Riparian Productivity along the Lower Brazos River

July 18, 2016

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Performed for:
River Studies Program
Texas Parks and Wildlife Department
P.O. Box 1685 San Marcos, TX 78667

TWDB Contract No. 1200011484
TPWD Contract No. 436130

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1. Introduction

With initial funding during 2009-2010 from the National Wildlife Federation, the current methodology was first implemented by Texas Conservation Science (TCS), in order to quantify environmental flow requirements of riparian forests and other floodplain habitats in east Texas, as part of a Texas Instream Flow Program (TIFP) project. The TIFP is a cooperative effort of TPWD, TWDB, and the Texas Commission on Environmental Quality. The TCS study is now expanded to evaluate flow regimes that sustain riparian habitats in the middle and lower reaches of the Guadalupe, Brazos, and Trinity River basins. With two additional sites on the middle Trinity River being established in 2016, the TIFP project currently includes 11 long-term riparian research stations mostly on private ranches and farms. With separate agency and private funding through the Caddo Lake Institute, three additional riparian research stations are operated by TCS and its partner organizations on Big Cypress Bayou. In this manner, a total of 14 stations within four Texas river basins currently utilize comparable methods for quantifying flows needed to sustain riparian habitats.

This report on riparian productivity along the lower Brazos River (LBR) concerns two riparian research sites (Wallis and San Felipe) initiated as part of the TIFP project. The LBR reach includes two TPWD instream flow study (IFS) sites: 12010 (Wallis) and 12020 (San Felipe). In addition to establishing and inventorying riparian forest transects within long-term study sites, the assessment includes inundation analyses of riparian areas along 30-mile reaches centered on each of the IFS sites. The San Felipe study site, with the quantitative forest ecology plots, was moved approximately 18 river miles downstream from the 12020 IFS reach, due to the absence of relatively intact riparian forest in the IFS reach suitable for plot establishment. In this manner, the selected San Felipe study site is located within the protected riparian corridor of Stephen F. Austin State Park.

The Brazos River riparian research seeks to improve our understanding and stewardship of the spatiotemporal complexity of floodplain habitats and their connections. King et al. (2009) identified the integration of different disciplines as the critical need in the restoration and conservation of floodplain habitats. In response, the LBR project integrates different approaches, including hydrology, remote sensing, and quantitative plant ecology.

The next section summarizes peer-reviewed research on the ecology, flow requirements, and ecosystem processes of riparian habitats. Riparian forests are emphasized, due to both their functional importance and their sensitivity to flow alterations. Subsequent sections address methods, results, discussion, and conclusions. Data are presented as figures and tables in the Appendix following Section 7 (Citations).

2. Background

2. 1 Riparian Habitats

Nilsson and Svedmark (2002) define riparian areas as non-equilibrium ecosystems forming landscape-scale networks of floodplains extending down to the low-water mark in the stream channels. Their research review focuses on three fundamental concepts that define riparian systems: (1) flow regime: regulates plant productivity and ecological function, (2) riparian corridor: material transport, and (3) transition zone: species-rich link between land and water processes. Adverse on-site impacts to riparian habitats and connectivity are also serious threats to downstream resources, including aquatic and terrestrial habitats, and the quantity and quality of stream flow (King et al. 2009).

Undisturbed floodplains comprise a diversity of habitats, including swamp and riparian forests, shrub and herbaceous wetlands, and both lentic and lotic aquatic habitats. Most important to the sustainability of essential ecosystem processes within floodplains is connectivity among these different habitat patches via water level fluctuations (Thoms et al. 2005, Junk et al. 1989). Within river-floodplain landscapes, habitats are differentiated by their dominant plant species and their range of environmental variability, which is primarily caused by spatiotemporally variable flows and geomorphic disturbance during large floods.

Floodplain habitats with different surface elevations vary in terms of dominant species due to dissimilar tolerances among species to elevation-specific regimes of inundation and soil saturation. An elevation change of only a few centimeters may cause habitat boundaries to move. Many papers lump streamside and backwater species together due to similar flood tolerances. However, Dale and Ware (2004) point out that species adaptations to the season of flooding and whether flooding is by moving or stagnant water may be as important as frequency and duration of inundation.

When researching connections between tree growth and inundation, Smith et al. (2013) showed that river flow and related soil moisture variables impacted tree growth more than climate. How forest productivity responds to variable flows is further complicated due to competitive interactions among species. For example, a higher frequency of floods may either directly increase riparian forest growth rates or indirectly do so by impeding less flood-adapted competitors. In addition to variable flows, riparian forest composition depends upon the location within the floodplain mosaic of geomorphology, soils, and available plant species.

In this manner, high species diversity results from a changeable inundation regime interacting with the geomorphologic patchwork of microtopography and soil types within floodplains (Junk et al. 1989). Unlike upland forests that are often dominated by one or two tree species, relatively undisturbed riparian forests exhibit a high diversity of tree species, primarily due to environmental variability (McKnight et al. 1981). In fact, the interplay among hydrology, geomorphology, and species causes riparian biodiversity to be usually double that of nearby upland forests (Gosselink et al. 1981).

2.2 Riparian Forest Hydrology

Defined for a particular site or stream reach, the “hydroperiod” is the spatiotemporal combination of frequency, timing, duration, and depth of inundation. Due to the evolutionary matching of species distributions and hydrologic cycles, the hydroperiod dictates species composition of both plants and animals in riparian forests (Bedinger 1981, King and Allen 1996). The most important influence of the hydroperiod on species composition in east Texas is flood duration (Dewey et al. 2006). Because it exerts a disproportionate influence on seedling establishment and the early stages of succession, the spring hydroperiod mostly controls the competitive sorting of species during annual tree recruitment. However, the long-term survival of riparian species and, thus, species dominance within mature riparian forests depends upon the annual hydroperiod (Townsend 2001).

2.2.1 Overbank Events

Annual or nearly annual flooding is a distinguishing feature of riparian forests. In the midwestern United States, most rivers and streams with relatively natural hydrology equal or exceed bank-full two out of three years (Leopold et al. 1964, Mitsch and Rust 1984). Throughout the Mississippi/Red River region, most riparian forests on relatively unregulated rivers flood about once per year for about 40 days on the average (Gosselink et al. 1981). In one of the most intensive studies of a natural flood regime in the southeastern U.S., the Ogeechee River in Georgia flooded greater than 50 percent of the natural floodplain for a minimum of least 30 days annually (Benke et al. 2000).

The existence of riparian forests depends upon flooding rivers. On the Cache River in Arkansas, intensive hydrologic studies show that more than 90 percent of the annual water budget for riparian forests consists of river inflows and outflows (Walton et al. 1996). These and other studies show that water sources other than stream flow, such as groundwater, precipitation, and evapotranspiration, are insignificant components of the riparian-forest water budget.

As floodplains become larger, floods tend to be less frequent, but increase in duration and seasonal predictability (Junk et al. 1989). Overbank flows perform many important ecosystem and societal functions, such as reducing storm damage, recharging alluvial aquifers, enhancing biological productivity, sequestering carbon, and redistributing nutrients, sediments, and organic matter (Hunter et al. 2008, Opperman et al. 2010). Annual flooding maximizes ecosystem and economic benefits, including biological production, plant and wildlife diversity, better water quality, and organic matter export (Gosselink et al. 1981, Hunter et al. 2008, Opperman et al. 2010).

2.2.2 Biological Requirements for Overbank Flows

Overbank flows are essential to the conservation of riparian forests. Floods distribute seeds and vegetative propagules to revitalize plant communities across the floodplain (Bendix and Hupp 2000). Seed germination and seedling establishment by many riparian plant species depend upon large floods that create new seedbeds by removing vegetation and exposing bare soil. Tree species differ in the timing of seed dispersal and germination, so that the timing and severity of floods rearrange the patchwork of different ages and species compositions that constitute riparian forests and other habitats (Hughes and Rood 2003).

Based on a literature search, Figure 1 presents flood duration and frequency targets to maintain each riparian habitat type in the study area. Flow prescriptions to conserve riparian forest regeneration include: (1) scheduling inundation to coincide with the phenology (seed dispersal and germination) of target tree species, (2) varying the interannual timing of floods to increase plant diversity, (3) reducing the rate of flood-water recession to maintain soil moisture for seedling germination and establishment, and (4) promoting channel movement and new sedimentation sites to create regeneration sites (Hughes and Rood 2003, Rood et al. 2005). Hughes and Rood (2003) demonstrate why the stream stage elevation should not drop faster than the average rate of seedling root growth, which they found to be less than one inch or 2.5 cm per day for eastern cottonwood in western North America."

Overbank flows are not only required to perpetuate and rejuvenate riparian vegetation, but also must have sufficient frequency and duration to eliminate upland plant species. In fact, increased mortality of upland species during extended flooding is singled out by Townsend (2001) as the most effective means of sustaining riparian species composition. To achieve the same mortality of upland species, Gosselink et al. (1981) recommend the total duration of discontinuous inundation should exceed that of continuous inundation. Most efficient in terms of dispatching upland tree species and conserving bottomland hardwood species are early growing season floods lasting two to four weeks. However, all four BLH species studied by Smith et al. (2013) in Florida, including hackberry, showed increased growth rates when floods occurred later in the calendar year. This response may be due to both respite from hot and dry summer conditions and adverse impacts to invading upland species.

2.3 Variable Flows for Sustainability

When hydrology is relatively undisturbed, riparian forests are among the most productive ecosystems, with primary production exceeding 1000 $g/m^2/y$ (Conner et al. 1990). Their high species diversity and flow subsidies maintain high primary and secondary production (Bayley 1995). Riparian forest productivity peaks with annual floods in winter and early spring (Conner et al. 1990). However, as discussed above, floods later in the growing season have the added benefit of excluding competition from invading upland species, which further boosts the productivity of riparian hardwood forests over the long term.

Though current-year flooding affects growth, stored energy resulting from flooding during the prior growing season is vital, since stem growth occurs early in the growing season. In this way, the link between annual tree productivity and flood duration is statistically significant for bottomland hardwood systems, but only when examined over a combined two-year period (Anderson and Mitsch 2008).

2.3.1 Ecosystem Services

Along a river, local and downstream water quality is affected by the condition of its riparian forests. When connected to naturally fluctuating river flows, riparian forests sustain enhanced capacities for the removal of nitrogen (N) and phosphorus (P) from floodwaters (Ardon et al. 2010). Due to longer residence times to absorb large nutrient pulses during storms, broad active floodplains, such as along the Brazos River, are important to reverse pollutant loading.

In addition to the rate of rise and fall, the timing of overbank flows relative to rising temperatures influences biological functions (Bayley 1995). Since most floods in Texas occur in winter or spring, the post-flood availability of carbon and nutrients often coincides with warm spring temperatures, which enhances the fertility of downstream river reaches and estuaries.

2.3.2 Habitat Productivity

High riparian productivity is sustained by high and overbank flows, which flush accumulated detritus and metabolic waste products, and increase annual rates of litterfall, nutrient turnover, and decomposition (Conner et al. 1990, Hunter et al. (2008). The temporal distribution of overbank flows determines not only habitat types, but also regulates biogeochemical processes in bottomland soils, such as decomposition, sedimentation, and N cycling (Hunter et al. 2008). Nutrient processing is augmented by flood pulsing that causes successive oxic and anoxic soil conditions within floodplain riparian forests.

The potential role of riparian forest biomass in mitigating climate change is substantial. Elevated primary productivity due to overbank flows allows riparian forests and wetlands to achieve the highest biomass per area of any temperate ecosystem (Gosselink et al. 1981). Research in northeast Louisiana found the range of carbon storage in riparian forests to be 90-124 Mg C/ha (Hunter et al. 2008).

2.3.3 Fish and Wildlife Stewardship

For fish and other biota, the primary function of the main river channel is access to adjacent floodplain resources, not production. Access to floodplains during overbank flows is critical, since almost all animal biomass within riverine systems is produced within floodplains, not river channels (Junk et al. 1989). For instance, even for smaller streams, 67-95 percent of invertebrate production takes place in the floodplain, not the stream channel (Smock et al. 1992). Consequently, many researchers find that bird, mammal, and fish populations decline in riparian ecosystems, when flood frequency decreases (Gosselink et al. 1981).

When the area of accessible floodplain expands, fish production increases (Junk et al. 1989). For instance, fish spawning is often coordinated with rising floodwater, with spring spawners targeting the seasonal coincidence of rising floodwaters and warmer temperature. Similar to the effect on tree recruitment, good fish recruitment depends on the gradual retreat of flood waters during the warm growing season (Junk et al. 1989). A slow drop in water levels also allows invertebrate prey populations, which increase due to coincidental nutrient runoff, to reach higher densities.

3. Methods

Figure 2 presents the locations of the two study sites for quantitative plant inventories at Wallis and San Felipe. The associated TPWD Instream Flow Study (IFS) reaches and inundation Study Areas are also depicted for orientation. Figures 3.1-3.2 present the study site vicinities. Including transect locations and site boundaries, Figures 4.1-4.3 provide details within each study site.

3.1 Forest Ecology

Within the LBR study reaches, the floodplain is mostly 5-10 km wide (Heitmuller 2014). Largely due to agricultural land uses, remnant riparian forests along the lower Brazos River mostly occupy the active meander belt, which generally extends no more than a few hundred meters both sides of the river centerline. The forests are relatively protected from human disturbance within the meander belt, which is unsuitable for agriculture by being too wet and prone to frequent fluvial disturbance. These are the riparian forests that are quantitatively sampled as described below.

3.1.1 Field Methods

The following vegetation measurements are taken along the 50-m transects. The tape measure is extended 50 m into the riparian forest from the mean high water mark (MHWM) in the direction determined to be perpendicular to the river channel. In the field, the MHWM is delineated as the lowest streamside extent of permanent woody vegetation. The tape is kept tight, straight, and level. Where the undisturbed riparian area extends further into the floodplain, transects may be stacked, so that the length of selected transects is extended in 50-m increments.

Herb-Seedling Layer: Point-Transect Method:

The herb-seedling layer (woody seedlings less than diameter-at-breast-height [DBH, 1.37 m] and herbs) is quantified using the point intercept method. Along the central 50-m transect in each 50 m X 10 m macroplot, canopy interception is measured at 51 points (0-50 m). All contacts between live plants (leaves, stems, etc.) and the tip of a narrow (1/8-inch diameter) vertical pin passed into vegetation are tallied. However, at each point the uppermost hit is tallied separately from further hits along the vertical projection until the ground is hit. Multiple vertical contacts with the same plant and species at a given point are recorded. The summed number of hits are used to estimate plant cover, leaf area, and relative importance for each species. The pin is kept as nearly vertical and on point as possible. A plumb bob is used to establish the vertical reference point (colored nail head, etc.) on ground for each point. The pin is kept vertical as it descends to this reference point.

In addition to canopy cover of leaves and stems, ground cover is recorded at each point according to the following categories:

BM	Bare mineral soil
BR	Bare rock
FF	Forest floor (organic litter layer)
MB	Moss on bare mineral soil
MR	Moss on rocks
MW	Moss on dead decaying fallen wood
NV	Other notable non-vegetation feature (identify)
VW	Other vegetated wetland (sedges, etc.)
RT	Root tip-ups
S	Snag
SWD	Semi-wet depressions (sparsely vegetated)
TB	Living tree or shrub bole
WD	Wet depressions (non-vegetated, gray/gley litter)
WD-C	Woody debris, coarse (> 20 cm dia.)
WD-F	Woody debris, fine (0.5 < 10 cm dia.)
WD-M	Woody debris, medium (10 < 20 cm dia.)

Shrub-Sapling Layer: Line-Intercept Method:

The shrub layer is defined as woody species 0.1-4.9 cm DBH, including tree and shrub species. For multi-stemmed woody species, the DBH of all stems must be < 5.0 cm to be included in this layer.

1. Except where the transect is an extension of an existing transect, a tape is used to measure 50 m into the riparian forest from the mean high water mark (MHWM). The bearing of forest transects is perpendicular to the river channel. The tape is kept tight, straight, and level to the ground surface.

2. The total intercept length for each species is determined within each 5-m increment. Intercept length is that portion of the transect length intercepted by the plant, as measured by a vertical projection of its circumscribed canopy that overlaps the line.

3. For each species, total intercept length to the nearest cm is recorded.

Tree Layer: Macroplot Method:

<u>Snags and live trees DBH</u>: The tree layer consists of all live and dead woody species with a DBH greater or equal to (≥) 5.0 cm. Throughout each 50 m X 10 m macroplot, the following measurements are recorded for all snags (standing dead trees with an angle greater than 45^0 to the horizontal) and live trees ≥ 5.0 cm DBH. The species name, DBH, and position of each tree is recorded along the central 50-m transect, as well as the perpendicular distance from the transect position to the tree. Also recorded is if the tree stem is left or right of the center transect, when facing the 50-m end of the transect. These data allow one to relocate each tree and if necessary construct a tree map for each macroplot. The data also allow the basal area, frequency, and density of tree species to be calculated on a per hectare basis, as described in Section 3.1.2.

In the USA, DBH is defined as the average stem diameter, outside bark, at 1.37 m (4.5') above the ground on the uphill side of the tree, disregarding any bark-litter mound at the base of tree. For consistent measurement, the steel diameter tape must be level and pulled taut, while avoiding bumps, stubs, and other outer bark and bole irregularities. For multi-stemmed woody species, trees are defined as having a least one stem ≥ 5.0 cm DBH, in order to be included in this layer. More than one DBH may be recorded for each multi-stemmed tree. Only stems ≥ 5.0 cm DBH are recorded.

The following procedure for measuring DBH of irregular trees is modified according to Avery and Burkhart (2001). When swellings, deformities, or branches occur at 1.37 m above the ground, DBH is taken above an irregularity where normal stem shape ceases to be affected. If a trunk forks immediately above DBH height, measure DBH immediately below swelling caused by fork. For forks below true DBH, each stem is normally measured at DBH above fork if DBH $\geq$ 5 cm. The exception is when normal DBH height is too close to fork so that it is influenced by swelling associated with the fork, in which case the DBH is measured immediately above such swelling. For swell-butted stems, DBH is measured above swell if swell is at normal DBH height.

Forest Canopy Cover: Spherical Densimeter Method: The instrument is held level, 12” – 18” in front of body and at elbow height, so that operator’s head is just outside of grid area. The operator assumes four equally spaced dots in each square of the densimeter grid, and systematically measures canopy cover based on the number of dots that intercept the overhead canopy. In this manner, with the operator sequentially facing North, East, South, and West, four sets of readings of the entire densimeter grid are recorded at the 15-m and 35-m points along the transect. The average value is calculated for the four sets of canopy hits at each point, then multiplied by 1.04 to estimate percent of forest canopy cover at each point.

3.1.2 Data Analysis

All field data were analyzed in Microsoft Excel using standard ecological calculations. This information was then summarized to determine the most important species for each vegetation layer, transect and site. Percent cover, frequency and density were calculated where applicable, and then used to attain percent relative values for each species in comparison to the other species present within each transect and site. These percent relative values were ultimately used to find the percent relative importance of each herbaceous, shrub, and tree species within each transect and site.

Herb Layer:

The point-intercept method was used to collect cover data for herbs and woody seedlings, in order to calculate percent cover and percent frequency for each species. Percent cover was calculated based on the total number of hits tallied for each species, divided by the total number of intercept points per transect (51). Percent frequency for a species or ground-cover attribute is determined by dividing the number of points where it occurs by the total number of points (51).

The total cover of vegetation or ground attributes for a given transect is determined by adding the cover percentages for all plant species or ground attributes, respectively. Total cover values for a site are determined by similarly adding transect totals and dividing by the total number of transects. These transect and site totals for percent cover may exceed 100 percent if multiple hits (overlapping canopies) are recorded at each point.

Percent relative cover by species or ground-cover attribute, is calculated by dividing the percent cover for each species or ground-cover attribute by the total cover for all species or ground-cover attributes, respectively. Similarly, percent relative frequency for a species or an attribute is provided by dividing the percent frequency for a given transect by the transect total for all species or attributes. For the herb layer, percent relative importance for each species or attribute is the sum of its percent relative cover and percent relative frequency divided by two.

Shrub Layer:

Data were collected from the shrub layer using the line-intercept method. Within each 5-m increment, percent cover was calculated by dividing the total intercept length of each species by 500 cm. Percent frequency was calculated for each species based on how many of the 5-m segments contained that species, out of the ten total segments. Total percent cover and frequency values for each species were determined for each transect. Averages were then calculated for each species across all eight transects. Percent relative cover and percent relative frequency were then calculated for each species within each transect. These values are determined by dividing the percent cover or frequency of that species by the total percent cover/frequency of all species in that transect. Percent relative importance was then calculated by averaging percent relative cover and percent relative frequency.

Tree Layer:

Tree field data were summarized in Microsoft Excel for each 50-m transect. DBH measurements, taken in the field for each individual tree located in the 50 m X 10 m transect, were used in calculating basal area in square meters per hectare (m^2/ha). These calculations were performed separately for snags and live trees. Frequency of distribution was also determined for individual species present on each transect. This was done by evaluating distance from the 0-m pin and plotting presence or absence in each 5-m segment of the 50-m transect, resulting in possible frequencies of 0-100% with 10% intervals. Frequency was also calculated in the same manner for all snags. Next, density was calculated for each transect. This was done by dividing the total number trees for a given species, by the area (500 m^2) of the plot, then converting the density to the number of trees per species per hectare. This was done for both snags and live trees.

Percent relative values for basal area, frequency, and density were then calculated for each species within each transect, in the same manner as described above for the shrub layer. Percent relative importance was then calculated for each species by averaging its three percent relative values.

Forest Canopy Cover:

Field calculations for the spherical densimeter method are described above. Average percent canopy cover values for each transect and site are subsequently tabulated.

3.2 <u>Inundation Analysis</u>

The methodology is empirical, in order to directly measure habitat inundation. Transitions among riparian habitats and from wetland to non-wetland floodplain communities can occur with a change in elevation of only a few centimeters (Alldredge and Moore 2012). Therefore, the following empirical approach may more accurately delineate wetted surfaces within the geomorphic complexity of riparian areas. In this manner, the wetted surface created by a given river stage provides a direct estimate of the affected elevations and habitat areas within riparian areas.

3.2.1 Flow Event Selection

Historical USGS daily stream flow records (1982-present) were analyzed to select flow-event dates for wetted-surface classification of Landsat data. Table 2 lists the USGS stream gages and respective periods of record, which are applicable for each of the riparian study sites. As necessary, event travel times were calculated based on stream miles between gage and study site, and comparison of stream flows recorded for successive USGS gages, in order to determine the actual event date at a given study site.

To avoid imagery obscured by canopy cover, only flow events during the leaf-off period between mid-December and mid-March were considered for wetted-surface analysis. To avoid error due to previous inundation lingering on the floodplain, none of the selected event days had higher flows in the preceding three days. In this manner, the selected days were limited to rising or stable flows. No dates were selected during a period of declining flows. Primarily due to issues with gaps within Landsat scenes and cloud cover, less than 0.5 percent of examined dates had usable Landsat data.

3.2.2 Wetted-Surface Classification

ENVI (Harris Geospatial Solutions software) and Environmental Systems Research Institute (ESRI) ArcGIS software are used to map wetted-surface based on each suitable Landsat thematic-mapper (TM) scene. TM is a sensor on Landsat satellite. Density slice (also called “level slice”), one type of single band image classification method, is used to conduct the wetted-surface classification. This method is especially helpful, since the wetted-surface has a unique digital number (DN) value. The unique DN value is assigned to some gray level (density) and all other DNs are assigned another level. The above procedure develops a simple map of the distribution of wetted-surface and all the other surface features. ENVI and ESRI ArcGIS software packages are used to yield wetted-surface maps based on each suitable Landsat TM scene. Wetted-surface classification follows the same step-wise methodology, as described below.

Wetted-Surface Mapping:

1. Download the acquired Landsat TM scenes for specified dates. Load the band 5 image in TIFF format.
2. Mask the study reaches. The mask is created from a 51X5-mile buffer of the study reaches and saved as a shapefile via ESRI ArcGIS.
3. The Landsat TM images covering the study reaches are classified into two thematic classes using the ENVI color slicing process. The minimum threshold is two. The original maximum threshold is 27. The maximum threshold varies from 27 to 67. Increase the maximum threshold until the wetted-surface class is clearly separated from non-wetted-surface class. Convert the two-class thematic image into shapefile format via ESRI ArcGIS.
4. Two thematic classes are then assigned to either wetted-surface class or non-wetted-surface class by visual interpretation using the raw image in bands 4, 3, and 2.
5. The resulting two-class image is re-coded using ESRI ArcGIS Raster Editor tool. The ESRI ArcGIS Eliminate tool is then run on the two-class image. The ESRI ArcGIS Eliminate tool is used to remove all groups of pixels less than one hectare in area, those areas smaller than one hectare are assigned the value of nearby larger class.

Quality Control:

1. Create a set of random points within the thematic classified area and assign the two-class code to each individual point via visual interpretation for referencing.
2. ESRI ArcGIS Spatial Selection is run on the random points using the wetted-surface and non-wetted-surface polygons separately. Assign the class information to the set of random points above.

The accuracy estimate is the ratio between the number of error wetted-surface (non-wetted-surface) points and the actual wetted-surface (non-wetted-surface) points.

3.3 Geographical Information System

ArcGIS ArcMap 10 was used to calculate inundation acreages for each TPWD Texas Ecological System (TES) type (Elliott, L.F., et al. 2014, Elliot, L.F. 2009) within the specified study reaches by overlaying final wetted-surface shape files maps based on suitable Landsat TM scenes. TES types are also called habitat types in this study. In order to accurately gage inundation acreages across several decades, channel meander was addressed in selected study areas.

The first step was to acquire suitable TPWD TES shapefiles for each study site (https://tpwd.texas.gov/gis/data/downloads), prepare study-reach shapefiles, and acquire previously prepared wetted-surface shapefiles for specified dates.

To compensate for channel meander, study-reach area shapefiles were created for each site with gaps for meanders moving more than 50 m laterally over the approximately three-decade long study period (Figure 2). To ensure channel position accuracy throughout the project, TWDB river channel (http://www.twdb.texas.gov/mapping/gisdata.asp) position is updated and adhered to the position indicated by TES “open water” data. Next, for meander channel position comparison, first and last Landsat TM shapefiles showing inundation were overlaid. Next, meanders were located where both a clear channel is outlined and there is a recognizable shift in location of banks between the two dates. Meanders were numbered for identification and future comparison to evaluate importance. Additionally, 1982 National High-Altitude Program (NAHP), 1988 USGS National Aerial Photography Program (NAPP), 1996 Texas Orthoimagery Program (TOP), and 2014 USDA National Agriculture Imagery Program (NAIP) color infrared imagery was referenced to compare meanders throughout study period and further verify movement.

Using the ArcGIS Measure tool, first and last Landsat TM inundation shapefiles were overlaid and distances between well-defined banks of each meander were measured. For each meander that moved 50 m or more, the following steps were used: Using the Split tool in ArcMap in conjunction with the TWDB river shapefile, the length attribute (set to miles) was measured for identified meanders, and then the buffer tool was used to create polygon shapefiles which identify channel positions for future reference. Using a study reach shapefile of 30x4 miles as a template, the line construction tool was used to create parallel lines to exclude meanders from study area. Constrain perpendicular to the channel was used when possible, as well as constrain parallel to the first line placed. Due to channel meander, the increased study reach length was tabulated and added to any channel segment in the exclusion area but not part of the meander (collateral). Meander length and collateral stream length were added to original 30-mile study reach to determine the amount of increase for total stream mile study length. For adjacent sites Navasota and Bryan, the overall increase was allotted 20% in the interfering direction and 80% in the opposite direction to avoid study reach overlap.

IFS center points were utilized as study reach centers, first by splitting TWDB river channel line at center point location as basis for splitting a certain length. A modified study reach was then created based on the new increased length to compensate for meander and collateral, using the split tool on each half upstream (US) and downstream (DS) of the center point. Split tool was set to 15 miles plus new increased length. US and DS lines were then combined after which the buffer tool was used with distance set to 2 miles and “dissolve all” option selected to create new study reach polygon. Next, additional buffers were also created with distances set to 0.5 and 1 miles to measure inundation distance incrementally from channel. Cut polygons tool was used on new study reach polygons with lines from previous meander-based line construction step as templates. Resulting gaps were deleted from the study reach polygon and merged. Any rounded ends were removed from study reach polygons by using similar method as in previous steps while constraining parallel.

In order to measure area of inundation, first TES data was clipped into the study-reach area polygon created in the previous step. If both Blackland Prairie and Central Texas Plains TES data sets are required for the study area, merge tool was used to combine into one after clipping. To tabulate acreages, an attribute field (double) in the TES attribute table named “area” was created and set to calculate area in hectares.

Using shp files created from incremental buffers (0-0.5 mile, 0.5-1 mile and 1-2 mile) extending from the river centerline located within the study reach, the Clip tool was used to apply TES data to each incremental sub-reach.

The Intersect tool was used to choose a Landsat wetted-surface shapefile and the incremental TES shapefiles as inputs, in order to determine which habitat types were located in the same position as the wetted-surface data for that increment.

For each incremental intersect, ArcMap's Summary Statistics tool was used to quickly summarize area data. Using Summary Statistics, the newly formed intersects' Statistics field was set to the previously created area attribute and the Case field to Common Name. Summary results were opened and acreages transferred from ArcMap into an Excel spreadsheet. Summary Statistics was also utilized when tabulating total habitat areas for study sites by using the previously clipped TES data as input with no wetted-surface intersect.

4. Results

4.1 Riparian Forest

Table 1 provides an annotated list of 139 representative plant species collected at the two LBR study sites. The list includes scientific and common names, wetland indicator status, family, environmental information, growth form, and relative abundance for each of the study sites.

4.1.1 Tree Layer

Habitat Overview

The LBR vegetation inventory provides an overview of tree species occupying riparian forest types. Riparian forests include forested wetlands (lower and upper swamps) at lower elevations and riparian forests (seasonally and temporarily flooded forests) at higher elevations (Figure 1). Lower swamps are often dominated by black willow (*Salix nigra*) and box elder. At low surface elevations primarily near the edge of the river and sometimes either side of the first naturally deposited levee, these forests flood for large portions of the growing season every year, and may be only intermittently exposed adjacent to the river channel.

Slightly higher elevations within the riparian corridor support upper swamps, which experience intermittent flooding or soil saturation (more than two months during the growing season). In the study areas, these swamps usually occupy the frequently wetted area between the first and second levees. Less commonly, upper swamps also occur in low-elevation swales and backwater areas often at some distance from the river channel. In fact, backwater swamps within the active floodplain farthest from the river and adjacent to transitional upland slopes, may be inundated longer than all but the streamside lower swamps, when overbank flows occur. Upper swamps are typically inundated every year for two or more months during the growing season. In addition to black willow and box elder, these swamps may include slippery elm, green ash, and rough-leaf dogwood common species.

Riparian forests include seasonally flooded and temporarily flooded forests (Figure 1). The probability of seasonally flooded riparian forests being flooded in a given year is 51-100 percent (Huffman and Forsythe, 1981a). When the natural hydrologic regime is relatively intact, these forests flood a total of 1-2 months (12.5-25 percent) during the growing season. Species composition of seasonally flooded forest is diverse, and within the LBR study reach is often dominated by various combinations of box elder, green ash, slippery elm, eastern cottonwood, roughleaf dogwood, and hackberry.

With an annual flood probability of 11-50 percent, temporarily flooded forests experience a total growing-season flood duration of 5-30 days or 2-12.5 percent (Figure 1; Huffman and Forsythe, 1981a). Tree species diversity in temporarily flooded forests is high, and in the LBR reach includes hackberry, eastern cottonwood, roughleaf dogwood, chinaberry, and both cedar and slippery elm, along with other species.

