Least Disturbed Streams Project: An Extension of the Texas Aquatic Ecoregion Project

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Cover Photo: Rio Grande River downstream of Alamito Creek near Presidio, Presidio County, Texas

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LIST OF ACRONYMNS

ALU	Aquatic Life Use
BIBI	Benthic Index of Biological Integrity
°C	degrees Celsius
Cl	chloride
CFS	cubic feet per second
DEM	Digital Elevation Model
DO	dissolved oxygen
EPT	Ephemeroptera-Plecoptera-Trichoptera
HQI	Habitat Quality Index
IBI	Index of Biotic Integrity
IBWC	International Boundary and Water Commission
ISD	Independent School District
LDS	Least Disturbed Streams
LULC	Land Use & Land Cover
m	meter
mg/L	milligrams per liter
mL	milliliter
MRLC	Multi-resolution land characteristics
NELAC	National Environmental Laboratory Accreditation Certified
NLCD	National Land Cover Database
NH3	ammonia
NO3 + NO2	nitrate + nitrite
RBP	Rapid Bioassessment Protocols
SO_4	sulfate
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TAC	Texas Administrative Code
30 TAC …	Title 30, Texas Administrative Code, Chapter or Section…
TCEQ	Texas Commission on Environmental Quality
TKN	total Kjeldahl nitrogen
TOC	total organic carbon
TP	total phosphorus
TPWD	Texas Parks and Wildlife Department
USGS	United States Geological Survey
YSI	Yellow Springs Instruments Company
σV	standard error of velocity

ACKNOWLEDGMENTS

Thank you to numerous staff from various programs at the Texas Parks and Wildlife Department and the Texas Commission on Environmental Quality, as well as several river authorities, who contributed countless hours of field work, sample analyses and data management for this project. We thank numerous landowners, as well as the National Park Service, for providing access to least disturbed stream sample sites.

The authors thank Steve Twidwell and Jack Davis, formerly with the Texas Commission on Environmental Quality, who conceptualized and coordinated field and lab work for the earliest stages of this project.

RECOMMENDATIONS FOR NAVIGATING AND UTILIZING THIS DOCUMENT

This report is an extensive document which contains a large amount of data that can be challenging to navigate. Given the size of this document and scope of work, the authors agreed that it would be beneficial to provide an overview of the structure of this report along with recommendations for navigating and utilizing this document.

Biological data used in this report span a 32-year period (1986-2018) and include data from Bayer et al. 1992 (1986-1990), opportunistic and routine collections between 1991 and 2015, and targeted collections by the authors from 2016-2018. Watershed characterization and land use have been assessed for each site and the following data were collected in the field: in-channel and riparian physical habitat, water quality, fish community, and benthic macroinvertebrate community. Specific details regarding desktop and field data collection for these five primary parameters can be found in the methods.

The results and discussion are organized by aggregated ecoregions based on ecoregion groupings associated with regionalized fish and benthic indices of biotic integrity (Linam et al. 2002; TCEQ 2019). Each section includes a general characterization of the ecoregions within the aggregated ecoregion, results for each individual site, and summary of data/trends for the aggregated ecoregion. A general description of the geographic extent, climatic and landscape characteristics, and major water features are provided for each ecoregion. Least disturbed streams are grouped alphabetically within each ecoregion and include results and discussion for each of the five primary parameters. Summary sections provide an overview of watershed characterization and land use trends and summarize water quality, physical habitat, and biological community data across all sites within the aggregated ecoregion.

For most sites, data were collected at a single station; however, there are instances where data were combined for multiple stations within a reach to characterize a reach of a least disturbed stream (e.g., Slaughter Creek: stations 12185 and 12186). Given the variation in the number of sampling events across least disturbed streams, basic summaries and descriptive statistics are presented in this report. More detailed data can be requested from the Texas Commission on Environmental Quality (TCEQ).

All water quality, physical habitat, and biological data were collected by TCEQ and Texas Parks and Wildlife Department (TPWD) who drafted this document and similar collection methodologies were used for each sampling event across the full time period. Additional water quality data were included from routine monitoring conducted by TCEQ's Surface Water Quality Monitoring (SWQM) Regional staff and Clean Rivers Program partners.

The authors recommend that users treat this document as a reference tool rather than a traditional project report. Please consult the Table of Contents to find specific sites and/or ecoregions of interest and review supplemental habitat and biological data for that site and/or ecoregion in the appendices.

A complete list of least disturbed streams can be found in Appendix A.

EXECUTIVE SUMMARY

The Texas Aquatic Ecoregion Project was originally undertaken from 1986-1990 in an effort to describe the biological diversity of wadeable streams across the state of Texas (Bayer et al. 1992). This project was necessary to address the diversity in the state recognized by the Texas Water Quality Standards which divides major water bodies into classified segments which have been assigned specific uses and water quality criteria. Prior to this project, however, most wadeable streams in Texas were placed in the limited aquatic life use category based on little data and the presumption that higher aquatic life uses were generally precluded because of wadeable streams' smaller size. Bayer et al. (1992) clearly demonstrated that wadeable streams in Texas exhibit a great diversity of aquatic life and deserve higher levels of protection.

Since the conclusion of the Texas Aquatic Ecoregion Project Report (Bayer et al. 1992), sampling in least disturbed streams has been sporadic and relatively uncoordinated. Thus, the Least Disturbed Streams Project was launched in 2016 as a cooperative project between TCEQ and TPWD to develop a coordinated plan for the continued assessment of least disturbed streams. Least disturbed streams represent the best available habitat in each ecoregion and serve as indicators of baseline conditions to be considered in the development of water quality standards. These data also contribute to the development and application of methods to effectively monitor, evaluate, and manage water quality in the state as directed in Title 30 of the Texas Administrative Code (30 TAC). Specifically, data collected from least disturbed streams have supported the development and refinement of the index of biotic integrity (IBI) for fishes and benthic macroinvertebrates. These IBIs are used to set aquatic life use categories for water bodies and assess attainment of established aquatic life use categories as directed in 30 TAC Chapter 220 which specifies that TCEQ conduct monitoring and assess the health of aquatic life in Texas.

This report provides summaries of data collected from 114 least disturbed streams across Texas since 1986 and includes an inventory of all fishes and benthic macroinvertebrates collected, results for water quality sampling, watershed land use information, and local physical habitat data for each stream. The report also includes results of the fish and benthic macroinvertebrate IBIs for each sample site. Of the 445 fish samples collected across all ecoregions, 78% (n = 346) indicated high or exceptional aquatic life use, while 63% (n = 262) of the 415 benthic macroinvertebrate samples also indicated high or exceptional aquatic life use.

INTRODUCTION

BACKGROUND

Water quality and biotic assemblages exhibit spatial heterogeneity at regional scales, at least in part, in response to variability in climatic and physiographic characteristics. In Texas, these characteristics exhibit considerable variability across the state exemplified by variation in water quality. As a result, spatial frameworks are necessary to structure monitoring, assessment, and management of environmental resources. Such a framework is provided by ecological regions, or ecoregions, which are areas of relatively homogeneous soil, vegetation, climatic, geologic, and physiographic profiles. Ecoregions also incorporate patterns in anthropogenic pressure on ecosystems and in the existing and attainable quality of environmental resources.

Griffith et al. (2007) identified twelve level III ecoregions in Texas (Figure 1) based on an analysis of spatial variability of climatic and physiographic characteristics. Previous studies by Twidwell and Davis (1989) and Bayer et al. (1992) have demonstrated that water quality and biotic assemblages vary geographically in Texas in a generally systematic way, and that ecoregions can provide an effective framework for analysis and management.

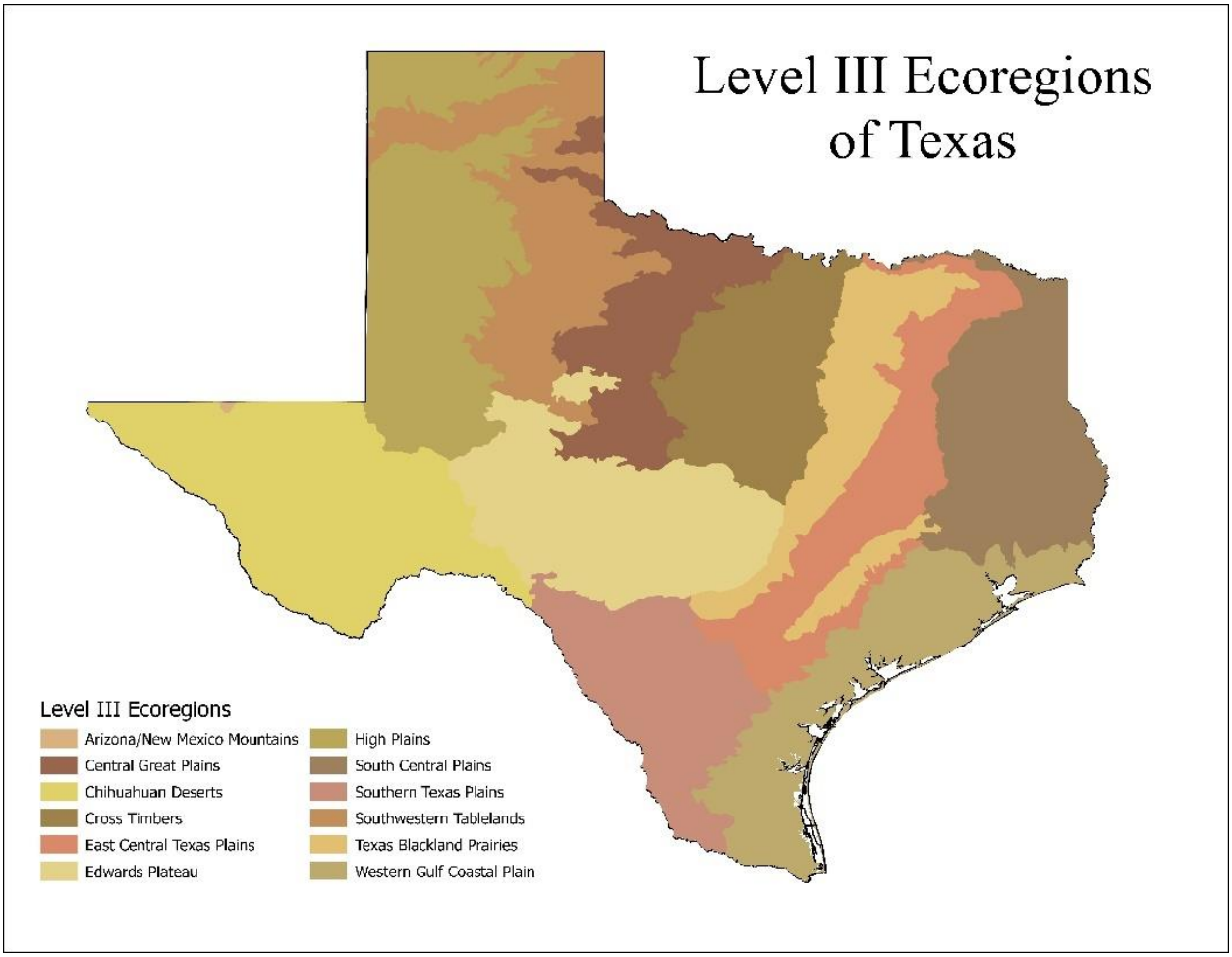

Figure 1. Level III Ecoregions of Texas.

The Texas Aquatic Ecoregion Project was the first comprehensive, coordinated effort to sample least disturbed streams to describe the biological and physical characteristics of lotic systems in Texas and to establish baselines for the development of indices designed to evaluate aquatic life use. Two primary publications resulted from the 1986-1990 effort: *An Assessment of Six Least Disturbed Unclassified Texas Streams* (Twidwell and Davis 1989) and *Texas Aquatic Ecoregion Project: An Assessment of Least Disturbed Streams* (Bayer et al. 1992). This project was designed as a continuation of the Texas Aquatic Ecoregion Project, and both utilized the following set of characteristics to select least disturbed streams to sample in each of the ecoregions in Texas specifying that each stream sampled should:

1. have little urban and industrial development in the watershed;
2. have little high intensity agriculture (i.e., cultivated crops);
3. have no major point sources of pollution;
4. have no atypical sources of non-point source pollution;
5. are not channelized or have not had major physical habitat modifications.

The least disturbed streams designation applies to the sample site and upstream watershed and does not include downstream portions that may not meet the criteria listed above. Streams with these characteristics provide information on background regional (ecoregion) water quality. These data can be utilized for water quality management objectives as described in Title 30 Texas Administration Code (30 TAC) §307.3(a) of the Texas Surface Water Quality Standards related to background (henceforth baseline) water quality. This section characterizes conditions that would occur in a waterbody in the absence of anthropogenic activities. Development of site-specific criteria using known baseline conditions of specific toxins of concern in receiving waters, sediment and/or indigenous biota (e.g., 30 TAC §307.6(c)(11)(A)) is an example of an application for this type of data.

Data collected on fish and benthic macroinvertebrate assemblages in these least disturbed streams describe biotic integrity on an ecoregion specific basis. This includes metrics such as species composition, diversity, and functional organization of a community of organisms in an environment relatively unaffected by pollution. Fish, benthic macroinvertebrate, and physical habitat data collected from least disturbed streams are used to quantitatively define aquatic life use (ALU) categories defined in 30 TAC §307.7(b)(3) and provide a mechanism for assessing support of these ALU categories in other streams not considered least disturbed.

PROJECT OBJECTIVE

The overall objective of the Least Disturbed Streams Project was to expand, refine, and consolidate the information on streams that can potentially serve as reference streams to support TCEQ and TPWD efforts to manage lotic systems most effectively in Texas.

The Least Disturbed Streams Project had five primary goals which will continue to be updated through future continuances:

1. Provide a list of least disturbed reference streams for each of the Texas ecoregions that have been evaluated as being appropriate reference streams (Appendix A).

2. Provide an organized, readily accessible database describing all fishes and benthic macroinvertebrates collected (Appendices D and E).
3. Provide an organized, readily accessible database of the physio-chemical characteristics of the streams sampled (Appendices B and C).
4. Provide detailed narrative interpretations of GIS data for all watersheds sampled in this report as well as making the GIS database available as needed.
5. Provide more quantitatively defined characteristics for least disturbed streams as given in the narratives associated with each watershed sampled for this report.

Actions to accomplish the Least Disturbed Streams Project objective and goals fell in five major categories:

- **Historical Data Compilation:** All available data on streams currently identified as least disturbed streams were organized and compiled, including historic data in paper files as well as in TCEQ's Surface Water Quality Monitoring Information System (SWQMIS) in the project module for the Texas Aquatic Ecoregion Project.
- **Designation Review of Existing Reference Streams:** Streams identified as least disturbed streams in the Texas Aquatic Ecoregion Project were evaluated to determine if the designation was still suitable (Appendix A).
- **Evaluation of Candidate Streams:** Candidate streams were evaluated to determine the necessity for adding to the list of least disturbed streams (Appendix A).
- **Ecoregion Surveys:** Field sampling was conducted in several—usually five to ten—streams in each ecoregion. Streams currently identified as least disturbed streams as well as candidate streams were sampled.
- **Temporal Variability Surveys:** A subset of the streams were sampled on several occasions to provide data on temporal variability at least disturbed sites (Appendix A and Figure 3).

The Least Disturbed Streams Project was planned and carried out in cooperation with the TPWD/TCEQ Interagency Biological Workgroup. Field sampling and data compilation was conducted cooperatively by TCEQ Central Office SWQM Team, TPWD River Studies Team, TCEQ regional biologists, and TPWD Water Resources Program. Data collected include field measurements, routine water chemistry, 24-hour dissolved oxygen, fish, benthic macroinvertebrates, periphyton cover, and physical habitat. Similar collection methods were used for each sampling event across the full time period from 1986-2018 unless specified. Data analysis was also conducted cooperatively between TPWD and TCEQ SWQM.

All data collected for the Least Disturbed Streams Project resides in SWQMIS and is associated with Project ID 312.

MATERIALS AND METHODS

WATERSHED CHARACTERIZATION

Figure 2 shows the workflow for characterizing the watersheds described in this report. ArcGIS was used to delineate watersheds for each site sampled. Digital Elevation Models (DEMs) for Colorado, New Mexico, and Texas were used for terrain pre-processing (USGS 2001). Each DEM was 7.5-minute data elevation with 30-meter resolution. The Arc Hydro Tools Tutorial (ESRI 2011) was followed to perform terrain pre-processing and subsequent terrain processing and watershed delineation.

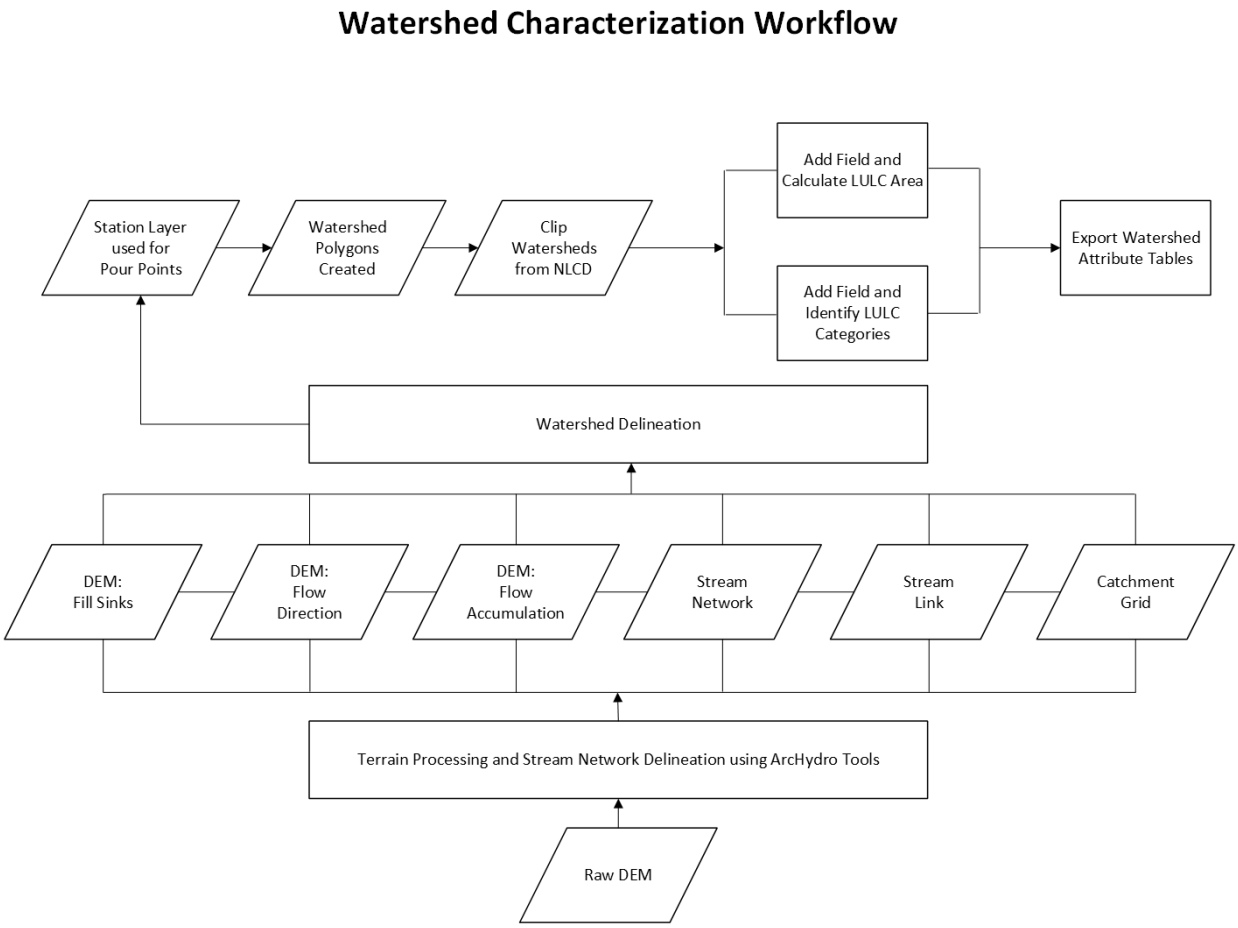

Figure 2. Watershed characterization workflow.

National Land Cover Data (NLCD) from the Multi-Resolution Land Characteristics (MRLC) Consortium was used to determine land uses within each watershed. Once watersheds were delineated using GIS, the resulting watershed layers were used to clip the NLCD land cover data. Land cover data for 1992, 2001, 2006, and 2011 were used for analyses. Fields for land use/land cover area (sq km) and land use classifications were added to each watershed attribute table (Table 1). Watershed land use data were exported into Excel and analyzed.

Due to the rapid advancement of mapping methods and surveying technologies, the 1992 land cover data is not entirely comparable to subsequent land use data sets and some land use changes over time may be attributed to these differences. The NLCD refined the land use classification approaches post-1992 resulting in slightly different land cover classifications for the 2001-2011 data sets (Wickham et al. 2014). Therefore, in order to make all land use data sets more comparable in our study, some of the 1992 land use classes were revised to align with the 2001-2011 land use classifications (Table 2). Land use classifications were further simplified in our study by grouping forest categories and wetland categories for analyses.

Outfall information was found in the TCEQ permits database. Unless otherwise specified, outfall information was accessed between 2018-2020.

Table 1. The land use/land cover for the watershed areas was obtained from the National Land Cover Database (NLCD) maintained by the U.S. Geological Survey. This table is adapted from the NLCD legend and describes the classifications for each class value used in this report.

Class/Value	Classification Description
Water	
11	**Open Water**- areas of open water, generally with less than 25% cover of vegetation or soil.
12	**Perennial Ice/Snow**- areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.
Developed	
21	**Developed, Open Space**- areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
22	**Developed, Low Intensity**- areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.
23	**Developed, Medium Intensity**- areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.
24	**Developed high Intensity**- highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.
Barren	
31	**Barren Land (Rock/Sand/Clay)**- areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
Forest	
41	**Deciduous Forest**- areas dominated by trees generally greater than 5 m tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
42	**Evergreen Forest**- areas dominated by trees generally greater than 5 m tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.
43	**Mixed Forest**- areas dominated by trees generally greater than 5 m tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.
Shrubland	
52	**Shrub/Scrub**- areas dominated by shrubs; less than 5 m tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Herbaceous	
71	**Grassland/Herbaceous**- areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling but can be utilized for grazing.

Class/Value	Classification Description
Planted/ Cultivated	
81	**Pasture/Hay**- areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
82	**Cultivated Crops**- areas used to produce annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
Wetlands	
90	**Woody Wetlands**- areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
95	**Emergent Herbaceous Wetlands**- areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Table 2. Combined 1992 land use classifications to align with 2001-2011 land use classifications.

LULC 1992	LULC 2001-2011
11 Open Water	11 Open Water
12 Perennial Ice/Snow	12 Perennial Ice/Snow
33 Transitional Barren; 85 Urban/Recreational Grasses	21 Developed, Open Space
21 Low Intensity Residential	22 Developed, Low Intensity
32 Quarries/Strip Mines/Gravel Pits	23 Developed, Medium Intensity
22 High Intensity Residential; 23 Commercial/Industrial/Transportation	24 Developed, High Intensity
31 Barren Land (Rock/Sand/Clay)	31 Barren Land (Rock/Sand/Clay)
41 Deciduous Forest	41 Deciduous Forest
42 Evergreen Forest	42 Evergreen Forest
43 Mixed Forest	43 Mixed Forest
51 Shrub/Scrub	52 Shrub/Scrub
71 Grassland/Herbaceous	71 Grassland/Herbaceous
81 Pasture/Hay; 84 Fallow	81 Pasture/Hay
82 Row Crops; 83 Small Grains; 61 Orchards/Vineyards/Other	82 Cultivated Crops
91 Woody Wetlands	90 Woody Wetlands
92 Emergent Herbaceous Wetlands	95 Emergent Herbaceous Wetlands

IN-CHANNEL AND RIPARIAN PHYSICAL HABITAT

Physical habitat data was collected following the methods outlined in Chapter 9 of the SWQM Procedures Manual Volume 2 (TCEQ 2014). The length of each study reach is 40 times the average wetted width with a minimum reach length of 150 m and a maximum of 500 m. For streams with a reach length of 150 to 300 m five equidistant transects are placed including the upper and lower ends of the reach. Reaches with a length of 301 m to 500 m were divided into six equidistant transects including the upper and lower ends. Transects were marked with survey flagging or some other identifiable markings and labeled "A" through "E" or "F" depending on the number of transects. Biological sampling was not conducted outside of the study reach unless it was deemed necessary by field crews.

Physical stream characteristics were measured at each transect. Stream characteristics were counted or observed in each study reach and included the number of riffles, the number of stream bends (poorly, moderately, or well-defined), the number of channel obstructions, the maximum pool width and depth, and water level. Instream physical characteristics were measured or observed 3 m upstream and downstream of each transect and included the stream width at the transect; the bank slope, erosion potential, and dominant riparian vegetation types on the left and right bank; the mesohabitat at the transect (riffle, run, glide, pool); the dominant substrate type; percent gravel or larger; percent instream cover; the instream cover types; the amount of macrophytes and algae; and the percentage of tree canopy cover. Additionally, stream depth is measured at 11 equidistance points along each transect and the thalweg depth (deepest portion of the channel) is recorded. The width of the natural vegetative buffer is recorded at each transect and the aesthetic (wilderness, natural, common, offensive) is recorded for the reach.

Physical habitat data is summarized and compiled averaging stream width and depth, percent of substrate gravel sized or larger, percent instream cover, percent stream-bank erosion potential, stream-bank slope, width of natural buffer vegetation, percent composition of riparian vegetation, and percent of tree-canopy coverage. The summarized physical habitat data is used to calculate the Habitat Quality Index (HQI), however data collected in the earlier studies do not include physical habitat measurements. Instream cover, bottom substrate stability, dimension of largest pool, water level, bank stability, channel sinuosity, riparian buffer, and overall aesthetic of the reach are used as metrics to calculate the HQI score. Each metric is scored based on the data collected at each site where higher scores correspond with reference conditions and lower scores correspond with more degraded conditions. Scores for each metric are totaled and the total HQI score relates to one of four categories (Exceptional, High, Intermediate, Limited).

WATER QUALITY

Multi-parameter water quality data sondes (YSI, Hydrolab) were used to measure temperature, pH, specific conductance, and dissolved oxygen. All water quality data sondes were calibrated and post-calibrated according to procedures from the TCEQ SWQM Procedures Manual Volume 1 (TCEQ 2012).

Water quality samples were collected by TCEQ field personnel or Clean Rivers Partners and submitted to a National Environmental Laboratory Accreditation Certified (NELAC) laboratory for analysis (TCEQ Laboratory in Sugar Land or LCRA-ELS in Austin). Parameters that were analyzed include: alkalinity, total organic carbon, chloride, sulfate, phosphorus, ammonia, total Kjeldahl nitrogen, total nitrogen, and chlorophyll-*a*; however, not all parameters were collected and analyzed at all stations. Water quality samples are generally collected from the centroid of the flow and at a depth of 0.3 meters as outlined in the TCEQ SWQM Procedures Manual Volume 1 (TCEQ 2012). Water quality data collected by TCEQ and the Clean Rivers Program partners are housed in TCEQ's SWQMIS database. Water quality data used for this report were accessed from SWQMIS on February 11, 2022.

Stream discharge data were pulled from stations where U.S. Geological Survey (USGS) stream flow gages were located. At stations where data were available, the median daily flow for the site was plotted.

FISH

Nekton samples were collected using both backpack electrofishers and seining methods as described in Chapter 3 of the SWQM Procedures Manual Volume 2 (TCEQ 2014). Backpack electrofishing samples were collected in an upstream manner starting at the bottom of the reach and working toward the top, while seines were fished in a downstream direction. Level of effort for backpack electrofisher was a minimum of 900 seconds and a minimum of six successful seine hauls were completed. Nekton sampling was conducted until no new species were collected for both methods. All available habitats were sampled along the reach. Nekton samples were vouchered by either photographing and/or preserved in 10% formalin and brought back to the lab to be stored in 95% ethanol for long term storage. Species that could not be identified in the field were preserved and identified later in the laboratory.

An index of biological integrity (IBI) was calculated for each fish assemblage sampling event using the regionalized IBI (Linam et al 2002). In general, the metrics to calculate the IBI are based on species richness, the proportions of tolerant and intolerant species, the percentages of different feeding guilds, the number of individuals collected, the number of non-native species, and fish health. The different ecoregions of Texas have between 8 and 12 metrics that were derived from historic data. Fish assemblage data for each sample event was scored according to the metrics of the ecoregion where the site is located, and the metric scores were summed to calculate aquatic life use (exceptional, high, intermediate, limited). These aquatic life use scores were summarized for each aggregated ecoregion by displaying the ranked mean for each stream sampled. Additionally, IBI scores and raw metric values were plotted through time to assess temporal trends ($\alpha = 0.05$).

BENTHIC MACROINVERTEBRATES

Benthic macroinvertebrate samples were collected following either the rapid bioassessment protocols (RBP) or quantitative Surber sampling methods outlined in Chapter 5 of the SWQM Procedures Manual Volume 2 (TCEQ 2014). The RBP's used to collect benthic

macroinvertebrate samples in this study are for wadable streams using a D-frame kicknet with mesh size ≤ 590 µm. Samples were collected from riffle habitat where available, otherwise samples were collected from runs, glides, and pools if no other preferred habitat were available along the reach. D-frame kicknet is placed with the mouth of the net facing into the flow of the stream while the sampler disturbs approximately 0.3 m^2 of the bottom substrate immediately upstream of the net. Any benthic organisms that are present are swept by the current and captured into the net. This process is repeated for a total of 5 minutes of sampling time. After the 5-minute sampling period is complete, the sample is washed in either the net or the sample is transferred into a No. 30 sieve or sieve bucket (mesh size ≤ 595 µm) to remove any sediments. The sample was then transferred into a specimen tray and a minimum of 140 organisms were collected with a goal of collecting 175 (+/- 20 percent). If 140 benthic macroinvertebrates were not present after 5 minutes of sampling, field crews would conduct another 5-minute round of sampling and continue processing the sample in the field until the appropriate number of benthic macroinvertebrates were collected.

Surber samples were collected by placing the Surber sampler on the substrate of a riffle with the mouth of the net facing into the current. Large rocks and debris in the Surber sample area were picked up and washed thoroughly allowing the macroinvertebrates and debris to flow into the net. A total of three replicates were collected from the stream in a manner that would represent the cross-sectional heterogeneity of the riffle.

Specimens were preserved in either 40% isopropyl alcohol or 70% ethanol and brought back to the laboratory for identification and enumeration. Benthic macroinvertebrates are identified to the appropriate taxonomic level based on recommendations from the SWQM Procedures Manual Volume 2 and are listed in Table 3 (TCEQ 2014). For reference, taxa that were identified to finer levels of taxonomic resolution were included in the species lists for each ecoregion. Voucher specimens from each sample event are retained for a period of no less than five (5) years.

A benthic index of biological integrity (BIBI) was calculated for each benthic macroinvertebrate assemblage sampling event using the Texas BIBI for surber samples (TCEQ 2014) and regionalized BIBI for RBP samples (TCEQ 2019). In general, the metrics to calculate the BIBI are based on taxa richness, an analysis of the presence of and relative abundance of tolerant and intolerant taxa, the percentages of different feeding guilds, and the taxa richness of sensitive taxa such as the Ephemeroptera, Plecoptera, and Trichopera (EPT). The different ecoregions of Texas each have 10 metrics that were derived from historic data. Benthic macroinvertebrate assemblage data for each sample event was scored according to the metrics of the ecoregion where the site is located, and the metric scores were summed to calculate aquatic life use (exceptional, high, intermediate, limited). These aquatic life use scores were summarized for each aggregated ecoregion by displaying the ranked mean for each stream sampled. Additionally, the aquatic life use categories associated with each BIBI score were plotted through time for each aggregated ecoregion to illustrate changes in the stream's benthic community over time.

Table 3. Taxonomic levels of identification for benthic macroinvertebrates from the SWQM Procedures Manual Volume 2.

Taxon	Identify to this level
Insecta	genus, except leave Chironomidae at family
Oligochaeta	leave at Oligochaeta
Hirudinea	leave at Hirudinea
Hydracarina	leave at Hydracarina
Isopoda	genus
Amphipoda	genus
Nematoda	leave at Nematoda
Ostracoda	leave at Ostracoda
Palaemonidae	genus
Cambaridae	leave at Cambaridae
Gastropoda	genus
Turbellaria	family
Pelecypoda	genus

RESULTS AND DISCUSSION

This report provides a summary of data collected from 142 sites on 114 least disturbed streams from 1986 to 2018 and includes data presented in Bayer et al. 1992 (Figure 3). Since the release of the Texas Aquatic Ecoregion Project report in 1992 (Bayer et al. 1992), a total of 101 sampling events were conducted on 85 streams across all aggregated ecoregions, and seventy of those were conducted on newly established sites (Figure 3). Blue dots represent historic sites that were sampled and included in Bayer et al. 1992 but were not revisited. Yellow dots represent revisited sites that were sampled and included in Bayer et al. 1992 and were re-sampled and included in this report. Green dots represent new sites that have been sampled since the release of Bayer et al. 1992 and were included in this report. Red dots represent sites that are not recommended as least disturbed streams because they are not representative of the respective ecoregion even though they meet the standards used to identify least disturbed streams.

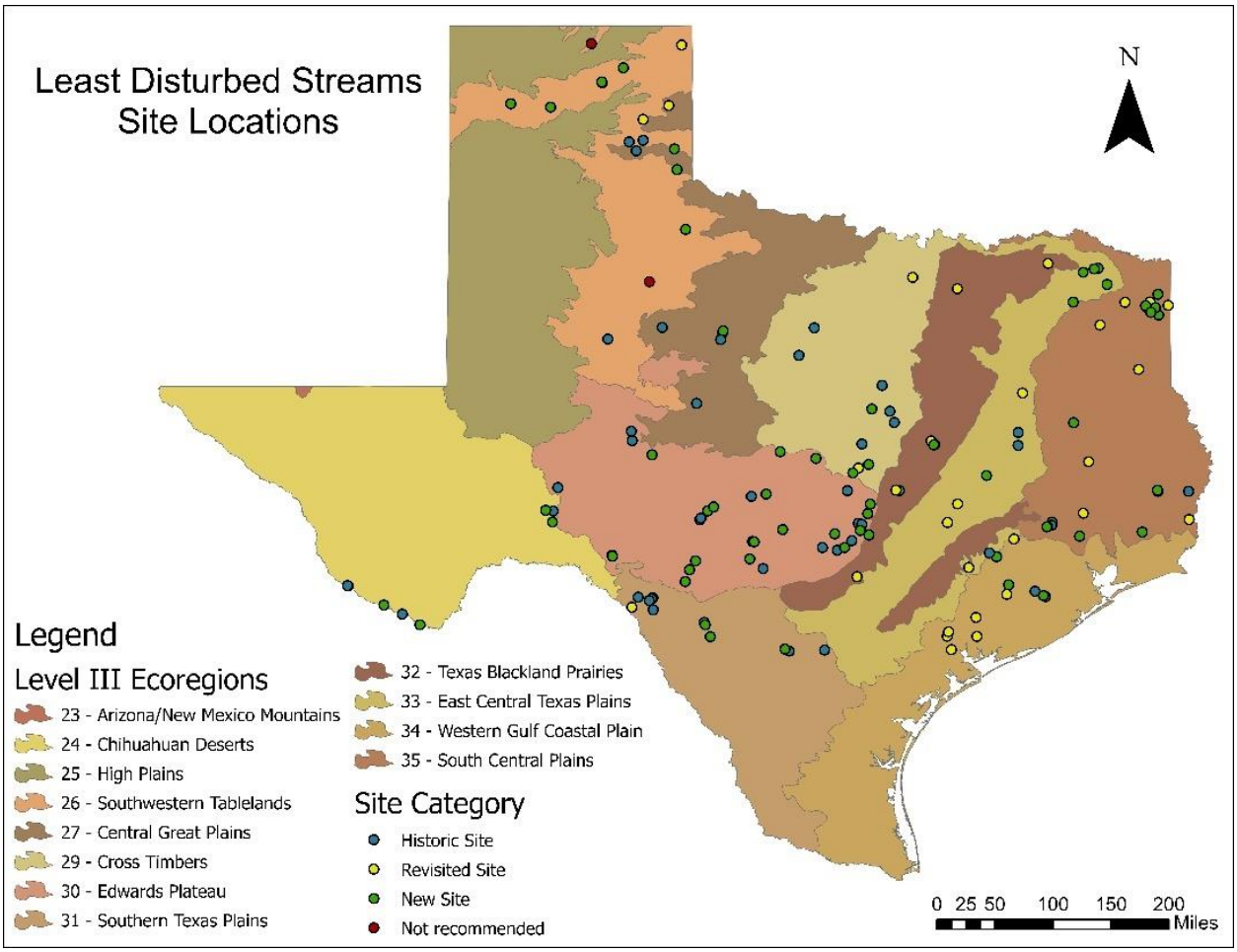

Figure 3. Map of least disturbed stream sampling locations in Texas.

ECOREGION 24 – SOUTHERN DESERTS

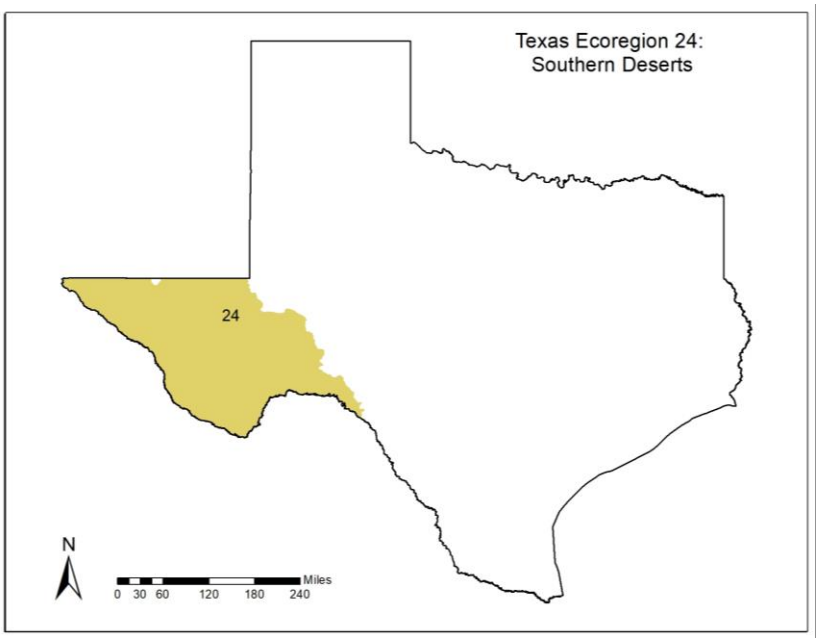

Figure 4. Map of Texas Ecoregion 24 – Southern Deserts.

Figure 5. Site photo from Independence Creek.

Ecoregion 24 Characterization

The Chihuahuan Deserts ecoregion extends from southeastern Arizona to the Edwards Plateau in south-central Texas and extends nearly 800 kilometers south into Mexico. In Texas, the ecoregion includes approximately 91,360 square kilometers. The High Plains, Edwards Plateau, and the Southern Texas Plains bound the Chihuahuan Deserts on the east, while the Rio Grande defines the western extent in Texas (Figure 4).

The region is relatively diverse and includes basins that exhibit the lowest surface elevations in west Texas, as well as mid-elevation grasslands, and mountains with elevations up to 1,800 meters. The Chihuahuan Deserts exhibit some of the lowest annual precipitation totals in Texas, ranging from 20 cm in low altitude basins up to 66 cm at higher altitudes in the mountains (Griffith et al. 2007). Rainfall occurs mostly between June and September, and the sparse precipitation often falls in heavy, episodic events.

Portions of the Rio Grande, and the Pecos River watersheds constitute the major drainages in the Chihuahuan in Texas. Most other streams in the ecoregion are ephemeral, flowing only after heavy rainfall events. Aside from a few isolated springs, notably Independence Creek near Sheffield, the Rio Grande, and the Pecos rivers provide the only stable aquatic habitats in the ecoregion. With the exception of the spring fed streams, surface waters in the ecoregion exhibit relatively high dissolved solids concentrations. Cottonwood (*Populus sp*.) are common in the riparian zone of these streams and provide a good landmark for the location of springs. The saltcedar (*Tamarix sp.*) and the river cane (*Phragmites australis*) have invaded riparian areas, and often become the dominant riparian vegetation.

Table 4. Streams sampled in Ecoregion 24.

Alamito Creek	Rio Grande: Presidio	Terlingua Creek
Independence Creek	Rio Grande: Contrabando	
Pecos River	Rio Grande: Johnson Ranch	

ALAMITO CREEK

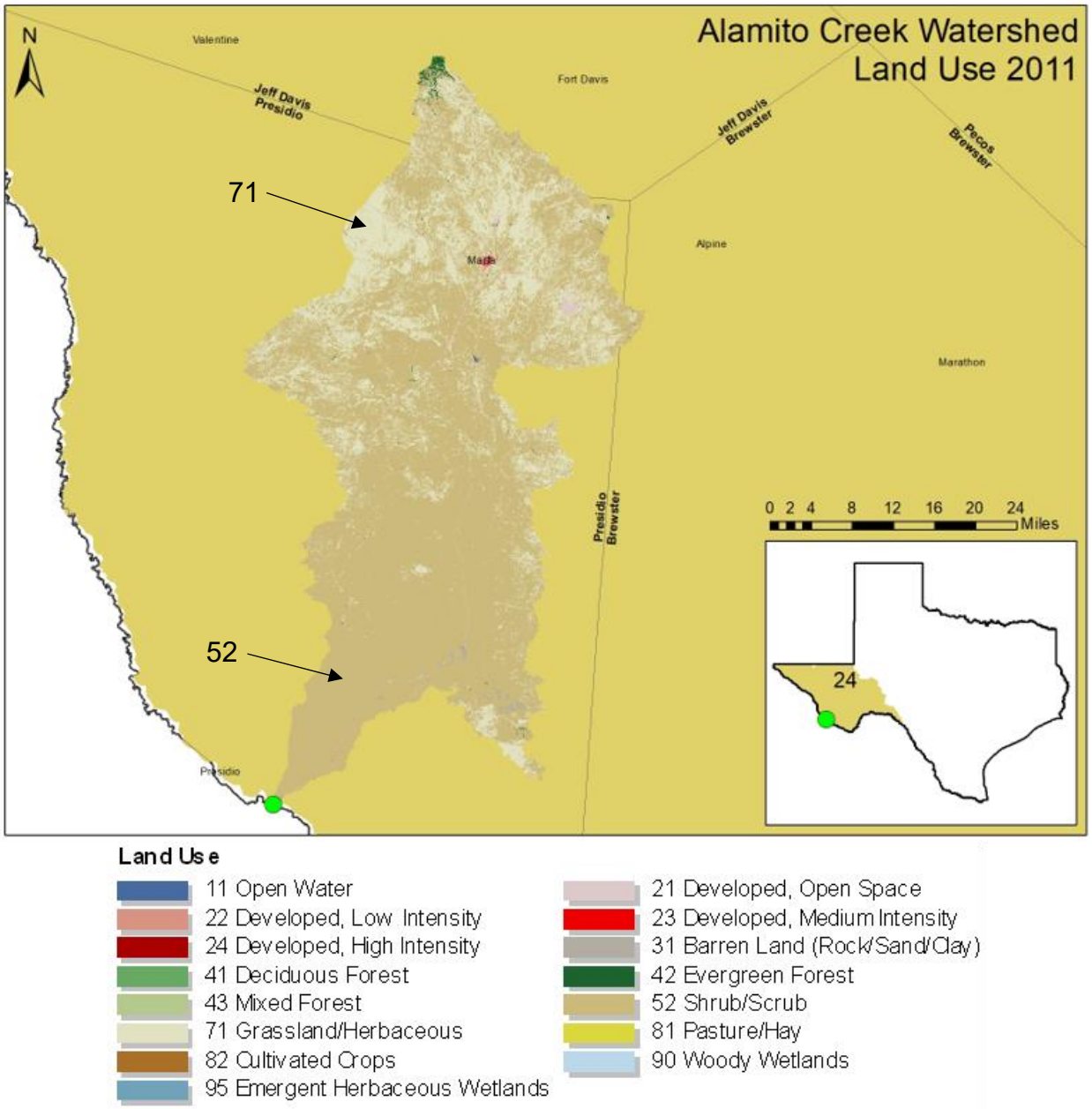

Figure 6. Map of Alamito Creek watershed location and 2011 land use; shrub/scrub and grasslands/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	July 11, 1989
Water Quality:	68 sample events
Fish:	July 11, 1989
Benthic Invertebrates:	July 11, 1989

Physical Characterization

Watershed and Land Use

Alamito Creek lies within the Rio Grande Basin. Sample site 13108 is located near FM 170, approximately 9.66 km southeast of Presidio in Presidio County (Figure 6).

The Alamito Creek watershed at site 13108 is approximately 3604.76 sq km. The station and much of the lower watershed are located in Level IV Ecoregion 24c, the Low Mountains and Bajadas, while the remaining watershed lie in Level IV Ecoregion 24b, the Chihuahuan Desert Grasslands. The dominant land cover in the watershed is shrub at 74.24% and is present throughout the watershed (Homer et al. 2015; Figure 6 and Figure 7). Grassland/herbaceous is the secondary land cover encompassing 24.25%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.89% and total cover for cultivated crops is 0.004%.

From 1992-2011 there was a 483 sq km decrease in grassland and a 14.09 sq km decrease in barren land (rock/sand/clay). There was a 469.82 sq km increase in shrub and a 27.05 sq km increase in open space development (Figure 8).

There are no permitted wastewater outfalls within the Alamito Creek watershed.

In Channel and Riparian Physical Habitat

Alamito Creek is a tributary to the Rio Grande River. Physical habitat for the creek was evaluated on July 11, 1989. The riparian width was 19 meters and was dominated by trees and shrubs, which each made up an average of 40% of the total riparian species, followed by grasses (20%). The average percentage of tree canopy cover was 8%. The dominant substrate was gravel and sand, and the average percent of substrate that was gravel size or larger was 40%. Average percent instream cover was 10%. Alamito Creek had an average depth of 0.1 meters and a maximum depth of 0.4 meters. The average width was 0.7 meters and average stream bank slope was 39 degrees. Stream flow at the site was 0.65 cfs. Average stream bank erosion potential was 70%. Three riffles were observed at the site and there were two total stream bends.

Water Quality

Water samples were collected at station 13108 over 68 sampling events from June 1977 through August 2007. Data were collected for many parameters including temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-a.

Biological Characterization

Fish

Nine species (six families) were collected from Alamito Creek. The only family represented by more than one species was Cyprinidae with four. Western Mosquitofish *Gambusia affinis* was the most abundant species. Of particular note was the collection of three state listed threatened

species, Mexican Stoneroller *Campostoma ornatum*, Chihuahua Shiner *Notropis chihuahua*, and Conchos Pupfish *Cyprinodon eximius*. Based on the fish assemblage, Alamito Creek rated as having an exceptional aquatic life use.

Benthic Macroinvertebrates

Considering the single Surber sample, a total of 2337 individuals representing 57 taxa from 12 orders of macroinvertebrates were collected from Alamito Creek (Appendix E). The Basommatophora, Diptera, Ephemeroptera, Hirudinida, Oligochaeta, and Trichoptera were the most commonly collected orders, collectively accounting for 93.8 percent of the total number of individuals collected (Appendix E). The Podocopida and Coleoptera were the only other orders which comprised at least one percent of the collections.

The functional organization of the Alamito Creek macroinvertebrate assemblage was dominated by scrapers, collector-gatherers, and predators which accounted for 40.8%, 31%, and 22.5%, respectively of the total number of individuals collected. The shredders (1.2%) were the least abundant functional group. This functional structure was relatively consistent.

The Central Bioregion Surber BIBI for the July 1989 Surber sample fell in the exceptional aquatic life use category.

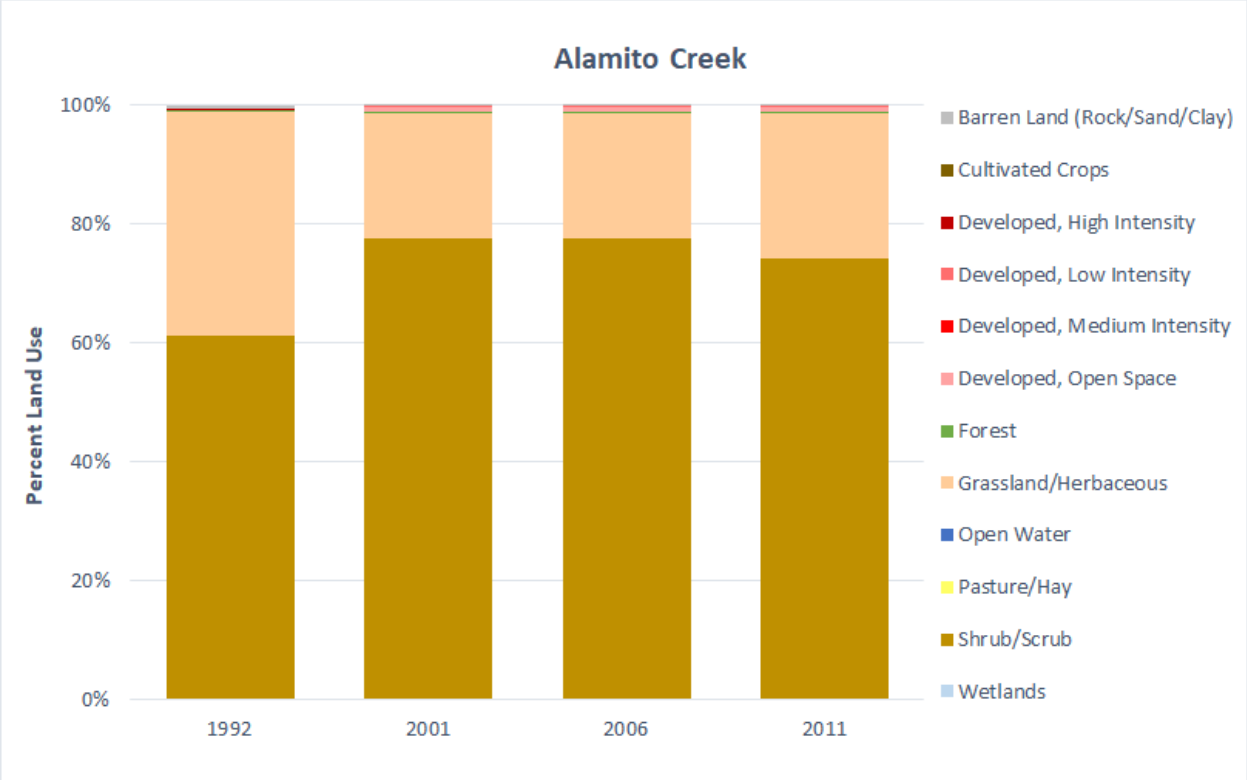

Figure 7. Percent land use in the Alamito Creek watershed from 1992-2011.

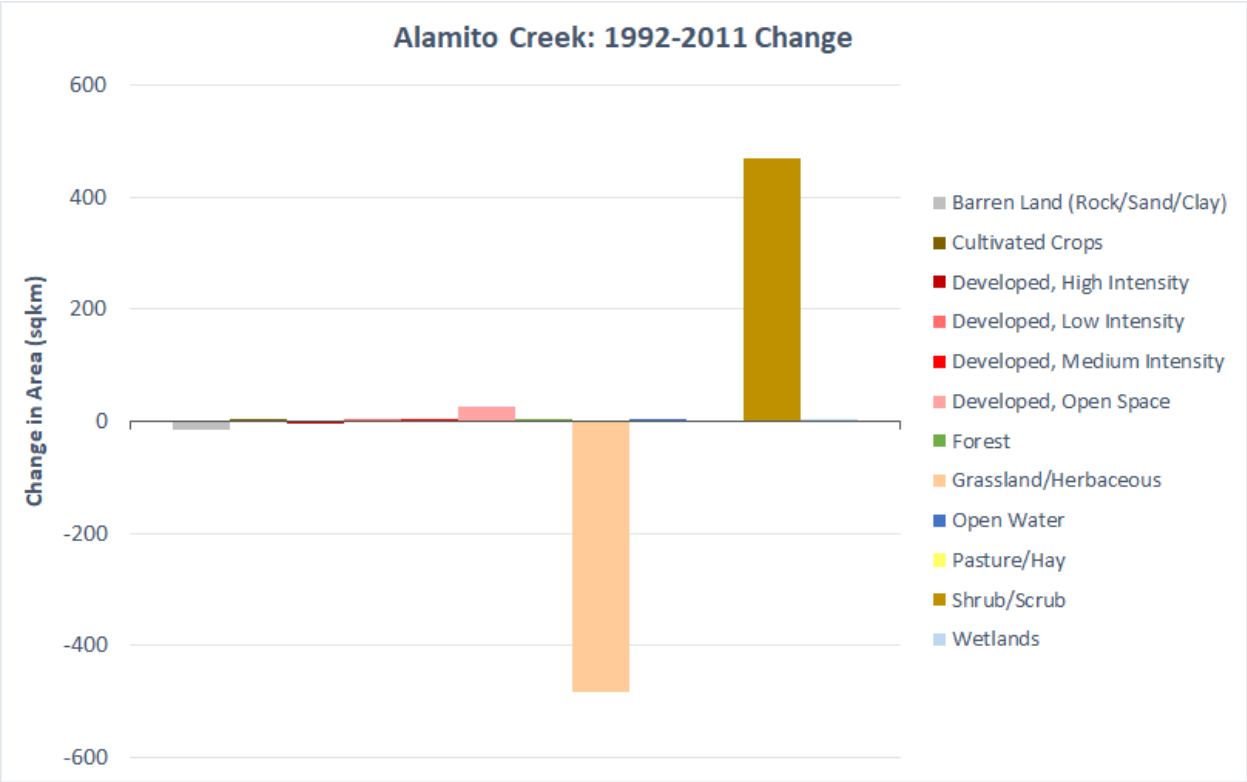

Figure 8. Land use change in area (sq km) from 1992-2011 for the Alamito Creek watershed.

INDEPENDENCE CREEK

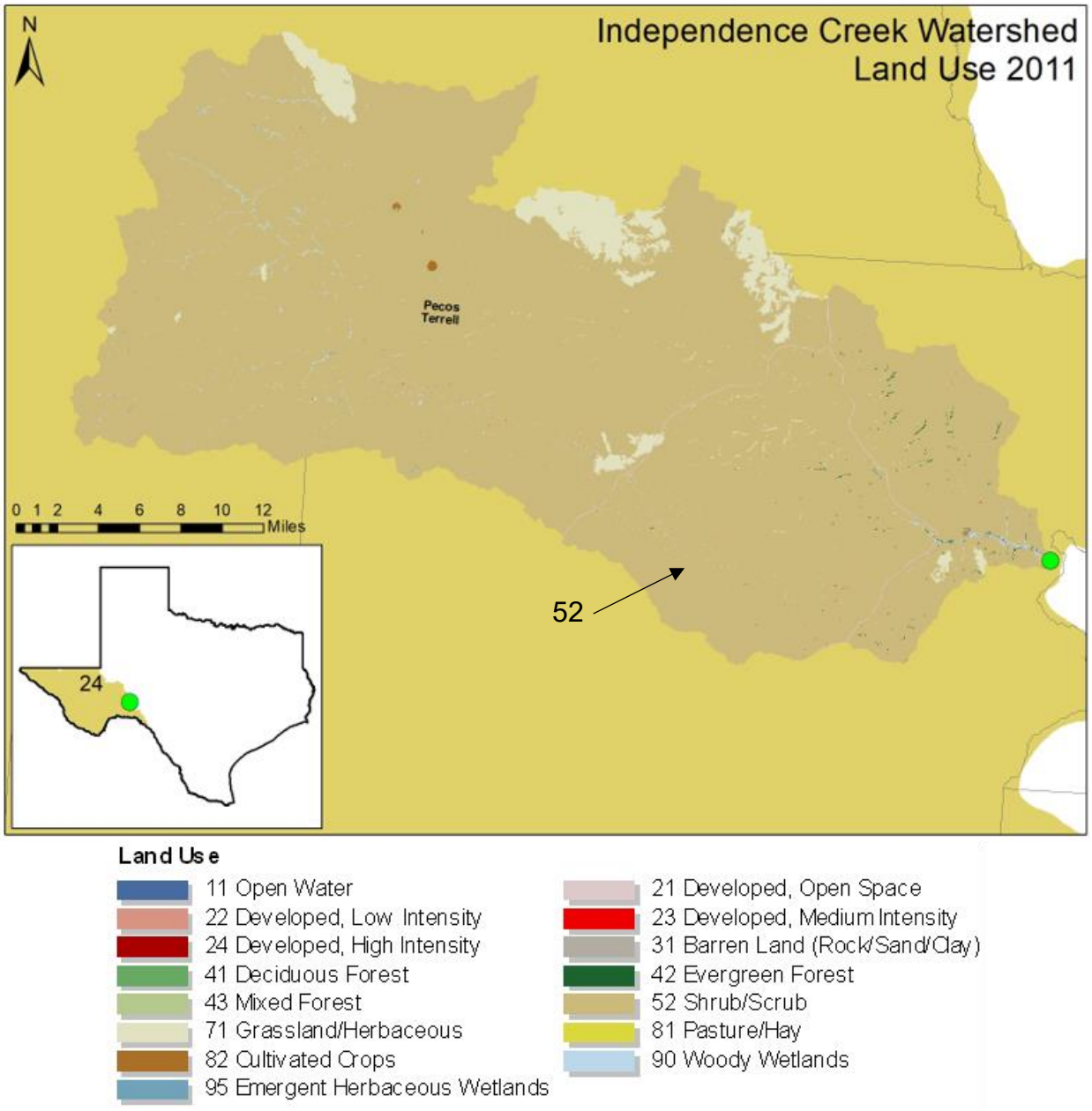

Figure 9. Map of Independence Creek watershed location and 2011 land use; shrub/scrub was the most common land use.

Sampling Dates

Physical Habitat:	August 28, 1990; September 28, 2016
Water Quality:	255 sampling events
Fish:	August 28, 1990; September 28, 2016
Benthic Invertebrates:	August 28, 1990; September 28, 2016

Physical Characterization

Watershed and Land Use

Independence Creek lies within the Rio Grande Basin. Sample site 13109 is located 0.8 km downstream of the John Chandler Ranch headquarters, approximately 27.9 km southeast of Sheffield in Terrell County (Figure 9).

The Independence Creek watershed at site 13109 is approximately 1996.50 sq km. The entire watershed is located in Level IV Ecoregion 24e, the Stockton Plateau. The dominant land cover in the watershed is shrub at 94.68% and is present throughout the watershed (Homer et al. 2015; Figure 9 and Figure 10). Grassland/herbaceous is the secondary land cover encompassing 4.31%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.36% and total cover for cultivated crops is 0.04%.

From 1992-2011 there was a 362.97 sq km decrease in grassland and a 5.89 sq km decrease in barren land (rock/sand/clay). There was a 352.49 sq km increase in shrub and an 8.49 sq km increase in wetlands (Figure 11).

There are no permitted wastewater outfalls within the Independence Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Independence Creek was evaluated on August 28, 1990 and again on September 28, 2016. The 2016 Habitat Quality Index score of 26 indicates an exceptional aquatic life use rating. Independence Creek is a perennial spring-fed stream that drains to the Pecos River. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters for both sampling events. The riparian zone was dominated by shrubs, which make up an average of 48% of the total riparian species, followed by grasses (31%) then trees (11%). The average percentage of tree canopy cover was 3%. The dominant substrate was gravel and cobble, and the average percent of substrate that was gravel size or larger was 82%. Average percent instream cover was 63% and instream cover types include boulders, cobble/gravel, algae, and macrophytes. Independence Creek ranges from 0.1-0.3 meters deep on average and 8.6-12.7 meters wide. Average stream bank slope was 16 degrees. Stream flow at the site was measured at a minimum value of 17.4 cfs and a maximum of 21 cfs. Average stream bank erosion potential was 34%. The deepest pool measured at Independence Creek was 0.7 meters. A maximum of eleven riffles were observed at the site in 2016 and the channel was highly braided with three total stream bends.

Water Quality

Water samples were collected at stations 13109 and 13110. Station 13109 was sampled over 253 sampling events from July 1976 through July 2020. Station 13110 was sampled twice, once in August 1990 and again in July 1999. Data from both stations included temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Continuous flow is available from USGS gage 08447020 (Figure 12). Between January 1985 through December 2019, the median flow was 22.1 cfs. Flow data for this site were not reported from October 1985 through August 2002. Daily average flows ranged from 7.33 cfs to 12,600 cfs, though flows were greater than 1000 cfs less than 0.2 percent of the time. Data were log transformed to better visualize flow patterns.

Biological Characterization

Fish

Nineteen species (10 families) were collected between the two sampling events (Appendix D). Cyprinidae was the richest family with five species. Texas Shiner *Notropis amabilis* was the most abundant species in 1987. Manantial Roundnose Minnow *Dionda argentosa* was the most abundant species in 2016. Of particular note was the collection of two state listed threatened species during both surveys, Proserpine Shiner *N. proserpina* and Rio Grande Darter *Etheostoma grahami*. The aquatic life use rated as high and exceptional for the 1990 and 2016 collections, respectively; however, when the coefficient of variability is applied to the 1990 fish assemblage data it also rises to exceptional.

Benthic Macroinvertebrates

Considering the single Surber sample and single RBP sample together, a total of 3168 individuals representing 82 taxa from 17 orders of macroinvertebrates were collected from Independence Creek (Appendix E). The Neotaenioglossa, Trichoptera, Amphipoda, Coleoptera, and Ephemeroptera were the most commonly collected orders, collectively accounting for 90.5 percent of the total number of individuals collected. The Neoophora, Hemiptera, and Diptera were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the August 1990 Surber sample fell in the high aquatic life use category. Likewise, the Ecoregion 24 BIBI for the September 2016 RBP sample fell in the high aquatic life use category.

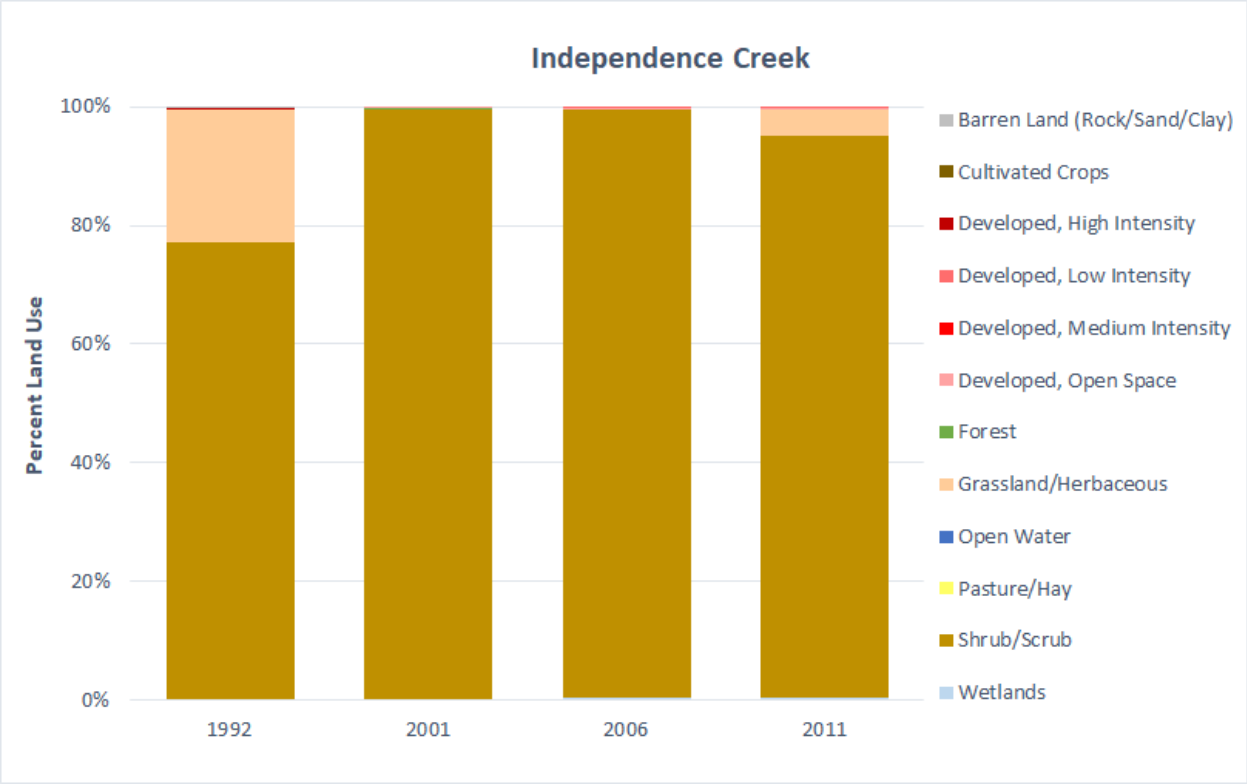

Figure 10. Percent land use in the Independence Creek watershed from 1992-2011.

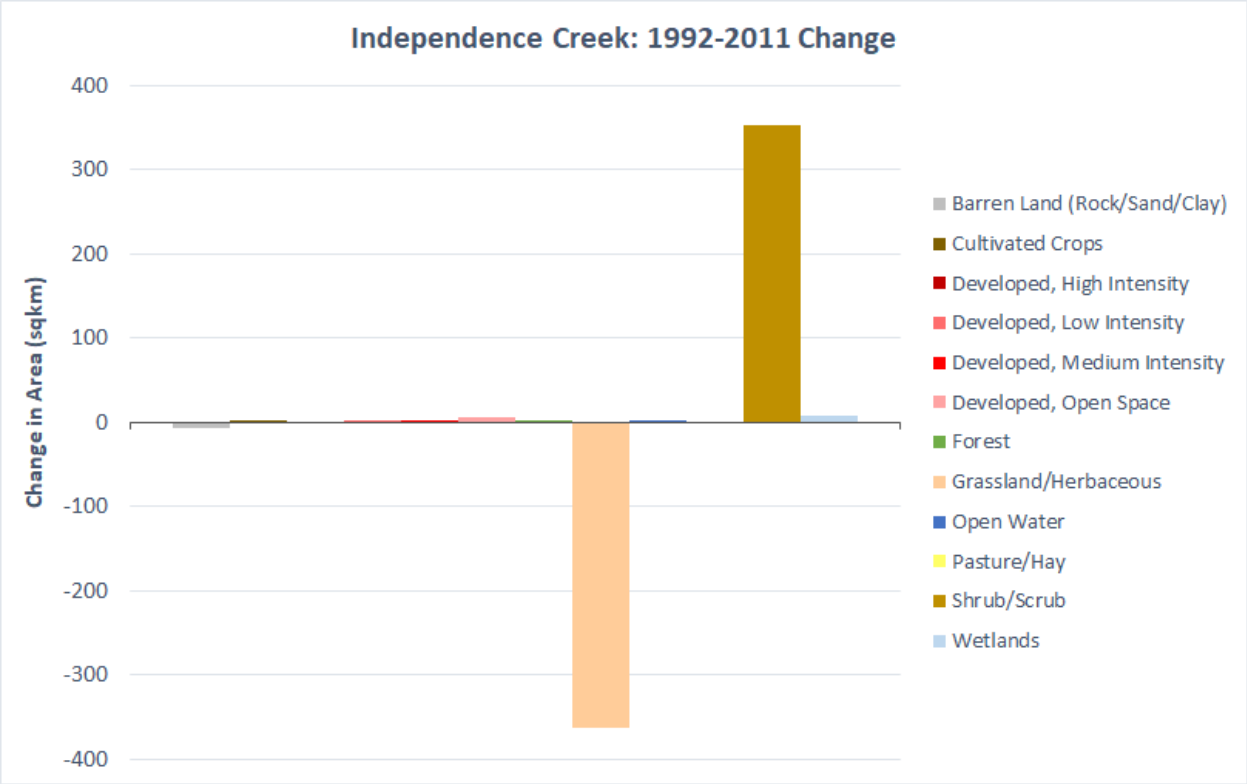

Figure 11. Land use change in area (sq km) from 1992-2011 for the Independence Creek watershed.

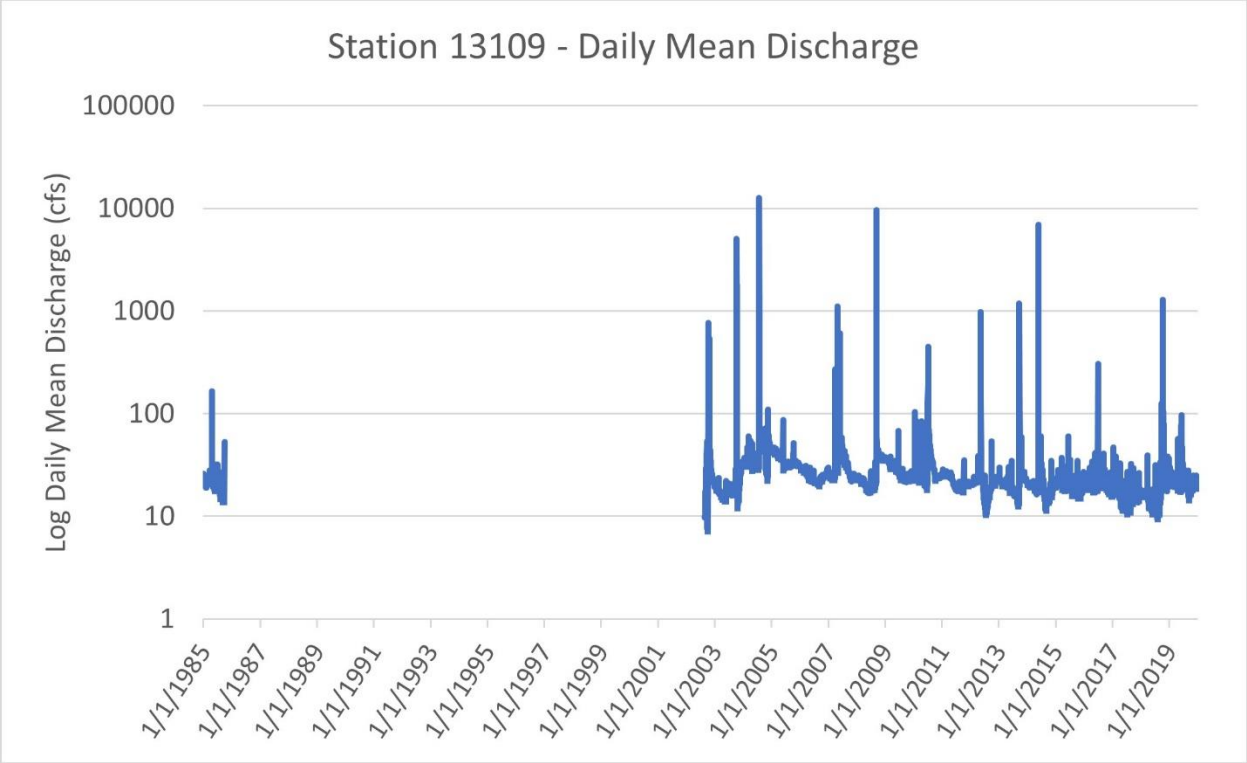

Figure 12. Log transformed daily mean discharge for Independence Creek at station 13109.

PECOS RIVER

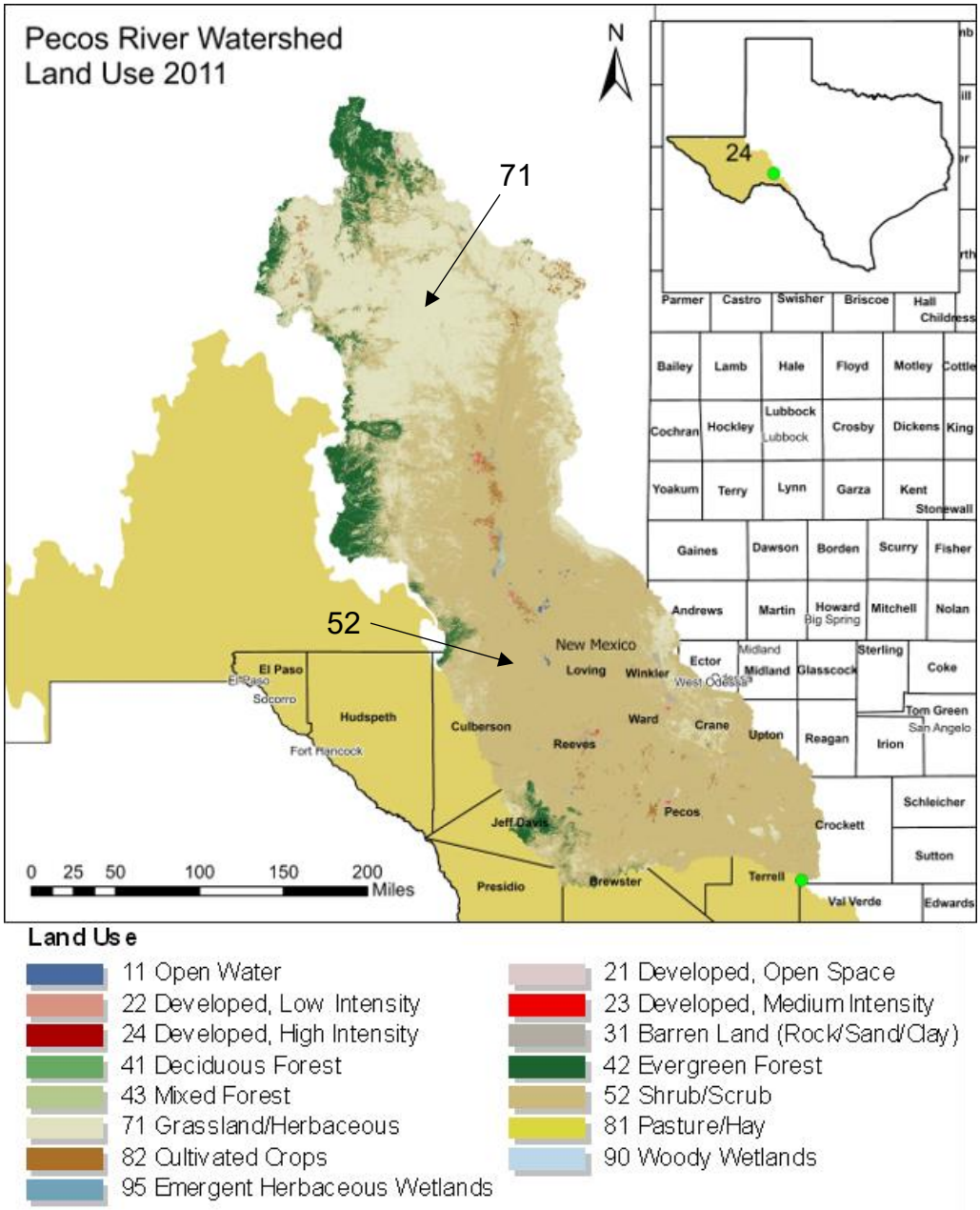

Figure 13. Map of Pecos River watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	September 29, 2016
Water Quality:	69 sampling events
Fish:	September 29, 2016
Benthic Invertebrates:	September 29, 2016

Physical Characterization

Watershed and Land Use

The Pecos River lies within the Rio Grande Basin. Sample site 18801 is located on the Brotherton Ranch 3.56 km upstream of the Terrell/Val Verde/Crockett County line, approximately 42.74 km south southeast of Sheffield in Terrell County (Figure 13).

The Pecos River watershed at site 18801 is approximately 3,613,942.76 sq km. The station and portion of the lower watershed are located in Level IV Ecoregion 24e, the Stockton Plateau. The middle portion of the watershed is located in Level IV Ecoregion 24a, the Chihuahuan Basins and Playas. Some of the watershed is located in Level IV Ecoregion 24b, the Chihuahuan Desert Grasslands, while other portions of the watershed cross into Ecoregions 23, 25, 26, and 30. The dominant land cover in the watershed is shrub at 62.67% and is present throughout the watershed (Homer et al. 2015; Figure 13 and Figure 14). Grassland/herbaceous is the secondary land cover encompassing 27.72%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 1.15% and total cover for cultivated crops is 0.91%.

From 1992-2011 there was an 828,497.53 sq km decrease in grassland/herbaceous and a 29,576.94 sq km decrease in barren land (rock/sand/clay). There was a 793,775.77 sq km increase in shrub and a 36,782.61 sq km increase in forest (Figure 15).

Within the Pecos River watershed in the state of Texas, there is one pending and three current domestic wastewater outfalls (discharges < 1 million gallons per day), three current stormwater outfalls, and one pending and three industrial wastewater outfalls (discharges ≥ 1 million gallons per day) within the Pecos River watershed. The one pending and one current domestic wastewater facilities are permitted to Quail Run Services, LLC, which is focused on wastewater generated on well site locations. The remaining domestic facilities are permitted to the University of Texas at Austin's McDonald Observatory and Fort Davis Water Supply Corporation. The three stormwater outfalls and two industrial wastewater facilities are permitted to Andrews County and Waste Control Specialists, LLC. The pending industrial wastewater facility is for the Town of Pecos City. The remaining industrial facility is permitted to the City of Alpine.

The pending industrial wastewater permit for the Town of Pecos City would discharge directly into the upper Pecos River.

In Channel and Riparian Physical Habitat

Physical habitat for the Pecos River was evaluated on September 29, 2016. The Pecos River originates in New Mexico and is one of the major tributaries of the Rio Grande. The site was located below the confluence with Independence Creek and the Habitat Quality Index score of 26 indicates an exceptional aquatic life use rating. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was dominated by shrubs, which made up an average of 90% of the total riparian species,

followed by grasses (5%) and trees (5%). The average percentage of tree canopy cover was 29%. The dominant substrate was boulders, and the average percent of substrate gravel size or larger was 56%. Average percent instream cover was 44% and instream cover types include boulders, undercut banks, cobble/gravel, macrophytes, woody debris, algae, and overhanging vegetation. The Pecos River site was 0.4 meters deep on average and 21.8 meters wide. Average stream bank slope was 36 degrees. Stream flow at the site was measured at 101 cfs. Average stream bank erosion potential was 31%. The deepest pool measured at the site was 0.5 meters. Four riffles were observed at the site and there were four total stream bends.

Water Quality

Water samples were collected at station 18801 over 69 sampling events from November 2008 through July 2020. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twenty species (11 families) were collected from the Pecos River. Cyprinidae was the richest family with six species. Red Shiner *Cyprinella lutrensis* was the most abundant species collected, closely followed by Bullhead Minnow *Pimephales vigilax*. Of particular note was the collection of two state listed threatened species, Proserpine Shiner and Rio Grande Darter. The aquatic life use (based upon the fish assemblage) rated as exceptional.

Benthic Macroinvertebrates

Considering the single RBP sample, a total of 333 individuals representing 28 taxa from 12 orders of macroinvertebrates were collected from the Pecos River (Appendix E). The Ephemeroptera, Coleoptera, Trichoptera, Diptera, Neoophora, and Hemiptera were the most commonly collected orders, collectively accounting for 93.1 percent of the total number of individuals collected. The Odonata and Veneroida were the only other orders which comprised at least one percent of the collections.

The Ecoregion 24 BIBI for the September 2016 RBP sample fell in the high aquatic life use category.

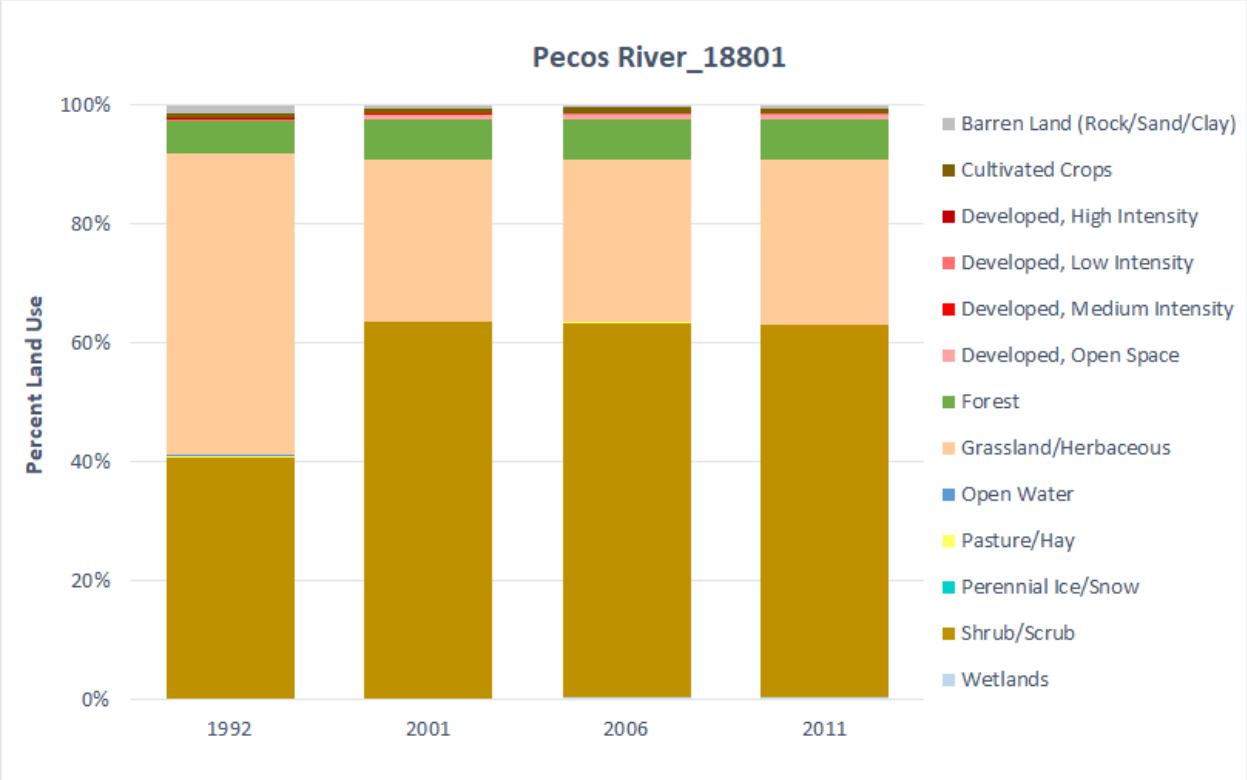

Figure 14. Percent land use in the Pecos River watershed from 1992-2011.

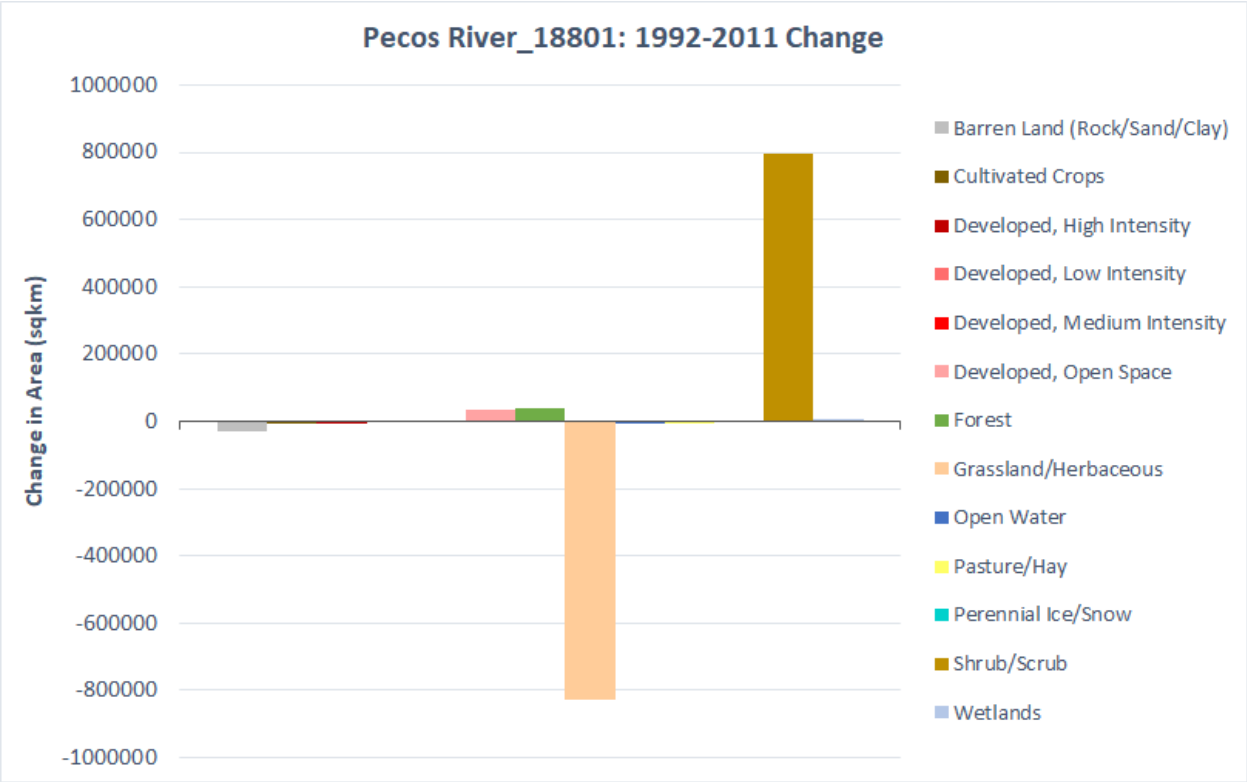

Figure 15. Land use change in area (sq km) from 1992-2011 for the Pecos River watershed.

RIO GRANDE: PRESIDIO

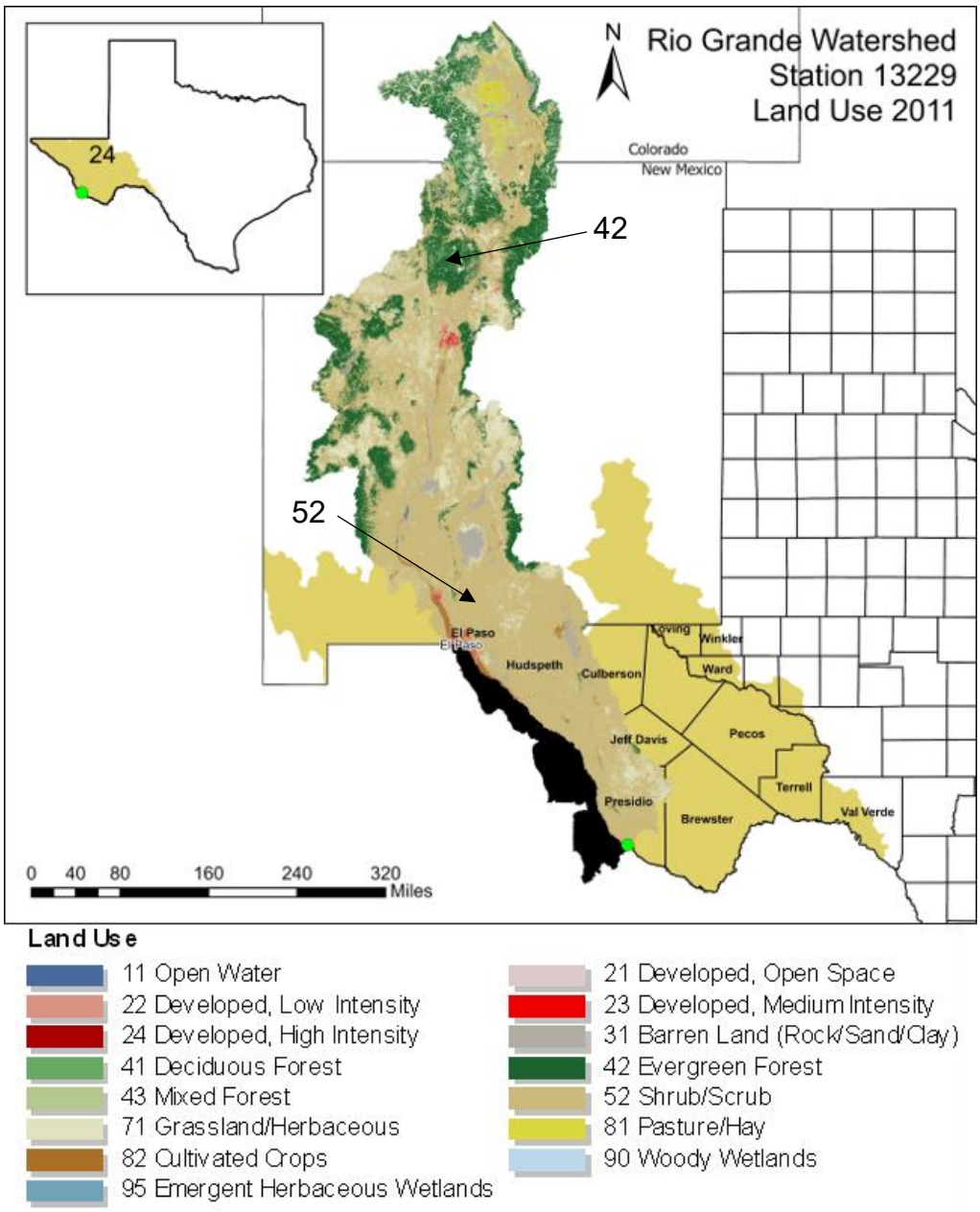

Figure 16. Map of Rio Grande watershed at Presidio and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	March 28, 2017
Water Quality:	566 sampling events
Fish:	March 28, 2017
Benthic Invertebrates:	March 28, 2017

Physical Characterization

Watershed and Land Use

The Rio Grande is the border between Texas and Mexico and is the basin's namesake. The Rio Grande Basin drains all west Texas, along the southwest border of Texas through Laredo, and the south Texas valley. Sample site 13229 is located 0.75 km downstream of the confluence with Alamito Creek, approximately 11 km southeast of Presidio in Presidio County (Figure 16).

The Rio Grande watershed at site 13229 is approximately 5,201,992.85 sq km. The station and portion of the lower watershed are located in Level IV Ecoregion 24c, the Low Mountains and Bajadas. The lower watershed also encompasses Level IV Ecoregion 24b, the Chihuahuan Desert Grasslands. The middle portion of the watershed is located in New Mexico and encompasses Level IV Ecoregion 24a, the Chihuahuan Basins and Playas. The middle portion of the watershed extends through Ecoregions 22 and 23. The upper watershed extends into Colorado and contains a portion of Ecoregion 21. The dominant land cover in the watershed is shrub at 53.67% and is present throughout the watershed (Homer et al. 2015; Figure 16 and Figure 17). Forest is the secondary land cover encompassing 17.07%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 1.49% and total cover for cultivated crops is 0.74%.

From 1992-2011 there was a 653,448.97 sq km decrease in grassland/herbaceous and a 50,939.49 sq km decrease in barren land (rock/sand/clay). There was a 591,336.72 sq km increase in shrub and a 40,768.72 sq km increase in wetlands (Figure 18).

Within the Rio Grande watershed in the state of Texas, there are six domestic wastewater outfalls (discharges < 1 million gallons per day), one current mining outfall (and one pending), and 10 industrial wastewater outfalls (discharges ≥ 1 million gallons per day) within the Rio Grande watershed at site 13229. The domestic wastewater facilities are permitted to the towns of Anthony, Fort Hancock, and Van Horn, Canutillo Independent School District (ISD), El Paso County, and Hudspeth County. The mining outfall is permitted to the Rio Grande Mining Company. The pending industrial wastewater facility is permitted to the Esperanza Water Service Company and six of the industrial wastewater facilities are permitted to the El Paso Water Utilities Public Service Board. The remaining industrial wastewater facilities are permitted to the City of Presidio, El Paso County Water Control and Improvement District No 4, Horizon Regional Municipal Water District, and El Paso Electric Company.

The domestic wastewater facility for Canutillo ISD and industrial wastewater facilities for the City of Presidio and El Paso Water Utilities Public Service Board discharge directly into the Rio Grande.

In Channel and Riparian Physical Habitat

Physical habitat for the Rio Grande River near Presidio was evaluated on March 28, 2017. The Habitat Quality Index score of 18.5 indicates an intermediate aquatic life use rating. The riparian

buffer at the site was measured to be 15 meters wide on average. The riparian zone was dominated by shrubs and grasses, which each make up an average of 35% of the total riparian species, followed by mowed fields (25%). The average percentage of tree canopy cover was 19%. The dominant substrate was cobble, and the average percent of substrate gravel size or larger was 65%. Average percent instream cover was 29% and instream cover types include overhanging vegetation, cobble/gravel, woody debris, algae and undercut banks. The Rio Grande near Presidio was 0.3 meters deep on average and 31 meters wide. Average stream bank slope was 30 degrees. Stream flow was recorded at 63 cfs from an IBWC gaging station at the site. Average stream bank erosion potential was 36%. The largest pool was measured to be one meter deep. One large riffle was observed at the site and there were two total stream bends.

Water Quality

Water samples were collected at station 13229 over 566 sampling events from May 1969 through December 2019. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-*a*.

Biological Characterization

Fish

Ten species (five families) were collected from this site on the Rio Grande. The richest family was Cyprinidae with five. Red shiner was the most abundant species. Of particular note was the collection of 50 juvenile Blue Sucker *Cycleptus elongatus,* a state listed threatened species. Based on the fish assemblage, the Rio Grande rated as having an intermediate aquatic life use; however, when the coefficient of variability is applied it rises to high. Metrics receiving the lowest score (1) included: number of sunfish species (none were collected); percentage of individuals as tolerant species (82%); and number of individuals.

Benthic Macroinvertebrates

Considering the single RBP sample, a total of 240 individuals representing 25 taxa from 7 orders of macroinvertebrates were collected from the Rio Grande at Presidio (Appendix E). The Ephemeroptera, Trichoptera, and Diptera were the most commonly collected orders, collectively accounting for 92.9 percent of the total number of individuals collected. Odonata and Hemiptera were the only other orders which comprised at least one percent of the collections. The Ecoregion 24 BIBI for the March 2017 Rio Grande at Presidio sample fell in the high aquatic life use category.

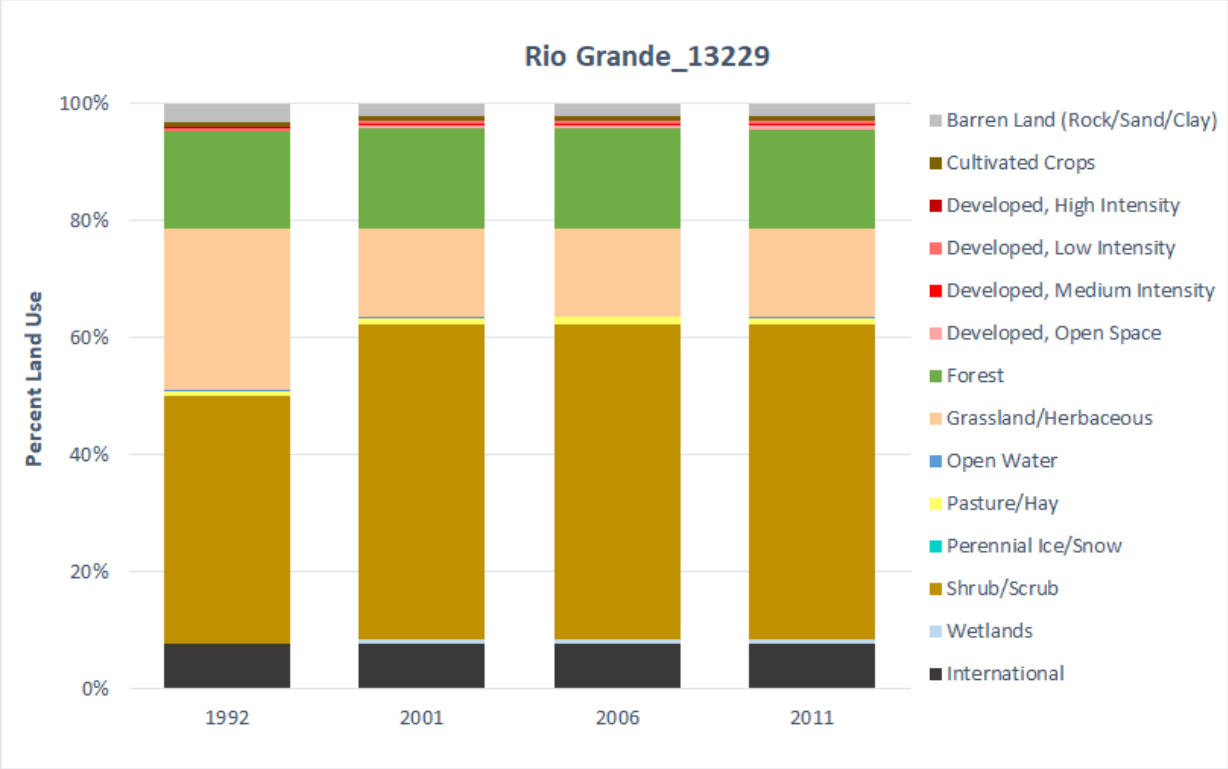

Figure 17. Percent land use in the Rio Grande watershed at Presidio from 1992-2011.

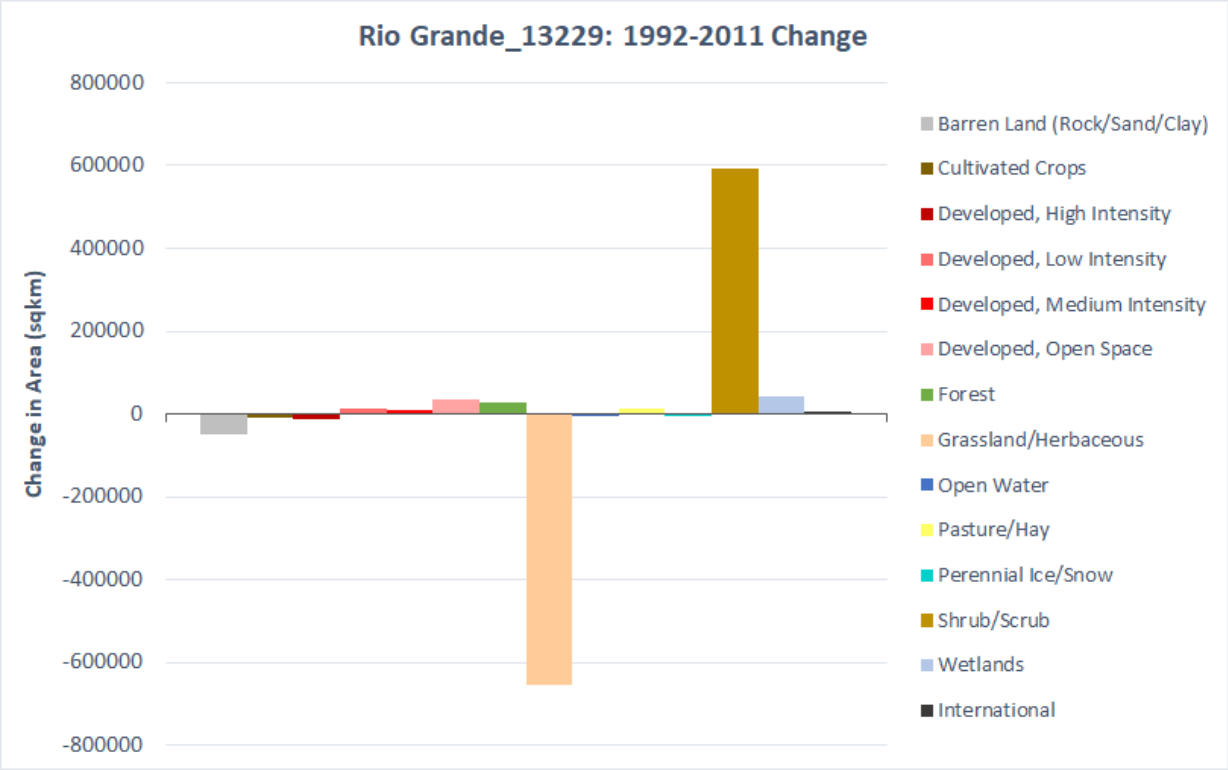

Figure 18. Land use change in area (sq km) from 1992-2011 for the Rio Grande watershed at Presidio.

RIO GRANDE: CONTRABANDO

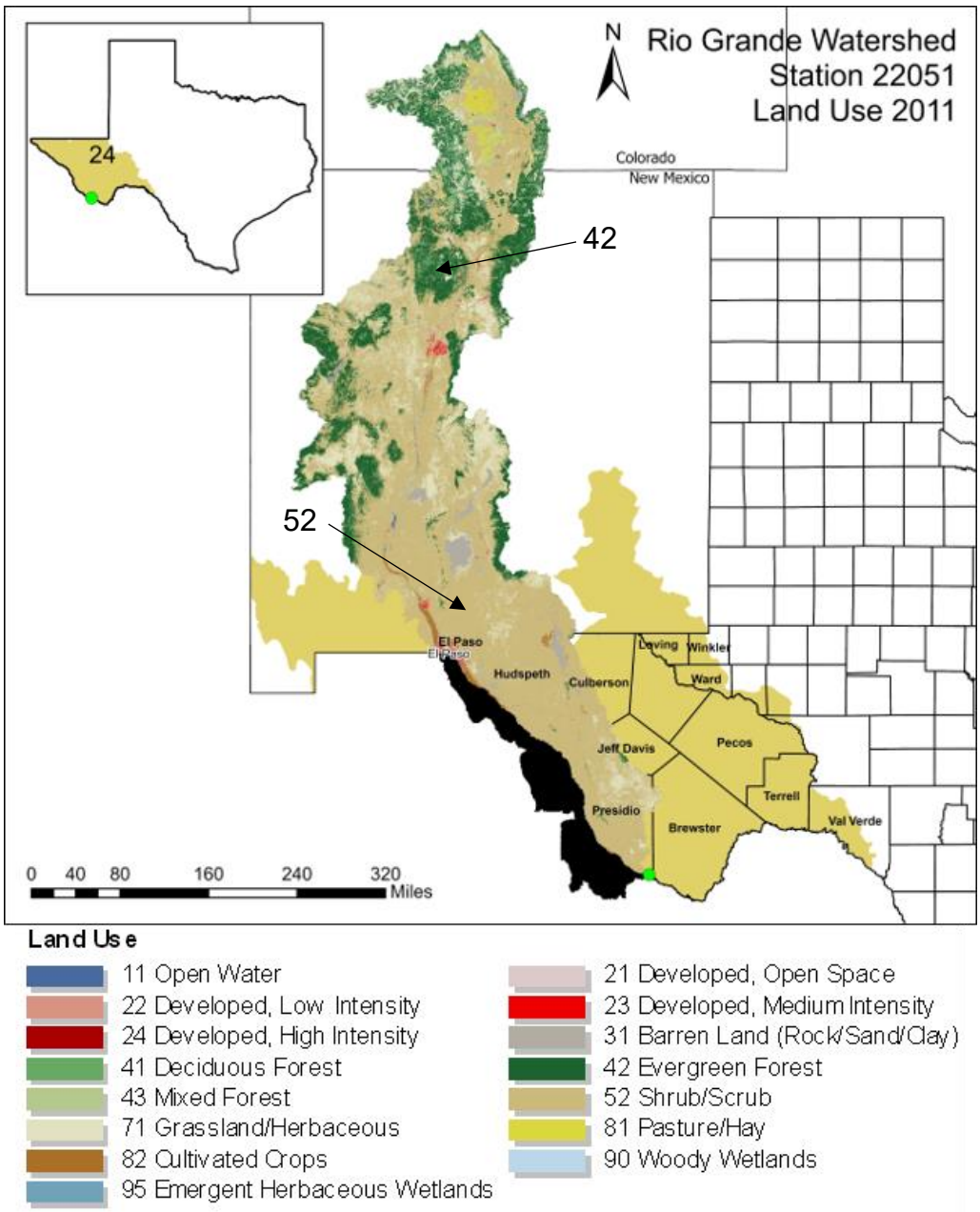

Figure 19. Map of Rio Grande watershed at Contrabando and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	March 29, 2017
Water Quality:	No sampling events
Fish:	March 29, 2017
Benthic Invertebrates:	March 29, 2017

Physical Characterization

Watershed and Land Use

The Rio Grande is the border between Texas and Mexico and is the basin's namesake. The Rio Grande Basin drains all west Texas, along the southwest border of Texas through Laredo, and the south Texas valley. Sample site 22051 is located downstream of the confluence with Contrabando Creek within Big Bend Ranch State Park on FM 170 in Presidio County (Figure 19).

The Rio Grande watershed at site 22051 is approximately 5,300,669.55 sq km. The station and portion of the lower watershed are located in Level IV Ecoregion 24c, the Low Mountains and Bajadas. The lower watershed also encompasses Level IV Ecoregion 24b, the Chihuahuan Desert Grasslands. The middle portion of the watershed is located in New Mexico and encompasses Level IV Ecoregion 24a, the Chihuahuan Basins and Playas. The middle portion of the watershed extends through Ecoregions 22 and 23. The upper watershed extends into Colorado and contains a portion of Ecoregion 21. The dominant land cover in the watershed is shrub at 53.26% and is present throughout the watershed (Homer et al. 2015; Figure 19 and Figure 20). Forest is the secondary land cover encompassing 16.75%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 1.47% and total cover for cultivated crops is 0.73%.

From 1992-2011 there was a 651,855.20 sq km decrease in grassland/herbaceous and a 51,111.82 sq km decrease in barren land (rock/sand/clay). There was a 589,422.05 sq km increase in shrub and a 40,783.23 sq km increase in wetlands (Figure 21).

Within the Rio Grande watershed in the state of Texas, there are six domestic wastewater outfalls (discharges < 1 million gallons per day), one current mining outfall (and one pending), and 10 industrial wastewater outfalls (discharges ≥ 1 million gallons per day) within the Rio Grande watershed at site 22051. The domestic wastewater facilities are permitted to the towns of Anthony, Fort Hancock, and Van Horn, Canutillo ISD, El Paso County, and Hudspeth County. The mining outfall is permitted to the Rio Grande Mining Company. The pending industrial wastewater facility is permitted to the Esperanza Water Service Company and six of the industrial wastewater facilities are permitted to the El Paso Water Utilities Public Service Board. The remaining industrial wastewater facilities are permitted to the City of Presidio, El Paso County Water Control and Improvement District No 4, Horizon Regional Municipal Water District, and El Paso Electric Company.

The domestic wastewater facility for Canutillo ISD and industrial wastewater facilities for the City of Presidio and El Paso Water Utilities Public Service Board discharge directly into the Rio Grande.

In Channel and Riparian Physical Habitat

Physical habitat for the Rio Grande River at Contrabando Creek was evaluated on March 29, 2017. The Habitat Quality Index score of 26 indicates an exceptional aquatic life use rating. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was dominated by shrubs, which make up an average of 55% of the total riparian species, followed by grasses (40%), and a small developed area (old movie set and dirt trails) covered approximately 5% of the riparian area. The average percentage of tree canopy cover was 36.5%. The dominant substrate was cobble, and the average percent of substrate gravel size or larger was 92.5%. Average percent instream cover was 50% and instream cover types include cobble/gravel, overhanging vegetation, undercut banks, boulders, algae, and woody debris. The Rio Grande at Contrabando Creek was 0.4 meters deep on average and 36 meters wide. Average stream bank slope was 50 degrees. Stream flow was not measured at this site. Average stream bank erosion potential was 27%. The deepest pool was 1.25 meters. Five riffles were observed at the site and there were three total stream bends.

Water Quality

Station 22051 was not sampled for water quality.

Biological Characterization

Fish

Nine species (four families) were collected from this site on the Rio Grande. The richest family was Cyprinidae with five. Blue Sucker, a state listed threatened species, was the most abundant species. Based on the fish assemblage, the Rio Grande rated as having an intermediate aquatic life use; however, when the coefficient of variability is applied it rises to high. Two metrics received the lowest score (1) - number of sunfish species (none were collected) and number of individuals.

Benthic Macroinvertebrates

Considering the single RBP sample, a total of 250 individuals representing 22 taxa from 8 orders of macroinvertebrates were collected from the Rio Grande at Contrabando Creek (Appendix E). The Ephemeroptera, Trichoptera, Coleoptera, and Hemiptera were the most commonly collected orders, collectively accounting for 92.4 percent of the total number of individuals collected. The Odonata, Diptera, Megaloptera, and Oligochaeta were the other orders collected, all of which comprised at least one percent of the collection. The Ecoregion 24 BIBI for the March 2017 Rio Grande at Contrabando Creek sample fell in the high aquatic life use category.

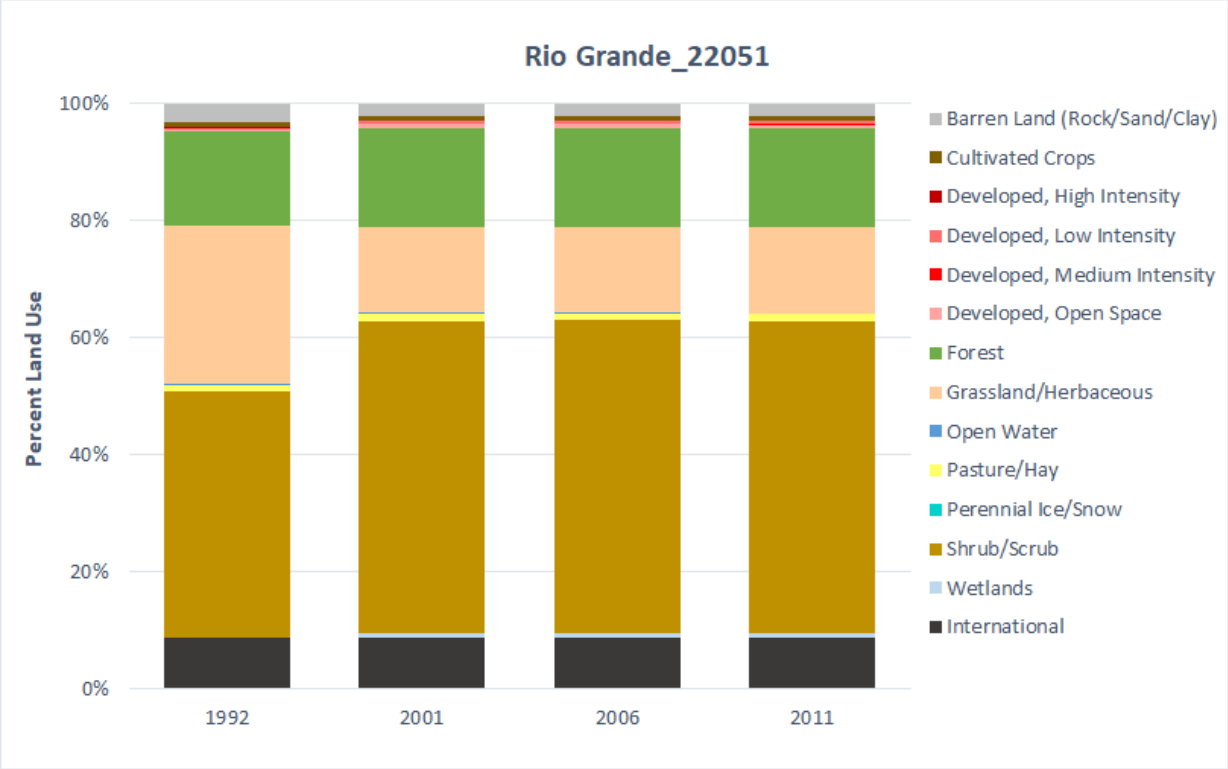

Figure 20. Percent land use in the Rio Grande watershed at Contrabando from 1992-2011.

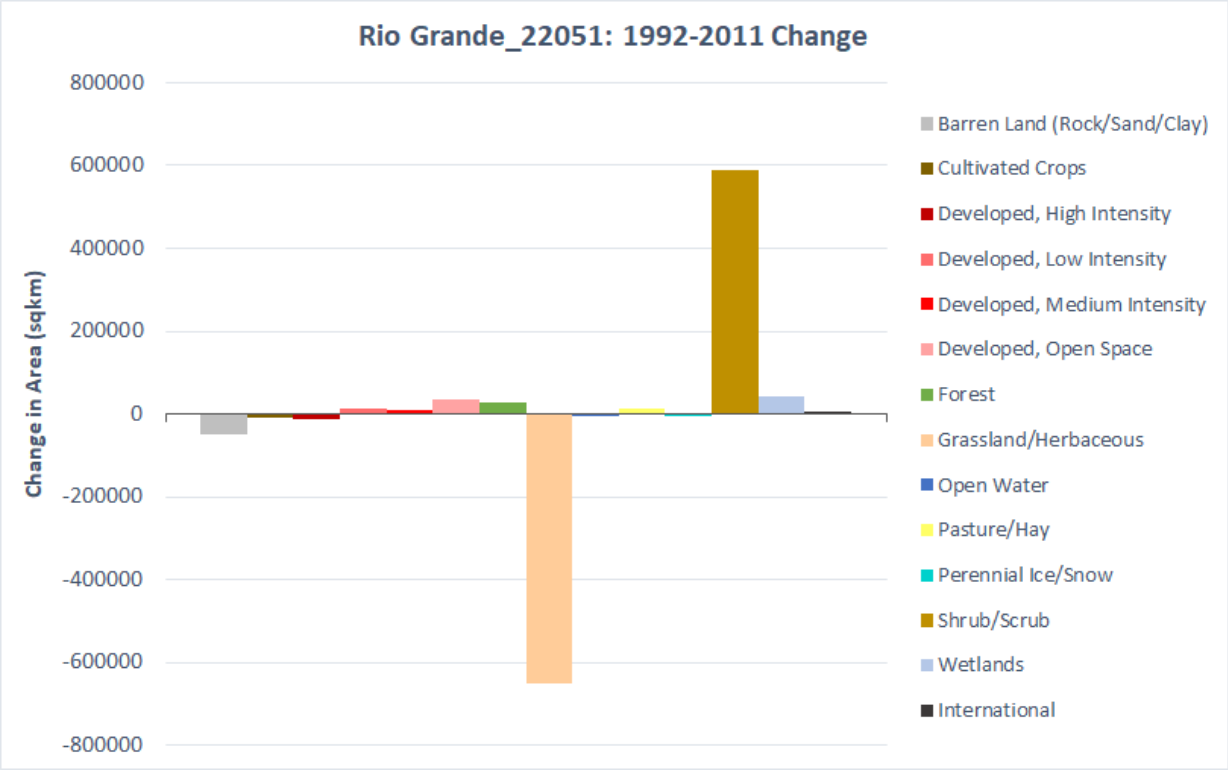

Figure 21. Land use change in area (sq km) from 1992-2011 for the Rio Grande watershed at Contrabando.

RIO GRANDE: JOHNSON RANCH

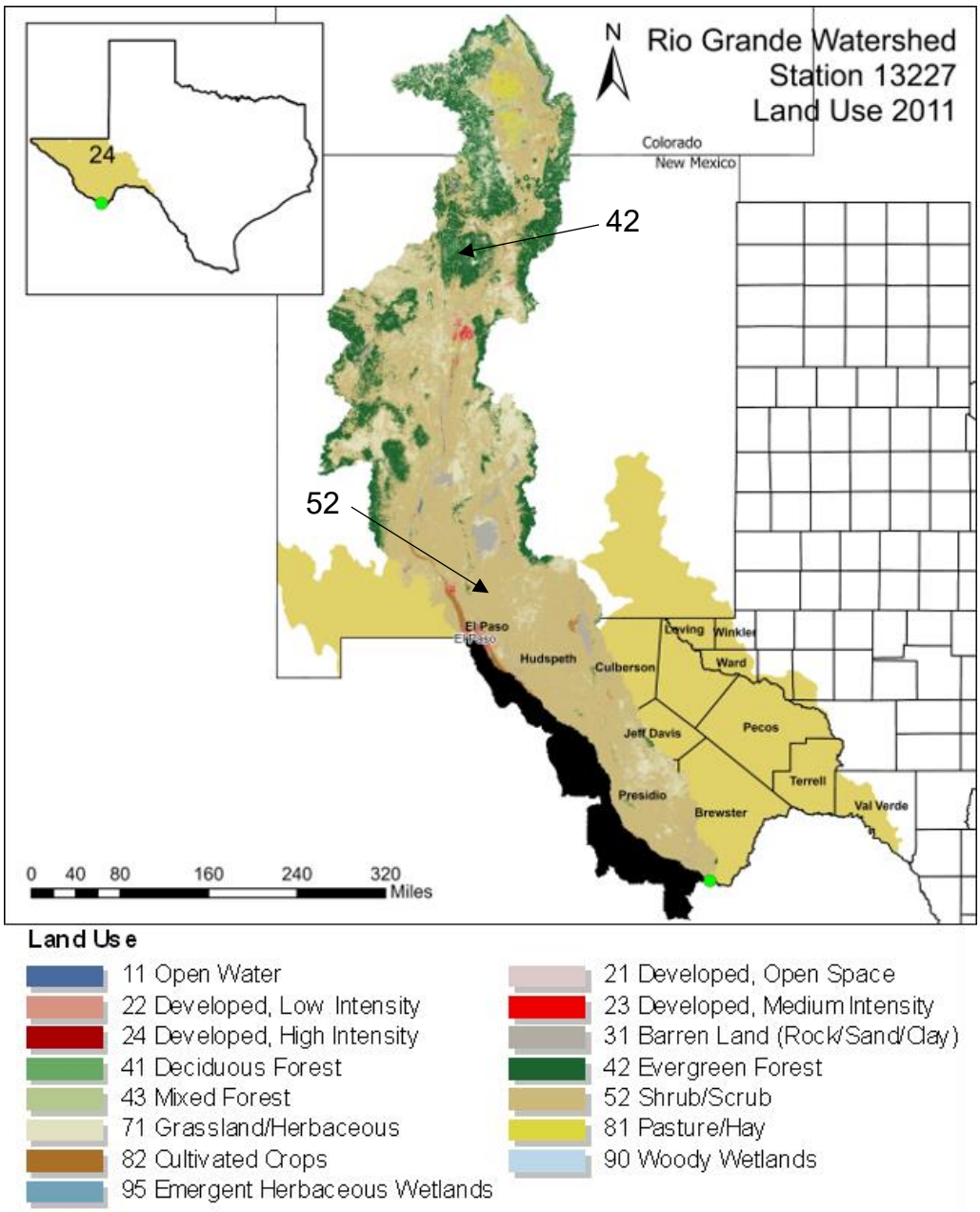

Figure 22. Map of Rio Grande watershed at Johnson Ranch and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	March 30, 2017
Water Quality:	70 sampling events
Fish:	March 30, 2017
Benthic Invertebrates:	March 30, 2017

Physical Characterization

Watershed and Land Use

The Rio Grande is the border between Texas and Mexico and is the basin's namesake. The Rio Grande Basin drains all west Texas, along the southwest border of Texas through Laredo, and the south Texas valley. Sample site 13227 is located approximately 3.22 km upstream of Johnson Ranch near Santa Elena, east of Castolon in Brewster County (Figure 22).

The Rio Grande watershed at site 13227 is approximately 5,510,980.99 sq km. The station and portion of the lower watershed are located in Level IV Ecoregion 24c, the Low Mountains and Bajadas. The lower watershed also encompasses Level IV Ecoregion 24b, the Chihuahuan Desert Grasslands. The middle portion of the watershed is located in New Mexico and encompasses Level IV Ecoregion 24a, the Chihuahuan Basins and Playas. The middle portion of the watershed extends through Ecoregions 22 and 23. The upper watershed extends into Colorado and contains a portion of Ecoregion 21. The dominant land cover in the watershed is shrub at 53.21% and is present throughout the watershed (Homer et al. 2015; Figure 22 and Figure 23). Forest is the secondary land cover encompassing 16.12%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 1.42% and total cover for cultivated crops is 0.70%.

From 1992-2011 there was a 657,738.72 sq km decrease in grassland/herbaceous and a 55,241.35 sq km decrease in barren land (rock/sand/clay). There was a 598,557.29 sq km increase in shrub and a 40,829.48 sq km increase in wetlands (Figure 24).

Within the Rio Grande watershed in the state of Texas, there are eight domestic wastewater outfalls (discharges < 1 million gallons per day), one current mining outfall, and one pending and eleven industrial wastewater outfalls (discharges ≥ 1 million gallons per day) within the Rio Grande watershed at site 13227. The domestic wastewater facilities are permitted to the towns of Anthony, Fort Hancock, and Van Horn, Canutillo ISD, El Paso County, Hudspeth County, Lajitas Municipal Services Company, and U.S. Department of Interior for Big Bend National Park. The mining outfall is permitted to the Rio Grande Mining Company. The pending industrial wastewater facility is permitted to the Esperanza Water Service Company and six of the industrial wastewater facilities are permitted to the El Paso Water Utilities Public Service Board. The remaining industrial wastewater facilities are permitted to the City of Presidio, El Paso County Water Control and Improvement District No 4, Horizon Regional Municipal Water District, El Paso Electric Company, and Study Butte Water Supply Corporation.

The domestic wastewater facility for Canutillo ISD and industrial wastewater facilities for the City of Presidio and El Paso Water Utilities Public Service Board discharge directly into the Rio Grande.

In Channel and Riparian Physical Habitat

Physical habitat for the Rio Grande River at Johnson Ranch in Big Bend National Park was evaluated on March 30, 2017. The Habitat Quality Index score of 24 indicates a high aquatic life use rating. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was dominated by shrubs, which make up an average of 82.5% of the total riparian species, followed by grasses (12.5%) then trees (5%). The average percentage of tree canopy cover was 38%. The dominant substrate was silt, and the average percent of substrate gravel size or larger was 53%. Average percent instream cover was 21% and instream cover types include cobble/gravel, undercut banks, overhanging vegetation, and woody debris. The Rio Grande at Johnson Ranch was 0.4 meters deep on average and 23 meters wide. Average stream bank slope was 45 degrees. Stream flow was recorded at 57 cfs from an IBWC gaging station at the site. Average stream bank erosion potential was 51%. The deepest pool measured at the site was 2.6 meters. Three riffles were observed at the site and there were four total stream bends.

Water Quality

Water samples were collected at station 13227 over 70 sampling events from September 1968 through February 2006. Data collected included temperature, flow, specific conductivity, dissolved oxygen, pH, ammonia, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Eight species (four families) were collected from this site on the Rio Grande. The family Cyprinidae was represented by three species, Catostomidae two species, Ictaluridae two species, and Fundulidae one. Blue Sucker, a state listed threatened species, was the most abundant species. Based on the fish assemblage, the Rio Grande rated as having a high aquatic life use. This site received a higher IBI metric score for percentage of tolerant species than the site sampled downstream of Presidio (5 versus 1), a higher metric score for percentage of non-native species than the Contrabando sample site (5 versus 3), and a higher metric score than both upstream sites for percentage of omnivores (5 versus 3).

Benthic Macroinvertebrates

Considering the single RBP sample, a total of 269 individuals representing 25 taxa from 8 orders of macroinvertebrates were collected from the Rio Grande at Johnson Ranch (Appendix E). The Ephemeroptera, Trichoptera, Coleoptera, and Odonata were the most commonly collected orders, collectively accounting for 91.4 percent of the total number of individuals collected. Hemiptera, Diptera, and Veneroida were the only other orders which comprised at least one percent of the collections. The Ecoregion 24 BIBI for the March 2017 Rio Grande at Presidio sample fell in the exceptional aquatic life use category.

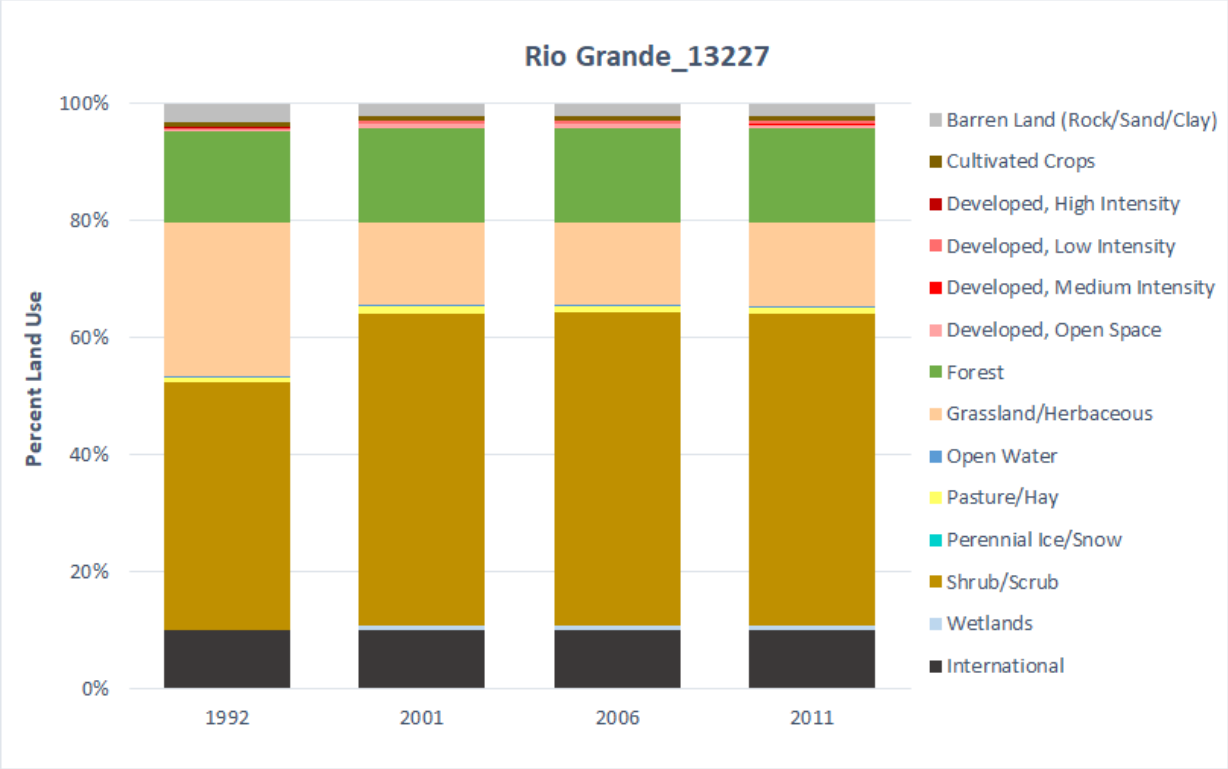

Figure 23. Percent land use in the Rio Grande watershed at Johnson Ranch from 1992-2011.

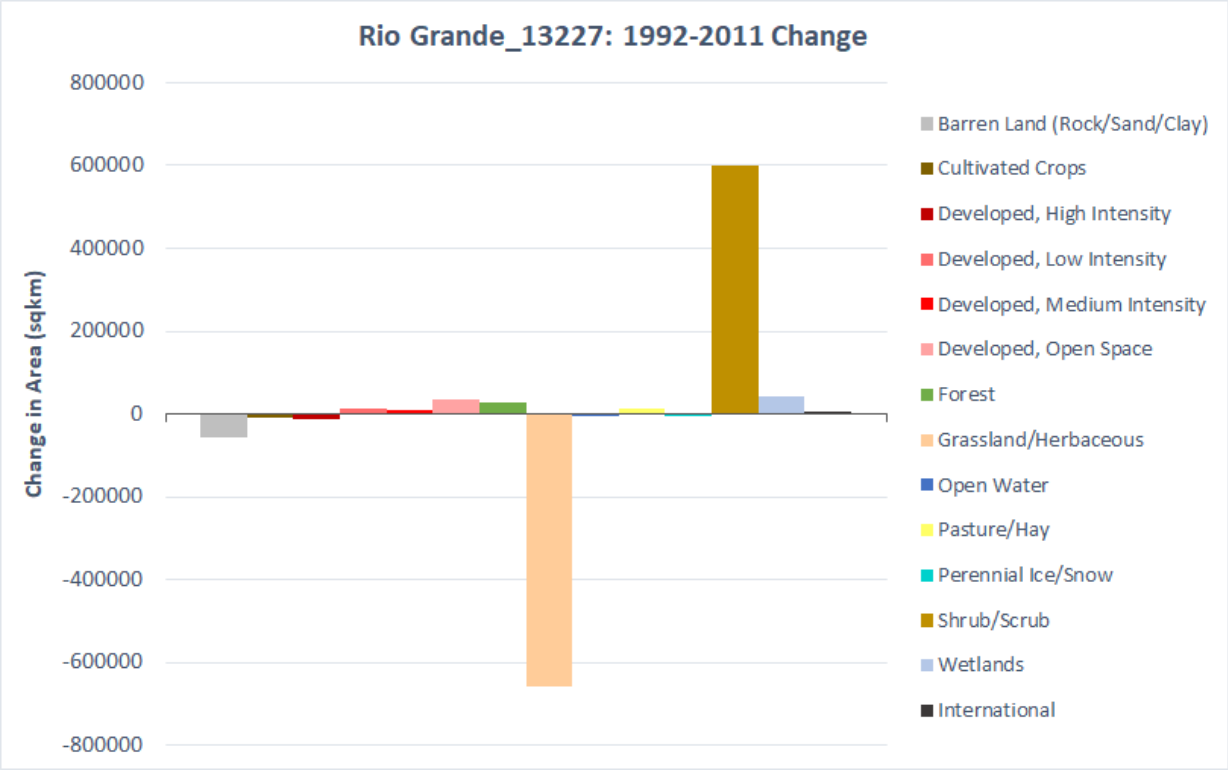

Figure 24. Land use change in area (sq km) from 1992-2011 for the Rio Grande watershed at Johnson Ranch.

TERLINGUA CREEK

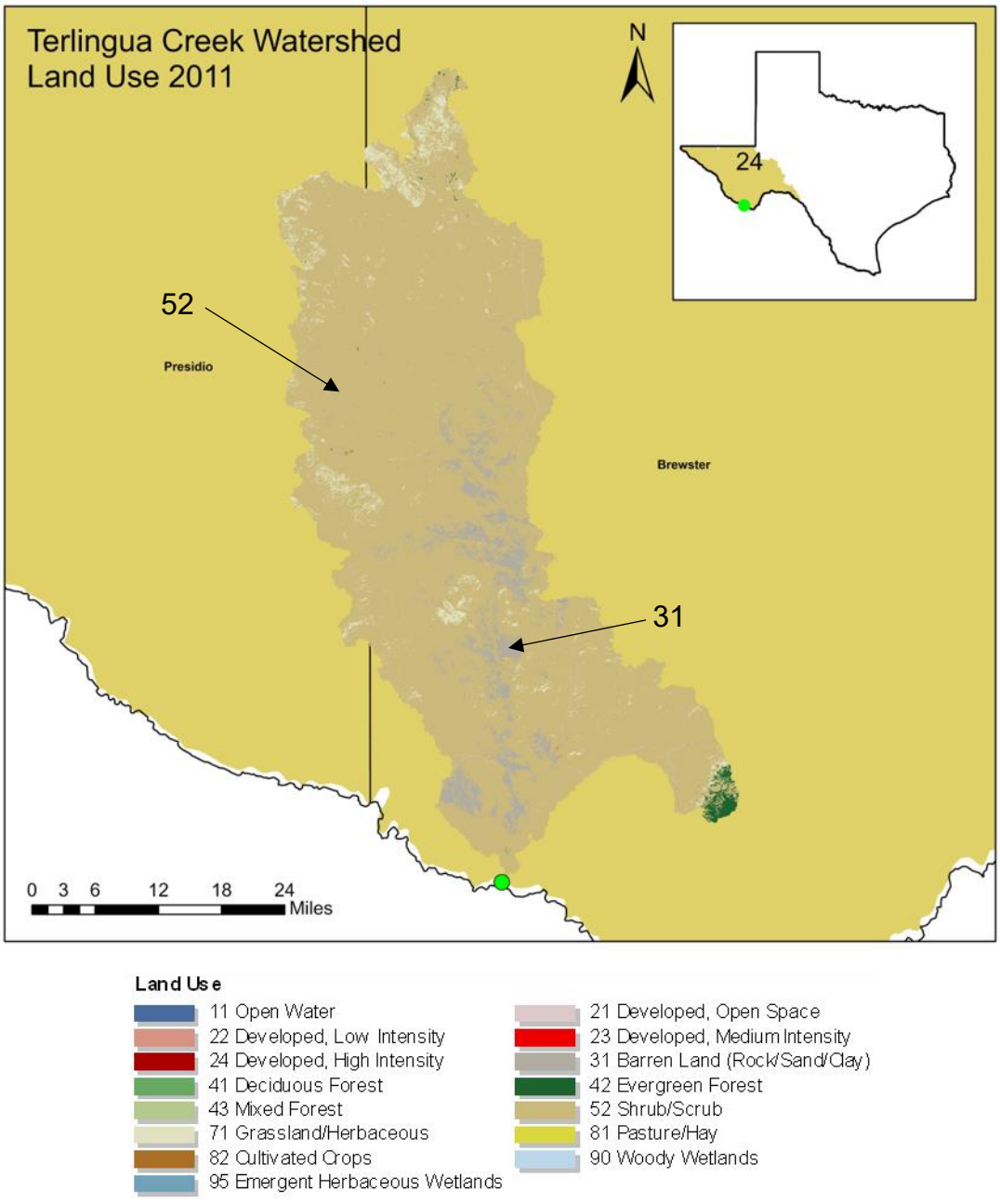

Figure 25. Map of Terlinuga Creek watershed location and 2011 land use; shrub/scrub and barren land were the most common land uses.

Sampling Dates

Physical Habitat:	No samples
Water Quality:	3 sampling events
Fish:	July 12, 1989
Benthic Invertebrates:	No samples

Physical Characterization

Watershed and Land Use

Terlingua Creek lies within the Rio Grande Basin. Sample site 13714 is located 250 m upstream from the confluence with the Rio Grande and approximately 13.7 km south of Terlingua in Brewster County (Figure 25).

The Terlingua Creek watershed at site 13714 is approximately 2831.74 sq km. The watershed spans across Level IV Ecoregions 24c, the Low Mountains and Bajadas, and 24b, the Chihuahuan Desert Grasslands. The dominant land cover in the watershed is shrub at 89.92% and is present throughout the watershed (Homer et al. 2015; Figure 25 and Figure 26). Barren land is the secondary land cover encompassing 5.57%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.23% and total cover for cultivated crops is 0.01%.

From 1992-2011 there was a 145.92 sq km decrease in grassland and a 116.32 sq km decrease in barren land (rock/sand/clay). There was a 259.04 sq km increase in shrub and a 4.94 sq km increase in open space development (Figure 27).

There are two wastewater outfalls – one domestic wastewater outfall (discharges < 1 million gallons per day) and one industrial wastewater outfall (discharges ≥ 1 million gallons per day) – within the Terlingua Creek watershed. The domestic wastewater facility is permitted to the US Department of the Interior for Big Bend National Park and the industrial wastewater facility is permitted to the Study Butte Water Supply Corporation. None of these facilities discharge directly into Terlingua Creek.

In Channel and Riparian Physical Habitat

Physical habitat data is not available for Terlingua Creek.

Water Quality

Water samples were collected at station 13714 over three sampling events in November 1992, August 1993, and August 2004. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-*a*.

Biological Characterization

Fish

Ten species (four families) were collected from Terlingua Creek. Cyprinidae was represented by seven species and was the only family with more than one species. Plains Killifish *Fundulus zebrinus* was the most abundant species. Of particular note was the presence of two state listed threatened species, Mexican Stoneroller and Chihuahua Shiner. Based on the fish assemblage, this site only rated as having an intermediate aquatic life use; however, when the coefficient of variability is applied it rises to high. Five of the eleven IBI metrics only received the lowest score

(1). These metrics included: number of sunfish species (none were collected); number of benthic invertivore species (none were collected); number of intolerant species (none were collected); percentage of individuals as tolerant species (82%); and number of individuals. The remaining six metrics each received the highest score (5).

Benthic Macroinvertebrates

No samples were collected for benthic macroinvertebrates.

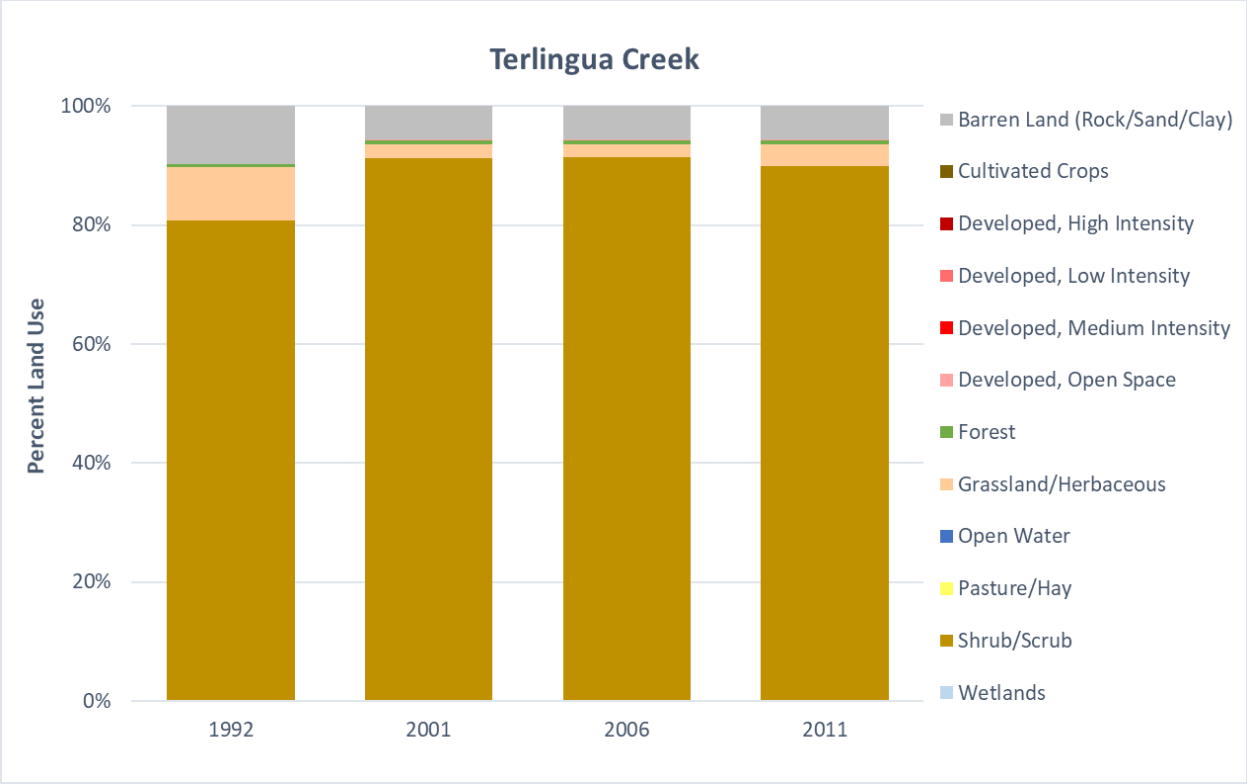

Figure 26. Percent land use in the Terlingua Creek watershed from 1992-2011.

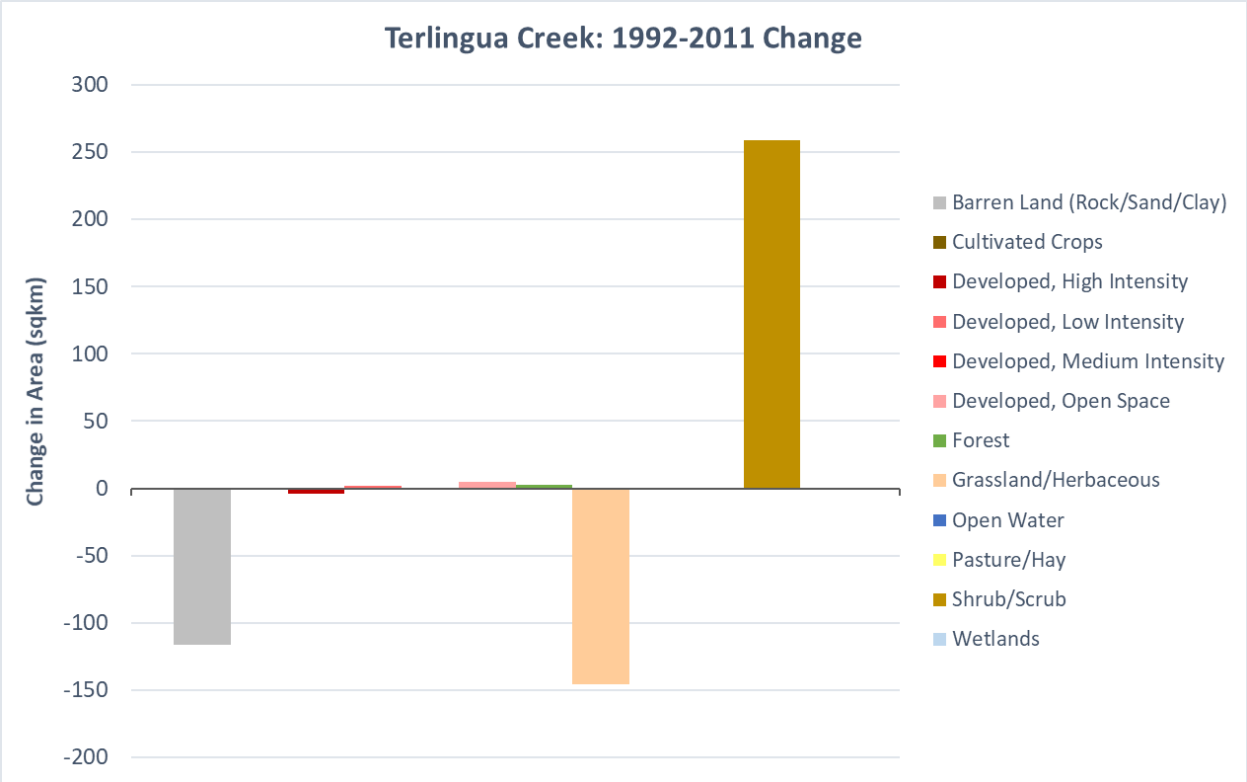

Figure 27. Land use change in area (sq km) from 1992-2011 for the Terlingua Creek watershed.

Ecoregion 24 Summary and Historical Characterization

Watershed and Land Use

Ecoregion 24 was historically predominately covered by vegetated semi-desert grassland and arid shrubland. The extent of desert shrubland is increasing due to gradual desertification partly due to historical grazing pressures (Griffith et al. 2007). In 2011 the overall primary land cover in the study watersheds was shrub and the secondary land covers were grassland and forest. Between 1992-2011, grassland experienced the largest decrease in combined land cover area across all watersheds (~2,792,532 sq km) and shrub experienced the largest increase (~2,574,173 sq km).

In Channel and Riparian Physical Habitat

Physical habitat for the Southern Deserts was evaluated at six stream sites over seven sampling events from 1989 to 2017. Watershed area varied from a minimum of 1,521 sq km at Independence Creek to a maximum of 5,510,981 sq km at the Rio Grande River at Johnson Ranch in Big Bend National Park. The sites generally had well vegetated riparian zones, and the riparian buffer was 25 meters on average with a minimum of 15 meters and maximum of 61 meters. Shrubs were the dominant riparian species (57% on average), followed by grasses (25%) then trees (11%), and average percent tree canopy coverage was 19.5%. Of the five sampling events that documented substrate type, cobble was the dominant substrate at three sites, with boulders reported as dominant at one site and silt at the remaining site. Average percentage of substrate gravel sized or larger was 67% and varied from a minimum of 40% to a maximum of 99.7%. Average percent instream cover was 40% and common instream cover types include boulders, undercut banks, cobble/gravel, macrophytes, woody debris, algae, and overhanging vegetation. Average stream depth and width measurements were 0.3 meters and 19 meters, respectively. Average stream bank slope was 33 degrees and erosion potential was moderate with an average of 40% which was reflected in the average bank stability HQI score (1.5) indicating moderately stable to moderately unstable stream banks. Maximum pool depth ranged from a minimum of 0.4 meters to a maximum of 2.6 meters. Total number of riffles varied from one to eleven, and total number of stream bends ranged from one to four.

HQI scores are available for five events and range from a maximum score of 26 (exceptional) at three sites (Pecos River, Rio Grande River at Contrabando Creek, and Independence Creek) to a minimum score of 18.5 (intermediate) at the Rio Grande River near Presidio. Of the five sampling events with an HQI score, three (60%) received a habitat assessment rating of exceptional, one received a rating of high (20%) and the remaining site (20%) received a rating of intermediate. The highest scoring HQI metrics for the Southern Deserts were the bottom substrate stability metric, number of riffles metric, and dimensions of largest pool metric. The lowest scoring HQI metrics on average were the bank stability metric and the channel flow status metric.

Water Quality

Water quality data from ecoregion 24 includes both small streams and larger rivers in west Texas. In this arid environment, temperature was 10 degrees Celsius in the 5th percentile to 29.3 degrees Celsius in the 95th percentile, and specific conductivity ranged from 163 to 8,990 us/cm. The secchi values observed indicated turbid waters at most sampling events with a median value of 0.24 meters with a range from 0.01 to 6.8 meters. The pH values had a range of 5.4 to 11. Chlorophyll-a data was highly variable between stations with a range of 0.1 to 205 ug/L. Additional water quality variables are summarized in appendix C of the report.

Fish

A total of 7,165 individuals consisting of 12 families and 36 species have been documented in eight sampling events across seven streams in the Southern Deserts from 1989 to 2017 (Appendix D - 1). For individual sites, taxa richness ranged from 20 species at the Pecos River from one sampling event in 2016 to a low of eight species at the Rio Grande at Johnson Ranch from one sampling event in 2017. The most abundant species collected across all sites and sampling events were Red Shiner (n = 1,703), Western Mosquitofish (n = 1,502), Bullhead Minnow (n = 934), Manantial Roundnose Minnow (n = 580), and Mexican Stoneroller (n = 370).

Index of biotic integrity scores across all sites and sampling events ranged from 35 to 47 resulting in aquatic life use categories of intermediate (n = 3), high (n = 2), and exceptional (n = 3; Figure 28). Of the eight sampling events in this ecoregion, 62.5% received an ALU rating of high or exceptional; 37.5% received an ALU of intermediate. Independence Creek was sampled twice and received a high and exceptional ALU. Three sites were sampled one time and received the same IBI score of 35 (intermediate): Rio Grande at Presidio, Rio Grande at Contrabando, and Terlingua Creek. All other sites received an ALU score of high or better.

Overall, IBI scores and individual metrics 1-11 did not significantly change through time (Figure 29; Figure 30; Figure 31); however, the percentage of individuals with disease/anomaly significantly decreased through time (Figure 31(12): $R^2 = 0.54$, $p = 0.04$). The decrease in the proportion of individuals with a disease/anomaly is likely due to sampler bias rather than a significant change in disease/anomaly. This is a characteristic that is often overlooked while in the field.

Benthic Macroinvertebrates

A total of 6,597 individuals representing 19 orders of aquatic macroinvertebrates were collected in the two Surber samples, and five RBP samples collected at six sites in the Chihuahuan Deserts ecoregion over the interval from July 1989 to March 2017 (Appendix E). Seven orders (Coleoptera, Diptera, Ephemeroptera, Trichoptera, Hemiptera, Odonata, and Clitellata) were represented at all six sites. The most commonly collected orders included Neotaenioglossa, Ephemeroptera, Trichoptera, Diptera, and Coleoptera which collectively represented 82% of the total number of individuals collected.

In terms of relative abundance, *Pyrgulopsis sp*. (Neotaenioglossa, Hydrobiidae) was the most abundant taxon, representing 18.7% of the total number of individuals collected at all sites.

