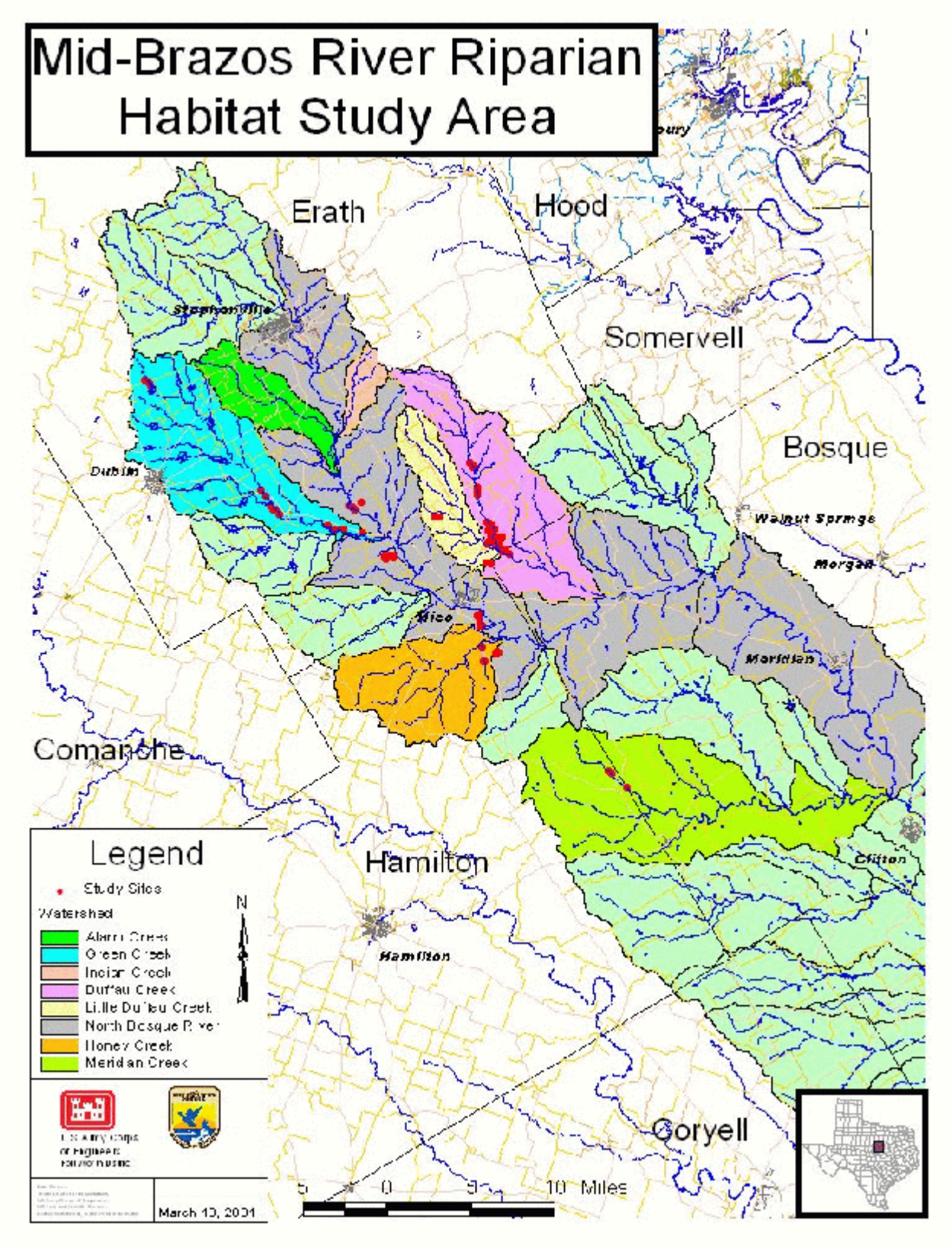
## Study Area

The study area is located along several tributaries of the Brazos River in Erath, Hamilton, and Bosque counties in Texas. These counties are in the west belt of the Cross Timbers vegetational area of the state. The terrain is flat on the river terraces with rolling hills in the uplands (Figure 1). Historically, this area was a savannah with large woodlands of predominantly blackjack and post oak with heavy undergrowth of briar and shrubs. Riparian corridors contain bottomland hardwoods consisting of flood tolerant tree and shrub species. The area is now used for livestock grazing. Most of the large woodlands have been cleared or fragmented.

## Habitat Evaluation Model

The draft *Wildlife Community Habitat Evaluation: A Model for Bottomland Hardwood Forests in the Southeastern United States* (Model) (USFWS 1992) was used to determine the existing value of the riparian habitat in the study area. This Model was developed by the USACE and the Service to evaluate the wildlife habitat quality of bottomland hardwood areas in the southeastern United States. Although this Model is only a draft, it was used because there is no other model available to assess riparian corridors, and the standard species Habitat Evaluation Procedure (HEP) analysis would have required more field time than what was available.

**Figure 1.**


Mid-Brazos River Riparian
Habitat Study Area
Erath
Hood
Somervell
Bosque
Comanche
Hamilton
Coryell
Stephenville
Dublin
Walnut Springs
Morgan
Meridian
Clifton
Hamilton
Legend
Study Sites
Watershed
Alarm Creek
Green Creek
Indian Creek
Duffau Creek
Little Duffau Creek
North Bosque River
Honey Creek
Meridian Creek
N
0
10 Miles
March 13, 2001

The bottomland hardwood Model output is a Habitat Suitability Index (HSI) of the native vertebrate wildlife species richness of the bottomland hardwood tracts on a regional basis which can be compared to that of optimum bottomland hardwood tracts. (See the Model for a more detail.) The HSI is scaled from 0-1.0, where a value of 1.0 represents optimum bottomland habitat with attributes that support the highest numbers of native wildlife species on a regional scale over a long time period. Optimum habitat has an "abundance of internal vegetation structure and internal variation due to interspersion of moisture regimes and gaps due to natural mortality of trees" (USFWS 1992). The ideal bottomland forest tract is "very large, with an abundance of interior mature forest habitat" subject to natural flooding, and "situated in a landscape that allows easy wildlife movement between tracts" (USFWS 1992). The Model reflects the effects of forest fragmentation and human disturbance.

Conditions used to describe bottomland forest habitat are expressed at two levels, plot and tract. Plots are a small area of land, usually circular in shape, in which specific biological data (variable measurements) are collected. This report contains information regarding the riparian hardwood stands located within the project area at the plot level. The habitat value in each plot will be expressed as a Suitability Index (SI) scaled from 0.2-1.0, where a value of 1.0 represents optimum bottomland habitat described above. The Model assumes plots with no mature forest elements still have a value of 0.2.

Tracts are contiguous units of riparian (bottomland) hardwood stands. Tract variables are measurements of landscape attributes that are used to assess the habitat on a landscape scale. The Duffau Creek watershed contained a sufficient number of plots that provided an opportunity to complete a tract analysis for a more accurate assessment of the riparian woodland tract within that watershed. The Duffau Creek Watershed Analysis will be completed in a subsequent planning aid letter.

## Data Collection

Vegetative and hydrological riparian habitat data (Appendices A-D) were collected in 27 plots on 23 early project participant lands (Appendix F) by two biologists, representing the Service and the Texas Institute of Applied Environmental Research. Habitat data were collected during two interagency site visits on June 14-15 and July 13-14, 2000. One or two sample plots were randomly selected on each participant's land. Only two criteria were used in selecting the locations: they had to be on land owned by one of the participants and they had to be in a riparian hardwood stand. These plots were used to determine the value of the riparian habitat on each of the participant's land. Table 1 displays the location of these plots.

The data plots were not measured exactly, but were estimated to be about 1/10th of an acre in size with a radius of about 37 feet (11.3 m). All measurements taken in the plots are estimates, because there was insufficient time to record exact measurements of the plot size, tree dbh, percent canopy cover, and distance from center of plot to major topographic change. Time was limited to only about 20 minutes per plot. Actual counts were recorded for all the other attributes. One biologist stood in the middle of the plots, took notes, and recorded measurements. The other biologist walked the plots taking an inventory of plant species and estimating habitat measurements. The width of the wooded riparian corridor, forb and grass species, and animal

**Table 1. Data Plot Locations**

| Plot | Location | Map Page # |
|---|---|---|
| Vaugn1 & Vaugn2 | Green Creek, approximately 6 miles north of Dublin and 1 mile east of Bunyan | F-2 |
| Ande1 | Green Creek, 2.75 miles northwest of Alexander | F-2 |
| Green1 | Green Creek, 4 miles west of Alexander | F-2 |
| John1 | Green Creek, 20.5 miles southeast of Alexander | F-3 |
| Self1 & Self2 | Green Creek, 13 miles west of Clairette | F-3 |
| Have1 & Have2 | North Bosque River, 15.75 miles northwest of Clairette | F-3 |
| Willi1 | North Bosque River about 14 miles southeast of Hico | F-4 |
| Puff2 | 27 miles southeast of Hico on a small tributary of Honey Creek | F-4 |
| Dun1 | East Hamilton County, 2.75 miles southeast of Fairy | F-5 |
| Swa | Approximately 1 mile north of the town of Duffau | F-1 |
| Flow1 | Duffau Creek, approximately 0.5 miles south of town | F-1 |
| Bat1 | Duffau Creek, between 2.5 and 4.5 mi. from the town of Duffau | F-1 |
| Bat2 | Duffau Creek | F-1 |
| Part1 | Duffau Creek | F-1 |
| Smit1 | Duffau Creek | F-1 |
| Drak1 | Duffau Creek | F-1 |
| Bell2 | Duffau Creek | F-1 |
| Mars1 | Duffau Creek | F-1 |
| Wils1 | Duffau Creek | F-1 |
| Bell1 | Duffau Creek | F-1 |
| Boud1 | Duffau Creek | F-1 |
| Boud2 | Duffau Creek | F-1 |
| Aldo1 | Little Duffau Creek, approximately 0.8 miles upstream of the confluence with Duffau Creek | F-1 |
| Anke1 | approximately 3 miles southwest of the town near a tributary of Little Duffau Creek | F-1 |

observations were also recorded (Appendix D). Appendix E contains a complete species list of all plants found in the plots. A Garmin Global Positioning System III unit was used to record the geographical coordinates of each plot (Appendix D). Digital photographs were taken in each compass direction from the center of each plot (see Appendix G for a representative view of each data plot). Data were recorded on standardized data sheets, one for each plot, developed specifically for recording the variables required to use with the bottomland hardwood habitat Model. These variables are described below.

## Plot Variables

The more structural diversity in a stand, the more habitat diversity is available, contributing to more species diversity. The following seven plot variables (PV) were measured in each sample plot and recorded on standardized data sheets.

**Mature Forest Elements (PV1)**

There are eight mature forest elements measured in each plot. The sum of the number of elements found in each plot is recorded. The Model assumes that the more mature forest elements there are, the better the habitat for bottomland hardwood vertebrate species. The elements are: (1) trees greater than or equal to 21.5 inches dbh; (2) trees greater than or equal to 29.5 inches dbh (large trees this size are counted both in elements 1 and 2); (3) dead branch greater than or equal to 4 inches diameter at trunk of live tree or cavity with an outside diameter greater than or equal to 4 inches; (4) upper or basal hollow with an outside diameter greater than or equal to 10 inches; (5) snags greater than or equal to 4 inches dbh and greater than or equal to 6.5 feet tall; (7) snags greater than or equal to 10 inches dbh and greater than or equal to 16.5 feet tall; (8) vines greater than or equal to 4 inches in diameter reaching the canopy; and (9) epiphytes greater than or equal to $1.2^2$ yards in the canopy.

The number of mature forest elements found in each plot was used to find the Suitability Index (SI) of PV1 for each plot. The Model assumes habitat with no mature forest elements still has a value of 0.2. The more mature forest elements found, the greater the SI value of the plot. A number of 8 or more forest elements is considered optimum habitat with an SI value of 1.0.

**Tree Canopy Cover (PV2)**

Some bird species require overstory canopy cover of trees greater than 16.5 feet tall for protection and nesting habitat. Percent overstory canopy cover was estimated while walking the plot area and looking upward.

The Canopy Cover SI increases as the percent canopy cover increases, until it reaches 70 percent closure. The optimum canopy closure (SI = 1.0) is assumed to be between 70 to 90 percent. The SI of a stand with over 90 percent canopy cover begins to decrease as canopy cover approaches 100 percent, because light is blocked out, reducing understory growth and food production. Percent overstory canopy cover was estimated by walking the plot and looking upward.

**Mast Types and Variety (PV3)**

A variety and abundance of mast (fruit) producing plants provide food for a variety of wildlife species. The number of mast (soft and hard) producing plant species (tree or shrub) is counted in each plot and recorded.

The Model assigns a Plot SI value for different combinations of mast types and numbers. Hard mast species have a higher value than soft mast species. The greater number of oak species, the higher the SI. A plot with soft and hard mast species and 3 or more oak species, greater than 8 inches dbh (25 cm), is considered optimum with an SI value of 1.0. Habitat with no mast species still has an SI of at least 0.1.

**Understory Cover (PV4)**

Understory vegetation provides cover and food for a wide diversity of animal (bird, mammal,

reptile, and amphibian) species. Percent shrub canopy cover (saplings,shrubs, and vines from 3.3 to 16.5 feet tall) was estimated by observation within the plots.

The Model assumes that habitat with no understory cover still has an SI of 0.2. The SI increases until understory cover reaches 20 percent. The Model assumes that an understory cover between 20 percent and 50 percent is optimum (SI = 1.0). The SI decreases as understory cover increases beyond 50 percent to 100 percent with an SI of 0.5.

**Ground Layer Elements (PV5)**

Many species depend on certain types of ground structure for cover and food. The greater diversity of ground cover, the greater diversity of ground species. Each of the 11 ground layer elements were counted in the plots: (1) live vegetation less than or equal to 3.3 feet tall and greater than or equal to 10 percent of plot, (2) leaf litter greater than or equal to 25 percent of the plot, (3) piles of debris or brush, (4) depressions for temporary water, (5) small burrows and cavities, (6) large burrows and cavities, (7) small stumps greater than or equal to 1 foot tall and greater than or equal to 6 inches dbh, (8) large stumps greater than or equal to 3.3 feet tall and greater than or equal to 1 foot dbh, (9) small logs greater than or equal to 6.5 feet long and greater than or equal to 6 inches wide, (10) large logs greater than or equal to 20 feet long and greater than or equal to 18 inches wide, and (11) number of mast species in the ground layer (0-3.3 feet tall). The number of ground layer elements present in each plot is summed, up to a maximum total of 11, and recorded.

The total number of elements determines the Ground Layer Elements SI. The Model assumes that habitat with no ground layer elements still has an SI value of 0.2. As the number of ground layer elements increase, up to the optimum of 10 elements, the SI value increases.

**Flood Tolerance Index (FTI) (PV6)**

The moisture regime of an area can be determined by the species of shrubs present. Small reptiles and amphibians depend on the ground surface and sub-surface moisture. Too much or too little flooding decreases the amount of time reptiles and amphibians can use the habitat. They need moisture, but not too much or too often.

Each species of shrub present in the plot was recorded. The Model assigns a FTI for each shrub and vine. The average FTI of the shrub species for each plot was computed and used to get a measure of the moisture regime of the plot. The Model assumes that an FTI of 4 to 5 constitutes an optimum condition (i.e. a plot that experiences some flooding on an irregular basis) with an SI value of 1.0. The SI value decreases when the number of species is greater than 5 or less than 4. Fewer than 4 species indicates drier conditions, more than 5 species indicates too much moisture.

**Interspersion of Moist Regimes (PV7)**

Wildlife habitat quality is improved by topographic variation, such as proximity of high and low ground, frequently flooded or permanently flooded. Such variation provides more diversity of

plant species and habitats (USFWS 1992). The distance between the center of the plot and the nearest major topographical change was estimated and recorded.

This distance was plotted on the graph in Figure 11 in the Model to determine the Interspersion of Moist Regimes SI. The Model assumes that the Interspersion of Moist Regimes SI has an optimum value of 1.0 when the distance to a major topographical change is 50 meters (150 feet) or less. The greater the distance beyond 50 meters, the smaller the SI value.