Data Summaries

Data for the tree layer at the two sites are summarized in Tables 3.1-3.2, while more detailed transect data for the tree layer are presented in the Tables 4.1-4.2. For live and dead tree species measured in the 50 m X 10 m macroplots, these tables list data for basal area (m^2/ha), frequency per 5-m increments, density (trees/ha), along with percent relative values and percent importance. The top three most important tree species in order of importance at each site are:

Wallis: slippery elm, box elder, box elder, roughleaf dogwood
San Felipe: sandpaper tree, cedar elm, hackberry

All of the tree species that dominate riparian forests at Wallis and San Felipe are wetland indicators, as are the overwhelming majority of riparian tree species measured at the sites (Table 1). These species depend upon overbank flows and/or high water tables. Not surprisingly given the long-term drought conditions, these same species also dominate the tallied snag species (Tables 4.1-4.3). The exotic invasive chinaberry is the exception, since it is an upland species that does not usually dominate, but is an important component among of snags in the riparian forest.

Table 5 presents the ratios of snags versus live trees as percentages for each tree species. Based on both their relatively high mortality and low importance among live trees, the dominant riparian tree species (black willow, box elder, and sycamore) are declining at the two LBR sites.

Forest canopy cover values are presented in Table 6 as both transect and site averages. Of the two sites on the lower Brazos River, the San Felipe site within Stephen F. Austin State Park (SFASP) has greater average canopy cover (92.51%), compared to the Wallis site (77.80%).

4.1.2 Shrub-Sapling Layer

For the riparian forest shrub-sapling layer, canopy cover and frequency data for species are presented in Tables 7.1-7.2 and 8.1-8.2, as overall site summaries by species and as transect summaries, respectively. In addition to canopy cover and frequency, species data include overall importance values. Dominant shrub-layer species at the more mesic

Wallis site include roughleaf dogwood (29.42%), hackberry (15.12%), and box elder (14.84%). At San Felipe, box elder (74.93%) is by far the most dominant shrub layer species, with roughleaf dogwood a distant second-most dominant species in this layer. Total shrub-sapling canopy cover is higher at Wallis (77.86%, Table 7.1) compared to San Felipe (63.16%, Table 7.2).

4.1.3 Herb-Seedling Layer and Ground Cover

Quantitative herb-seedling data are summarized in Tables 9.1-9.2 and 10.1-10.2, by site and transect, respectively. The layer is dominated by Canadian blacksnakeroot, and hierba del marrano (37.01% and 22.85% importance, respectively) at the Wallis site, which has significantly more herb-seedling species (22) than the San Felipe site (seven). At San Felipe, dewberry is the dominant herb-seedling species (65.81% importance), with Virginia wild rye (14.83%) and poison ivy (12.21%) also important. No tree species has an importance value of over 1% in the herb-seedling layer at Wallis site, though box elder and roughleaf dogwood are relatively more important in the species-depauperate herb-seedling layer at San Felipe.

Table 11 summarizes the ground-cover transect data. In riparian forests at both of the LBR sites, the dominant ground cover is forest floor (organic leaf and twig litter), with mean cover values of 97.30% and 69.85%, respectively, at Wallis and San Felipe. When all size classes are combined, woody debris is the second-most important ground cover at the two sites, particularly at San Felipe where woody debris accounts for a mean cover of 23.53%.

4.2 <u>Habitat Inundation</u>

Table 2 provides information regarding the USGS stream gages used to select streamflow data for wetted-surface classifications at the Wallis and San Felipe study sites and reaches. Stream gages are identified as to dates when their data is applicable to classifications completed for the two study areas. Distances (stream miles) are included between the gages and their respective riparian study sites, in order to estimate flow-event travel times used to extrapolate which USGS mean daily discharge data are applicable to classifications at a given study site.

For each of the 30-mile river study reaches (Figure 2), inundation was measured within two miles of the river channel centerline, for a total width of four miles. In this manner, area (ha) and percent of habitat inundation were empirically determined for 120 square miles (31,079.88 ha) along each study reach. In order to avoid error while using habitat acreages based on the point-in-time (2007) TPWD-TES data (Elliott, L.F., et al. 2014), inundated habitats were not included where the main river channel meandered more than 50 m laterally. During the wetted-surface classifications, habitat inundation connected to the main river channel and total floodplain inundation were separately quantified. Though the entire four-mile wide riparian buffer was classified for each reach, channel-connected inundation did not occur further than 1.0 mile from the river centerline for any flow event.

Final habitat-inundation results are provided in Tables 12-17. These include summary synopses (Tables 12-13) of mean daily discharge versus inundation by bottomland habitat types, open water, and total habitat. More detailed habitat totals are presented for channel-connected (Tables 14-15) and total inundation (Tables 16-17). For the two LBR study reaches, the overall ranges for total inundated habitat and river discharge are:

		Total Habitat Inundation (ha):	
Site	Mean Daily Discharge (cfs)	Channel-Connected	All
Wallis	487-56,100	170.88-656.80	206.54-860.26
San Felipe	674-71,000	224.58-847.60	243.40-1,191.02

The reach-specific link between mean daily discharge and habitat inundation is plotted for channel-connected and total habitat inundation at Wallis (Figures 5-6) and San Felipe (Figures 7-8). These graphs show a quickening in the rates of habitat inundation at 45,300 cfs and 21,000 cfs, respectively, at Wallis and San Felipe. This inflection is likely associated with the initiation of overbank flows at these discharge volumes.

Figures 9.1-10.7 map flooded habitats at low, medium, and high flows for the Wallis and San Felipe study reaches, encompassing both channel-connected and total inundation. As covered in the methods (Section 3.3), gaps in mapped habitat inundation are inserted where significant channel meanders occur, in order to increase accuracy when measuring areas of flooded habitat types.

Tables 18-19 compile and Figures 9-10 chart available elevation data for the Wallis and San Felipe study sites. Due to almost continuous overbank flows high flows since spring 2015 and other delays, elevation profiles by the Texas Parks and Wildlife Department (TPWD) for the LBR vegetation transects are incomplete and without sufficient quality control. With assistance from TPWD and the Texas Water Development Board (TWDB), TCS will proceed to finalize transect elevations as soon as floodwaters recede. This will allow the correlation of river stage to the occurrence of plant species along the transect profiles.

5. Discussion

5.1 Forest Status

Given the unavailability of both historical data and an undisturbed reference area, Alldredge and Moore (2012) inventoried current plant species composition, using methods similar to the current study. In this manner, they evaluated environmental flows necessary to maintain floodplain habitats downstream from Toledo Bend Reservoir in east Texas. The basis of this inventory method is the relative importance of wetland-adapted and flood-intolerant upland species along elevational gradients within floodplain plant communities.

At the longer reach scale of this riparian study, plant population metrics sensitive to the long-term effect of a changing flow pattern include species composition, canopy cover, the ratio of relative importance values for live trees versus snags, and the percentage of wetland indicator species among dominant plant species (Merritt et al. 2010).

Riparian wetlands are often identified based on plant composition, which includes herbaceous (marshes and wet grasslands) and woody communities (hardwood forests and shrublands). Regulatory wetlands are usually delineated as areas where wetland indicator plant species are dominant, which means more than 50% of species in the obligate (OBL), facultative wetland

(FACW), or facultative (FAC) category (USACE 1987, Lichvar et al. 2014). FAC- plant species are not considered wetland indicators. However, soil and hydrology are also important and sometimes overriding indicators of regulatory wetlands.

As discussed in more depth in Section 5.2, Heitmuller (2014) determined that two-year return flows are now lower than flood stage by 5 m at the Hempstead USGS gage, which is near the two LBR sites and is the source of streamflow data used for the TCS inundation research in the San Felipe study reach. The decrease in two-year return flows means that overbank flows may now occur in the LBR reach only every three years or longer.

5.1.1 Tree Layer

Both LBR sites share the same four dominant tree species: black willow, box elder, sycamore, and eastern cottonwood (Tables 3-1-4.2), which are wetland indicators. These species prefer areas with frequent inundation and shallow groundwater (Duke 2011), and may be stressed due to declining high flow events leading to deeper groundwater. All four species have high mortality at the LBR sites, as indicated by their relatively high importance of snags. However, box elder has relatively strong sapling recruitment at both sites (see Section 5.1.2), which offsets its high mortality rate, and, therefore, may be most sustainable of the four dominant tree species in the long term.

Tree-layer species that are increasing due to relatively low ratios of snags to live trees, plus stronger sapling recruitment (Section 5.1.2), include roughleaf dogwood and hackberry. The invasive Chinese tallow is present but not important at both sites.

In the LBR study sites, hydroperiod requirements of the dominant riparian tree species (Figure 1) do not appear to be currently available, as evidenced by their high mortality rates and lack of recent recruitment. Among dominant riparian tee species, only box elder appears to have sufficient reproduction to maintain despite high mortality.

5.1.2 Shrub-Sapling Layer

The much higher species diversity of this layer at Wallis compared to San Felipe may be due to the lower elevations and consequently more active low regime at the former site. Except for the occasional occurrence of peppervine, poison ivy, and mustang grape, the shrub-sapling layer at both LBR sites is overwhelming dominated by tree saplings (Tables 7.1-8.2). The most important tree sapling species are box elder and roughleaf dogwood. Hackberry, black willow, and eastern cottonwood are also important at Wallis, which has a more active flow regime than San Felipe.

5.1.3 Herb-Seedling Layer

A striking feature of the herb-seedling layer is the near total absence of tree seedlings. For example, the most important tree species in this layer at both Wallis and San Felipe is box elder, with importance values of only 0.63% and 3.00%, respectively. The only other tree species among sampled seedlings were deciduous holly (0.50%), hackberry (0.74%), and eastern cottonwood (0.37%) at Wallis, and roughleaf dogwood (1.37%) at San Felipe. No black willow seedlings occurred in this layer at either site. the in

Differences in autecology between black willow and box elder may explain the difference in their status within the herb-seedling layer. Black willow and box elder are both phreatophytes that reproduce sexually, so increased flows during the seedling stage are critical. Both species flower in spring, and prefer full sun and moist soils usually near rivers and other water bodies. The first two growing seasons are especially important for reproduction. Box elder seeds ripen in autumn, and disperse from autumn to spring, and remain viable over winter until the spring, when they germinate both in shade or full sun (USDA-NRCS 2016). However, black willow seeds ripen in April to July and are very short-lived, so that their dispersal depends on the timing of particular river stages (USDA-NRCS 2016).

The absence of black willow seedlings at the two LBR sites is likely due to its short-lived seeds needing higher river stages during seed fall, in order to germinate near the riverbank, but above the scour of oncoming high-flow events (Pezeshkia et al. 2007). The lack of black willow reproduction at the LBR study sites may be due to the April-July river stage during its seed fall not rising to the mean high water mark (MHWM) or above, for the successful establishment of black willow to occur during recent years.

5.2 Riparian Hydrology

Along the two inundation-study reaches at Wallis and San Felipe, the rate of remotely sensed habitat inundation fluctuates with little increase until flows exceed 43,300 cfs and 21,000 cfs, respectively. The operation of reservoirs upstream from Waco may significantly reduce inundation of riparian habitats, due to both lower regulated flows and channel incision. Upstream dam releases renew their sediment load by eroding and transporting channel sediments downstream, which results in channel incision. In the middle and lower reaches of the Brazos River, the resulting lowering of the river bed, relative to its floodplain, has exacerbated the effect of reduced high and overbank flow releases from the reservoirs. Smith et al. (2013) and Alldredge and Moore (2012) demonstrate how reservoirs cause river channel incision and disconnect rivers from their wetlands and floodplains.

As discussed above, the two-year flow stage on the Brazos River has become lower than flood stage by 4-5 m, due to reservoir operations and channel incision (Heitmuller 2014). The result of lowered river stage and bed incision is that the reduced peak flows remain within the Brazos River channel, so that Brazos floodplains are 6-13 m above river base flows (Duke 2011). Habitat inundation results also indicate that flood events may no longer connect with significant portions of the floodplain, unless streamflow rates are sufficient to overtop the incised channel of the Brazos River.

Despite the reduced frequency of high and overbank flows below Waco, the benefits of such flows to floodplain sustainability extend beyond the extent of habitat inundation reported in this study. Lateral (surface) connectivity of environmental flows also connects vertically to maintain groundwater and saturated soils. Though unquantified by the wetted-surface classification methodology, these vertical connections cause environmental flows to sustain a larger floodplain area beyond the area of surface inundation.

In addition, the area of inundation is not always directly related to daily mean river discharge, for several reasons. Both temporary and permanent obstructions within side channels may be responsible. Temporary side-channel blockage may include logs and other woody debris and deposited sediment of varying amounts following high flow events either in the main river channel or tributaries. Variable tributary inflow during local rain events may also confound a direct relationship between habitat inundation and daily mean river discharge. These tributary inflows back up depending on the stage elevation of the main river channel, which leads to variable inundation for a given river discharge.

More permanent impediments to the connection of river floodwaters to floodplain backwater habitats include local geomorphic factors, such as the elevations of intervening natural levees that segment the floodplain and berm elevations within side channels. At all six study sites included in the larger Brazos River riparian assessment, a complicating factor with levees is the apparently recent occurrence of levee breaks, possibly due to increased tree mortality and subsequent erosion. An advantage of the empirical wetted-surface method used in this study is that complicated site variables affecting floodplain inundation are taken into account.

This study focuses on the connection of high and overbank flows to riparian habitats, in order to examine which frequencies and durations of environmental flows maximize riparian benefits, even as water availability is reduced. Though difficult due to the altered flow regime, the re-establishment of a more natural flow regime is essential to restore riparian forest functions (Alldredge and Moore 2012; Merritt et al. 2010). Due to the large coordinated effort required to modify the flow regime of major rivers, floodplain restoration has mostly been implemented through smaller local projects, where disturbed vegetation and hydrology are re-established (King et al. 2009).

For individual sites, flow re-establishment is not overly difficult. Research by Hunter et al. (2008) demonstrated that simply placing flashboard risers in drainage ditches re-created a hydroperiod and wetland functions similar to natural riparian forests. However, riparian restoration at the current study's reach and landscape scales requires significantly more effort than at the local scale, including collaborations with multiple agencies and stakeholders, baseline vegetation and hydrology data, development and implementation of environmental-flow regimes, and long-term hydrologic and vegetation monitoring.

Despite these difficulties, the restoration of a more natural flow regime along the Brazos River is possible within a resized active floodplain. Historical cross-sections at nine USGS gauging stations provide evidence of channel incision being remedied in the middle and lower Brazos River by sediment delivered to the main channel by tributaries and active meanders (Heitmuller 2014).

6. Conclusion

The sustainability of riparian forests and other wetlands is important to maintain buffers to absorb sediments and nutrients transported by rivers and lessen agricultural inflows (King et al. 2009). In addition to aquatic ecosystems, healthy riparian forests maintain prime wildlife habitats, including hunting leases that support private landowners.

Study results quantify the discharge rates needed to inundate important riparian habitats within the LBR study reach, as determined by wetted-surface remote sensing. Along the two study reaches at Wallis and San Felipe, the rate of habitat inundation remains low and variable, until flows exceed 43,300 cfs and 21,000 cfs, respectively. Channel incision and lower regulated flows appear to be causing a change in riparian forest composition from dominance by black willow, box elder, green ash, slippery elm, and eastern cottonwood, to a drier forest dominated by box elder, roughleaf dogwood, and hackberry.

Below Waco, the Brazos River is undammed, which may allow its tributaries to re-establish more naturally variable flows. This more active flood regime may cause lateral meanders of the river channel, which create new alluvial surfaces through deposition of mobilized sediment in point bars, oxbows, and swales. If sufficient high flows occur on a seasonal basis during seed fall and subsequent seedling establishment, newly scoured and filled surfaces may sustain flood-tolerant pioneer species, like black willow and box elder. However, a decline in high and overbank flows appears to be shifting the composition of riparian forests to increased dominance by late successional species adapted to drier conditions, particularly at San Felipe.

6.1 Future Research Needs

This riparian assessment initiates long-term inundation and forest-plot studies, in which riparian vegetation dynamics and historical river discharge are linked. Recommendations for future research and implementation include the following:

(1) With the assistance of TPWD and TWDB, elevation profiles along the vegetation transects need to be completed as soon as possible, in order to relate extrapolated stage elevations at the study sites to the distribution of plant species within study plots.

(2) Long-term monitoring of riparian tree species indicative of floodplain integrity should be linked to historical streamflow and related floodplain processes. Knowing the long-term status of black willow and box elder, which dominate riverside locations with increased inundation, allows one to determine the width of the most frequently flooded zone. Due to their dominance in sustainable riparian forests and their ongoing decline in LBR riparian forests, eastern cottonwood and green ash reproduction should be monitored. Sugarberry should also be monitored, since its increase may be due to drier conditions and increased disturbance.

(3) Increased focus on inundation mapping and vegetation-flow response guilds should be the focus of future research, so that riparian assessments and associated restoration techniques may become broadly applicable (Merritt et al. 2010). A shift in the species composition of guilds usually indicates an environmental variable, such as hydrology or geomorphic flood damage, has been altered. The box elder-black willow guild is an example of a response guild sensitive to both hydrological and geomorphic change, within the LBR study reach.

(4) Empirical and quantitative performance standards should be formulated, in order to confirm success in terms of ecosystem functions, within the overall riparian zone and for local restoration efforts that may become increasingly needed in the future.

(5) Basin- and reach-specific objectives for resizing restored riparian corridors should be developed, in order to maximize critical ecosystem processes as flow regimes are altered (Rood et al. 2005).

(6) Tracking the extent of dieback zones within riparian forests along the middle and lower Brazos River would provide a landscape perspective to the status of ecosystem functions. The Normalized Difference Vegetation Index (NDVI) method may be used. Dieback zones are a dominant feature along the Brazos River below Waco, but poorly understood in regard to causes and extent.

7. Citations

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Appendix 1: Tables

Table 1 Representative Species List *
Wallis and San Felipe Study Sites

Scientific Name	Common Name	Wetland Indicator Status	Family	Envi	Life Form	Study Site Abundance Codes W	Study Site Abundance Codes S
Acalypha ostryifolia	pineland three-seed mercury	UPL	Euphorbiaceae	B	H		R
Acer negundo	box elder	FAC	Aceraceae	B,R	T	A	A
Allium sp.	onion	NA	Alliaceae	R	H	C	A
Alternanthera philoxeroides	alligator weed	OBL	Amaranthaceae	R,W,A	H	U	U
Amaranthus sp.	pigweed	NA	Amaranthaceae	B	H		R
Amaranthus palmeri	careless weed	FACU	Amaranthaceae	R	H	U	
Ambrosia trifida	giant ragweed	FAC	Asteraceae	B,R	H	A	C
Ammannia coccinea	valley redstem	OBL	Lythraceae	R,W,A	H		U
Amorpha fruticosa	false indigo	FACW	Fabaceae	B	S		R
Ampelopsis arborea	peppervine	FAC	Vitaceae	R	WV	C	A
Ampelopsis cordata	heart-leaf ampelopsis	FAC	Vitaceae	B,R	WV		A
Apocynum cannabinum	dogbane	FACU	Apocynaceae	B,R	H		U
Aster sp.	aster	NA	Asteraceae	B	H		C
Aster subulatus	hierba del marrano	OBL	Asteraceae	R,W,A	H	A	
Bacopia monnieri	coastal water-hyssop	OBL	Scrophulariaceae	R,W	H		U
Bidens frondosa	devil's beggartick	FACW	Asteraceae	R	H		R
Boerhavia cylindrica	smallspike false nettle	UPL	Urticaceae	R,W	H	C	C
Brunnichia ovata	American buckwheat vine	FACW	Polygonaceae	B,R	HV		U
Callicarpa americana	American beautyberry	FACU	Verbenaceae	B	S		R
Calyptocarpus vialis	horseherb	FAC	Asteraceae	B	H	U	C
Campsis radicans	trumpet creeper	FAC	Bignoniaceae	B	WV	A	A

* Sources (scientific & common names): Ladybird Johnson Wildflower Center 2015 (primary) & USDA, NRCS 2015 (secondary)
Environment codes: A-aquatic, B-bottomland forest, R-riverbank, W-wetland
Life Form Codes: T-tree, S-shrub, H-herb, WV-woody vine, HV-herbaceous vine
Study Sites: Wallis (W) and San Felipe (S)
Abundance Codes: A-abundant, C-common, U-uncomon, R-rare, L-likely but not seen, blank-not found
Wetland indicator status codes (USDA 2015): OBL- Obligate Wetland, FACW- Facultative Wetland, FAC- Facultative,
FACU- Facultative Upland, UPL- Obligate Upland, NA- Not Available

Table 1 Representative Species List (continued)
Wallis and San Felipe Study Sites

Scientific Name	Common Name	Wetland Indicator Status	Family	Envi	Life Form	Study Site Abundance Codes	
						W	S
Capsicum annuum	bird pepper	UPL	Solanaceae	B	S		R
Carya illinoinensis	pecan	FACU	Juglandaceae	B	T		A
Celtis laevigata	hackberry	FACW	Ulmaceae	B,R	T	A	A
Cephalanthus occidentallis	buttonbush	OBL	Rubiceae	R,W	S		R
Chasmanthium latifolium	inland sea oats	FAC	Poaceae	B,R,W	H		A
Chenopodium ambrosioides	epazote	FACU	Chenopodiaceae	B,R	H	C	
Chloracantha spinosa	spiny chloracantha	FACW	Asteraceae	B,R	H	A	C
Cissus incisa	ivy tree-bine	UPL	Vitaceae	B	WV		C
Clematis pitcheri	leatherflower	FACU	Ranunculaceae	B	HV		R
Cocculus carolinus	Carolina snailseed	FAC	Menispermaceae	B	WV		U
Commelina sp.	day-flower	NA	Commelinacae	B	H	U	U
Conoclinium coelestinum	blue-mist flower	FAC	Asteraceae	B	H		R
Conyza canadensis	horseweed	UPL	Asteraceae	B	H	A	C
Cornus drummondii	roughleaf dogwood	FAC	Cornaceae	B	T	A	A
Croton capitatus	hogwort	UPL	Euphorbiaceae	B	H	R	
Croton monanthogynus	prairie tea	UPL	Euphorbiaceae	B	H	R	L
Cyperus sp.	flatsedge	NA	Cyperaceae	R,W	H	C	C
Desmodium canadense	showy tick trefoil	FAC	Fabaceae	B,R	H	U	C
Dichondra sp.	pony-foot	NA	Convolvulae	B	H		C
Dicliptera brachiata	branched foldwing	FACW	Acanthaceae	B,R	H	A	C
Diodia virginiana	Virginia buttonweed	FACW	Rubiaceae	B,R	H		U
Dracopis amplexicaulis	clasping-leaf coneflower	FAC	Asteraceae	B	H		L
Eclipta prostrata	pie-plant	FACW	Asteraceae	B,R	H		L
Elephantopus carolinianus	Carolina elephantsfoot	FACU	Asteraceae	B	H	C	U
Elymus virginicus	Virginia wild rye	FAC	Poaceae	B	H		A
Equisetum hyemale	scouring-rush horsetail	FACW	Equisetaceae	R,W,A	H	U	

Table 1 Representative Species List (continued)
Wallis and San Felipe Study Sites

Scientific Name	Common Name	Wetland Indicator Status	Family	Envi	Life Form	Study Site Abundance Codes	
						W	S
Equisetum laevigatum	smooth horsetail	FAC	Equisetaceae	R,W,A	H		U
Eupatorium incarnatum	pink boneset	FACU	Asteraceae	B	H	A	
Eupatorium serotinum	late flowering boneset	FAC	Asteraceae	B	H	C	C
Forestiera acuminata	eastern swamp-privet	OBL	Oleaceae	R,W,A	S		R
Fraxinus pennsylvanica	green ash	FACW	Oleaceae	B,R	T	U	A
Gleditsia triacanthos	honey locust	FAC	Fabaceae	B	T		R
Helianthus annus	common sunflower	FAC	Asteraceae	B,R	H		R
Heliotropum indicum	turnsole	FAC	Boraginaceae	B,R	H		R
Hibiscus laevis	halberdleaf rosemallow	OBL	Malvaceae	R,W	H		U
Hydrocotyle sp.	pennywort	NA	Umbelliferae	R	H		R
Hydrocotyle verticillata	whorled marshpennywort	OBL	Umbelliferae	R	H		C
Ilex decidua	deciduous holly	FACW	Aquifoliaceae	B	T	A	
Ilex vomitoria	yaupon holly	FAC	Aquifoliaceae	B	T	R	A
Ipomoea sp.	morning-glory	NA	Convolulaceae	B,R	HV		C
Ipomoea wrightii	Wright morning-glory	FACW	Convolulaceae	B,R	HV		R
Iva annua	annual marshelder	FAC	Asteraceae	R	H		C
Lactuca floridana	woodland lettuce	FACU	Asteraceae	B	H		U
Leucospora multifida	narrowleaf paleseed	OBL	Scrophulariaceae	R,W	H	C	U
Ligustrum sinenese	Chinese ligustrum	FAC	Oleaceae	B,R	S/T	R	U
Lindernia dubia	yellowseed false pimpernel	OBL	Scrophulariaceae	R,W	H	R	
Lonicera japonica	common garden honeysuckle	FACU	Caprifoliae	B	WV		A
Ludwigia octovalvis	Mexican primrose-willow	OBL	Onagraceae	R,W	H	R	
Ludwigia peploides	water-primrose	OBL	Onagraceae	R,W,A	H	C	
Maclura pomifera	osage orange	FACU	Moraceae	B	T		U
Malachra capitata	malva de caballo	UPL	Malvaceae	B	H	R	
Malvastrum coromandelianum	threelobe false mallow	FACU	Malvaceae	B,R	H	C	

Table 1 Representative Species List (continued)
Wallis and San Felipe Study Sites

Scientific Name	Common Name	Wetland Indicator Status	Family	Envi	Life Form	Study Site Abundance Codes	
						W	S
Malvaviscus arboreus var. *drummondii*	Turk's cap	UPL	Malvaceae	B	H		U
Marsilea vestita	hairy water clover	OBL	Marsileaceae	R,W,A	H	U	R
Matelea gonocarpos	angularfruit milkvine	FACW	Asclepiaceae	B,R	HV	U	R
Melia azedarach	Chinaberry	UPL	Meliaceae	B	T		R
Melothria pendula	speckled gourd	FAC	Cucurbitaceae	B,R	H	U	C
Mikania scandens	climbing hempweed	FACW	Asteraceae	B	HV	A	R
Mimosa strigillosa	powderpuff	FAC	Fabaceae	B,R	H		U
Myrica cerifera	wax myrtle	FAC	Myricaceae	B	S/T		R
Oplismenus hirtellus	basketgrass	FAC	Poaceae	B,W	H		C
Oxalis dillenii	slender yellow woodsorrel	FACU	Oxalidaceae	B	H	C	U
Parthenium hysterophorus	false ragweed	FAC	Asteraceae	R	H		L
Parthenocissus quinquefolia	Virginia creeper	FACU	Vitaceae	B	V	C	A
Phyla lanceolata	lanceleaf frogfruit	OBL	Verbenaceae	R,W	H		A
Physalis sp.	yellow ground cherry	NA	Solanaceae	B	H		R
Phytolacca americana	pigeonberry	FACU	Phytolaccaceae	B	H		U
Platanus occidentalis	sycamore	FACW	Plantanaceae	B,R	T	A	A
Pluchea sp.	stinkweed	NA	Asteraceae	R,W	H	U	
Polygonum ramosissimum	bushy knotweed	FACU	Polygonaceae	B	H/S		R
Polygonum lapathifolium	Pennsylvania smartweed	FACW	Polygonaceae	R,W	H		C
Polygonum sp.	smartweed	NA	Polygonaceae	R,W	H	C	C
Populus deltoides	eastern cottonwood	FAC	Salicaceae	B,R	T	A	A
Rapistrum rugosum	bastard cabbage	UPL	Brassicaceae	B	H	U	
Rhynchosia minima	least snoutbean	UPL	Fabaceae	B	HV	C	U
Rivina humilis	pigeonberry	UPL	Phytolaccaceae	B,R	H	U	U
Rorippa palustris	bog yellowcress	OBL	Brassicaceae	R,W	H		R
Rubus trivialis	dewberry	FACU	Rosaceae	B	S	A	A

Table 1 Representative Species List (continued)
Wallis and San Felipe Study Sites

Scientific Name	Common Name	Wetland Indicator Status	Family	Envi	Life Form	Study Site Abundance Codes	
						W	S
Rudbeckia hirta	back-eyed Susan	FACU	Asteraceae	B	H		R
Sagittaria graminea	grassy arrowhead	OBL	Alismataceae	R,W	H		U
Sagittaria platyphylla	delta arrowhead	OBL	Alismataceae	R,W	H		U
Salix nigra	black willow	OBL	Salicaceae	R,W,A	T	A	A
Sambucus nigra var. canadensis	common elderberry	UPL	Caprifoliaceae	X	X	A	C
Samolus parviflorus	thin-leaf brookweed	OBL	Primulaceae	R,W,A	H		R
Sanicula canadensis	Canadian blacksnakeroot	FACU	Apiaciae	B	H		C
Sapindus saponaria	wingleaf soapberry	FACU	Sapindaceae	B	T	A	
Sapium sebiferum	Chinese tallow	FAC	Euphorbiaceae	B,R	T		R
Saururus cernuus	lizard's tail	OBL	Saururaceae	R,W	H		R
Sesbania drummondii	rattlebox	FACW	Fabaceae	R,W	H	U	
Sesbania herbacea	bigpod sesbania	NA	Fabaceae	R,W	H	U	
Sideroxylon lanuginosum	gum bumelia	FACU	Sapotaceae	B	T	R	U
Smilax bona-nox	saw greenbrier	FAC	Smilacaceae	B,R	WV	A	
Smilax tamnoides	bristly greenbrier	FAC	Smilacaceae	B,R	WV	U	U
Solidago altissima	Canadian goldenrod	FACU	Asteraceae	B	H	A	
Spermacoce glabra	smooth buttonweed	FACW	Rubiaceae	B,R	H		C
Strophostyles helvola	amberique-bean	FAC	Fabaceae	B	H	R	R
Symphoricarpos orbiculatus	coralberry	FACU	Oleaceae	B	S	U	
Teucrium canadense	Canada germander	FACW	Lamiaceae	B,R	H		A
Teucrium cubense	coast germander	UPL	Lamiaceae	B	H		R
Tillandsia recurvata	ball moss	UPL	Bromeliaceae	B	H		A
Tillandsia usenoides	Spanish moss	FAC	Bromeliaceae	B	H		A
Torilis arvensis	hedge parsely	UPL	Apiaciae	B	H	C	A
Toxicodendron radicans	poison ivy	FAC	Anacardiaceae	B,R	S/V	A	A
Ulmus rubra	slippery elm	FAC	Ulmaceae	B	T		A

Table 1 Representative Species List (concluded)
Wallis and San Felipe Study Sites

Scientific Name	Common Name	Wetland Indicator Status	Family	Envi	Life Form	Study Site Abundance Codes	
						W	S
Verbena urticifolia	white vervain	FAC	Verbenaceae	B	H		U
Verbena halei	Texas vervain	NA	Verbenaceae	B	H	U	
Verbena xutha	gulf vervain	UPL	Verbenaceae	B	H	U	L
Verbesina encelioides	cowpen daisy	FAC	Asteraceae	B,W	H	R	
Verbesina virginica	frostweed	FACU	Asteraceae	B,W	H		C
Viburnum rufidulum	rusty blackhaw	UPL	Caprifoliaceae	B,R	S/T	R	
Viola sp.	violet	NA	Violaceae	B	H	R	
Vitis aestivalis	long grape	FACU	Vitaceae	B, R	WV		A
Vitis cinerea	winter grape	FAC	Vitaceae	B, R	WV	C	A
Vitis mustangensis	mustang grape	UPL	Vitaceae	B, R	WV	U	A
Xanthium strumarium	rough cocklebur	FAC	Asteraceae	B, R	H	A	C
Zanthoxylum hirsutum	toothache tree	UPL	Rutaceae	B	S		U

Table 2. USGS Stream Gages Used to Select Flow Events at Riparian Study Sites
Periods of Record and Stream Distances to LBR IFS and Study Sites:
Wallis (IFS # 12010) and San Felipe (IFS # 12020)

USGS Stream Gages: Wallis and San Felipe Study Sites						
					Stream Distances	
Gage #	Name	Available Data	County	IFS # (Landsat data acquisition)	Gage to IFS Reach	Gage to Study Site
8111500	BR nr Hempstead, TX	10/1/38-pres	Waller / Washington	12020 (full)	12020: 26.0 mi Downstream	San Felipe Study Site: 43.5 mi Downstream
8114000	BR at Richmond, TX	1/1/1903-pres	Fort Bend	12010 (full)	12010: 31.8 mi Upstream	Wallis Study Site: 31.1 mi Upstream