However, it should be noted that all 1,371 individuals of this taxon were collected in a single Surber sample at Independence Creek. Other relatively abundant taxa include *Helicopsyche sp*., *Fallceon quilleri*, *Elimia comalensis*, *Cochliopina riograndensis*, *Cheumatopsyche sp*., and *Traverella sp*. Four of these six taxa are considered scraper/grazers, utilizing attached periphyton as a primary energy source. This reflects the open canopy, and ample insolation characterizing streams in the Chihuahuan Deserts.

Fallceon quilleri, was the only genus collected at all six sites, and six of seven collections. *Cheumatopsyche sp*., and *Erpetogomphus sp*. were also widely distributed genera/species, occurring in collections from five of six sites.

The BIBI scores for the Surber samples collected at Alamito Creek in 1989, and at Independence Creek in 1990 fell in the exceptional and high aquatic life use categories respectively. Similarly, the RBP IBI score for four of five RBP samples collected over the interval from September 2016 thru March 2017 RBP IBI scores fell in the high aquatic life use category, while the RBP IBI score for the sample collected on the Rio Grande at Johnson Ranch in Big Bend National Park fell in the exceptional. These findings suggest that the biotic integrity of these streams has remained relatively constant and in the high to exceptional range over the 28-year interval (Figure 32; Figure 33).

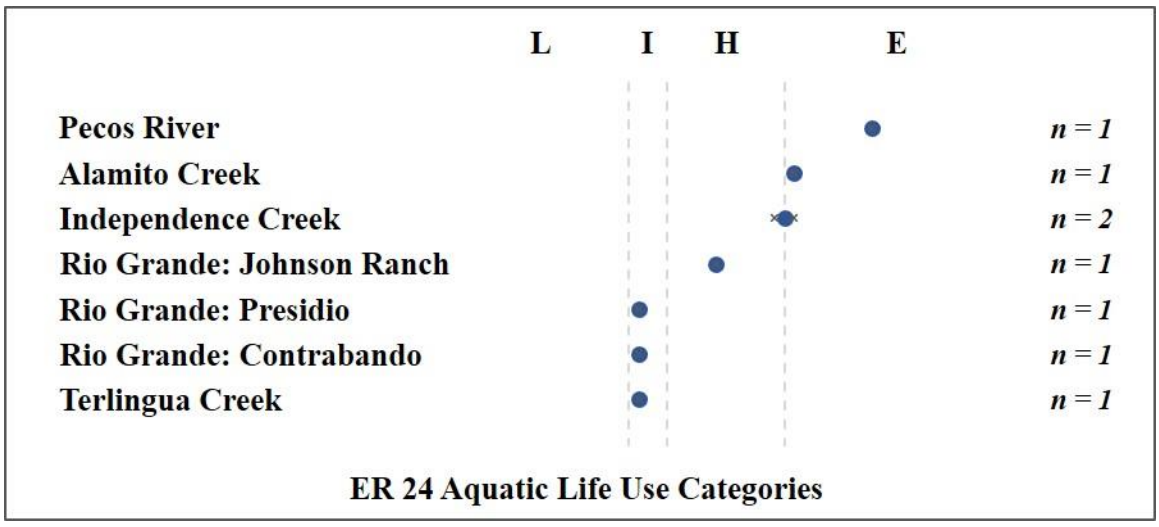

Figure 28. Aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all fish sampling events in Ecoregion 24 grouped by site and ranked by mean ALU score (blue dot); number of sampling events per site noted on right.

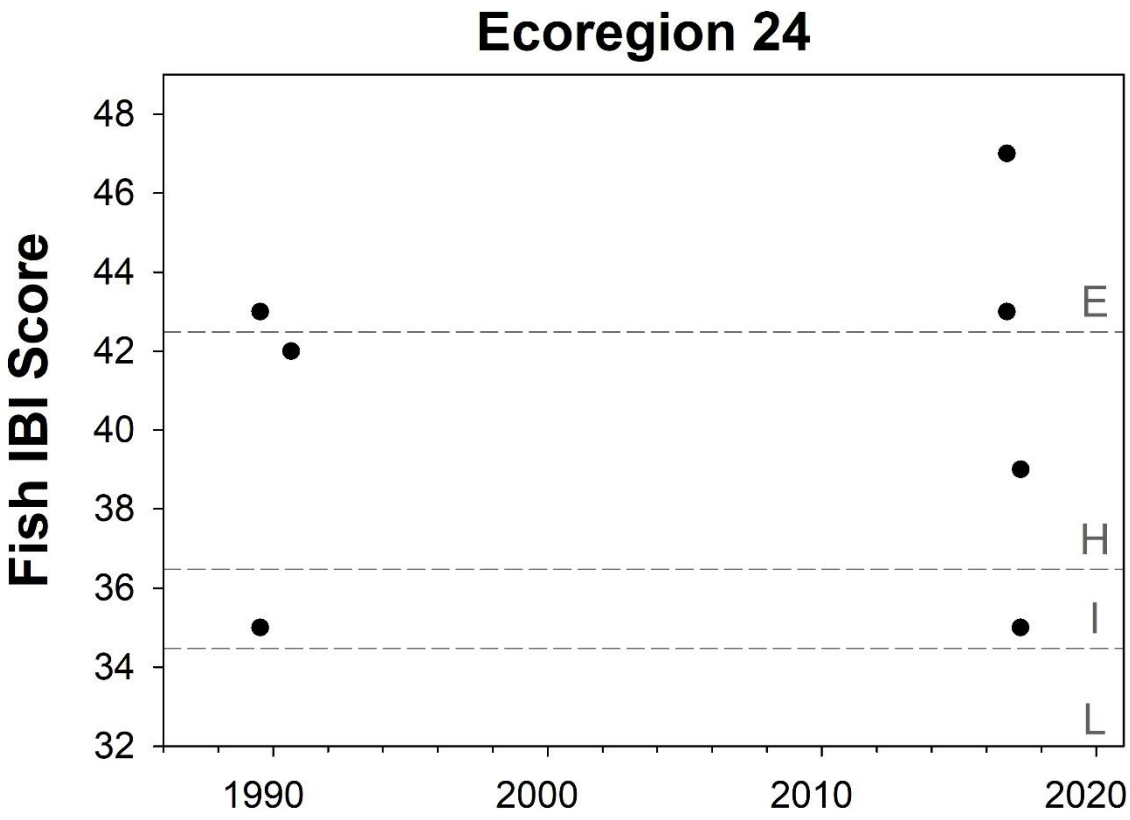

Figure 29. Fish index of biotic integrity scores through time for all sampling events in Ecoregion 24; break lines for aquatic life use categories (i.e., limited, intermediate, high, and exceptional) shown on each graph for reference (see Linam et al. 2002).

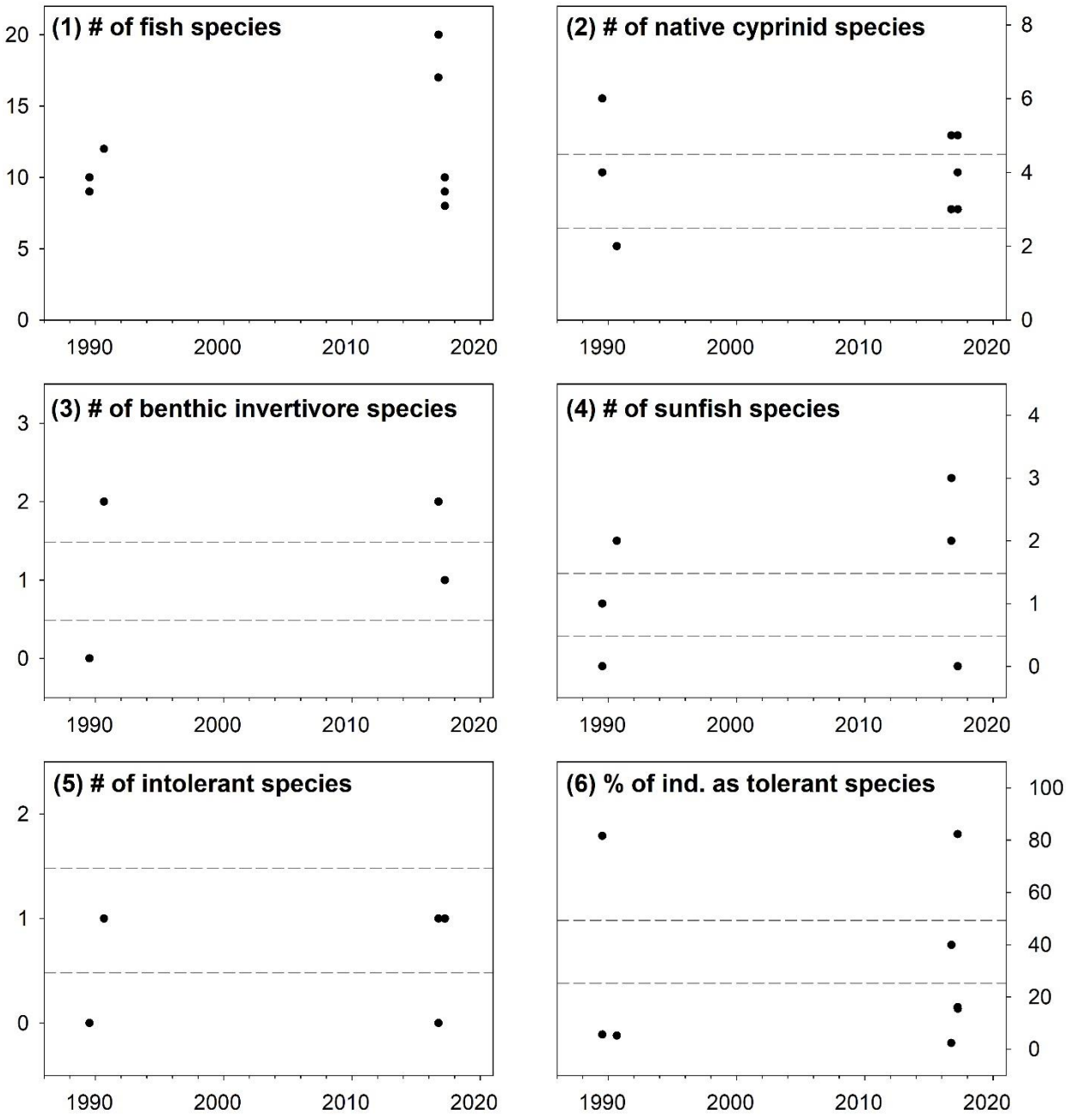

Figure 30. Raw values for fish index of biotic integrity metrics 1-6 through time for all sampling events in Ecoregion 24; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002).

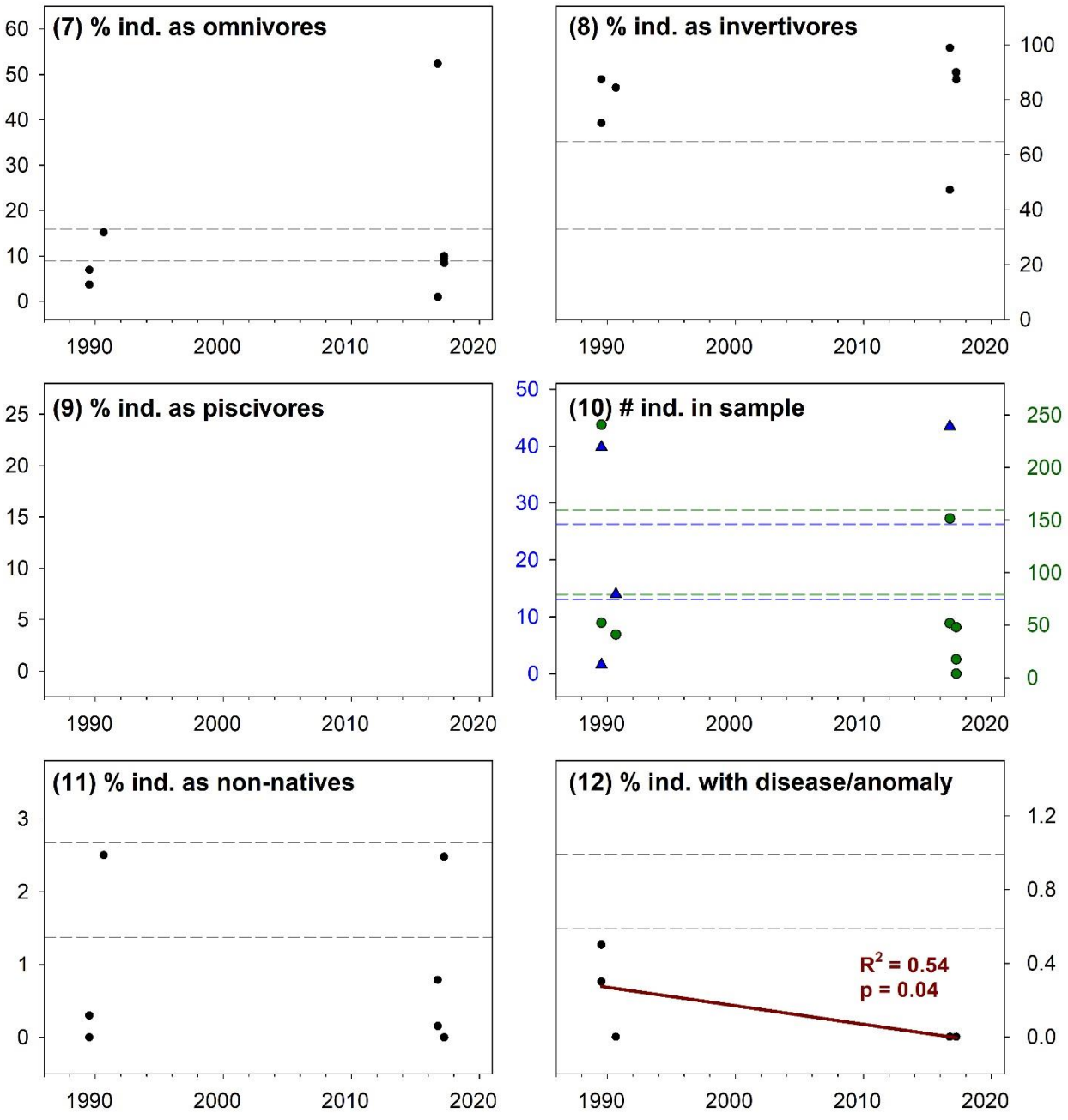

Figure 31. Raw values for fish index of biotic integrity metrics 7-12 through time for all sampling events in Ecoregion 24; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002); number of ind./seine haul represented by green circles and number of ind./min electrofishing represented by blue triangles for metric number 10; metrics that are not included in the IBI for this ecoregion are blank.

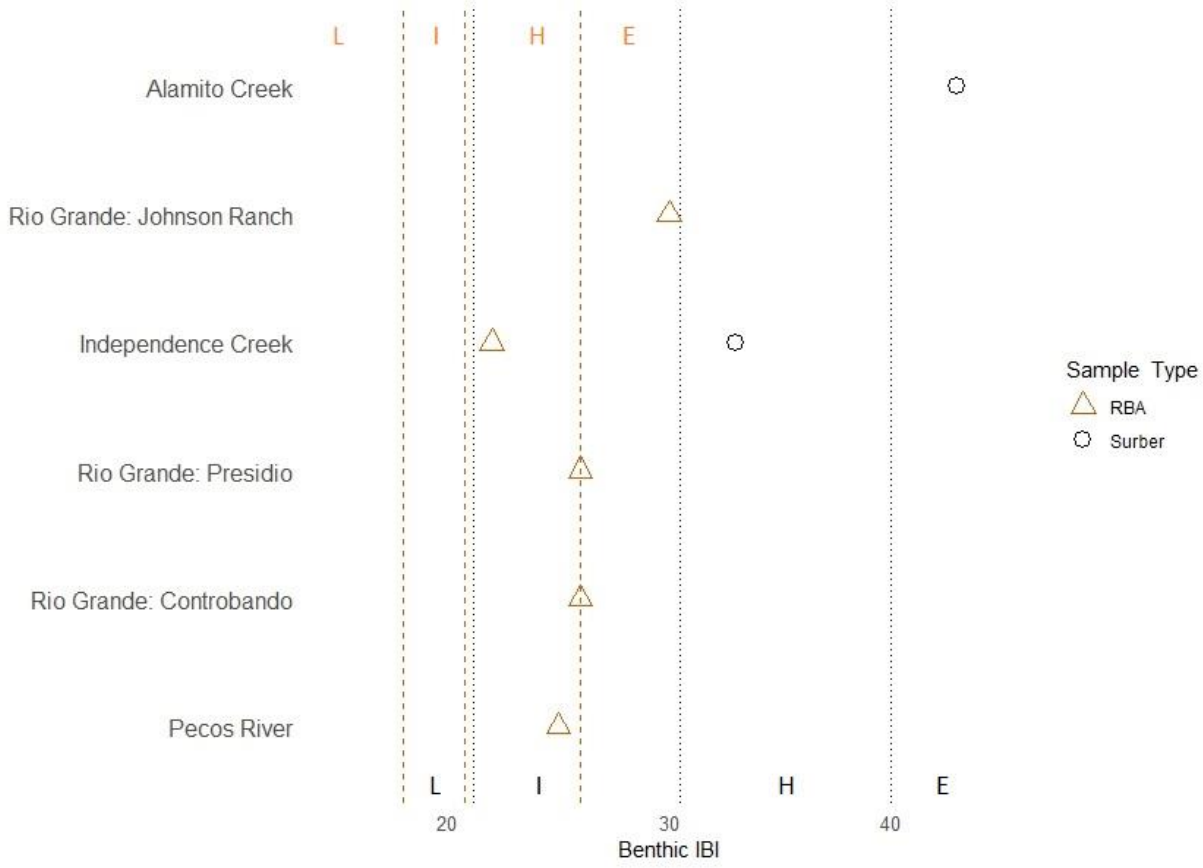

Figure 32. Benthic IBIs and aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all benthic sampling events in Ecoregions 24 grouped by site and ranked by mean IBI score. RBP IBIs scores are red triangles and ALU cutoffs are in red dashed lines. Surber IBI scores are black circles and ALU cutoffs are in black dotted lines.

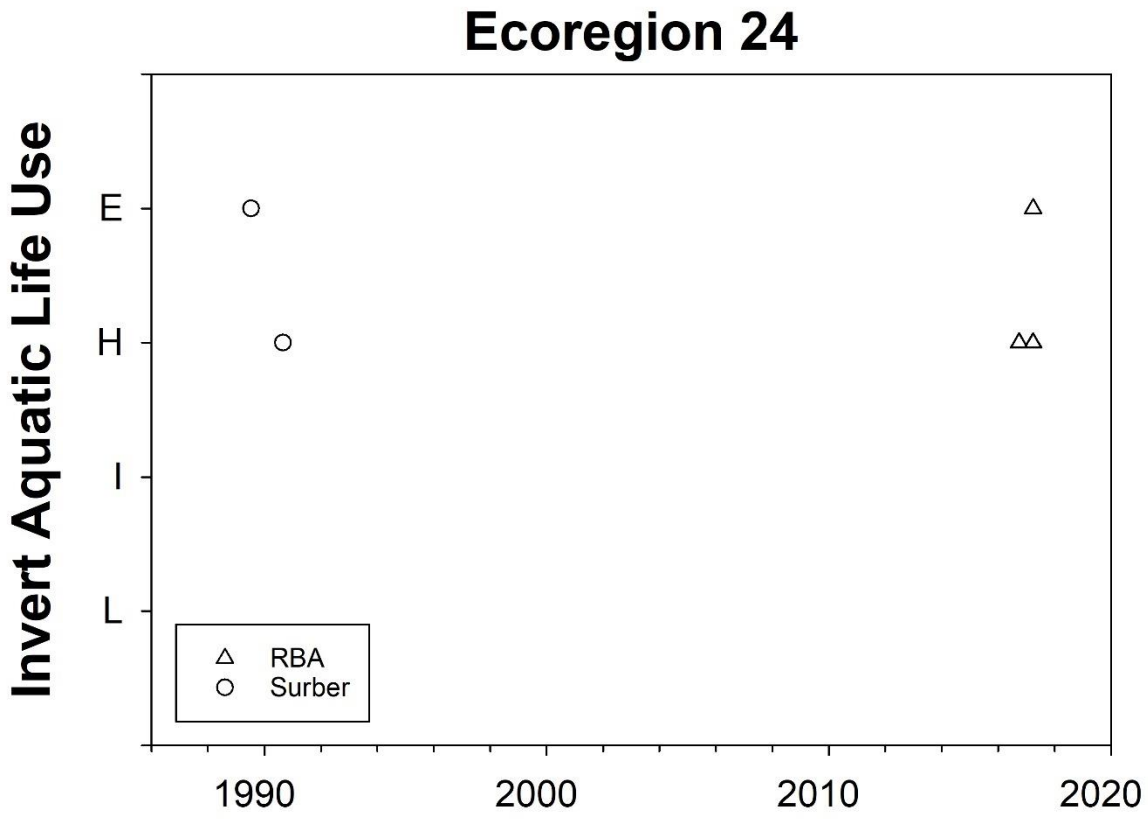

Figure 33. Benthic aquatic life use (ALU) categories through time for all sampling events in Ecoregion 24; Surber ALUs are noted by circles and RBP ALUs are noted by triangles.

ECOREGIONS 25 AND 26 – WESTERN HIGH PLAINS AND SOUTHWESTERN TABLELANDS

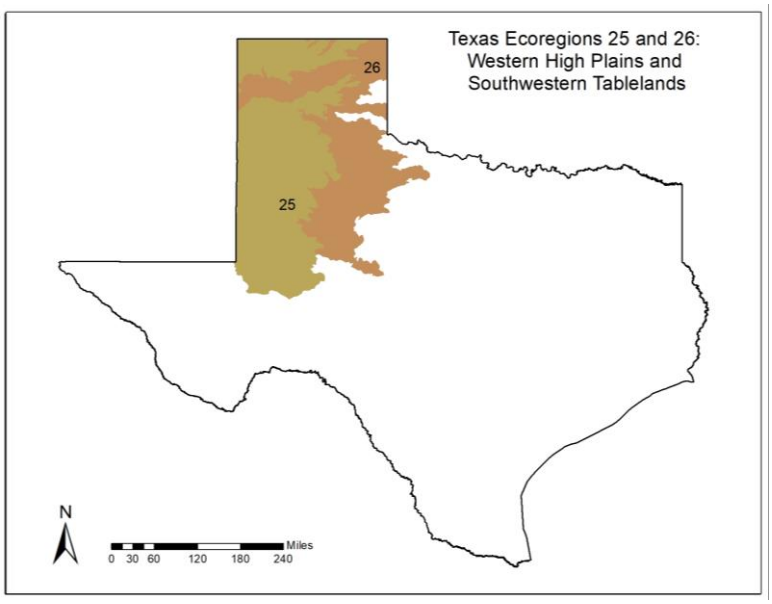

Figure 34. Map of Texas aggregate Ecoregions 25 and 26 – Western High Plains and Southwestern Tablelands.

Figure 35. Site photo from Wolf Creek.

Ecoregion 25 Characterization

In Texas, the High Plains ecoregion is an area of predominantly smooth to slightly irregular plains covering approximately 84,063 square kilometers in the western half of the Texas panhandle and extending from the Pecos River in the south to the Oklahoma border in the north (Figure 34). The ecoregion is delineated from adjacent lowlands to the east and west by sharp escarpments. Beyond the northern border of the Texas panhandle the High Plains ecoregion extends north, crossing the Oklahoma panhandle, western Kansas, eastern Colorado and into western Nebraska and southeastern Wyoming.

Croplands, rangeland, and oil and gas production are common activities in the region. Major urban areas include Midland, Odessa, Lubbock, and Amarillo. The natural vegetation of the ecoregion is characterized primarily by short grasses. Harvard (shin) oak (*Quercus harvardii*), yucca (*Yucca spp*.), and bunch grasses grow on deep sand strips known as the Shinnery Sands, primarily in the southwestern portion of the ecoregion. There are numerous seasonal depressional wetlands, called playa lakes, that occur in the ecoregion (Griffith et al. 2007).

Annual average precipitation is low, ranging from 33–56 cm, so there is a low density of streams which, unless spring fed, are usually intermittent. The major rivers in the ecoregion include the Canadian and the Red. Deep incisions created by the Canadian River, which bisects the ecoregion north of Amarillo, form broad areas of complex topography known as "The Breaks" (U.S. Forest Service, https://www.fs.fed.us/land/pubs/ecoregions/ch37.html). Riparian vegetation includes hackberry (*Celtis spp.*), elm (*Ulnis spp.*), sumac (*Rhus spp*.), cottonwood (Populus spp.), and willow (*Salix spp*.) (Griffith et al. 2007).

Ecoregion 26 Characterization

The southwestern tablelands are characterized by red hued canyons, mesas, badlands, and dissected river breaks (Griffith et al. 2007). In Texas, the southwestern tablelands cover approximately 60,186 square kilometers. The ecoregion begins in the south along the Colorado River just west of Ballinger and below E.V. Spence Reservoir and extends north to the northeast corner of the Texas panhandle including the Wolf Creek watershed (Figure 34). The ecoregion includes most of the Canadian River watershed in Texas in an east to west corridor, the western half of which is known as the Canadian Breaks. Portions of the ecoregion extend north thru Oklahoma into Kansas and Colorado, and west and east into New Mexico and Oklahoma respectively. The ecoregion includes portions of the Colorado, Pease, Brazos, and Canadian River watersheds.

Sub-humid grassland and semiarid rangeland cover much of the region with only a small portion in cropland. Riparian areas may be characterized by trees and shrubs including cottonwood (*Populus deltoides*), elm (*Ulmus crassifolia*), black willow (*Salix nigra*), sand sagebrush (*Artemisia filifolia*), and invasive salt cedars, as well as by grasses such as big bluestem, switchgrass, and yellow Indiangrass.

Streams in the southwestern tablelands are generally relatively salty and shallow with sandy substrates which often impart a reddish turbidity and provides an unstable, shifty habitat for benthic invertebrates. The streams are also characterized by periodic low flows. Stream channels may be broad with extensive areas of exposed sand and sandy bars.

Table 5. Streams sampled in aggregate Ecoregions 25 and 26.

Bluff Creek	Chicken Creek	Salt Fork Red River
Buck Creek	McClellan Creek	White Deer Creek
Canadian River at US 385	North Fork Wichita River	Whitefish Creek
Canadian River at SH 70	Saddlers Creek	Wolf Creek

BLUFF CREEK

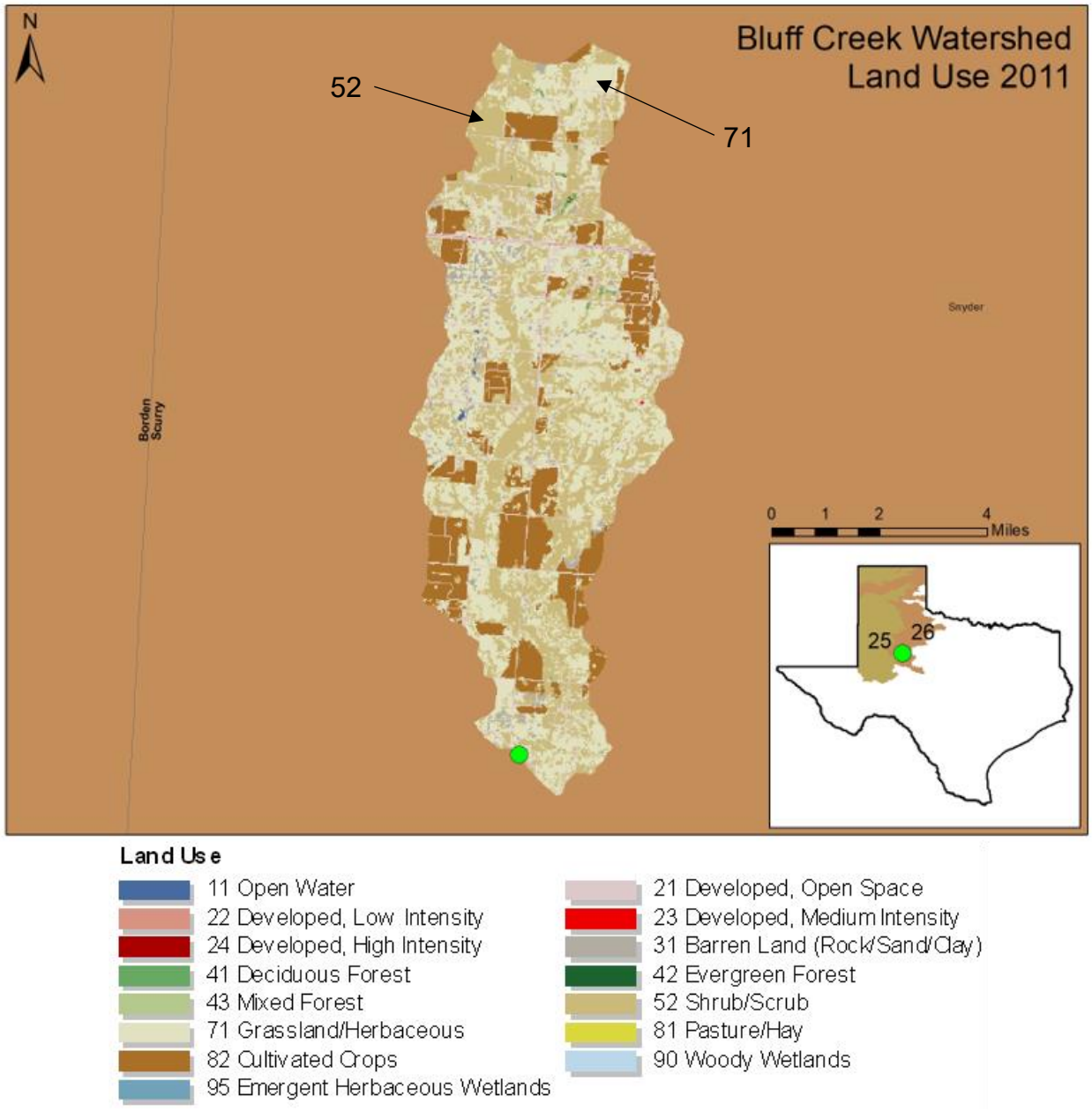

Figure 36. Map of Bluff Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	August 30, 1988
Water Quality:	5 sampling events
Fish:	August 25, 1988; April 5, 1989
Benthic Invertebrates:	August 25, 1988

Physical Characterization

Watershed and Land Use

Bluff Creek lies within the Colorado River Basin. Sample site 12205 is located at FM 1606, approximately 19 km southwest of Snyder in Scurry County (Figure 36).

The Bluff Creek watershed at site 12205 is about 111.61 sq km. The watershed is in Level IV Ecoregion 26b, the Flat Tablelands and Valleys. The dominant land cover in the watershed is grassland/herbaceous at 38.43% and is present throughout the watershed (Homer et al. 2015; Figure 36 and Figure 37). Shrub is the secondary land cover encompassing 34.34%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 7.42% and total cover for cultivated crops is 16.93%.

From 1992-2011 there was a 22.56 sq km decrease in grassland and a 6.55 sq km decrease in barren land (rock/sand/clay). There was a 25.92 sq km increase in shrubs and a 7.75 sq km increase in open space development (Figure 38).

There are no permitted wastewater outfalls within the Bluff Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Bluff Creek was evaluated on August 30, 1988. Bluff Creek drains to the Colorado River below Lake J. B. Thomas. The average riparian width was 46 meters, and the riparian zone was dominated by trees, which made up an average of 65% of the total riparian species, followed by grasses (25%) then shrubs (10%). The average percentage of tree canopy cover was 65%. The dominant substrate was sand with some gravel and large boulders, and the average percent of substrate that was gravel size or larger was 19%. Average percent instream cover was 39%. Bluff Creek had an average depth of 0.4 meters and a maximum depth of 0.7 meters. The average width was 4.1 meters and average stream bank slope was 40 degrees. The stream flow at the site was 0.21 cfs. Average stream bank erosion potential was 22%. Five riffles were observed at the site and there were three total stream bends.

Water Quality

Water samples were collected at station 12205 over 5 sampling events from August 1988 through July 1999. Data were collected for temperature, flow, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-*a*.

Biological Characterization

Fish

Nine species (three families) were collected between the two sampling events. Cyprinidae and Centrarchidae were each represented by four species. Red Shiner was the most abundant fish species. Both fish assemblage samples rated as having an exceptional aquatic life use.

Benthic Macroinvertebrates

Considering the one Surber sample from 1988, a total of 5542 individuals representing 46 taxa from 13 orders of macroinvertebrates were collected from Bluff Creek (Appendix E). Veneroida (Bivalvia), Oligochaeta, and Diptera were the most commonly collected orders, collectively accounting for 90 percent of the total number of individuals collected. Trichoptera, Odonata, and Coleoptera were the only other orders which comprised at least one percent of the collection. The Surber BIBI for the sample fell in the exceptional aquatic life use category.

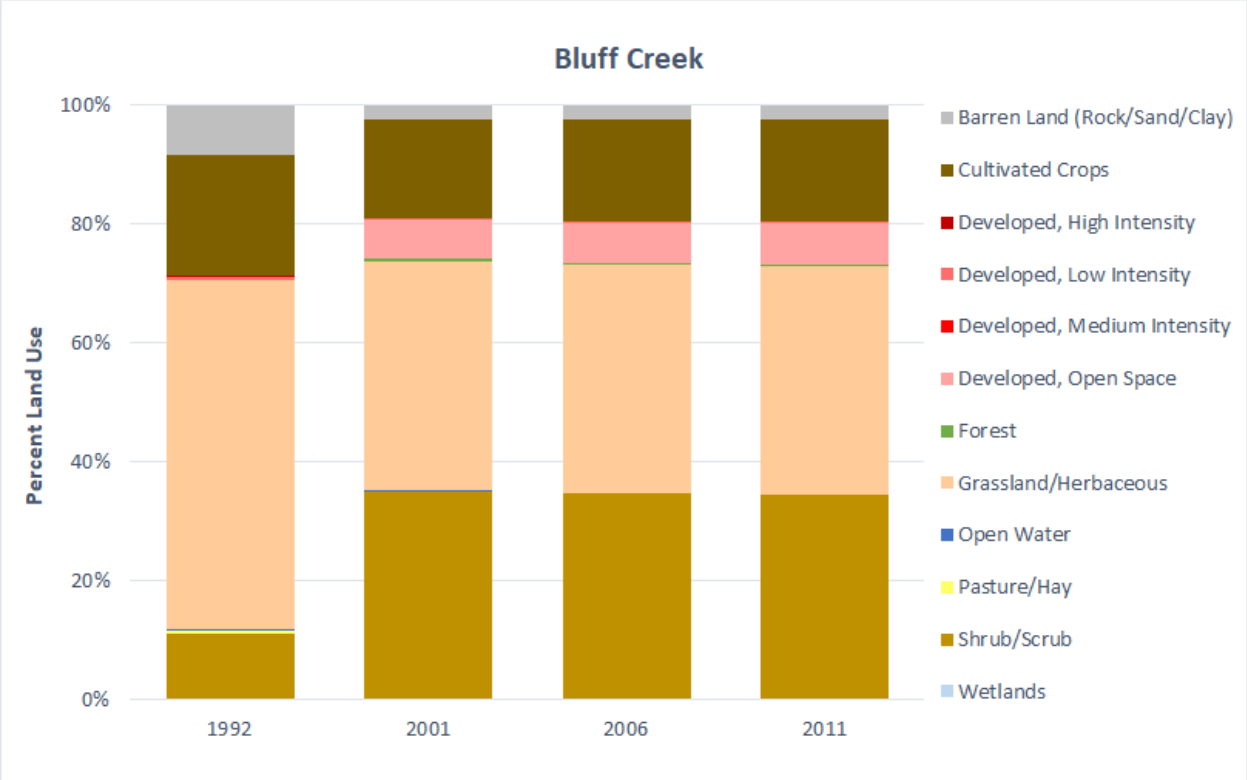

Figure 37. Percent land use in the Bluff Creek watershed from 1992-2011.

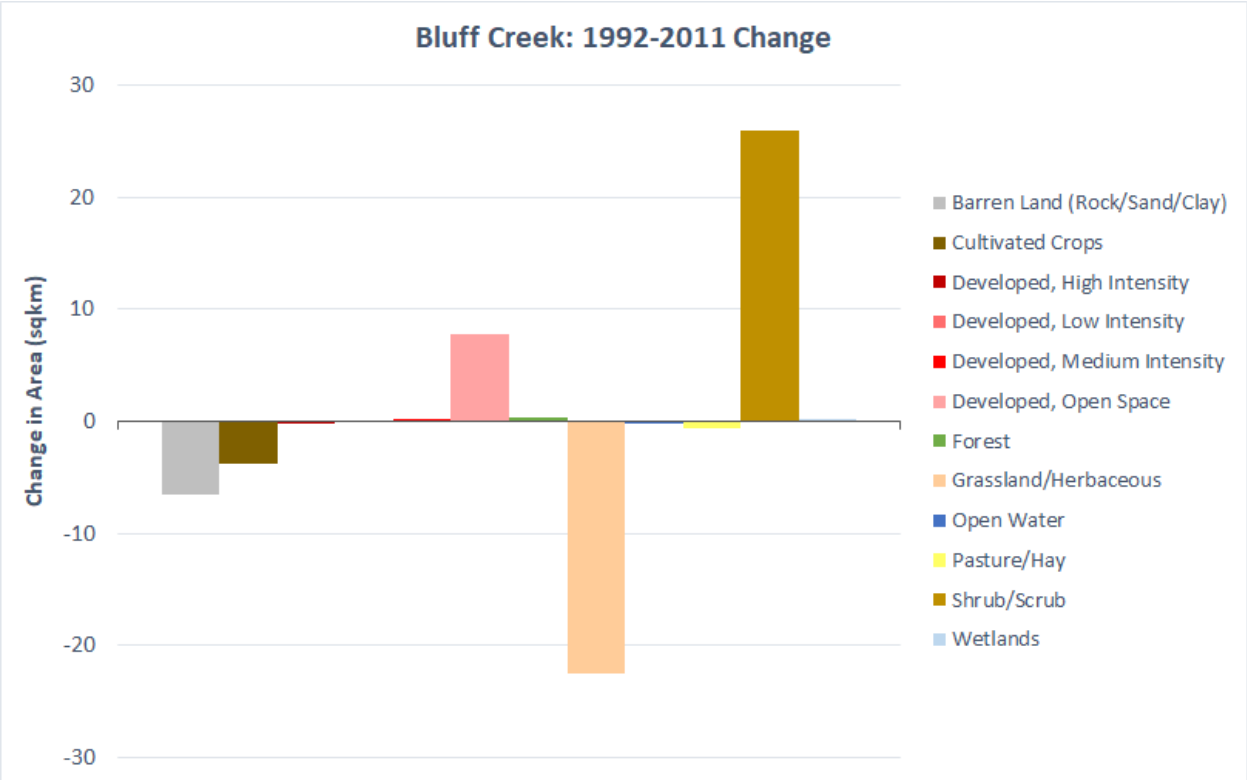

Figure 38. Land use change in area (sq km) from 1992-2011 for the Bluff Creek watershed.

BUCK CREEK

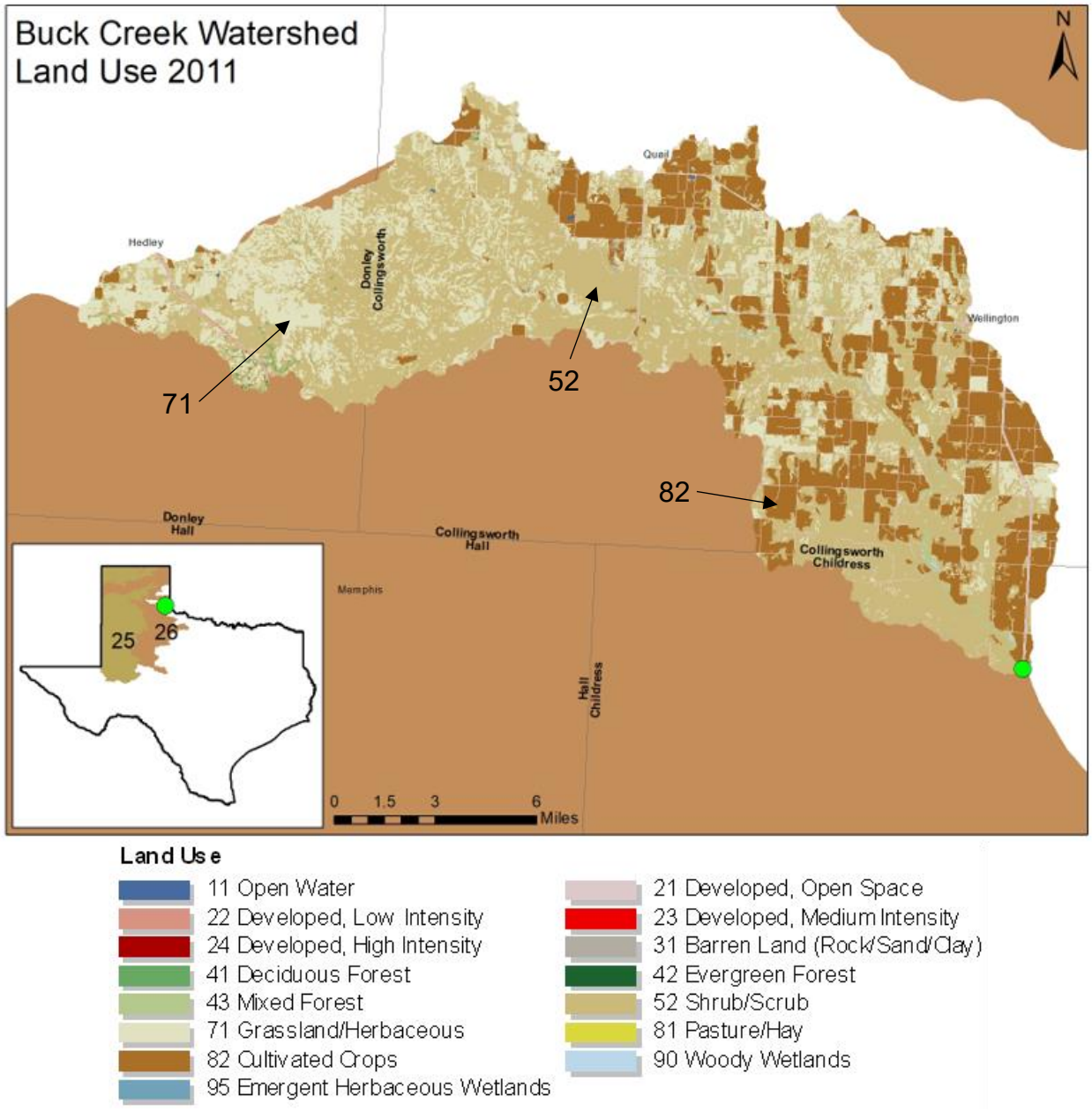

Figure 39. Map of Buck Creek watershed location and 2011 land use; shrub/scrub, grassland/herbaceous, and cultivated crops were the most common land uses.

Sampling Dates

Physical Habitat:	May 9, 2018
Water Quality:	172 sampling events
Fish:	May 9, 2018
Benthic Invertebrates:	May 9, 2018

Physical Characterization

Watershed and Land Use

Buck Creek lies within the Red River Basin. Sample site 15811 is located at US 83, approximately 16.8 km southwest of Dodson in Childress County (Figure 39).

The Buck Creek watershed at site 15811 is approximately 509.68 sq km. The station and small portion of the watershed lie in Level IV Ecoregion 26b, the Flat Tablelands and Valleys. Most of the lower and middle watershed cross into Level IV Ecoregion 27h, the Red Prairie, while the remaining portion of the watershed lies in Level IV Ecoregion 26c, the Caprock Canyons, Badlands, and Breaks. The dominant land cover in the watershed is shrub at 50.33% and is present throughout the watershed (Homer et al. 2015; Figure 39 and Figure 40). Cultivated crops are the secondary land cover encompassing 22.79%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.31%.

From 1992-2011 there was a 107.35 sq km decrease in cultivated crops and a 102.87 sq km decrease in grassland. There was a 196.83 sq km increase in shrubs and a 16.11 sq km increase in open space development (Figure 41).

There are no permitted wastewater outfalls within the Buck Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Buck Creek was evaluated on May 9, 2018. The Habitat Quality Index score of 23.5 indicates a high aquatic life use rating. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was dominated by trees, which make up an average of 42.5% of the total riparian species, followed by grasses (32.5%) then shrubs (25%). The average percentage of tree canopy cover was 22.9%. The dominant substrate was sand and the average percent of substrate gravel size or larger was 7%. The average percent instream cover was 49% and instream cover types include woody debris, macrophytes, algae, and overhanging vegetation. Buck Creek was 0.28 meters deep on average and 5.2 meters wide. The average stream bank slope was 15 degrees, and the average stream bank erosion potential was 20%. Stream flow at the site was 0.82 cfs. The deepest pool measured at Buck Creek was 0.92 meters. Two riffles were observed at the site and there were seven total stream bends.

Water Quality

Water quality data were collected 172 times from station 15811 from December 1997 through January 2019. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-*a*.

Biological Characterization

Fish

Nine species (five families) were collected from Buck Creek. Centrarchidae yielded three species, Cyprinidae and Ictaluridae each yielded two, and Fundulidae and Poeciliidae one. The most abundant species was Red Shiner. Based on the fish assemblage the aquatic life use rated as intermediate. IBI metrics that received the lowest rating (1) included: number of native cyprinid species (only Red Shiner); percentage of individuals as non-native species (4.5%, Common Carp *Cyprinus carpio*); and number of individuals per seine haul.

Benthic Macroinvertebrates

Considering the one RBP sample from 2018, a total of 279 individuals representing 25 taxa from 9 orders of macroinvertebrates were collected from Buck Creek (Appendix E). Ephemeroptera, Odonata, Basommatophora, and Diptera were the most commonly collected orders, collectively accounting for 92 percent of the total number of individuals collected. Coleoptera, Amphipoda, and Oligochaeta were the only other orders which comprised at least one percent of the collection. The statewide BIBI for this RBP sample fell in the intermediate aquatic life use category.

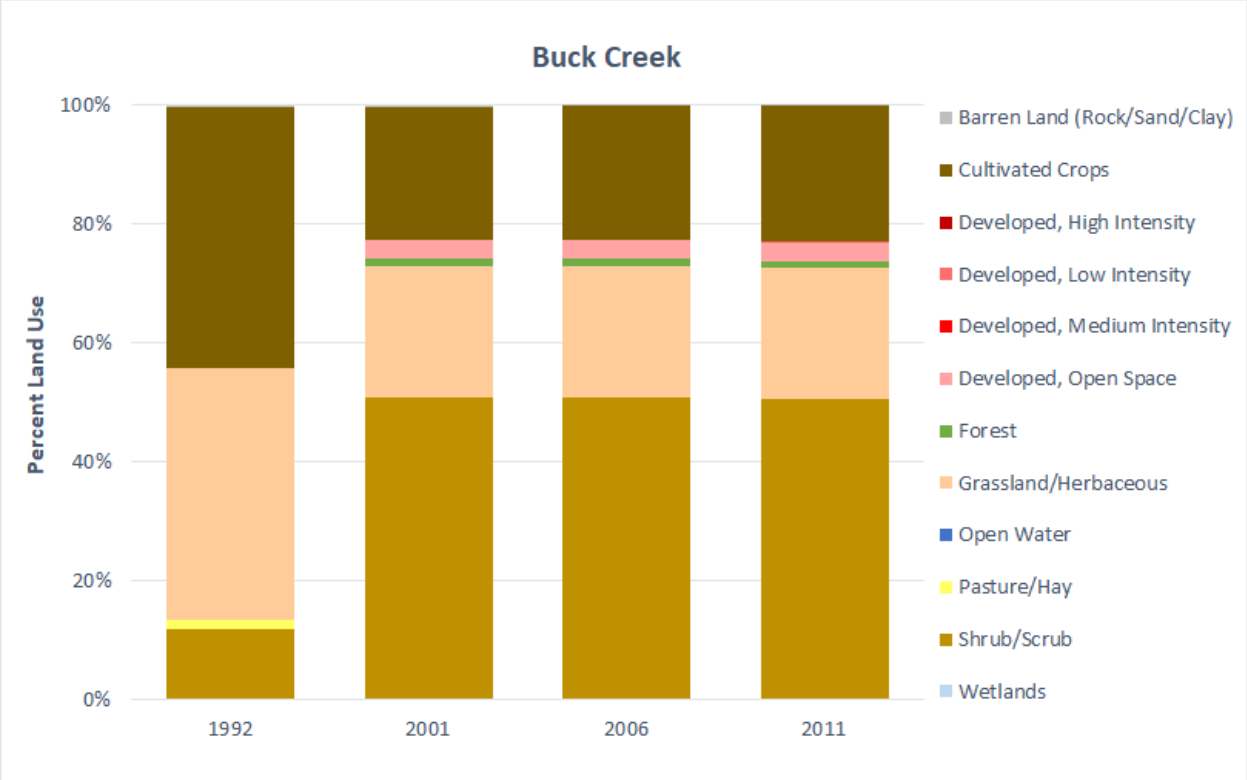

Figure 40. Percent land use in the Buck Creek watershed from 1992-2011.

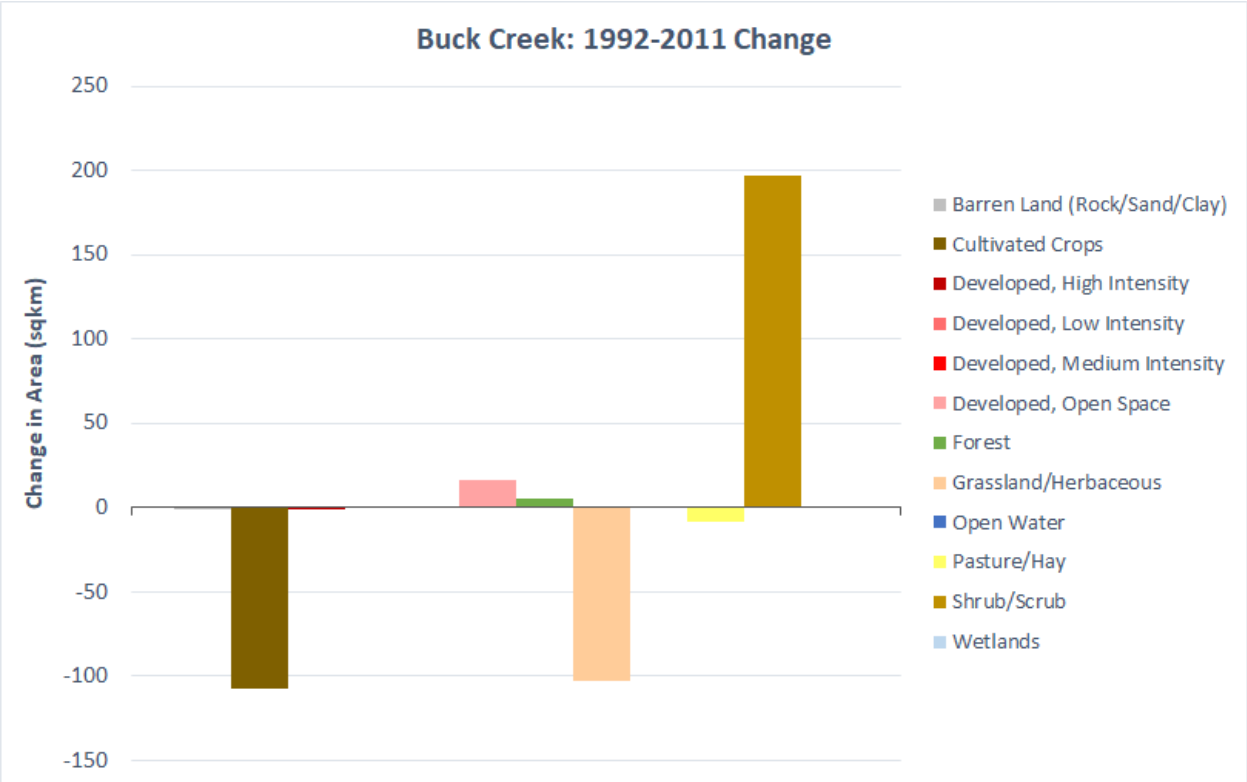

Figure 41. Land use change in area (sq km) from 1992-2011 for the Buck Creek watershed.

CANADIAN RIVER: US 385

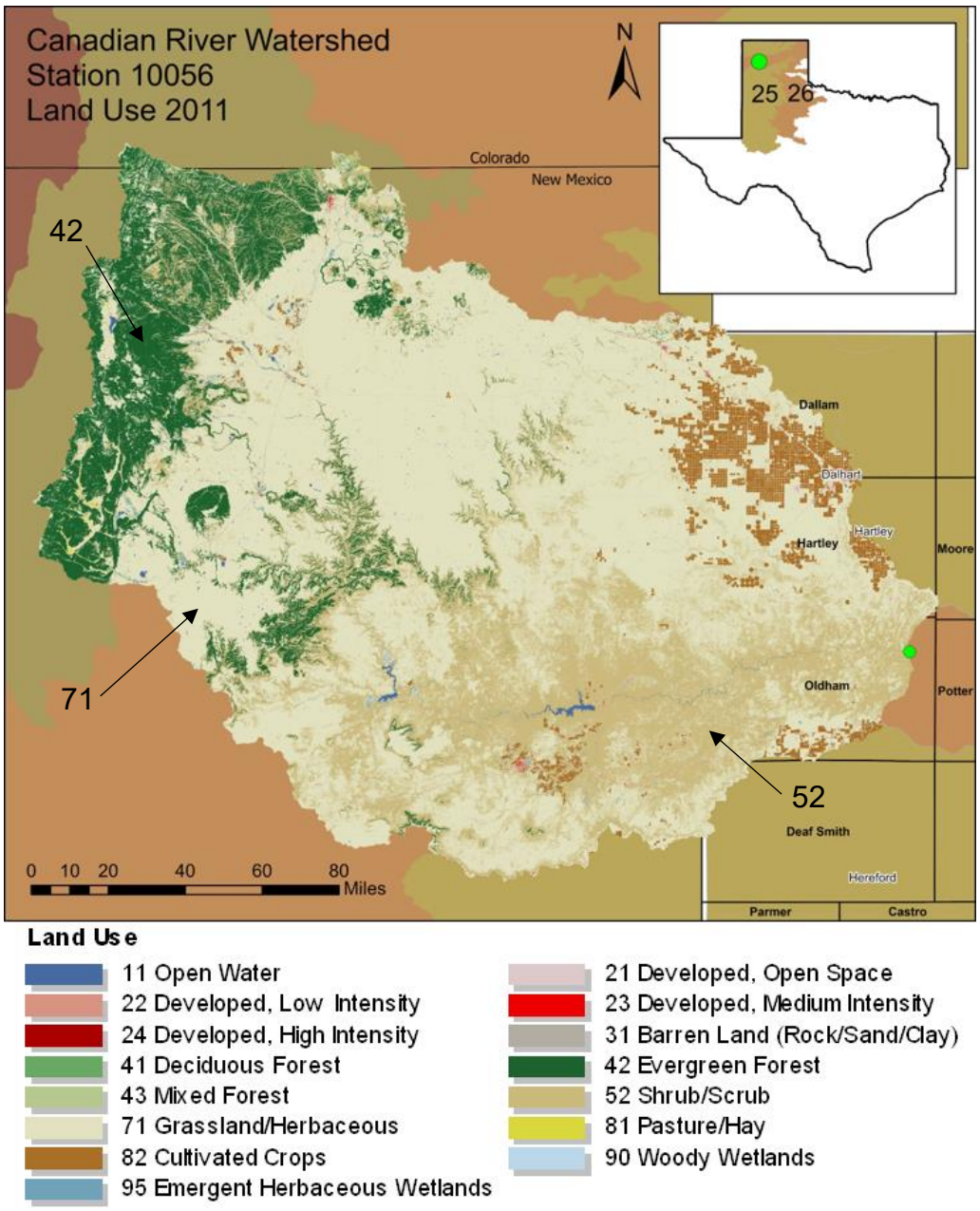

Figure 42. Map of Canadian River watershed at US 385 and 2011 land use; grassland/herbaceous, shrub/scrub, and forest were the most common land uses.

Sampling Dates

Physical Habitat:	June 26, 2018
Water Quality:	233 sampling events
Fish:	June 26, 2018
Benthic Invertebrates:	June 26, 2018

Physical Characterization

Watershed and Land Use

The Canadian River is the basin's namesake and is a major river basin in Texas. Sample site 10056 is located at US 385 south of Channing in Oldham County (Figure 42).

The Canadian River watershed at site 10056 is approximately 1,466,288.91 sq km. The station and lower portion of the watershed lie in Level IV Ecoregion 26d, the Semiarid Canadian Breaks. The middle and upper watershed spans into New Mexico and include portions of Level IV Ecoregion 26m, the Canadian Canyons, Level IV Ecoregion 26n, the Conchas/Pecos Plains, Level IV Ecoregion 26l, the Upper Canadian Plateau, and Level IV Ecoregion 26h, the Pinyon-Juniper Woodlands and Savannas. Small portions of the watershed cross into Ecoregion 25, the High Plains, and Ecoregion 21, the Southern Rockies. The dominant land cover in the watershed is grassland at 59.24% and is present throughout the watershed (Homer et al. 2015; Figure 42 and Figure 43). Shrub is the secondary land cover encompassing 23.47%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.86% and total cover for cultivated crops is 3.85%.

From 1992-2011 there was a 125,778.91 sq km decrease in grassland and a 13,232.18 sq km decrease in pasture/hay. There was a 118,244.20 sq km increase in shrubs and a 10843.96 sq km increase in open space development (Figure 44).

Within the Texas portion of the watershed at site 10056, there is one industrial wastewater outfall (discharges ≥ 1 million gallons per day) which is permitted to the City of Dalhart. This facility does not discharge directly into the Canadian River.

In Channel and Riparian Physical Habitat

Physical habitat for the Canadian River at US 385 was evaluated on June 26, 2018. The Habitat Quality Index score of 18.5 indicates an intermediate aquatic life use rating. The riparian buffer at the sampling site was measured to be 18 meters on average. The riparian zone was dominated by grasses, which make up an average of 60% of the total riparian species, followed by shrubs (32.5%) then trees (7.5%). The average percentage of tree canopy cover was 6.6%. The dominant substrate was sand, and the average percentage of substrate gravel size or larger was 0.17%. The average percent instream cover was 1.5% and instream cover types include roots, overhanging vegetation, undercut banks, macrophytes, and gravel. The Canadian River at US 385 was 0.09 meters deep on average and 13.6 meters wide. The average stream bank slope was 19.7 degrees. Stream flow at the site was measured at 3.9 cfs. Average stream bank erosion potential was 85%. The deepest pool was 0.84 meters. Four riffles were observed at the site and there were four total stream bends.

Water Quality

Water samples were collected at station 10056 over 233 sampling events from May 1969 through September 2020. Data collected included temperature, flow, specific conductivity, dissolved

oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a. Continuous flow data for station 10056 is available from USGS gage 07227470.

Biological Characterization

Fish

Eleven species (six families) were collected from the Canadian River. Cyprinidae was the only family represented by more than one species (six), including one federally listed threatened species, Arkansas River Shiner *Notropis girardi*. Red Shiner was the most abundant species, closely followed by Plains Killifish. Based on the fish assemblage, the US 385 site on the Canadian River rated as having a high aquatic life use. All metrics, except two, scored the highest rating (5). Catch per unit effort was very low thus resulting in the lowest score for that metric (1). The number of sunfish species scored a three with only one sunfish species, Green Sunfish *Lepomis cyanellus*, being collected.

Benthic Macroinvertebrates

Considering the one RBP sample from 2018, a total of 200 individuals representing 24 taxa from eight orders of macroinvertebrates were collected from the Canadian River at Hwy 385 (Appendix E). Odonata, Ephemeroptera, Diptera, and Trichoptera were the most commonly collected orders, collectively accounting for 93 percent of the total number of individuals collected. Coleoptera, Hemiptera, Amphipoda, and Oligochaeta were the only other orders which comprised at least one percent of the collections. The statewide BIBI for the RBP sample fell in the intermediate aquatic life use category.

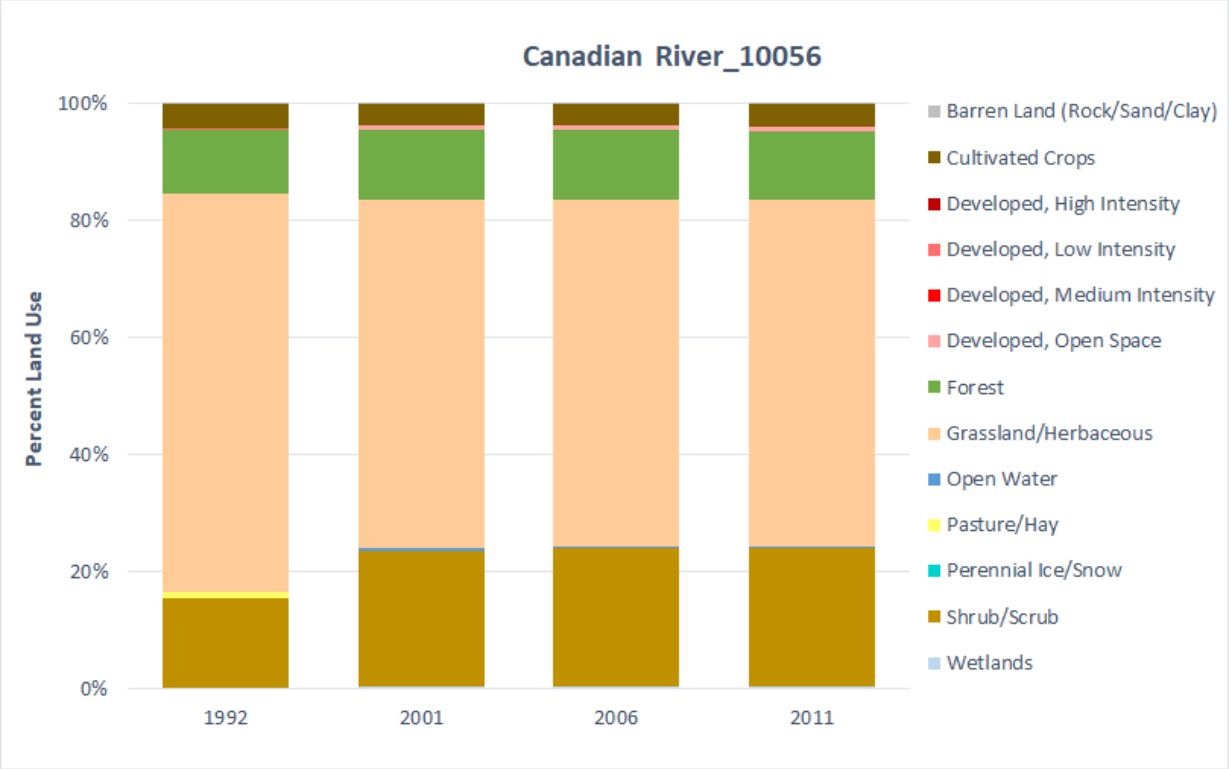

Figure 43. Percent land use in the Canadian River watershed at US 385 from 1992-2011.

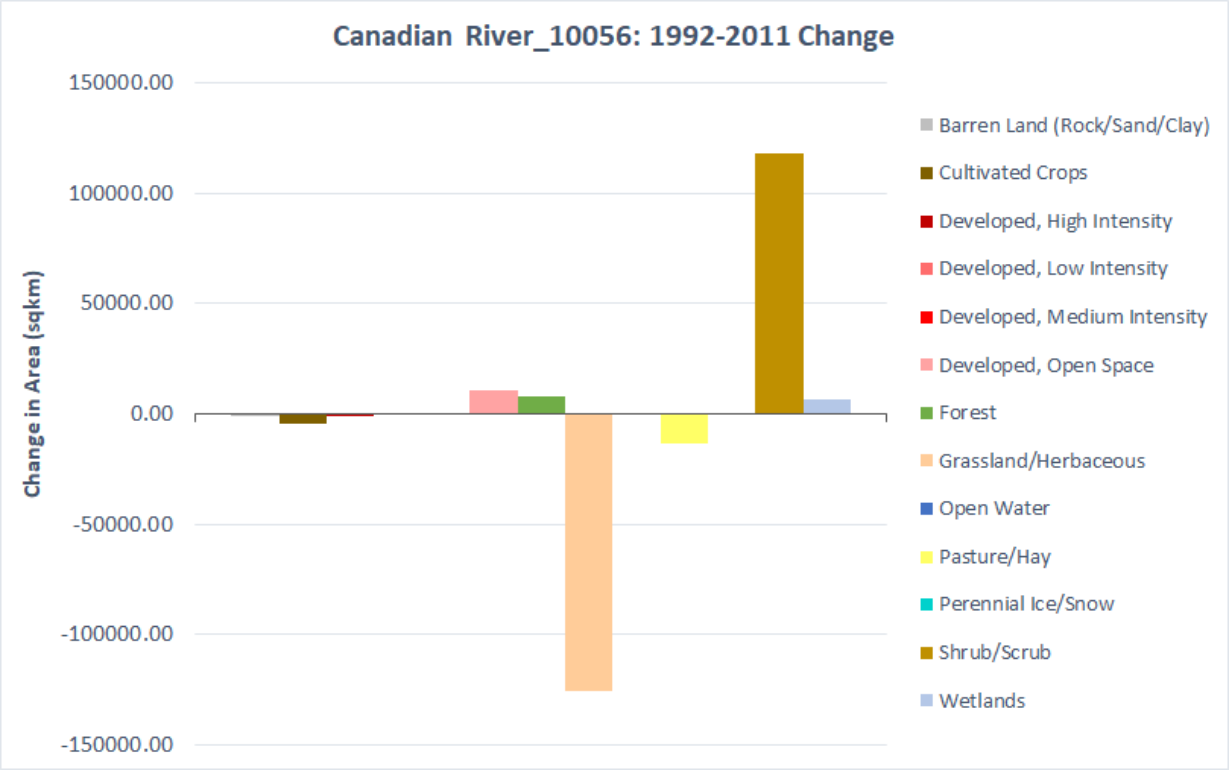

Figure 44. Land use change in area (sq km) from 1992-2011 for the Canadian River watershed at US 385.

CANADIAN RIVER: SH 70

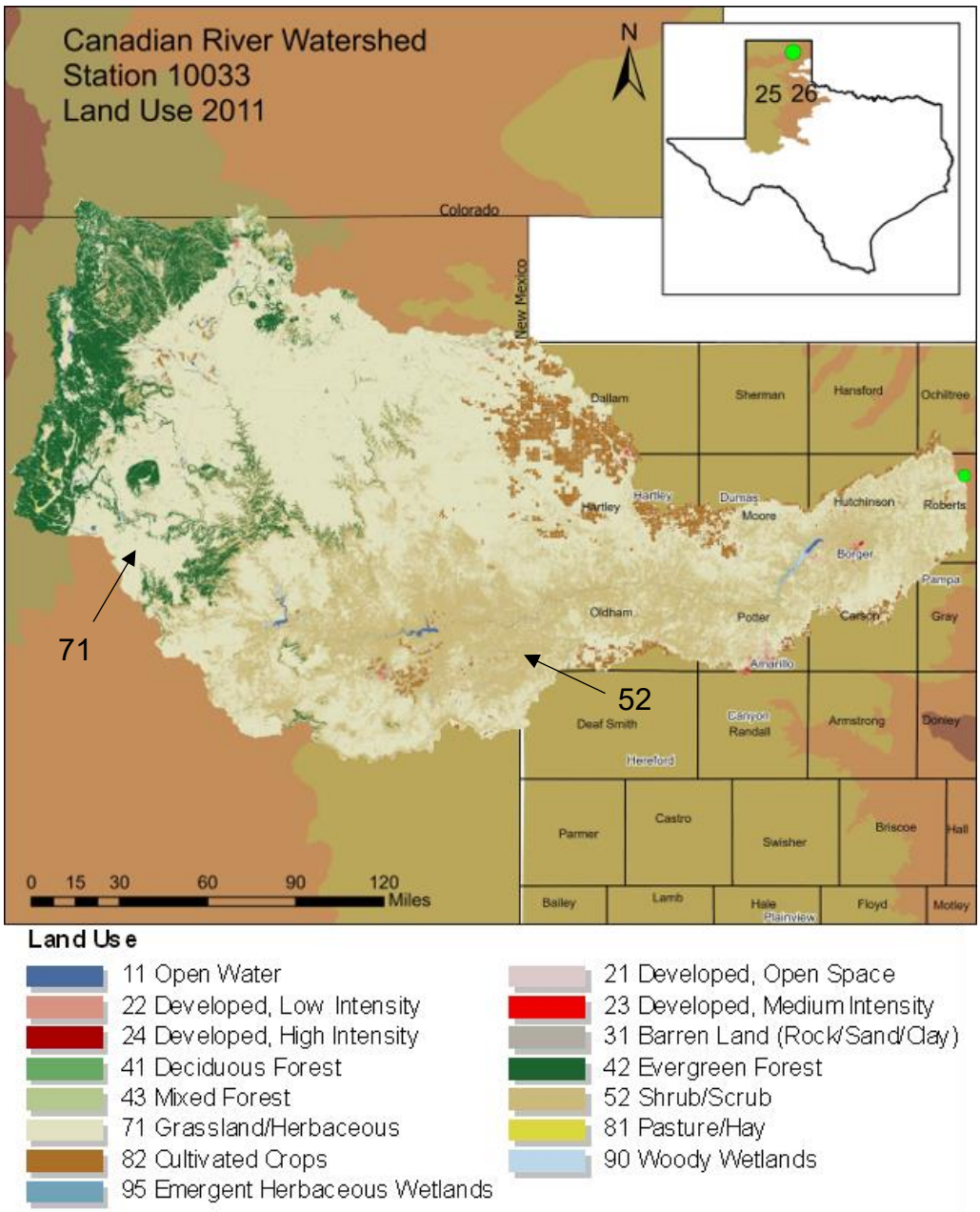

Figure 45. Map of Canadian River watershed at SH 70 and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	June 28, 2018
Water Quality:	184 sampling events
Fish:	June 28, 2018
Benthic Invertebrates:	June 28, 2018

Physical Characterization

Watershed and Land Use

The Canadian River is the basin's namesake and is a major river basin in Texas. Sample site 10033 is located at SH 70 north of Pampa in Roberts County (Figure 45).

The Canadian River watershed at site 10033 is approximately 1,717,422.14 sq km. The station and lower portion of the watershed lie in Level IV Ecoregion 26a, the Canadian/Cimarron Breaks, while the middle watershed lies in Level IV Ecoregion 26d, the Semiarid Canadian Breaks. The upper watershed spans into New Mexico and include portions of Level IV Ecoregion 26m, the Canadian Canyons, Level IV Ecoregion 26n, the Conchas/Pecos Plains, Level IV Ecoregion 26l, the Upper Canadian Plateau, and Level IV Ecoregion 26h, the Pinyon-Juniper Woodlands and Savannas. Small portions of the watershed cross into Ecoregion 25, the High Plains, and Ecoregion 21, the Southern Rockies. The dominant land cover in the watershed is grassland at 58.19% and is present throughout the watershed (Homer et al. 2015; Figure 45 and Figure 46). Shrub is the secondary land cover encompassing 25.47%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 1.15% and total cover for cultivated crops is 4.26%.

From 1992-2011 there was a 151,067.94 sq km decrease in grassland and a 14,408.63 sq km decrease in pasture/hay. There was a 150,363.07 sq km increase in shrubs and a 14,320.35 sq km increase in open space development (Figure 47).

Within the Texas portion of the watershed at site 10033, there is one pending and one current domestic wastewater outfall (discharges < 1 million gallons per day), 13 stormwater outfalls, and 31 industrial wastewater outfalls (discharges ≥ 1 million gallons per day). The current domestic wastewater facility is permitted to Orion Engineered Carbons, LLC, a producer of carbon black for polymers, coatings, rubber, and inks. The pending domestic wastewater facility is for the city of Skellytown. One of the stormwater outfalls and nine of the industrial facilities are permitted to Southwestern Public Service Company, a subsidiary of Xcel Energy. The remaining 12 stormwater outfalls and 14 of the industrial facilities are permitted to WRB Refining LLC and ConocoPhillips Company. Two industrial facilities are permitted to Chevron Phillips Chemical Company LP. The remaining six industrial facilities are permitted to the cities of Amarillo, Borger, Dalhart, Dumas, as well as Asarco LLC, a copper refinery, and Solvay Specialty Polymers USA, LLC, a manufacturer of plastic products. None of these facilities discharge directly into the Canadian River.

In Channel and Riparian Physical Habitat

Physical habitat for the Canadian River at SH 70 was evaluated on June 28, 2018. The Habitat Quality Index score of 20 indicates a high aquatic life use rating. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was dominated by shrubs (primarily *Phragmites* sp.), which make up an average of 90% of the total riparian species, followed by trees (primarily invasive Salt Cedar,

5%) and grasses (5%). The average percentage of tree canopy cover was 59.4%. The dominant substrate was sand, and the average percentage of substrate gravel size or larger was 0%. The average percent instream cover was 12% and instream cover types include overhanging vegetation, algae, undercut banks, and macrophytes. The Canadian River at SH 70 was 0.3 meters deep on average and 7.9 meters wide. The average stream bank slope was 22.3 degrees. Stream flow at the site was measured at 34.4 cfs. Average stream bank erosion potential was 6%. The deepest pool was 1.0 meter. No riffles were observed at the site and there were five total stream bends.

Water Quality

Water samples were collected at station 10033 over 184 sampling events from December 1970 through January 2021. Data collected included temperature, flow, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Four species (three families) were collected from the SH 70 site on the Canadian River. Cyprinidae had two species represented and Poeciliidae and Centrarchidae one each. Red Shiner was the most abundant species. Based on the fish assemblage, this site rated as only having an intermediate aquatic life use. Three IBI metrics received the lowest score (1). These metrics included: number of species; number of sunfish species (none were collected); and number of individuals per seine haul.

Benthic Macroinvertebrates

Considering the one RBP sample from 2018, a total of 198 individuals representing 24 taxa from 11 orders of macroinvertebrates were collected from the Canadian River at Hwy 70 (Appendix E). Ephemeroptera, Diptera, Trichoptera, and Amphipoda were the most commonly collected orders, collectively accounting for 93 percent of the total number of individuals collected. Basommatophora, Coleoptera, Oligochaeta, Hirudinida, Neoophora, Odonata, and Ostracoda were the only other orders collected, all of which comprised at least one percent of the collections. The statewide BIBI for the RBP sample fell in the intermediate aquatic life use category.

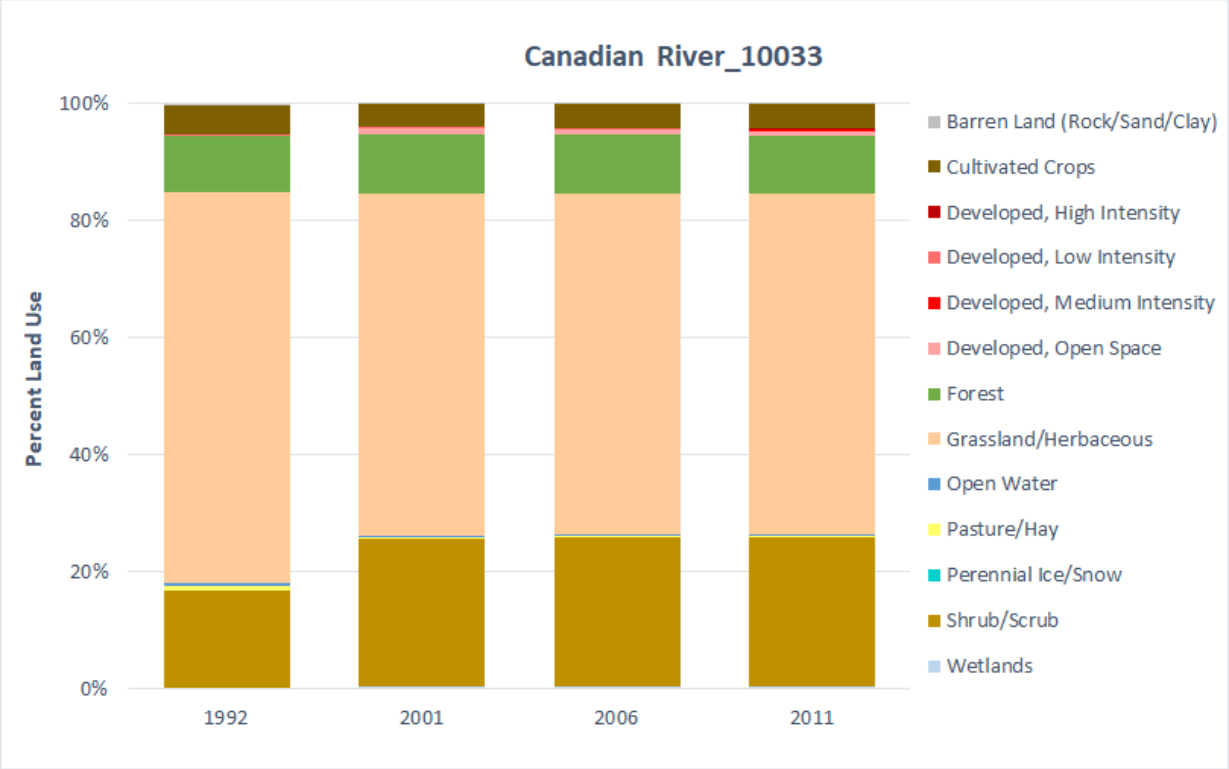

Figure 46. Percent land use in the Canadian River watershed at SH 70 from 1992-2011.

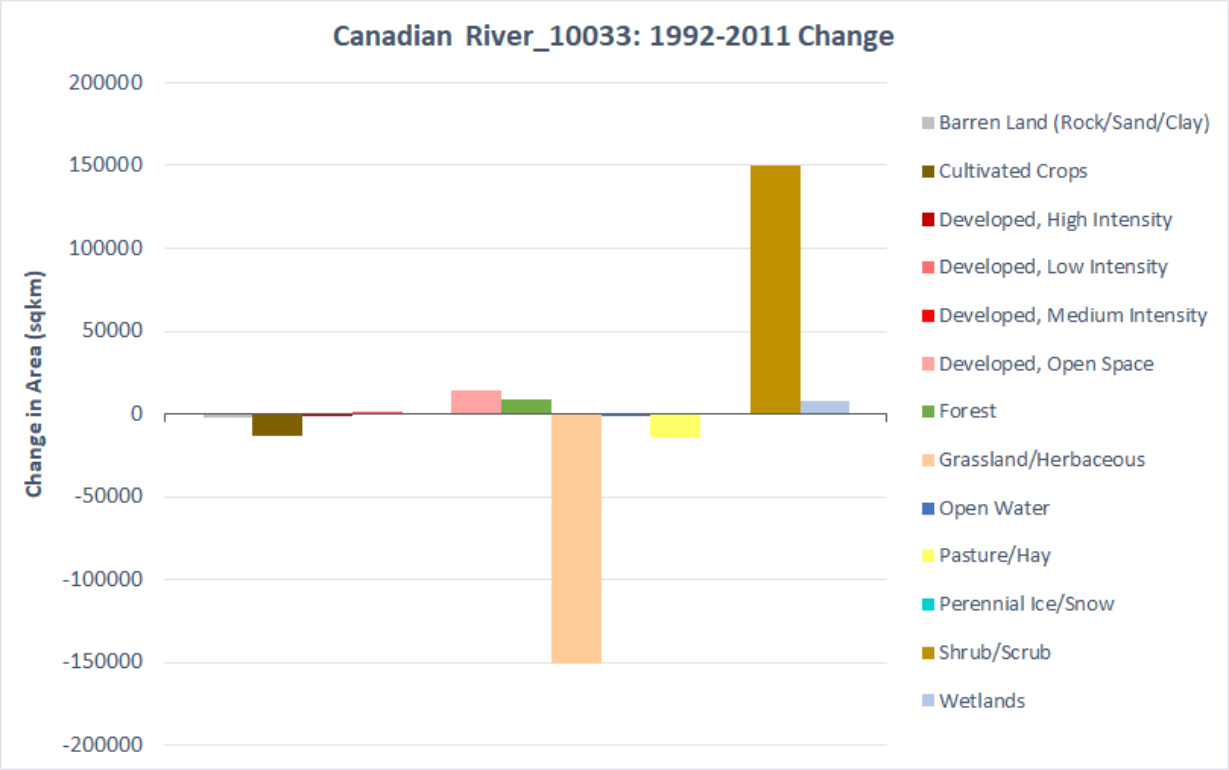

Figure 47. Land use change in area (sq km) from 1992-2011 for the Canadian River watershed at SH 70.

CHICKEN CREEK

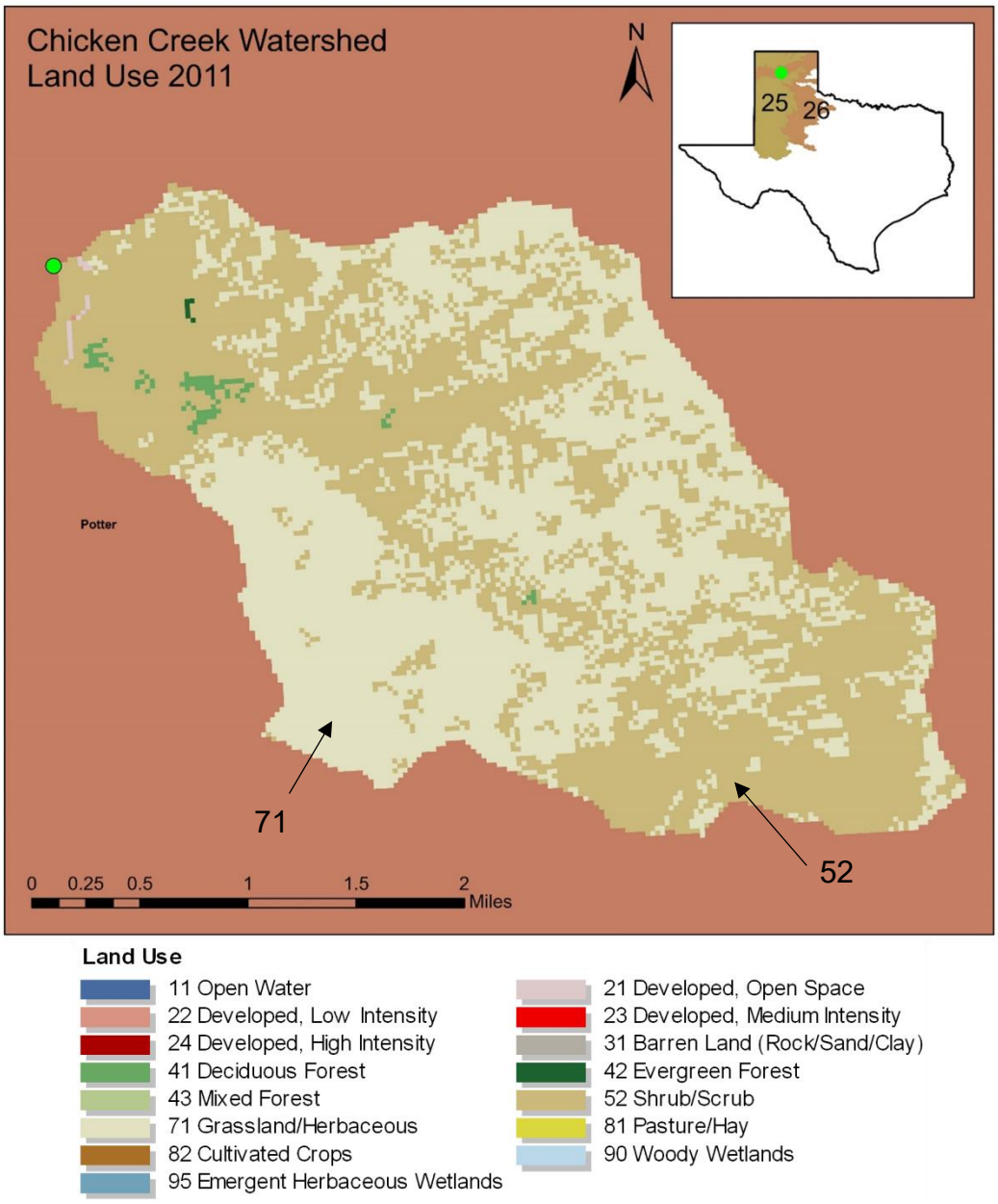

Figure 48. Map of Chicken Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	June 27, 2018
Water Quality:	June 27, 2018
Fish:	June 27, 2018
Benthic Invertebrates:	June 27, 2018

Physical Characterization

Watershed and Land Use

Chicken Creek lies within the Canadian River Basin. Sample site 22092 is located on the LX Ranch, approximately 150 meters upstream of the confluence with the Canadian River and approximately 28 km north of Amarillo in Potter County (Figure 48).

The Chicken Creek watershed at site 22092 is approximately 13.46 sq km. The entire watershed lies within Level IV Ecoregion 26a, the Canadian/Cimarron Breaks. The dominant land cover in the watershed is grassland at 49.89% and shrub at 49.31%, both are present throughout the watershed (Homer et al. 2015; Figure 48 and Figure 49). The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.14% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 1.12 sq km decrease in barren land and a 0.22 sq km decrease in grassland. There was a 1.37 sq km increase in shrubs and a 0.09 sq km increase in forest (Figure 50).

There are no permitted wastewater outfalls within the Chicken Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Chicken Creek was evaluated on June 27, 2018. The Habitat Quality Index score of 24 indicates a high aquatic life use rating. Chicken Creek is a first order spring fed stream that drains to the Canadian River above Lake Meredith. The lower portion of the creek is located in an off-road vehicle area within the Lake Meredith National Recreation Area. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at 18.5 meters. The riparian zone was dominated by shrubs, which make up an average of 45% of the total riparian species, followed by grasses (37.5%) then trees (17.5%). The average percentage of tree canopy cover was 52%. The dominant substrate was gravel, and the average percentage of substrate gravel size or larger was 83%. The average percent instream cover was 81% and instream cover types include macrophytes, overhanging vegetation, algae, gravel/cobble, and undercut banks. Chicken Creek was 0.07 meters deep on average and 1.5 meters wide. The average stream bank slope was 42.6 degrees. Stream flow at the site was 0.03 cfs. Average stream bank erosion potential was 29%. The deepest pool measured at Chicken Creek was 0.46 meters. Two riffles were observed at the site and there were nine total stream bends.

Water Quality

Water quality data were collected once at station 22092 in June 2018. Parameters measured included temperature, flow, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-*a*.

Biological Characterization

Fish

Six species (five families) were collected. Cyprinidae was represented by two species. The other families only had one. Western Mosquitofish was the most abundant species. The aquatic life use (based upon the fish assemblage) rated as high.

Benthic Macroinvertebrates

Considering the one RBP sample from 2018, a total of 229 individuals representing 25 taxa from 11 orders of macroinvertebrates were collected from Chicken Creek (Appendix E). Odonata, Trichoptera, Basommatophora, Ephemeroptera, Coleoptera, and Diptera were the most commonly collected orders, collectively accounting for 92 percent of the total number of individuals collected. Decapoda, Oligochaeta, and Hemiptera were the only other orders which comprised at least one percent of the collections. The statewide BIBI for the RBP sample fell in the high aquatic life use category.

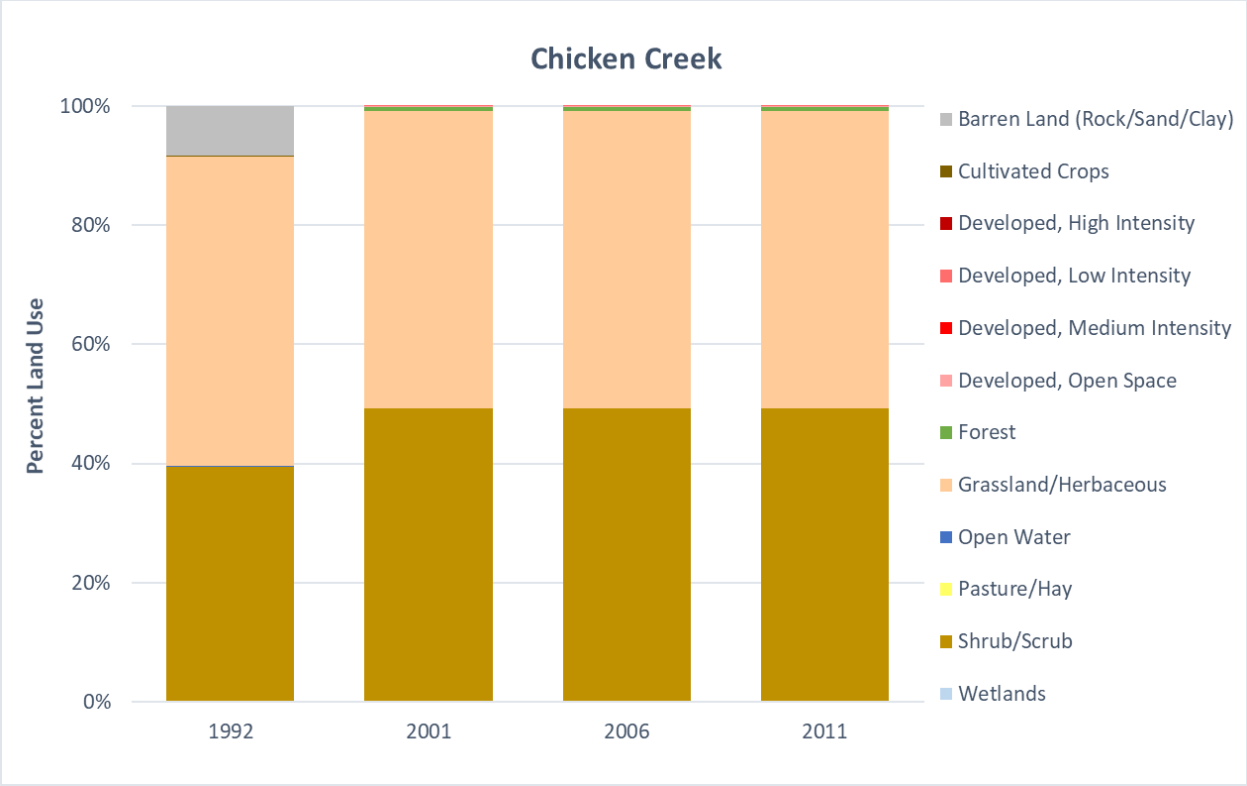

Figure 49. Percent land use in the Chicken Creek watershed from 1992-2011.

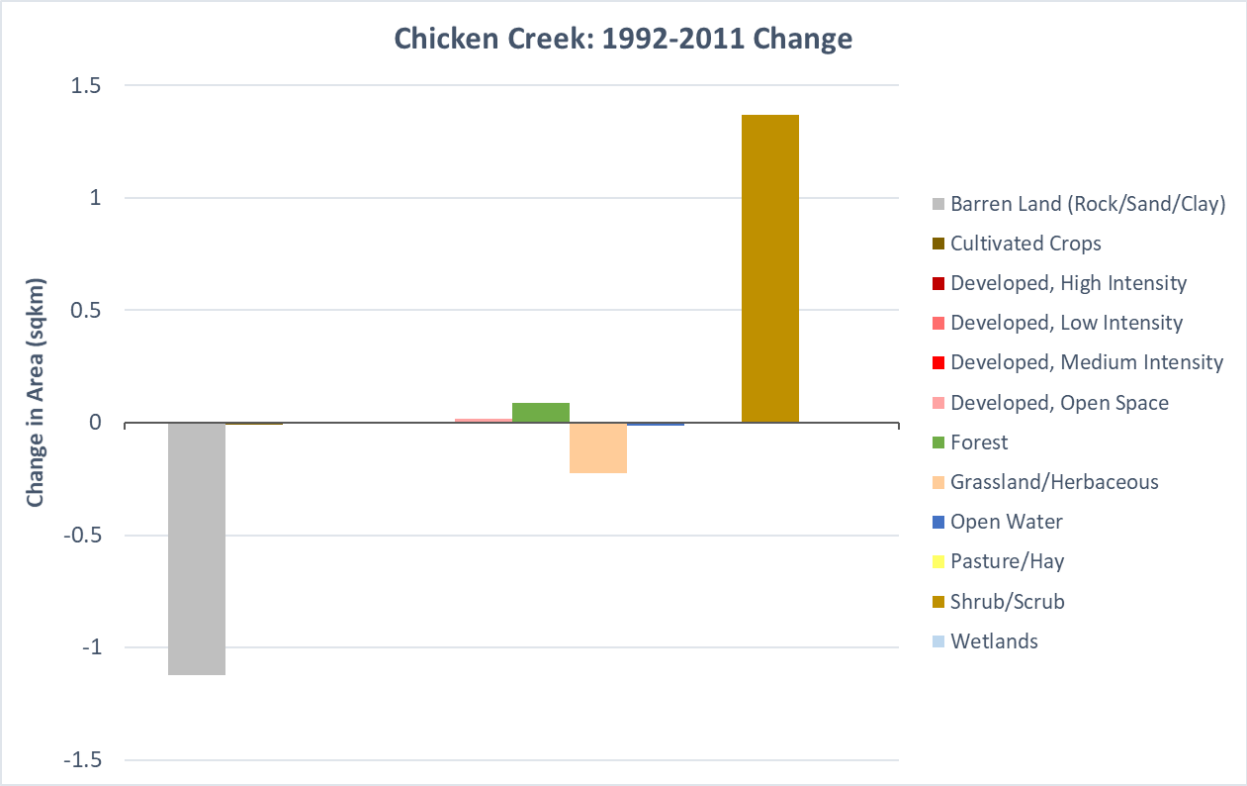

Figure 50. Land use change in area (sq km) from 1992-2011 for the Chicken Creek watershed.

McClellan Creek

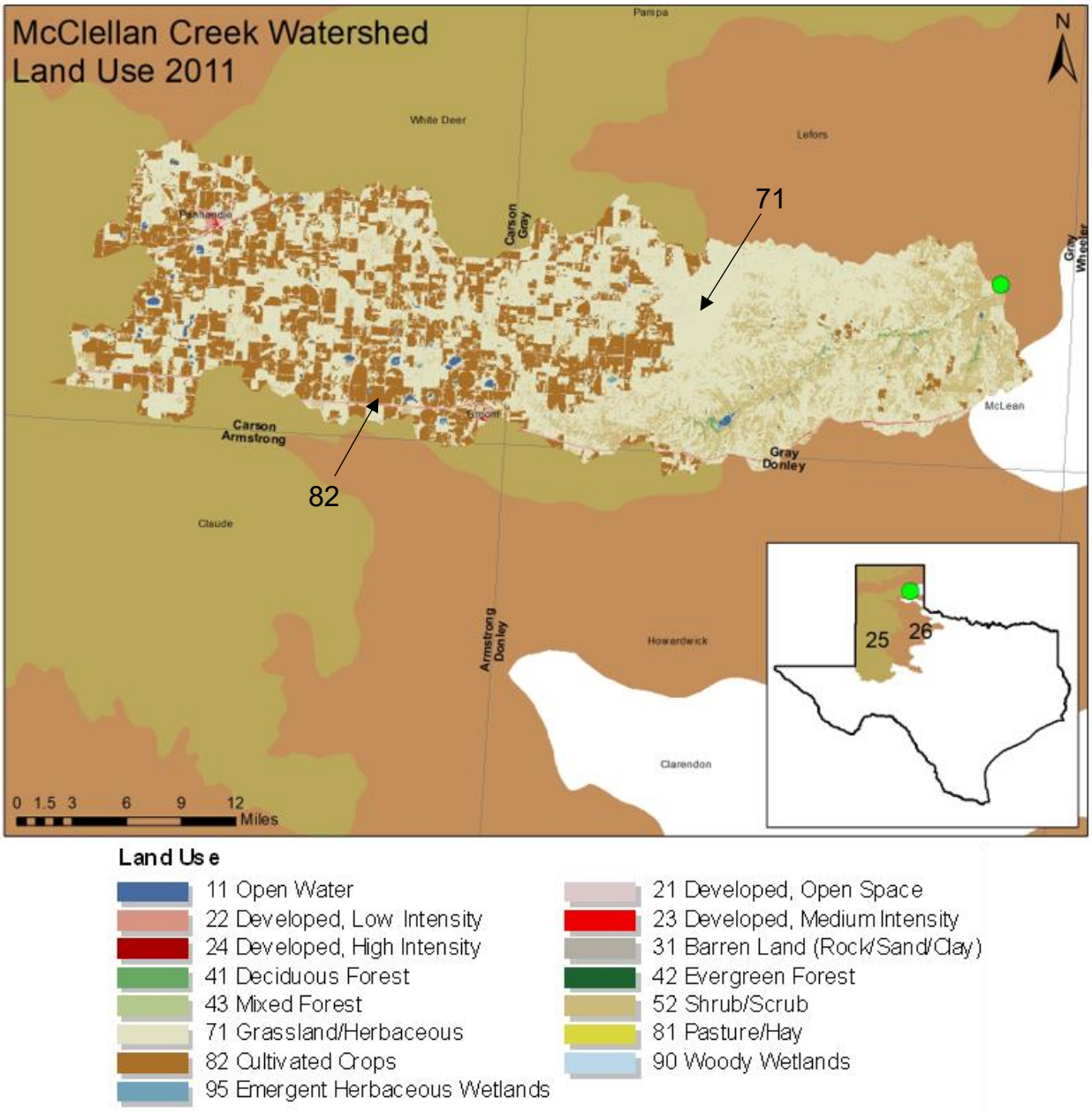

Figure 51. Map of McClellan Creek watershed location and 2011 land use; grassland/herbaceous and cultivated crops were the most common land uses.

Sampling Dates

Physical Habitat:	July 17, 1990; May 8, 2018
Water Quality:	77 sampling events
Fish:	July 17, 1990; May 8, 2018
Benthic Invertebrates:	July 17, 1990; May 8, 2018

Physical Characterization

Watershed and Land Use

McClellan Creek lies within the Red River Basin. Sample site 10064 is located at SH 273, approximately 10.5 km north of McLean in Gray County (Figure 51).

The McClellan Creek watershed at site 10064 is approximately 1456.61 sq km. The station and lower portion of the watershed lie within Level IV Ecoregion 26a, the Canadian/Cimarron Breaks. The upper watershed crosses into Level IV Ecoregion 25i, the Llano Estacado. The dominant land cover in the watershed is grassland/herbaceous at 54.88% and is present throughout the watershed (Homer et al. 2015; Figure 51 and Figure 52). Cultivated crops are the secondary land cover encompassing 26.88%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 4.36%.

From 1992-2011 there was a 316.73 sq km decrease in cultivated crops and a 68.50 sq km decrease in pasture/hay. There was a 247.31 sq km increase in grassland and an 88.92 sq km increase in shrub (Figure 53).

There are no permitted wastewater outfalls within the McClellan Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for McClellan Creek was evaluated on July 17, 1990, and again on May 8, 2018. The 2018 Habitat Quality Index score of 23.5 indicates a high aquatic life use rating. McClellan Creek is a perennial stream that drains to the North Fork Red River. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters for both sampling events. The riparian zone was dominated by grasses, which make up an average of 67% of the total riparian species, followed by trees (19%) then shrubs (14%). The average percentage of tree canopy cover was 35%. The dominant substrate was sand, and the average percent of substrate that was gravel size or larger was 5%. The average percentage of instream cover was 30% and instream cover types include gravel, macrophytes, algae, and woody debris. McClellan Creek ranges from 0.1-0.2 meters deep on average and 3.9-5.5 meters wide. The average stream bank slope was 25.6 degrees. Stream flow at the site was measured at a minimum value of 2.1 cfs and a maximum of 3.2 cfs. Average stream bank erosion potential was 40%. The deepest pool measured at McClellan Creek was 0.6 meters. A maximum of three riffles were observed at the site and there were four total stream bends.

Water Quality

Water quality data were collected 77 times from station 10064 from July l990 through January 2019. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-*a*.

Continuous flow data is available from USGS gage 07301200 (Figure 54). Flow data were collected from October 1995 through September 2009; the median flow was 3.83 cfs over this time period and daily average flows ranged from 1.78 cfs to 7.94 cfs.

Biological Characterization

Fish

Twelve species (six families) were collected between the two sampling events. Centrarchidae and Cyprinidae yielded the most species with four each. Red Shiner and Plains Killifish were the most abundant species in the 1990 collection; no Red Shiner and only one Plains Killifish were collected in the 2018 sample. The number of individuals collected in 2018 was very reduced from what was found in the earlier collection. Bluegill *Lepomis macrochirus* was the most abundant species in 2018, even though only 12 individuals were collected. Based upon the fish assemblage, the aquatic life use declined from exceptional to intermediate between 1990 and 2018. Two native cyprinid species (Red Shiner and Fathead Minnow *Pimephales promelas*) were collected in 1990 (metric score of 3); only one (Sand Shiner *Notropis stramineus*) was collected in 2018 (metric score of 1). No non-native species were collected in 1990; however, 7.1% of the individuals collected in 2018 were non-native species, resulting in a metric score of 1. Catch per unit of effort declined from 27.3 individuals per seine haul in 1990 to only 2.7 individuals per seine haul in 2018. The percentage of omnivores increased from 3.7 (metric score of 5) to 14.3 (metric score of 3). The decline in aquatic life use is most likely due to the major drought that gripped Texas from 2010 to 2015.

Benthic Macroinvertebrates

Considering the one Surber sample from 1990 and one RBP sample from 2018 collectively, a total of 3426 individuals representing 63 taxa from 17 orders of macroinvertebrates were collected from McClellan Creek (Appendix E). Diptera, Ephemeroptera, and Trichoptera were the most commonly collected orders, collectively accounting for 91 percent of the total number of individuals collected. Amphipoda, Odonata, Coleoptera, Veneroida (Bivalvia), and Neoophora were the only other orders which comprised at least one percent of the collections. The Surber BIBI for the 1990 sample fell in the exceptional aquatic life use category. The statewide BIBI for the 2018 RBP sample also fell in the exceptional aquatic life use category.

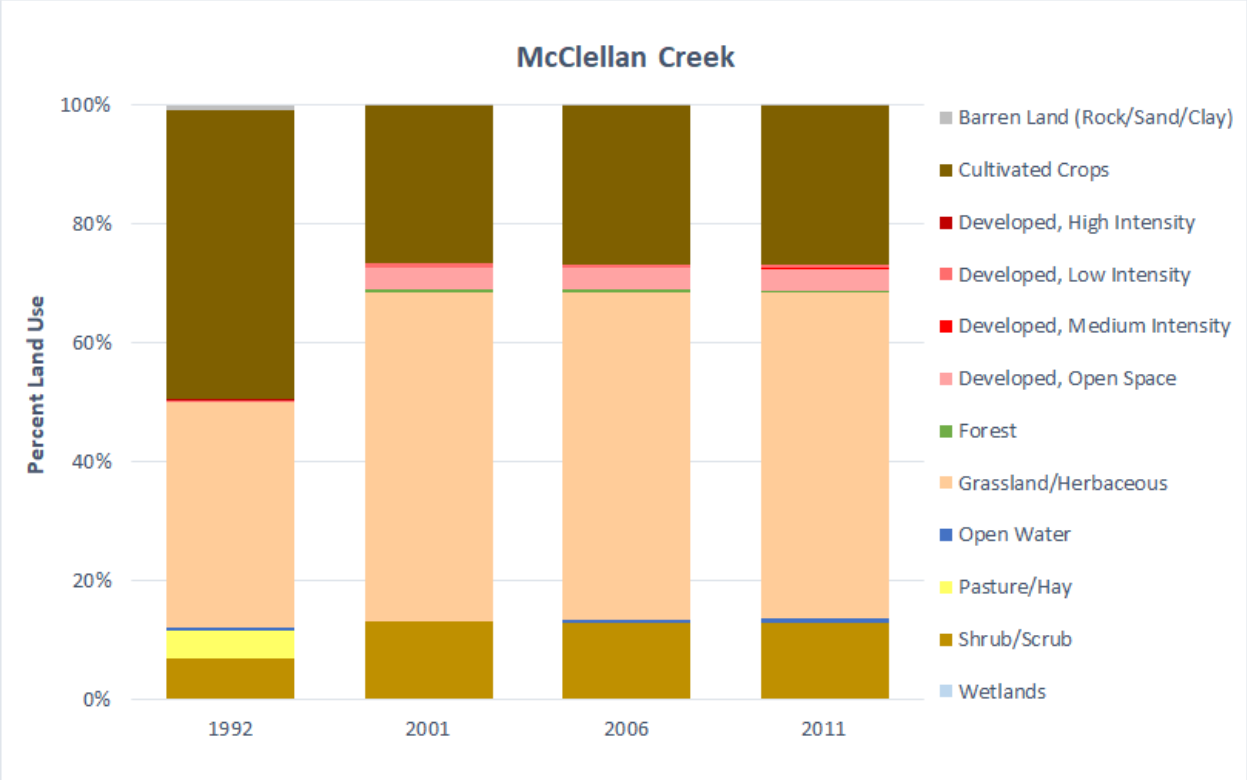

Figure 52. Percent land use in the McClellan Creek watershed from 1992-2011.

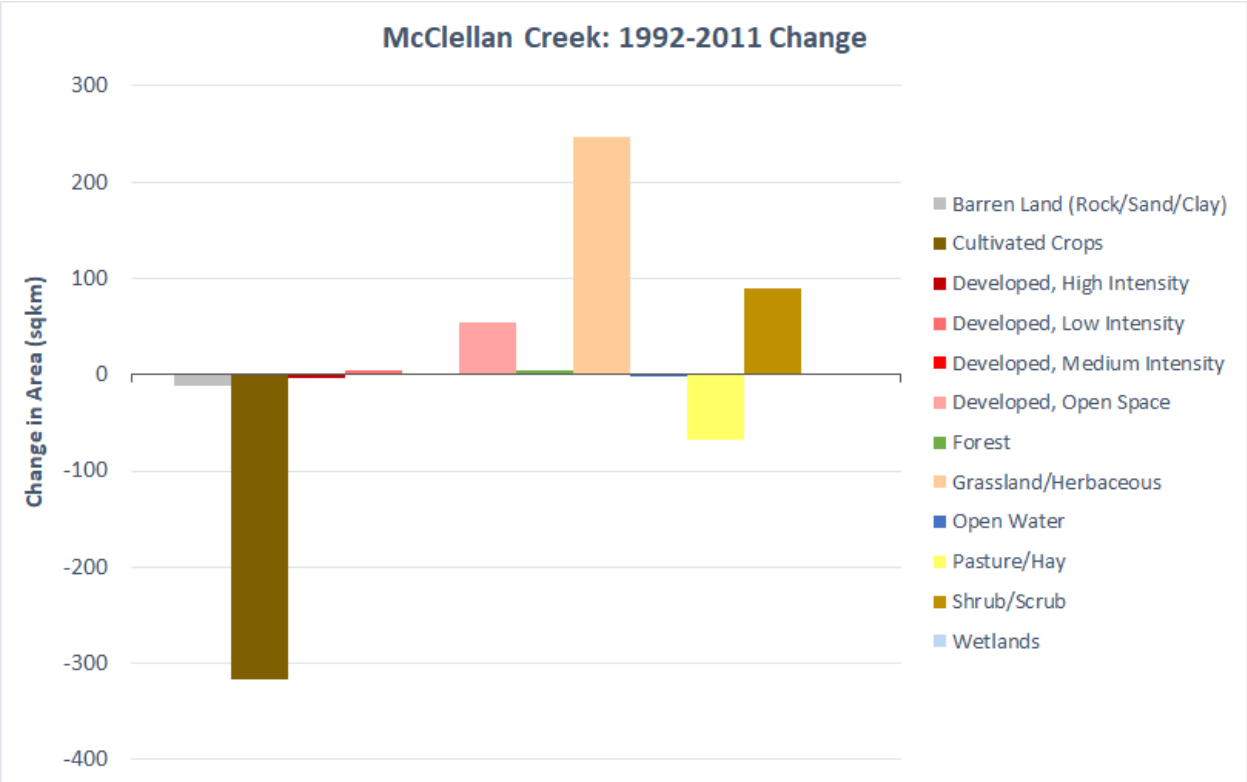

Figure 53. Land use change in area (sq km) from 1992-2011 for the McClellan Creek watershed.

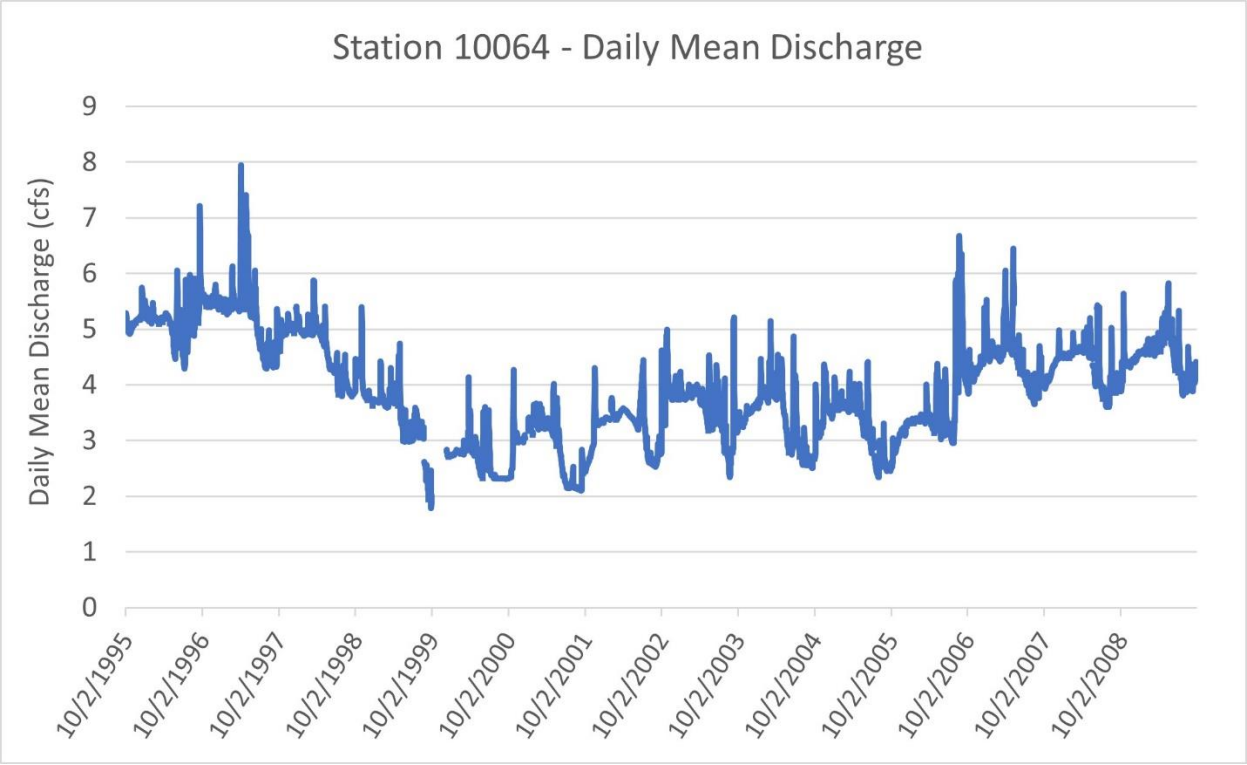

Figure 54. Daily mean discharge for McClellan Creek at station 10064.

NORTH FORK WICHITA RIVER

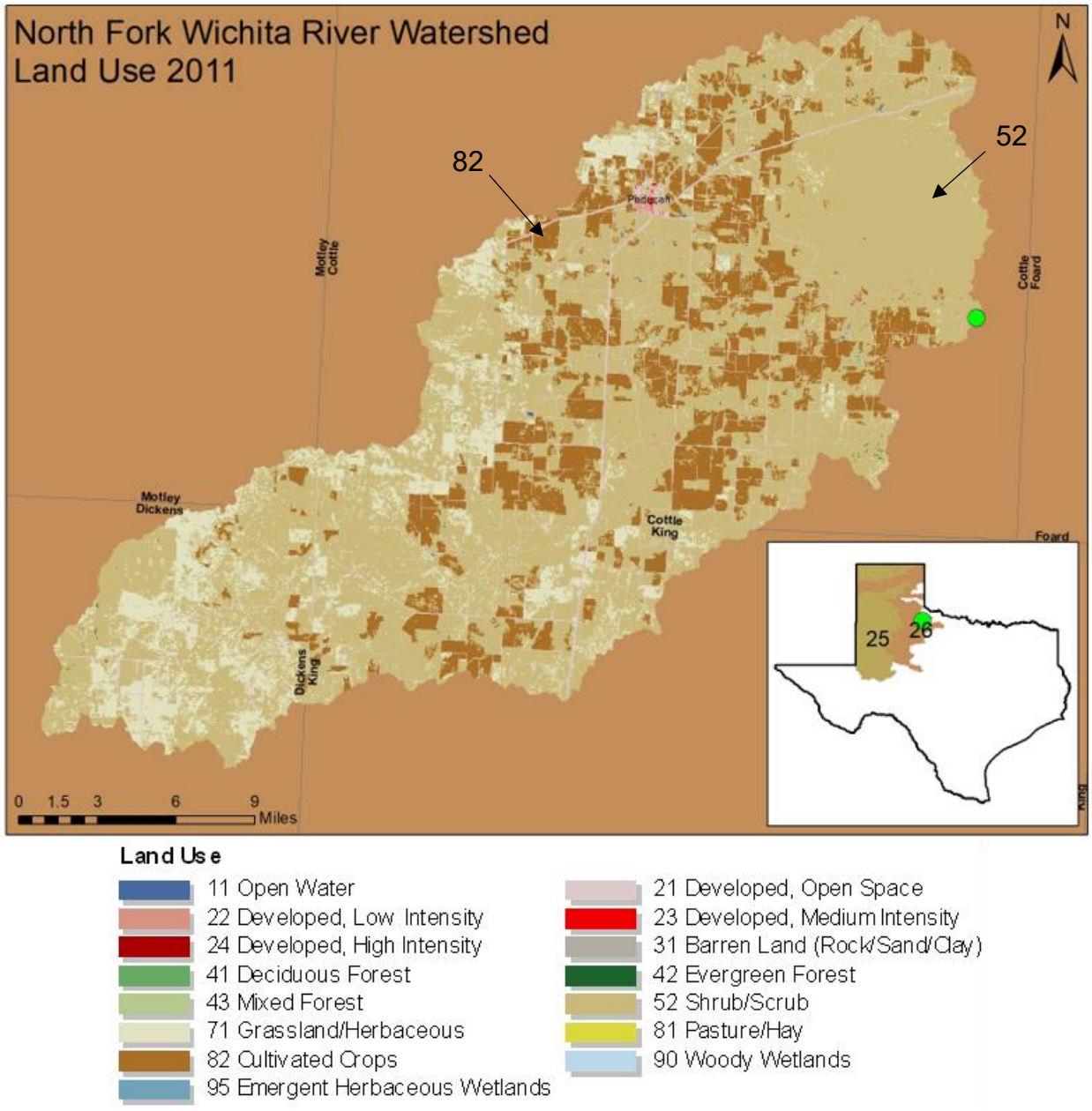

Figure 55. Map of North Fork Wichita River watershed location and 2011 land use; shrub/scrub and cultivated crops were the most common land uses.

Sampling Dates

Physical Habitat:	May 10, 2018
Water Quality:	158 sampling events
Fish:	May 10, 2018
Benthic Invertebrates:	May 10, 2018

Physical Characterization

Watershed and Land Use

The North Fork Wichita River lies within the Red River Basin. Sample site 15119 is located 6 km downstream of Cottonwood Creek and 2.04 km upstream of CR 493 east southeast of Paducah in Cottle County (Figure 55).

The North Fork Wichita River watershed at site 15119 is approximately 1230.44 sq km. The station and a small portion of the lower watershed are located in Level IV Ecoregion 26c, the Caprock Canyons, Badlands, and Breaks. The majority of the watershed is in Level IV Ecoregion 26b, the Flat Tablelands and Valleys. The dominant land cover in the watershed is shrub at 65.82% and is present throughout the watershed (Homer et al. 2015; Figure 55 and Figure 56). Cultivated crops are the secondary land cover encompassing 17.39%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.61%.

From 1992-2011 there was a 367 sq km decrease in cultivated crops and a 257.12 sq km decrease in grassland. There was a 624.86 sq km increase in shrubs and a 41.93 sq km increase in open space development (Figure 57).

There are no permitted wastewater outfalls within the North Fork Wichita River watershed.

In Channel and Riparian Physical Habitat

Physical habitat for the North Fork Wichita River was evaluated on May 10, 2018. The North Fork Wichita is fed by highly saline springs and conductivity at the site was over 28,000 µs/cm. The Habitat Quality Index score of 24.5 indicates a high aquatic life use rating, but the high salt content of the river limits the diversity of aquatic assemblages found there. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was dominated by shrubs, which make up an average of 55% of the total riparian species, followed by grasses (30%) then trees (15%). The average percentage of tree canopy cover was 41%. The dominant substrate was silt, and the average percent of substrate gravel size or larger was 28%. The average percent instream cover was 54% and instream cover types include macrophytes, algae, overhanging vegetation, woody debris, undercut banks, and cobble/gravel. The North Fork Wichita River was 0.28 meters deep on average and 18.2 meters wide. The average stream bank slope was 13.5 degrees. Stream flow at the site was 5.15 cfs. Average stream bank erosion potential was 26%. The deepest pool measured at the North Fork Wichita was 1.58 meters. Two riffles were observed at the site and there were five total stream bends.

Water Quality

Water samples were collected at station 15119 over 158 sampling events from December 1994 through February 2019. Parameters measured included temperature, flow, transparency, specific

conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*.

Biological Characterization

Fish

Only two species (two families) were collected from the North Fork Wichita River resulting in a limited aquatic life use rating. Red River Pupfish *Cyprinodon rubrofluviatilis* and Plains Killifish comprised 79% and 21% of the individuals, respectively. Five of the eight IBI metrics received the lowest score (1).

Benthic Macroinvertebrates

Considering the one RBP sample from 2018, a total of 310 individuals representing 14 taxa from seven orders of macroinvertebrates were collected from the North Fork Wichita River (Appendix E). Hemiptera, Diptera, Odonata, and Coleoptera were the most commonly collected orders, collectively accounting for 96 percent of the total number of individuals collected. Ostracoda, Decapoda, and Oligochaeta were the only other orders which comprised at least one percent of the collections. The statewide BIBI for the RBP sample fell in the limited aquatic life use category.

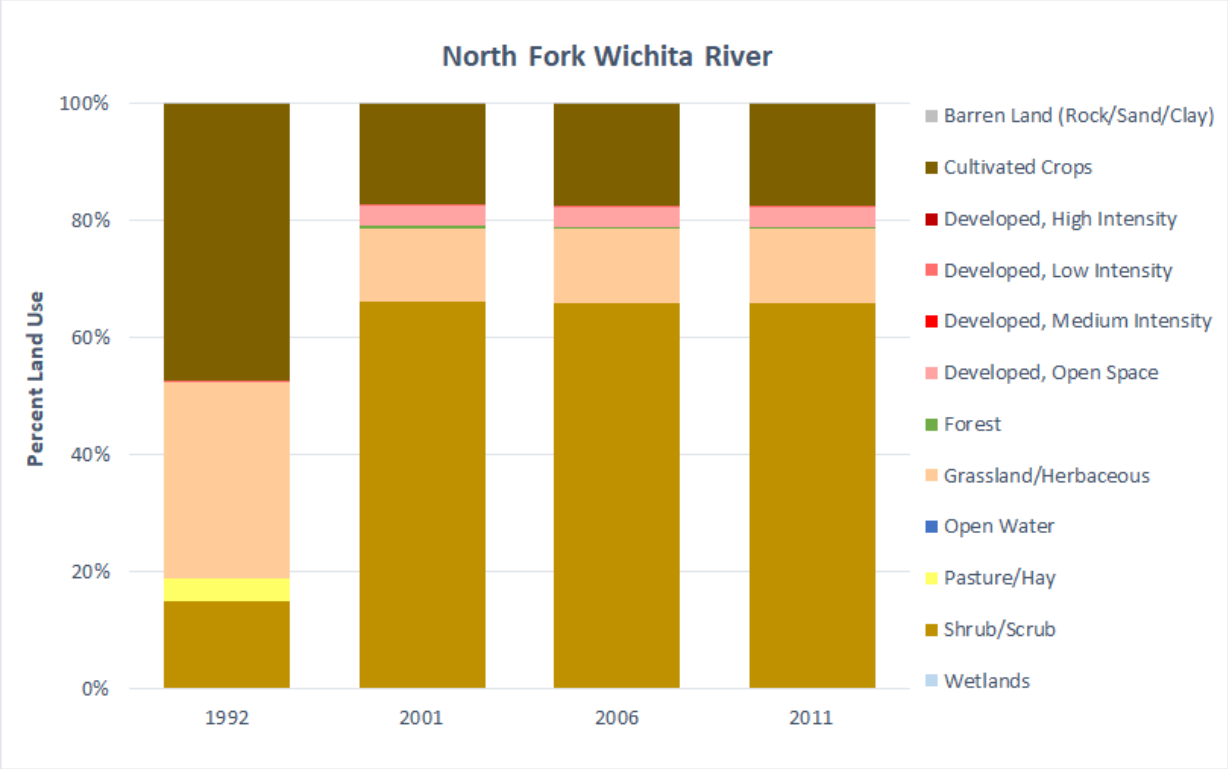

Figure 56. Percent land use in the North Fork Wichita River watershed from 1992-2011.

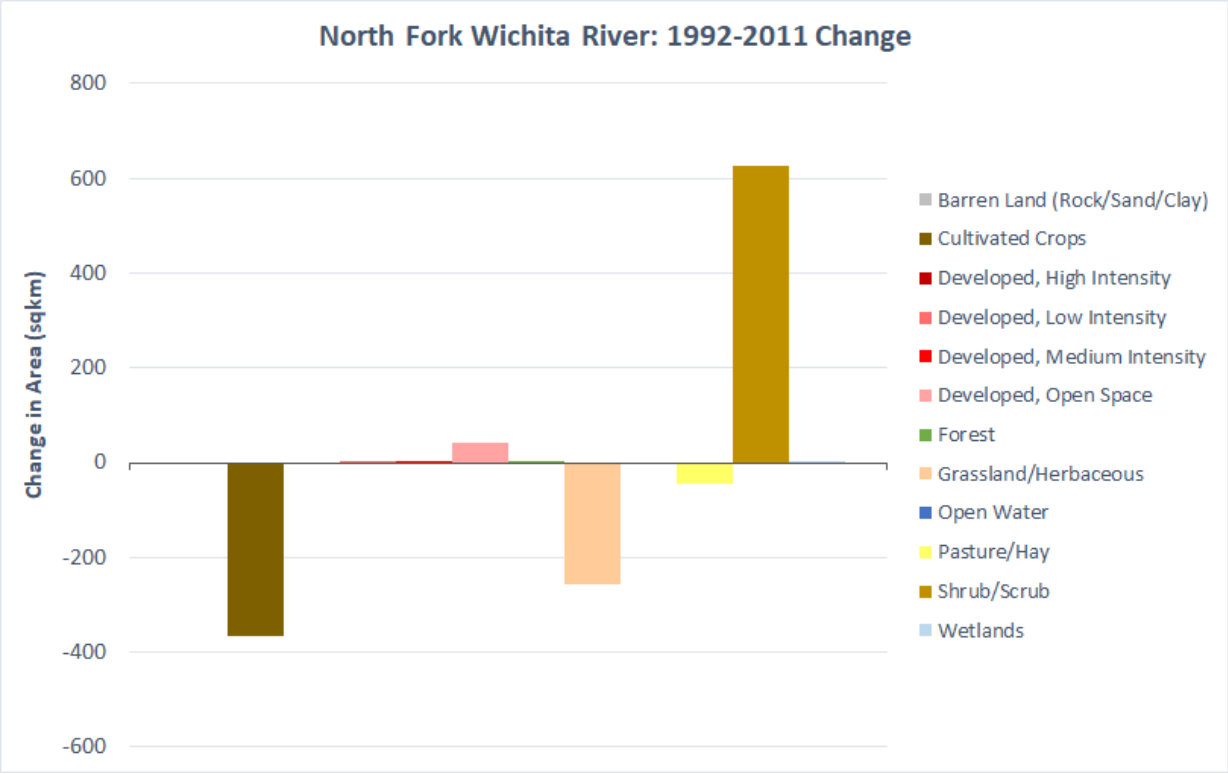

Figure 57. Land use change in area (sq km) from 1992-2011 for the North Fork Wichita River watershed.

SADDLERS CREEK

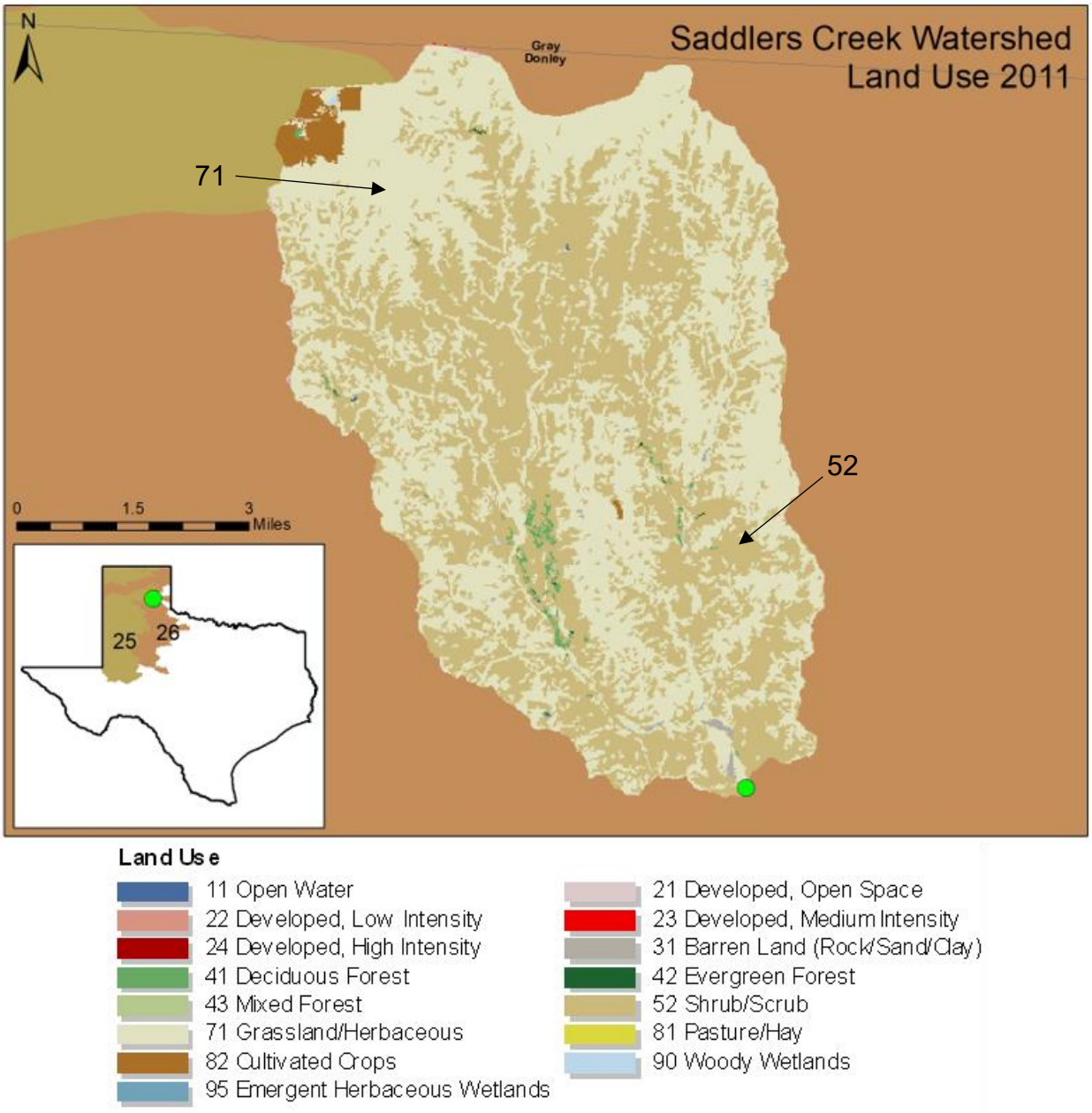

Figure 58. Map of Saddlers Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	August 16, 1989
Water Quality:	August 16, 1989
Fish:	August 17, 1989
Benthic Invertebrates:	August 17, 1989

Physical Characterization

Watershed and Land Use

Saddlers Creek lies within the Red River Basin. Sample site 10078 is located on Matthews/Griffin Ranch Road, approximately 7.3 km upstream of the Salt Fork Red River, 11.3 km east of Howardwick in Donley County (Figure 58).

The Saddlers Creek watershed at site 10078 is approximately 127.27 sq km. The vast majority of the watershed lies within Level IV Ecoregion 26a, the Canadian/Cimarron Breaks. A very small portion of the upper watershed lies within Ecoregion 25. The dominant land cover in the watershed is grassland/herbaceous at 52.10% and is present throughout the watershed (Homer et al. 2015; Figure 58 and Figure 59). Shrub is the secondary land cover encompassing 45.50%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.16% and total cover for cultivated crops is 1.33%.

From 1992-2011 there was a 34.78 sq km decrease in grassland and a 4.66 sq km decrease in barren land (rock/sand/clay). There was a 40.91 sq km increase in shrub and a 0.72 sq km increase in forest (Figure 60).

There are no permitted wastewater outfalls within the Saddlers Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Saddlers Creek was evaluated on August 16, 1989. The riparian width was 30 meters. The riparian zone was dominated by grasses, which made up 100% of the total riparian species. The average percentage of tree canopy cover was 5%. The dominant substrate was sand, and the average percent of substrate that was gravel size or larger was 2%. Average percent instream cover was 5%. Saddlers Creek had an average depth of 0.06 meters and a maximum depth of 0.09 meters. The average width was 8.2 meters and average stream bank slope was 21 degrees. Stream flow at the site was 2.76 cfs. Average stream bank erosion potential was 80%. Six riffles were observed at the site and there was one poorly defined stream bend.

Water Quality

Water quality data was collected once at station 10078 in August 1989. Parameters measured included temperature, flow, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate and chlorophyll-*a*.

Biological Characterization

Fish

Seven species (five families) were collected. Cyprinidae was represented by three species and was the only family with more than one species. Plains Killifish was the most abundant species. Based on the fish assemblage, the aquatic life use rating was intermediate; however, when the

coefficient of variability is applied it rises to high. The percentage of individuals as omnivores received the lowest metric rating (1) while all others received threes and fives.

Benthic Macroinvertebrates

Considering the one Surber sample from 1989, a total of nine individuals representing six taxa from three orders of macroinvertebrates were collected from Saddler's Creek (Appendix E). The orders collected and the percentage of individuals represented by each order are as follows: Diptera (56%), Ephemeroptera (11%), and Odonata (33%). The Surber BIBI for the sample fell in the intermediate aquatic life use category.

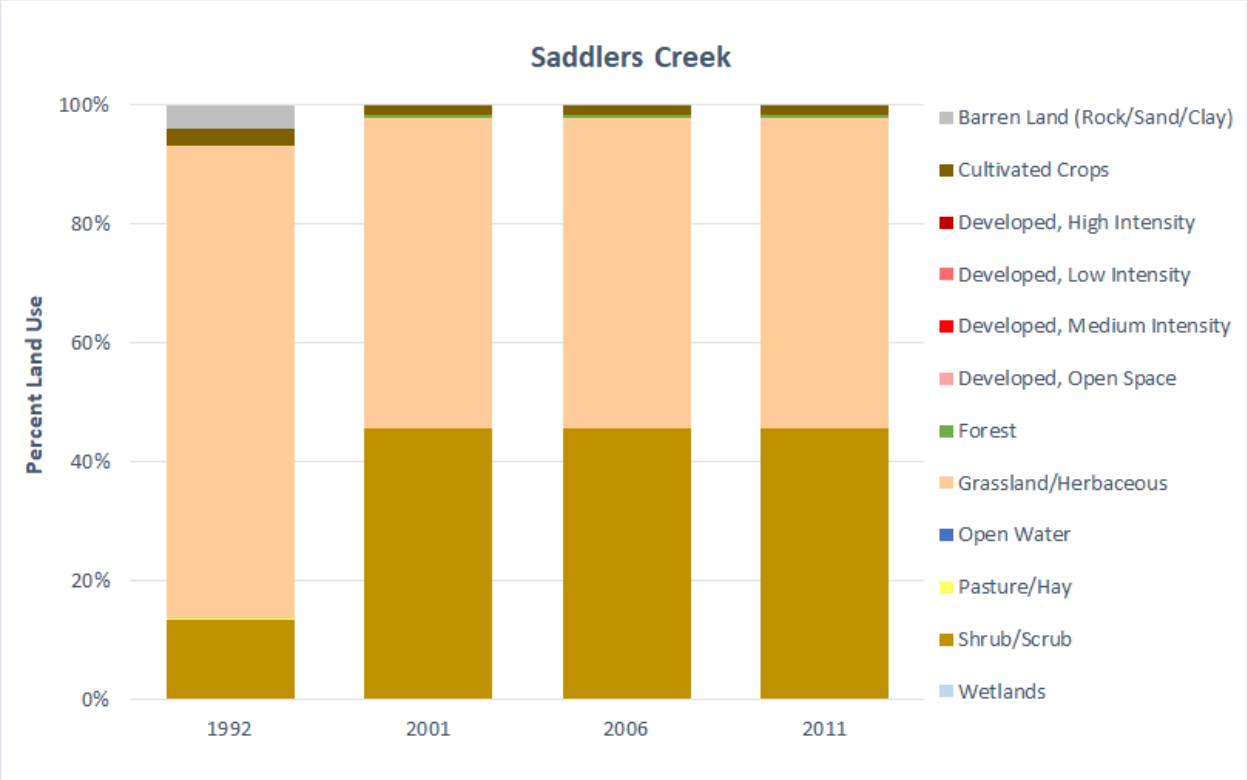

Figure 59. Percent land use in the Saddlers Creek watershed from 1992-2011.

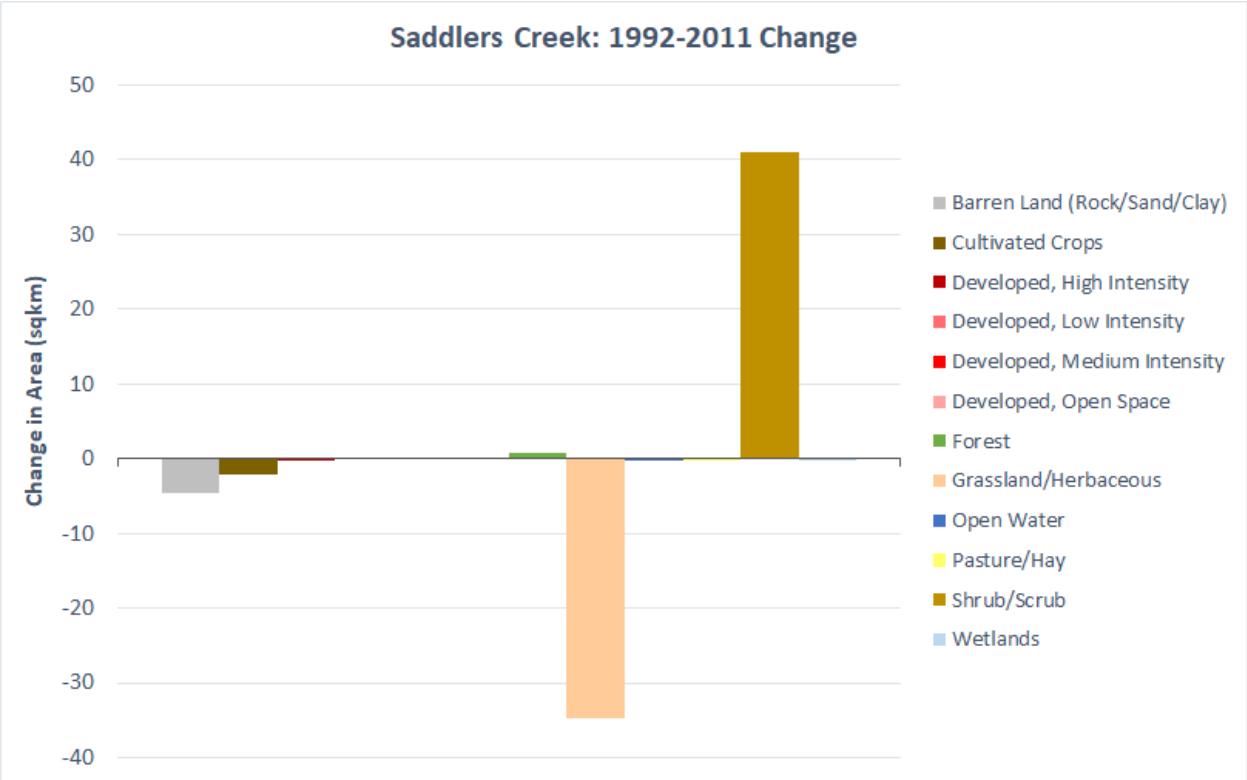

Figure 60. Land use change in area (sq km) from 1992-2011 for the Saddlers Creek watershed.

SALT FORK RED RIVER

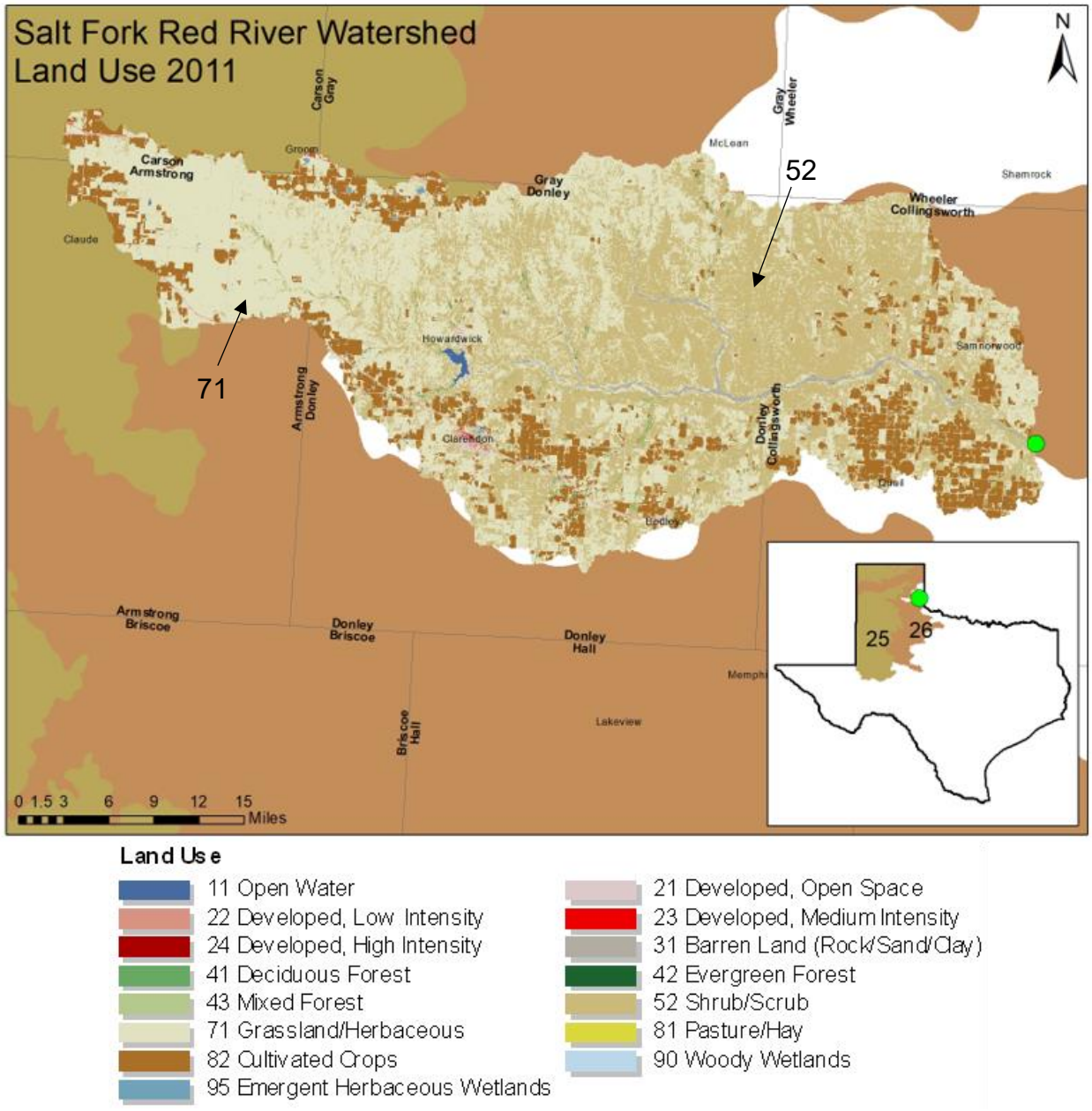

Figure 61. Map of Salt Fork Red River watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	May 9, 2018
Water Quality:	317 sampling events
Fish:	May 9, 2018
Benthic Invertebrates:	May 9, 2018

Physical Characterization

Watershed and Land Use

The Salt Fork Red River lies within the Red River Basin. Sample site 10171 is located 80 m downstream of US 83, approximately 11 km north of Wellington in Collingsworth County (Figure 61).

The Salt Fork Red River watershed at site 10171 is approximately 2880.33 sq km. The station and a third of the watershed lie in Level IV Ecoregion 26c, the Caprock Canyons, Badlands, and Breaks. Another third of the watershed lies in Level IV Ecoregion 27h, the Red Prairie, while the final third of the watershed lies in Level IV Ecoregion 26a, the Canadian/Cimarron Breaks. A small area of the uppermost end of the watershed crosses into Level IV Ecoregion 25i, the Llano Estacado. The dominant land cover in the watershed is grassland/herbaceous at 43.55% and is present throughout the watershed (Homer et al. 2015; Figure 61 and Figure 62). Shrub is the secondary land cover encompassing 38.15%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 2.55% and total cover for cultivated crops is 13.85%.

From 1992-2011 there was a 510.65 sq km decrease in cultivated crops and a 297.41 sq km decrease in grassland. There was a 772.03 sq km increase in shrub and a 66.55 sq km increase in open space development (Figure 63).

There are no permitted wastewater outfalls within the Salt Fork Red River watershed.

In Channel and Riparian Physical Habitat

Physical habitat for the Salt Fork Red River was evaluated on May 9, 2018. The Habitat Quality Index score of 18.5 indicates an intermediate aquatic life use rating. The riparian buffer at the sampling site was measured to be 17 meters on average. The riparian zone was dominated by trees, which make up an average of 40% of the total riparian species, followed by grasses (32.5%) then shrubs (27.5%). The average percentage of tree canopy cover was 35.3%. The dominant substrate was sand, and the average percentage of substrate gravel size or larger was 1.2%. The average percent instream cover was 19% and instream cover types include macrophytes, overhanging vegetation, woody debris, algae, and gravel. The Salt Fork Red River was 0.05 meters deep on average and 16.5 meters wide. The average stream bank slope was 24.7 degrees. Stream flow at the site was 7.8 cfs. Average stream bank erosion potential was 26%. The deepest pool was 0.42 meters. Six riffles were observed at the site and there were five total stream bends.

Water Quality

Water samples were collected at station 10171 over 317 sampling events from September 1968 through January 2019. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*.

Continuous flow data is available from USGS gage 07300000 (Figure 64). Between January 1985 through December 2019, the median flow was 16 cfs. Daily average flows ranged from 0.04 cfs to 17,500 cfs, though flows were greater than 1000 cfs less than 0.4 percent during this time period. Data have been log transformed to better visualize flow patterns.

Biological Characterization

Fish

Eight species (five families) were collected from the Salt Fork Red River. Only two families were represented by more than one species - Centrarchidae with three and Cyprinidae with two. Fifty-three percent of the individuals collected were Plains Killifish. Based on the fish assemblage, the aquatic life use rates as high. All but two IBI metrics received the highest score (5). These two IBI metrics were the number of native cyprinid species (3) and number of individuals per seine haul (1).

Benthic Macroinvertebrates

Considering the one RBP sample from 2018, a total of 251 individuals representing 30 taxa from 10 orders of macroinvertebrates were collected from the Salt Fork Red River (Appendix E). Ephemeroptera, Diptera, Coleoptera, Odonata, and Trichoptera were the most commonly collected orders, collectively accounting for 95 percent of the total number of individuals collected. Basommatophora, Decapoda, and Hemiptera were the only other orders which comprised at least one percent of the collections. The BIBI for this RBP sample fell in the high aquatic life use category.

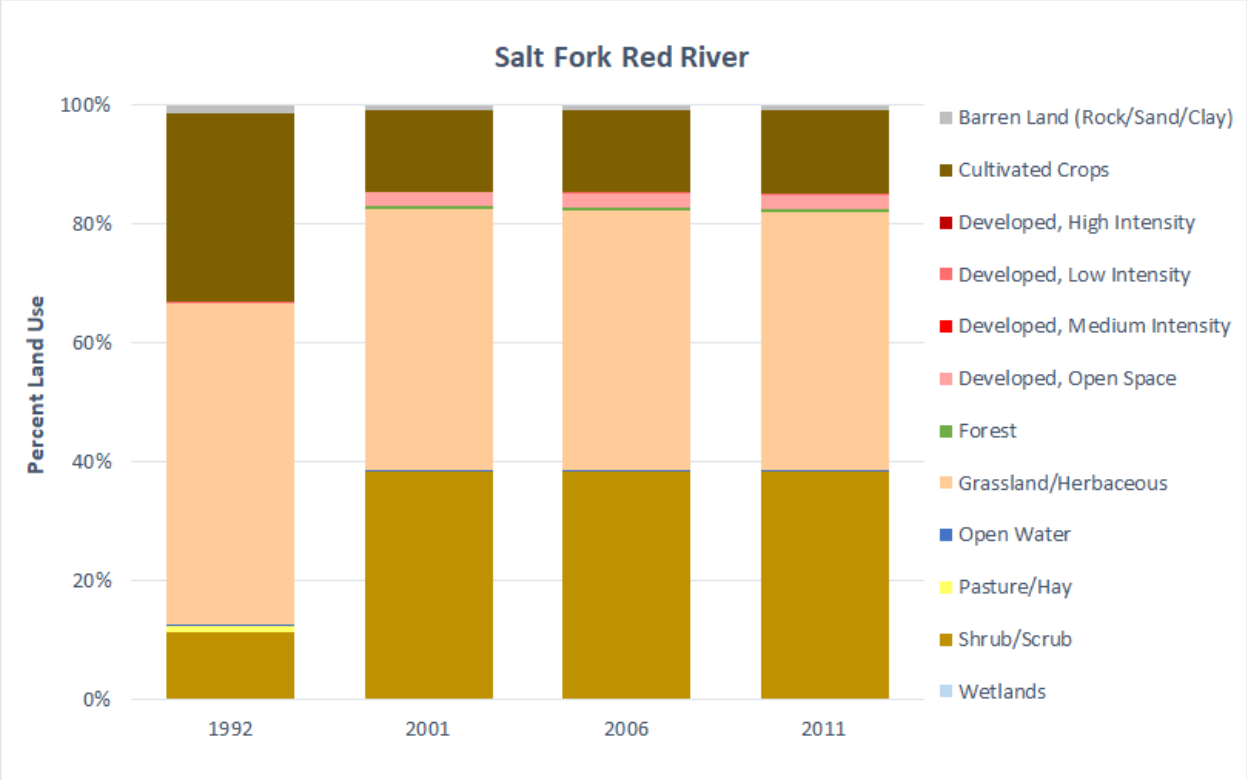

Figure 62. Percent land use in the Salt Fork Red River watershed from 1992-2011.