## Plot Suitability Indices (SI)

The Model gives a simple equation to obtain a value for the Plot SI. Using the 7 plot variables, three habitat component suitability indices are calculated using the following equations:

$$\text{Tree Layer SI} = \frac{(\text{SIPV1} + \text{SIPV2} + \text{SIPV3})}{3}$$

$$\text{Additional Structure SI} = \frac{(\text{SIPV4} + \text{SIPV5})}{2}$$

$$\text{Hydrology SI} = \frac{(\text{SIPV6} + \text{SIPV7})}{2}$$

The Plot SI is then calculated by using this equation:

$$\text{Plot SI} = \frac{((2 \text{ X tree layer SI}) + \text{additional structure SI} + \text{hydrology SI})}{4}$$

The Model assumes that a plot with the very poorest of habitat would still yield a plot SI of 0.2. This means that it is estimated to support approximately 20% of the native richness of a plot with optimal quality habitat. As the plot SI value increases, so does the native richness cababilities of the habitat. A plot SI of 1.0 depicts the riparian habitat to have a 100 percent native wildlife species richness capability.

# Results

## Overall Plot Variable Descriptions

Table 2 shows the list of structural attributes measured in the data plots and their average and range of values of all the plots combined. Appendix A shows the number of attributes present in each plot.

### Mature Forest Elements (PV1)

The average number of mature forest elements in the plots is 4.81, with a range of 1 to 8 elements (Table 2). Table 3 shows the number of plots containing each of the mature forest elements. Appendix B shows which mature forest elements were present in each plot. Over half of the data plots contained all but two of the mature forest elements measured. The two mature forest elements found in the least number of data plots was trees greater than or equal to 29.5 inches dbh (11 plots) and the presence of epiphytes greater than or equal to 1.2 yds² in the

canopy (3 plots). All of the plots had at least one mature forest element present. Two plots only had one present. Seventy-four percent of the plots had between 4 to 7 mature forest elements present. Only the John1 plot along Green Creek had all the elements present, which is considered optimum.

**Table 2. Structural Habitat Composition of All Data Plots in the Mid-Brazos Watershed**

| **Plot Attributes** | **Ave. Value** | **Range of Values** |
|---|---|---|
| Total number of hard mast tree species (woody plants >16.5' tall, excluding vines) (PV3) | 2.35 | 0 - 6 |
| Total number of soft mast tree species (woody plants >16.5' tall, excluding vines) (PV3) | 1.92 | 0 - 4 |
| Number of oak species ≥ 8 " dbh (PV3) | 1.11 | 0 - 3 |
| Maximum dbh in tree layer (inches) (PV1) | 33.26 | 10 - 110 |
| Total number mast producing woody species/ shrub layer (3.3' to 16.5' tall, including vines) (PV3) | 6.37 | 2 - 10 |
| Average Flood Tolerance Index (FTI) (PV6) | 5.59 | 4.85 - 6.136 |
| % Overstory canopy cover (trees ≥ 16.5' tall) (PV2) | 54.63 | 10 - 90 |
| % Understory canopy cover (saplings, shrubs & vines 3.3' to 16.5' tall) (PV4) | 42.22 | 10 - 90 |
| Total number of mature forest elements (PV1) | 4.81 | 1 - 8 |
| Total number of ground layer elements (PV5) | 7.11 | 4 - 10 |
| Number of mast species in ground layer (0 - 3.3' tall) (PV5) | 4.78 | 0 - 10 |
| Distance (feet) from center of plot to major topographic change (PV7) | 105.58 | 2 - 500 |

Large trees are essential for high quality riparian habitat as mast producers and cover. The average maximum dbh of the largest trees in each plot was 33.26 inches. The range of the maximum dbh of these trees was from 10 to 110 inches dbh. The largest trees in the plots were black walnut, bur oak, pecan, cedar elm, sugar hackberry, ashe juniper, cottonwood, Bois d’ Arc, American elm, post oak, and live oak. The largest tree found in the plots was a cottonwood at 110 dbh. The next two largest trees, an American elm and pecan, were both found in the same plot and were both 90 inches dbh.

**Table 3. Number of Plots Containing Each Mature Forest Element**

| Mature Forest Elements Present (PV1) | Number of Plots Out of a Total of 27 |
|---|---|
| Tree ≥ 21.5" dbh | 19 (70%) |
| Tree ≥ 29.5" dbh | 11 (41%) |
| Dead branch ≥ 4" dia. at trunk of live tree or cavity ≥ 4" outside diameter | 25 (93%) |
| Upper or basal hollow ≥ 10" outside dia. | 14 (52%) |
| Snag ≥ 4" dbh and ≥ 6.5' tall | 21( 78%) |
| Snag > 10" dbh and >16.5' tall | 19 (70%) |
| Vine ≥ 4" dia. Reaching canopy | 18 (67%) |
| Epiphytes ≥ 1.2 sq. yds. in canopy | 3 (11%) |

## Tree Canopy Cover (PV2)

The average percent overstory canopy cover for trees greater than or equal to 16.5 feet tall is 54.63 percent, with a range of 10 to 90 percent (Table 2). Nine plots (33 percent) had a tree canopy cover between 70 and 90 percent (optimum). These plots are scattered in the study area. The rest of the 27 plots (66 percent) ranged between 10 and 60 percent. No plot had a tree canopy cover greater than 90 percent.

## Mast Types and Variety (PV3)

There was an average of 2.35 hard mast tree species (woody plants >16.5' tall, excluding vines) found in the plots (Table 2). Four plots had no hard mast species and some had up to 6 hard mast species, which were post oak, red oak, live oak, pecan, bur oak, and black walnut. Of the 27 data plots, 17 contained pecan, 14 contained live oak and black walnut, 10 contained red oak, 6 contained bur oak, and 2 contained post oak.

The average number of oak species greater than 8 inches dbh was 1.11 per plot, with a range of no oak trees to 3 oak tree species greater than 8 inches dbh present (Table 2). Ten plots (37 percent) had no oak species present, 8 plots contained one species of oak, 5 contained 2 species of oak, and 4 contained 3 species of oak. The largest oaks found in the plots were a live oak and a post oak, both more than 60 inches dbh.

There was an average of 1.92 soft mast tree species (woody plants >16.5' tall, excluding vines) found in the plots (Table 2). Two plots had no soft mast species and some had up to 4 soft mast species present. Of the 27 data plots, 18 contained sugar hackberry,16 contained ashe juniper, 5 contained Bois d'Arc and mesquite, 4 contained red mulberry, and 3 contained gum bumelia.

The average total number mast producing woody species found in the shrub layer (3.3' to 16.5' tall, including vines) in each plot was 6.37 (Table 2), with a range of 2 to 10 species. Hard mast shrub species found were black walnut, pecan, live oak, and red oak. Soft mast species found in the shrub layer were more numerous: gum bumelia, greenbrier, sugar hackberry, Indian cherry, poison ivy, tickletongue, ashe juniper, yaupon, Eve's necklace, buttonbush, sumac, Chinaberry, red mulberry, mustang grape, muscadine grape, southern black hawthorne, soapberry, wild plum, parsley hawthorne, poison oak, mesquite, American beauty berry, and honey locust.

The average number of mast producing species in the ground layer (0 - 3.3 feet tall) is 4.78, with a range of 0 to 10 mast species (Table 2). The species of mast producers in the ground layer was not recorded. Four plots had the optimum number of 3 or more oak species, with greater than 8 inches dbh, and soft mast producting species present.

Non-mast producing tree and shrub species found in the plots were cottonwood, cedar elm, Virginia creeper, morning glory, American elm, black willow, box elder, Texas kidney wood, cork elm, and redbud.

**Understory Cover (PV4)**

The average percent of understory canopy cover for saplings, shrubs and vines (3.3 to 16.5 feet tall) is 42 percent, with a range of 10 to 90 percent (Table 2). Seventeen (63 percent) of the plots range between 20 and 50 percent understory canopy cover (optimum). Of the remaining 10 plots, 3 had less than 20 percent understory cover and 7 had between 60 and 90 percent.

**Ground Layer Elements (PV5)**

The average total number of ground layer elements in the plots is 7.11, with a range of 4 to 10 elements (Table 2). Table 4 shows the number of plots containing each of the ground layer elements. Appendix C shows which of the ground layer elements were present in each plot. Sixteen (59 percent) of the data plots contained all but three of the ground layer elements. The two ground layer elements found in the least number of data plots was large logs greater than or equal to 20 feet long and greater than or equal to 18 inches wide (11 plots), and large stumps greater than or equal to 3.3 feet tall and greater than or equal to 1foot dbh (11 plots). All of the plots had at least 4 ground layer elements present. Three plots had all 8 elements present (optimum). Over half of the plots had either 6 or 7 ground layer elements. All of the plots had small logs greater than or equal to 6.5 feet long and greater than or equal to 6 inches wide.

**Flood Tolerance Index (PV6)**

The average FTI of all the data plots is 5.59, with a range of 4.85 to 6.136 (Table 2). Only 2 plots were in the optimum range between 4 and 5 FTI. The other 25 plots were above the range, indicating too much flooding over a long period of time, but only slightly.

**Table 4. Number of Plots Containing Each Ground Layer Element**

| Ground Layer Elements Present (PV5) | Number of Plots Out of a Total of 27 (%) |
|---|---|
| Live vegetation ≤ 3.3" tall and ≥ 10% of plot | 26 (96) |
| Leaf litter ≥ 25% of the plot | 25 (93) |
| Piles of debris or brush present | 26 (96) |
| Depressions for temporary water present | 24 (89) |
| Small burrows and cavities present | 16 (59) |
| Large burrows and cavities present | 14 (52) |
| Small stumps ≥ 1' tall ≥ 6" dbh present | 12 (45) |
| Large stumps ≥ 3.3' tall ≥ 1' dbh present | 11 (41) |
| Small logs ≥ 6.5' long ≥ 6" wide present | 27 (100) |
| Large logs ≥ 20' long ≥ 18" wide present | 11 (41) |

**Interspersion of Moisture Regimes (PV7)**

The average distance from the center of the plots to a major topographic change is 94 feet, with a range of 2 to 500 feet (Figure 2). A major topographical change is in 10 (37 percent) of the plots (diameter = 37.5 feet), most of the topographical changes are due to the creek itself. Eighty-five (23) percent of the plots have changes within 150 feet from the center, which is considered optimum. These data may give the impression that there are frequent major topographical changes in the landscape, but this is not the case. One of the criteria for plot location was that they must be located within riparian areas, therefore, the creek, being a major topographical change, will bias these data. The riparian areas will have a tendency to contain a major topographical change.

## Plot Suitability Indices (SI)

Tables 5, 6, and 7 show the SI value for each plot variable in the Duffau Creek, Green Creek watersheds, and all other sites, respectively, for all the plots and the total average of each. Averaging the values in Table 7 would not provide any meaningful data because there are not enough of them within the same wooded tract or sub-watershed to yield meaningful conclusions regarding tract analysis. These plots are scattered within the North Bosque watershed.

**Table 5. Plot Variable Suitability Indices on the Duffau and Little Duffau Creeks**

| | SUITABILITY INDICES | | | | | | |
|---|---|---|---|---|---|---|---|
| **PLOT** | **PV1** | **PV2** | **PV3** | **PV4** | **PV5** | **PV6** | **PV7** |
| Smit 1 | 0.70 | 0.40 | 0.60 | 0.60 | 0.80 | 0.95 | 1.00 |
| Mars 1 | 0.90 | 0.90 | 0.60 | 0.80 | 0.60 | 0.90 | 1.00 |
| Bat 1 | 0.60 | 0.75 | 0.60 | 0.90 | 0.70 | 0.90 | 0.70 |
| Bat 2 | 0.60 | 0.40 | 0.20 | 1.00 | 0.80 | 0.85 | 1.00 |
| Part 1 | 0.70 | 0.60 | 0.60 | 0.70 | 0.70 | 0.80 | 1.00 |
| Bell 1 | 0.60 | 0.75 | 0.40 | 0.85 | 0.60 | 1.00 | 1.00 |
| Bell 2 | 0.70 | 1.00 | 0.40 | 0.75 | 0.80 | 0.85 | 1.00 |
| Drak 1 | 0.90 | 1.00 | 0.80 | 1.00 | 0.70 | 0.85 | 1.00 |
| Wils 1 | 0.60 | 1.00 | 0.60 | 0.90 | 0.70 | 0.80 | 1.00 |
| Boud 1 | 0.80 | 0.90 | 0.80 | 1.00 | 0.90 | 0.80 | 1.00 |
| Boud 2 | 0.35 | 0.20 | 0.20 | 1.00 | 0.70 | 0.95 | 1.00 |
| Flow 1 | 0.40 | 0.60 | 0.20 | 1.00 | 0.70 | 0.90 | 1.00 |
| Swa 1 | 0.80 | 1.00 | 0.30 | 1.00 | 0.70 | 0.95 | 1.00 |
| Algo 1 | 0.35 | 0.20 | 0.80 | 1.00 | 0.50 | 0.80 | 1.00 |
| Ake 1 | 0.80 | 0.45 | 0.60 | 0.55 | 0.80 | 0.85 | 1.00 |
| **AVERAGE** | 0.65 | 0.68 | 0.51 | 0.87 | 0.71 | 0.88 | 0.98 |

**Table 6. Plot Variable Suitability Indices on Green Creek**

| | SUITABILITY INDEXES | | | | | | |
|---|---|---|---|---|---|---|---|
| **PLOT** | **PV1** | **PV2** | **PV3** | **PV4** | **PV5** | **PV6** | **PV7** |
| John 1 | 1.00 | 0.90 | 0.80 | 1.00 | 1.00 | 0.95 | 1.00 |
| Green 1 | 0.70 | 0.75 | 1.00 | 1.00 | 0.90 | 0.85 | 1.00 |
| Ande 1 | 0.80 | 0.90 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Self 1 | 0.90 | 1.00 | 0.80 | 1.00 | 1.00 | 0.85 | 1.00 |
| Self 3 | 0.25 | 1.00 | 1.00 | 1.00 | 0.70 | 0.85 | 1.00 |
| **AVERAGE** | 0.73 | 0.91 | 0.92 | 1.00 | 0.92 | 0.89 | 1.00 |

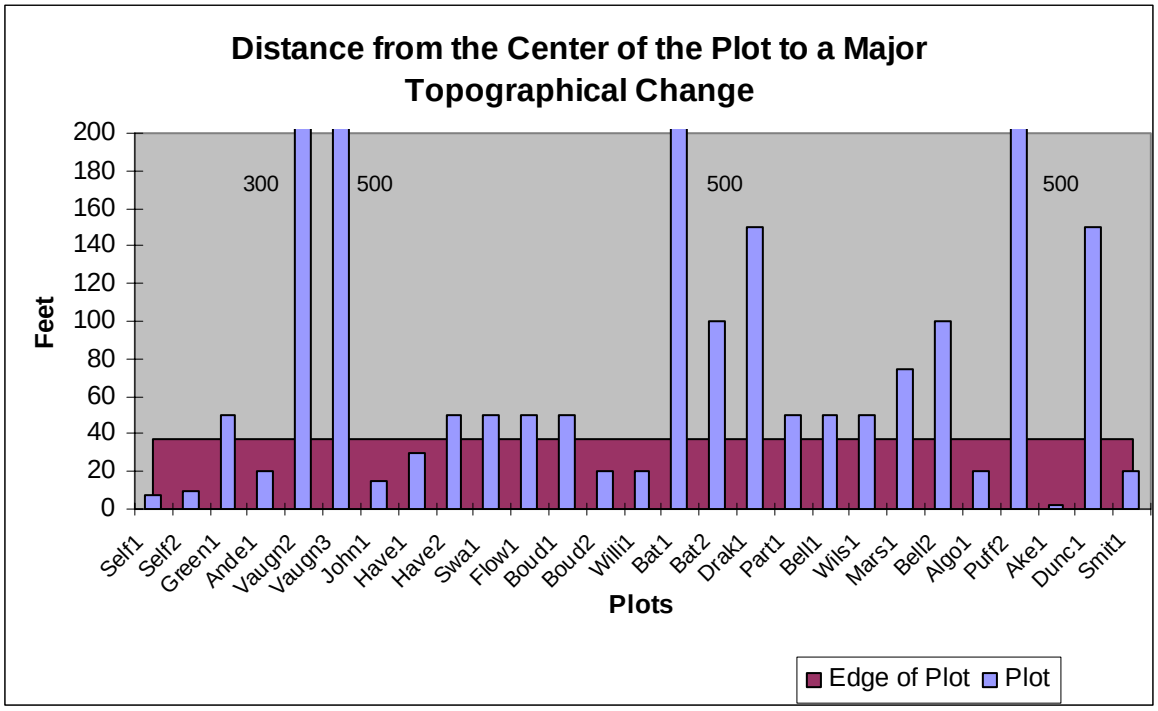
**Table 7. Plot Variable Suitability Indices on Other Sites**

| | SUITABILITY INDEXES | | | | | | |
|---|---|---|---|---|---|---|---|
| **PLOT** | **PV1** | **PV2** | **PV3** | **PV4** | **PV5** | **PV6** | **PV7** |
| Have 1 | 0.70 | 1.00 | 1.00 | 1.00 | 0.90 | 0.90 | 1.00 |
| Have 2 | 0.90 | 1.00 | 0.40 | 1.00 | 0.80 | 0.90 | 1.00 |
| Willi 1 | 0.90 | 1.00 | 0.80 | 1.00 | 0.85 | 0.90 | 1.00 |
| Puff 2 | 0.25 | 0.90 | 0.60 | 1.00 | 0.80 | 0.90 | 0.70 |
| Dun 1 | 0.40 | 0.20 | 0.60 | 0.75 | 0.85 | 1.00 | 0.70 |
| Vaugn 2 | 0.60 | 0.35 | 0.60 | 1.00 | 0.65 | 0.80 | 0.85 |
| Vaugn 3 | 0.80 | 1.00 | 0.60 | 0.55 | 0.70 | 0.95 | 0.70 |