Table 3.1 Summary of Tree Layer Field Data
Wallis Study Site

Common Name	Scientific Name	Basal Area m^2/ha	Frequency 5m increments	Density trees/ha	% Relative Values *			
					Basal Area	Frequency	Density	Importance
Live:								
black willow	*Salix nigra*	7.32	47.50%	735.00	44.74%	25.68%	55.37%	41.93%
sycamore	*Platanus occidentalis*	4.60	37.50%	230.00	28.10%	20.27%	17.33%	21.90%
eastern cottonwood	*Populus deltoides*	2.34	22.50%	102.50	14.31%	12.16%	7.72%	11.40%
box elder	*Acer negundo*	1.12	22.50%	90.00	6.82%	12.16%	6.78%	8.59%
roughleaf dogwood	*Cornus drummondii*	0.31	25.00%	92.50	1.88%	13.51%	6.97%	7.45%
hackberry	*Celtis laevigata*	0.36	11.25%	35.00	2.17%	6.08%	2.64%	3.63%
American elm	*Ulmus americana*	0.12	6.25%	17.50	0.76%	3.38%	1.32%	1.82%
slippery elm	*Ulmus rubra*	0.04	5.00%	10.00	0.27%	2.70%	0.75%	1.24%
Chinese tallow	*Sapium sebiferum*	0.11	2.50%	5.00	0.68%	1.35%	0.38%	0.80%
red mulberry	*Morus rubra*	0.02	1.25%	2.50	0.14%	0.68%	0.19%	0.34%
gum bumelia	*Sideroxylon lanuginosum*	0.01	1.25%	2.50	0.04%	0.68%	0.19%	0.30%
yaupon holly	*Ilex vomitoria*	0.01	1.25%	2.50	0.04%	0.68%	0.19%	0.30%
cedar elm	*Ulmus crassifolia*	0.00	1.25%	2.50	0.03%	0.68%	0.19%	0.30%
	Live totals:	16.37	185.00%	1,327.50	100.00%	100.00%	100.00%	100.00%
Snags:								
black willow	*Salix nigra*	0.42	10.00%	32.50	60.62%	50.00%	50.00%	53.54%
sycamore	*Platanus occidentalis*	0.10	7.50%	22.50	14.86%	34.62%	34.62%	28.03%
box elder	*Acer negundo*	0.15	2.50%	5.00	21.13%	7.69%	7.69%	12.17%
roughleaf dogwood	*Cornus drummondii*	0.01	1.25%	2.50	2.00%	3.85%	3.85%	3.23%
eastern cottonwood	*Populus deltoides*	0.01	1.25%	2.50	1.39%	3.85%	3.85%	3.03%
	Snag totals:	0.69	22.50%	65.00	100.00%	100.00%	100.00%	100.00%

Table 3.2 Summary of Tree Layer Field Data
San Felipe Study Site

Common Name	Scientific Name	Basal Area m^2/ha	Frequency 5m increments	Density trees/ha	% Relative Values *			
					Basal Area	Frequency	Density	Importance
Live:								
black willow	*Salix nigra*	10.10	43.75%	340.00	46.47%	27.56%	39.88%	37.97%
box elder	*Acer negundo*	5.19	62.50%	305.00	23.89%	39.37%	35.78%	33.01%
sycamore	*Platanus occidentalis*	2.74	25.00%	135.00	12.59%	15.75%	15.84%	14.72%
eastern cottonwood	*Populus deltoides*	2.91	3.75%	10.00	13.40%	2.36%	1.17%	5.65%
roughleaf dogwood	*Cornus drummondii*	0.13	10.00%	37.50	0.62%	6.30%	4.40%	3.77%
hackberry	*Celtis laevigata*	0.15	3.75%	7.50	0.69%	2.36%	0.88%	1.31%
American elm	*Ulmus americana*	0.14	3.75%	5.00	0.64%	2.36%	0.59%	1.20%
pecan	*Carya illinoensis*	0.30	2.50%	5.00	1.39%	1.57%	0.59%	1.19%
Chinese tallow	*Sapium sebiferum*	0.03	1.25%	2.50	0.14%	0.79%	0.29%	0.41%
slippery elm	*Ulmus rubra*	0.02	1.25%	2.50	0.10%	0.79%	0.29%	0.39%
tootheache tree	*Zanthoxylum hirsutum*	0.01	1.25%	2.50	0.06%	0.79%	0.29%	0.38%
green ash	*Fraxinus pennsylvanica*	0.00	0.00%	0.00	0.00%	0.00%	0.00%	0.00%
	Live totals:	21.74	158.75%	852.50	100.00%	100.00%	100.00%	100.00%
Snags:								
black willow	*Salix nigra*	1.02	13.75%	35.00	79.07%	73.68%	73.68%	75.48%
box elder	*Acer negundo*	0.27	6.25%	12.50	20.93%	26.32%	26.32%	24.52%
	Snag totals:	1.29	20.00%	47.50	100.00%	100.00%	100.00%	100.00%

* % Rel = (Species total/All-species Total)*100

Table 4.1 Summary of Tree Layer Transect Data
Wallis Study Site

Common Name	Scientific Name	1			4			6A			6B			7			12A			12B			13			% Relative
		BA	Frq	Den	BA	Frq	Den	BA	Frq	Den	BA	Frq	Den	BA	Frq	Den	BA	Frq	Den	BA	Frq	Den	BA	Frq	Den	Importance
Live:																										
black willow	*Salix nigra*	7.8	60.0%	1040.0	13.0	70%	1500.0	17.1	70%	1500.0	0.0	0%	0.0	6.0	80%	620.0	9.1	80%	520.0	0.0	0%	0.0	5.6	20%	700.0	41.9%
sycamore	*Platanus occidentalis*	4.7	60.0%	400.0	3.0	30%	240.0	3.2	20%	100.0	2.0	30%	60.0	6.1	40%	360.0	4.2	30%	300.0	6.4	40%	160.0	7.2	50%	220.0	21.9%
eastern cottonwood	*Populus deltoides*	0.7	20%	160.0	0.2	20%	80.0	0.1	10%	20.0	12.8	40%	80.0	1.7	50%	380.0	0.2	30%	80.0	2.9	10%	20.0	0.0	0%	0.0	11.4%
box elder	*Acer negundo*	0.1	10.0%	20.0	1.5	30%	160.0	0.1	20%	60.0	0.0	0%	0.0	0.1	20%	40.0	0.6	30%	140.0	2.1	20%	40.0	4.4	50%	260.0	8.6%
rough dogwood	*Cornus drummondii*	0.4	20%	100.0	0.0	10%	20.0	0.0	0%	0.0	0.1	10%	40.0	0.3	40%	120.0	0.2	30%	60.0	1.2	60%	340.0	0.2	30%	60.0	7.5%
hackberry	*Celtis laevigata*	0.0	0.0	0.0	0.0	0%	0.0	0.0	0%	0.0	0.1	20%	40.0	0.0	10%	20.0	0.1	10%	20.0	2.7	50%	200.0	0.0	0%	0.0	3.6%
American elm	*Ulmus americana*	0.0	0.0	0.0	0.0	0%	0.0	0.0	0%	0.0	1.0	50%	140.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	1.8%
slippery elm	*Ulmus rubra*	0.0	0.0	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.2	30%	60.0	0.0	0%	0.0	0.1	10%	20.0	0.0	0%	0.0	1.2%
Chinese tallow	*Sapium sebiferum*	0.0	0.0	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.9	20%	40.0	0.0	0%	0.0	0.8%
red mulberry	*Morus rubra*	0.0	0.0	0.0	0.0	0%	0.0	0.0	0%	0.0	0.2	10%	20.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.3%
gum bumelia	*Sideroxylon lanuginosum*	0.0	0.0	0.0	0.0	0%	0.0	0.0	0%	0.0	0.1	10%	20.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.3%
yaupon holly	*Ilex vomitoria*	0.0	0.0	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	10%	20.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.3%
cedar elm	*Ulmus crassifolia*	0.0	0.0	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	10%	20.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.3%
	Live totals:	13.7	NA	1720.0	17.8	NA	2000.0	20.5	NA	1680.0	16.3	NA	440.0	14.6	NA	1600.0	14.3	NA	1120.0	16.3	NA	820.0	17.4	NA	1240.0	100.0%
Snags:																										
black willow	*Salix nigra*	0.1	10.0%	20.0	0.0	0%	0.0	0.0	0%	0.0	1.7	10%	20.0	1.4	50%	200.0	0.2	10%	20.0	0.0	0%	0.0	0.0	0%	0.0	53.5%
sycamore	*Platanus occidentalis*	0.4	30.0%	100.0	0.3	10%	40.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.1	10%	20.0	0.0	0%	0.0	0.1	10%	20.0	28.0%
box elder	*Acer negundo*	0.0	10.0%	20.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	1.1	10%	20.0	0.0	0%	0.0	12.2%
rough dogwood	*Cornus drummondii*	0.0	0.0	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.1	10%	20.0	0.0	0%	0.0	3.2%
eastern cottonwood	*Populus deltoides*	0.0	0.0	0.0	0.0	0%	0.0	0.0	0%	0.0	0.1	10%	20.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	3.0%
	Snag totals:	0.5	NA	140.0	0.3	NA	40.0	0.0	NA	0.0	1.8	NA	40.0	1.4	NA	200.0	0.3	NA	40.0	1.2	NA	40.0	0.1	NA	20.0	100.0%

* Basal Area (BA) = m^2/ha, Frequency (Frq) = per 5-m increments, Density (Den) = trees/ha, NA = Not applicable
% Relative value = (Species total/All-species total)*100, % Relative Importance = Average (% Relative basal area, % Relative frequency, % Relative density)

Table 4.2 Summary of Tree Layer Transect Data
San Felipe Study Site

Common Name	Scientific Name	1			4			5A			5B			5C			9A			9B			9C			% Relative
		BA	Frq	Den	BA	Frq	Den	BA	Frq	Den	BA	Frq	Den	BA	Frq	Den	BA	Frq	Den	BA	Frq	Den	BA	Frq	Den	Importance
Live:																										
black willow	*Salix nigra*	18.8	70.0%	580.0	23.2	100.0%	640.0	14.7	60.0%	560.0	0.0	0.0%	0.0	0.0	0.0%	0.0	16.0	90.0%	760.0	8.1	30.0%	180.0	0.0	0.0%	0.0	38.0%
box elder	*Acer negundo*	4.9	80.0%	600.0	1.3	80.0%	320.0	1.5	50.0%	300.0	10.6	50.0%	200.0	16.2	90.0%	300.0	1.9	40.0%	140.0	1.0	40.0%	100.0	4.1	70.0%	480.0	33.0%
sycamore	*Platanus occidentalis*	2.6	40.0%	300.0	0.0	0.0%	0.0	0.0	0.0%	0.0	12.3	50.0%	200.0	0.0	0.0%	0.0	0.2	50.0%	180.0	1.8	30.0%	300.0	5.0	30.0%	100.0	14.7%
eastern cottonwood	*Populus deltoides*	0.0	0.0%	0.0	0.1	10.0%	20.0	0.0	0.0%	0.0	0.0	0.0%	0.0	10.2	10.0%	20.0	0.0	0.0%	0.0	0.0	0.0%	0.0	13.0	10.0%	40.0	5.6%
rough dogwood	*Cornus drummondii*	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	10.0%	20.0	0.3	10.0%	80.0	0.0	0.0%	0.0	0.3	30.0%	100.0	0.4	30.0%	100.0	3.8%
hackberry	*Celtis laevigata*	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	10.0%	20.0	0.3	10.0%	20.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.8	10.0%	20.0	1.3%
American elm	*Ulmus americana*	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	1.1	30.0%	40.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	1.2%
pecan	*Carrya illinoensis*	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	2.4	20.0%	40.0	1.2%
Chinese tallow	*Sapium sebiferum*	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.2	10.0%	20.0	0.0	0.0%	0.0	0.4%
slippery elm	*Ulmus rubra*	0.2	10.0%	20.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.4%
tootheache tree	*Zanthoxylum hirsutum*	0.0	0.0%	0.0	0.0	0.0%	0.0	0.1	10.0%	20.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.4%
green ash	*Fraxinus pennsylvanica*	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0%
	Live totals:	26.5	NA	1500.0	24.6	NA	980.0	16.4	NA	880.0	24.1	NA	480.0	27.0	NA	420.0	18.0	NA	1080.0	11.5	NA	700.0	25.8	NA	780.0	100.0%
Snags:																										
black willow	*Salix nigra*	2.2	20.0%	80.0	0.6	20.0%	40.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.0	0.0%	0.0	3.6	50.0%	120.0	1.7	20.0%	40.0	0.0	0.0%	0.0	75.5%
box elder	*Acer negundo*	0.5	10.0%	20.0	0.1	10.0%	20.0	0.0	0.0%	0.0	0.2	10.0%	20.0	0.0	0.0%	0.0	0.0	0.0%	0.0	0.3	10.0%	20.0	1.1	10.0%	20.0	24.5%
	Snag totals:	2.7	NA	100.0	0.7	NA	60.0	0.0	NA	0.0	0.2	NA	20.0	0.0	NA	0.0	3.6	NA	120.0	2.0	NA	60.0	1.1	NA	20.0	100.0%

* Basal Area (BA) = m^2/ha, Frequency (Frq) = per 5-m increments, Density (Den) = trees/ha, NA = Not applicable
% Relative value = (Species total/All-species total)*100, % Relative Importance = Average (% Relative basal area, % Relative frequency, % Relative density)

Table 5. Percent Snag Versus Live Tree Layer Data
Wallis and San Felipe Study Sites

Wallis:

Tree Species		**% Snag/Live Basal Area**
box elder	*Acer negundo*	13.09%
black willow	*Salix nigra*	5.73%
roughleaf dogwood	*Cornus drummondii*	4.50%
sycamore	*Platanus occidentalis*	2.23%
eastern cottonwood	*Populus deltoides*	0.41%
	All Species:	4.23%

San Felipe:

Tree Species		**% Snag/Live Basal Area**
black willow	*Salix nigra*	10.09%
box elder	*Acer negundo*	5.19%
	All Species:	5.93%

Table 6. Forest Canopy Cover Data
Wallis and San Felipe Study Sites

Wallis:		**San Felipe:**	
Transect:	Average % Canopy	Transect:	Average % Canopy
4	77.64	1	94.41
6A	75.43	4	96.62
6B	76.99	5A	92.27
1	78.29	5B	93.78
13	76.47	5C	90.71
7	69.97	9A	89.99
12A	75.43	9B	93.37
12B	92.20	9C	88.89
Site Average:	77.80%	Site Average:	92.51%
		Two-Site Average:	**85.15%**

Table 7.1 Summary of Shrub Layer Field Data
Wallis Study Site

Common Name	Scientific Name	Cover	Frequency	% Relative Values		
				Cover	Frequency	Importance
roughleaf dogwood	*Cornus drummondii*	24.85%	52.50%	31.92%	26.92%	29.42%
hackberry	*Celtis laevigata*	12.06%	28.75%	15.49%	14.74%	15.12%
box elder	*Acer negundo*	10.13%	32.50%	13.00%	16.67%	14.84%
black willow	*Salix nigra*	9.28%	21.25%	11.91%	10.90%	11.40%
eastern cottonwood	*Populus deltoides*	6.15%	17.50%	7.90%	8.97%	8.44%
slippery elm	*Ulmus rubra*	3.94%	12.50%	5.06%	6.41%	5.73%
sycamore	*Platanus occidentalis*	3.81%	11.25%	4.90%	5.77%	5.33%
common elderberry	*Sambucus nigra var. canadensis*	1.88%	8.75%	2.41%	4.49%	3.45%
peppervine	*Ampelopsis arborea*	2.48%	5.00%	3.18%	2.56%	2.87%
wingleaf soapberry	*Sapindus saponaria*	2.50%	1.25%	3.21%	0.64%	1.93%
yaupon holly	*Ilex vomitoria*	0.33%	1.25%	0.42%	0.64%	0.53%
poison ivy	*Toxicodendron radicans*	0.30%	1.25%	0.39%	0.64%	0.51%
deciduous holly	*Ilex decidua*	0.18%	1.25%	0.22%	0.64%	0.43%
	Total	77.86%	195.00%	100.00%	100.00%	100.00%

Table 7.2 Summary of Shrub Layer Field Data
San Felipe Study Site

Common Name	Scientific Name	Cover	Frequency	% Relative Values		
				Cover	Frequency	Importance
box elder	*Acer negundo*	52.66%	60.00%	83.38%	66.48%	74.93%
rough-leaf dogwood	*Cornus drummondii*	3.53%	10.00%	5.58%	10.93%	8.26%
slippery elm	*Ulmus rubra*	1.38%	7.50%	2.18%	8.20%	5.19%
mustang grape	*Vitis mustangensis*	2.75%	5.00%	4.35%	5.46%	4.91%
sycamore	*Platanus occidentalis*	1.41%	2.75%	2.24%	3.01%	2.62%
black willow	*Salix nigra*	1.01%	2.50%	1.60%	2.73%	2.17%
hackberry	*Celtis laevigata*	0.28%	1.25%	0.44%	1.37%	0.90%
toothache tree	*Zanthoxylum hirsutum*	0.15%	1.25%	0.24%	1.37%	0.80%
	Total	63.16%	NA	100.00%	100.00%	100.00%

Table 8.1 Summary of Shrub Layer Transect Data
Wallis Study Site

Common Name	Scientific Name	1		4		6A		6B		7		12A		12B		13		Avg		% Relative
		Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Importance
roughleaf dogwood	*Cornus drummondii*	27.7%	50.0%	7.5%	40.0%	28.8%	40.0%	19.4%	50.0%	21.1%	50.0%	34.9%	50.0%	25.0%	70.0%	34.4%	70.0%	24.9%	52.5%	29.4%
hackberry	*Celtis laevigata*	0.0%	0.0%	3.9%	20.0%	4.4%	10.0%	45.9%	100.0%	0.0%	0.0%	18.0%	30.0%	20.9%	50.0%	3.4%	20.0%	12.1%	28.8%	15.1%
box elder	*Acer negundo*	13.4%	20.0%	19.4%	60.0%	11.4%	30.0%	5.1%	50.0%	1.2%	10.0%	14.1%	40.0%	2.6%	10.0%	13.8%	40.0%	10.1%	32.5%	14.8%
black willow	*Salix nigra*	11.8%	40.0%	33.2%	40.0%	21.6%	40.0%	0.0%	0.0%	1.8%	10.0%	5.8%	40.0%	0.0%	0.0%	0.0%	0.0%	9.3%	21.3%	11.4%
eastern cottonwood	*Populus deltoides*	10.2%	30.0%	0.0%	0.0%	11.9%	30.0%	0.0%	0.0%	10.4%	40.0%	16.7%	40.0%	0.0%	0.0%	0.0%	0.0%	6.2%	17.5%	8.4%
slippery elm	*Ulmus rubra*	1.2%	10.0%	4.7%	10.0%	0.0%	0.0%	22.8%	60.0%	1.8%	10.0%	0.0%	0.0%	0.0%	0.0%	1.0%	10.0%	3.9%	12.5%	5.7%
sycamore	*Platanus occidentalis*	7.6%	20.0%	8.4%	20.0%	2.7%	20.0%	0.0%	0.0%	11.2%	20.0%	0.6%	10.0%	0.0%	0.0%	0.0%	0.0%	3.8%	11.3%	5.3%
common elderberry	*Sambucus nigra var. canadensis*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0%	10.0%	2.8%	10.0%	0.0%	0.0%	3.4%	20.0%	4.8%	30.0%	1.9%	8.8%	3.4%
peppervine	*Ampelopsis arborea*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	10.0%	0.0%	0.0%	0.0%	0.0%	17.8%	30.0%	2.5%	5.0%	2.9%
wingleaf soapberry	*Sapindus saponaria*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	20.0%	10.0%	2.5%	1.3%	1.9%
yaupon holly	*Ilex vomitoria*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.6%	10.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	1.3%	0.5%
poison ivy	*Toxicodendron radicans*	0.0%	0.0%	2.4%	10.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	1.3%	0.5%
deciduous holly	*Ilex decidua*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	10.0%	0.0%	0.0%	0.2%	1.3%	0.4%
	Total	71.9%	NA	79.5%	NA	80.8%	NA	99.8%	NA	52.3%	NA	90.1%	NA	53.3%	NA	95.2%	NA	77.9%	NA	100.0%

Table 8.2 Summary of Shrub Layer Transect Data
San Felipe Study Site

Common Name	Scientific Name	1		4		5A		5B		5C		9A		9B		9C		Avg		% Relative
		Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Importance
box elder	*Acer negundo*	76.6%	90.0%	100.0%	100.0%	66.0%	90.0%	13.6%	20.0%	0.0%	0.0%	87.1%	90.0%	38.0%	50.0%	39.9%	40.0%	52.7%	60.0%	74.9%
roughleaf dogwood	*Cornus drummondii*	0.0%	0.0%	2.2%	10.0%	2.6%	10.0%	5.0%	10.0%	0.0%	0.0%	5.8%	10.0%	3.2%	20.0%	9.4%	20.0%	3.5%	10.0%	8.3%
slippery elm	*Ulmus rubra*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%	40.0%	7.4%	20.0%	0.0%	0.0%	0.0%	0.0%	1.4%	7.5%	5.2%
mustang grape	*Vitis mustangensis*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.0%	20.0%	0.0%	0.0%	12.0%	20.0%	0.0%	0.0%	2.8%	5.0%	4.9%
sycamore	*Platanus occidentalis*	3.7%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.6%	20.0%	0.0%	0.0%	0.0%	0.0%	1.4%	2.8%	2.6%
black willow	*Salix nigra*	0.0%	0.0%	1.4%	10.0%	6.7%	10.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	2.5%	2.2%
hackberry	*Celtis laevigata*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.2%	10.0%	0.0%	0.0%	0.3%	1.3%	0.9%
toothache tree	*Zanthoxylum hirsutum*	0.0%	0.0%	1.2%	10.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	1.3%	0.8%
	Total	80.3%	NA	104.8%	NA	75.3%	NA	18.6%	NA	13.6%	NA	107.9%	NA	55.4%	NA	49.3%	NA	63.2%	NA	100.0%

Table 9.1 Summary of Herb Layer Field Data
Wallis Study Site

Common Name	Scientific Name	Cover	Frequency	% Relative Values		
				Cover	Frequency	Importance
Canadian blacksnakeroot	*Sanicula canadensis*	31.13%	20.83%	32.56%	41.46%	37.01%
hierba del marrano	*Aster subulatus*	30.64%	6.86%	32.05%	13.66%	22.85%
giant ragweed	*Ambrosia trifida*	6.37%	3.92%	6.67%	7.80%	7.24%
poison ivy	*Toxicodendron radicans*	5.39%	3.92%	5.64%	7.80%	6.72%
elderberry	*Samucus canadensis*	5.64%	3.19%	5.90%	6.34%	6.12%
giant ragweed	*Ambrosia trifida*	3.92%	1.72%	4.10%	3.41%	3.76%
climbing hempweed	*Mikania scandens*	2.45%	1.72%	2.56%	3.41%	2.99%
smallspike false nettle	*Boerhavia cylindrica*	1.72%	1.47%	1.79%	2.93%	2.36%
sedge	*Carex sp.*	1.96%	0.98%	2.05%	1.95%	2.00%
unknown	*NA*	0.98%	0.98%	1.03%	1.95%	1.49%
Virginia wild rye	*Elymus virginicus*	0.74%	0.74%	0.77%	1.46%	1.12%
inland sea oats	*Chasmanthium latifolium*	0.74%	0.74%	0.77%	1.46%	1.12%
trumpet creeper	*Campsis radicans*	0.74%	0.74%	0.77%	1.46%	1.12%
peppervine	*Ampelopsis arborea*	0.49%	0.49%	0.51%	0.98%	0.74%
hackberry	*Celtis laevigata*	0.49%	0.49%	0.51%	0.98%	0.74%
box elder	*Acer negundo*	0.74%	0.25%	0.77%	0.49%	0.63%
deciduous holly	*Ilex decidua*	0.49%	0.25%	0.51%	0.49%	0.50%
dewberry	*Rubus trivialis*	0.25%	0.25%	0.26%	0.49%	0.37%
saw greenbrier	*Smilax bona-nox*	0.25%	0.25%	0.26%	0.49%	0.37%
cottonwood	*Populus deltoides*	0.25%	0.25%	0.26%	0.49%	0.37%
onion	*Allium sp.*	0.25%	0.25%	0.26%	0.49%	0.37%
	Total	95.59%	50.25%	100.00%	100.00%	100.00%

Table 9.2 Summary of Herb Layer Field Data
San Felipe Study Site

Common Name	Scientific Name	Cover	Frequency	% Relative Values		
				Cover	Frequency	Importance
dewberry	*Rubus trivialis*	275.98%	31.62%	71.90%	59.72%	65.81%
Virginia wild rye	*Elymus virginicus*	53.43%	8.33%	13.92%	15.74%	14.83%
poison ivy	*Toxicodendron radicans*	33.33%	8.33%	8.68%	15.74%	12.21%
box elder	*Acer negundo*	8.82%	1.96%	2.30%	3.70%	3.00%
peppervine	*Ampelopsis arborea*	6.13%	0.98%	1.60%	1.85%	1.72%
roughleaf dogwood	*Cornus drummondii*	3.43%	0.98%	0.89%	1.85%	1.37%
unknown dicot		2.70%	0.74%	0.70%	1.39%	1.05%
		383.82%	52.94%	100.00%	100.00%	100.00%

Table 10.1 Summary of Herb Layer Transect Data
Wallis Study Site

Common Name	Scientific Name	1		4		6A		6B		7		12A		12B		13		Site Averages		% Relative
		Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Importance
Canadian blacksnakeroot	*Sanicula canadensis*	21.6%	13.7%	11.8%	11.8%	0.0%	0.0%	31.4%	25.5%	27.5%	19.6%	11.8%	9.8%	72.5%	43.1%	72.5%	43.1%	31.1%	20.8%	37.0%
hierba del marrano	*Aster subulatus*	3.9%	3.9%	147.1%	13.7%	0.0%	0.0%	2.0%	2.0%	58.8%	17.6%	33.3%	17.6%	0.0%	0.0%	0.0%	0.0%	30.6%	6.9%	22.9%
giant ragweed	*Ambrosia trifida*	29.4%	17.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	21.6%	13.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.4%	3.9%	7.2%
poison ivy	*Toxicodendron radicans*	3.9%	3.9%	3.9%	2.0%	13.7%	11.8%	0.0%	0.0%	11.8%	9.8%	9.8%	3.9%	0.0%	0.0%	0.0%	0.0%	5.4%	3.9%	6.7%
elderberry	*Samucus canadensis*	13.7%	5.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.7%	9.8%	15.7%	9.8%	5.6%	3.2%	6.1%
giant ragweed	*Ambrosia trifida*	0.0%	0.0%	2.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	29.4%	11.8%	0.0%	0.0%	0.0%	0.0%	3.9%	1.7%	3.8%
climbing hempweed	*Mikania scandens*	0.0%	0.0%	0.0%	0.0%	15.7%	11.8%	0.0%	0.0%	0.0%	0.0%	3.9%	2.0%	0.0%	0.0%	0.0%	0.0%	2.5%	1.7%	3.0%
smallspike false nettle	*Boerhavia cylindrica*	2.0%	2.0%	7.8%	5.9%	3.9%	3.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.7%	1.5%	2.4%
sedge	*Cyperus sp.*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.7%	7.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	1.0%	2.0%
unknown dicot seedling		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	2.0%	0.0%	0.0%	5.9%	5.9%	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%	1.5%
Virginia wild rye	*Elymus virginicus*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.9%	3.9%	2.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.7%	1.1%
inland sea oats	*Chasmanthium latifolium*	2.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.9%	3.9%	0.7%	0.7%	1.1%
trumpet creeper	*Campsis radicans*	2.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.9%	3.9%	0.0%	0.0%	0.7%	0.7%	1.1%
peppervine	*Ampelopsis arborea*	0.0%	0.0%	2.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.5%	0.7%
box elder	*Acer negundo*	5.9%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.2%	0.6%
deciduous holly	*Ilex decidua*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.9%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.2%	0.5%
hackberry	*Celtis laevigata*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	2.0%	2.0%	2.0%	0.5%	0.5%	0.5%
dewberry	*Rubus trivialis*	0.0%	0.0%	0.0%	0.0%	2.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.2%	0.4%
saw greenbrier	*Smilax bona-nox*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.2%	0.4%
cottonwood	*Populus deltoides*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.2%	0.4%
onion	*Allium sp.*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.2%	0.4%
	Total	84.3%	52.9%	174.5%	37.3%	35.3%	29.4%	52.9%	39.2%	127.5%	66.7%	102.0%	58.8%	94.1%	58.8%	94.1%	58.8%	95.6%	50.2%	100.0%

Table 10.2 Summary of Herb Layer Transect Data
San Felipe Study Site

Common Name	Scientific Name	1		4		5A		5B		5C		9A		9B		9C		Site Averages		% Relative
		Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Cov	Frq	Importance
dewberry	*Rubus trivialis*	0.0%	0.0%	0.0%	0.0%	74.5%	9.8%	458.8%	58.8%	886.3%	78.4%	0.0%	0.0%	170.6%	25.5%	617.6%	80.4%	276.0%	31.6%	65.8%
Virginia wild rye	*Elymus virginicus*	5.9%	2.0%	0.0%	0.0%	0.0%	0.0%	196.1%	29.4%	180.4%	25.5%	0.0%	0.0%	13.7%	2.0%	31.4%	7.8%	53.4%	8.3%	14.8%
poison ivy	*Toxicodendron radicans*	82.4%	17.6%	23.5%	7.8%	21.6%	5.9%	0.0%	0.0%	0.0%	0.0%	117.6%	31.4%	21.6%	3.9%	0.0%	0.0%	33.3%	8.3%	12.2%
box elder	*Acer negundo*	25.5%	3.9%	0.0%	0.0%	9.8%	2.0%	7.8%	2.0%	0.0%	0.0%	0.0%	0.0%	21.6%	5.9%	5.9%	2.0%	8.8%	2.0%	3.0%
peppervine	*Ampelopsis arborea*	43.1%	5.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.9%	2.0%	0.0%	0.0%	0.0%	0.0%	6.1%	1.0%	1.7%
roughleaf dogwood	*Cornus drummondii*	0.0%	0.0%	0.0%	0.0%	5.9%	2.0%	5.9%	2.0%	0.0%	0.0%	7.8%	2.0%	7.8%	2.0%	0.0%	0.0%	3.4%	1.0%	1.4%
unknown dicot		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.9%	2.0%	5.9%	2.0%	9.8%	2.0%	0.0%	0.0%	2.7%	0.7%	1.0%
	Total	156.9%	NA	23.5%	NA	111.8%	NA	668.6%	NA	1072.5%	NA	137.3%	NA	245.1%	NA	654.9%	NA	383.8%	NA	100.0%

Table 11. Ground-Cover Transect Data
Wallis and San Felipe Study Sites

Wallis transects	**1**	**4**	**6A**	**6B**	**7**	**12A**	**12B**	**13**	**Mean**
Forest floor	98.04%	96.08%	96.08%	98.04%	98.04%	96.08%	98.04%	98.04%	97.30%
Woody debris, fine (0.5<10 cm dia.)	1.96%	0.00%	1.96%	1.96%	1.96%	3.92%	1.96%	1.96%	1.96%
Woody debris, coarse (>20 cm dia.)	0.00%	3.92%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.49%
Bare mineral soil	0.00%	0.00%	1.96%	0.00%	0.00%	0.00%	0.00%	0.00%	0.25%
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