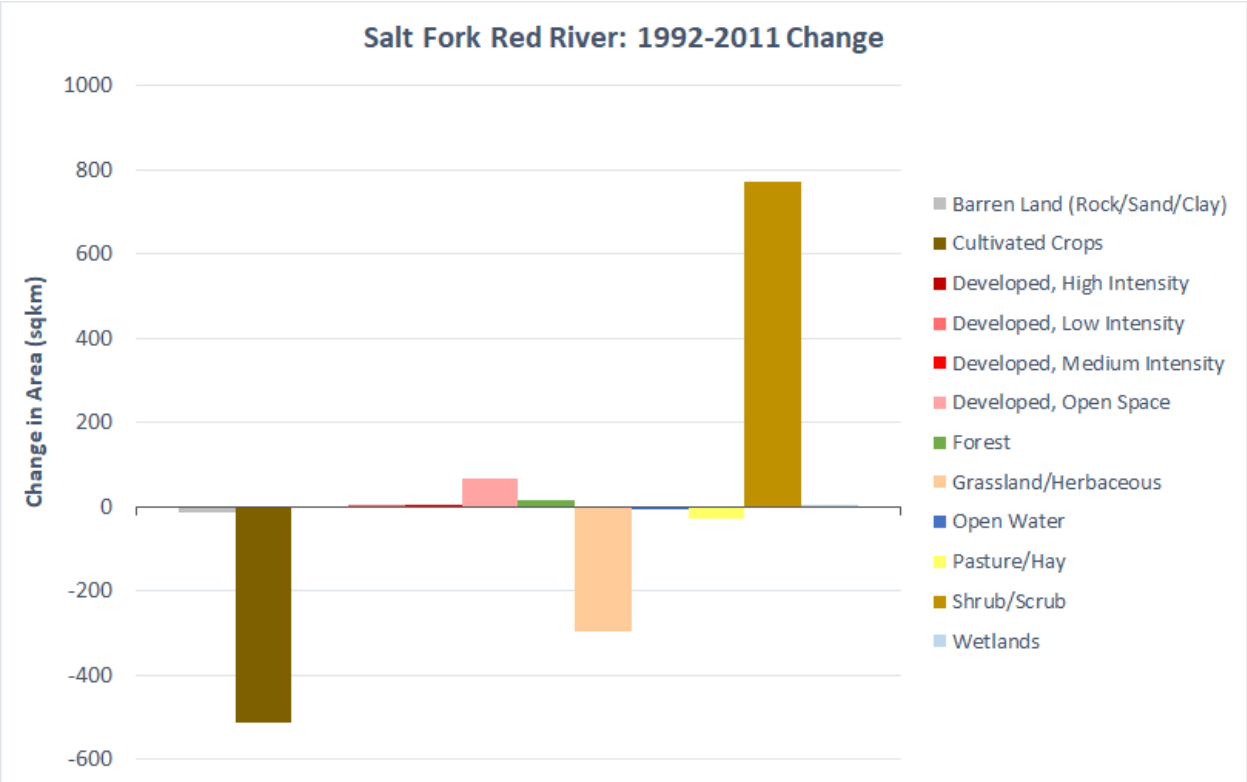

Figure 63. Land use change in area (sq km) from 1992-2011 for the Salt Fork Red River watershed.

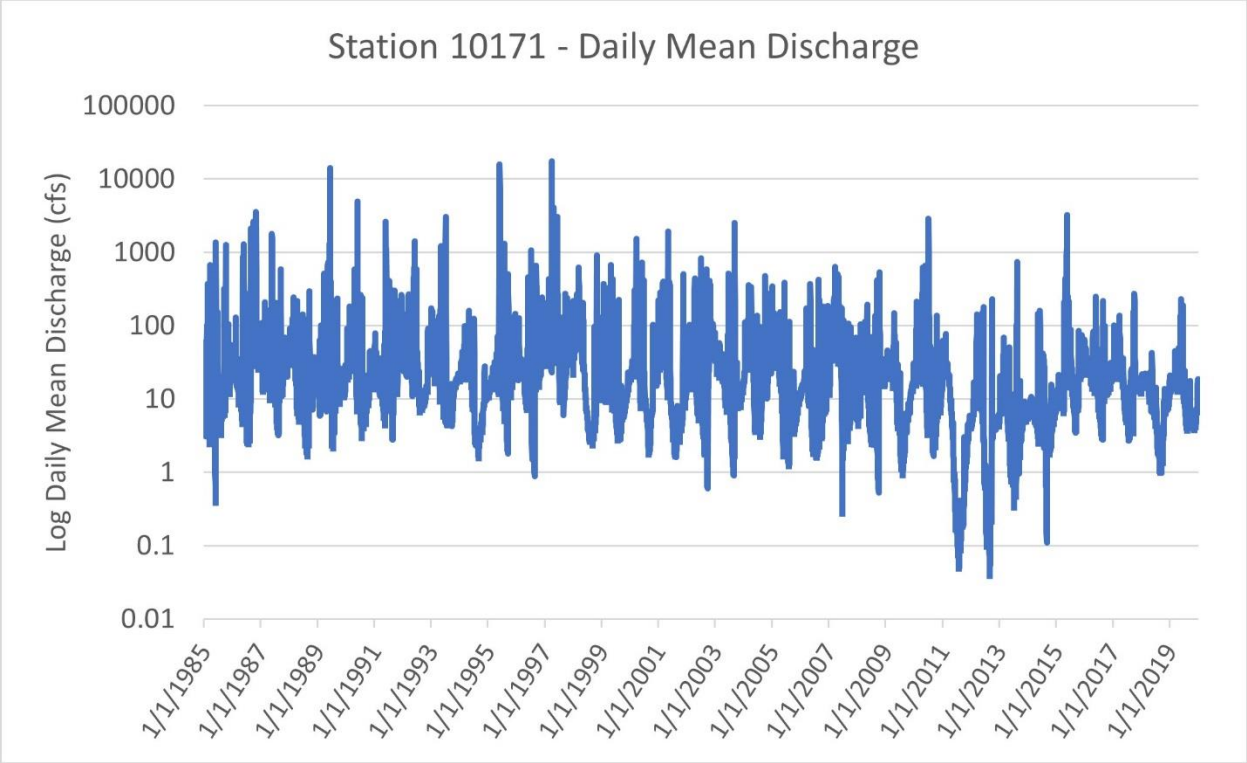

Figure 64. Log transformed daily mean discharge for Salt Fork Red River at station 10171.

WHITE DEER CREEK

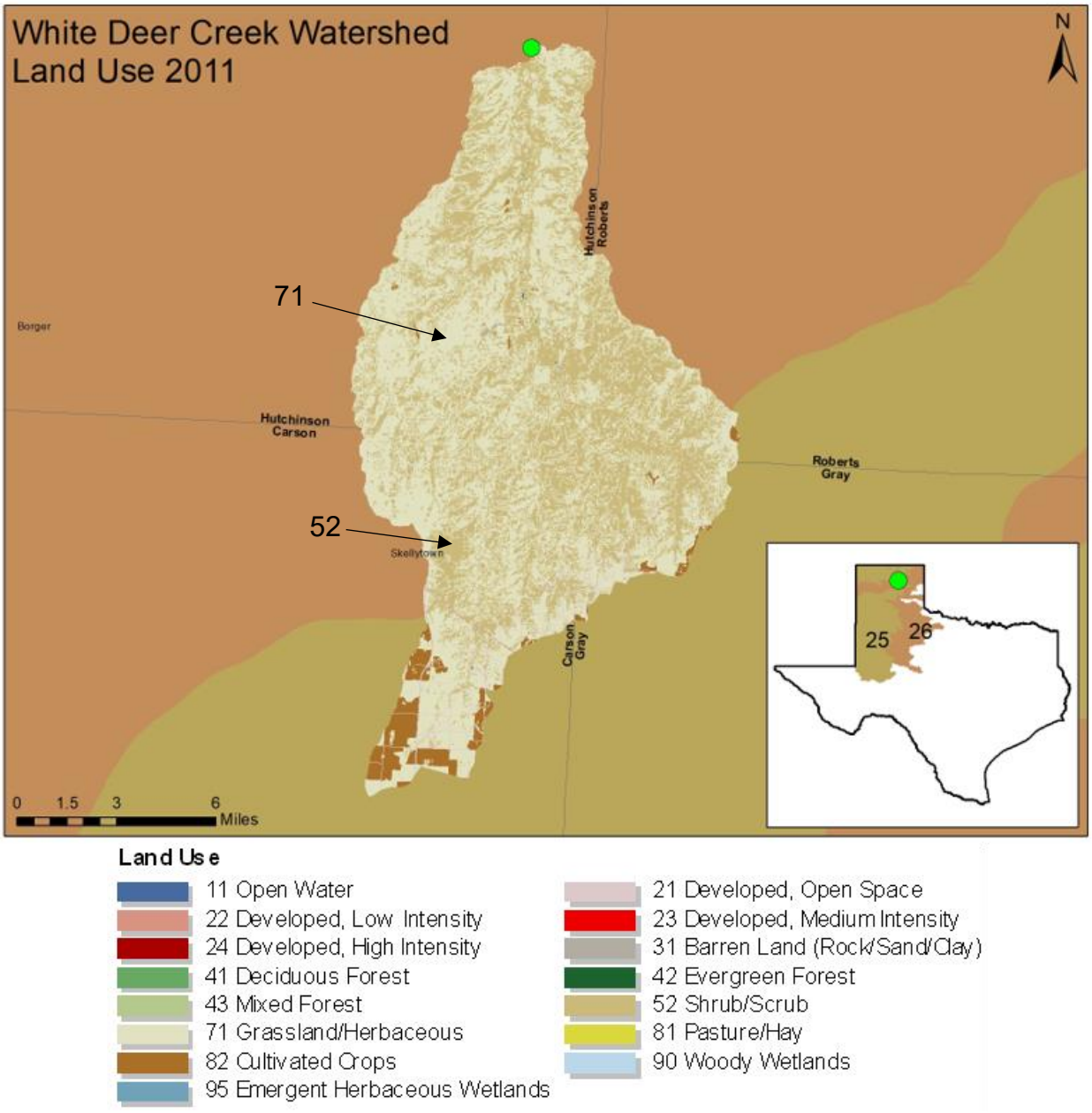

Figure 65. Map of White Deer Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	May 14, 2003; July 22, 2003; May 19, 2016
Water Quality:	50 sampling events
Fish:	May 14, 2003; July 23, 2003; May 19, 2016
Benthic Invertebrates:	May 14, 2003; July 22, 2003; May 19, 2016

Physical Characterization

Watershed and Land Use

White Deer Creek lies within the Canadian River Basin. Sample site 21174 is located at a jeep trail crossing, 0.45 km east of Duncan Ranch at the end of CR 26, approximately 24.03 km north northeast of Skellytown in Hutchinson County (Figure 65).

The White Deer Creek watershed at site 21174 is approximately 346.38 sq km. The station and a majority of the watershed are in Level IV Ecoregion 26a, the Canadian/Cimarron Breaks. A small portion of the upper watershed crosses into Level IV Ecoregion 25i, the Llano Estacado. The dominant land cover in the watershed is grassland/herbaceous at 55.20% and is present throughout the watershed (Homer et al. 2015; Figure 65 and Figure 66). Shrub is the secondary land cover encompassing 39.70%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 1.55% and total cover for cultivated crops is 3.40%.

From 1992-2011 there was an 80.62 sq km decrease in grassland and a 17.80 sq km decrease in cultivated crops. There was a 100.96 sq km increase in shrub and a 5.09 sq km increase in open space development (Figure 67).

There are no permitted wastewater outfalls within the White Deer Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for White Deer Creek was evaluated at two sites: one on May 14 and July 22, 2003, and the second site on May 19, 2016. Both sites were on the Duncan Ranch in Hutchinson County, and the 2016 site was about 1.4 kilometers downstream of the 2003 site. Habitat Quality Index scores in 2003 (both 18.5) indicate an intermediate aquatic life use and the score of 20.5 in 2016 indicates a high aquatic life use. The riparian buffer was 13 meters on average in 2003 and greater than 20 meters in 2016. The riparian zone was dominated by grasses, which make up an average of 75% of the total riparian species, followed by trees (16%) then shrubs (9%). The average percentage of tree canopy cover was 22%. The dominant substrate was sand in 2003 and silt in 2016. The average percent of substrate gravel size or larger was 0% in 2003 and 9% in 2016. Average percent instream cover was 34.5% and instream cover types include gravel, woody debris, macrophytes, algae, undercut banks, root mats, and overhanging vegetation. White Deer Creek ranges from 0.27-0.4 meters deep on average and 4.5-5.2 meters wide. The average stream bank slope was 20.7 degrees. Stream flow at the site was measured at a minimum value of 0.2 cfs and a maximum of 3.3 cfs. Average stream bank erosion potential was 22%. The deepest pool at White Deer Creek was 1.5 meters in 2016. No riffles were observed, and the maximum number of stream bends was seven.

Water Quality

Water samples were collected at station 21174 during 50 sampling events from October 2007 through January 2021. Data were collected for temperature, flow, transparency, specific

conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Based upon the fish assemblage, the aquatic life use declined from exceptional to intermediate between 2003 and 2016. Two native cyprinid species (Red Shiner and Sand Shiner) were collected in 2003 (metric score of 3); however, only Red Shiner was collected in the more recent sample (metric score of 1). Common Carp, a non-native species, was collected in every sample but increased in abundance from 0.4% to 5.2% between the latter and more recent collections. Catch per unit of effort declined by over 50% in each consecutive sample resulting in metric scores of 5, 3, and 1, respectively. Only a minimal incidence of anomalies (metric score of 5) were noted during 2003 while 1.7% of the individuals collected in 2016 were identified with some sort of physical anomaly, thus resulting in a metric score of 1. The decline in aquatic life use is most likely due to the major drought that gripped Texas from 2010 to 2015.

Benthic Macroinvertebrates

Considering the two RBP samples from 2003 and the one RBP sample from 2016 collectively, a total of 457 individuals representing 57 taxa from 12 orders of macroinvertebrates were collected from White Deer Creek (Appendix E). Ephemeroptera, Diptera, Trichoptera, Amphipoda, Odonata, Coleoptera, and Basommatophora were the most commonly collected orders, collectively accounting for 90 percent of the total number of individuals collected. Hemiptera, Neoophora, Oligochaeta, and Trombidiformes were the only other orders which comprised at least one percent of the collections. The statewide BIBI for one RBP sample (Duncan Ranch, 14 May 2003) fell in the high aquatic life use category, while the BIBI for the other two samples fell in the intermediate aquatic life use category.

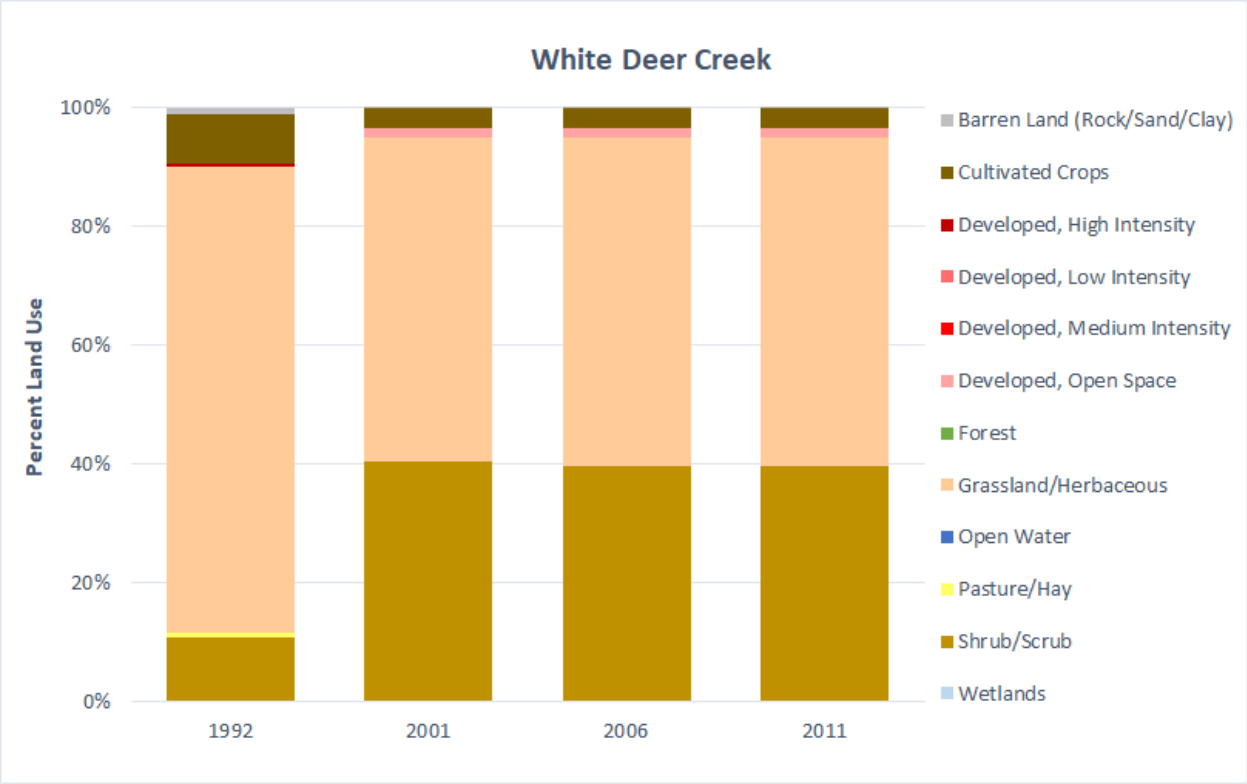

Figure 66. Percent land use in the White Deer Creek watershed from 1992-2011.

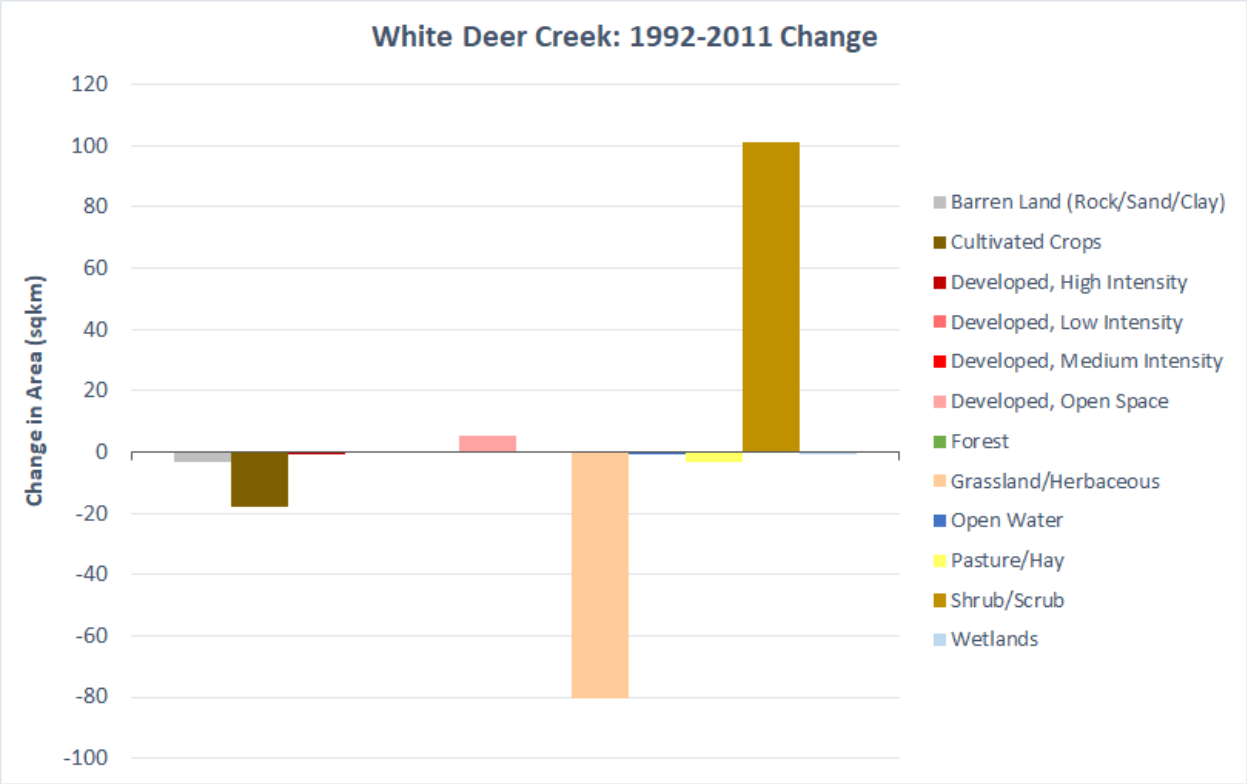

Figure 67. Land use change in area (sq km) from 1992-2011 for the White Deer Creek watershed.

WHITEFISH CREEK

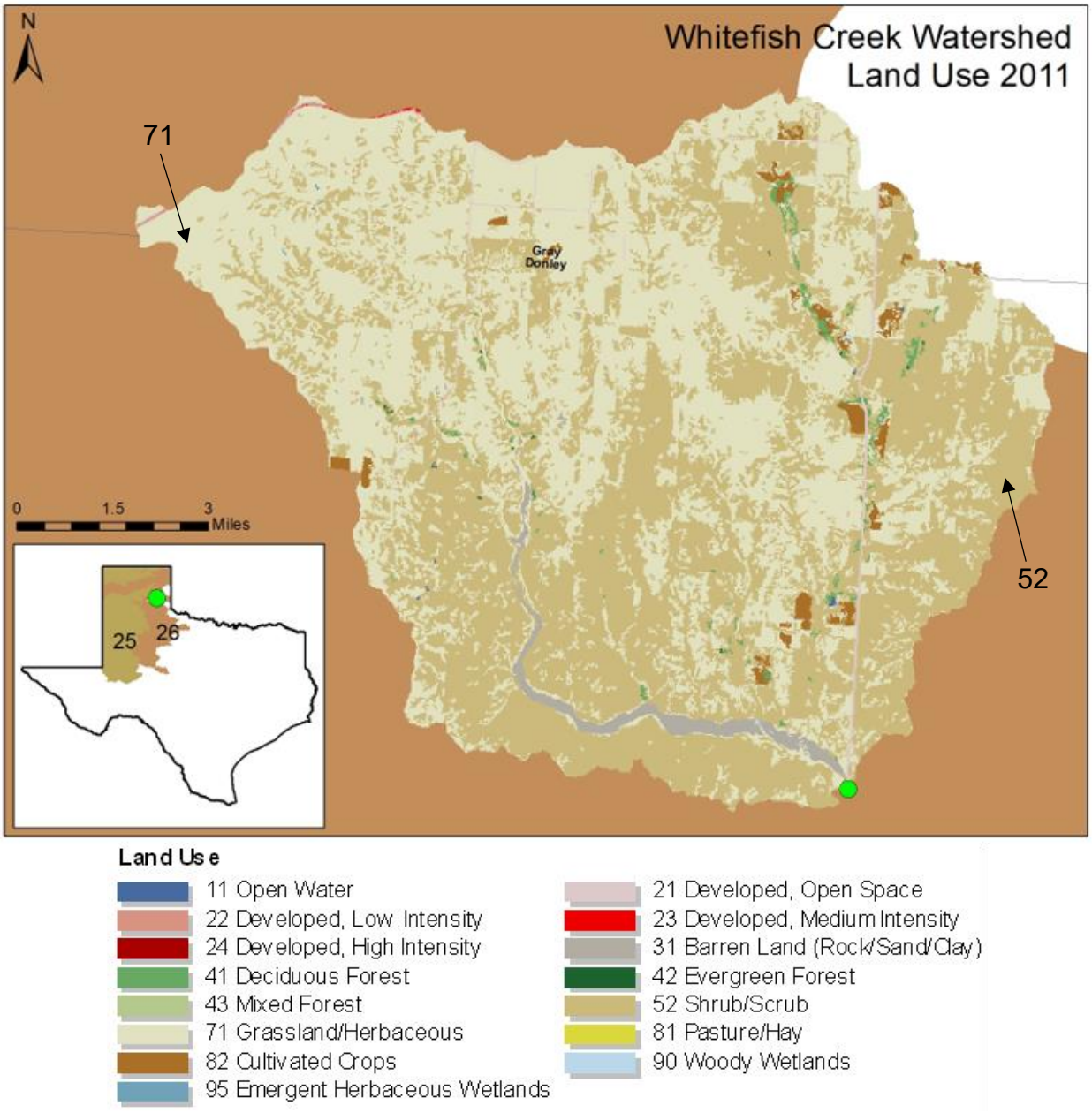

Figure 68. Map of Whitefish Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	August 16, 1989
Water Quality:	14 sampling events
Fish:	August 16, 1989
Benthic Invertebrates:	August 16, 1989

Physical Characterization

Watershed and Land Use

Whitefish Creek lies within the Red River Basin. Sample site 10077 is located downstream of CR 27, approximately 22.5 km northeast of Hedley in Donley County (Figure 68).

The Whitefish Creek watershed at site 10077 is approximately 270.78 sq km. The station and a portion of the lower watershed are located in Level IV Ecoregion 26c, the Caprock Canyons, Badlands, and Breaks, while the remaining majority of the watershed is located in Level IV Ecoregion 26a, the Canadian/Cimarron Breaks. The dominant land cover in the watershed is shrub at 48.51% and is present throughout the watershed (Homer et al. 2015; Figure 68 and Figure 69). Grassland/herbaceous is the secondary land cover encompassing 47.47%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.82% and total cover for cultivated crops is 1.24%.

From 1992-2011 there was a 71.79 sq km decrease in grassland and a 24.12 sq km decrease in cultivated crops. There was a 97.75 sq km increase in shrub and a 1.95 sq km increase in open space development (Figure 70).

There are no permitted wastewater outfalls within the Whitefish Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Whitefish Creek was evaluated on August 16, 1989. The riparian width was 30 meters. The riparian zone was dominated by grasses, which made up an average of 95% of the total riparian species, followed by shrubs (3%) then trees (2%). The average percentage of tree canopy cover was 0%. The dominant substrate was sand, and the average percent of substrate that was gravel size or larger was 11%. The average percent instream cover was 1%. Whitefish Creek had an average depth of 0.1 meters and a maximum depth of 0.2 meters. The average width was 7.1 meters, and the average stream bank slope was 39 degrees. The stream flow at the site was 1.15 cfs. Average stream bank erosion potential was 53%. Six riffles were observed at the site and there were two total stream bends.

Water Quality

Water samples were collected at station 10077 over 14 sampling events from November 1988 through July 1999. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a.*

Biological Characterization

Fish

Six species (five families) were collected. Centrarchidae was represented by two species and was the only family with more than one species. Plains Killifish were the most abundant species. The aquatic life use (based upon the fish assemblage) rated as high.

Benthic Macroinvertebrates

Considering the one Surber sample from 1989, a total of five individuals representing four taxa from three orders of macroinvertebrates were collected from Whitefish Creek (Appendix E). The orders collected and the percentage of individuals represented by each order are as follows: Diptera (60%), Odonata (20%), and Trichoptera (33%). The Surber BIBI for the sample fell in the intermediate aquatic life use category.

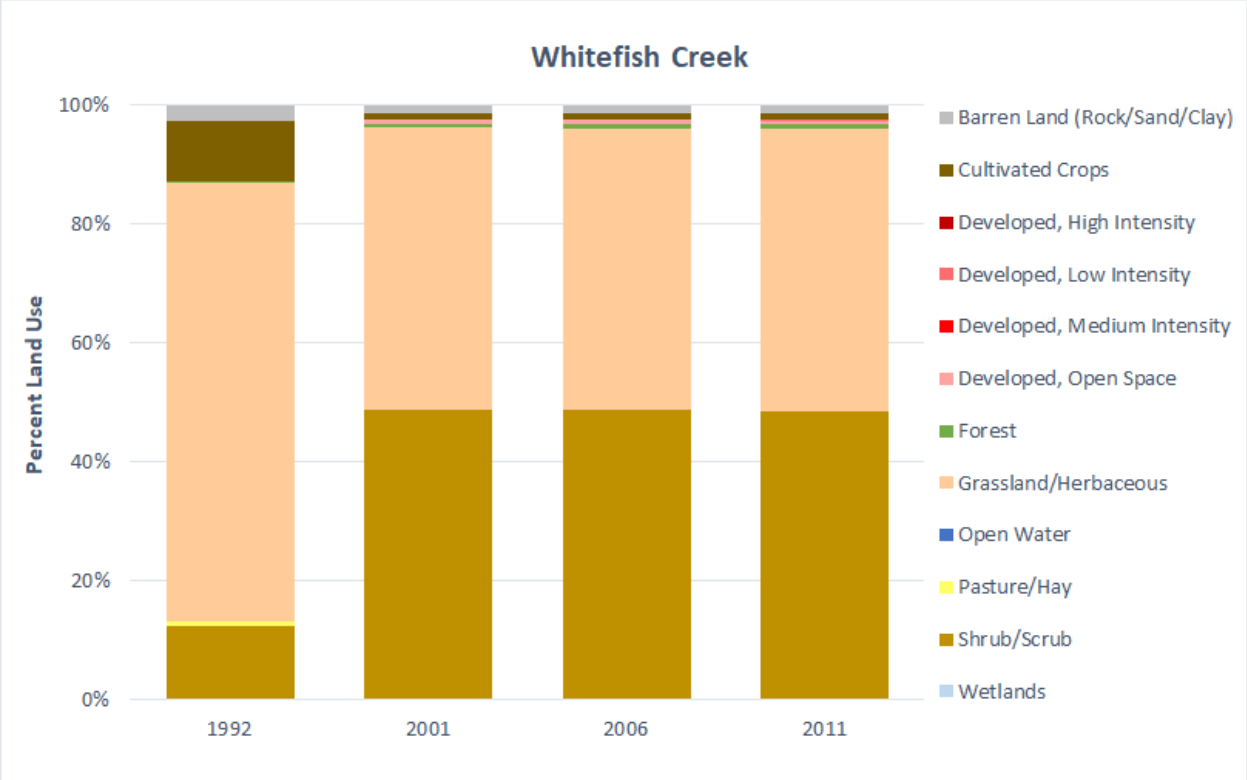

Figure 69. Percent land use in the Whitefish Creek watershed from 1992-2011.

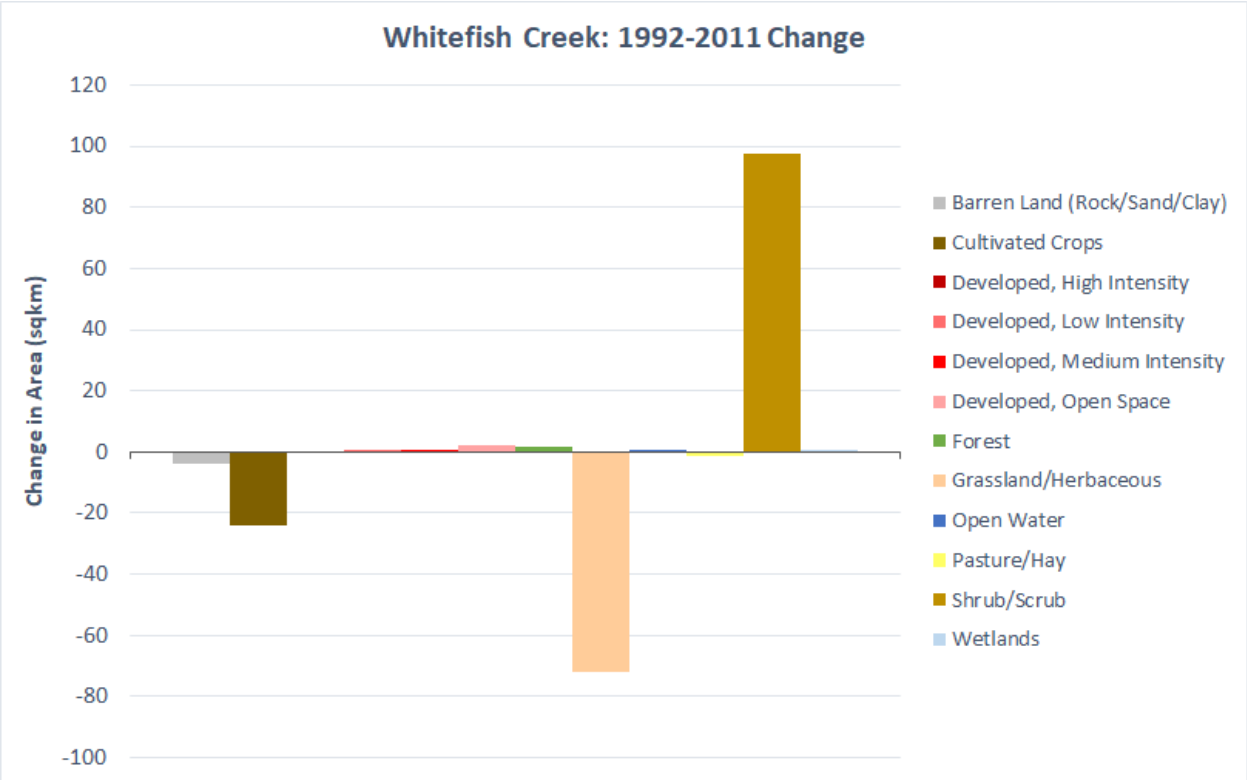

Figure 70. Land use change in area (sq km) from 1992-2011 for the Whitefish Creek watershed.

WOLF CREEK

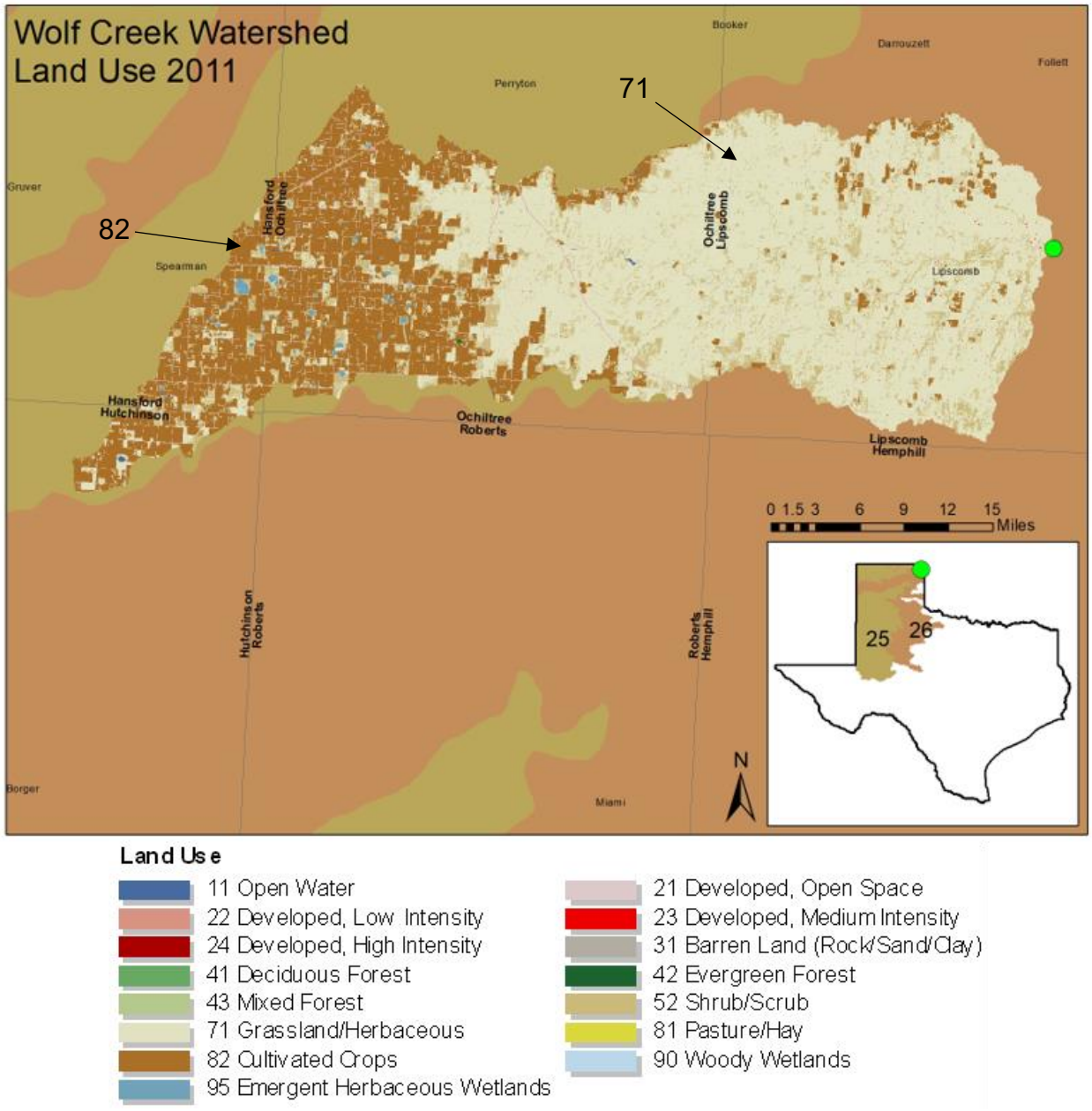

Figure 71. Map of Wolf Creek watershed location and 2011 land use; grassland/herbaceous and cultivated crops were the most common land uses.

Sampling Dates

Physical Habitat:	July 18, 1990; May 18, 2016
Water Quality:	74 sampling events
Fish:	July 17, 1990; May 18, 2016
Benthic Invertebrates:	July 17, 1990; May 18, 2016

Physical Characterization

Watershed and Land Use

Wolf Creek lies within the Canadian River Basin. Sample site 10059 is located 50 m upstream of FM 1454, approximately 27.4 km east of Lipscomb in Lipscomb County (Figure 71).

The Wolf Creek watershed at site 10059 is approximately 2533.02 sq km. The station and lower watershed are located in Level IV Ecoregion 26a, the Canadian/Cimarron Breaks, and the upper watershed is located in Level IV Ecoregion 25e, the Canadian/Cimarron High Plains. The dominant land cover in the watershed is grassland/herbaceous at 55.96% and is present in the middle and lower watershed (Homer et al. 2015; Figure 71 and Figure 72). Cultivated crops is the secondary land cover encompassing 28.36%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.02%.

From 1992-2011 there was a 294.91 sq km decrease in cultivated crops and a 64.93 sq km decrease in pasture/hay. There was a 153.29 sq km increase in grassland and a 132.54 sq km increase in shrub (Figure 73).

There are no permitted wastewater outfalls within the Wolf Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Wolf Creek was evaluated on July 18, 1990, and again on May 18, 2016. The 2016 Habitat Quality Index score of 22 indicates a high aquatic life use rating. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters for both sampling events. The riparian zone was dominated by shrubs, which make up an average of 44% of the total riparian species, followed by grasses (43%) then trees (13%). The average percentage of tree canopy cover was 16%. The dominant substrate was sand, and the average percent of substrate that was gravel size or larger was 3.5%. The average percent instream cover was 35% and instream cover types include woody debris, algae, macrophytes, and gravel. Wolf Creek ranges from 0.1-0.2 meters deep on average and 2.5-5.0 meters wide. The average stream bank slope was 22.4 degrees. Stream flow at the site was measured at a minimum value of 2.3 cfs and a maximum of 2.4 cfs. Average stream bank erosion potential was 31%. The deepest pool measured at Wolf Creek was 2.6 meters. No riffles were observed at the site and the maximum number of stream bends was eight.

Water Quality

Water samples were collected at station 10059 over 74 sampling events from July 1990 through January 2019. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*.

Biological Characterization

Fish

Ten species (four families) were collected between the two sampling events. Cyprinidae and Centrarchidae were each represented by four species. Red Shiner was the most abundant species in 1990. Longear Sunfish *Lepomis megalotis* was the most abundant species in 2016. Based upon the fish assemblage, the aquatic life use declined from exceptional to intermediate between the 1990 and 2016 collections. Species richness declined from eight to five, no native cyprinid species were collected in 2016 even though three were present in the 1990 samples (Red Shiner, Suckermouth Minnow *Phenacobius mirabilis*, and Sand Shiner), and non-native species (Common Carp) comprised 2.1% of the individuals in the 2016 collection (none were collected in 1990). The decline in aquatic life use is most likely due to the major drought that gripped Texas from 2010 to 2015. Residents in the area indicated this creek went dry during parts of that time period. The absence of any native cyprinid species would support those claims.

Benthic Macroinvertebrates

Considering the one Surber sample from 1990 and one RBP sample from 2016 collectively, a total of 1879 individuals representing 85 taxa from 20 orders of macroinvertebrates were collected from Wolf Creek (Appendix E). Ephemeroptera, Diptera, Trichoptera, Oligochaeta, Odonata, and Coleoptera were the most commonly collected orders, collectively accounting for 93 percent of the total number of individuals collected. Neoophora, Amphipoda, and Phylum Nematoda were the only other groups which comprised at least one percent of the collections. The Surber BIBI for the Surber sample fell in the exceptional aquatic life use category. The statewide BIBI for the RBP sample fell in the high aquatic life use category.

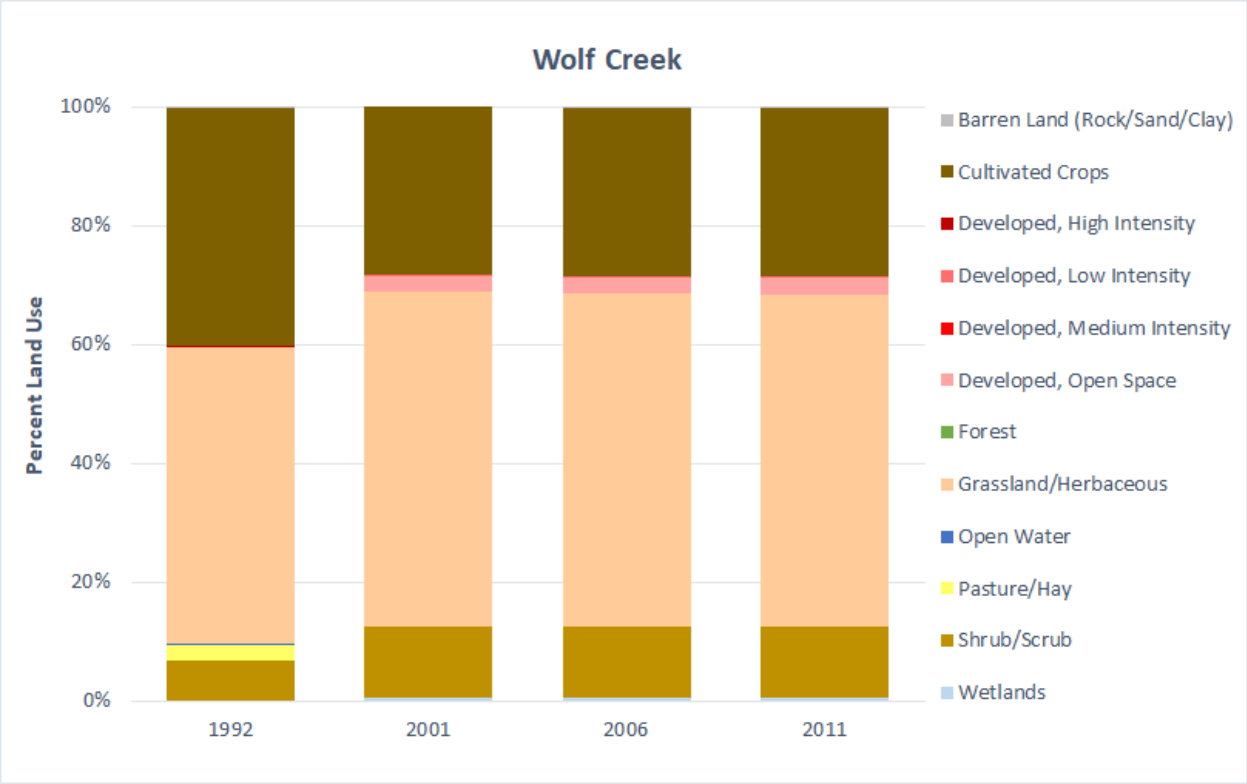

Figure 72. Percent land use in the Wolf Creek watershed from 1992-2011.

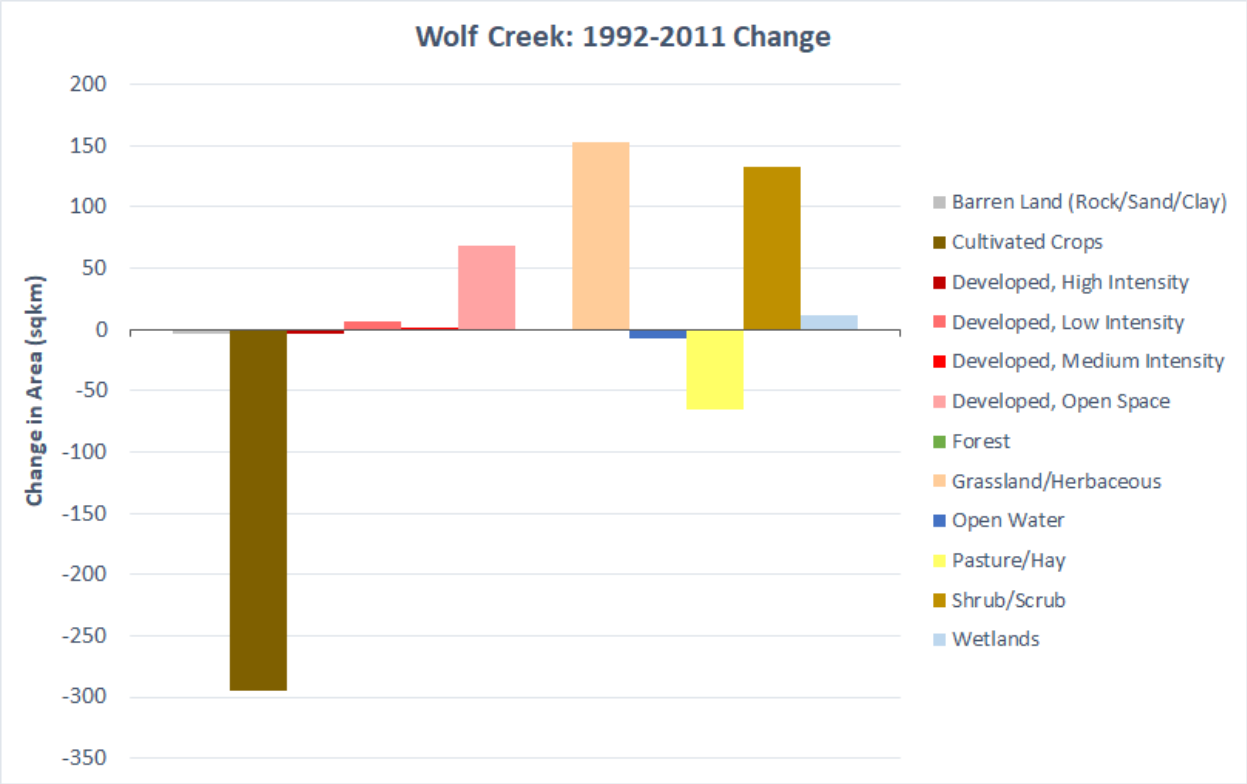

Figure 73. Land use change in area (sq km) from 1992-2011 for the Wolf Creek watershed.

Ecoregions 25 and 26 Summary and Historical Characterization

Watershed and Land Use

Ecoregion 25 was historically covered by grama-buffalo tallgrass prairie and now contain croplands to grow cotton, wheat, and grain sorghum. There are many playa lakes in this area that recharge the Ogallala Aquifer and provide seasonal wetland habitat for migrating waterfowl (Griffith et al. 2007). Currently, no sites have been sampled in this ecoregion for this study.

Ecoregion 26 was historically covered by grama-buffalo tallgrass, mesquite-buffalo grass, and juniper-scrub oak-midgrass savanna. Much of this area is now used for cropland to grow wheat, grain sorghum, cotton, and corn as well as cattle grazing and some oil and gas production (Griffith et al. 2007). In 2011 the overall primary land cover in the study watersheds was grassland and the secondary land cover was shrub. Between 1992-2011, grassland experienced the largest decrease in combined land cover area across all watersheds (~277,056.60 sq km) and shrub experienced the largest increase (~270,467.90 sq km).

In Channel and Riparian Physical Habitat

Physical habitat for the Southwestern Tablelands was evaluated at 12 stream sites over 16 sampling events from 1988 to 2018. Watershed area varied from a minimum of 13.5 sq km at Chicken Creek to a maximum of 1,717,422 sq km at the Canadian River north of Pampa. The sites generally had well vegetated riparian zones, and the riparian buffer was 37 meters on average with a minimum of 12 meters and maximum of 107 meters. Grasses were the dominant riparian species (54% on average), followed by shrubs (27%) then trees (19%), and average percent tree canopy coverage was 28%. Of the 11 sampling events that documented substrate type, sand was the dominant substrate at eight sites, followed by silt at two sites, then gravel at one site. Average percentage of substrate gravel sized or larger was 11% and varied from a minimum of 0% to a maximum of 83%. Average percent instream cover was 31% and common instream cover types include macrophytes, algae, overhanging vegetation, woody debris, undercut banks, and gravel. Average stream depth and width measurements were 0.2 meters and 7 meters, respectively. Average stream bank slope was 25 degrees and erosion potential was generally low, with an average of 35% which was reflected in the high average bank stability HQI score (2.4) indicating stable to moderately stable stream banks. Maximum pool depth ranged from a minimum of 0.1 meters to a maximum of 2.6 meters. Total number of riffles varied from zero to six, and total number of stream bends ranged from one to nine.

HQI scores are available for 11 events and range from a maximum score of 24.5 (high) at the North Fork Wichita River to a minimum score of 18.5 (intermediate) at the Salt Fork Red River, White Deer Creek, and the Canadian River above Lake Meredith. Of the 11 sampling events with an HQI score, seven (64%) received a habitat assessment rating of high and the remaining four (36%) received a rating of intermediate. The highest scoring HQI metrics for the Southwestern Tablelands were the dimensions of largest pool metric and the available instream

cover metric. The lowest scoring HQI metrics on average were the bottom substrate stability metric and the channel flow status metric.

Water Quality

Water quality data from ecoregion 26 includes both small streams and larger rivers. As this ecoregion encompasses all freshwater streams in the panhandle region, temperature ranged from 0 to 37 degrees Celsius and specific conductivity ranged from 256 to 30600 us/cm. The higher specific conductivity values were found only at the North Fork of the Wichita river. The secchi values observed varied with a median value of 0.4 meters with a range from 0 to 1.5 meters. The pH values had a range of 5.1 to 9.2. Chlorophyll-a data was highly variable between stations with a range of 0.1 to 131 ug/L. Most waterbodies had relatively stable chlorophyll-a values though several streams had highly variable chlorophyll-a data. Additional water quality variables are summarized in appendix C of the report.

Fish

A total of 4,075 individuals consisting of seven families and 23 species have been documented in 17 sampling events across 12 streams in the Western High Plains and Southwestern Tablelands from 1988 to 2018 (Appendix D - 2). For individual sites, taxa richness ranged from 12 species at McClellan Creek across two sampling events in 1990 and 2018 to a low of two species at the North Fork of the Wichita River from one sampling event in 2018. The most abundant species collected across all sites and sampling events were Red Shiner (n = 1,442), Plains Killifish (n = 926), Western Mosquitofish (n = 708), Red River Pupfish (n = 357), and Bluegill (n = 127).

Index of biotic integrity scores across all sites and sampling events ranged from 20 to 38 resulting in aquatic life use categories of limited (n = 1), intermediate (n = 6), high (n = 4), and exceptional (n = 6; Figure 74). Of the 17 sampling events in this ecoregion, 59% received an ALU rating of high or exceptional; 41% received an ALU of intermediate or limited. Most sites that were sampled multiple times received ALUs in at least two different categories. All sites received one ALU score of intermediate or better except for the North Fork of the Wichita River which received an ALU score of limited only.

Overall, IBI scores significantly decreased through time (Figure 75; $R^2 = 0.41$, $p < 0.01$); however, individual metrics did not significantly change through time (Figure 76; Figure 77). The decline in aquatic life use is most likely due to a major drought that gripped Texas from 2010 to 2015 resulting in many of these streams drying for extended periods of time.

Benthic Macroinvertebrates

A total of 12,785 individuals representing 23 orders of aquatic macroinvertebrates were collected in the five Surber samples, and 11 RBP samples collected from 11 streams in the Western High Plains and Southwestern Tablelands over the interval from August 1988 to June 2018 (Appendix E). Diptera and Odonata were the only two orders that were represented at all 11 streams. Other orders with a wide distribution include pulmonate snails, Coleoptera, Ephemeroptera, and Trichoptera, each of which were collected from nine of 11 streams. The most commonly

collected orders included Diptera, Veneroida, Ephemeroptera, Clitella, Trichoptera, Odonata, and Coleoptera which collectively represented 95% of the total number of individuals collected.

The fingernail clam *Sphaerium sp.* was the most abundant genus, representing 26% of the total number of individuals collected at all sites. However, it should be noted that 3,338 individuals of this taxon were collected in a single Surber sample at Bluff Creek in August 1988. Other genera that were relatively abundant include *Fallceon sp*., *Limnodrilus sp*., *Rheotanytarsus sp*., *Trichorythodes sp*., and *Cheumatopsyche sp*.

Berosus sp., *Erpetogomphus sp*., and *Hetaerina sp*., were the most widely distributed genera, each occurring at 10 of the 11 streams sampled. *Caenis sp*., and *Cheumatopsyche sp*., were also widely distributed genera/species, occurring in collections from nine of 11 streams. The apparent abundance and relatively wide distribution of these genera in the streams sampled in the Western High Plains and Southwestern Tablelands ecoregion are likely related to the often sandy, and fine sediments that often characterize the streams in this ecoregion.

The BIBI scores for the Surber samples collected at Bluff Creek in 1988, as well as for McClellan Creek, and Wolf Creek collected in 1990 each fell in the exceptional aquatic life use category, while the BIBI scores for Whitefish Creek and Saddler's Creek both collected in 1989 fell in the intermediate aquatic life use category. Results for the RBP IBI for the RBP sample collected at McClellan Creek in 2018 fell in the Exceptional ALU category. The RBP IBI score for the Chicken Creek RBP sample collected in 2018 fell in the high aquatic life use category, while the results for Buck Creek, the Canadian River, and White Deer Creek fell in the intermediate category. Results for the RBP IBI for the North Fork Wichita River fell in the limited aquatic life use category. Collectively, these results reflect relatively constant benthic biotic integrity over the interval August 1988 to June 2018 (Figure 78; Figure 79).

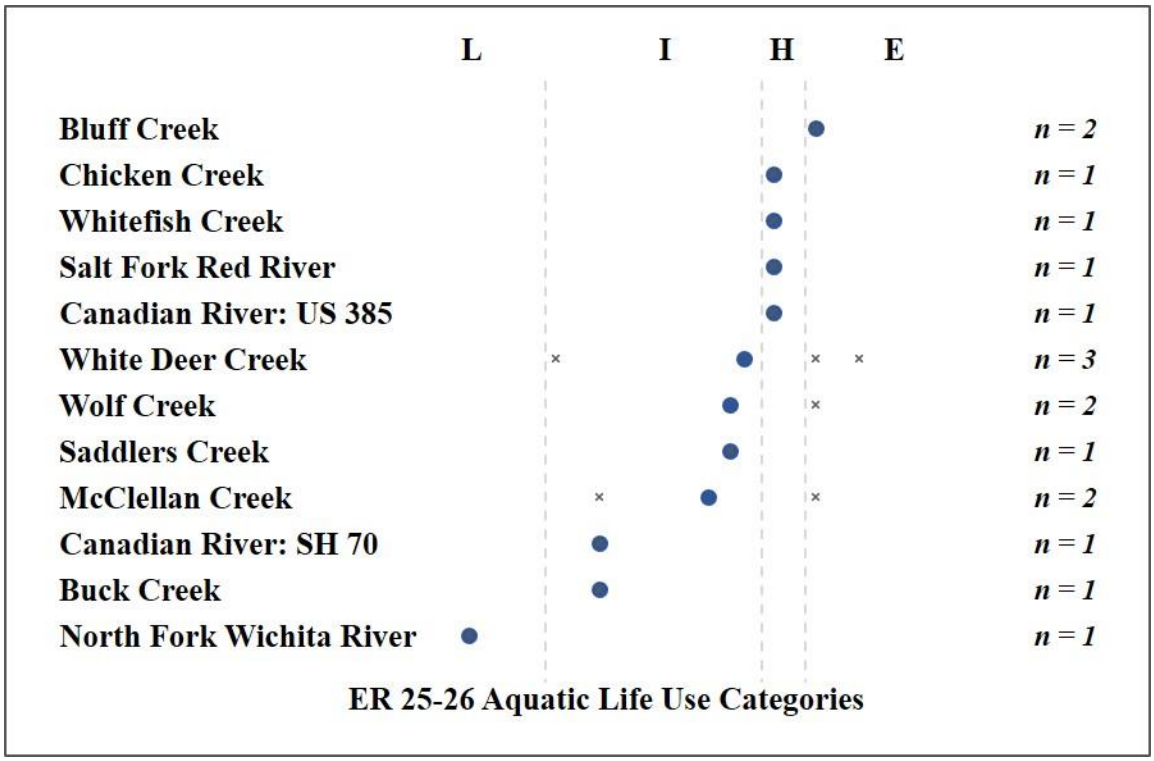

Figure 74. Aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all fish sampling events in Ecoregions 25 and 26 grouped by site and ranked by mean ALU score (blue dot); number of sampling events per site noted on right.

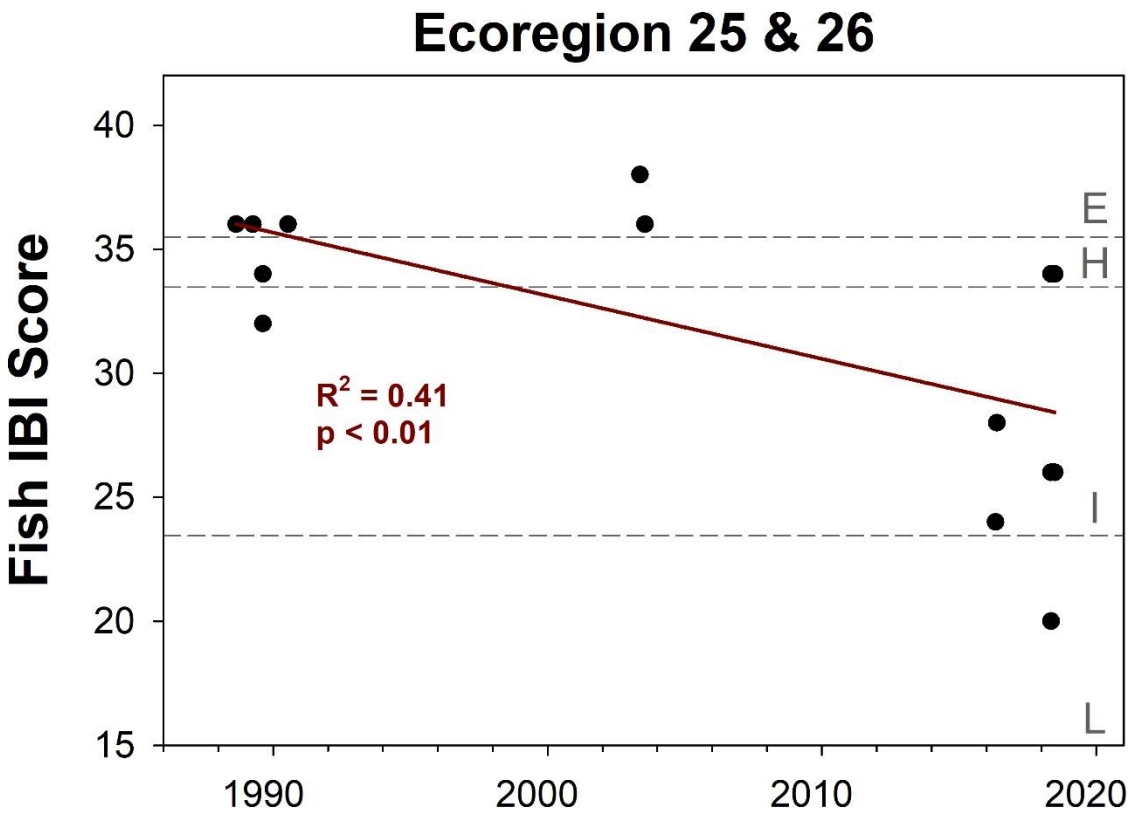

Figure 75. Fish index of biotic integrity scores through time for all sampling events in Ecoregions 25 and 26; break lines for aquatic life use categories (i.e., limited, intermediate, high, and exceptional) shown on each graph for reference (see Linam et al. 2002).

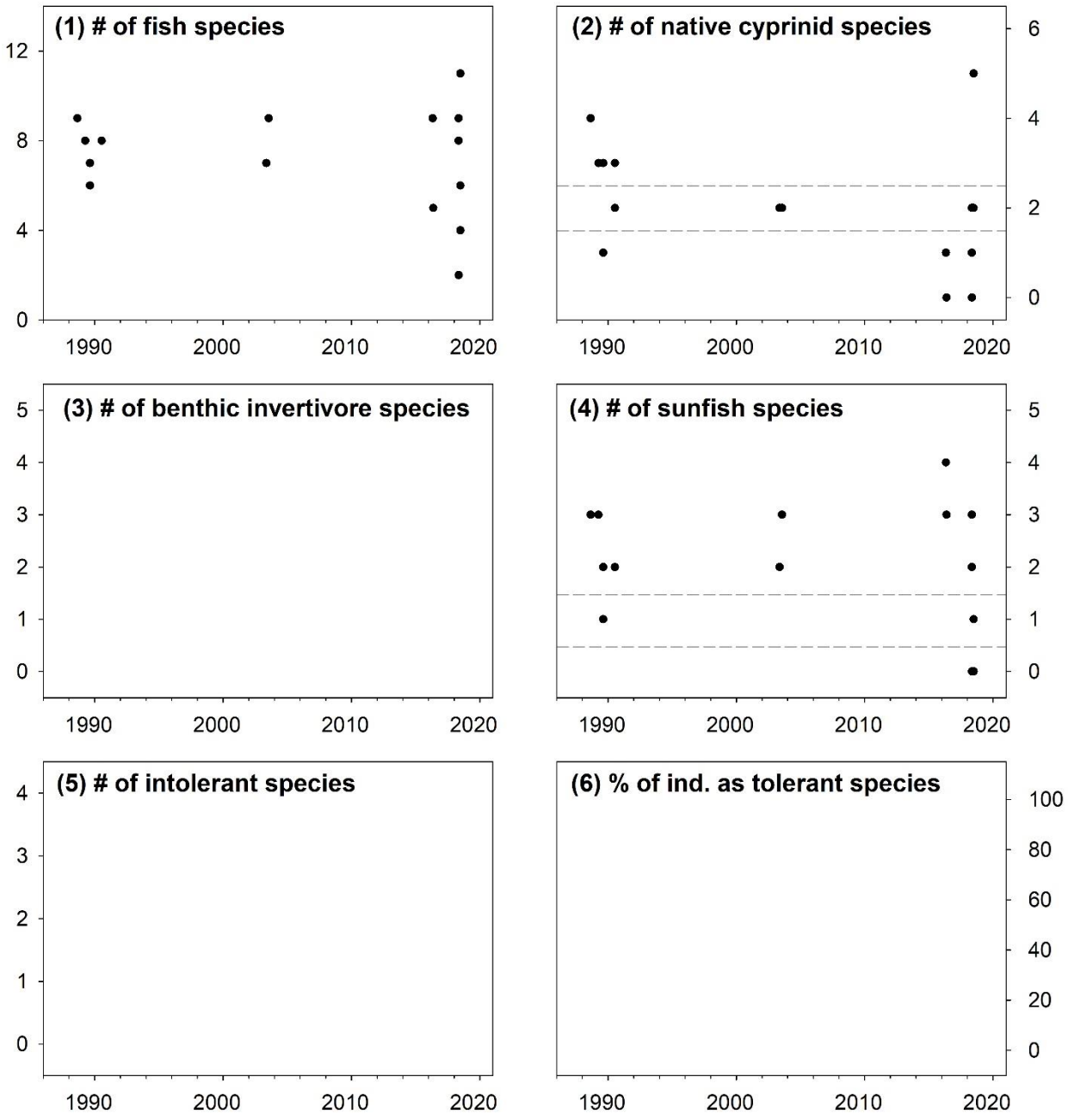

Figure 76. Raw values for fish index of biotic integrity metrics 1-6 through time for all sampling events in Ecoregions 25 and 26; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002); metrics that are not included in the IBI for this aggregated ecoregion are blank.

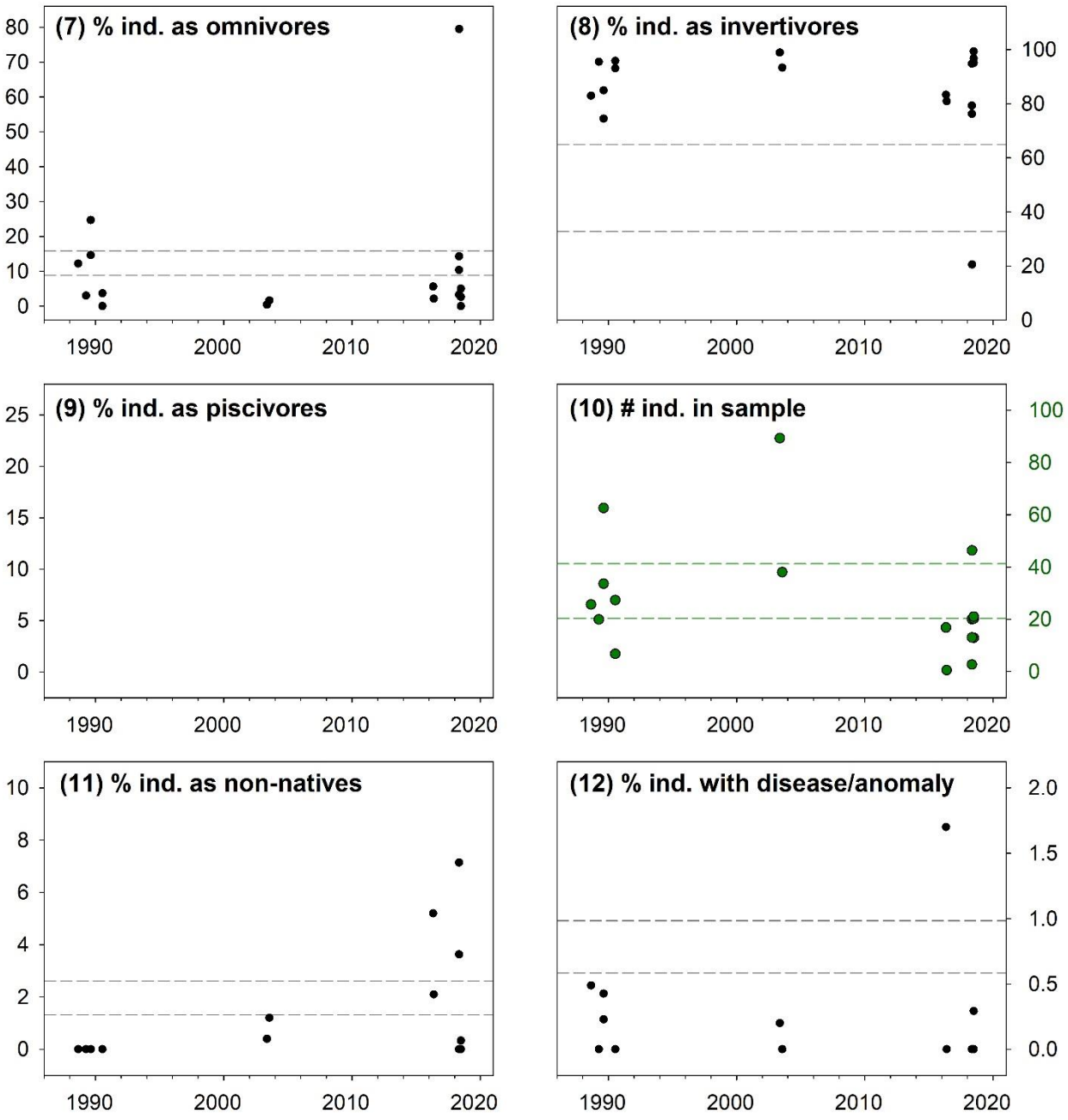

Figure 77. Raw values for fish index of biotic integrity metrics 7-12 through time for all sampling events in Ecoregions 25 and 26; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002); number of ind./seine haul represented by green circles and number of ind./min electrofishing represented by blue triangles for metric number 10; metrics that are not included in the IBI for this aggregated ecoregion are blank.

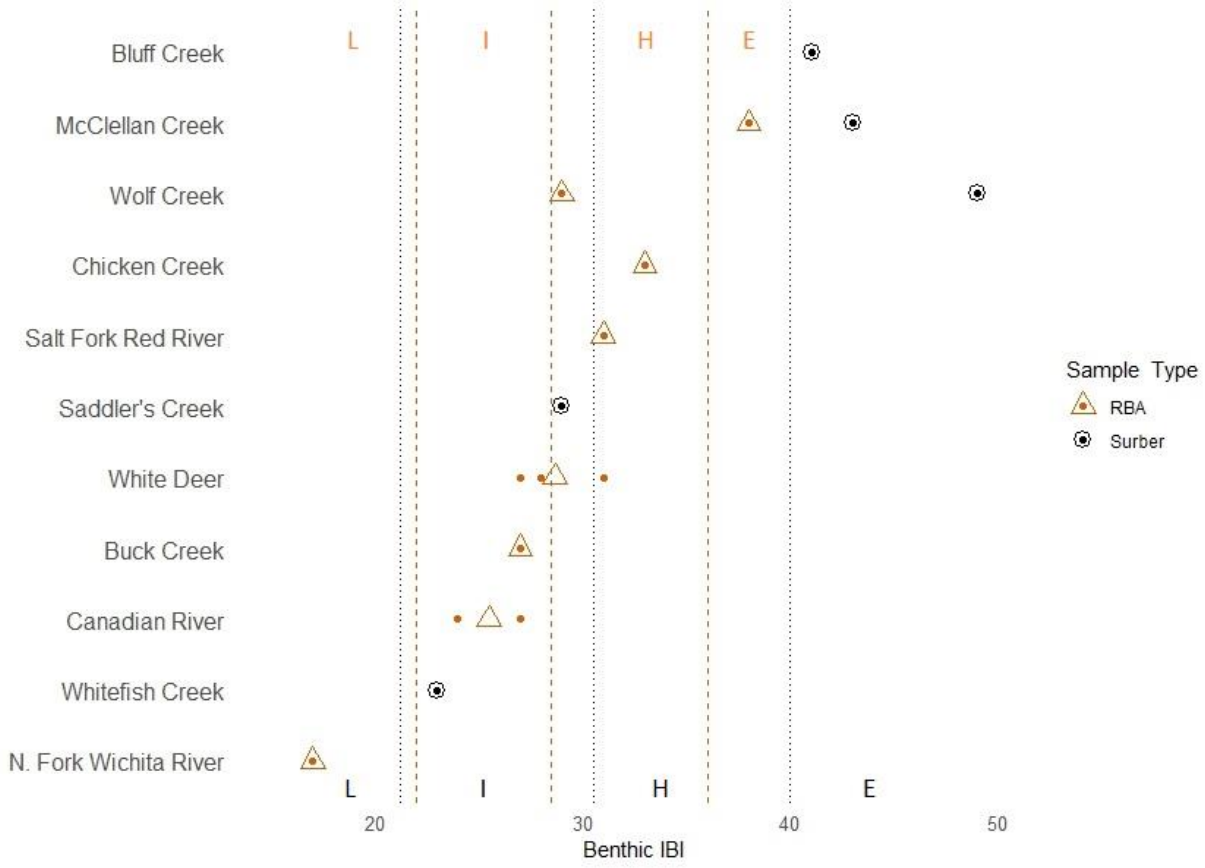

Figure 78. Benthic IBIs and aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all benthic sampling events in Ecoregions 25 and 26 grouped by site and ranked by mean IBI score. Site scores are solid circles, and mean scores are hollow circles for Surber IBI sample and hollow triangles for RBP IBI samples. RBP IBI ALU cut offs are red dashed lines and Surber ALU cutoffs are in black dotted lines.

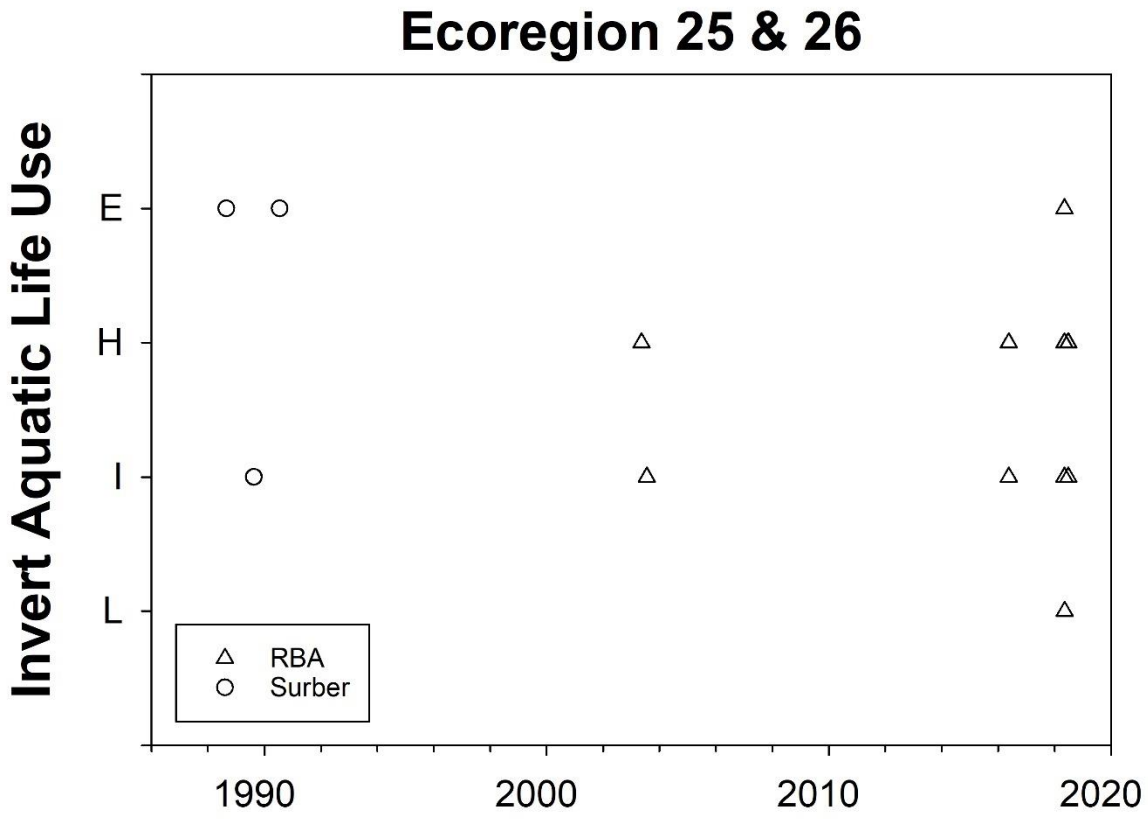

Figure 79. Benthic aquatic life use (ALU) categories through time for all sampling events in Ecoregions 25 and 26; Surber ALUs are noted by circles and RBP ALUs are noted by triangles.

ECOREGIONS 27, 29, AND 32 – SUBHUMID AGRICULTURAL PLAINS

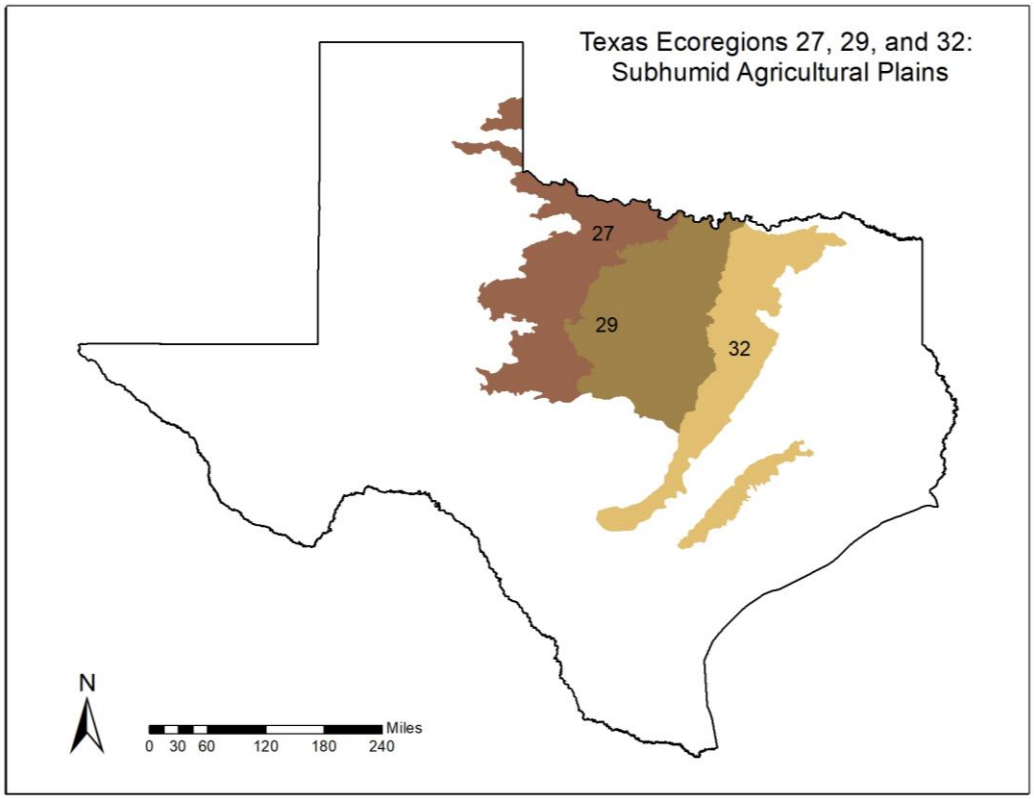

Figure 80. Map of Texas aggregate Ecoregions 27, 29, and 32 – Subhumid Agricultural Plains.

Figure 81. Site photo from Sweetwater Creek.

Ecoregion 27 Characterization

In Texas, the Central Great Plains ecoregion covers approximately 46,695 sq km and encompasses all or part of 35 counties in the north central portion of the state (Figure 80). The ecoregion is bordered on the west by the Southwestern Tablelands (Ecoregion 26), on the east by the Cross Timbers (Ecoregion 29), by the Edwards Plateau (Ecoregion 30) to the south, and, for most of the northern border in Texas, by the Red River. Portions of the Red, Brazos, Canadian, and Colorado River Basins are included in the ecoregion. Beyond Texas, the ecoregion extends through central Oklahoma, and Kansas into central Nebraska.

Most of the ecoregion is currently cropland, replacing the grassland which historically predominated. Griffith et al. (2007) note the region historically formed a transition from the tallgrass to the east, and the shortgrass to the west. This reflects the precipitation pattern in the ecoregion which decreases from an annual average of 66-81 cm in the eastern portion to 51-71cm in the western portion of the ecoregion (Griffith et al. 2007). Streams in the ecoregion are generally relatively turbid and are often reddish in color due to transport of iron-rich sediments which characterize the prairie ecoregion. Riparian vegetation along these streams often includes pecan *Carya illinoensis*, cottonwood *Populus* sp., hackberry *Celtis* sp., cedar elm *Ulmus crassifolia*, and little walnut *Juglans micrcarpa.* Instream cover as well as stable substrate is often limited in streams in this ecoregion, especially in the western portion.

Table 6. Streams sampled in Ecoregions 27.

Cottonwood Creek	Elm Creek	Sweetwater Creek
Deadman Creek	Lelia Lake Creek	

COTTONWOOD CREEK

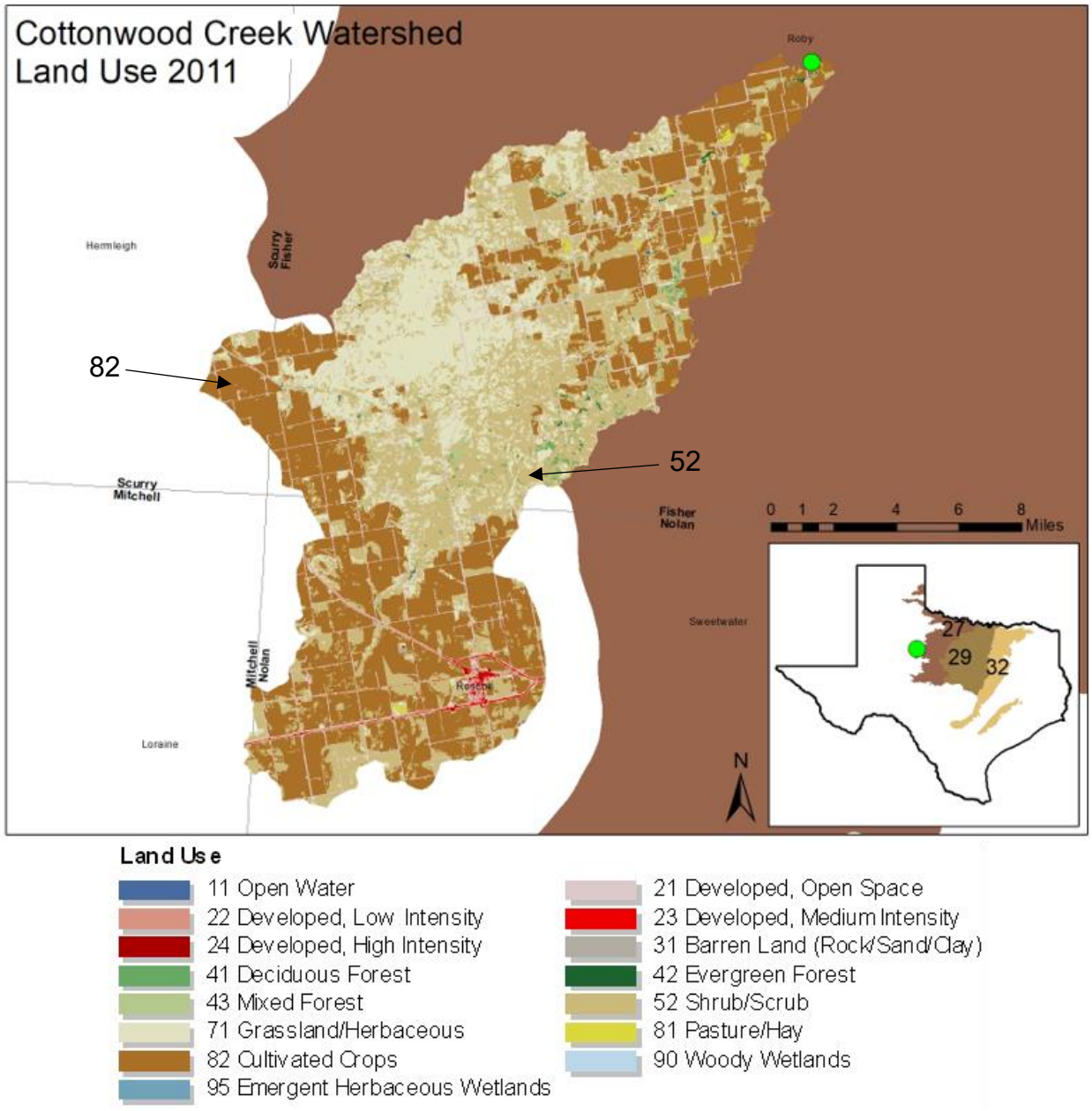

Figure 82. Map of Cottonwood Creek watershed location and 2011 land use; cultivated crops and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	August 24, 1988
Water Quality:	8 sampling events
Fish:	August 24, 1988; April 5, 1989
Benthic Invertebrates:	August 24, 1988

Physical Characterization

Watershed and Land Use

Cottonwood Creek lies within the Brazos River Basin. Sample site 11710 is located 1.19 km downstream of SH 70 near the City of Roby in Fisher County (Figure 82).

The Cottonwood Creek watershed at site 11710 is approximately 536.78 sq km. The station and lower half of the watershed is located in Level IV Ecoregion 27h, the Red Prairie, and the upper half of the watershed is located in Level IV Ecoregion 26b, the Flat Tablelands and Valleys. The dominant land cover in the watershed is cultivated crops at 40.57% and is present in the lower half and upper half the watershed (Homer et al. 2015; Figure 82 and Figure 83). Shrub is the secondary land cover encompassing 32.65% and is mostly located in the middle of the watershed. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 6.84%.

From 1992-2011 there was an 83.82 sq km decrease in cultivated crops and a 49.69 sq km decrease in pasture/hay. There was a 128.51 sq km increase in shrub and a 30.54 sq km increase in open space development (Figure 84).

There are no permitted wastewater outfalls within the Cottonwood Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Cottonwood Creek was evaluated on August 24, 1988. Cottonwood Creek is a tributary to the Clear Fork Brazos River. The riparian width was 30 meters. The riparian zone was dominated by grasses, which made up an average of 80% of the total riparian species, followed by trees and shrubs (10% each). The average percentage of tree canopy cover was 20%. The dominant substrate was silt except in riffles where gravel was dominant, and the average percent of substrate that was gravel size or larger was 24%. Average percent instream cover was 30%. Cottonwood Creek had an average depth of 0.2 meters and a maximum depth of 0.5 meters. The average width was 2.5 meters and average stream bank slope was 37 degrees. Stream flow at the site was 0.35 cfs. Average stream bank erosion potential was 23%. Six riffles were observed at the site and there were two total stream bends.

Water Quality

Water samples were collected at station 11710 over eight sampling events from August 1988 through July 1999. Data were collected for temperature, flow, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Fourteen species (five families) were collected between the two sampling events. Eleven of the species were in the families Centrarchidae (six species) and Cyprinidae (five species). Red

Shiner was the most abundant species. The aquatic life use rated as high and intermediate for the 1988 and 1989 fish assemblages, respectively; however, when the coefficient of variability was applied to the 1989 sample it also attained a high rating. The major reasons for the creek not achieving an exceptional rating was the absence of benthic invertivore species, high percentage of tolerant individuals, and low percentage of piscivores.

Benthic Macroinvertebrates

A total of 2,208 individuals representing 37 taxa from nine orders of macroinvertebrates were collected in the Surber sample from Cottonwood Creek (Appendix E). Trichoptera, Diptera, Oligochaeta, Coleoptera and Ostracoda were the most commonly collected orders.

Results of the Ecoregions 27, 29, and 32 Surber BIBI fell in the high aquatic life use category for the sample collected in 1988.

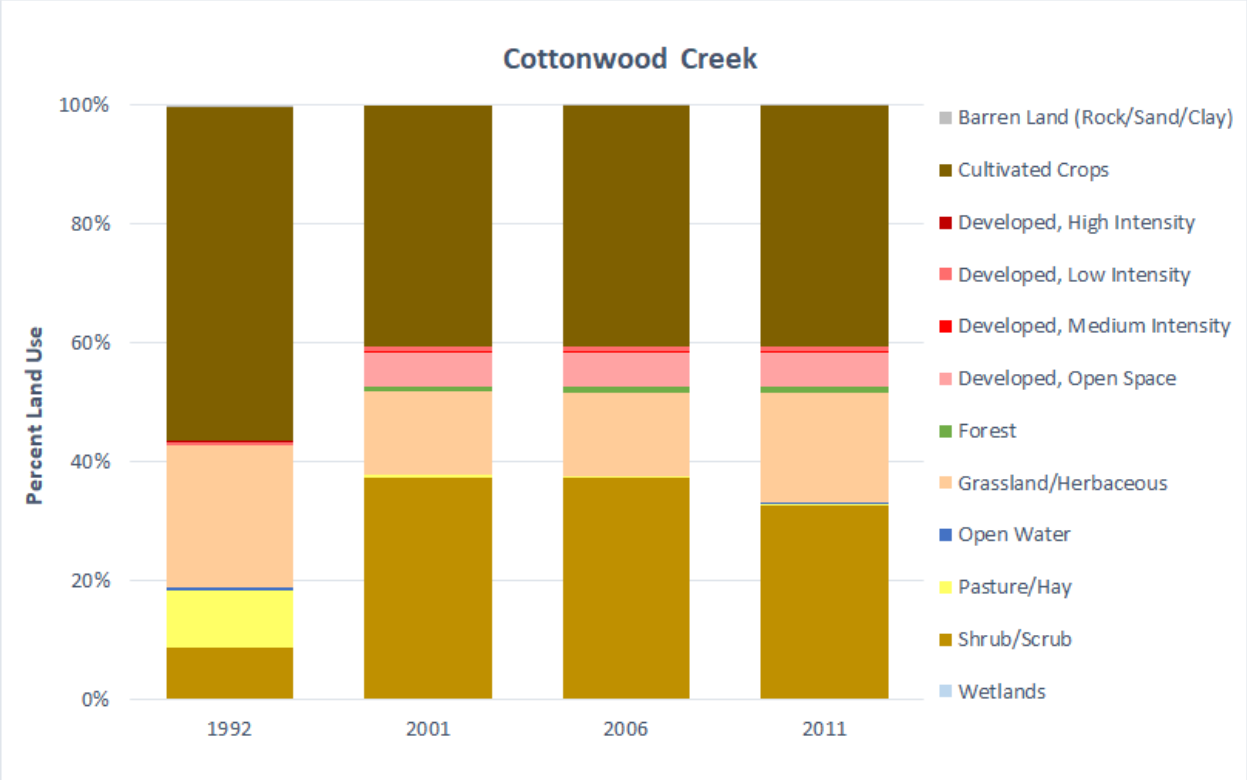

Figure 83. Percent land use in the Cottonwood Creek watershed from 1992-2011.

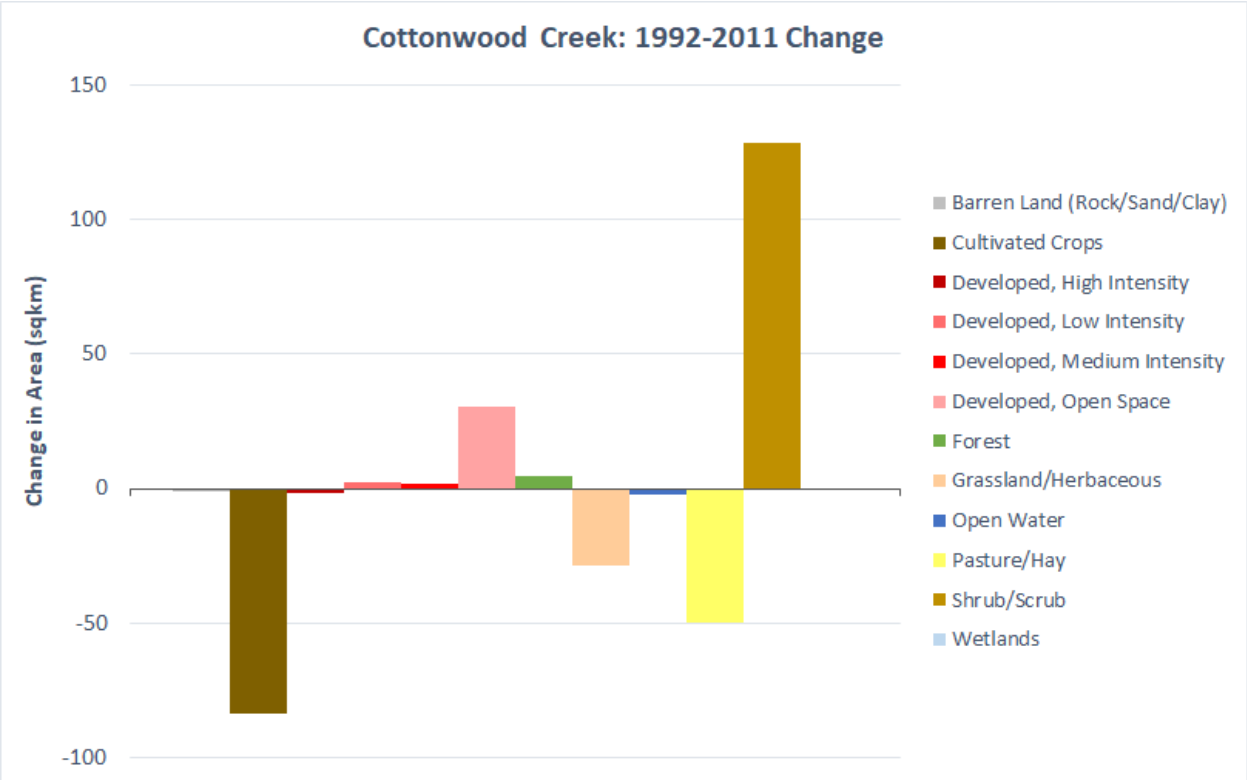

Figure 84. Land use change in area (sq km) from 1992-2011 for the Cottonwood Creek watershed.

DEADMAN CREEK

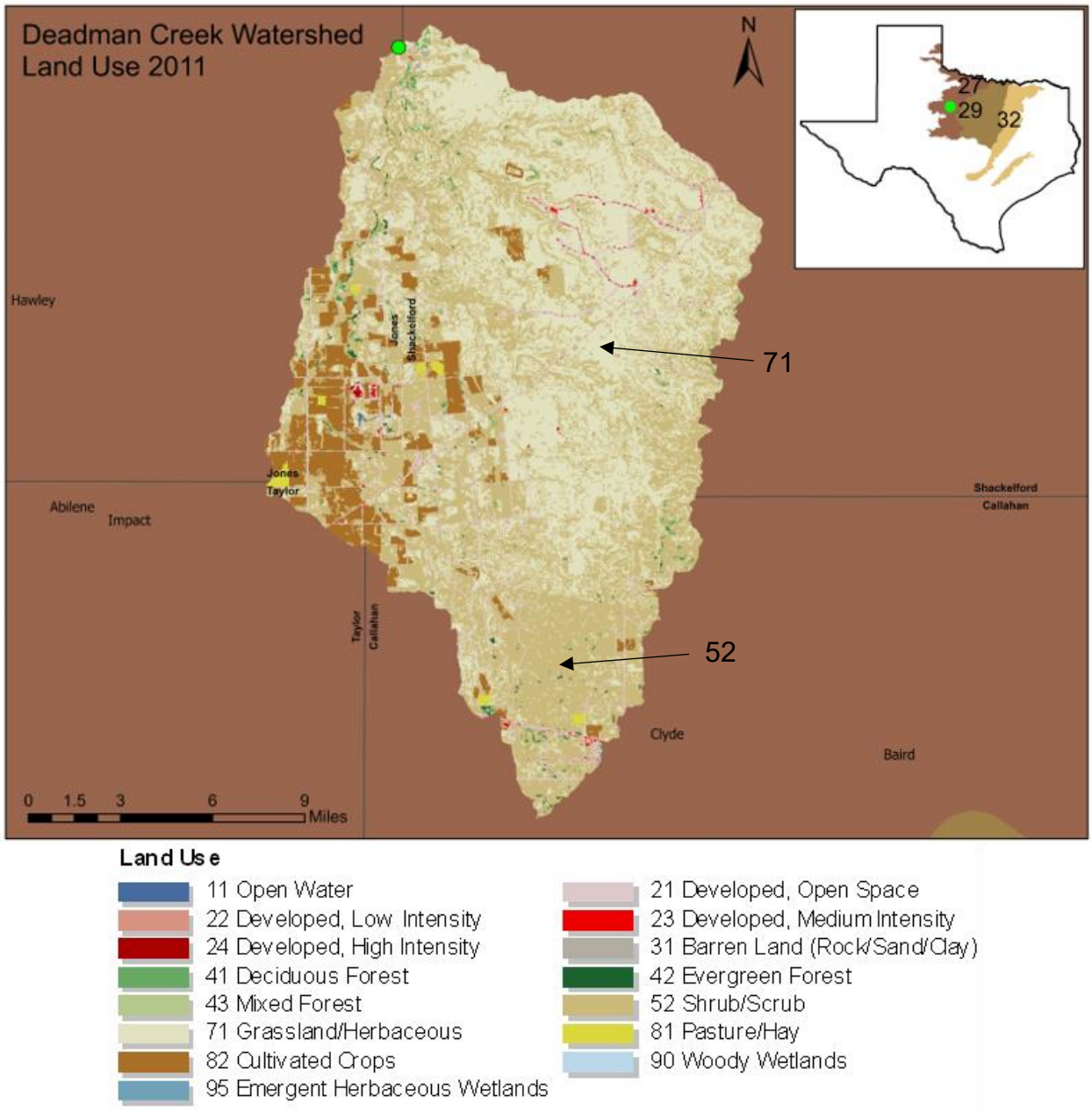

Figure 85. Map of Deadman Creek watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	August 24, 1988; June 28, 2005; August 29, 2005; July 11, 2018
Water Quality:	111 sampling events
Fish:	August 24, 1988; July 11, 2018
Benthic Invertebrates:	August 24, 1988; June 28, 2005; August 29, 2005; July 11, 2018

Physical Characterization

Watershed and Land Use

Deadman Creek lies within the Brazos River Basin. Sample site 11696 is located 87 meters upstream of CR 303, approximately 5.15 km east of Nugent in Jones County (Figure 85).

The Deadman Creek watershed at site 11696 is approximately 455.88 sq km. The station and small portion of the watershed lies in Level IV Ecoregion 27h, the Red Prairie, while the majority of the watershed lies in Level IV Ecoregion 27j, the Limestone Plains. The dominant land cover in the watershed is shrub at 45.09% and is present throughout the watershed (Homer et al. 2015; Figure 85 and Figure 86). Grassland/herbaceous is the secondary land cover encompassing 40.51%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 5.20% and total cover for cultivated crops is 7.48%.

From 1992-2011 there was a 66.62 sq km decrease in pasture/hay and a 44.87 sq km decrease in grassland. There was a 119.33 sq km increase in shrub and a 20.59 sq km increase in open space development (Figure 87).

There is one industrial wastewater outfall (discharges ≥ 1 million gallons per day) within the Deadman Creek watershed permitted to the City of Abilene. The wastewater facility does not discharge directly into Deadman Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Deadman Creek was evaluated at three sites over four sampling events from 1988 to 2018. Deadman Creek is an intermittent stream with perennial pools that drains to the Clear Fork Brazos River north of Abilene. Habitat Quality Index scores are available for three sample events and indicate an intermediate to high aquatic life use rating (18.5-22). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 18 to 20 meters wide. The riparian zone was generally dominated by grasses followed by trees then shrubs. The average percentage of tree canopy cover ranged from 37% to 56%. The dominant stream substrate was silt although gravel, cobble, and boulders were also common and the average percent of substrate gravel size or larger varied from 26% to 51%. Average percent instream cover was 14% to 67% and instream cover types include overhanging vegetation, macrophytes, cobble, gravel, boulders, and algae. Deadman Creek ranged from 0.2-0.6 meters deep on average and 10-24 meters wide. Average stream bank slope ranged from 29-76 degrees. Stream flow at the sites was measured at a minimum value of 0.1 cfs and a maximum of 13 cfs. Average stream bank erosion potential was 13%-21%. The deepest pool measured at Deadman Creek was 1.0 meters. Number of riffles observed at the sites varied from one to two, and total number of stream bends ranged from one to three.

Water Quality

Station 11697 is sampled quarterly by TCEQ. One hundred and eleven sampling events occurred between October 1981 and June 2020. Samples for this waterbody have also been collected at

station 11699 during one sampling event in August 1988. Data from station 11697 were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a. USGS gage 08084100 is located near station 11697, but no flow data was collected at this site.

Biological Characterization

Fish

Sixteen species (seven families) were collected between the two sampling events. Centrarchidae and Cyprinidae were the richest families with six and four species, respectively. Western Mosquitofish was the most abundant species in 1988 whereas Red Shiner was most abundant in 2018. The aquatic life use (based upon the fish assemblage) declined from high to intermediate between 1988 and 2018. The major reasons for the lower rating was due to a reduction in number of sunfish species, increase in percentage of omnivorous individuals, and a decrease in percentage of piscivorous individuals. Five sunfish species were collected in 1988. In 2018, only Bluegill and Longear Sunfish were found. Green Sunfish, Warmouth *Lepomis gulosus*, and White Crappie *Pomoxis annularis* were absent. Since these three species are piscivorous their absence also contributed to the decline in IBI metric score (from five to one) for percentage of piscivorous individuals. Two piscivorous species were added in 2018; however, single individuals of Flathead Catfish *Pylodictis olivaris* and Longnose Gar *Lepisosteus osseus* were insufficient to overcome the loss of the more abundant sunfish species. The slight increase in omnivores from 7% to 11% resulted in a decrease in IBI metric score from five to three.

Benthic Macroinvertebrates

Considering the Surber sample collected August 24, 1988, and the RBP samples collected in 2005 and 2018, a total of 6,357 individuals representing 79 taxa from 15 orders of macroinvertebrates were collected from Deadman Creek (Appendix E). Pelecypoda, Trichoptera, Oligochaeta, Coleoptera, Diptera, Ostracoda, and Turbellaria were the most commonly collected orders. Odonata, Gastropoda, and Amphipoda were the only additional taxa with abundance greater than one percent of the collections.

Results of the Ecoregions 27, 29, and 32 Surber BIBI fell in the intermediate aquatic life use category for the sample collected in 1988, while the results for the July 2018 regionalized RBP BIBI fell in the exceptional aquatic life use category and the June and August 2005 samples fell in the high aquatic life use category.

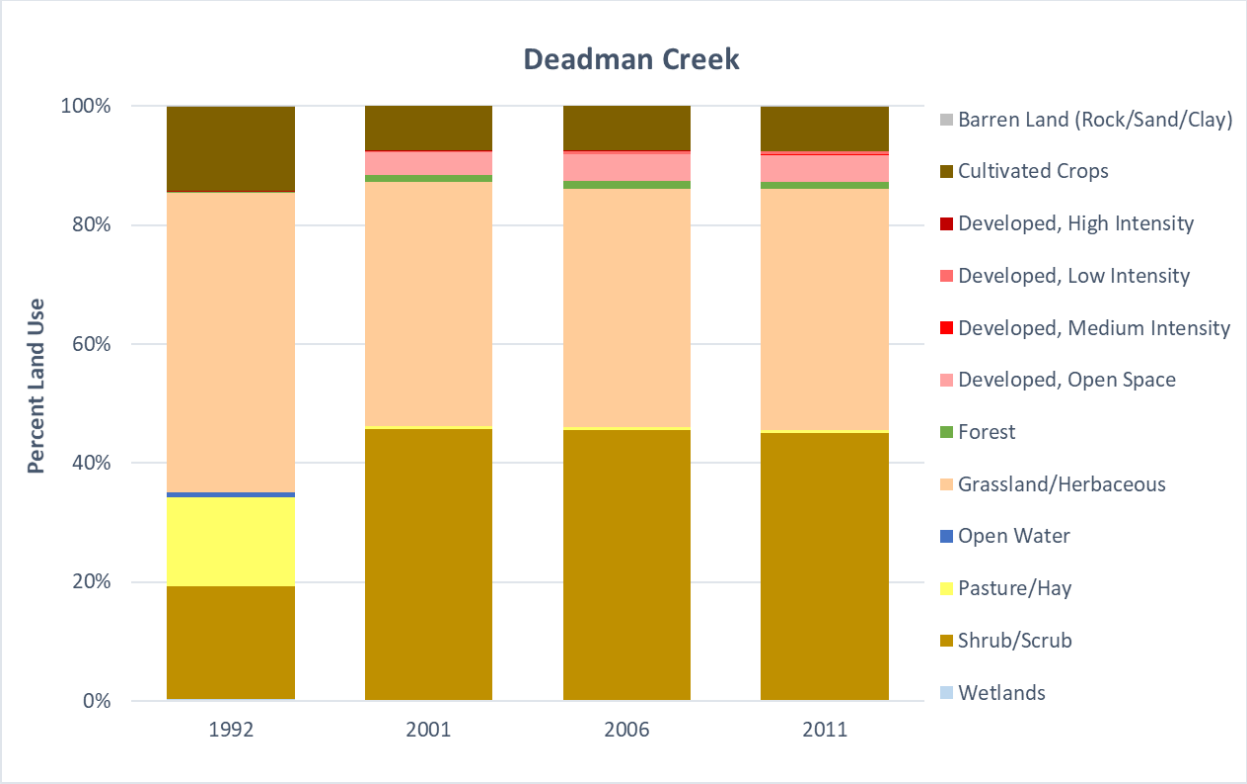

Figure 86. Percent land use in the Deadman Creek watershed from 1992-2011.

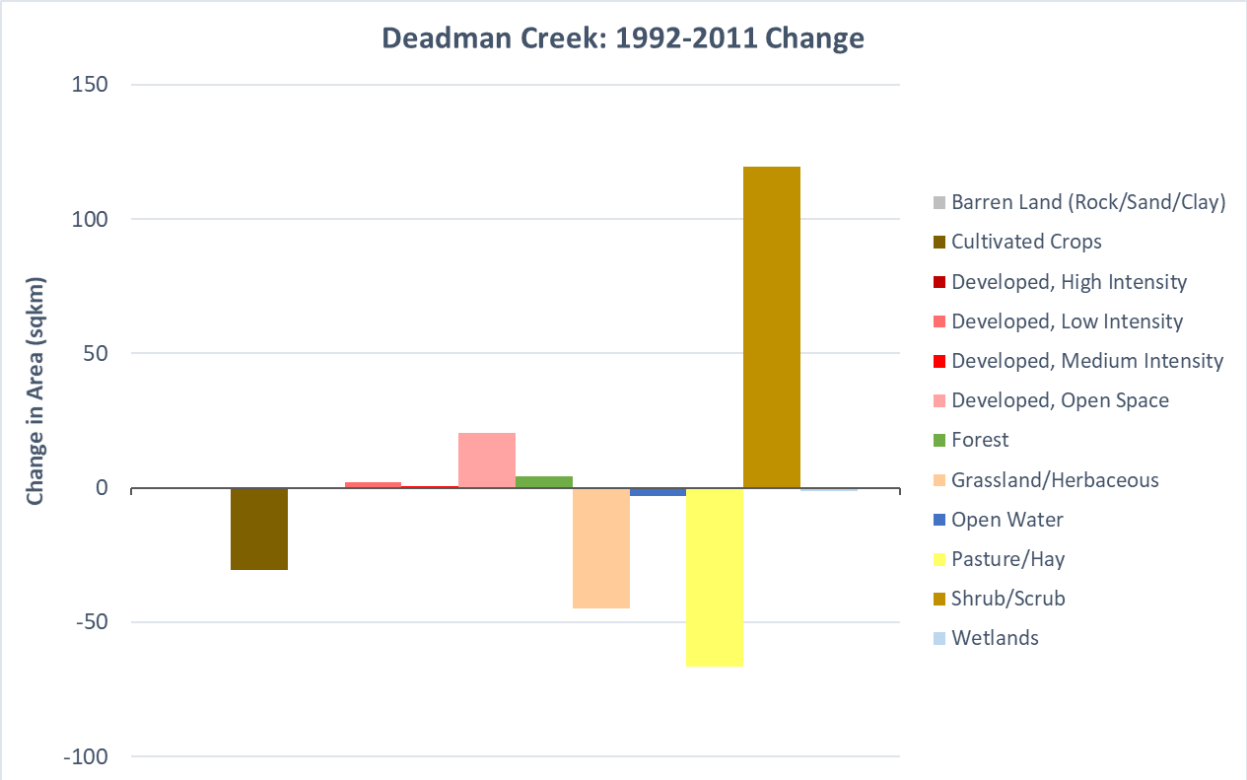

Figure 87. Land use change in area (sq km) from 1992-2011 for the Deadman Creek watershed.

ELM CREEK

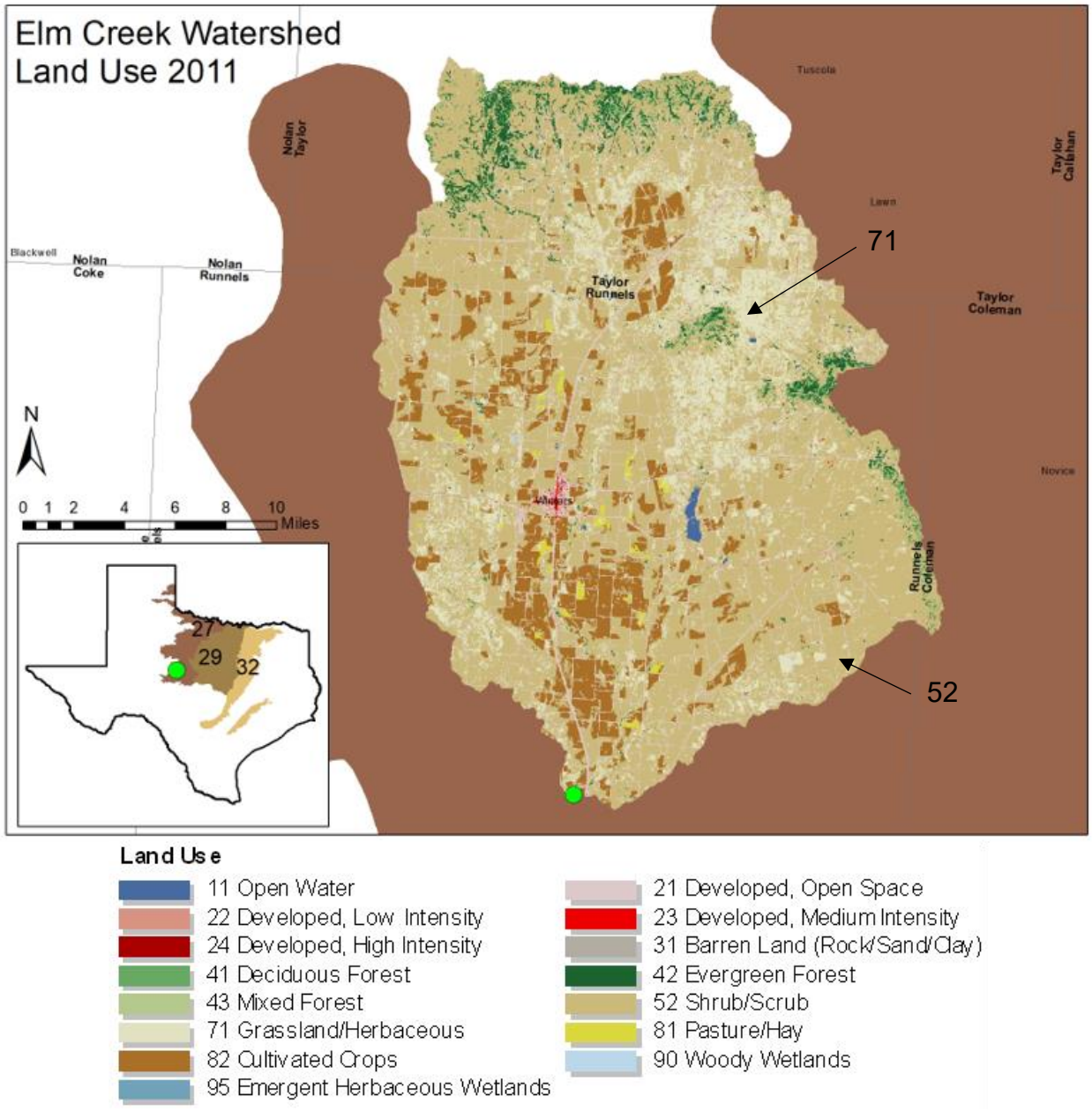

Figure 88. Map of Elm Creek watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	August 23, 1988
Water Quality:	99 sampling events
Fish:	August 23, 1988; April 4, 1989
Benthic Invertebrates:	August 23, 1988

Physical Characterization

Watershed and Land Use

Elm Creek lies within the Colorado River Basin. Sample site 12207 is located approximately 15 m downstream of CR 330 north of Ballinger in Runnels County (Figure 88).

The Elm Creek watershed at site 12207 is approximately 1145.66 sq km. The station and most of the watershed lies in Level IV Ecoregion 27h, the Red Prairie, while another large portion lies in Level IV Ecoregion 27j, the Limestone Plains. A small portion of the upper watershed lies within Ecoregion 30. The dominant land cover in the watershed is shrub at 62.55% and is present throughout the watershed (Homer et al. 2015; Figure 88 and Figure 89). Grassland/herbaceous is the secondary land cover encompassing 14.22%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 7.09% and total cover for cultivated crops is 11.12%.

From 1992-2011 there was a 382.86 sq km decrease in cultivated crops and a 109.48 sq km decrease in grassland. There was a 445.45 sq km increase in shrub and a 76.83 sq km increase in open space development (Figure 90).

There are no permitted wastewater outfalls within the Elm Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Elm Creek was evaluated on August 23, 1988. Elm Creek is an intermittent stream with perennial pools that drains to the Colorado River below E. V. Spence Reservoir. It is impounded upstream of the sampling site to form Lake Winters. The riparian width was 23 meters. The riparian zone was dominated by trees, which made up an average of 80% of the total riparian species, followed by grasses (15%) then shrubs (5%). The average percentage of tree canopy cover was 14%. The dominant substrate was silt and silt covered bedrock, but gravel was common in riffles and the average percent of substrate that was gravel size or larger was 25%. Average percent instream cover was 25%. Elm Creek had an average depth of 0.6 meters and a maximum depth of 1.8 meters. The average width was 14 meters and average stream bank slope was 53 degrees. Stream flow at the site was 0.1 cfs. Average stream bank erosion potential was 54%. Three riffles were observed at the site and there were two total stream bends.

Water Quality

Water samples were collected at station 12207 over 99 sampling events from August 1988 through August 2011. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Sixteen species (nine families) were collected between the two sampling events. Centrarchidae yielded the most species with five. Red Shiner was the most abundant species. The aquatic life use rating for both fish collections was only intermediate. The assemblage was dominated by tolerant species (54 to 85% of the individuals) and had very low numbers of piscivores.

Benthic Macroinvertebrates

A total of 4,380 individuals representing 48 taxa from 14 orders of macroinvertebrates were collected in the Surber sample from Elm Creek (Appendix E). Trichoptera, Coleoptera, Ephemeroptera, and Diptera were the most commonly collected orders.

Results of the Ecoregions 27, 29, and 32 Surber BIBI fell in the exceptional aquatic life use category.

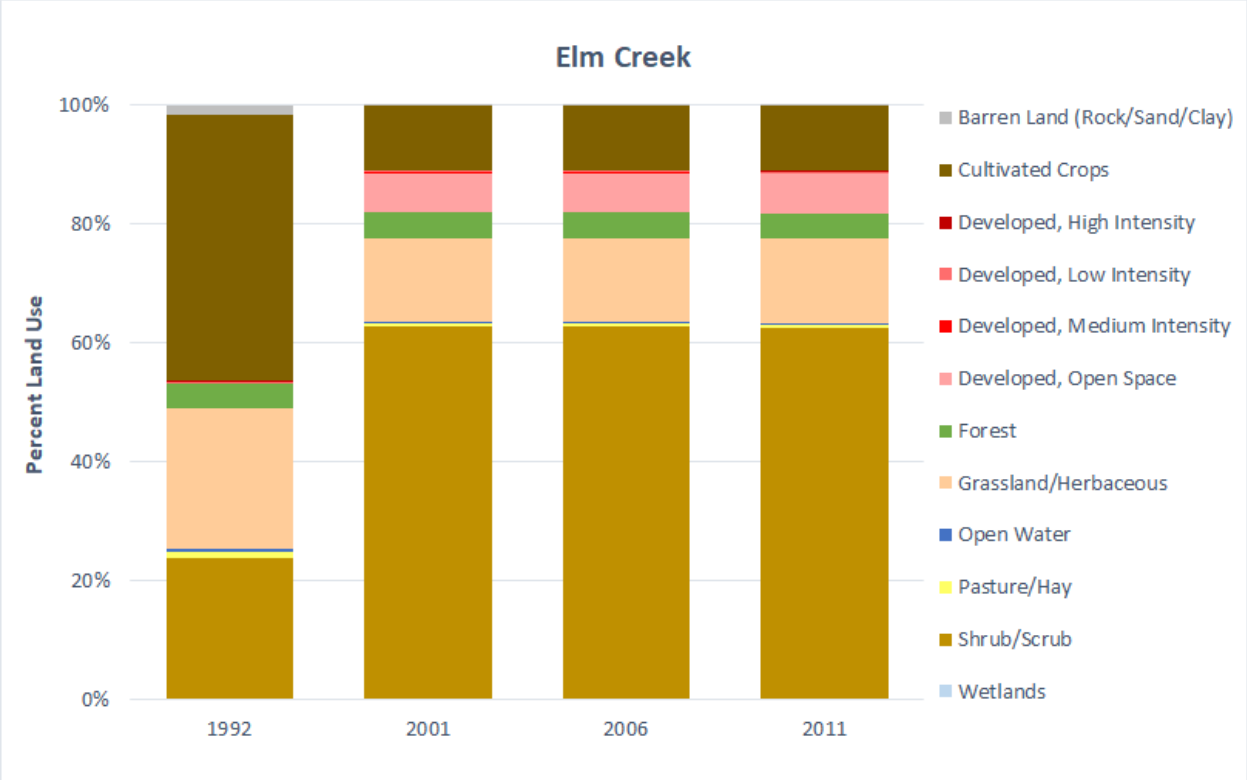

Figure 89. Percent land use in the Elm Creek watershed from 1992-2011.

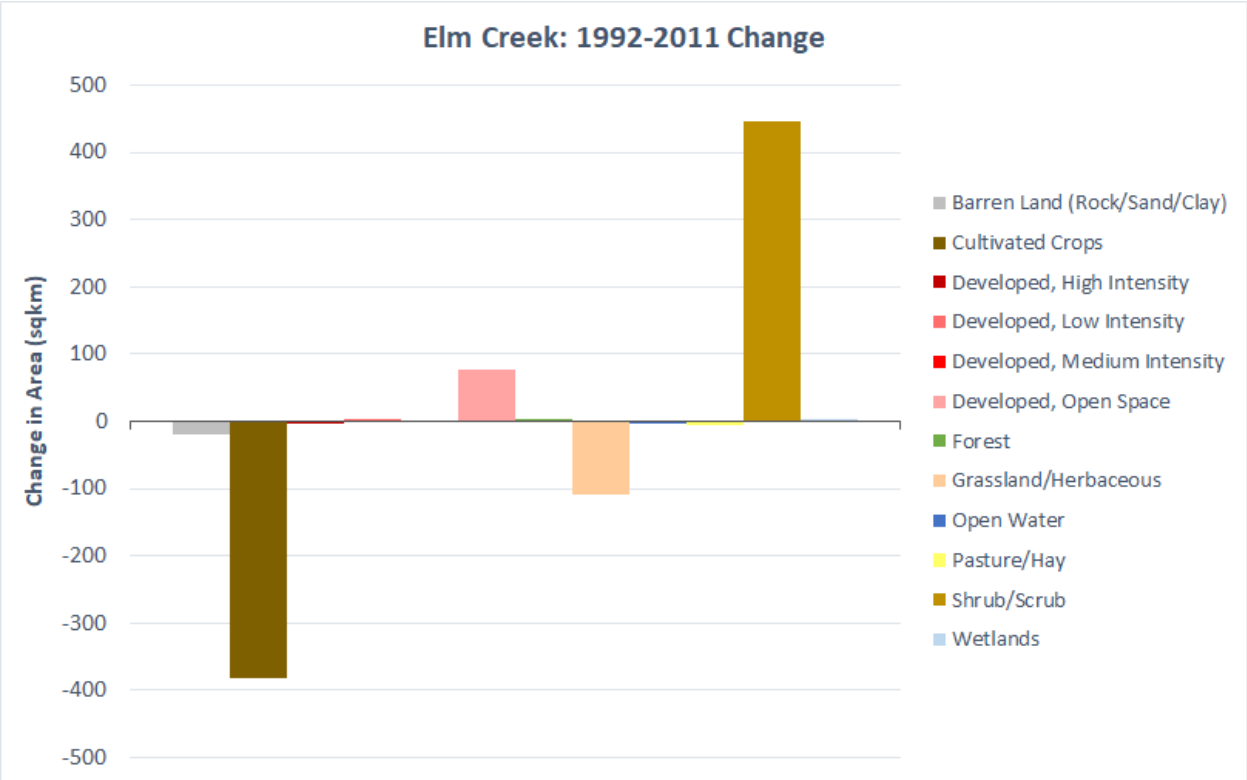

Figure 90. Land use change in area (sq km) from 1992-2011 for the Elm Creek watershed.

LELIA LAKE CREEK

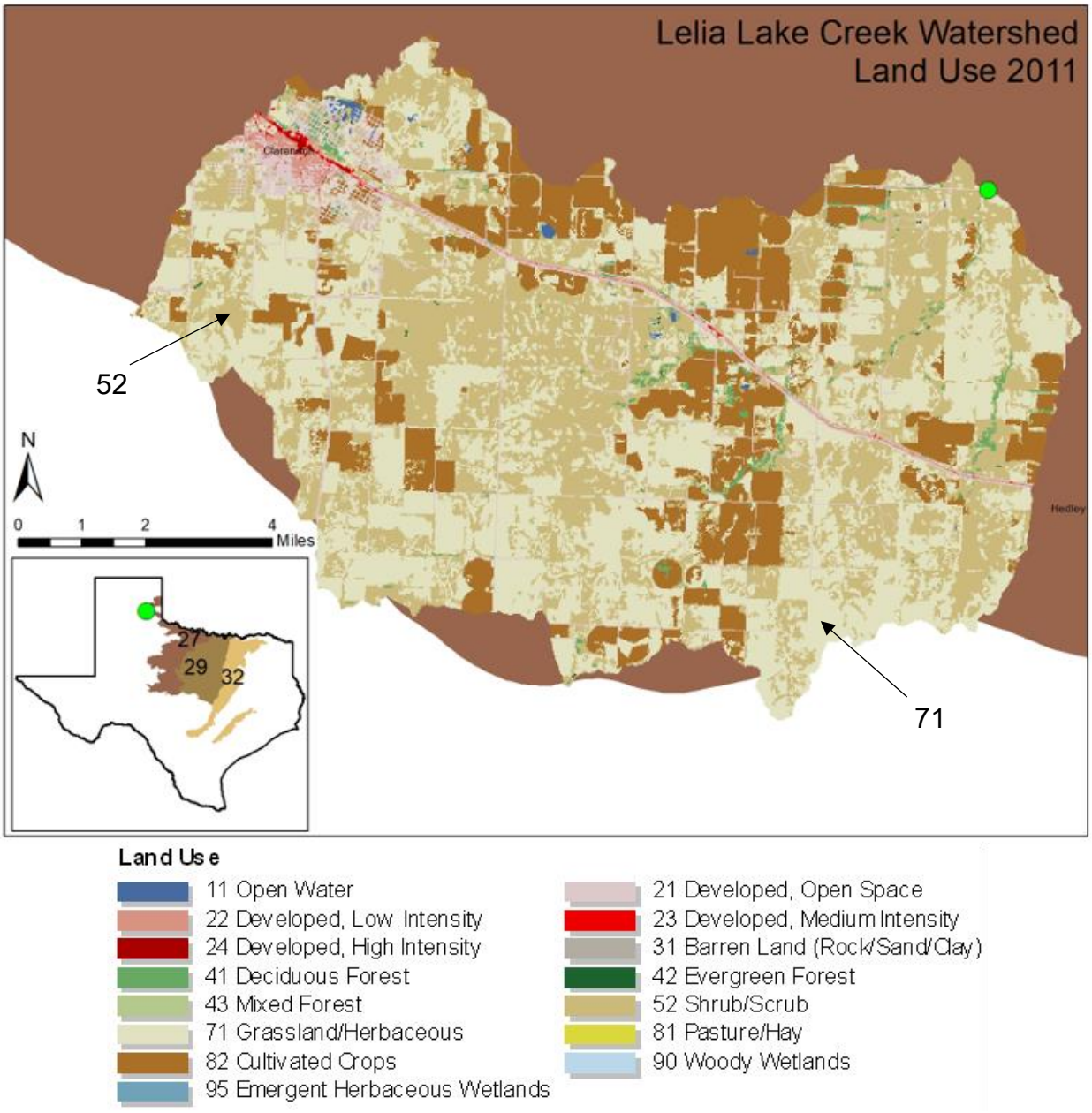

Figure 91. Map of Lelia Lake Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	August 16, 1989
Water Quality:	96 sampling events
Fish:	August 16, 1989
Benthic Invertebrates:	August 17, 1989

Physical Characterization

Watershed and Land Use

Lelia Lake Creek lies within the Red River Basin. Sample site 10076 is located at FM 2471, approximately 8 km north-northwest of Hedley in Donley County (Figure 91).

The Lelia Lake Creek watershed at site 10076 is approximately 249.36 sq km. The entire watershed lies within Level IV Ecoregion 27h, the Red Prairie. The dominant land cover in the watershed is grassland/herbaceous at 40.91% and is present throughout the watershed (Homer et al. 2015; Figure 91 and Figure 92). Shrub is the secondary land cover encompassing 34.30%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 5.65% and total cover for cultivated crops is 17.59%.

From 1992-2011 there was a 104.30 sq km decrease in cultivated crops and a 2.98 sq km decrease in pasture/hay. There was a 73.09 sq km increase in shrub and a 21.22 sq km increase in grassland (Figure 93).

There are no permitted wastewater outfalls within the Lelia Lake Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Lelia Lake Creek was evaluated on August 16, 1989. Lelia Lake Creek is a perennial stream that drains to the Salt Fork Red River. The riparian width was 16 meters. The riparian zone was dominated by grasses which made up an average of 60% of the total riparian species, followed by trees and shrubs (20% each). The average percentage of tree canopy cover was 0%. The dominant substrate was sand and gravel, and the average percent of substrate that was gravel size or larger was 27%. Average percent instream cover was 2%. Lelia Lake Creek had an average depth of 0.06 meters and a maximum depth of 0.12 meters. The average width was 7.4 meters and average stream bank slope was 25 degrees. Stream flow at the site was 4.5 cfs. Average stream bank erosion potential was 75%. Four riffles were observed at the site and there was one stream bend.

Water Quality

Water samples were collected at station 10076 over 96 sampling events from August 1988 through December 2019. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a. No 24-hour data have been collected at this site.

Continuous flow data is available from USGS gage 07299890 (Figure 94). Between July 1997 through December 2019, the median flow was 1.2 cfs. Daily average flows ranged from 0 cfs to 318 cfs, though flows were greater than 100 cfs only 0.18 percent of the time in this period. Data have been log transformed to better visualize flow patterns.

Biological Characterization

Fish

The aquatic life use (based upon the fish assemblage) rated as limited; however, when the coefficient of variability is applied it rises to intermediate. Species richness was very low (only six species and four families), no benthic invertivores were collected, only one sunfish species (Green Sunfish, a tolerant species) was present, the assemblage was dominated by tolerant species (99% of the individuals), and the percentage of piscivorous individuals was low. The two most abundant species were Plains Killifish and Red Shiner.

Benthic Macroinvertebrates

A total of 120 individuals representing 20 taxa from seven orders of macroinvertebrates were collected in the Surber sample from Lelia Lake Creek (Appendix E). Ephemeroptera, Diptera and Trichoptera were the most commonly collected orders, collectively accounting for 88 percent of the total number of individuals collected. Gastropoda, Odonata, Coleoptera, and Pelecypoda comprised the remaining orders collected.

The Ecoregions 27, 29, and 32 Surber BIBI fell in the high aquatic life use category for the sample.

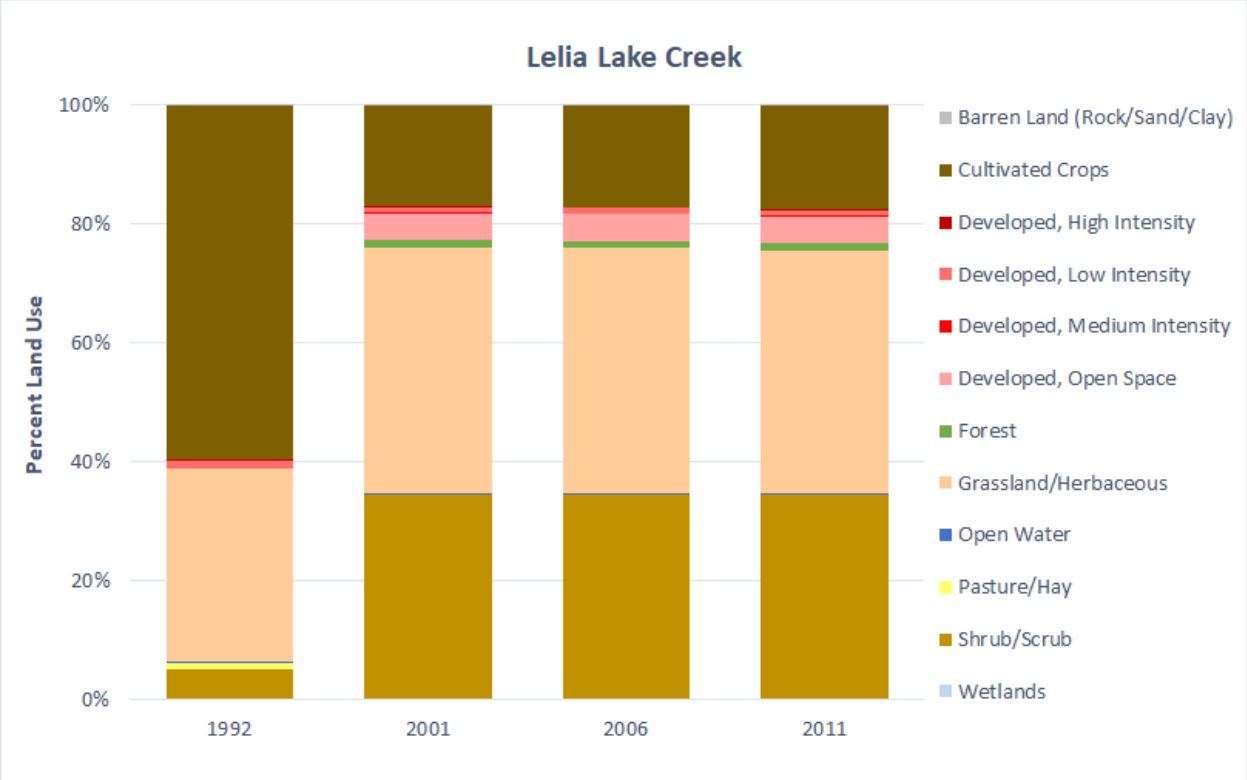

Figure 92. Percent land use in the Lelia Lake Creek watershed from 1992-2011.

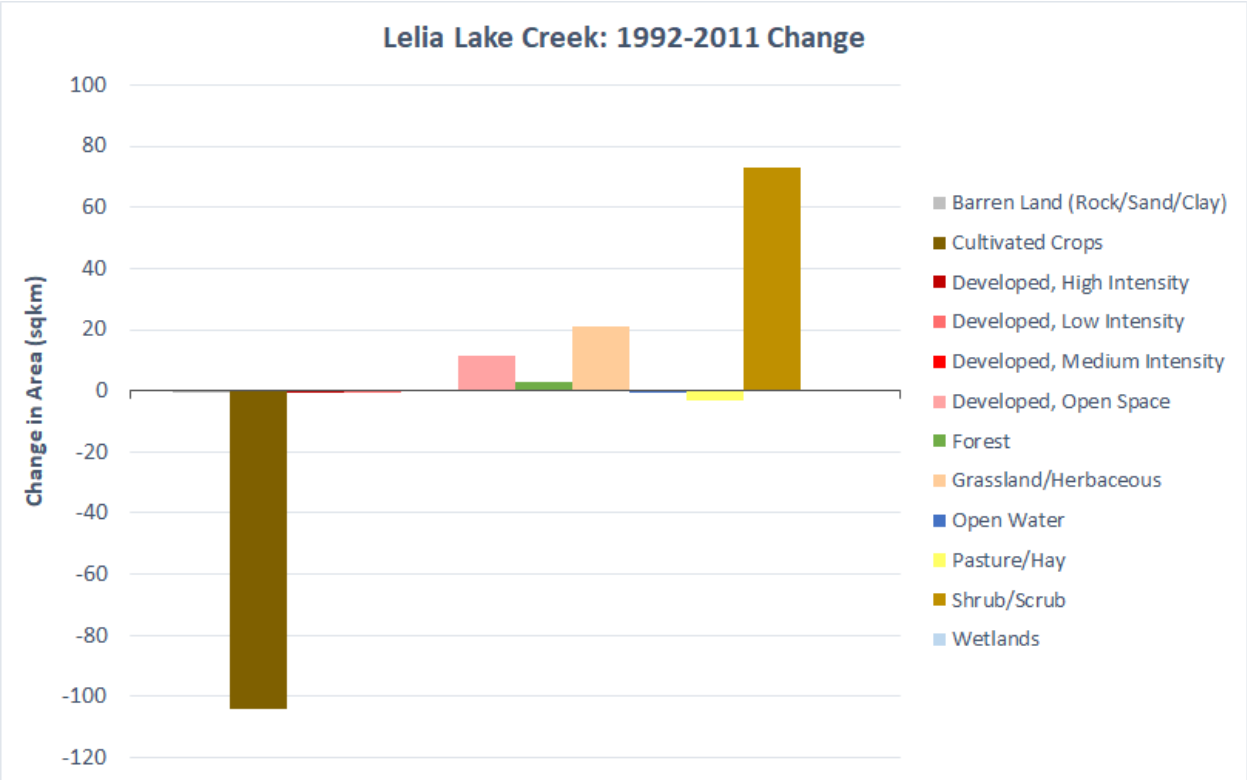

Figure 93. Land use change in area (sq km) from 1992-2011 for the Lelia Lake Creek watershed.

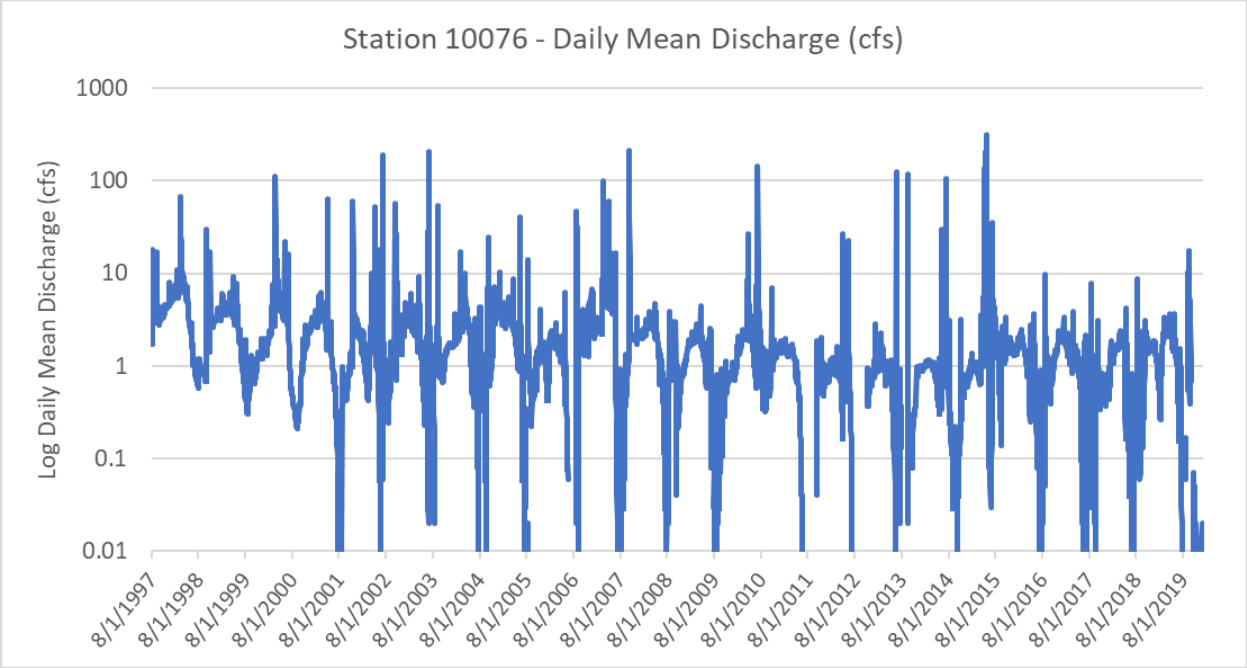

Figure 94. Log transformed daily mean discharge for Lelia Lake Creek at station 10076.

SWEETWATER CREEK

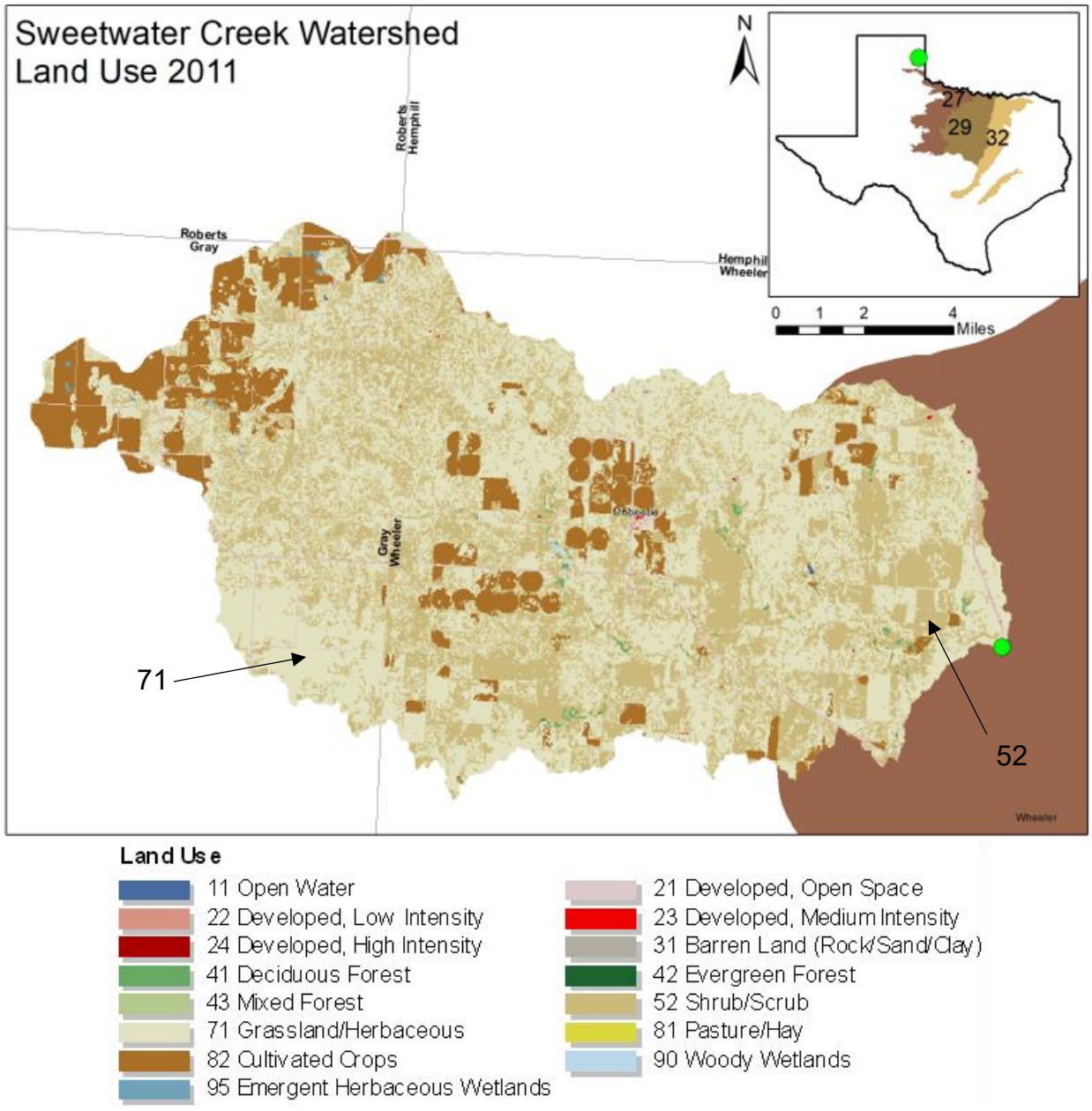

Figure 95. Map of Sweetwater Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	September 8, 1987; May 8, 2018
Water Quality:	71 sampling events
Fish:	September 8, 1987; May 8, 2018
Benthic Invertebrates:	September 9, 1987 (x2); May 8, 2018

Physical Characterization

Watershed and Land Use

Sweetwater Creek lies within the Red River Basin. Sample site 10072 is located at US 83, approximately 6.25 km north-northwest of Wheeler in Wheeler County (Figure 95).

The Sweetwater Creek watershed at site 10072 is approximately 433.19 sq km. The station and lower watershed are located in Level IV Ecoregion 27h, the Red Prairie, a large portion of the middle watershed lies in Level IV Ecoregion 26a, the Canadian/Cimarron Breaks, and the most upper portion of the watershed lies in Level IV Ecoregion 25i, the Llano Estacado. The dominant land cover in the watershed is grassland/herbaceous at 49.78% and is present throughout the watershed (Homer et al. 2015; Figure 95 and Figure 96). Shrub is the secondary land cover encompassing 35.36%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 2.12% and total cover for cultivated crops is 12.21%.

From 1992-2011 there was a 70.0 sq km decrease in cultivated crops and a 45.09 sq km decrease in grassland. There was a 114.63 sq km increase in shrub and an 8.46 sq km increase in open space development (Figure 97).

There are no permitted wastewater outfalls within the Sweetwater Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Sweetwater Creek was evaluated on September 8, 1987 and again on May 8, 2018. Sweetwater Creek is a perennial stream that drains to the North Fork Red River in Oklahoma. The following summary information is based on data collected during the most recent sampling event in 2018. The Habitat Quality Index score of 21 indicates a high aquatic life use rating. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters, although evidence of cattle grazing was present throughout the reach. The riparian zone was dominated by grasses, which make up an average of 60% of the total riparian species, followed by trees (25%) then shrubs (15%). The average percentage of tree canopy cover was 37%. The dominant substrate was sand, and the average percent of substrate that was gravel size or larger was 0%. Average percent instream cover was 88% and instream cover types include woody debris, algae, and abundant macrophytes (primarily Typha sp.). Sweetwater Creek was 0.24 meters deep on average and 5.5 meters wide. Average stream bank slope was 19 degrees and average stream bank erosion potential was 40.5%. The deepest pool measured at Sweetwater Creek was 0.6 meters. Stream flow at the site was measured at a minimum value of 1.2 cfs in 2018 and a maximum of 5.1 cfs in 1987. No riffles were observed at the site in 2018 and there were six total stream bends.

Water Quality

Water samples were collected at station 10072 over 71 sampling events from September 1987 through October 2011. Data were collected for temperature, flow, transparency, specific

conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Fourteen species (four families) were collected between the two sampling events. All but two species were in the Cyprinidae or Centrarchidae families. The fish assemblage significantly shifted between the 1987 and 2018 collections from a more lotic based assemblage to one more lentic in nature. Of the fourteen species collected only four were present in both collections. These were Common Carp, Western Mosquitofish, Longear Sunfish, and Largemouth Bass *Micropterus salmoides*. Five native minnow species were collected in 1987 - Red Shiner, Blacktail Shiner *Cyprinella venusta*, Golden Shiner *Notemigonus crysoleucas*, Red River Shiner *Notropis bairdi*, and Bullhead Minnow. None were collected in 2018. Sunfish species increased from two to four, with the addition of Green Sunfish, Warmouth, and Bluegill (and the loss of Orangespotted Sunfish *Lepomis humilis*). The percentage of individuals as non-native species increased from 0.9% (metric score of 5) to 6.5% (metric score of 1). The most abundant species in 1987 was Western Mosquitofish. Longear Sunfish was the most abundant species in 2018. Based on the fish assemblage, the creek rated as having an intermediate aquatic life use; however, when the coefficient of variability was applied the rating for the 1987 sample increased to high.

Benthic Macroinvertebrates

Considering the two September 9, 1987 Surber samples, and the May 8, 2018 RBP sample collectively, a total of 784 individuals representing 73 taxa from 13 orders of macroinvertebrates were collected from Sweetwater Creek (Appendix E). Diptera, Ephemeroptera, Odonata, and Coleoptera were the most commonly collected orders, collectively accounting for 87.6 percent of the total number of individuals collected. Trichoptera, Gastropoda, and Amphipoda were the only other orders which represented greater than one percent of the total collection.

The Ecoregions 27, 29, and 32 BIBI for the Surber samples collected September 9, 1987 both fell in the high aquatic life use category, while the regionalized BIBI for the RBP sample collected May 8, 2018 fell in the intermediate aquatic life use category.

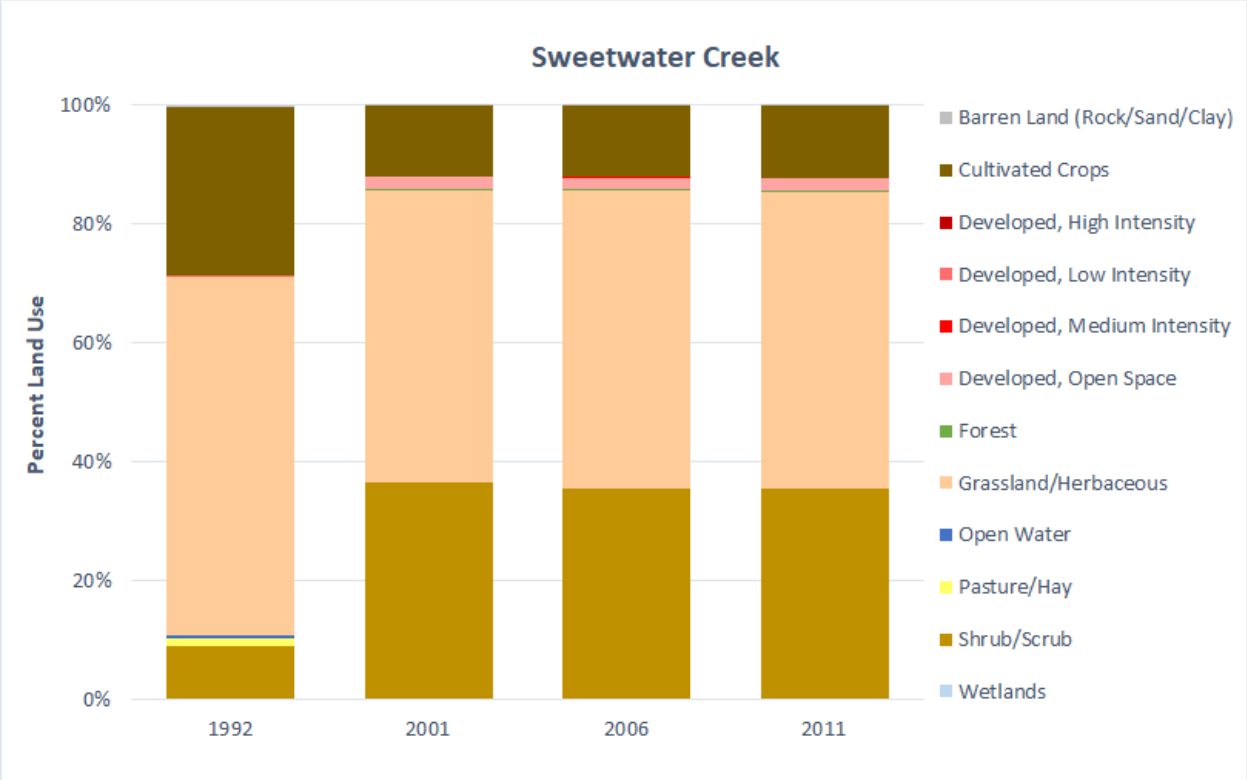

Figure 96. Percent land use in the Sweetwater Creek watershed from 1992-2011.