**Table 8. Suitability Indices for Plots on Duffau and Little Duffau Creeks**

| | PLOT SUITABILITY INDEX (SI) VALUES | | | |
|---|---|---|---|---|
| **PLOT** | **TREE LAYER SI** | **STRUCTURE SI** | **HYDROLOGY SI** | **PLOT SI** |
| Smit 1 | 0.567 | 0.700 | 0.975 | 0.700 |
| Mars 1 | 0.800 | 0.700 | 0.950 | 0.810 |
| Bat 1 | 0.650 | 0.800 | 0.550 | 0.660 |
| Bat 2 | 0.400 | 0.900 | 0.925 | 0.650 |
| Part 1 | 0.630 | 0.700 | 0.900 | 0.715 |
| Bell 1 | 0.580 | 0.725 | 1.000 | 0.720 |
| Bell 2 | 0.700 | 0.775 | 0.925 | 0.775 |
| Drak 1 | 0.900 | 0.850 | 0.925 | 0.890 |
| Wils 1 | 0.730 | 0.800 | 0.900 | 0.790 |
| Boud 1 | 0.830 | 0.950 | 0.900 | 0.880 |
| Boud 2 | 0.250 | 0.850 | 0.975 | 0.580 |
| Flow 1 | 0.400 | 0.850 | 0.950 | 0.650 |
| Swa 1 | 0.700 | 0.850 | 0.975 | 0.810 |
| Algo 1 | 0.450 | 0.750 | 0.900 | 0.640 |
| Ake 1 | 0.620 | 0.670 | 0.925 | 0.710 |
| **AVERAGE** | 0.614 | 0.791 | 0.912 | 0.732 |

**Figure 2. The distance from the center of the plots to a major topographical change.**




The Model does not recommend computation of an SI value for each plot, because the Model is intended to assess average conditions for the wildlife community of the entire tract it is in. However, due to the lack of a more adequate method to assess specific site habitat conditions, the SI values for the plots will be used to evaluate the bottomland hardwood stands located on the private land owned by the 6 project participants. The plot SI values for plots located in the Duffau watershed will be used to complete a tract analysis described in the Model. This analysis will be included in a subsequent planning aid report.

Table 8 displays the SI values for the plots in the Duffau Creek watershed per plot, their averages, and the overall plot SI value for the Duffau bottomland hardwood tract.

Table 9 displays the SI values for the plots in the Green Creek watershed per plot, their averages, and the overall plot SI value for the Green Creek bottomland hardwood tract.

**Table 9. Suitability Indices for Plots on Green Creek**

| | PLOT SUITABILITY INDEX (SI) VALUES | | | |
|---|---|---|---|---|
| **PLOT** | **TREE LAYER SI** | **STRUCTURE SI** | **HYDROLOGY SI** | **PLOT SI** |
| John 1 | 0.900 | 1.000 | 0.975 | 0.940 |
| Green 1 | 0.820 | 0.950 | 0.925 | 0.880 |
| Ande 1 | 0.900 | 1.000 | 0.975 | 0.940 |
| Self 1 | 0.900 | 1.000 | 0.925 | 0.930 |
| Self 3 | 0.750 | 0.850 | 0.925 | 0.820 |
| **AVERAGE** | 0.854 | 0.960 | 0.945 | 0.902 |

Table 10 displays the SI values for the plots scattered within the Mid-Brazos River watershed and their averages. It would be inappropriate to use these SI values for a tract analysis, because they are not located within the same tract.

**Table 10. Suitability Indices for Plots on Other Sites**

| | PLOT SUITABILITY INDEX (SI) VALUES | | | |
|---|---|---|---|---|
| **PLOT** | **TREE LAYER SI** | **STRUCTURE SI** | **HYDROLOGY SI** | **PLOT SI** |
| Have 1 | 0.900 | 0.950 | 0.950 | 0.925 |
| Have 2 | 0.766 | 0.900 | 0.950 | 0.845 |
| Willi 1 | 0.900 | 0.925 | 0.950 | 0.918 |
| Puff 2 | 0.580 | 0.900 | 0.800 | 0.720 |
| Dun 1 | 0.400 | 0.800 | 0.850 | 0.610 |
| Vaugn 2 | 0.520 | 0.825 | 0.825 | 0.670 |
| Vaugn 3 | 0.800 | 0.625 | 0.825 | 0.760 |

## Detailed Description of Plots on Participating Lands

Only 6 landowners are still participating in the project, therefore, this report will provide detailed information and recommendations for the bottomland hardwood habitat located on their lands

only. A tract level analysis has not been computed for any of these areas, but a preliminary calculation was made to get an estimate of the HSI and HUs for each participant's land. The Model assumes the lowest HSI value a riparian forest plot can have is 0.2, therefore any plots that have an HSI compute lower than this value is assumed to have an HSI of 0.2

The Bell 1 plot is located on the Bell property where Duffau Creek crosses Highway 220, approximately 3.75 miles southeast of the town of Duffau (page F-1). There are 11.88 acres of riparian corridor, which was approximately 100 feet wide at the plot site. The area had been flooded recently prior to the date of the site visit. The Plot Variable SI values can be found in Table 5 and the habitat attribute values for this plot can be found on pages A-4, B-4, and C-4. The overstory canopy cover (PV2) was 50 percent and the understory canopy cover (PV4) was 75 percent, which are both considered good for mature forest habitat. There was an average number of mast producing species (PV3). Hard mast tree species included pecan only. Ashe juniper and hackberry were the only soft mast tree species present, with cedar elm and American elm occurring in the plot as well. There were several soft mast shrubs, including mustang grape, gum bumelia, yaupon, mesquite, buttonbush, sugar hackberry, poison ivy, greenbrier, and Eve's necklace. A complete plant species list for this plot can be found on page D-21. There were an average number of mature forest elements (PV1) (Appendix B) and ground layer elements (PV5) (Appendix C). The average FTI (PV6) for the plot was optimum and the distance to a major topographic change (PV7) was optimum, which was the creek itself. The Tree Layer SI was 0.58, the Structure SI was 0.725, and the Hydrology SI was 1.0 (Table 8). The Plot SI is 0.72, which is considered good to average for native vertebrate species richness. Considering that the riparian corridor along Duffau Creek is narrow and fragmented, void of interior forest attributes, and the disturbance from the highway, the plot HSI should be reduced to 0.2. There are an estimated 2.35 habitat units available.

The Flow1 plot is located on the Flowers property located less than a mile southeast of the Town of Duffau (page F-1). There are 2.88 acres of riparian corridor, which was approximately 75 feet wide at the plot site. The area had been flooded recently prior to the date of the site visit. The Plot Variable SI values can be found in Table 5 and the habitat attribute values for this plot can be found on pages A-2, B-2, and C-2. The overstory canopy cover (PV2) was 40 percent and the understory canopy cover (PV4) was 25 percent, which are average and optimum, respectively, for mature forest habitat. The number of mast producing species (PV3) was average. There were no hard mast tree species. Sugar hackberry, Bois d'Arc, and mesquite were the only soft mast tree species present, with cedar elm occurring in the plot as well. Small pecan and black walnut were the only two hard mast shrubs present. There were several soft mast shrubs, including mustang and muscadine grape, greenbrier, and Indian cherry. A complete plant species list for this plot can be found on page D-14. There were a below average number of mature forest elements (PV1) (Appendix B) and an average number of ground layer elements (PV5) (Appendix C). The average FTI (PV6) for the plot was optimum and the distance to a major topographic change (PV7) was optimum. The Tree Layer SI was 0.4, the Structure SI was 0.85, and the Hydrology SI was 0.95 (Table 8). The Plot SI is 0.65, which is considered average for native vertebrate species richness. Considering that the riparian corridor along Duffau Creek is narrow and fragmented, making it void of interior forest attributes, the plot HSI should be reduced to 0.2. There are an estimated 0.58 habitat units available.

The Dun1 plot is located on the Duncan property on the North Prong of Meridian Creek, approximately 5 miles northwest of the Town of Cranes Gap (page F-5). There are 30.23 acres of riparian corridor, which was approximately 75 feet wide at the plot site. The area has been over grazed. The Plot Variable SI values can be found in Table 7 and the habitat attribute values for this plot can be found on pages A-5, B-5, and C-5. The overstory canopy cover (PV2) was 10 percent and the understory canopy cover (PV4) was 15 percent, which are poor and good, respectively, for mature forest habitat. The number of mast producing species (PV3) was average. The only hard mast tree species present was black walnut. Gum bumelia was the only soft mast tree species present, with cedar elm occurring in the plot as well. There were several soft mast shrubs, including tickletongue, greenbrier, sugar hackberry, ashe juniper, yaupon, Eve's necklace, buttonbush, and sumac. A complete plant species list for this plot can be found on page D-27. There were an average number of mature forest elements (PV1) (Appendix B) and an average number of ground layer elements (PV5) (Appendix C). The average FTI (PV6) for the plot was optimum and the distance to a major topographic change (PV7) was optimum. The Tree Layer SI was 0.4, the Structure SI was 0.8, and the Hydrology SI was 0.8 (Table 10). The Plot SI is 0.61, which is considered average to good for native vertebrate species richness. Considering that the riparian corridor along Meridian Creek is narrow and fragmented, void of interior forest attributes, the plot HSI should be reduced to 0.2. There are an estimated 6.0 habitat units available.

Puff2 is approximately 3.5 miles southeast of Hico on a small tributary of Honey Creek (page F-4). There are 1.71 acres of riparian corridor, which was approximately 30 feet wide at the plot site. The stand is close to the house and the banks of the creek have been trampled by cattle. The Plot Variable SI values can be found in Table 7 and the habitat attribute values for this plot can be found on pages A-4, B-4, and C-4. The overstory canopy cover (PV2) was 60 percent and the understory canopy cover (PV4) was 20 percent, which are very good and optimum, respectively, for mature forest habitat. The number of mast producing species (PV3) was below average to poor. There were no hard mast tree species present in the plot. Ashe juniper was the only soft mast tree species present, with cedar elm and black willow. There were several soft mast shrubs, including ashe juniper, yaupon, Indian cherry, buttonbush, parsley hawthorne, mustang grape, and sumac. A complete plant species list for this plot can be found on page D-25. There were a below average number of mature forest elements (PV1) (Appendix B) and an good number of ground layer elements (PV5) (Appendix C). The average FTI (PV6) for the plot was good and the distance to a major topographic change (PV7) was average. The Tree Layer SI was 0.58, the Structure SI was 0.9, and the Hydrology SI was 0.8 (Table 10). The Plot SI is 0.72, which is considered average to good for native vertebrate species richness. Considering that the riparian corridor along Honey Creek is narrow and fragmented, void of interior forest attributes, and the disturbance from the house and highway activity, the plot HSI should be reduced to 0.2. There are an estimated 0.34 habitat units available.

Willi1 is approximately 1.5 miles southeast of Hico on Honey Creek (page F-4). There are 3.68 acres of riparian corridor, which was approximately 10 to 30 feet wide at the plot site. There is a large amount of erosion along the banks of the creek. The Plot Variable SI values can be found in Table 7 and the habitat attribute values for this plot can be found on pages A-3, B-3, and C-3. The overstory canopy cover (PV2) was 80 percent and the understory canopy cover (PV4) was 20 percent, which are very good and optimum, respectively, for mature forest habitat. The

number of mast producing species (PV3) was good. There were 3 hard mast tree species present in the plot, live oak, pecan, and bur oak. Sugar Hackberry was the only soft mast tree species present, with cedar elm, American elm, and one very large cottonwood (>100 inches dbh) occurring in the plot as well. There were 2 hard mast shrub sized tree species, pecan and black walnut and several soft mast shrubs, including ashe juniper, Chinaberry, buttonbush, gum bumelia, greenbrier, and poison ivy. A complete plant species list for this plot can be found on page D-18. There were a very good number of mature forest elements (PV1) (Appendix B) and an good number of ground layer elements (PV5) (Appendix C). The average FTI (PV6) for the plot was very good and the distance to a major topographic change (PV7) was optimum. The Tree Layer SI was 0.9, the Structure SI was 0.925, and the Hydrology SI was 0.95 (Table 10). The Plot SI is 0.918, which is considered very good for native vertebrate species richness. Considering that the riparian corridor along Honey Creek is narrow and fragmented, void of interior forest attributes, the plot HSI should be reduced to 0.24. There are an estimated 0.88 habitat units available.

Plots Vaugn2 and Vaugn3 are located on the Vaughn property on Green Creek approximately 1 mile northeast of the Town of Bunyan (page F-2). There are 11.49 acres of riparian corridor, which ranges from approximately 50 to 125 feet wide on either side of the creek. The stand is adjacent to an agricultural field that is to be planted to grassland. It currently contains Indian grass and little bluestem. The property has been leased for grazing to help open the understory, however, Plot Vaugn3 has very little understory. The Plot Variable SI values can be found in Table 7 and the habitat attribute values for this plot can be found on pages A-1, B-1, and C-1. The overstory canopy cover (PV2) averages 45 percent and the understory canopy cover (PV4) averages 30 percent, which are average and optimum, respectively, for mature forest habitat. The number of mast producing species (PV3)was average. There 2 hard mast tree species present in the plot, pecan and live oak. Sugar hackberry and mesquite were the only two soft mast tree species present, with cedar elm and American elm occurring in the plot as well. There were several soft mast shrubs, including Indian cherry, gum bumelia, sugar hackberry, greenbrier, and poison ivy. A complete plant species list for these plots can be found on pages D-10 and D-11. There were an average to good number of mature forest elements (PV1) (Appendix B) and an average number of ground layer elements (PV5) (Appendix C). The average flood tolerance index (PV6) for the plot was good and the distance to a major topographic change (PV7) was average to good. The average Tree Layer SI was 0.66, the average Structure SI was 0.725, and the Hydrology SI was 0.825 (Table 10). The average Plot SI for both of these plot is 0.72, which is considered average/good for native vertebrate species richness. Considering that most of the areas along the Green Creek riparian corridor is narrow and fragmented and void of interior forest attributes, the plot HSI should be reduced to 0.25. There are an estimated 2.8 habitat units available.

# Threatened and Endangered Species and Birds of Conservation Concern

The current list of federally threatened (T), endangered (E), and candidate (C) species known to occur in Erath and Hamilton Counties is as follows:

black-capped vireo (*Vireo atricapilla*) – E, Erath, Hamilton
golden-cheeked warbler (*Dendroica chrysoparia*) – E, Erath, Hamilton
interior least tern *(Sterna antillarum*) – E, Hamilton
whooping crane (*Grus americana*) – E, Erath, Hamilton
bald eagle (*Haliaeetus leucocephalus*) – T, Erath, Hamilton
piping plover (*Charadrius melodus*) – T, Hamilton
black-tailed prairie dog (*Cynomys ludovicianus*) – C, Erath

There is no designated critical habitat for listed species in Erath or Hamilton County. Candidate species are not afforded federal protection under the Endangered Species Act; however, we recommend that potential impacts to these species be considered during project planning.