San Felipe transects	**1**	**4**	**5A**	**5B**	**5C**	**9A**	**9B**	**9C**	**Mean**
Forest floor	47.06%	50.98%	72.55%	66.67%	90.20%	68.63%	82.35%	80.39%	69.85%
Woody debris, coarse (>20 cm dia.)	29.41%	5.88%	13.73%	9.80%	9.80%	29.41%	13.73%	11.76%	15.44%
Woody debris, medium (10<20 cm dia.)	15.69%	19.61%	0.00%	0.00%	0.00%	1.96%	1.96%	5.88%	5.64%
Bare mineral soil	0.00%	13.73%	13.73%	0.00%	0.00%	0.00%	0.00%	1.96%	3.68%
Living tree or shrub bole	0.00%	0.00%	0.00%	23.53%	0.00%	0.00%	0.00%	0.00%	2.94%
Woody debris, fine (0.5<10 cm dia.)	7.84%	9.80%	0.00%	0.00%	0.00%	0.00%	1.96%	0.00%	2.45%
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 12 Inundation Data Synopsis: Habitat Inundation (ha) versus River Flow (cfs)
Brazos River: Wallis Study Reach
Summary and Detailed Data Available in Companion Spreadsheet: LBR.TCS.BW.Inund.Final.6-8-16

Date:	02/02/09	02/18/09	12/27/06	03/22/06	02/02/06	12/18/00	12/03/09	03/08/04	01/19/01	01/21/93	02/25/94	01/01/03	03/16/01	01/19/92
Mean Daily Discharge (cfs):	487	553	789	808	1,290	4,610	9,880	12,400	13,400	19,000	19,100	21,900	45,300	56,100
Channel-Connnected Habitat Inundation*: Riparian Habitats within One Mile of River Centerline**														
Herbaceous Wetlands (ha):	8.73	7.10	15.45	7.62	14.01	22.92	36.62	37.08	59.01	55.88	85.96	63.51	74.92	259.08
Bottomland Forests (ha):	7.49	6.28	10.79	4.33	9.73	14.66	16.42	15.88	23.07	27.65	45.23	29.23	28.64	127.72
Total Bottomland Habitats (ha):	1.21	0.82	4.64	3.29	4.27	8.23	20.18	21.18	35.91	28.20	40.63	34.25	46.25	131.31
Open Water (ha):	158.78	142.45	196.77	128.52	188.12	208.17	242.51	233.96	254.69	255.33	297.12	281.32	268.59	316.58
Total Inundated Habitats (ha):	170.88	152.48	216.85	137.42	206.00	238.23	295.06	288.69	351.83	336.02	417.92	380.70	389.65	656.80
All Habitat Inundation*: Floodplain Habitats within Two Miles of River Centerline														
Herbaceous Wetlands (ha):	9.72	7.79	20.37	8.44	16.53	30.99	51.60	47.76	87.58	82.15	114.07	90.62	96.17	344.79
Bottomland Forests (ha):	7.90	6.50	13.38	4.64	10.73	18.70	24.13	19.73	34.93	40.88	58.10	41.83	39.70	184.73
Total Bottomland Habitats (ha):	1.80	1.29	6.96	3.80	5.80	12.27	26.99	27.94	52.51	41.18	55.76	48.64	56.35	159.99
Open Water (ha):	191.86	174.32	241.14	159.79	225.83	246.33	300.93	282.64	297.63	297.52	340.11	336.97	310.84	361.53
Total Inundated Habitats (ha):	206.54	186.06	275.07	170.32	259.56	304.31	400.01	361.59	460.04	443.54	516.11	499.42	474.23	860.26

*** Habitat Types by Ecoregions, Texas Ecological Systems Data: https://tpwd.texas.gov/gis (Elliott, L.F., et al. 2014)**

**** No channel-connected inundation occurred more than 1 mi from river centerline**

Table 13 Inundation Data Synopsis: Habitat Inundation (ha) versus River Flow (cfs)
Brazos River: San Felipe Study Reach
Summary and Detailed Data Available in Companion Spreadsheet: LBR.TCS.BS.Inund.Final.6-8-16

Date:	12/01/11	02/26/06	02/02/06	40,582.0	39,078.0	02/07/02	03/08/04	02/25/94	01/21/93	01/19/92	03/07/92
Mean Daily Discharge (cfs):	674	1,380	1,840	1,970	2,200	7,640	16,900	19,200	21,000	58,200	71,000
Channel-Connnected Habitat Inundation*: Riparian Habitats within One Mile of River Centerline**											
Herbaceous Wetlands (ha):	7.23	6.19	6.81	7.14	11.26	11.11	14.16	27.10	23.64	129.89	184.32
Bottomland Forests (ha):	10.69	10.86	12.91	11.60	20.59	19.81	23.76	65.43	54.77	151.42	197.21
Total Bottomland Habitats (ha):	17.92	17.05	19.72	18.74	31.85	30.93	37.97	92.53	78.42	281.31	381.55
Open Water (ha):	206.36	268.46	274.58	270.99	327.26	376.26	414.67	430.08	410.88	427.00	417.80
Total Inundated Habitats (ha):	224.58	285.81	294.64	290.00	359.99	411.87	471.46	564.01	528.12	756.63	847.60
All Habitat Inundation*: Floodplain Habitats within Two Miles of River Centerline											
Herbaceous Wetlands (ha):	11.87	23.55	22.53	19.86	34.17	45.49	46.64	81.75	95.76	373.76	355.65
Bottomland Forests (ha):	14.47	15.57	17.63	14.91	32.60	44.90	41.44	97.27	93.49	260.07	304.35
Total Bottomland Habitats (ha):	26.34	39.57	40.71	35.36	68.33	91.52	89.58	180.95	192.71	645.92	664.67
Open Water (ha):	215.05	303.14	304.82	287.16	358.23	422.97	462.28	477.02	454.08	473.45	457.60
Total Inundated Habitats (ha):	243.40	345.79	348.36	326.09	439.47	526.42	578.99	718.27	709.35	1,244.54	1,191.02

*** Habitat Types by Ecoregions, Texas Ecological Systems Data: https://tpwd.texas.gov/gis (Elliott, L.F., et al. 2014)**

**** No channel-connected inundation occurred more than 1 mi from river centerline**

Table 14 Channel-Connected Inundation Summary Data: Wallis Riparian Study Reach
Summary and Detailed Data Available in Companion Spreadsheet: LBR.TCS.BW.Inund.Final.6-8-16

Wallis Riparian Study Reach: 0-1 mi from River Centerline*	Total Habitat Area (ha)			487 cfs						553 cfs						789 cfs						808 cfs						1,290 cfs					
Channel-Connected Inundation versus River Flow	By Buffer Distance			02/02/09						02/18/09						12/27/06						03/22/06						02/02/06					
Central Texas/Post Oak Savanna Habitat Types**	0-0.5 mi	0.5-1 mi	0-1 mi Total	0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total	
	ha	ha	ha	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**2,593.1**	**840.6**	**3,433.7**	**8.7**	**0.3%**	**0.0**	**0.0%**	**8.7**	**0.3%**	**7.1**	**0.3%**	**0.0**	**0.0%**	**7.1**	**0.2%**	**15.5**	**0.6%**	**0.0**	**0.0%**	**15.5**	**0.5%**	**7.6**	**0.3%**	**0.0**	**0.0%**	**7.6**	**0.2%**	**14.0**	**0.5%**	**0.0**	**0.0%**	**14.0**	**0.4%**
Bottomland Forest Subtotals	**1,173.4**	**156.3**	**1,329.6**	**7.5**	**0.6%**	**0.0**	**0.0%**	**7.5**	**0.6%**	**6.3**	**0.5%**	**0.0**	**0.0%**	**6.3**	**0.5%**	**10.8**	**0.9%**	**0.0**	**0.0%**	**10.8**	**0.8%**	**4.3**	**0.4%**	**0.0**	**0.0%**	**4.3**	**0.3%**	**9.7**	**0.8%**	**0.0**	**0.0%**	**9.7**	**0.7%**
Bottomland Shrubland Subtotals	11.6	7.8	19.4	0.0	0.2%	0.0	0.0%	0.0	0.1%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.2%	0.0	0.0%	0.0	0.1%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Herbaceous Wetland Subtotals	**1,408.0**	**676.5**	**2,084.6**	**1.2**	**0.1%**	**0.0**	**0.0%**	**1.2**	**0.1%**	**0.8**	**0.1%**	**0.0**	**0.0%**	**0.8**	**0.0%**	**4.6**	**0.3%**	**0.0**	**0.0%**	**4.6**	**0.2%**	**3.3**	**0.2%**	**0.0**	**0.0%**	**3.3**	**0.2%**	**4.3**	**0.3%**	**0.0**	**0.0%**	**4.3**	**0.2%**
UPLAND HABITATS:	1,767.3	2,561.5	4,328.7	1.5	0.1%	0.0	0.0%	1.5	0.0%	1.4	0.1%	0.0	0.0%	1.4	0.0%	2.1	0.1%	0.0	0.0%	2.1	0.0%	0.5	0.0%	0.0	0.0%	0.5	0.0%	1.5	0.1%	0.0	0.0%	1.5	0.0%
Upland Forest//Woodland Subtotals	985.3	915.3	1,900.6	1.5	0.2%	0.0	0.0%	1.5	0.1%	1.4	0.1%	0.0	0.0%	1.4	0.1%	2.1	0.2%	0.0	0.0%	2.1	0.1%	0.5	0.0%	0.0	0.0%	0.5	0.0%	1.5	0.2%	0.0	0.0%	1.5	0.1%
Upland Grassland Subtotals	782.0	1,646.1	2,428.1	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
DISTURBED & INVASIVE HABITATS:	2,816.5	2,774.7	5,591.2	1.8	0.1%	0.0	0.0%	1.8	0.0%	1.5	0.1%	0.0	0.0%	1.5	0.0%	2.5	0.1%	0.0	0.0%	2.5	0.0%	0.8	0.0%	0.0	0.0%	0.8	0.0%	2.3	0.1%	0.0	0.0%	2.3	0.0%
OPEN WATER	436.2	24.6	460.9	158.8	36.4%	0.0	0.0%	158.8	34.5%	142.4	32.7%	0.0	0.0%	142.4	30.9%	196.8	45.1%	0.0	0.0%	196.8	42.7%	128.5	29.5%	0.0	0.0%	128.5	27.9%	188.1	43.1%	0.0	0.0%	188.1	40.8%
GRAND TOTALS:	**7,613.1**	**6,201.4**	**13,814.4**	**170.9**	**2.2%**	**0.0**	**0.0%**	**170.9**	**1.2%**	**152.5**	**2.0%**	**0.0**	**0.0%**	**152.5**	**1.1%**	**216.8**	**2.8%**	**0.0**	**0.0%**	**216.8**	**1.6%**	**137.4**	**1.8%**	**0.0**	**0.0%**	**137.4**	**1.0%**	**206.0**	**2.7%**	**0.0**	**0.0%**	**206.0**	**1.5%**

Wallis Riparian Study Reach: 0-1 mi from River Centerline*	Total Habitat Area (ha)			4,610 cfs						9,880 cfs						12,400 cfs						13,400 cfs						19,000 cfs					
Channel-Connected Inundation versus River Flow	By Buffer Distance			12/18/00						12/03/09						03/08/04						01/19/01						01/21/93					
Central Texas/Post Oak Savanna Habitat Types**	0-0.5 mi	0.5-1 mi	0-1 mi Total	0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total	
	ha	ha	ha	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**2,593.1**	**840.6**	**3,433.7**	**22.9**	**0.9%**	**0.0**	**0.0%**	**22.9**	**0.7%**	**36.6**	**1.4%**	**0.0**	**0.0%**	**36.6**	**1.1%**	**37.1**	**1.4%**	**0.0**	**0.0%**	**37.1**	**1.1%**	**59.0**	**2.3%**	**0.0**	**0.0%**	**59.0**	**1.7%**	**55.9**	**2.2%**	**0.0**	**0.0%**	**55.9**	**1.6%**
Bottomland Forest Subtotals	**1,173.4**	**156.3**	**1,329.6**	**14.7**	**1.2%**	**0.0**	**0.0%**	**14.7**	**1.1%**	**16.4**	**1.4%**	**0.0**	**0.0%**	**16.4**	**1.2%**	**15.9**	**1.4%**	**0.0**	**0.0%**	**15.9**	**1.2%**	**23.1**	**2.0%**	**0.0**	**0.0%**	**23.1**	**1.7%**	**27.6**	**2.4%**	**0.0**	**0.0%**	**27.6**	**2.1%**
Bottomland Shrubland Subtotals	11.6	7.8	19.4	0.0	0.2%	0.0	0.0%	0.0	0.1%	0.0	0.2%	0.0	0.0%	0.0	0.1%	0.0	0.2%	0.0	0.0%	0.0	0.1%	0.0	0.2%	0.0	0.0%	0.0	0.1%	0.0	0.4%	0.0	0.0%	0.0	0.2%
Herbaceous Wetland Subtotals	**1,408.0**	**676.5**	**2,084.6**	**8.2**	**0.6%**	**0.0**	**0.0%**	**8.2**	**0.4%**	**20.2**	**1.4%**	**0.0**	**0.0%**	**20.2**	**1.0%**	**21.2**	**1.5%**	**0.0**	**0.0%**	**21.2**	**1.0%**	**35.9**	**2.6%**	**0.0**	**0.0%**	**35.9**	**1.7%**	**28.2**	**2.0%**	**0.0**	**0.0%**	**28.2**	**1.4%**
UPLAND HABITATS:	1,767.3	2,561.5	4,328.7	2.9	0.2%	0.0	0.0%	2.9	0.1%	1.7	0.1%	0.0	0.0%	1.7	0.0%	1.5	0.1%	0.0	0.0%	1.5	0.0%	2.4	0.1%	0.0	0.0%	2.4	0.1%	3.7	0.2%	0.0	0.0%	3.7	0.1%
Upland Forest//Woodland Subtotals	985.3	915.3	1,900.6	2.7	0.3%	0.0	0.0%	2.7	0.1%	1.4	0.1%	0.0	0.0%	1.4	0.1%	1.3	0.1%	0.0	0.0%	1.3	0.1%	1.9	0.2%	0.0	0.0%	1.9	0.1%	2.9	0.3%	0.0	0.0%	2.9	0.2%
Upland Grassland Subtotals	782.0	1,646.1	2,428.1	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.3	0.0%	0.0	0.0%	0.3	0.0%	0.2	0.0%	0.0	0.0%	0.2	0.0%	0.5	0.1%	0.0	0.0%	0.5	0.0%	0.8	0.1%	0.0	0.0%	0.8	0.0%
DISTURBED & INVASIVE HABITATS:	2,816.5	2,774.7	5,591.2	4.3	0.2%	0.0	0.0%	4.3	0.1%	14.2	0.5%	0.0	0.0%	14.2	0.3%	16.1	0.6%	0.0	0.0%	16.1	0.3%	35.8	1.3%	0.0	0.0%	35.8	0.6%	21.1	0.7%	0.0	0.0%	21.1	0.4%
OPEN WATER	436.2	24.6	460.9	208.2	47.7%	0.0	0.0%	208.2	45.2%	242.5	55.6%	0.0	0.0%	242.5	52.6%	234.0	53.6%	0.0	0.0%	234.0	50.8%	254.7	58.4%	0.0	0.0%	254.7	55.3%	255.3	58.5%	0.0	0.0%	255.3	55.4%
GRAND TOTALS:	**7,613.1**	**6,201.4**	**13,814.4**	**238.2**	**3.1%**	**0.0**	**0.0%**	**238.2**	**1.7%**	**295.1**	**3.9%**	**0.0**	**0.0%**	**295.1**	**2.1%**	**288.7**	**3.8%**	**0.0**	**0.0%**	**288.7**	**2.1%**	**351.8**	**4.6%**	**0.0**	**0.0%**	**351.8**	**2.5%**	**336.0**	**4.4%**	**0.0**	**0.0%**	**336.0**	**2.4%**

Wallis Riparian Study Reach: 0-1 mi from River Centerline*	Total Habitat Area (ha)			19,100 cfs						21,900 cfs						45,300 cfs						56,100 cfs					
Channel-Connected Inundation versus River Flow	By Buffer Distance			02/25/94						01/01/03						03/16/01						01/19/92					
Central Texas/Post Oak Savanna Habitat Types**	0-0.5 mi	0.5-1 mi	0-1 mi Total	0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total	
	ha	ha	ha	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**2,593.1**	**840.6**	**3,433.7**	**86.0**	**3.3%**	**0.0**	**0.0%**	**86.0**	**2.5%**	**63.5**	**2.4%**	**0.0**	**0.0%**	**63.5**	**1.8%**	**74.9**	**2.9%**	**0.0**	**0.0%**	**74.9**	**2.2%**	**258.9**	**####**	**0.2**	**0.0%**	**259.1**	**7.5%**
Bottomland Forest Subtotals	**1,173.4**	**156.3**	**1,329.6**	**45.2**	**3.9%**	**0.0**	**0.0%**	**45.2**	**3.4%**	**29.2**	**2.5%**	**0.0**	**0.0%**	**29.2**	**2.2%**	**28.6**	**2.4%**	**0.0**	**0.0%**	**28.6**	**2.2%**	**127.7**	**####**	**0.0**	**0.0%**	**127.7**	**9.6%**
Bottomland Shrubland Subtotals	11.6	7.8	19.4	0.1	0.8%	0.0	0.0%	0.1	0.5%	0.0	0.2%	0.0	0.0%	0.0	0.1%	0.0	0.2%	0.0	0.0%	0.0	0.1%	0.1	0.5%	0.0	0.0%	0.1	0.3%
Herbaceous Wetland Subtotals	**1,408.0**	**676.5**	**2,084.6**	**40.6**	**2.9%**	**0.0**	**0.0%**	**40.6**	**1.9%**	**34.3**	**2.4%**	**0.0**	**0.0%**	**34.3**	**1.6%**	**46.3**	**3.3%**	**0.0**	**0.0%**	**46.3**	**2.2%**	**131.2**	**9.3%**	**0.2**	**0.0%**	**131.3**	**6.3%**
UPLAND HABITATS:	1,767.3	2,561.5	4,328.7	4.4	0.2%	0.0	0.0%	4.4	0.1%	4.3	0.2%	0.0	0.0%	4.3	0.1%	2.0	0.1%	0.0	0.0%	2.0	0.0%	5.5	0.3%	0.0	0.0%	5.5	0.1%
Upland Forest//Woodland Subtotals	985.3	915.3	1,900.6	3.4	0.3%	0.0	0.0%	3.4	0.2%	3.4	0.3%	0.0	0.0%	3.4	0.2%	1.6	0.2%	0.0	0.0%	1.6	0.1%	4.2	0.4%	0.0	0.0%	4.2	0.2%
Upland Grassland Subtotals	782.0	1,646.1	2,428.1	1.0	0.1%	0.0	0.0%	1.0	0.0%	0.9	0.1%	0.0	0.0%	0.9	0.0%	0.5	0.1%	0.0	0.0%	0.5	0.0%	1.3	0.2%	0.0	0.0%	1.3	0.1%
DISTURBED & INVASIVE HABITATS:	2,816.5	2,774.7	5,591.2	30.5	1.1%	0.0	0.0%	30.5	0.5%	31.6	1.1%	0.0	0.0%	31.6	0.6%	44.1	1.6%	0.0	0.0%	44.1	0.8%	75.7	2.7%	0.0	0.0%	75.7	1.4%
OPEN WATER	436.2	24.6	460.9	297.1	68.1%	0.0	0.0%	297.1	64.5%	281.3	64.5%	0.0	0.0%	281.3	61.0%	268.6	61.6%	0.0	0.0%	268.6	58.3%	316.6	72.6%	0.0	0.0%	316.6	68.7%
GRAND TOTALS:	**7,613.1**	**6,201.4**	**13,814.4**	**417.9**	**5.5%**	**0.0**	**0.0%**	**417.9**	**3.0%**	**380.7**	**5.0%**	**0.0**	**0.0%**	**380.7**	**2.8%**	**389.7**	**5.1%**	**0.0**	**0.0%**	**389.7**	**2.8%**	**656.7**	**8.6%**	**0.2**	**0.0%**	**656.8**	**4.8%**

* No channel-connected inundation more than 1 mi from river centerline

** Habitat Types by Ecoregions, Texas Ecological Systems Data: https://tpwd.texas.gov/gis (Elliott, L.F., et al. 2014)

Table 15 Channel-Connected Inundation Summary Data: San Felipe Riparian Study Reach

Summary and Detailed Data Available in Companion Spreadsheet: LBR.TCS.BS.Inund.Final.6-8-16

San Felipe Riparian Study Reach: 0-1 mi from River Centerline*	Total Habitat Area (ha)			674 cfs						1,380 cfs						1,840 cfs						1,970 cfs					
Channel-Connected Inundation versus River Flow	By Buffer Distance			12/01/11						02/26/06						02/02/06						02/08/11					
Central Texas/Post Oak Savanna/Columbia Bottomlands Habitat Types**	0-0.5 mi	0.5-1 mi	0-1 mi Total	0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total	
ha	ha	ha	ha	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**6,330.6**	**3,589.6**	**9,920.2**	**17.9**	**0.3%**	**0.0**	**0.0%**	**17.9**	**0.2%**	**17.1**	**0.3%**	**0.0**	**0.0%**	**17.1**	**0.2%**	**19.7**	**0.3%**	**0.0**	**0.0%**	**19.7**	**0.2%**	**18.7**	**0.3%**	**0.0**	**0.0%**	**18.7**	**0.2%**
Swamp Forest Subtotals	2.5	0.0	2.5	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Bottomland Forest Subtotals	**2,674.6**	**988.7**	**3,663.3**	**10.7**	**0.4%**	**0.0**	**0.0%**	**10.7**	**0.3%**	**10.9**	**0.4%**	**0.0**	**0.0%**	**10.9**	**0.3%**	**12.9**	**0.5%**	**0.0**	**0.0%**	**12.9**	**0.4%**	**11.6**	**0.4%**	**0.0**	**0.0%**	**11.6**	**0.3%**
Bottomland Shrubland Subtotals	61.2	48.7	109.9	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Herbaceous Wetland Subtotals	**3,592.4**	**2,552.1**	**6,144.5**	**7.2**	**0.2%**	**0.0**	**0.0%**	**7.2**	**0.1%**	**6.2**	**0.2%**	**0.0**	**0.0%**	**6.2**	**0.1%**	**6.8**	**0.2%**	**0.0**	**0.0%**	**6.8**	**0.1%**	**7.1**	**0.2%**	**0.0**	**0.0%**	**7.1**	**0.1%**
UPLAND HABITATS:	478.0	1,608.5	2,086.5	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.2	0.0%	0.0	0.0%	0.2	0.0%	0.2	0.0%	0.0	0.0%	0.2	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%
Upland Forest//Woodland Subtotals	101.2	346.9	448.2	0.1	0.1%	0.0	0.0%	0.1	0.0%	0.1	0.1%	0.0	0.0%	0.1	0.0%	0.2	0.2%	0.0	0.0%	0.2	0.0%	0.1	0.1%	0.0	0.0%	0.1	0.0%
Upland Grassland Subtotals	376.8	1,261.6	1,638.3	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
DISTURBED & INVASIVE HABITATS:	546.4	1,029.8	1,576.2	0.2	0.0%	0.0	0.0%	0.2	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%
OPEN WATER	586.0	31.3	617.2	206.2	35.2%	0.1	0.4%	206.4	33.4%	268.3	45.8%	0.1	0.4%	268.5	43.5%	274.4	46.8%	0.1	0.4%	274.6	44.5%	270.9	46.2%	0.1	0.4%	271.0	43.9%
GRAND TOTALS:	**7,941.0**	**6,259.1**	**14,200.2**	**224.5**	**2.8%**	**0.1**	**0.0%**	**224.6**	**1.6%**	**285.7**	**3.6%**	**0.1**	**0.0%**	**285.8**	**2.0%**	**294.5**	**3.7%**	**0.1**	**0.0%**	**294.6**	**2.1%**	**289.9**	**3.7%**	**0.1**	**0.0%**	**290.0**	**2.0%**

San Felipe Riparian Study Reach: 0-1 mi from River Centerline*	Total Habitat Area (ha)			2,200 cfs						7,640 cfs						16,900 cfs						19,200 cfs					
Channel-Connected Inundation versus River Flow	By Buffer Distance			12/27/06						02/07/02						03/08/04						02/25/94					
Central Texas/Post Oak Savanna/Columbia Bottomlands Habitat Types**	0-0.5 mi	0.5-1 mi	0-1 mi Total	0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total	
ha	ha	ha	ha	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**6,330.6**	**3,589.6**	**9,920.2**	**31.9**	**0.5%**	**0.0**	**0.0%**	**31.9**	**0.3%**	**30.9**	**0.5%**	**0.0**	**0.0%**	**30.9**	**0.3%**	**38.0**	**0.6%**	**0.0**	**0.0%**	**38.0**	**0.4%**	**92.5**	**1.5%**	**0.0**	**0.0%**	**92.5**	**0.9%**
Swamp Forest Subtotals	2.5	0.0	2.5	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Bottomland Forest Subtotals	**2,674.6**	**988.7**	**3,663.3**	**20.6**	**0.8%**	**0.0**	**0.0%**	**20.6**	**0.6%**	**19.8**	**0.7%**	**0.0**	**0.0%**	**19.8**	**0.5%**	**23.8**	**0.9%**	**0.0**	**0.0%**	**23.8**	**0.6%**	**65.4**	**2.4%**	**0.0**	**0.0%**	**65.4**	**1.8%**
Bottomland Shrubland Subtotals	61.2	48.7	109.9	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.1%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Herbaceous Wetland Subtotals	**3,592.4**	**2,552.1**	**6,144.5**	**11.3**	**0.3%**	**0.0**	**0.0%**	**11.3**	**0.2%**	**11.1**	**0.3%**	**0.0**	**0.0%**	**11.1**	**0.2%**	**14.2**	**0.4%**	**0.0**	**0.0%**	**14.2**	**0.2%**	**27.1**	**0.8%**	**0.0**	**0.0%**	**27.1**	**0.4%**
UPLAND HABITATS:	478.0	1,608.5	2,086.5	0.5	0.1%	0.0	0.0%	0.5	0.0%	0.3	0.1%	0.0	0.0%	0.3	0.0%	0.5	0.1%	0.0	0.0%	0.5	0.0%	4.2	0.9%	0.0	0.0%	4.2	0.2%
Upland Forest//Woodland Subtotals	101.2	346.9	448.2	0.4	0.4%	0.0	0.0%	0.4	0.1%	0.2	0.2%	0.0	0.0%	0.2	0.1%	0.3	0.3%	0.0	0.0%	0.3	0.1%	0.9	0.9%	0.0	0.0%	0.9	0.2%
Upland Grassland Subtotals	376.8	1,261.6	1,638.3	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.2	0.1%	0.0	0.0%	0.2	0.0%	3.3	0.9%	0.0	0.0%	3.3	0.2%
DISTURBED & INVASIVE HABITATS:	546.4	1,029.8	1,576.2	0.4	0.1%	0.0	0.0%	0.4	0.0%	4.4	0.8%	0.0	0.0%	4.4	0.3%	18.3	3.4%	0.0	0.0%	18.3	1.2%	37.2	6.8%	0.0	0.0%	37.2	2.4%
OPEN WATER	586.0	31.3	617.2	327.1	55.8%	0.1	0.4%	327.3	53.0%	376.1	64.2%	0.1	0.4%	376.3	61.0%	414.5	70.7%	0.1	0.4%	414.7	67.2%	430.1	73.4%	0.0	0.1%	430.1	69.7%
GRAND TOTALS:	**7,941.0**	**6,259.1**	**14,200.2**	**359.9**	**4.5%**	**0.1**	**0.0%**	**360.0**	**2.5%**	**411.7**	**5.2%**	**0.1**	**0.0%**	**411.9**	**2.9%**	**471.3**	**5.9%**	**0.1**	**0.0%**	**471.5**	**3.3%**	**564.0**	**7.1%**	**0.0**	**0.0%**	**564.0**	**4.0%**

San Felipe Riparian Study Reach: 0-1 mi from River Centerline*	Total Habitat Area (ha)			21,000 cfs						58,200 cfs						71,000 cfs					
Channel-Connected Inundation versus River Flow	By Buffer Distance			01/21/93						01/19/92						03/07/92					
Central Texas/Post Oak Savanna/Columbia Bottomlands Habitat Types**	0-0.5 mi	0.5-1 mi	0-1 mi Total	0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total	
ha	ha	ha	ha	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**6,330.6**	**3,589.6**	**9,920.2**	**78.4**	**1.2%**	**0.0**	**0.0%**	**78.4**	**0.8%**	**275.0**	**4.3%**	**6.3**	**0.2%**	**281.3**	**2.8%**	**375.5**	**5.9%**	**6.0**	**0.2%**	**381.5**	**3.8%**
Swamp Forest Subtotals	2.5	0.0	2.5	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Bottomland Forest Subtotals	**2,674.6**	**988.7**	**3,663.3**	**54.8**	**2.0%**	**0.0**	**0.0%**	**54.8**	**1.5%**	**148.3**	**5.5%**	**3.1**	**0.3%**	**151.4**	**4.1%**	**195.3**	**7.3%**	**1.9**	**0.2%**	**197.2**	**5.4%**
Bottomland Shrubland Subtotals	61.2	48.7	109.9	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Herbaceous Wetland Subtotals	**3,592.4**	**2,552.1**	**6,144.5**	**23.6**	**0.7%**	**0.0**	**0.0%**	**23.6**	**0.4%**	**126.7**	**3.5%**	**3.2**	**0.1%**	**129.9**	**2.1%**	**180.2**	**5.0%**	**4.1**	**0.2%**	**184.3**	**3.0%**
UPLAND HABITATS:	478.0	1,608.5	2,086.5	3.1	0.7%	0.0	0.0%	3.1	0.2%	6.5	1.4%	0.0	0.0%	6.5	0.3%	6.0	1.3%	0.0	0.0%	6.0	0.3%
Upland Forest//Woodland Subtotals	101.2	346.9	448.2	0.7	0.7%	0.0	0.0%	0.7	0.2%	1.2	1.2%	0.0	0.0%	1.2	0.3%	0.8	0.8%	0.0	0.0%	0.8	0.2%
Upland Grassland Subtotals	376.8	1,261.6	1,638.3	2.4	0.6%	0.0	0.0%	2.4	0.1%	5.2	1.4%	0.0	0.0%	5.2	0.3%	5.2	1.4%	0.0	0.0%	5.2	0.3%
DISTURBED & INVASIVE HABITATS:	546.4	1,029.8	1,576.2	35.7	6.5%	0.0	0.0%	35.7	2.3%	41.8	7.7%	0.0	0.0%	41.8	2.7%	42.3	7.7%	0.0	0.0%	42.3	2.7%
OPEN WATER	586.0	31.3	617.2	410.9	70.1%	0.0	0.1%	410.9	66.6%	426.8	72.8%	0.2	0.8%	427.0	69.2%	417.6	71.3%	0.2	0.8%	417.8	67.7%
GRAND TOTALS:	**7,941.0**	**6,259.1**	**14,200.2**	**528.1**	**6.7%**	**0.0**	**0.0%**	**528.1**	**3.7%**	**750.1**	**9.4%**	**6.5**	**0.1%**	**756.6**	**5.3%**	**841.3**	**####**	**6.3**	**0.1%**	**847.6**	**6.0%**

* No channel-connected inundation more than 1 mi from river centerline

** Habitat Types by Ecoregions, Texas Ecological Systems Data: https://tpwd.texas.gov/gis (Elliott, L.F., et al. 2014)

Table 16 All Inundation (0-2 mi) Summary Data: Wallis Riparian Study Reach
Summary and Detailed Data Available in Companion Spreadsheet: LBR.TCS.BW.Inund.Final.6-8-16

Wallis Riparian Study Reach: 0-2 mi from River Centerline	Total Habitat Area (ha)			
Total Inundation versus River Flow	By Buffer Distance			
Central Texas/Post Oak Savanna Habitat Types*	0-0.5 mi	0.5-1 mi	1-2 mi	0-2 mi Total
	ha	ha	ha	ha
BOTTOMLAND HABITATS:	**2,593.1**	**840.6**	**1,713.9**	**5,147.7**
Bottomland Forest Subtotals	**1,173.4**	**156.3**	**640.7**	**1,970.4**
Bottomland Shrubland Subtotals	11.6	7.8	4.1	23.6
Herbaceous Wetland Subtotals	**1,408.0**	**676.5**	**1,069.0**	**3,153.7**
UPLAND HABITATS:	1,767.3	2,561.5	5,020.1	9,348.6
Upland Forest//Woodland Subtotals	985.3	915.3	2,015.0	3,915.5
Upland Grassland Subtotals	782.0	1,646.1	3,005.1	5,433.1
DISTURBED & INVASIVE HABITATS:	2,816.5	2,774.7	4,239.1	9,830.4
OPEN WATER	436.2	24.6	67.3	528.1
GRAND TOTALS:	**7,613.1**	**6,201.4**	**11,040.3**	**24,854.8**