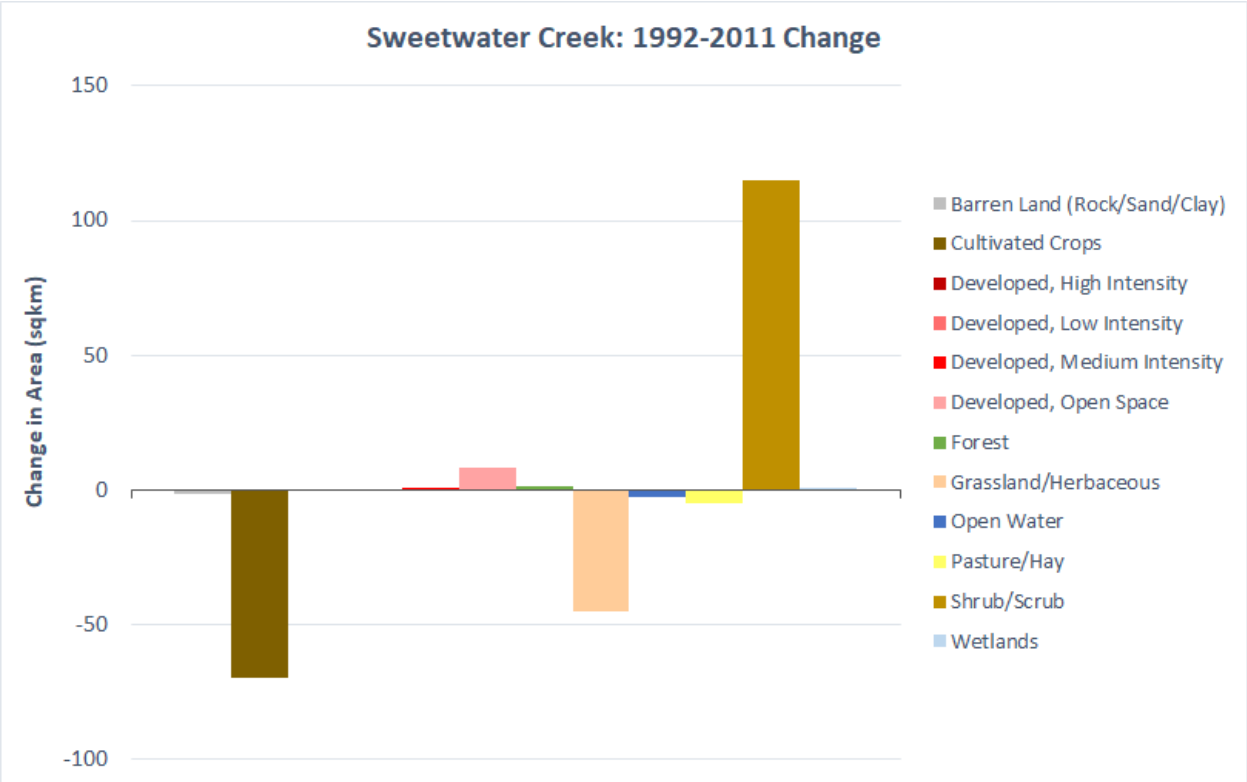

Figure 97. Land use change in area (sq km) from 1992-2011 for the Sweetwater Creek watershed.

Ecoregion 29 Characterization

In Texas, the Cross Timbers ecoregion covers approximately 51,921sq km and encompasses all or part of 35 counties in the north central portion of the state (Figure 80). The ecoregion is bordered on the west by the Central Great Plains (Ecoregion 27), on the east by the Texas Blackland Prairies (Ecoregion 29), by the Edwards Plateau (Ecoregion 30) to the south, and to the north in Texas, by the Red River. Portions of the Red, Brazos, Trinity, and Colorado River Basins are included in the ecoregion. Beyond Texas, the ecoregion extends into southeastern Oklahoma.

The ecoregion is characterized by a mix of forest, woodland, savannah, and prairie and is used primarily as rangeland and pastureland (Griffith et al. 2007). Griffith et al. (2007) also note the region forms a transition from the once prairie, now winter wheat growing area to the west, to the forested low mountains or hills of eastern Oklahoma and Texas. Annual average precipitation in the ecoregion generally decreases from 84-94 cm in the eastern portions to 69-89 cm in the western portions. Riparian vegetation along streams in the ecoregion often includes pecan, black willow *Salix nigra,* cottonwood, sycamore *Platanus occidentalis*, boxelder *Acer negundo,* hackberry, and post oak *Quercus stellata.*

Table 7. Streams sampled in Ecoregion 29.

Bluff Creek	Ioni Creek	South Fork Rocky Creek
Clear Creek	Neils Creek	Steele Creek
Colony Creek	Reese Creek	
Cowhouse Creek	Rocky Creek	

BLUFF CREEK

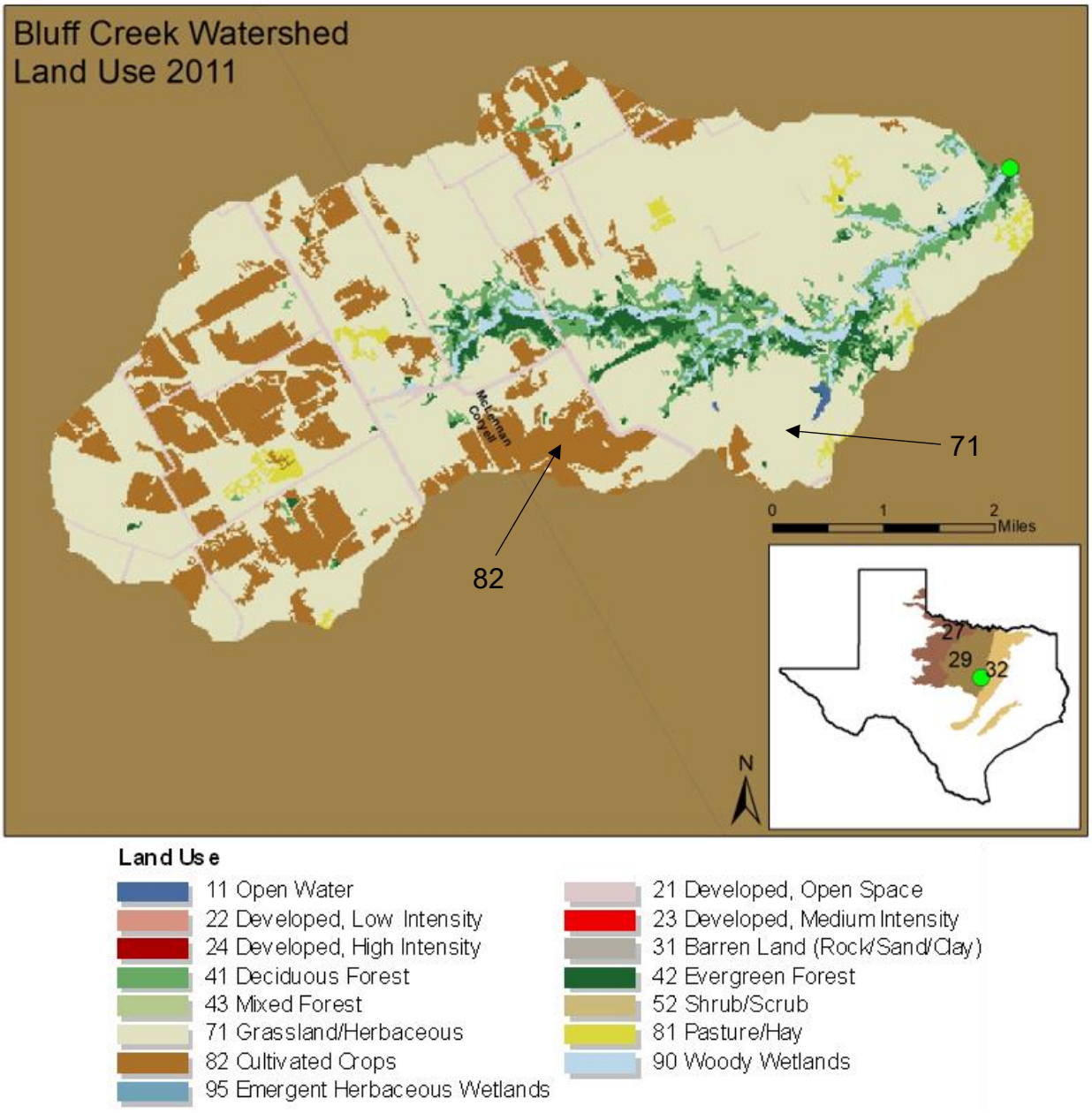

Figure 98. Map of Bluff Creek watershed location and 2011 land use; grassland/herbaceous and cultivated crops were the most common land uses.

Sampling Dates

Physical Habitat:	July 12, 1988
Water Quality:	3 sampling events
Fish:	July 12, 1988; April 18, 1989
Benthic Invertebrates:	July 12, 1988

Physical Characterization

Watershed and Land Use

Bluff Creek lies within the Brazos River Basin. Sample site 11832 is located upstream of Prairie Chapel Road, approximately 4.5 km northwest of Crawford in McLennan County (Figure 98).

The Bluff Creek watershed at site 11832 is approximately 67.19 sq km. The entire watershed lies within Level IV Ecoregion 29e, the Limestone Cut Plain. The dominant land cover in the watershed is grassland/herbaceous at 65.88% and is present throughout the watershed (Homer et al. 2015; Figure 98 and Figure 99). Cultivated crops is the secondary land cover encompassing 18.39%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.37%.

From 1992-2011 there was a 14.02 sq km decrease in pasture/hay and an 8.77 sq km decrease in shrub. There was a 17.83 sq km increase in grassland and a 3.33 sq km increase in cultivated crops (Figure 100).

There are no permitted wastewater outfalls within the Bluff Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Bluff Creek was evaluated on July 12, 1988. Bluff Creek is a tributary to the Middle Bosque River. The riparian width was 76 meters. The riparian zone was dominated by trees, which made up an average of 60% of the total riparian species, followed by shrubs (30%) then grasses (10%). The average percentage of tree canopy cover was 43%. The dominant substrate was gravel, and the average percent of substrate that was gravel size or larger was 50%. Average percent instream cover was 42%. Bluff Creek had an average depth of 0.2 meters and a maximum depth of 0.5 meters. The average width was 5.7 meters and average stream bank slope was 36 degrees. Stream flow at the site was 0.04 cfs. Average stream bank erosion potential was 22%. Six riffles were observed at the site and there were four total stream bends.

Water Quality

Water samples were collected at station 11832 over three sampling events from July 1988 through July 1999. Data were collected for temperature, flow, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Only eight species (five families) were collected between the two sampling events. One-half of the species were within the family Centrarchidae. Western Mosquitofish was the most abundant species in the 1988 sample whereas Central Stoneroller *Campostoma anomalum* was the most abundant one in 1989. The aquatic life use ratings for the fish collections were only intermediate and limited for the 1988 and 1989 collections, respectively. When the coefficient of variability is

applied the aquatic life uses rise one category to high and intermediate. The lower ratings were mostly due to limited species richness, only one native cyprinid species being collected (Central Stoneroller) and catch per unit of effort being very low.

Benthic Macroinvertebrates

A total of 790 individuals representing 54 taxa from 12 orders of macroinvertebrates were collected in the Surber sample from Bluff Creek (Appendix E) on July 12, 1988. Diptera, Coleoptera, Trichoptera, Oligochaeta, and Ephemeroptera were the most commonly collected orders, collectively accounting for 94 percent of the total number of individuals collected. Plecoptera and Gastropoda were the only other orders which comprised at least one percent of the collection.

The Ecoregions 27, 29, and 32 Surber BIBI fell in the high aquatic life use category for the sample.

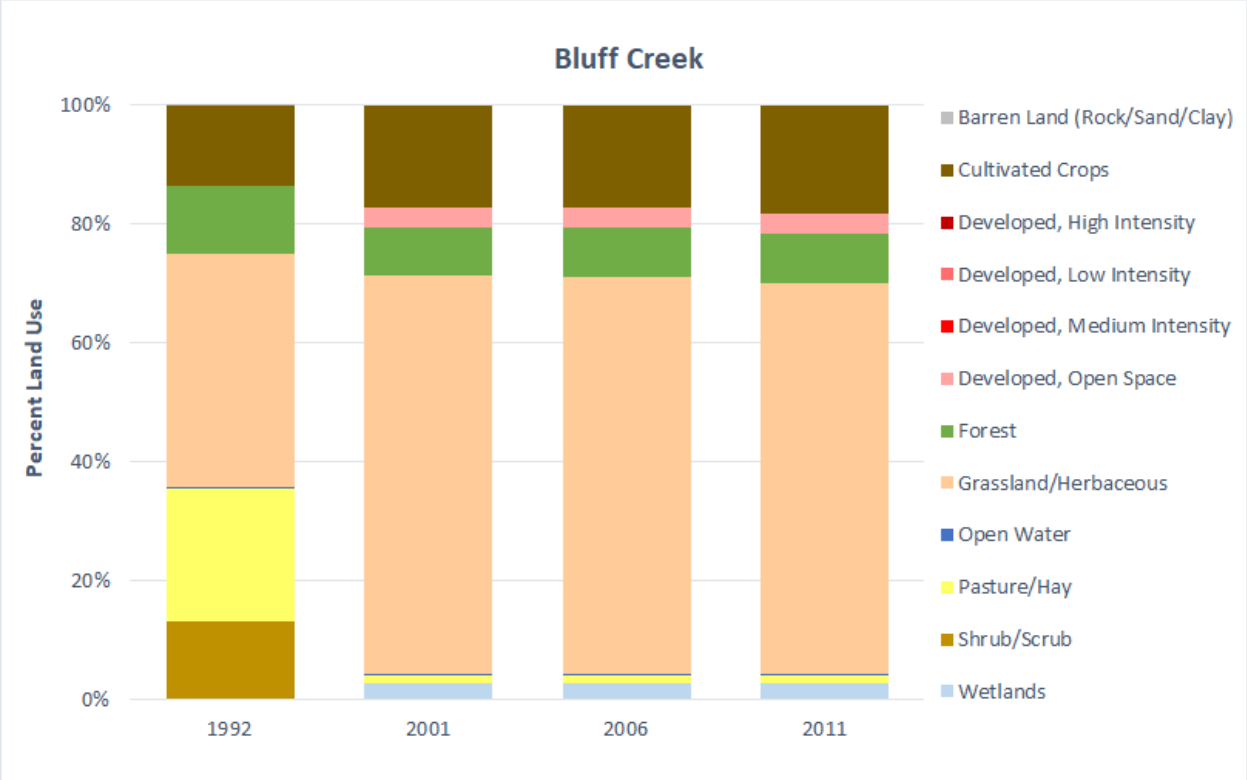

Figure 99. Percent land use in the Bluff Creek watershed from 1992-2011.

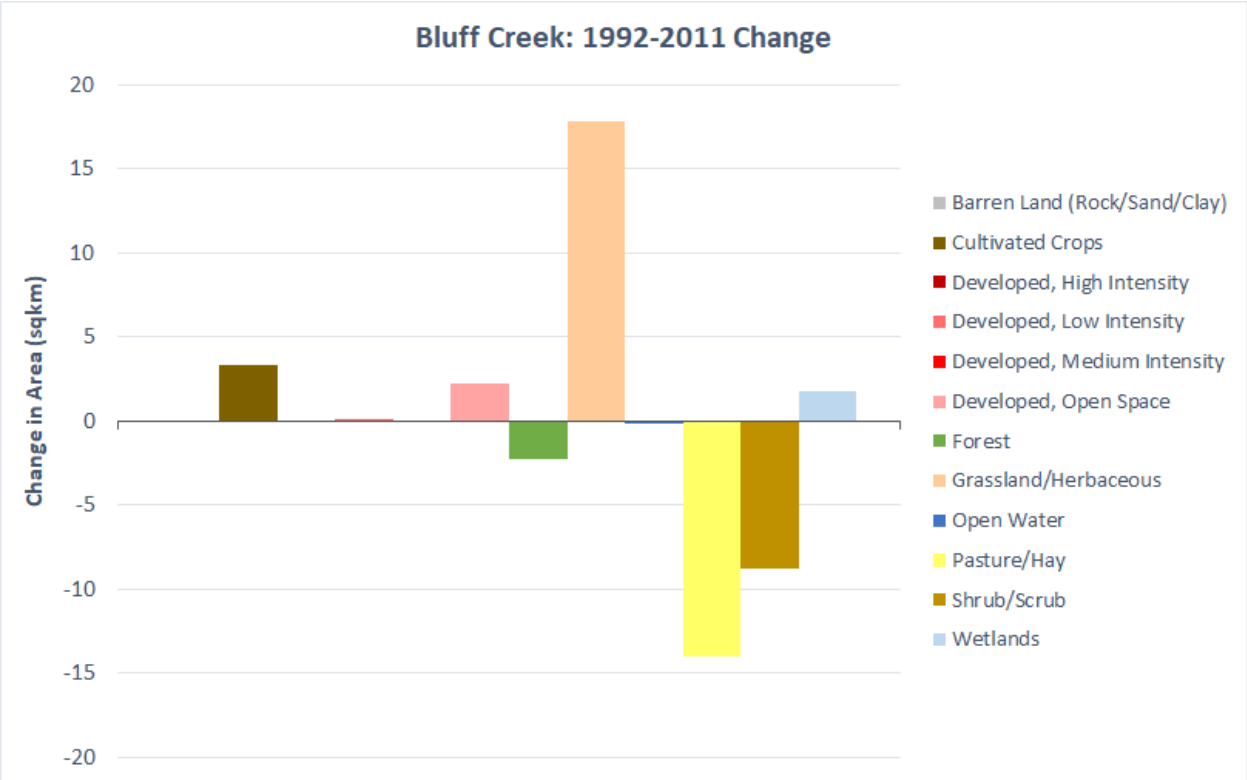

Figure 100. Land use change in area (sq km) from 1992-2011 for the Bluff Creek watershed.

CLEAR CREEK

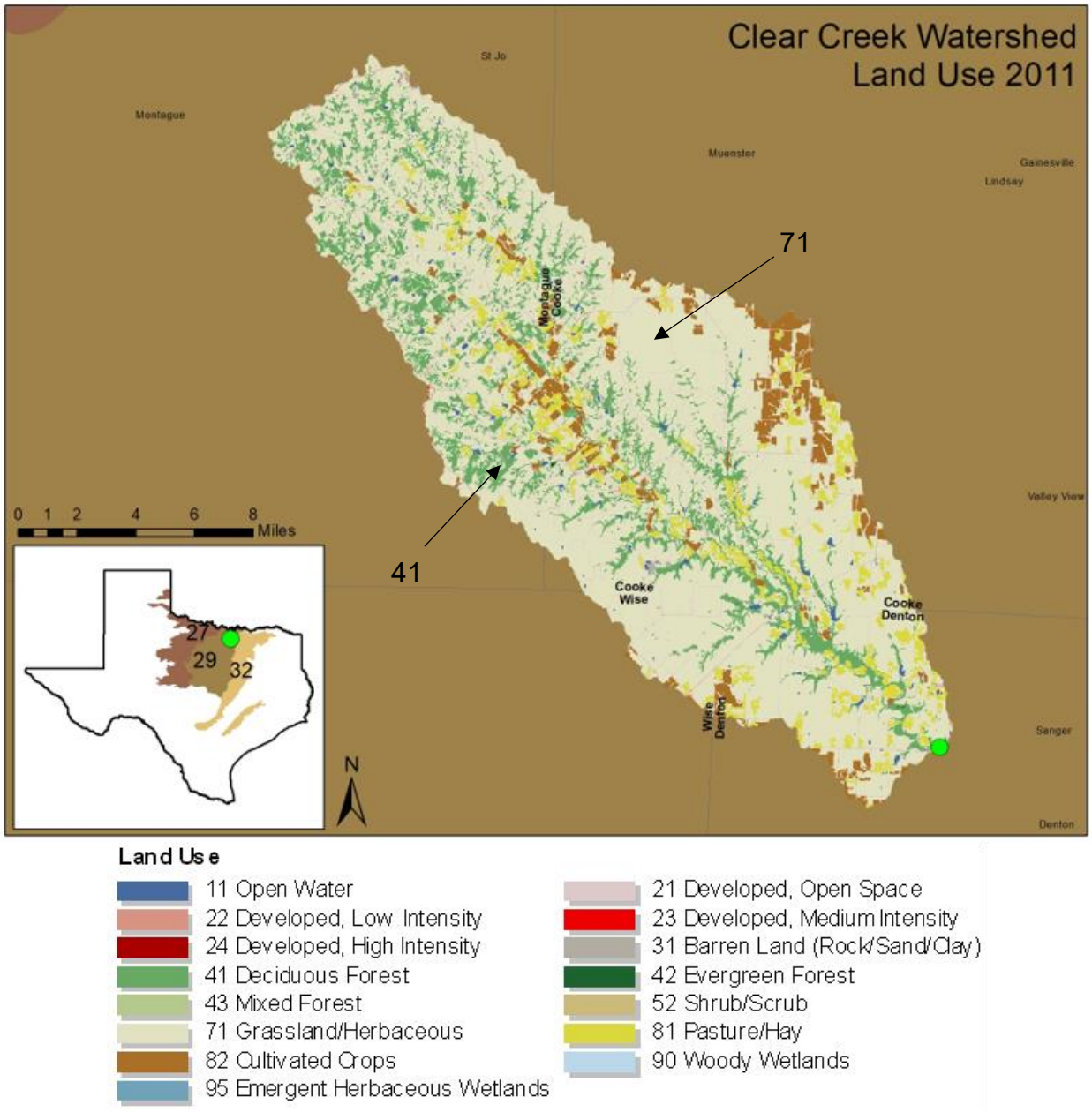

Figure 101. Map of Clear Creek watershed location and 2011 land use; grassland/herbaceous and forest were the most common land uses.

Sampling Dates

Physical Habitat:	August 2, 1989
Water Quality:	98 sampling events
Fish:	August 2, 1989; May 30, 2012
Benthic Invertebrates:	August 2, 1989 (5/30/2012 benthic sample not located)

Physical Characterization

Watershed and Land Use

Clear Creek lies within the Trinity River Basin. Sample site 10859 is located upstream of FM 455 west of Sanger in Denton County (Figure 101).

The Clear Creek watershed at site 10859 is approximately 634.50 sq km. The station and most of the lower watershed lies within Level IV Ecoregion 29d, the Grand Prairie, while the remaining watershed lies within Level IV Ecoregion 29c, Western Cross Timbers. The dominant land cover in the watershed is grassland/herbaceous at 66.74% and is present throughout the watershed (Homer et al. 2015; Figure 101 and Figure 102). Forest is the secondary land cover encompassing 14.93%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 4.23% and total cover for cultivated crops is 5.92%.

From 1992-2011 there was a 93.12 sq km decrease in pasture/hay and a 40.57 sq km decrease in shrub. There was a 131.88 sq km increase in grassland and a 24.72 sq km increase in open space development (Figure 103).

There are no permitted wastewater outfalls within the Clear Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Clear Creek was evaluated on August 2, 1989. Clear Creek is a perennial stream that drains to the Elm Fork Trinity River above Lake Lewisville. The riparian width was 5 meters. The riparian zone was dominated by trees, which made up an average of 50% of the total riparian species, followed by shrubs (30%) then grasses (20%). The average percentage of tree canopy cover was 25%. The dominant substrate was sand in pools and gravel in riffles, and the average percent of substrate that was gravel size or larger was 36%. Average percent instream cover was 21%. Clear Creek had an average depth of 0.6 meters and a maximum depth of 2.1 meters. The average width was 11.8 meters and average stream bank slope was 41 degrees. Stream flow at the site was 22.7 cfs. Average stream bank erosion potential was 61%. Five riffles were observed at the site and there were three total stream bends.

Water Quality

Water samples were collected at station 10859 over 98 sampling events from August 1989 through September 2020. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Nineteen species (nine families) were collected between the two sampling events. Centrarchidae and Ictaluridae were the two most species rich families with five and four, respectively. Red Shiner was the most abundant species in the 1989 collection, whereas Orangethroat Darter

Etheostoma spectabile was the most abundant one in 2012. Central Stoneroller, River Carpsucker *Carpiodes carpio*, Bigscale Logperch *Percina macrolepida*, and Flathead Catfish were unique to the 1989 collection. Gizzard Shad *Dorosoma cepedianum*, Longnose Gar, and White Crappie were only collected in 2012. The aquatic life use (based upon the fish assemblage) rated as high for both collections.

Benthic Macroinvertebrates

A total of 934 individuals representing 40 taxa from 11 orders of macroinvertebrates were collected in the Surber sample from Clear Creek (Appendix E) on August 2, 1989. Trichoptera, Ephemeroptera, and Diptera, were the most commonly collected orders, collectively accounting for 96 percent of the total number of individuals collected. Coleoptera and Pelecypoda were the only other orders which comprised at least one percent of the collection.

The Ecoregions 27, 29, and 32 Surber BIBI fell in the exceptional aquatic life use category for the sample.

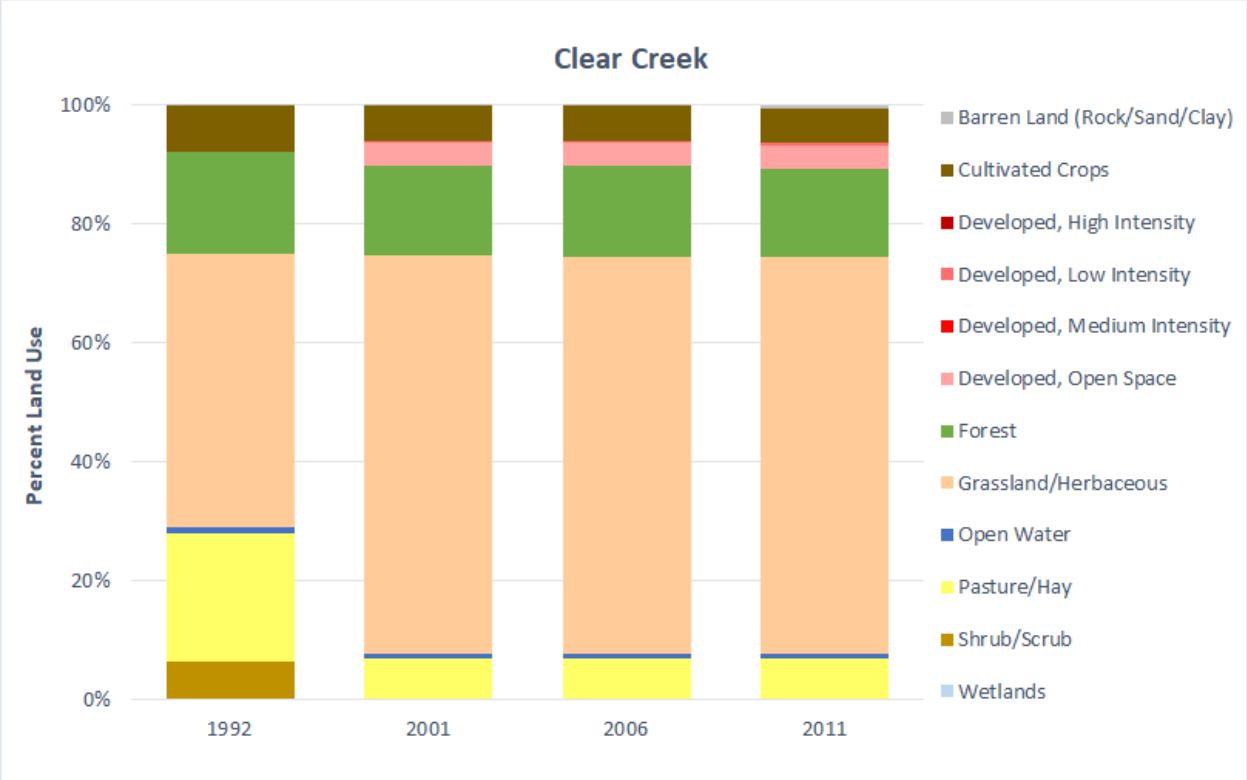

Figure 102. Percent land use in the Clear Creek watershed from 1992-2011.

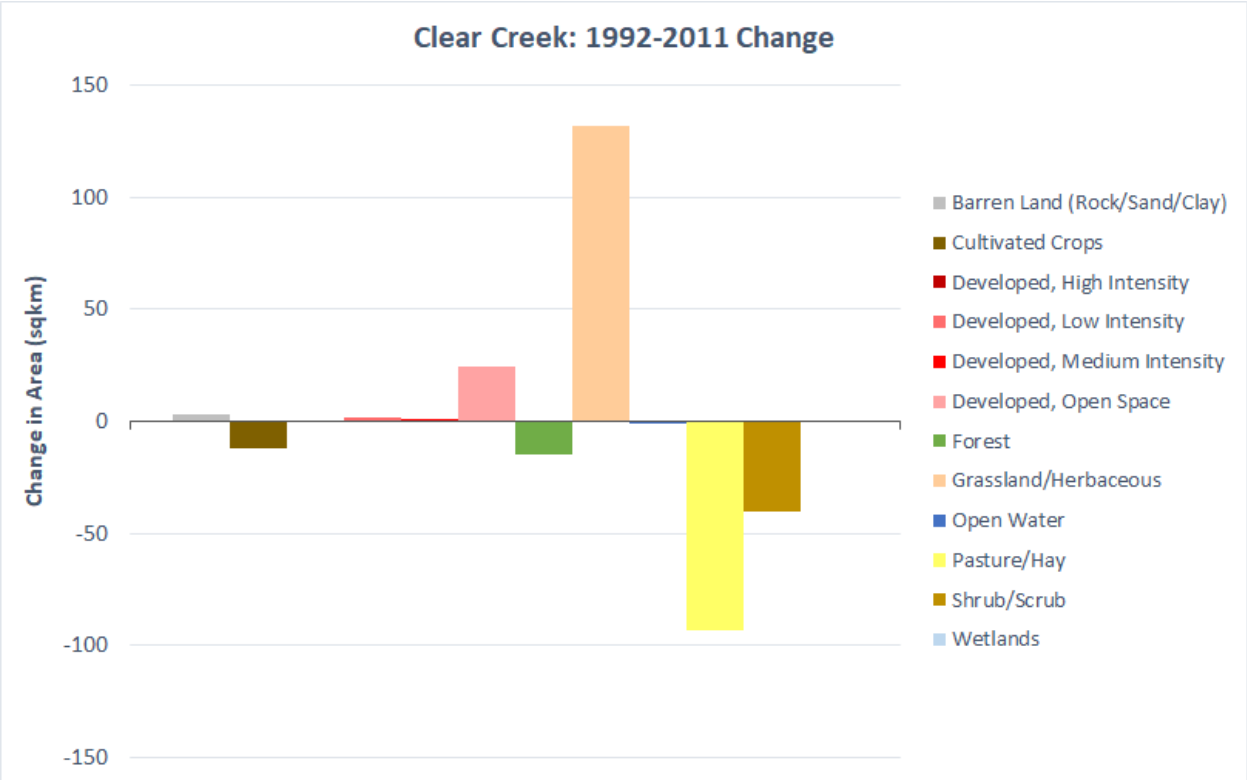

Figure 103. Land use change in area (sq km) from 1992-2011 for the Clear Creek watershed.

COLONY CREEK

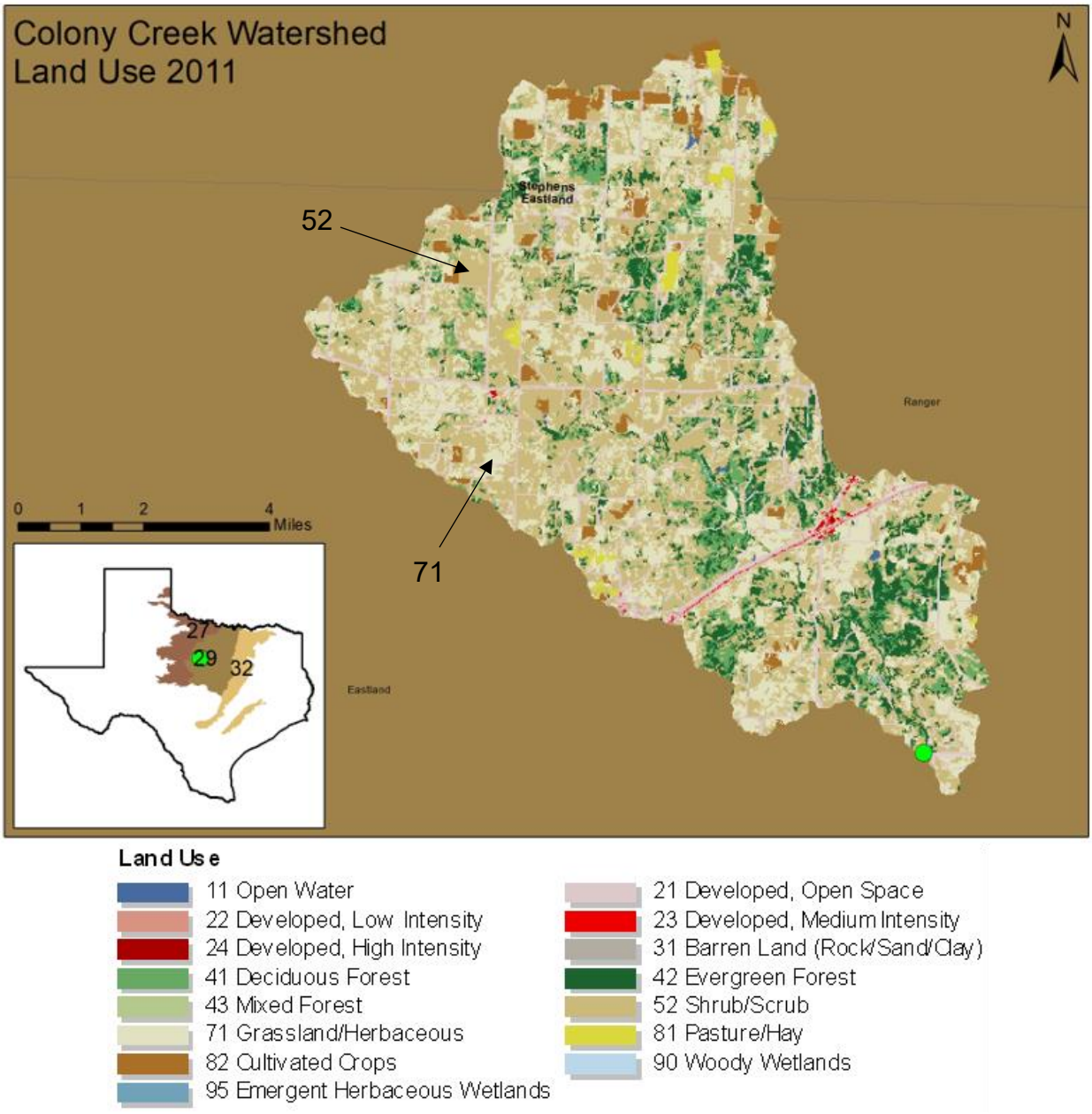

Figure 104. Map of Colony Creek watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	July 13, 1988
Water Quality:	14 sampling events
Fish:	July 13, 1988; April 19, 1989
Benthic Invertebrates:	July 13, 1988

Physical Characterization

Watershed and Land Use

Colony Creek lies within the Brazos River Basin. Sample site 11837 is located upstream of FM 570, approximately 8.37 km south of Ranger in Eastland County (Figure 104).

The Colony Creek watershed at site 11837 is approximately 158.16 sq km. The entire watershed lies within Level IV Ecoregion 29c, the Western Cross Timbers. The dominant land cover in the watershed is shrub at 42.78% and is present throughout the watershed (Homer et al. 2015; Figure 104 and Figure 105). Grassland/herbaceous is the secondary land cover encompassing 25.52%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 9.43% and total cover for cultivated crops is 3.55%.

From 1992-2011 there was a 37.28 sq km decrease in grassland and a 25.70 sq km decrease in pasture/hay. There was a 38.08 sq km increase in shrub and a 14.65 sq km increase in forest (Figure 106).

There is one domestic wastewater outfall (discharges < 1 million gallons per day) within the Colony Creek watershed permitted to the Eastland County Water Supply District which discharges directly into Colony Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Colony Creek was evaluated on July 13, 1988. Colony Creek drains to the Leon River below Leon Reservoir. The riparian width was 38 meters. The riparian zone was dominated by shrubs, which made up an average of 40% of the total riparian species, followed by trees and grasses (30% each). The average percentage of tree canopy cover was 13%. The dominant substrate was gravel with some sand and exposed bedrock, and the average percent of substrate that was gravel size or larger was 50%. Average percent instream cover was 29%. Colony Creek had an average depth of 0.6 meters and a maximum depth of 1.6 meters. The average width was 11.2 meters and average stream bank slope was 48 degrees. Stream flow at the site was 1.4 cfs. Average stream bank erosion potential was 27%. Four riffles were observed at the site and there were two total stream bends.

Water Quality

Water samples were collected at station 11837 over 14 sampling events from July 1988 through July 1999. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Fourteen species (six families) were collected between the two sampling events. Centrarchidae and Cyprinidae were the most species rich families with five and four, respectively. Red Shiner

was the most abundant species. The aquatic life use rated as high and intermediate for the 1988 and 1989 fish assemblages, respectively; however, when the coefficient of variability was applied to the 1989 sample it also attained a high rating.

Benthic Macroinvertebrates

A total of 1,193 individuals representing 40 taxa from 12 orders of macroinvertebrates were collected in the Surber sample from Colony Creek (Appendix E) on July 13, 1988. Trichoptera, Gastropoda, Diptera, and Pelecypoda were the most commonly collected orders, collectively accounting for 88 percent of the total number of individuals collected. Coleoptera, Oligochaeta, and Odonata were the only other orders which comprised at least one percent of the collection.

The Ecoregions 27, 29, and 32 Surber BIBI fell in the exceptional aquatic life use category for the sample.

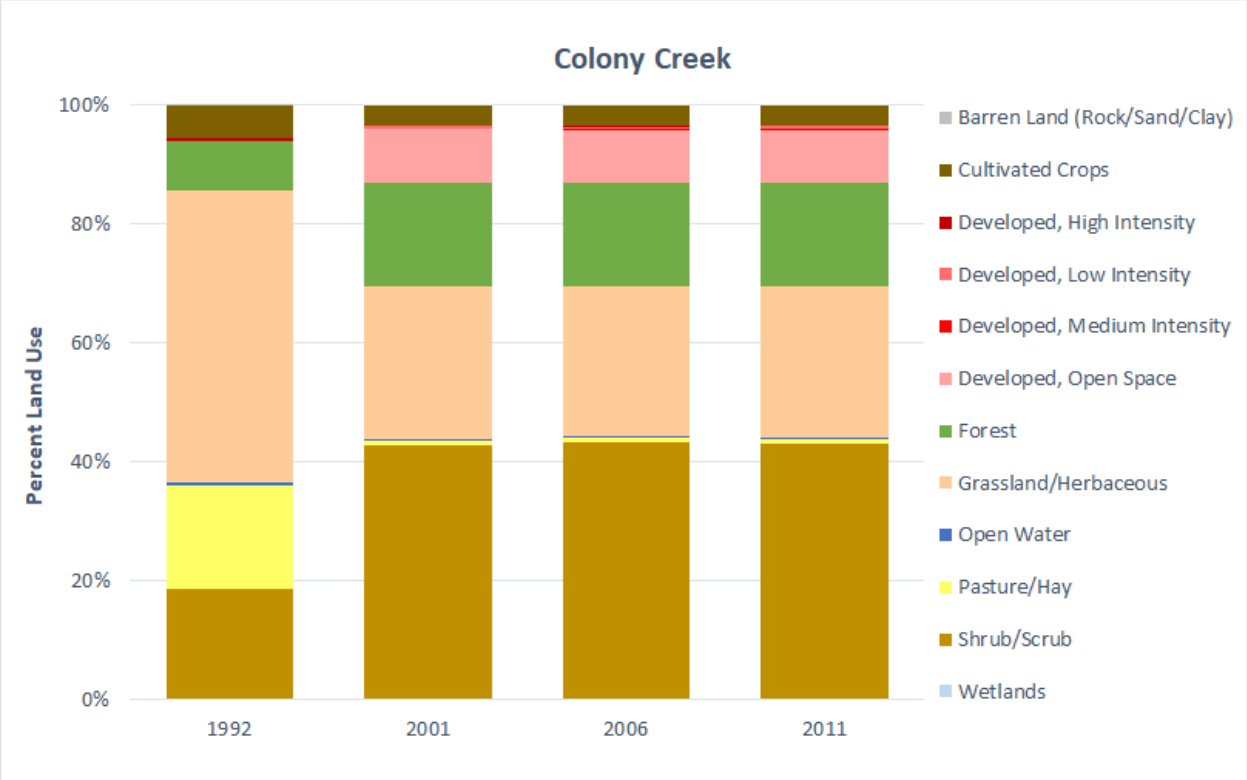

Figure 105. Percent land use in the Colony Creek watershed from 1992-2011.

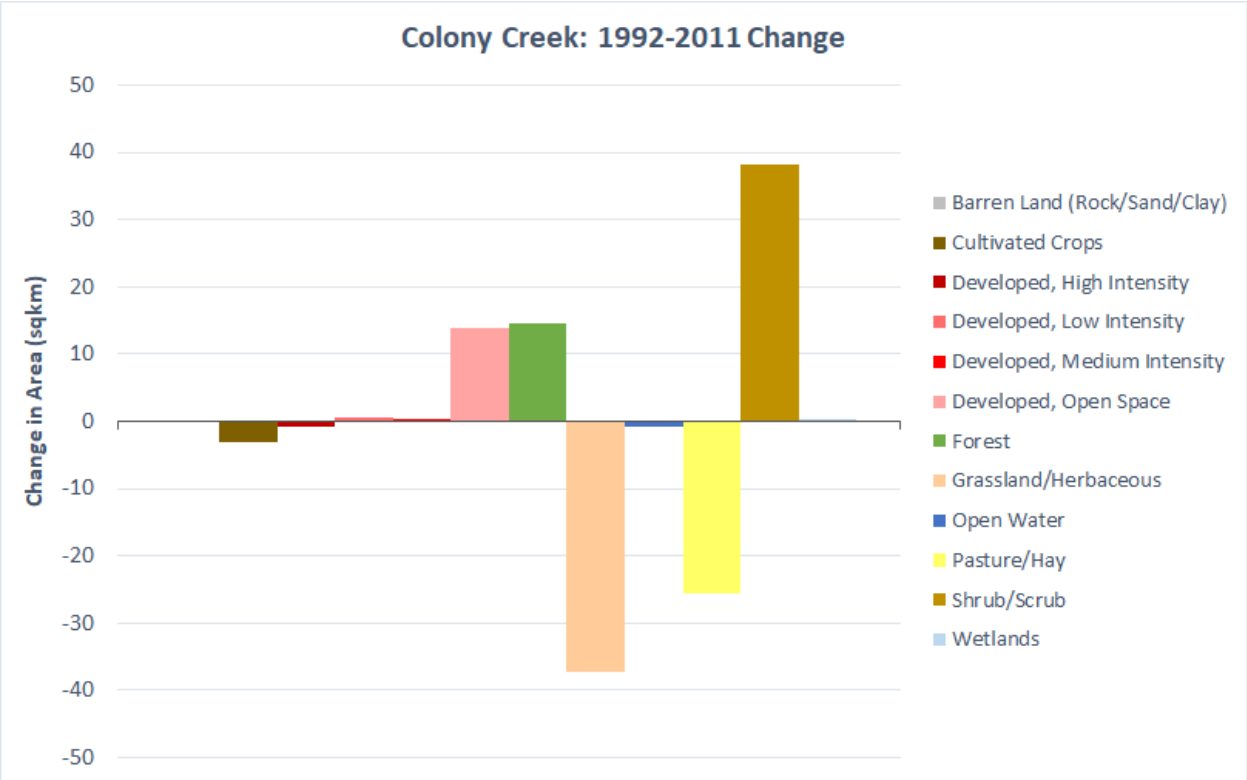

Figure 106. Land use change in area (sq km) from 1992-2011 for the Colony Creek watershed.

COWHOUSE CREEK

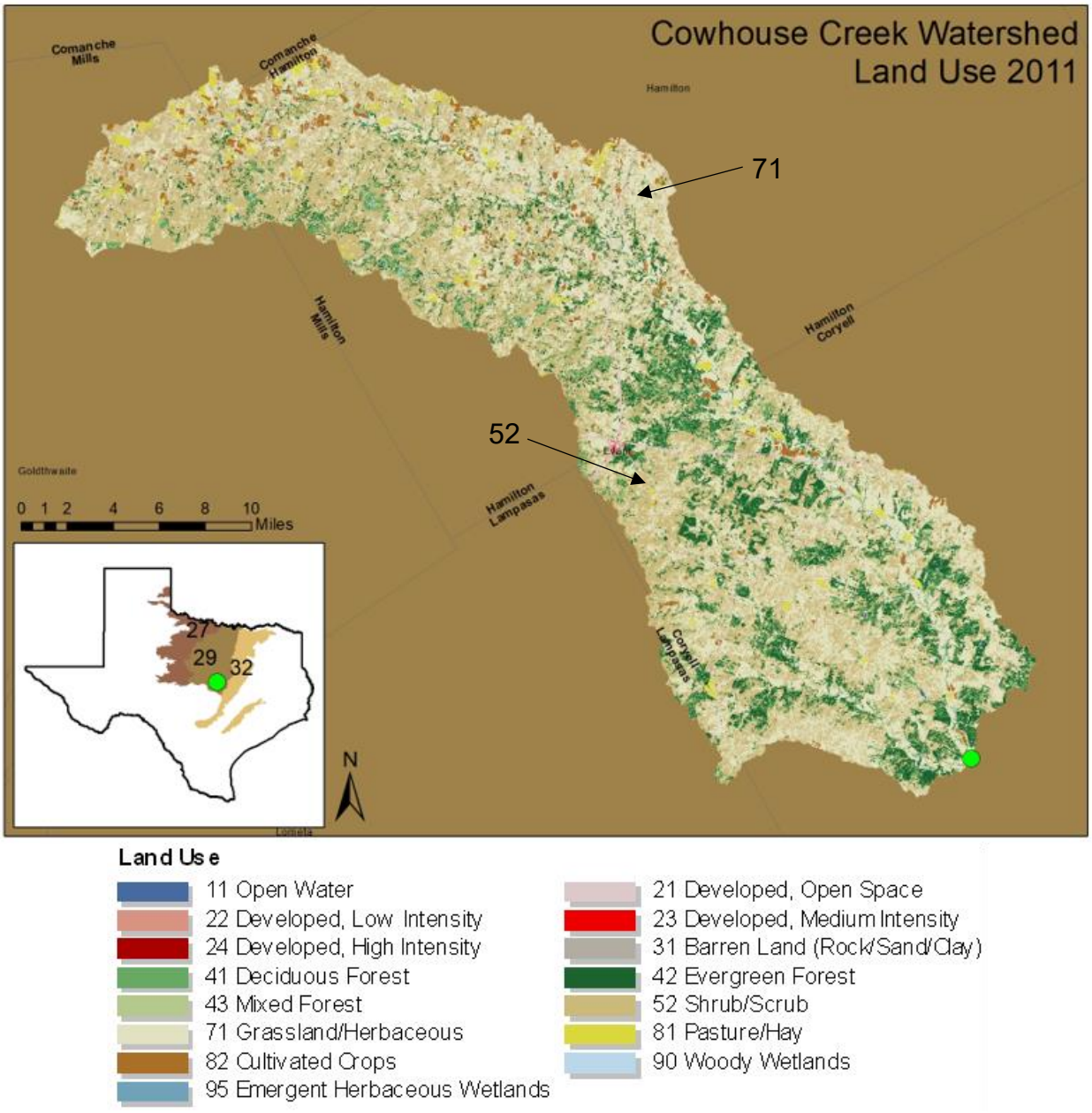

Figure 107. Map of Cowhouse Creek watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	June 21, 1989
Water Quality:	157 sampling events
Fish:	June 21, 1989
Benthic Invertebrates:	June 21, 1989; September 17, 1990

Physical Characterization

Watershed and Land Use

Cowhouse Creek lies within the Brazos River Basin. Sample site 11805 is located 71 m downstream of FM 116 southwest of Gatesville in Coryell County (Figure 107).

The Cowhouse Creek watershed at site 11805 is approximately 1180.17 sq km. The entire watershed lies within Level IV Ecoregion 29e, the Limestone Cut Plain. The dominant land cover in the watershed is shrub at 40.77% and is present throughout the watershed (Homer et al. 2015; Figure 107 and Figure 108). Grassland/herbaceous is the secondary land cover encompassing 34.20%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 2.55% and total cover for cultivated crops is 2.29%.

From 1992-2011 there was a 62.91 sq km decrease in cultivated crops and a 38.41 sq km decrease in pasture/hay. There was a 66.33 sq km increase in grassland and a 28.57 sq km increase in open space development (Figure 109).

There is one domestic wastewater outfall (discharges < 1 million gallons per day) within the Cowhouse Creek watershed permitted to the City of Evant. The wastewater facility does not discharge directly into Cowhouse Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Cowhouse Creek was evaluated on June 21, 1989. Cowhouse Creek is an intermittent stream with perennial pools that drains to the Cowhouse Creek Arm of Belton Lake. The riparian width was 28 meters. The riparian zone was dominated by trees, which made up an average of 70% of the total riparian species, followed by shrubs (20%) then grasses (10%). The average percentage of tree canopy cover was 45%. The dominant substrate was gravel, and the average percent of substrate that was gravel size or larger was 57%. Average percent instream cover was 11%. Cowhouse Creek had an average depth of 0.8 meters and a maximum depth of 1.6 meters. The average width was 17.2 meters and average stream bank slope was 54 degrees. Stream flow at the site was 51.7 cfs. Average stream bank erosion potential was 49%. Four riffles were observed at the site and there were three total stream bends.

Water Quality

Water samples were collected at station 11805 over 157 sampling events from June 1989 through June 2019. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Continuous flow data is available from USGS gage 08101000 downstream of station 11805 (Figure 110). Between January 1985 through December 2019, the median flow was 10.2 cfs. Daily average flows ranged from 0 cfs to 25,600 cfs, though flows in that period were greater than 1000 cfs about 0.07 percent of the time. Data have been log transformed to better visualize flow patterns.

Biological Characterization

Fish

Eleven species (four families) were collected. The majority of the species were within the families Centrarchidae and Cyprinidae with five and four species represented, respectively. Blacktail Shiner was the most abundant species. The aquatic life use (based upon the fish assemblage) was high.

Benthic Macroinvertebrates

Considering the two Surber samples collectively, a total of 858 individuals representing 64 taxa from 15 orders of macroinvertebrates were collected from Cowhouse Creek (Appendix E). Ephemeroptera, Trichoptera, and Diptera were the most commonly collected orders, collectively accounting for 82 percent of the total number of individuals collected. Odonata, Megaloptera, and Coleoptera were the only other orders which comprised at least one percent of the collections.

The Ecoregions 27, 29, and 32 Surber BIBI fell in the exceptional aquatic life use category for both samples.

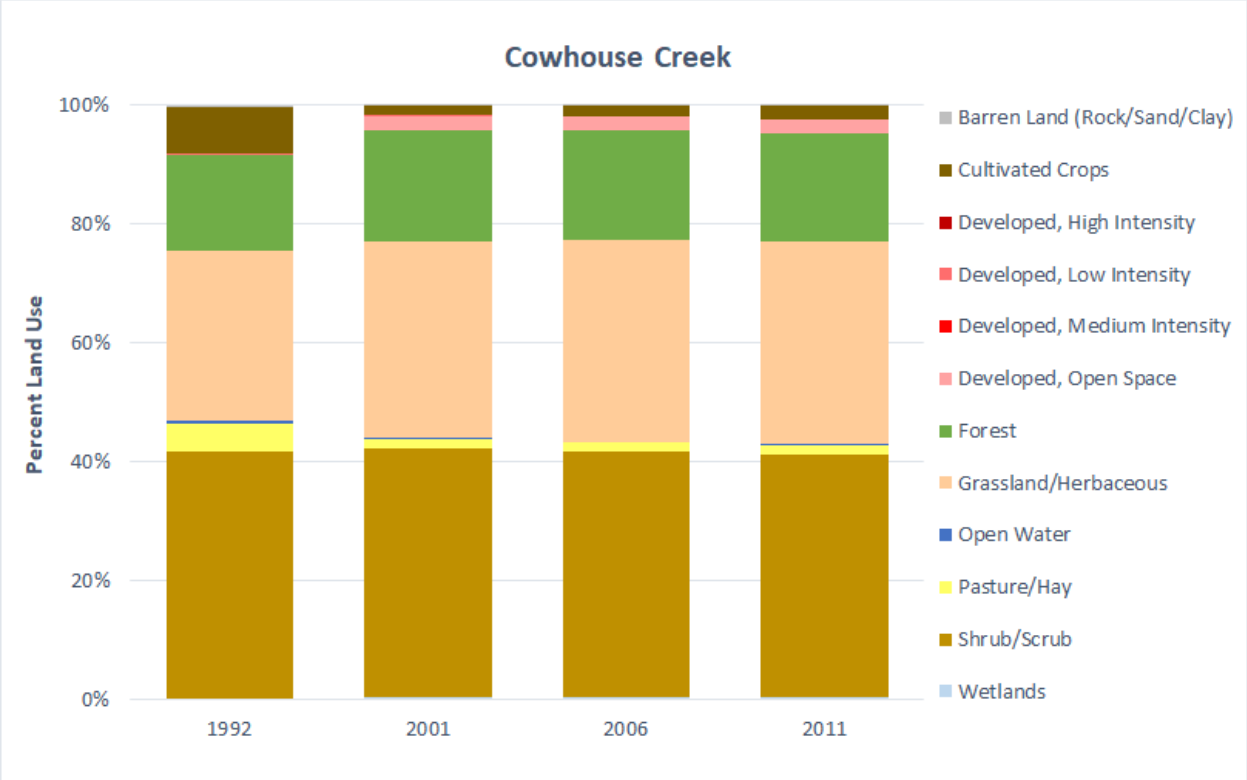

Figure 108. Percent land use in the Cowhouse Creek watershed from 1992-2011.

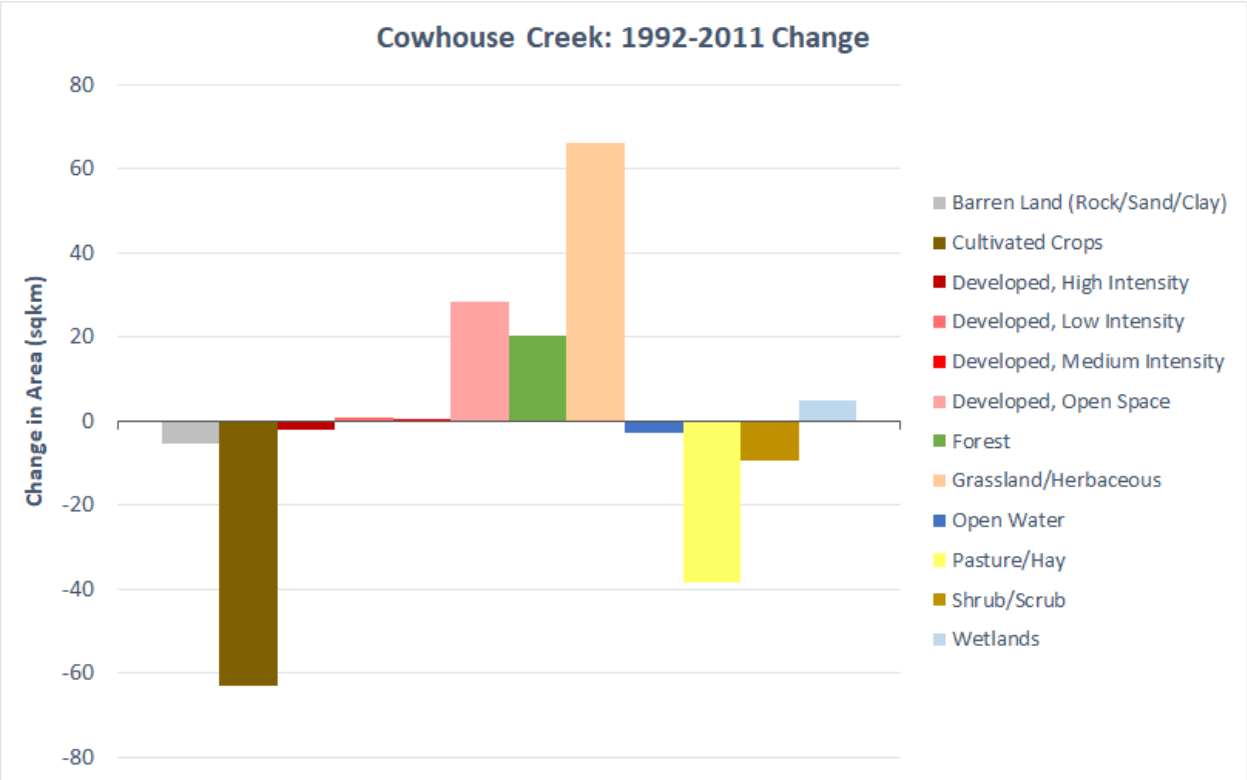

Figure 109. Land use change in area (sq km) from 1992-2011 for the Cowhouse Creek watershed.

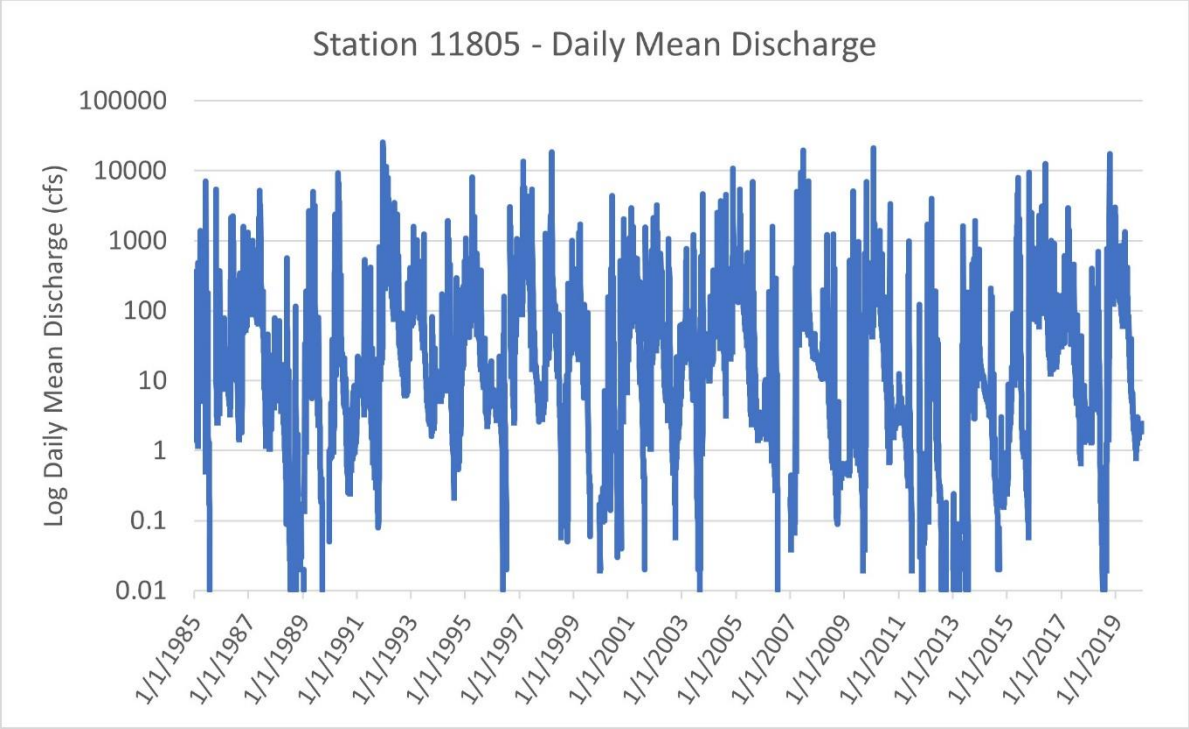

Figure 110. Log transformed daily mean discharge for Cowhouse Creek at station 11805.

IONI CREEK

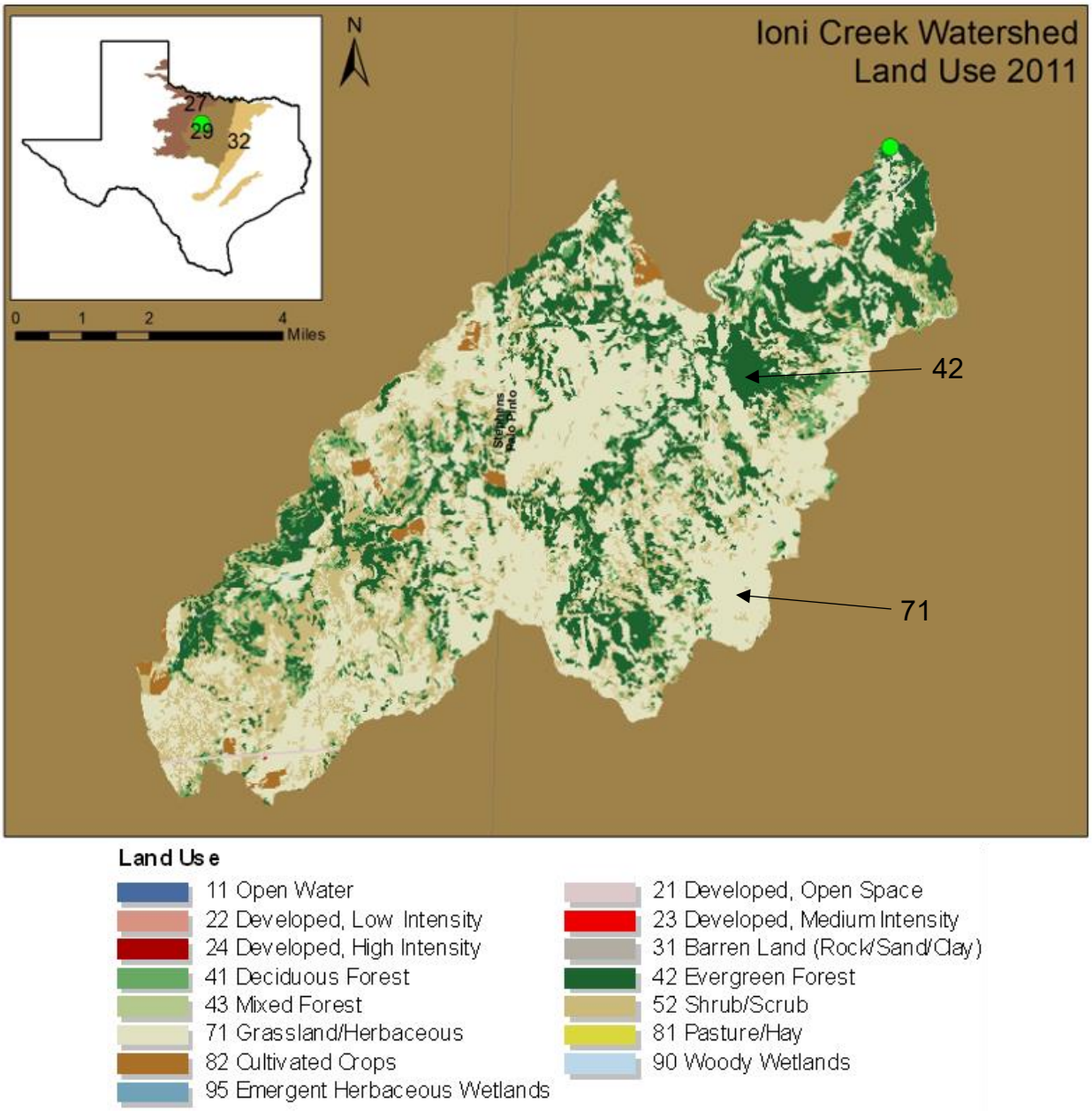

Figure 111. Map of Ioni Creek watershed location and 2011 land use; grassland/herbaceous and forest were the most common land uses.

Sampling Dates

Physical Habitat:	July 13, 1988
Water Quality:	14 sampling events
Fish:	July 14, 1988; April 19, 1989
Benthic Invertebrates:	July 14, 1988

Physical Characterization

Watershed and Land Use

Ioni Creek lies within the Brazos River Basin. Sample site 11716 is located 0.40 km upstream of SH 16, approximately 19.96 km west of Palo Pinto in Palo Pinto County (Figure 111).

The Ioni Creek watershed at site 11716 is approximately 146.07 sq km. The entire watershed lies within Level IV Ecoregion 29f, the Carbonate Cross Timbers. The dominant land cover in the watershed is grassland/herbaceous at 50.50% and is present throughout the watershed (Homer et al. 2015; Figure 111 and Figure 112). Forest is the secondary land cover encompassing 28.66%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.36% and total cover for cultivated crops is 1.33%.

From 1992-2011 there was a 16.51 sq km decrease in forest and a 4.65 sq km decrease in pasture/hay. There was a 15.89 sq km increase in grassland and a 5.35 sq km increase in shrub (Figure 113).

There are no permitted wastewater outfalls within the Ioni Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Ioni Creek was evaluated on July 13, 1988. Ioni Creek is a tributary to the Brazos River below Possum Kingdom Lake. The riparian width was 46 meters. The riparian zone was dominated by trees, which made up an average of 70% of the total riparian species, followed by shrubs (20%) then grasses (10%). The average percentage of tree canopy cover was 40%. The dominant substrate was gravel, and the average percent of substrate that was gravel size or larger was 50%. Average percent instream cover was 10%. Ioni Creek had an average depth of 1.1 meters and a maximum depth of 2.1 meters. The average width was 15 meters and average stream bank slope was 49 degrees. The stream was not flowing on July 13, 1988, but a large spring fed pool was present. Average stream bank erosion potential was 28%. No riffles or stream bends were observed at the site.

Water Quality

Water samples were collected at station 11716 over 14 sampling events from July 1988 through July 1999. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Thirteen species (seven families) were collected between the two sampling events. Centrarchidae yielded the greatest number of species with four. Juvenile sunfish were the most abundant taxa in the 1988 sample, closely followed by Blacktail Shiner which was the most abundant species in 1989. The aquatic life use (based upon the fish assemblage) rated as high and intermediate for

the 1988 and 1989 collections, respectively; however, when the coefficient of variability was applied to the 1989 sample it also attained a high rating.

Benthic Macroinvertebrates

A total of 1,007 individuals representing 48 taxa from 15 orders of macroinvertebrates were collected in the Surber sample from Ioni Creek (Appendix E) on July 14, 1988. Ephemeroptera, Oligochaeta, Diptera, and Trichoptera were the most commonly collected orders, collectively accounting for 83 percent of the total number of individuals collected. Coleoptera, Turbellaria, Ostracoda, Odonata, and Amphipoda were the only other orders which comprised at least one percent of the collection.

The Ecoregions 27, 29, and 32 Surber BIBI fell in the high aquatic life use category for the sample.

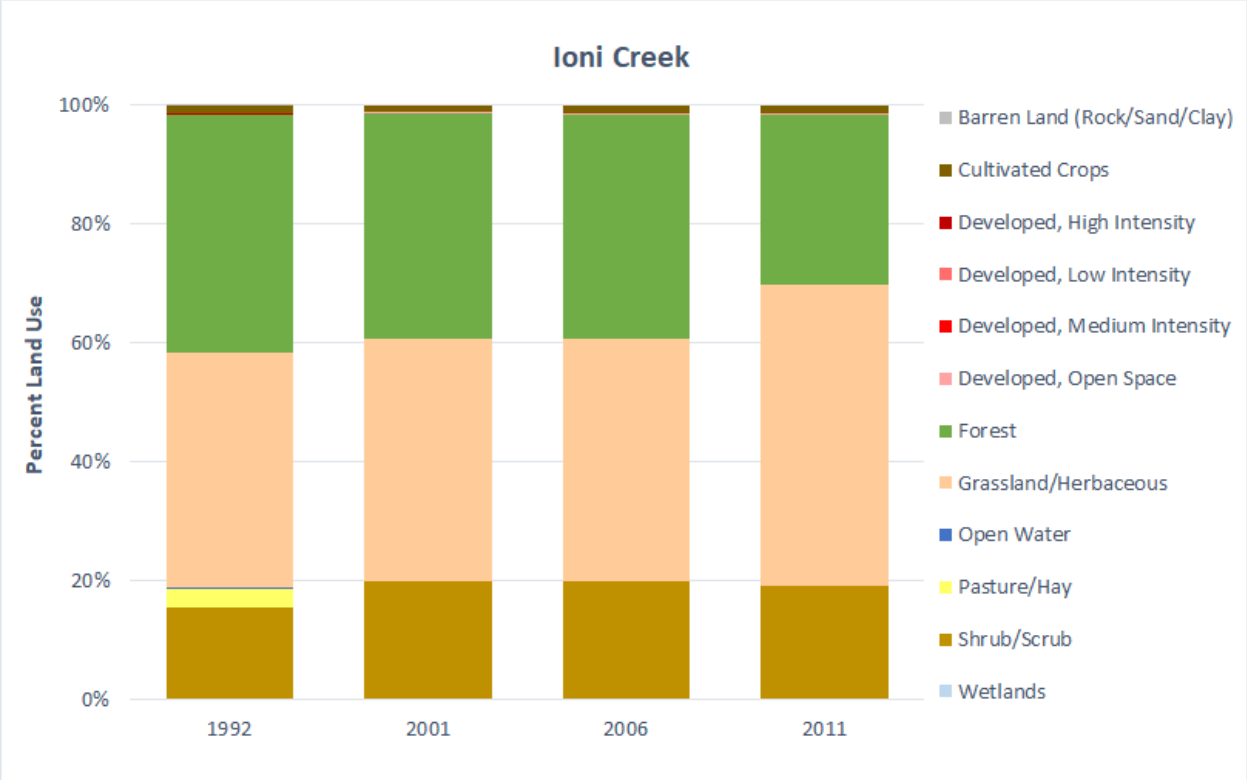

Figure 112. Percent land use in the Ioni Creek watershed from 1992-2011.

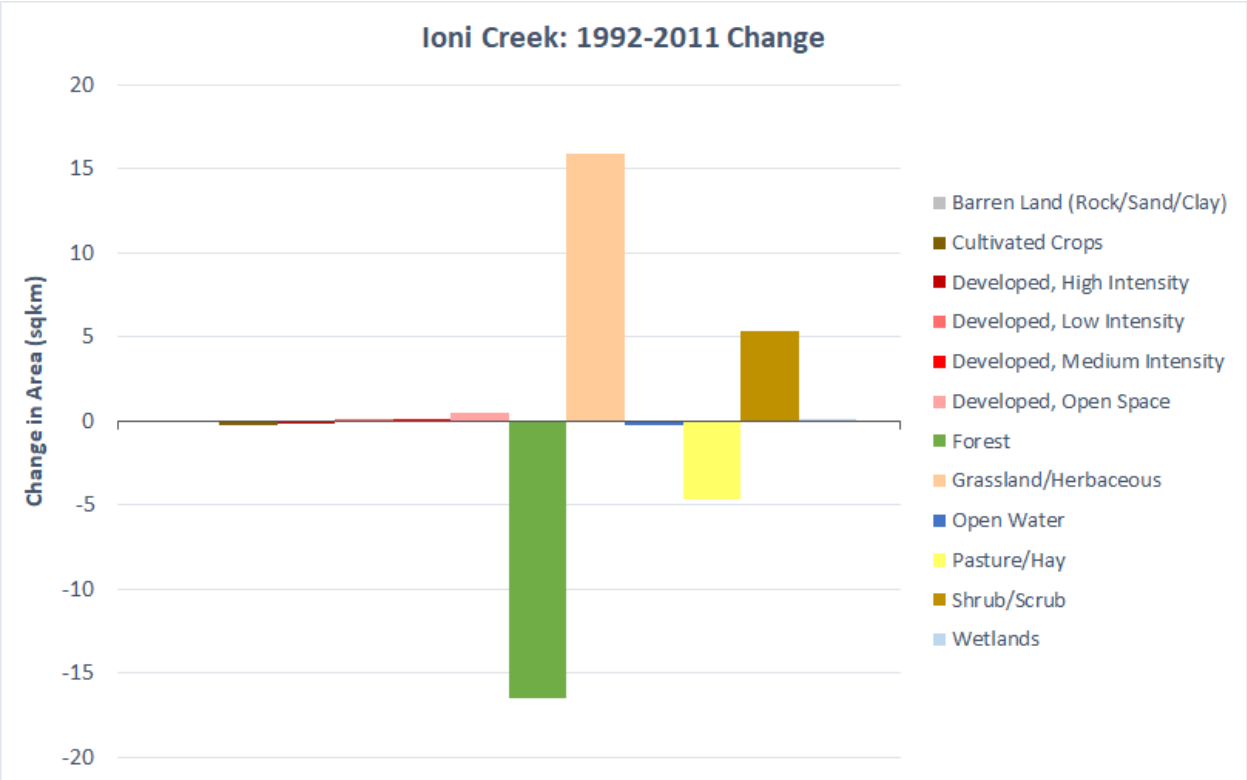

Figure 113. Land use change in area (sq km) from 1992-2011 for the Ioni Creek watershed.

NEILS CREEK

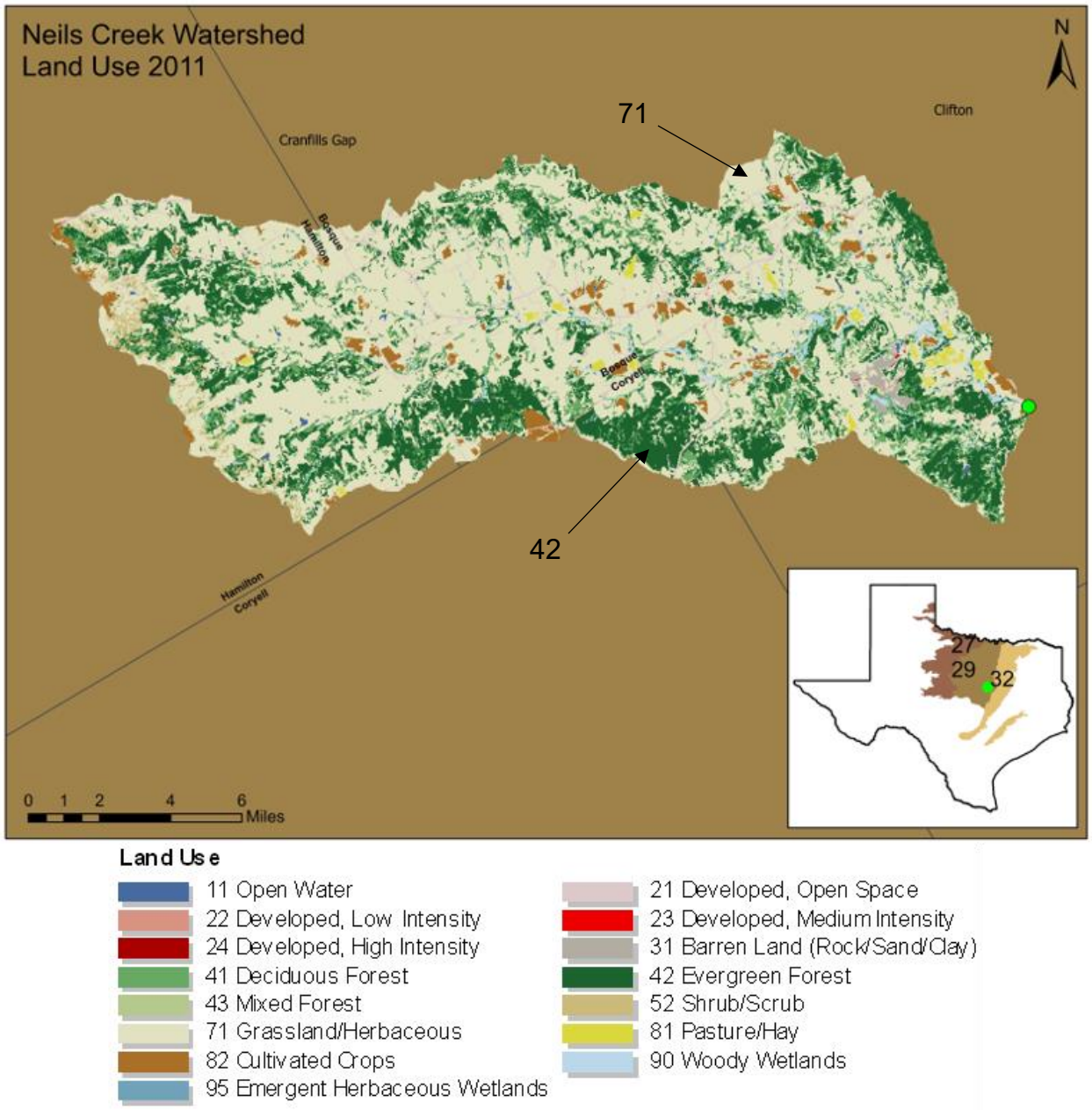

Figure 114. Map of Neils Creek watershed location and 2011 land use; grassland/herbaceous and forest were the most common land uses.

Sampling Dates

Physical Habitat:	July 19, 1989; July 18, 2017
Water Quality:	742 sampling events
Fish:	July 19, 1989; July 18, 2017
Benthic Invertebrates:	July 19, 1989; July 18, 2017

Physical Characterization

Watershed and Land Use

Neils Creek lies within the Brazos River Basin. Sample site 11826 is located at SH 6 southeast of Clifton in Bosque County (Figure 114).

The Neils Creek watershed at site 11826 is approximately 355.43 sq km. The entire watershed lies within Level IV Ecoregion 29e, the Limestone Cut Plain. The dominant land cover in the watershed is grassland/herbaceous at 55.03% and is present throughout the watershed (Homer et al. 2015; Figure 114 and Figure 115). Forest is the secondary land cover encompassing 34.70%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.02% and total cover for cultivated crops is 2.73%.

From 1992-2011 there was a 67.41 sq km decrease in shrub and a 13.73 sq km decrease in pasture/hay. There was a 63.80 sq km increase in grassland and a 9.93 sq km increase in open space development (Figure 116).

There are no permitted wastewater outfalls within the Neils Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Neils Creek was evaluated on July 19, 1989 and again on July 18, 2017. Neils Creek is an intermittent stream with perennial pools that drains to the North Bosque River south of Clifton. The following summary information is based on data collected during the most recent sampling event in 2017. The Habitat Quality Index score of 20.5 indicates a high aquatic life use rating. The riparian zone was moderately vegetated throughout the reach with an average riparian buffer measured at 4.75 meters. The riparian zone was dominated by grasses, which made up an average of 35% of the total riparian species, followed by trees (30%) then shrubs (22.5%), with the remaining 12.5% composed of cultivated fields. The average percentage of tree canopy cover was 69%. The dominant substrate was gravel, and the average percent of substrate that was gravel size or larger was 91%. Average percent instream cover was 35% and instream cover types include woody debris, undercut banks, roots, cobble, gravel, boulders, macrophytes, overhanging vegetation, and bedrock ledges. Neils Creek was 0.4 meters deep on average and 18 meters wide. Average stream bank slope was 32 degrees, and average stream bank erosion potential was 60%. The deepest pool measured at Neils Creek was 1.5 meters. Stream flow at the creek was measured at a minimum value of 1.2 cfs in 2017 and a maximum of 7.9 cfs in 1989. Four riffles were observed at the site in 2017 and there were three total stream bends.

Water Quality

Water samples were collected at station 11826 over 741 sampling events from July 1989 through August 2018. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a. Water samples and data were also

collected for the Least Disturbed Streams biological sampling event in July 2017 at station 21999, which is upstream of station 11826.

Biological Characterization

Fish

Sixteen species (six families) were collected between the two sampling events. Centrarchidae and Cyprinidae yielded the highest number of species with six and five, respectively. Blacktail Shiner was the most abundant species in both collections. Several species were only collected in 1989. These included Yellow Bullhead *Ameiurus natalis*, Red Shiner, Bullhead Minnow, and Spotted Bass *Micropterus punctulatus*. Their absence from the 2017 collection does not reflect any significant issue, especially given that each were collected in very low numbers in 1989. Two species unique to the 2017 sample were Central Stoneroller and Mimic Shiner *Notropis volucellus*, which was the second most abundant species. Mimic Shiner is listed as an intolerant species (Linam and Kleinsasser 1989). Their addition to the fish assemblage could be an indication of improved water quality. The aquatic life use (based upon the fish assemblage) rated as high for both collections; however, when the coefficient of variability was applied the 2017 sample obtained an exceptional rating.

Benthic Macroinvertebrates

Considering the Surber sample and the RBP sample collectively, a total of 341 individuals representing 48 taxa from 12 orders of macroinvertebrates were collected from Neils Creek (Appendix E). Trichoptera, Ephemeroptera, Diptera, and Odonata were the most commonly collected orders, collectively accounting for 93 percent of the total number of individuals collected. Megaloptera, Hemiptera, Plecoptera and Coleoptera were the only other orders which comprised at least one percent of the collections.

The Ecoregions 27, 29, and 32 BIBI for the 1989 Surber sample, as well as the 2017 RBP sample, fell in the exceptional aquatic life use category.

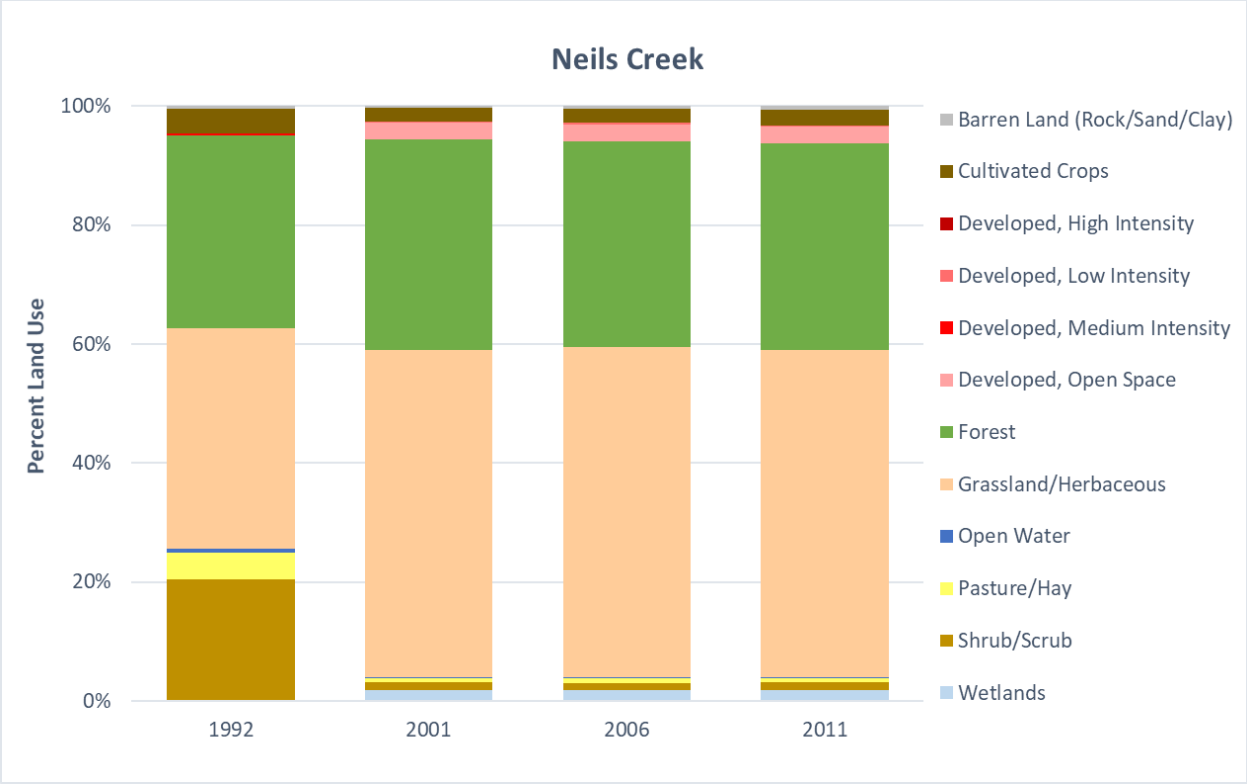

Figure 115. Percent land use in the Neils Creek watershed from 1992-2011.

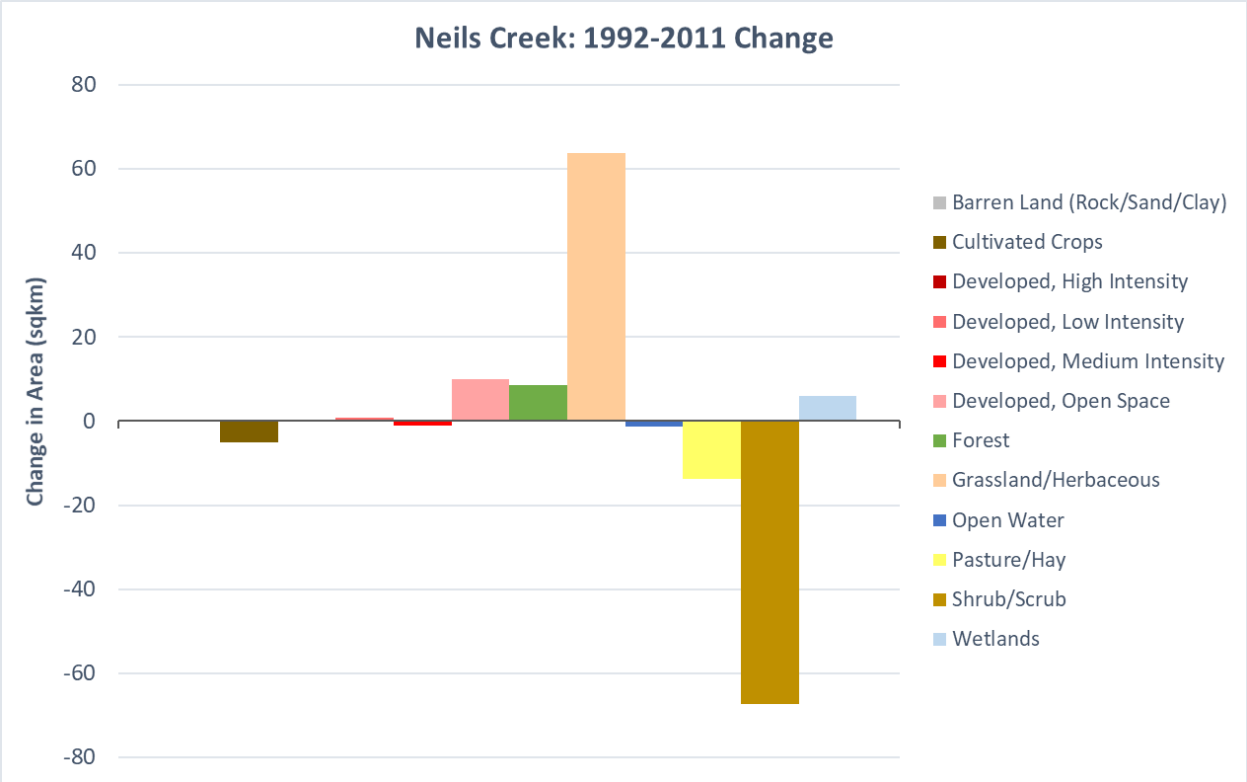

Figure 116. Land use change in area (sq km) from 1992-2011 for the Neils Creek watershed.

REESE CREEK

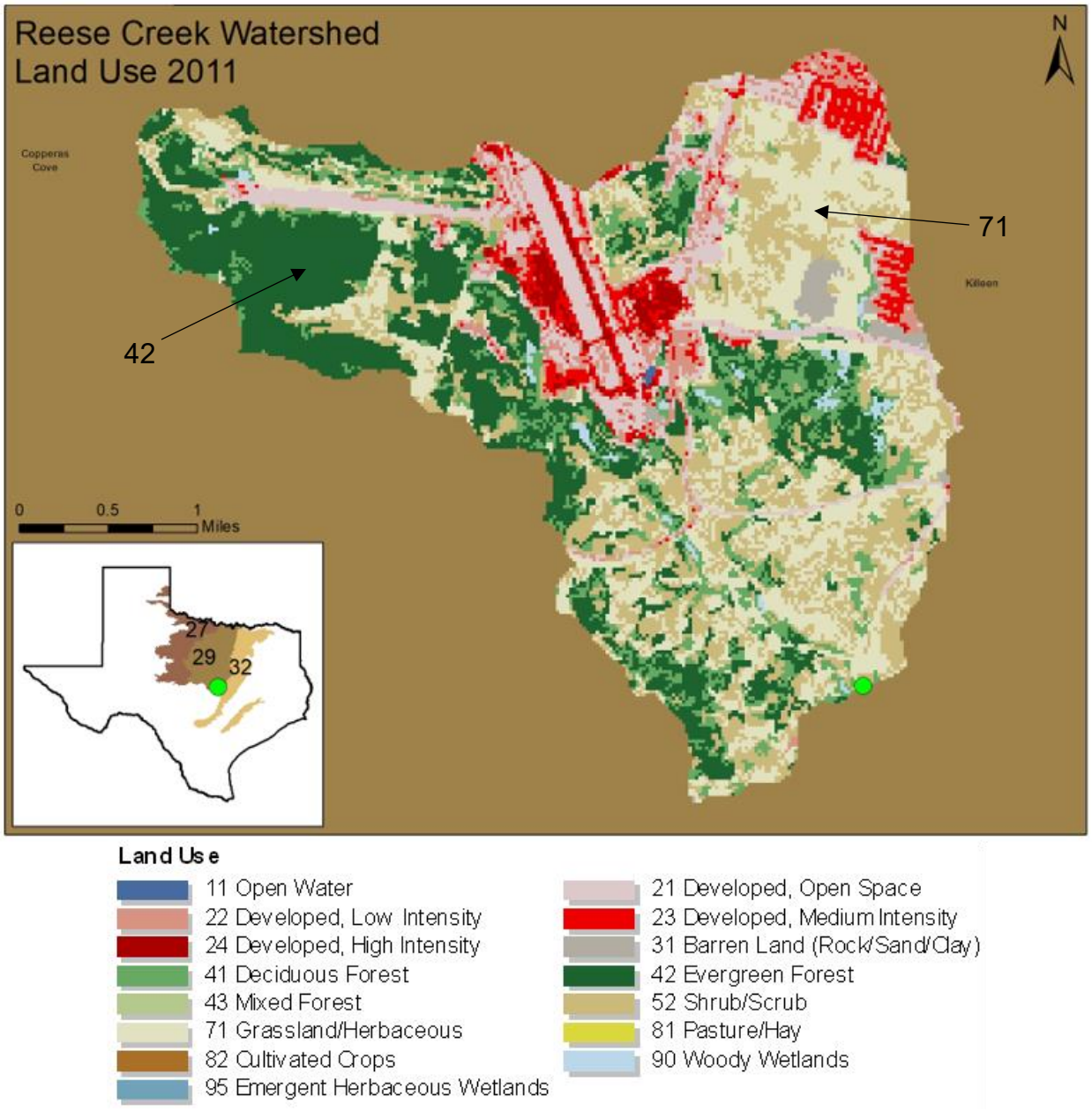

Figure 117. Map of Reese Creek watershed location and 2011 land use; forest and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	April 19, 2006; September 17, 2007
Water Quality:	2 sampling events
Fish:	June 5, 2006; September 21, 2007
Benthic Invertebrates:	June 5, 2006; September 21, 2007

Physical Characterization

Watershed and Land Use

Reese Creek lies within the Brazos River Basin. Sample site 18850 is located 360 m downstream of Maxdale Road, approximately 4.09 km south-southwest of Killeen in Bell County (Figure 117).

The Reese Creek watershed at site 18850 is approximately 25.86 sq km. The entire watershed lies within Level IV Ecoregion 29e, the Limestone Cut Plain. The dominant land cover in the watershed is forest at 33.98% and is present mostly in the middle and upper portion of the watershed (Homer et al. 2015; Figure 117 and Figure 118). Grassland/herbaceous is the secondary land cover encompassing 22.57%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 21.02% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 3.47 sq km decrease in grassland and a 0.92 sq km decrease in barren land (rock/sand/clay). There was a 2.24 sq km increase in shrub and a 1.14 sq km increase in medium intensity development (Figure 119).

There are no permitted wastewater outfalls within the Reese Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Reese Creek was evaluated during two sampling events from 2006 to 2007. Reese Creek is a perennial stream that drains to the Lampasas River above Stillhouse Hollow Lake. Habitat Quality Index scores indicate a high aquatic life use rating (21.5 and 23). Riparian areas were generally well vegetated throughout the reach with an average riparian buffer ranging from 12 to 18 meters wide. The riparian zone was dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover ranged from 36% to 75%. The dominant stream substrate was cobble and bedrock, and the average percent of substrate gravel size or larger varied from 40% to 60%. Average percent instream cover was 21% to 45%. Reese Creek ranged from 0.1-0.3 meters deep on average and 3.2-4.1 meters wide. Average stream bank slope ranged from 22-50 degrees. Stream flow at the site was measured at 0.06 cfs in 2007. Average stream bank erosion potential was 14%-31%. The deepest pool measured at Reese Creek was 0.8 meters. Seven riffles were observed at the site for both sampling events, and the total number of stream bends ranged from four to six.

Water Quality

Water samples were collected at station 18850 over two sampling events in June 2006 and September 2007. Data were collected for temperature, flow, transparency, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Ten species (four families) were collected. The families Cyprinidae and Centrarchidae tied for most species with four each. Central Stoneroller was the most abundant species. The aquatic life use (based upon the fish assemblage) rated as intermediate in 2006 and high in 2007; however, when the coefficient of variability is applied the 2006 aquatic life use rises to high.

Benthic Macroinvertebrates

Considering the two RBP samples collectively, a total of 457 individuals representing 26 taxa from 10 orders of macroinvertebrates were collected from Reese Creek (Appendix E). Trichoptera, Diptera, Ephemeroptera, and Odonata were the most commonly collected orders, collectively accounting for 97 percent of the total number of individuals collected. Coleoptera was the only other order which comprised at least one percent of the collections.

The Ecoregions 27, 29, and 32 BIBI for the 2006 RBP sample fell in the intermediate aquatic life use category while the RBP BIBI for the sample collected in 2007 fell in the high aquatic life use category.

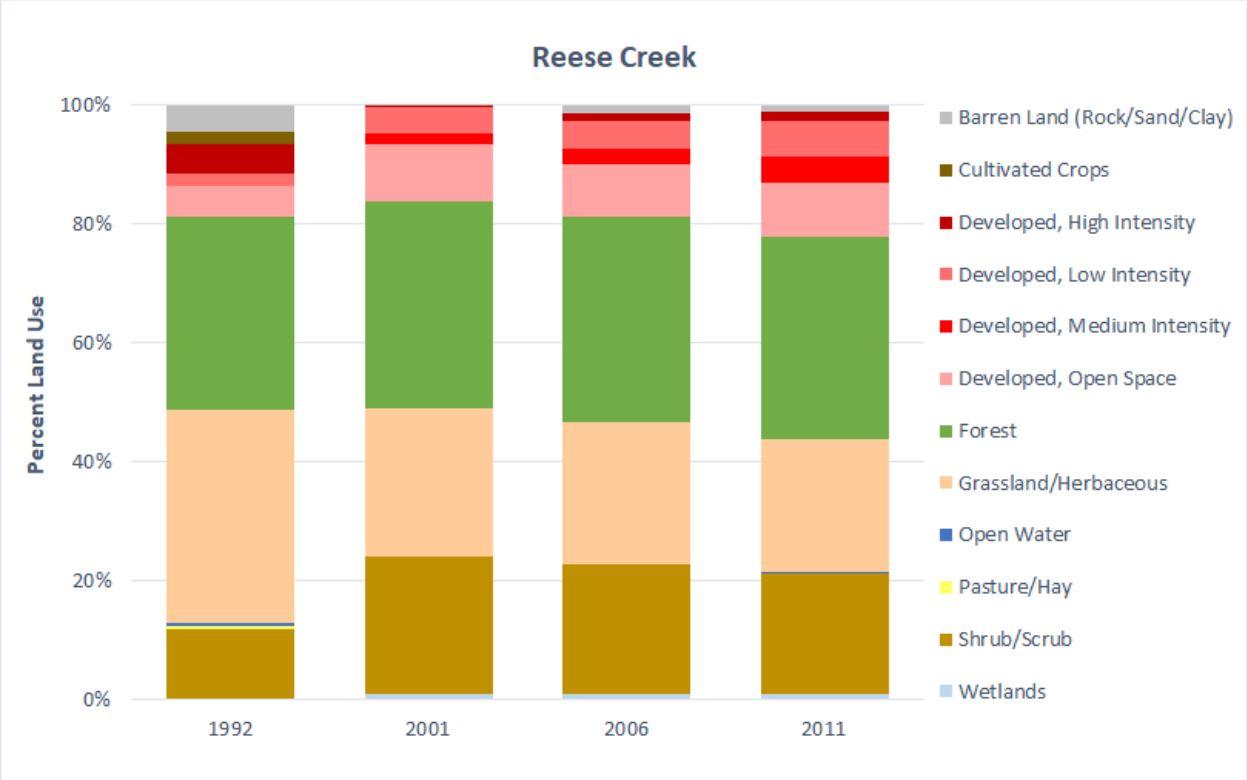

Figure 118. Percent land use in the Reese Creek watershed from 1992-2011.

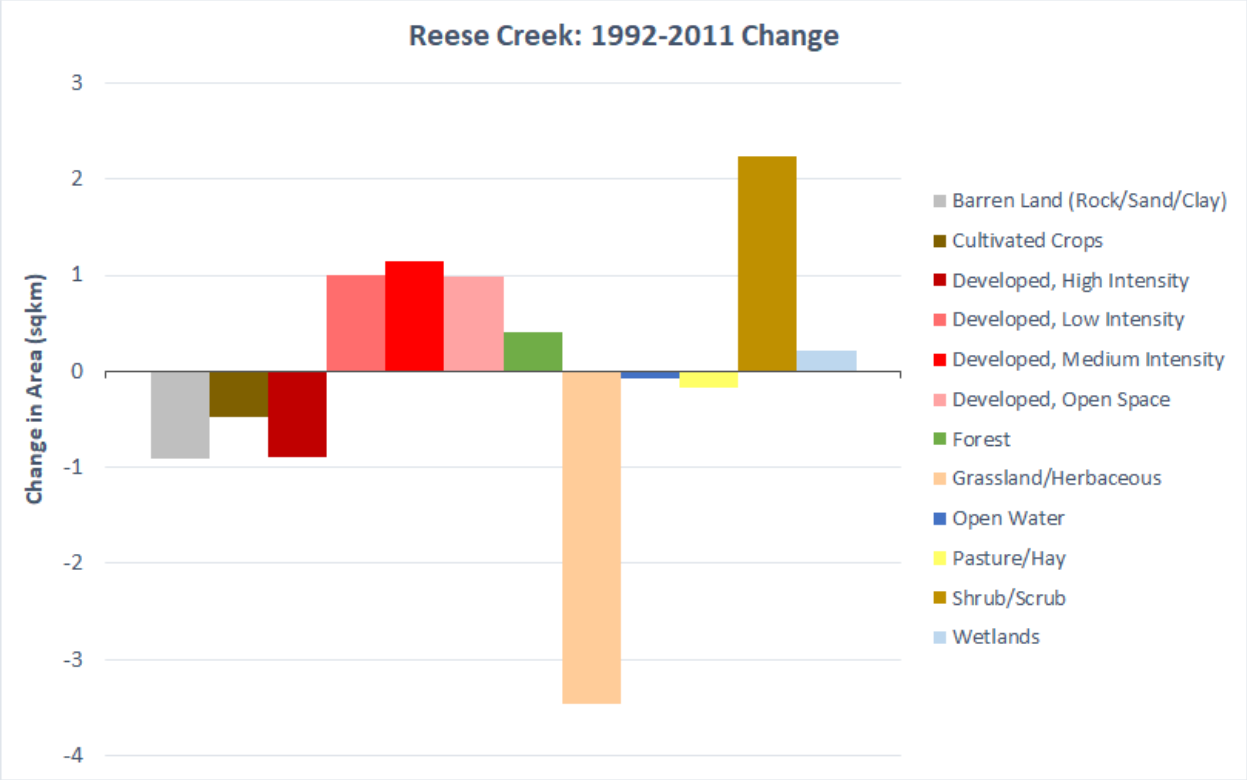

Figure 119. Land use change in area (sq km) from 1992-2011 for the Reese Creek watershed.

ROCKY CREEK

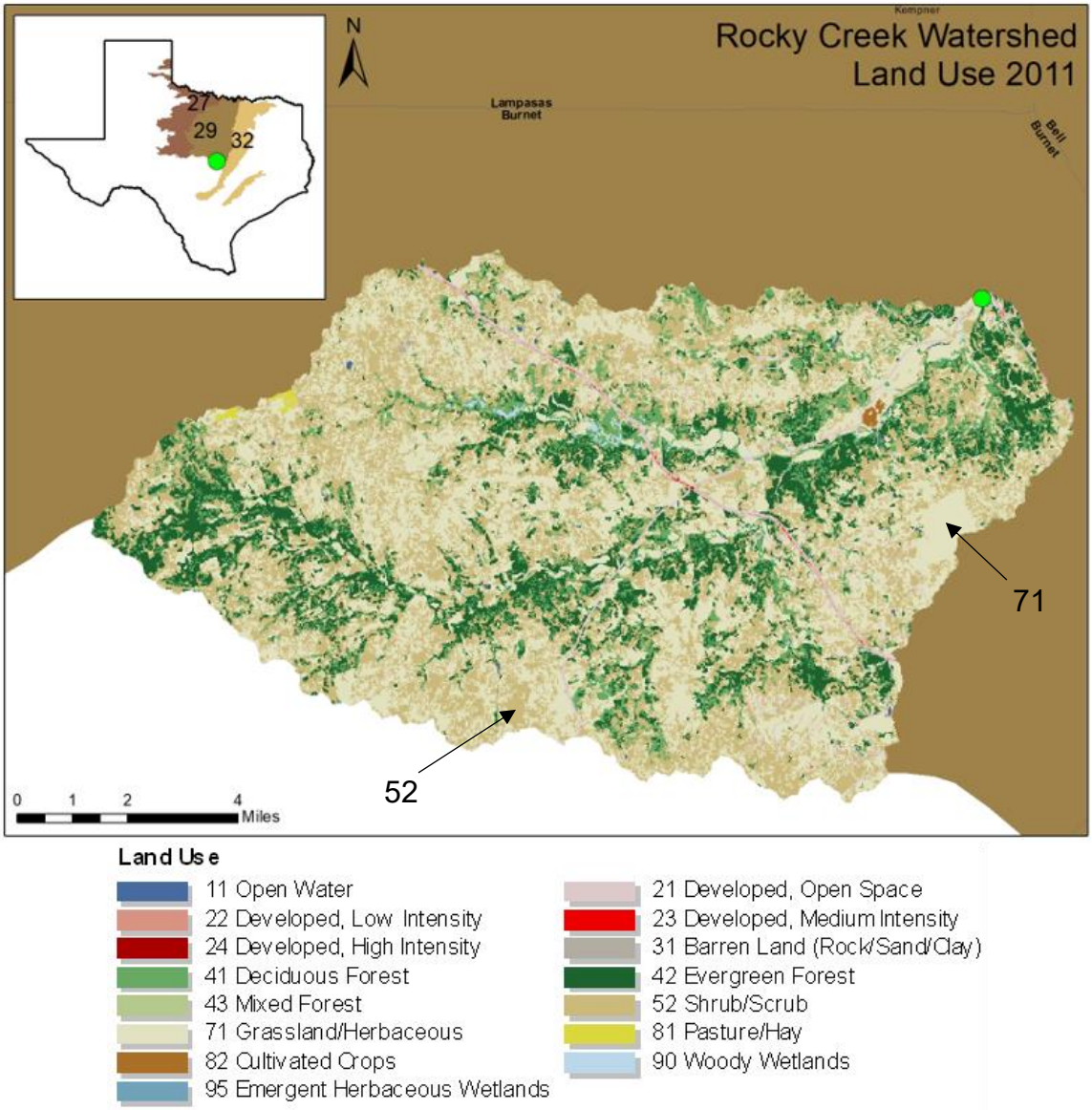

Figure 120. Map of Rocky Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	June 30, 1988; August 3, 2002; April 16, 2003; August 20, 2003; May 5, 2004; August 16, 2004
Water Quality:	108 sampling events
Fish:	June 30, 1988; March 23, 1989; August 7, 2002; April 16, 2003; August 20, 2003; May 3, 2004; August 30, 2004
Benthic Invertebrates:	June 30, 1988; August 6, 2002; April 16, 2003; August 20, 2003; May 5, 2004; August 18, 2004

Physical Characterization

Watershed and Land Use

Rocky Creek lies within the Brazos River Basin. Sample site 11724 is located at FM 963, approximately 1.26 km upstream of the Lampasas River near Oakalla in Burnet County (Figure 120).

The Rocky Creek watershed at site 11724 is approximately 294.98 sq km. The station and vast majority of the watershed are located in Level IV Ecoregion 29e, the Limestone Cut Plain, while a small portion of the watershed boundary crosses into Ecoregion 30. The dominant land cover in the watershed is grassland/herbaceous at 36.98% and is present throughout the watershed (Homer et al. 2015; Figure 120 and Figure 121). Shrub is the secondary land cover encompassing 35.72%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 2.47% and total cover for cultivated crops is 0.10%.

From 1992-2011 there was a 13.43 sq km decrease in grassland and a 3.99 sq km decrease in forest. There was a 12.91 sq km increase in shrub and a 6.65 sq km increase in open space development (Figure 122).

There are no permitted wastewater outfalls within the Rocky Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Rocky Creek was evaluated during six sampling events from 1988 to 2004. Rocky Creek is an intermittent stream with perennial pools that drains to the Lampasas River above Stillhouse Hollow Lake. Habitat Quality Index scores are available for five events and indicate an intermediate to high aquatic life use rating (18-24). Riparian areas were generally well vegetated throughout the reach with an average riparian buffer ranging from 15-18 meters wide. The riparian zone was dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 25% to 40%. The dominant stream substrate was bedrock, and the average percent of substrate gravel size or larger varied from 50% to 90%. Average percent instream cover was 17% to 56%. Rocky Creek ranged from 0.12-0.35 meters deep on average and 8-17 meters wide. Average stream bank slope ranged from 38-45 degrees. Stream flow at the site was measured at a minimum value of 0.02 cfs and a maximum of 75 cfs. Average stream bank erosion potential was 21%-42%. The deepest pool measured at Rocky Creek was 0.8 meters. Number of riffles observed at the site varied from two to five and there were three stream bends.

Water Quality

Water samples were collected at station 11724 over 108 sampling events from June 1988 through June 2019. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twenty-four species (eight families) were collected over the course of the seven sampling events. Centrarchidae and Cyprinidae yielded the greatest species richness with eight and seven, respectively. Blacktail Shiner was the most abundant species in every collection except the one from May 2004 where Orangespotted Sunfish outnumbered it. Two species, Blacktail Shiner and Mimic Shiner, were present in every collection. Every fish assemblage rated as having either an exceptional or high aquatic life use. When the coefficient of variability was applied, every collection except August 2004 rated as exceptional. This most recently collected sample yielded fewer sunfish species (three verses 4-6) and many fewer species overall (nine verses 13-16) resulting in scores of three rather than five for those specific IBI metrics. Though it did not affect the metric score, the August 2004 sample also yielded the lowest number of cyprinid species and smallest percentage of piscivores.

Benthic Macroinvertebrates

Considering the one Surber sample and five RBP samples collectively, a total of 979 individuals representing 93 taxa from 19 orders of macroinvertebrates were collected from Rocky Creek (Appendix E). Diptera, Hemiptera, Ephemeroptera, Trichoptera, Basommatophora, Coleoptera, and Odonata were the most commonly collected orders, collectively accounting for 91.4 percent of the total number of individuals collected. Plecoptera, Veneroida, Megaloptera, and Oligochaeta were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the 1988 Surber sample fell in the exceptional aquatic life use category. The Ecoregions 27, 29, and 32 BIBI for the April 2003 and May 2004 samples fell in the high aquatic life use category, while the samples from August 2002 and August 2004 fell in the intermediate aquatic life use category. The August 2003 RBP sample fell in the limited aquatic life use category.

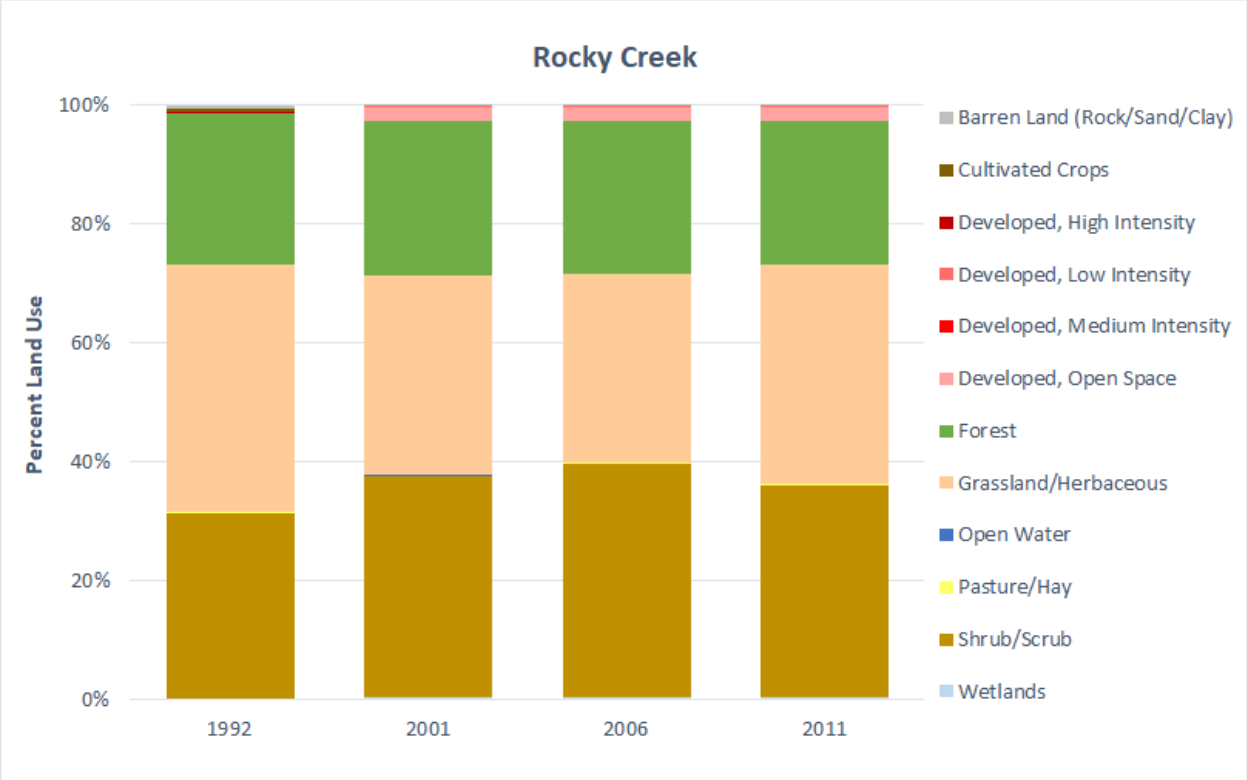

Figure 121. Percent land use in the Rocky Creek watershed from 1992-2011.

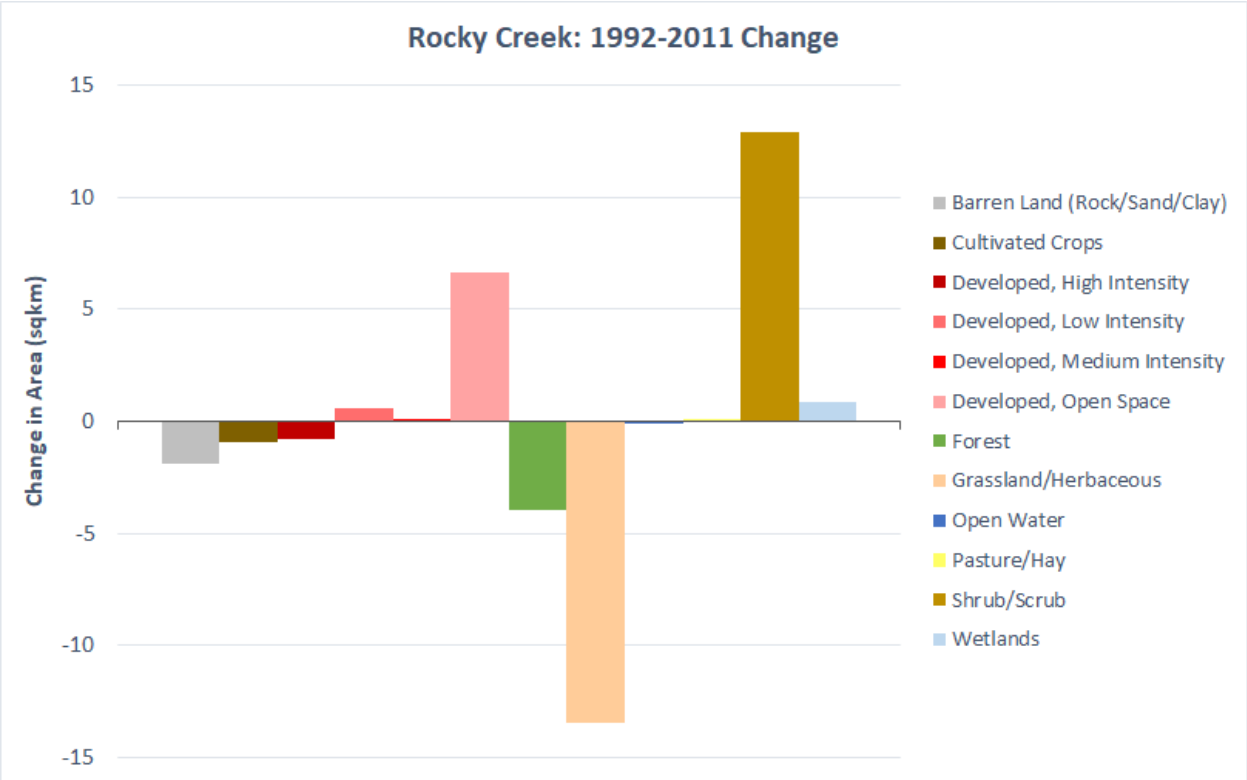

Figure 122. Land use change in area (sq km) from 1992-2011 for the Rocky Creek watershed.

SOUTH FORK ROCKY CREEK

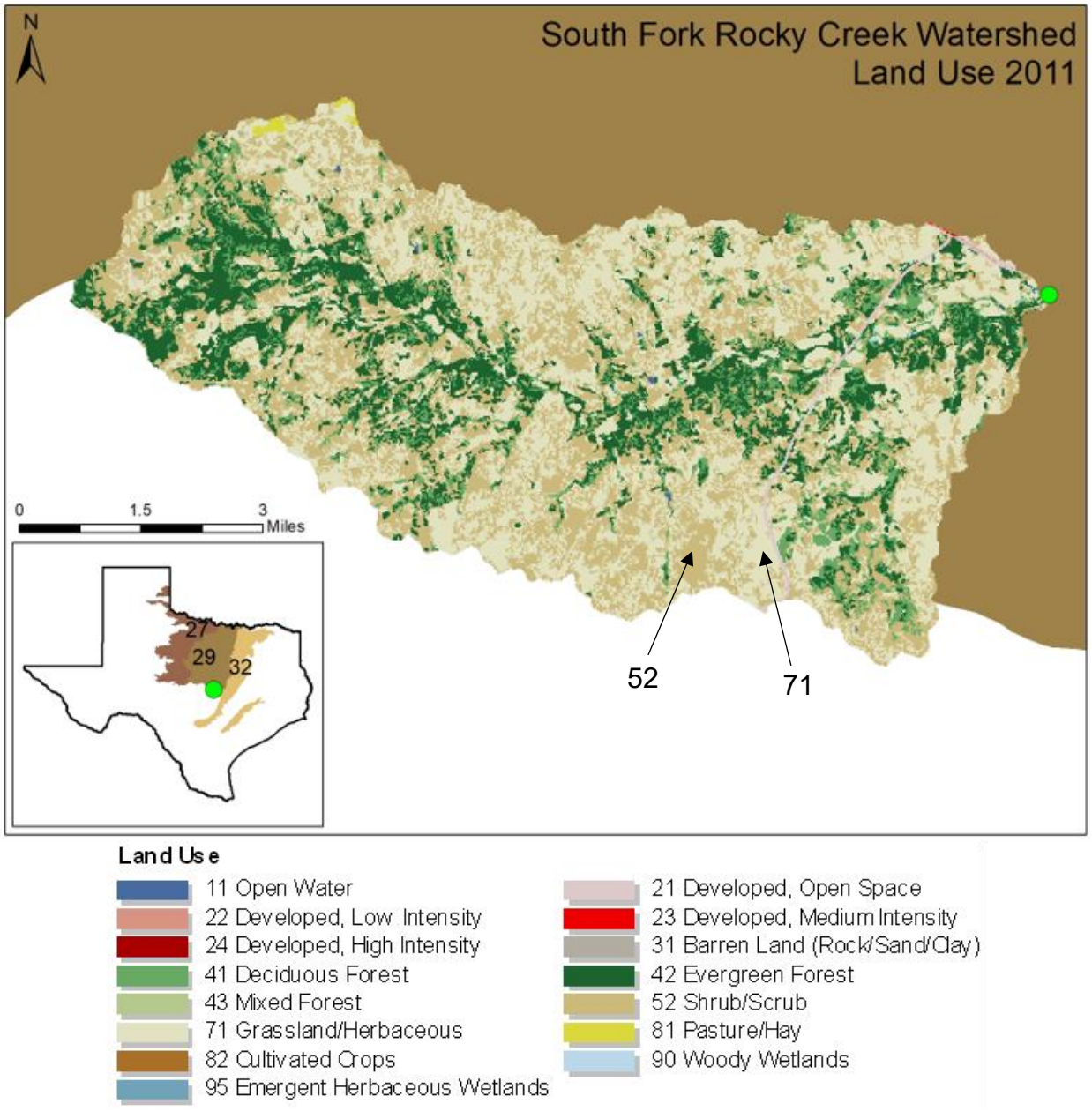

Figure 123. Map of South Fork Rocky Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	April 18, 2003; August 19, 2003; May 5, 2004; September 24, 2007
Water Quality:	19 sampling events
Fish:	April 18, 2003; August 19, 2003; May 4, 2004; September 24, 2007
Benthic Invertebrates:	August 7, 2002; April 18, 2003; May 5, 2004; August 20, 2004; September 24, 2007

Physical Characterization

Watershed and Land Use

South Fork Rocky Creek lies within the Brazos River Basin. Sample site 18333 is located 405 m upstream of US 183 near Watson in Burnet County (Figure 123).

The South Fork Rocky Creek watershed at site 18333 is approximately 120.72 sq km. The station and vast majority of the watershed are located in Level IV Ecoregion 29e, the Limestone Cut Plain, while a small portion of the watershed boundary crosses into Ecoregion 30. The dominant land cover in the watershed is grassland/herbaceous at 37.28% and is present throughout the watershed (Homer et al. 2015; Figure 123 and Figure 124). Shrub is the secondary land cover encompassing 35.54%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.73% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 4.91 sq km decrease in forest and a 4.50 sq km decrease in shrub. There was a 9.26 sq km increase in grassland and a 0.82 sq km increase in open space development (Figure 125).

There are no permitted wastewater outfalls within the South Fork Rocky Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for South Fork Rocky Creek was evaluated during four sampling events from 2003 to 2007. South Fork Rocky Creek is an intermittent stream with perennial pools that drains to Rocky Creek in northern Burnet County. Habitat Quality Index scores are available for all four events and indicate an intermediate to exceptional aquatic life use rating (19-26). Riparian areas were variable with an average riparian buffer ranging from 3.4 meters wide in April 2003 to greater than 20 meters wide in 2004 and 2007. The riparian zone was generally dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 5% to 28%. The dominant stream substrate was cobble and bedrock, and the average percent of substrate gravel size or larger varied from 34% to 90%. Average percent instream cover was 13% to 82%. South Fork Rocky Creek ranged from 0.2-0.4 meters deep on average and 6.8-11.7 meters wide. Average stream bank slope ranged from 33-50 degrees. Stream flow at the site was measured at a minimum value of 0 cfs and a maximum of 20 cfs. Average stream bank erosion potential was 27%-48%. The deepest pool measured at South Fork Rocky Creek was 1.8 meters. Number of riffles observed at the site varied from one to seven, and total number of stream bends ranged from three to four.

Water Quality

Water samples were collected at station 18333 over 19 sampling events from August 2002 through March 2020. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Fifteen species (six families) were collected over the course of the four sampling events. Centrarchidae was the richest family with seven species. Five species were collected in every sample. These included Blacktail Shiner, Orangethroat Darter, Green Sunfish, Bluegill, and Longear Sunfish. The aquatic life use (based upon the fish assemblage) rated as high for all four collections. When the coefficient of variability was applied the 2004 sample reached exceptional.

Benthic Macroinvertebrates

Considering the five RBP samples collectively, a total of 620 individuals representing 54 taxa from 16 orders of macroinvertebrates were collected from South Fork Rocky Creek (Appendix E). Ephemeroptera, Trichoptera, Diptera, Odonata, and Hemiptera were the most commonly collected orders, collectively accounting for 91.8 percent of the total number of individuals collected. Plecoptera, Neoophora, Coleoptera, and Oligochaeta were the only other orders which comprised at least one percent of the collections.

The Ecoregions 27, 29, and 32 BIBI for the 2007 RBP sample fell in the exceptional aquatic life use category while the RBP BIBI for the sample collected in 2002 fell in the high aquatic life use category. The RBP samples from 2003 and 2004 fell in the intermediate aquatic life use category.

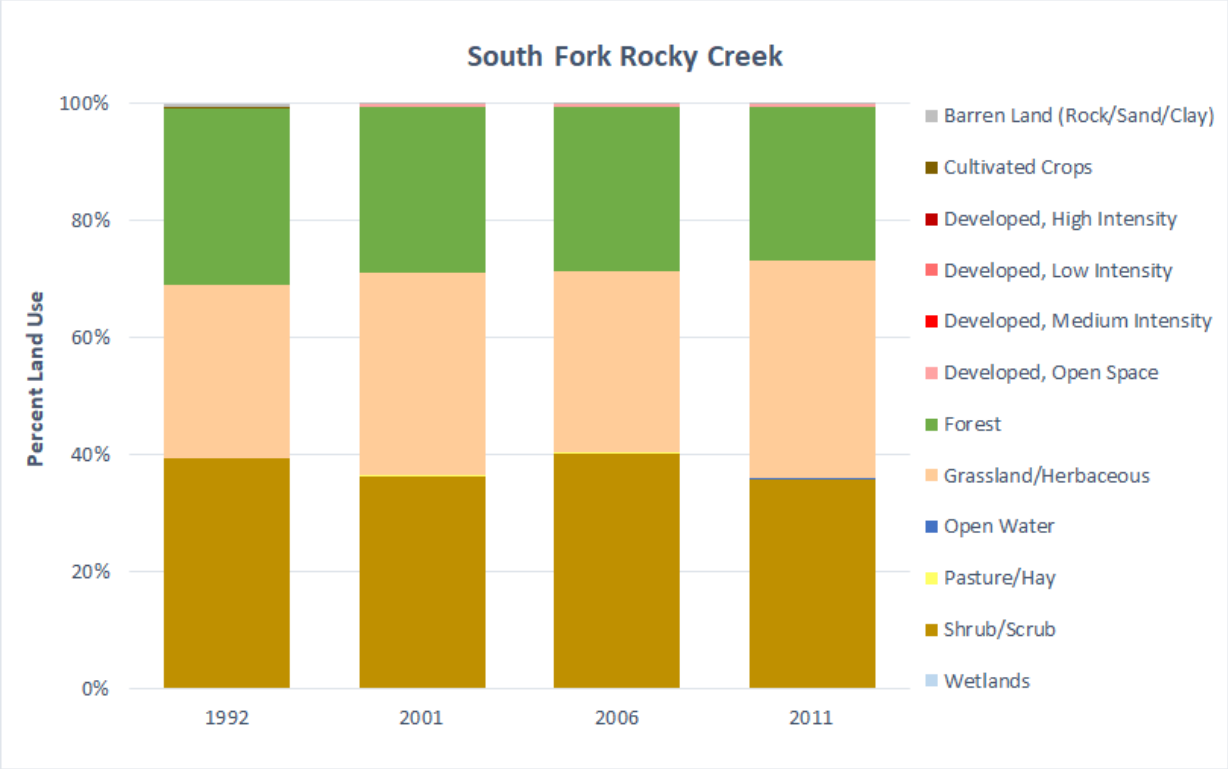

Figure 124. Percent land use in the South Fork Rocky Creek watershed from 1992-2011.

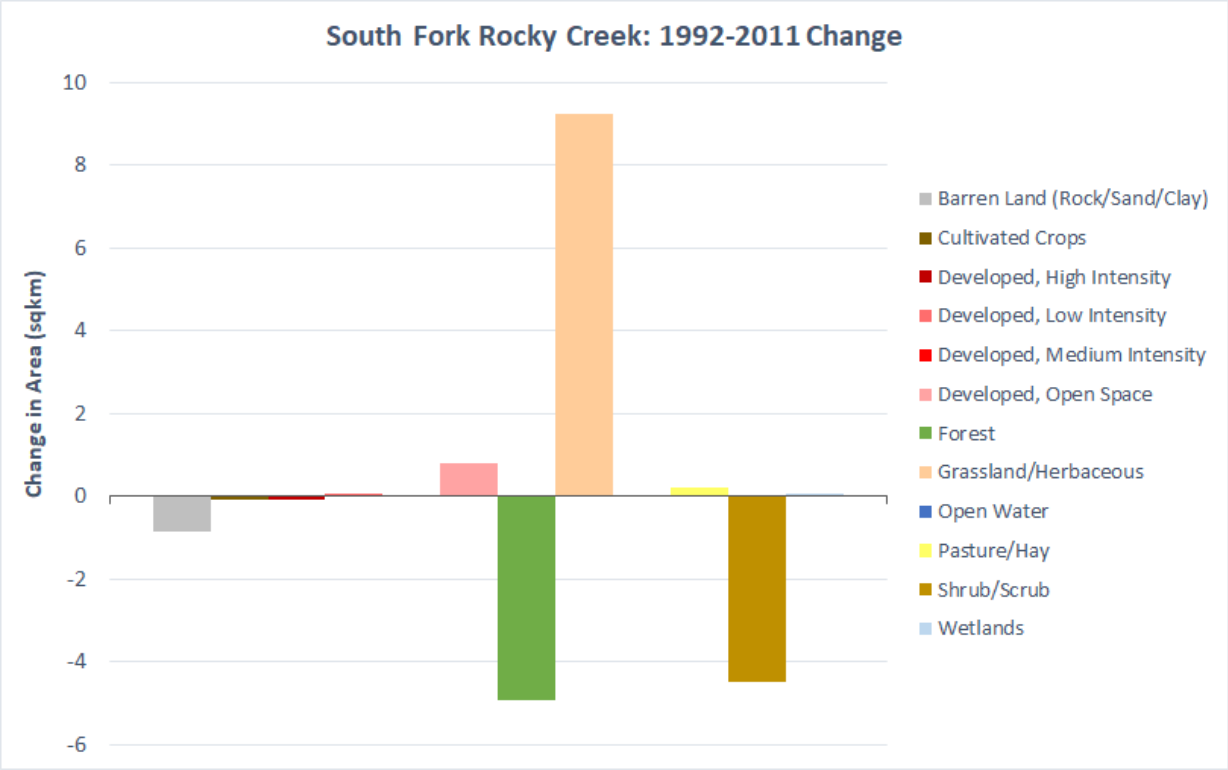

Figure 125. Land use change in area (sq km) from 1992-2011 for the South Fork Rocky Creek watershed.

STEELE CREEK

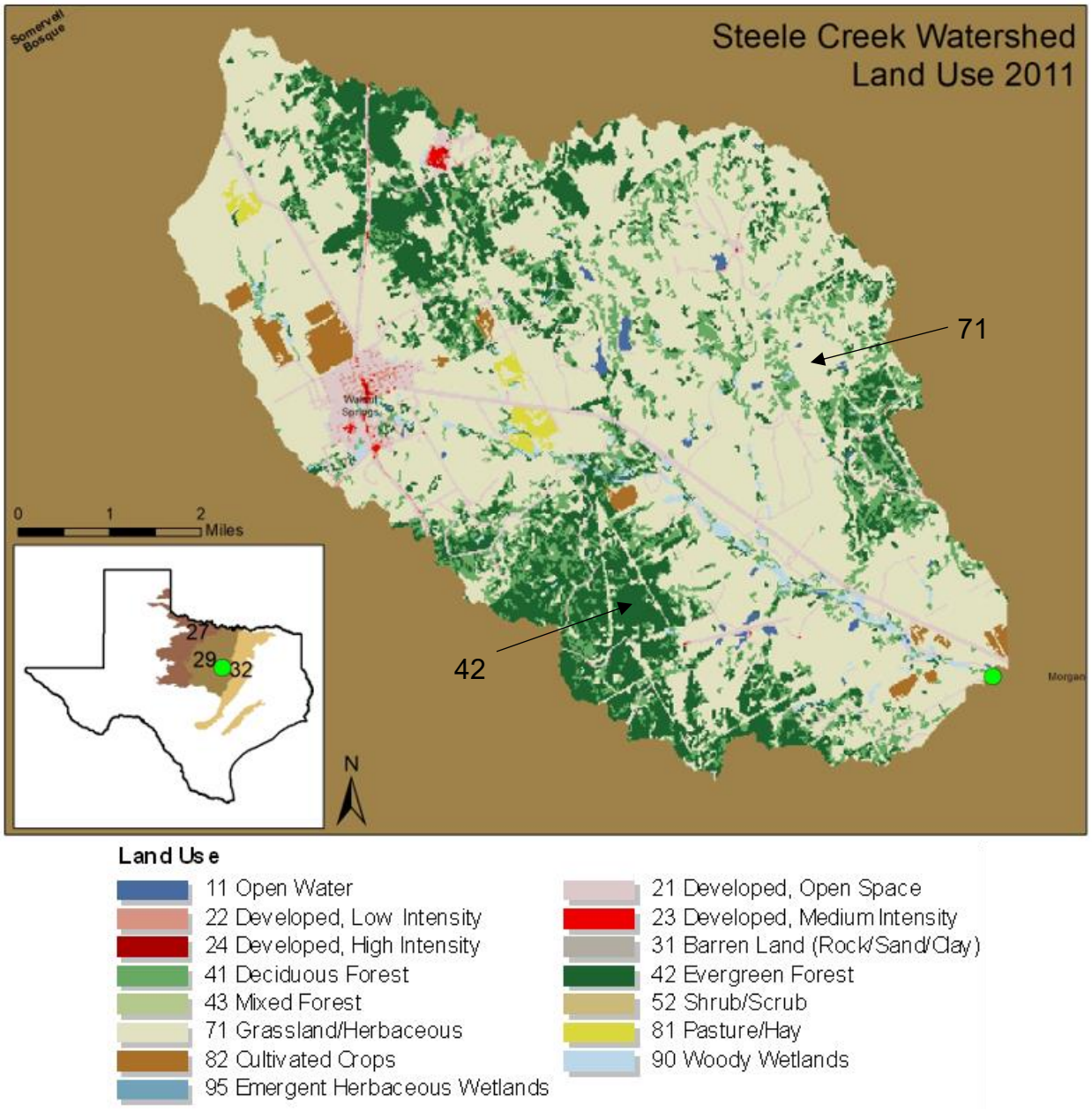

Figure 126. Map of Steele Creek watershed location and 2011 land use; grassland/herbaceous and forest were the most common land uses.

Sampling Dates

Physical Habitat:	July 12, 1988
Water Quality:	3 sampling events
Fish:	July 13, 1988; April 18, 1989
Benthic Invertebrates:	July 13, 1988

Physical Characterization

Watershed and Land Use

Steele Creek lies within the Brazos River Basin. Sample site 11836 is located 639 m upstream of CR 2620, approximately 1.93 km west of Morgan in Bosque County (Figure 126).

The Steele Creek watershed at site 11836 is approximately 113.46 sq km. The entire watershed lies within Level IV Ecoregion 29e, the Limestone Cut Plain. The dominant land cover in the watershed is grassland/herbaceous at 60.18% and is present throughout the watershed (Homer et al. 2015; Figure 126 and Figure 127). Forest is the secondary land cover encompassing 29.19%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 6.47% and total cover for cultivated crops is 1.57%.

From 1992-2011 there was a 22.81 sq km decrease in shrub and an 8.36 sq km decrease in pasture/hay. There was an 18.63 sq km increase in grassland and a 6.86 sq km increase in forest (Figure 128).

There is one domestic wastewater outfall (discharges < 1 million gallons per day) within the Steele Creek watershed permitted to the City of Walnut Springs which discharges directly into Steele Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Steele Creek was evaluated on July 12, 1988. Steele Creek is a perennial stream that drains to the Steele Creek Arm of Lake Whitney. The riparian width was 30 meters. The riparian zone was dominated by trees, which made up an average of 40% of the total riparian species, followed by shrubs and grasses (30% each). The average percentage of tree canopy cover was 10%. The dominant substrate was bedrock in riffles/runs with gravel and sand in pools, and the average percent of substrate that was gravel size or larger was 18%. Average percent instream cover was 8%. Steele Creek had an average depth of 0.4 meters and a maximum depth of 0.8 meters. The average width was 10.5 meters and average stream bank slope was 30 degrees. Stream flow at the site was 0.7 cfs. Average stream bank erosion potential was 28%. Five riffles were observed at the site and there were two total stream bends.

Water Quality

Water samples were collected at station 11836 over three sampling events from July 1988 through July 1999. Data were collected for temperature, flow, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Fifteen species (six families) were collected between the two sampling events. Centrarchidae and Cyprinidae yielded the greatest species richness with five and four, respectively. Blacktail Shiner

was the most abundant species. The aquatic life use rated as exceptional and high for the 1988 and 1989 fish assemblages, respectively.

Benthic Macroinvertebrates

A total of 270 individuals representing 41 taxa from 10 orders of macroinvertebrates were collected in the Surber sample from Steele Creek (Appendix E) on July 13, 1988. Diptera, Ephemeroptera, Odonata, Trichoptera, and Coleoptera were the most commonly collected orders, collectively accounting for 91.5 percent of the total number of individuals collected. Basommatophora and Hoplonemertea were the only other orders which comprised at least one percent of the collection.

The Ecoregions 27, 29, and 32 Surber BIBI fell in the high aquatic life use category for the sample.

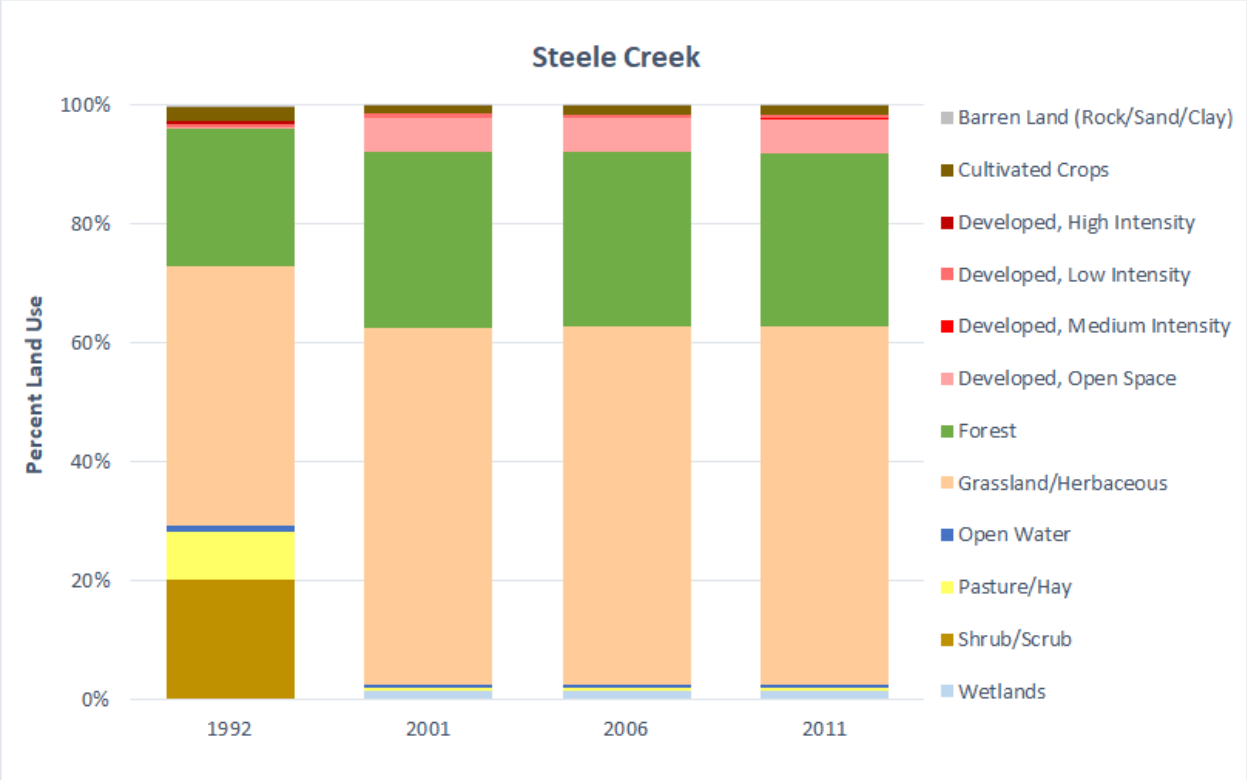

Figure 127. Percent land use in the Steele Creek watershed from 1992-2011.

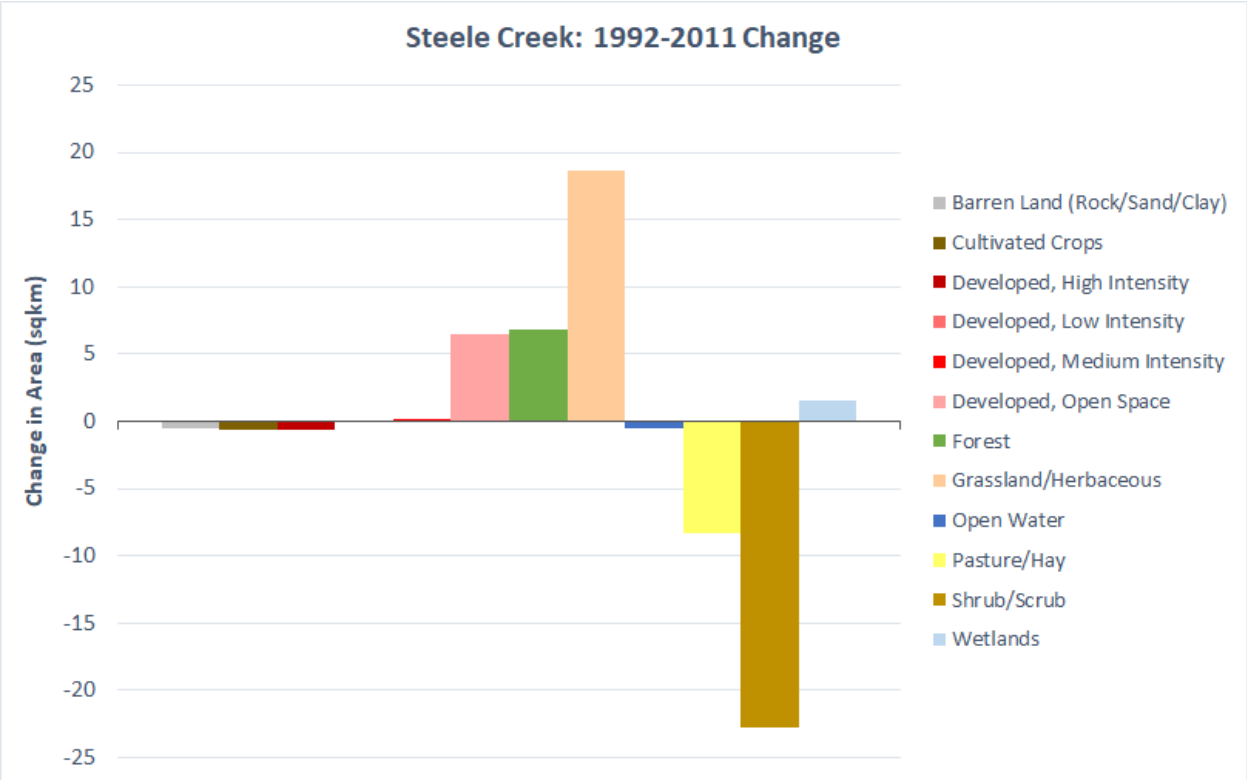

Figure 128. Land use change in area (sq km) from 1992-2011 for the Steele Creek watershed.

Ecoregion 32 Characterization

The Texas Blackland Prairies ecoregion is comprised of two parallel bands separated by the East Central Texas Plains ecoregion (Ecoregion 33) and extending from southern Texas north to very near the Oklahoma border. The ecoregion covers approximately 43,380 sq km and encompasses all or part of 42 counties in the swath the ecoregion cuts across the central part of the state (Figure 80). The ecoregion is bordered on the west by the Cross Timbers (Ecoregion 29), the Edwards Plateau (Ecoregion 30), and by a small stretch adjacent to the Southern Texas Plains (Ecoregion 31). The East Central Texas Plains (Ecoregion 33) forms the southern, eastern, and northern extent of the blackland prairies. Portions of the Red, Brazos, Trinity, San Antonio, and Colorado River Basins are included in the ecoregion. The ecoregion is contained entirely within the state.

The ecoregion was historically prairie with grasses such as little bluestem *Schizachyrium scoparium*, big bluestem *Andropogon gerardi*, yellow Indiangrass *Sorghastrum nutans*, and switchgrass *Panicum virgatum* remaining in areas that have not been converted to cropland, pasture, and forage production (Griffith et al. 2007). Griffith et al. (2007) also note the ecoregion is experiencing growth in urban areas. Annual average precipitation in the ecoregion generally ranges from 71-107 cm. Riparian vegetation along streams in the ecoregion often includes bur oak *Quercus macrocarpa*, Shumard oak *Q. shumardii,* hackberry, elm, ash *Fraxinus* sp., cottonwood, and pecan.

Table 8. Streams sampled in Ecoregion 32.

Auds Creek	Deer Creek	Willis Creek
Cow Bayou	Geronimo Creek	Wilson Creek

AUDS CREEK

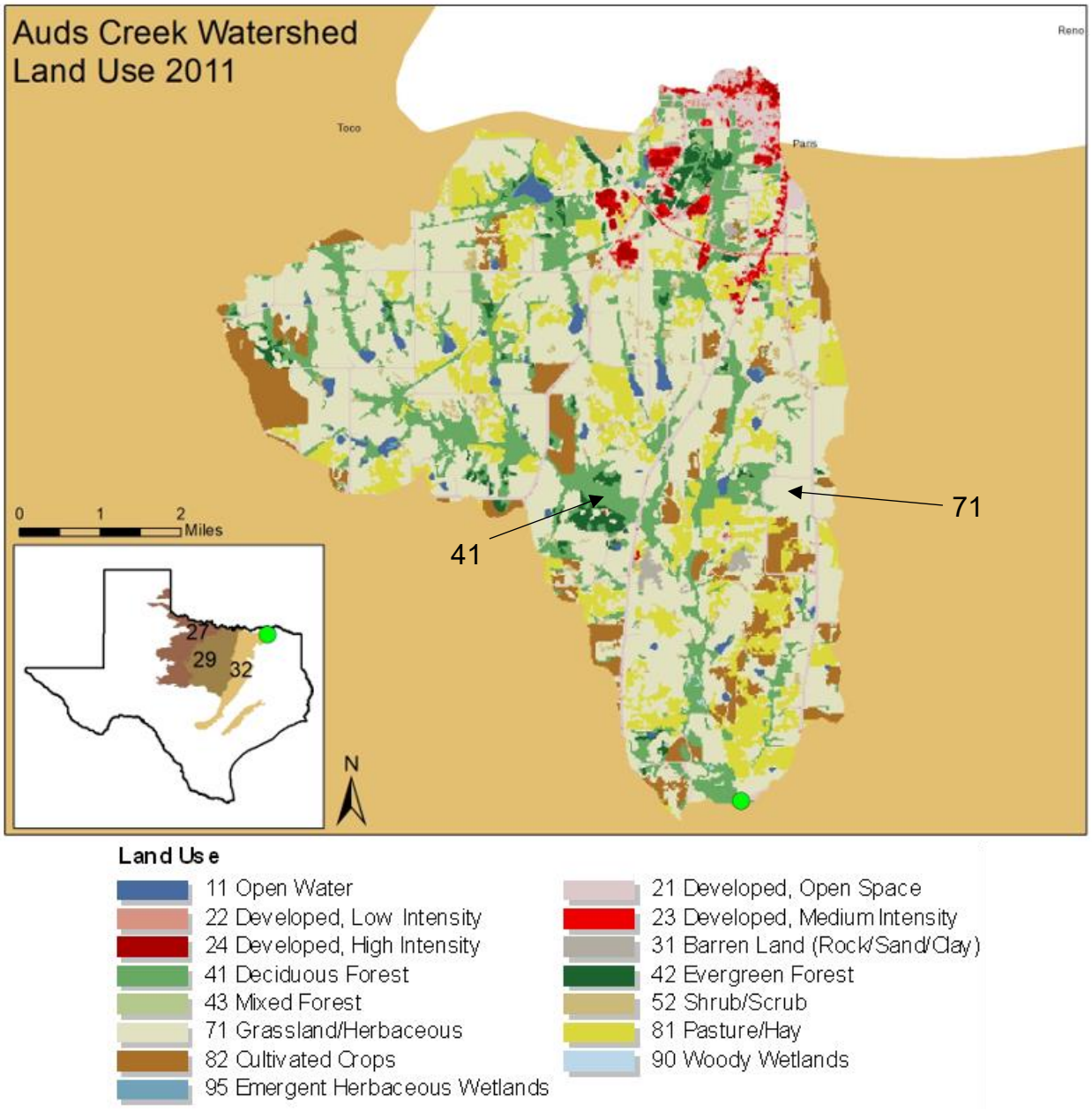

Figure 129. Map of Auds Creek watershed location and 2011 land use; grassland/herbaceous and forest were the most common land uses.

Sampling Dates

Physical Habitat:	August 1, 1989; May 22, 2002
Water Quality:	12 sampling events
Fish:	August 2, 1989; May 22, 2002; July 4, 2002
Benthic Invertebrates:	August 2, 1989; May 22, 2002; July 4, 2002

Physical Characterization

Watershed and Land Use

Auds Creek lies within the Sulphur River Basin. Sample site 10197 is located at FM 1184 south of Paris in Lamar County (Figure 129).

The Auds Creek watershed at site 10197 is approximately 103.92 sq km. The vast majority of the watershed lies within Level IV Ecoregion 32a, the Northern Blackland Prairie. There is a small portion of the upper watershed that crosses into Ecoregion 33. The dominant land cover in the watershed is grassland/herbaceous at 48.40% and is present throughout the watershed (Homer et al. 2015; Figure 129 and Figure 130). The secondary land cover is forest at 17.57%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 8.80% and total cover for cultivated crop is 7.44%.