The piping plover and whooping crane are migrants in north central Texas, spending winter along the Gulf Coast and would only be encountered during migration. The interior least tern is a summer resident in north central Texas, but has not been documented nesting in Hamilton County. Terns nest on bare to sparsely vegetated sandbars in rivers and streams in Texas, from May through August. Because natural nesting sites have become sparse, interior least terns have nested in non-typical/non-natural areas which provide similar habitat requirements, such as sandpits, exposed areas near reservoirs, gravel levee roads, dredged islands and dikefields.

The bald eagle is a winter and possible spring resident, which nests, roosts, and perches in tall trees near water, feeding primarily on fish, turtles, and waterfowl. Winter habitat includes reservoirs, lakes, playas, rivers, and marshes. Most wintering bald eagles migrate north February through March; however, nesting eagles either stay throughout the entire year or migrate late in the summer.

Golden-cheeked warblers nest and rear their young during spring and summer in oak-juniper woodlands in central Texas. The 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. In north-central Texas black-capped vireo habitat is associated with rocky limestone outcrops and escarpment areas. Common woody vegetation found in vireo habitat include: oaks, mountain laurel, sumacs, redbud, persimmon, and junipers. The species composition appears to be less

important than the presence of adequate broad-leaved shrubs interspersed with open grassy areas, foliage to ground level, and an irregular canopy height.

An evaluation of the proposed projects potential effects to these listed species should be conducted. If the evaluation concludes that one or more of the listed species may be affected, the Service's Arlington Field Office should be contacted.

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).

The following are 24 bird species on the BCC lists for the Oaks and Prairies Bird Conservation Region where the project areas are located:

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
Mississippi kite (*Ictinia mississippiensis*) - forest, open woodland, semiarid rangeland

# Recommendations

Our habitat analysis indicates the following specific measures could restore natural riparian habitats within all 6 project areas.

1. We recommend widening the riparian woodland corridors along the river and creeks as much as possible (up to 150 feet on each side) by planting a diverse cover of 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. Some forest species are sensitive to fragmentation, requiring interior habitat. The model defines interior forest habitat as the area at least 100 meters (328 feet) from the forest edge. The core factor is a variable in the Model that is determined by the amount of interior area. Tracts with no core habitat are assumed to support approximately 25 percent fewer species (those species sensitive to fragmentation) over a long time period on a regional scale. Native hard and soft mast producing trees and shrubs, such as pecan, bur oak, red oak, and black walnut, wild plum, sumac, hawthorne, box elder, honey locust, dogwoods, persimmon, and coral-berry to name a few, are recommended to 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 that 25 percent soft mast producers. Shrubs should be planted at no more than 30 percent stems.

2. 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.

3. Provide brush and log piles in the existing riparian habitat and grasslands to provide cover for small mammals.

4. Buffer strips of shrubs and grasslands can be created on each side of the riparian corridors to protect them and provide a core area for forest interior species.

5. Emergent wetlands can be created off stream to provide nonpoint source pollution control. In this role, wetlands would provide several benefits that contribute to water quality improvements. First, the wetlands provide water quality function through solids settling, nutrient transformation, and biological uptake. Second, 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.

6. Plant locally available native aquatic plants, shrubs, and woody debris around the water edges. We recommend the use of locally available sedges, water willow (*Justicia*

*americana*), softstem bulrush (*Schoenoplectus tabernaemontani*), water pennywort (*Hydrocotyle umbellata*), switch grass (*Panicum virgatum*), smartweeds (*Polygonum sp*.), and buttonbush (*Cephalanthus occidentalis*). The wetland should not be mowed unless it is to manage non-desirable species, i.e., invasives, exotics.

7. We suggest that the direct, indirect, and cumulative impacts to and the conservation of the specific species listed in the Service's *Birds of Conservation Concern 2002* (BCC) published in December 2002, be considered in project planning. "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.

8. 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.

9. Riparian restoration areas should be protected so that this will be able to mature and provide habitat conditions through time. One of the most significant measures which can be taken is control of livestock. Fencing should be a required component of each restoration project area. Uncontrolled livestock or off-road vehicular traffic can drastically damage newly established and exisiting vegetation. Rotating livestock to other pastures and reducing numbers of livestock may be some options.

10. Build in-stream rock or log structures to trap sediment, slow the stream, and create fish habitat.

11. Eradicate exotic plants and invasive shrubs in the restored riparian corridor.

12. Control bank erosion through use of biological engineering to the maximum extent possible.

13. Prohibit the use of fertilizers, pesticides, and herbicides in the conservation easements, except for the control and eradication of exotic or invasive species listed in the the habitat restoration plans.

14. If the private landowners desire to deviate from the habitat restorations plans, we recommend that any modifcations be pre-approved by the USACE project biologist and coordinated with the Service.

# Conclusion

In summary, with the inclusion of these recommendations, we believe reforestation and wetland creation/restoration will improve habitat diversity and quality in all 6 the project areas, benefitting a variety of resident and migratory wildlife species.

# Literature Cited


Biro, Peter A. 1998. Staying Cool: Behavioral Thermoregulation during summer by young-of-year brook trout in a lake. Transactions of the American Fisheries Society 127 (2): 212–222.

Brode, J.M. and R.B. Bury. 1984. The importance of riparian systems to amphibians and reptiles. Pages 30-36 *in* R.E. Warner and K.M. Hendrix, eds. California Riparian System: Ecology, Conservation, and Productive Management. Univ. of California Press: Berkley.

Burk, J.D., G.A. Hurst, D.R. Smith, B.D. Leopold, and J.G. Dickson. 1990. Wild turkey use of streamside management zones in loblolly pine plantations. Proc. National Wild Turkey Symp. 6:84-89.

Cole, G.A. 1983. Textbook of limnology. 3rd ed. The C.V. Mosby Company: St. Louis.

Cummins, K.W.,M.A. Wilzbach, D.M. Gates, J.B. Perry, and W.B. Taliaferro. 1989. Shredders and riparian vegetation: leaf litter that falls into streams influences communities of stream invertebrates. Bioscience 39(1): 24-30.

Dickson, J.G. 1989. Streamside zones and wildlife in southern U.S. forests. Pages131-133 *in* Greswell, R.E., B. Kershner, eds. Practical Approaches to riparian resource management: an educational workshop. U.S. Bureau of Land Management, Billings, Montana.

Dickson, J.G.,and J.C. Huntley. 1987. Riparian zones and wildlife in southern forest: the problem and squirrel relationships. Pages 37-39 *in* J.G. Dickson and O.E. Maughan, eds. Managing southern forests for wildlife and fish. U.S. Forest Service. Gen. Tech. Rep. SO-65.

Dickson, J.G., J.H. Williamson, R.N. Connor, and B. Ortego. 1995. Streamside zones and breeding birds in eastern Texas. Wild. Soc. Bull. 23(4):750-755.

Flebbe, P.A. 1999. Trout use of woody debris and habitat in Wine Spring Creek, North Carolina. Forest Ecology and Management 114:367-376.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. Bioscience 41:540-551.

Halls, L.K. 1973. Managing deer habitat in loblolly-shortleaf pine forest. Journal of Forestry 71:752-757.

Henley, W.F., M.A. Patterson, R.J. Neves, and A.D. Lemly. 2000. Effects of sedimentation and turbidity on lotic food webs: a concise review for natural resource managers. Reviews in Fisheries Science 8(2):125-139.

Lowrance, R.T.,J Fail, Jr., O. Hendrickson, Jr., R. Leonard, and L. Asmussen. 1984. Riparian forest as nutrient filters in agricultural watersheds. Bioscience 34:374-377.

Maser, C., and J. Sedell. 1994. From the forest to the sea: the ecology of wood in streams, rivers, estuaries, and oceans. St. Lucie Press: Delray Beach, Florida.

Miller, E. 1987. Effects of forestry practices on relationships between riparian area and aquatic systems. Pages 40-47 *in* J.G. Dickson and O.E. Maughan, eds. Managing southern forests for wildlife and fish. U.S. Forest Service. Gen. Tech. Rep. SO-65.

Ringler, N.H. and J.D. Hall. 1975. Effects of logging on water temperature and dissolved oxygen in spawning beds. Transactions of the American Fisheries Society 104:111–121.

Rudolph, D.C., and J.G. Dickson. 1990. Streamside zone width and amphibians and reptiles abundance. Southwestern Naturalist 35:472-476.

Texas Water Development Board (TWDB). 1997. Water for Texas Today and Tomorrow: a consensus-based update to the state water plan. TWDB, Austin, Texas.

Texas Natural Resource Conservation Commission (TNRCC). 1999. State of Texas 1999 Clean Water Act Section 303(d) List, December 1999. TNRCC, Austin, Texas.

U.S. Army USACE of Engineers (USACE). 1999. Middle Brazos Reconnaissance Study. USACE, Fort Worth, Texas.

U.S. Fish and Wildlife Service (USFWS). 1992. Wildlife community Habitat Evaluation: A Model for Bottomland Hardwood Forests in the Southeastern United States. Draft. U.S. Fish and Wildlife Service. Biological Report 92/X.

U.S. Fish and Wildlife Service (USFWS). 1998. A fishery survey of the Middle Brazos River basin in North-Central Texas. USFWS, Arlington, Texas.

Williams, J.E., C.A. Wood, and M.P. Dombeck, eds. 1997. Watershed restoration: principles and practices. American Fisheries Society, Bethesda, Maryland.

Young, K.A., S.G. Hinch, T.G. Northcote. 1999. Status of resident coastal cutthroat trout and their habitat twenty-five years after riparian logging. North American Journal of Fisheries Management 19 (4):901—911.

# Appendices

## Appendix A. Structural Habitat Composition Attributes in Each Plot

| Attribute | Self1 | Self2 | Gaith1 | Ande | Vaugn 2 | Vaugn 3 |
|---|---|---|---|---|---|---|
| Total # of mature forest elements (See Appendix B) (PV1) | 7 | 1 | 5 | 6 | 4 | 6 |
| Total number of hard mast tree species (woody plants >16.5' tall,excluding vines) (PV3) | 5 | 5 | 5 | 3 | 2 | 2 |
| Total number of soft mast tree species (woody plants >16.5' tall,excluding vines) (PV3) | 2 | 2 | 3 | 0 | 2 | 1 |
| Number of oak species ≥ 8 " dbh (PV3) | 2 | 3 | 3 | 3 | 1 | 1 |
| Maximum dbh in tree layer (inches) (PV3) | 40 | 30 | 25 | 20 | 25 | 65 |
| Total mast producing woody species/ shrub layer (3.3' to 16.5' tall, including vines) (PV3) | 8 | 7 | 4 | 3 | 2 | 4 |
| Average Flood Tolerance Index (FTI) (PV6) | 5.8 | 5.8 | 5.84 | 5.22 | 6.136 | 5.2 |
| % Overstory canopy cover (trees ≥ 16.5' tall) (PV2) | 80 | 90 | 50 | 60 | 20 | 70 |
| % Understory canopy cover (saplings, shrubs & vines 3.3' to 16.5' tall) (PV4) | 50 | 50 | 30 | 50 | 50 | 10 |
| Distance (feet) from center of plot to major topographic change (PV7) | 7 | 10 | 50 | 20 | 300 | 500 |
| Number of ground layer elements (See Appendix C) (PV5) | 10 | 6 | 9 | 10 | 5 | 6 |

## Appendix A Continued

| Attribute | John1 | Have1 | Have2 | Swa1 | Flow1 | Boud1 |
|---|---|---|---|---|---|---|
| Total # of mature forest elements (See Appendix B) **(**PV1**)** | 8 | 5 | 7 | 6 | 3 | 6 |
| Total number of hard mast tree species (woody plants >16.5' tall,excluding vines) (PV3) | 4 | 4 | 2 | 2 | 0 | 6 |
| Total number of soft mast tree species (woody plants >16.5' tall,excluding vines) (PV3) | 1 | 2 | 2 | 0 | 3 | 3 |
| Number of oak species ≥ 8 " dbh (PV3) | 2 | 3 | 0 | 0 | 0 | 2 |
| Maximum dbh in tree layer (inches) (PV3) | 60 | 20 | 90 | 36 | 28 | 32 |
| Total mast producing woody species/ shrub layer (3.3' to 16.5' tall, including vines) (PV3) | 7 | 4 | 8 | 4 | 7 | 9 |
| Average Flood Tolerance Index (FTI) (PV6) | 5.41 | 5.49 | 5.57 | 5.35 | 5.45 | 5.94 |
| % Overstory canopy cover (trees ≥ 16.5' tall) (PV2) | 60 | 80 | 90 | 80 | 40 | 60 |
| % Understory canopy cover (saplings, shrubs & vines 3.3' to 16.5' tall) (PV4) | 50 | 33 | 20 | 30 | 25 | 30 |
| Distance (feet) from center of plot to major topographic change (PV7) | 15 | 30 | 50 | 50 | 50 | 50 |
| Number of ground layer elements (See Appendix C) (PV5) | 10 | 9 | 7 | 6 | 6 | 9 |

## Appendix A Continued

| Attribute | Boud2 | Willi1 | Bat1 | Bat2 | Drak1 | Part1 |
|---|---|---|---|---|---|---|
| Total # of mature forest elements (See Appendix B) (PV1) | 2 | 7 | 4 | 4 | 4 | 7 |
| Total number of hard mast tree species (woody plants >16.5' tall,excluding vines) (PV3) | 0 | 3 | 1 | 0 | 4 | 2 |
| Total number of soft mast tree species (woody plants >16.5' tall,excluding vines) (PV3) | 1 | 1 | 2 | 4 | 4 | 2 |
| Number of oak species ≥ 8 " dbh (PV3) | 0 | 2 | 1 | 0 | 2 | 1 |
| Maximum dbh in tree layer (inches) (PV3) | 10 | 110 | 18 | 22 | 32 | 40 |
| Total mast producing woody species/ shrub layer (3.3' to 16.5' tall, including vines) (PV3) | 6 | 4 | 4 | 6 | 9 | 8 |
| Average Flood Tolerance Index (FTI) (PV6) | 5.14 | 5.55 | 5.57 | 5.8 | 5.85 | 6.01 |
| % Overstory canopy cover (trees ≥ 16.5' tall) (PV2) | 10 | 80 | 50 | 25 | 90 | 40 |
| % Understory canopy cover (saplings, shrubs & vines 3.3' to 16.5' tall) (PV4) | 30 | 20 | 60 | 40 | 30 | 80 |
| Distance (feet) from center of plot to major topographic change (PV7) | 20 | 20 | 500 | 100 | 150 | 50 |
| Number of ground layer elements (See Appendix C) (PV5) | 7 | 8 | 6 | 7 | 8 | 6 |

## Appendix A Continued

| Attribute | Bell1 | Wils1 | Mars1 | Bell2 | Algo | Puff2 |
|---|---|---|---|---|---|---|
| Total # of mature forest elements (See Appendix B) (PV1) | 4 | 4 | 7 | 5 | 2 | 1 |
| Total number of hard mast tree species (woody plants >16.5' tall,excluding vines) (PV3) | 1 | 4 | 3 | 1 | 1 | 0 |
| Total number of soft mast tree species (woody plants >16.5' tall,excluding vines) (PV3) | 2 | 1 | 3 | 3 | 1 | 1 |
| Number of oak species ≥ 8 " dbh (PV3) | 0 | 1 | 1 | 0 | 0 | 0 |
| Maximum dbh in tree layer (inches) (PV3) | 16 | 20 | 32 | 25 | 15 | 14 |
| Total mast producing woody species/ shrub layer (3.3' to 16.5' tall, including vines) (PV3) | 10 | 7 | 10 | 8 | 8 | 6 |
| Average Flood Tolerance Index (FTI) (PV6) | 4.85 | 6.09 | 5.56 | 5.81 | 5.91 | 5.47 |
| % Overstory canopy cover (trees ≥ 16.5' tall) (PV2) | 50 | 75 | 60 | 70 | 20 | 60 |
| % Understory canopy cover (saplings, shrubs & vines 3.3' to 16.5' tall) (PV4) | 75 | 60 | 70 | 85 | 30 | 20 |
| Distance (feet) from center of plot to major topographic change (PV7) | 50 | 50 | 75 | 100 | 20 | 500 |
| Number of ground layer elements (See Appendix C) (PV5) | 5 | 6 | 6 | 7 | 4 | 7 |