	487 cfs							
	02/02/09							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**8.9**	**0.3%**	**0.1**	**0.0%**	**0.7**	**0.0%**	**9.7**	**0.2%**
Bottomland Forest Subtotals	**7.6**	**0.6%**	**0.1**	**0.1%**	**0.2**	**0.0%**	**7.9**	**0.4%**
Bottomland Shrubland Subtotals	0.0	0.2%	0.0	0.0%	0.0	0.0%	0.0	0.1%
Herbaceous Wetland Subtotals	**1.3**	**0.1%**	**0.0**	**0.0%**	**0.5**	**0.0%**	**1.8**	**0.1%**
UPLAND HABITATS:	1.5	0.1%	0.1	0.0%	0.7	0.0%	2.4	0.0%
Upland Forest//Woodland Subtotals	1.5	0.2%	0.0	0.0%	0.5	0.0%	2.0	0.1%
Upland Grassland Subtotals	0.0	0.0%	0.1	0.0%	0.2	0.0%	0.3	0.0%
DISTURBED & INVASIVE HABITATS:	1.8	0.1%	0.1	0.0%	0.6	0.0%	2.6	0.0%
OPEN WATER	159.5	36.6%	7.9	32.0%	24.5	36.5%	191.9	36.3%
GRAND TOTALS:	**171.7**	**2.3%**	**8.2**	**0.1%**	**26.7**	**0.2%**	**206.5**	**0.8%**

	553 cfs							
	02/18/09							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**7.2**	**0.3%**	**0.1**	**0.0%**	**0.5**	**0.0%**	**7.8**	**0.2%**
Bottomland Forest Subtotals	**6.3**	**0.5%**	**0.1**	**0.1%**	**0.1**	**0.0%**	**6.5**	**0.3%**
Bottomland Shrubland Subtotals	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Herbaceous Wetland Subtotals	**0.9**	**0.1%**	**0.0**	**0.0%**	**0.4**	**0.0%**	**1.3**	**0.0%**
UPLAND HABITATS:	1.4	0.1%	0.1	0.0%	0.6	0.0%	2.1	0.0%
Upland Forest//Woodland Subtotals	1.4	0.1%	0.0	0.0%	0.3	0.0%	1.7	0.0%
Upland Grassland Subtotals	0.0	0.0%	0.1	0.0%	0.3	0.0%	0.5	0.0%
DISTURBED & INVASIVE HABITATS:	1.5	0.1%	0.1	0.0%	0.3	0.0%	1.8	0.0%
OPEN WATER	143.7	32.9%	7.6	31.0%	23.0	34.2%	174.3	33.0%
GRAND TOTALS:	**153.8**	**2.0%**	**7.9**	**0.1%**	**24.4**	**0.2%**	**186.1**	**0.7%**

	789 cfs							
	12/27/06							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**16.2**	**0.6%**	**1.0**	**0.1%**	**3.2**	**0.2%**	**20.4**	**0.4%**
Bottomland Forest Subtotals	**10.9**	**0.9%**	**0.7**	**0.5%**	**1.8**	**0.3%**	**13.4**	**0.7%**
Bottomland Shrubland Subtotals	0.0	0.2%	0.0	0.0%	0.0	0.0%	0.0	0.1%
Herbaceous Wetland Subtotals	**5.3**	**0.4%**	**0.3**	**0.0%**	**1.4**	**0.1%**	**7.0**	**0.2%**
UPLAND HABITATS:	2.4	0.1%	1.1	0.0%	1.7	0.0%	5.2	0.1%
Upland Forest//Woodland Subtotals	2.3	0.2%	0.2	0.0%	0.6	0.0%	3.1	0.1%
Upland Grassland Subtotals	0.0	0.0%	0.9	0.1%	1.1	0.0%	2.1	0.0%
DISTURBED & INVASIVE HABITATS:	3.1	0.1%	0.6	0.0%	4.7	0.1%	8.4	0.1%
OPEN WATER	198.4	45.5%	13.0	53.0%	29.7	44.1%	241.1	45.7%
GRAND TOTALS:	**220.0**	**2.9%**	**15.8**	**0.3%**	**39.3**	**0.4%**	**275.1**	**1.1%**

	808 cfs							
	03/22/06							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**7.8**	**0.3%**	**0.1**	**0.0%**	**0.5**	**0.0%**	**8.4**	**0.2%**
Bottomland Forest Subtotals	**4.4**	**0.4%**	**0.0**	**0.0%**	**0.3**	**0.0%**	**4.6**	**0.2%**
Bottomland Shrubland Subtotals	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Herbaceous Wetland Subtotals	**3.5**	**0.2%**	**0.1**	**0.0%**	**0.3**	**0.0%**	**3.8**	**0.1%**
UPLAND HABITATS:	0.5	0.0%	0.2	0.0%	0.2	0.0%	0.8	0.0%
Upland Forest//Woodland Subtotals	0.5	0.0%	0.0	0.0%	0.1	0.0%	0.6	0.0%
Upland Grassland Subtotals	0.0	0.0%	0.1	0.0%	0.1	0.0%	0.2	0.0%
DISTURBED & INVASIVE HABITATS:	0.8	0.0%	0.1	0.0%	0.4	0.0%	1.3	0.0%
OPEN WATER	129.3	29.6%	9.1	36.9%	21.4	31.9%	159.8	30.3%
GRAND TOTALS:	**138.4**	**1.8%**	**9.4**	**0.2%**	**22.5**	**0.2%**	**170.3**	**0.7%**

	1,290 cfs							
	02/02/06							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**15.0**	**0.6%**	**0.5**	**0.1%**	**1.1**	**0.1%**	**16.5**	**0.3%**
Bottomland Forest Subtotals	**9.9**	**0.8%**	**0.2**	**0.1%**	**0.6**	**0.1%**	**10.7**	**0.5%**
Bottomland Shrubland Subtotals	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Herbaceous Wetland Subtotals	**5.1**	**0.4%**	**0.3**	**0.0%**	**0.4**	**0.0%**	**5.8**	**0.2%**
UPLAND HABITATS:	1.7	0.1%	0.2	0.0%	1.0	0.0%	3.0	0.0%
Upland Forest//Woodland Subtotals	1.7	0.2%	0.0	0.0%	0.6	0.0%	2.3	0.1%
Upland Grassland Subtotals	0.0	0.0%	0.2	0.0%	0.4	0.0%	0.7	0.0%
DISTURBED & INVASIVE HABITATS:	2.9	0.1%	2.0	0.1%	9.3	0.2%	14.2	0.1%
OPEN WATER	189.3	43.4%	10.5	42.7%	26.1	38.8%	225.8	42.8%
GRAND TOTALS:	**208.9**	**2.7%**	**13.2**	**0.2%**	**37.5**	**0.3%**	**259.6**	**1.0%**

Wallis Riparian Study Reach: 0-2 mi from River Centerline	Total Habitat Area (ha)			
Total Inundation versus River Flow	By Buffer Distance			
Central Texas/Post Oak Savanna Habitat Types*	0-0.5 mi	0.5-1 mi	1-2 mi	0-2 mi Total
	ha	ha	ha	ha
BOTTOMLAND HABITATS:	**2,593.1**	**840.6**	**1,713.9**	**5,147.7**
Bottomland Forest Subtotals	**1,173.4**	**156.3**	**640.7**	**1,970.4**
Bottomland Shrubland Subtotals	11.6	7.8	4.1	23.6
Herbaceous Wetland Subtotals	**1,408.0**	**676.5**	**1,069.0**	**3,153.7**
UPLAND HABITATS:	1,767.3	2,561.5	5,020.1	9,348.6
Upland Forest//Woodland Subtotals	985.3	915.3	2,015.0	3,915.5
Upland Grassland Subtotals	782.0	1,646.1	3,005.1	5,433.1
DISTURBED & INVASIVE HABITATS:	2,816.5	2,774.7	4,239.1	9,830.4
OPEN WATER	436.2	24.6	67.3	528.1
GRAND TOTALS:	**7,613.1**	**6,201.4**	**11,040.3**	**24,854.8**

	4,610 cfs							
	12/18/00							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**24.1**	**0.9%**	**1.7**	**0.2%**	**5.1**	**0.3%**	**31.0**	**0.6%**
Bottomland Forest Subtotals	**15.1**	**1.3%**	**1.1**	**0.7%**	**2.4**	**0.4%**	**18.7**	**0.9%**
Bottomland Shrubland Subtotals	0.0	0.2%	0.0	0.0%	0.0	0.0%	0.0	0.1%
Herbaceous Wetland Subtotals	**9.0**	**0.6%**	**0.6**	**0.1%**	**2.7**	**0.3%**	**12.3**	**0.4%**
UPLAND HABITATS:	3.4	0.2%	0.6	0.0%	4.9	0.1%	8.9	0.1%
Upland Forest//Woodland Subtotals	3.2	0.3%	0.0	0.0%	0.6	0.0%	3.9	0.1%
Upland Grassland Subtotals	0.2	0.0%	0.6	0.0%	4.3	0.1%	5.0	0.1%
DISTURBED & INVASIVE HABITATS:	11.3	0.4%	1.3	0.0%	5.5	0.1%	18.1	0.2%
OPEN WATER	209.6	48.1%	9.8	39.6%	26.9	40.1%	246.3	46.6%
GRAND TOTALS:	**248.4**	**3.3%**	**##**	**0.2%**	**42.4**	**0.4%**	**304.3**	**1.2%**

	9,880 cfs							
	12/03/09							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**39.3**	**1.5%**	**4.1**	**0.5%**	**8.3**	**0.5%**	**51.6**	**1.0%**
Bottomland Forest Subtotals	**17.1**	**1.5%**	**2.3**	**1.5%**	**4.7**	**0.7%**	**24.1**	**1.2%**
Bottomland Shrubland Subtotals	0.0	0.2%	0.0	0.0%	0.5	11.2%	0.5	2.0%
Herbaceous Wetland Subtotals	**22.1**	**1.6%**	**1.7**	**0.3%**	**3.1**	**0.3%**	**27.0**	**0.9%**
UPLAND HABITATS:	1.9	0.1%	2.0	0.1%	2.1	0.0%	6.1	0.1%
Upland Forest//Woodland Subtotals	1.6	0.2%	0.9	0.1%	0.4	0.0%	2.9	0.1%
Upland Grassland Subtotals	0.4	0.0%	1.1	0.1%	1.7	0.1%	3.2	0.1%
DISTURBED & INVASIVE HABITATS:	21.9	0.8%	5.0	0.2%	14.6	0.3%	41.4	0.4%
OPEN WATER	246.8	56.6%	##	69.0%	37.1	55.2%	300.9	57.0%
GRAND TOTALS:	**309.9**	**4.1%**	**##**	**0.5%**	**62.1**	**0.6%**	**400.0**	**1.6%**

	12,400 cfs							
	03/08/04							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**40.9**	**1.6%**	**2.7**	**0.3%**	**4.2**	**0.2%**	**47.8**	**0.9%**
Bottomland Forest Subtotals	**16.3**	**1.4%**	**1.3**	**0.8%**	**2.1**	**0.3%**	**19.7**	**1.0%**
Bottomland Shrubland Subtotals	0.0	0.2%	0.0	0.0%	0.1	1.7%	0.1	0.4%
Herbaceous Wetland Subtotals	**24.5**	**1.7%**	**1.4**	**0.2%**	**2.0**	**0.2%**	**27.9**	**0.9%**
UPLAND HABITATS:	1.8	0.1%	0.7	0.0%	1.6	0.0%	4.2	0.0%
Upland Forest//Woodland Subtotals	1.6	0.2%	0.1	0.0%	0.7	0.0%	2.4	0.1%
Upland Grassland Subtotals	0.3	0.0%	0.6	0.0%	0.9	0.0%	1.8	0.0%
DISTURBED & INVASIVE HABITATS:	23.0	0.8%	1.0	0.0%	3.0	0.1%	27.0	0.3%
OPEN WATER	237.0	54.3%	14.7	59.6%	31.0	46.0%	282.6	53.5%
GRAND TOTALS:	**302.7**	**4.0%**	**19.0**	**0.3%**	**39.9**	**0.4%**	**361.6**	**1.5%**

	13,400 cfs							
	01/19/01							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**66.2**	**2.6%**	**6.1**	**0.7%**	**15.3**	**0.9%**	**87.6**	**1.7%**
Bottomland Forest Subtotals	**24.1**	**2.1%**	**2.3**	**1.5%**	**8.5**	**1.3%**	**34.9**	**1.8%**
Bottomland Shrubland Subtotals	0.0	0.2%	0.0	0.0%	0.1	3.0%	0.1	0.6%
Herbaceous Wetland Subtotals	**42.0**	**3.0%**	**3.7**	**0.6%**	**6.7**	**0.6%**	**52.5**	**1.7%**
UPLAND HABITATS:	2.6	0.1%	0.6	0.0%	4.5	0.1%	7.6	0.1%
Upland Forest//Woodland Subtotals	2.1	0.2%	0.0	0.0%	0.4	0.0%	2.5	0.1%
Upland Grassland Subtotals	0.5	0.1%	0.6	0.0%	4.1	0.1%	5.1	0.1%
DISTURBED & INVASIVE HABITATS:	46.7	1.7%	4.9	0.2%	15.6	0.4%	67.2	0.7%
OPEN WATER	257.5	59.0%	##	46.5%	28.7	42.7%	297.6	56.4%
GRAND TOTALS:	**372.9**	**4.9%**	**##**	**0.4%**	**64.2**	**0.6%**	**460.0**	**1.9%**

	19,000 cfs							
	01/21/93							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**61.0**	**2.4%**	**5.8**	**0.7%**	**15.4**	**0.9%**	**82.2**	**1.6%**
Bottomland Forest Subtotals	**28.7**	**2.4%**	**2.7**	**1.7%**	**9.5**	**1.5%**	**40.9**	**2.1%**
Bottomland Shrubland Subtotals	0.0	0.4%	0.0	0.0%	0.1	1.3%	0.1	0.4%
Herbaceous Wetland Subtotals	**32.2**	**2.3%**	**3.1**	**0.5%**	**5.9**	**0.5%**	**41.2**	**1.3%**
UPLAND HABITATS:	4.4	0.3%	0.7	0.0%	4.5	0.1%	9.7	0.1%
Upland Forest//Woodland Subtotals	3.5	0.4%	0.1	0.0%	0.7	0.0%	4.3	0.1%
Upland Grassland Subtotals	1.0	0.1%	0.7	0.0%	3.8	0.1%	5.4	0.1%
DISTURBED & INVASIVE HABITATS:	27.6	1.0%	7.7	0.3%	18.9	0.4%	54.2	0.6%
OPEN WATER	257.5	59.0%	10.9	44.1%	29.1	43.3%	297.5	56.3%
GRAND TOTALS:	**350.5**	**4.6%**	**25.1**	**0.4%**	**68.0**	**0.6%**	**443.5**	**1.8%**

Wallis Riparian Study Reach: 0-2 mi from River Centerline	Total Habitat Area (ha)			
Total Inundation versus River Flow	By Buffer Distance			
Central Texas/Post Oak Savanna Habitat Types*	0-0.5 mi	0.5-1 mi	1-2 mi	0-2 mi Total
	ha	ha	ha	ha
BOTTOMLAND HABITATS:	**2,593.1**	**840.6**	**1,713.9**	**5,147.7**
Bottomland Forest Subtotals	**1,173.4**	**156.3**	**640.7**	**1,970.4**
Bottomland Shrubland Subtotals	11.6	7.8	4.1	23.6
Herbaceous Wetland Subtotals	**1,408.0**	**676.5**	**1,069.0**	**3,153.7**
UPLAND HABITATS:	1,767.3	2,561.5	5,020.1	9,348.6
Upland Forest//Woodland Subtotals	985.3	915.3	2,015.0	3,915.5
Upland Grassland Subtotals	782.0	1,646.1	3,005.1	5,433.1
DISTURBED & INVASIVE HABITATS:	2,816.5	2,774.7	4,239.1	9,830.4
OPEN WATER	436.2	24.6	67.3	528.1
GRAND TOTALS:	**7,613.1**	**6,201.4**	**11,040.3**	**24,854.8**

	19,100 cfs							
	02/25/94							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**92.7**	**3.6%**	**6.9**	**0.8%**	**14.5**	**0.8%**	**114.1**	**2.2%**
Bottomland Forest Subtotals	**46.8**	**4.0%**	**2.9**	**1.8%**	**8.4**	**1.3%**	**58.1**	**2.9%**
Bottomland Shrubland Subtotals	0.1	0.8%	0.0	0.0%	0.1	2.9%	0.2	0.9%
Herbaceous Wetland Subtotals	**45.8**	**3.3%**	**4.0**	**0.6%**	**6.0**	**0.6%**	**55.8**	**1.8%**
UPLAND HABITATS:	4.8	0.3%	1.1	0.0%	6.1	0.1%	12.0	0.1%
Upland Forest//Woodland Subtotals	3.7	0.4%	0.0	0.0%	2.2	0.1%	5.9	0.2%
Upland Grassland Subtotals	1.1	0.1%	1.1	0.1%	3.9	0.1%	6.1	0.1%
DISTURBED & INVASIVE HABITATS:	38.0	1.3%	3.3	0.1%	8.6	0.2%	49.9	0.5%
OPEN WATER	299.7	68.7%	9.6	38.8%	30.8	45.8%	340.1	64.4%
GRAND TOTALS:	**435.2**	**5.7%**	**##**	**0.3%**	**60.0**	**0.5%**	**516.1**	**2.1%**

	21,900 cfs							
	01/01/03							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**70.7**	**2.7%**	**5.6**	**0.7%**	**14.3**	**0.8%**	**90.6**	**1.8%**
Bottomland Forest Subtotals	**30.2**	**2.6%**	**2.9**	**1.9%**	**8.7**	**1.4%**	**41.8**	**2.1%**
Bottomland Shrubland Subtotals	0.0	0.2%	0.0	0.0%	0.1	3.0%	0.1	0.6%
Herbaceous Wetland Subtotals	**40.4**	**2.9%**	**2.7**	**0.4%**	**5.5**	**0.5%**	**48.6**	**1.5%**
UPLAND HABITATS:	5.2	0.3%	1.4	0.1%	5.3	0.1%	11.8	0.1%
Upland Forest//Woodland Subtotals	4.2	0.4%	0.1	0.0%	1.5	0.1%	5.8	0.1%
Upland Grassland Subtotals	1.0	0.1%	1.3	0.1%	3.8	0.1%	6.1	0.1%
DISTURBED & INVASIVE HABITATS:	45.1	1.6%	5.1	0.2%	9.8	0.2%	60.0	0.6%
OPEN WATER	285.1	65.4%	##	65.7%	35.7	53.1%	337.0	63.8%
GRAND TOTALS:	**406.1**	**5.3%**	**##**	**0.5%**	**65.1**	**0.6%**	**499.4**	**2.0%**

	45,300 cfs							
	03/16/01							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**81.1**	**3.1%**	**4.5**	**0.5%**	**10.6**	**0.6%**	**96.2**	**1.9%**
Bottomland Forest Subtotals	**29.8**	**2.5%**	**2.7**	**1.7%**	**7.2**	**1.1%**	**39.7**	**2.0%**
Bottomland Shrubland Subtotals	0.0	0.2%	0.0	0.0%	0.1	2.3%	0.1	0.5%
Herbaceous Wetland Subtotals	**51.3**	**3.6%**	**1.8**	**0.3%**	**3.3**	**0.3%**	**56.3**	**1.8%**
UPLAND HABITATS:	2.2	0.1%	0.4	0.0%	2.1	0.0%	4.7	0.1%
Upland Forest//Woodland Subtotals	1.7	0.2%	0.0	0.0%	0.3	0.0%	2.0	0.1%
Upland Grassland Subtotals	0.5	0.1%	0.4	0.0%	1.8	0.1%	2.7	0.0%
DISTURBED & INVASIVE HABITATS:	53.4	1.9%	2.4	0.1%	6.8	0.2%	62.5	0.6%
OPEN WATER	271.3	62.2%	12.0	48.7%	27.6	41.0%	310.8	58.9%
GRAND TOTALS:	**408.0**	**5.4%**	**19.2**	**0.3%**	**47.0**	**0.4%**	**474.2**	**1.9%**

	56,100 cfs							
	01/19/92							
	0-0.5 mi		0.5-1 mi		1-2 mi		0-2 mi Total	
	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**266.8**	**####**	**##**	**2.1%**	**60.3**	**3.5%**	**344.8**	**6.7%**
Bottomland Forest Subtotals	**132.1**	**####**	**9.4**	**6.0%**	**43.3**	**6.8%**	**184.7**	**9.4%**
Bottomland Shrubland Subtotals	0.1	0.5%	0.0	0.0%	0.0	0.0%	0.1	0.3%
Herbaceous Wetland Subtotals	**134.7**	**9.6%**	**8.3**	**1.2%**	**17.0**	**1.6%**	**160.0**	**5.1%**
UPLAND HABITATS:	6.2	0.4%	1.9	0.1%	7.2	0.1%	15.3	0.2%
Upland Forest//Woodland Subtotals	4.9	0.5%	0.1	0.0%	1.4	0.1%	6.4	0.2%
Upland Grassland Subtotals	1.3	0.2%	1.8	0.1%	5.8	0.2%	8.9	0.2%
DISTURBED & INVASIVE HABITATS:	92.6	3.3%	##	0.4%	33.6	0.8%	138.6	1.4%
OPEN WATER	317.5	72.8%	##	46.8%	32.5	48.3%	361.5	68.5%
GRAND TOTALS:	**683.2**	**9.0%**	**##**	**0.7%**	**###**	**1.2%**	**860.3**	**3.5%**

Table 17 All Inundation (0-2 mi) Summary Data: San Felipe Riparian Study Reach
Summary and Detailed Data Available in Companion Spreadsheet: LBR.TCS.BS.Inund.Final.6-8-16

San Felipe Riparian Study Reach: 0-1 mi from River Centerline*	Total Habitat Area (ha)			674 cfs						1,380 cfs						1,840 cfs						1,970 cfs					
Channel-Connected Inundation versus River Flow	By Buffer Distance			12/01/11						02/26/06						02/02/06						02/08/11					
Central Texas/Post Oak Savanna/Columbia Bottomlands Habitat Types**	0-0.5 mi	0.5-1 mi	0-1 mi Total	0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total	
ha	ha	ha	ha	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**6,330.6**	**3,589.6**	**9,920.2**	**17.9**	**0.3%**	**0.0**	**0.0%**	**17.9**	**0.2%**	**17.1**	**0.3%**	**0.0**	**0.0%**	**17.1**	**0.2%**	**19.7**	**0.3%**	**0.0**	**0.0%**	**19.7**	**0.2%**	**18.7**	**0.3%**	**0.0**	**0.0%**	**18.7**	**0.2%**
Swamp Forest Subtotals	2.5	0.0	2.5	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Bottomland Forest Subtotals	**2,674.6**	**988.7**	**3,663.3**	**10.7**	**0.4%**	**0.0**	**0.0%**	**10.7**	**0.3%**	**10.9**	**0.4%**	**0.0**	**0.0%**	**10.9**	**0.3%**	**12.9**	**0.5%**	**0.0**	**0.0%**	**12.9**	**0.4%**	**11.6**	**0.4%**	**0.0**	**0.0%**	**11.6**	**0.3%**
Bottomland Shrubland Subtotals	61.2	48.7	109.9	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Herbaceous Wetland Subtotals	**3,592.4**	**2,552.1**	**6,144.5**	**7.2**	**0.2%**	**0.0**	**0.0%**	**7.2**	**0.1%**	**6.2**	**0.2%**	**0.0**	**0.0%**	**6.2**	**0.1%**	**6.8**	**0.2%**	**0.0**	**0.0%**	**6.8**	**0.1%**	**7.1**	**0.2%**	**0.0**	**0.0%**	**7.1**	**0.1%**
UPLAND HABITATS:	478.0	1,608.5	2,086.5	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.2	0.0%	0.0	0.0%	0.2	0.0%	0.2	0.0%	0.0	0.0%	0.2	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%
Upland Forest//Woodland Subtotals	101.2	346.9	448.2	0.1	0.1%	0.0	0.0%	0.1	0.0%	0.1	0.1%	0.0	0.0%	0.1	0.0%	0.2	0.2%	0.0	0.0%	0.2	0.0%	0.1	0.1%	0.0	0.0%	0.1	0.0%
Upland Grassland Subtotals	376.8	1,261.6	1,638.3	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
DISTURBED & INVASIVE HABITATS:	546.4	1,029.8	1,576.2	0.2	0.0%	0.0	0.0%	0.2	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%
OPEN WATER	586.0	31.3	617.2	206.2	35.2%	0.1	0.4%	206.4	33.4%	268.3	45.8%	0.1	0.4%	268.5	43.5%	274.4	46.8%	0.1	0.4%	274.6	44.5%	270.9	46.2%	0.1	0.4%	271.0	43.9%
GRAND TOTALS:	**7,941.0**	**6,259.1**	**14,200.2**	**224.5**	**2.8%**	**0.1**	**0.0%**	**224.6**	**1.6%**	**285.7**	**3.6%**	**0.1**	**0.0%**	**285.8**	**2.0%**	**294.5**	**3.7%**	**0.1**	**0.0%**	**294.6**	**2.1%**	**289.9**	**3.7%**	**0.1**	**0.0%**	**290.0**	**2.0%**

San Felipe Riparian Study Reach: 0-1 mi from River Centerline*	Total Habitat Area (ha)			2,200 cfs						7,640 cfs						16,900 cfs						19,200 cfs					
Channel-Connected Inundation versus River Flow	By Buffer Distance			12/27/06						02/07/02						03/08/04						02/25/94					
Central Texas/Post Oak Savanna/Columbia Bottomlands Habitat Types**	0-0.5 mi	0.5-1 mi	0-1 mi Total	0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total	
ha	ha	ha	ha	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**6,330.6**	**3,589.6**	**9,920.2**	**31.9**	**0.5%**	**0.0**	**0.0%**	**31.9**	**0.3%**	**30.9**	**0.5%**	**0.0**	**0.0%**	**30.9**	**0.3%**	**38.0**	**0.6%**	**0.0**	**0.0%**	**38.0**	**0.4%**	**92.5**	**1.5%**	**0.0**	**0.0%**	**92.5**	**0.9%**
Swamp Forest Subtotals	2.5	0.0	2.5	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Bottomland Forest Subtotals	**2,674.6**	**988.7**	**3,663.3**	**20.6**	**0.8%**	**0.0**	**0.0%**	**20.6**	**0.6%**	**19.8**	**0.7%**	**0.0**	**0.0%**	**19.8**	**0.5%**	**23.8**	**0.9%**	**0.0**	**0.0%**	**23.8**	**0.6%**	**65.4**	**2.4%**	**0.0**	**0.0%**	**65.4**	**1.8%**
Bottomland Shrubland Subtotals	61.2	48.7	109.9	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.1%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Herbaceous Wetland Subtotals	**3,592.4**	**2,552.1**	**6,144.5**	**11.3**	**0.3%**	**0.0**	**0.0%**	**11.3**	**0.2%**	**11.1**	**0.3%**	**0.0**	**0.0%**	**11.1**	**0.2%**	**14.2**	**0.4%**	**0.0**	**0.0%**	**14.2**	**0.2%**	**27.1**	**0.8%**	**0.0**	**0.0%**	**27.1**	**0.4%**
UPLAND HABITATS:	478.0	1,608.5	2,086.5	0.5	0.1%	0.0	0.0%	0.5	0.0%	0.3	0.1%	0.0	0.0%	0.3	0.0%	0.5	0.1%	0.0	0.0%	0.5	0.0%	4.2	0.9%	0.0	0.0%	4.2	0.2%
Upland Forest//Woodland Subtotals	101.2	346.9	448.2	0.4	0.4%	0.0	0.0%	0.4	0.1%	0.2	0.2%	0.0	0.0%	0.2	0.1%	0.3	0.3%	0.0	0.0%	0.3	0.1%	0.9	0.9%	0.0	0.0%	0.9	0.2%
Upland Grassland Subtotals	376.8	1,261.6	1,638.3	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.1	0.0%	0.0	0.0%	0.1	0.0%	0.2	0.1%	0.0	0.0%	0.2	0.0%	3.3	0.9%	0.0	0.0%	3.3	0.2%
DISTURBED & INVASIVE HABITATS:	546.4	1,029.8	1,576.2	0.4	0.1%	0.0	0.0%	0.4	0.0%	4.4	0.8%	0.0	0.0%	4.4	0.3%	18.3	3.4%	0.0	0.0%	18.3	1.2%	37.2	6.8%	0.0	0.0%	37.2	2.4%
OPEN WATER	586.0	31.3	617.2	327.1	55.8%	0.1	0.4%	327.3	53.0%	376.1	64.2%	0.1	0.4%	376.3	61.0%	414.5	70.7%	0.1	0.4%	414.7	67.2%	430.1	73.4%	0.0	0.1%	430.1	69.7%
GRAND TOTALS:	**7,941.0**	**6,259.1**	**14,200.2**	**359.9**	**4.5%**	**0.1**	**0.0%**	**360.0**	**2.5%**	**411.7**	**5.2%**	**0.1**	**0.0%**	**411.9**	**2.9%**	**471.3**	**5.9%**	**0.1**	**0.0%**	**471.5**	**3.3%**	**564.0**	**7.1%**	**0.0**	**0.0%**	**564.0**	**4.0%**

San Felipe Riparian Study Reach: 0-1 mi from River Centerline*	Total Habitat Area (ha)			21,000 cfs						58,200 cfs						71,000 cfs					
Channel-Connected Inundation versus River Flow	By Buffer Distance			01/21/93						01/19/92						03/07/92					
Central Texas/Post Oak Savanna/Columbia Bottomlands Habitat Types**	0-0.5 mi	0.5-1 mi	0-1 mi Total	0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total		0-0.5 mi		0.5-1 mi		0-1 mi Total	
ha	ha	ha	ha	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
BOTTOMLAND HABITATS:	**6,330.6**	**3,589.6**	**9,920.2**	**78.4**	**1.2%**	**0.0**	**0.0%**	**78.4**	**0.8%**	**275.0**	**4.3%**	**6.3**	**0.2%**	**281.3**	**2.8%**	**375.5**	**5.9%**	**6.0**	**0.2%**	**381.5**	**3.8%**
Swamp Forest Subtotals	2.5	0.0	2.5	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Bottomland Forest Subtotals	**2,674.6**	**988.7**	**3,663.3**	**54.8**	**2.0%**	**0.0**	**0.0%**	**54.8**	**1.5%**	**148.3**	**5.5%**	**3.1**	**0.3%**	**151.4**	**4.1%**	**195.3**	**7.3%**	**1.9**	**0.2%**	**197.2**	**5.4%**
Bottomland Shrubland Subtotals	61.2	48.7	109.9	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Herbaceous Wetland Subtotals	**3,592.4**	**2,552.1**	**6,144.5**	**23.6**	**0.7%**	**0.0**	**0.0%**	**23.6**	**0.4%**	**126.7**	**3.5%**	**3.2**	**0.1%**	**129.9**	**2.1%**	**180.2**	**5.0%**	**4.1**	**0.2%**	**184.3**	**3.0%**
UPLAND HABITATS:	478.0	1,608.5	2,086.5	3.1	0.7%	0.0	0.0%	3.1	0.2%	6.5	1.4%	0.0	0.0%	6.5	0.3%	6.0	1.3%	0.0	0.0%	6.0	0.3%
Upland Forest//Woodland Subtotals	101.2	346.9	448.2	0.7	0.7%	0.0	0.0%	0.7	0.2%	1.2	1.2%	0.0	0.0%	1.2	0.3%	0.8	0.8%	0.0	0.0%	0.8	0.2%
Upland Grassland Subtotals	376.8	1,261.6	1,638.3	2.4	0.6%	0.0	0.0%	2.4	0.1%	5.2	1.4%	0.0	0.0%	5.2	0.3%	5.2	1.4%	0.0	0.0%	5.2	0.3%
DISTURBED & INVASIVE HABITATS:	546.4	1,029.8	1,576.2	35.7	6.5%	0.0	0.0%	35.7	2.3%	41.8	7.7%	0.0	0.0%	41.8	2.7%	42.3	7.7%	0.0	0.0%	42.3	2.7%
OPEN WATER	586.0	31.3	617.2	410.9	70.1%	0.0	0.1%	410.9	66.6%	426.8	72.8%	0.2	0.8%	427.0	69.2%	417.6	71.3%	0.2	0.8%	417.8	67.7%
GRAND TOTALS:	**7,941.0**	**6,259.1**	**14,200.2**	**528.1**	**6.7%**	**0.0**	**0.0%**	**528.1**	**3.7%**	**750.1**	**9.4%**	**6.5**	**0.1%**	**756.6**	**5.3%**	**841.3**	**####**	**6.3**	**0.1%**	**847.6**	**6.0%**