From 1992-2011 there was a 35.68 sq km decrease in pasture/hay and a 21.72 sq km decrease in cultivated crops. There was a 50.29 sq km increase in grassland/herbaceous and a 5.65 sq km increase in open space development (Figure 131).

There are five industrial wastewater outfalls (discharges ≥ 1 million gallons per day) and three stormwater outfalls within the Auds Creek watershed. The stormwater outfalls and one industrial wastewater facility are permitted to Kimberly Clark Corporation, an American multinational personal care corporation that produces mostly paper-based consumer products. Two of the industrial wastewater outfalls are permitted to La Frontera Holdings, LLC which is a natural gas generation facility, another facility is permitted to Lamar Power Partners, an electricity generation power plant, and the final facility is permitted to Turner Industries Group, LLC a company involved with construction, pipe, module, and vessel fabrication. None of these facilities or stormwater outfalls discharge directly into Auds Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Auds Creek was evaluated on August 1, 1989 and again on May 22, 2002. Auds Creek is a perennial stream that drains to the North Sulphur River south of Paris. The following summary information is based on data collected during the most recent sampling event in 2002. The Habitat Quality Index score of 18 indicates an intermediate aquatic life use rating. Riparian areas were generally well vegetated throughout the reach with an average riparian buffer measured at 13 meters, and there was evidence that the stream had been terraced and channelized in the distant past. The riparian zone was dominated by grasses followed by trees then shrubs. The average percentage of tree canopy cover was 8%. The dominant substrate was silt, and the average percent of substrate that was gravel size or larger was 39%. Average percent instream cover was 30%. Auds Creek was 0.3 meters deep on average and 9 meters wide. Average stream bank slope was 27 degrees, and average stream bank erosion potential was 53%. No pools were measured on Auds Creek in 2002. Stream flow at the site was measured at a minimum value of 1.3 cfs in 1989 and a maximum of 2.6 cfs in 2002. Two riffles were observed at the site in 2002 and there were two well defined stream bends.

Water Quality

Water samples were collected at station 10197 over 12 sampling events from August 1989 through July 2002. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Sixteen species (four families) were collected over the course of three sampling events. The family with the most species represented was Centrarchidae with seven. Red Shiner, a tolerant species, was the most abundant species collected. The aquatic life use rating for all fish collections was only intermediate; however, when the coefficient of variability is applied, the 2002 collections rise to high. The primary reasons for the lower aquatic life use ratings were the absence of benthic invertivore species, the assemblage being dominated by tolerant species (greater than 85% of the individuals), and the low catch rate.

Benthic Macroinvertebrates

Considering the one Surber sample and two RBP samples collectively, a total of 403 individuals representing 34 taxa from 12 orders of macroinvertebrates were collected from Auds Creek (Appendix E). Ephemeroptera, Diptera, Trichoptera, and Odonata were the most commonly collected orders, collectively accounting for 92.6 percent of the total number of individuals collected. Coleoptera, Veneroida, and Hemiptera were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the 1989 Surber sample fell in the high aquatic life use category. Similarly, the Ecoregions 27, 29, and 32 BIBI for the two 2002 RBP samples fell in the intermediate aquatic life use category.

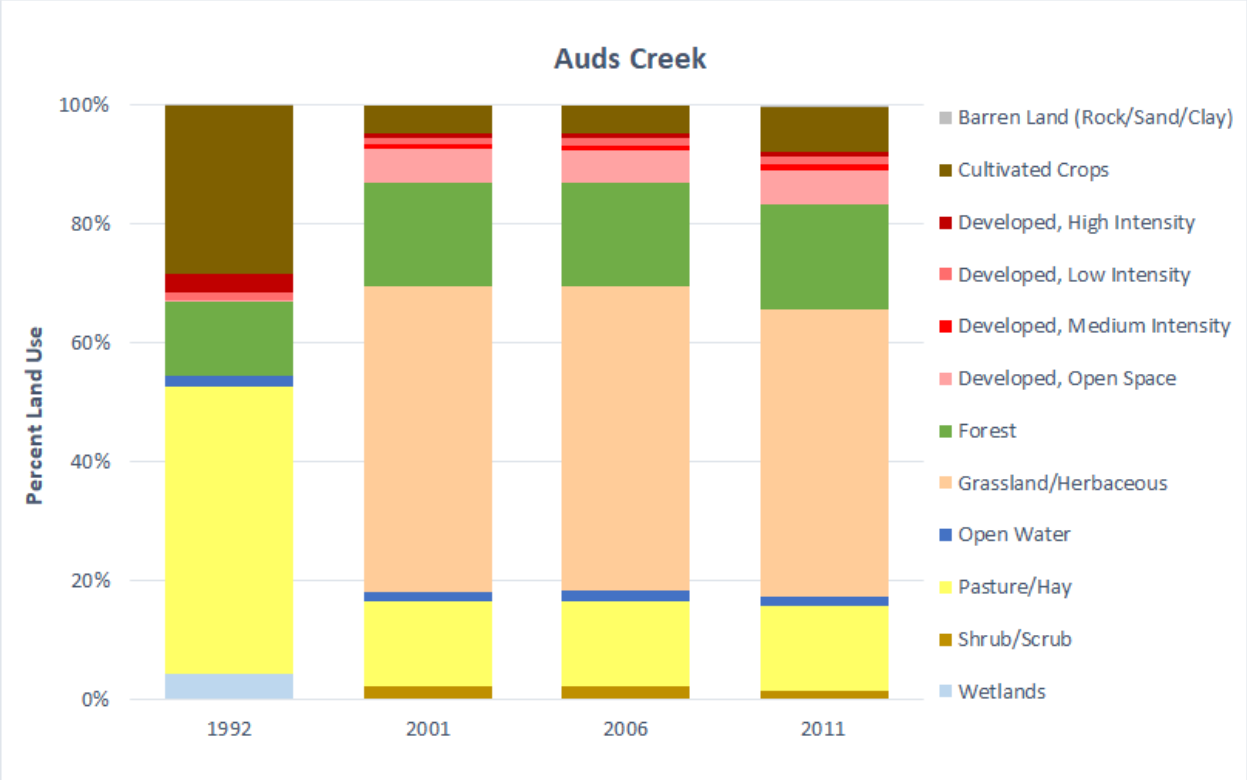

Figure 130. Percent land use in the Auds Creek watershed from 1992-2011.

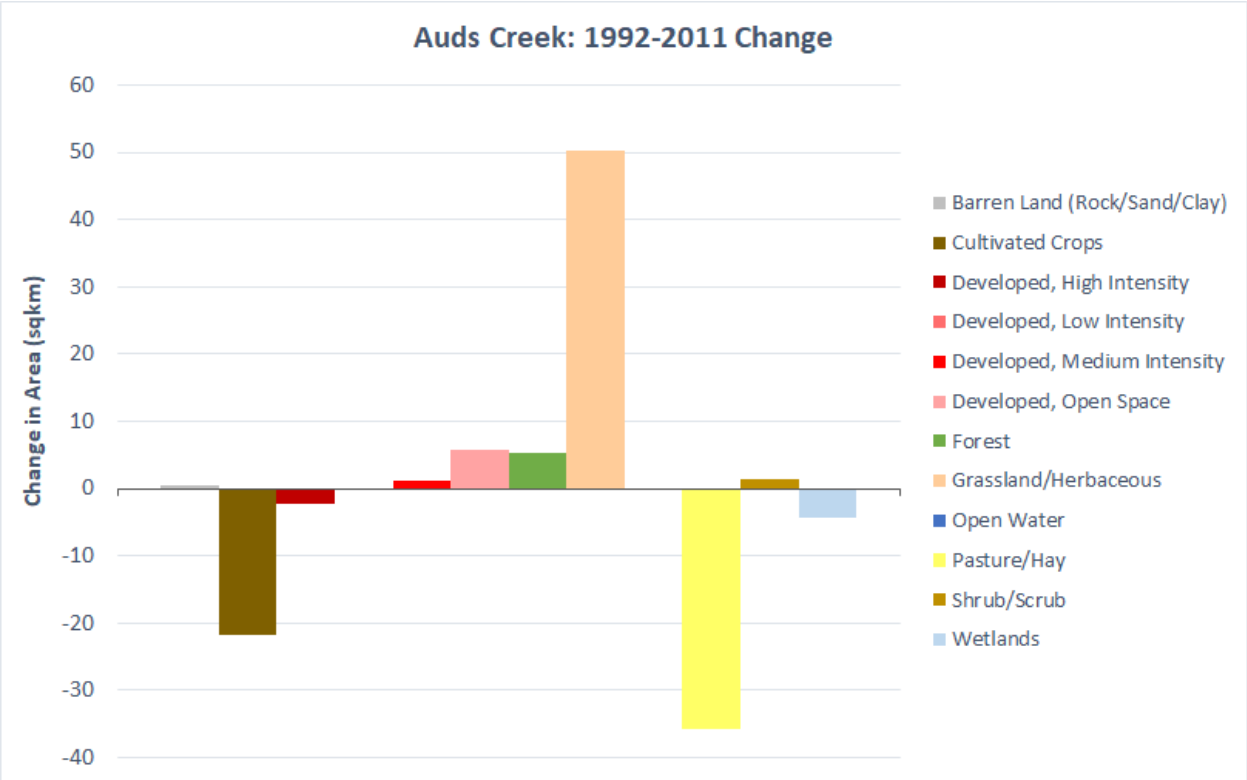

Figure 131. Land use change in area (sq km) from 1992-2011 for the Auds Creek watershed.

COW BAYOU

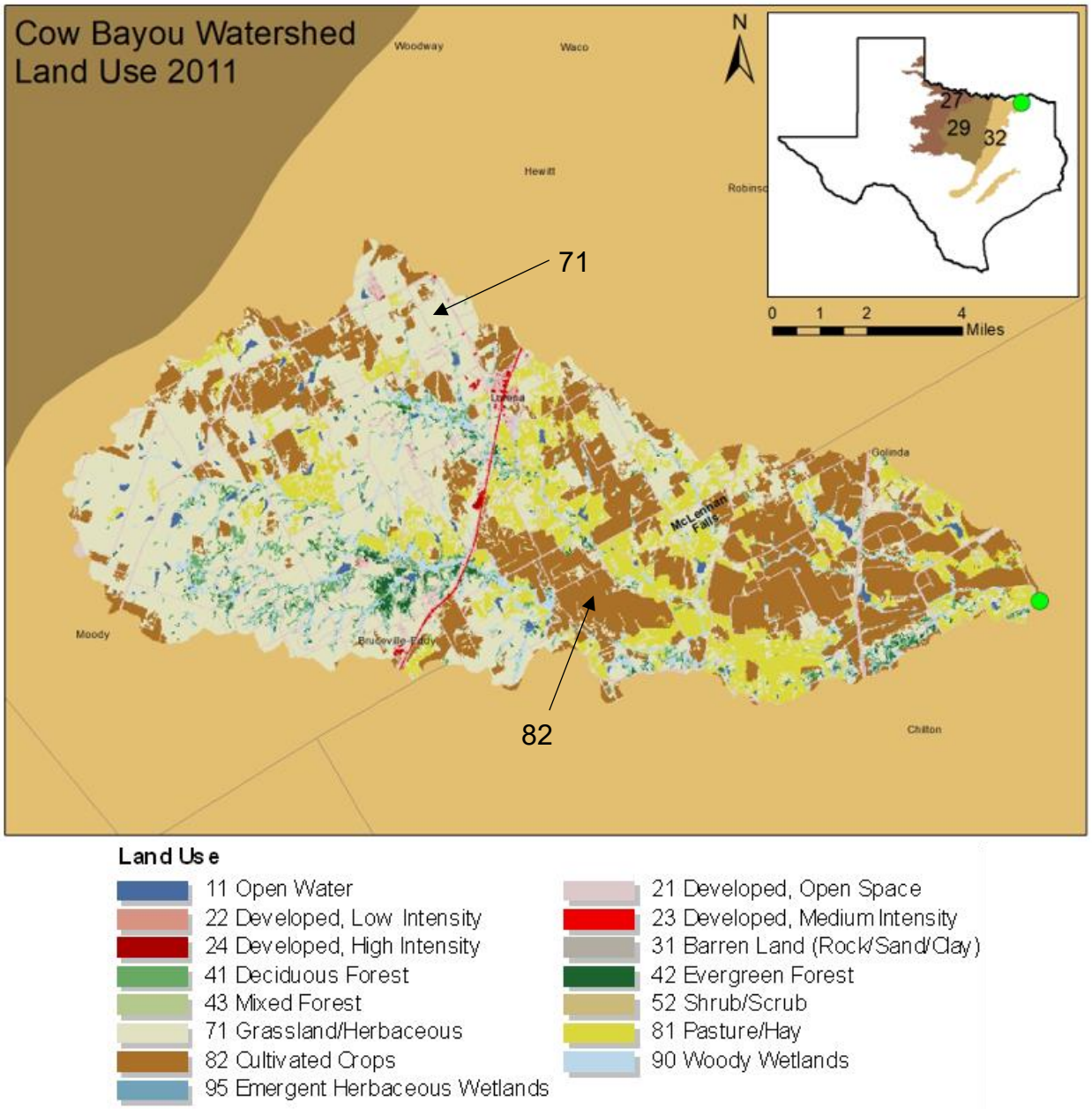

Figure 132. Map of Cow Bayou watershed location and 2011 land use; grassland/herbaceous and cultivated crops were the most common land uses.

Sampling Dates

Physical Habitat:	July 14, 1987; April 29, 2010
Water Quality:	4 sampling events
Fish:	July 14, 1987; April 30, 2010; July 26, 2010
Benthic Invertebrates:	July 16, 1987 (two locations); April 30, 2010; July 26, 2010

Physical Characterization

Watershed and Land Use

Cow Bayou lies within the Brazos River Basin. Sample site 11717 is located downstream of CR 417, approximately 2.57 km south of Satin in Falls County (Figure 132).

The Cow Bayou watershed at site 11717 is approximately 289.11 sq km. The entire watershed lies within Level IV Ecoregion 32a, the Northern Blackland Prairie. The dominant land cover in the watershed is grassland/herbaceous at 42% and is mostly present in the upper watershed (Homer et al. 2015; Figure 132 and Figure 133). Cultivated crops is the secondary land cover encompassing 26.56%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 7.61%.

From 1992-2011 there was a 41.48 sq km decrease in shrub and a 20.32 sq km decrease in forest. There was a 51.56 sq km increase in grassland and a 19.34 sq km increase in open space development (Figure 134).

There is one domestic wastewater outfall (discharges < 1 million gallons per day) within the Cow Bayou watershed permitted to the City of Bruceville-Eddy. This facility does not discharge directly into Cow Bayou.

In Channel and Riparian Physical Habitat

Physical habitat for Cow Bayou was evaluated on July 14, 1987 and again on April 29, 2010. Cow Bayou is a perennial stream that drains to the Brazos River in Falls County. The following summary information is based on data collected during the most recent sampling event in 2010. The Habitat Quality Index score of 20.5 indicates a high aquatic life use rating. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at 18 meters wide. The riparian zone was dominated by grasses, which made up an average of 62% of the total riparian species, followed by trees (18%) then shrubs (15%). The average percentage of tree canopy cover was 64%. The dominant substrate was sand, and the average percent of substrate that was gravel size or larger was 28%. Average percent instream cover was 6%. Cow Bayou was 0.3 meters deep on average and 8 meters wide. Average stream bank slope was 32 degrees, and average stream bank erosion potential was 34%. The deepest pool measured at Cow Bayou was 1.2 meters. Stream flow at the site was measured at a minimum value of 6.7 cfs in 1987 and a maximum of 32 cfs in 2010. Two riffles were observed at the site in 2010 and there were four total stream bends.

Water Quality

Water samples were collected at station 11717 over 4 sampling events from July 1987 through July 1999. Data were collected for temperature, flow, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twenty-seven species (eight families) were collected over the course of the three sampling events. Cyprinidae and Centrarchidae were the most species rich families, yielding eight and seven species, respectively. Blacktail Shiner was the most abundant species in the 1987 collection, whereas Red Shiner was the most abundant species in both 2010 collections. Based upon the fish assemblage, Cow Bayou rated as having a high aquatic life use in 1987 and April 2010 and an exceptional aquatic life use in July 2010. When the coefficient of variability is applied the 1987 sample rises to exceptional.

Benthic Macroinvertebrates

Considering the two Surber samples and two RBP samples collectively, a total of 667 individuals representing 69 taxa from 17 orders of macroinvertebrates were collected from Cow Bayou (Appendix E). Diptera, Trichoptera, Ephemeroptera, Odonata, Veneroida, and Plecoptera were the most commonly collected orders, collectively accounting for 91.9 percent of the total number of individuals collected. Coleoptera, Tricladida, and Megaloptera were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the 1987 Surber samples at Falls County Road and FM 2643 fell in the exceptional and high aquatic life use categories, respectively. The Ecoregions 27, 29, and 32 BIBI for the April and July 2010 RBP samples fell in the intermediate and high aquatic life use categories, respectively.

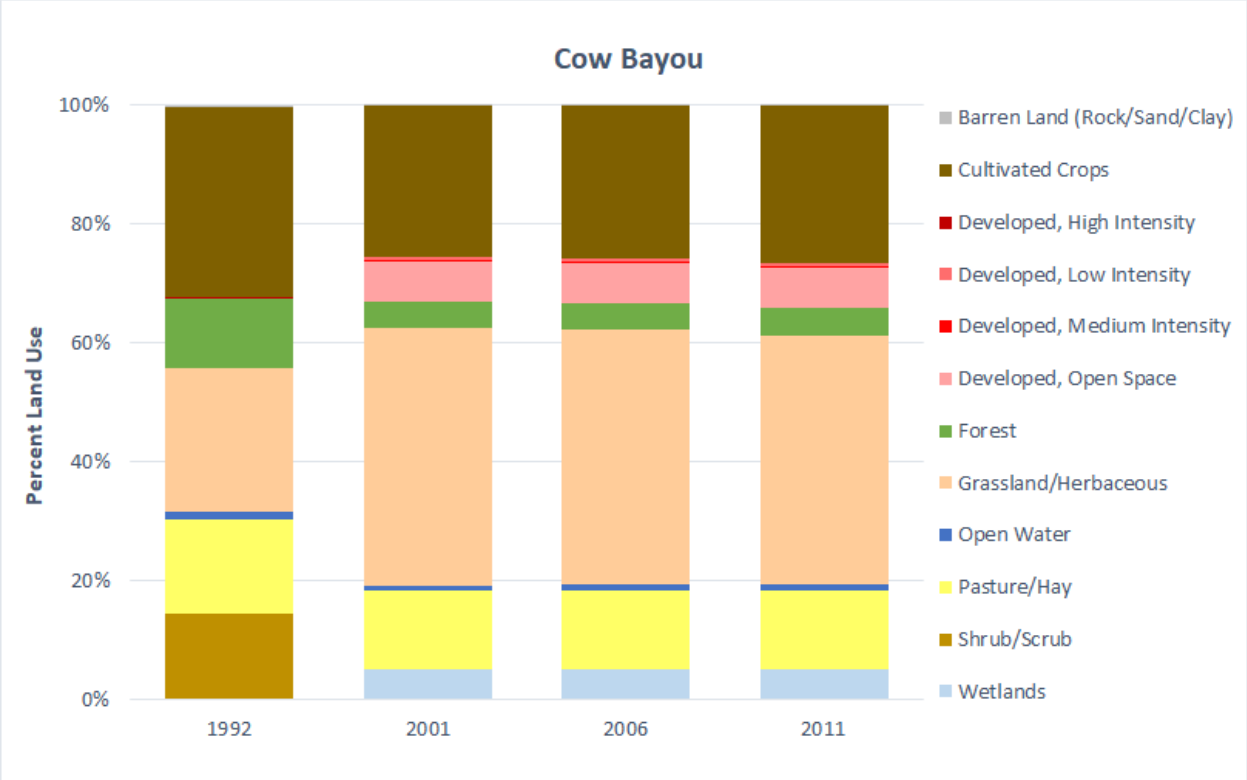

Figure 133. Percent land use in the Cow Bayou watershed from 1992-2011.

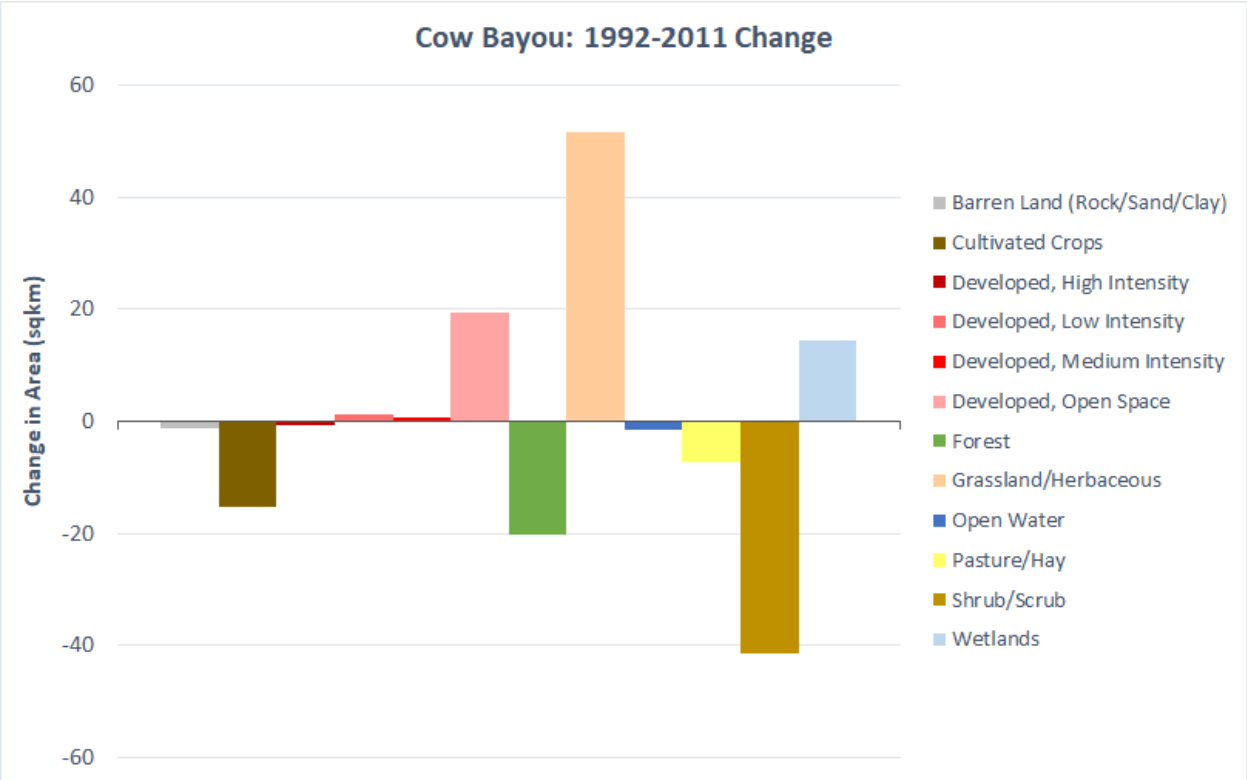

Figure 134. Land use change in area (sq km) from 1992-2011 for the Cow Bayou watershed.

DEER CREEK

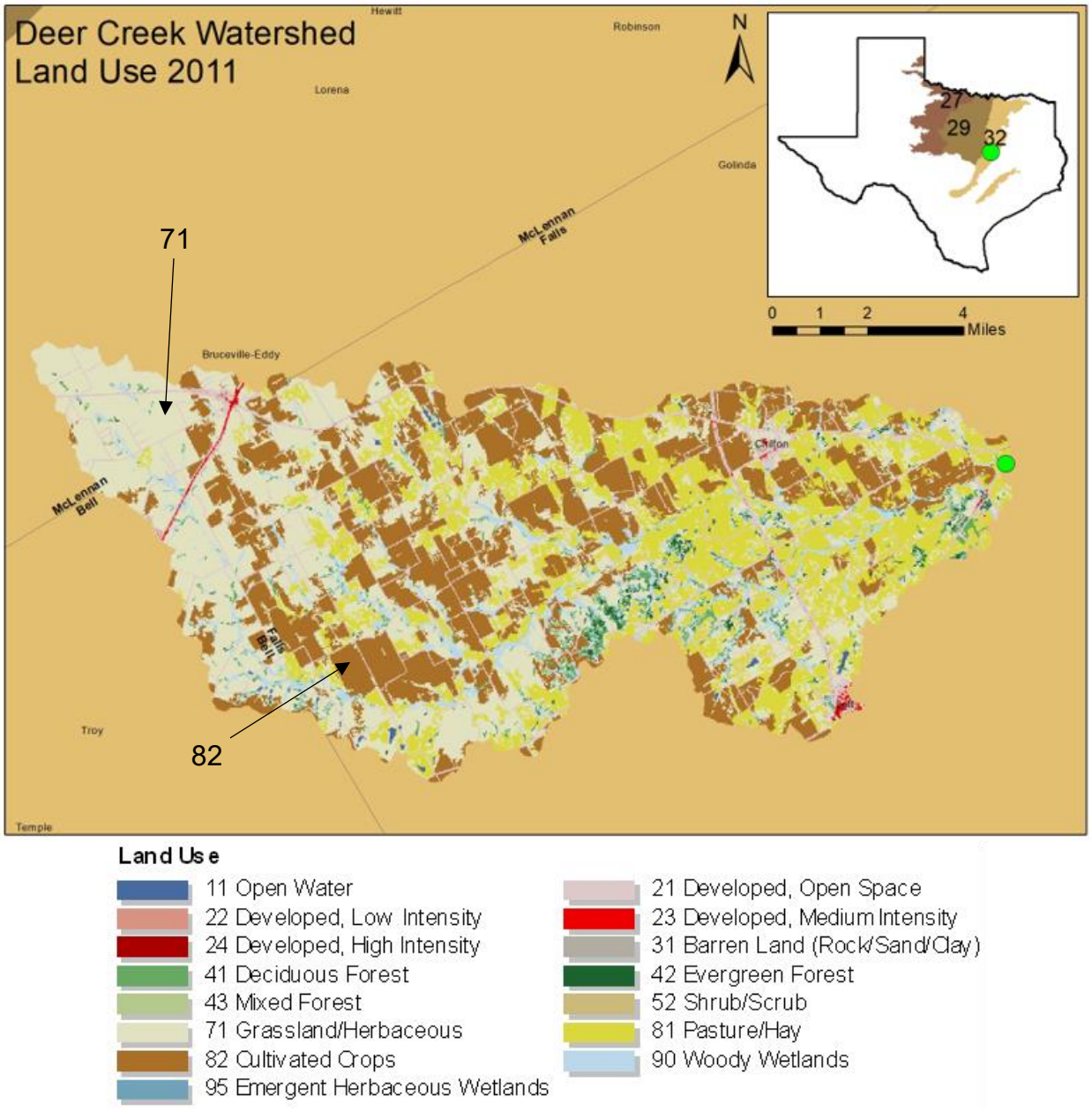

Figure 135. Map of Deer Creek watershed location and 2011 land use; grassland/herbaceous and cultivated crops were the most common land uses.

Sampling Dates

Physical Habitat:	July 18, 1989; March 31, 2004; July 21, 2004
Water Quality:	101 sampling events at two stations
Fish:	July 18, 1989; March 31, 2004; July 21, 2004
Benthic Invertebrates:	July 18, 1989; March 31, 2004; July 21, 2004

Physical Characterization

Watershed and Land Use

Deer Creek lies within the Brazos River Basin. Sample site 11723 is located downstream of SH 320 west of Marlin in Falls County (Figure 135).

The Deer Creek watershed at site 11723 is approximately 296.93 sq km. The vast majority of the watershed lies within Level IV Ecoregion 32a, the Northern Blackland Prairie, the station and a very small portion of the lower watershed lies in Level IV Ecoregion 32c, the Floodplains and Low Terraces. The dominant land cover in the watershed is grassland/herbaceous at 34.97% and is mostly present in the upper watershed (Homer et al. 2015; Figure 135 and Figure 136). Cultivated crops is the secondary land cover encompassing 27.07%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 8.50%.

From 1992-2011 there was a 47.81 sq km decrease in shrub and a 30.46 sq km decrease in forest. There was a 32.88 sq km increase in grassland and a 23.29 sq km increase in open space development (Figure 137).

There are two domestic wastewater outfalls (discharges < 1 million gallons per day) within the Deer Creek watershed permitted to the City of Lott and Chilton Water Supply and Sewer Service Corporation. These facilities do not discharge directly into Deer Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Deer Creek was evaluated during three sampling events, one in 1989 and two in 2004. Deer Creek is a perennial stream that drains to the Brazos River in Falls County. The following summary information is based on data collected during the two most recent sampling events in 2004. Habitat Quality Index scores indicate an intermediate to high aquatic life use rating (19 and 21.5). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 17 to 21 meters wide. The riparian zone was generally dominated by shrubs followed by trees then grasses. The average percentage of tree canopy cover ranged from 17% to 19%. The dominant stream substrates were clay and bedrock, and the average percent of substrate gravel size or larger varied from 10% to 28%. Average percent instream cover was 2% to 9%. Deer Creek ranged from 0.3-0.4 meters deep on average and 14.8-15.4 meters wide. Average stream bank slope ranged from 36-40 degrees. Stream flow at the site was measured at a minimum value of 6 cfs and a maximum of 8.5 cfs. Average stream bank erosion potential was 36%-49%. The deepest pool measured at Deer Creek was 1.1 meters. Number of riffles observed at the site varied from five to six, and there was one well defined stream bend.

Water Quality

Water samples were collected at station 16407 over 69 sampling events from June 1998 through August 2007. Station 11723 was sampled over 32 water sampling events from July 1989 to February 2020. Data were collected for temperature, flow, transparency, specific conductivity,

dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twenty-one species (eight families) were collected over the course of the three sampling events. Centrarchidae and Cyprinidae were the most species rich families with six and five species, respectively. Red Shiner was the most abundant species collected in each sampling event. Based on the fish assemblage, Deer Creek only attained a limited aquatic life use rating in 1987. No benthic invertivores were collected, the percentage of tolerant and omnivorous individuals was high, and the percentage of piscivorous individuals was low. However, when the coefficient of variability was applied the rating increased to intermediate. Both samples from 2004 attained high aquatic life use ratings. Three benthic invertivore species were collected and the percentage of omnivorous individuals significantly declined.

Benthic Macroinvertebrates

Considering the one Surber sample and two RBP samples collectively, a total of 1,071 individuals representing 44 taxa from 10 orders of macroinvertebrates were collected from Deer Creek (Appendix E). Trichoptera, Diptera, and Ephemeroptera the most commonly collected orders, collectively accounting for 97.3 percent of the total number of individuals collected. No other orders comprised one percent or more of the collections.

The Central Bioregion Surber BIBI for the 1989 Surber sample fell in the high aquatic life use category. The Ecoregions 27, 29, and 32 BIBI for the March and July 2004 RBP samples fell in the intermediate and high aquatic life use categories, respectively.

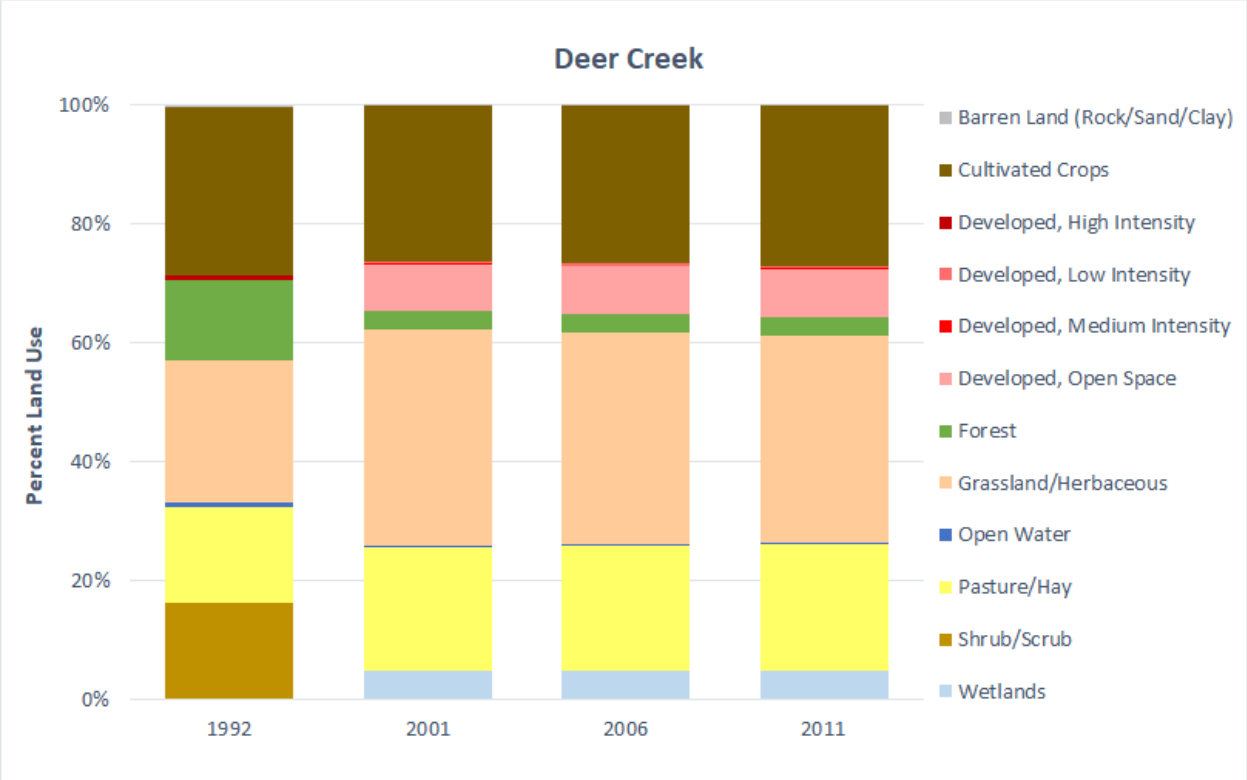

Figure 136. Percent land use in the Deer Creek watershed from 1992-2011.

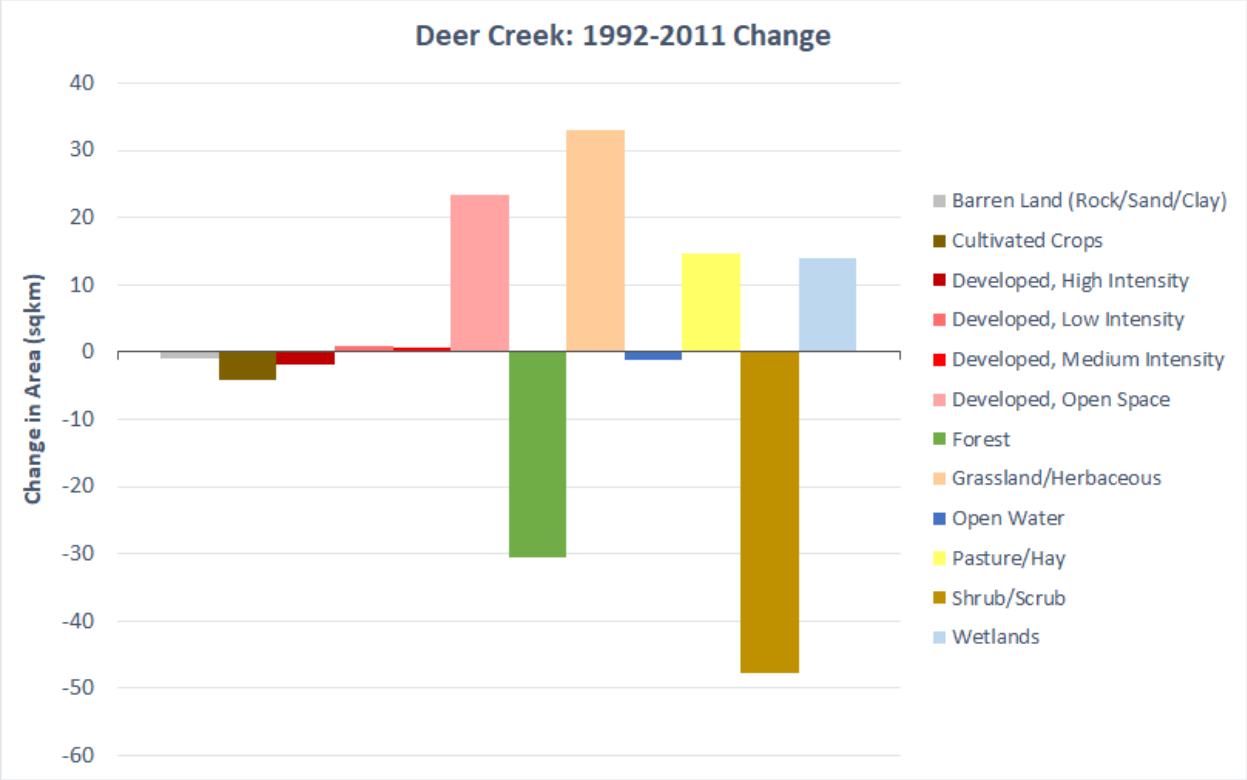

Figure 137. Land use change in area (sq km) from 1992-2011 for the Deer Creek watershed.

GERONIMO CREEK

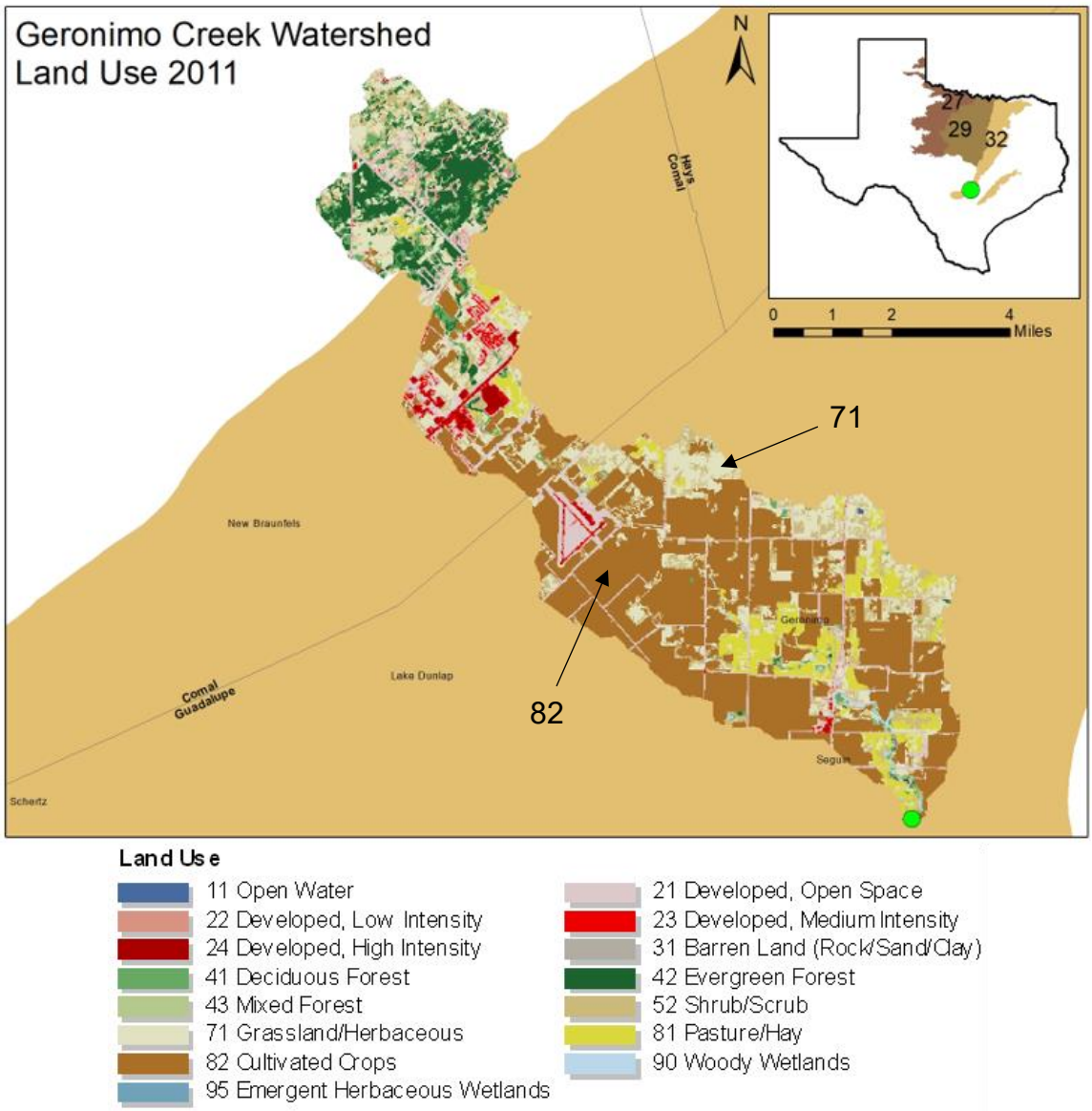

Figure 138. Map of Geronimo Creek watershed location and 2011 land use; cultivated crops and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	June 29, 1988; August 16, 2010; July 15, 2011; July 24, 2012; June 17, 2013; August 2, 2013
Water Quality:	227 sampling events
Fish:	June 29, 1988; March 14, 1989; August 16, 2010; July 15, 2011; June 17, 2013; August 2, 2013
Benthic Invertebrates:	June 29, 1988; August 16, 2010; July 15, 2011; July 24, 2012; June 17, 2013; August 2, 2013

Physical Characterization

Watershed and Land Use

Geronimo Creek lies within the Guadalupe River Basin. Sample site 12576 is located at Haberle Road, approximately 4.82 km south of Geronimo in Guadalupe County (Figure 138).

The Geronimo Creek watershed at site 12576 is approximately 106.94 sq km. The station and majority of the watershed lies within Level IV Ecoregion 32a, the Northern Blackland Prairie, the most upper part of the watershed crosses into Ecoregion 30. The dominant land cover in the watershed is cultivated crops at 41.21% and is present in the lower and middle watershed (Homer et al. 2015; Figure 138 and Figure 139). Grassland/herbaceous is the secondary land cover encompassing 18.39%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 12.56%.

From 1992-2011 there was a 17.57 sq km decrease in pasture/hay and an 8.34 sq km decrease in forest. There was an 8.08 sq km increase in open space development and a 7.89 sq km increase in grassland (Figure 140).

There is one domestic wastewater outfall (discharges < 1 million gallons per day) permit pending within the Geronimo Creek watershed. This facility does not discharge directly into Geronimo Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Geronimo Creek was evaluated during six sampling events from 1988 to 2013. Geronimo Creek is a perennial stream that drains to the Guadalupe River southeast of Seguin. Habitat Quality Index scores are available for five sample events and indicate a high aquatic life use rating (22-24). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 16 meters wide to greater than 20 meters. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover ranged from 79% to 95%. The dominant stream substrate was cobble and gravel, and the average percent of substrate gravel size or larger varied from 66% to 91%. Average percent instream cover was 38% to 54% and instream cover types include roots, gravel, undercut banks, woody debris, macrophytes, algae, and overhanging vegetation. Geronimo Creek ranged from 0.3-0.6 meters deep on average and 5-7 meters wide. Average stream bank slope ranged from 91-122 degrees. Stream flow at the site was measured at a minimum value of 2.4 cfs and a maximum of 8.6 cfs. Average stream bank erosion potential was 12%-33%. The deepest pool measured at Geronimo Creek was 1.1 meters. Number of riffles observed at the site varied from two to three and there were three stream bends.

Water Quality

Water samples were collected at station 12576 over 227 sampling events from June 1988 through December 2019. Data were collected for temperature, flow, transparency, specific conductivity,

dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twenty-six species (nine families) were collected over the course of the six sampling events. Ten species were collected within the family Centrarchidae, more than were collected within any other family. Texas Shiner was collected in every sample and was the most abundant species in all but the 2011 and August 2013 collections. Redbreast Sunfish *Lepomis auritus*, a non-native species first appearing in the 2010 collection, and Channel Catfish *Ictalurus punctatus* were the most abundant species for those two dates, respectively. Red Shiner and Longear Sunfish were also present in every sampling event. Intermediate aquatic life use ratings were produced by the 1988 and August 2013 fish assemblages. When the coefficient of variability was applied, the aquatic life use rating increased to high for the 2013 collection. All other dates achieved a high or exceptional rating. Low catch per unit effort was noted in every collection.

Benthic Macroinvertebrates

Considering the one Surber sample and five RBP samples collectively, a total of 1,212 individuals representing 85 taxa from 17 orders of macroinvertebrates were collected from Geronimo Creek (Appendix E). Coleoptera, Ephemeroptera, Trichoptera, Hemiptera, and Odonata were the most commonly collected orders, collectively accounting for 90.6 percent of the total number of individuals collected. Diptera and Veneroida were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the 1988 Surber sample fell in the exceptional aquatic life use category. The Ecoregions 27, 29, and 32 BIBI for the 2010, 2011, 2012, June 2013, and August 2013 RBP samples all fell in the exceptional aquatic life use category as well.

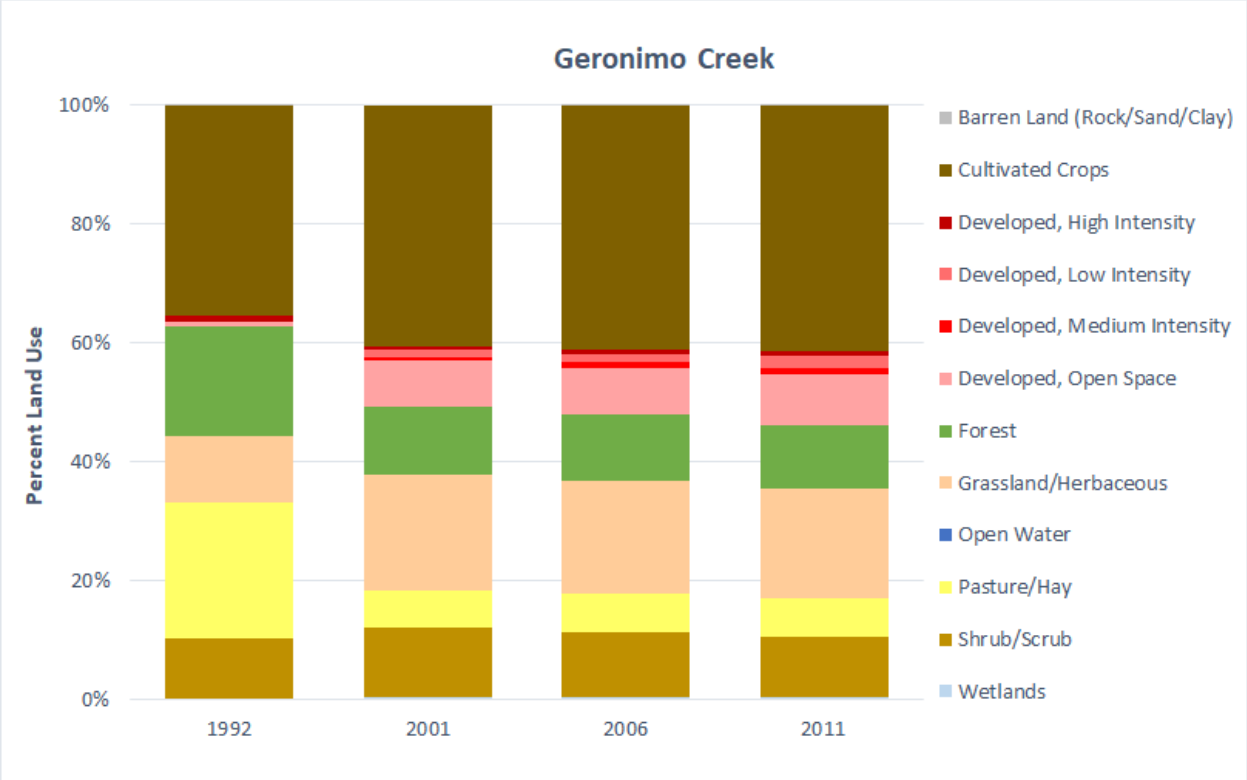

Figure 139. Percent land use in the Geronimo Creek watershed from 1992-2011.

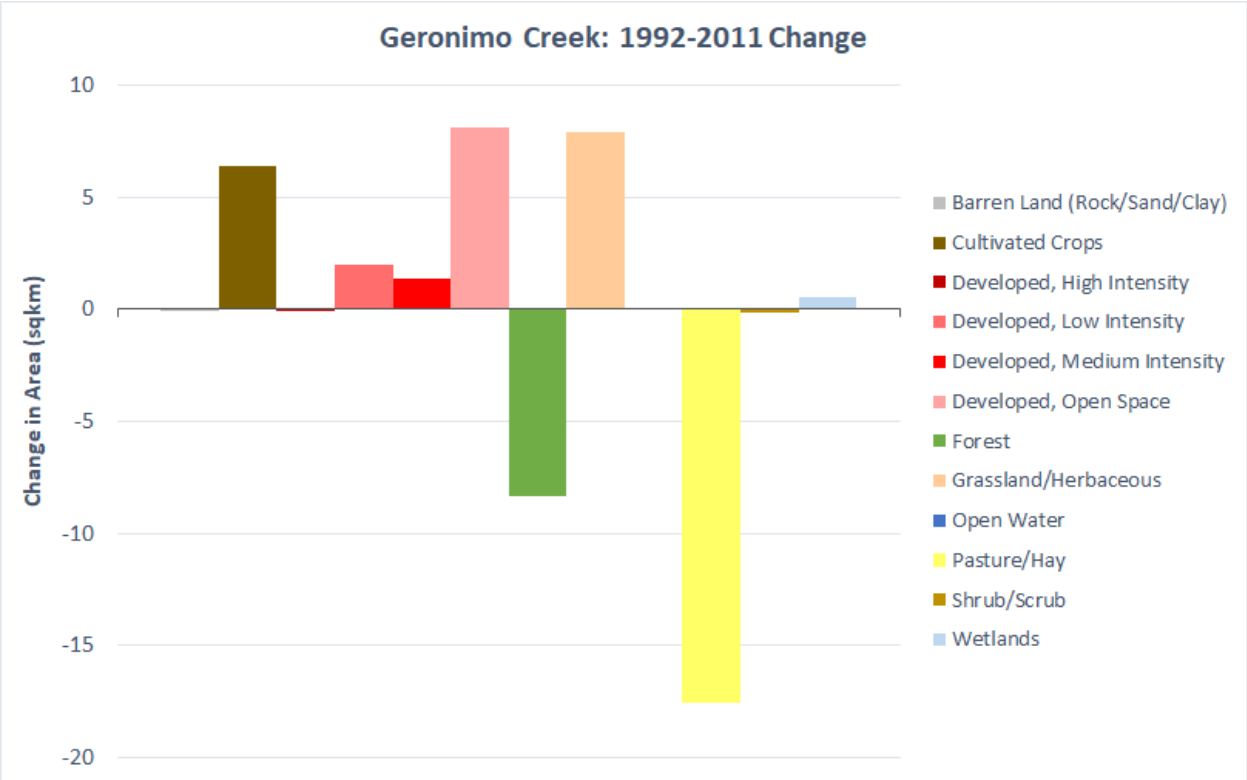

Figure 140. Land use change in area (sq km) from 1992-2011 for the Geronimo Creek watershed.

WILLIS CREEK

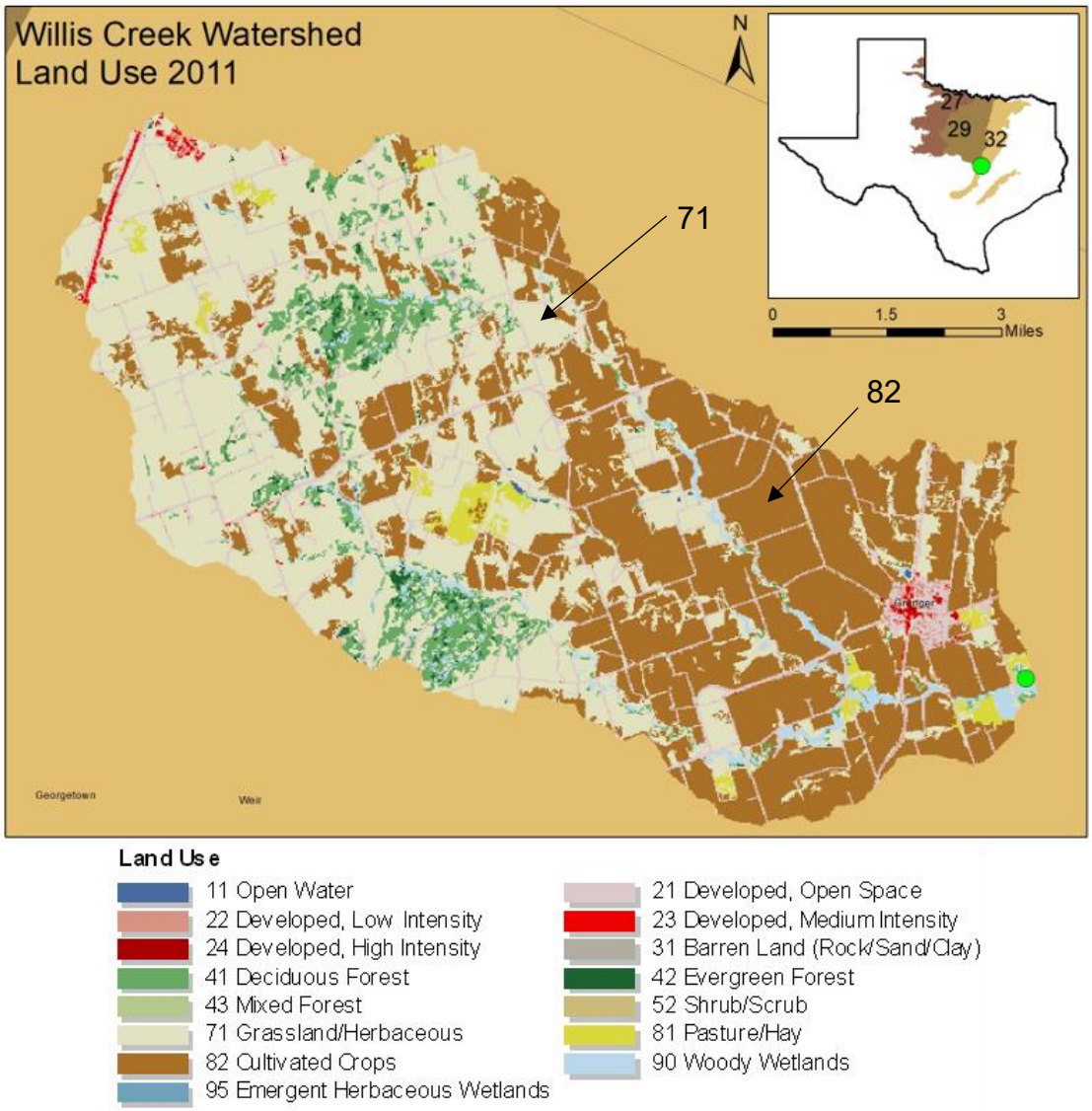

Figure 141. Map of Willis Creek watershed location and 2011 land use; grassland/herbaceous and cultivated crops were the most common land uses.

Sampling Dates

Physical Habitat:	July 18, 1989; April 20, 2004; July 13, 2004; June 3, 2008; July 8, 2008; August 12, 2008
Water Quality:	75 sampling events at station 11573, 9 sampling events at station 20022
Fish:	July 18, 1989; April 20, 2004; July 13, 2004; May 8, 2007; June 4, 2008; July 8, 2008; August 12, 2008
Benthic Invertebrates:	July 19, 1989; April 20, 2004; July 13, 2004; June 4, 2008; July 8, 2008; August 12, 2008

Physical Characterization

Watershed and Land Use

Willis Creek lies within the Brazos River Basin. Sample site 20022 is located 810 m downstream of CR 348, approximately 2.5 km southeast of Granger in Williamson County (Figure 141).

The Willis Creek watershed at site 20022 is approximately 171.36 sq km. The entire watershed lies within Level IV Ecoregion 32a, the Northern Blackland Prairie. The dominant land cover in the watershed is grassland/herbaceous at 42.83% and is present mostly in the upper watershed (Homer et al. 2015; Figure 141 and Figure 142). Cultivated crops is the secondary land cover encompassing 38.36%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 9%.

From 1992-2011 there was a 24.10 sq km decrease in shrub and a 19.55 sq km decrease in pasture/hay. There was a 31.20 sq km increase in grassland and a 13.53 sq km increase in open space development (Figure 143).

There is one domestic wastewater outfall (discharges < 1 million gallons per day) within the Willis Creek watershed permitted to the City of Granger. This facility does not discharge directly into Willis Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Willis Creek was evaluated at two sites during six sampling events from 1989 to 2008. Willis Creek is a perennial stream that drains to the Willis Creek arm of Granger Lake. Habitat Quality Index scores are available for five sample events and indicate a high aquatic life use rating (20-24). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 19 to 21 meters wide. The riparian zone was generally dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 75% to 92%. The dominant stream substrate was gravel, and the average percent of substrate gravel size or larger varied from 41% to 75%. Average percent instream cover was 6% to 20%. Willis Creek ranged from 0.2-0.4 meters deep on average and 3-6 meters wide. Average stream bank slope ranged from 30-45 degrees. Stream flow at the site was measured at a minimum value of 0.1 cfs and a maximum of 7.4 cfs. Average stream bank erosion potential was 44%-62%. The deepest pool measured at Willis Creek was 2 meters. Number of riffles observed at the site varied from one to seven, and total number of stream bends ranged from seven to nine.

Water Quality

Water samples were collected at stations 11573 and 20022 totaling 84 sampling events from July 1989 through August 2010. There were 75 sampling events at station 11573 from July 1989 through August 2010, and 9 sampling events at station 20022 from April 2007 through August 2010. Data were collected for temperature, flow, transparency, specific conductivity, dissolved

oxygen, pH, alkalinity (only at station 11573), ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twenty-five species (nine families) were collected over the course of the seven sampling events. The families Cyprinidae and Centrarchidae each yielded seven species, making them the most species rich families. Longear Sunfish was the most abundant species in all but the 1989 and June 2008 collections, where Western Mosquitofish and Red Shiner were the most abundant ones. Five species were collected in every sampling event and included Red Shiner, Blacktail Shiner, Bullhead Minnow, Green Sunfish, and Longear Sunfish. All fish collections (except for May 2007) rated as having a high aquatic life use. The 2007 sample rated as intermediate, even after applying the coefficient of variability. This collection was the only one without benthic invertivore species. The aquatic life use for the April 2004 and August 2008 fish assemblages rise to exceptional when the coefficient of variability is applied.

Benthic Macroinvertebrates

Considering the one Surber sample and five RBP samples collectively, a total of 1,706 individuals representing 106 taxa from 22 orders of macroinvertebrates were collected from Willis Creek (Appendix E). Ephemeroptera, Diptera, Trichoptera, Odonata, Haplotaxida, Coleoptera, and Amphipoda were the most commonly collected orders, collectively accounting for 90.7 percent of the total number of individuals collected. Basommatophora, Plecoptera, Veneroida, Hemiptera, and Tricladida were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the 1989 Surber sample fell in the exceptional aquatic life use category. The Ecoregions 27, 29, and 32 BIBI for the five RBP samples fell in either the high aquatic life use category (April 2004, August 2008) or the exceptional life use category (July 2004, June 2008, July 2008).

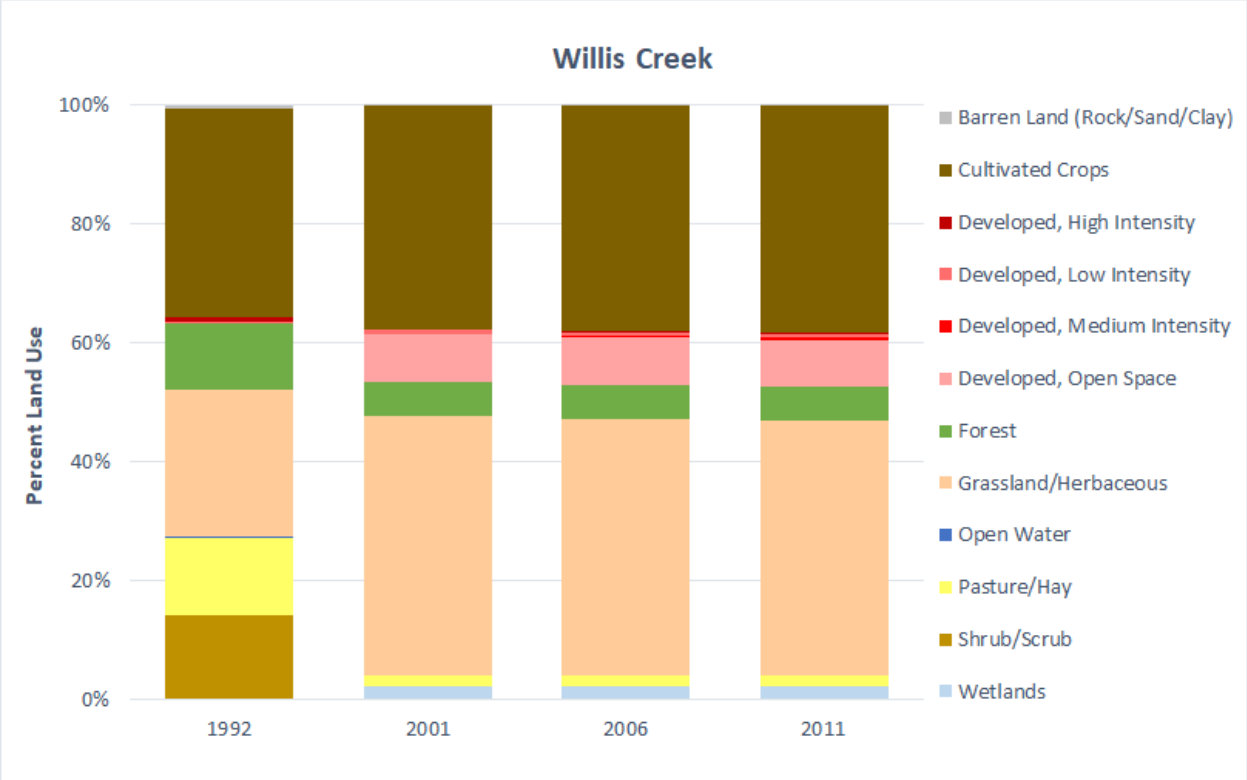

Figure 142. Percent land use in the Willis Creek watershed from 1992-2011.

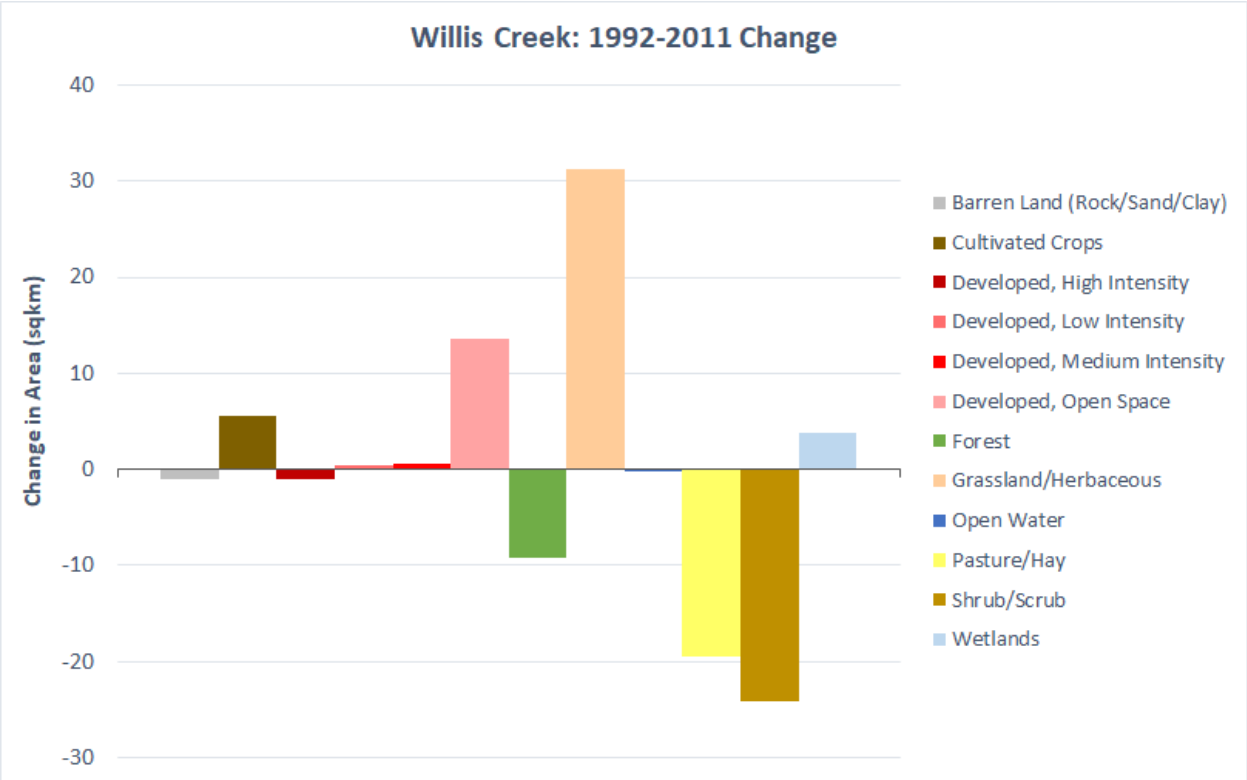

Figure 143. Land use change in area (sq km) from 1992-2011 for the Willis Creek watershed.

WILSON CREEK

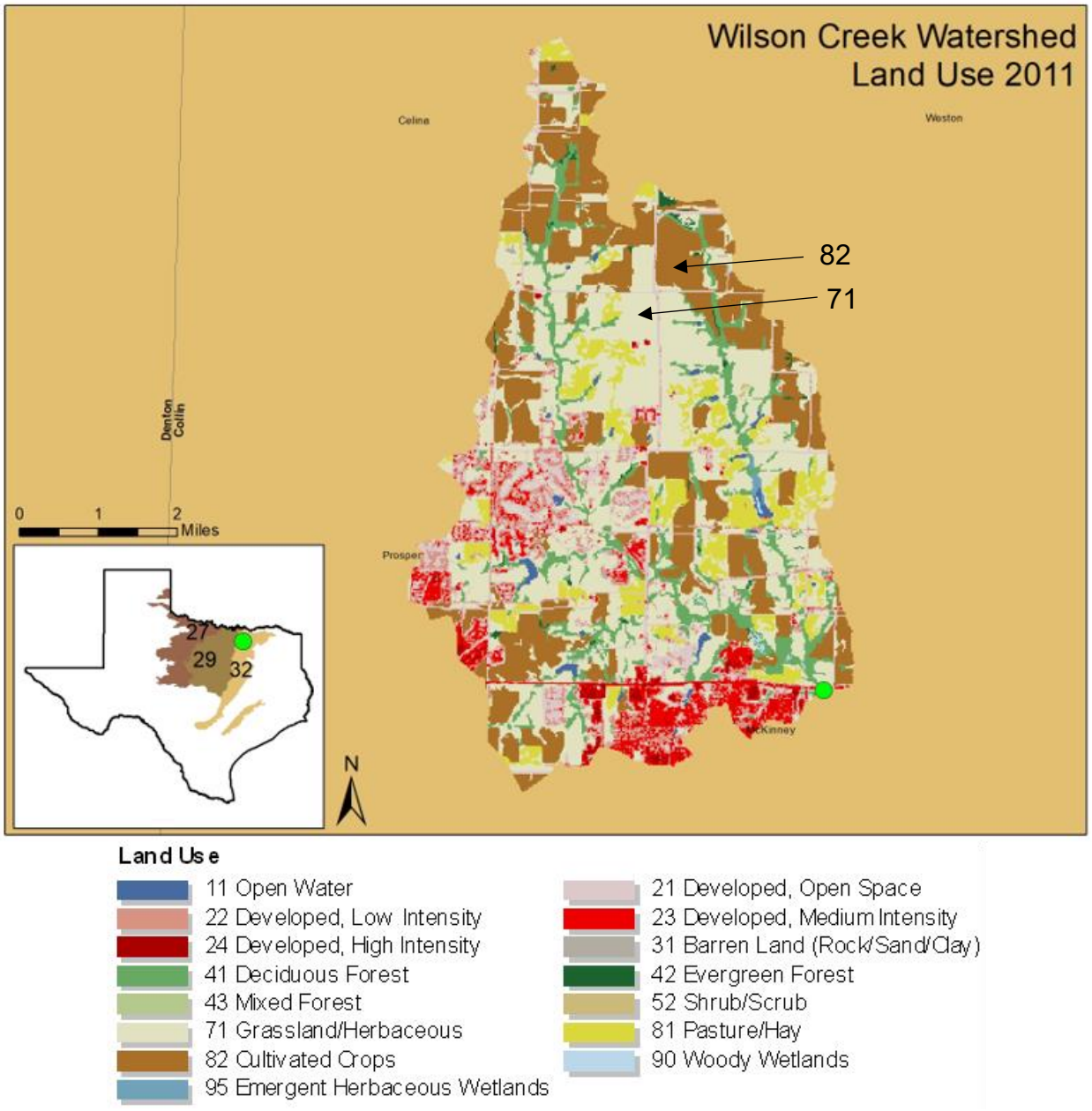

Figure 144. Map of Wilson Creek watershed location and 2011 land use; grassland/herbaceous and cultivated crops were the most common land uses.

Sampling Dates

Physical Habitat:	August 1, 1989; June 17, 2003; August 6, 2003
Water Quality:	90 sampling events
Fish:	August 1, 1989; June 17, 2003; August 6, 2003; May 31, 2012; August 7, 2012
Benthic Invertebrates:	August 1, 1989; June 17, 2003; August 6, 2003

Physical Characterization

Watershed and Land Use

Wilson Creek lies within the Trinity River Basin. Sample site 10777 is located 45 m downstream of US 380, west of McKinney in Collin County (Figure 144).

The Wilson Creek watershed at site 10777 is approximately 80.34 sq km. The entire watershed lies within Level IV Ecoregion 32a, the Northern Blackland Prairie. The dominant land cover in the watershed is grassland/herbaceous at 34.56% and is present throughout watershed (Homer et al. 2015; Figure 144 and Figure 145). Cultivated crops is the secondary land cover encompassing 24.47%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 22.53%.

From 1992-2011 there was a 19 sq km decrease in pasture/hay and a 16.85 sq km decrease in cultivated crops. There was a 16.88 sq km increase in grassland and a 7.23 sq km increase in open space development (Figure 146).

There are no permitted wastewater outfalls within the Wilson Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Wilson Creek was evaluated during three sampling events from 1989 to 2003. Wilson Creek is an intermittent stream with perennial pools that drains to the East Fork arm of Lake Lavon. Habitat Quality Index scores are available for two sample events and indicate an intermediate aquatic life use rating (15 and 17). Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The average percentage of tree canopy cover ranged from 68% to 85%. The dominant stream substrate was gravel and cobble, and the average percent of substrate gravel size or larger varied from 45% to 52%. Average percent instream cover was 33% to 42% and instream cover types include leaf packs, algae, woody debris, cobble/gravel, and undercut banks. Wilson Creek ranged from 0.2-0.3 meters deep on average and 5-7 meters wide. Average stream bank slope ranged from 42-49 degrees. Stream flow at the site was measured at a minimum value of 5 cfs and a maximum of 7 cfs. Average stream bank erosion potential was 45%-63%. No pools were documented at Wilson Creek during the most recent sampling events in 2003. Three riffles observed at the site in 2003 and there were four total stream bends.

Water Quality

Water samples were collected at station 10777 over 90 sampling events from October 1988 through January 2019. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Sixteen species (six families) were collected over the course of the five sampling events. Centrarchidae and Cyprinidae yielded the two highest species richnesses by family with five and four, respectively. Yellow Bullhead, Central Stoneroller, Red Shiner, Blackstripe Topminnow *Fundulus notatus*, Western Mosquitofish, Green Sunfish, Bluegill, and Longear Sunfish were collected in every sampling event. Two species, Channel Catfish and Orangespotted Sunfish, were only collected in 1989, albeit in small numbers. One River Carpsucker and two Tadpole Madtoms *Noturus gyrinus* were collected during 2012. Several Spotted Sucker *Minytrema melanops* were also collected in 2012 but showed up in a 2003 sample as well. Every fish assemblage sample rated as having an intermediate aquatic life use except for the August 2003 and May 2012 collections which rated as limited and high, respectively. When the coefficient of variability is applied, the June 2003 aquatic life use rises to high, and the August 2003 sample rises to intermediate.

Benthic Macroinvertebrates

Considering the one Surber sample and two RBP samples collectively, a total of 349 individuals representing 34 taxa from 11 orders of macroinvertebrates were collected from Wilson Creek (Appendix E). Trichoptera, Diptera, Ephemeroptera, and Coleoptera were the most commonly collected orders, collectively accounting for 92.3 percent of the total number of individuals collected. Odonata and Plecoptera were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the 1989 Surber sample fell in the intermediate aquatic life use category. The Ecoregions 27, 29, and 32 BIBI for the two RBP samples fell in the intermediate aquatic life use category (June 2003) and the limited aquatic life use category (August 2003).

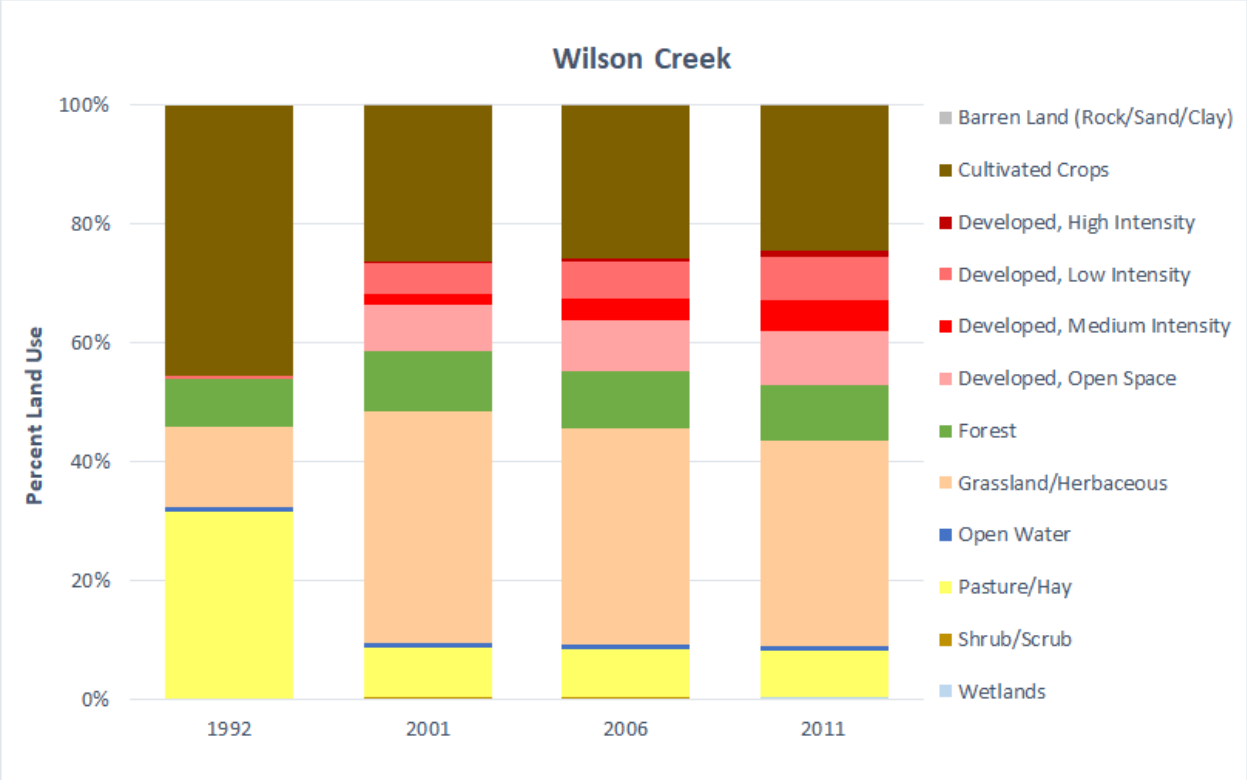

Figure 145. Percent land use in the Wilson Creek watershed from 1992-2011.

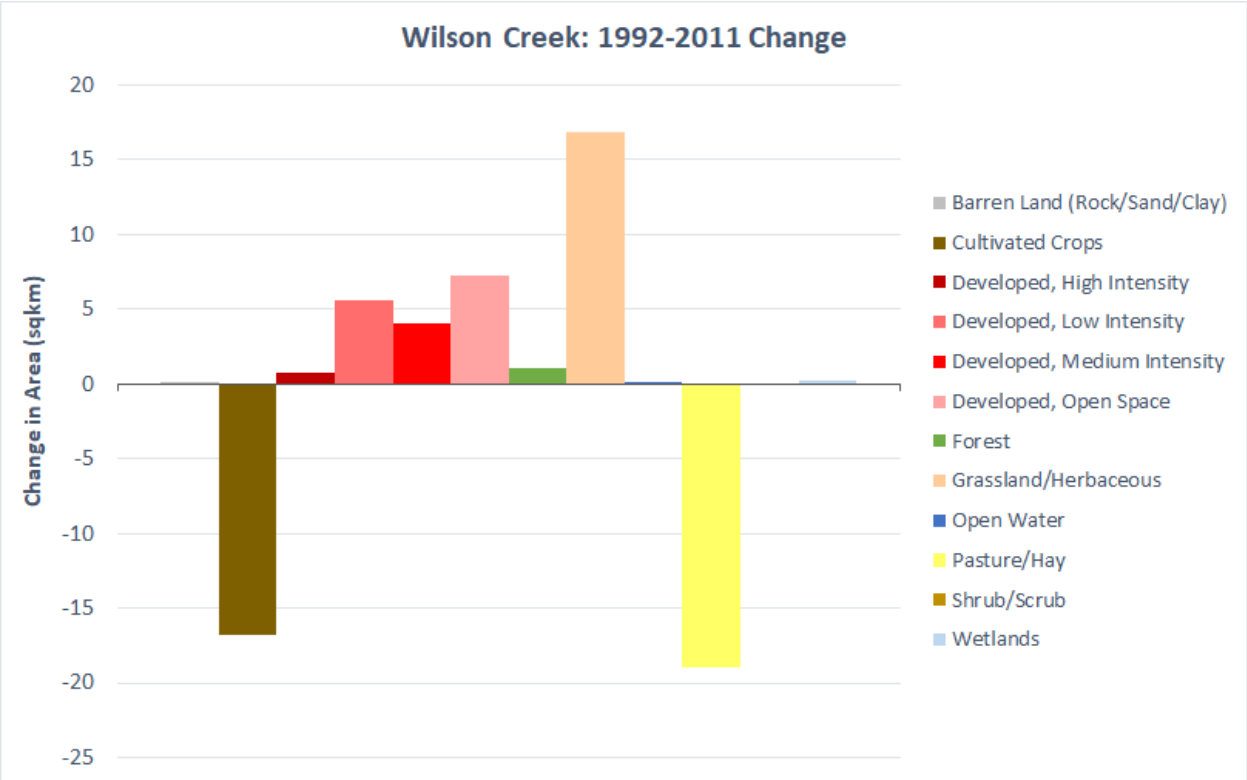

Figure 146. Land use change in area (sq km) from 1992-2011 for the Wilson Creek watershed.

Ecoregions 27, 29, and 32 Summary and Historical Characterization

Watershed and Land Use

Ecoregion 27 was historically grassland with scattered shrubs in the southern portion of the region. Most of the area is now cropland to grow cotton, wheat, and grain sorghum (Griffith et al. 2007). In 2011 the most common land covers in the study watersheds were grassland and shrub. Between 1992-2011, cultivated crop decreased in combined land cover area across all watersheds (~640.98 sq km) and shrub experienced the greatest increase (~881.01 sq km).

Ecoregion 29 was historically prairie to the west and forested hills to the east. The area to the west is now wheat cropland and to the east is mostly rangeland. Oil and gas production have been a major activity for nearly a century (Griffith et al. 2007). In 2011 the overall primary land cover in the study watersheds was grassland and the secondary cover was forest. Between 1992-2011, pasture/hay decreased in combined land cover area across all watersheds (~107.14 sq km) and grassland experienced the greatest increase (~323.62 sq km).

Ecoregion 32 was historically prairie grassland; however, pasture and forage production for livestock is now common. Additionally, much of the region is being converted to urban and industrial areas (Griffith et al. 2007). In 2011 the overall primary land cover in the study watersheds was grassland and the secondary land cover was cultivated crop. Between 1992-2011, shrub experienced the largest decrease in combined land cover across all watersheds (~113.39 sq km) and grassland experienced the largest increase (~182.81 sq km).

In Channel and Riparian Physical Habitat

Physical habitat for the Subhumid Agricultural Plains was evaluated at 21 streams over 51 sampling events from 1987 to 2018. Watershed area varied from a minimum of 26 sq km at Reese Creek to a maximum of 1,180 sq km at Cowhouse Creek. The sites generally had well vegetated riparian zones, and the riparian buffer was measured at a minimum of 3 meters and maximum of 76 meters. Trees were the dominant riparian species, followed by grasses then shrubs, and average percent tree canopy coverage varied from 0% to 95%. Dominant substrate at the sites was generally cobble/gravel or bedrock. Average percentage of substrate gravel sized or larger for all three ecoregions combined was 50%, and varied from a minimum of 0% to a maximum of 91%. Average percent instream cover was 30% and common instream cover types include overhanging vegetation, woody debris, macrophytes, cobble/gravel, boulders, algae, undercut banks, roots, leaf packs, and bedrock ledges. Average stream depth and width measurements were 0.4 meters and 9 meters, respectively. Average stream bank slope was 47 degrees and erosion potential was moderate, with an average of 37% which was reflected in the average bank stability HQI score (1.4) indicating moderately stable to moderately unstable stream banks. Maximum pool depth ranged from a minimum of 0.1 meters to a maximum of 2.7 meters. Total number of riffles varied from zero to ten, and total number of stream bends ranged from zero to nine. Additional in-channel and riparian physical habitat attributes are summarized in Appendix B.

HQI scores are available for 32 events and range from a maximum score of 26 (exceptional) at South Fork Rocky Creek in May 2004 to a minimum score of 15 (intermediate) at Wilson Creek in August 2003. Of the 32 sampling events with an HQI score, one (3%) received a habitat assessment rating of exceptional, 23 (72%) received a rating of high, and the remaining eight (25%) received a rating of intermediate. The highest scoring HQI metrics for the Subhumid Agricultural Plains were the bottom substrate stability metric and the number of riffles metric. The lowest scoring HQI metrics on average were the bank stability metric and the channel sinuosity metric.

Water Quality

Water quality data from ecoregions 27, 29 and 32 had a mean temperature of 23 degrees Celsius with a range from 0.5 to 35.4 degrees Celsius, and specific conductivity ranged from 62 to 7,560 us/cm. The secchi values had a median value of 0.6 meters with a range from 0.01 to 1.52 meters. The pH values had a range of 6.9 to 8.98. Chlorophyll-a data was highly variable between stations with a range of 0.25 to 190.3 ug/L. Additional water quality variables are summarized in appendix C of the report.

Fish

A total of 28,414 individuals consisting of 14 families and 55 species have been documented in 62 sampling events across 21 streams in the Subhumid Agricultural Plains from 1987 to 2018 (Appendix D - 3). For individual sites, taxa richness ranged from 27 species at Cow Bayou across three sampling events from 1987 to 2010 to a low of six species at Lelia Lake Creek from one sampling event in 1989. Taxa richness at each site was somewhat correlated with the number of sampling events during the period of record. The most abundant species collected across all sites and sampling events were Red Shiner (n = 9,169), Blacktail Shiner (n = 4,758), Western Mosquitofish (n = 2,852), Longear Sunfish (n = 2,319), and Central Stoneroller (n = 2,016).

Index of biotic integrity scores across all sites and sampling events ranged from 31 to 52 resulting in aquatic life use categories of limited (n = 4), intermediate (n = 19), high (n = 32), and exceptional (n = 7; Figure 147). Of the 62 sampling events in this ecoregion aggregate, 63% received an ALU rating of high or exceptional; 37% received an ALU of intermediate or limited. Most sites that were sampled multiple times received ALUs in at least two different categories. All sites received one ALU score of intermediate or better except for Lelia Lake Creek which received an ALU score of limited only.

Overall, IBI scores and individuals metrics 1,2,4 and 6-8 did not change through time (Figure 148; Figure 149; Figure 150); however, the number of benthic invertivores, percentage of individuals as piscivores, number of individuals per minute electrofishing, and percentage of individuals as non-native species significantly increased through time (Figure 149(3): $R^2 = 0.08$, $p = 0.03$; Figure 150(9): $R^2 = 0.09$, $p = 0.02$; Figure 150(10eshock): $R^2 = 0.15$, $p < 0.01$; Figure 150(11): $R^2 = 0.07$, $p = 0.04$) and the number of individuals per seine haul and percentage of individuals with disease/anomaly significantly decreased through time (Figure 150(10seine): R^2

= 0.09, p = 0.02; Figure 150(12): R^2 = 0.07, p = 0.03). Although these were significant relationships, R^2 values were very low.

The increase in percentage of individuals as non-native species is mostly attributable to high numbers of Redbreast Sunfish collected during 2010 and 2011 in Geronimo Creek. In these two samples, 15 and 24.3%, of the fish collected were non-native. Two collections from Geronimo Creek in 2013 yielded no non-natives. When the 2010 and 2011 samples are removed the mean percentage declines from 1.5 to 0.3, which is more in line with the mean percentage calculated for the early samples (0.0). The increase in benthic invertivores, piscivores, and number of individuals per minute electrofishing is due to a combination of things, including the influence of the new waterbodies that were sampled as well as possible improvements in streams that were resampled. The mean number of benthic invertivore species collected from waterbodies that were not resampled was only 0.5 while the mean for newly added waterbodies was 1.3. When comparing waterbodies that were resampled, the mean number of benthic invertivore species collected during the early period was 1.1 compared to 1.6 in the more recent time period. Similar results are reflected for piscivores and number of individuals per minute electrofishing. The highest mean percentage of piscivores (9.7) was collected from the newly added waterbodies while the lowest mean percentage (5.3) was found in the waterbodies that were not resampled. For waterbodies that had historical and recent collections, the mean percentage of individuals as piscivores was 7.7% compared to 8.5% for the more recent samples. The mean number of individuals collected per minute of electrofishing from waterbodies that were not resampled was 4.3 while the mean for newly added waterbodies was 7.0. When comparing waterbodies that were resampled, the mean number collected per minute during the early time period was 4.4 compared to 6.9 in the more recent time period.

The decline in number of individuals per seine haul is attributed to two creeks that were not resampled (Cottonwood and Elm creeks). These creeks yielded the three highest catches per seine haul (greater than 300 fish per haul). Had these creeks been resampled it is very likely that no significant change would have been detected given that the 11 waterbodies that were resampled had nearly the identical value for the early and more recent time periods (37.4 verses 42.4, respectively). The decrease in the proportion of individuals with a disease/anomaly is likely due to sampler bias rather than a significant change in disease/anomaly. This is a characteristic that is often overlooked while in the field.

Benthic Macroinvertebrates

A total of 26,706 individuals representing 37 orders of aquatic macroinvertebrates were collected in the 22 Surber samples, and 35 RBP samples from 21 streams in the Subhumid Agricultural Plains over the interval from July 1987 to July 2018. The Trichoptera, Veneroida, Diptera, Ephemeroptera, and Coleoptera were the most abundant orders, collectively representing 81% of the total collection from the Subhumid Agricultural plains.

The fingernail clam *Sphaerium sp.,* the filtering caddisfly *Cheumatopsyche sp*., the oligochaete *Limnodrilus sp*., and the riffle beetle *Stenelmis sp*. were the most abundant genera, collectively

representing 46% of the total number of individuals collected at all sites. Other genera that were relatively abundant include the chironomid *Polypedilum sp*., the mayfly *Tricorythodes sp*., the caddisfly *Chimarra sp*., the mayfly *Caenis sp*., and the damselfly *Argia sp*.

The Chironomidae, and the riffle beetle *Stenelmis sp*. were the most widely distributed taxa, occurring in 54, and 53 of the 57 total samples respectively. Other widely distributed genera include the damselfly *Argia sp*., the chironomid *Polypedilum sp.*, and the mayfly *Fallceon sp.* each of which were present in over half of the total number of samples in the ecoregion.

Eleven of 35 RBP IBI scores for kicknet samples fell in the exceptional aquatic life use category, 10 RBP IBI scores indicated high, 12 intermediate, and two samples collected from Rocky Creek and Wilson Creek in August 2003 fell in the limited aquatic life use category (Figure 151; Figure 152). Related to the limited aquatic life use indicated for single samples at each of these two streams, other samples indicated higher integrity. Of the five samples collected from station 11724 on Rocky Creek, only the August 2003 sample indicated limited aquatic life use, while the RBP IBI score for the samples collected in August 2002, and August 2004 indicated intermediate, and the samples collected in April 2003, and May 2004 fell in the high aquatic life use category. Eleven of 22 Surber sample BIBI scores fell in the exceptional aquatic life use category, nine BIBI scores fell in the high category, and two BIBI results fell in the intermediate category. None of the Surber BIBI results indicated a limited aquatic life use category (Figure 151; Figure 152).

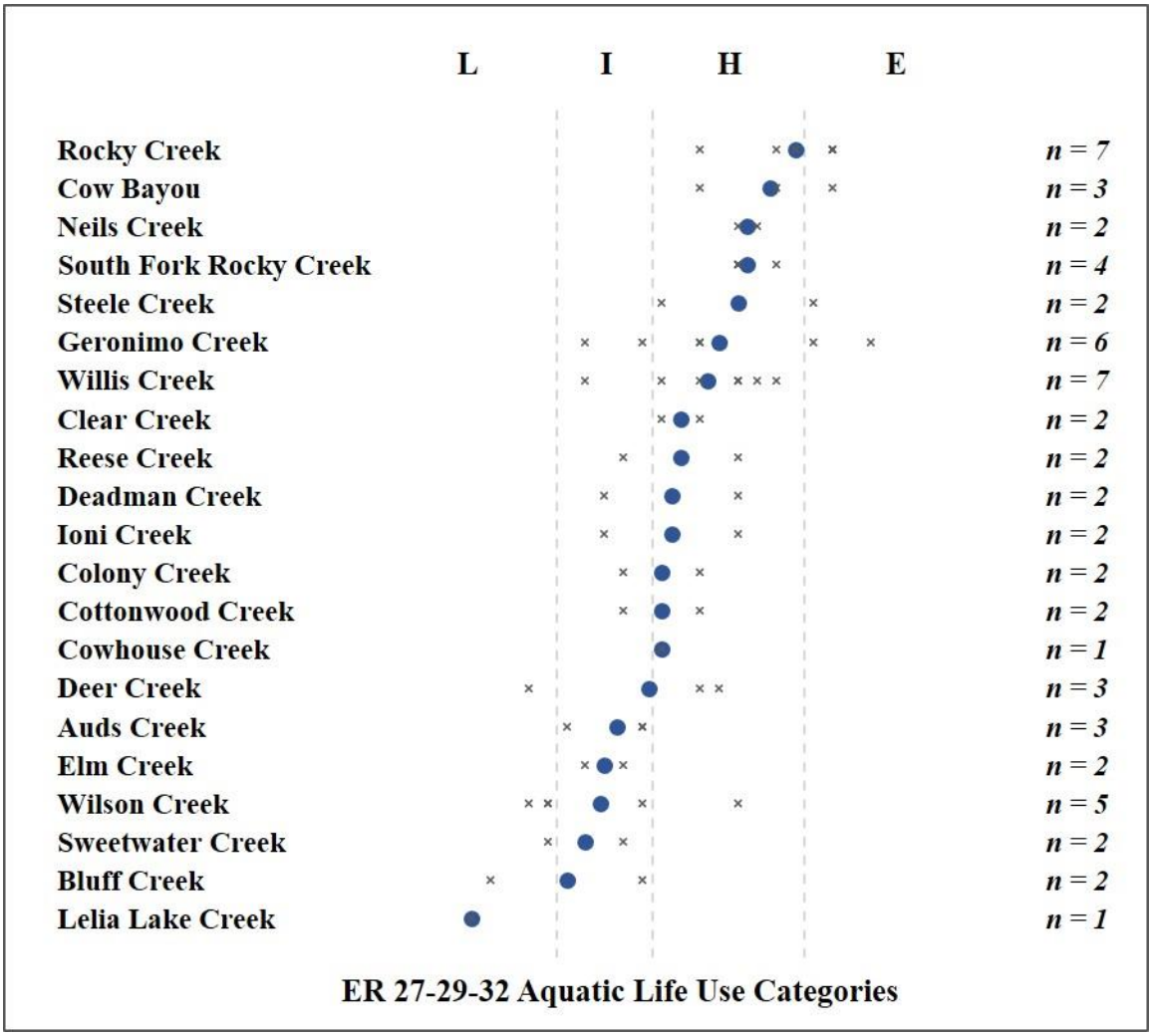

Figure 147. Aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all fish sampling events in Ecoregions 27, 29, and 32 grouped by site and ranked by mean ALU score (blue dot); number of sampling events per site noted on right.

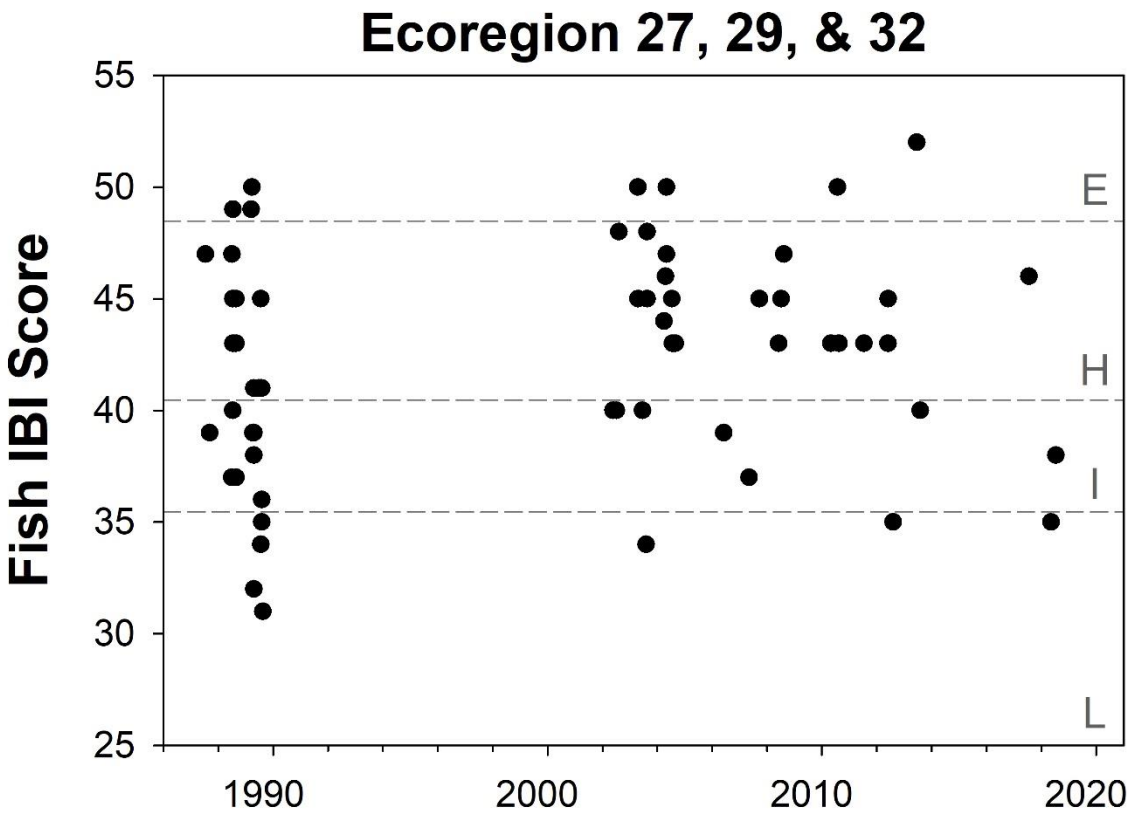

Figure 148. Fish index of biotic integrity scores through time for all sampling events in Ecoregions 27, 29, and 32; break lines for aquatic life use categories (i.e., limited, intermediate, high, and exceptional) shown on each graph for reference (see Linam et al. 2002).

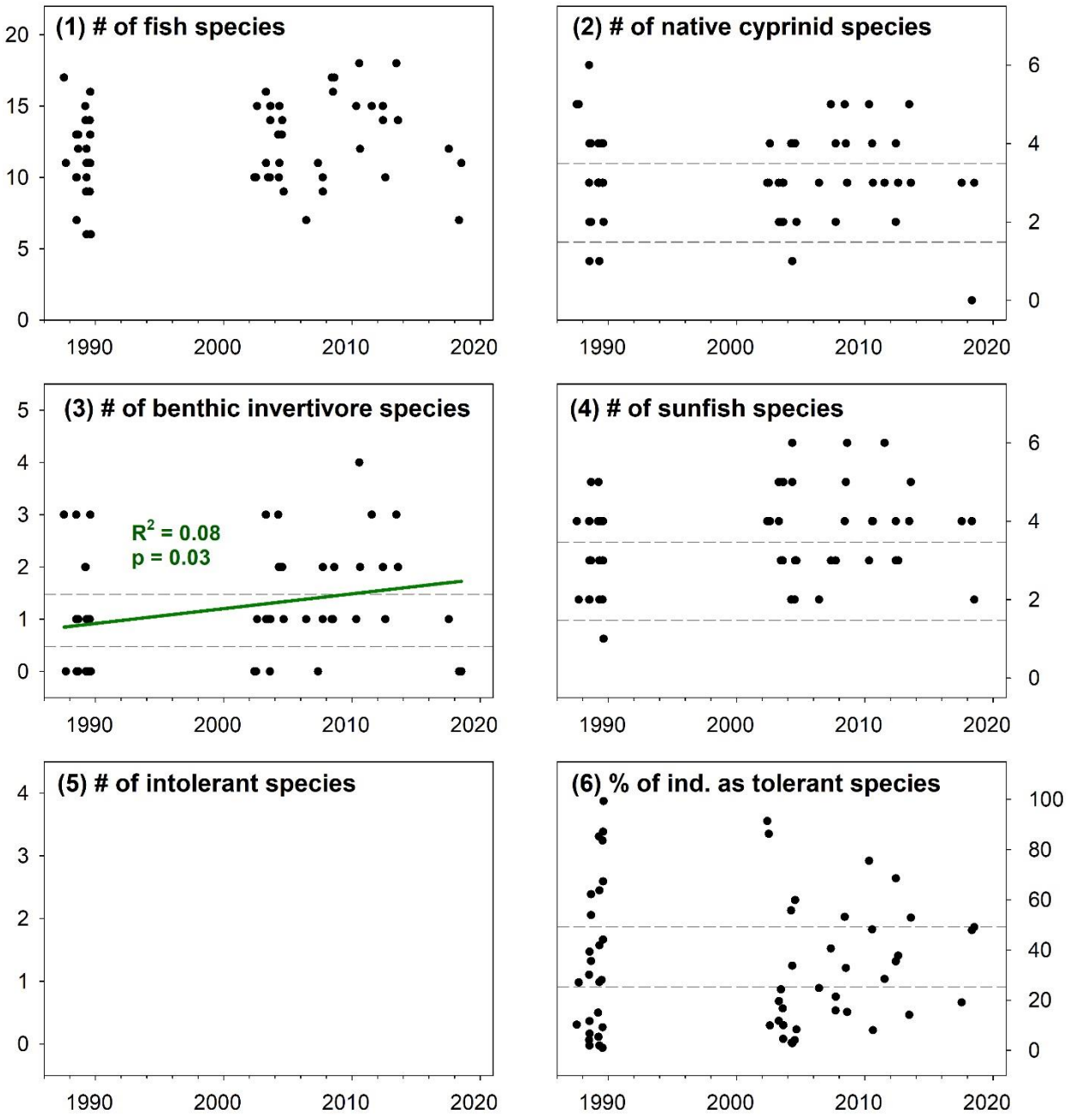

Figure 149. Raw values for fish index of biotic integrity metrics 1-6 through time for all sampling events in Ecoregions 27, 29, and 32; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002); metrics that are not included in the IBI for this aggregated ecoregion are blank.

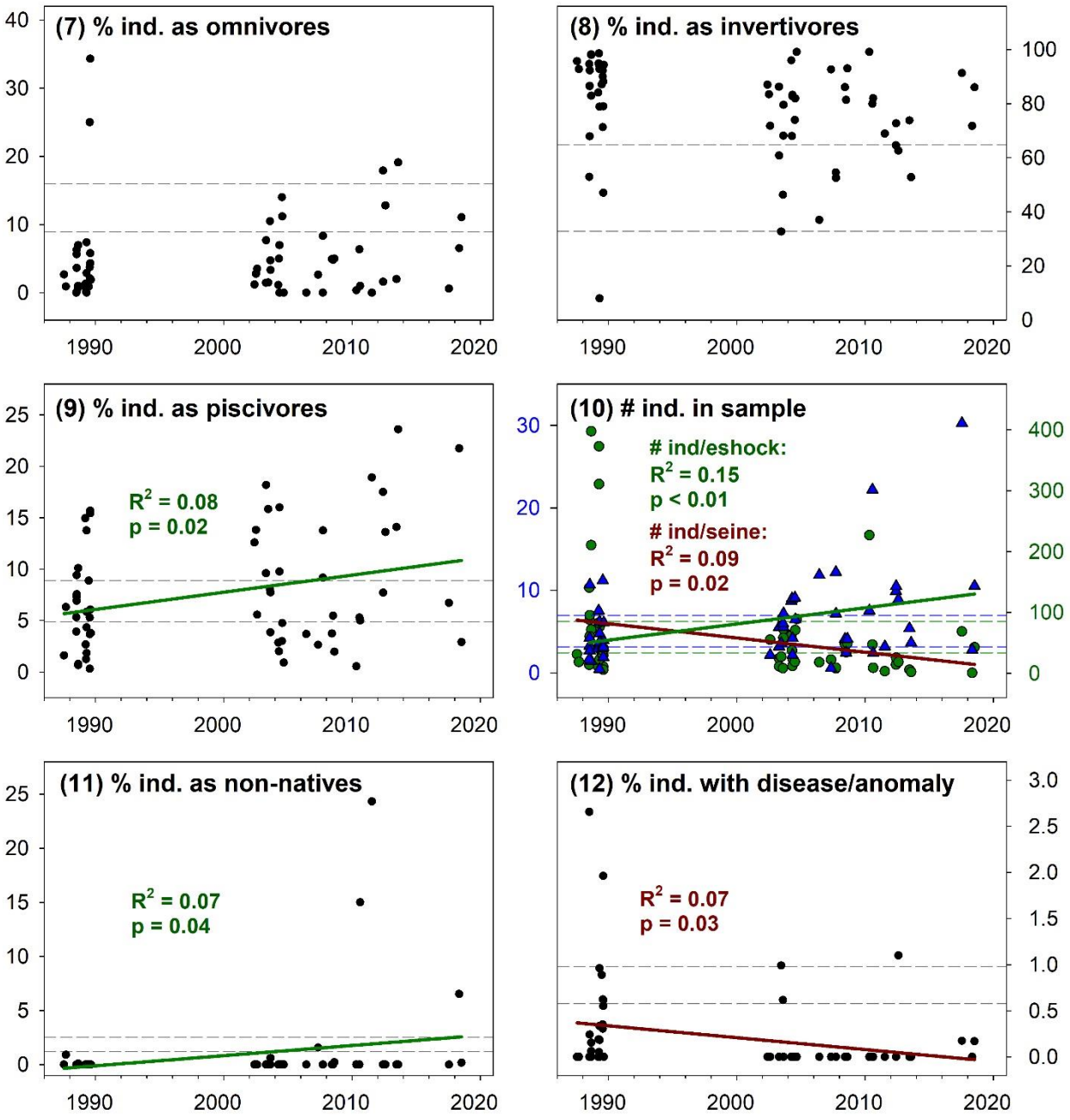

Figure 150. Raw values for fish index of biotic integrity metrics 7-12 through time for all sampling events in Ecoregions 27, 29, and 32; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002); number of ind./seine haul represented by green circles and number of ind./min electrofishing represented by blue triangles for metric number 10.

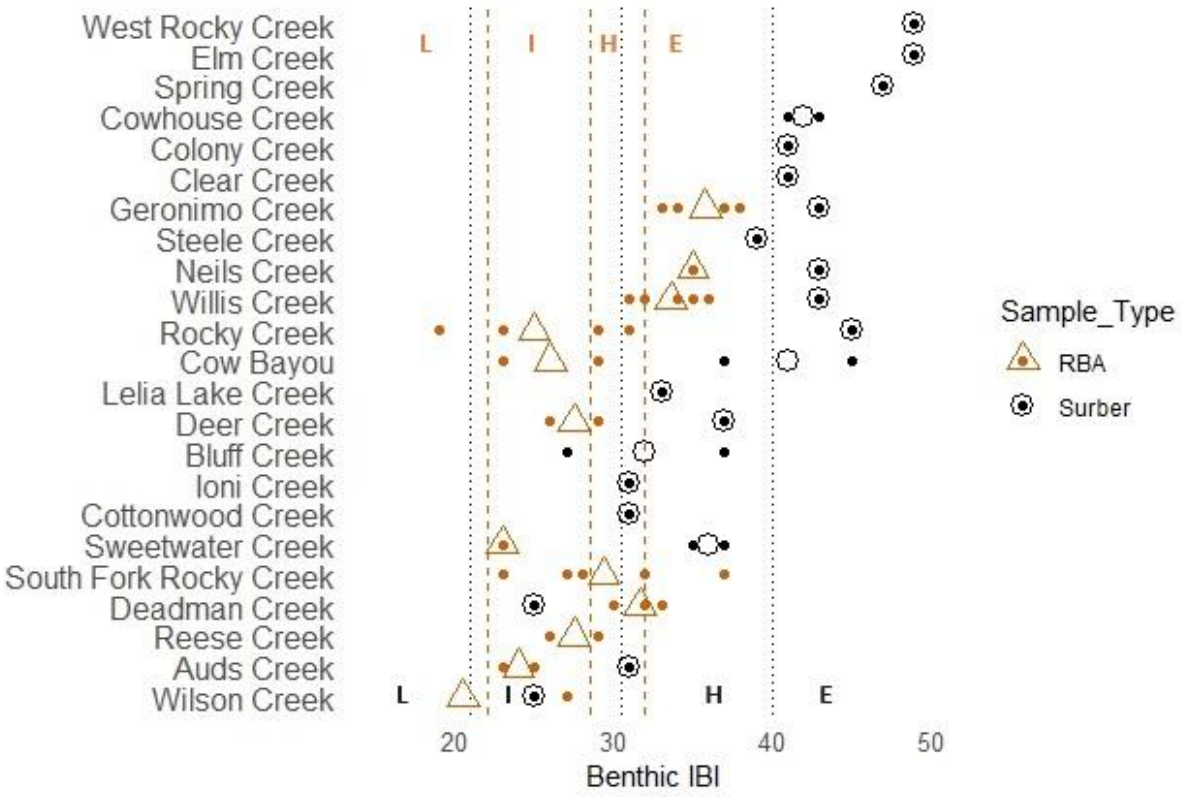

Figure 151. Benthic IBIs and aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all benthic sampling events in Ecoregions 27, 29, and 32 grouped by site and ranked by mean IBI score. Site scores are solid circles, and mean scores are hollow circles for Surber IBI sample and hollow triangles for RBP IBI samples. RBP IBI ALU cut offs are red dashed lines and Surber ALU cutoffs are in black dotted lines.

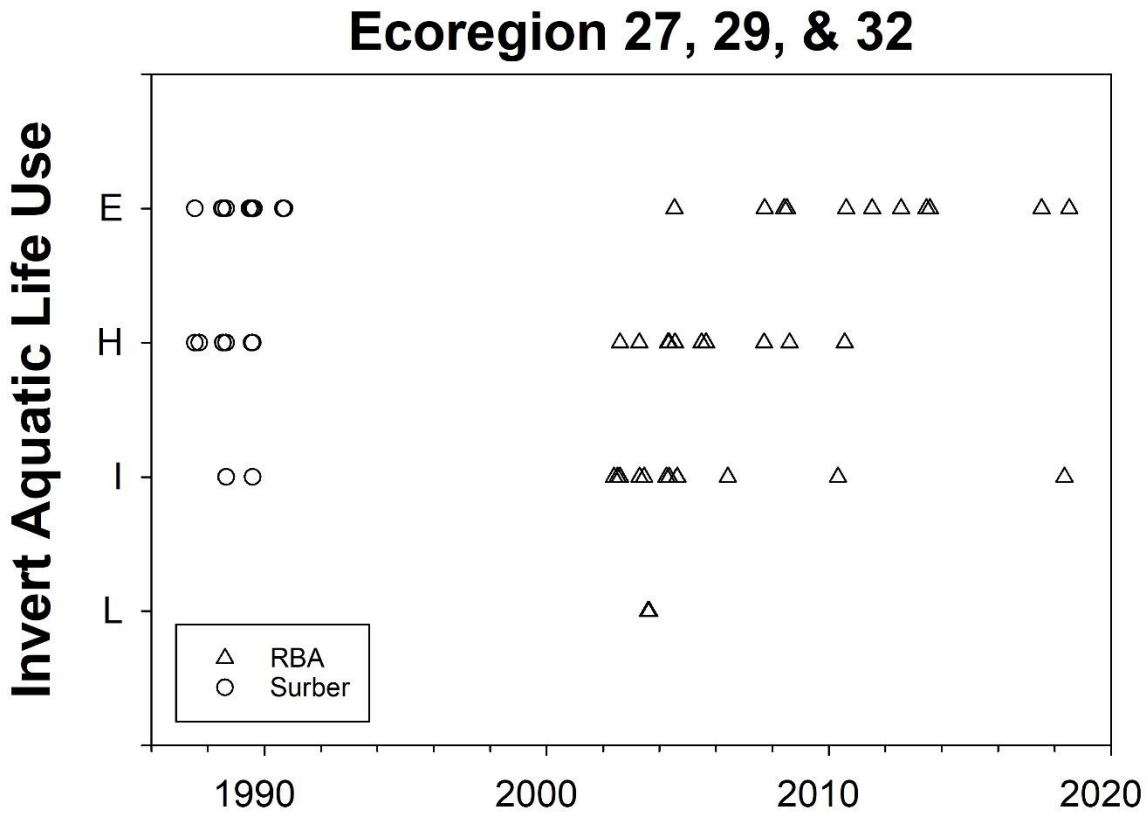

Figure 152. Benthic aquatic life use (ALU) categories through time for all sampling events in Ecoregions 27, 29, and 32; Surber ALUs are noted by circles and RBP ALUs are noted by triangles.

ECOREGION 30 – CENTRAL TEXAS PLATEAU

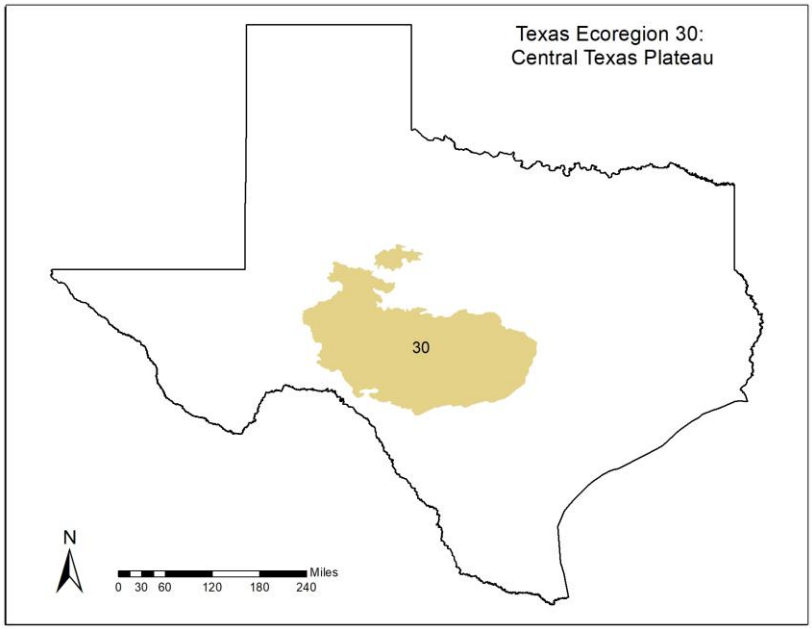

Figure 153. Map of Texas Ecoregion 30 – Central Texas Plateau.

Figure 154. Site photo from the Llano River.

Ecoregion 30 Characterization

The Edwards Plateau covers approximately 75,000 sq km in the central part of the state (Figure 153). The region is characterized as a dissected limestone plateau with a sparse network of perennial streams (Griffith et al. 2007). The south and eastern portion of the ecoregion is comprised of a landscape with more hills, and has a sharp fault line that separates this area from neighboring ecoregions. To the west, the ecoregion forms a transition between the live oak savannas of central Texas and the arid west Texas desert.

Most of the region is covered by juniper-oak savanna and mesquite-oak savanna. Annual average precipitation ranges from 16 to 22 inches in the western portion of the ecoregion and 26 to 34 inches in the central and more northern areas. Cattle, sheep, goats, and wildlife grazing are the primary land use activities due to relatively high summer temperatures, high evapotranspiration rates, shallow soils, and rocky terrain. Crop farming is a minor land use activity that takes place mainly in alluvial valleys.

Due to the widespread karst topography within this ecoregion, most streams are relatively clear and cool relative to surrounding areas. Cobble and gravel substrates are common in the streams, and provides a diverse stable habitat for aquatic life, though other instream cover may be limited. The ecoregion includes portions of the Llano, Guadalupe, Colorado, Devil's, and Nueces River watersheds. Riparian vegetation includes elm (*Ulmus spp.*), willow (*Salix spp.*), American sycamore (*Plantanus americanus*), and the invasive salt-cedar (*Tamarix ramosissima*). Relict stands of baldcypress (*Taxodium distichum*) persist along some streams.

Table 9. Streams sampled in Ecoregion 30.

Barton Creek	Johnson Creek	Onion Creek
Brushy Creek	Little Barton Creek	Pedernales River
Bull Creek	Little Blanco River	San Saba River
Bullhead Creek	Live Oak Creek	Slaughter Creek
Carpers Creek	Llano River	South Concho River
Colorado River	Medina River	South Llano River
Cypress Creek	Montell Creek	Spring Creek
Devils River	North Prong Medina River	West Rocky Creek
Guadalupe River	Nueces River	
James River	Oatmeal Creek	

BARTON CREEK

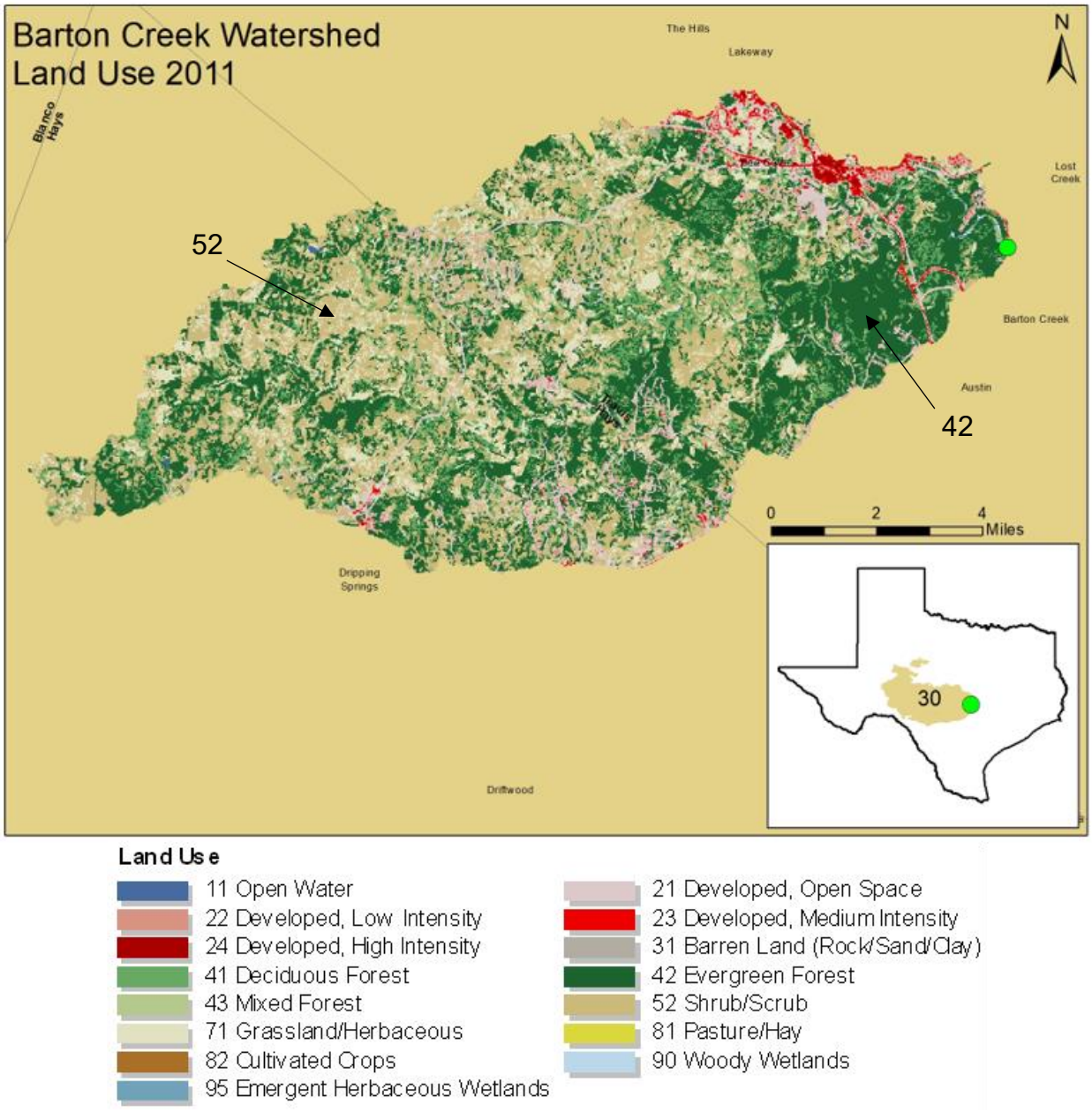

Figure 155. Map of Barton Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	July 7, 1988
Water Quality:	15 sampling events
Fish:	July 7, 1988; March 31, 1989
Benthic Invertebrates:	July 7, 1988

Physical Characterization

Watershed and Land Use

Barton Creek lies within the Colorado River Basin. Sample site 12494 is located downstream of SH 71 near the city of Barton Creek in Travis County (Figure 155).

The Barton Creek watershed at site 12494 is approximately 249.22 sq km. The entire watershed is located within Level IV Ecoregion 30c, the Balcones Canyonlands. The dominant land cover in the watershed is forest at 47.15% and is present throughout the watershed (Homer et al. 2015; Figure 155 and Figure 156). Shrub is the secondary land cover encompassing 30.8%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 9.82% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 45.69 sq km decrease in grassland and an 8.63 sq km decrease in forest. There was a 45.97 sq km increase in shrub and a 16.31 sq km increase in open space development (Figure 157).

There are no permitted wastewater outfalls within the Barton Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Barton Creek was evaluated on July 7, 1988. Barton Creek is a spring fed perennial stream that drains to Lady Bird Lake on the Colorado River. The riparian width was 20 meters. The riparian zone was dominated by trees, which made up an average of 40% of the total riparian species, followed by shrubs and grasses (30% each). The average percentage of tree canopy cover was 10%. The dominant substrate was cobble and gravel, and the average percent of substrate that was gravel size or larger was 50%. Average percent instream cover was 11%. Barton Creek had an average depth of 0.5 meters and a maximum depth of 1.1 meters. The average width was 6 meters and average stream bank slope was 33 degrees. Stream flow at site 12494 was 0.5 cfs. Average stream bank erosion potential was 12%. Five riffles were observed at the site and there were two total stream bends.

Water Quality

Water samples were collected at station 12494 over 15 sampling events from May 1985 through July 1999. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Thirteen species (five families) were collected between the two sampling events on July 7, 1988 and March 31, 1989. Most of the species (seven) were within the family Centrarchidae. Central Stoneroller, followed very closely by Blacktail Shiner and Western Mosquitofish, was the most abundant species in 1988. Western Mosquitofish was the most abundant species in 1989. The

aquatic life use rating for both fish collections was only intermediate. Low numbers of native minnow species, benthic invertivore species, intolerant species, piscivores, and individuals were collected. In addition, a large percentage of the population collected was comprised of non-native species (Redbreast Sunfish).

Benthic Macroinvertebrates

From the single July 1988 Surber sample, a total of 539 individuals representing 42 taxa from 14 orders of macroinvertebrates were collected from Barton Creek (Appendix E). The Diptera, Ephemeroptera, Trichoptera, Hoplonemertea, Odonata, and Coleoptera were the most commonly collected orders, collectively accounting for 92.9 percent of the total number of individuals collected. The Ostracoda and Basommatophora were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the July 1988 Surber sample fell within the exceptional aquatic life use category.

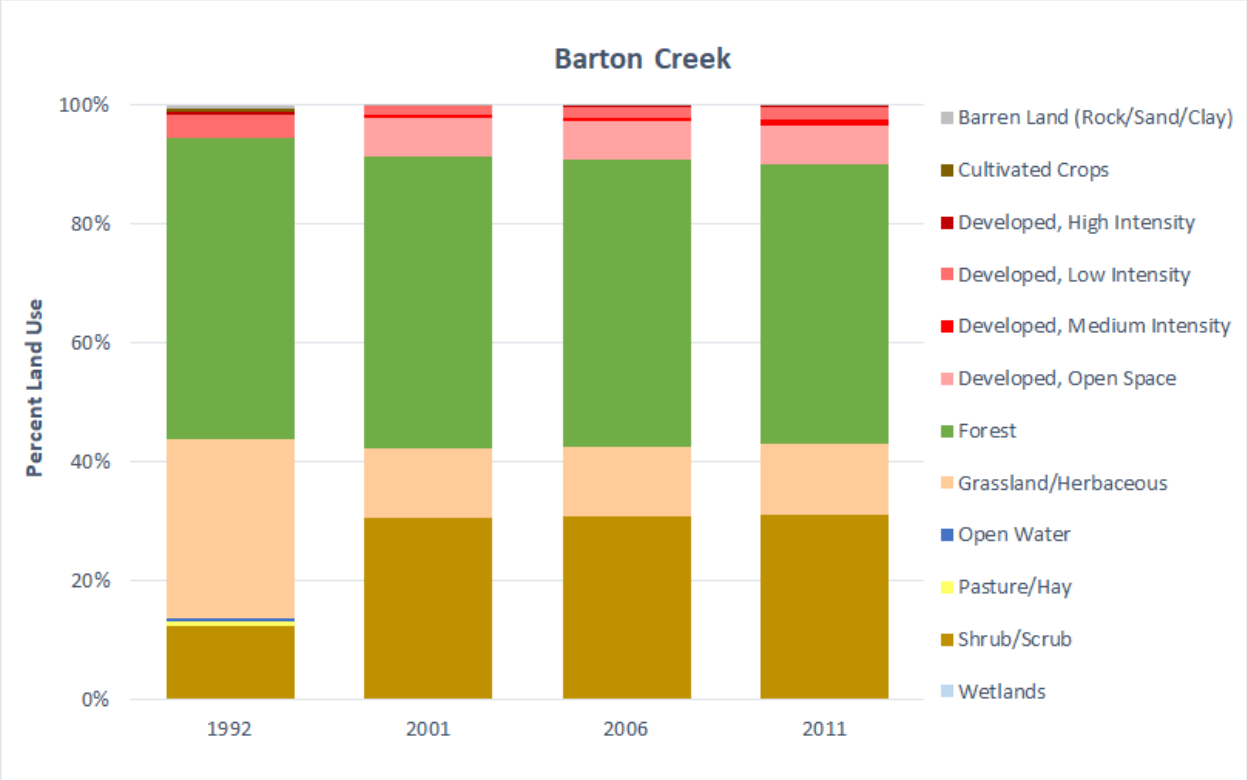

Figure 156. Percent land use in the Barton Creek watershed from 1992-2011.

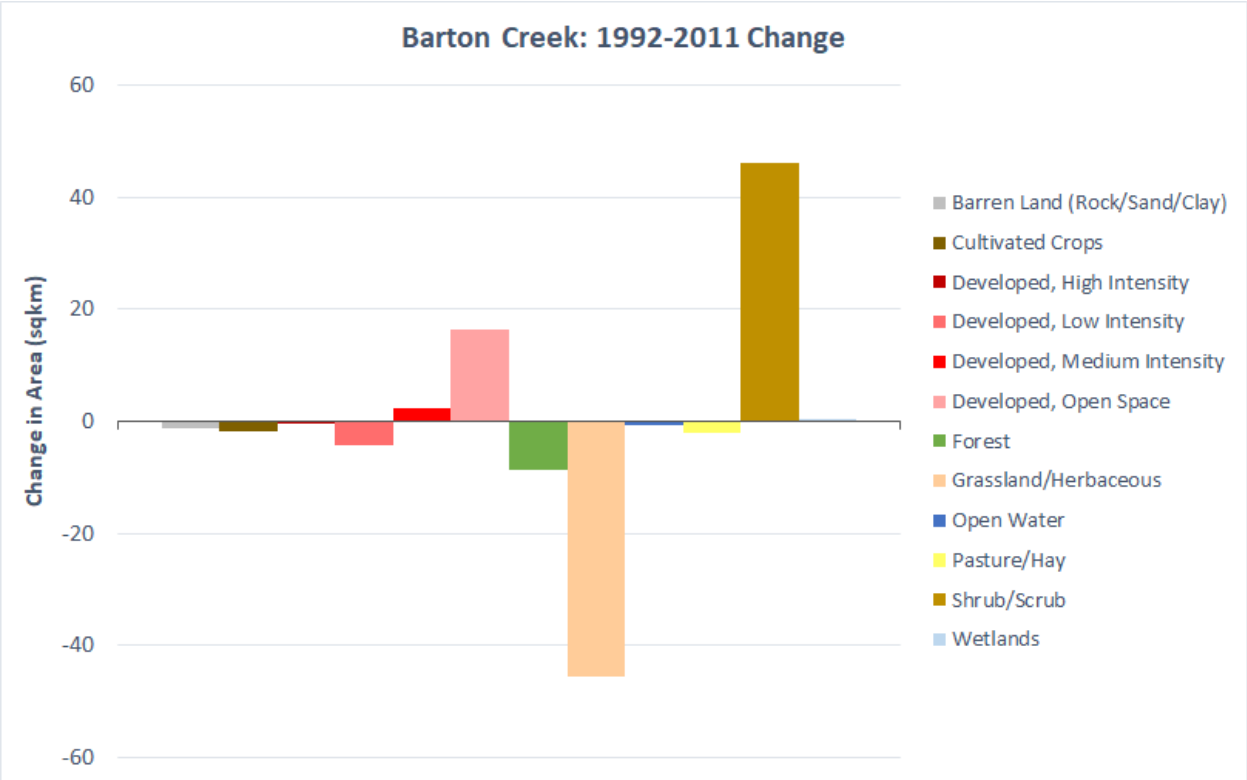

Figure 157. Land use change in area (sq km) from 1992-2011 for the Barton Creek watershed.

BRUSHY CREEK

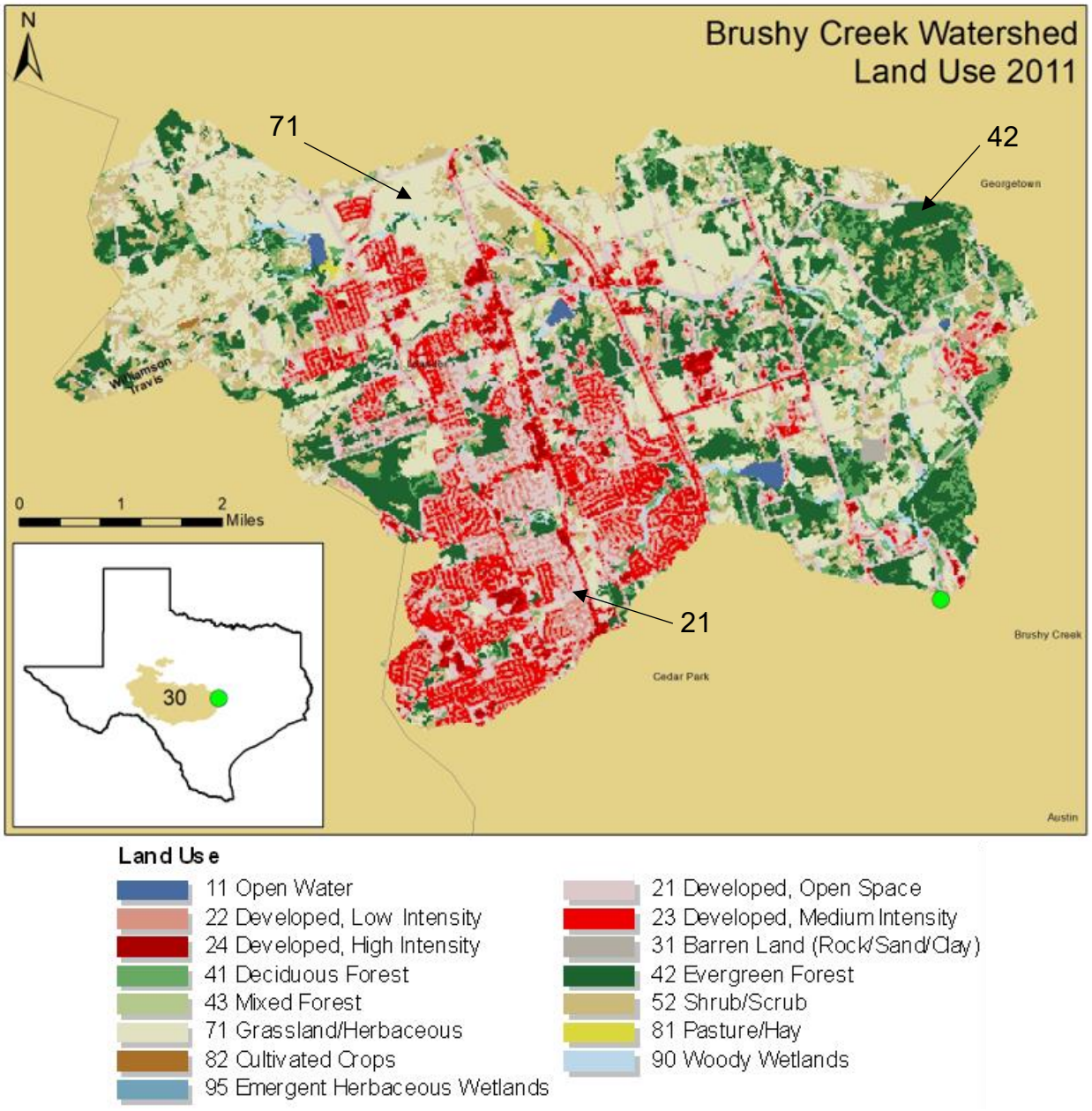

Figure 158. Map of Brushy Creek watershed location and 2011 land use; grassland/herbaceous, forest, and open space development were the most common land uses.

Sampling Dates

Physical Habitat:	October 7, 1999; May 10, 2004; July 7, 2004
Water Quality:	81 sampling events
Fish:	May 10, 2004; July 7, 2004
Benthic Invertebrates:	May 10, 2004; July 7, 2004

Physical Characterization

Watershed and Land Use

Brushy Creek lies within the Brazos River Basin. Sample site 17374 is located upstream of FM 1431 east of Cedar Park in Williamson County (Figure 158).

The Brushy Creek watershed at site 17374 is approximately 87.25 sq km. The entire watershed is located within Level IV Ecoregion 30c, the Balcones Canyonlands. The dominant land covers in the watershed are grassland/herbaceous at 25.07% and forest at 24.02%, both are present throughout the watershed (Homer et al. 2015; Figure 158 and Figure 159). Open space development is the secondary land cover encompassing 16.01%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 37.60% and total cover for cultivated crops is 0.04%.

From 1992-2011 there was a 15.11 sq km decrease in forest and a 7.32 sq km decrease in shrub. There was a 13.9 sq km increase in open space development and an 8.02 sq km increase in medium intensity development (Figure 160).

There is one domestic wastewater outfall (discharges < 1 million gallons per day) within the Brushy Creek watershed. The wastewater facility is permitted to the City of Leander and discharges directly into Brushy Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Brushy Creek was evaluated at two sites during three sampling events from 1999 to 2004. Brushy Creek is a perennial stream that drains to the San Gabriel River. Habitat Quality Index scores are available for all three sample events and indicate a high aquatic life use rating (21.5-24). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 17 to 21 meters. The riparian zone was generally dominated by grasses followed by shrubs then trees. The average percentage of tree canopy cover ranged from 24% to 51%. The dominant stream substrate was gravel, and the average percent of substrate gravel size or larger varied from 22% to 86%. Average percent instream cover was 5% to 44% and instream cover types include overhanging vegetation, undercut banks, macrophytes, snags, algae, and cobble/gravel. Brushy Creek ranged from 0.3-0.5 meters deep on average and 5-13 meters wide. Average stream bank slope ranged from 24-50 degrees. Stream flow was measured at a minimum value of 0.1 cfs and a maximum of 23 cfs. Average stream bank erosion potential was 9%-25%. The deepest pool measured at Brushy Creek was 1.2 meters. Number of riffles observed at the site varied from two to five, and total number of stream bends ranged from three to four.

Water Quality

Water samples were collected at station 17374 over 81 sampling events from June 1997 through November 2014. Data were collected for temperature, flow, transparency, specific conductivity,

dissolved oxygen, pH, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Fourteen species (five families) were collected between the two sampling events on May 10, 2004 and July 7, 2004. Over one-half of the species (eight) were within the family Centrarchidae. Blacktail Shiner was the most abundant species. Based on the fish assemblage, both collections rated as having a high aquatic life use.

Benthic Macroinvertebrates

From the May 2004 and July 2004 RBP samples collectively, a total of 383 individuals representing 30 taxa from 12 orders of macroinvertebrates were collected from Brushy Creek (Appendix E). The Coleoptera, Trichoptera, Diptera, and Ephemeroptera were the most commonly collected orders, collectively accounting for 90.9 percent of the total number of individuals collected. The Odonata, Lepidoptera, Neoophora, and Hemiptera were the only other orders which comprised at least one percent of the collections.

The Ecoregion 30 BIBIs fell within the intermediate for the May 2004 sample and high aquatic life use for the July 2004 sample .

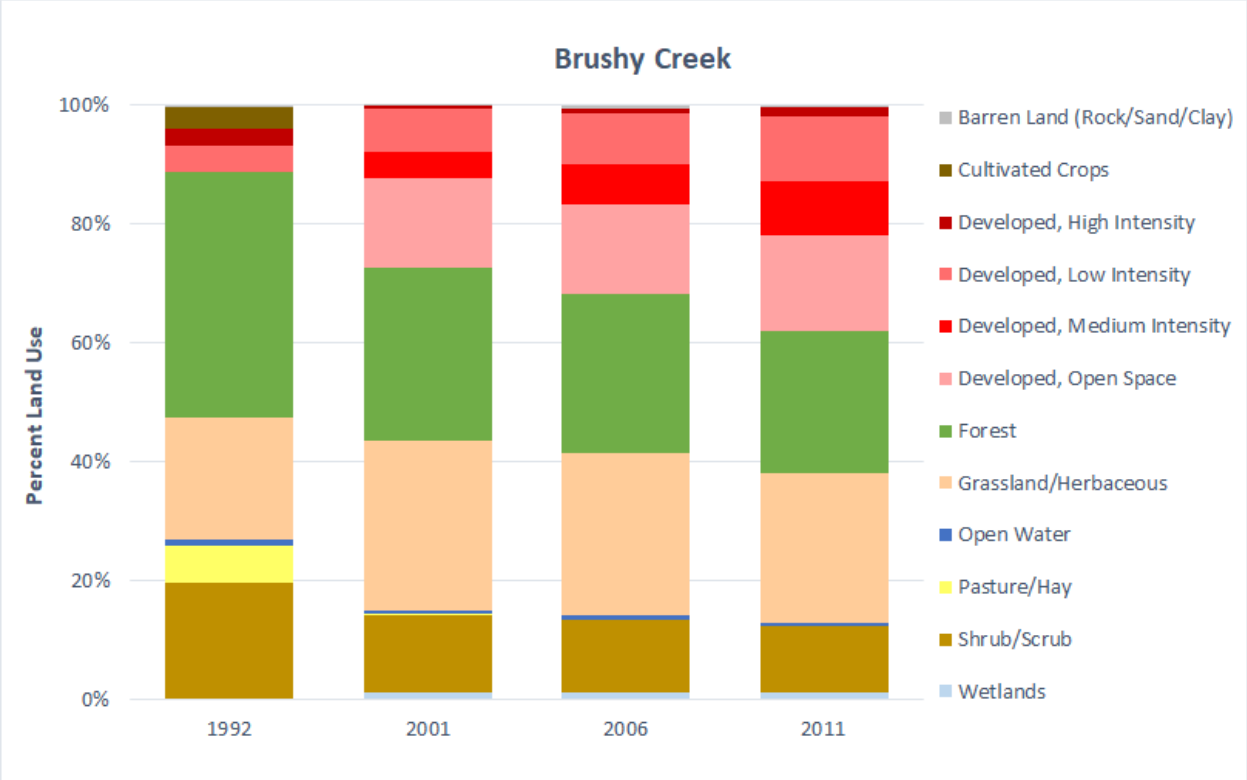

Figure 159. Percent land use in the Brushy Creek watershed from 1992-2011.

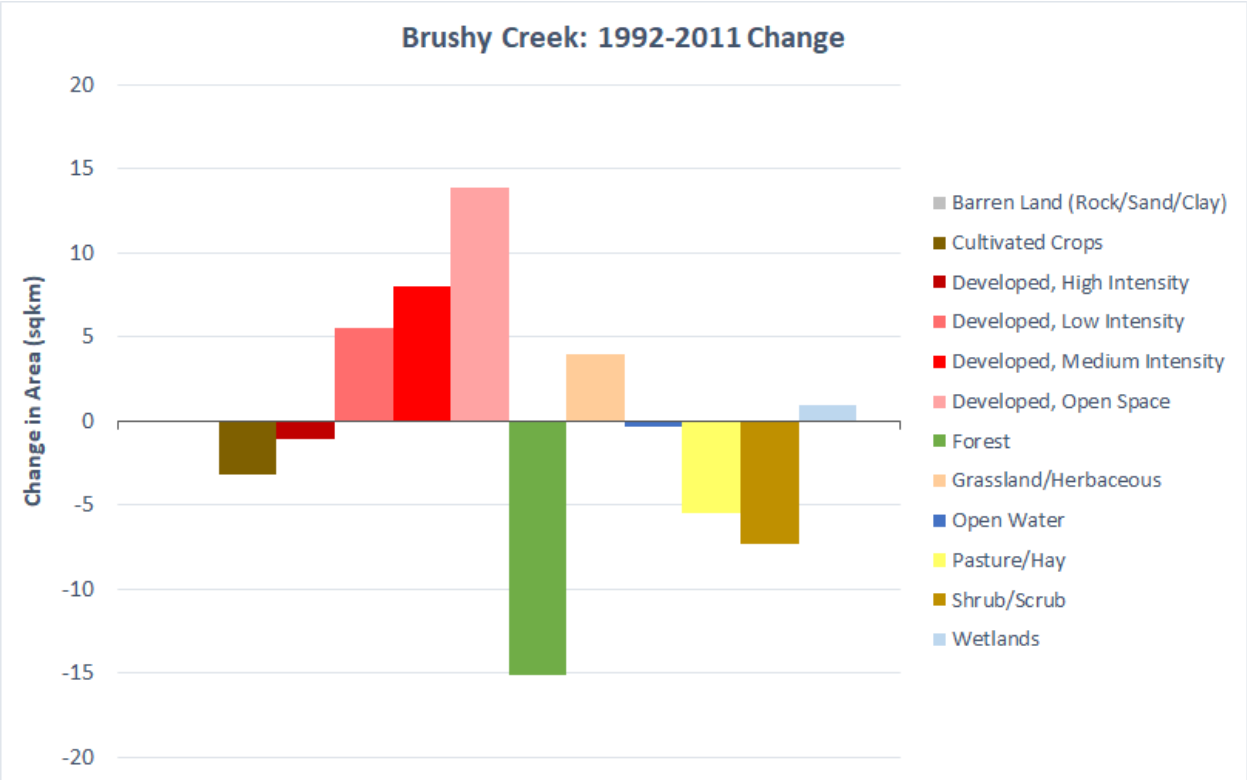

Figure 160. Land use change in area (sq km) from 1992-2011 for the Brushy Creek watershed.

BULL CREEK

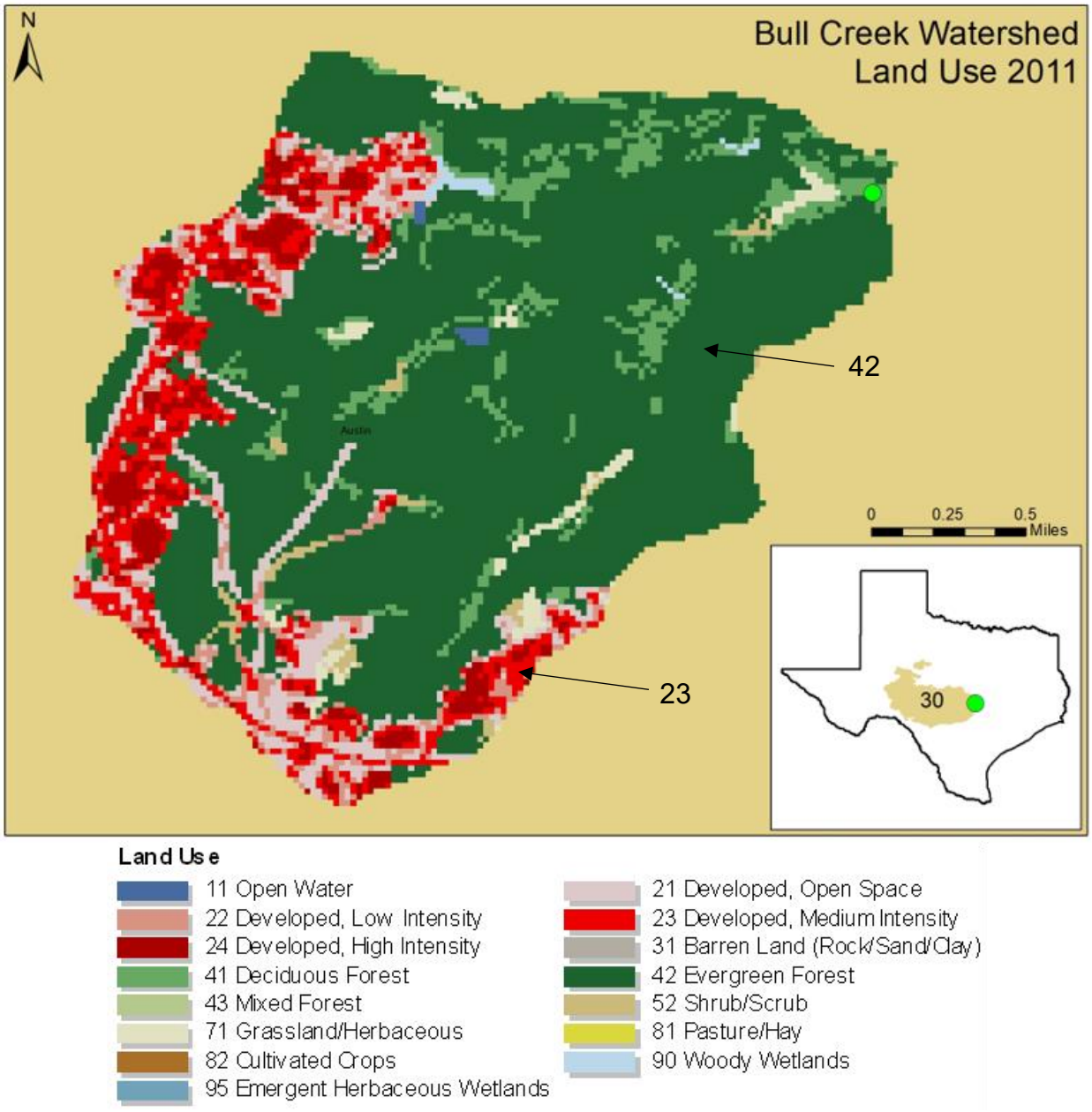

Figure 161. Map of Bull Creek watershed location and 2011 land use; forest and medium intensity development were the most common land uses.

Sampling Dates

Physical Habitat:	June 22, 2006; September 7, 2016
Water Quality:	123 sampling events
Fish:	September 7, 2016
Benthic Invertebrates:	September 7, 2016

Physical Characterization

Watershed and Land Use

Bull Creek lies within the Colorado River Basin. Sample site 16322 is located 0.47 km south of the intersection of Wyndham Drive and Corley Drive in the City of Austin in Travis County (Figure 161).

The Bull Creek watershed at site 16322 is approximately 10.59 sq km. The entire watershed is located within Level IV Ecoregion 30c, the Balcones Canyonlands. The dominant land cover in the watershed is forest at 75.56% and is present throughout the majority of the watershed (Homer et al. 2015; Figure 161 and Figure 162). Medium intensity development is the secondary land cover encompassing 7.29%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 23.08% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 1.56 sq km decrease in shrub and a 0.16 sq km decrease in forest. There was a 0.77 sq km increase in medium intensity development and a 0.69 sq km increase in open space development (Figure 163).

There are no wastewater outfalls within the Bull Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Bull Creek was evaluated at two sites during two sampling events in 2006 and 2016. Bull Creek is a perennial stream that drains to Lake Austin. Habitat Quality Index scores are available for both sample events and indicate a high aquatic life use rating (22-25). Riparian areas were well vegetated throughout the reach with an average riparian buffer greater than 20 meters. The riparian zone was generally dominated by shrubs followed by trees then grasses. The average percentage of tree canopy cover ranged from 63% to 72%. The dominant stream substrates were sand and cobble, and the average percent of substrate gravel size or larger varied from 81% to 93%. Average percent instream cover was 25% to 59% and instream cover types include overhanging vegetation, leaf packs, snags, undercut banks, boulders, woody debris, root mats, and cobble/gravel. Bull Creek ranged from 0.3-0.4 meters deep on average and 4-12 meters wide. Average stream bank slope ranged from 21-42 degrees. Stream flow was measured at a minimum value of 1.3 cfs and a maximum of 2.4 cfs. Average stream bank erosion potential was 17%. The deepest pool measured at Bull Creek was 1.2 meters. Three riffles were observed at each site and total number of stream bends ranged from one to four.

Water Quality

Water samples were collected at station 16322 over 123 sampling events from June 1996 through June 2020. Parameters measured included temperature, flow, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, and sulfate. Continuous 24-hr data was collected at this station.

Biological Characterization

Fish

Six species (three families) were collected from Bull Creek. Centrarchidae was the only family represented by more than one species. Central Stoneroller was the most abundant species. Based on the fish assemblage, the aquatic life use only rated as intermediate. Only one native cyprinid species (Central Stoneroller) was collected, but no benthic invertivore or intolerant species were collected.