## Appendix A Continued

| Attribute | Ake1 | Dun1 | Smit1 |
|---|---|---|---|
| Total # of mature forest elements (See Appendix B) (PV1) | 6 | 3 | 5 |
| Total number of hard mast tree species (woody plants >16.5' tall,excluding vines) (PV3) | 2 | 1 | 3 |
| Total number of soft mast tree species (woody plants >16.5' tall,excluding vines) (PV3) | 3 | 1 | 2 |
| Number of oak species ≥ 8 " dbh (PV3) | 1 | 0 | 1 |
| Maximum dbh in tree layer (inches) (PV3) | 34 | 20 | 19 |
| Total mast producing woody species/ shrub layer (3.3' to 16.5' tall, including vines) (PV3) | 4 | 8 | 7 |
| Average Flood Tolerance Index (FTI) (PV6) | 5.8 | 5 | 5.29 |
| % Overstory canopy cover (trees ≥ 16.5' tall) (PV2) | 30 | 10 | 25 |
| % Understory canopy cover (saplings, shrubs & vines 3.3' to 16.5' tall) (PV4) | 10 | 12 | 90 |
| Distance (feet) from center of plot to major topographic change (PV7) | 2 | 150 | 20 |
| Number of ground layer elements (See Appendix C) (PV5) | 7 | 8 | 4 |

## Appendix B. Presence of Mature Forest Elements (PV1) in Each Plot

| Attribute | Self1 | Self2 | Gaith1 | Ande | Vaugn 2 | Vaugn 3 |
|---|---|---|---|---|---|---|
| Tree ≥ 21.5" dbh | X | X | X | X | X | X |
| Tree ≥ 29.5" dbh | X | | | | | X |
| Dead branch ≥ 4" dia. at trunk of live tree or cavity ≥ 4" outside diameter | X | | X | X | X | X |
| Upper or basal hollow ≥ 10" outside dia. | X | | | X | | X |
| Snag ≥ 4" dbh and ≥ 6.5' tall | X | | X | X | X | X |
| Snag > 10" dbh and >16.5' tall | X | | X | X | X | X |
| Vine ≥ 4" dia. Reaching canopy | X | | X | X | | X |
| Epiphytes ≥ 1.2 sq. yds. in canopy | | | | | | |
| Total number of mature forest elements | 7 | 1 | 5 | 6 | 4 | 6 |

## Appendix B Continued

| Attribute | John1 | Have1 | Have2 | Swa1 | Flow1 | Boud1 |
|---|---|---|---|---|---|---|
| Tree ≥ 21.5" dbh | X | X | X | X | X | X |
| Tree ≥ 29.5" dbh | X | | X | X | | X |
| Dead branch ≥ 4" dia. at trunk of live tree or cavity ≥ 4" outside diameter | X | X | X | X | X | X |
| Upper or basal hollow ≥ 10" outside dia. | X | X | X | X | | |
| Snag ≥ 4" dbh and ≥ 6.5' tall | X | X | X | X | | X |
| Snag > 10" dbh and >16.5' tall | X | X | X | X | X | X |
| Vine ≥ 4" dia. Reaching canopy | X | | X | | | X |
| Epiphytes ≥ 1.2 sq. yds. in canopy | X | | | | | |
| Total number of mature forest elements | 8 | 5 | 7 | 6 | 3 | 6 |

## Appendix B Continued

| Attribute | Boud2 | Willi1 | Bat1 | Bat2 | Drak1 | Part1 |
|---|---|---|---|---|---|---|
| Tree ≥ 21.5" dbh | | X | | X | X | X |
| Tree ≥ 29.5" dbh | | X | | | | X |
| Dead branch ≥ 4" dia. at trunk of live tree or cavity ≥ 4" outside diameter | X | X | X | X | X | X |
| Upper or basal hollow ≥ 10" outside dia. | | X | | | | X |
| Snag ≥ 4" dbh and ≥ 6.5' tall | X | X | X | X | X | X |
| Snag > 10" dbh and >16.5' tall | | X | X | X | X | X |
| Vine ≥ 4" dia. Reaching canopy | | X | X | | | X |
| Epiphytes ≥ 1.2 sq. yds. in canopy | | | | | | |
| Total number of mature forest elements | 2 | 7 | 4 | 4 | 4 | 7 |

## Appendix B Continued

| Attribute | Bell1 | Wils1 | Mars1 | Bell2 | Algo | Puff2 |
|---|---|---|---|---|---|---|
| Tree ≥ 21.5" dbh | | | X | X | | |
| Tree ≥ 29.5" dbh | | | X | | | |
| Dead branch ≥ 4" dia. at trunk of live tree or cavity ≥ 4" outside diameter | X | X | X | X | X | |
| Upper or basal hollow ≥ 10" outside dia. | X | X | X | X | | |
| Snag ≥ 4" dbh and ≥ 6.5' tall | X | X | | X | | |
| Snag > 10" dbh and >16.5' tall | | | X | | | X |
| Vine ≥ 4" dia. Reaching canopy | X | X | X | X | X | |
| Epiphytes ≥ 1.2 sq. yds. in canopy | | | X | | | |
| Total number of mature forest elements | 4 | 4 | 7 | 5 | 2 | 1 |

## Appendix B Continued

| Attribute | Ake1 | Dun1 | Smit1 |
|---|---|---|---|
| Tree ≥ 21.5" dbh | X | | |
| Tree ≥ 29.5" dbh | X | | |
| Dead branch ≥ 4" dia. at trunk of live tree or cavity ≥ 4" outside diameter | X | X | X |
| Upper or basal hollow ≥ 10" outside dia. | | X | X |
| Snag ≥ 4" dbh and ≥ 6.5' tall | X | | X |
| Snag > 10" dbh and >16.5' tall | X | | X |
| Vine ≥ 4" dia. Reaching canopy | X | | X |
| Epiphytes ≥ 1.2 sq. yds. in canopy | | X | |
| Total number of mature forest elements | 6 | 3 | 5 |

## Appendix C. Presence of Ground Layer Elements (PV5) in Each Plot

| Attribute | Self1 | Self2 | Gaith1 | Ande | Vaugn2 | Vaugn3 |
|---|---|---|---|---|---|---|
| Live vegetation ≤ 3.3" tall and ≥ 10% of plot | x | x | x | x | x | x |
| Leaf litter ≥ 25% of the plot | x | x | x | x | x | x |
| Piles of debris or brush present | x | x | x | x | x | x |
| Depressions for temporary water present | x | x | | x | x | x |
| Small burrows and cavities present | x | x | x | x | | |
| Large burrows and cavities present | x | | x | x | | |
| Small stumps ≥ 1' tall ≥ 6" dbh present | x | | x | x | | |
| Large stumps ≥ 3.3' tall ≥ 1' dbh present | x | | x | x | | x |
| Small logs ≥ 6.5' long ≥ 6" wide present | x | x | x | x | x | x |
| Large logs ≥ 20' long ≥ 18" wide present | x | | x | x | | x |
| Total number of ground layer elements | 10 | 6 | 9 | 10 | 5 | 6 |
| Number of mast species in ground layer (0 - 3.3' tall) | 0 | 6 | 3 | 6 | 5 | 3 |

## Appendix C Continued

| Attribute | John1 | Have1 | Have2 | Swa1 | Flow1 | Boud1 |
|---|---|---|---|---|---|---|
| Live vegetation ≤ 3.3" tall and ≥ 10% of plot | x | x | x | x | x | x |
| Leaf litter ≥ 25% of the plot | x | x | x | x | x | x |
| Piles of debris or brush present | x | x | | x | x | x |
| Depressions for temporary water present | x | x | x | x | x | x |
| Small burrows and cavities present | x | x | x | | | x |
| Large burrows and cavities present | x | x | | | | |
| Small stumps ≥ 1' tall ≥ 6" dbh present | x | x | | | | x |
| Large stumps ≥ 3.3' tall ≥ 1' dbh present | x | x | x | x | | x |
| Small logs ≥ 6.5' long ≥ 6" wide present | x | x | x | x | x | x |
| Large logs ≥ 20' long ≥ 18" wide present | x | | x | | x | x |
| Total number of ground layer elements | 10 | 9 | 7 | 6 | 6 | 9 |
| Number of mast species in ground layer (0 - 3.3' tall) | 6 | 2 | 6 | 6 | 5 | 10 |

## Appendix C Continued

| Attribute | Boud2 | Willi1 | Bat1 | Bat2 | Drak1 | Part1 |
|---|---|---|---|---|---|---|
| Live vegetation ≤ 3.3" tall and ≥ 10% of plot | x | x | | x | x | x |
| Leaf litter ≥ 25% of the plot | x | x | | x | x | x |
| Piles of debris or brush present | x | x | x | x | x | x |
| Depressions for temporary water present | x | x | x | x | x | x |
| Small burrows and cavities present | x | x | x | | | |
| Large burrows and cavities present | | x | x | x | x | |
| Small stumps ≥ 1' tall ≥ 6" dbh present | x | | x | x | | x |
| Large stumps ≥ 3.3' tall ≥ 1' dbh present | | | | | x | |
| Small logs ≥ 6.5' long ≥ 6" wide present | x | x | x | x | x | x |
| Large logs ≥ 20' long ≥ 18" wide present | | x | | | x | |
| Total number of ground layer elements | 7 | 8 | 6 | 7 | 8 | 6 |
| Number of mast species in ground layer (0 - 3.3' tall) | 4 | 4 | 1 | 5 | 4 | 6 |

## Appendix C Continued

| Attribute | Bell1 | Wils1 | Mars1 | Bell2 | Algo1 | Puff2 |
|---|---|---|---|---|---|---|
| Live vegetation ≤ 3.3" tall and ≥ 10% of plot | x | x | x | x | x | x |
| Leaf litter ≥ 25% of the plot | x | x | x | x | x | x |
| Piles of debris or brush present | x | x | x | x | x | x |
| Depressions for temporary water present | x | x | x | x | | x |
| Small burrows and cavities present | | | | x | | x |
| Large burrows and cavities present | | | x | x | | x |
| Small stumps ≥ 1' tall ≥ 6" dbh present | | x | | | | |
| Large stumps ≥ 3.3' tall ≥ 1' dbh present | | | | | | |
| Small logs ≥ 6.5' long ≥ 6" wide present | x | x | x | x | x | x |
| Large logs ≥ 20' long ≥ 18" wide present | | | | | | |
| Total number of ground layer elements | 5 | 6 | 6 | 7 | 4 | 7 |
| Number of mast species in ground layer (0 - 3.3' tall) | 7 | 7 | 8 | 8 | 3 | 4 |

## Appendix C Continued

| Attribute | Ake1 | Dun1 | Smit1 |
|---|---|---|---|
| Live vegetation ≤ 3.3" tall and ≥ 10% of plot | x | x | x |
| Leaf litter ≥ 25% of the plot | | x | x |
| Piles of debris or brush present | x | x | x |
| Depressions for temporary water present | x | x | x |
| Small burrows and cavities present | x | x | x |
| Large burrows and cavities present | x | x | |
| Small stumps ≥ 1' tall ≥ 6" dbh present | | | x |
| Large stumps ≥ 3.3' tall ≥ 1' dbh present | | x | |
| Small logs ≥ 6.5' long ≥ 6" wide present | x | x | x |
| Large logs ≥ 20' long ≥ 18" wide present | x | | |
| Total number of ground layer elements | 7 | 8 | 7 |
| Number of mast species in ground layer (0 - 3.3' tall) | 4 | 2 | 4 |

# HEP Site Observations for the Mid-Brazos Habitat Study

Terry Smith July 14, 2000
Duffau Creek
Plot: **Smit 1**
Coordinates: 032° 02' 43.2" N, 098° 00' 01.4" W

Area had been recently flooded. The corridor was only 100 - 200 ft. wide. An old fence runs along through it. Depression area available for a wetland area. Overstory Canopy Cover = 25% Understory Canopy Cover = 90%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Live Oak | Ashe Juniper | Cedar Elm |
| Pecan | Bois d' Arc | |
| Black Walnut | | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Mustang Grape | Virginia Creeper |
| | Greenbrier | |
| | Youpon | |
| | Indian Cherry | |
| | Sugar Hackberry | |
| | Eve's Necklace | |
| | Buttonbush | |

Herbaceous Plants:

Switchgrass
Bullnettle
Violet Woodsorrel
Wild Petunia
Cruciferacae sp.
Composite sp.
Andropogon sp.

# HEP Site Observations for the Mid-Brazos Habitat Study

Marrs June 21, 2000
Duffau Creek
Plot: **Mars 1**
Coordinates: 032° 02' 11.8" N, 098° 00' 03.6" W

The corridor was only 100 - 200 ft. wide sloping towards the creek. A cattle trail runs through the site. Most of the ground is bare sand. The other side of the creek is a 35 ft. cliff, the other side is more sloping. Overstory Canopy Cover = 60% Understory Canopy Cover = 70%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Live Oak | Ashe Juniper | Cedar Elm |
| Red Oak | Red Mulberry | |
| Black Walnut | Bois d' Arc | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Black Walnut | Mustang Grape | Virginia Creeper |
| Pecan | Greenbrier | Morning Glory |
| Live Oak | Youpon | Cedar Elm |
| | Ashe Juniper | |
| | Sugar Hackberry | |
| | Eve's Necklace | |
| | Red Mulberry | |

Herbaceous Plants:

Broadleaf uniola
Prickly Pear
Violet Woodsorrel
Wild Petunia
Composite sp.

# HEP Site Observations for the Mid-Brazos Habitat Study

Margo Battershell June 20, 2000
Duffau Creek
Plot: **Bat 1**
Coordinates: 032° 02' 57.4" N, 098° 00' 17.5" W

Ground in plot area was washed bare and stems were laying down due the recent flood. Cattle trail running along the corridor. Most of the oaks are dead due to oak decline. Riparian corridor was approximately 75 - 100 ft. wide.
Overstory Canopy Cover = 50% Understory Canopy Cover = 60%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Live Oak | Ashe Juniper | Cedar Elm |
| | Sugar Hackberry | American Elm |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Muscadine Grape | Virginia Creeper |
| | Greenbrier | American Elm |
| | Honey Locust | Cedar Elm |
| | Sugar Hackberry | |

Herbaceous Plants:

Mexican Hat
Johnsongrass
Prickly Pear
Wild Petunia
Composite sp.
Lichen
Andropogon sp.
Bermuda grass
Texas Vervain

# HEP Site Observations for the Mid-Brazos Habitat Study

Ray Battershell June 20, 2000
Duffau Creek
Plot: **Bat 2**
Coordinates: 032° 02' 56.1" N, 098° 00' 19" W

Ground in plot area was washed bare and stems were laying down due the recent flood. Riparian corridor was approximately 100 ft. wide. Overstory Canopy Cover = 25% Understory Canopy Cover = 40%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Ashe Juniper | Cedar Elm |
| | Gum Bumelia | |
| | Bois d' Arc | |
| | Sugar Hackberry | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Youpon | Virginia Creeper |
| Live Oak | Greenbrier | American Elm |
| | Ashe Juniper | Cedar Elm |
| | Gum Bumelia | |

Herbaceous Plants:

Prickly Pear
Wild Petunia
Violet Woodsorrel
Nut-grass
berry vine?
Broadleaf uniola

# HEP Site Observations for the Mid-Brazos Habitat Study

Alford Haven June 15, 2000
Bosque River
Plot: **Have 1**
Coordinates: 032° 03' 51.9" N, 098° 08' 29.0" W

The riparian buffer is about 50 feet on one side and about 25 - 30 feet on the other. The riparian buffer has been severely impacted by cattle. There is a small draw across the property that may be a good opportunity for re-establishing a riparian corridor. Overstory Canopy Cover = 90% Understory Canopy Cover = 20%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Post Oak | Sugar Hackberry | Cedar Elm |
| Red Oak | | |
| Pecan | | |
| Bur Oak | | |

Black Walnut was just outside of the survey area.

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Mulberry | Virginia Creeper |
| | Greenbrier | American Elm |
| | Sugar Hackberry | |
| | Mustang Grape | |

Herbaceous Plants:

Grass sp.

# HEP Site Observations for the Mid-Brazos Habitat Study

Alford Haven June 15, 2000
Bosque River
Plot: **Have 2**
Coordinates: 032° 03' 42.6" N, 098° 08' 21.2" W

Junction of tributary and the main Bosque River. Mostly grasses ground cover. Buffer on the east side of the Bosque River is about 100 feet wide. The Bosque had a high flow at the time of the survey. Overstory Canopy Cover = 80% Understory Canopy Cover = 33%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Sugar Hackberry | Cedar Elm |
| Black Walnut | Mulberry | American Elm |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Chinaberry | Virginia Creeper |
| Black Walnut | Greenbrier | Pockweed |
| | Poison Ivy | |
| | Gum Bumelia | |
| | Indian Cherry | |
| | Sugar Hackberry | |

Herbaceous Plants:

Grass sp.
Ranunculus sp.
Hedge Parsley
Composite sp.