*** No channel-connected inundation more than 1 mi from river centerline**

**** Habitat Types by Ecoregions, Texas Ecological Systems Data: https://tpwd.texas.gov/gis (Elliott, L.F., et al. 2014)**

Table 18 Elevation Data: Vegetation Transects
Wallis Study Site

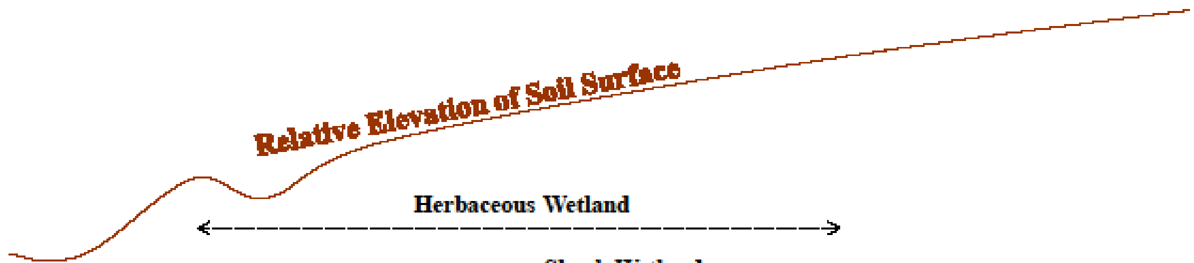
Transect 1A		Transect 4A		Transect 6AB		Transect 7A		Transect 12AB		Transect 13A	
Distance (m)	Elevation (ft AMSL)	Distance (m)	Elevation (ft AMSL)	Distance (m)	Elevation (ft AMSL)	Distance (m)	Elevation (ft AMSL)	Distance (m)	Elevation (ft AMSL)	Distance (m)	Elevation (ft AMSL)
0.00	70.15	0.00	69.14	0.00	70.40	0.00	74.77	0.00	74.10	0.00	71.05
0.30	70.34	1.79	72.97	0.60	71.97	1.51	76.72	0.03	74.15	3.01	72.85
3.01	73.39	3.89	76.77	1.50	73.72	2.11	77.32	1.82	75.85	5.42	75.30
4.81	75.69	5.98	78.47	2.70	75.92	3.01	77.12	3.03	77.15	7.53	77.90
6.01	77.79	8.97	80.12	4.80	79.27	5.42	77.87	6.05	80.05	8.43	79.55
9.02	79.89	10.47	80.37	6.00	79.92	6.62	79.17	7.26	81.55	9.03	79.75
12.03	81.84	11.96	80.37	8.99	79.62	8.43	80.22	9.08	82.25	11.44	78.95
15.03	82.74	14.95	78.97	11.99	80.62	12.04	80.17	12.11	81.00	12.04	79.85
18.04	82.79	17.94	77.32	13.49	80.67	15.05	80.72	15.13	80.45	12.94	77.85
21.05	83.24	19.59	77.07	14.99	81.02	18.06	83.12	16.34	80.90	13.25	77.75
22.85	84.24	20.93	78.02	17.99	78.57	19.57	85.27	18.16	81.80	13.85	78.30
24.05	85.24	22.73	80.57	20.38	76.17	21.07	87.15	20.43	83.95	15.05	78.90
25.56	86.89	23.92	82.17	22.18	76.52	23.78	90.25	21.19	84.95	18.06	82.95
27.06	88.69	25.42	84.30	24.28	78.62	25.29	90.40	24.21	88.75	21.07	87.27
28.26	90.79	26.91	86.10	28.48	84.57	27.09	89.40	27.24	92.25	24.08	91.57
30.07	92.14	28.41	88.10	29.98	84.52	30.10	88.30	28.15	92.89	25.29	92.82
33.07	90.84	29.90	90.35	32.67	82.97	33.11	87.75	30.27	92.24	25.89	93.72
36.08	90.34	30.80	91.20	35.07	84.27	36.12	87.70	33.29	90.64	26.49	93.52
39.09	90.89	32.89	91.55	38.07	86.82	39.13	89.15	36.32	89.89	28.60	90.67
42.09	91.44	35.89	91.70	38.97	88.03	42.14	90.15	38.44	90.84	30.10	89.42
45.10	91.89	37.83	90.60	41.97	89.88	45.15	92.05	39.35	91.64	31.01	88.97
48.11	93.29	38.88	90.10	44.96	91.33	48.16	92.85	40.56	92.39	33.11	89.87
49.91	94.79	40.67	88.90	47.06	93.08	49.97	93.07	42.37	92.89	36.12	90.62
50.00	94.97	42.02	88.75	49.76	93.33	50.00	93.09	45.40	93.04	39.13	92.32
		44.86	91.40	50.00	93.36			48.43	93.34	42.14	94.77
		47.85	91.80	51.58	92.48			50.00	93.63	45.15	96.79
		49.94	92.05	54.01	91.68			51.46	93.79	48.16	97.89
		50.00	92.06	55.54	91.88			54.51	94.64	49.97	97.69
				58.58	91.98			57.56	96.19	50.00	97.60
				60.10	92.13			60.61	95.74		
				61.92	92.48			63.66	93.74		
				64.66	94.88			66.71	92.84		
				66.18	96.33			69.76	92.24		
				69.22	96.71			72.80	91.89		
				72.26	96.86			75.85	91.69		
				75.30	97.61			78.90	92.04		
				78.35	97.21			81.95	92.84		
				81.39	95.91			85.00	93.59		
				83.82	95.36			88.05	94.14		
				85.64	95.56			91.10	94.39		
				87.47	95.06			93.84	94.49		
				90.51	93.66			97.50	93.09		
				93.86	93.51			99.94	92.84		
				96.59	92.76			100.00	92.78		
				99.64	92.11						
				100.00	91.79						

Table 19 Elevation Data: Vegetation Transects
San Felipe Study Site

Transect 5ABC		Transect 9ABC			
Distance (m)	Elevation (ft AMSL)	Distance (m)	Elevation (ft AMSL)	Distance (m)	Elevation (ft AMSL)
0.0	94.3	0.0	97.8	81.0	112.1
3.0	98.9	2.4	102.3	84.9	111.2
5.4	102.6	3.9	104.9	91.2	110.2
9.6	107.2	6.9	109.0	95.8	110.3
13.0	109.0	11.5	110.0	100.0	112.5
15.4	108.3	19.9	109.5	101.8	112.7
18.7	105.5	21.8	107.9	105.2	111.8
23.5	103.0	25.1	106.6	111.2	111.7
28.9	101.8	28.1	106.3	118.2	110.1
35.5	101.6	32.0	108.2	125.2	109.6
41.9	102.3	33.8	107.6	130.7	109.4
46.7	103.6	36.9	105.7	137.7	110.5
50.0	105.8	39.9	106.0	143.8	113.2
53.0	108.0	41.7	107.2	145.3	113.3
56.7	110.6	44.7	109.3	150.0	111.6
58.8	112.2	48.0	108.1		
64.3	111.5	50.0	107.5		
76.1	110.8	51.7	107.5		
85.6	109.1	52.7	107.9		
90.7	108.7	57.7	107.0		
99.8	108.3	60.0	105.7		
107.1	108.0	62.3	103.9		
116.3	107.9	65.2	101.0		
128.4	109.1	68.3	101.5		
136.3	109.5	70.1	103.2		
146.0	109.6	75.8	110.2		
150.0	110.0	77.9	112.4		

Appendix 2: Figures

Figure 1 Riparian Habitats in Lower Brazos River Study Areas: Landscape Context, Tree Species, and Hydrology



Herbaceous Wetland (Lower Swamp through Seasonally Flooded Forest)

Shrub Wetland (Lower Swamp through Temporarily Flooded Forest)

Bottomland Habitat Types:	Stream & Other Open Water	Forested Wetland: Lower Swamp (Streamside)	Forested Wetland: Upper Swamp (Between 1st & 2nd levees)	Riparian Hardwood Forest: Seasonally Flooded Forest (Sloughs, Low flats, & Backwater areas)	Riparian Hardwood Forest: Temporarily Flooded Forest (High flats)	Transition to Uplands
Common Tree Species: (In overall order of importance):	None	Black willow, Box elder	Box elder, Green ash, Black willow, Slippery elm	Eastern cottonwood Box elder Green ash Slippery elm	Eastern cottonwood Slippery elm Roughleaf dogwood Hackberry	Roughleaf dogwood Hackberry Cedar elm Chinaberry Post oak Eastern red cedar
Hydrologic Regime [1]:	Permanently Flooded	Intermittently exposed	Semipermanently flooded	Seasonally flooded	Temporarily flooded	Intermittently flooded
Flood Frequency- percent of years [2]:	100%	~ 100%	51-100%	51-100%	11-50%	1-10%
Growing-Season Inundation & Soil Saturation, total duration [2]:	100% (~ 8 mos.)	~ 100% (> 4 mos.)	>25% (> 2 mos.)	12.5-25% (1-2 mos.)	2-12.5% (5-30 days)	< 2% (< 5 days)

Footnotes: [1] Diamond, D. 2009. FIA Bottomland Summary: East Texas. Unpub. document, Missouri Resource Assessment Partnership, School of Natural Resources, U. Mo. - Columbia.

[2] Huffman, T., and S.W. Forsythe. 1981. Bottomland hardwood forest communities and their relation to anaerobic soil communities. in: Clark, J.R., and J. Benforado. Wetlands of Bottomland Hardwood Forests, Elsevier Scientific Pub. Co., New York, N.Y., pp. 187-196.

Figure 2 Vicinity Map

Wallis and San Felipe Study Sites

Figure 3.1 Location Map: Wallis Study Site

Figure 3.2 Location Map: San Felipe Study Site

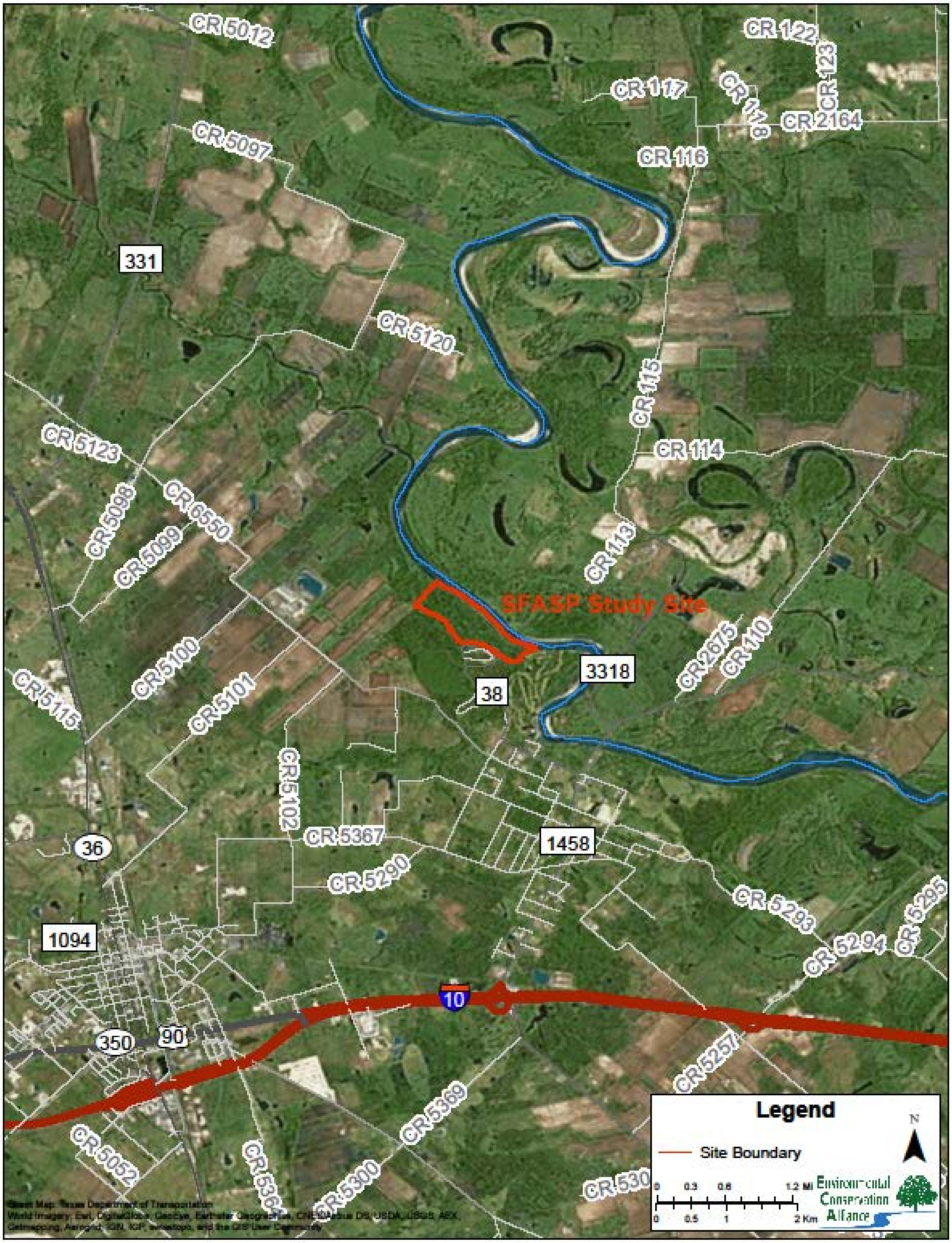


Figure 4.1 San Felipe Study Site: Transect Locations

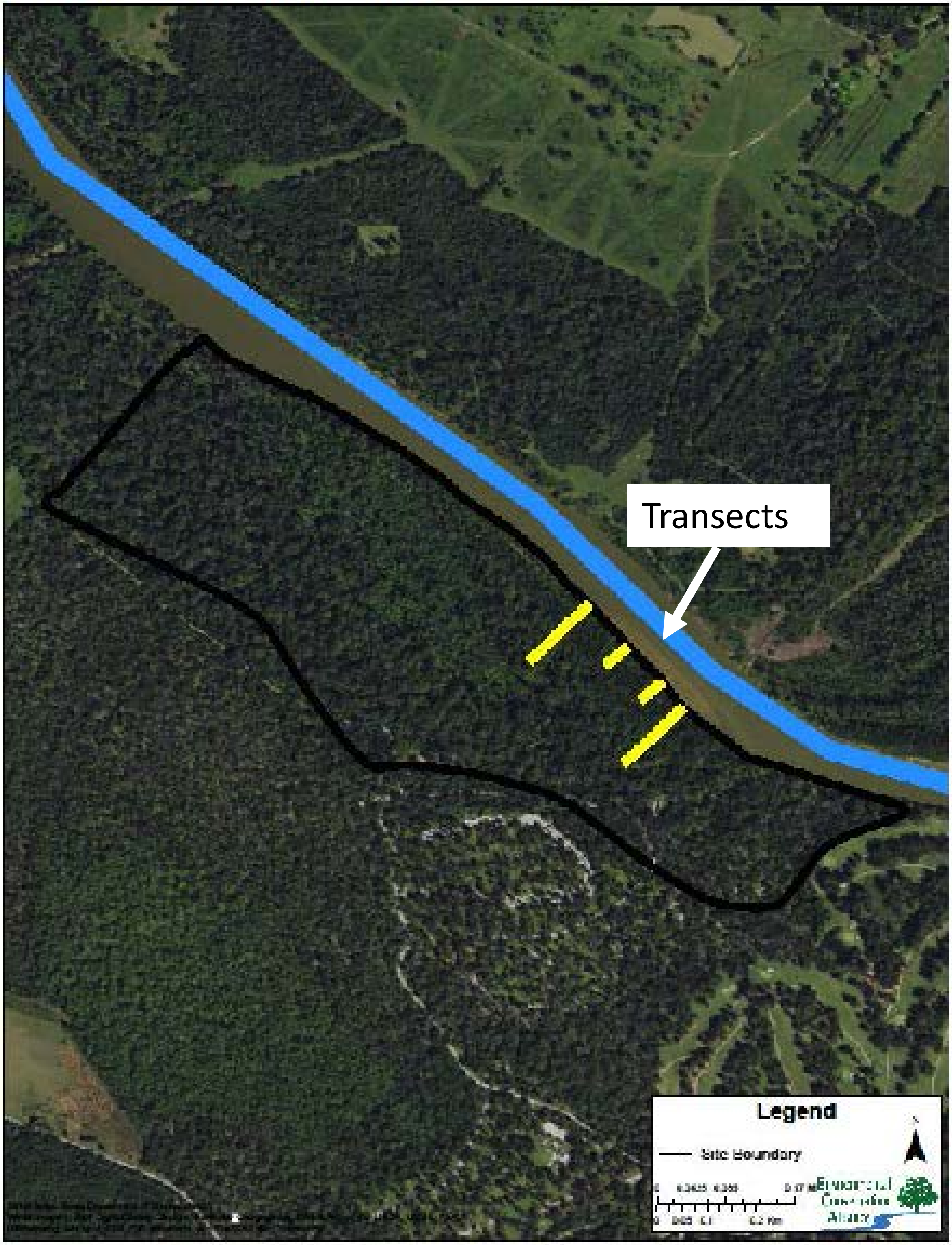


Figure 4.2 Wallis Study Site: Transect Locations

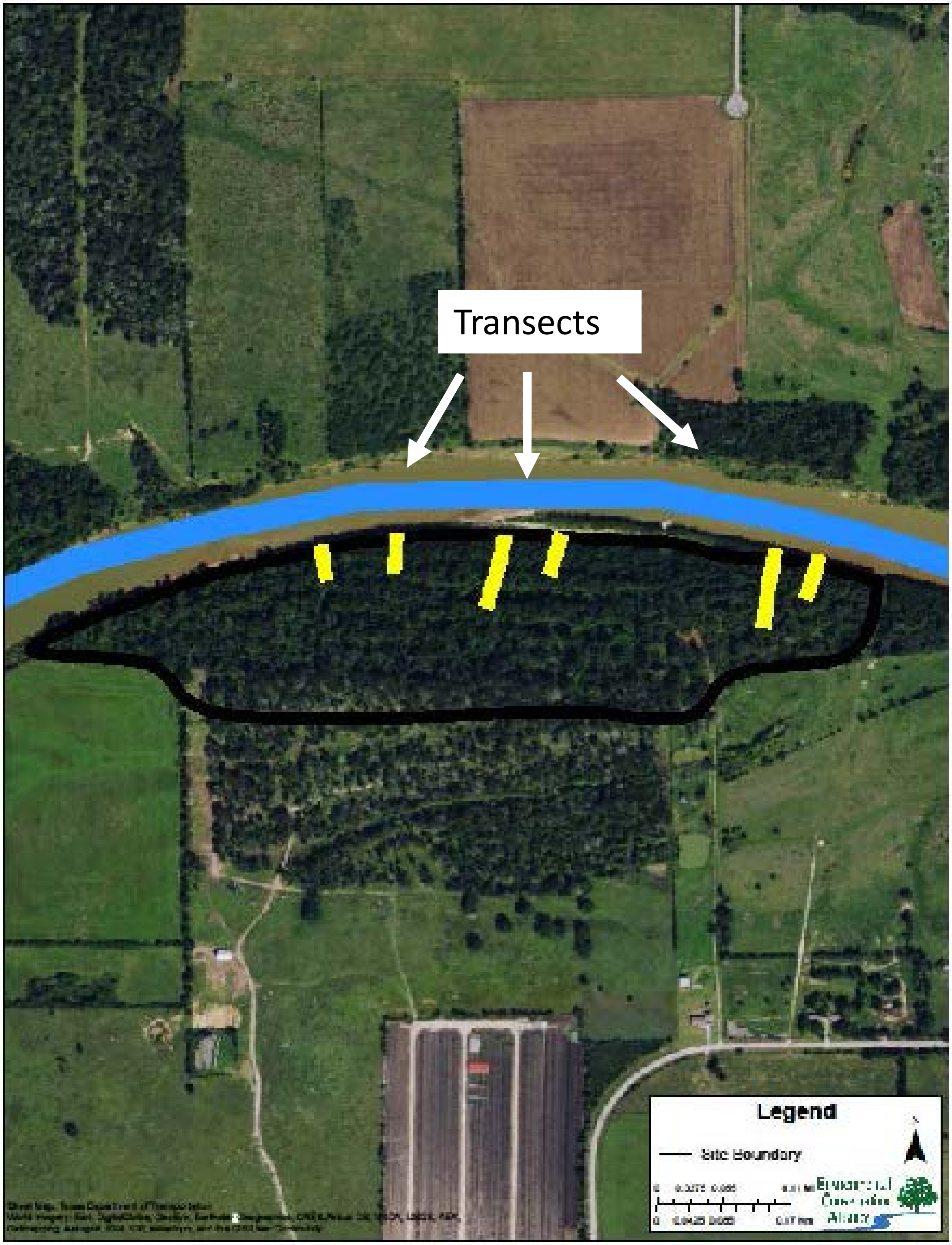


Figure 5. Channel-Connected Inundation: Wallis Study Reach (graph)
Habitat Inundation versus Mean Daily Discharge

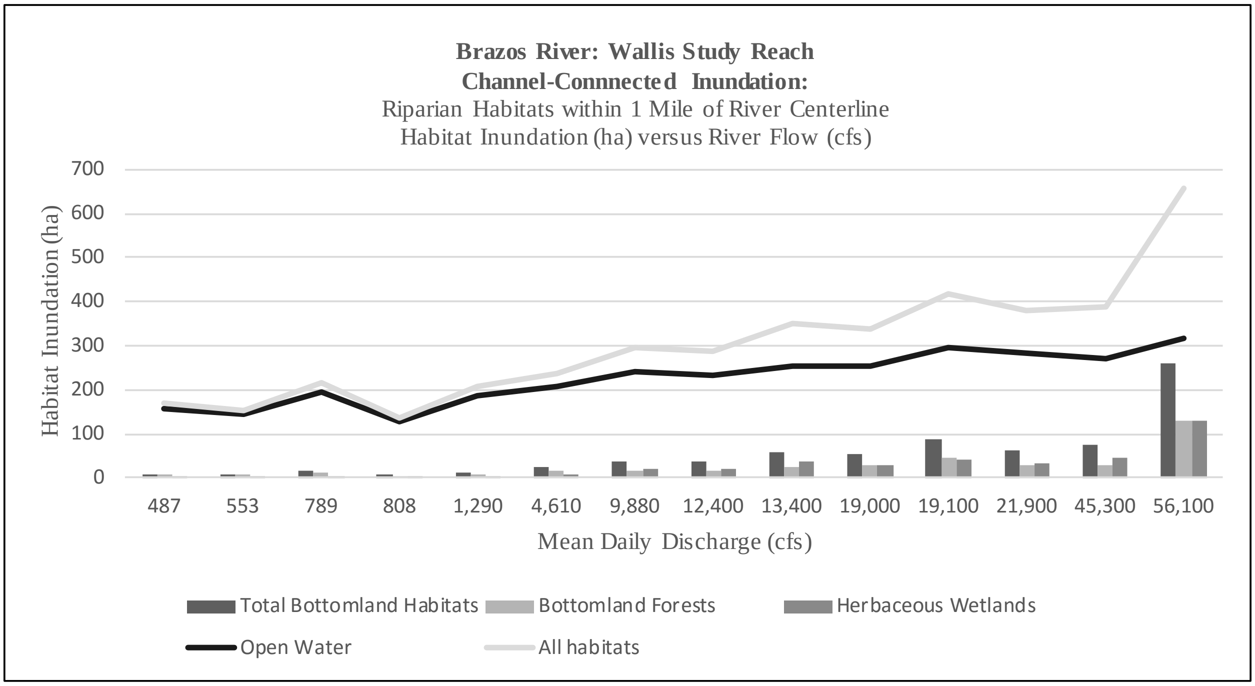


Figure 6 All Inundation: Wallis Study Reach (graph)
Habitat Inundation versus Mean Daily Discharge

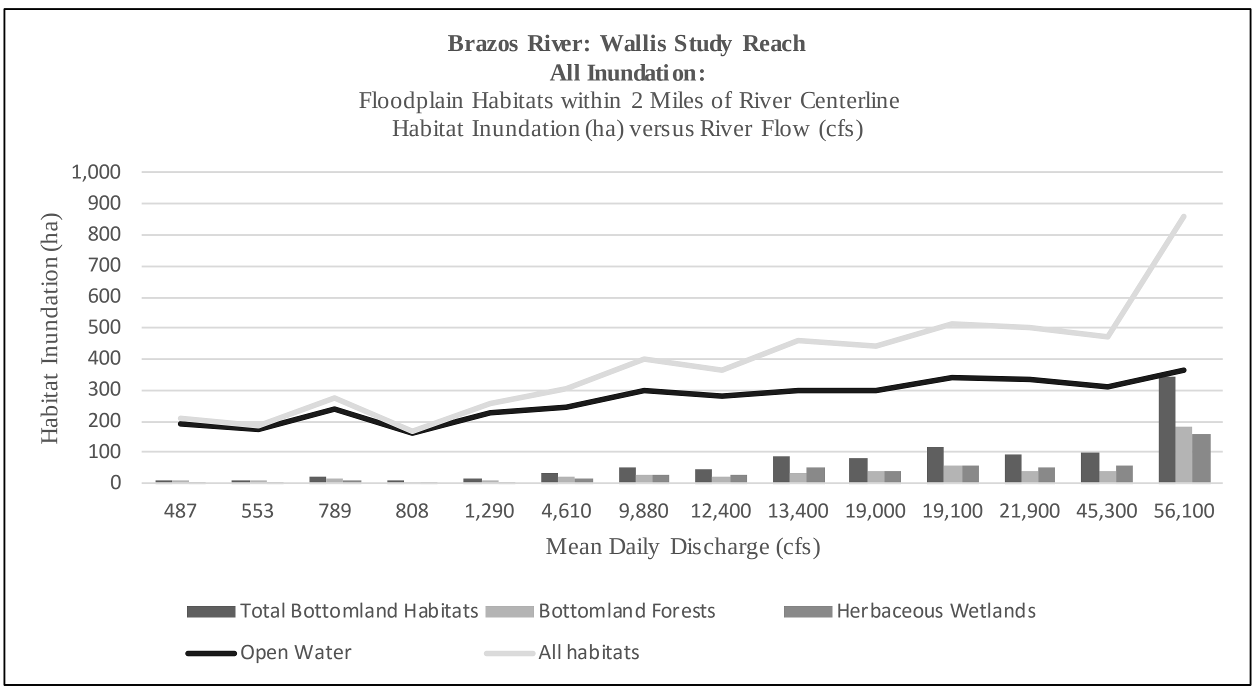


Figure 7 Channel-Connected Inundation: San Felipe Study Reach (graph)
Habitat Inundation versus Mean Daily Discharge

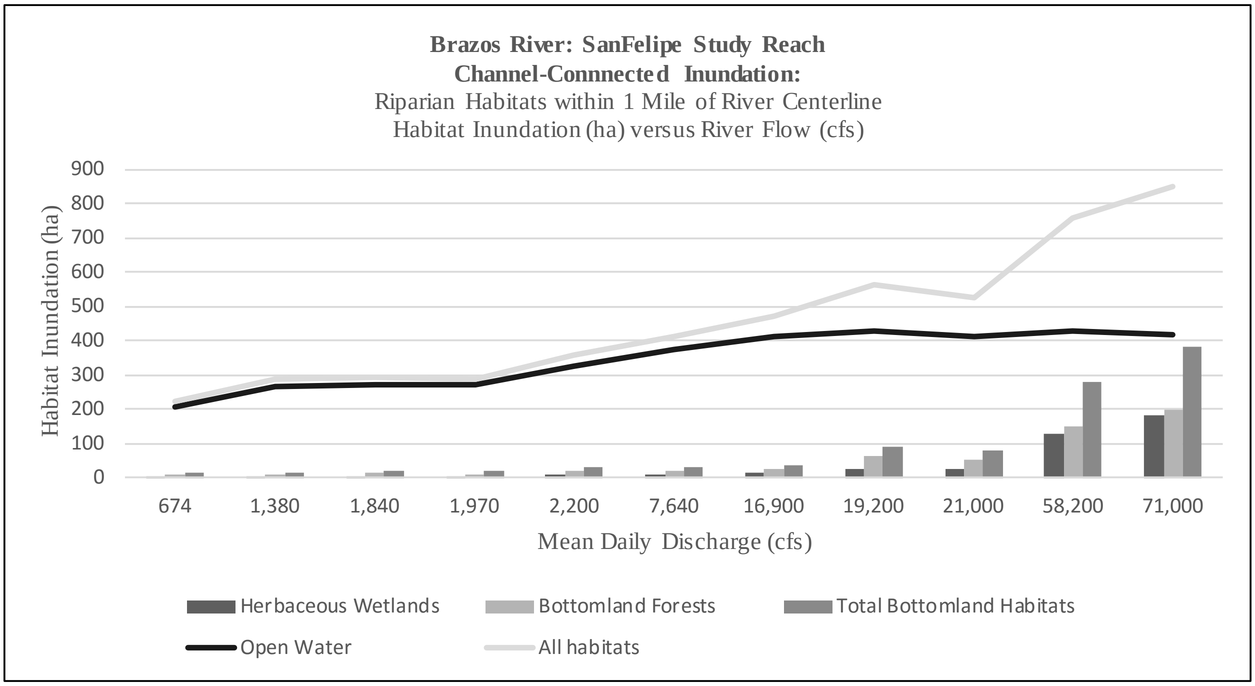


Figure 8 All Inundation: San Felipe Study Reach (graph)
Habitat Inundation versus Mean Daily Discharge

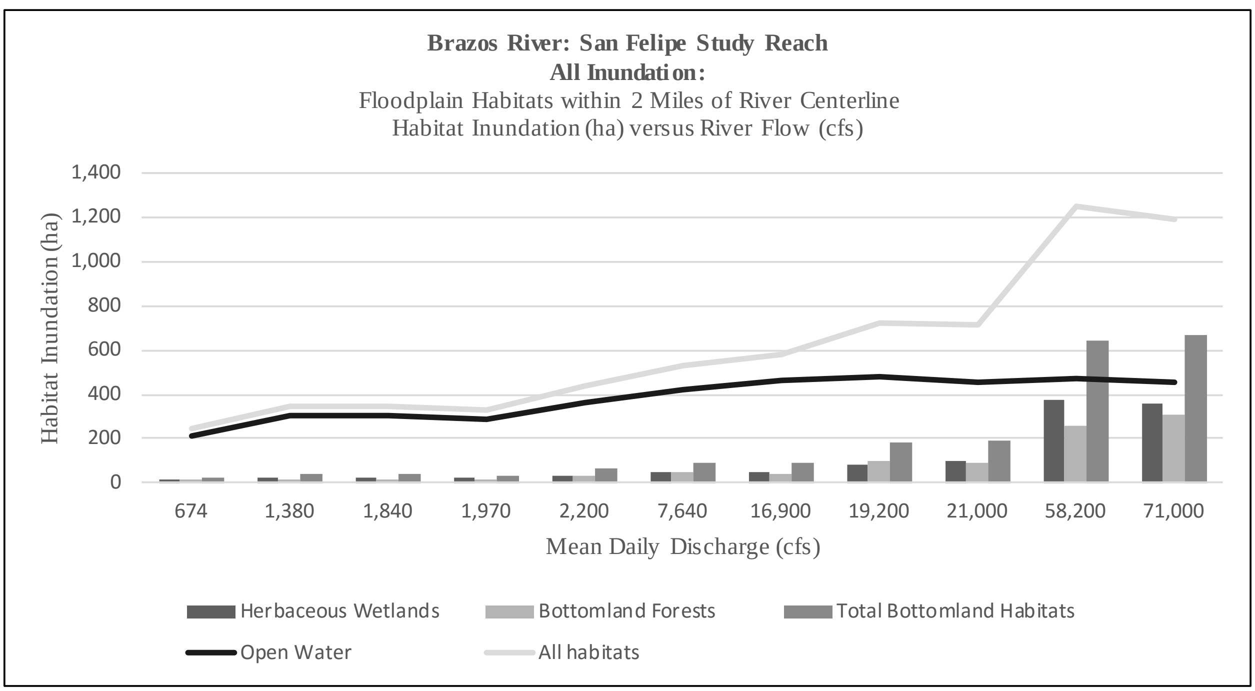


Figure 9.1 Inundation Maps: Wallis Study Reach
Legend for Central Texas/Post Oak Savanna Habitat Types