Benthic Macroinvertebrates

From the single September 2016 RBP sample, a total of 222 individuals representing 23 taxa from 9 orders of macroinvertebrates were collected from Bull Creek (Appendix E). The Diptera, Trichoptera, Ephemeroptera, Coleoptera, and Odonata were the most commonly collected orders, collectively accounting for 95.9 percent of the total number of individuals collected. The Megaloptera was the only other order which comprised at least one percent of the collections.

The Ecoregion 30 BIBI for the September 2016 RBP sample fell within the intermediate aquatic life use category.

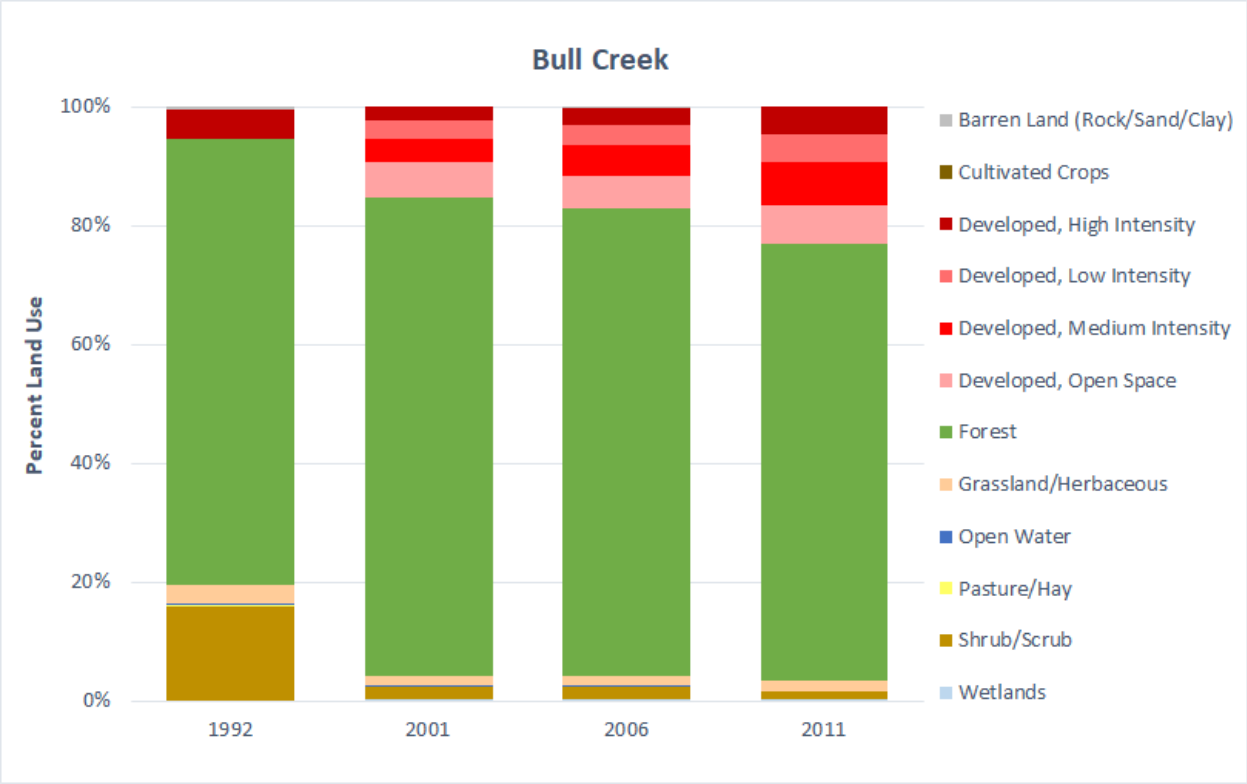

Figure 162. Percent land use in the Bull Creek watershed from 1992-2011.

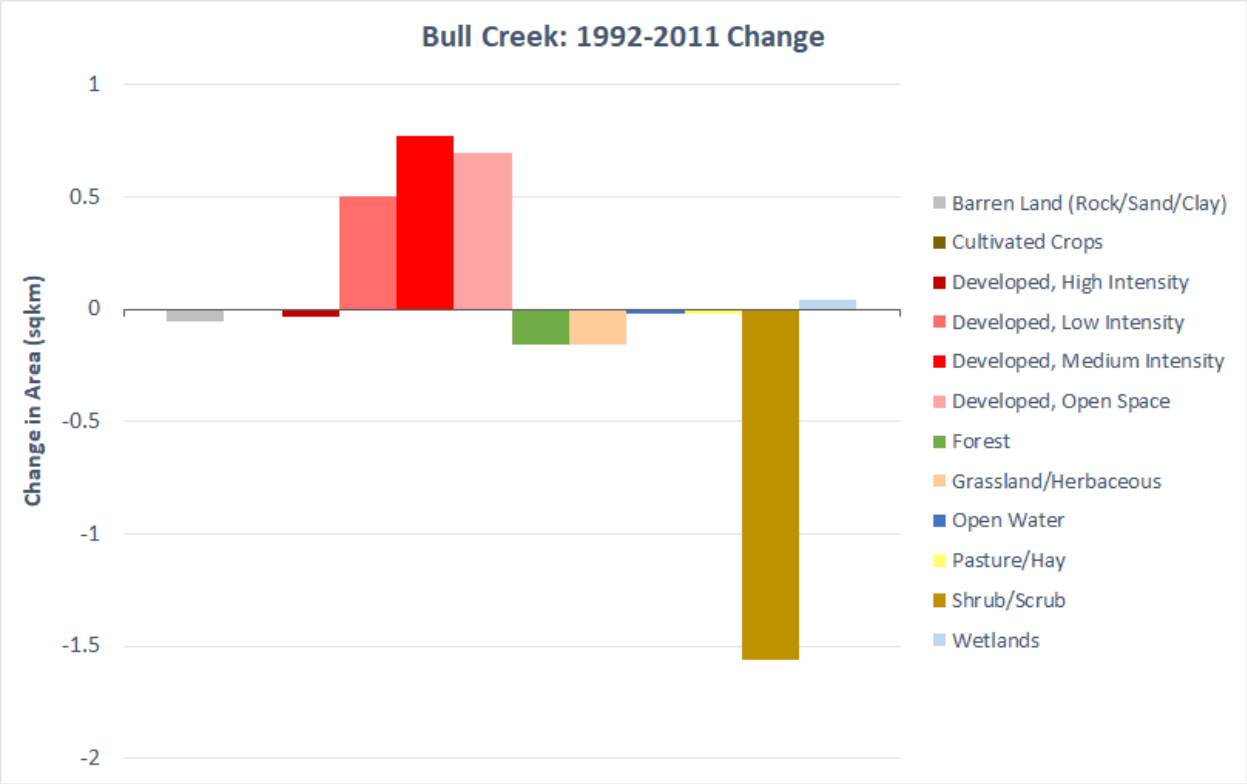

Figure 163. Land use change in area (sq km) from 1992-2011 for the Bull Creek watershed.

BULLHEAD CREEK

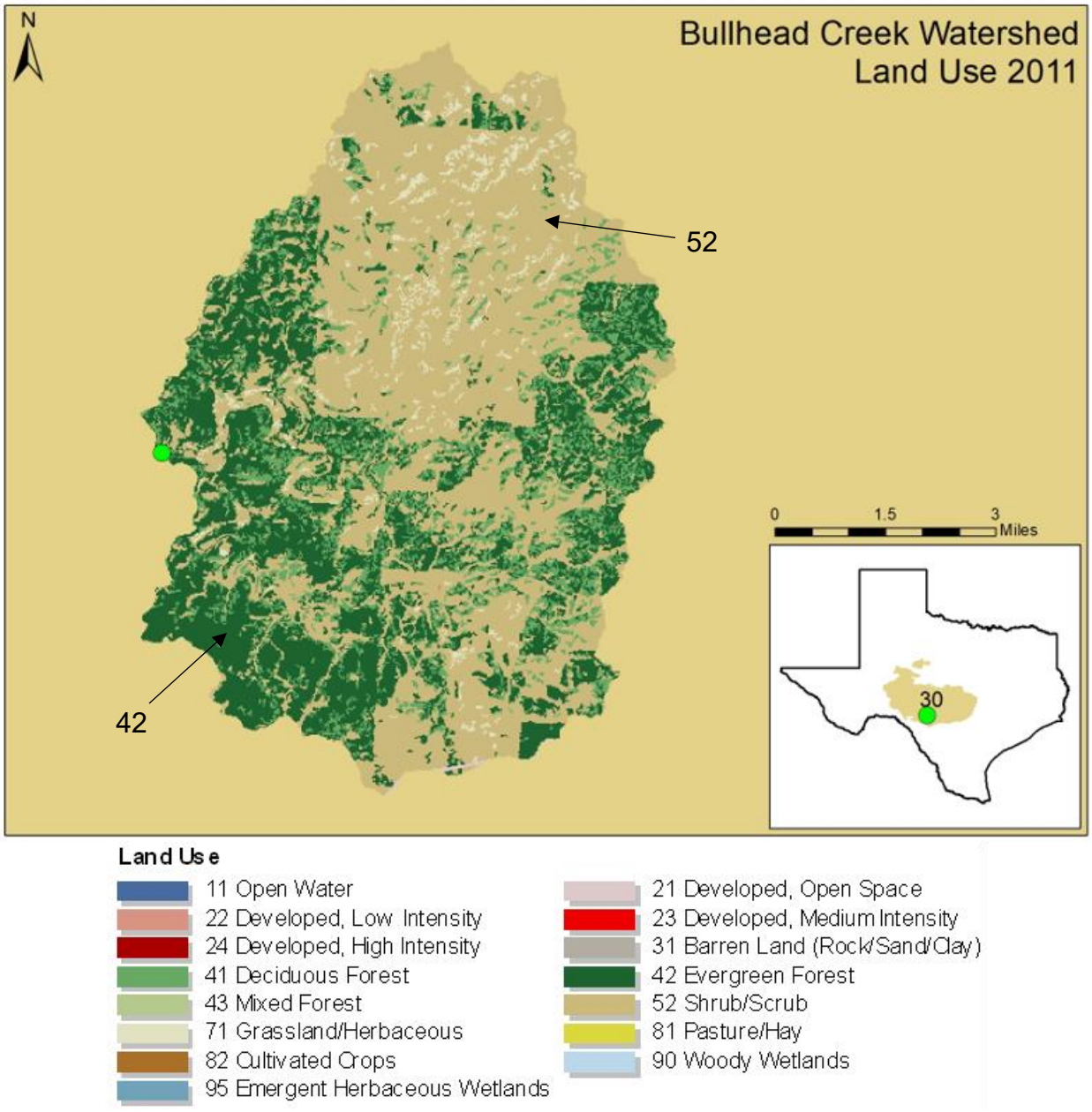

Figure 164. Map of Bullhead Creek watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	No samples
Water Quality:	May 17, 2011
Fish:	August 12, 2010; May 17, 2011
Benthic Invertebrates:	August 12, 2010 (x2); May 17, 2011 (x2)

Physical Characterization

Watershed and Land Use

Bullhead Creek lies within the Nueces River Basin. Sample site 20832 is located 5.5 km northeast of Vance and 0.15 km south of Ranch Road 2631 in Real County (Figure 164).

The Bullhead Creek watershed at site 20832 is approximately 129.51 sq km. The entire watershed is located within Level IV Ecoregion 30c, the Balcones Canyonlands. The dominant land cover in the watershed is shrub at 53.5% and is present throughout the watershed (Homer et al. 2015; Figure 164 and Figure 165). Forest is the secondary land cover encompassing 43.46%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.11% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 23.29 sq km decrease in grassland/herbaceous and a 10.83 sq km decrease in forest. There was a 35.80 sq km increase in shrub and a 0.12 sq km increase in open space development (Figure 166).

There are no wastewater outfalls within the Bullhead Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat data is not available for Bullhead Creek.

Water Quality

Station 20832 was sampled in May 2011. Parameters measured included alkalinity, ammonia, phosphorus, total organic carbon, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Sixteen species (seven families) were collected between the two 2010 and 2011 sampling events. Cyprinidae and Centrarchidae were the two richest families with five and four species, respectively. Nueces Roundnose Minnow (*Dionda serena*) was the most abundant species collected in 2010. Longear Sunfish was the most abundant species in the 2011 collection. The aquatic life use (based upon the fish assemblage) rated as exceptional and high for the 2010 and 2011 collections, respectively; however, when the coefficient of variability is applied the 2011 sample also achieves an exceptional rating.

Benthic Macroinvertebrates

From the four RBP samples (2 sample events August 2010 and 2 sample events May 2011) collectively, a total of 1004 individuals representing 53 taxa from 13 orders of macroinvertebrates were collected from Bullhead Creek (Appendix E). The Trichoptera, Ephemeroptera, Hemiptera, Diptera, and Coleoptera were the most commonly collected orders, collectively accounting for 93.8 percent of the total number of individuals collected. The

Tricladida and Odonata were the only other orders which comprised at least one percent of the collections.

The two August 2010 RBP and the one May 2011 RBP Ecoregion 30 BIBIs fell within the high aquatic life use category. The other May 2011 RBP sample fell within the intermediate aquatic life use category.

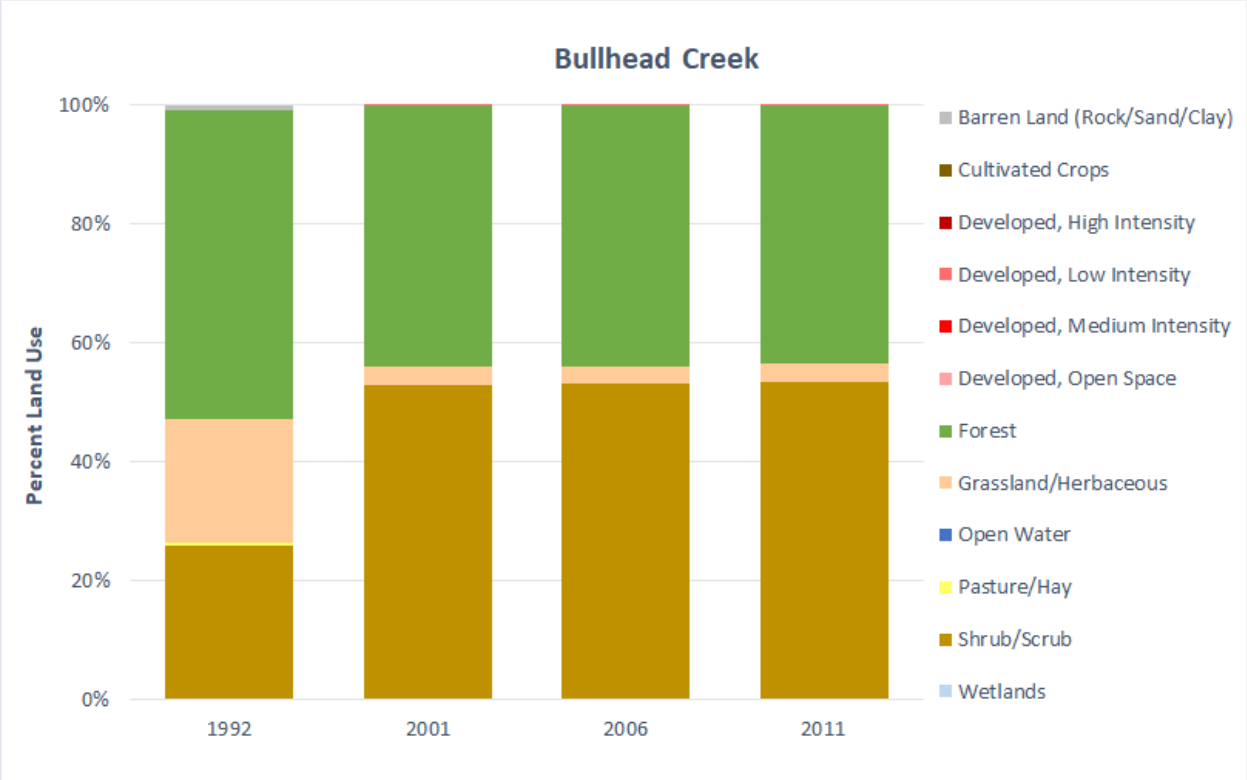

Figure 165. Percent land use in the Bullhead Creek watershed from 1992-2011.

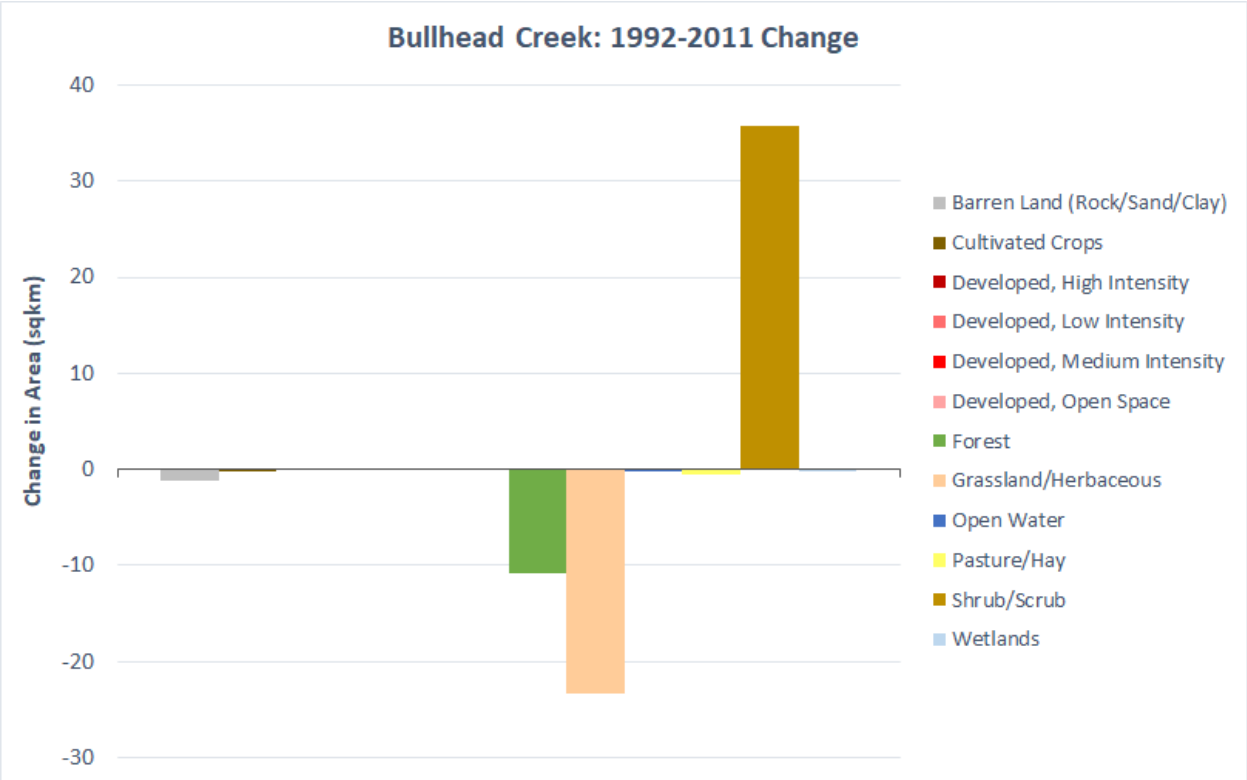

Figure 166. Land use change in area (sq km) from 1992-2011 for the Bullhead Creek watershed.

CARPERS CREEK

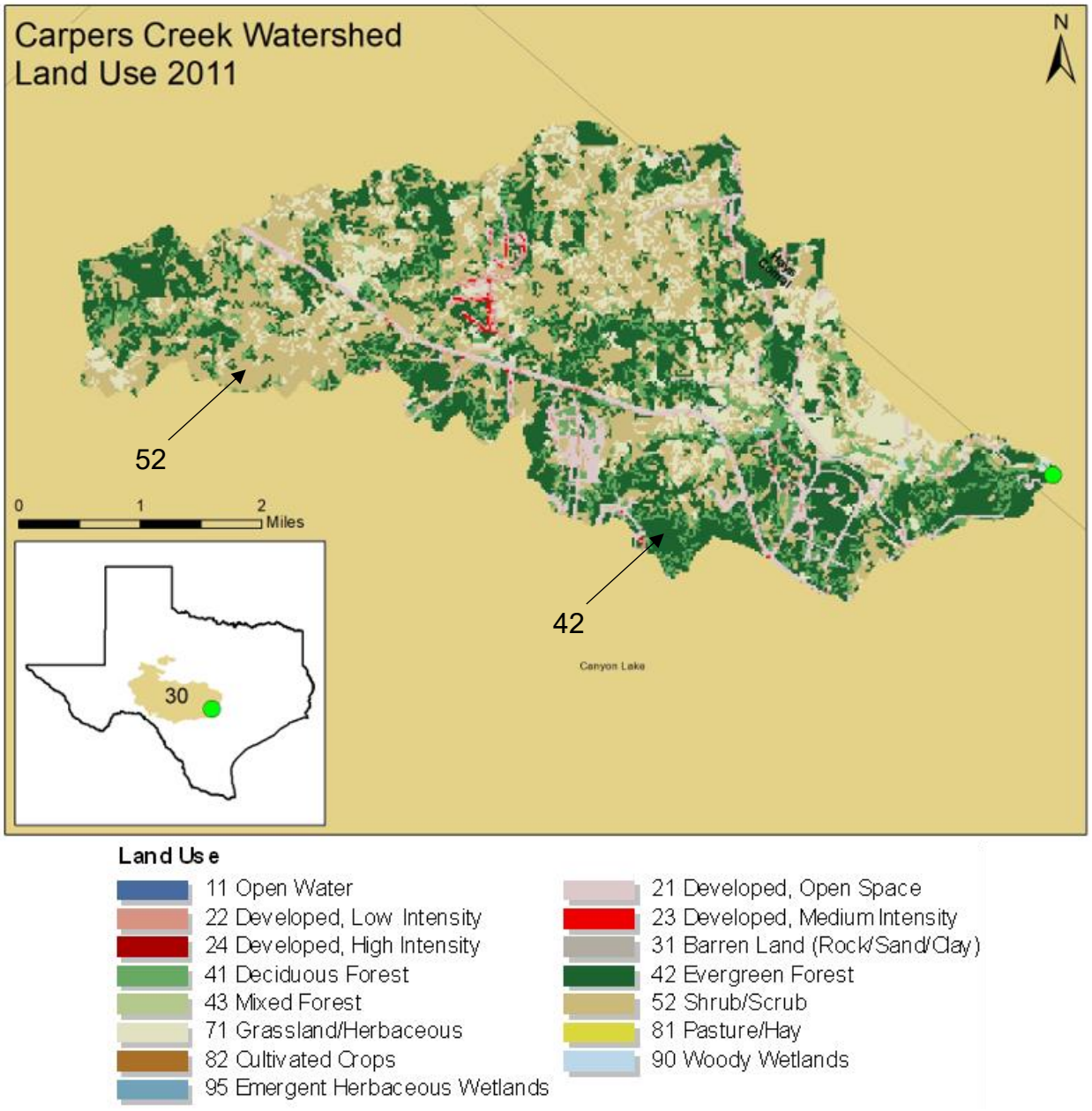

Figure 167. Map of Carpers Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	September 24, 1988
Water Quality:	3 sampling events
Fish:	March 22, 1989
Benthic Invertebrates:	September 28, 1988

Physical Characterization

Watershed and Land Use

Carpers Creek lies within the Guadalupe River Basin. Sample site 12540 is located on Knox Ranch, 6.44 km southeast of Fischer in Hays County (Figure 167).

The Carpers Creek watershed at site 12540 is approximately 39.61 sq km. The entire watershed is located within Level IV Ecoregion 30c, the Balcones Canyonlands. The dominant land cover in the watershed is forest at 43.51% and is present throughout the watershed (Homer et al. 2015; Figure 167 and Figure 168). Shrub is the secondary land cover encompassing 32.65%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.09% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 7.87 sq km decrease in forest and a 3.75 sq km decrease in grassland/herbaceous. There was a 10.60 sq km increase in shrub and a 2.79 sq km increase in open space development (Figure 169).

There are no wastewater outfalls within the Carpers Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Carpers Creek was evaluated on September 24, 1988. Carpers Creek is a tributary to the Upper Blanco River. The riparian width was 21 meters. The riparian zone was dominated by trees, which made up an average of 60% of the total riparian species, followed by grasses (30%) then shrubs (10%). The average percentage of tree canopy cover was 83%. The dominant substrate was cobble and gravel, and the average percent of substrate that was gravel size or larger was 65%. Average percent instream cover was 44%. Carpers Creek had an average depth of 0.6 meters and a maximum depth of 1.7 meters. The average width was 8 meters and average stream bank slope was 35 degrees. Stream flow at the site was 0.05 cfs. Average stream bank erosion potential was 46%. Six riffles were observed at the site and there were three total stream bends.

Water Quality

Station 12540 was sampled for water quality over 3 events in September 1988 and March 1999. Parameters measured included temperature, flow, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Fourteen species (six families) were collected from Carpers Creek. One-half of the species were within the family Centrarchidae. Bluegill was the most abundant species. Of particular note was the collection of an American Eel (*Anguilla rostrata*) as there has been recent concern over the status of this migratory species throughout the United States. The aquatic life use (based upon the fish assemblage) rated as high.

Benthic Macroinvertebrates

From the single September 1988 Surber sample, a total of 1004 individuals representing 56 taxa from 17 orders of macroinvertebrates were collected from Carpers Creek (Appendix E). The Coleoptera, Diptera, Trichoptera, Oligochaeta (now Clitellata), Neoophora, Amphipoda, Basommatophora, and Ephemeroptera were the most commonly collected orders, collectively accounting for 91.7 percent of the total number of individuals collected. The Odonata, Veneroida, Hirudinida, Hoplonemertea, and Nematoda were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the September 1988 Surber sample fell within the exceptional aquatic life use category.

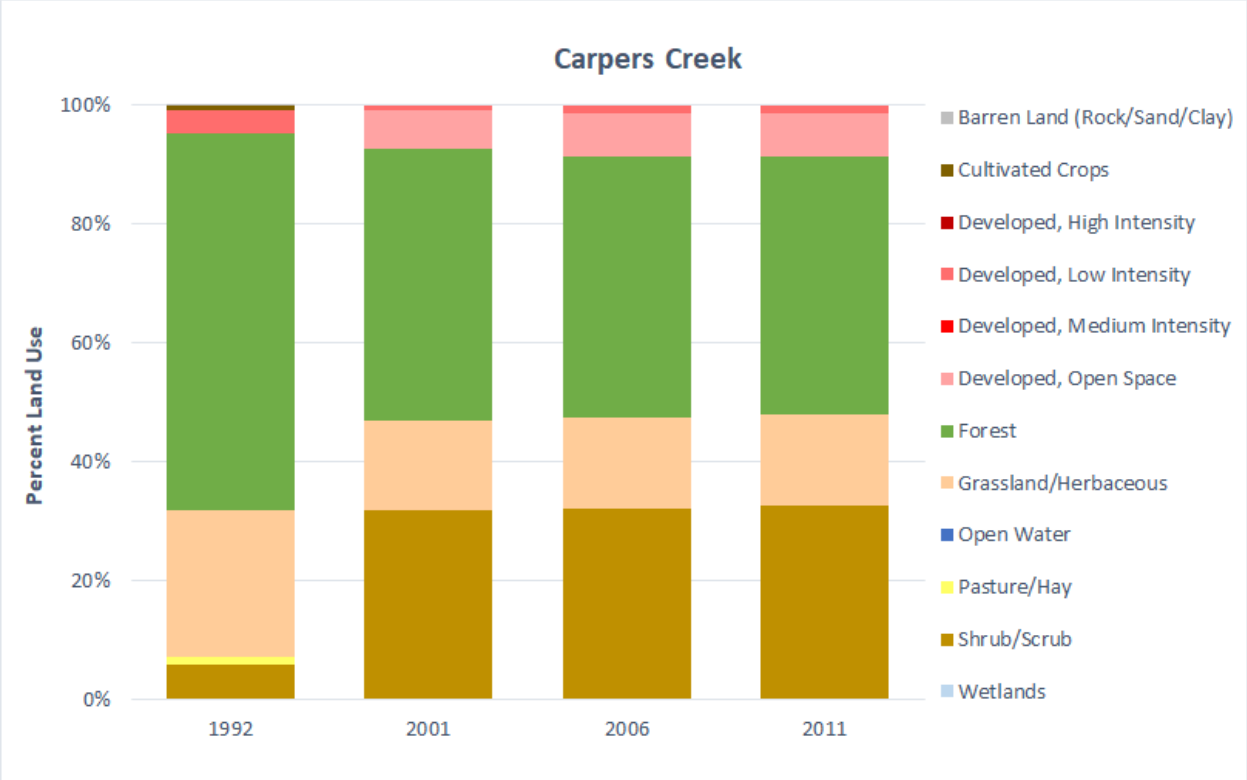

Figure 168. Percent land use in the Carpers Creek watershed from 1992-2011.

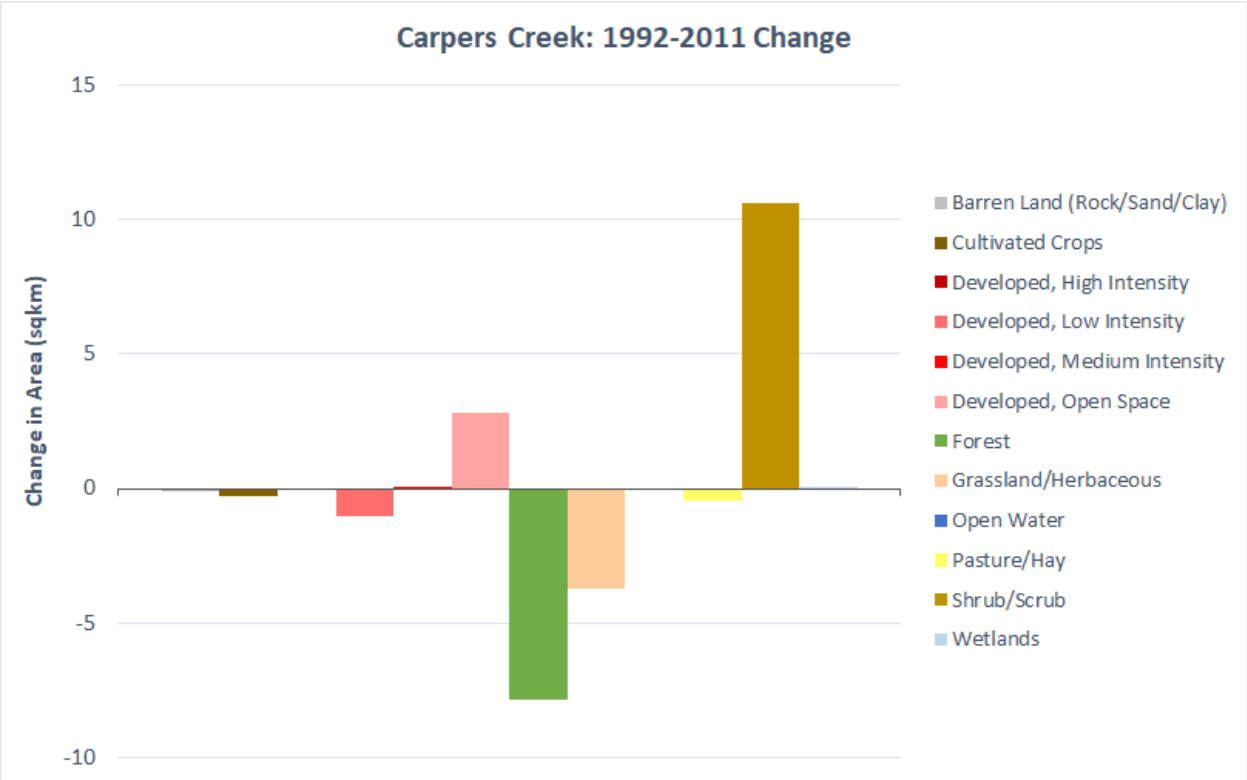

Figure 169. Land use change in area (sq km) from 1992-2011 for the Carpers Creek watershed.

COLORADO RIVER

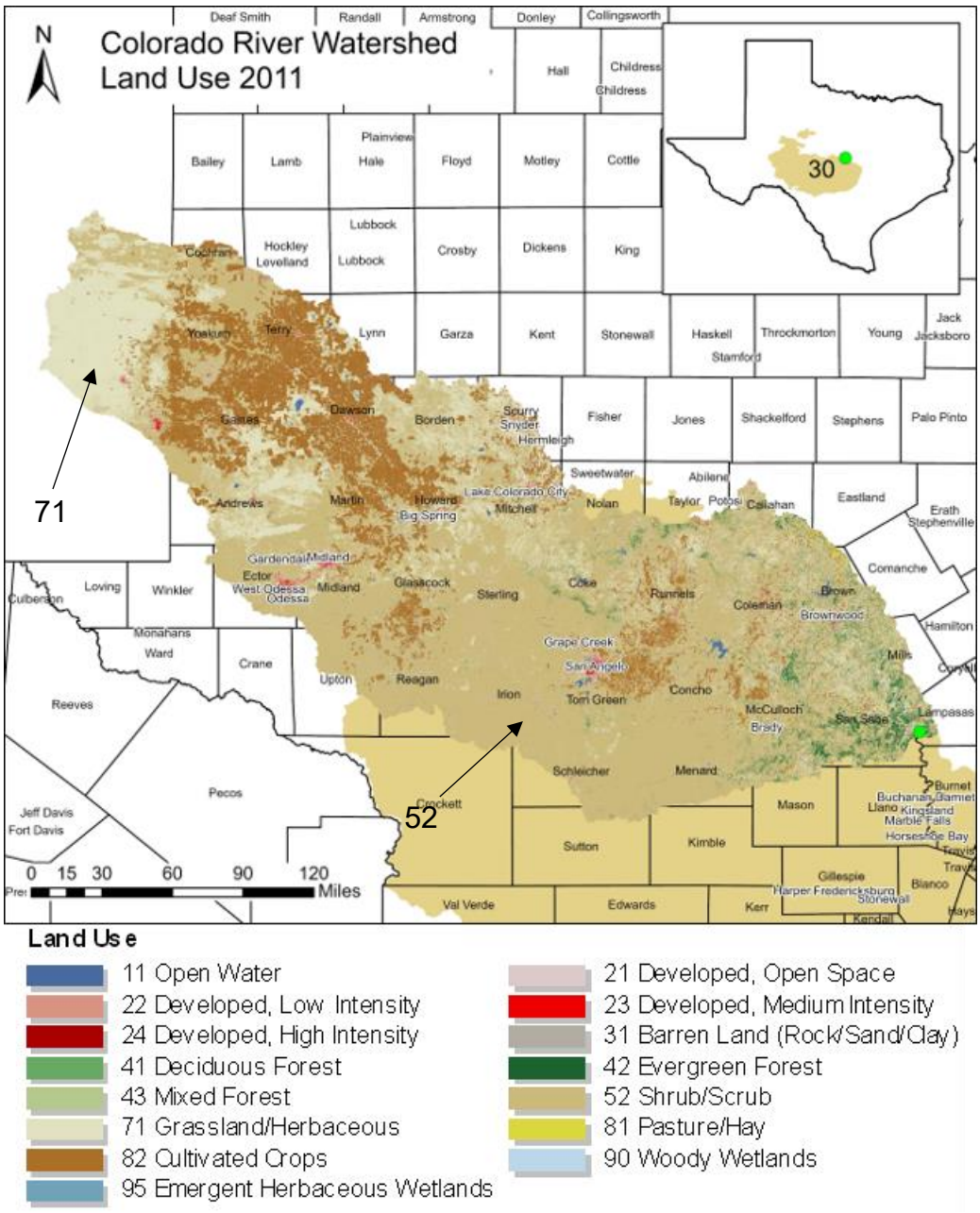

Figure 170. Map of Colorado River watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat: March 30, 2010; September 23, 2010; March 30, 2011; August 30, 2011; May 30, 2012; July 26, 2012; March 26, 2013; July 31, 2013

Water Quality: No water samples at this station

Fish:	March 30, 2010; September 23, 2010; March 30, 2011; August 30, 2011; May 30, 2012; July 26, 2012; March 26, 2013; July 31, 2013
Benthic Invertebrates:	March 30, 2010; September 23, 2010; March 30, 2011; May 30, 2012; July 26, 2012; March 27, 2013; July 31, 2013

Physical Characterization

Watershed and Land Use

The Colorado River is the basin's namesake and is a major river basin in Texas. Sample site 20641 is located 1.04 km downstream from the confluence of Lynch Creek, approximately 26 km east of Lampasas in San Saba County (Figure 170).

The Texas portion of the Colorado River watershed at site 20641 is approximately 2,538,769.67 sq km. The station and a portion of the extreme lower watershed are located in Level IV Ecoregion 30a, the Edwards Plateau Woodland; however, the watershed spans across Ecoregions 25, 26, 27, 29, and Level IV Ecoregion 30d, the Semiarid Edwards Plateau. The dominant land cover in the watershed is shrub at 57.83% and is present throughout the watershed (Homer et al. 2015; Figure 170 and Figure 171). Grassland/herbaceous is the secondary land cover encompassing 18.76%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 4.63% and total cover for cultivated crops is 15.02%.

From 1992-2011 there was a 262,157.66 sq km decrease in grassland and an 88,058.57 sq km decrease in cultivated crop. There was a 312,598.46 sq km increase in shrub and a 97,280.36 sq km increase in open space development (Figure 172).

There are 26 current and one pending domestic wastewater outfalls (discharges < 1 million gallons per day) and 18 industrial wastewater outfalls (discharges ≥ 1 million gallons per day) within the Colorado River watershed. Most of the domestic wastewater facilities are permitted to cities and wastewater treatment corporations. The one pending domestic wastewater facility is for Park Sewer Company. The industrial wastewater facilities are permitted to larger cities in the watershed, as well as three permitted to Alon USA, which is an independent refiner and marketer of petroleum products; three are permitted to Cooper Natural Resources Inc, which manufactures and sells sodium sulfate throughout North America and Mexico; two are permitted to Luminant Generation Company, LLC, a power generation business; one is permitted to Gulf Coast Waste Disposal Authority; and two are permitted to Unimin Corp, a mining company. One domestic facility permitted to the City of Robert Lee discharges directly into the Colorado River.

In Channel and Riparian Physical Habitat

Physical habitat for the Colorado River was evaluated during eight sampling events from 2010 to 2013. Segment 1409 of the Colorado River begins at the confluence with the San Saba River and drains to the headwaters of Lake Buchanan near Colorado Bend State Park. Habitat Quality Index scores are available for all eight sample events and indicate an intermediate to high aquatic life use rating (14-25). Riparian areas were well vegetated throughout the reach with an average

riparian buffer ranging from 11 meters wide to greater than 20 meters. The riparian zone was generally dominated by grasses followed by trees then bare soil/rock. The average percentage of tree canopy cover ranged from 17% to 44%. The dominant stream substrate was cobble and gravel, and the average percent of substrate gravel size or larger varied from 51% to 83%. Average percent instream cover was 2% to 42%. The Colorado River ranged from 0.5-0.8 meters deep on average and 45- 64 meters wide. Average stream bank slope ranged from 33- 74 degrees. Stream flow at the site was measured at a minimum value of 0 cfs and a maximum of 291 cfs. Average stream bank erosion potential was 20%-66%. The deepest pool measured on the Colorado River was 2.7 meters. Number of riffles observed at the site varied from zero to four, and total number of stream bends ranged from zero to two.

Water Quality

Only samples for instantaneous flow were collected at station 20641 in 8 sampling events from March 2010 through July 2013. No other water quality parameters were reported.

Biological Characterization

Fish

Thirty-five species (12 families) were collected over the course of the eight sampling events. Centrarchidae and Cyprinidae were the richest families with 10 and nine species, respectively. Red Shiner was the most abundant species in five collections, but it was slightly exceeded by Blacktail Shiner in March 2010 and Western Mosquitofish in September 2010. Western Mosquitofish was also the most abundant species in the August 2011 collection.

Of the eight fish collections, only the March 2010 fish assemblage rated as having an exceptional aquatic life use. All others rated as high. Application of the coefficient of variability results in the September 2010 assemblage also attaining an exceptional rating. A general increase in the percentage of individuals comprised of tolerant, omnivorous, and non-native species were the major reasons for the 2011, 2012, and 2013 samples rating high rather than exceptional. The composition of tolerant species was fairly consistent between samples (six of the 11 tolerant species collected over the eight sampling events were present in every sample and two species were collected in all but two samples); however, their respective abundances were higher in the latter years. As far as non-native species are concerned, Common Carp was present in every sample. In addition to Common Carp, Redbreast Sunfish was collected in 2012 and Goldfish (*Carassius auratus*) in 2013.

Benthic Macroinvertebrates

From the seven RBP samples (collected March and September 2010, March 2011, May and July 2012, and March and July 2013) collectively, a total of 1541 individuals representing 50 taxa from 15 orders of macroinvertebrates were collected from the Colorado River (Appendix E). The Ephemeroptera, Trichoptera, Diptera, Coleoptera, and Odonata were the most commonly collected orders, collectively accounting for 91.6 percent of the total number of individuals

collected. The Turbellaria, Veneroida, and Basommatophora were the only other orders which comprised at least one percent of the collections.

The Ecoregion 30 BIBIs for the March 2010 RBP sample fell within the limited aquatic life use category. The September 2010, March 2011, May 2012, and July 2012 samples fell within the high aquatic life use category, while the samples from March and July 2013 fell within the intermediate aquatic life use category.

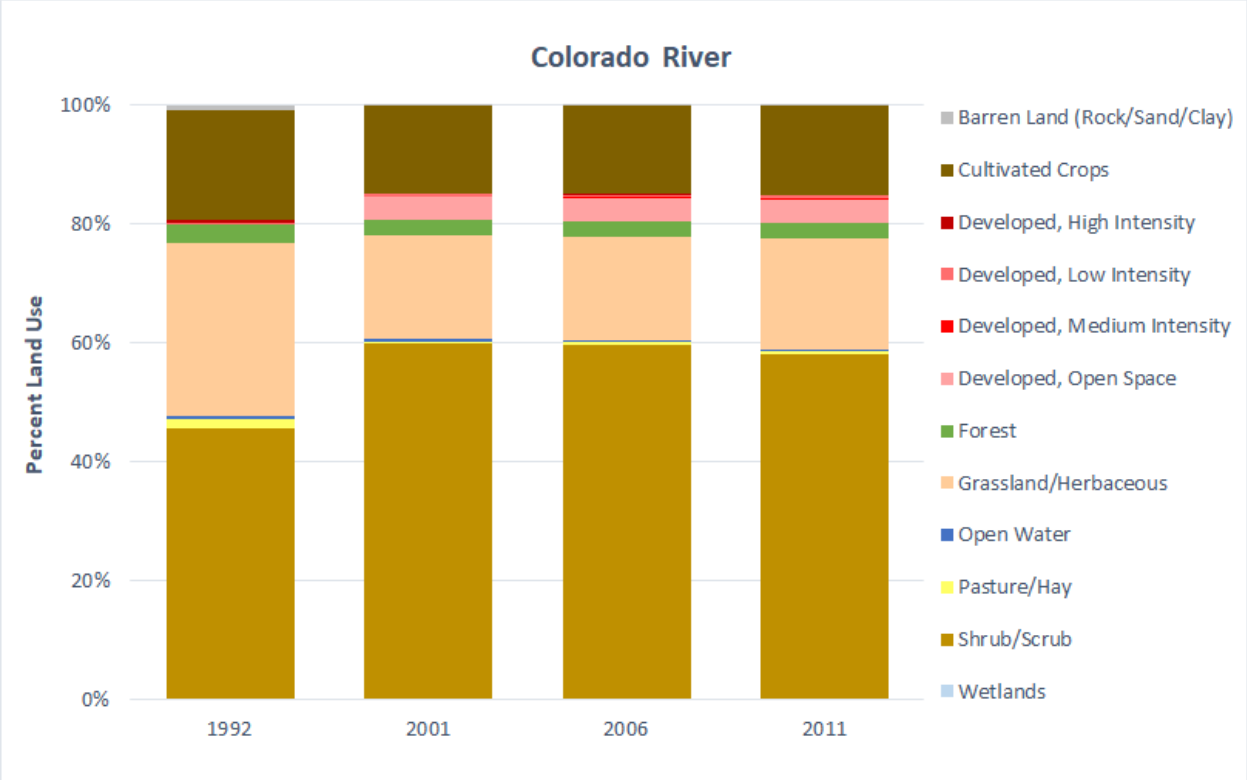

Figure 171. Percent land use in the Colorado River watershed from 1992-2011.

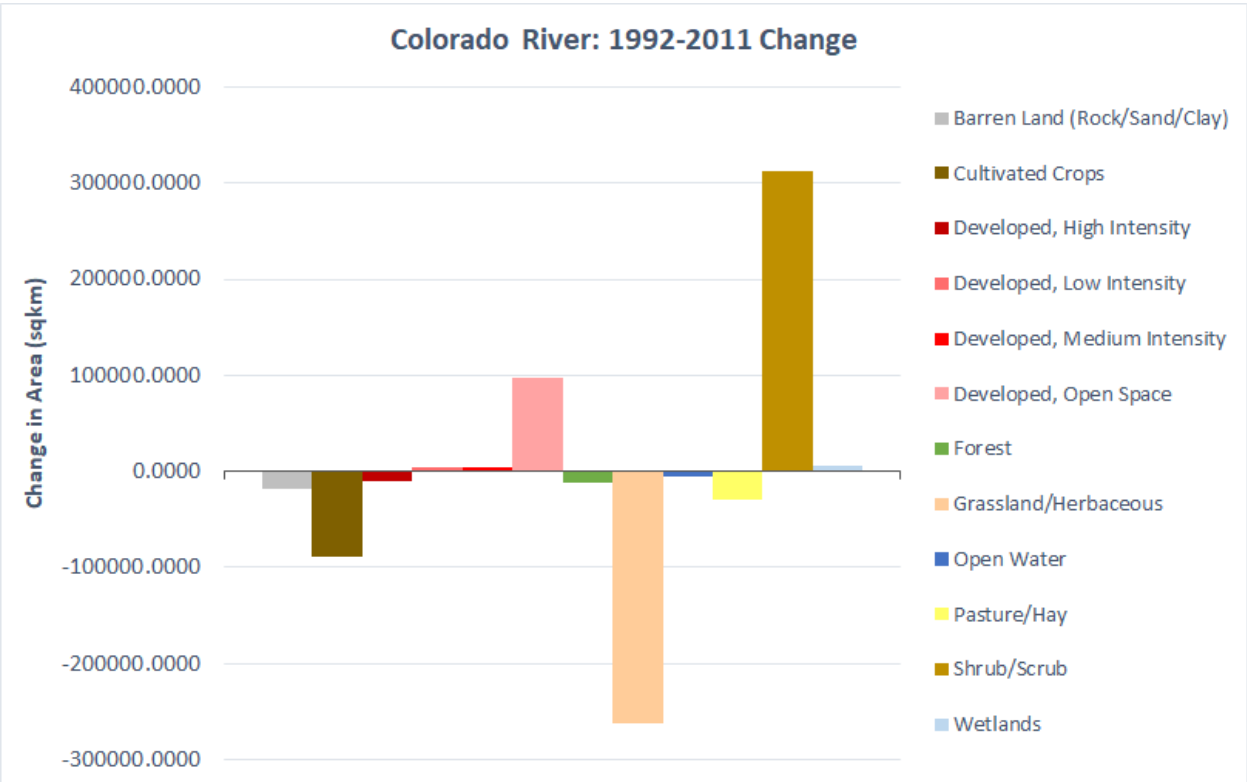

Figure 172. Land use change in area (sq km) from 1992-2011 for the Colorado River watershed.

CYPRESS CREEK

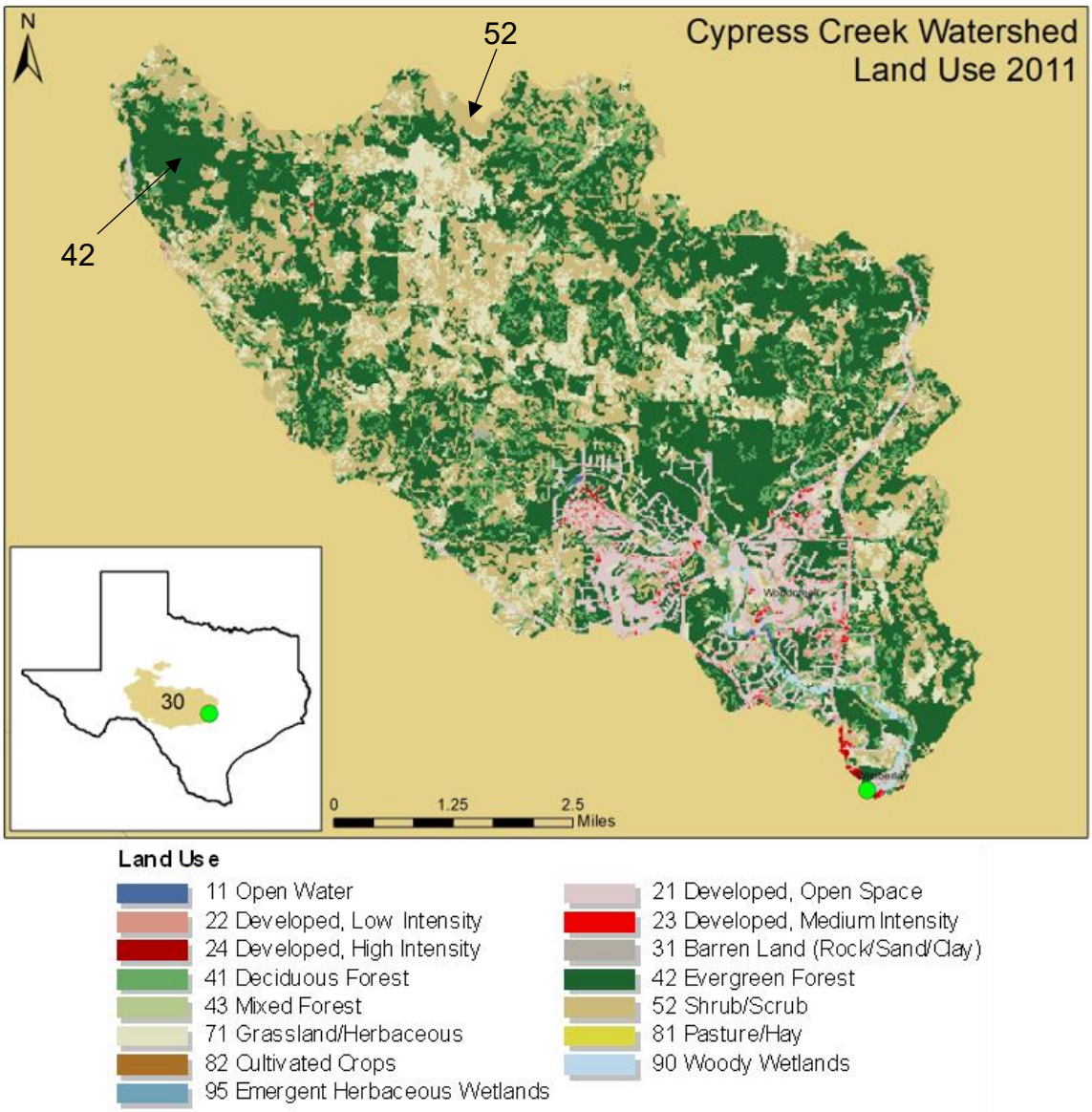

Figure 173. Map of Cypress Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	August 18, 2006; September 28, 2007; July 18, 2008; August 20, 2010; July 14, 2011; July 25, 2012; June 18, 2013; August 23, 2013
Water Quality:	182 sampling events
Fish:	August 18, 2006; September 28, 2007; July 18, 2008; August 20, 2010; July 14, 2011; July 25, 2012; June 18, 2013; August 23, 2013
Benthic Invertebrates:	August 18, 2006; September 28, 2007; July 18, 2008; August 20, 2010; July 25, 2012; June 18, 2013

Physical Characterization

Watershed and Land Use

Cypress Creek lies within the Guadalupe River Basin. Sample site 12674 is located at FM 12 in the city of Wimberley in Hays County (Figure 173).

The Cypress Creek watershed at site 12674 is approximately 97.71 sq km. The entire watershed is located within Level IV Ecoregion 30c, the Balcones Canyonlands. The dominant land cover in the watershed is forest at 51.56% and is present throughout the watershed (Homer et al. 2015; Figure 173 and Figure 174). Shrub is the secondary land cover encompassing 27.97%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 8.67% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 14.71 sq km decrease in grassland/herbaceous and a 13.19 sq km decrease in forest. There was a 22.73 sq km increase in shrub and a 6.25 sq km increase in open space development (Figure 175).

There are no wastewater outfalls within the Cypress Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Cypress Creek was evaluated during eight sampling events from 2006 to 2013. Cypress Creek is a perennial stream that drains to the Upper Blanco River near Wimberley. Habitat Quality Index scores are available for all eight sample events and indicate an intermediate to high aquatic life use rating (15-21). Riparian areas were variable over time with an average riparian buffer ranging from 1.7 meters wide in 2012 to greater than 20 meters in 2007. The riparian zone was generally dominated by grasses followed by trees then shrubs. The average percentage of tree canopy cover ranged from 80% to 99%. The dominant stream substrate was gravel and bedrock, and the average percent of substrate gravel size or larger varied from 10% to 65%. Average percent instream cover was 32% to 55% and instream cover types include roots, gravel, snags, undercut banks, woody debris, macrophytes, algae, and overhanging vegetation. Cypress Creek ranged from 0.2-0.6 meters deep on average and 4-16 meters wide. Average stream bank slope ranged from 10-66 degrees. Stream flow at the site was measured at a minimum value of 0 cfs and a maximum of 16 cfs. Average stream bank erosion potential was 11%-25%. The deepest pool measured at Cypress Creek was 1.4 meters. Number of riffles observed at the site varied from zero to three, and total number of stream bends ranged from two to five.

Water Quality

Water samples were collected at station 12674 over 182 sampling events from December 1973 through August 2019. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a. Continuous 24 hour data, were collected for temperature, specific conductance, and dissolved oxygen at this site.

Biological Characterization

Fish

Twenty-five species (eight families) were collected over the course of the eight sampling events. Centrarchidae was the richest family with 11 species. Four of the eight fish collections rated as having a high aquatic life use. The remaining four rated as intermediate. When the coefficient of variability is applied the 2008 collection also obtains a high rating. IBI metrics consistently rating very low include: number of intolerant species; percentage of individuals as non-native species; and number of individuals.

Benthic Macroinvertebrates

From the six RBP samples (collected August 2006, September 2007, July 2008, August 2010, July 2012, and June 2013) together, a total of 775 individuals representing 40 taxa from 12 orders of macroinvertebrates were collected from Cypress Creek (Appendix E). The Trichoptera, Diptera, Oligochaeta, Hemiptera, Odonata, Veneroida, and Basommatophora were the most commonly collected orders, collectively accounting for 92.0 percent of the total number of individuals collected. The Ephemeroptera, Coleoptera, and Tricladida were the only other orders which comprised at least one percent of the collections.

The Ecoregion 30 BIBI for the August 2006, July 2008, and June 2013 RBP samples fell within the limited aquatic life use category, while the RBP samples from September 2007, August 2010, and July 2012 fell within the intermediate aquatic life use category.

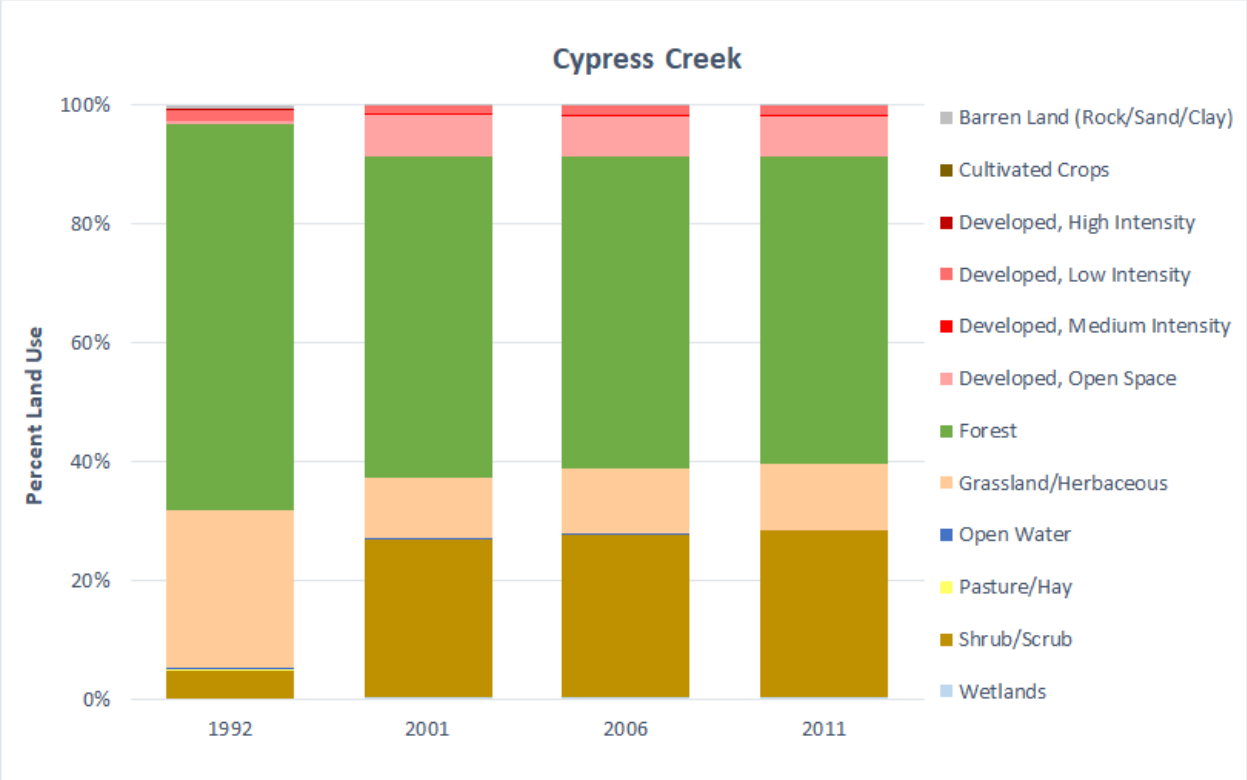

Figure 174. Percent land use in the Cypress Creek watershed from 1992-2011.

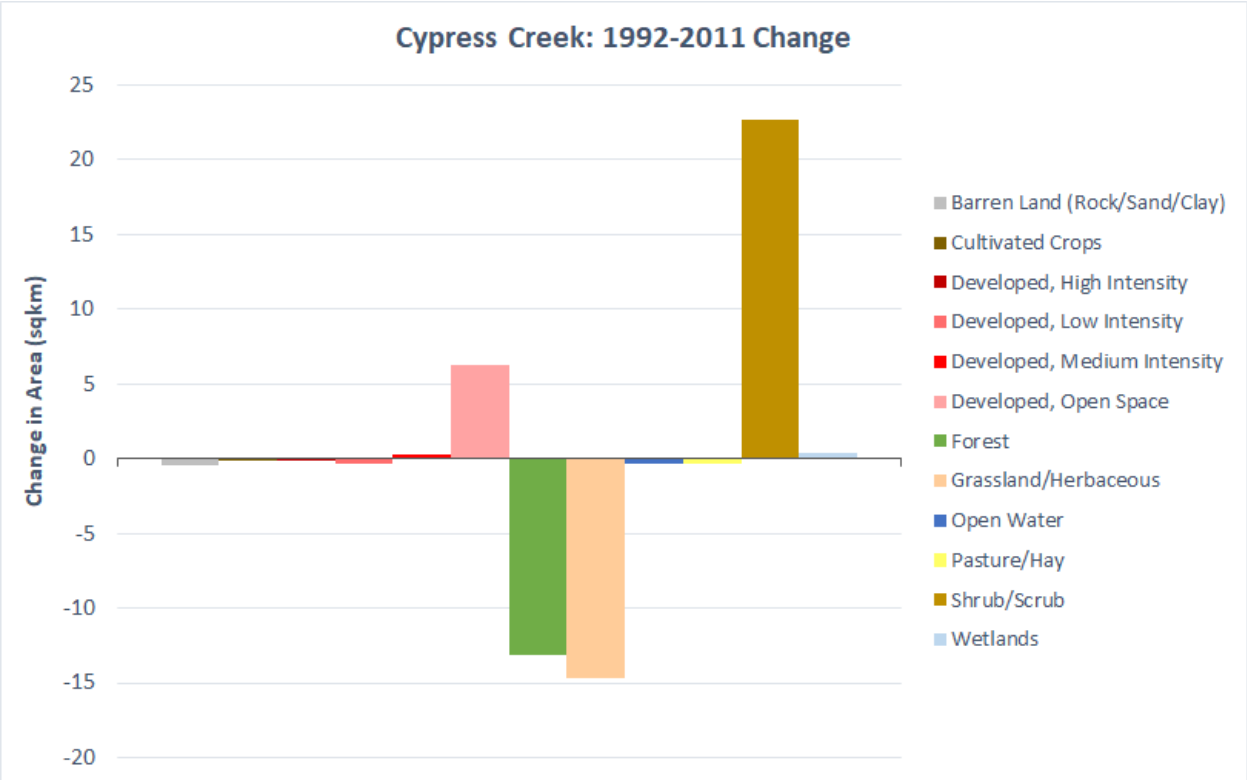

Figure 175. Land use change in area (sq km) from 1992-2011 for the Cypress Creek watershed.

DEVILS RIVER

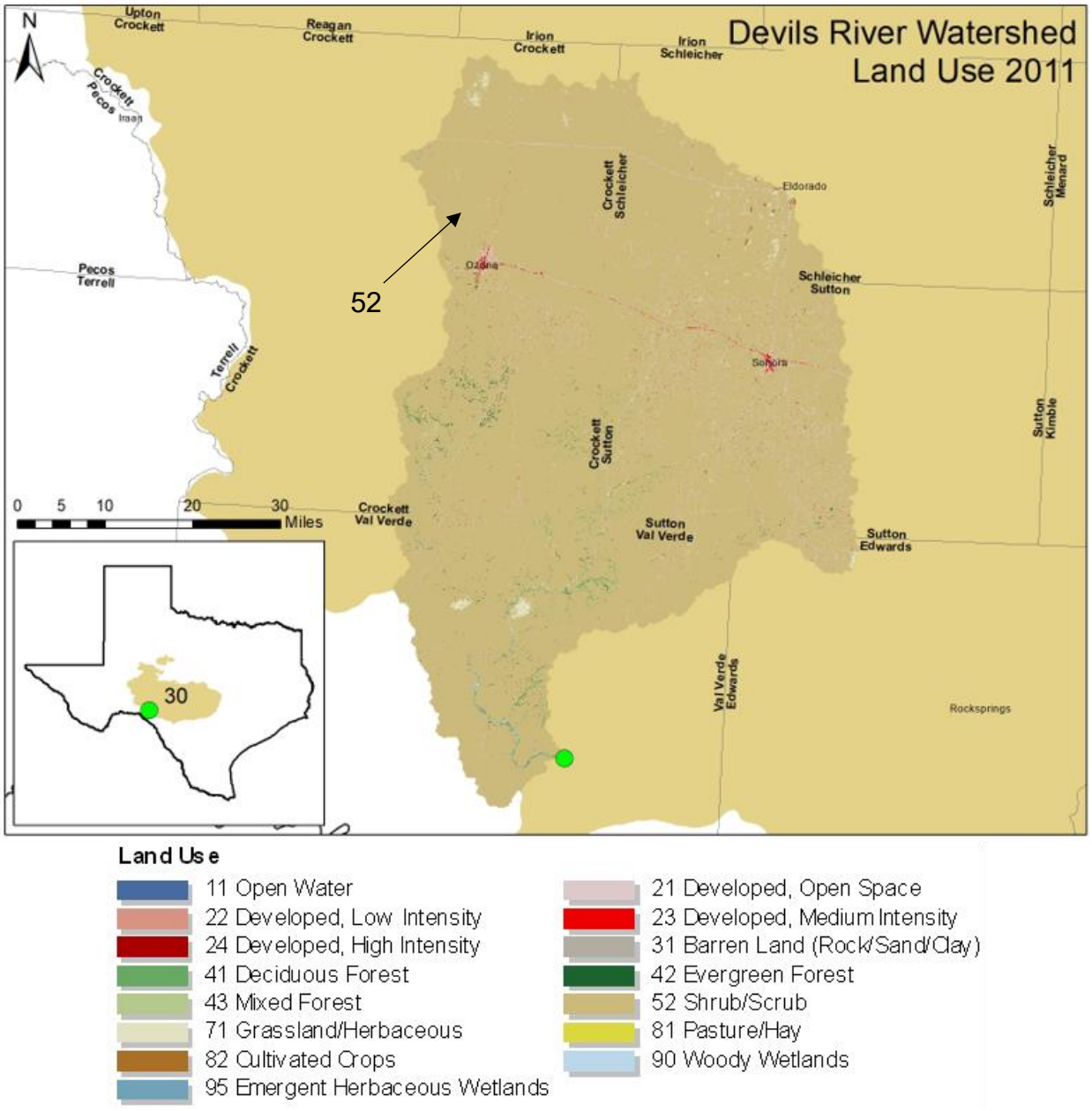

Figure 176. Map of Devils River watershed location and 2011 land use; shrub/scrub was the most common land use.

Sampling Dates

Physical Habitat:	July 10, 1989; August 2, 2017
Water Quality:	76 sampling events
Fish:	July 10, 1989; August 2, 2017
Benthic Invertebrates:	July 10, 1989; August 2, 2017

Physical Characterization

Watershed and Land Use

Devils River lies within the Rio Grande River Basin. Sample site 13239 is located in the Devils River State Natural Area, 1.7 km upstream of Dolan Creek in Val Verde County (Figure 176).

The Devils River watershed at site 13239 is approximately 7489.92 sq km. The vast majority of the watershed is located within Level IV Ecoregion 30d, the Semiarid Edwards Plateau. A small portion of the watershed lies within Level IV Ecoregion 30a, the Edwards Plateau Woodland, and another small portion lies within Level IV Ecoregion 24a, the Chihuahuan Basins and Playas. The dominant land cover in the watershed is shrub at 95.36% and is present throughout the watershed (Homer et al. 2015; Figure 176 and Figure 177). Open space development is the secondary land cover encompassing 2.17%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 2.82% and total cover for cultivated crops is 0.06%.

From 1992-2011 there was a 1788.49 sq km decrease in grassland/herbaceous and a 55.28 sq km decrease in forest. There was a 1706.91 sq km increase in shrub and a 162.30 sq km increase in open space development (Figure 178).

There are two domestic wastewater outfalls (discharges < 1 million gallons per day), one industrial wastewater outfall (discharges ≥ 1 million gallons per day), and two stormwater facilities within the Devils River watershed. One domestic wastewater facility is permitted to the City of Sonora and the other is permitted to Crockett County Water Control and Improvement District. The industrial wastewater facility is permitted to Multi-Chem Group, LLC, a Halliburton Service which develops and supplies oil and gas chemicals. The two stormwater facilities are also permitted to Multi-Chem Group, LLC. None of these facilities discharge directly into the Devils River.

In Channel and Riparian Physical Habitat

Physical habitat for the Devils River was evaluated on July 10, 1989, and again on August 2, 2017. The Devils River is a perennial stream that drains to the Devils River Arm of the International Amistad Reservoir. The following summary information is based on data collected during the most recent sampling event in 2017. The Habitat Quality Index score of 28 indicates an exceptional aquatic life use rating. The riparian zone was well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was dominated by grasses, which made up an average of 45% of the total riparian species, followed by shrubs (35%) then trees (20%). The average percentage of tree canopy cover was 49%. The dominant substrate was bedrock, and the average percent of substrate that was gravel size or larger was 33%. Average percent instream cover was 64% and instream cover types include woody debris, undercut banks, algae, snags, cobble, gravel, boulders, macrophytes, overhanging vegetation, and bedrock ledges. The Devils River was 0.45 meters deep on average and 52 meters wide. Average stream bank slope was 23 degrees, and average stream bank erosion

potential was 8%. The deepest pool measured at the Devils River was 1.7 meters. Stream flow was measured at a minimum value of 63 cfs in 2017 and a maximum of 110 cfs in 1989. Nine riffles were observed at the site in 2017 and there were four total stream bends.

Water Quality

Water samples were collected at station 13239 over 76 sampling events from July 1989 through February 2020. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Nineteen species (eight families) were collected between the two sampling events, including three protected species. Devils River Minnow (*Dionda diaboli*) is listed as federally threatened while Proserpine Shiner and Rio Grande Darter are listed as state threatened species. The family represented by the most species was Cyprinidae with seven species. Texas Shiner was the most abundant species collected in 1989. Blacktail Shiner was the most abundant species in 2017. The aquatic life use for both fish collections rated high. Two IBI metrics decreased from the maximum score of five to one - number of individuals per sampling effort and percentage of non-native species. Even though four non-native species were collected in 1989 (Common Carp, Redbreast Sunfish, Smallmouth Bass (*Micropterus dolomieu*), and Blue Tilapia (*Oreochromis aureus*)), they comprised less than 1% of the individuals collected. The one non-native species collected in 2017, Redbreast Sunfish, comprised 5.6% of the individuals collected.

Benthic Macroinvertebrates

From the July 1989 Surber sample and August 2017 RBP sample together, a total of 1170 individuals representing 101 taxa from 20 orders of macroinvertebrates were collected from Devils River (Appendix E). The Diptera, Ephemeroptera, Trichoptera, Coleoptera, Amphipoda, Hemiptera, Odonata, Neotaenioglossa, and Neoophora were the most commonly collected orders, collectively accounting for 90.4 percent of the total number of individuals collected. The Basommatophora, Tricladida, Veneroida, and Oligochaeta were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the July 1989 Surber sample fell within the exceptional aquatic life use category. The Ecoregion 30 BIBI for the August 2017 RBP sample fell within the high aquatic life use category.

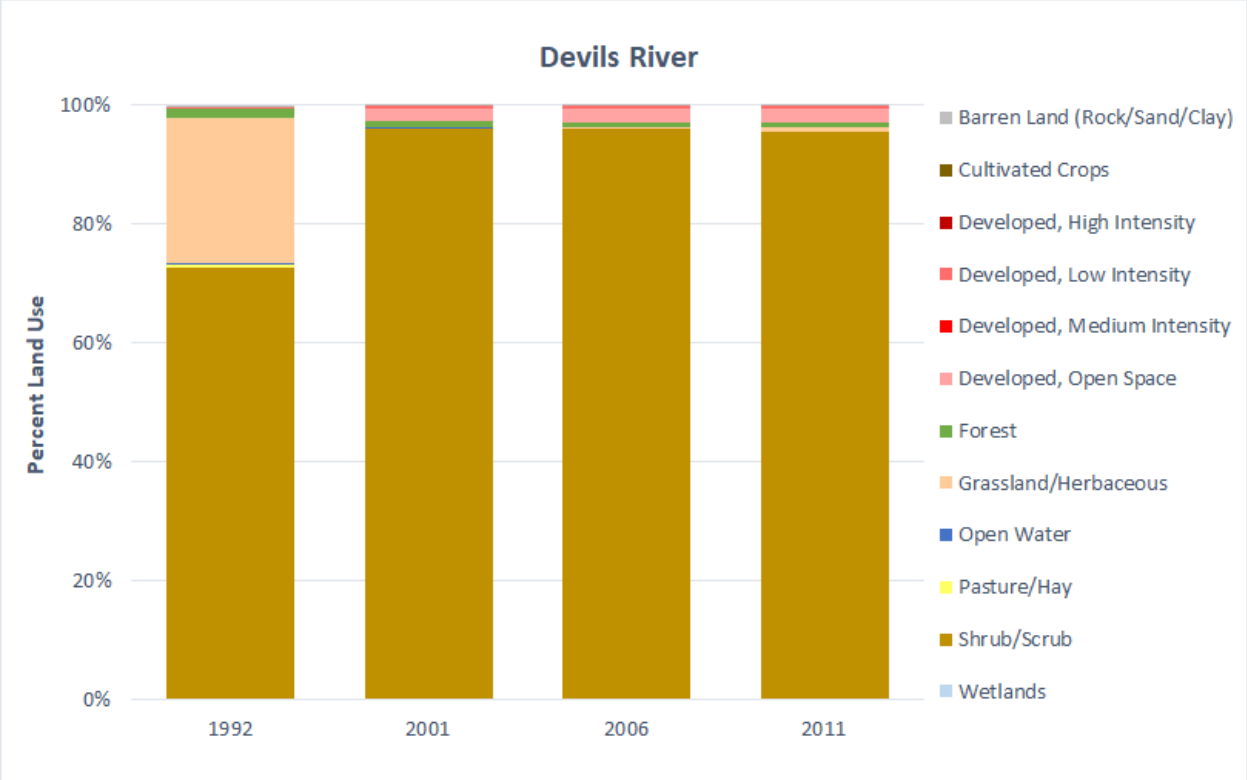

Figure 177. Percent land use in the Devils River watershed from 1992-2011.

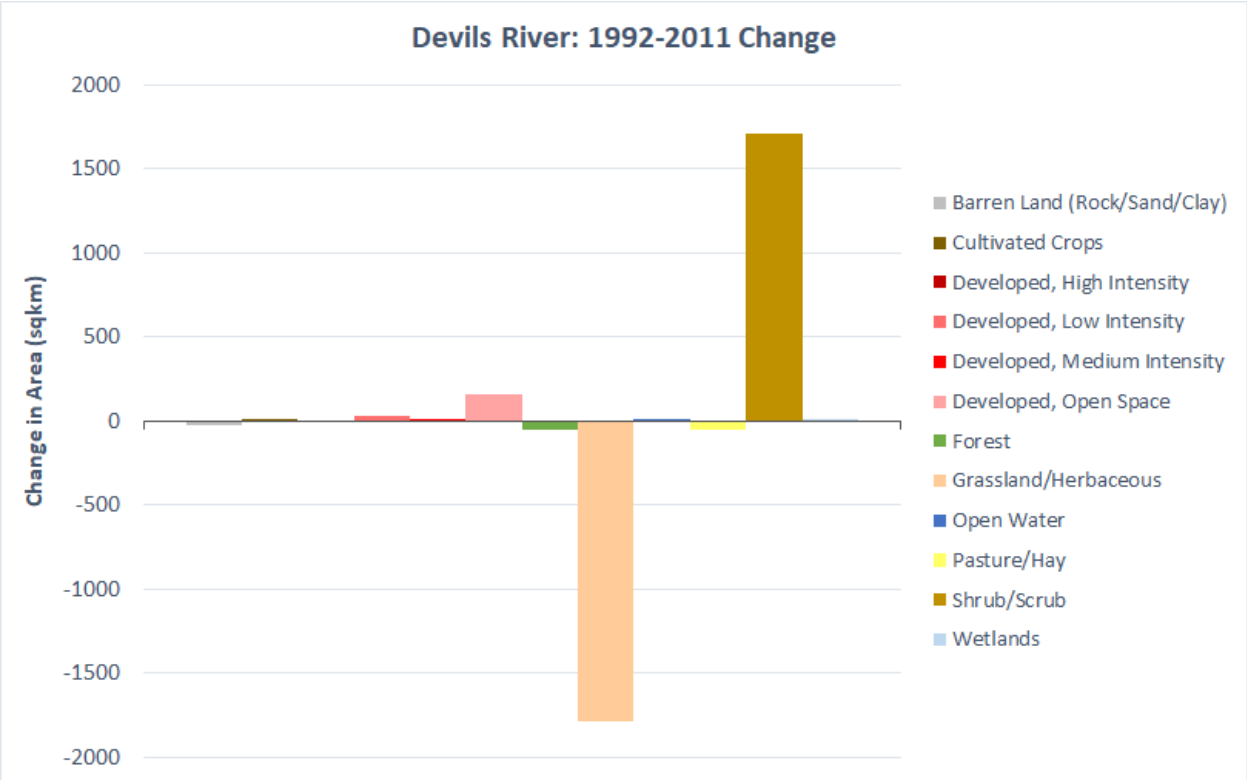

Figure 178. Land use change in area (sq km) from 1992-2011 for the Devils River watershed.

GUADALUPE RIVER

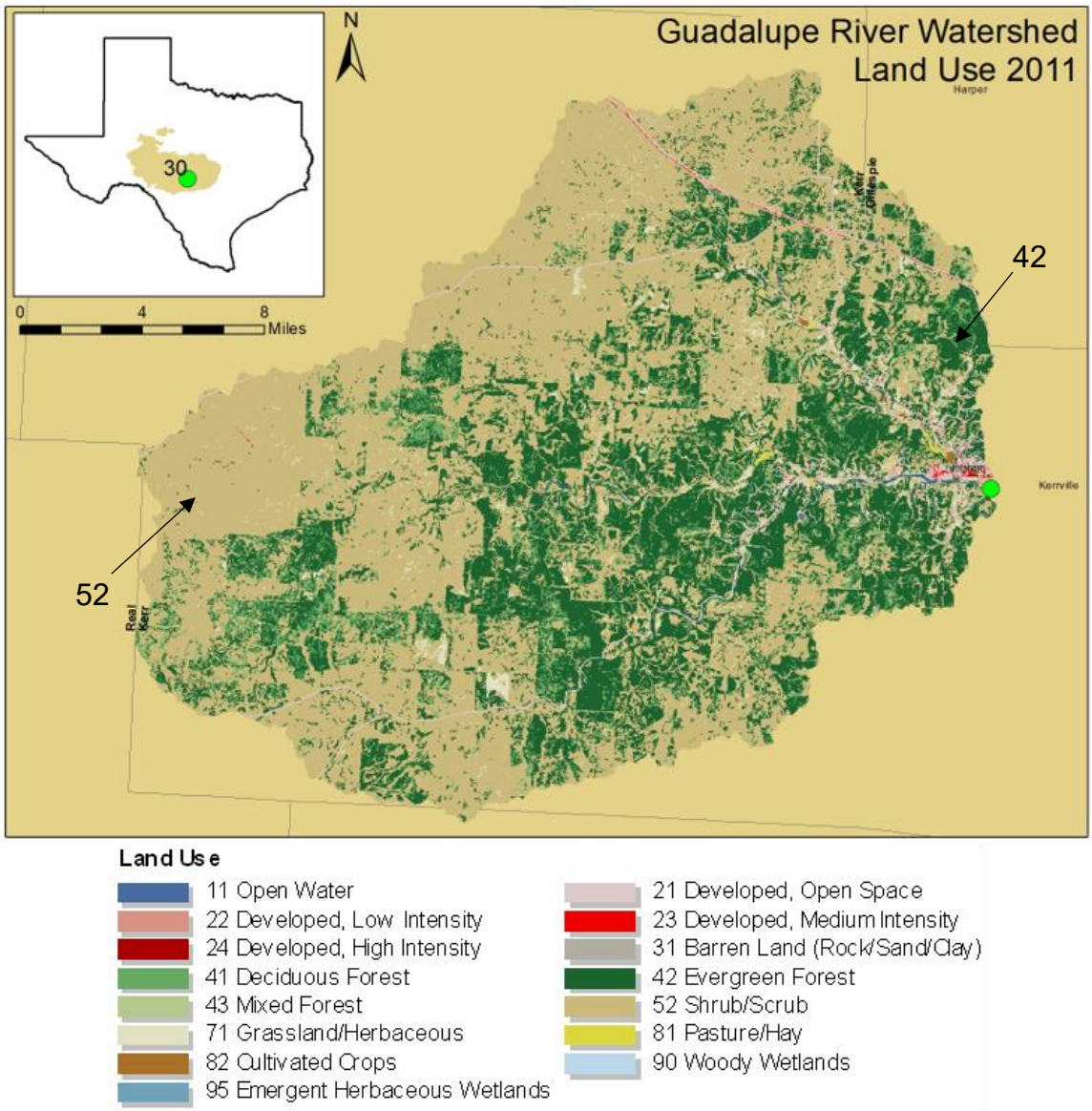

Figure 179. Map of Guadalupe River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	October 3, 2006; September 22, 2008; September 1, 2009; August 17, 2010; June 23, 2015; July 29, 2015
Water Quality:	95 sampling events
Fish:	October 3, 2006; September 22, 2008; September 1, 2009; August 17, 2010; June 23, 2015; July 29, 2015
Benthic Invertebrates:	October 3, 2006; September 22, 2008; September 1, 2009; August 17, 2010; June 23, 2015; July 29, 2015

Physical Characterization

Watershed and Land Use

Guadalupe River is the basin's namesake and is a major river basin in Texas. Sample site 15111 is located at Riverview Road in the city of Ingram in Kerr County (Figure 179).

The Guadalupe River watershed at site 15111 is approximately 1161.05 sq km. The site and lower portion of the watershed is located within Level IV Ecoregion 30c, the Balcones Canyonlands and the upper portion of the watershed lies within Level IV Ecoregion 30a, the Edwards Plateau Woodland. The dominant land cover in the watershed is shrub at 59.33% and is concentrated in the upper watershed (Homer et al. 2015; Figure 179 and Figure 180). Forest is the secondary land cover encompassing 36.08%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 2.30% and total cover for cultivated crops is 0.04%.

From 1992-2011 there was a 178.04 sq km decrease in forest and a 140.75 sq km decrease in grassland/herbaceous. There was a 330.33 sq km increase in shrub and a 22.13 sq km increase in open space development (Figure 181).

There are no wastewater outfalls in this portion of the Guadalupe River watershed.

In Channel and Riparian Physical Habitat

Physical habitat for the Guadalupe River was evaluated during six sampling events from 2006 to 2015. Segment 1806 of the Guadalupe River begins at the confluence with the North Fork Guadalupe River and the South Fork Guadalupe River in Kerr County and drains to the headwaters of Canyon Lake in Comal County. Habitat Quality Index scores are available for all six sample events and indicate a high aquatic life use rating (21-24). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 13 meters wide to greater than 20 meters. The riparian zone was generally dominated by grasses followed by trees then shrubs. The average percentage of tree canopy cover ranged from 50% to 88%. The dominant stream substrate was bedrock, and the average percent of substrate gravel size or larger varied from 19% to 52%. Average percent instream cover was 36% to 45% and instream cover types include overhanging vegetation, snags, woody debris, root mats, macrophytes, algae, and gravel. The Guadalupe River ranged from 0.4-0.9 meters deep on average and 18-26 meters wide. Average stream bank slope ranged from 23-38 degrees. Stream flow at the site was measured at a minimum value of 26 cfs and a maximum of 109 cfs. Average stream bank erosion potential was 15%-21%. The deepest pool measured at the Guadalupe River was 2.1 meters. Number of riffles observed at the site varied from three to four, and total number of stream bends ranged from two to three.

Water Quality

Water samples were collected at station 15111 over 95 sampling events from August 1997 through March 2019. Parameters measured included temperature, flow, transparency, specific

conductance, dissolved oxygen, pH, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twenty-two species (six families) were collected over the course of the six sampling events. Centrarchidae and Cyprinidae held the majority of the species with eight and seven, respectively. Blacktail Shiner was the most abundant species in all but the 2008 and July 2015 collections, where Texas Shiner was the most abundant species. Six species were collected in every sample - Blacktail Shiner, Texas Shiner, Orangethroat Darter, Western Mosquitofish, Texas Logperch (*Percina carbonaria*), and Guadalupe Bass (*Micropterus treculii*). All but the 2008 fish collection rated as having a high aquatic life use. The 2008 collection rated exceptional, scoring higher than the other collections mostly due to the high catch per unit effort. The 2010 collection also recorded a high catch per unit effort and was the only sample that achieves an exceptional aquatic life use when the coefficient of variability is applied.

Benthic Macroinvertebrates

From the six RBP samples (collected October 2006, September 2008 and 2009, August 2010, and June and July 2015) together a total of 1104 individuals representing 59 taxa from 13 orders of macroinvertebrates were collected from the Guadalupe River (Appendix E). The Ephemeroptera, Coleoptera, Trichoptera, Hemiptera, Odonata, Veneroida, and Megaloptera were the most commonly collected orders, collectively accounting for 91.8 percent of the total number of individuals collected. The Oligochaeta and Diptera were the only other orders which comprised at least one percent of the collections.

The Ecoregion 30 BIBI for the October 2006 RBP sample fell within the limited aquatic life use category, while the BIBIs for the September 2008 and 2009 RBP samples fell within the intermediate aquatic life use category. Considering the August 2010 and June 2015 RBP samples, the BIBIs fell within the high aquatic life use category. Finally, the RBP sample from July 2015 fell within the exceptional aquatic life use category.

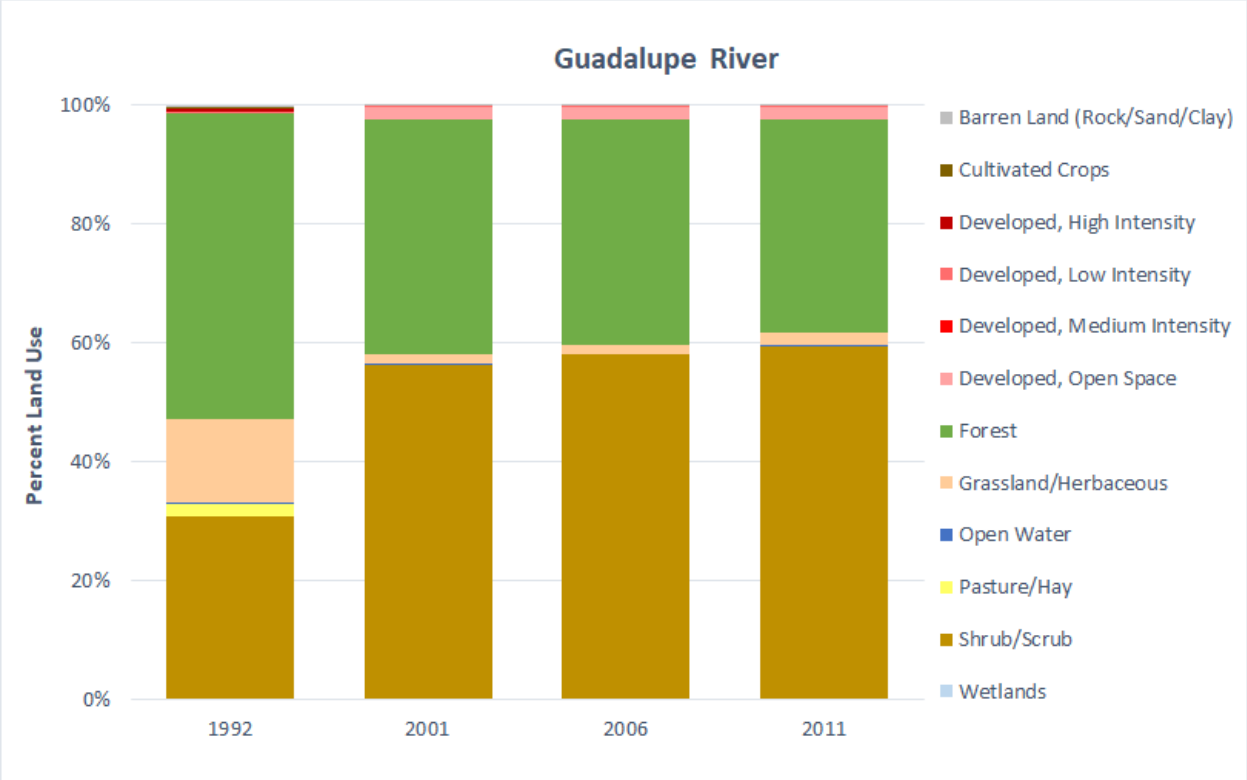

Figure 180. Percent land use in the Guadalupe River watershed from 1992-2011.

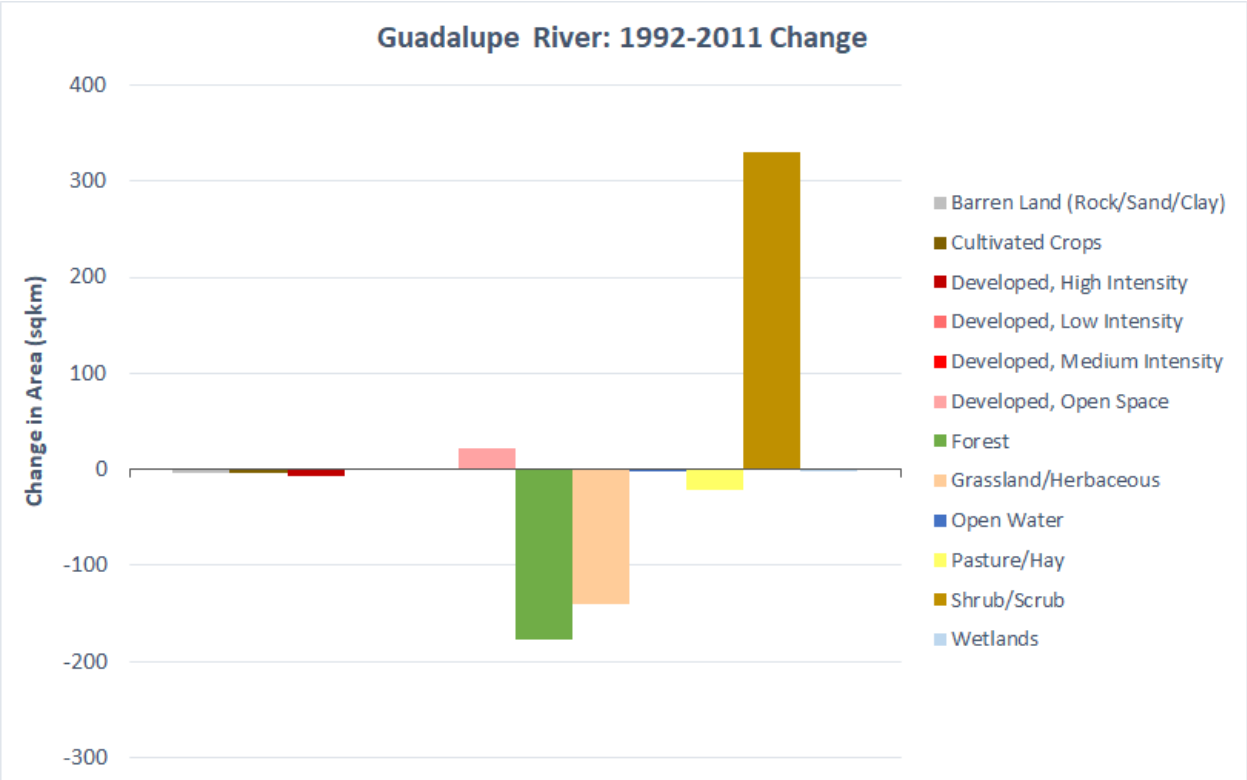

Figure 181. Land use change in area (sq km) from 1992-2011 for the Guadalupe River watershed.

JAMES RIVER

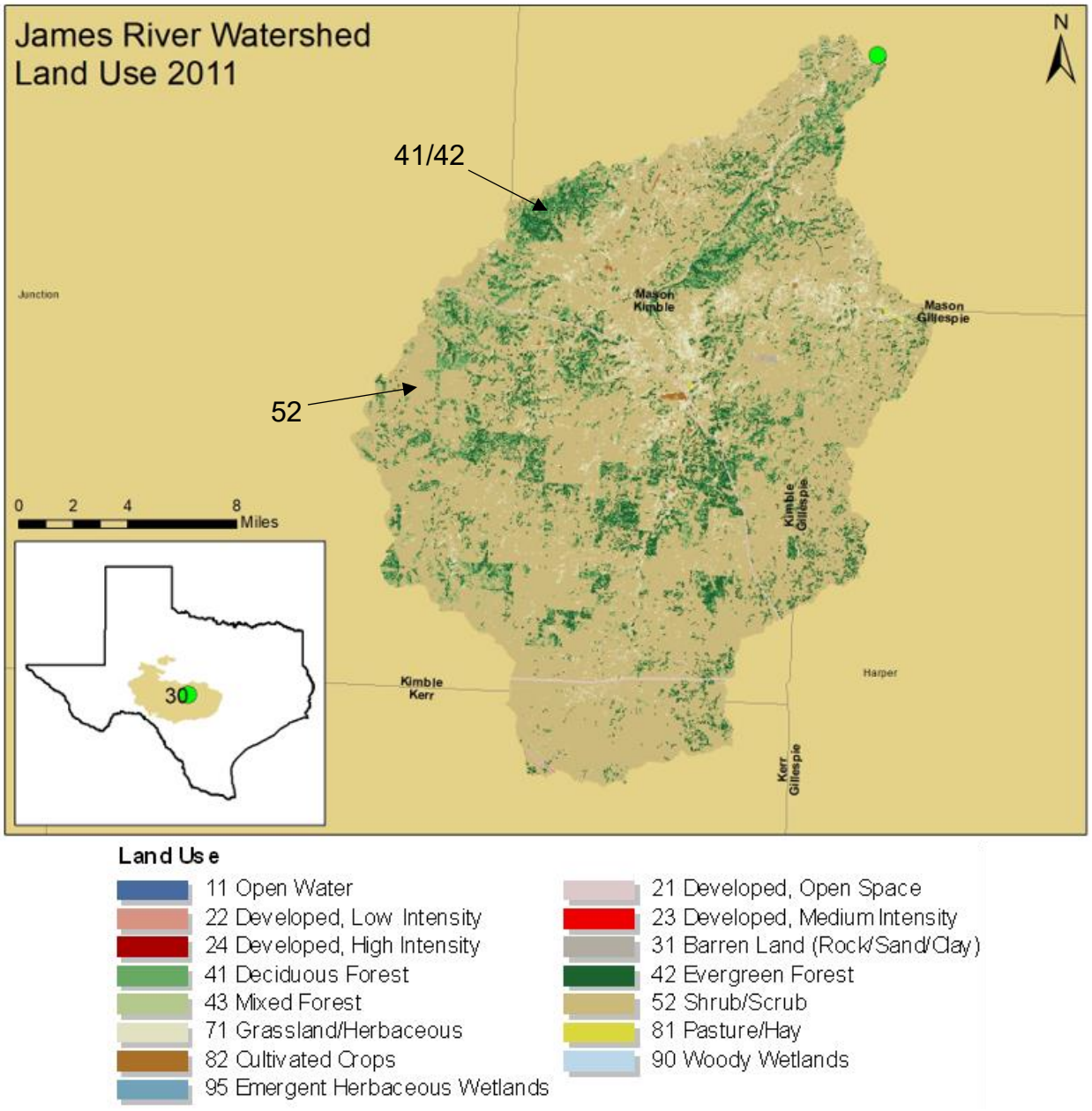

Figure 182. Map of James River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	July 22, 1987
Water Quality:	2 sampling events
Fish:	July 23, 1987
Benthic Invertebrates:	July 23, 1987 (x2)

Physical Characterization

Watershed and Land Use

James River lies within the Colorado River Basin. Sample site 12208 is located on a private ranch road 1.93 km upstream of the Llano River and 12.87 km southeast of Mason in Mason County (Figure 182).

The James River watershed at site 12208 is approximately 876.62 sq km. The entire watershed lies within Level IV Ecoregion 30a, the Edwards Plateau Woodland. The dominant land cover in the watershed is shrub at 77.35% and is present throughout the watershed (Homer et al. 2015; Figure 182 and Figure 183). Forest is the secondary land cover encompassing 17.11%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.57% and total cover for cultivated crops is 0.16%.

From 1992-2011 there was a 158.51 sq km decrease in forest and a 148.36 sq km decrease in grassland/herbaceous. There was a 324.73 sq km increase in shrub and a 4.54 sq km increase in open space development (Figure 184).

There are no wastewater outfalls in the James River watershed.

In Channel and Riparian Physical Habitat

Physical habitat for the James River was evaluated on July 22, 1987. The James River is a spring fed perennial stream that drains to the Llano River. The riparian width was 15 meters. The riparian zone was dominated by shrubs, which made up an average of 40% of the total riparian species, followed by grasses (35%) then trees (25%). The average percentage of tree canopy cover was 0%. The dominant substrate was cobble/gravel over bedrock, and the average percent of substrate that was gravel size or larger was 90%. Average percent instream cover was 25%. The James River had an average depth of 0.5 meters and a maximum depth of 2 meters. The average width was 19.1 meters and average stream bank slope was 26 degrees. Stream flow at the site was 18.8 cfs. Average stream bank erosion potential was 20%. Four riffles were observed at the site and there were two total stream bends.

Water Quality

Station 12208 was sampled for water quality twice in July 1988. Parameters measured included temperature, flow, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twenty-one species (nine families) were collected from the James River. The family with the greatest species richness was Cyprinidae with nine species. Red Shiner was the most abundant species. The aquatic life use (based upon the fish assemblage) rated as high.

Benthic Macroinvertebrates

From the two July 1987 Surber samples together, a total of 561 individuals representing 71 taxa from 14 orders of macroinvertebrates were collected from the James River (Appendix E). The Ephemeroptera, Diptera, Trichoptera, Odonata, Coleoptera, and Oligochaeta were the most commonly collected orders, collectively accounting for 92.2 percent of the total number of individuals collected. The Basommatophora, Neoophora, and Megaloptera were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for both July 1987 Surber samples fell within the exceptional aquatic life use category.

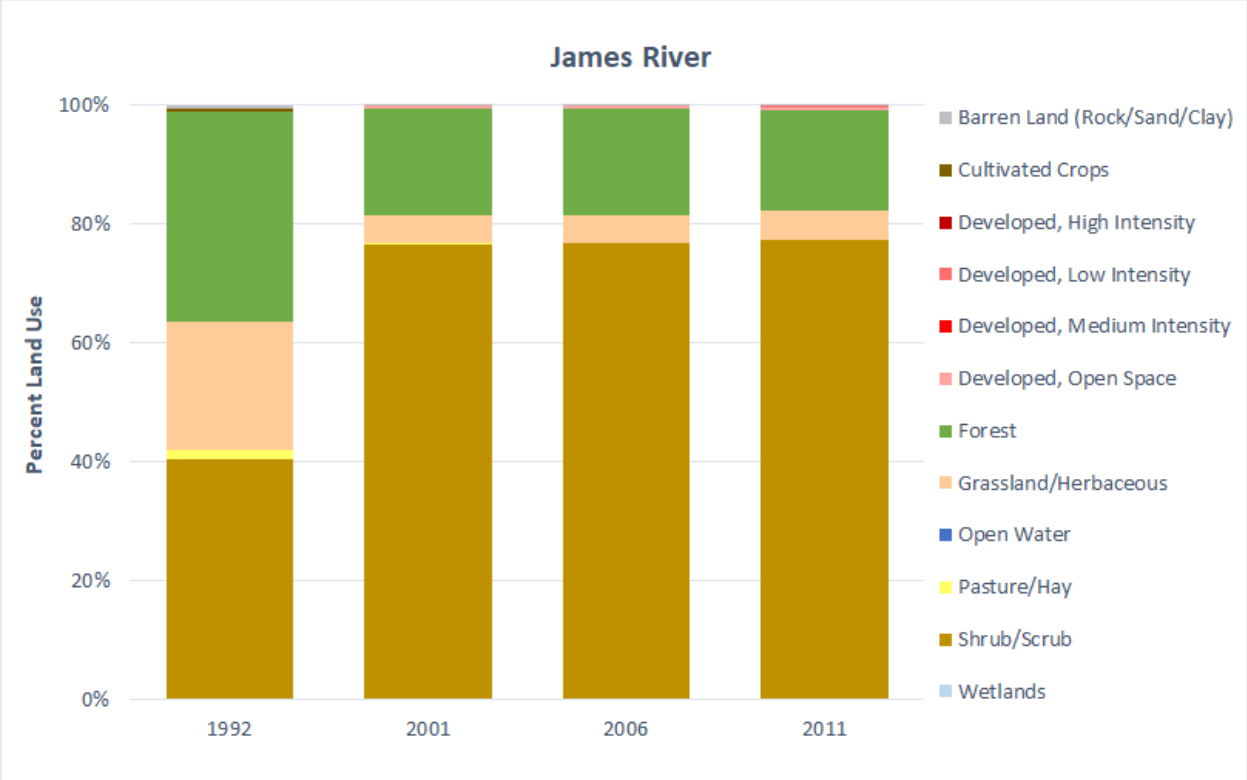

Figure 183. Percent land use in the James River watershed from 1992-2011.

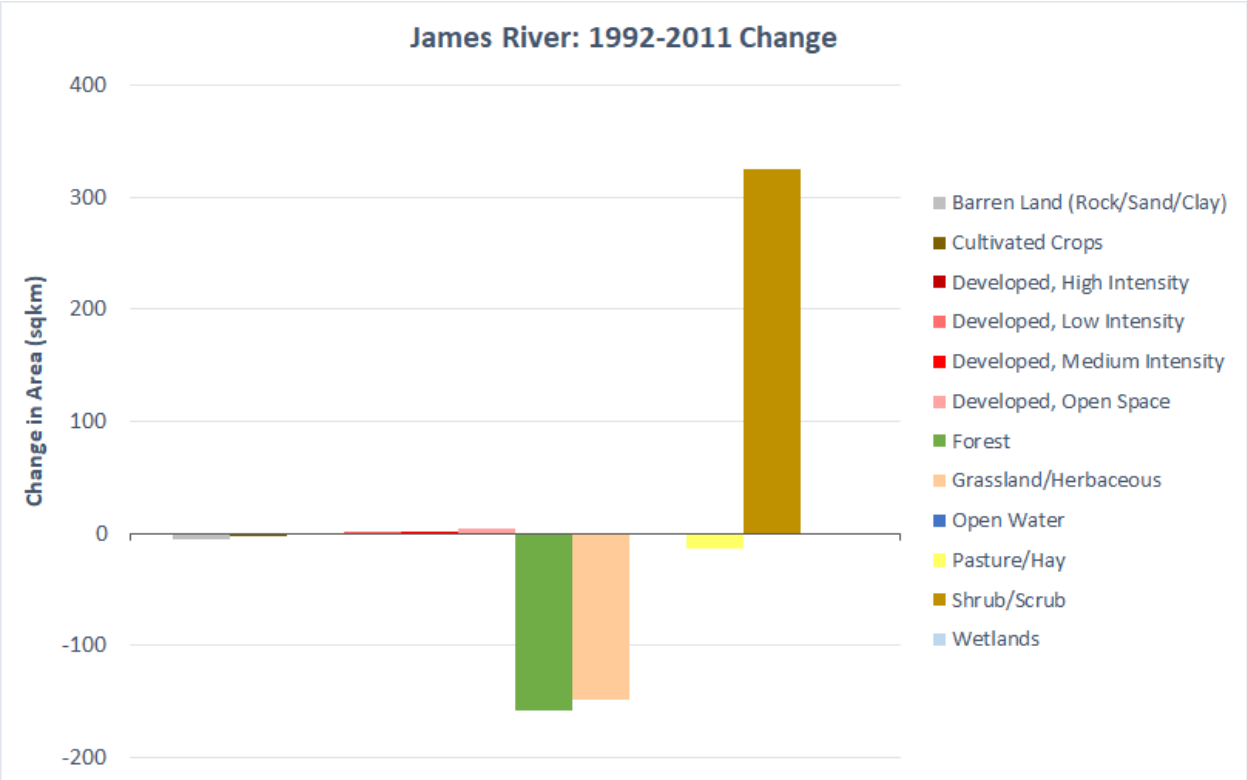

Figure 184. Land use change in area (sq km) from 1992-2011 for the James River watershed.

JOHNSON CREEK

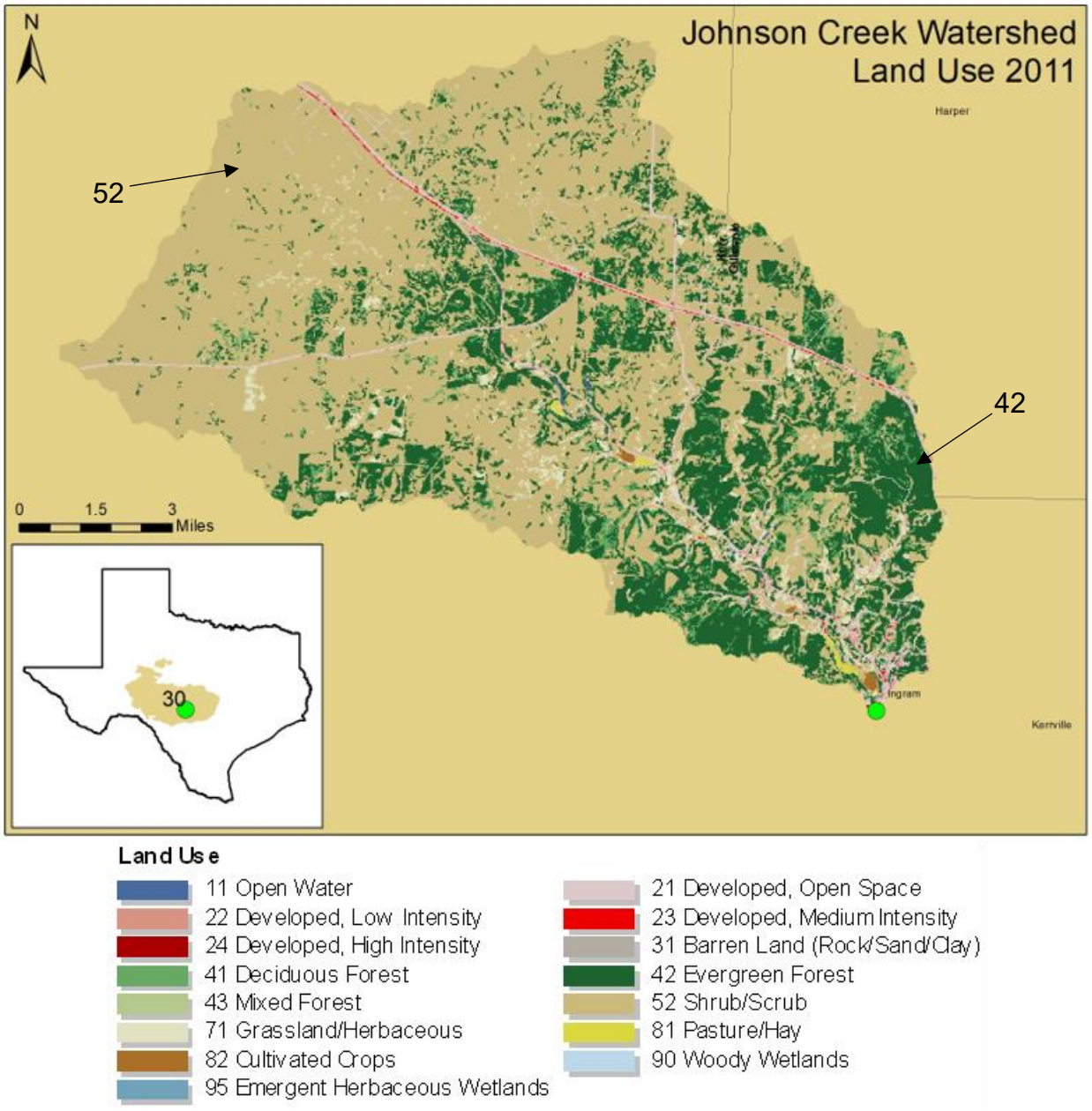

Figure 185. Map of Johnson Creek watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	May 5, 2016; August 31, 2016
Water Quality:	353 sampling events
Fish:	May 5, 2016; August 31, 2016
Benthic Invertebrates:	May 5, 2016; August 31, 2016

Physical Characterization

Watershed and Land Use

Johnson Creek lies within the Guadalupe River Basin. Sample site 12678 is located at SH 39 in the City of Ingram in Kerr County (Figure 185).

The Johnson Creek watershed at site 12678 is approximately 328.95 sq km. Site 12678 and the lower watershed lie within Level IV Ecoregion 30c, the Balcones Canyonlands, and the upper watershed lies within Level IV Ecoregion 30a, the Edwards Plateau Woodland. The dominant land cover in the watershed is shrub at 64.53% and is concentrated in the upper watershed (Homer et al. 2015; Figure 185 and Figure 186). Forest is the secondary land cover encompassing 28.61%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.96% and total cover for cultivated crops is 0.12%.

From 1992-2011 there was a 64.42 sq km decrease in forest and a 37.8 sq km decrease in grassland/herbaceous. There was a 101.26 sq km increase in shrub and a 10.58 sq km increase in open space development (Figure 187).

There are no wastewater outfalls in the Johnson Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Johnson Creek was evaluated during two sampling events in 2016. Johnson Creek is a perennial stream that drains to the Guadalupe River near Kerrville. Habitat Quality Index scores for both sample events indicate a high aquatic life use rating (23-25). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 15 to 18 meters wide. The riparian zone was generally dominated by grasses followed by trees then shrubs. The average percentage of tree canopy cover ranged from 65% to 76%. The dominant stream substrate was bedrock, and the average percent of substrate gravel size or larger varied from 11% to 47%. Average percent instream cover was 26% to 32% and instream cover types include roots, gravel, undercut banks, woody debris, snags, macrophytes, algae, and overhanging vegetation. Johnson Creek ranged from 0.5-0.6 meters deep on average and 28-38 meters wide. Average stream bank slope ranged from 34-53 degrees. Stream flow at the site was measured at a minimum value of 19 cfs and a maximum of 42 cfs. Average stream bank erosion potential was 21%-23%. The deepest pool measured at Johnson Creek was 2.5 meters. Four riffles were observed at the site and there were three total stream bends.

Water Quality

Water samples were collected at station 12678 over 353 sampling events from November 1985 through March 2019. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Eighteen species (six families) were collected between the two sampling events. The richest family was Centrarchidae with eight species. Blacktail Shiner was the most abundant species. Both fish collections rate as having a high aquatic life use; however, when the coefficient of variability is applied both rise to exceptional.

Benthic Macroinvertebrates

From the May and August 2016 RBP samples together, a total of 406 individuals representing 42 taxa from 13 orders of macroinvertebrates were collected from Johnson Creek (Appendix E). The Ephemeroptera, Coleoptera, Trichoptera, Amphipoda, Hemiptera, Diptera, and Odonata were the most commonly collected orders, collectively accounting for 93.1 percent of the total number of individuals collected. The Veneroida, Decapoda, Oligochaeta, and Megaloptera were the only other orders which comprised at least one percent of the collections.

The Ecoregion 30 BIBI for both the May and August 2016 RBP samples fell within the high aquatic life use category.

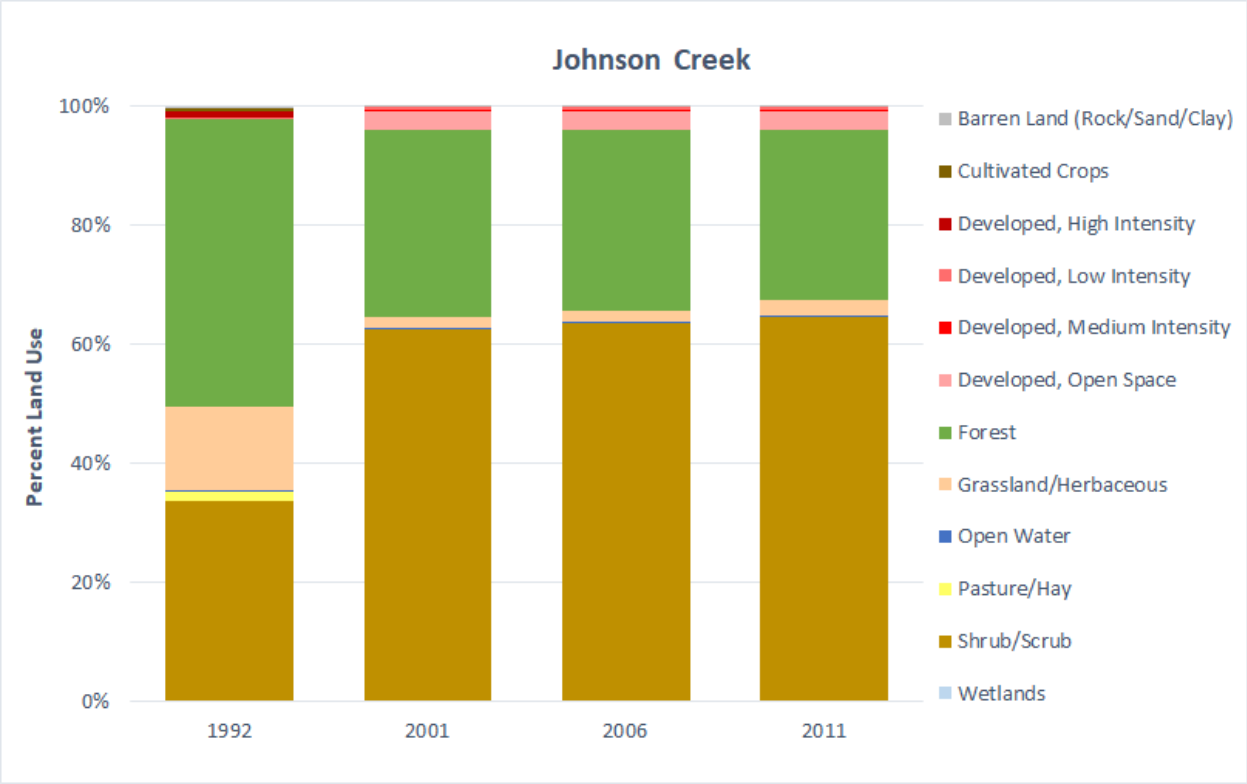

Figure 186. Percent land use in the Johnson Creek watershed from 1992-2011.

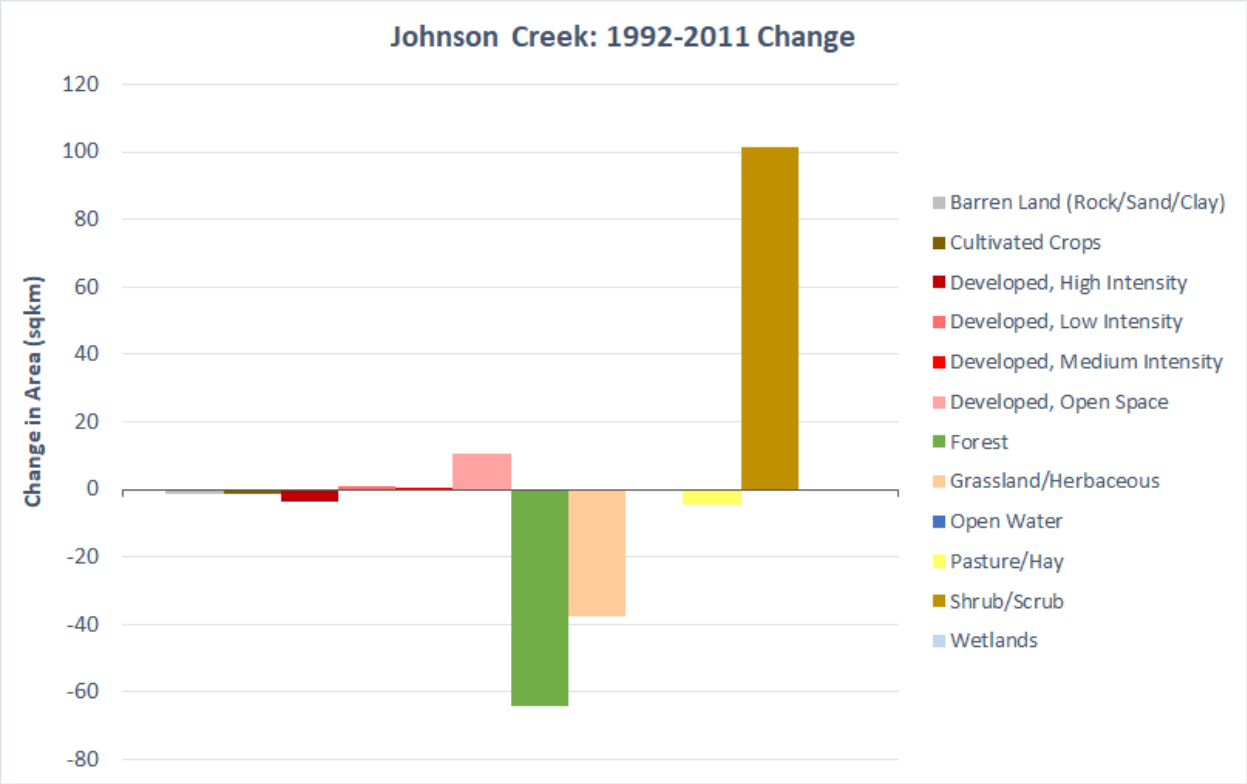

Figure 187. Land use change in area (sq km) from 1992-2011 for the Johnson Creek watershed.

LITTLE BARTON CREEK

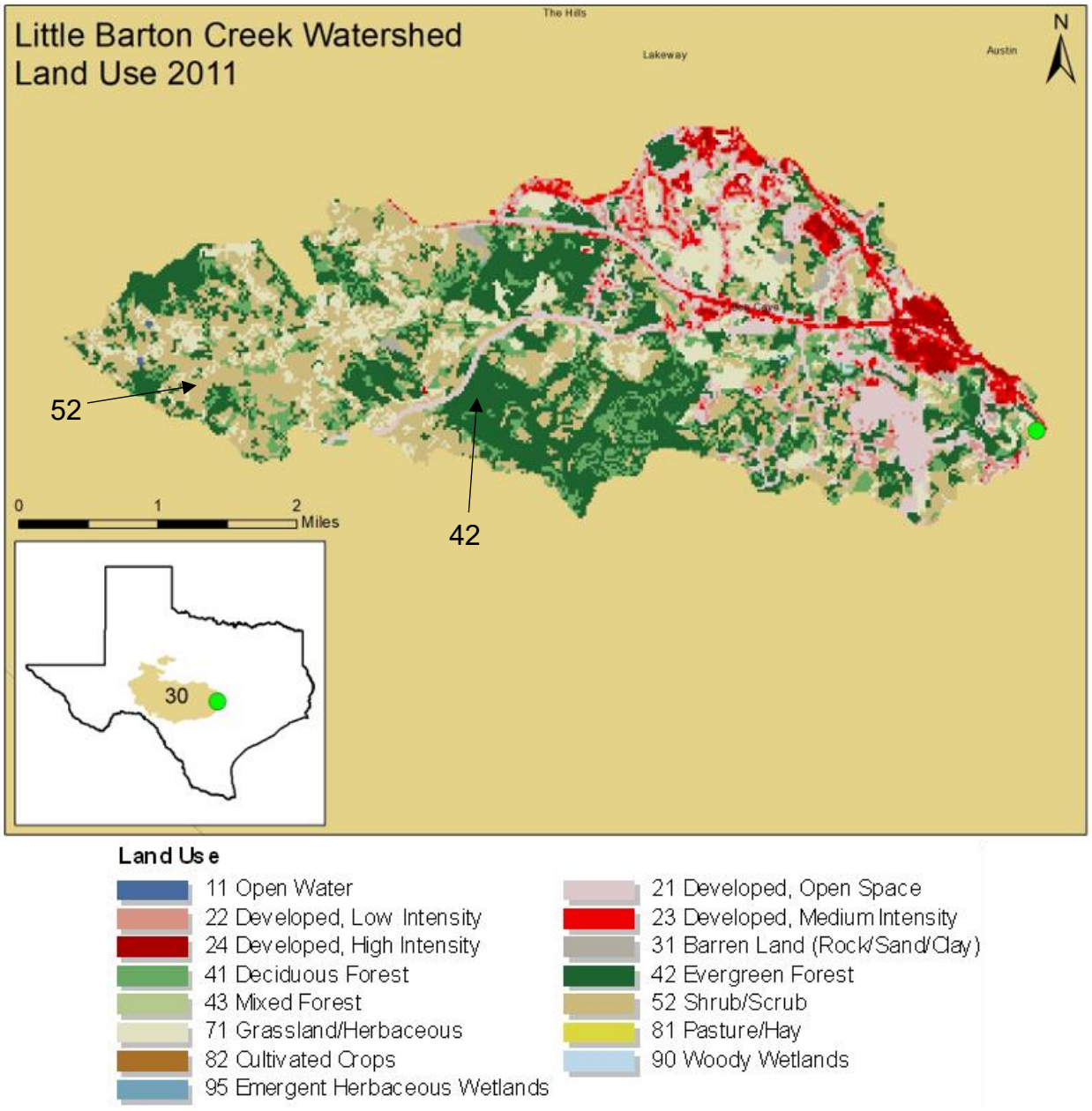

Figure 188. Map of Little Barton Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	July 16, 1988
Water Quality:	50 sampling events
Fish:	July 7, 1988; March 15, 1989
Benthic Invertebrates:	July 7, 1988

Physical Characterization

Watershed and Land Use

Little Barton Creek lies within the Colorado River Basin. Sample site 12252 is located on a private road near US 71 between Bee Cave and Austin in Travis County (Figure 188).

The Little Barton Creek watershed at site 12252 is approximately 29.84 sq km. The entire watershed lies within Level IV Ecoregion 30c, the Balcones Canyonlands. The dominant land cover in the watershed is forest at 37.53% and is concentrated in the middle of the watershed (Homer et al. 2015; Figure 188 and Figure 189). Shrub is the secondary land cover encompassing 25.29%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 23.84% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 6.51 sq km decrease in grassland/herbaceous and a 2.51 sq km decrease in forest. There was a 3.56 sq km increase in open space development and a 2.86 sq km increase in shrub (Figure 190).

There are no wastewater outfalls in the Little Barton Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Little Barton Creek was evaluated on July 16, 1988. Little Barton Creek is a tributary to Barton Creek. The riparian width was 18 meters. The riparian zone was dominated by trees and shrubs, which each made up an average of 40% of the total riparian species followed by grasses (20%). The average percentage of tree canopy cover was 14%. The dominant substrate was cobble and gravel with some bedrock, and the average percent of substrate that was gravel size or larger was 50%. Average percent instream cover was 26%. Little Barton Creek had an average depth of 0.4 meters and a maximum depth of 1.2 meters. The average width was 8 meters and average stream bank slope was 29 degrees. Stream flow at the site was 0.2 cfs. Average stream bank erosion potential was 26%. Five riffles were observed at the site and there were four total stream bends.

Water Quality

Water samples were collected at station 12252 over 50 sampling events from May 1985 through May 2003. Parameters measured included temperature, flow, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twelve species (five families) were collected between the two sampling events. Centrarchidae represented one-half of the species collected. Blacktail Shiner was the most abundant species. The fish assemblages from 1988 and 1989 rated as having an intermediate and high aquatic life

use, respectively. When the coefficient of variability is applied the 1988 sample also rises to high.

Benthic Macroinvertebrates

From the July 1988 Surber sample, a total of 608 individuals representing 57 taxa from 13 orders of macroinvertebrates were collected from Little Barton Creek (Appendix E). The Trichoptera, Diptera, Ephemeroptera, Oligochaeta, and Hoplonemertea were the most commonly collected orders, collectively accounting for 92.9 percent of the total number of individuals collected. The Basommatophora, Neoophora, and Odonata were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the July 1988 Surber sample fell within the exceptional aquatic life use category.

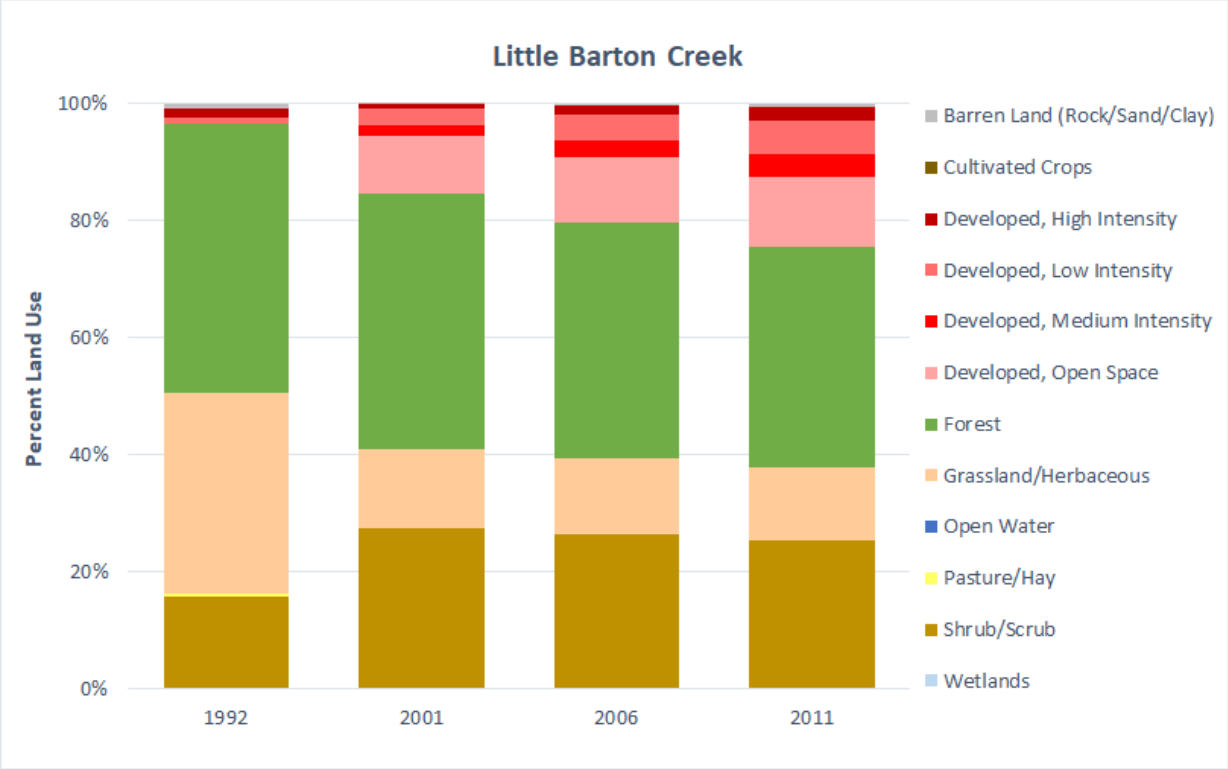

Figure 189. Percent land use in the Little Barton Creek watershed from 1992-2011.

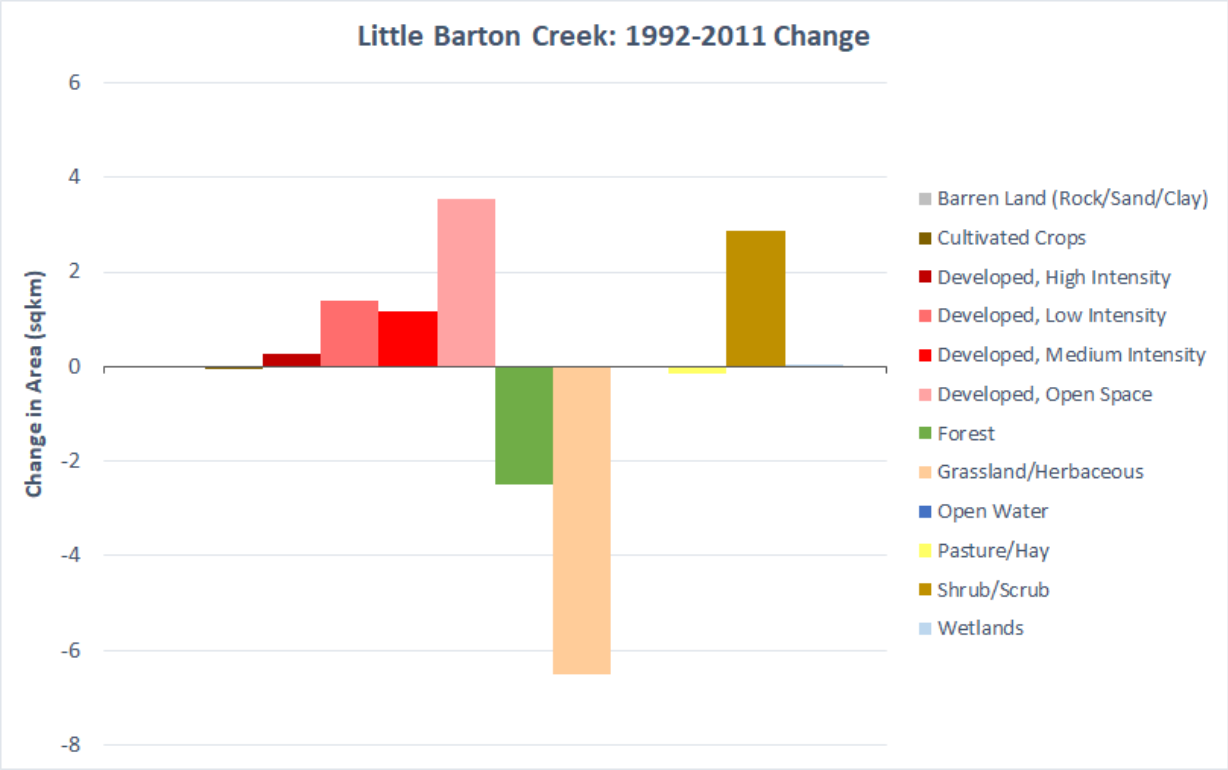

Figure 190. Land use change in area (sq km) from 1992-2011 for the Little Barton Creek watershed.

LITTLE BLANCO RIVER

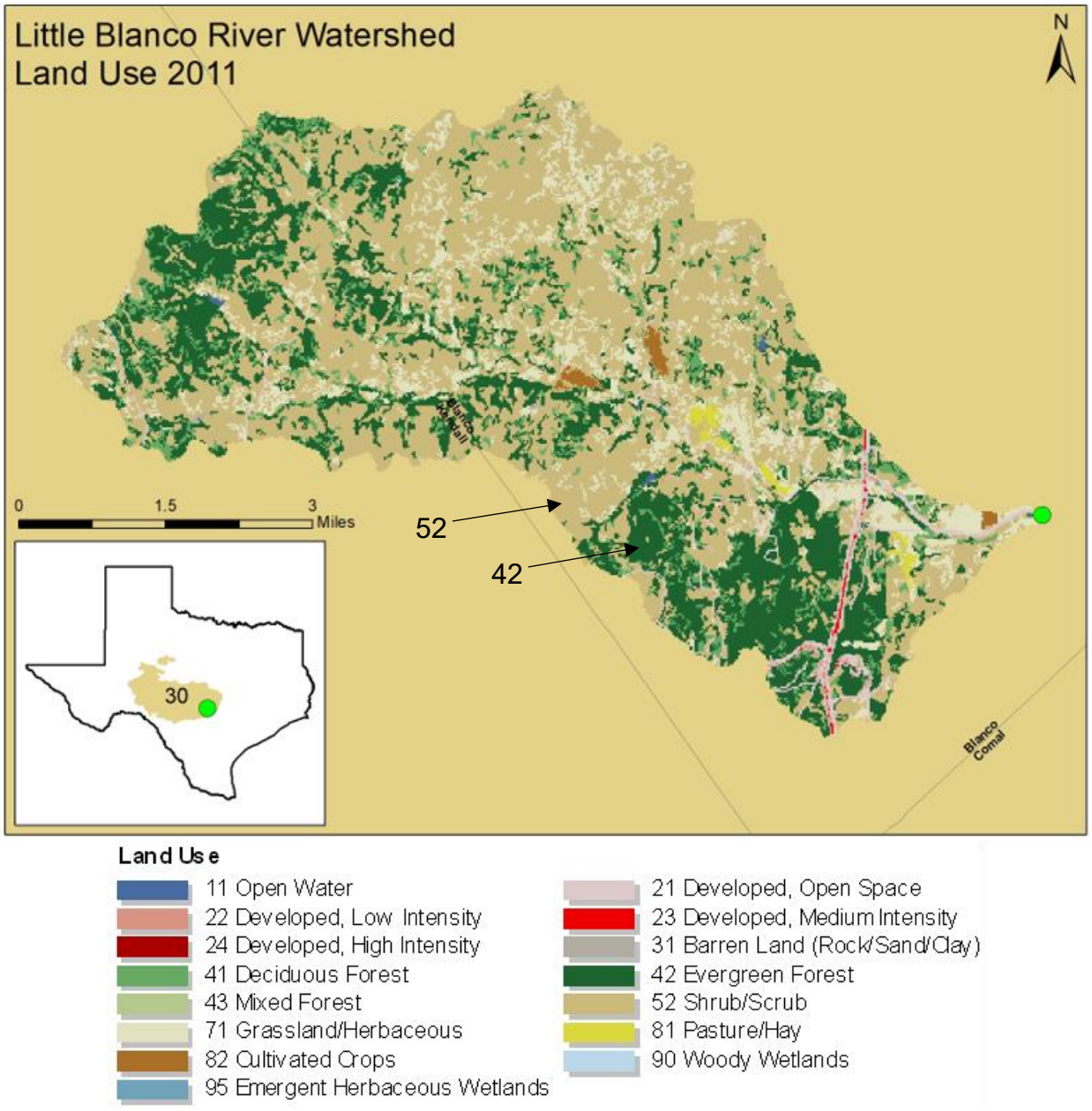

Figure 191. Map of Little Blanco River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	June 29, 1988
Water Quality:	8 sample events
Fish:	June 29, 1988; March 22, 1989
Benthic Invertebrates:	June 29, 1988

Physical Characterization

Watershed and Land Use

Little Blanco River lies within the Guadalupe River Basin. Sample site 12560 is located at Chick Ranch Road, 5.79 km northeast of Twin Sisters in Blanco County (Figure 191).

The Little Blanco River watershed at site 12560 is approximately 78.20 sq km. The entire watershed lies within Level IV Ecoregion 30c, the Balcones Canyonlands. The dominant land cover in the watershed is shrub at 51.70% and is present throughout the watershed (Homer et al. 2015; Figure 191 and Figure 192). Forest is the secondary land cover encompassing 32.61%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 2.89% and total cover for cultivated crops is 0.48%.

From 1992-2011 there was a 26.24 sq km decrease in grassland/herbaceous and an 8.79 sq km decrease in forest. There was a 36.95 sq km increase in shrub and a 1.88 sq km increase in open space development (Figure 193).

There are no wastewater outfalls in the Little Blanco River watershed.

In Channel and Riparian Physical Habitat

Physical habitat for the Little Blanco River was evaluated on June 29, 1988. The Little Blanco River is a tributary to the upper Blanco River. The riparian width was 15 meters. The riparian zone was dominated by shrubs, which made up an average of 50% of the total riparian species, followed by grasses (30%) then trees (20%). The average percentage of tree canopy cover was 0%. The dominant substrate was solid limestone bedrock with significant amounts of cobble and gravel, and the average percent of substrate that was gravel size or larger was 30%. Average percent instream cover was 25%. The Little Blanco River had an average depth of 0.7 meters and a maximum depth of 1.6 meters. The average width was 9.4 meters and average stream bank slope was 33 degrees. Stream flow at the site was 2.4 cfs. Average stream bank erosion potential was 36%. Five riffles were observed at the site and there were two total stream bends.

Water Quality

Station 12560 was sampled for water quality over 8 events from June 1988 through November 1993. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Thirteen species (five families) were collected between the two sampling events. Centrarchidae harbored the greatest species richness with six species. Red Shiner was the most abundant species in the 1988 collection. Redbreast Sunfish was the most abundant species in 1989. The aquatic life use rating for both fish collections was only intermediate; however, when the coefficient of

variability is applied the 1989 sample rises to high. The main reasons for the lower aquatic life use ratings were the absence of benthic invertivore and intolerant species, low percentage of piscivores, and high percentage of non-native species (Redbreast Sunfish).

Benthic Macroinvertebrates

From the June 1988 Surber sample, a total of 366 individuals representing 52 taxa from 13 orders of macroinvertebrates were collected from the Little Blanco River (Appendix E). The Trichoptera, Ephemeroptera, Coleoptera, Diptera, Hemiptera, and Oligochaeta were the most commonly collected orders, collectively accounting for 91.5 percent of the total number of individuals collected. The Neoophora, Odonata, and Basommatophora were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the June 1988 Surber sample fell within the exceptional aquatic life use category.

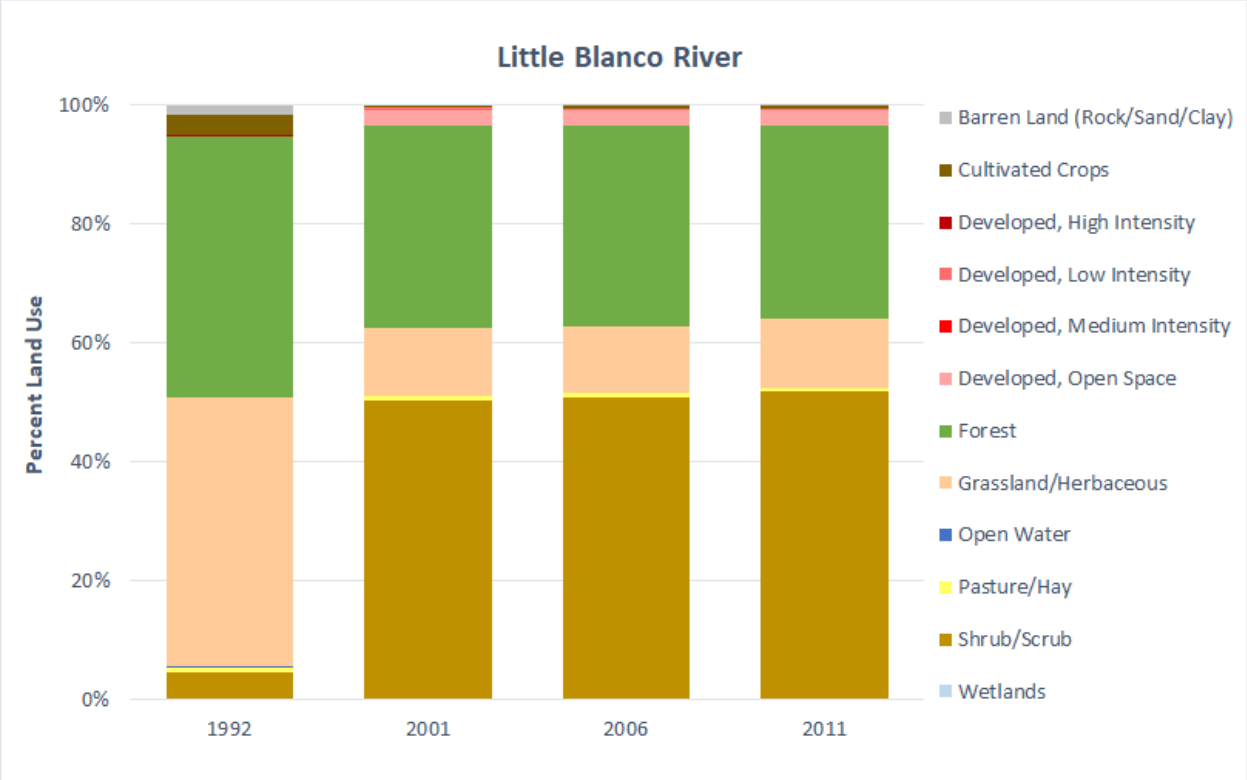

Figure 192. Percent land use in the Little Blanco River watershed from 1992-2011.

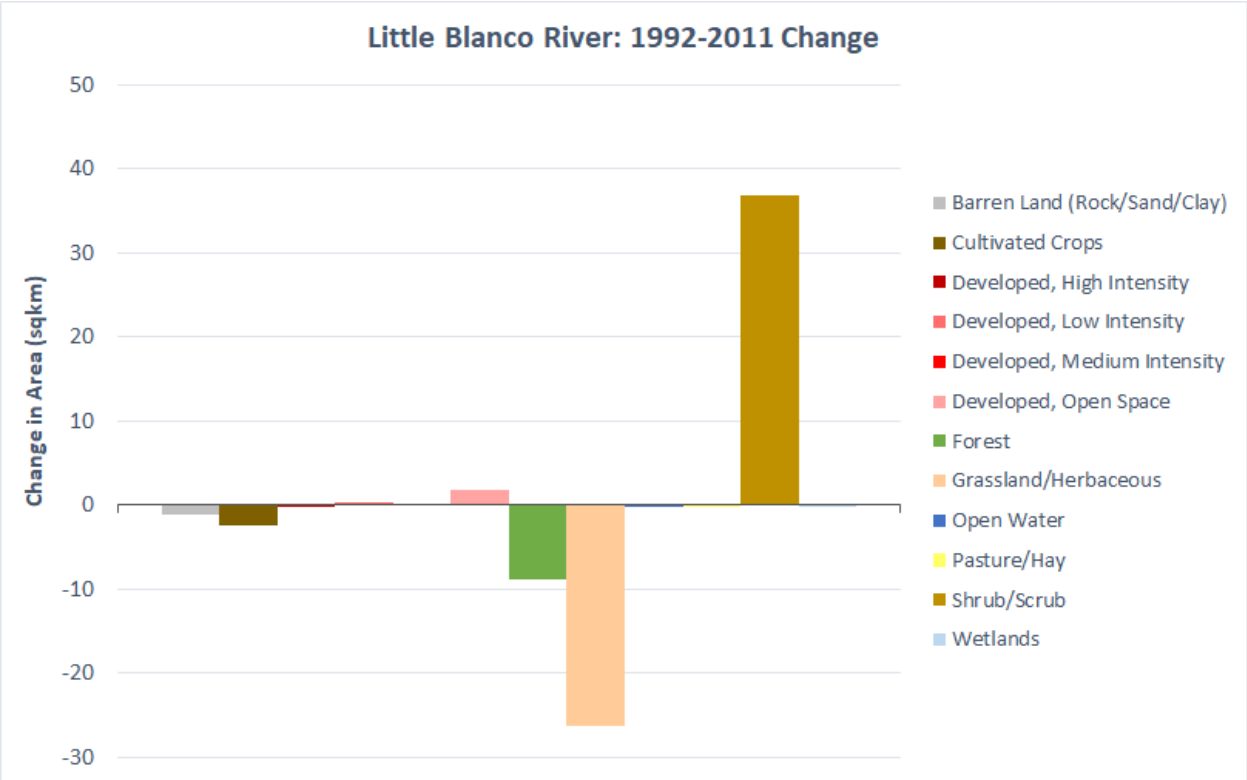

Figure 193. Land use change in area (sq km) from 1992-2011 for the Little Blanco River watershed.

LIVE OAK CREEK

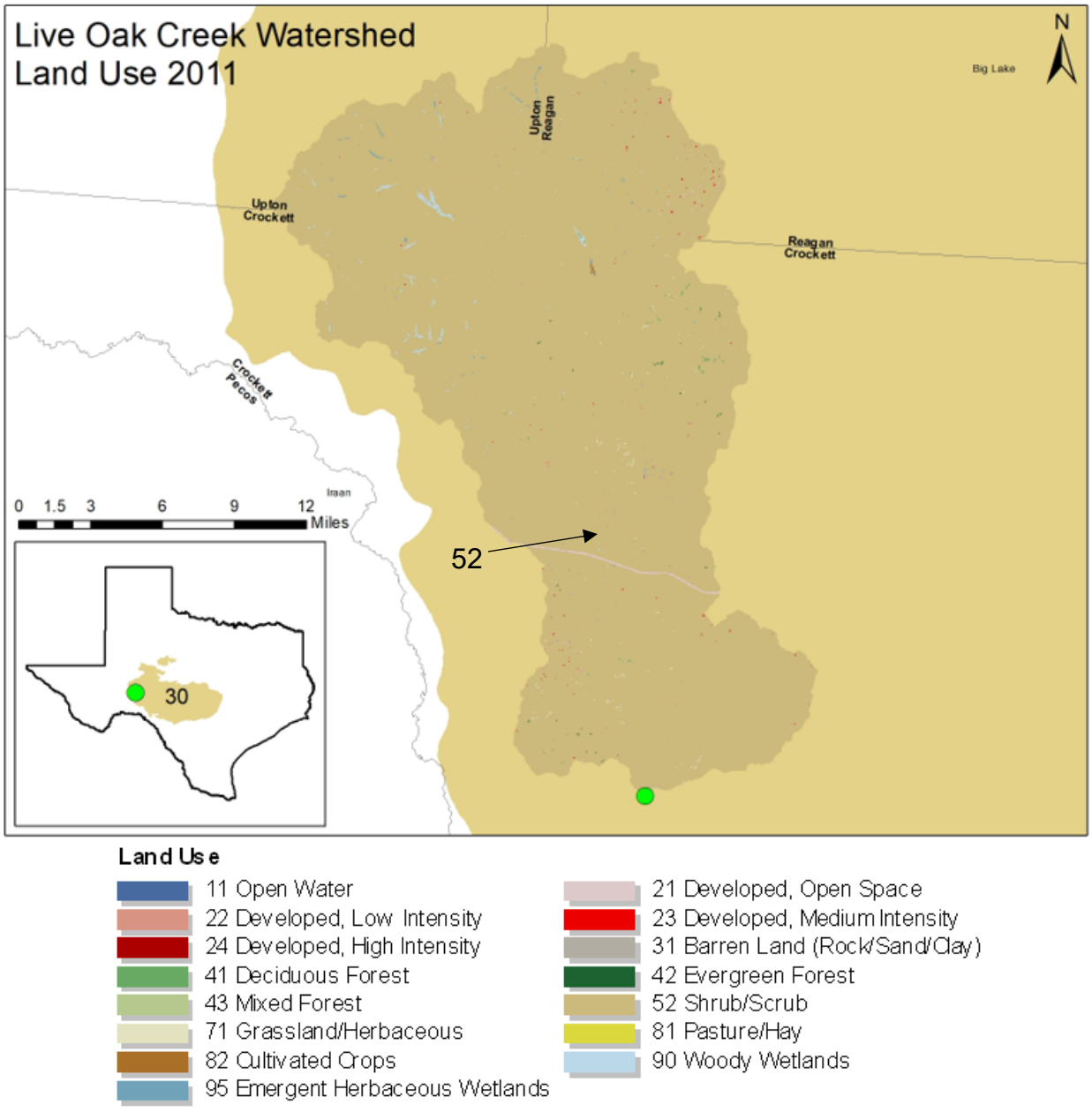

Figure 194. Map of Live Oak Creek watershed location and 2011 land use; shrub/scrub was the most common land use.

Sampling Dates

Physical Habitat:	August 30, 1990
Water Quality:	August 30, 1990
Fish:	August 30, 1990
Benthic Invertebrates:	August 29, 1990

Physical Characterization

Watershed and Land Use

Live Oak Creek lies within the Rio Grande River Basin. Sample site 13112 is located at IH 10, 43.4 km west of Ozona in Crockett County (Figure 194).

The Live Oak Creek watershed at site 13112 is approximately 959.81 sq km. The entire watershed lies within Level IV Ecoregion 30d, the Semiarid Edwards Plateau. The dominant land cover in the watershed is shrub at 98.91% and is present throughout the watershed (Homer et al. 2015; Figure 194 and Figure 195). Wetlands is the secondary land cover encompassing 0.37%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.46% and total cover for cultivated crops is 0.01%.

From 1992-2011 there was a 354.75 sq km decrease in grassland/herbaceous and a 4.40 sq km decrease in barren land. There was a 351.04 sq km increase in shrub and a 3.53 sq km increase in wetlands (Figure 196).

There are no wastewater outfalls in the Live Oak Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Live Oak Creek was evaluated on August 30, 1990. Live Oak Creek is a spring fed tributary to the upper Pecos River. The riparian width was 65 meters. The riparian zone was dominated by shrubs, which made up an average of 60% of the total riparian species, followed by trees (30%) then grasses (10%). The average percentage of tree canopy cover was 0%. The dominant substrate was cobble and gravel with some exposed bedrock, and the average percent of substrate that was gravel size or larger was 49%. Average percent instream cover was 13%. Live Oak Creek had an average depth of 0.2 meters and a maximum depth of 0.7 meters. The average width was 16.4 meters and average stream bank slope was 34 degrees. Stream flow at the site was 2.0 cfs. Average stream bank erosion potential was 31%. Five riffles were observed at the site and there were no stream bends.