# HEP Site Observations for the Mid-Brazos Habitat Study

H.L. Self June 14, 2000
Green Creek
Plot: **Self 1**
Coordinates: 032° 02' 40.5" N, 098° 09' 00.8" W

The river banks were eroded. Cattle had access to the river. The riparian corridor was about 30 feet wide with some gaps. This area had very large trees. Overstory Canopy Cover = 80% Understory Canopy Cover = 50%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Sugar Hackberry | Black Willow |
| Black Walnut | Ashe Juniper | |
| Bur Oak | | |
| Red Oak | | |
| Live Oak | | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Southern Black Hawthorne | Virginia Creeper |
| | Greenbrier | Cedar Elm |
| | Poison Ivy | |
| | Gum Bumelia | |
| | Soapberry | |
| | American Beauty Berry | |
| | Wild Plum | |
| | Grape | |
| | Buttonbush | |

Herbaceous Plants:

| | | | |
|---|---|---|---|
| Johnsongrass | Sweet Clover | Day Flower | Doveweed |
| Helenium Sp. | Tasajillo | Violet Woodsorrel | Bullnettle |

# HEP Site Observations for the Mid-Brazos Habitat Study

H.L. Self June 14, 2000
Green Creek
Plot: **Self 2**
Coordinates: 032° 02' 27.5" N, 098° 08' 32.7" W

The river banks were eroded. Cattle had access to the river. The riparian corridor was about 30 feet wide with some gaps. Overstory Canopy Cover = 90% Understory Canopy Cover = 50%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Sugar Hackberry | Black Willow |
| Black Walnut | Ashe Juniper | |
| Bur Oak | | |
| Red Oak | | |
| Live Oak | | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Southern Black Hawthorne | Cedar Elm |
| | Greenbrier | |
| | Buttonbush | |
| | Gum Bumelia | |
| | Soapberry | |
| | American Beauty Berry | |
| | Wild Plum | |
| | Grape | |

Herbaceous Plants:

Ironweed
Rescuegrass
Tumblegrass
Common Witchgrass
Clammyweed
Wild Petunia
Orchard Grass
Thistle
Virginia Wildrye
Little Bluestem
Orange Zexmenia

# HEP Site Observations for the Mid-Brazos Habitat Study

Jerry Johnson June 15, 2000
Green Creek
Plot: **John 1**
Coordinates: 032° 02' 50.3" N, 098° 09' 59.5" W

Old beaver activity. The creek is about 35 feet wide with some water, but not flowing. The bank is about 15 to 20 feet high. The riparian corridor is 25 - 30 feet wide. The small tributary on the property was dry, with a wide riparian corridor. Overstory Canopy Cover = 60% Understory Canopy Cover = 50%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Sugar Hackberry | Cedar Elm |
| Black Walnut | | American Elm |
| Post Oak | | |
| Red Oak | | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Parsley Hawthorne | Virginia Creeper |
| | Greenbrier | |
| | Indian Cherry | |
| | Poison Oak | |
| | Poison Ivy | |
| | Grape | |

Herbaceous Plants:

Mistletoe

# HEP Site Observations for the Mid-Brazos Habitat Study

Allen Vaughn June 15, 2000
Green Creek
Plot: **Vaugn 2**
Coordinates: 032° 10' 27.7" N, 098° 20' 48.2" W

Old beaver activity. The adjacent farm field is to be planted to grassland. Currently it has Indian grass, little bluestem. It has been leased out for grazing to get rid of overgrowth. Overstory Canopy Cover = 20% Understory Canopy Cover = 50%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Sugar Hackberry | Cedar Elm |
| Live Oak | Mesquite | American Elm |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Gum Bumelia | Virginia Creeper |
| | Greenbrier | Cork Elm |
| | Indian Cherry | |
| | Poison Ivy | |

Herbaceous Plants:

Prickly Pear

# HEP Site Observations for the Mid-Brazos Habitat Study

Allen Vaughn June 15, 2000
Green Creek
Plot: **Vaugn 3**
Coordinates: 032° 10' 26.2" N, 098° 20' 59.1" W

Water in the creek about 2 feet deep. Large live oaks with large dead limbs, little understory. Overstory Canopy Cover = 70% Understory Canopy Cover = 10%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Sugar Hackberry | Cedar Elm |
| Live Oak | | American Elm |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Gum Bumelia | Virginia Creeper |
| | Greenbrier | American Elm |
| | Sugar Hackberry | |

Herbaceous Plants:

Composite sp.

# HEP Site Observations for the Mid-Brazos Habitat Study

Joe Gaither June 15, 2000
Green Creek
Plot: **Green 1**
Coordinates: 032° 03' 29.1" N, 098° 12' 57.0" W

North shore is eroded. South shore is barren. Overstory Canopy Cover = 50% Understory Canopy Cover = 30%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Sugar Hackberry | Cedar Elm |
| Live Oak | Mulberry | Box Elder |
| Black Walnut | Mesquite | Slippery Elm |
| Bur Oak | | |
| Red Oak | | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Gum Bumelia | Virginia Creeper |
| | Greenbrier | American Elm |
| | Grape | |
| | Sumac | |

Herbaceous Plants:

Sensitive Brier
Sumac
Ragweed
Johnsongrass
Maximilian Sunflower
Doveweed
Bullnettle
Fern
Smartweed
Cocklebur
Water Willow
Nutgrass
Prickly Pear
Yucca sp.
False Poinsettia
Marsh-mallow

# HEP Site Observations for the Mid-Brazos Habitat Study

Elvin Anderson June 14, 2000
Green Creek
Plot: **Ande 1**
Coordinates: 032° 04' 43.9" N, 098° 14' 01.6" W

Overstory Canopy Cover = 60% Understory Canopy Cover = 50%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Bur Oak | | Cedar Elm |
| Red Oak | | Black Willow |
| Black Walnut | | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Wild Plum | Morning Glory |
| | Greenbrier | American Elm |
| | Indian Cherry | |
| | Sumac | |
| | Poison Ivy | |

Herbaceous Plants:

Sweet Clover
Violet Woodsorrel
Helenium Sp.
Chick-pea

# HEP Site Observations for the Mid-Brazos Habitat Study

Lee Flowers June 16, 2000
Duffau Creek
Plot: **Flow 1**
Coordinates: 032° 04' 36.4" N, 098° 00' 56.9" W

The Riparian corridor is about 75 feet wide. Overstory Canopy Cover = 40% Understory Canopy Cover = 25%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Bois d' Arc | Cedar Elm |
| | Sugar Hackberry | |
| | Mesquite | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Ashe Juniper | Morning Glory |
| Black Walnut | Greenbrier | Virginia Creeper |
| | Indian Cherry | Texas Kidney Wood |
| | Mustang Grape | |
| | Muscadine Grape | |

Herbaceous Plants:

Johnsongrass
Broadleaf uniola
Composite Sp.
Hedge Parsley

# HEP Site Observations for the Mid-Brazos Habitat Study

C.D. Swaffar June 16, 2000
Duffau Creek
Plot: **Swa 1**
Coordinates: 032° 05' 53.9" N, 098° 01' 12.5" W

Riparian corridor is about 100 feet wide on the west side of the creek. Overstory Canopy Cover = 80% Understory Canopy Cover = 30%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | | Cork Elm |
| Black Walnut | | Black Willow |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Gum Bumelia | Morning Glory |
| Black Walnut | Greenbrier | Virginia Creeper |
| | Muscadine Grape | American Elm |
| | Mulberry | Cedar Elm |

Herbaceous Plants:

Lichen
Chasmanthium latifolium
Helenium Sp.
Ironweed
Agropyron sp.

# HEP Site Observations for the Mid-Brazos Habitat Study

Joe Boudreaux June 16, 2000
Duffau Creek
Plot: **Boud 2**
Coordinates: 032° 01' 43.5" N, 097° 59' 41.4" W

The corridor is about 75 feet wide. Overstory Canopy Cover = 10% Understory Canopy Cover = 30%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Ashe Juniper | Cedar Elm |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Mesquite | Morning Glory |
| | Greenbrier | Virginia Creeper |
| | Youpon | |
| | Ashe Juniper | |
| | Sugar Hackberry | |

Herbaceous Plants:

Grass sp.
Chasmanthium latifolium
Prickly Pear
Sida sp.
Maximilian Sunflower
Spurge sp.
Little Bluestem
Twist-leaf Yucca
Antelope-horns
Gayfeather

# HEP Site Observations for the Mid-Brazos Habitat Study

Joe Boudreaux June 16, 2000
Duffau Creek
Plot: **Boud 1**
Coordinates: 032° 01' 24.5" N, 097° 59' 26.3" W

Corridor is adjacent to a hay field. The corridor is about 100 feet wide. Overstory Canopy Cover = 60%
Understory Canopy Cover = 30%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Live Oak | Ashe Juniper | Cedar Elm |
| Pecan | Mesquite | American Elm |
| Red Oak | Sugar Hackberry | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Gum Bumelia | Virginia Creeper |
| | Greenbrier | |
| | Youpon | |
| | Ashe Juniper | |
| | American Beauty Berry | |
| | Indian Cherry | |
| | Chinaberry | |
| | Mustang Grape | |
| | Poison Ivy | |

Herbaceous Plants:

Maximilian Sunflower

# HEP Site Observations for the Mid-Brazos Habitat Study

Ken Williford June 16, 2000
Bosque River
Plot: **Willi 1**
Coordinates: 031° 57' 38.8" N, 098° 00' 42.6" W

The riparian corridor is only 10 feet in some places and up to 30 feet in others. There is major erosion of the creek banks. The cottonwood tree is very large, greater than 100 inches DBH. Grass field surround the corridor.
Overstory Canopy Cover = 80% Understory Canopy Cover = 20%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Live Oak | Sugar Hackberry | Cedar Elm |
| Pecan | | American Elm |
| Bur Oak | | Cottonwood |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Black Walnut | Gum Bumelia | Virginia Creeper |
| Pecan | Greenbrier | Redbud |
| | Buttonbush | |
| | Ashe Juniper | |
| | Chinaberry | |
| | Poison Ivy | |

Herbaceous Plants:

Hedge Parsley
Wheatgrass

# HEP Site Observations for the Mid-Brazos Habitat Study

Floyd Drake June 20, 2000
Duffau
Plot: **Drak 1**
Coordinates: 032° 02' 27.7" N, 097° 59' 54.1" W

Riparian buffer is about 200 feet wide. Cattle are roaming free in the riparian area. Overstory Canopy Cover = 90%
Understory Canopy Cover = 30%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Live Oak | Sugar Hackberry | Cedar Elm |
| Pecan | Ashe Juniper | |
| Black Walnut | Red Mulberry | |
| Red Oak | Bois d'Arc | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Red Oak | Mustang Grape | Virginia Creeper |
| Pecan | Greenbrier | |
| Live Oak | Red Mulberry | |
| | Indian Cherry | |
| | Youpon | |
| | Parsley Hawthorne | |

Herbaceous Plants:

Nutgrass
Violet Woodsorrel
Maximilian Sunflower

# HEP Site Observations for the Mid-Brazos Habitat Study

Ronnie Partain June 20, 2000
Duffau Creek
Plot: **Part 1**
Coordinates: 032° 02' 46.3" N, 098° 00' 09.1" W

There was only a small stretch of the creek on his land. Neighbor of Battershell and Drake. Cattle can get into the riparian corridor. Not opposed to more fencing. Overstory Canopy Cover = 40% Understory Canopy Cover = 80%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Live Oak | Sugar Hackberry | Cedar Elm |
| Pecan | Ashe Juniper | American Elm |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Mustang Grape | Cedar Elm |
| | Greenbrier | Virginia Creeper |
| | Southern Blackhaw | |
| | Indian Cherry | |
| | Youpon | |
| | Eve’s Necklace | |
| | Ashe Juniper | |

Herbaceous Plants:

Prickly Pear
Violet Woodsorrel
Maximilian Sunflower
Wild Petunia
Chasmanthium latifolium

# HEP Site Observations for the Mid-Brazos Habitat Study

Jim Bell June 21, 2000
Duffau Creek
Plot: **Bell 1**
Coordinates: 032° 01' 55.9" N, 097° 59' 47.3" W

Riparian corridor is about 100feet wide. Recently flooded. Many shrubs were laying down and lots of debris carried by the high water was trapped in the brush. Overstory Canopy Cover = 50% Understory Canopy Cover = 75%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Sugar Hackberry | Cedar Elm |
| | Ashe Juniper | American Elm |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Black Walnut | Mustang Grape | Morning Glory |
| | Greenbrier | Virginia Creeper |
| | Gum Bumelia | Black Willow |
| | Sugar Hackberry | |
| | Youpon | |
| | Eve’s Necklace | |
| | Mesquite | |
| | Poison Ivy | |
| | Buttonbush | |

Herbaceous Plants:

| | | |
|---|---|---|
| Prickly Pear | Ironweed | Johnsongrass |
| Violet Woodsorrel | Little Bluestem | Bermuda Grass |
| Maximilian Sunflower | Nutgrass | Water-willow |
| Wild Petunia | Carolina Foxtail | Mexican-hat |
| Chasmanthium latifolium | Day Flower | Fleabane Daisy |

# HEP Site Observations for the Mid-Brazos Habitat Study

Lori Wilson June 21, 2000
Duffau Creek
Plot: **Wils 1**
Coordinates: 032° 02' 05.7" N, 097° 59' 52.9" W

Buffer about 100 feet wide. Recently flooded. Overstory Canopy Cover = 75% Understory Canopy Cover = 60%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Ashe Juniper | Cedar Elm |
| Black Walnut | | |
| Red Oak | | |
| Live Oak | | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Red Oak | Mustang Grape | Cedar Elm |
| | Greenbrier | Virginia Creeper |
| | Gum Bumelia | |
| | Ashe Juniper | |
| | Youpon | |
| | Eve’s Necklace | |

Herbaceous Plants:
Wild Petunia
Violet Woodsorrel
Bermuda Grass
Maximilian Sunflower
Chasmanthium latifolium
Mallow
Fleabane Daisy
Wheatgrass

# HEP Site Observations for the Mid-Brazos Habitat Study

Cindy Bell June 21, 2000
Duffau Creek
Plot: **Bell 2**
Coordinates: 032° 02' 21.2" N, 098° 00' 02.7" W

Recently flooded. The riparian buffer is 200 - 250 feet wide. The owner is interested in building a dam on the creek. He wants to build ponds. There are no cattle. Overstory Canopy Cover = 70% Understory Canopy Cover = 85%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Black Walnut | Ashe Juniper | Cedar Elm |
| | Sugar Hackberry | |
| | Gum Bumelia | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Mustang Grape | Cedar Elm |
| | Greenbrier | Virginia Creeper |
| | Gum Bumelia | American Elm |
| | Ashe Juniper | |
| | Youpon | |
| | Indian Cherry | |
| | Sugar Hackberry | |
| | Red Mulberry | |

Herbaceous Plants:
Wild Petunia
Violet Woodsorrel
Prickly Pear
Maximilian Sunflower

# HEP Site Observations for the Mid-Brazos Habitat Study

Mark Algood June 21, 2000
Little Duffau Creek
Plot: **Algo 1**
Coordinates: 032° 01' 49.1" N, 098° 00' 20.0" W

The riparian corridor is only about 30 feet wide. Opens up to pasture with scattered mesquite and juniper. The water quality of the creek is poor due to runoff from a dairy farm upstream. Algae is growing over the top of brown colored water. There are no fish present. The water in the creek was higher than normal due to the recent flood.
Overstory Canopy Cover = 20% Understory Canopy Cover = 30%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Pecan | Ashe Juniper | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Red Oak | Mustang Grape | Cedar Elm |
| | Poison Ivy | |
| | Gum Bumelia | |
| | Ashe Juniper | |
| | Youpon | |
| | Sugar Hackberry | |
| | Wild Plum | |

Herbaceous Plants:

Grass sp.
Maximilian Sunflower
Prickly Pear

# HEP Site Observations for the Mid-Brazos Habitat Study

Jim Puff July 13, 2000
Tributary of Honey Creek
Plot: **Puff 2**
Coordinates: 031° 56' 0784" N, 098° 00' 42.11" W