Figure 9.2 Channel-Connected Inundation Map: Wallis Study Reach
01/19/92 Inundation Event: 56,100 cfs

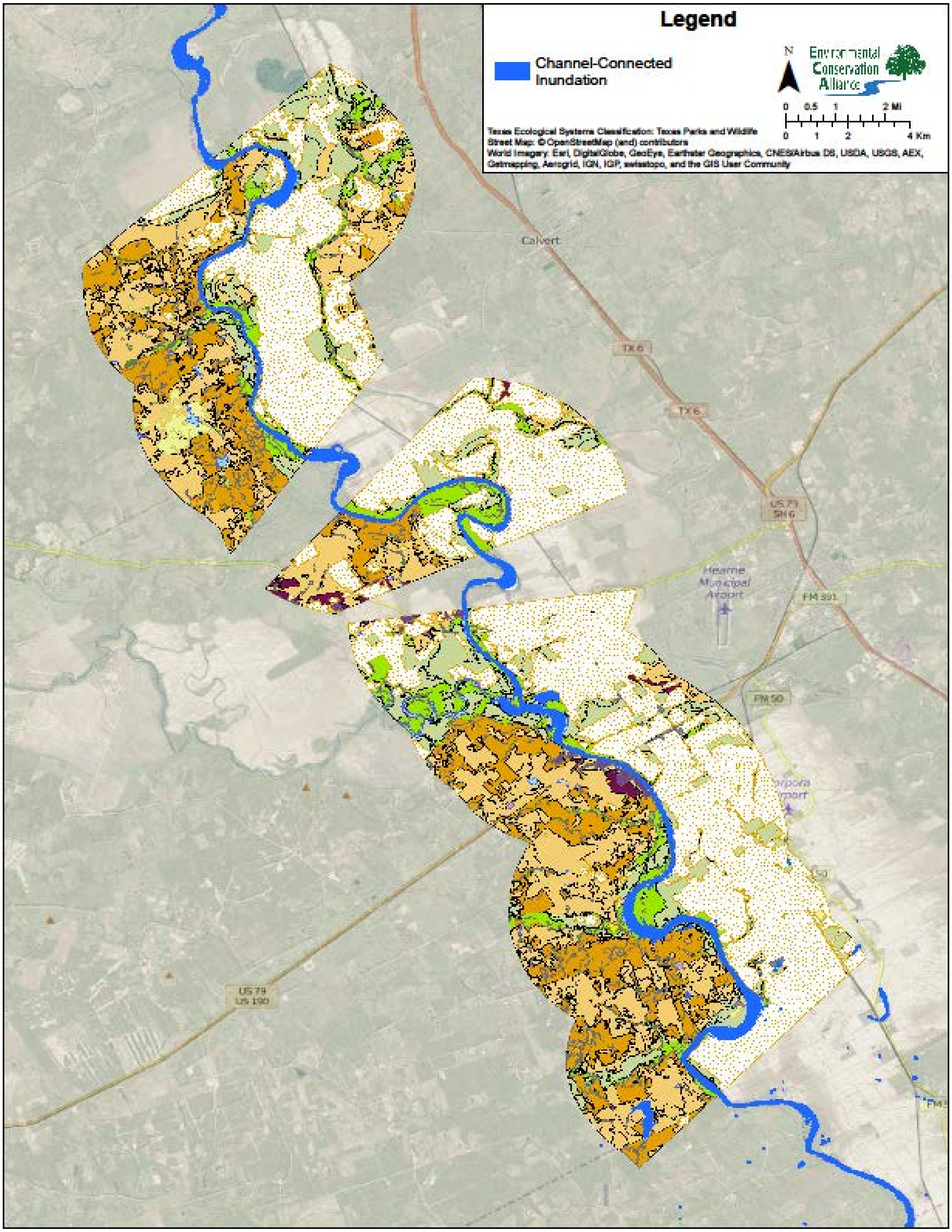


Figure 9.3 Channel-Connected Inundation Map: Wallis Study Reach
01/19/01 Inundation Event: 13,400 cfs

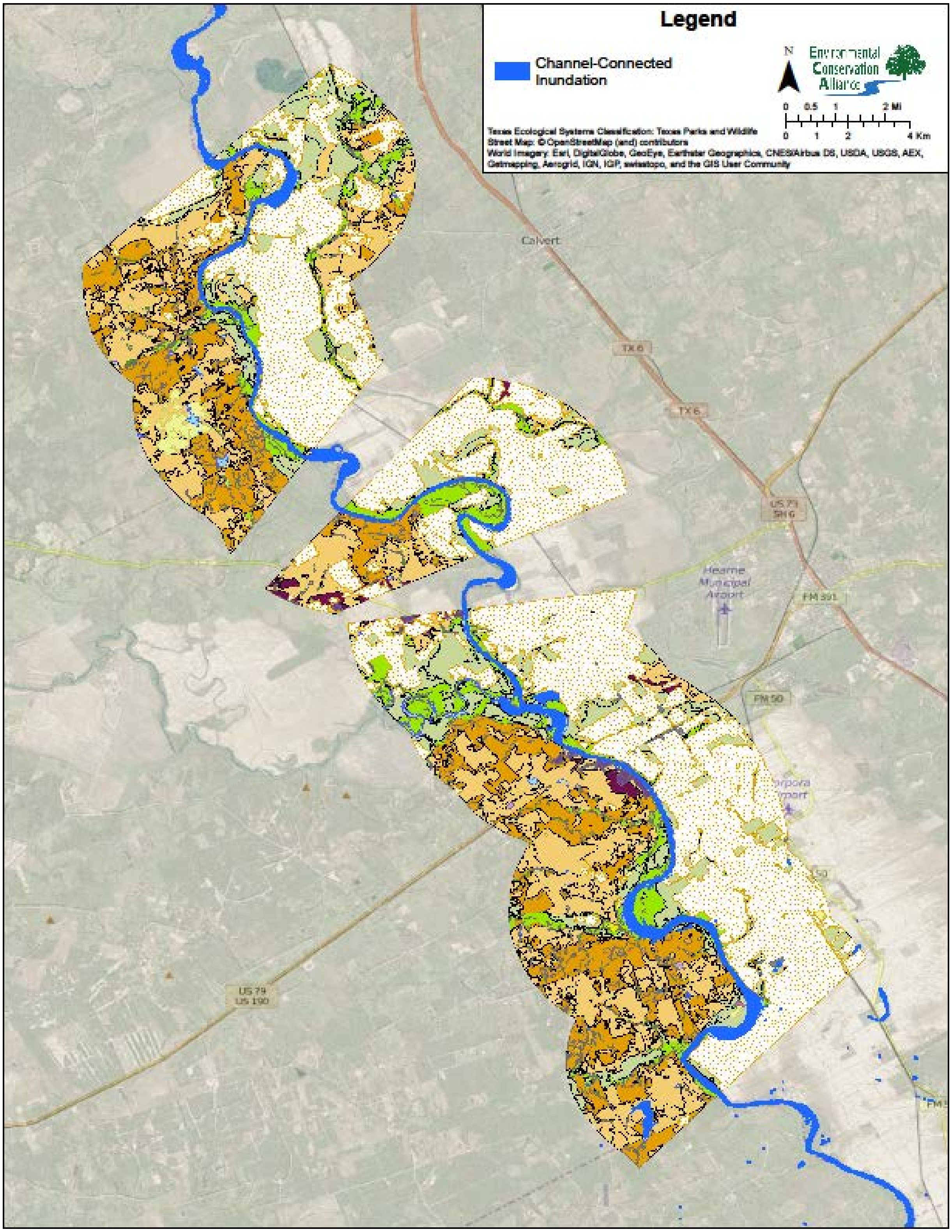


Figure 9.4 Channel-Connected Inundation Map: Wallis Study Reach
02/02/09 Inundation Event: 487 cfs

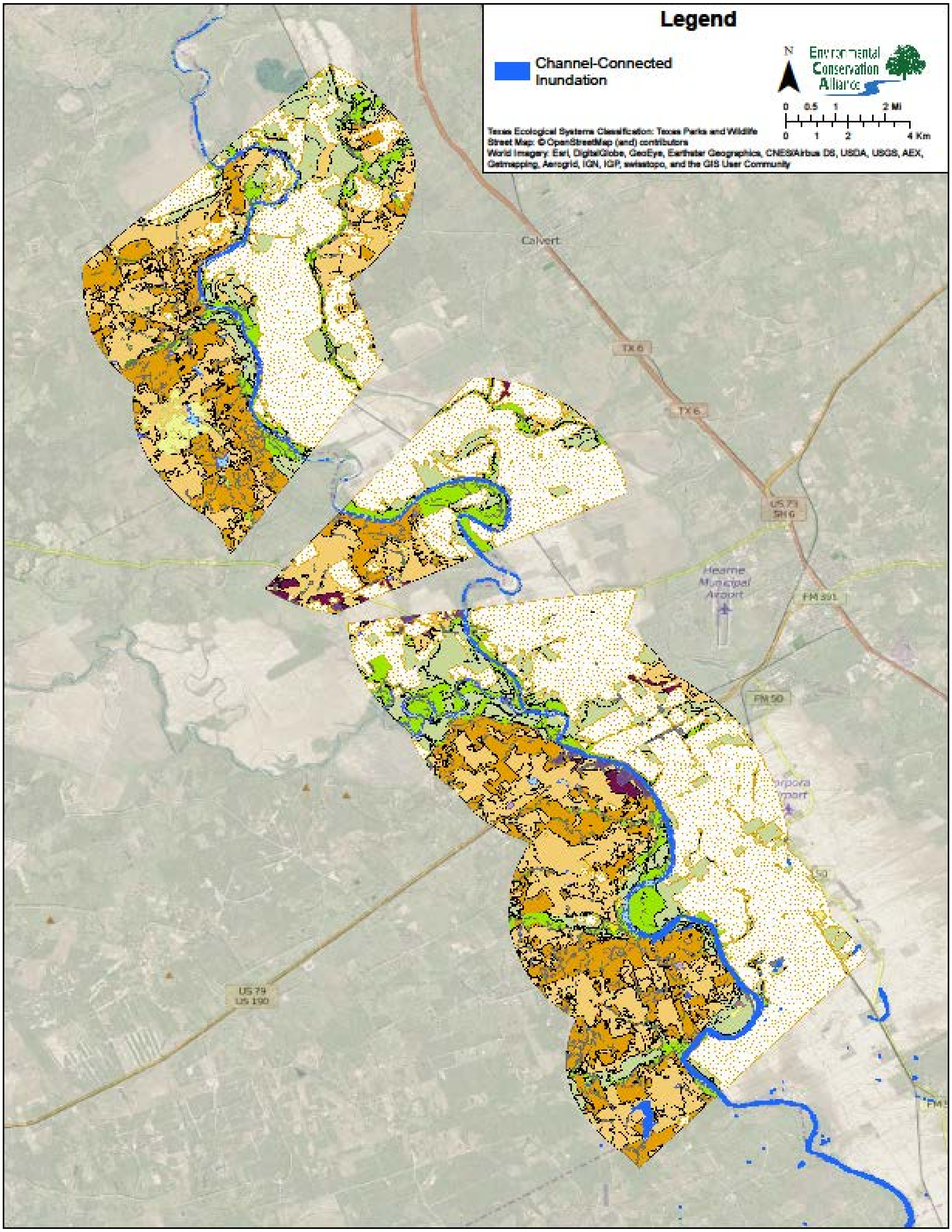


Figure 9.5 All Inundation Map: Wallis Study Reach
01/19/92 Inundation Event: 56,100 cfs

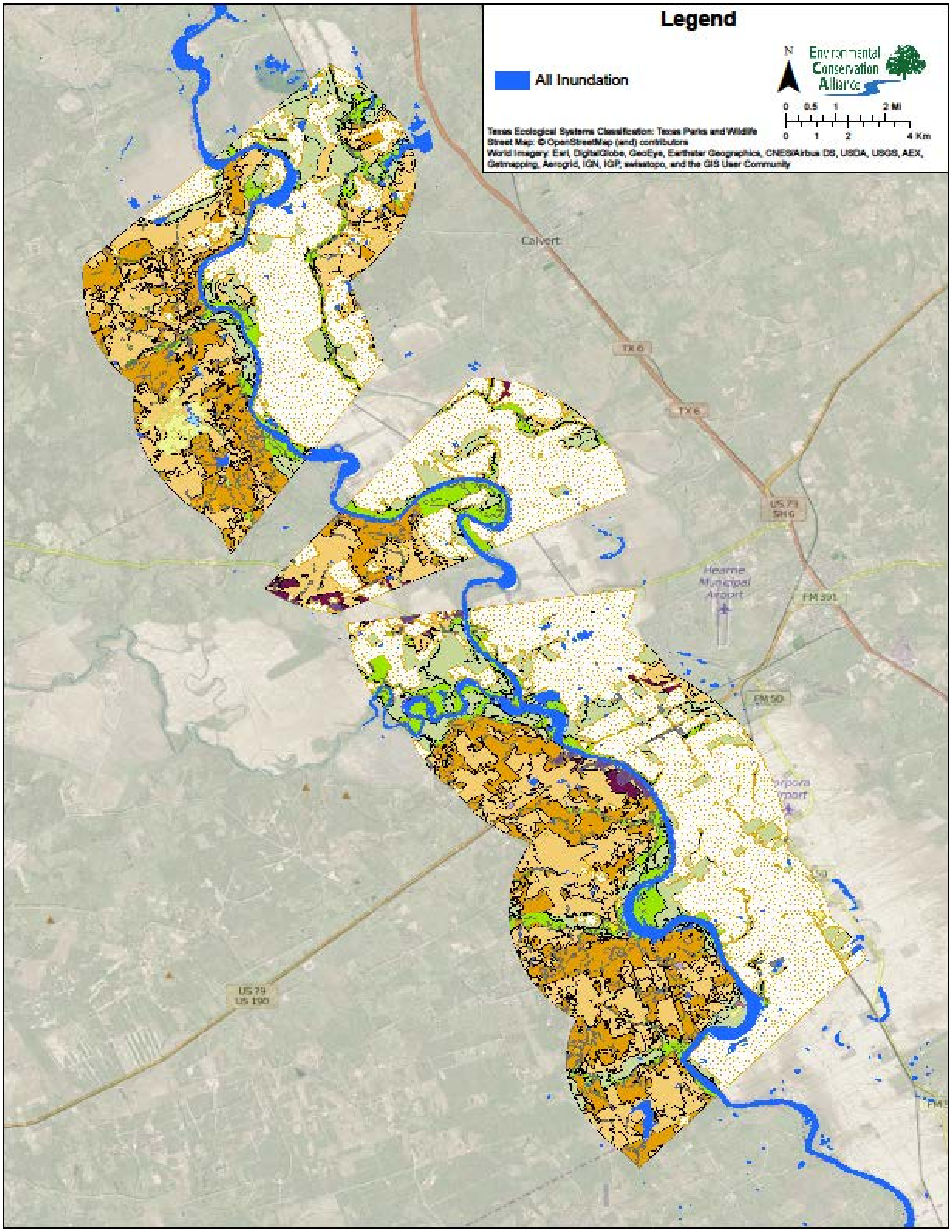


Figure 9.6 All Inundation Map: Wallis Study Reach
01/19/01 Inundation Event: 13,400 cfs

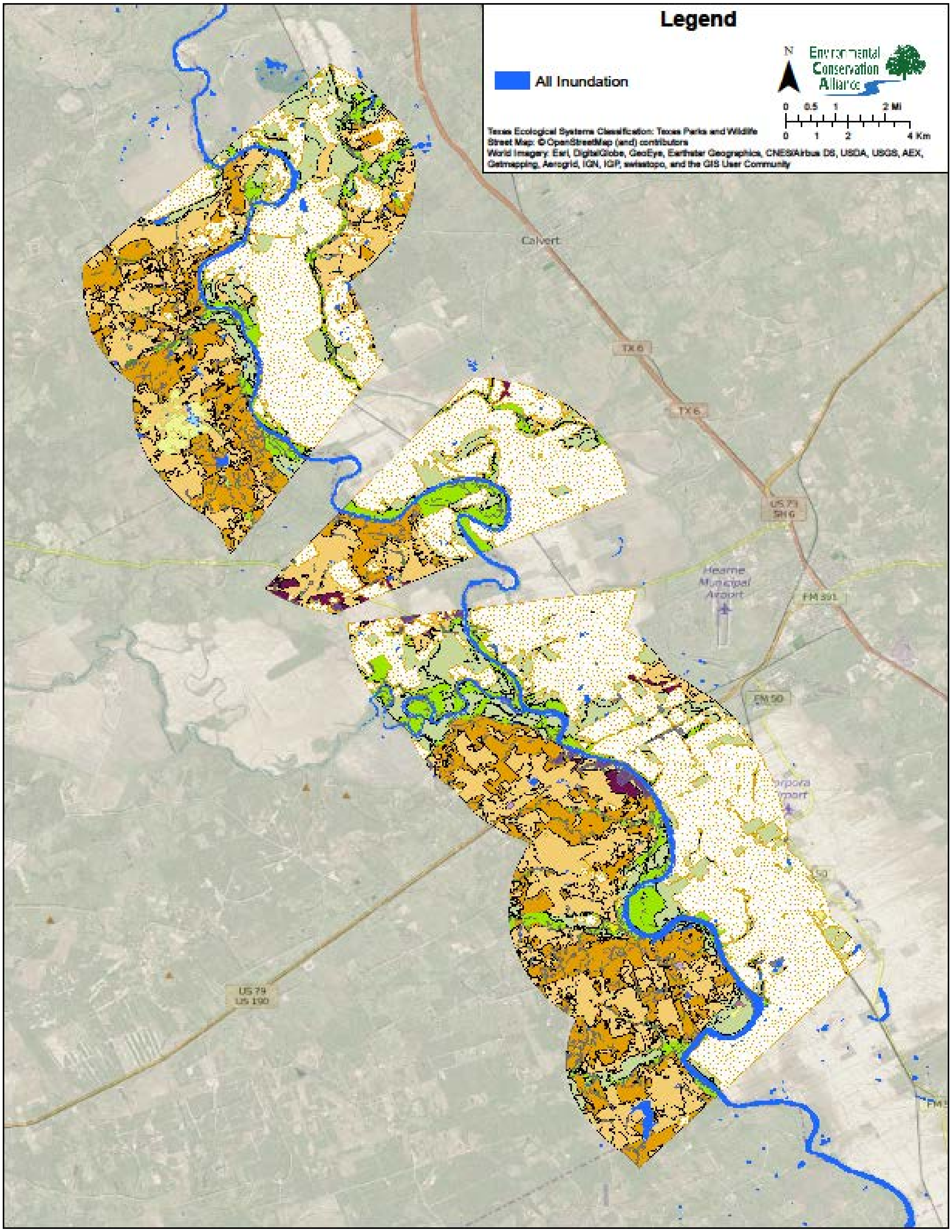


Figure 9.7 All Inundation Map: Wallis Study Reach
02/02/09 Inundation Event: 487 cfs

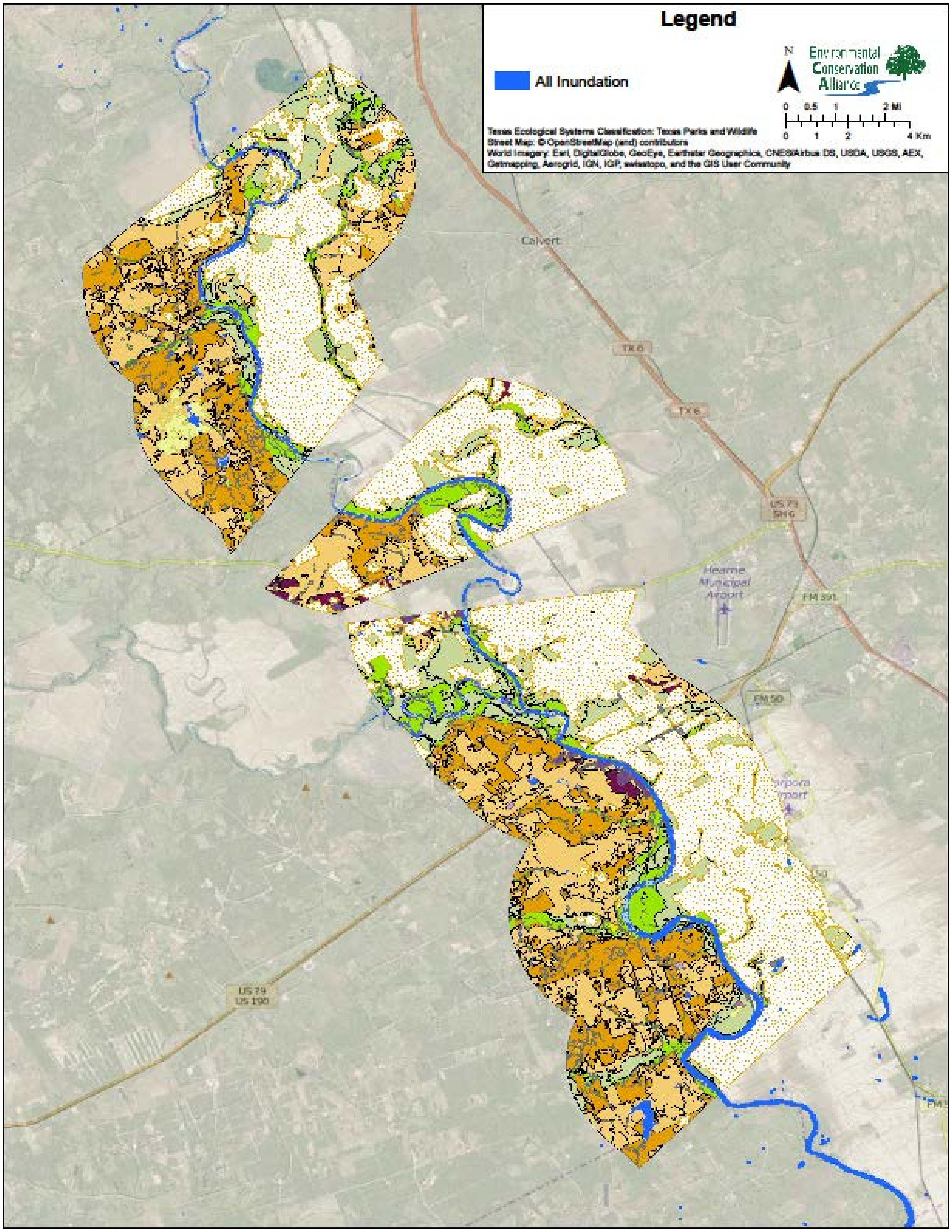


Figure 10.1 Inundation Maps: San Felipe Study Reach
Legend for Central Texas/Post Oak Savanna/Columbia Bottomlands Habitat Types

Figure 10.2 Channel-Connected Inundation Map: San Felipe Study Reach
03/07/92 Inundation Event: 71,000 cfs

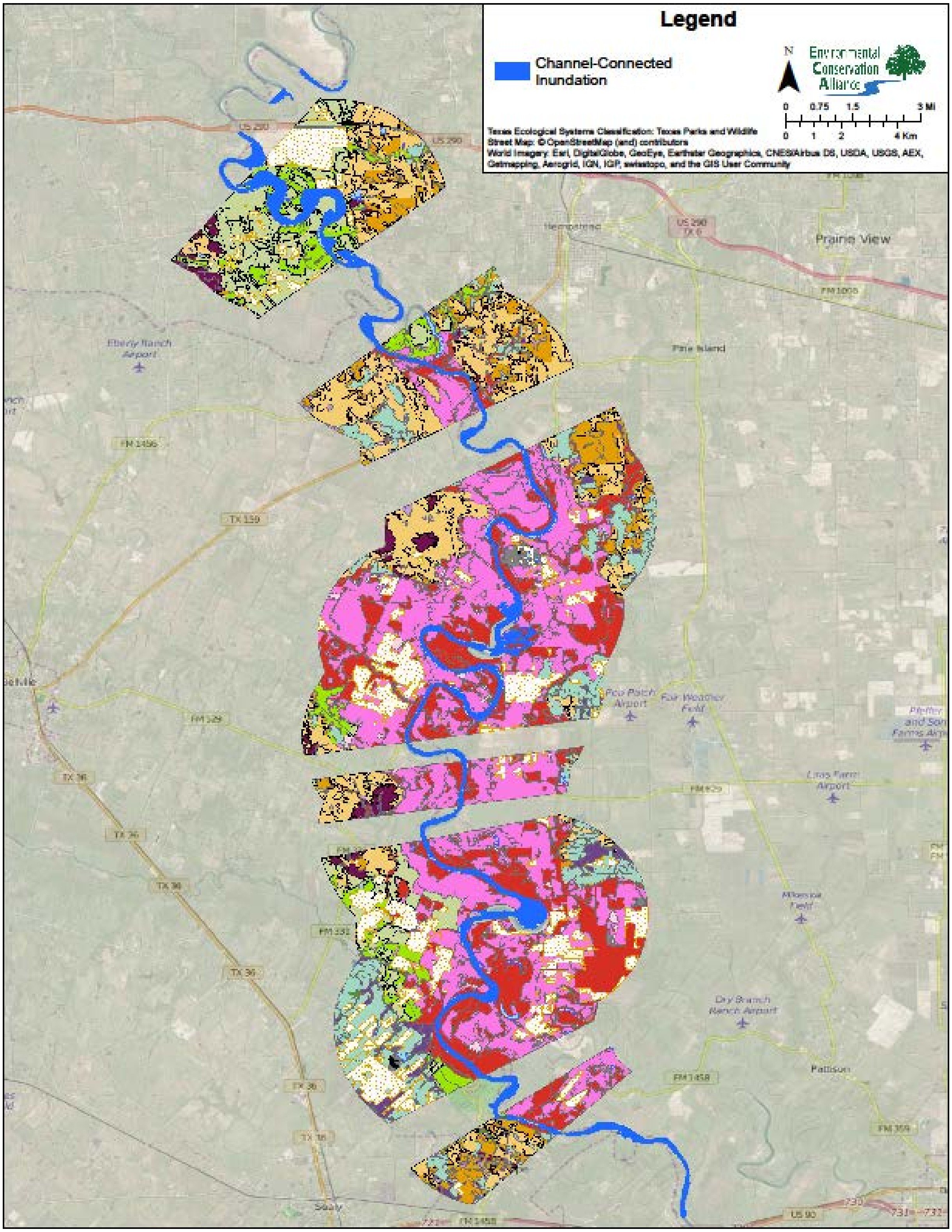


Figure 10.3 Channel-Connected Inundation Map: San Felipe Study Reach
02/25/94 Inundation Event: 19,200 cfs

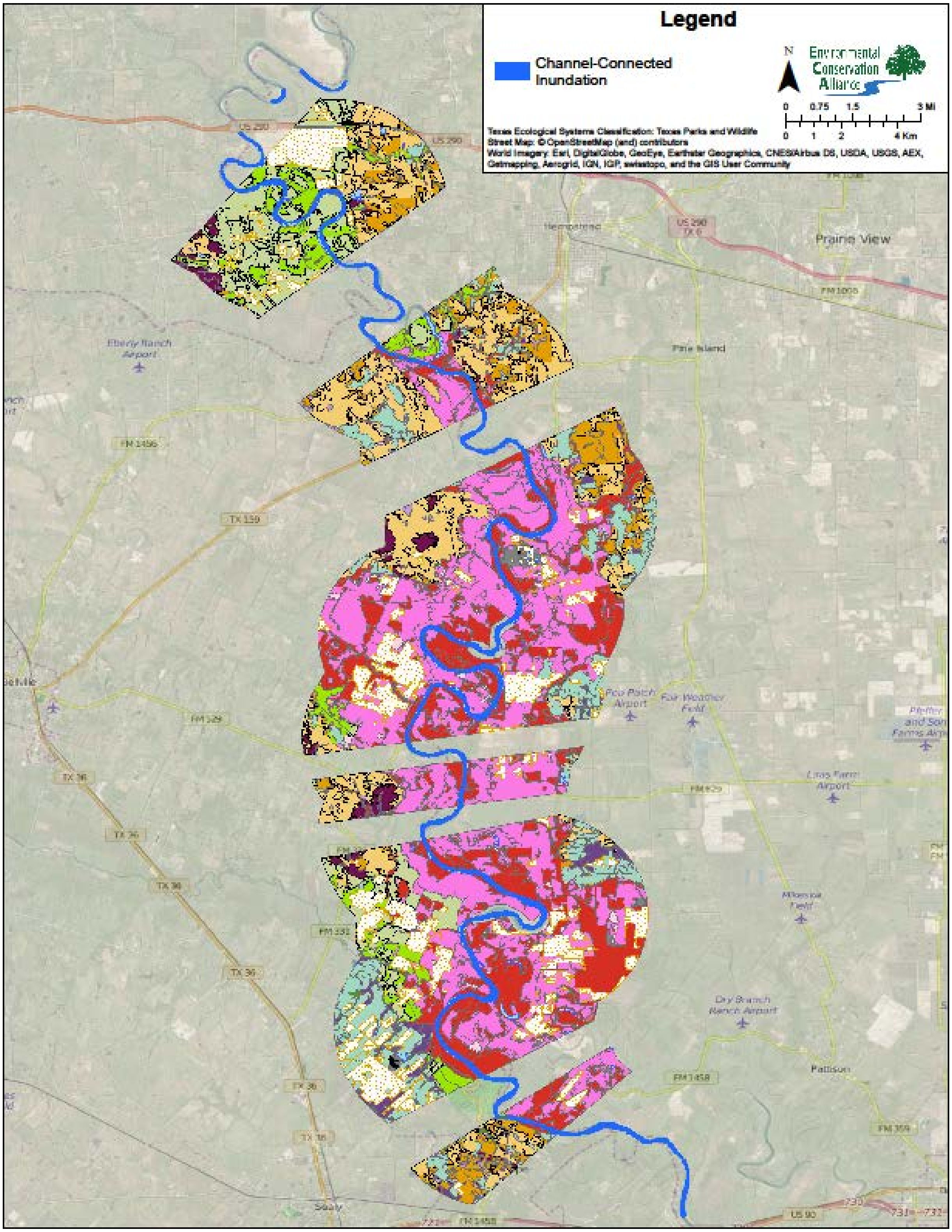


Figure 10.4 Channel-Connected Inundation Map: San Felipe Study Reach
12/01/11 Inundation Event: 674 cfs