Water Quality

Station 13112 was sampled for water quality in August 1990. Parameters measured included temperature, flow, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Nine species (eight families) were collected from Live Oak Creek, including one state listed threatened species, Proserpine Shiner. Cyprinidae was the only family represented by more than one species. Roundnose Minnow was the most abundant species, comprising 88% of the individuals collected. Live Oak Creek rated as only having an intermediate aquatic life use. The

low aquatic life use rating was due to the small number of native cyprinid and sunfish species, absence of benthic invertivore species, and an imbalanced trophic structure.

Benthic Macroinvertebrates

From the August 1990 Surber sample, a total of 774 individuals representing 49 taxa from 13 orders of macroinvertebrates were collected from Live Oak Creek (Appendix E). The Diptera, Ephemeroptera, Trichoptera, Coleoptera, Lepidoptera, and Hoplonemertea were the most commonly collected orders, collectively accounting for 91.3 percent of the total number of individuals collected. The Neoophora, Odonata, and Oligochaeta were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the August 1990 Surber sample fell within the exceptional aquatic life use category.

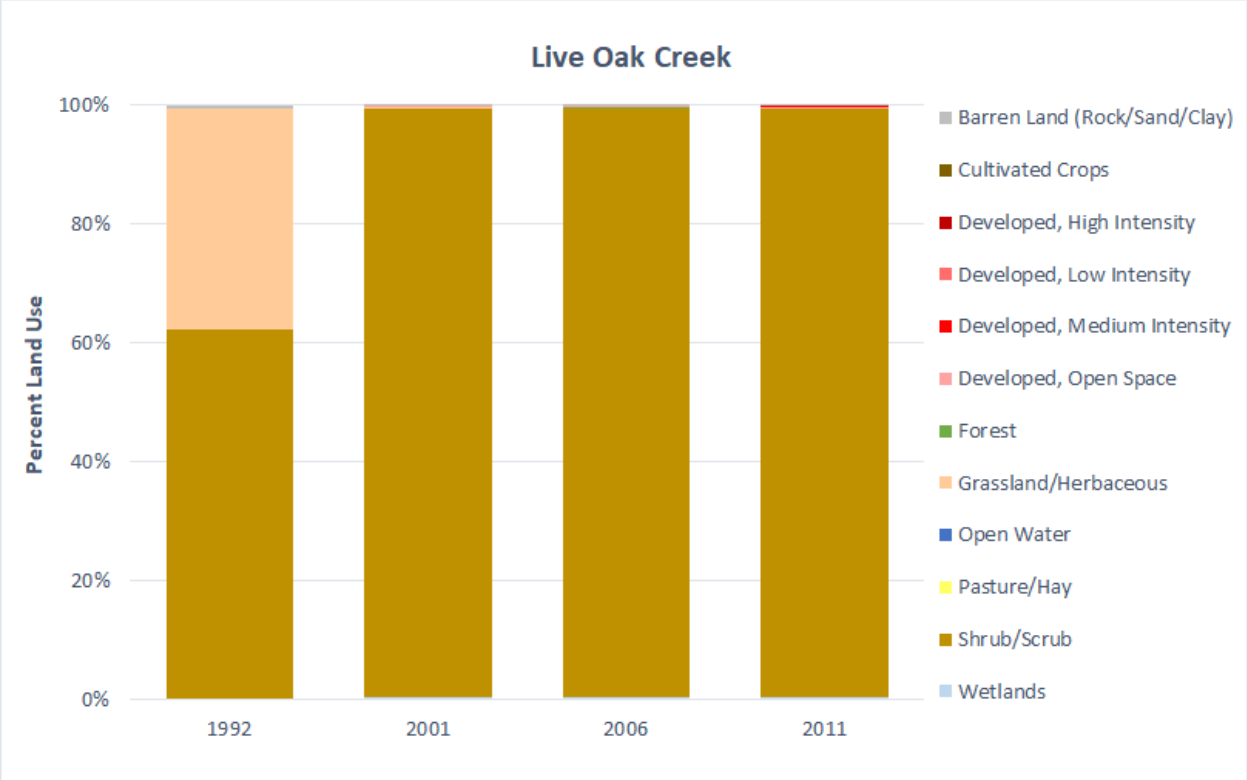

Figure 195. Percent land use in the Live Oak Creek watershed from 1992-2011.

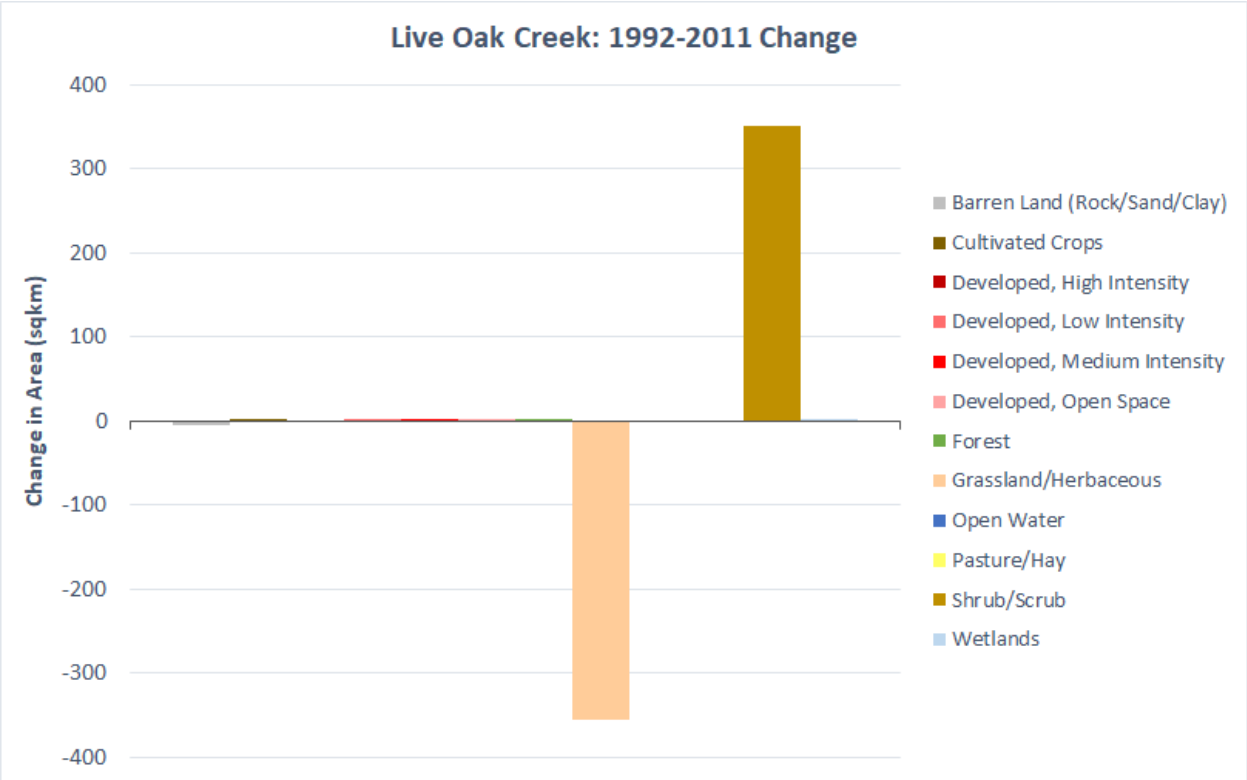

Figure 196. Land use change in area (sq km) from 1992-2011 for the Live Oak Creek watershed.

LLANO RIVER

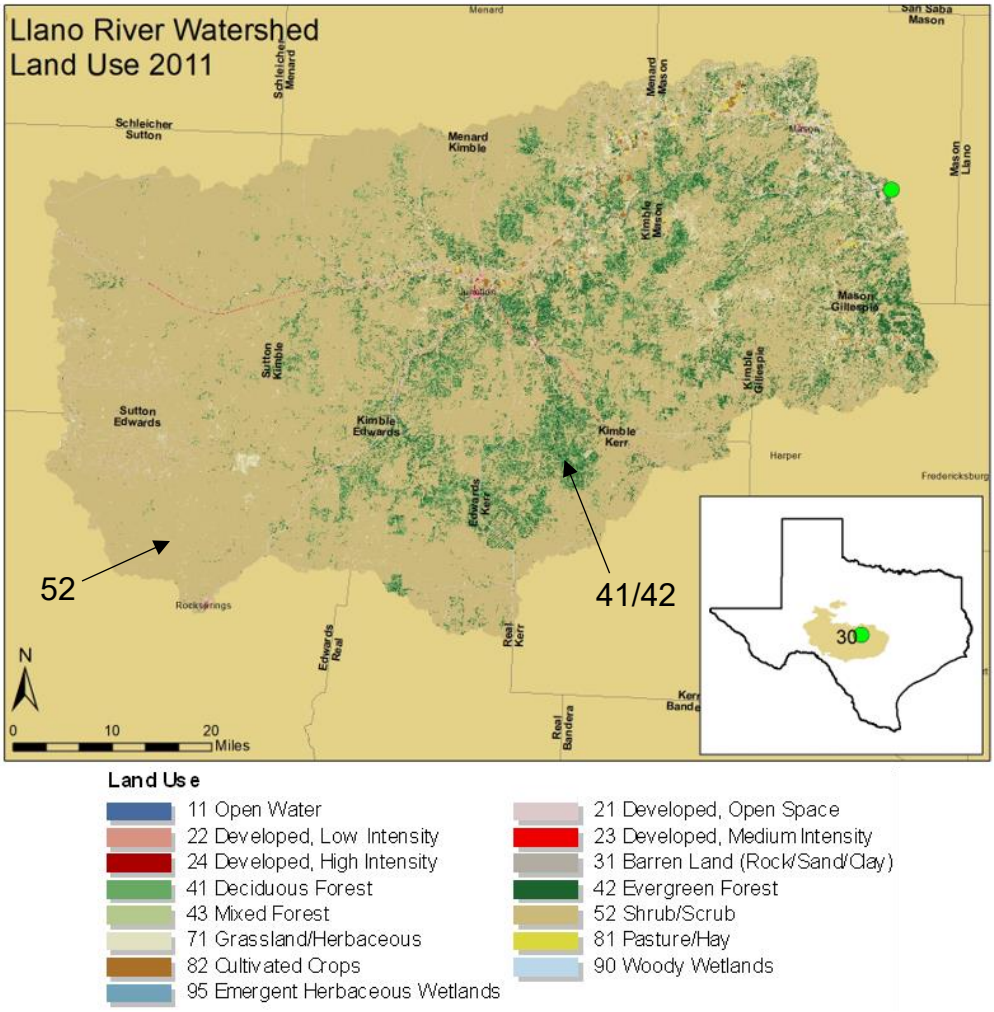

Figure 197. Map of Llano River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	Station 17471: March 22, 2010; July 7, 2010; March 22, 2011; August 23, 2011; March 22, 2012; September 5, 2012; May 21, 2013; July 10, 2013; Station 17363: 13 collections between August 2000 and April 2009
Water Quality:	33 sampling events at station 17471
Fish:	Station 17471: March 22, 2010; July 7, 2010; March 22, 2011; August 23, 2011; March 22, 2012; September 5, 2012; May 21, 2013; July 10, 2013; Station 17363: 14 collections between May 2001 and April 2009
Benthic Invertebrates:	March 29, 2000; August 16, 2000; May 23, 2001; August 15, 2001; March 18; 2002; September 4, 2002; April 30, 2003; July 29, 2003; March 16, 2004; September 21, 2004; March 23, 2005; September 14,

2005; March 22, 2006; October 30, 2007; March 17, 2008; July 10, 2008; April 15, 2009; March 22, 2010; July 7, 2010; March 22, 2011; August 23, 2011; March 22, 2012; September 5, 2012; May 21, 2013; July 10, 2013

Physical Characterization

Watershed and Land Use

The Llano River lies within the Colorado River Basin. Sample site 17363 is located 3.22 km downstream of US 87, east of Hedwigs Hill in Mason County (Figure 197).

The Llano River watershed at site 17363 is approximately 8991.41 sq km. The site and a small portion of the watershed lie within Level IV Ecoregion 30b, the Llano Uplift, while the vast majority of the watershed lies within Level IV Ecoregion 30a, the Edwards Plateau Woodland. The dominant land cover in the watershed is shrub at 80.16% and is present throughout the watershed (Homer et al. 2015; Figure 197 and Figure 198). Forest is the secondary land cover encompassing 13.95%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 1.85% and total cover for cultivated crops is 0.39%.

From 1992-2011 there was a 1460.72 sq km decrease in grassland/herbaceous and a 948.89 sq km decrease in forest. There was a 2539.77 sq km increase in shrub and a 140.05 sq km increase in open space development (Figure 199).

There are two domestic wastewater outfalls (discharges < 1 million gallons per day) and one industrial wastewater outfall (discharges ≥ 1 million gallons per day) within the Llano River watershed. The domestic wastewater facilities are permitted to the City of Junction and the City of Mason. The industrial wastewater facility is permitted to Grayden Cedar Works, Inc., a private company that supplies cedar wood oil and fiber. The domestic facility permitted to the City of Junction discharges directly into the Llano River.

In Channel and Riparian Physical Habitat

Physical habitat for the Llano River was evaluated at two sites during 21 sampling events from 2000 to 2013. The Llano River is a perennial stream that drains to the Llano River arm of Lake Lyndon B. Johnson in the southeast corner of Llano County. Habitat Quality Index scores are available for 19 sample events and indicate an intermediate to high aquatic life use rating (19-24). Riparian areas were well vegetated throughout the reach with the average riparian buffers being greater than 20 meters for all but two sampling events. The riparian zone was generally dominated by grasses followed by bare ground then trees and shrubs. The average percentage of tree canopy cover ranged from 0% to 42%. The dominant stream substrates were sand and gravel, and the average percent of substrate gravel size or larger varied from 12% to 92%. Average percent instream cover was 10% to 65% and instream cover types include overhanging vegetation, undercut banks, boulders, snags, root mats, algae, and gravel. The Llano River ranged from 0.4-0.9 meters deep on average and 22-65 meters wide. Average stream bank slope

ranged from 27-64 degrees. Stream flow was measured at a minimum value of 30 cfs and a maximum of 271 cfs. Average stream bank erosion potential was 11%-89%. The deepest pool measured at the Llano River was 3.1 meters. Number of riffles observed at the two sites varied from zero to five, and total number of stream bends ranged from zero to three.

Water Quality

Thirty-three water samples were collected at station 17471 from August 2009 through August 2015. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a. Only flow measurements were collected at station 17363.

Biological Characterization

Fish

Data from two sampling stations (about 91 km apart) were used to evaluate the aquatic life use of this river reach. A combined total of 33 species (10 families) were collected from these two sites over the course of eight sampling events at station 17471 and 14 sampling events at tation 17363. The two richest families were Cyprinidae and Centrarchidae with 10 and nine species, respectively. Blacktail Shiner was the most abundant species in 14 of the 22 collections and was present in every sample. Other species present in every collection included: Channel Catfish, Redbreast Sunfish, Longear Sunfish, Guadalupe Bass, and Orangethroat Darter. Of the 22 fish collections, 13 rated as having an exceptional aquatic life use. The remaining nine collections rated as high. When the coefficient of variability is applied to the samples rated as high, four increase to the exceptional range.

Benthic Macroinvertebrates

From the 25 RBP samples collectively, a total of 3775 individuals representing 77 taxa from 21 orders of macroinvertebrates were collected from the Llano River (Appendix E). The Ephemeroptera, Coleoptera, Trichoptera, Hemiptera, Diptera, and Odonata were the most commonly collected orders, collectively accounting for 90.3 percent of the total number of individuals collected. The Veneroida, Turbellaria, Megaloptera, and Basommatophora were the only other orders which comprised at least one percent of the collections.

The Ecoregion 30 BIBIs for each of the RBP samples fell within the following aquatic life use categories:

- Intermediate (August 2000, May 2001, March 2002, September 2002, July 2003, March 2005, April 2009)
- High (March 2000, August 2001, April 2003, March 2004, September 2004, September 2005, March 2006, October 2007, March 2008, July 2008, March 2010, July 2010, March 2012, September 2012, July 2013)
- Exceptional (March 2011, August 2011, May 2013)

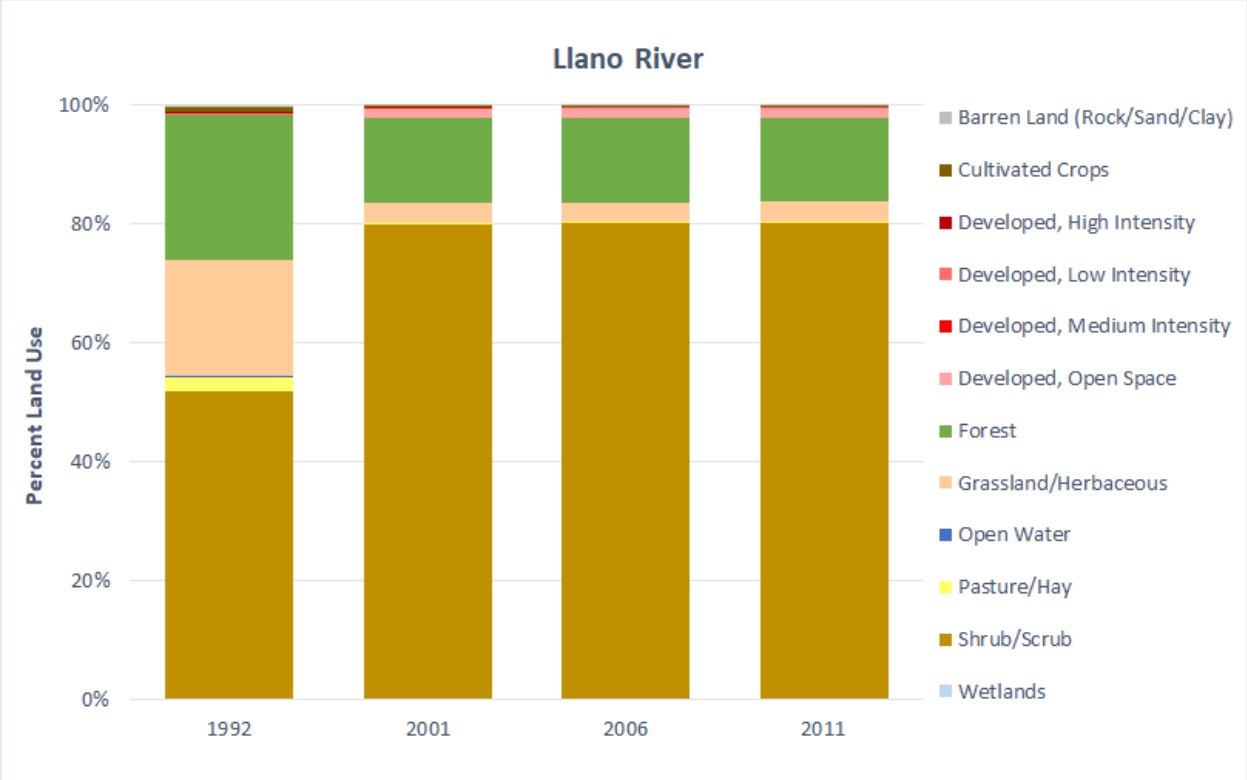

Figure 198. Percent land use in the Llano River watershed from 1992-2011.

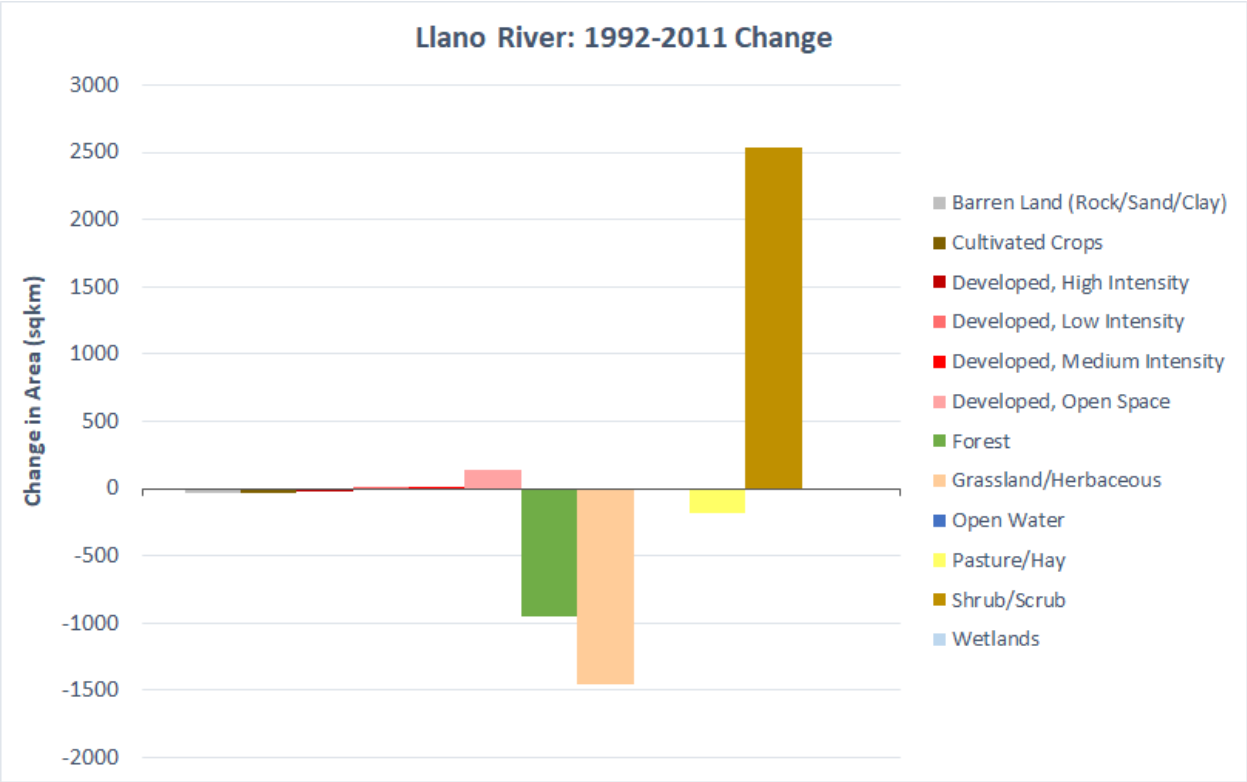

Figure 199. Land use change in area (sq km) from 1992-2011 for the Llano River watershed.

MEDINA RIVER

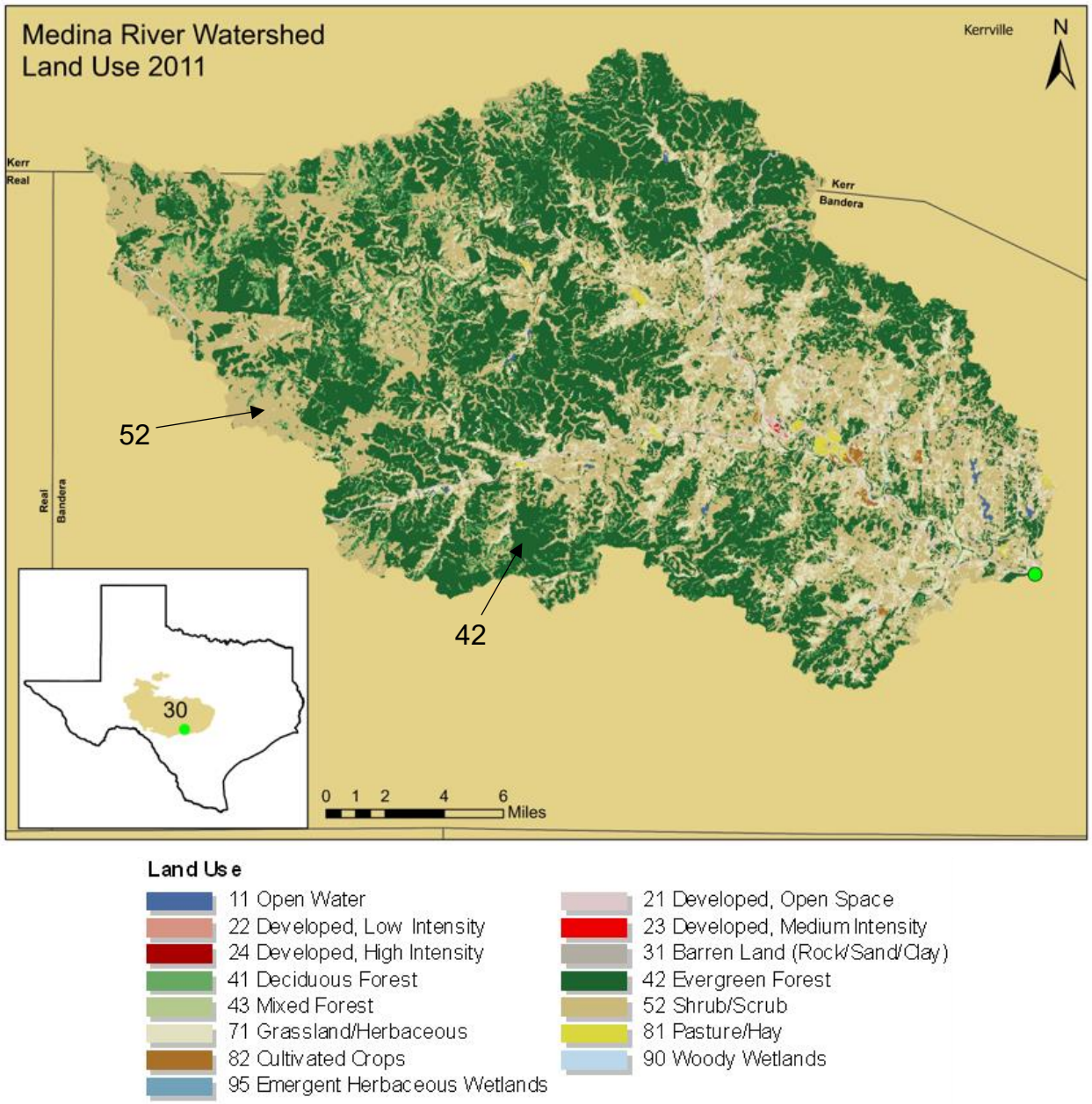

Figure 200. Map of Medina River watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	June 20, 1989
Water Quality:	72 sampling events
Fish:	June 20, 1989
Benthic Invertebrates:	June 20, 1989

Physical Characterization

Watershed and Land Use

The Medina River lies within the San Antonio River Basin. Sample site 12832 is located at SH 16, 4.78 km west/northwest of Bandera in Bandera County (Figure 200).

The Medina River watershed at site 12832 is approximately 787.95 sq km. The site and vast majority of the watershed lie within Level IV Ecoregion 30c, the Balcones Canyonlands. A small portion of the upper watershed lies within Level IV Ecoregion 30a, the Edwards Plateau Woodland. The dominant land cover in the watershed is forest at 49.93% and is mostly present in the middle portion of the watershed (Homer et al. 2015; Figure 200 and Figure 201). Shrub is the secondary land cover encompassing 38.41%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 1.64% and total cover for cultivated crops is 0.18%.

From 1992-2011 there was an 82.40 sq km decrease in forest and a 38.42 sq km decrease in grassland/herbaceous. There was a 136.45 sq km increase in shrub and a 12.28 sq km increase in open space development (Figure 202).

There are no wastewater outfalls in the Medina River watershed.

In Channel and Riparian Physical Habitat

Physical habitat for the Medina River was evaluated on June 20, 1989. The Medina River is a perennial spring-fed tributary to the San Antonio River. The riparian width was 7 meters. The riparian zone was dominated by trees, which made up an average of 60% of the total riparian species, followed by shrubs and grasses (20% each). The average percentage of tree canopy cover was 18%. The dominant substrate was cobble/gravel in riffles and pools, and limestone bedrock dominated in glides and runs. The average percent of substrate that was gravel size or larger was 57%. Average percent instream cover was 16%. The Medina River had an average depth of 0.7 meters and a maximum depth of 1.9 meters. The average width was 11.1 meters and average stream bank slope was 32 degrees. Stream flow at the site was 19.6 cfs. Average stream bank erosion potential was 30%. Six riffles were observed at the site and there were two total stream bends.

Water Quality

Water samples were collected at station 12832 over 72 sampling events from September 1973 through May 2022. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Fifteen species (six families) were collected from the Medina River. Centrarchidae and Cyprinidae were the richest families with six and five species, respectively. Texas Shiner was the most abundant species. The aquatic life use (based upon the fish assemblage) rated as high; however, when the coefficient of variability is applied the rating increases to exceptional.

Benthic Macroinvertebrates

From the June 1989 Surber sample, a total of 487 individuals representing 56 taxa from 14 orders of macroinvertebrates were collected from the Medina River (Appendix E). The Trichoptera, Ephemeroptera, Diptera, Coleoptera, and Odonata were the most commonly collected orders, collectively accounting for 91.6 percent of the total number of individuals collected. The Lepidoptera, Oligochaeta, Veneroida, and Megaloptera were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the June 1989 Surber sample fell within the exceptional aquatic life use category.

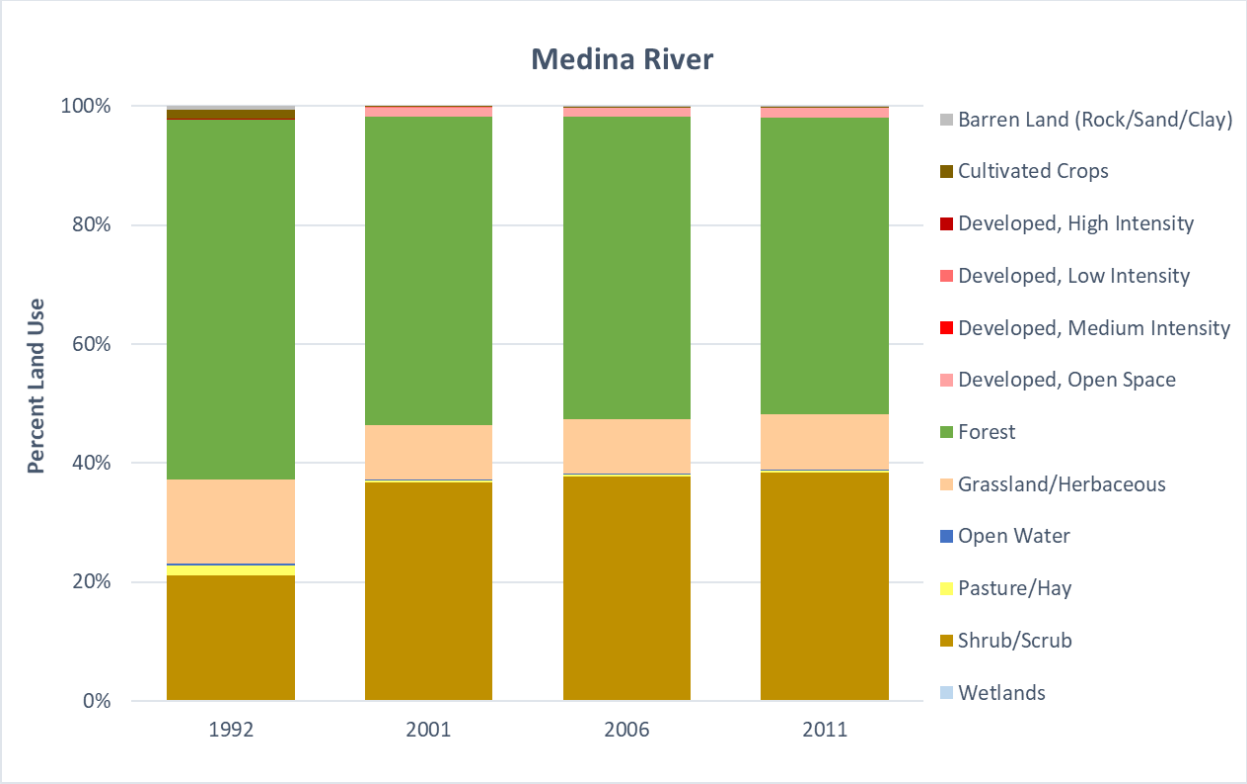

Figure 201. Percent land use in the Medina River watershed from 1992-2011.

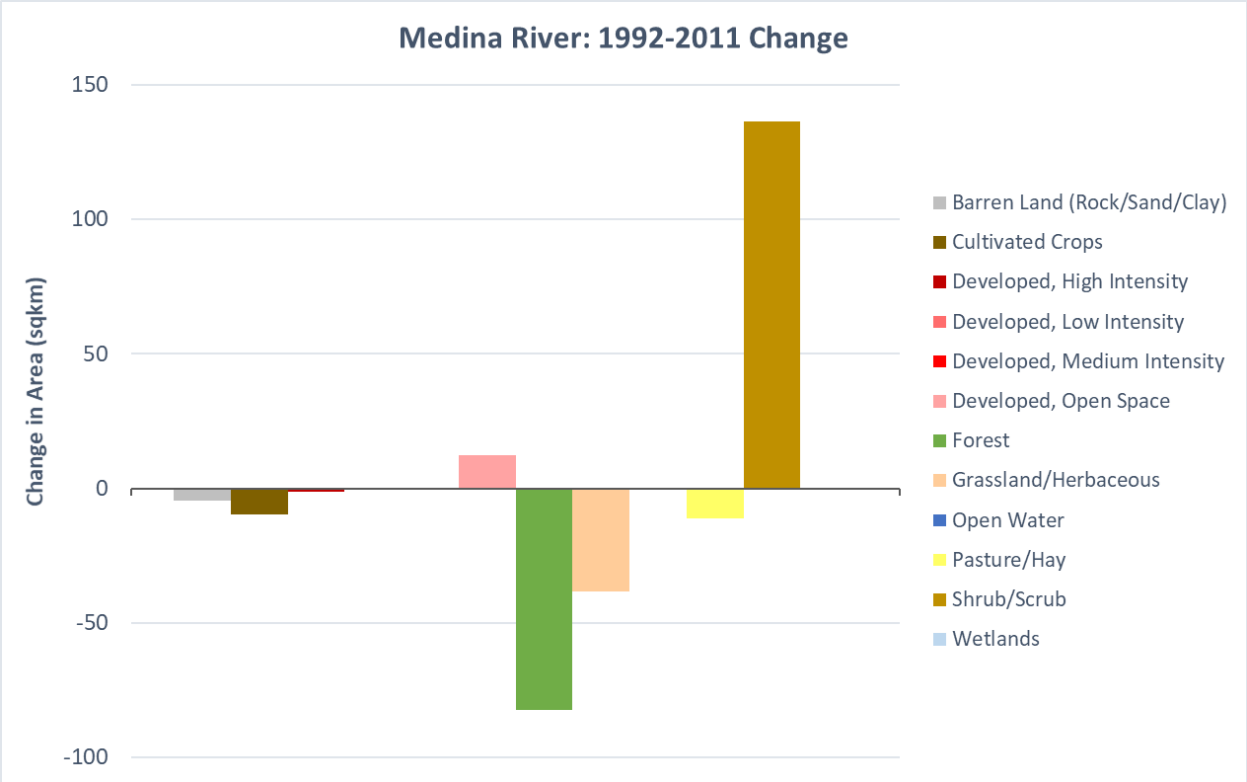

Figure 202. Land use change in area (sq km) from 1992-2011 for the Medina River watershed.

MONTELL CREEK

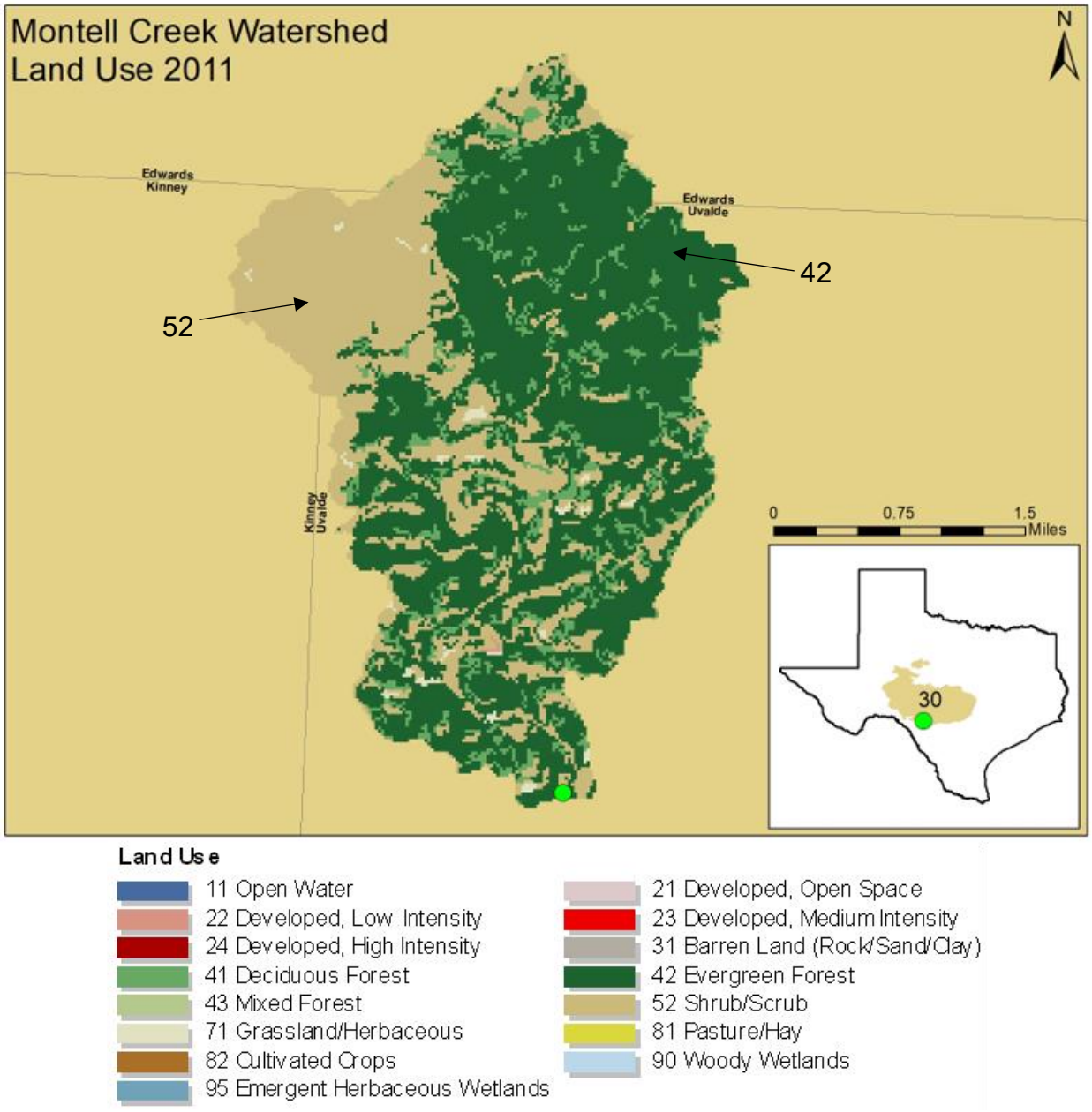

Figure 203. Map of Montell Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	No samples
Water Quality:	2 sampling events
Fish:	August 11, 2010; May 17, 2011
Benthic Invertebrates:	August 11, 2010; May 17, 2011

Physical Characterization

Watershed and Land Use

Montell Creek lies within the Nueces River Basin. Sample site 20831 is located at CR 415 approximately 13 km northwest of Montell in Uvalde County (Figure 203).

The Montell Creek watershed at site 20831 is approximately 20.60 sq km. The entire watershed lies within Level IV Ecoregion 30c, the Balcones Canyonlands. The dominant land cover in the watershed is forest at 66.53% and is present throughout the watershed (Homer et al. 2015; Figure 203 and Figure 204). Shrub is the secondary land cover encompassing 32.66%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.04% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 4.52 sq km decrease in forest and a 0.51 sq km decrease in grassland/herbaceous. There was a 5.28 sq km increase in shrub and a 0.009 sq km increase in low intensity development (Figure 205).

There are no wastewater outfalls in the Montell Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat data is not available for Montell Creek.

Water Quality

Station 20831 was sampled in April 2010 and May 2011. Parameters measured included temperature, flow, specific conductance, dissolved oxygen, alkalinity, ammonia, phosphorus, total organic carbon, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Thirteen species (six families) were collected between the two sampling events. Centrarchidae and Cyprinidae were the richest families with five and four species, respectively. Plateau Shiner (*Cyprinella lepida*) was the most abundant species in the 2010 collection, Longear Sunfish in 2011. Both fish assemblages rated as having a high aquatic life use.

Benthic Macroinvertebrates

From the two RBP samples (August 2010 and May 2011) together, a total of 474 individuals representing 42 taxa from 11 orders of macroinvertebrates were collected from Montell Creek (Appendix E). The Trichoptera, Coleoptera, Ephemeroptera, Diptera, and Odonata were the most commonly collected orders, collectively accounting for 92.2 percent of the total number of individuals collected. The Hemiptera and Neoophora were the only other orders which comprised at least one percent of the collections.

The Ecoregion 30 BIBIs for both the August 2010 and May 2011 RBP samples fell within the high aquatic life use category.

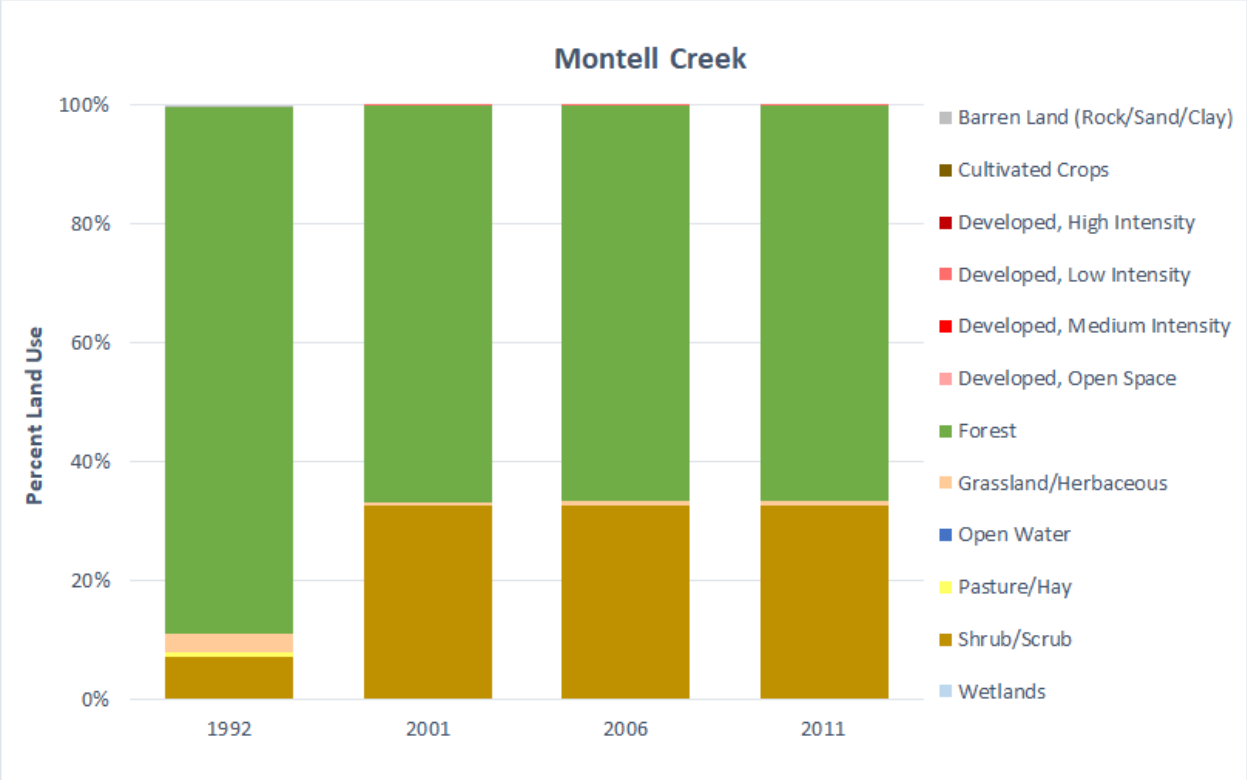

Figure 204. Percent land use in the Montell Creek watershed from 1992-2011.

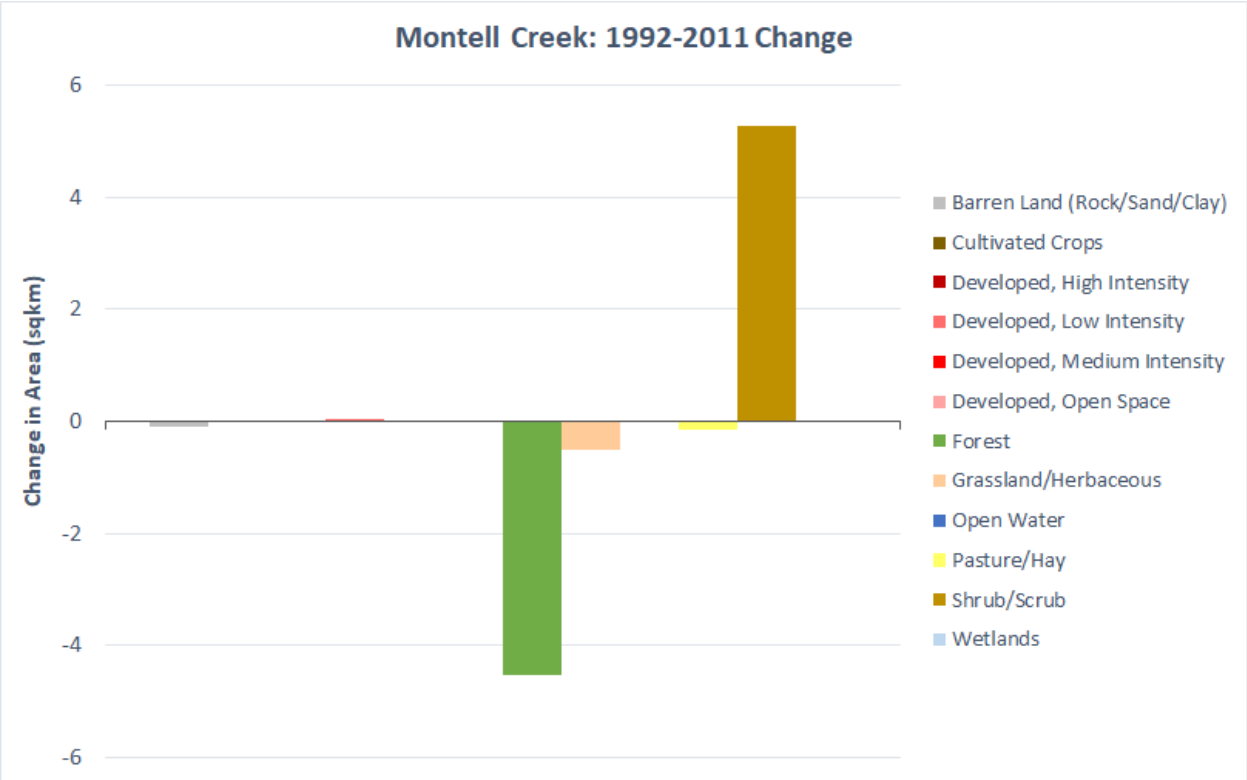

Figure 205. Land use change in area (sq km) from 1992-2011 for the Montell Creek watershed.

NORTH PRONG MEDINA RIVER

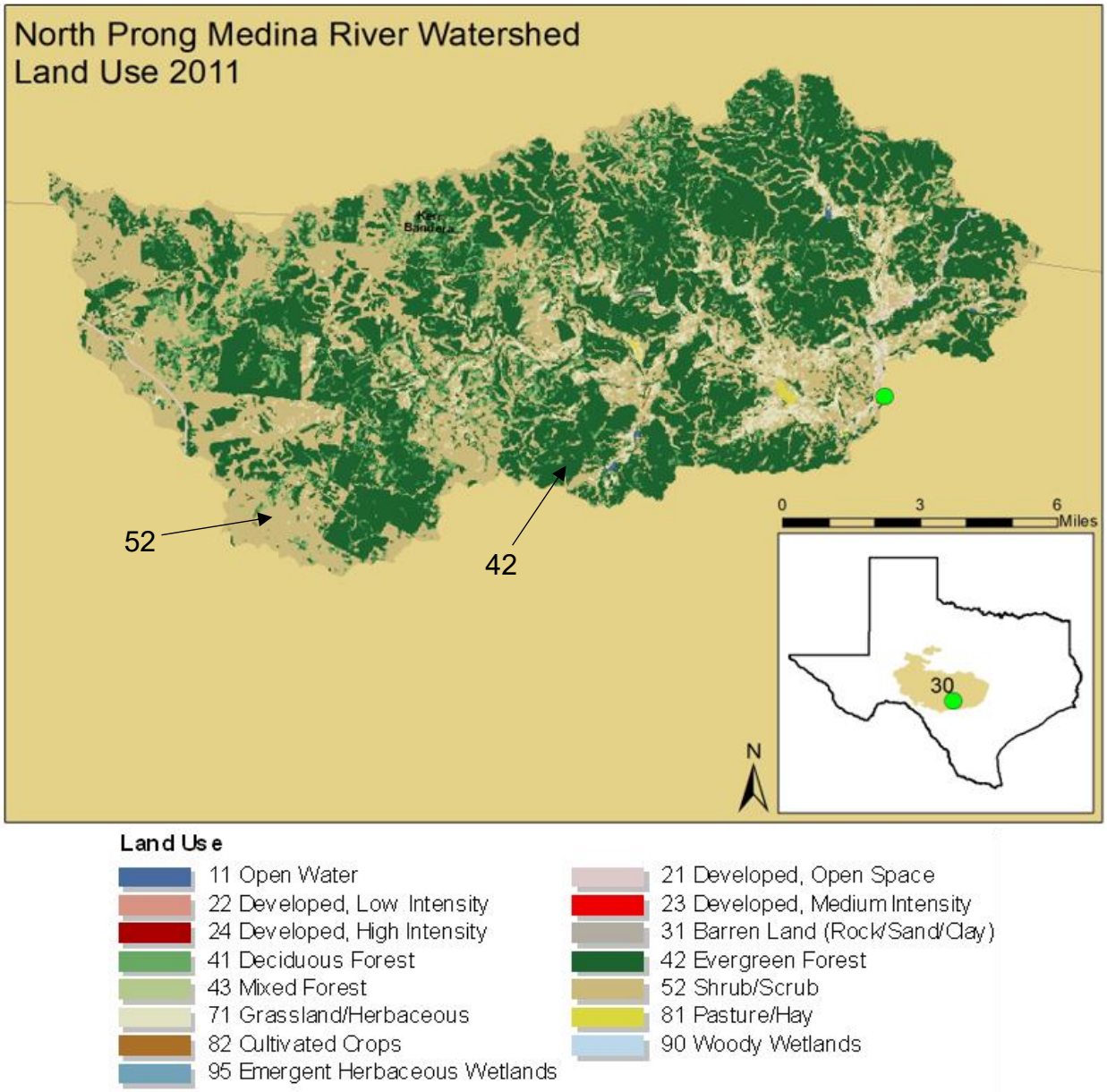

Figure 206. Map of North Prong Medina River watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	July 7, 2008; June 5, 2012; March 19, 2013; September 11, 2015; November 13, 2015
Water Quality:	64 sampling events
Fish:	July 7, 2008; June 5, 2012; March 19, 2013; July 15, 2015; July 30, 2015; September 11, 2015; November 13, 2015
Benthic Invertebrates:	June 5, 2012; March 19, 2013; July 30, 2015

Physical Characterization

Watershed and Land Use

North Prong Medina River lies within the San Antonio River Basin. Sample site 18447 is located upstream of SH 16, approximately 24 km northwest of Bandera in Bandera County (Figure 206).

The North Prong Medina River watershed at site 18447 is approximately 369.17 sq km. The vast majority of the watershed lies within Level IV Ecoregion 30c, the Balcones Canyonlands, while a small portion in the upper watershed lies within Level IV Ecoregion 30a, the Edwards Plateau Woodland. The dominant land cover in the watershed is forest at 56.93% and is present throughout the watershed (Homer et al. 2015; Figure 206 and Figure 207). Shrub is the secondary land cover encompassing 37.72%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.36% and the total for cultivated crops is 0.02%.

From 1992-2011 there was a 28.18 sq km decrease in grassland/herbaceous and a 22.72 sq km decrease in forest. There was a 61.15 sq km increase in shrub and a 1.29 sq km increase in open space development (Figure 208).

There are no wastewater outfalls in the North Prong Medina River watershed.

In Channel and Riparian Physical Habitat

Physical habitat for the North Prong Medina River was evaluated during five sampling events from 2008 to 2015. The North Prong Medina River is a perennial stream that drains to the Medina River in northern Bandera County. Habitat Quality Index scores are available for all five sample events and indicate a high to exceptional aquatic life use rating (21.5-29.5). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 9 meters wide to greater than 20 meters. The riparian zone was generally dominated by grasses followed by trees then shrubs. The average percentage of tree canopy cover ranged from 71% to 88%. The dominant stream substrate was cobble/gravel, and the average percent of substrate gravel size or larger varied from 88% to 100%. Average percent instream cover was 30% to 56% and instream cover types include roots, snags, cobble/gravel, boulders, woody debris, macrophytes, algae, and overhanging vegetation. The North Prong Medina River ranged from 0.1-0.3 meters deep on average and 7-10 meters wide. Average stream bank slope ranged from 14-22 degrees. Stream flow at the site was measured at a minimum value of 2.2 cfs and a maximum of 13 cfs. Average stream bank erosion potential was 18%-32%. The deepest pool measured at the North Prong Medina River was 2 meters. Number of riffles observed at the site varied from one to nine, and total number of stream bends ranged from one to seven.

Water Quality

Water samples were collected at station 18447 over 64 sampling events from August 2004 through April 2019. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, ammonia, total Kjeldahl nitrogen, total nitrogen,

phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a. Data include 24-hour sampling events.

Biological Characterization

Fish

Twenty-one species (eight families) were collected over the course of the seven sampling events. The family represented by the most species was Centrarchidae with seven species. The most abundant species per collection varied with Central Stoneroller being the most abundant species in three of the collections, Western Mosquitofish in two, and Blacktail Shiner and Bluegill in one. Based on the fish assemblages, all but one of the samples received high aquatic life use ratings. The November 2015 collection rated as exceptional. When the coefficient of variability is applied, the 2008 and July 2015 samples also attain exceptional ratings.

Benthic Macroinvertebrates

From the three RBP samples collected June 2012, March 2013, and July 2015 together, a total of 589 individuals representing 55 taxa from 12 orders of macroinvertebrates were collected from the North Prong Medina River (Appendix E). The Ephemeroptera, Trichoptera, Coleoptera, and Diptera were the most commonly collected orders, collectively accounting for 92.9 percent of the total number of individuals collected. The Odonata and Plecoptera were the only other orders which comprised at least one percent of the collections.

The assigned aquatic life use based on the Ecoregion 30 BIBI ended up being different for each of the RBP samples. The June 2012 sample had a high aquatic life use, the March 2013 sample had an intermediate aquatic life use, and the July 2015 sample had an exceptional aquatic life use.

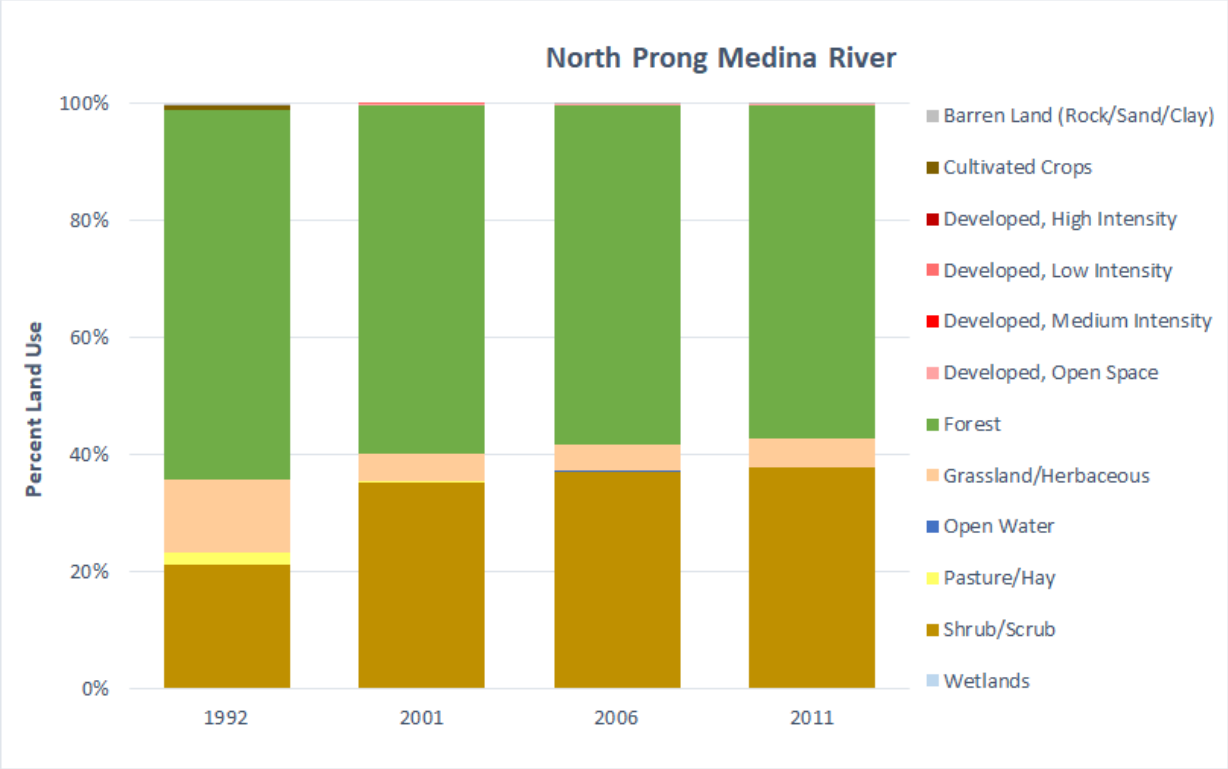

Figure 207. Percent land use in the North Prong Medina River watershed from 1992-2011.

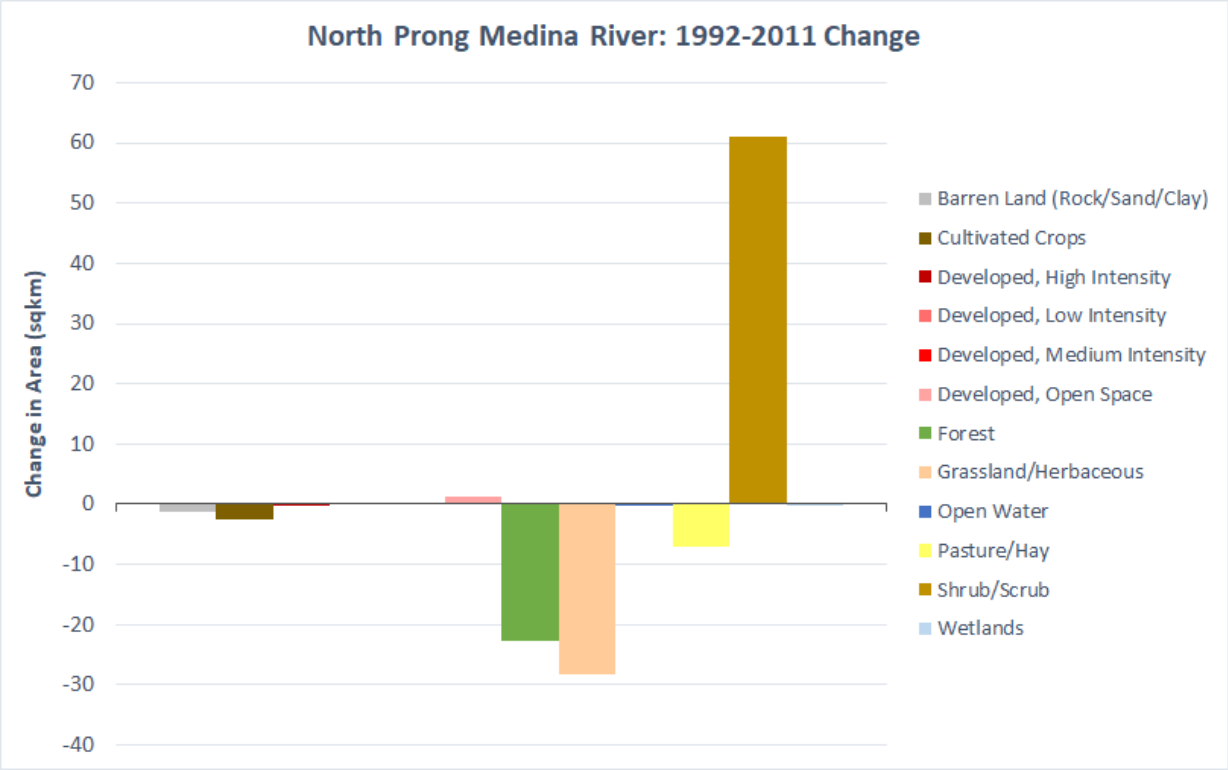

Figure 208. Land use change in area (sq km) from 1992-2011 for the North Prong Medina River watershed.

NUECES RIVER

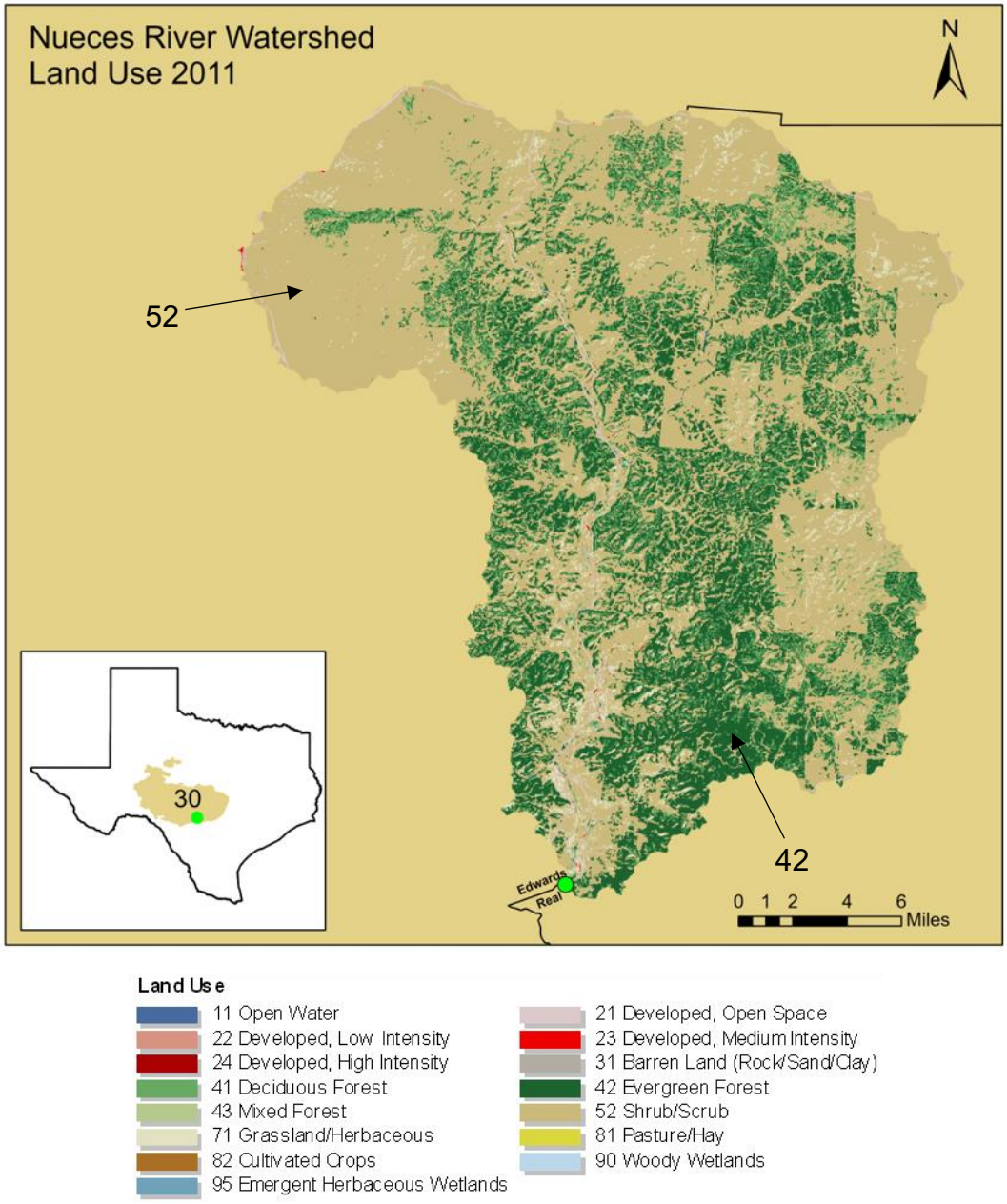

Figure 209. Map of Nueces River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	No samples
Water Quality:	68 sampling events
Fish:	August 10, 2010; May 18, 2011
Benthic Invertebrates:	August 10, 2010; May 18, 2011

Physical Characterization

Watershed and Land Use

The Nueces River is the basin's namesake and is a major river basin in Texas. Sample site 13005 is located at SH 55 south of Barksdale in Edwards and Real Counties (Figure 209).

The upper Nueces River watershed at site 13005 is approximately 906.99sq km. The vast majority of the watershed lies within Level IV Ecoregion 30c, the Balcones Canyonlands and a portion of the upper watershed lies within Level IV Ecoregion 30a, the Edwards Plateau Woodland. The dominant land cover in the watershed is shrub at 59.93% and is present throughout the watershed but is most concentrated in the upper watershed (Homer et al. 2015; Figure 209 and Figure 210). Forest is the secondary land cover encompassing 36.15%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.93% and total cover for cultivated crops is 0.01%.

From 1992-2011 there was a 141.03 sq km decrease in forest and a 125.77 sq km decrease in grassland/herbaceous. There was a 274.84 sq km increase in shrub and a 7.08 sq km increase in open space development (Figure 211).

There are no wastewater outfalls in this portion of the upper Nueces River watershed.

In Channel and Riparian Physical Habitat

Physical habitat data is not available for the upper Nueces River.

Water Quality

Water samples were collected at station 13005 over 68 sampling events from September 1983 through August 2017. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Eighteen species (eight families) were collected between the two sampling events. The two most species rich families were Cyprinidae and Centrarchidae with five and four species, respectively. Nueces Roundnose Minnow was the most abundant species. Based on the fish assemblage, the 2010 sample rated as having an exceptional aquatic life use while the 2011 sample rated as high; however, when the coefficient of variability is applied the 2011 sample also attains an exceptional rating.

Benthic Macroinvertebrates

From the two RBP samples collected August 2010 and May 2011 together, a total of 497 individuals representing 39 taxa from 13 orders of macroinvertebrates were collected from the Nueces River (Appendix E). The Ephemeroptera, Trichoptera, Diptera, Amphipoda, Neoophora, and Hemiptera were the most commonly collected orders, collectively accounting for 92.2

percent of the total number of individuals collected. The Coleoptera and Odonata were the only other orders which comprised at least one percent of the collections.

The Ecoregion 30 BIBI for the August 2010 RBP samples fell within the high aquatic life use category, while the BIB from the May 2011 sample fell within the intermediate aquatic life use category.

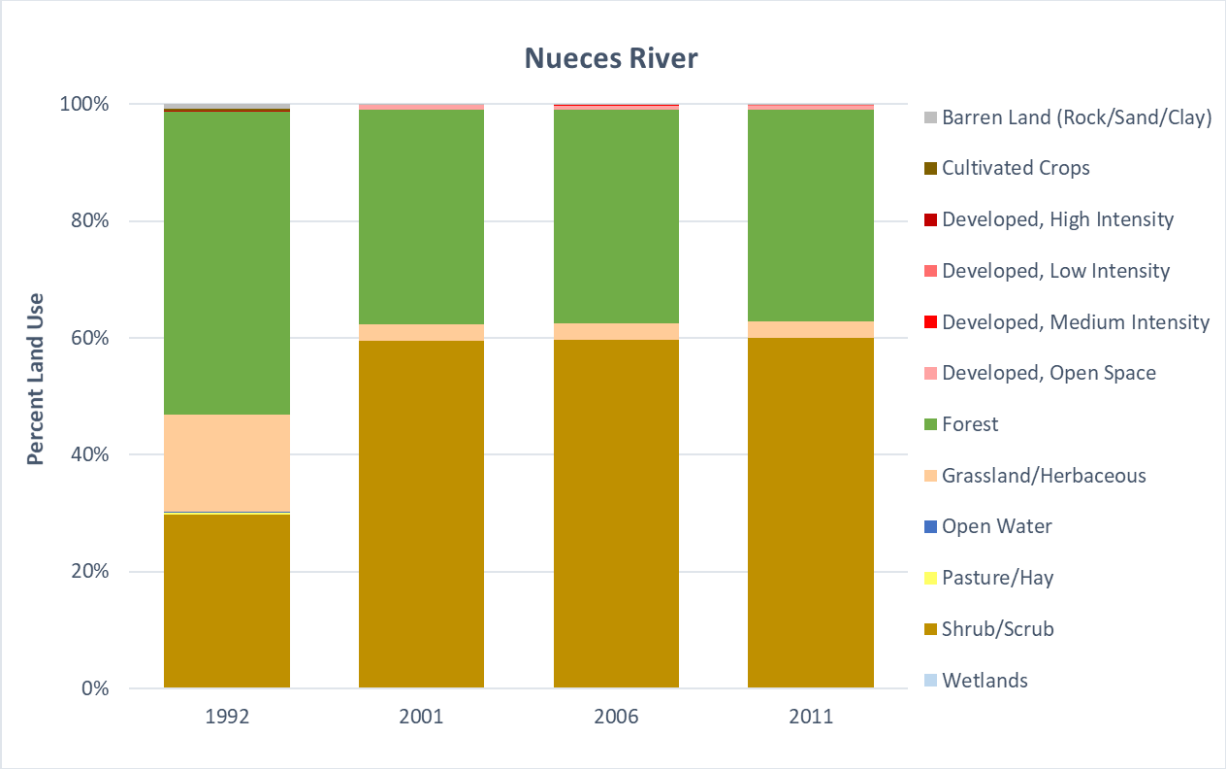

Figure 210. Percent land use in the upper Nueces River watershed from 1992-2011.

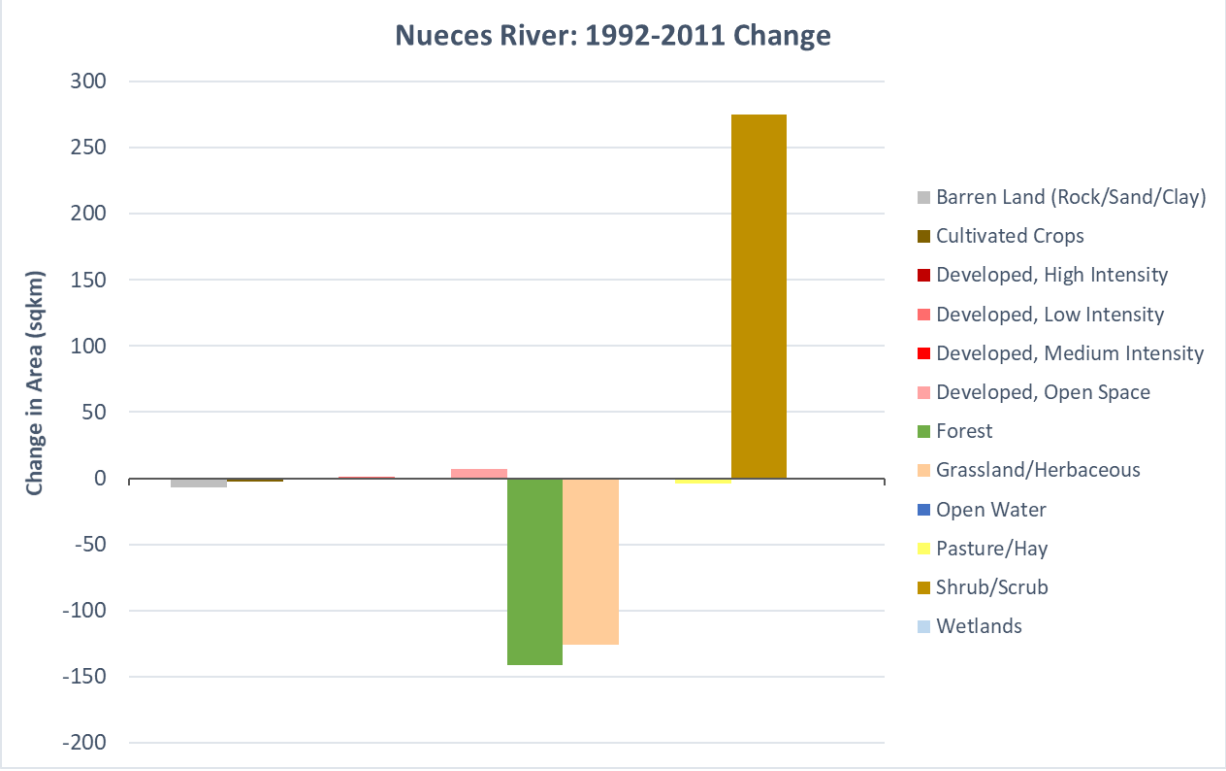

Figure 211. Land use change in area (sq km) from 1992-2011 for the upper Nueces River watershed.

OATMEAL CREEK

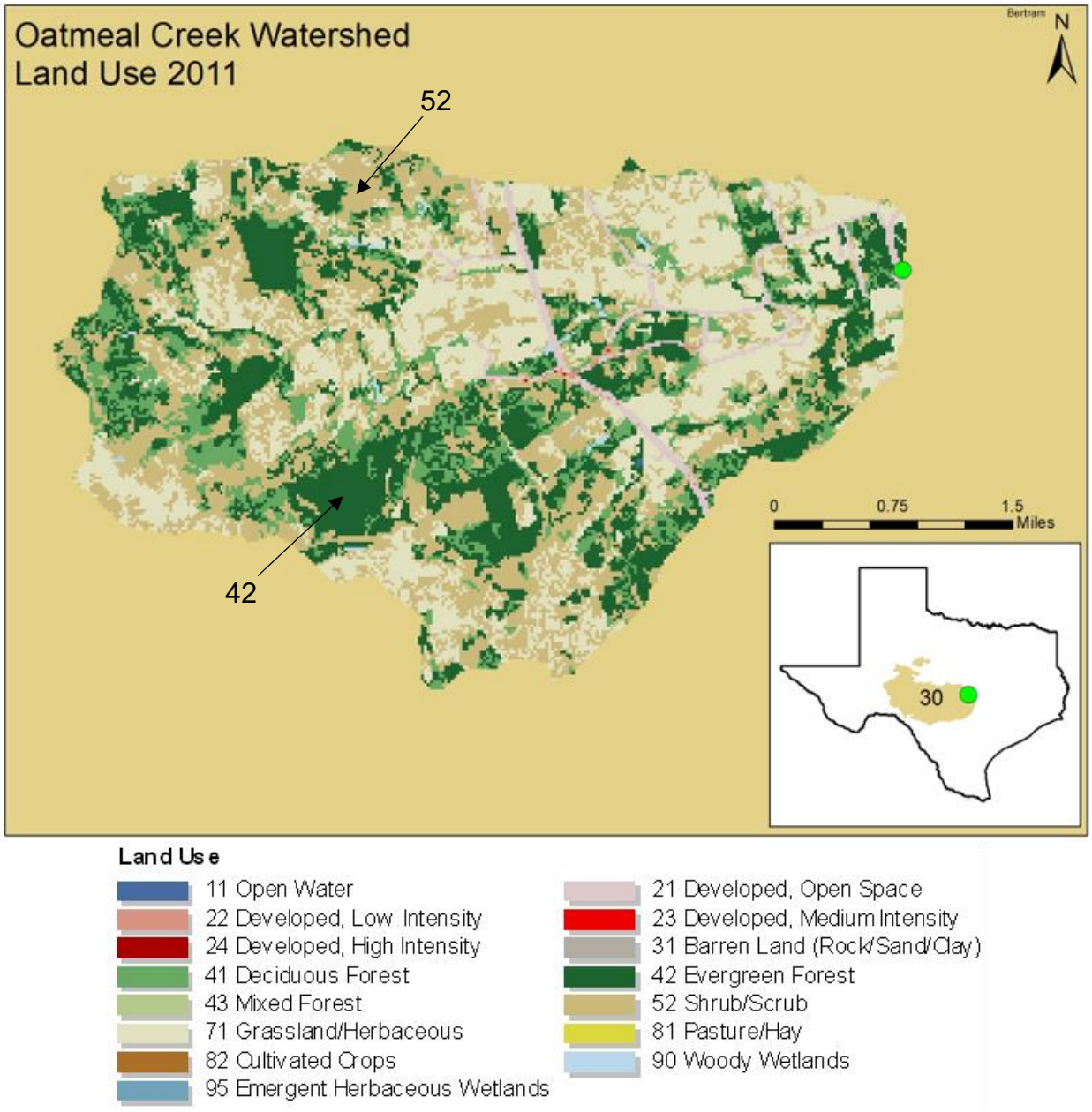

Figure 212. Map of Oatmeal Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	June 30, 1988
Water Quality:	11 sampling events
Fish:	June 30, 1988; March 23, 1989
Benthic Invertebrates:	June 30, 1988

Physical Characterization

Watershed and Land Use

Oatmeal Creek lies within the Brazos River Basin. Sample site 11726 is located downstream of FM 1174, approximately 5.79 km south of Bertram in Burnet County (Figure 212).

The Oatmeal Creek watershed at site 11726 is approximately 31.80 sq km. The entire watershed lies within Level IV Ecoregion 30c, the Balcones Canyonlands. The dominant land cover in the watershed is forest at 36.41% and is present throughout the watershed (Homer et al. 2015; Figure 212 and Figure 213). Shrub is the secondary land cover encompassing 32.76%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.17% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 4.80 sq km decrease in forest and a 0.70 sq km decrease in cultivated crop. There was a 2.54 sq km increase in shrub and a 2.05 sq km increase in grassland/herbaceous (Figure 214).

There are no wastewater outfalls in the Oatmeal Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Oatmeal Creek was evaluated on June 30, 1988. Oatmeal Creek is a tributary to the South Fork San Gabriel River. The riparian width was 15 meters. The riparian zone was dominated by shrubs, which made up an average of 40% of the total riparian species, followed by trees and grasses (30% each). The average percentage of tree canopy cover was 20%. The dominant substrate was cobble/gravel and boulders, and the average percent of substrate that was gravel size or larger was 31%. Average percent instream cover was 26%. Oatmeal Creek had an average depth of 0.6 meters and a maximum depth of 1.5 meters. The average width was 6.6 meters and average stream bank slope was 56 degrees. Stream flow at the site was 0.06 cfs. Average stream bank erosion potential was 20%. Four riffles were observed at the site and there were two total stream bends.

Water Quality

Station 11726 was sampled over 11 events for water quality from June 1988 to July 1999. Parameters measured included temperature, flow, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twelve species (five families) were collected between the two sampling events. Species were fairly evenly distributed among the families. Central Stoneroller was the most abundant species collected in 1988. Blacktail Shiner was the most abundant species in the 1989 sample. The aquatic life use ratings (based upon the fish assemblages) were intermediate and high for the

1988 and 1989 samples, respectively. When the coefficient of variability is applied to the 1988 collection it also rises to high.

Benthic Macroinvertebrates

From the June 1988 Surber sample, a total of 245 individuals representing 42 taxa from 14 orders of macroinvertebrates were collected from Oatmeal Creek (Appendix E). The Diptera, Coleoptera, Trichoptera, Neoophora, Ephemeroptera, Odonata, Hemiptera, Trombidiformes, and Basommatophora were the most commonly collected orders, collectively accounting for 91.4 percent of the total number of individuals collected. The Hoplonemertea, Megaloptera, Oligochaeta, Anthoathecata, and Ostracoda were the other orders collected, all of which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the June 1988 Surber sample fell within the exceptional aquatic life use category.

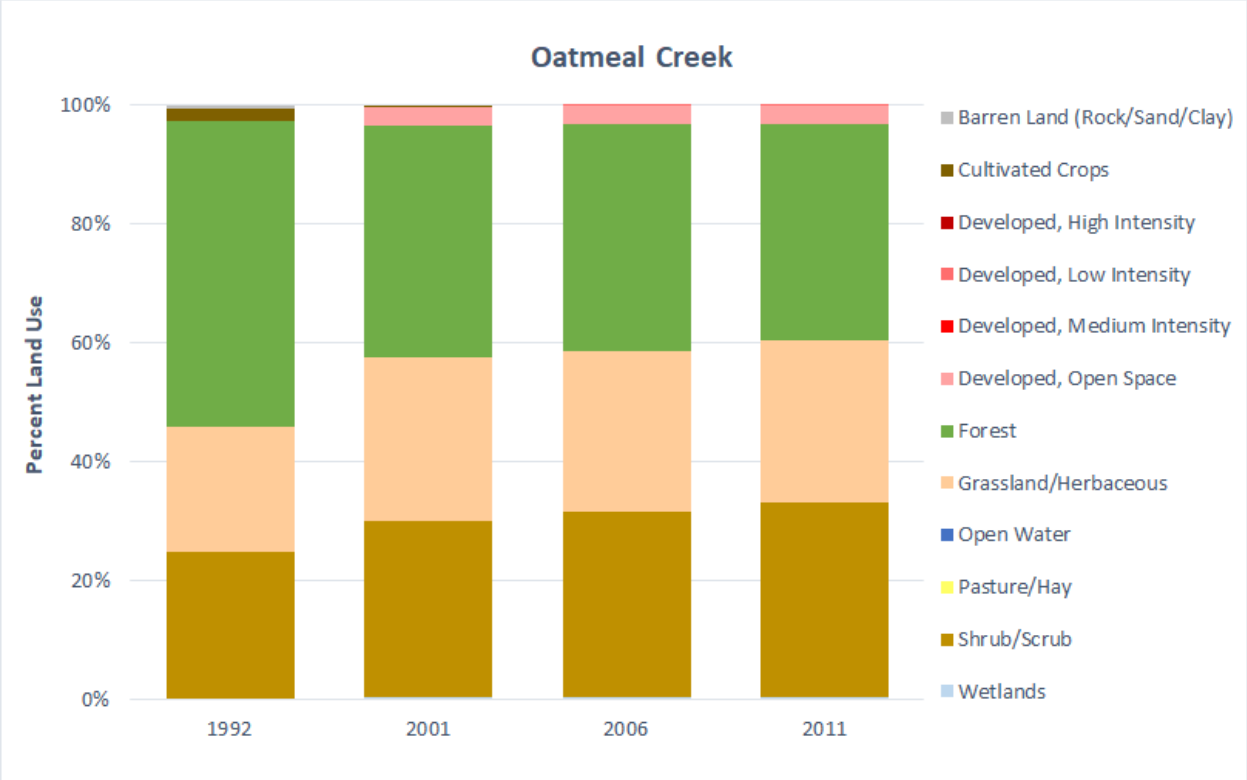

Figure 213. Percent land use in the Oatmeal Creek watershed from 1992-2011.

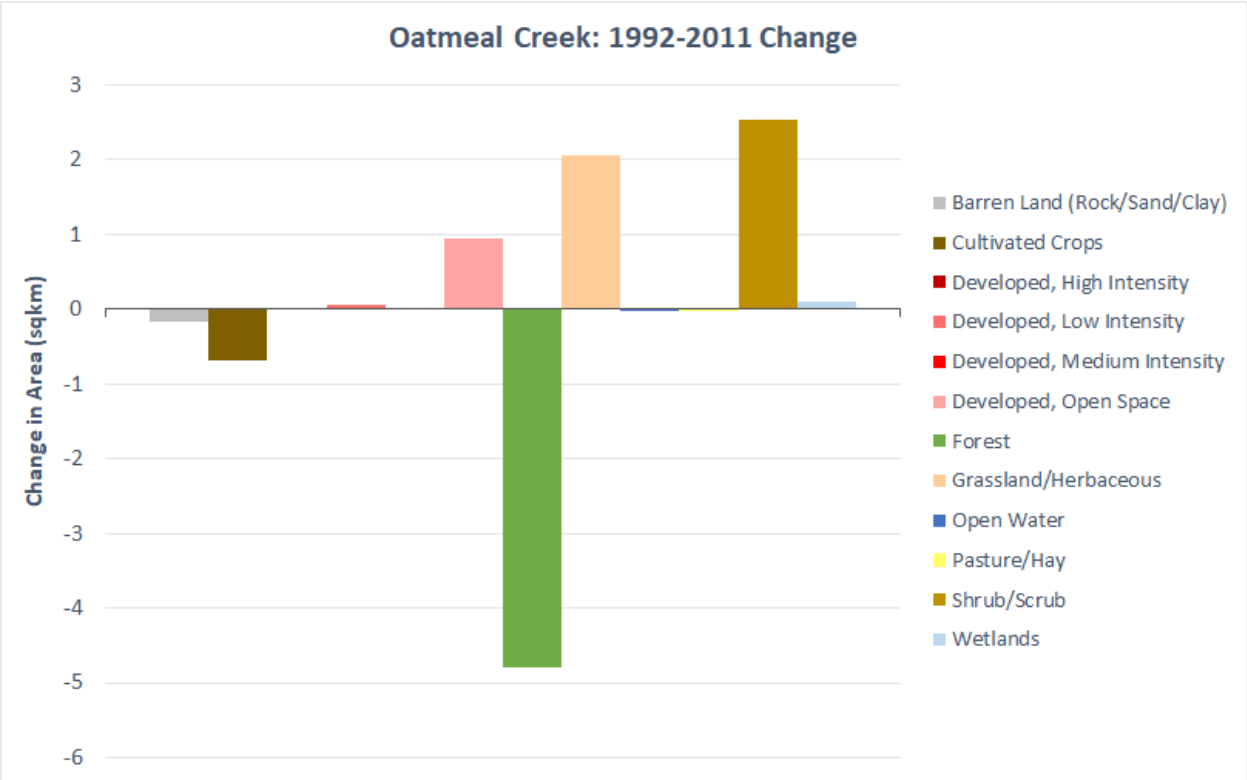

Figure 214. Land use change in area (sq km) from 1992-2011 for the Oatmeal Creek watershed.

ONION CREEK

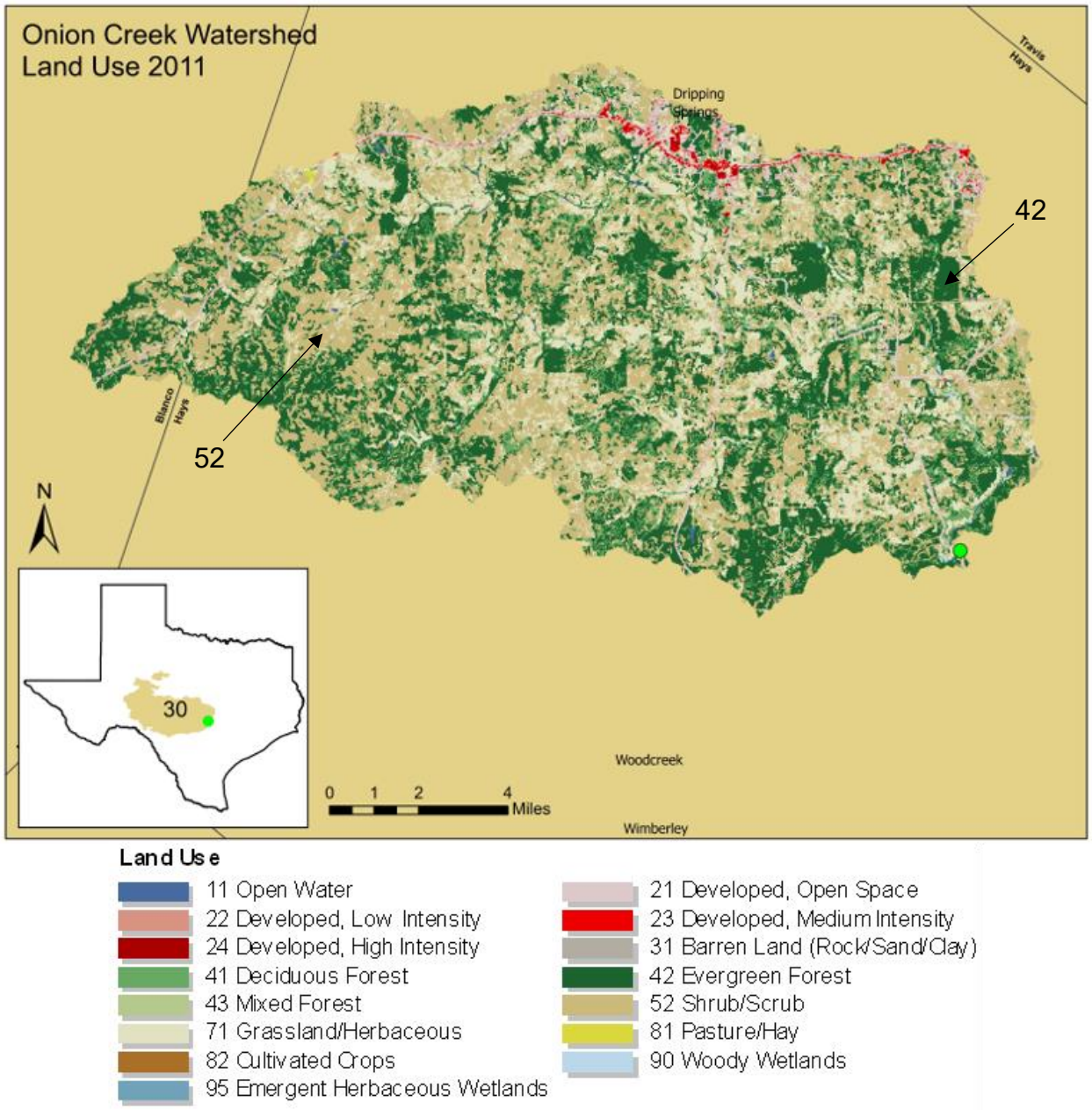

Figure 215. Map of Onion Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	July 6, 1988; July 26, 2016
Water Quality:	July 26, 2016
Fish:	July 6, 1988; March 14, 1989; July 26, 2016
Benthic Invertebrates:	July 6, 1988; July 26, 2016

Physical Characterization

Watershed and Land Use

Onion Creek lies within the Colorado River Basin. Sample site 12451 is located at FM 150 approximately 4.8 km south of Driftwood in Hays County (Figure 215).

The Onion Creek watershed at site 12451 is approximately 320.70 sq km. The entire watershed lies within Level IV Ecoregion 30c, the Balcones Canyonlands. The dominant land cover in the watershed is forest at 39.84% and is present throughout the watershed (Homer et al. 2015; Figure 215 and Figure 216). Shrub is the secondary land cover encompassing 38.75%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.79% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 55.98 sq km decrease in grassland/herbaceous and a 43.67 sq km decrease in forest. There was a 101.17 sq km increase in shrub and an 8.68 sq km increase in open space development (Figure 217).

There is one industrial wastewater outfall (discharges ≥ 1 million gallons per day) within the Onion Creek watershed permitted to the City of Dripping Springs. The wastewater facility does not discharge directly into Onion Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Onion Creek was evaluated on July 6, 1988 and again on July 26, 2016. Onion Creek is a perennial stream that drains to the Colorado River in Travis County. The following summary information is based on data collected during the most recent sampling event in 2016. The Habitat Quality Index score of 26.5 indicates an exceptional aquatic life use rating. The riparian zone was well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was dominated by grasses, which made up an average of 41.5% of the total riparian species, followed by trees (36.5%) then shrubs (22%). The average percentage of tree canopy cover was 66%. The dominant substrate was cobble, and the average percent of substrate that was gravel size or larger was 47%. Average percent instream cover was 55% and instream cover types include overhanging vegetation, leaf packs, snags, woody debris, root mats, algae, macrophytes, bedrock ledges, boulders, and cobble/gravel. Onion Creek was 0.65 meters deep on average and 7.5 meters wide. Average stream bank slope was 32 degrees, and average stream bank erosion potential was 14.5%. The deepest pool measured at Onion Creek was 1.2 meters. Stream flow was measured at a minimum value of 1.1 cfs in 2016 and a maximum of 1.8 cfs in 1988. Three riffles were observed at the site in 2016 and there were four total stream bends.

Water Quality

Water samples were collected at station 21941 on July 2016 for this project. This site is also sampled by the city of Austin. Parameters measured included temperature, flow, specific

conductance, dissolved oxygen, pH, alkalinity, total Kjeldahl nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Thirteen species (four families) were collected over the course of the three sampling events. Centrarchidae was represented by the most species, with six species. Each sample had a different species that was the most abundant one for the collection: Blacktail Shiner (1988), Central Stoneroller (1989), and Bluegill (2016). The aquatic life use rating for all three fish collections was only intermediate; however, when the coefficient of variability is applied the 1988 sample rises to high. The low aquatic life use rating is due to the absence of benthic invertivore and intolerant species, small number of native cyprinid species, and high percentage of individuals as non-native species.

Benthic Macroinvertebrates

From the July 1988 Surber sample and July 2016 RBP sample together, a total of 1480 individuals representing 87 taxa from 17 orders of macroinvertebrates were collected from Onion Creek (Appendix E). The Trichoptera, Coleoptera, Ephemeroptera, Diptera, Veneroida, Odonata, and Megaloptera were the most commonly collected orders, collectively accounting for 92.7 percent of the total number of individuals collected. The Oligochaeta, Trombidiformes, Basommatophora, and Neoophora were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the July 1988 Surber sample fell within the exceptional aquatic life use category. The Ecoregion 30 BIBI for the July 2016 RBP sample fell within the high aquatic life use category.

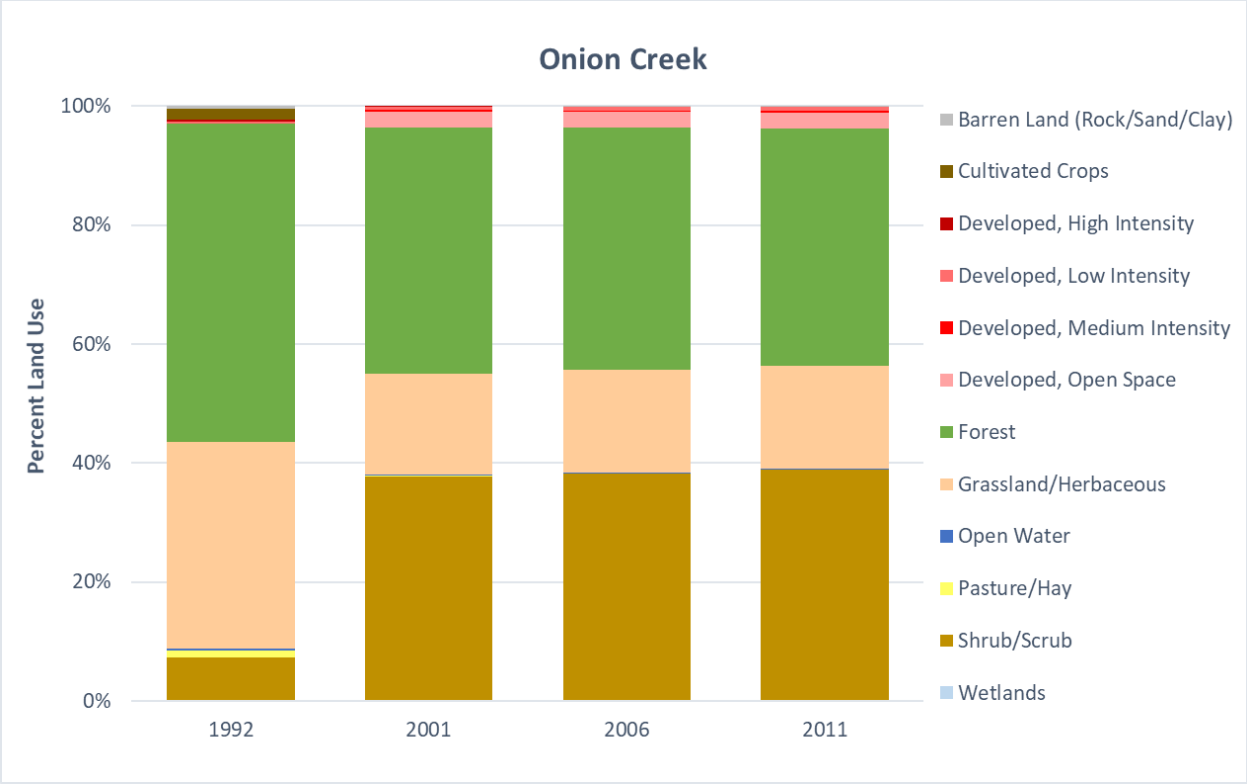

Figure 216. Percent land use in the Onion Creek watershed from 1992-2011.

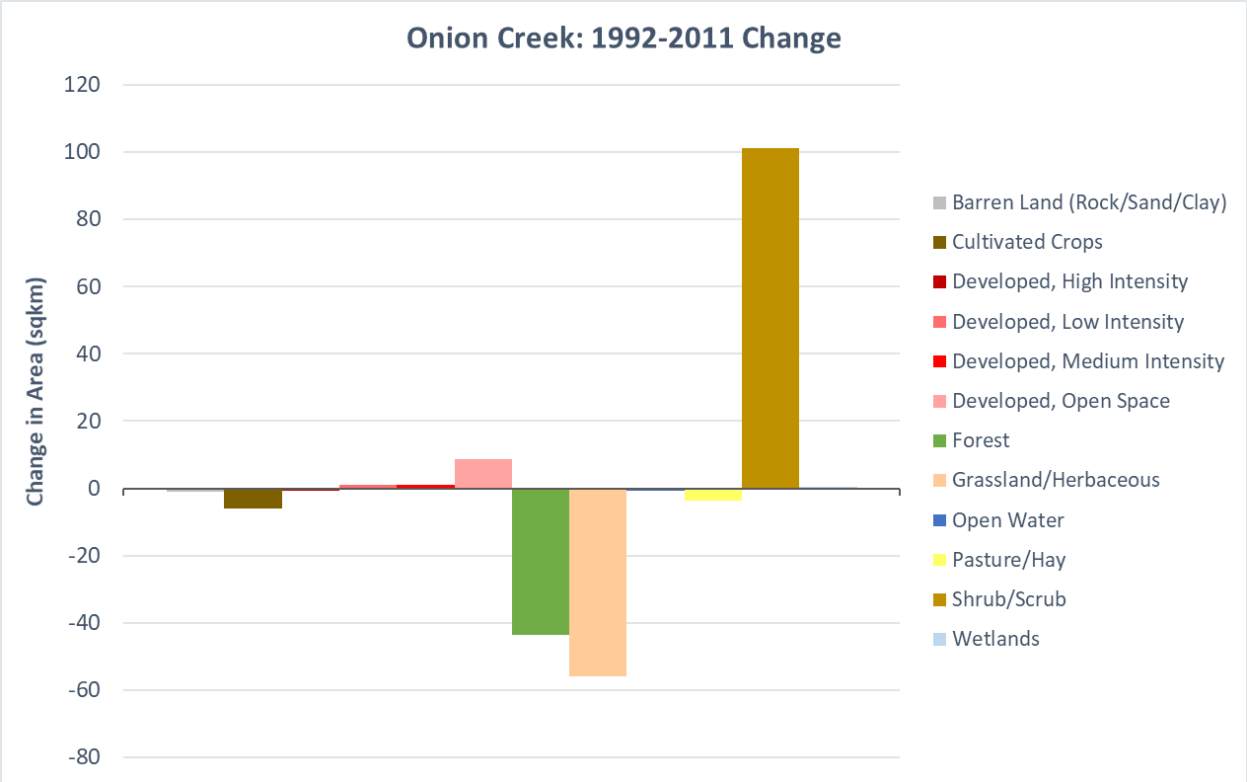

Figure 217. Land use change in area (sq km) from 1992-2011 for the Onion Creek watershed.

PEDERNALES RIVER

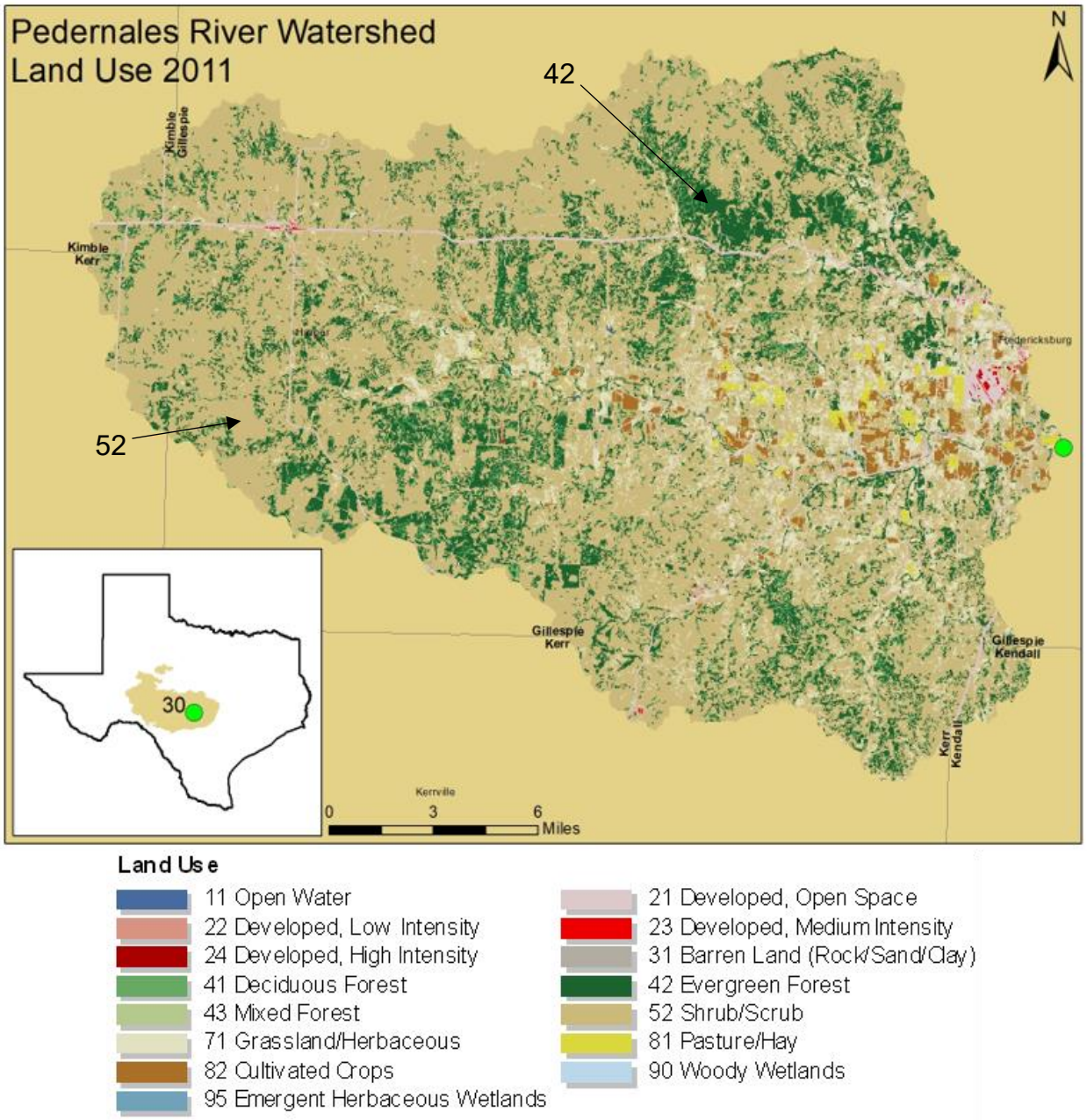

Figure 218. Map of Pedernales River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	March 31, 2009; March 23, 2010; August 26, 2010; March 21, 2011; August 24, 2011; April 30, 2012; September 4, 2012; March 20, 2013; July 9, 2013
Water Quality:	127 sampling events

Fish:	March 31, 2009; March 23, 2010; August 26, 2010; March 21, 2011; August 24, 2011; April 30, 2012; September 4, 2012; March 20, 2013; July 9, 2013
Benthic Invertebrates:	March 31, 2009; March 23, 2010; August 26, 2010; March 21, 2011; August 24, 2011; April 30, 2012; September 4, 2012; March 20, 2013; July 9, 2013

Physical Characterization

Watershed and Land Use

Pedernales River lies within the Colorado River Basin. Sample site 17472 is located at US 87, approximately 4.82 km south of Fredericksburg in Gillespie County (Figure 218).

The Pedernales River watershed at site 17472 is approximately 956.52 sq km. The entire watershed lies within Level IV Ecoregion 30a, the Edwards Plateau Woodland. The dominant land cover in the watershed is shrub at 66.33% and is present throughout the watershed (Homer et al. 2015; Figure 218 and Figure 219). Forest is the secondary land cover encompassing 20.65%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.12% and the total for cultivated crops is 1.55%.

From 1992-2011 there was a 210.47 sq km decrease in forest and a 60.21 sq km decrease in grassland/herbaceous. There was a 302.06 sq km increase in shrub and a 26.78 sq km increase in open space development (Figure 220).

There are no wastewater outfalls in the Pedernales River watershed.

In Channel and Riparian Physical Habitat

Physical habitat for the Pedernales River was evaluated during nine sampling events from 2009 to 2013. The Pedernales River is a perennial stream that drains to the Pedernales River arm of Lake Travis. Habitat Quality Index scores are available for all sample events and indicate a high aquatic life use rating (20.5-24.5). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 17 meters wide to greater than 20 meters. The riparian zone was generally dominated by grasses followed by bare rock/soil then shrubs and trees. The average percentage of tree canopy cover ranged from 0% to 13%. The dominant stream substrate was gravel, and the average percent of substrate gravel size or larger varied from 31% to 65%. Average percent instream cover was 18% to 48%. The Pedernales River ranged from 0.2-0.6 meters deep on average and 8-23 meters wide. Average stream bank slope ranged from 17-36 degrees. Stream flow at the site was measured at a minimum value of 0 cfs and a maximum of 92 cfs. Average stream bank erosion potential was 37%-89%. The deepest pool measured at the Pedernales River was 2.2 meters. Number of riffles observed at the site varied from one to two, and total number of stream bends ranged from two to five.

Water Quality

Water samples were collected at station 17472 over 127 sampling events from June 2001 through October 2020. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twenty-five species (seven families) were collected over the course of the nine sampling events. Centrarchidae and Cyprinidae yielded the greatest species richnesses with eight and seven species, respectively. The most abundant species per collection varied with Blacktail Shiner being the most abundant species in five of the collections, Redbreast Sunfish in three, and Red Shiner in one. Despite the high incidence of non-native species, namely Redbreast Sunfish, six of the nine fish assemblage samples rated as having an exceptional aquatic life use. When the coefficient of variability is applied to the other three samples (all of which rated high), two rise to exceptional.

Benthic Macroinvertebrates

From the nine RBP samples (collected March 2009, March and August 2010, March and August 2011, April and September 2012, and March and July 2013) together, a total of 1800 individuals representing 65 taxa from 18 orders of macroinvertebrates were collected from the Pedernales River (Appendix E). The Ephemeroptera, Coleoptera, Odonata, Trichoptera, and Diptera were the most commonly collected orders, collectively accounting for 90.1 percent of the total number of individuals collected. The Hemiptera, Turbellaria, and Amphipoda were the only other orders which comprised at least one percent of the collections.

The Ecoregion 30 BIBI for the RBP samples fell in the following aquatic life use categories:

- Intermediate (March 2010, August 2011, April 2012, July 2013)
- High (March 2009, August 2010, September 2012, March 2013)
- Exceptional (March 2011)

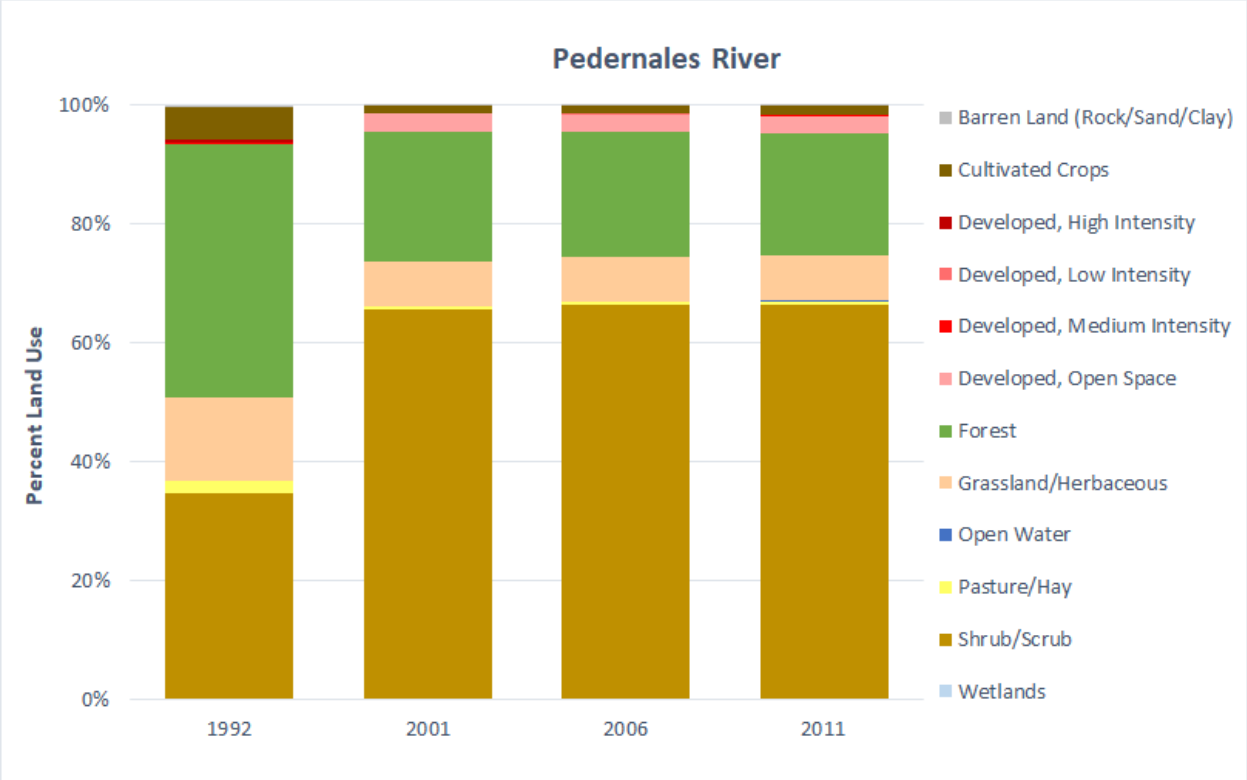

Figure 219. Percent land use in the Pedernales River watershed from 1992-2011.

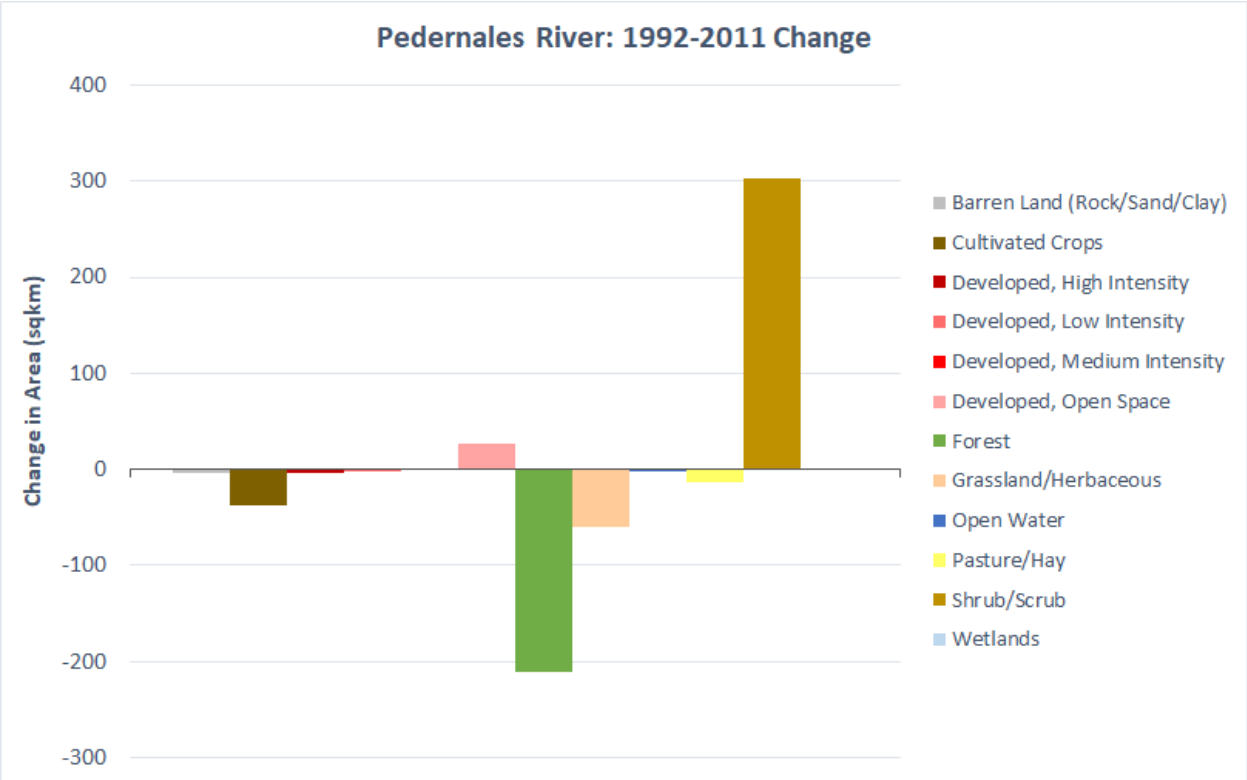

Figure 220. Land use change in area (sq km) from 1992-2011 for the Pedernales River watershed.

SAN SABA RIVER

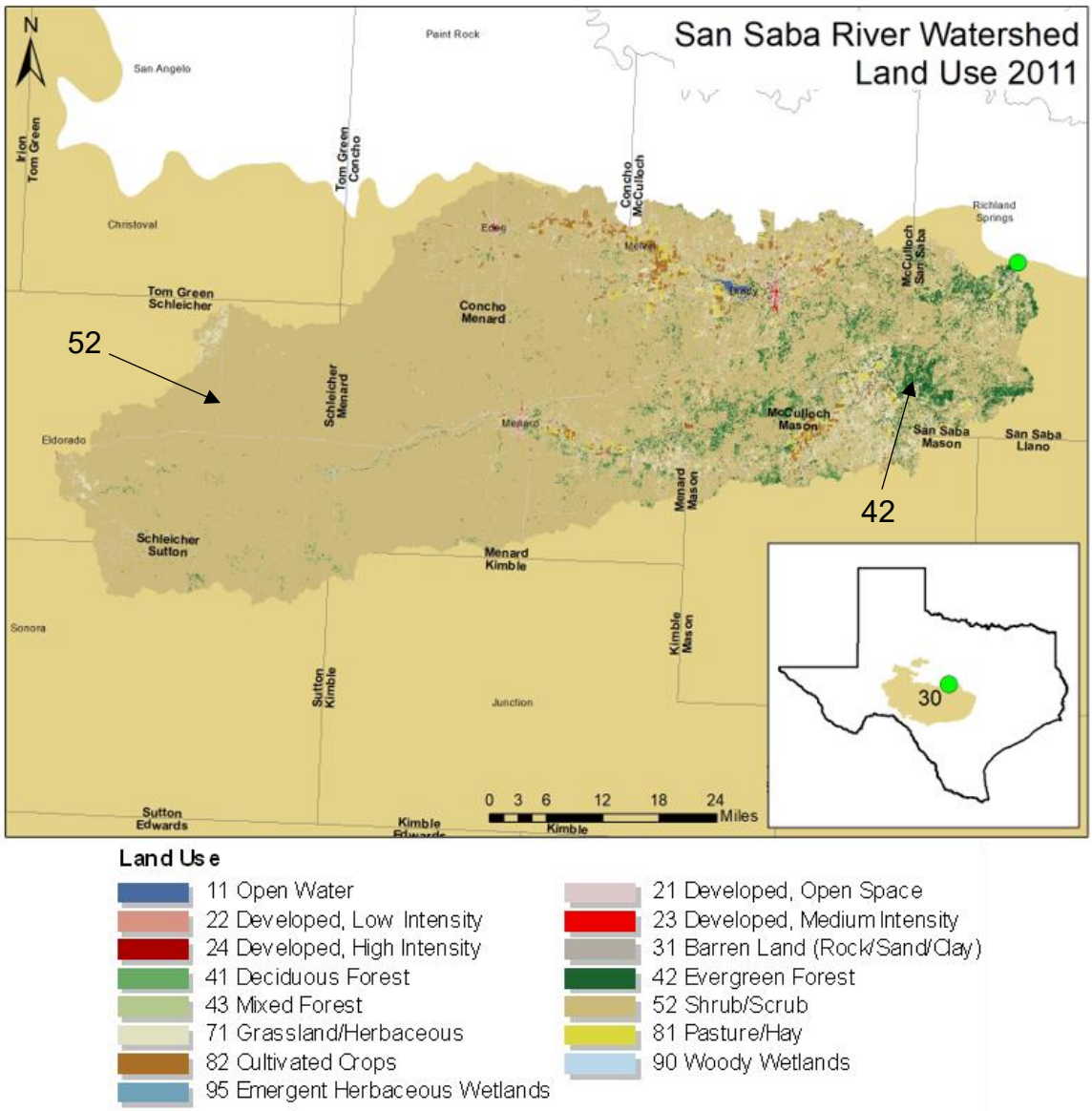

Figure 221. Map of San Saba River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	March 29, 2010; September 20, 2010; March 29, 2011; July 26, 2011; May 29, 2012; July 25, 2012; March 27, 2013; July 24, 2013
Water Quality:	20 sampling events
Fish:	March 29, 2010; September 20, 2010; March 29, 2011; July 26, 2011; May 29, 2012; July 25, 2012; March 27, 2013; July 24, 2013
Benthic Invertebrates:	March 29, 2010; September 20, 2010; March 29, 2011; July 26, 2011; May 29, 2012; July 25, 2012; March 27, 2013; July 25, 2013

Physical Characterization

Watershed and Land Use

San Saba River lies within the Colorado River Basin. Sample site 20662 is located at CR 340, approximately 15.92 km west of San Saba in San Saba County (Figure 221).

The San Saba River watershed at site 20662 is approximately 7218.56 sq km. The station and the majority of the watershed lie within Level IV Ecoregion 30a, the Edwards Plateau Woodland; small portions of the watershed also lie in Level IV Ecoregion 30b, the Llano Uplift, as well as Ecoregion 27. The dominant land cover in the watershed is shrub at 85.55% and is present throughout the watershed (Homer et al. 2015; Figure 221 and Figure 222). Forest is the secondary land cover encompassing 5.59%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 2.53% and total cover for cultivated crops is 1.23%.

From 1992-2011 there was a 1196.48 sq km decrease in grassland and a 296.99 sq km decrease in cultivated crop. There was a 1734.79 sq km increase in shrub and a 164.31 sq km increase in open space development (Figure 223).

There are four domestic wastewater outfalls (discharges < 1 million gallons per day) and two industrial wastewater outfalls (discharges ≥ 1 million gallons per day) within the San Saba River watershed. The domestic wastewater facilities are permitted to the cities of Eden, Brady, and Menard. The industrial wastewater facilities are permitted to Unimin Corp., a mining company. One of the domestic facilities permitted to the City of Menard discharges directly into the San Saba River.

In Channel and Riparian Physical Habitat

Physical habitat for the San Saba River was evaluated during eight sampling events from 2010 to 2013. The San Saba River is a perennial stream that drains to the Colorado River Above Lake Buchanan. Habitat Quality Index scores are available for all sample events and indicate an intermediate to high aquatic life use rating (19-25). Riparian areas were well vegetated throughout the reach with an average riparian buffer greater than 20 meters. The riparian zone was generally dominated by grasses followed by bare rock/soil then trees and shrubs. The average percentage of tree canopy cover ranged from 25% to 46%. The dominant stream substrate was silt, and the average percent of substrate gravel size or larger varied from 19% to 68%. Average percent instream cover was 27% to 56%. The San Saba River ranged from 0.9-1.2 meters deep on average and 31-69 meters wide. Average stream bank slope ranged from 44-66 degrees. Stream flow at the site was measured at a minimum value of 22 cfs and a maximum of 165 cfs. Average stream bank erosion potential was 32%-67%. The deepest pool measured at the San Saba River was 3.8 meters. Number of riffles observed at the site varied from one to two, and total number of stream bends ranged from two to four.

Water Quality

Water samples were collected at station 20662 over 20 sampling events from March 2010 through July 2014. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twenty-eight species (10 families) were collected over the course of eight sampling events. Centrarchidae was represented by the greatest number of species with nine species. Blacktail Shiner was the most abundant species in all collections. Five of the eight fish collections rate as having an exceptional aquatic life use (the other three rate as high). With the application of the coefficient of variability all eight rate as exceptional.

Benthic Macroinvertebrates

From the eight RBP samples (collected March and September 2010, March and July 2011, May and July 2012, and March and July 2013) together, a total of 1644 individuals representing 52 taxa from 18 orders of macroinvertebrates were collected from the San Saba River (Appendix E). The Ephemeroptera, Coleoptera, Trichoptera, Diptera, Hemiptera, and Veneroida were the most commonly collected orders, collectively accounting for 92.9 percent of the total number of individuals collected. The Turbellaria and Odonata were the only other orders which comprised at least one percent of the collections.

The Ecoregion 30 BIBI for the March 2010 and July 2013 RBP samples fell within the intermediate aquatic life use category, while the BIBIs for all other RBP samples fell within the high aquatic life use category (September 2010, March 2011, July 2011, May 2012, July 2012, March 2013).

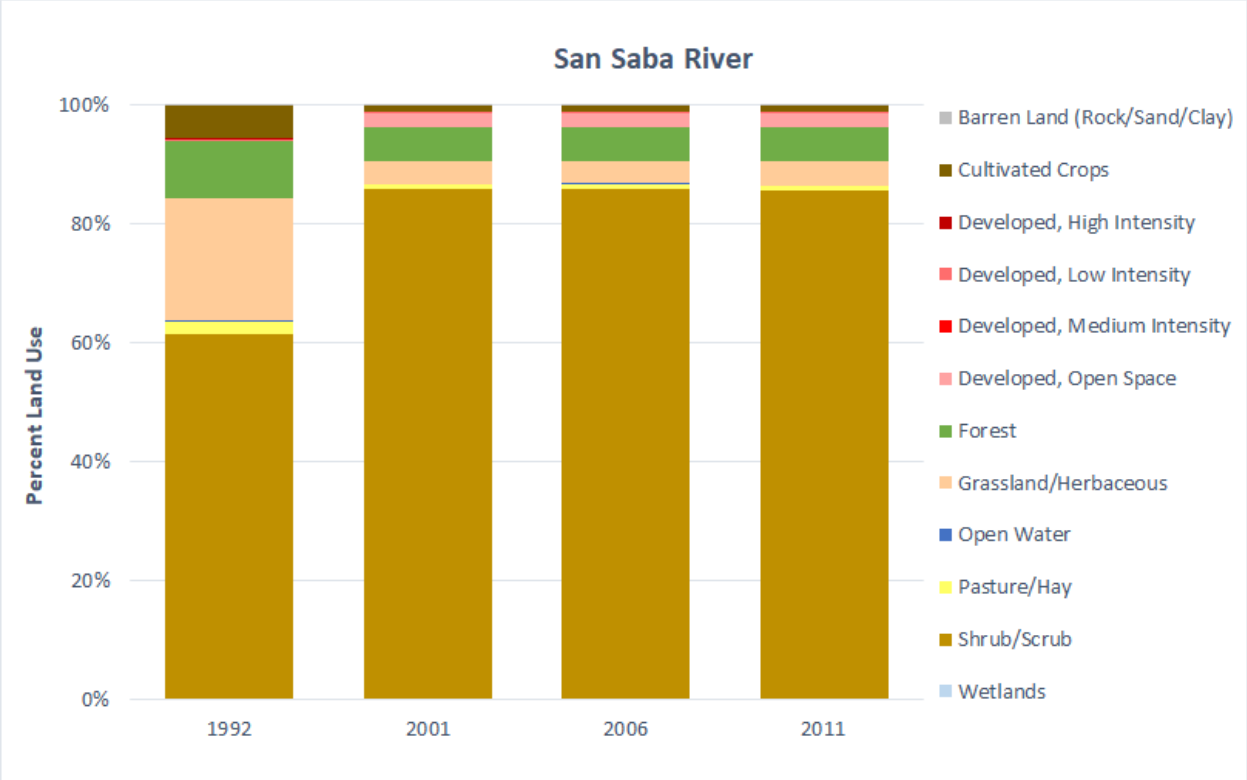

Figure 222. Percent land use in the San Saba River watershed from 1992-2011.

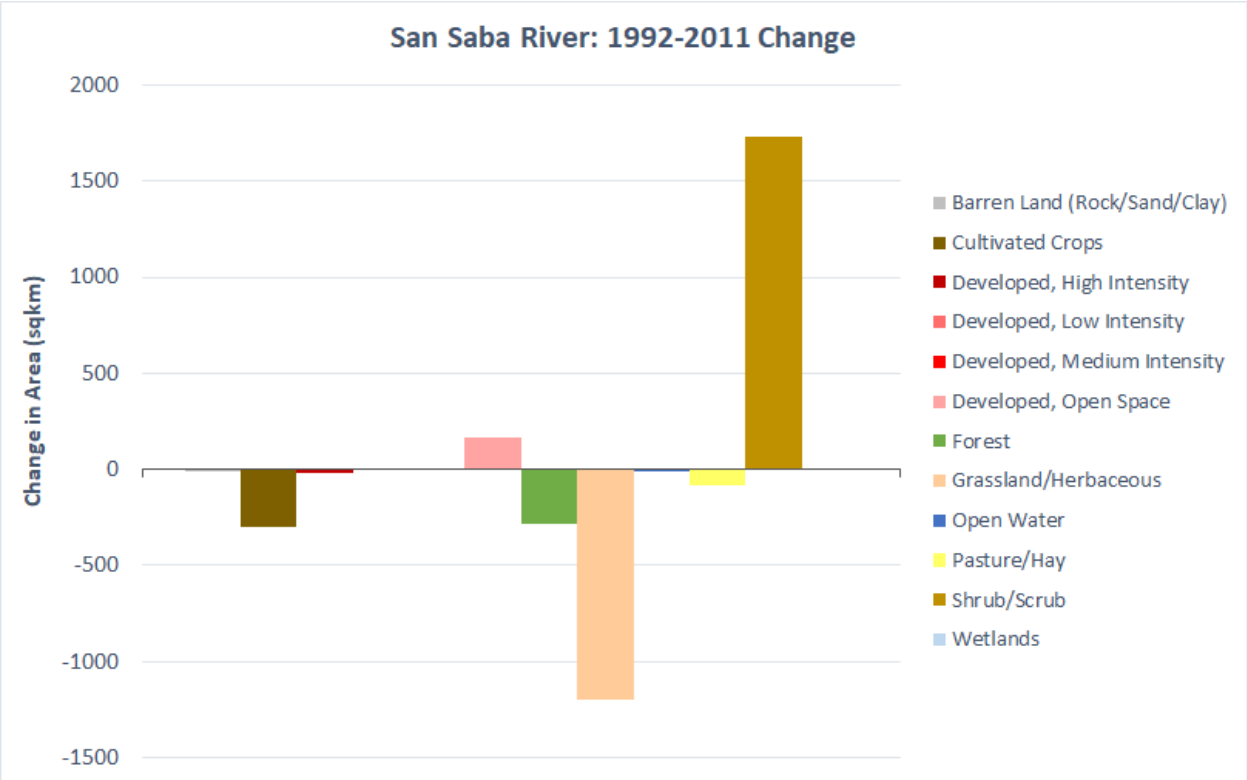

Figure 223. Land use change in area (sq km) from 1992-2011 for the San Saba River watershed.

SLAUGHTER CREEK

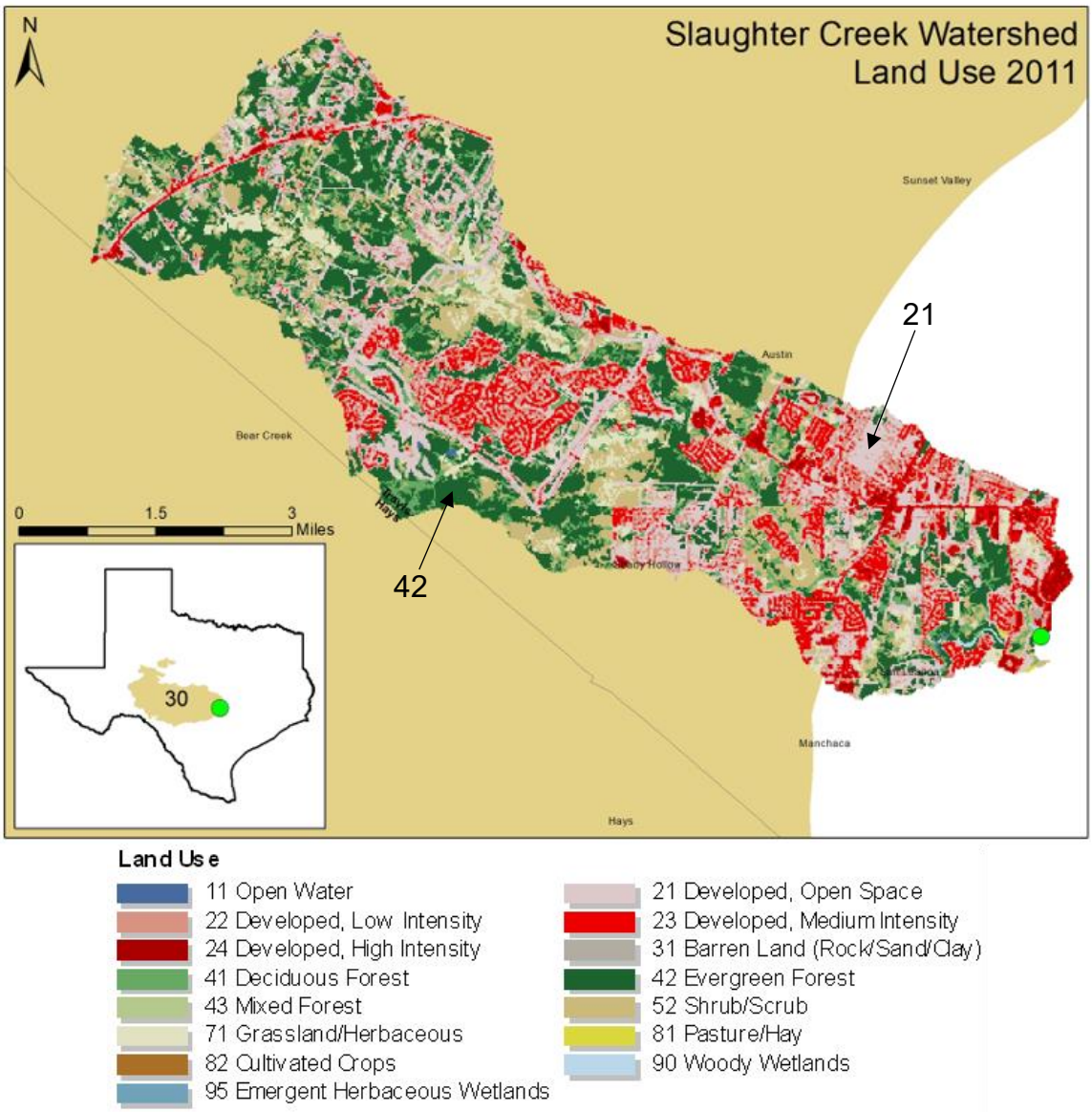

Figure 224. Map of Slaughter Creek watershed location and 2011 land use; forest and open space development were the most common land uses.

Sampling Dates

Physical Habitat:	Station 12186: April 28, 2003; July 15, 2003; August 16, 2004; Station 12185: April 29, 2003; July 15, 2003; August 16, 2004
Water Quality:	135 sampling events
Fish:	Station 12186: April 28, 2003; July 15, 2003; August 16, 2004; Station 12185: April 29, 2003; July 15, 2003; August 16, 2004
Benthic Invertebrates:	Station 12186: April 28, 2003; July 15, 2003; August 16, 2004; Station 12185: April 29, 2003; July 15, 2003; August 16, 2004

Physical Characterization

Watershed and Land Use

Slaughter Creek lies within the Colorado River Basin. Sample site 12185 is located at Old San Antonio Road south of Austin in Travis County (Figure 224).

The Slaughter Creek watershed at site 12185 is approximately 77.71 sq km. The site and lower watershed lie within Level IV Ecoregion 32a, the Northern Blackland Prairie, however the vast majority of the watershed lies within Level IV Ecoregion 30c, the Balcones Canyonlands. The dominant land cover in the watershed is forest at 34.07% and is concentrated in the upper watershed (Homer et al. 2015; Figure 224 and Figure 225). Open space development is the secondary land cover encompassing 21.07%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 46.82% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 9.95 sq km decrease in forest and a 5.52 sq km decrease in high intensity development. There was a 16.02 sq km increase in open space development and an 8.75 sq km increase in medium intensity development (Figure 226).

There are no wastewater outfalls in the Slaughter Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Slaughter Creek was evaluated at two sites during six sampling events from 2003 to 2004. Slaughter Creek is an intermittent stream with perennial pools that drains to Onion Creek in Travis County. Habitat Quality Index scores are available for all six sample events and indicate an intermediate to high aquatic life use rating (19-24). Riparian areas were well vegetated throughout the reach with an average riparian buffer greater than 20 meters. The riparian zone was generally dominated by grasses followed by trees then shrubs. The average percentage of tree canopy cover ranged from 3% to 100%. The dominant stream substrate was bedrock, and the average percent of substrate gravel size or larger varied from 74% to 100%. Average percent instream cover was 18% to 40% and instream cover types include overhanging vegetation, leaf packs, macrophytes, snags, undercut banks, boulders, root mats, algae, and cobble/gravel. Slaughter Creek ranged from 0.3-1.0 meter deep on average and 6-14 meters wide. Average stream bank slope ranged from 10-133 degrees. Stream flow at the sites was measured at a minimum value of 0 cfs and a maximum of 0.8 cfs. Average stream bank erosion potential was 20%-53%. The deepest pool measured at Slaughter Creek was 1.9 meters. Number of riffles observed at the sites varied from zero to four, and each site had just one stream bend.

Water Quality

Water samples were collected at stations 12186 and 12185. Station 12186 was sampled 90 times from June 1983 through June 2019 and 45 sampling events were conducted at station 12185 between April 1985 and May 2020. Parameters measured included temperature, flow,

transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Continuous flow data is available from USGS gage 08158840 (Figure 227). Flow data were collected from December 1991 through December 2019; the median flow was 0.27 cfs over this time period and daily average flows ranged from 0 cfs to 981 cfs, though flows exceeded 100 cfs only about 0.8 percent of the time in this period.

Biological Characterization

Fish

Data from two sampling stations (about 16 km apart) were used to evaluate the aquatic life use of this creek reach. A combined total of 16 species (five families) were collected from these two sites over the course of three sampling events at Station 12186 and three sampling events at Station 12185. The family Centrarchidae yielded the most species with seven species. Western Mosquitofish, Green Sunfish, Bluegill, and Longear Sunfish were collected in every sample from both sites. Every collection, but the July 2003 sample from the upstream station (12186), rated as having a high aquatic life use. This sampling event only scored as intermediate; however, when the coefficient of variability is applied it also attains a high rating. The downstream fish assemblage collected in April 2003 elevates to exceptional with the application of the coefficient of variability.

Benthic Macroinvertebrates

From the six RBP samples collectively, a total of 1054 individuals representing 73 taxa from 16 orders of macroinvertebrates were collected from Slaughter Creek (Appendix E). The Odonata, Trichoptera, Diptera, Ephemeroptera, Coleoptera, Neoophora, Amphipoda, and Basommatophora were the most commonly collected orders, collectively accounting for 93.5 percent of the total number of individuals collected. The Hemiptera and Trombidiformes were the only other orders which comprised at least one percent of the collections.

The Ecoregion 30 BIBI for the July 2003 and the August 2004 RBP samples from station 12186 fell within the limited aquatic life use category, while the BIBI for the other RBP samples (both samples from April 2003, and the station 12185 samples from July 2003 and August 2004) fell within the intermediate aquatic life use category.

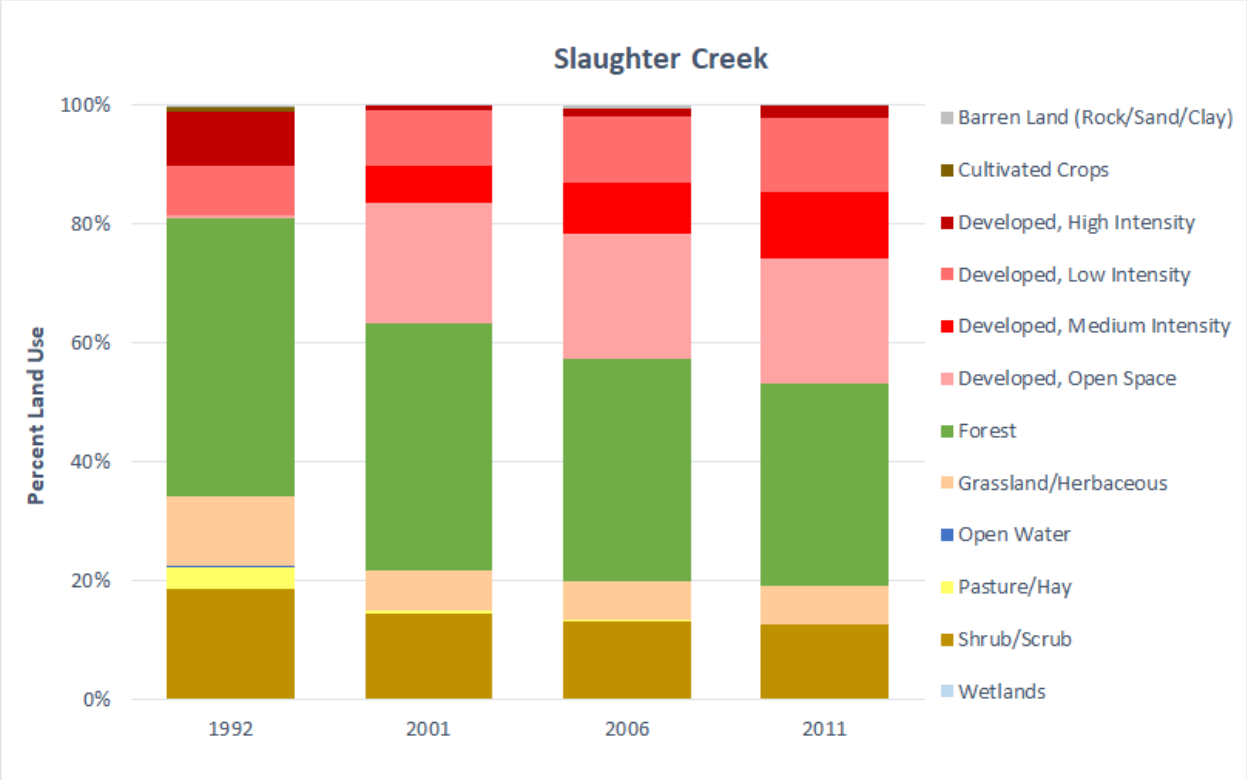

Figure 225. Percent land use in the Slaughter Creek watershed from 1992-2011.

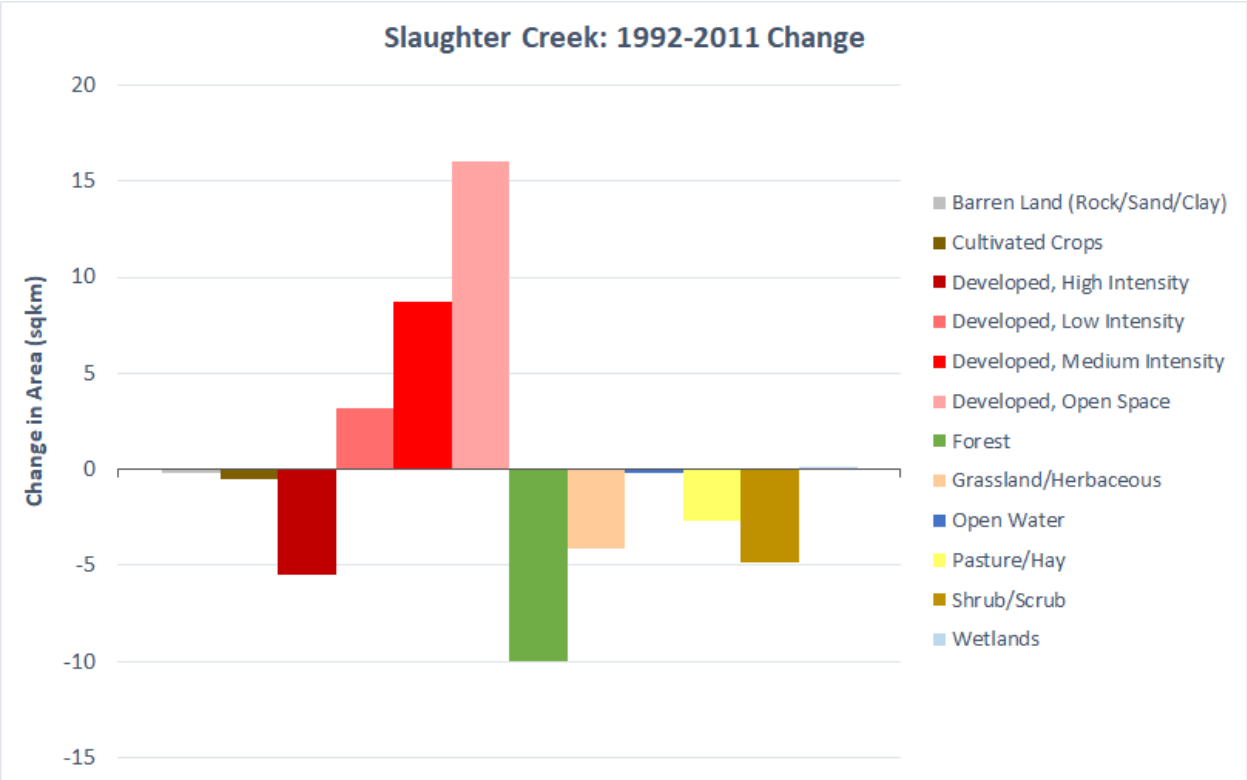

Figure 226. Land use change in area (sq km) from 1992-2011 for the Slaughter Creek watershed.

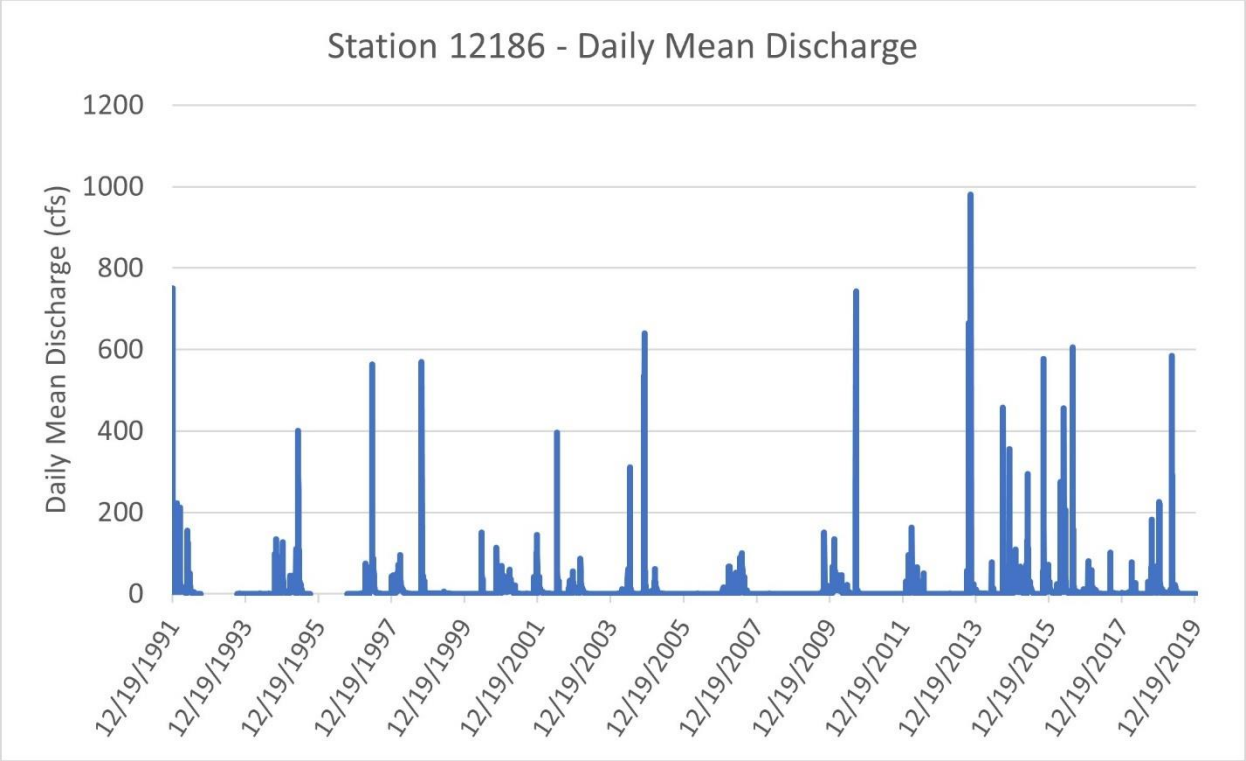

Figure 227. Daily mean discharge for Slaughter Creek at station 12186.