About 50 yards in length from property line northeast from the house. About 30 feet wide corridor. Some large rock and undercuff when water present. Surrounding area in native grasses. Mr. Puff is interested in improving the duck use on his property. The two ponds and seasonal creek could use more shade. The banks of the ponds have been trampled by cattle. Overstory Canopy Cover = 60% Understory Canopy Cover = 20%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Ashe Juniper | Cedar Elm |
| | | Black Willow |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Mustang Grape | Cedar Elm |
| | Sumac | Black Willow |
| | Parsley Hawthorne | |
| | Ashe Juniper | |
| | Youpon | |
| | Buttonbush | |
| | Indian Cherry | |

Herbaceous Plants:

Native grasses

# HEP Site Observations for the Mid-Brazos Habitat Study

Paul Ake July 14, 2000
Ephemeral tributary of Little Duffau Creek
Plot: **Ake 1**
Coordinates: 032° 03' 15.2" N, 098° 03' 20.7" W

Buffer about 20 feet wide. Cattle and horses have access to the corridor. The creek was dry. The banks of the water tank was eroded due to cattle assess. Overstory Canopy Cover = 30% Understory Canopy Cover = 10%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Live Oak | Ashe Juniper | Cedar Elm |
| Black Walnut | Sugar Hackberry | Cork Elm |
| | Mesquite | |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Mustang Grape | Virginia Creeper |
| | Greenbrier | |
| | Gum Bumelia | |
| | Youpon | |

Herbaceous Plants:
Wild Petunia
Western Ironweed
Wooly Ironweed
Maximilian Sunflower
Crabgrass
Texas Wintergrass
Buffalo Gourd
Spike-rush

# HEP Site Observations for the Mid-Brazos Habitat Study

H.D. Duncan June 14, 2000
Meridian Creek
Plot: **Dun 1**
Coordinates: 031° 49' 53.05" N, 097° 52' 57.35" W

The riparian corridor is over grazed. Mr. Duncan is interested in reforestation. Most of the riparian area north of the river is sparse. The riparian corridor is about 75 feet wide. The riparian corridor south of the highway is much better habitat. Overstory Canopy Cover = 10% Understory Canopy Cover = 15%

Trees:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| Black Walnut | Gum Bumelia | Cedar Elm |

Shrubs and Vines:

| HARD MAST SPECIES | SOFT MAST SPECIES | OTHER SPECIES |
|---|---|---|
| | Tickletongue | Black Willow |
| | Greenbrier | |
| | Sugar Hackberry | |
| | Ashe Juniper | |
| | Youpon | |
| | Eve's Necklace | |
| | Buttonbush | |
| | Sumac | |

Herbaceous Plants:

Wild Petunia
Maximilian Sunflower
Bermuda Grass
Western Ironweed
Little Bluestem
Mud-Plantain
Water Willow
Windmillgrass
Wildrye
Meadow Dropseed
Prairie Trisetum

# Appendix E. Plants Found in the Study Plots

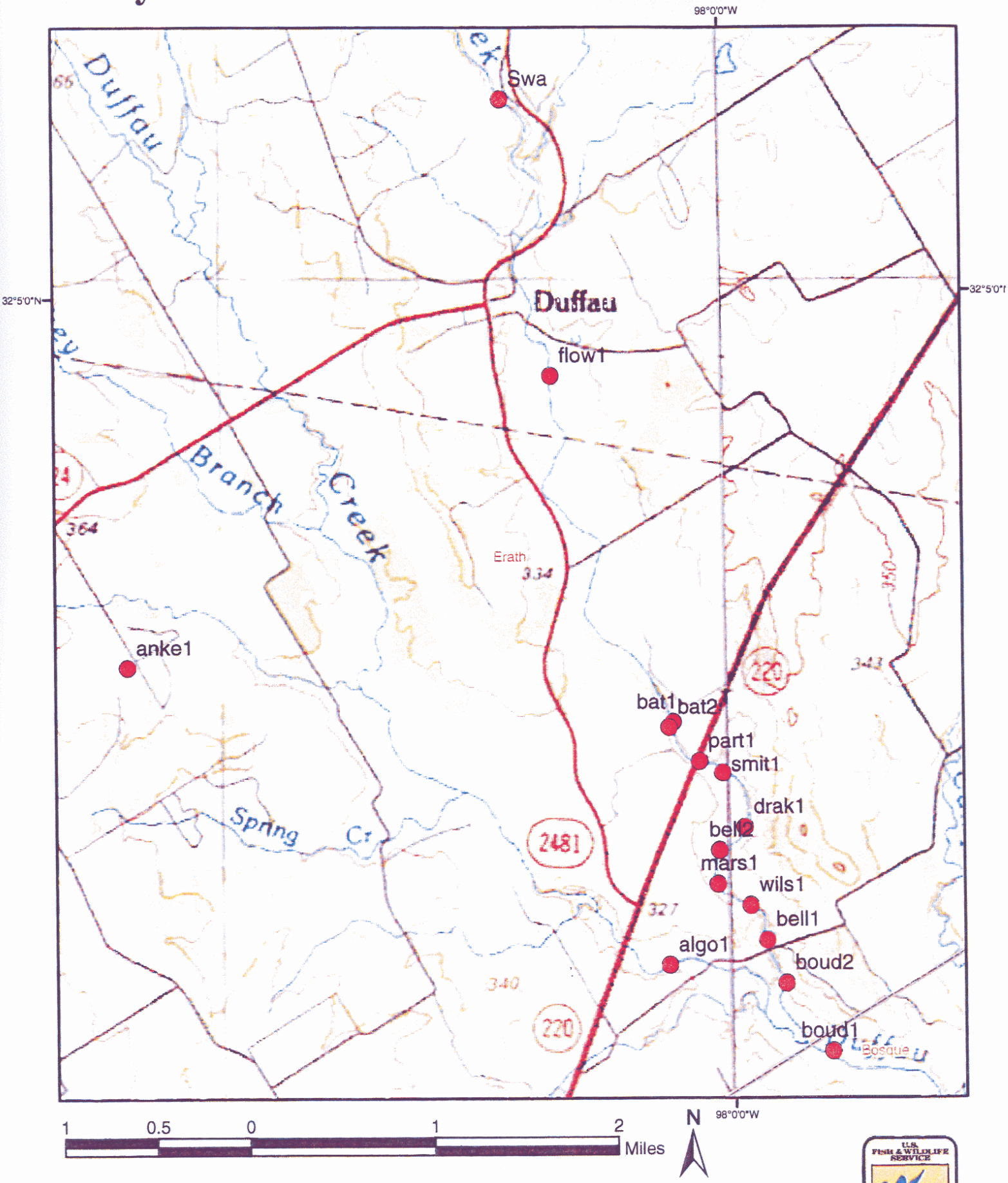
| Plants by Common Name in Alphabetical Order | | Plants by Scientific Name in Alphabetical Order | |
|---|---|---|---|
| | | | |
| Common Name | Scientific Name | Scientific Name | Common Name |
| American Beauty-berry | *Callicarpa americana* | *Alopecurus carolinianus* | Carolina Foxtail |
| American Elm | *Ulmus americana* | *Ambrosia trifida* | Giant Ragweed |
| Antelope-horns | *Asclepias asperula* | *Andropogon sp.* | Bluestem species |
| Ashe Juniper | *Juniperus ashei* | *Asclepias asperula* | Antelope-horns |
| Bermudagrass | *Cynodon dactylon* | *Bromus unioloides* | Rescuegrass |
| Black Walnut | *Juglans microcarpa* | *Bumelia lanuginosa* | Gum Bumelia |
| Black Willow | *Salix nigra* | *Callicarpa americana* | American Beauty-berry |
| Bluestem species | *Andropogon sp.* | *Carya illinoensis* | Pecan |
| Bois d'Arc | *Maclura pomifera* | *Celtis laevigata* | Sugar Hackberry |
| Chasmanthium latifolium | *Chasmanthium latifloium* | *Cephalanthus occidentalis* | Common Buttonbush |
| Buffalo Gourd | *Cucurbita foetidissima* | *Cercis canadensis* | Redbud |
| Bullnettle | *Cnidoscolus texanus* | *Cercis canadensis var. texensis* | Texas Redbud |
| Bur Oak | *Quercus macrocarpa* | *Chamaesyce sp.* | Spurge |
| Buttercup | *Ranunculus sp.* | *Chasmanthium latifloium* | Chasmanthium latifolium |
| Carolina Foxtail | *Alopecurus carolinianus* | *Chloris verticillata* | Windmillgrass |
| Cedar Elm | *Ulmus crassifolia* | *Cicer sp.* | Chick-pea |
| Chick-pea | *Cicer sp.* | *Cirsium sp.* | Thistle |
| Chinaberry | *Melia azedarach* | *Cnidoscolus texanus* | Bullnettle |
| Clammyweed | *Polanisia dodecandra* | *Composite sp.* | Composite |
| Cocklebur | *Xanthium strumarium* | *Crataegus marshallii* | Parsley Hawthorne |
| Common Buttonbush | *Cephalanthus occidentalis* | *Croton monanthogynus* | Doveweed |
| Common Plantain | *Plantago rugelii* | *Cruciferacea sp.* | Mustard Family |
| Common Witchgrass | *Panicum capillare* | *Cucurbita foetidissima* | Buffalo Gourd |
| Composite | *Composite sp.* | *Cynodon dactylon* | Bermudagrass |
| Cork Elm | *Ulmus alata* | *Cyperus rotundus* | Nut-grass |
| Cottonwood | *Populus deltoides* | *Dactylis glomerata* | Orchard Grass |
| Doveweed | *Croton monanthogynus* | *Eleocharis sp.* | Spike-rush |
| Eve's Necklace | *Sophora affinis* | *Elymus sp.* | Wildrye |
| False Poinsettia | *Euphorbia cyathophora* | *Elymus virginicus* | Virginia Wildrye |
| Fern | *Polypodiophta sp* | *Erigeron sp.* | Fleabane Daisy |
| Fleabane Daisy | *Erigeron sp.* | *Euphorbia cyathophora* | False Poinsettia |
| Gayfeather | *Liatris sp.* | *Eysenhardtia texana* | Texas Kidney Wood |
| Giant Ragweed | *Ambrosia trifida* | *Frangula caroliniana* | Indian Cherry |
| Gum Bumelia | *Bumelia lanuginosa* | *Helenium sp.* | Sneezeweed |
| Hedge-parsley | *Torilis arvensis* | *Helianthus maximiliani* | Maximilian Sunflower |
| Indian Cherry | *Frangula caroliniana* | *Heteranthera sp.* | Mud-Plaintain |
| Ironweed | *Vernonia sp.* | *Hibiscus sp.* | Marsh-mallow |
| Johnsongrass | *Sorghun halepense* | *Ilex vomitoria* | Youpon |
| Lichen | | *Ipomoea cordatotriloba* | Wild Morning-glory |
| Little Bluestem | *Schizachyrium scoparium* | *Juglans microcarpa* | Black Walnut |

| | | | |
|---|---|---|---|
| Live Oak | *Quercus virginiana* | *Juniperus ashei* | Ashe Juniper |
| Mallow | *Sida sp.* | *Justicia americana* | Water-willow |
| Marsh-mallow | *Hibiscus sp.* | *Liatris sp.* | Gayfeather |
| Maximilian Sunflower | *Helianthus maximiliani* | *Maclura pomifera* | Bois d'Arc |
| Meadow Dropseed | *Sporobolus asper* | *Melia azedarach* | Chinaberry |
| Mesquite | *Prosopis grandulosa* | *Melilotus albus* | Sweet Clover |
| Mexican-hat | *Ratibida columnifera* | *Mimosa sp.* | Sensitive Brier |
| Mistletoe | *Phoradendron tomentosum* | *Morus rubra* | Red Mulberry |
| Mud-Plaintain | *Heteranthera sp.* | *Opuntia leptocaulis* | Tasajillo |
| Muscadine Grape | *Vitis rotundifolia* | *Opuntia sp.* | Prickly Pear |
| Mustang Grape | *Vitis mustangensis* | *Oxalis violacea* | Violet Woodsorrel |
| Mustard Family | *Cruciferacea sp.* | *Panicum capillare* | Common Witchgrass |
| Nut-grass | *Cyperus rotundus* | *Panicum virgatum* | Switchgrass |
| Ohio Spiderwort | *Tradescantia ohiensis* | *Parthenocissus quinquefolia* | Virginia-creeper |
| Orange Zexmenia | *Wedelia texana* | *Pascopyrum smithii* | Western Wheatgrass |
| Orchard Grass | *Dactylis glomerata* | *Phoradendron tomentosum* | Mistletoe |
| Parsley Hawthorne | *Crataegus marshallii* | *Phytolaccta americana* | Pokeweed |
| Pecan | *Carya illinoensis* | *Plantago rugelii* | Common Plantain |
| Poison ivy | *Toxicodendron radicans* | *Polanisia dodecandra* | Clammyweed |
| Poison Oak | *Toxicodendron pubescens* | *Polygonum sp.* | Smartweed |
| Pokeweed | *Phytolaccta americana* | *Polypodiophta sp* | Fern |
| Post Oak | *Quercus stellata* | *Populus deltoides* | Cottonwood |
| Prairie Trisetum | *Trisetum interruptum* | *Prosopis grandulosa* | Mesquite |
| Prickly Pear | *Opuntia sp.* | *Prunus mexicana* | Wild Plum |
| Red Mulberry | *Morus rubra* | *Quercus macrocarpa* | Bur Oak |
| Red Oak | *Quercus shumardii* | *Quercus shumardii* | Red Oak |
| Redbud | *Cercis canadensis* | *Quercus stellata* | Post Oak |
| Rescuegrass | *Bromus unioloides* | *Quercus virginiana* | Live Oak |
| Saw Greenbrier | *Smilax bona-nox* | *Ranunculus sp.* | Buttercup |
| Sensitive Brier | *Mimosa sp.* | *Ratibida columnifera* | Mexican-hat |
| Slippery Elm | *Ulmus rubra* | *Rhus sp.* | Sumac |
| Smartweed | *Polygonum sp.* | *Ruellia sp.* | Wild Petunia |
| Sneezeweed | *Helenium sp.* | *Salix nigra* | Black Willow |
| Soapberry | *Sapindus drummondii* | *Sapindus drummondii* | Soapberry |
| Southern Blackhaw | *Viburnum rufidulum* | *Schedonnardus paniculatus* | Tumblegrass |
| Spike-rush | *Eleocharis sp.* | *Schizachyrium scoparium* | Little Bluestem |
| Spurge | *Chamaesyce sp.* | *Sida sp.* | Mallow |
| Sugar Hackberry | *Celtis laevigata* | *Smilax bona-nox* | Saw Greenbrier |
| Sumac | *Rhus sp.* | *Sophora affinis* | Eve's Necklace |
| Sweet Clover | *Melilotus albus* | *Sorghun halepense* | Johnsongrass |
| Switchgrass | *Panicum virgatum* | *Sporobolus asper* | Meadow Dropseed |
| Tasajillo | *Opuntia leptocaulis* | *Stipa leucotricha* | Texas Wintergrass |
| Texas Kidney Wood | *Eysenhardtia texana* | *Torilis arvensis* | Hedge-parsley |
| Texas Redbud | *Cercis Canadensis var. texensis* | *Toxicodendron pubescens* | Poison Oak |
| Texas Vervain | *Verbena halei* | *Toxicodendron radicans* | Poison ivy |