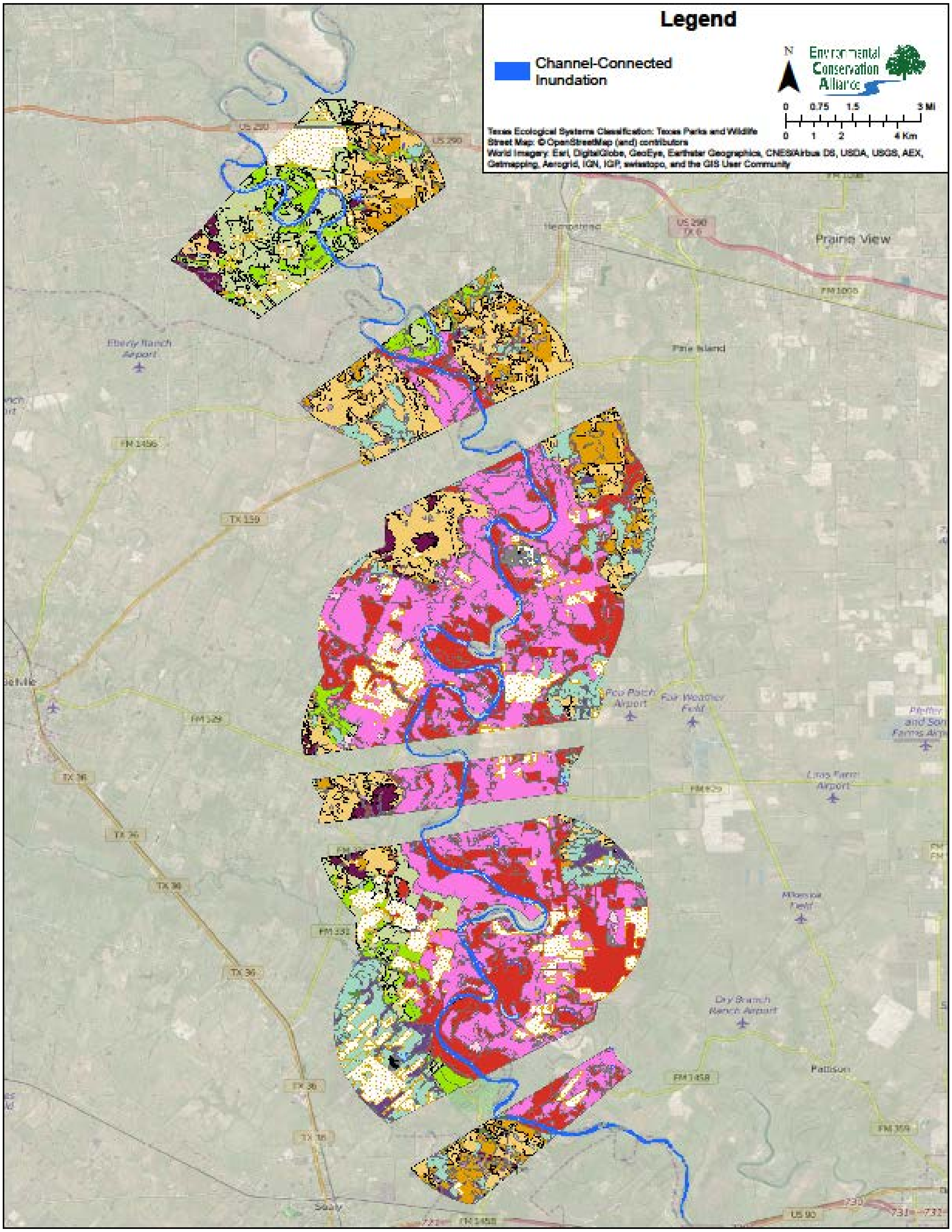


Figure 10.5 All Inundation Map: San Felipe Study Reach
03/07/92 Inundation Event: 71,000 cfs

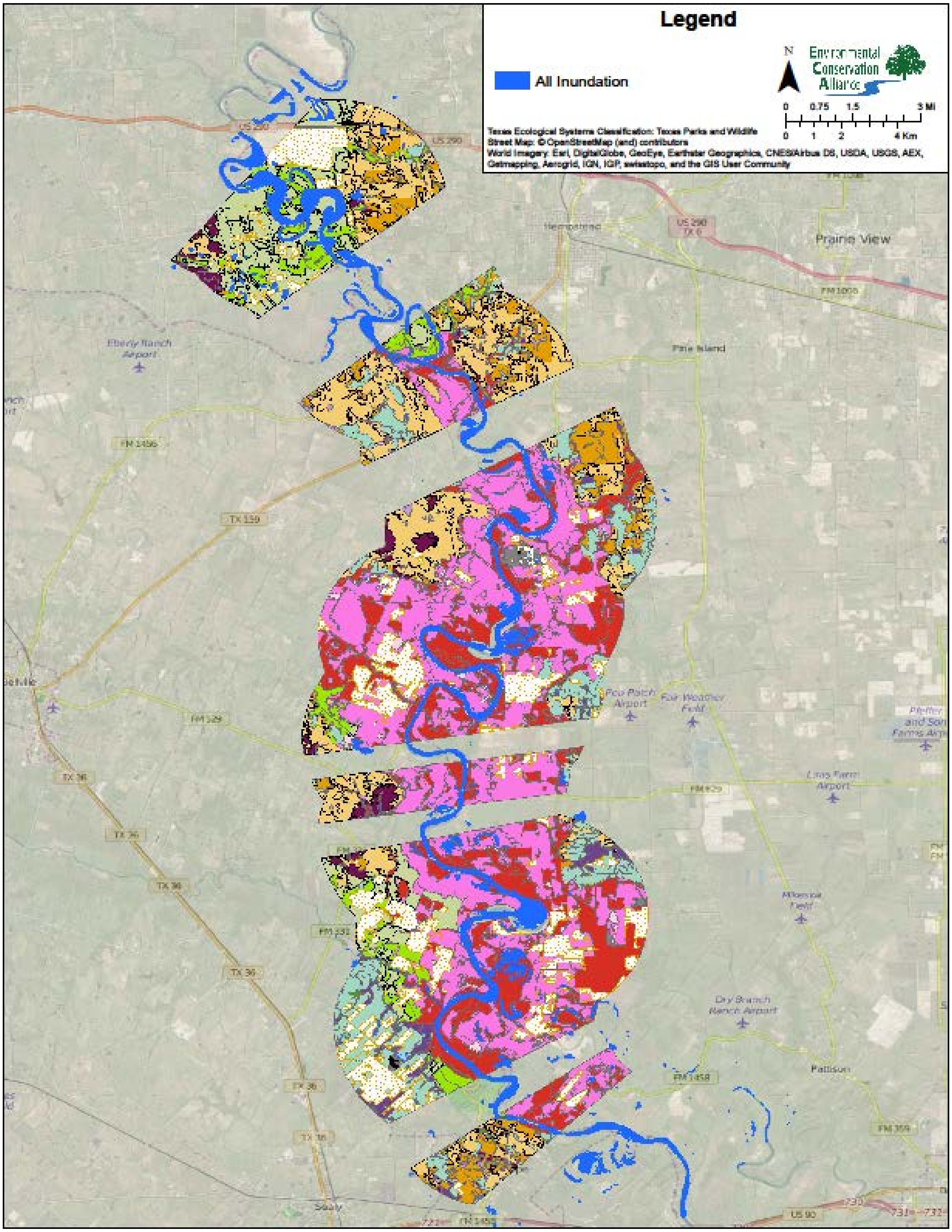


Figure 10.6 All Inundation Map: San Felipe Study Reach
02/25/94 Inundation Event: 19,200 cfs

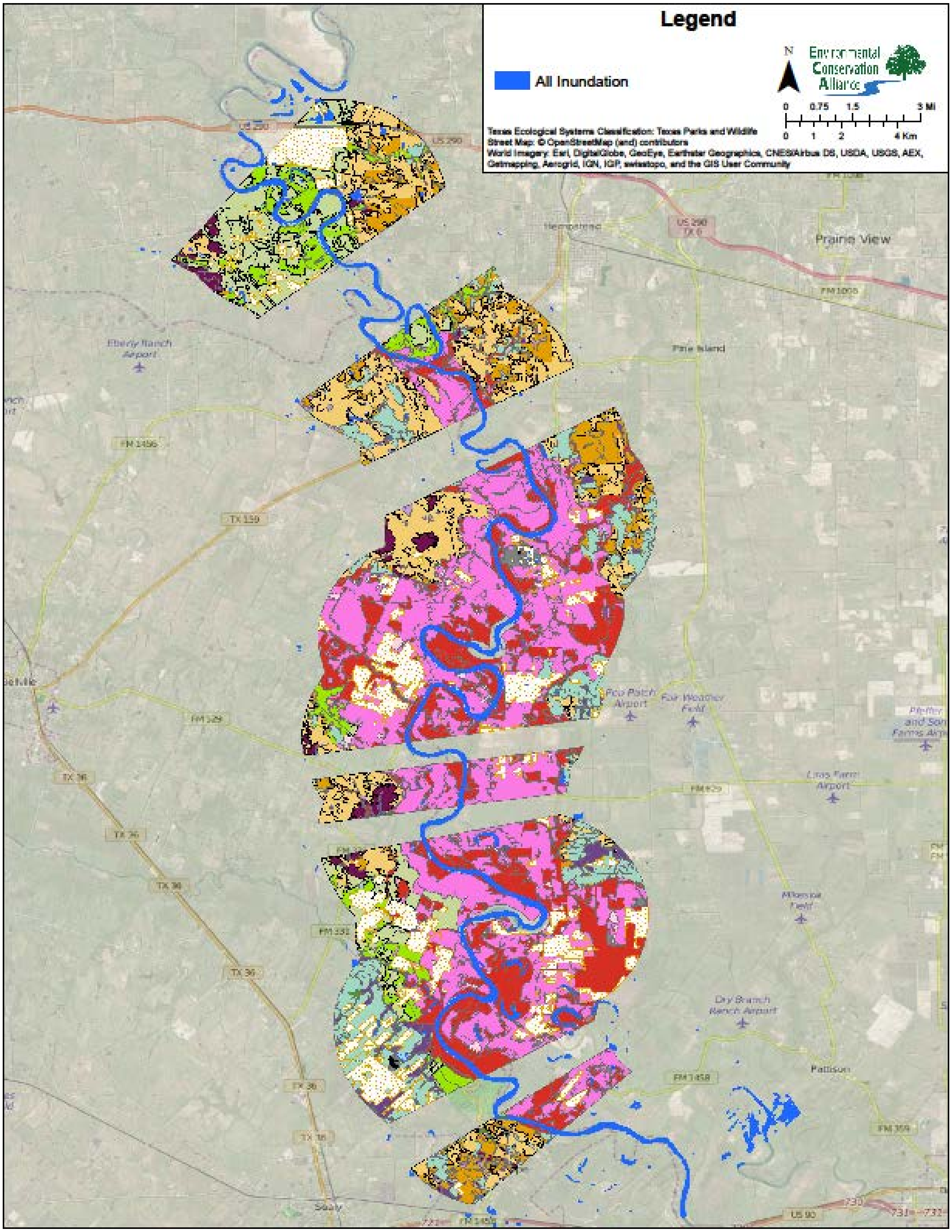


Figure 10.7 All Inundation Map: San Felipe Study Reach
12/01/11 Inundation Event: 674 cfs

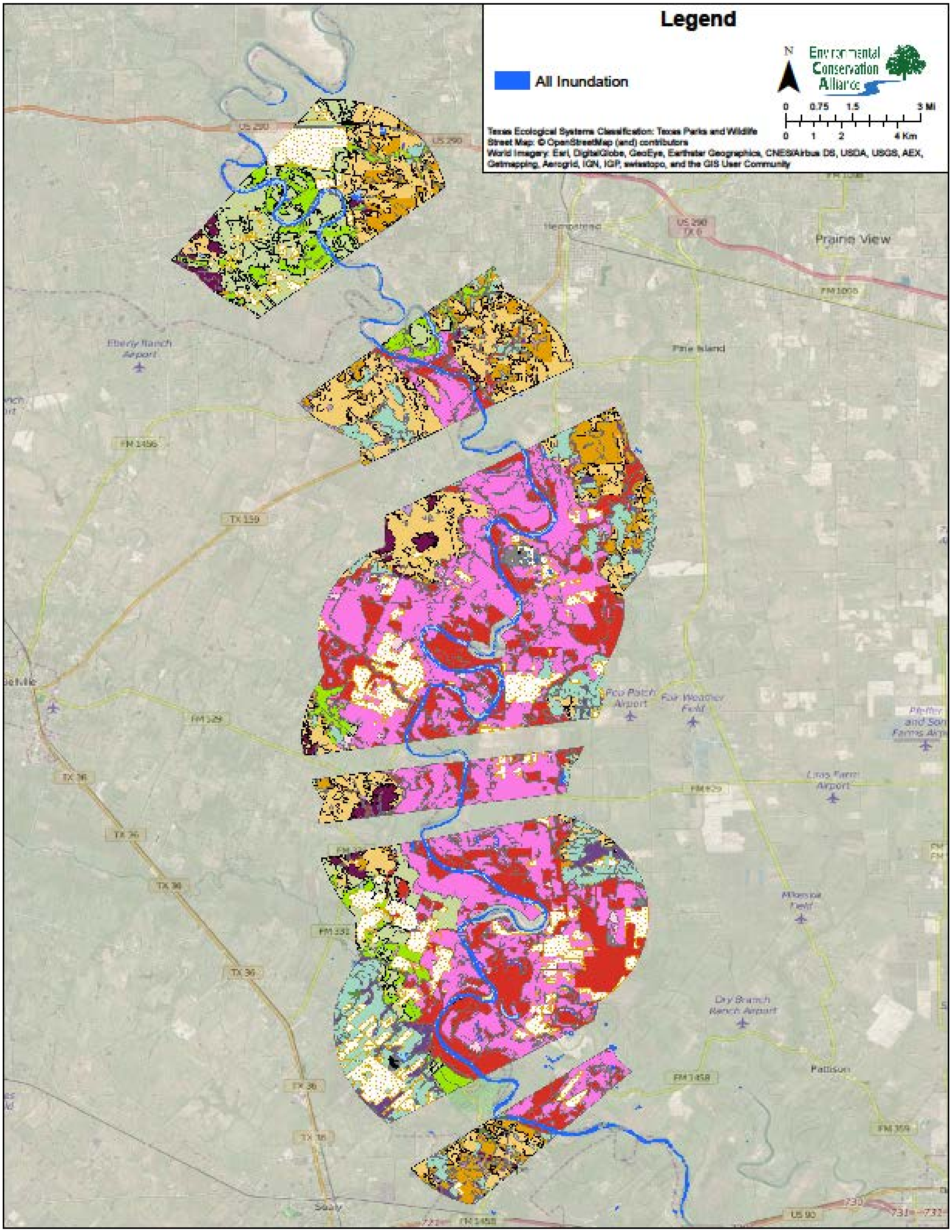
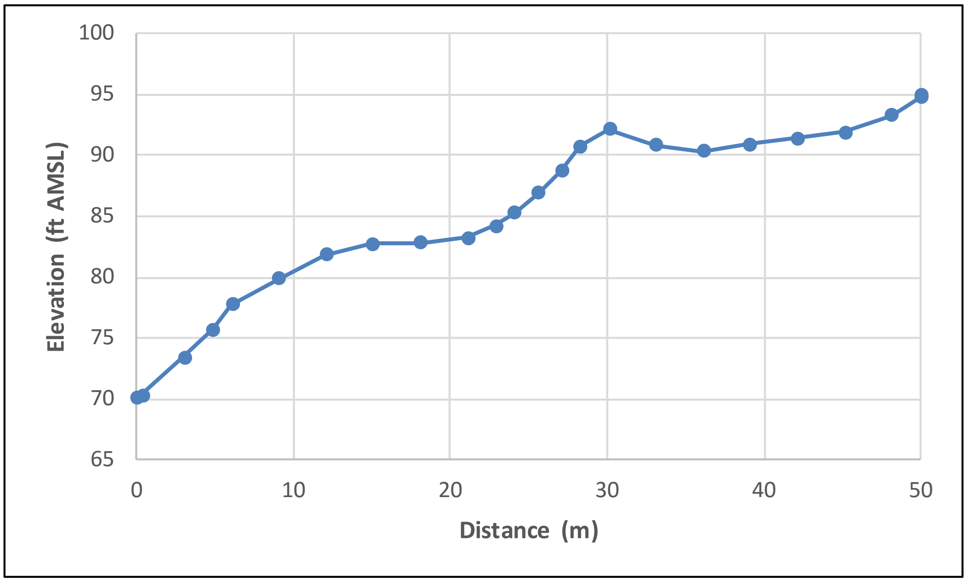


Figure 11 Elevation Profiles: Vegetation Transects
Wallis Study Site

Wallis Study Site, Transect 1A



Wallis Study Site, Transect 4A

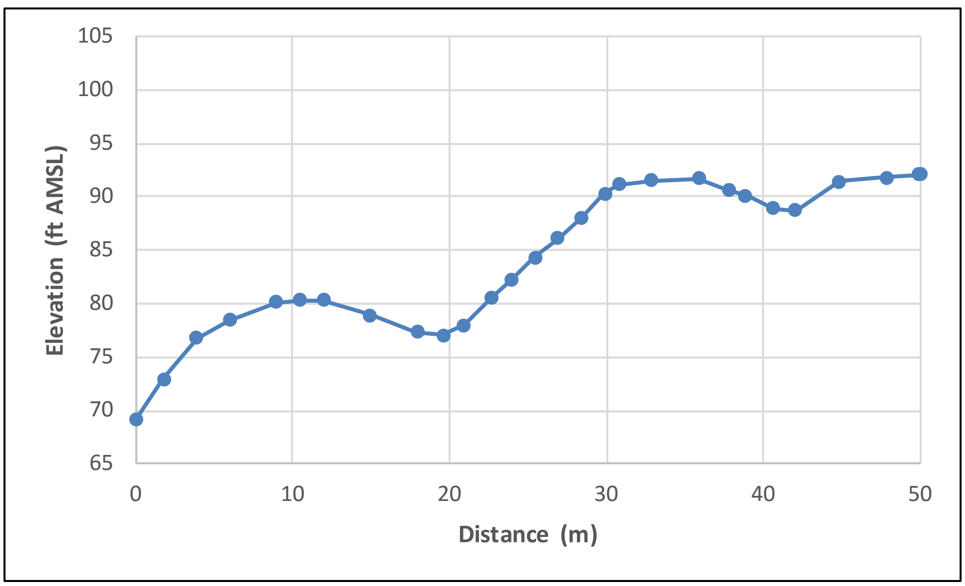
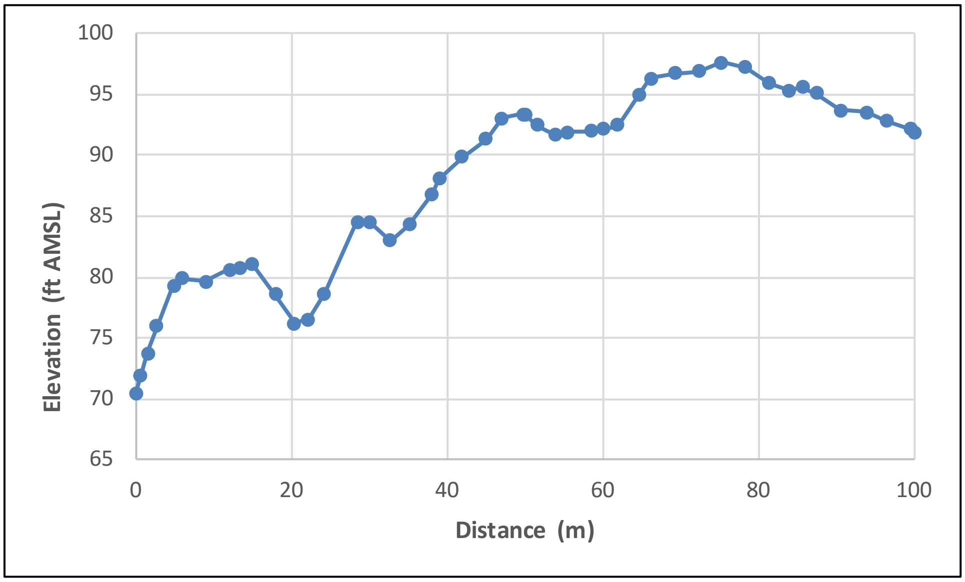


Figure 11 Elevation Profiles: Vegetation Transects
Wallis Study Site (continued)

Wallis Study Site, Transect 6AB



Wallis Study Site, Transect 7A

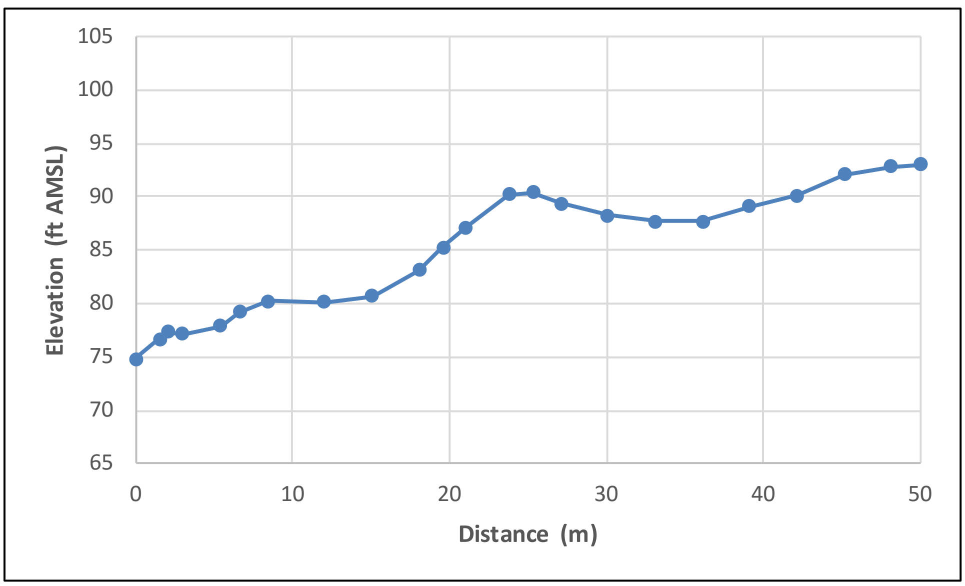


Figure 11 Elevation Profiles: Vegetation Transects
Wallis Study Site (concluded)

Wallis Study Site, Transect 12AB

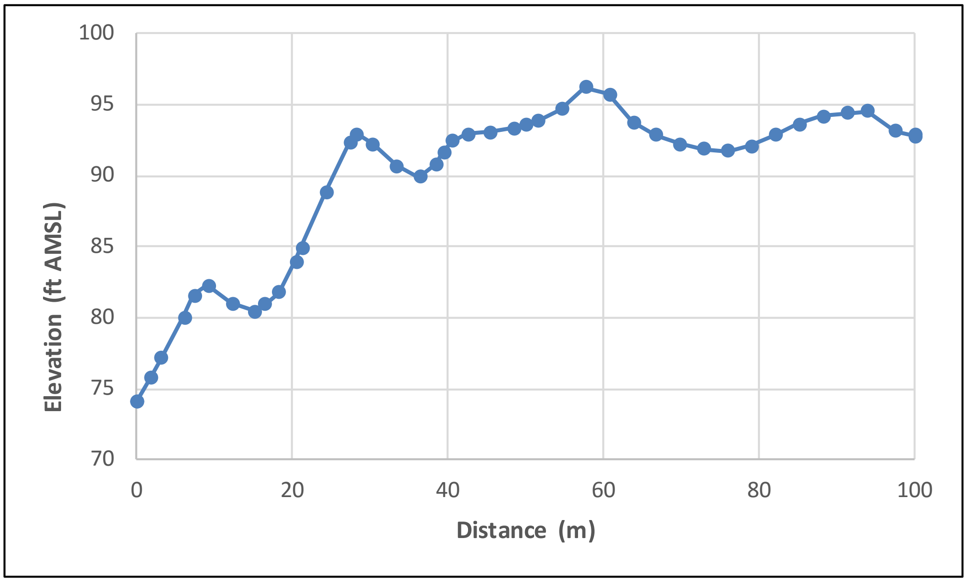
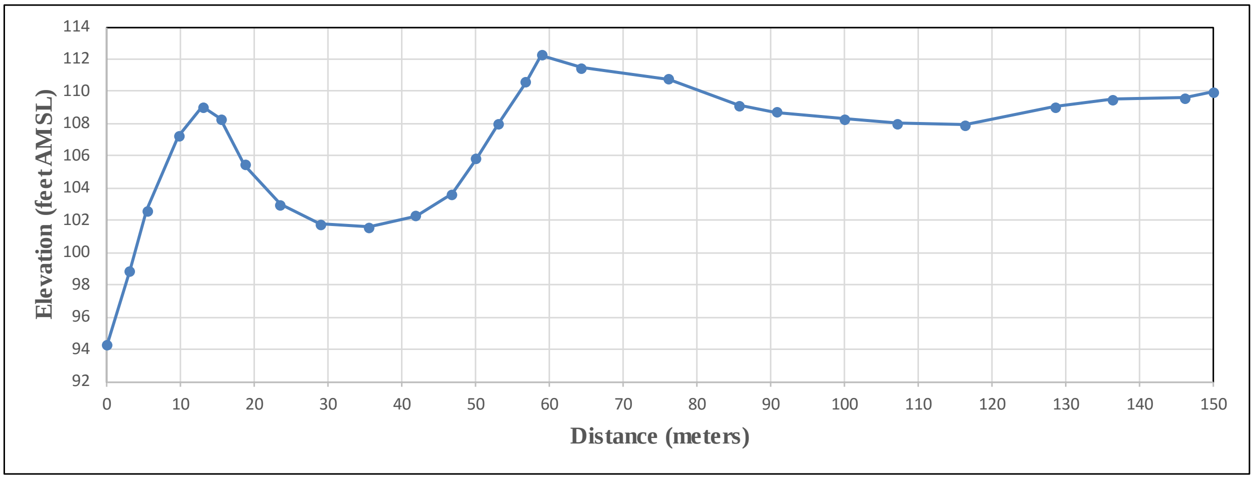
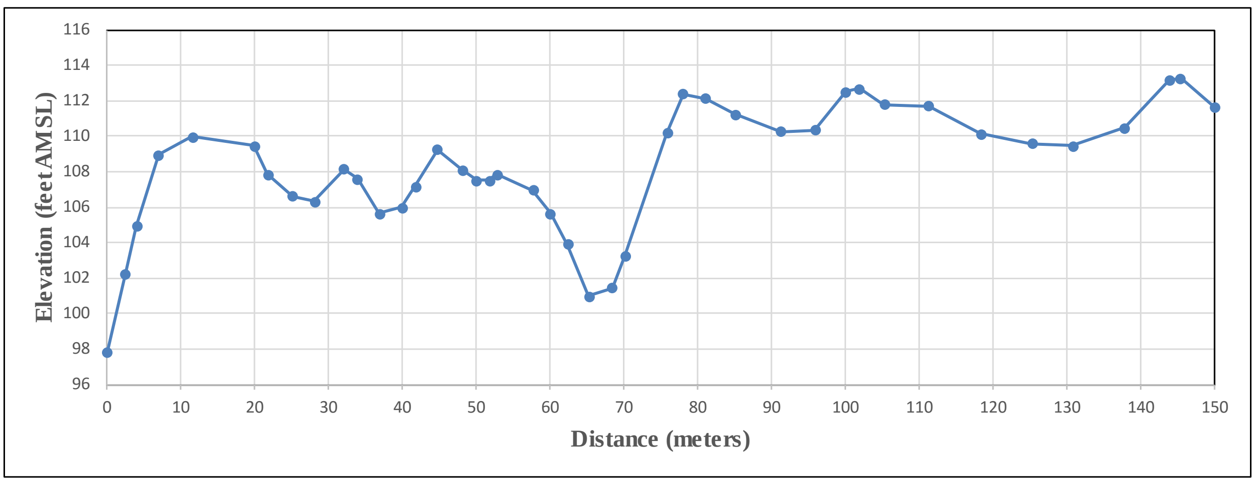


Figure 12 Elevation Profiles: Vegetation Transects
San Felipe Study Site

San Felipe Study Site, Transect 5ABC



San Felipe Study Site, Transect 9ABC



Appendix 3: Response to 6/14/16 Comments by the Texas Water Development Board

NOTE: All required and suggested changes were made, in addition to expanding the data analyses and re-writing much of the report. Tom Hayes

Riparian Productivity along the Lower Brazos River
Draft-final report to the Texas Water Development Board

Contract number 1200011484

REQUIRED CHANGES

General Draft Final Report Comments:

1. Please reference "TWDB Contract No. 1200011484" on the cover of the report.
2. Please correct the following typos:
    a. Page 13, 4th paragraph, last sentence, "as described Section 3.1.2" should be "as described in Section 3.1.2."
    b. Page 17, 2nd paragraph, 3rd sentence, "limited to a rising or stable flows" should be "limited to rising or stable flows."
    c. Page 20, 1st paragraph, 3rd sentence, "set to .5" should be "set to 0.5."
    d. Page 20, 3rd paragraph, 1st sentence, "was used apply" should be "was used to apply."
    e. Page 22, 3rd paragraph, 1st sentence, "which are experience" should be "which experience."
    f. Page 24, 2nd paragraph, 3rd sentence, "meandered most than" should be "meandered more than."
    g. Page 24, 4th paragraph, 2nd sentence, "habitats were downstream" should be "habitats downstream."
    h. Page 26, 2nd paragraph, 1st sentence, "higher the river stages" should be "higher river stages."
    i. Page 26, 2nd paragraph, last sentence, "second levees , where" should be "second levees, where."
    j. Page 34, "Van Dyke. 2012. Hydrological shifts" should be "Van Dyke. 2013. Hydrological shifts."
3. On page 4, in the 1st paragraph, reference is made to a larger "Texas Parks and Wildlife Department -Texas Water Development Board (TPWD-TWDB) project." More specifically, this is a Texas Instream Flow Program (TIFP) project. The TIFP is a cooperative effort of TPWD, TWDB, and the Texas Commission on Environmental Quality. Please refer to the larger project as the TIFP throughout the document.
4. The abbreviation "DBH" is used on page 11, last paragraph, 1st sentence before it is defined on page 12. Please insure all abbreviations are defined in the text before they are used.
5. Please provide definitions for the following abbreviates used in the document: ENVI, ESRI, TM, NAHP, NAPP, TOP, NAIP, OBL, FACW, and FAC.
6. On page 27, in the second paragraph, reference is made to "the 1/25/16 Middle and Lower Brazos River (MLBR) riparian assessment." Please provide a citation and reference for this document.
7. For Figures 4.1 and 4.2 on pages 39 and 40, please provide an explanation in the legend regarding the significance of the yellow lines.

8. In Table 1 on page 41, it is unclear if the column heading “Life Form” is equivalent to “Growth Form” in the footnotes. Please adopt one or the other designation to avoid confusion. To avoid confusion, please add a footnote to confirm that the “W” and “S” labels on the two, far right columns designate the Wallis and San Felipe study sites, respectively. Also, please designate the contents of two far right columns as being abundance codes.

SUGGESTED CHANGES

9. Page 8, 2nd paragraph, last sentence. Reference is made to “the average rate of seedling root growth, which is less than one inch or 2.5 cm per day.” The value of 2.5 cm per day was developed specifically for cottonwood seedlings in western North America. As acknowledged by Hughes and Rood (2003), “decline rate is influenced by floodplain substrate texture, plant species, and the ambient weather conditions related to water demand, particularly temperature, rainfall events, wind and sunshine.” For other riparian tree species in different physical settings, it’s reasonable to expect a different decline rate (either more or less than 2.5 cm) may be appropriate. Therefore, please consider amending your statement to read something like: “the average rate of seedling root growth, which they found to be less than one inch or 2.5 cm per day for cottonwood in Western North America.”
10. Page 8, 3rd paragraph, 2nd to last sentence states “early spring floods following leaf emergence probably should last a total of two to four weeks.” This statement seems to be related specifically to bottomland hardwood forests, which were apparently the subject of research by Gosselink et al. (1981) and Townsend (2001). For other situations, different flood durations may be more appropriate. Please consider amending the statement to read something like the following “for bottomland hardwood forests such as those along the lower Brazos River, early spring floods following leaf emergence should last a total of two to four weeks.”
11. Page 9, 2nd paragraph, 1st sentence states “The link between annual tree productivity and flood duration is statistically significant, but only when examined over a combined two-year period.” The work of Anderson and Mitsch (2008) was specific to a bottomland hardwood forest. In other situations, a longer or shorter time period may be more significant. Please consider modifying the statement to something like the following “The link between annual tree productivity and flood duration is statistically significant for bottomland hardwood systems, but only when examined over a combined two-year period.”