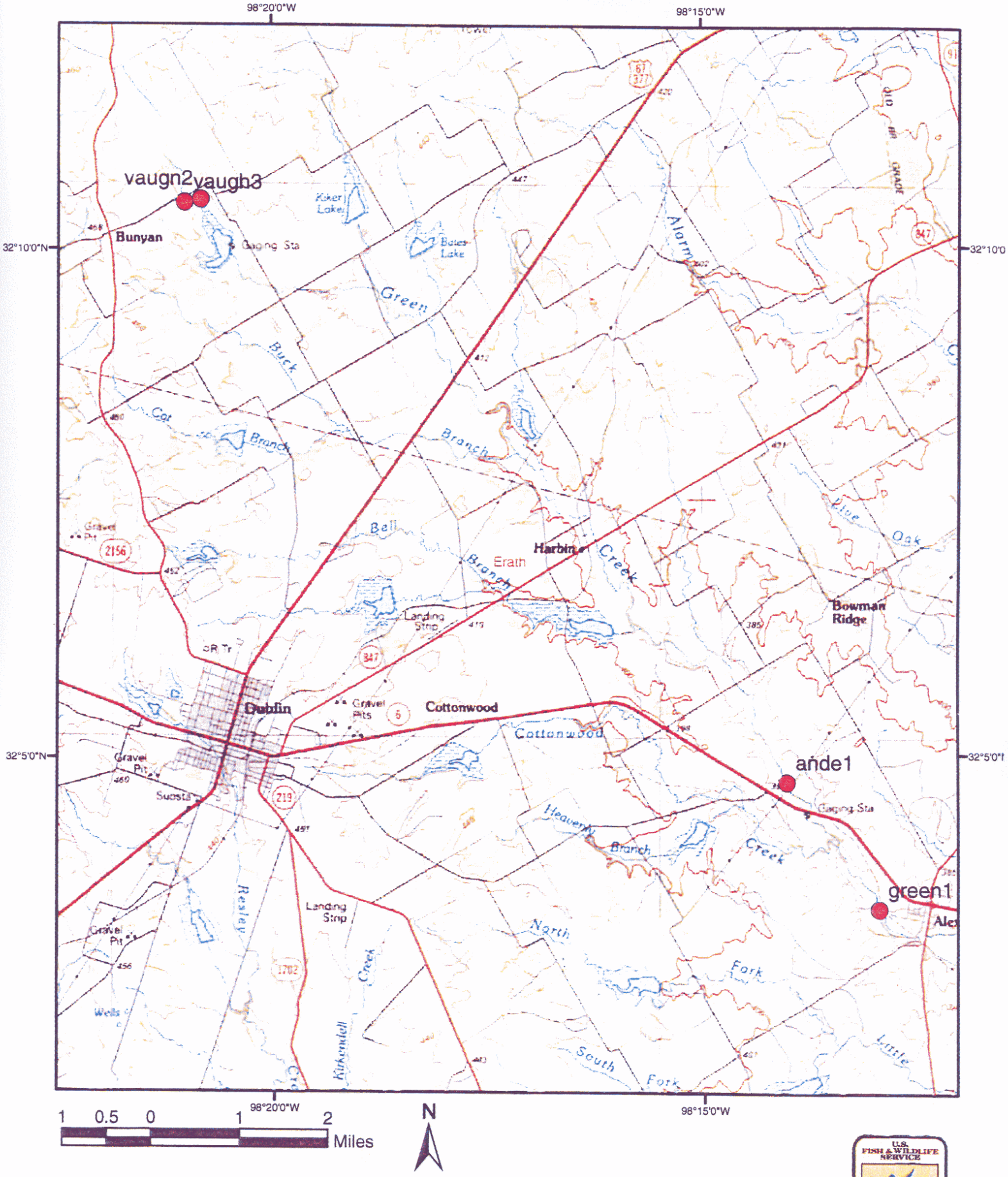
| | | | |
|---|---|---|---|
| Texas Wintergrass | *Stipa leucotricha* | *Tradescantia ohiensis* | Ohio Spiderwort |
| Thistle | *Cirsium sp.* | *Trisetum interruptum* | Prairie Trisetum |
| Tickletongue | *Zanthoxylum hisutum* | *Ulmus alata* | Winged Elm |
| Tumblegrass | *Schedonnardus paniculatus* | *Ulmus americana* | American Elm |
| Twist-leaf Yucca | *Yucca pallida* | *Ulmus crassifolia* | Cedar Elm |
| Violet Woodsorrel | *Oxalis violacea* | *Ulmus rubra* | Slippery Elm |
| Virginia Wildrye | *Elymus virginicus* | *Verbena halei* | Texas Vervain |
| Virginia-creeper | *Parthenocissus quinquefolia* | *Vernonia baldwinii* | Western Ironweed |
| Water-willow | *Justicia americana* | *Vernonia lindheimeri* | Wooly Ironweed |
| Western Ironweed | *Vernonia baldwinii* | *Vernonia sp.* | Ironweed |
| Western Wheatgrass | *Pascopyrum smithii* | *Viburnum rufidulum* | Southern Blackhaw |
| Wild Morning-glory | *Ipomoea cordatotriloba* | *Vitis mustangensis* | Mustang Grape |
| Wild Petunia | *Ruellia sp.* | *Vitis rotundifolia* | Muscadine Grape |
| Wild Plum | *Prunus mexicana* | *Wedelia texana* | Orange Zexmenia |
| Wildrye | *Elymus sp.* | *Xanthium strumarium* | Cocklebur |
| Windmillgrass | *Chloris verticillata* | *Yucca pallida* | Twist-leaf Yucca |
| Wooly Ironweed | *Vernonia lindheimeri* | *Zanthoxylum hisutum* | Tickletongue |
| Youpon | *Ilex vomitoria* | | Lichen |

# Appendix F. Maps

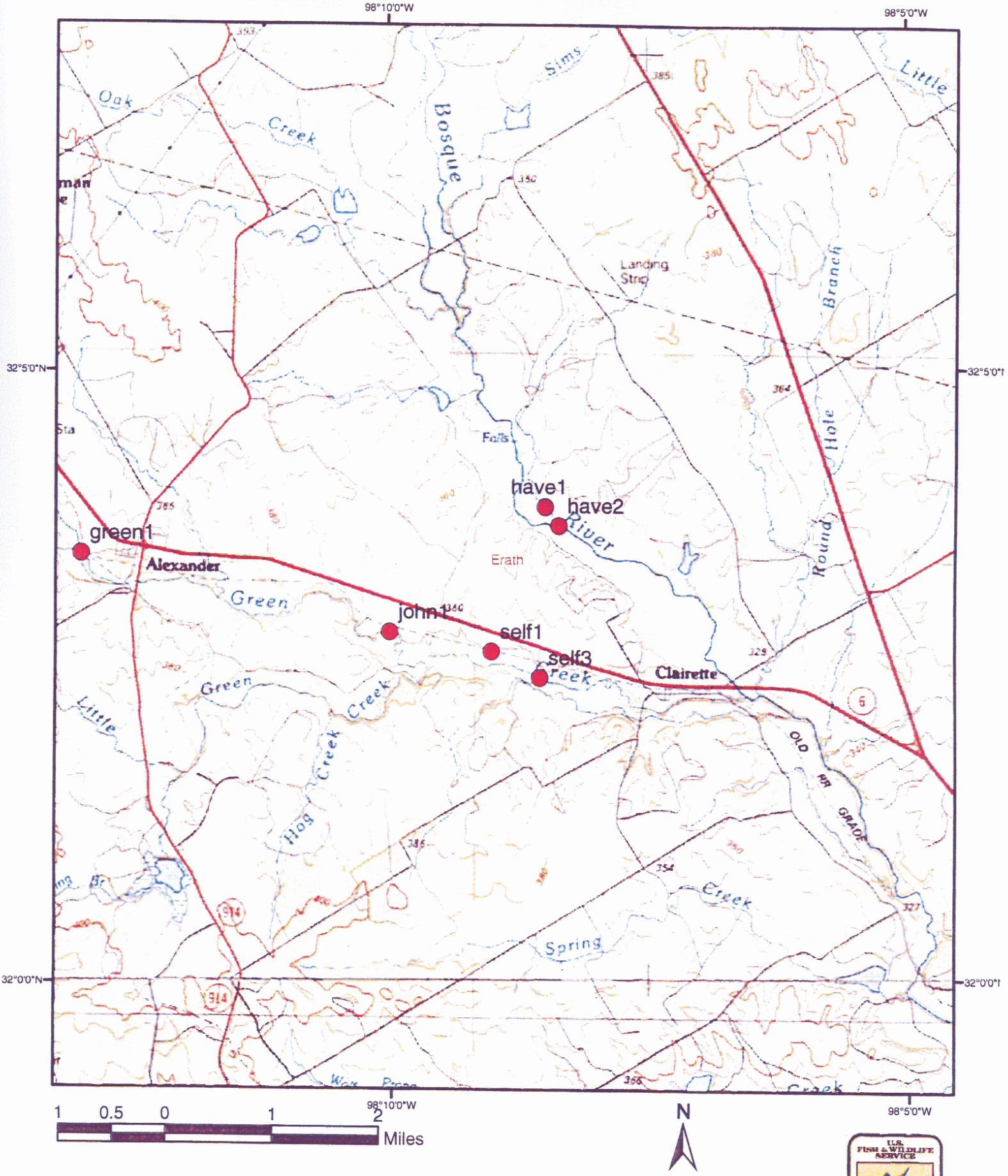
# Study Plots in the Duffau Creek Watershed



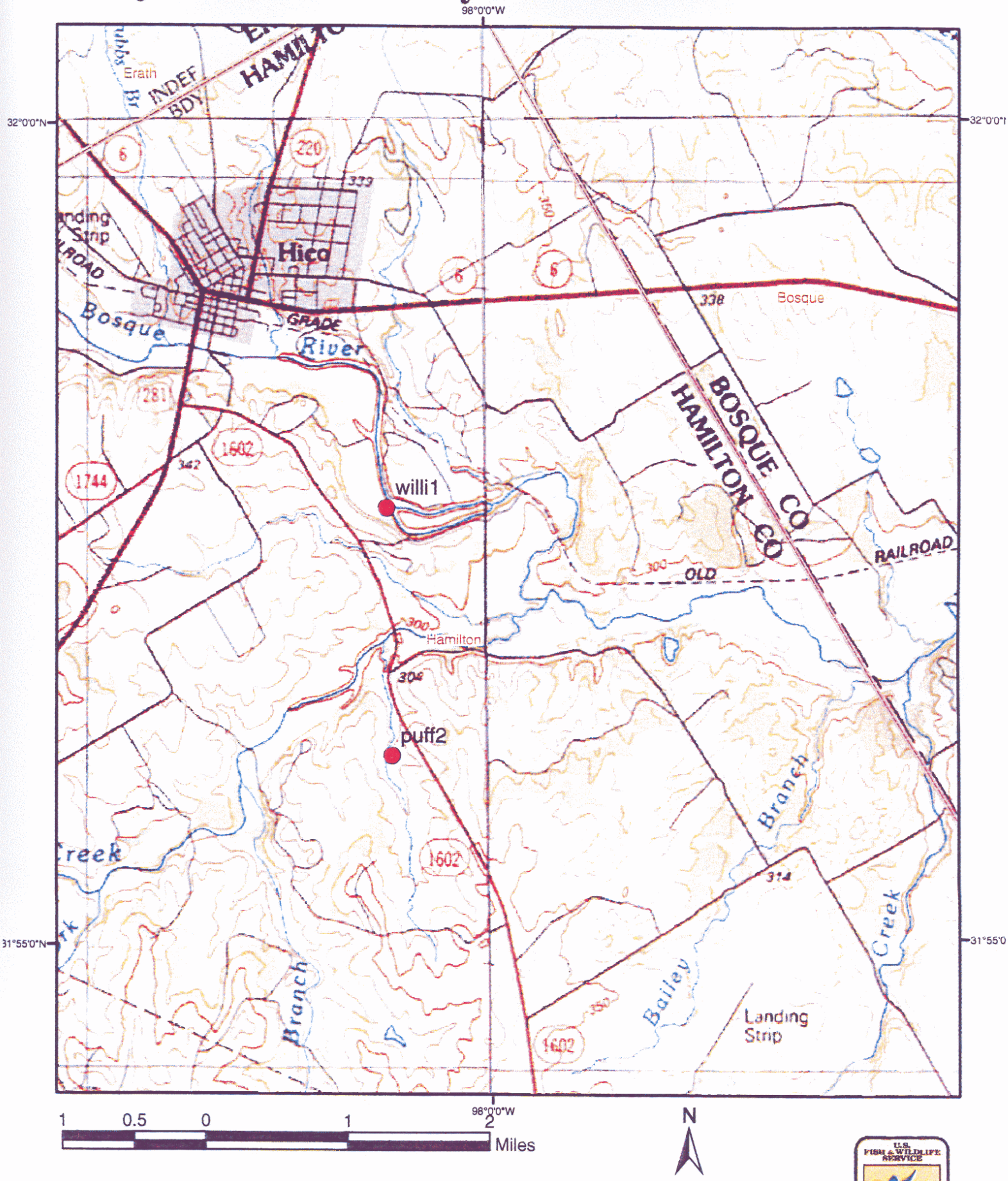
# Study Plots in the Green Creek Watershed



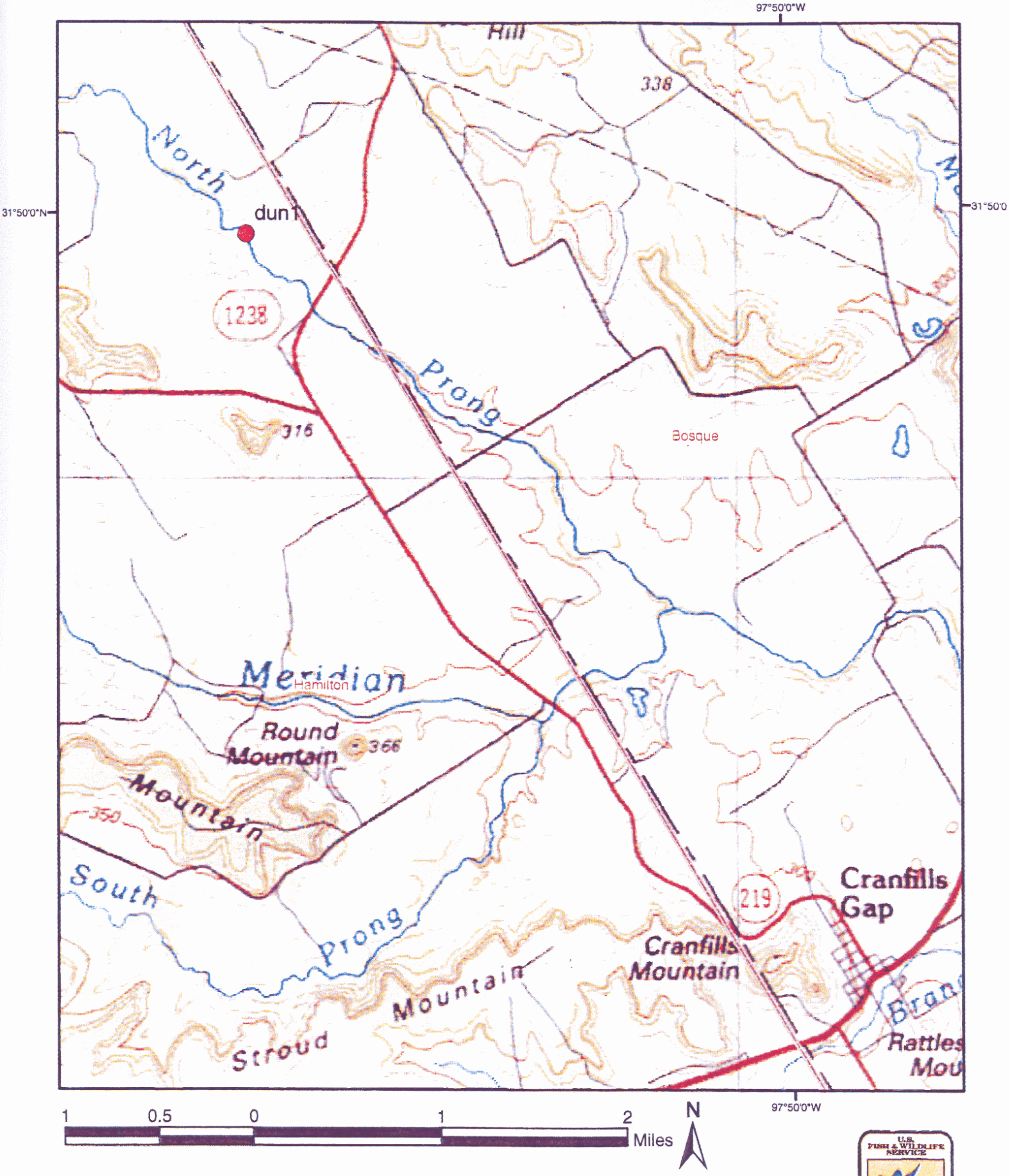
# Study Plots in the Green Creek Watershed



# Study Plots in the Honey Creek Watershed



# Study Plots in the Meridian Creek Watershed



Plot Self 1

Plot Self2

Plot Gait1

Plot Ande 1

Plot Vaugn 2

Plot Vaugn 3

Plot John1

Plot Haven1

Plot Haven 2

Plot Swa1

Plot Flow1

Plot Boud1

Plot Boud2

Plot Willi1

Plot Bat1

Plot Bat2

Plot Drak1

Plot Part1

Plot Bell 1

Plot Wils 1

Plot Mars1

Bell2

Plot Algo1

Plot Ake1

Plot Dunc1

Plot Smit1