SOUTH CONCHO RIVER

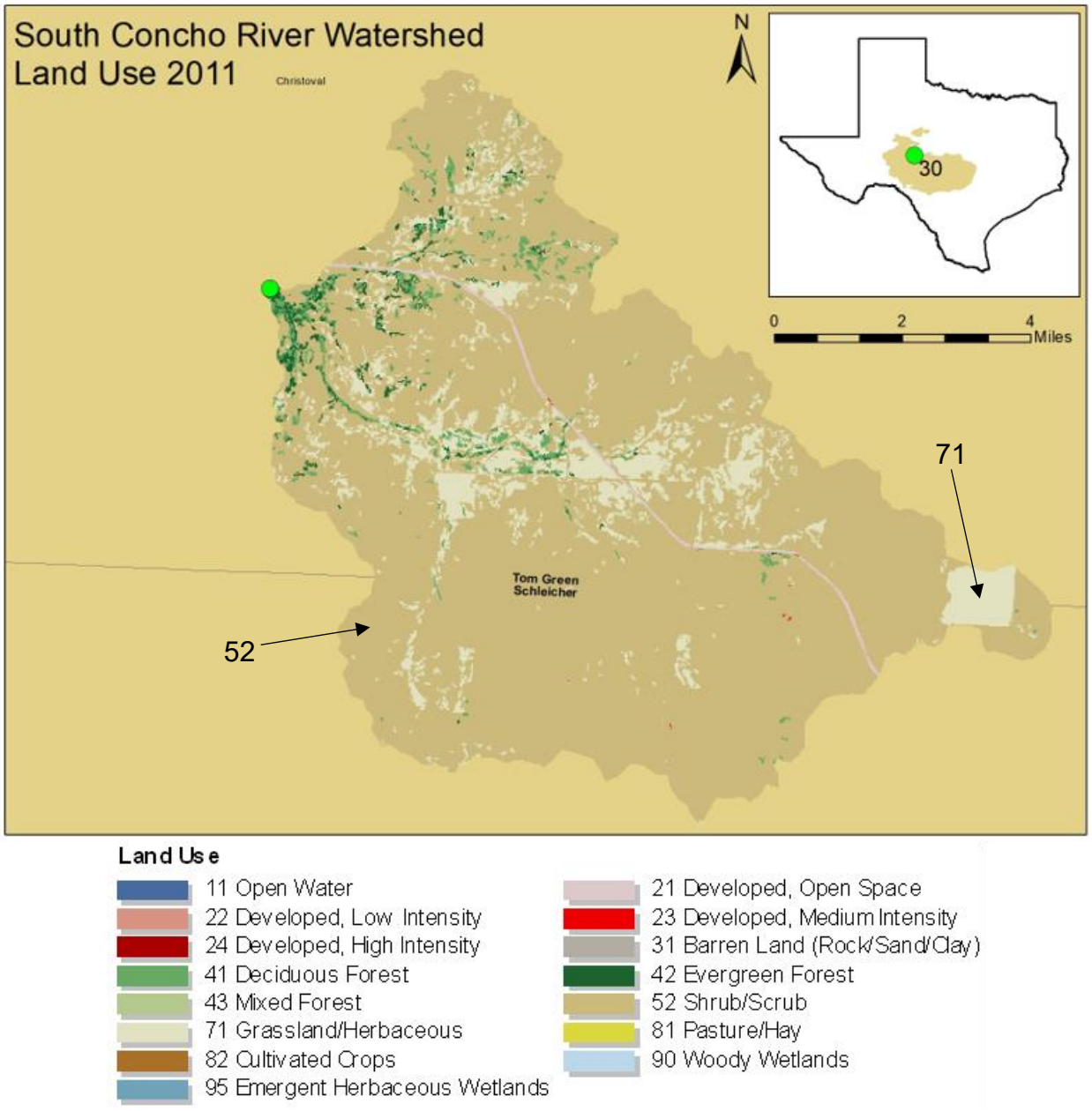

Figure 228. Map of South Concho River watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	No samples
Water Quality:	16 sampling events
Fish:	April 19, 2011; July 14, 2011
Benthic Invertebrates:	No samples

Physical Characterization

Watershed and Land Use

South Concho River lies within the Colorado River Basin. Sample site 18869 is located on private property 600 m upstream of the confluence of Cold Creek, approximately 4.78 km south of Christoval in Tom Green County (Figure 228).

The South Concho River watershed at site 18869 is approximately 185.67 sq km. The entire watershed lies within Level IV Ecoregion 30d, the Semiarid Edwards Plateau. The dominant land cover in the watershed is shrub at 84.87% and is present throughout the watershed (Homer et al. 2015; Figure 228 and Figure 229). Grassland/herbaceous is the secondary land cover encompassing 11.07%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.71% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 12.60 sq km decrease in shrub and a 0.17 sq km decrease in barren land. There was a 10.74 sq km increase in grassland and a 1.23 sq km increase in open space development (Figure 230).

There are no wastewater outfalls in the South Concho River watershed.

In Channel and Riparian Physical Habitat

Physical habitat data is not available for the South Concho River.

Water Quality

Water samples were collected at station 18869 over 16 sampling events from September 2006 through July 2011. Parameters measured included flow, alkalinity, ammonia, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Eighteen species (seven families) were collected between the two sampling events. Centrarchidae yielded the greatest species richness with seven species. Largespring Gambusia *(Gamusia geiseri)* was the most abundant species in both collections. The aquatic life use (based upon the fish assemblage) rated high in July 2011 (exceptional, when the coefficient of variability is applied) and exceptional in April 2011.

Benthic Macroinvertebrates

No samples were collected for benthic macroinvertebrates.

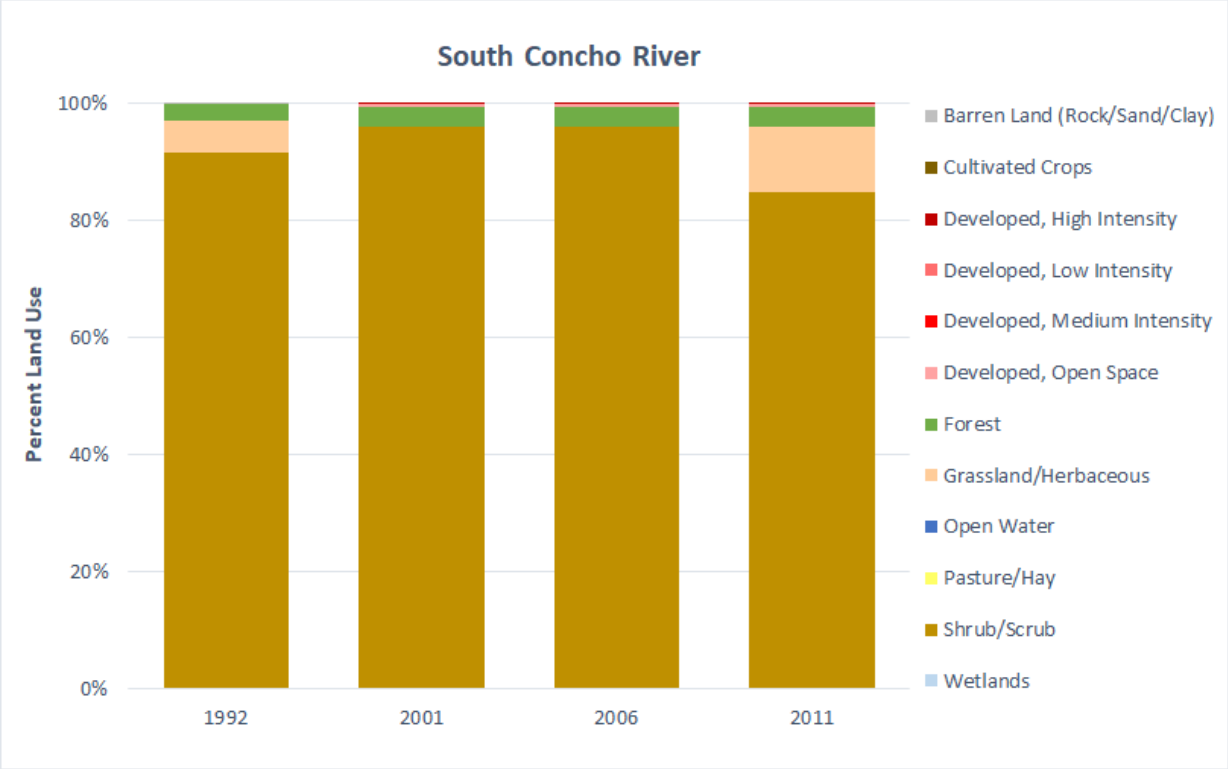

Figure 229. Percent land use in the South Concho River watershed from 1992-2011.

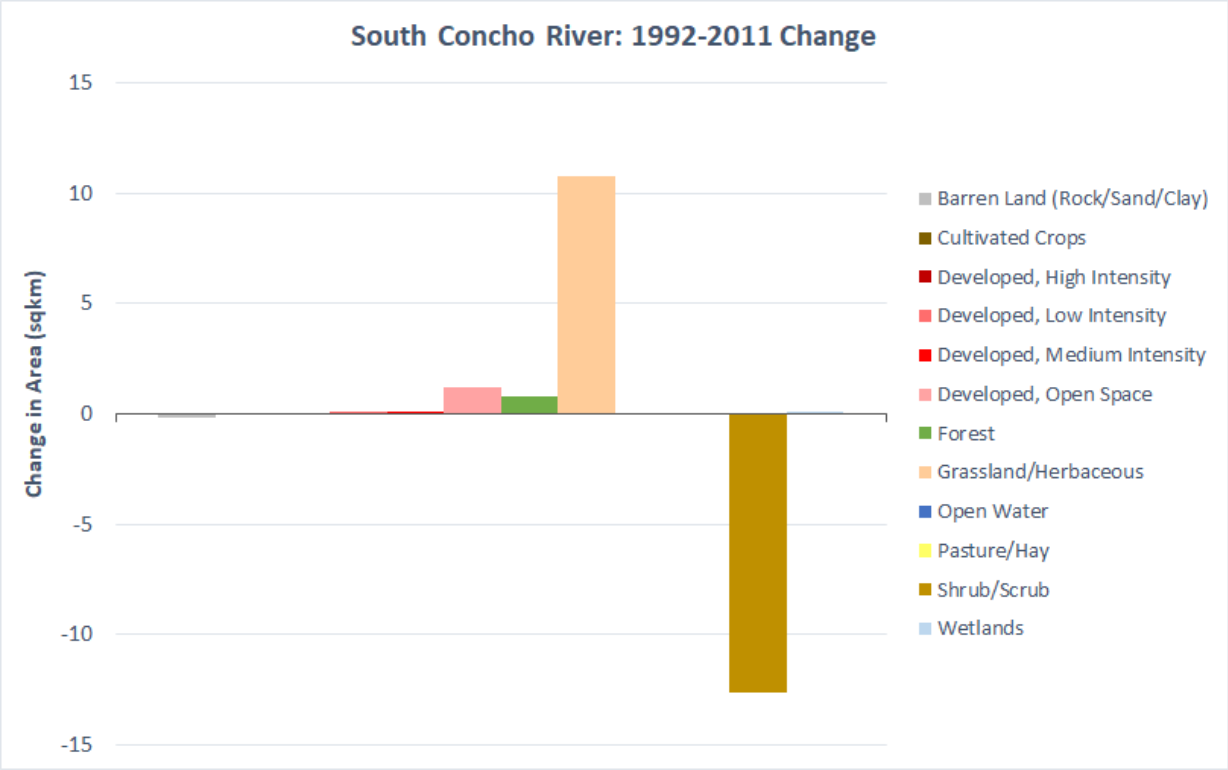

Figure 230. Land use change in area (sq km) from 1992-2011 for the South Concho River watershed.

SOUTH LLANO RIVER

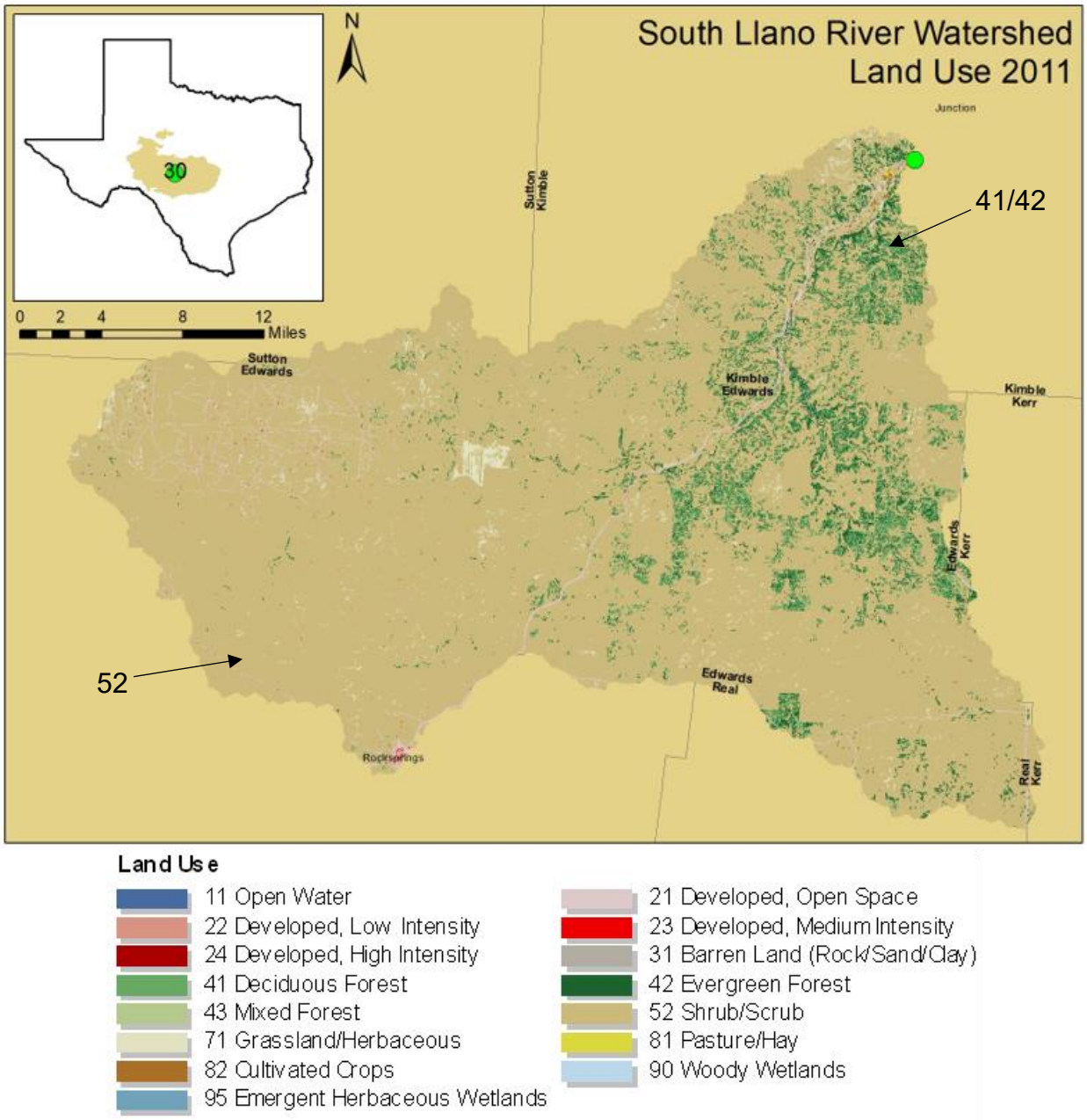

Figure 231. Map of South Llano River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	June 21, 1989; March 19, 2002; April 29, 2003; September 20, 2004; March 22, 2005; September 13, 2005; March 21, 2006; March 20, 2007; October 9, 2007; April 30, 2008; July 11, 2008
Water Quality:	55 sampling events

Fish:	US 377 - June 21, 1989; April 19, 2011; July 13, 2011; South Llano River State Park - 16 collections between June 2000 and July 2008
Benthic Invertebrates:	June 21, 1989; March 19, 2002; August 28, 2002; April 29, 2003; July 30, 2003; March 15, 2004; September 20, 2004; March 22, 2005; September 13, 2005; March 21, 2006; March 20, 2007; October 9, 2007; April 30, 2008; July 11, 2008

Physical Characterization

Watershed and Land Use

South Llano River lies within the Colorado River Basin. Sample site 17009 is located in South Llano River State Park 225 m south of US 377 near the city of Junction in Kimble County (Figure 231).

The South Llano River watershed at site 17009 is approximately 2248.17 sq km. The entire watershed lies within Level IV Ecoregion 30a, the Edwards Plateau Woodland. The dominant land cover in the watershed is shrub at 87.75% and is present throughout the watershed (Homer et al. 2015; Figure 231 and Figure 232). Forest is the secondary land cover encompassing 9.00%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 1.66% and total cover for cultivated crops is 0.03%.

From 1992-2011 there was a 398.86 sq km decrease in grassland and a 240.28 sq km decrease in forest. There was a 698.52 sq km increase in shrub and a 30.77 sq km increase in open space development (Figure 233).

There is one pending domestic wastewater outfall (discharges < 1 million gallons per day) within the South Llano River watershed permitted to the City of Rocksprings. This facility does not discharge directly into the South Llano River.

In Channel and Riparian Physical Habitat

Physical habitat for the South Llano River was evaluated at two sites during eleven sampling events from 1989 to 2008. The South Llano River is a perennial stream that drains to the main stem Llano River at the confluence with the North Llano River near Junction. Habitat Quality Index scores are available for ten sample events and indicate a high to exceptional aquatic life use rating (22-25.5). Riparian areas were well vegetated throughout the reach with an average riparian buffer greater than 20 meters. The riparian zone was generally dominated by grasses followed by bare rock/soil then shrubs and trees. The average percentage of tree canopy cover ranged from 0% to 8%. The dominant stream substrate was cobble, and the average percent of substrate gravel size or larger varied from 53% to 92%. Average percent instream cover was 18% to 47% and instream cover types include undercut banks, overhanging vegetation, macrophytes, snags, cobble, boulders, root mats, and gravel. The South Llano River ranged from 0.5-0.8 meters deep on average and 18-26 meters wide. Average stream bank slope ranged from 28-66 degrees. Stream flow at the site was measured at a minimum value of 25 cfs and a

maximum of 134 cfs. Average stream bank erosion potential was 39%-88%. The deepest pool measured at the South Llano River was 2.2 meters. Number of riffles observed at the site varied from one to three, and total number of stream bends ranged from one to four.

Water Quality

Water samples were collected at stations 17009 and 18197. Station 17009 was sampled 15 times from February 2000 through July 2008, and 40 sampling events were conducted at station 18197 between May 2004 and October 2020. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Fish collections from two sample stations (within about 15 km of each other) were used in the evaluation of this river reach. Twenty-eight species (10 families) were collected over the course of the 19 sampling events. Centrarchidae was the richest family with nine species. The species with the greatest abundance varied in the collections but bounced between four minnow species. Texas Shiner had the greatest abundance in 10 samples, Blacktail Shiner in four, Central Stoneroller in three, and Mimic Shiner in two. All but four of the fish samples rated as having an exceptional aquatic life use. Samples collected in June 2000, March 2005, September 2005, and July 2011 rated as high. When the coefficient of variability is applied to the high ratings the aquatic life use rating for the March 2005 and July 2011 rise to exceptional.

Benthic Macroinvertebrates

From the June 1989 Surber sample and thirteen RBP samples (collected March and August 2002, April and July 2003, March and September of 2004 and 2005, March 2006, March and October 2007, and April and July 2008) together, a total of 2479 individuals representing 93 taxa from 16 orders of macroinvertebrates were collected from the South Llano River (Appendix E). The Ephemeroptera, Coleoptera, Trichoptera, Diptera, Hemiptera, and Odonata were the most commonly collected orders, collectively accounting for 93.9 percent of the total number of individuals collected. The Megaloptera and Neoophora were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the June 1989 Surber sample fell within the exceptional aquatic life use category. The Ecoregion 30 BIBIs for the 13 RBP samples fell within the intermediate aquatic life use category.

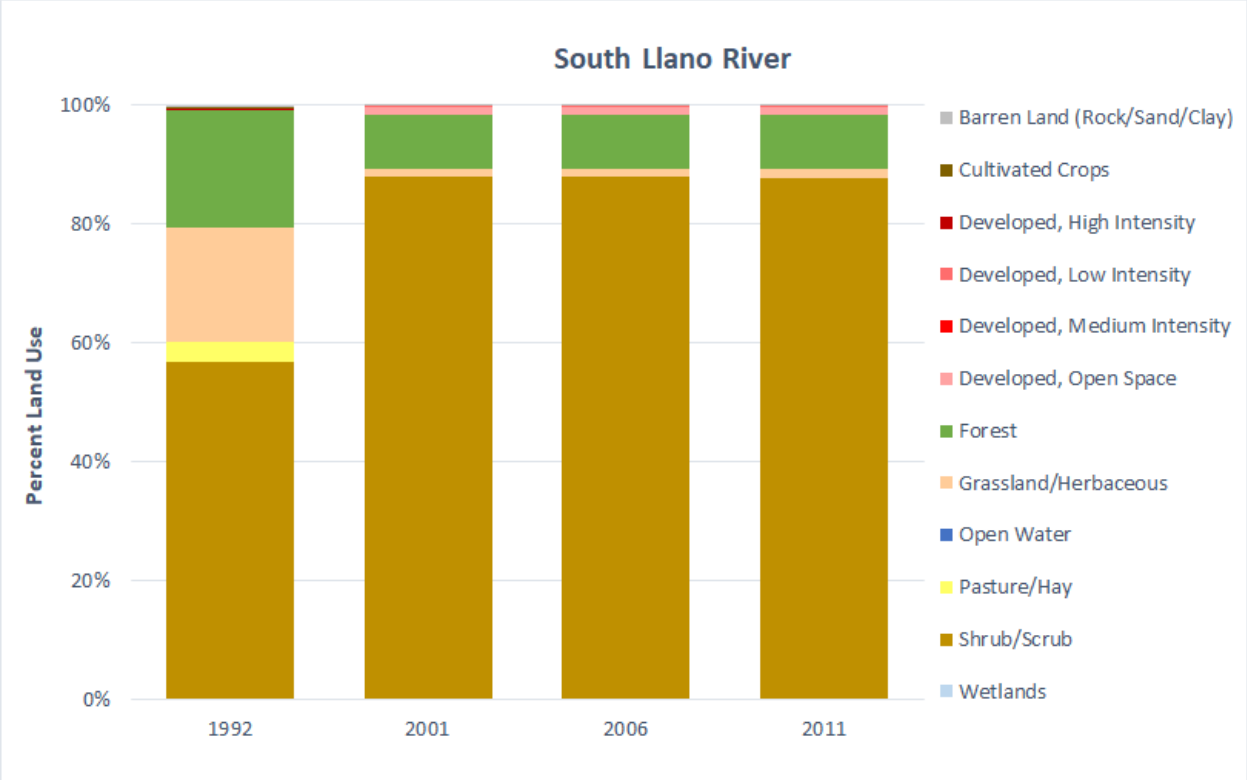

Figure 232. Percent land use in the South Llano River watershed from 1992-2011.

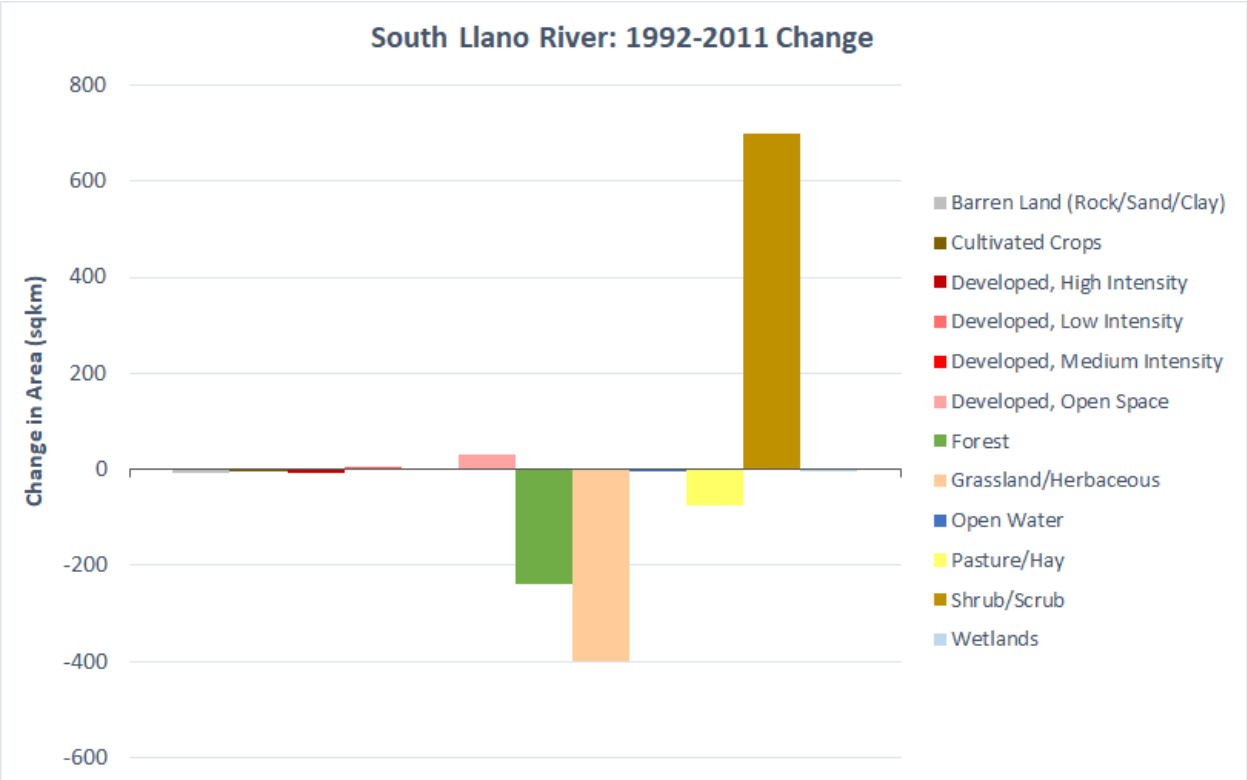

Figure 233. Land use change in area (sq km) from 1992-2011 for the South Llano River watershed.

SPRING CREEK

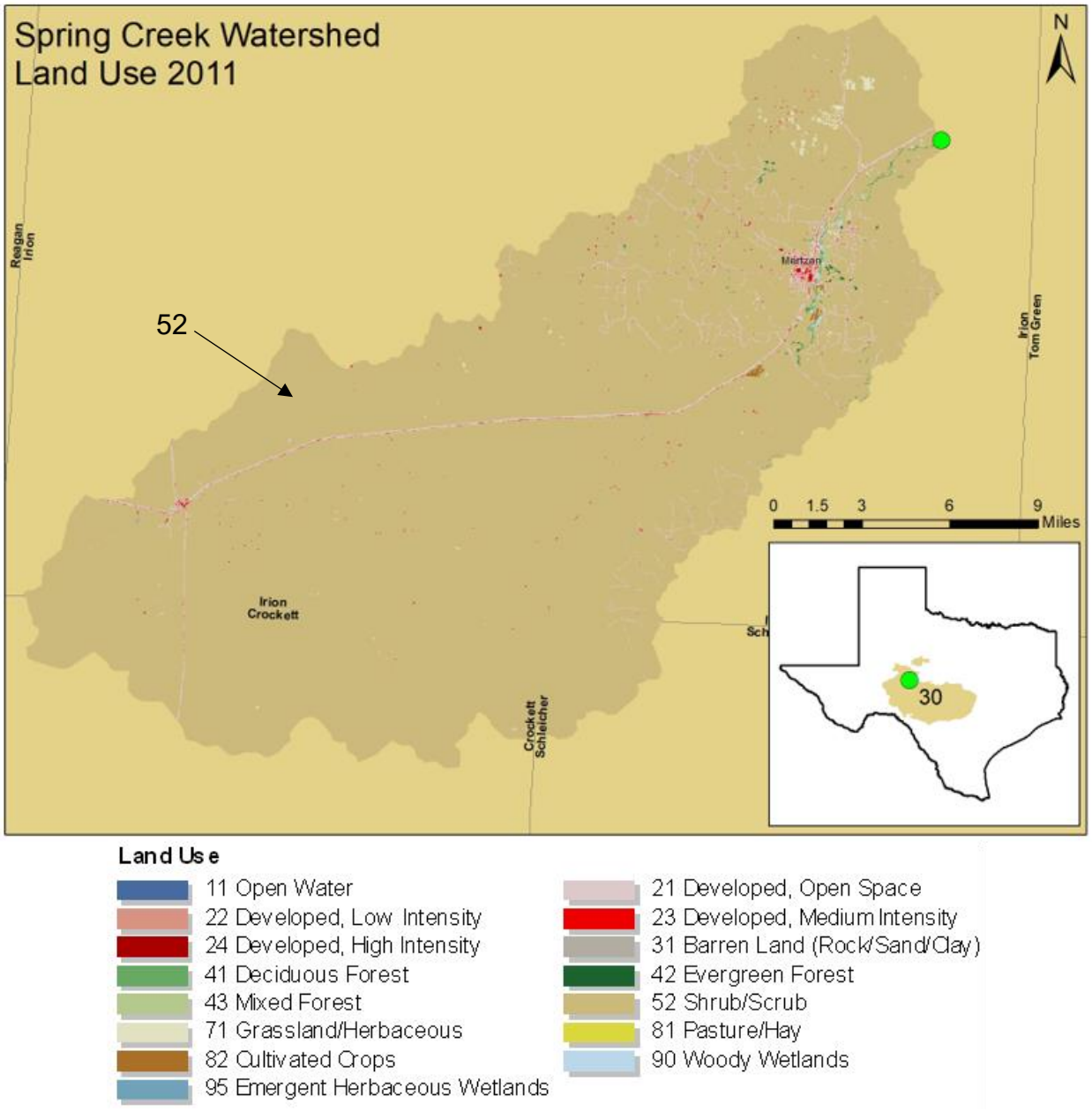

Figure 234. Map of Spring Creek watershed location and 2011 land use; shrub/scrub was the most common land use.

Sampling Dates

Physical Habitat:	August 28, 1990
Water Quality:	20 events
Fish:	August 28, 1990
Benthic Invertebrates:	August 28, 1990

Physical Characterization

Watershed and Land Use

Spring Creek lies within the Colorado River Basin. Sample site 12162 is located at Sherwood Cemetery Road, 16.7 km northeast of Mertzon in Irion County (Figure 234).

The Spring Creek watershed at site 12162 is approximately 992.70 sq km. The entire watershed lies within Level IV Ecoregion 30d, the Semiarid Edwards Plateau. The dominant land cover in the watershed is shrub at 96.68% and is present throughout the watershed (Homer et al. 2015; Figure 234 and Figure 235). Open space development is the secondary land cover encompassing 1.89%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 2.67% and the total for cultivated crops is 0.06%.

From 1992-2011 there was a 64.48 sq km decrease in grassland and a 13.68 sq km decrease in forest. There was a 58.50 sq km increase in shrub and an 18.75 sq km increase in open space development (Figure 236).

There are no wastewater outfalls in the Spring Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Spring Creek was evaluated on August 28, 1990. Spring Creek is a spring fed stream that drains to Twin Buttes Reservoir on the Concho River. The riparian width was 23 meters. The riparian zone was dominated by grasses, which made up an average of 65% of the total riparian species, followed by shrubs (20%) then trees (15%). The average percentage of tree canopy cover was 0%. The dominant substrate was bedrock with areas of cobble/gravel, and the average percent of substrate that was gravel size or larger was 82%. Average percent instream cover was 13%. Spring Creek had an average depth of 0.4 meters and a maximum depth of 1.9 meters. The average width was 19.8 meters and average stream bank slope was 21 degrees. Stream flow at the site was 17.4 cfs. Average stream bank erosion potential was 4%. Four riffles were observed at the site and there were no stream bends.

Water Quality

Water samples were collected at station 12162 over 20 sampling events from January 1987 through July 1999. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twelve species (five families) were collected from Spring Creek. Only Centrarchidae and Cyprinidae were represented by more than one species with five and four species, respectively. Blacktail Shiner was the most abundant species collected. Based upon the fish assemblage, Spring Creek rated as having a high aquatic life use.

Benthic Macroinvertebrates

From the August 1990 Surber sample, a total of 659 individuals representing 71 taxa from 18 orders of macroinvertebrates were collected from Spring Creek (Appendix E). The Coleoptera, Diptera, Ephemeroptera, Trichoptera, Odonata, and Veneroida were the most commonly collected orders, collectively accounting for 90.3 percent of the total number of individuals collected. The Oligochaeta, Hemiptera, Lepidoptera, and Basommatophora were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the August 1990 Surber sample fell within the exceptional aquatic life use category.

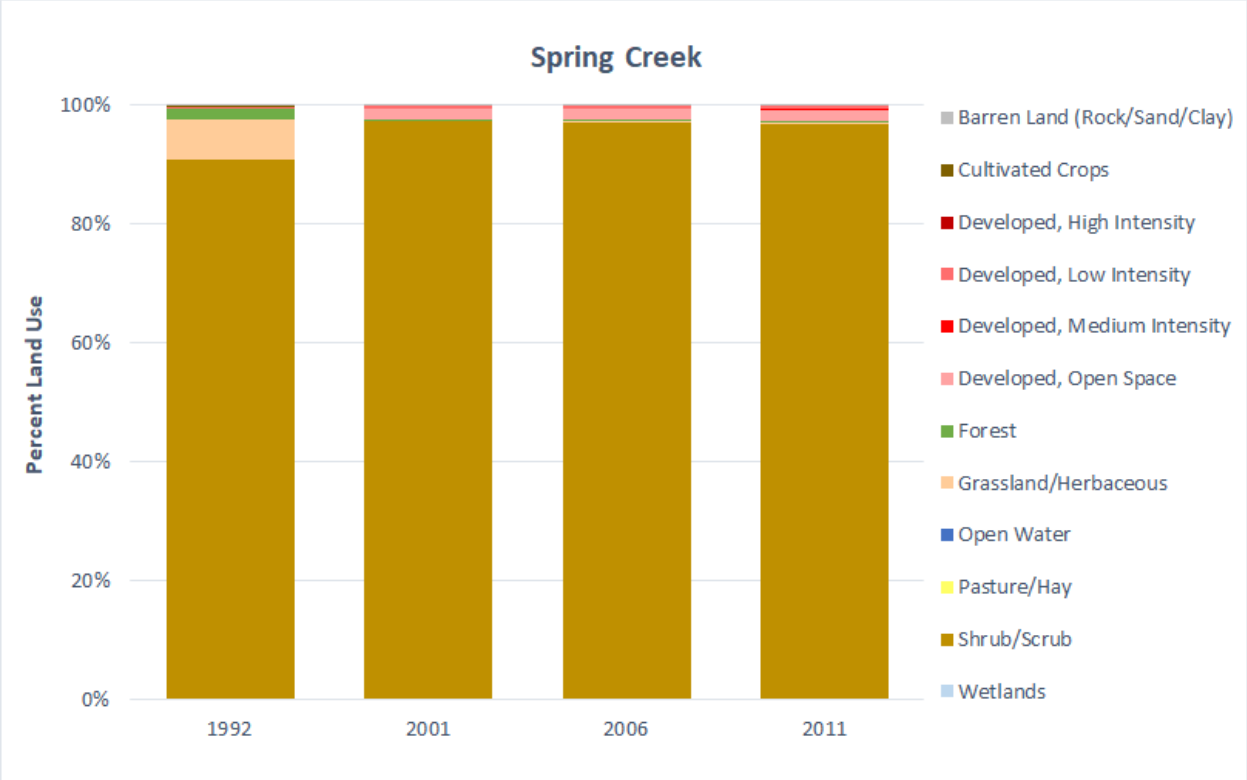

Figure 235. Percent land use in the Spring Creek watershed from 1992-2011.

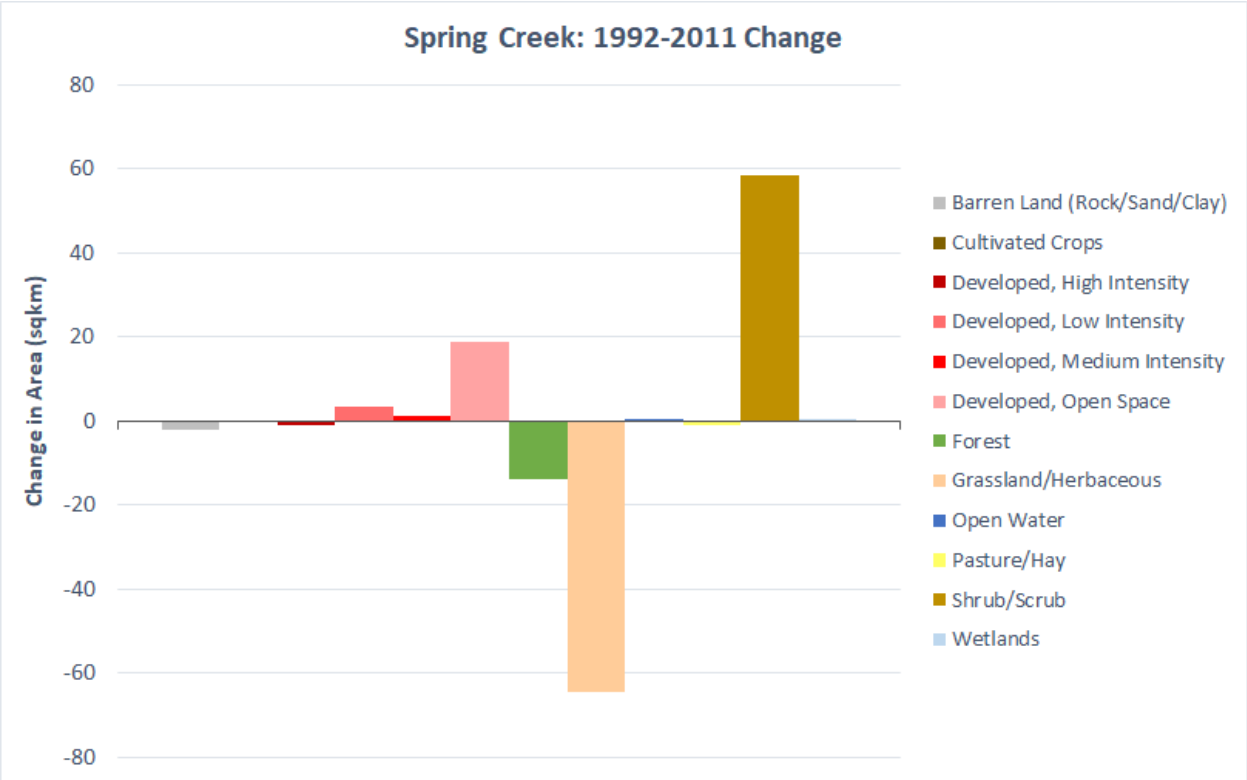

Figure 236. Land use change in area (sq km) from 1992-2011 for the Spring Creek watershed.

WEST ROCKY CREEK

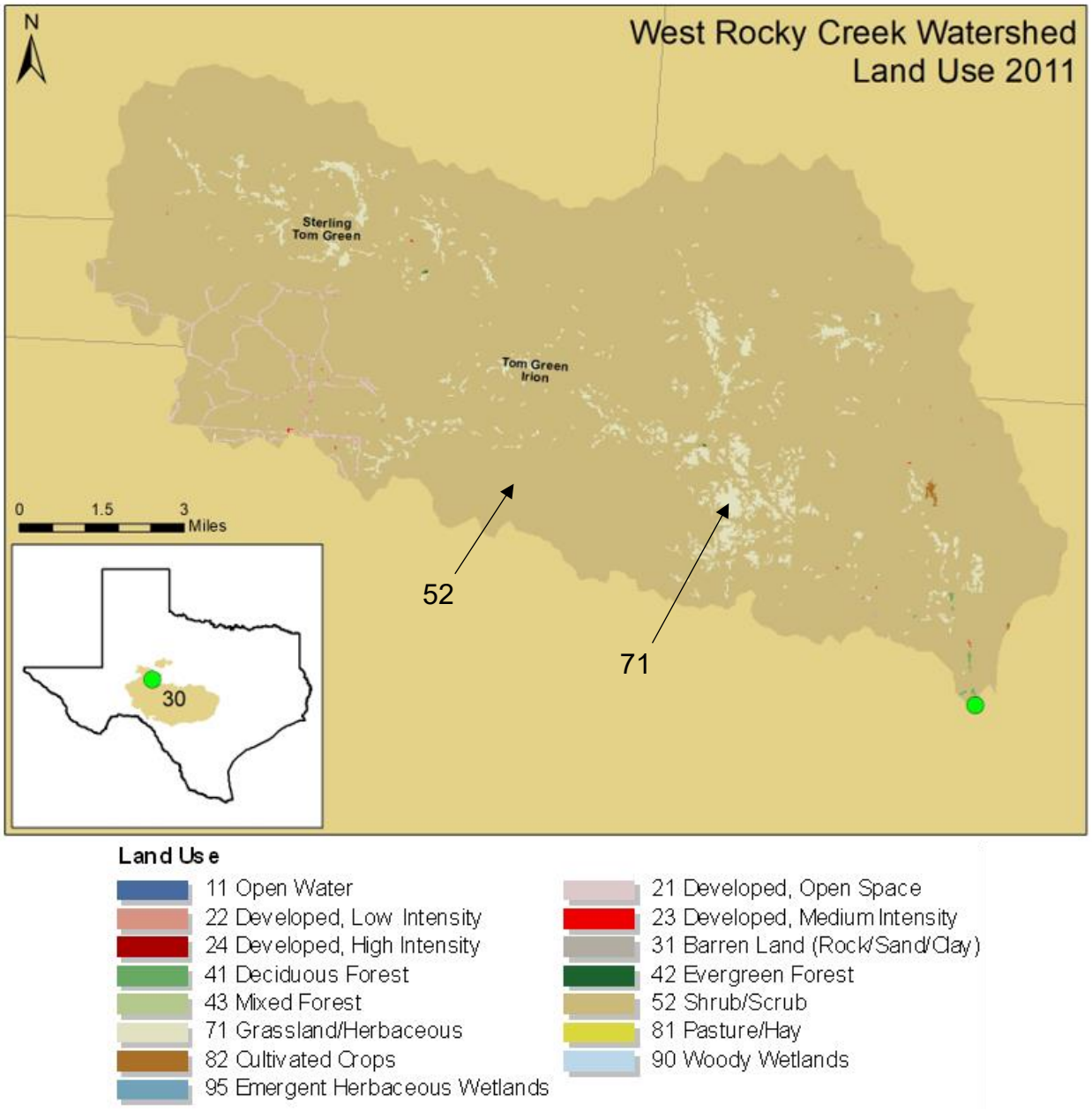

Figure 237. Map of West Rocky Creek watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	August 27, 1990
Water Quality:	69 sampling events
Fish:	August 27, 1990
Benthic Invertebrates:	August 27, 1990

Physical Characterization

Watershed and Land Use

West Rocky Creek lies within the Colorado River Basin. Sample site 12165 is located at FM 853, 43.4 km northeast of Mertzon in Irion County (Figure 237).

The West Rocky Creek watershed at site 12165 is approximately 292.19 sq km. The entire watershed lies within Level IV Ecoregion 30d, the Semiarid Edwards Plateau. The dominant land cover in the watershed is shrub at 95.52% and is present throughout the watershed (Homer et al. 2015; Figure 237 and Figure 238). Grassland/herbaceous is the secondary land cover encompassing 3.56%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.83% and the total for cultivated crops is 0.04%.

From 1992-2011 there was a 9.41 sq km decrease in grassland and a 1.97 sq km decrease in cultivated crops. There was a 10.14 sq km increase in shrub and a 2.00 sq km increase in open space development (Figure 239).

There are no wastewater outfalls in the West Rocky Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for West Rocky Creek was evaluated on August 27, 1990. West Rocky Creek is a perennial stream that drains to the Middle Concho River. The riparian width was 30 meters. The riparian zone was dominated by trees and grasses, which each made up an average of 40% of the total riparian species, followed by shrubs (20%). The average percentage of tree canopy cover was 6%. The dominant substrate was cobble/gravel and boulders, and the average percent of substrate that was gravel size or larger was 83%. Average percent instream cover was 7%. West Rocky Creek had an average depth of 0.9 meters and a maximum depth of 1.5 meters. The average width was 10.9 meters and average stream bank slope was 26 degrees. Stream flow at the site was 1.6 cfs. Average stream bank erosion potential was 7%. Two riffles were observed at the site and there were no stream bends.

Water Quality

Water samples were collected at station 12165 over 69 sampling events from August 1990 through September 2019. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Eleven species (six families) were collected from West Rocky Creek. Centrarchidae was the richest family with five species. Longear Sunfish was the most abundant species. Based upon the fish assemblage, West Rocky Creek rated as having a high aquatic life use.

Benthic Macroinvertebrates

From the August 1990 Surber sample, a total of 1235 individuals representing 68 taxa from 18 orders of macroinvertebrates were collected from West Rocky Creek (Appendix E). The Trichoptera, Diptera, Ephemeroptera, Veneroida, Coleoptera, and Oligochaeta were the most commonly collected orders, collectively accounting for 94.1 percent of the total number of individuals collected. The Neoophora and Hemiptera were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the August 1990 Surber sample fell within the exceptional aquatic life use category.

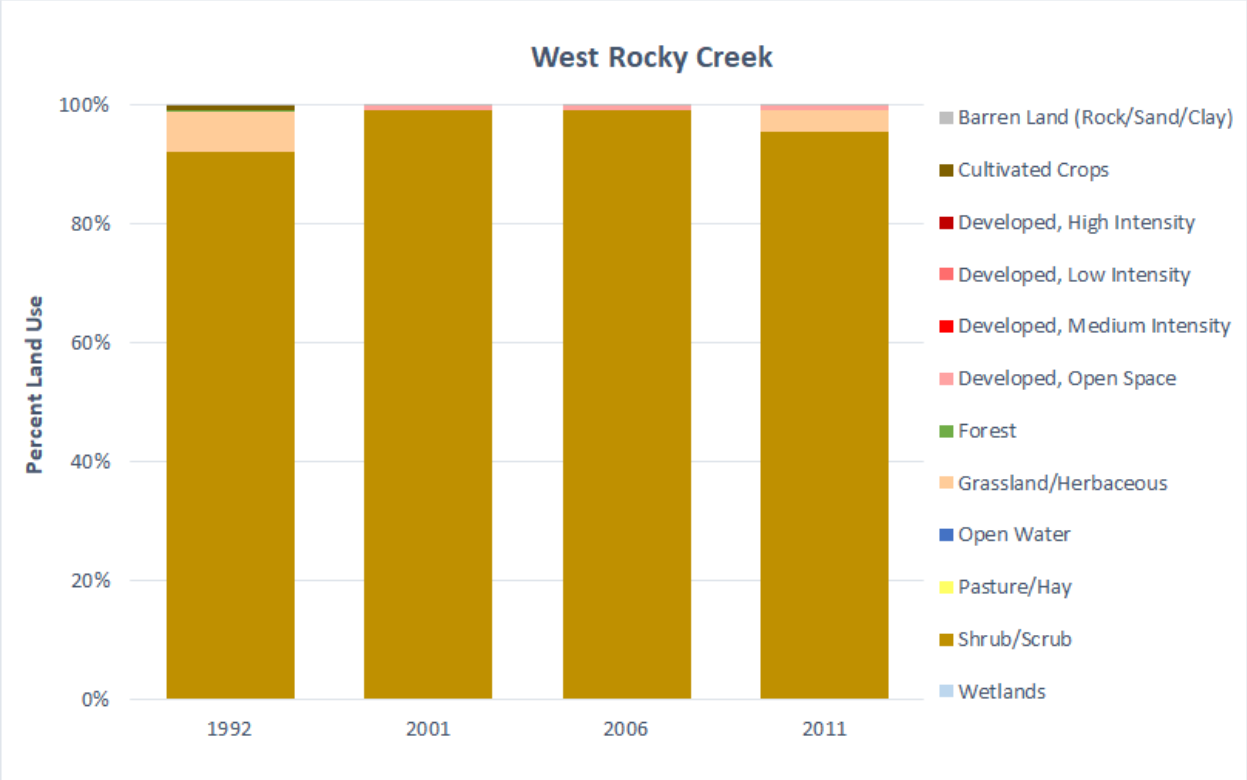

Figure 238. Percent land use in the West Rocky Creek watershed from 1992-2011.

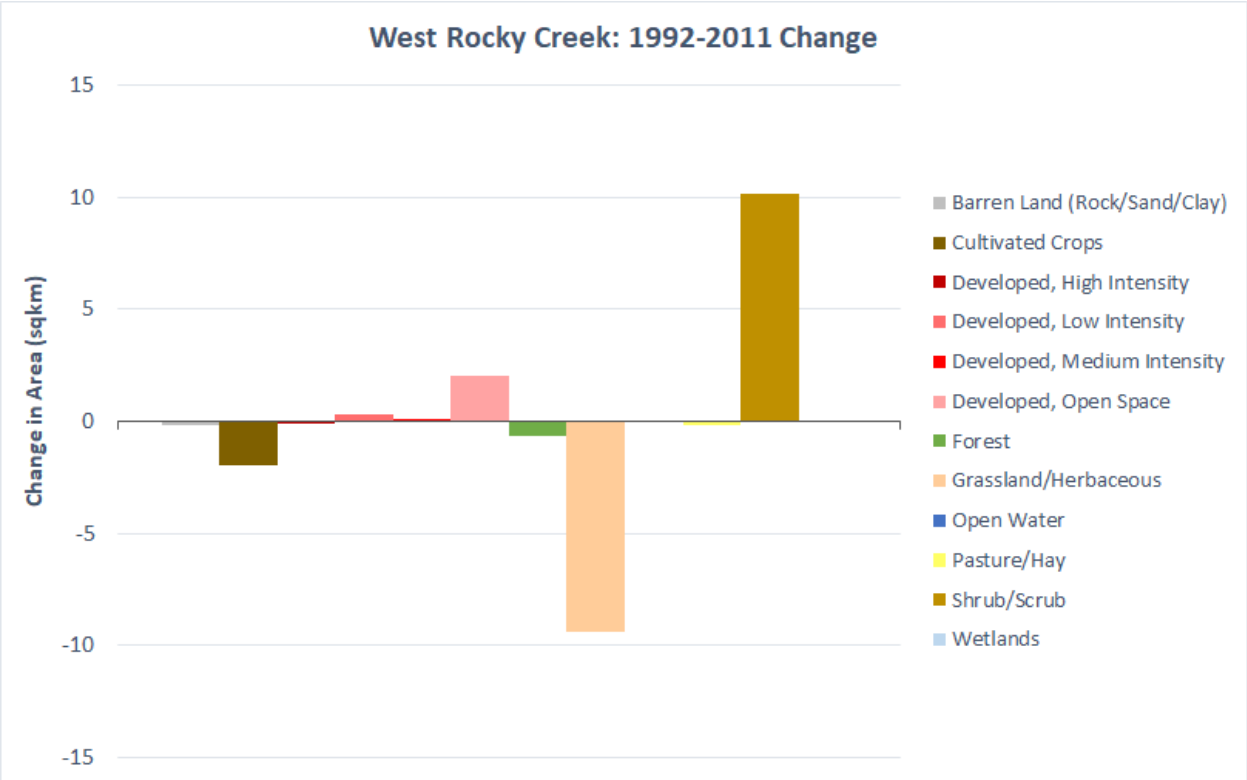

Figure 239. Land use change in area (sq km) from 1992-2011 for the West Rocky Creek watershed.

Ecoregion 30 Summary and Historical Characterization

Watershed and Land Use

Ecoregion 30 was historically covered by juniper-oak savannah and mesquite-oak savannah; however, due to the absence of fires, rapid seed dispersal, and low palatability to browsers, Ashe juniper (*Juniperus ashei*) has expanded throughout the ecoregion. Much of the area is used for grazing beef cattle, sheep, goats, exotic game mammals, and wildlife (Griffith et al. 2007). In 2011 the overall primary land cover in the study watersheds was shrub and the secondary land cover was forest. Between 1992-2011, grassland experienced the largest decrease in combined land cover area across all watersheds (~267,631.45 sq km) and shrub experienced the largest increase (~321,489.99 sq km).

In Channel and Riparian Physical Habitat

Physical habitat for the Central Texas Plateau was evaluated at 24 stream sites over 103 sampling events from 1987 to 2017. Watershed area varied from a minimum of 10.6 sq km at Bull Creek to a maximum of 2,538,770 sq km at the Colorado River above Lake Buchanan. The sites generally had well vegetated riparian zones, and the riparian buffer was 40 meters on average with a minimum of 1.7 meters and maximum of 956 meters. Grasses were the dominant riparian species (49% on average), followed by trees (21%) then shrubs (13%), and average percent tree canopy coverage was 33%. Dominant substrate at the sites was generally cobble/gravel or bedrock. Average percentage of substrate gravel sized or larger was 58% and varied from a minimum of 4% to a maximum of 100%. Average percent instream cover was 34% and common instream cover types include macrophytes, leaf packs, algae, overhanging vegetation, boulders, bedrock ledges, snags, woody debris, undercut banks, and cobble/gravel. Average stream depth and width measurements were 0.6 meters and 27 meters, respectively. Average stream bank slope was 40 degrees and erosion potential was moderate, with an average of 41% which was reflected in the average bank stability HQI score (1.3) indicating moderately stable to moderately unstable stream banks. Maximum pool depth ranged from a minimum of 0.7 meters to a maximum of 3.8 meters. Total number of riffles varied from zero to nine, and total number of stream bends ranged from zero to seven. Additional in-channel and riparian physical habitat attributes are summarized in Appendix B.

HQI scores are available for 88 events and range from a maximum score of 29.5 (exceptional) at the North Prong Medina River to a minimum score of 14 (intermediate) at the Colorado River downstream of Lynch Creek. Of the 88 sampling events with an HQI score, six (7%) received a habitat assessment rating of exceptional, 73 (83%) received a rating of high, and the remaining nine (10%) received a rating of intermediate. The highest scoring HQI metrics for the Central Texas Plateau were the dimensions of largest pool metric and the bottom substrate stability metric. The lowest scoring HQI metrics on average were the bank stability metric and the channel flow status metric.

Water Quality

Water quality data from ecoregion 30 included samples from both large and small waterbodies, which exhibited a wide range of values for many parameters. Specific conductivity had a wide range of 98 to 3280 with a median value of 483 us/cm at 25C. The clear hill country streams are common in this region, reflected in a median secchi value of 1.1 meters. In many wadeable streams the secchi tube measures a maximum of 1.2 meters. The pH values had a median of 7.82 and ranged from 6.2 to 9.4. Nutrient concentrations in the streams were mostly low, though higher for nitrogen species than for total phosphorus. The median total phosphorus concentration of 0.02 mg/L and the median TKN concentration was 0.22 mg/L. Chlorophyll-a concentrations in these streams were often low with the 95th percentile of samples at 6.105 ug/L and a median value of 1 ug/L. Additional water quality variables are summarized in appendix C of the report.

Fish

A total of 67,466 individuals consisting of 18 families and 70 species have been documented in 125 sampling events across 28 streams in the Central Texas Plateau from 1987 to 2017 (Appendix D - 4). For individual sites, taxa richness ranged from 35 species at the Colorado River across eight sampling events from 2010 to 2013 to a low of six species at Bull Creek from one sampling event in 2016. Taxa richness at each site was somewhat correlated with the number of sampling events during the period of record. The most abundant species collected across all sites and sampling events were Blacktail Shiner (n = 16,629), Texas Shiner (n = 9,760), Mimic Shiner (n = 4,386), Longear Sunfish (n = 4,205), and Central Stoneroller (n = 3,557).

Index of biotic integrity scores across all sites and sampling events ranged from 32 to 58 resulting in aquatic life use categories of intermediate (n = 16), high (n = 64), and exceptional (n = 45; Figure 240). Of the 125 sampling events in this ecoregion, 87% received an ALU rating of high or exceptional; 13% received an ALU of intermediate. Most sites that were sampled multiple times received ALUs in at least two different categories. All sites received one ALU score of high or better except for Onion Creek, Little Blanco River, Barton Creek, Bull Creek, and Live Oak Creek which all received ALU scores of intermediate; no sites received an ALU score of limited.

Overall, IBI scores, the number of fish species, the number of native cyprinids, the number of benthic invertivores, the number of intolerant species, and the number of individuals per minute electrofishing significantly increased through time (Figure 241: $R^2 = 0.11$, $p < 0.01$; Figure 242(1): $R^2 = 0.10$, $p < 0.01$; Figure 242(2): $R^2 = 0.04$, $p = 0.03$; Figure 242(3): $R^2 = 0.07$, $p < 0.01$; Figure 242(5): $R^2 = 0.05$, $p < 0.01$; Figure 243(10eshock): $R^2 = 0.08$, $p < 0.01$) and the percent of individuals with disease/anomaly significantly decreased through time (Figure 243(12): $R^2 = 0.07$, $p < 0.01$). Although these were significant relationships, R^2 values were very low. Individual metrics 4, 6-9, and 11 did not change through time (Figure 242; Figure 243).

The increase in IBI scores is due to the new waterbodies that were sampled rather than improvements in streams that were resampled. Of the 30 sample sites within Ecoregion 30, 17 were new stations added since the original sampling conducted in the late 1980s and early 1990s, 10 were original sites, and three were waterbodies sampled during the 1980s that were resampled

over twenty years later. The three repeat sample sites yielded the same aquatic life use ratings as they did when originally sampled. Seventy percent of the sample stations that were not resampled yielded high ALUs. The remaining 30% rated as intermediate. Conversely, of the new sample stations, 35% rated exceptional, 59% intermediate, and 6% intermediate. A similar relationship between the original sample stations (that were not resampled) and the new sample stations was also discovered for the other metrics that significantly increased. The decrease in the proportion of individuals with a disease/anomaly is likely due to sampler bias rather than a significant change in disease/anomaly. This is a characteristic that is often overlooked while in the field.

Benthic Macroinvertebrates

A total of 26,875 individuals representing 30 orders of aquatic macroinvertebrates were collected in the 14 Surber samples and 98 RBP samples collected at 27 streams in the Central Texas Plateau from July 1987 to August 2017 (Appendix E). Six orders (Coleoptera, Diptera, Ephemeroptera, Trichoptera, Hemiptera, and Odonata) were represented at all sites, which collectively represented 87% of the total number of individuals collected.

The caddisfly *Chimarra* sp. (Trichoptera, Philopotamidae) was the most abundant taxon representing 7% of the total number of individuals collected at all sites. Other relatively abundant taxa include the filtering caddisfly *Cheumatopsyche* sp., mayflies *Thraulodes* sp., *Isonychia* sp., and *Traverella* sp., the riffle beetles *Hexacylloepus* sp. and *Microcylloepus* sp., and the damselfly *Argia* sp.

The caddisfly *Chimarra* sp. and damselfly *Argia* sp. were the most widely distributed genera occurring in 26 of the 27 total streams sampled. Other widely distributed genera include the caddisfly *Cheumatopsyche* sp. occurring in collections from 25 of 27 streams, the microcaddisfly *Hydroptila* sp. and the dobsonfly *Corydalus cornutus* which were each collected in 22 of 27 streams.

Six of 98 RBP IBI scores for kicknet samples fell within the exceptional aquatic life use category, 52 RBP IBI scores indicated high, 33 intermediate, and seven samples fell within the limited aquatic life use category (Figure 244; Figure 245). All 14 Surber sample BIBI scores fell within the exceptional aquatic life use category. Results for the regionalized RBP and Surber IBI's indicate relatively stable biotic integrity over the interval from 1987 to 2017 (Figure 244; Figure 245).

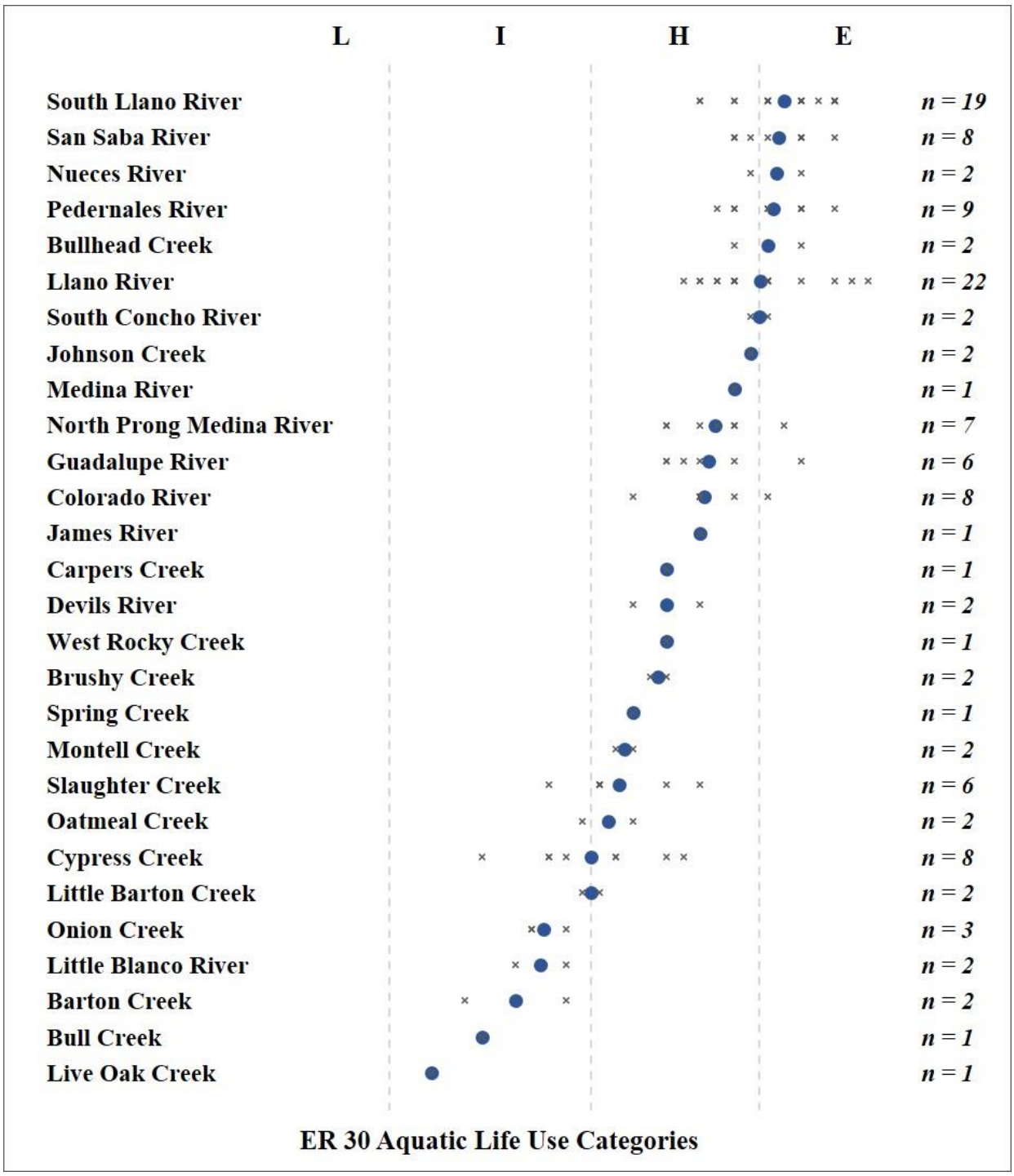

Figure 240. Aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all fish sampling events in Ecoregion 30 grouped by site and ranked by mean ALU score (blue dot); number of sampling events per site noted on right.

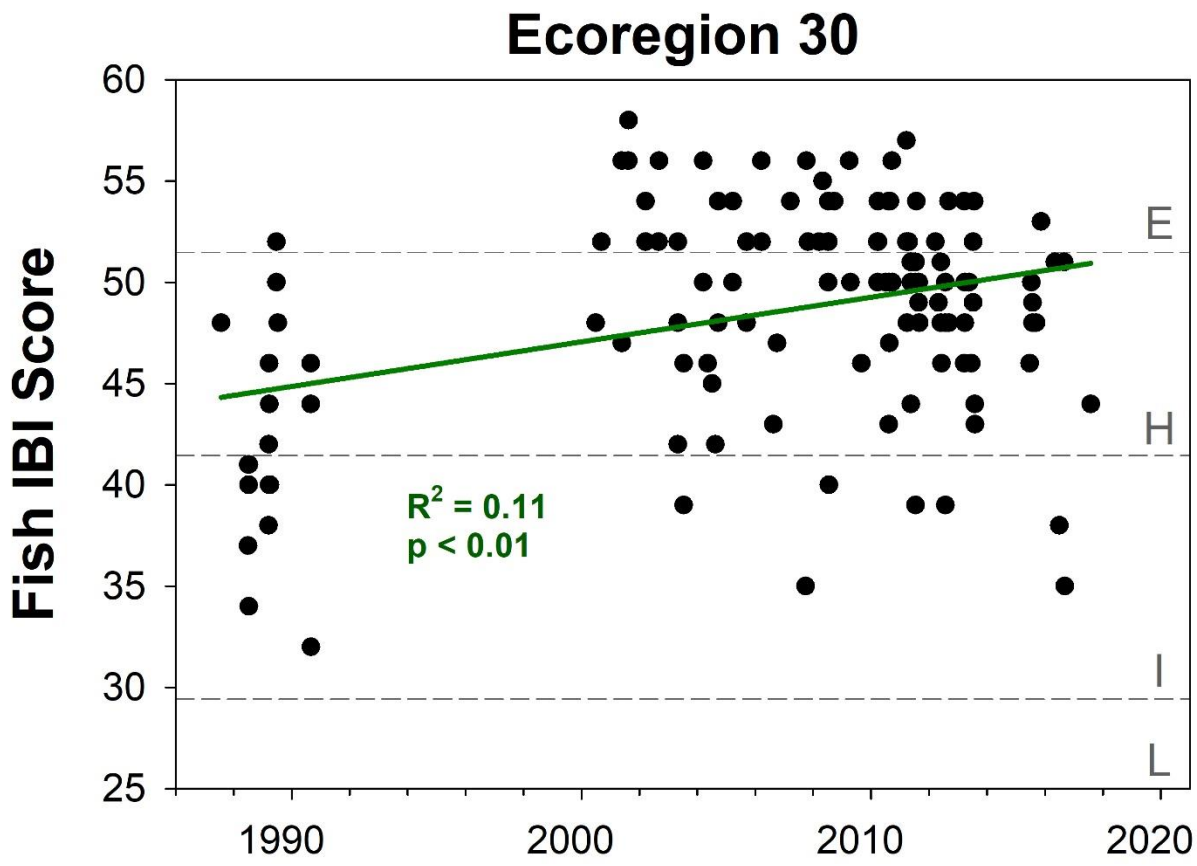

Figure 241. Fish index of biotic integrity scores through time for all sampling events in Ecoregion 30; break lines for aquatic life use categories (i.e., limited, intermediate, high, and exceptional) shown on each graph for reference (see Linam et al. 2002).

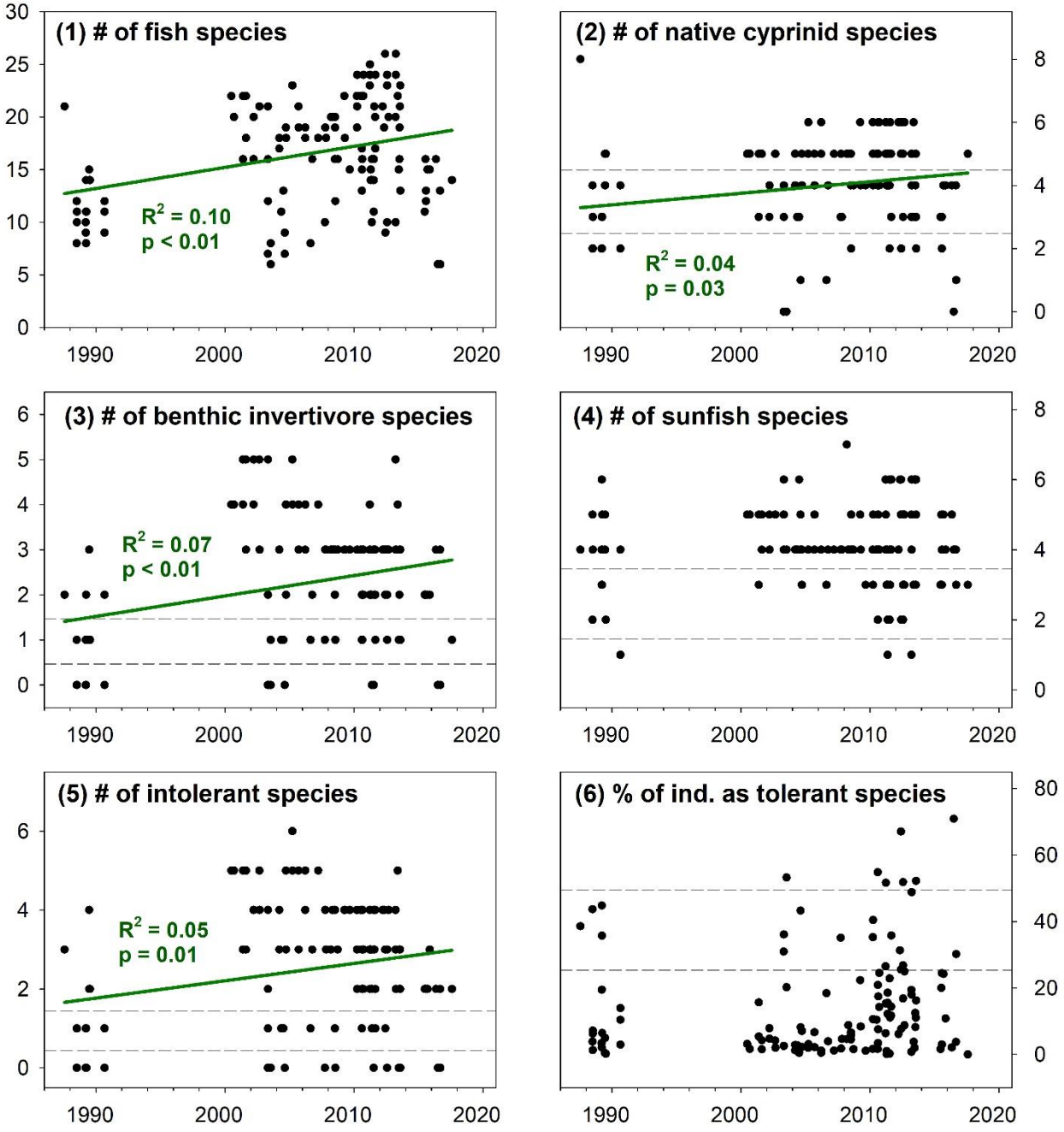

Figure 242. Raw values for fish index of biotic integrity metrics 1-6 through time for all sampling events in Ecoregions 30; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002).

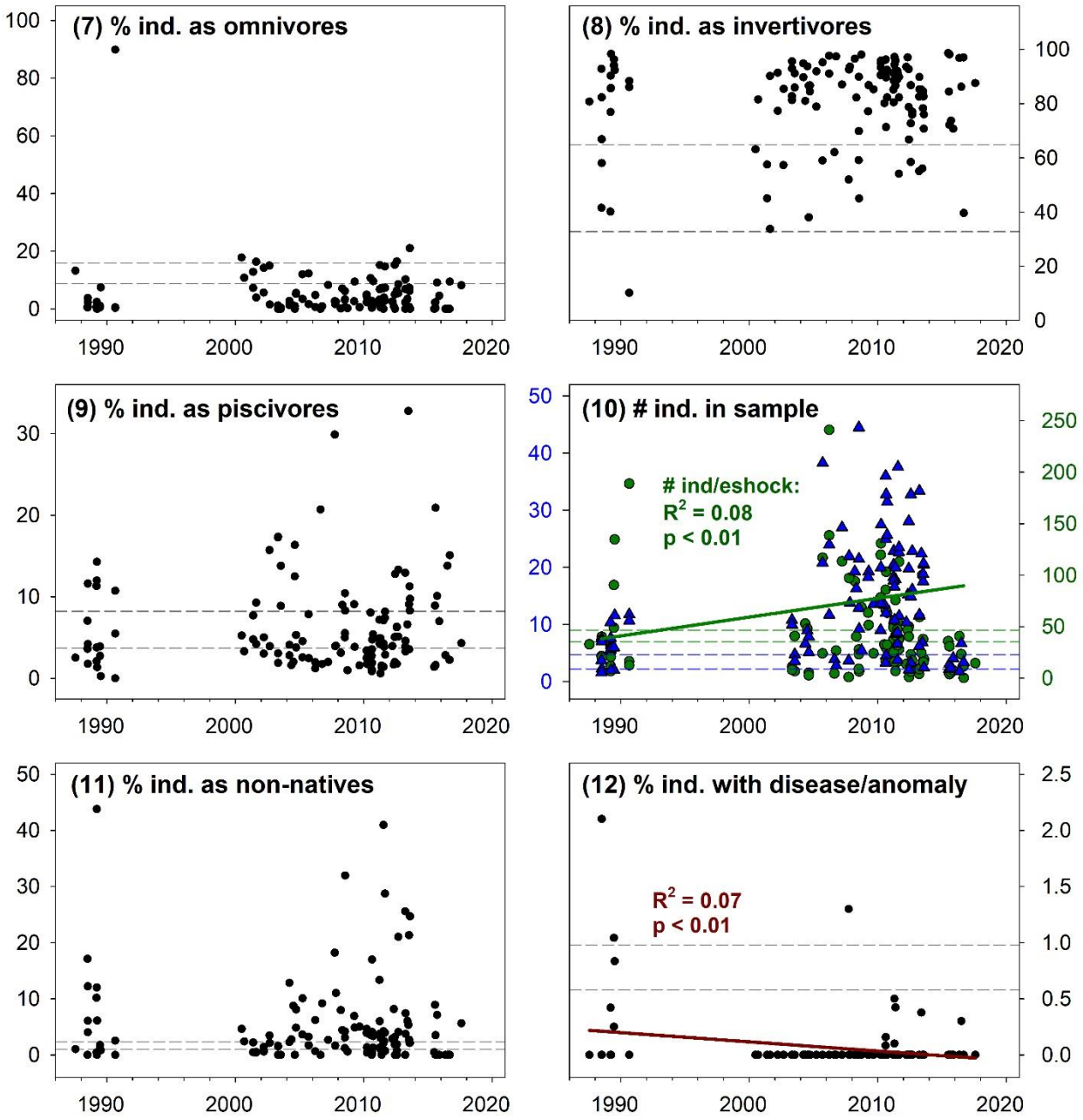

Figure 243. Raw values for fish index of biotic integrity metrics 7-12 through time for all sampling events in Ecoregions 30; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002); number of ind./seine haul represented by green circles and number of ind./min electrofishing represented by blue triangles for metric number 10.

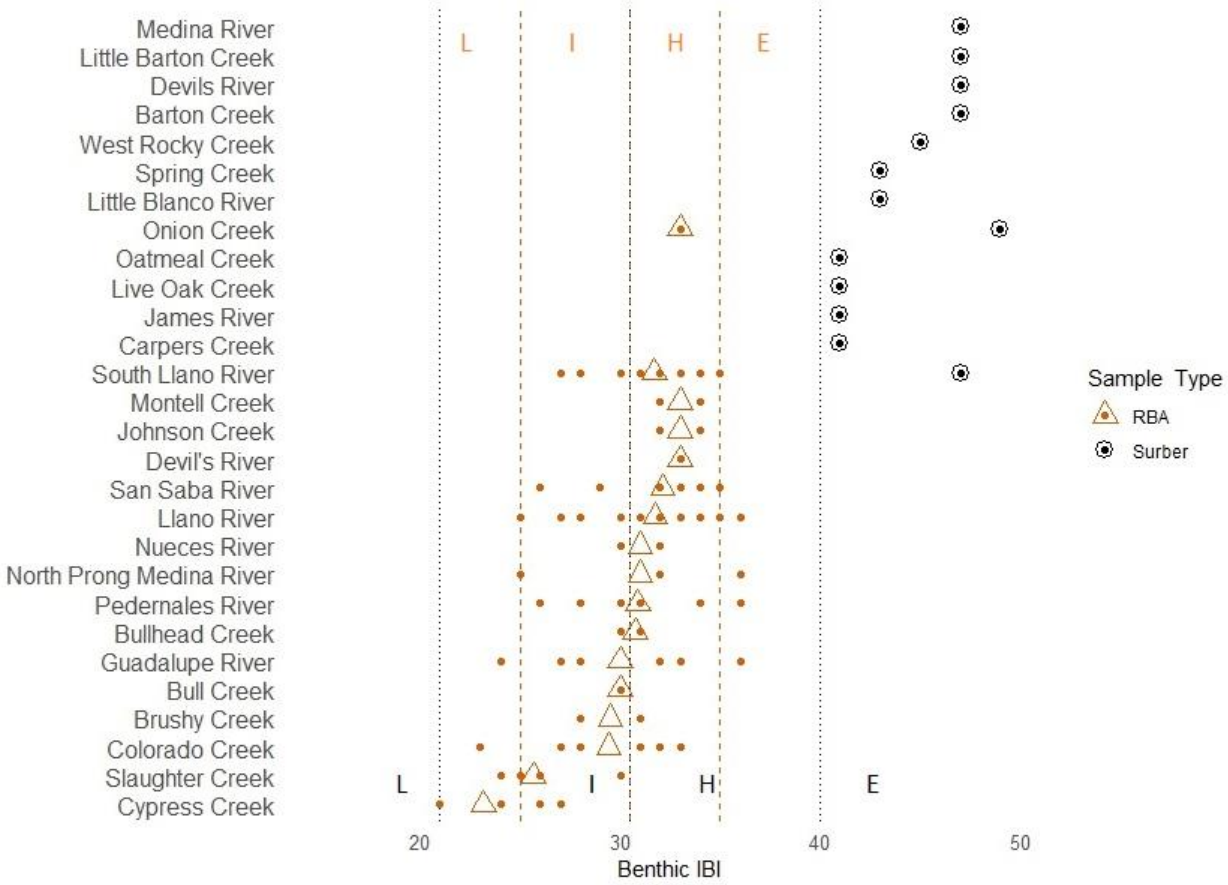

Figure 244. Benthic IBIs and aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all benthic sampling events in Ecoregion 30 grouped by site and ranked by mean IBI score. Site scores are solid circles, and mean scores are hollow circles for Surber IBI samples and hollow triangles for RBP IBI samples. RBP IBI ALU cut offs are red dashed lines and Surber ALU cutoffs are in black dotted lines.

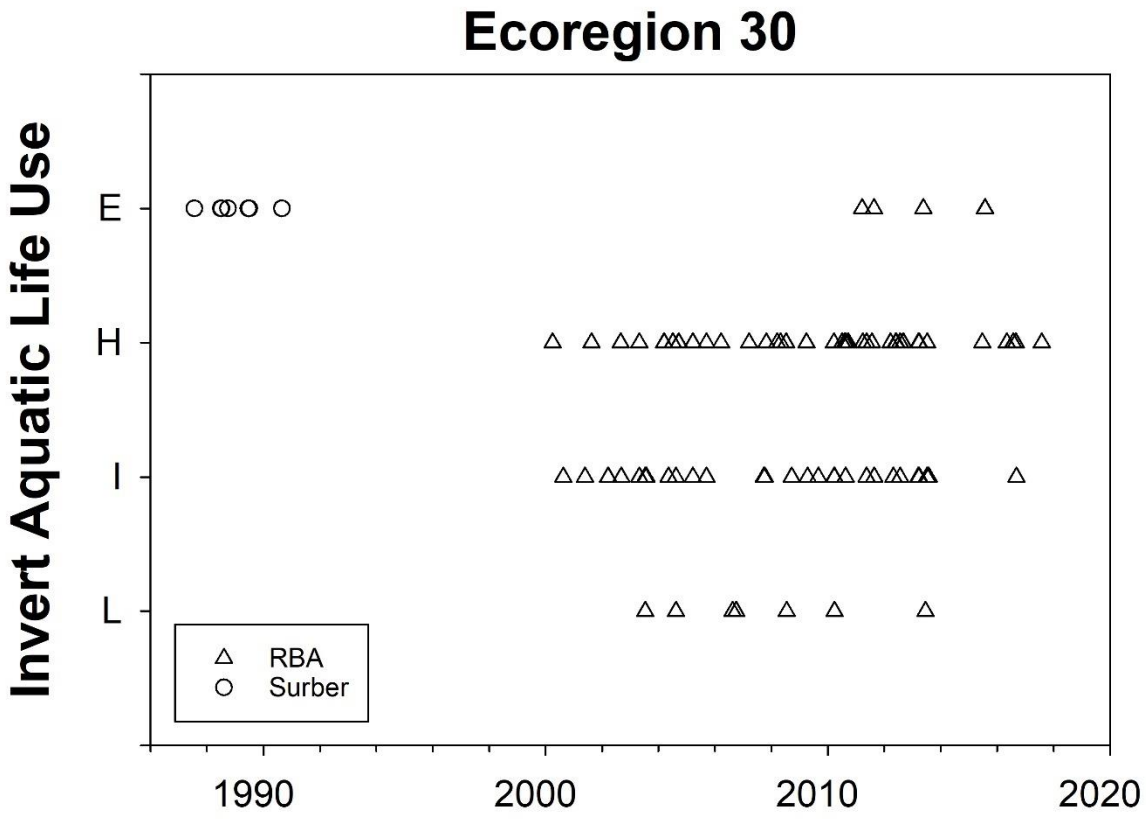

Figure 245. Benthic aquatic life use (ALU) categories through time for all sampling events in Ecoregion 30; Surber ALUs are noted by circles and RBP ALUs are noted by triangles.

ECOREGION 31 – SOUTHERN TEXAS PLAINS

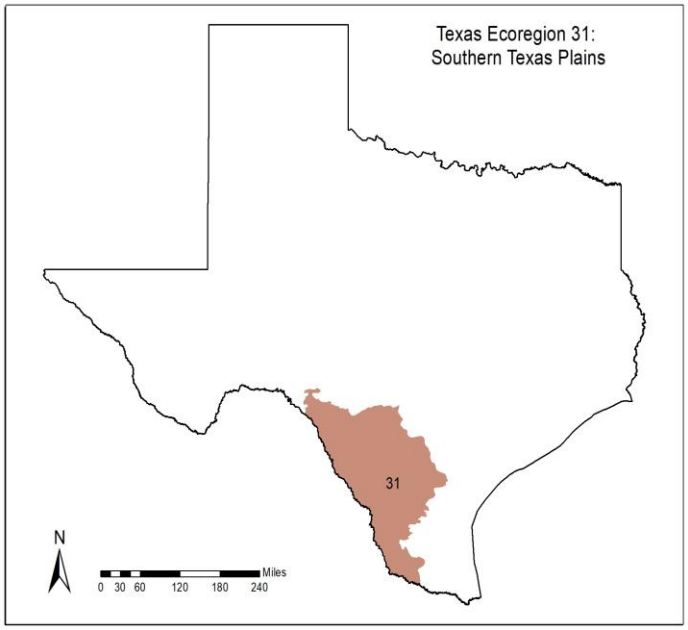

Figure 246. Map of Texas Ecoregion 31 – Southern Texas Plains.

Figure 247. Site photo from the Upper Nueces River.

Ecoregion 31 Characterization

The Southern Texas Plains ecoregion covers approximately 53,500 sq km of what is referred to as the "brush country" in southwest Texas (Figure 246) and contains a high diversity of plant and animal life (Griffith et al., 2007). This diversity is, to a great degree, a result of the convergence of the Chihuahuan Deserts to the west, the thornscrub and floodplain woodlands along the Rio Grande to the south, and coastal grasslands to the east. In Texas, the Rio Grande forms the western boundary of the ecoregion. To the north, the ecoregion is bounded by the Edwards Plateau ecoregion. The Texas Blackland Prairies, the East Central Texas Plains, and the Western Gulf Coastal Plain form the eastern boundary. The ecoregion includes portions of the Rio Grande, Nueces and Devil's River watersheds.

In general, the ecoregion was historically characterized as rolling to moderately dissected grassland plains. More recently, as a result of grazing and fire suppression, mesquite, and other thorny brush are now predominant. Currently, most of the ecoregion is used for rangeland, with only small areas of cultivated grain sorghum, cotton, and watermelons.

Climatically, the region is considered to be subtropical, having hot dry summers and mild winters. Typically, precipitation occurs bimodally with peaks in the spring and again in the fall. Extended droughts are not uncommon, and annual average precipitation varies from 48 – 71 cm.

Streams in the ecoregion may exhibit influences from the Edwards Plateau, either as a result of taking their origin from aquifers beneath the Edwards, or from having originated in the Edwards with resultant surficial flow from there into the South Texas Plains. Sycamore, Pinto, and San Felipe creeks are notable examples of this, each being characterized by relatively clear, cool, spring flow. The presence of these types of streams in such an arid region provides important relatively stable aquatic habitats.

Table 10. Streams sampled in Ecoregion 31.

Las Moras Creek	Nueces River	Sycamore Creek
Metate Creek	Pinto Creek	
Mud Creek	San Miguel Creek	

LAS MORAS CREEK

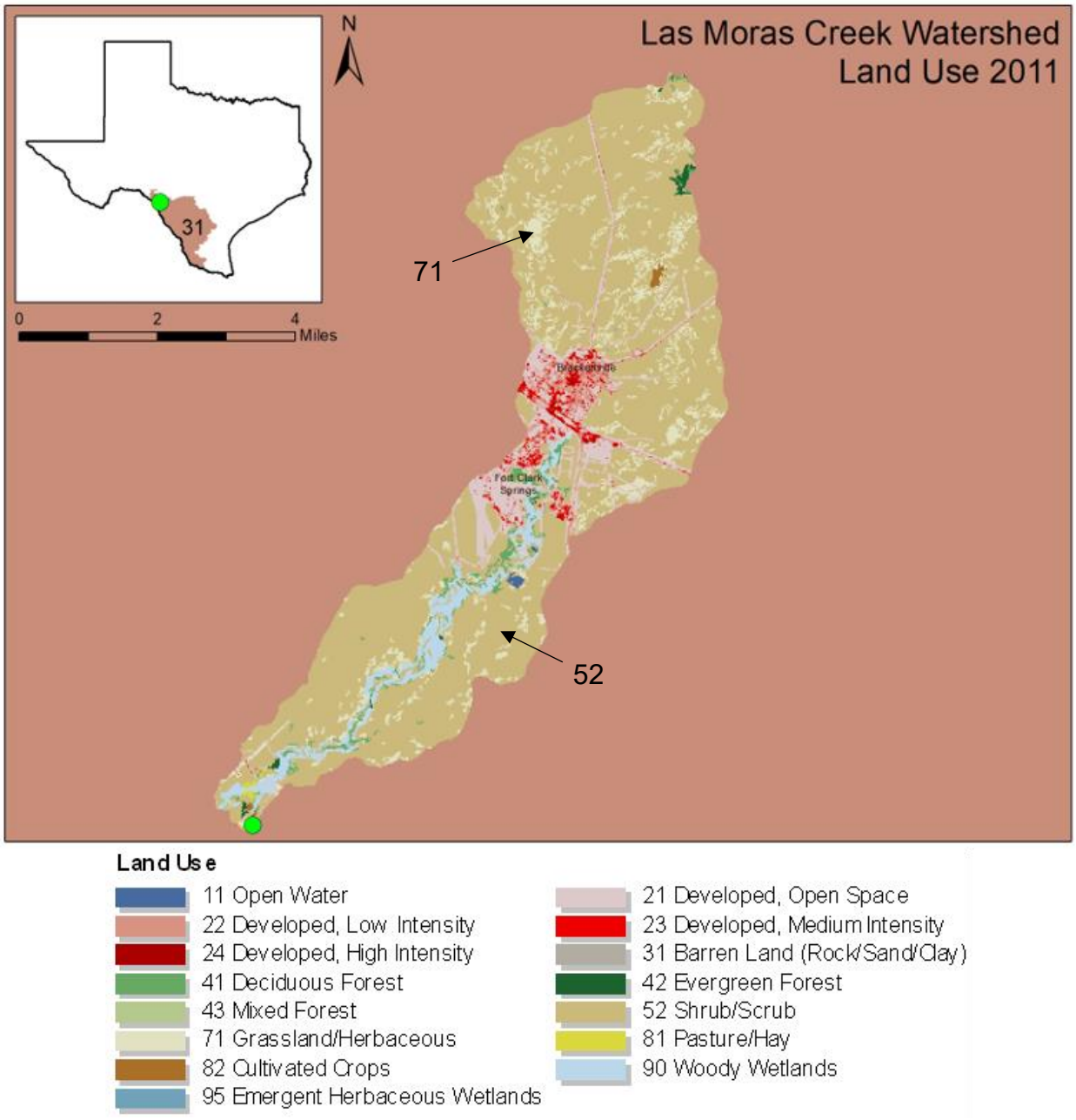

Figure 248. Map of Las Moras Creek watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	June 13, 1990
Water Quality:	3 sampling events
Fish:	June 13, 1990
Benthic Invertebrates:	June 13, 1990

Physical Characterization

Watershed and Land Use

Las Moras Creek lies within the Rio Grande Basin. Sample site 13130 is located near the Southern Pacific Railroad, approximately 12.9 km south of Brackettville in Kinney County (Figure 248).

The Las Moras Creek watershed at site 13130 is approximately 70.05 sq km. The entire watershed lies within Level IV Ecoregion 31c, the Texas-Tamaulipan Thornscrub. The dominant land cover in the watershed is shrub, which is present throughout 71.1% of the watershed (Homer et al. 2015; Figure 248 and Figure 249). Grassland/herbaceous is the second most prevalent land cover, encompassing 9.20%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 12.61%; and the total for cultivated crops is 0.22%.

From 1992-2011 there was a 6.38 sq km decrease in forest and a 3.20 sq km decrease in cultivated crops. There was a 5.24 sq km increase in shrub and a 4.84 sq km increase in open space development (Figure 250).

There is one domestic wastewater outfall (which discharges less than one million gallons per day) within the Las Moras Creek watershed permitted to the City of Brackettville. This facility discharges directly into Las Moras Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Las Moras Creek was evaluated on June 13, 1990. Las Moras Creek is a spring fed stream that drains to the Rio Grande River. The riparian width was 42 meters. The riparian zone was dominated by trees, which made up an average of 50% of the total riparian species, followed by grasses (45%) then shrubs (5%). The average percentage of tree canopy cover was 88%. The dominant substrate was clay with some sand, and the average percent of substrate that was gravel size or larger was 0%. Average percent instream cover was 24%. Las Moras Creek had an average depth of 0.5 meters and a maximum depth of 0.9 meters. The average width was 4.4 meters and average stream bank slope was 22 degrees. Stream flow at the site was 35.1 cfs. Average stream bank erosion potential was 35%. One riffle was observed at the site and there were 10 poorly defined stream bends.

Water Quality

Water samples were collected at three stations on this segment: station 13129 over 3 sampling events from February 1993 to June 1988, station 14941 at 4 events from November 1995 through August 1996, and once at station 22310 in July 2021. Data were collected for temperature, flow, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a. Continuous 24 hour dissolved oxygen samples were only collected in July 2021 at station 22310 on this waterbody.

Biological Characterization

Fish

Nine species (five families) were collected from Las Moras Creek, with fairly even distribution among the families. Mexican Tetra, *Astyanx mexicanus,* was the most abundant species. Based upon the fish assemblage, the aquatic life use only rated as intermediate. The main reasons for the low aquatic life use rating were the small number of native cyprinid and sunfish species, low percentage of piscivorous individuals, and the high percentage of individuals as non-native species (3.1%, Common Carp).

Benthic Macroinvertebrates

Considering the single Surber sample from June 13, 1990, a total of 289 individuals representing 42 taxa from 12 orders of macroinvertebrates were collected from Las Moras Creek (Appendix E). Coleoptera, Ephemeroptera, Trichoptera, Oligochaeta, Odonata, and Diptera were the most collected orders, collectively accounting for 94.1percent of the total number of individuals collected. The Basommatophora and Lepidoptera were the only other orders collected which comprised greater than one percent of the collection. The Central Bioregion Surber BIBI for the 1990 Surber sample fell in the exceptional aquatic life use category.

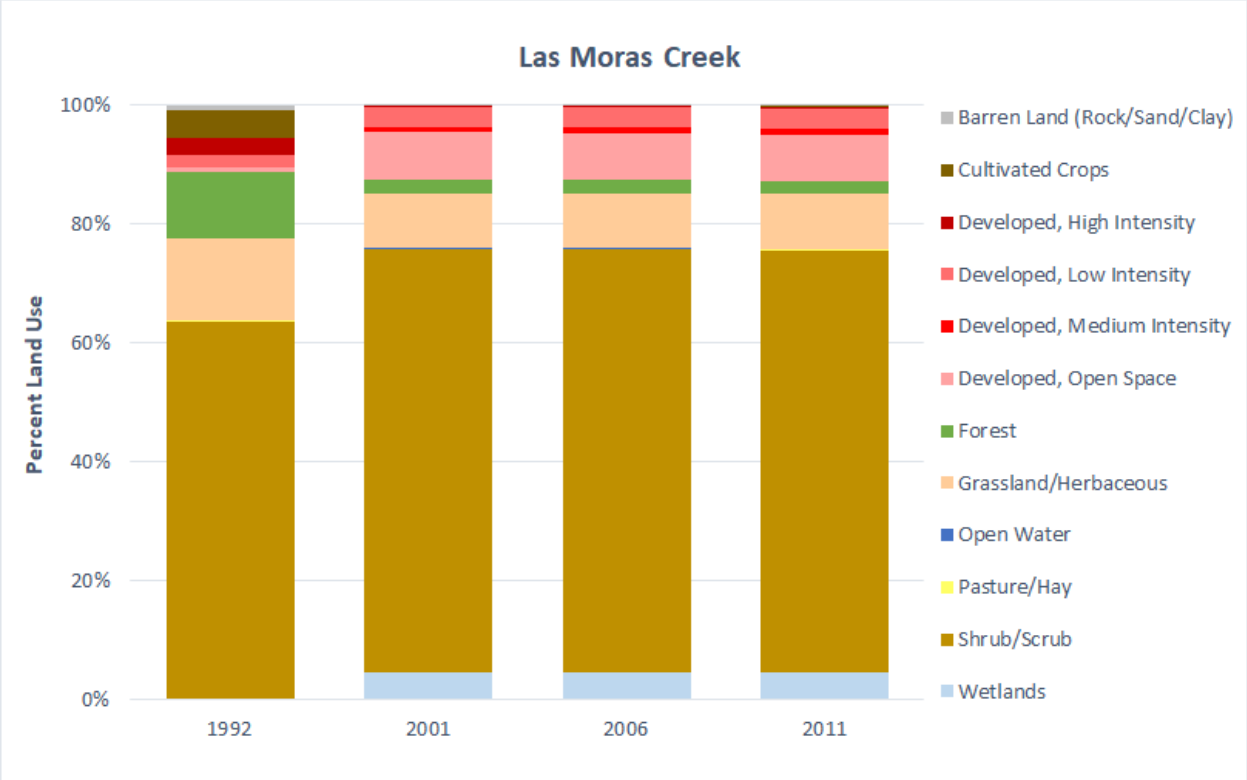

Figure 249. Percent land use in the Las Moras Creek watershed from 1992-2011.

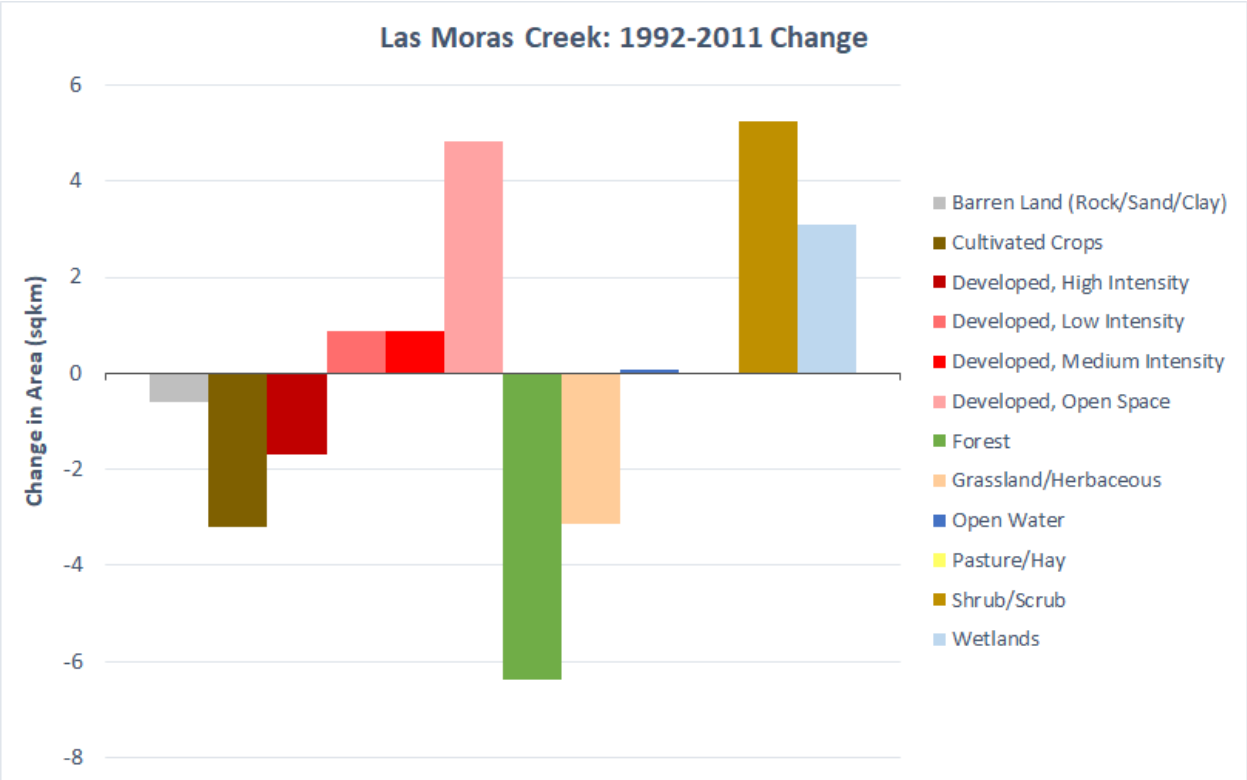

Figure 250. Land use change in area (sq km) from 1992-2011 for the Las Moras Creek watershed.

METATE CREEK

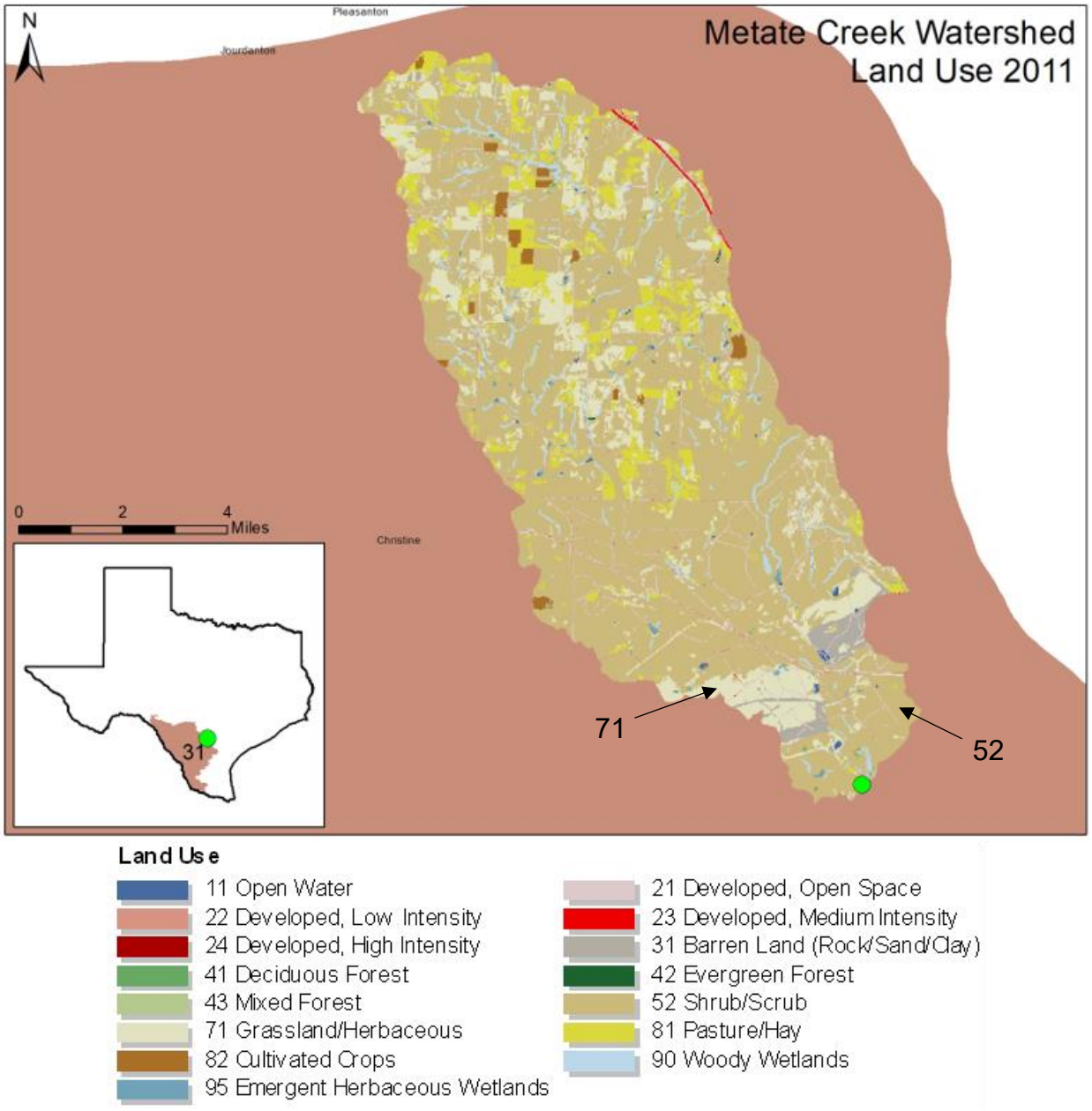

Figure 251. Map of Metate Creek watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	July 30, 1990
Water Quality:	2 sampling events
Fish:	July 30, 1990
Benthic Invertebrates:	July 30, 1990

Physical Characterization

Watershed and Land Use

Metate Creek lies within the Nueces River Basin. Sample site 12954 is located at FM 791, approximately 11.3 km southwest of Campbellton in Atascosa County (Figure 251).

The Metate Creek watershed at site 12954 is approximately 197.71 sq km. The entire watershed lies within Level IV Ecoregion 31c, the Texas-Tamaulipan Thornscrub. The dominant land cover in the watershed is shrub at 66.82% and is present throughout the watershed (Homer et al. 2015; Figure 251 and Figure 252). Grassland/herbaceous is the secondary land cover, encompassing 13.71%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 4.08% and the total for cultivated crops is 0.91%.

From 1992-2011 there was a 44.22 sq km decrease in forest and a 5.59 sq km decrease in cultivated crops. There was a 17.46 sq km increase in shrub and a 13.81 sq km increase in grassland (Figure 253).

There are no wastewater outfalls in the Metate Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Metate Creek was evaluated on July 30, 1990. The riparian width was 49 meters. The riparian zone was dominated by trees, which made up an average of 50% of the total riparian species, followed by shrubs (30%), then grasses (20%). The average percentage of tree canopy cover was 45%. The dominant substrate was clay/silt, and the average percent of substrate that was gravel size or larger was 0%. The average percent instream cover was 42%. Metate Creek had an average depth of 0.4 meter and a maximum depth of 0.7 meter. The average width was 5.1 meters, and the average stream bank slope was 48 degrees. Stream flow at the site was 0.04 cfs. Average stream bank erosion potential was 50%. Two riffles were observed at the site, and there was one poorly defined stream bend.

Water Quality

Water samples were collected at station 12954 over two sampling events, one in July 1990 and another in July 1999. Data were collected for temperature, flow, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a. One 24-hour dissolved oxygen samples was collected on this segment in July 1990.

Biological Characterization

Fish

Eight species (five families) were collected from Metate Creek. Species were fairly evenly distributed among the families. Western Mosquitofish was the most abundant species. The aquatic life use (based upon the fish assemblage) rated as high.

Benthic Macroinvertebrates

Considering the single Surber sample from July 30, 1990, a total of 169 individuals representing 24 taxa from 8 orders of macroinvertebrates were collected from Metate Creek (Appendix E). Oligochaeta, Diptera, Basommatophora, and Coleoptera were the most commonly collected orders, collectively accounting for 94.1 percent of the total number of individuals collected. Ostracoda, Gastropoda, and Odonata were the only other orders collected which comprised greater than one percent of the collections. The Central Bioregion Surber BIBI for the 1990 Surber sample fell in the intermediate aquatic life use category.

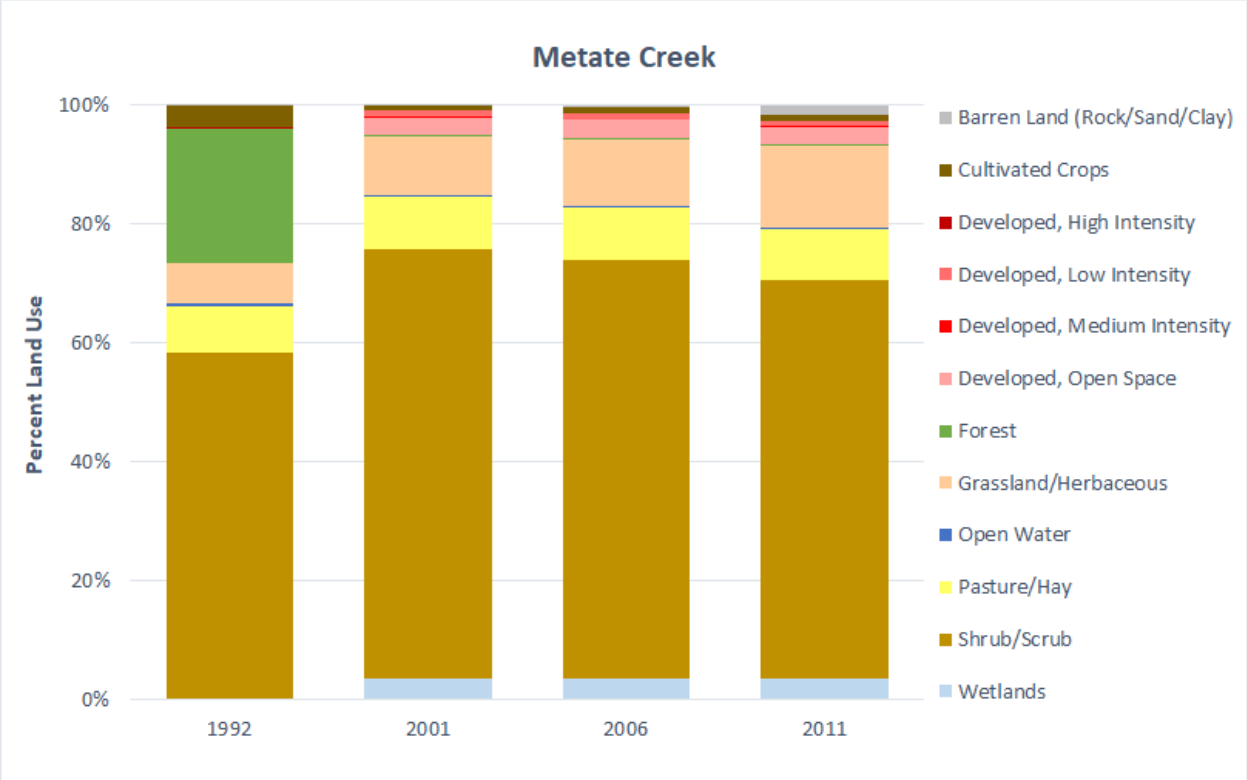

Figure 252. Percent land use in the Metate Creek watershed from 1992-2011.

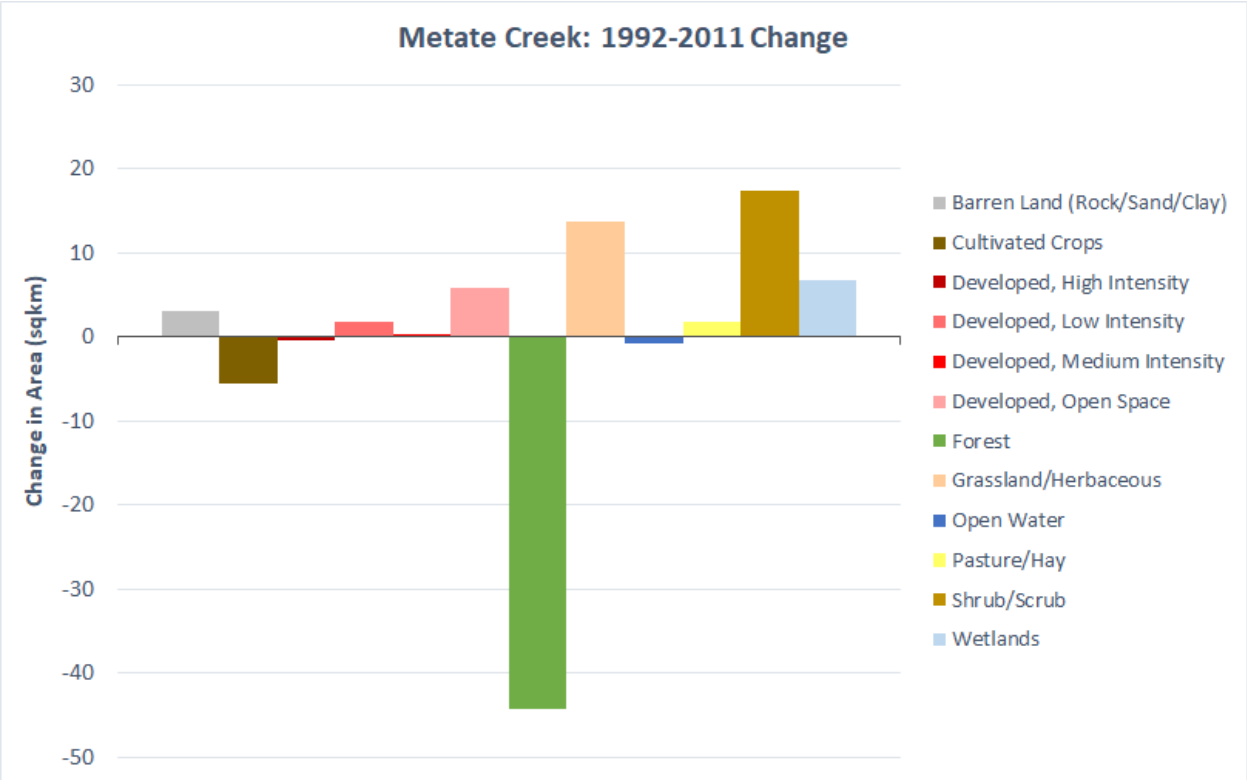

Figure 253. Land use change in area (sq km) from 1992-2011 for the Metate Creek watershed.

MUD CREEK

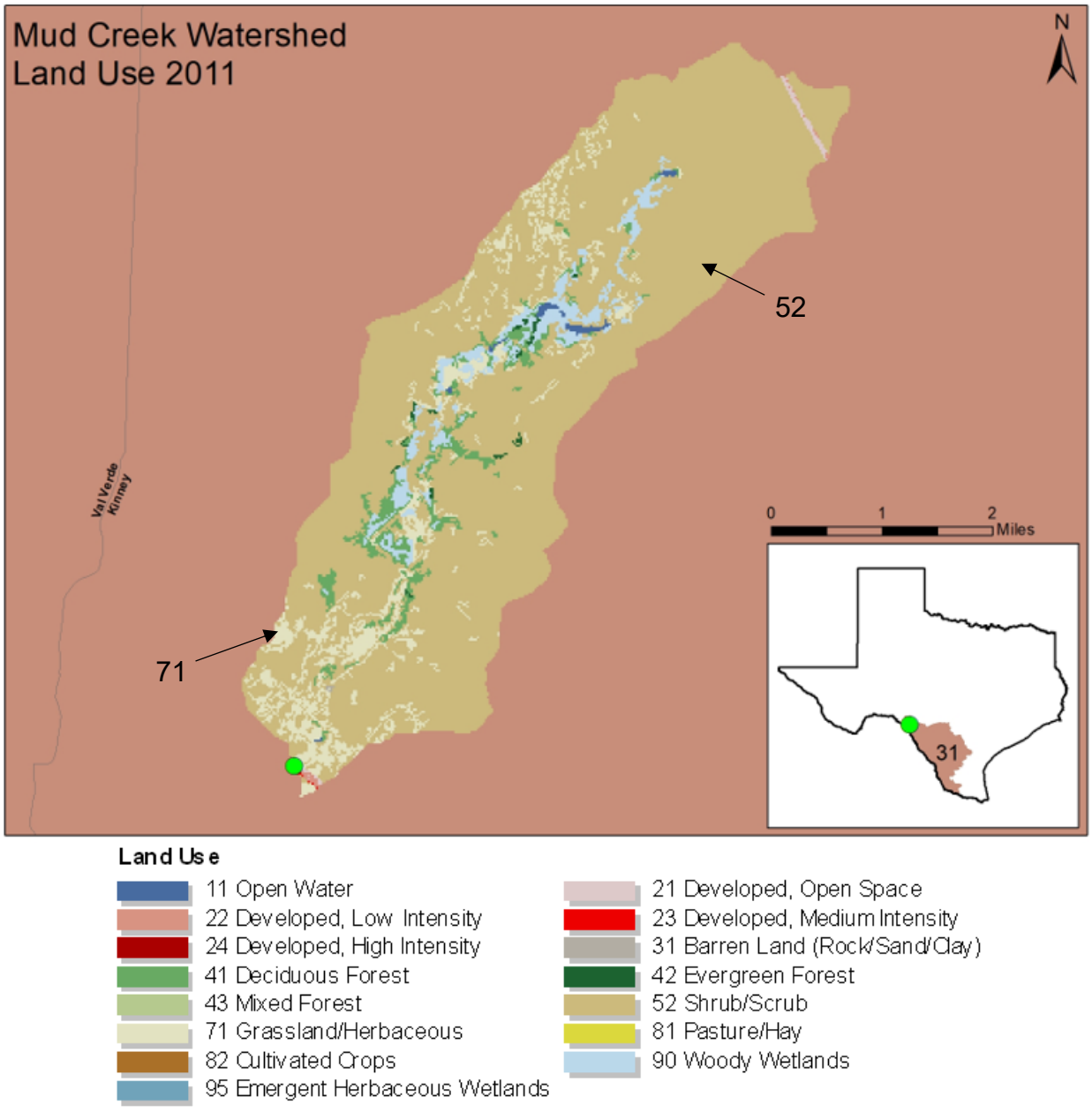

Figure 254. Map of Mud Creek watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	June 14, 1990
Water Quality:	6 sampling events
Fish:	June 14, 1990
Benthic Invertebrates:	June 14, 1990

Physical Characterization

Watershed and Land Use

Mud Creek lies within the Rio Grande Basin. Sample site 13136 is located at US 90, approximately 27.4 km west of Brackettville in Kinney County (Figure 254).

The Mud Creek watershed at site 13136 is approximately 36.16 sq km. The entire watershed lies within Level IV Ecoregion 31b, the Semiarid Edwards Bajada. The dominant land cover in the watershed is shrub at 82.51% and is present throughout the watershed (Homer et al. 2015; Figure 254 and Figure 255). Grassland/herbaceous is the secondary land cover, encompassing 8.66%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.45% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 2.14 sq km decrease in grassland and a 1.79 sq km decrease in forest. There was a 2.81 sq km increase in shrub and a 1.44 sq km increase in wetlands (Figure 256).

There are no wastewater outfalls in the Mud Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Mud Creek was evaluated on June 14, 1990. Mud Creek is a spring-fed stream that drains to Sycamore Creek, a tributary of the Rio Grande River. The riparian width was 36 meters. The riparian zone was dominated by grasses, which made up an average of 70% of the total riparian species, followed by shrubs (20%) then trees (10%). The average percentage of tree canopy cover was 0%. The dominant substrate was clay/silt, and the average percent of substrate that was gravel size or larger was 6%. Average percent instream cover was 39%. Mud Creek had an average depth of 0.2 meters and a maximum depth of 0.4 meters. The average width was 8.5 meters, and the average stream bank slope was 8 degrees. Stream flow at the site was 0.93 cfs. Average stream bank erosion potential was 22%. No riffles were observed at the site, and there was one moderately defined stream bend.

Water Quality

Water samples were collected at station 13136 over 6 sampling events from June 1993 to July 1999. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a. One 24-hour dissolved oxygen sample was collected on this segment in June 1990.

Biological Characterization

Fish

Nine species (five families) were collected from Mud Creek. The Centrarchidae family had the greatest species richness, with four species present. Common Carp, a non-native species, was the most abundant species collected, making up over 50% of the individuals in the sample. The

aquatic life use only rated as intermediate. The only metric that did not receive a reduced score was the percentage of individuals with a disease or anomaly.

Benthic Macroinvertebrates

Considering the single Surber sample from June 14, 1990, a total of 258 individuals representing 45 taxa from 12 orders of macroinvertebrates were collected from Mud Creek (Appendix E). The Diptera, Coleoptera, Odonata, Ephemeroptera, Oligochaeta, and Trichoptera were the most commonly collected orders, collectively accounting for 91.5 percent of the total number of individuals collected. The Basommatophora, Hemiptera, and Veneroida were the only other orders which comprised at least one percent of the collections. The Central Bioregion Surber BIBI for the 1990 Surber sample fell in the high aquatic life use category.

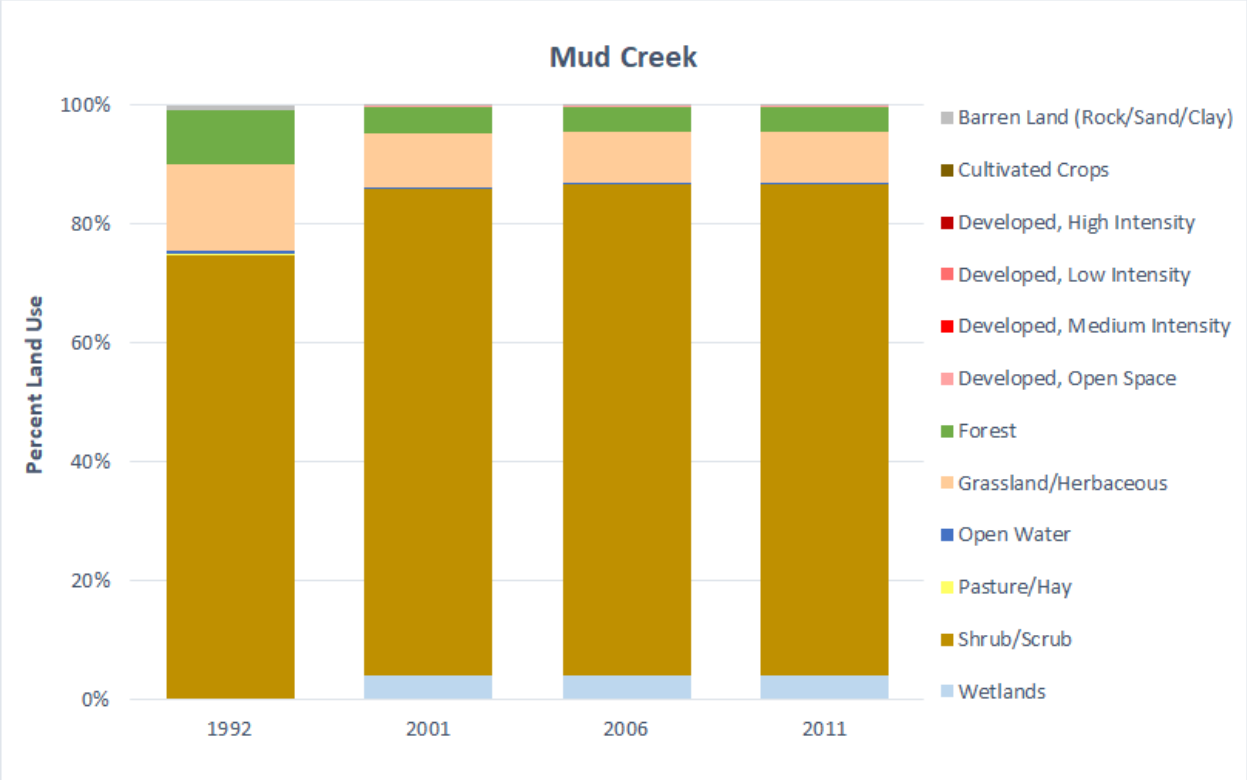

Figure 255. Percent land use in the Mud Creek watershed from 1992-2011.

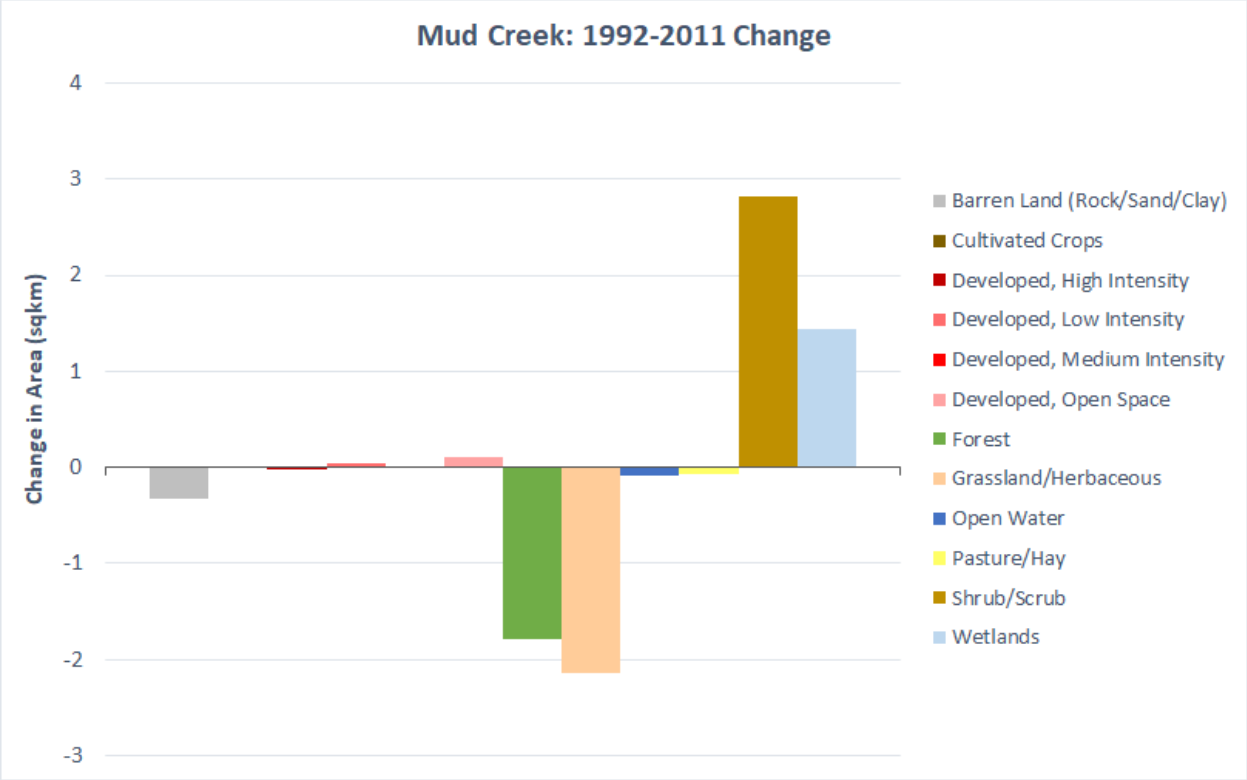

Figure 256. Land use change in area (sq km) from 1992-2011 for the Mud Creek watershed.

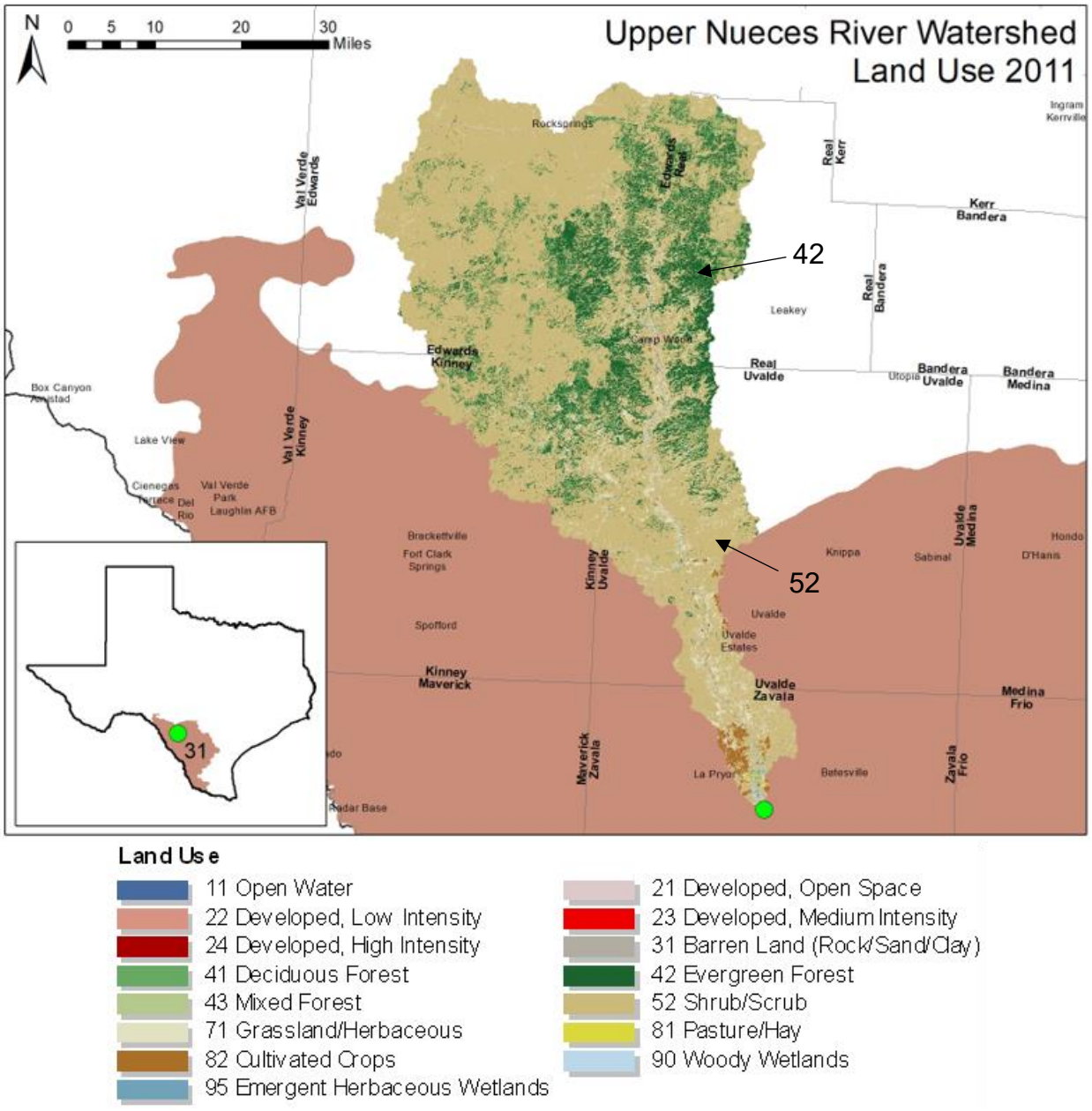

Figure 257. Map of Upper Nueces River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

Sampling Dates

Physical Habitat:	April 18, 2002; September 18, 2002; October 2, 2017; June 12, 2018
Water Quality:	June 12, 2018
Fish:	April 16-18, 2002; September 17-18, 2002; October 2, 2017; June 12, 2018
Benthic Invertebrates:	October 2, 2017; June 12, 2018

Physical Characterization

Watershed and Land Use

Nueces River is the basin's namesake and is a major river basin in Texas. Sample site 22083 is located on La Pryor Ranch, approximately 8.85 river km downstream of SH 57 and 8.71 km southeast of La Pryor in Zavala County (Figure 257).

The Nueces River watershed at site 22083 is approximately 5160.44 sq km. The station and lower watershed lie within Level IV Ecoregion 31a, the Northern Nueces Alluvial Plains. A small portion of the watershed lies within Level IV Ecoregion 31c, the Texas-Tamaulipan Thornscrub, while the middle and upper watershed lie within Ecoregion 30. The dominant land cover is shrub, which is present throughout 71.90% of the watershed (Homer et al. 2015; Figure 257 and Figure 258). Forest is the secondary land cover encompassing 20.19% of the watershed. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 1.73%, and total for cultivated crop is 0.82%.

From 1992-2011 there was an 805.94 sq km decrease in forest and a 539.77 sq km decrease in grassland. There was a 1407.05 sq km increase in shrub and a 79.07 sq km increase in open space development (Figure 259).

There are no wastewater outfalls in the Nueces River watershed.

In Channel and Riparian Physical Habitat

Physical habitat for the Nueces River was evaluated at two sites across four sampling events. One site, located at the intersection of US 83, was sampled on April 18, 2002, September 18, 2002, and October 2, 2017. The second site, located on La Pryor Ranch, was sampled on June 12, 2018. Habitat Quality Index scores in April and September 2002 were 18.5 and 20, respectively and indicate an intermediate to high aquatic life use, while scores in 2017 and 2018 (25 and 28, respectively) indicate a high to exceptional aquatic life use rating. The riparian buffer ranged from 0 meters in 2002 to greater than 20 meters in 2017 and 2018. The riparian zone was primarily dominated by trees, followed by shrubs, then grasses. The average percentage of tree canopy cover ranged from 18% to 77%. The dominant substrate was cobble/gravel in 2002 and 2017, and silt in 2018. The average percent of substrate that was gravel size or larger ranged from 60% to 87%. Average percent instream cover varied from 34% to 86%, and instream cover types include macrophytes, cobble/gravel, woody debris, algae, overhanging vegetation, and undercut banks. The Nueces River ranges from 0.3-0.6 meters deep on average and 11-39 meters wide. Average stream bank slope was between 24 and 39 degrees. Stream flow at the site was measured at a minimum value of 10 cfs in 2018 and a maximum of 80 cfs in September 2002. Average stream bank erosion potential was 31% to 79%. The deepest pool was 2.4 meters in 2018. The maximum number of riffles observed was six in September 2002 and the maximum number of stream bends was four in 2018.

Water Quality

Water samples were collected during one event at station 22083 in June 2018. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a. One 24-hour dissolved oxygen sample was collected on this segment during the June 2018 sampling event.

Biological Characterization

Fish

Data from five sampling stations located from upstream of FM 481 to US 57 (about 35 kilometers), were used to evaluate aquatic life use. 29 species (nine families) were collected over the course of 10 sampling events. The Centrarchidae family had the greatest species richness, with nine species present. Of the twenty-nine species, six were present in every sample. These six species were Blacktail Shiner, Western Mosquitofish, Rio Grande Cichlid (*Herichthys cyanoguttatus)*, Channel Catfish, Green Sunfish, and Longear Sunfish. Seven of the ten fish collections rated as exceptional, three as high. Two of the high ratings were from the most recent collections (from two different sampling locations). Both recent collections remained as high when the coefficient of variability was applied; however, the April 2002 collection rose to exceptional.

Benthic Macroinvertebrates

Considering the two RBP samples (October 2, 2017 and June 12, 2018) together, a total of 584 individuals representing 55 taxa from 17 orders of macroinvertebrates were collected from the Nueces River (Appendix E). Ephemeroptera, Trichoptera, Diptera, Coleoptera, Odonata, Hemiptera, and Neoophora were the most commonly collected orders, collectively accounting for 91.6 percent of the total number of individuals collected. Neotaenioglossa, Veneroida, Oligochaeta, and Lepidoptera were the only other orders which comprised at least 1% of the collections. The Statewide BIBI for both RBP samples fell in the exceptional aquatic life use category.

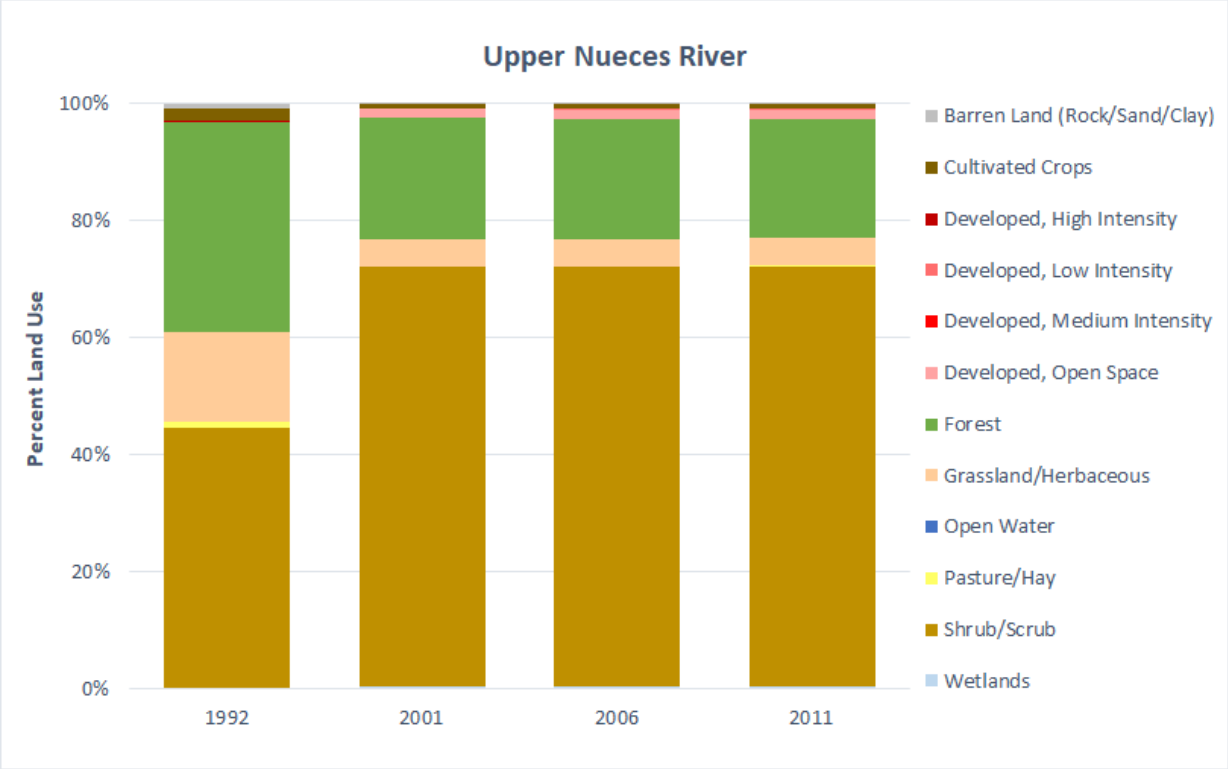

Figure 258. Percent land use in the Upper Nueces River watershed from 1992-2011.

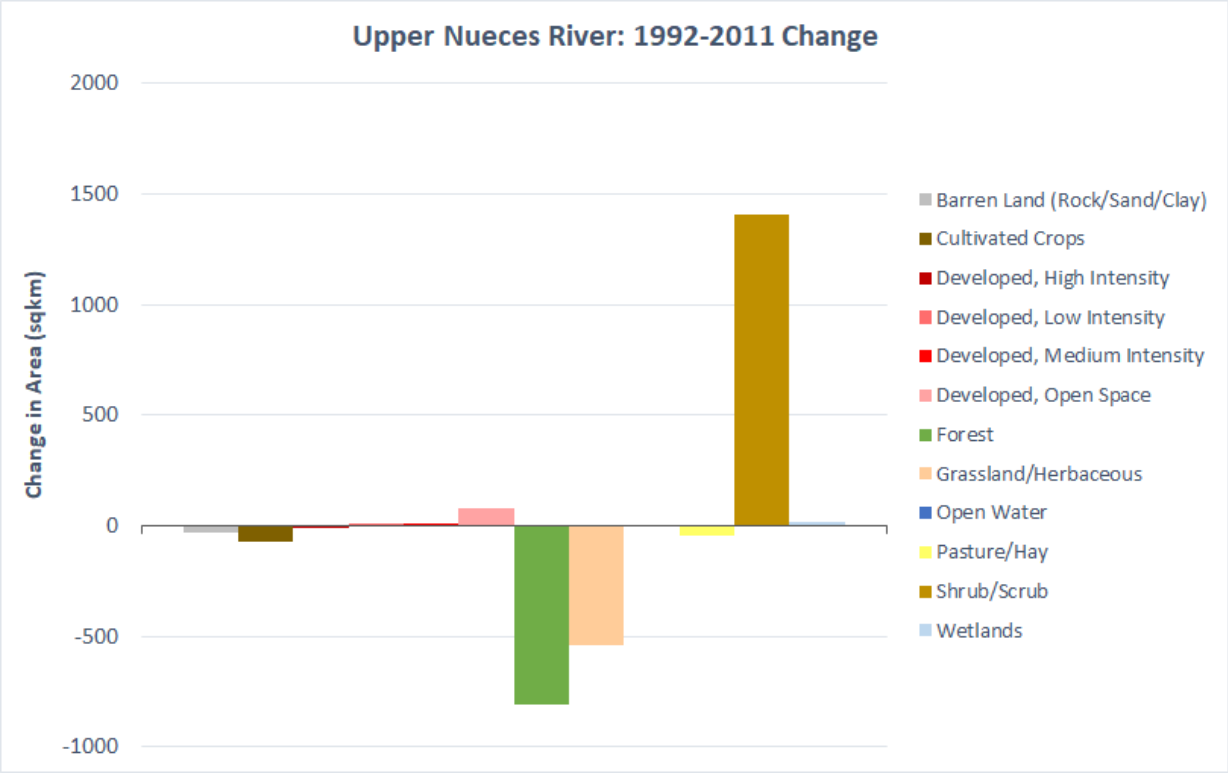

Figure 259. Land use change in area (sq km) from 1992-2011 for the Upper Nueces River watershed.

PINTO CREEK

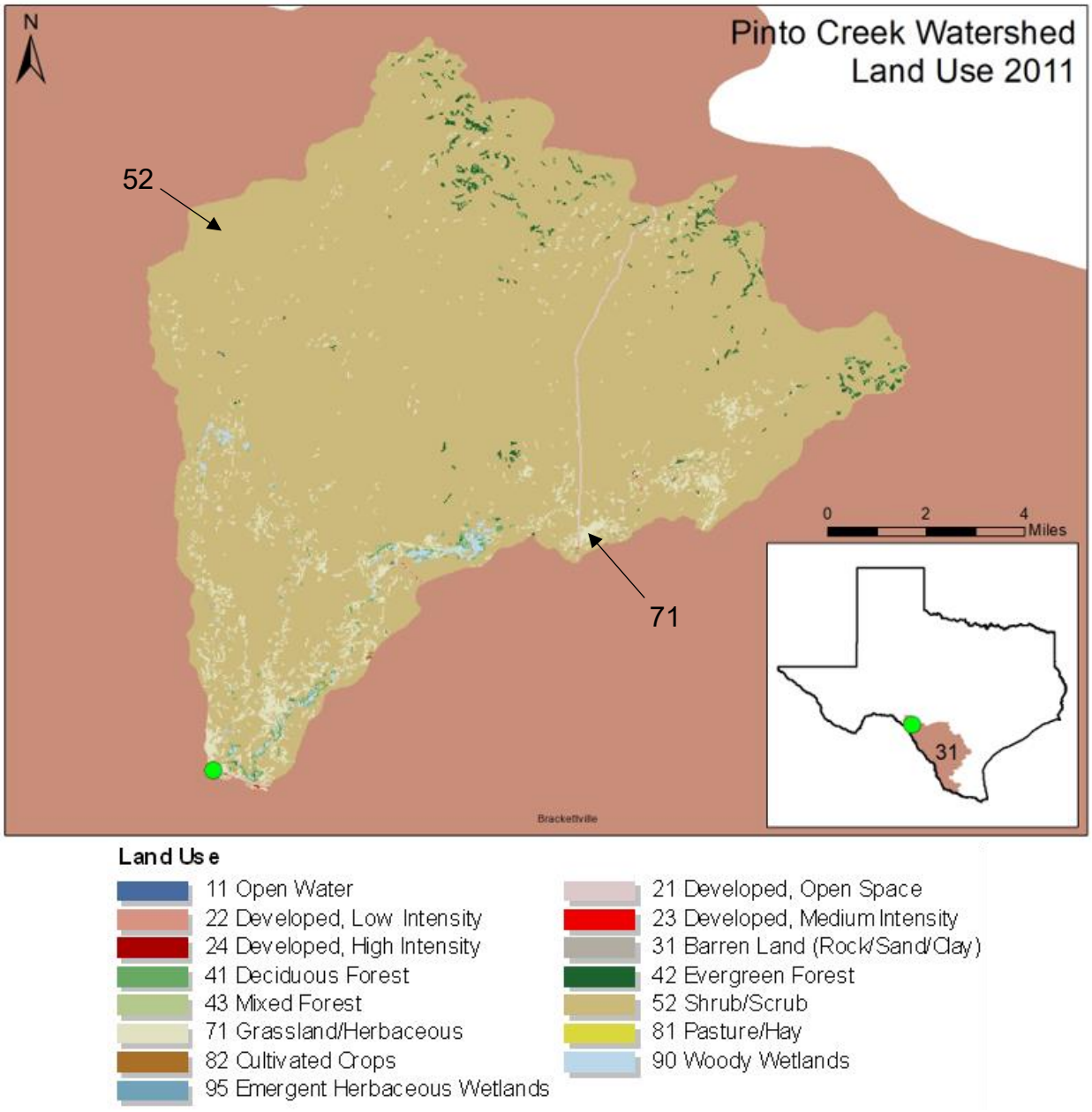

Figure 260. Map of Pinto Creek watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	June 13, 1990; July 7, 2016; February 28, 2017
Water Quality:	July 2016; February 2017
Fish:	June 13, 1990; July 7, 2016; February 28, 2017
Benthic Invertebrates:	June 13, 1990; July 7, 2016; February 28, 2017

Physical Characterization

Watershed and Land Use

Pinto Creek lies within the Rio Grande Basin. Sample site 13137 is located on US 90, 12.9 kilometers west of Brackettville in Kinney County (Figure 260).

The Pinto Creek watershed at site 13137 is approximately 309.39 sq km. The station and majority of the watershed lie within Level IV Ecoregion 31b, the Semiarid Edwards Bajada. A small portion of the upper watershed lies within Level IV Ecoregion 31c, the Texas-Tamaulipan Thornscrub. The dominant land cover is shrub, present throughout 93.48% of the watershed (Homer et al. 2015; Figure 260 and Figure 261). Grassland/herbaceous is the secondary land cover encompassing 4.17%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.35%, and the total for cultivated crop is 0.01%.

From 1992-2011 there was a 57.56 sq km decrease in grassland and a 24.50 sq km decrease in forest. There was a 98.44 sq km increase in shrub and a 1.64 sq km increase in wetlands (Figure 262).

There are no wastewater outfalls in the Pinto Creek watershed.

In Channel and Riparian Physical Habitat

Pinto Creek is a spring-fed stream that drains to the Rio Grande River. Physical habitat for Pinto Creek was evaluated at three sites within an 8-kilometer stretch north of US 90. One site was sampled on June 13, 1990, the second on July 7, 2016, and the third site on February 28, 2017. Habitat Quality Index scores in 2016 and 2017 were 23 and 23.5, respectively, and both indicate a high aquatic life use rating. The riparian buffer was wide and ranged from 12 meters on average to greater than 20 meters. The riparian zone was dominated by trees, followed by shrubs and grasses; and the average percentage of tree canopy cover ranged from 39% to 41%. The dominant substrate was silt, but cobble and gravel were common in riffle/run habitats, and the average percent of substrate gravel size or larger ranged from 16% to 28%. Average percent instream cover varied from 47% to 54%, and instream cover types included abundant macrophytes, algae, woody debris, overhanging vegetation, undercut banks, root mats, cobble/gravel, and boulders. Pinto Creek was 0.7-1.1 meters deep on average and 17 to 22 meters wide. The deepest pool at Pinto Creek was 3 meters. Average stream bank slope ranged from 22-28 degrees, and stream bank erosion potential was 15% to 23% on average. Stream flow at the site was measured at a minimum value of 9.3 cfs in 2016 and a maximum of 29 cfs in 2017. At least one riffle was observed for each sampling event, and the maximum number of stream bends recorded was four in 2017.

Water Quality

Water samples were collected at two stations along Pinto Creek: at station 21921 in July 2016 and at station 21987 in February 2017. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total

nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a. One 24-hour dissolved oxygen sample was collected on this segment in June 1990.

Biological Characterization

Fish

Eighteen species (seven families) were collected over the course of the three sampling events. Centrarchidae was the most species-rich family, with seven species. The two most recent collections (which were conducted in a reach upstream of the 1990 collection) yielded Devils River Minnow (a federally listed threatened species) and Headwater Catfish, *Ictalurus lupus* (a state listed threatened species). Each of the three collections had a different dominant species. Red Shiner was the most abundant species in 1990 (it was not collected in the other two samples), Texas Shiner was the most abundant in 2016, and Western Mosquitofish was the most abundant in 2017. All three fish assemblages rated as having a high aquatic life use.

Benthic Macroinvertebrates

Considering the single Surber sample from June 13, 1990 and the two RBP samples (July 7, 2016 and February 28, 2017) collectively, a total of 2,534 individuals representing 124 taxa from 18 orders of macroinvertebrates were collected from Pinto Creek (Appendix E). Trichoptera, Ephemeroptera, Veneroida, Diptera, Odonata, Coleoptera, Oligochaeta, Neoophora, and Amphipoda were the most commonly collected orders, collectively accounting for 93.4 percent of the total number of individuals collected. Basommatophora, Hoplonemertea, and Hemiptera were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the 1990 Surber sample fell in the exceptional aquatic life use category. The statewide BIBI for the February 2017 and July 2016 RBP samples fell in the exceptional and high aquatic life use categories, respectively.

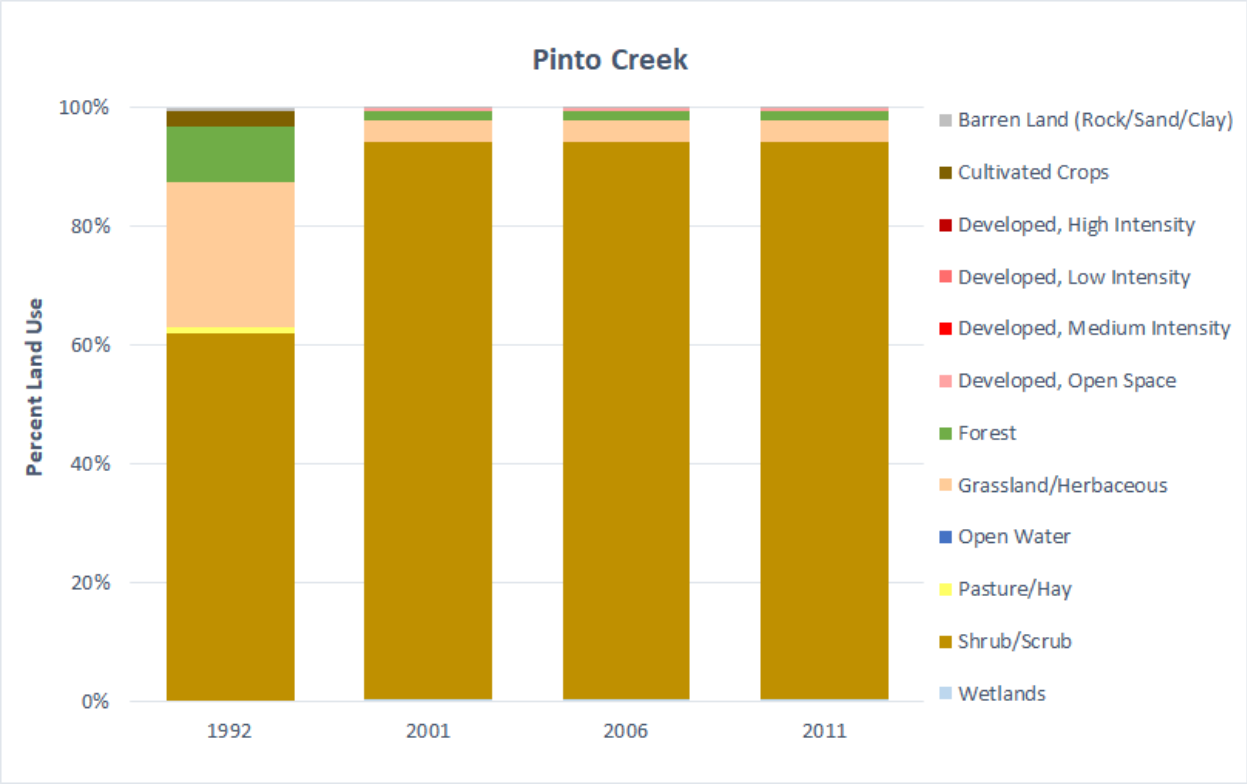

Figure 261. Percent land use in the Pinto Creek watershed from 1992-2011.

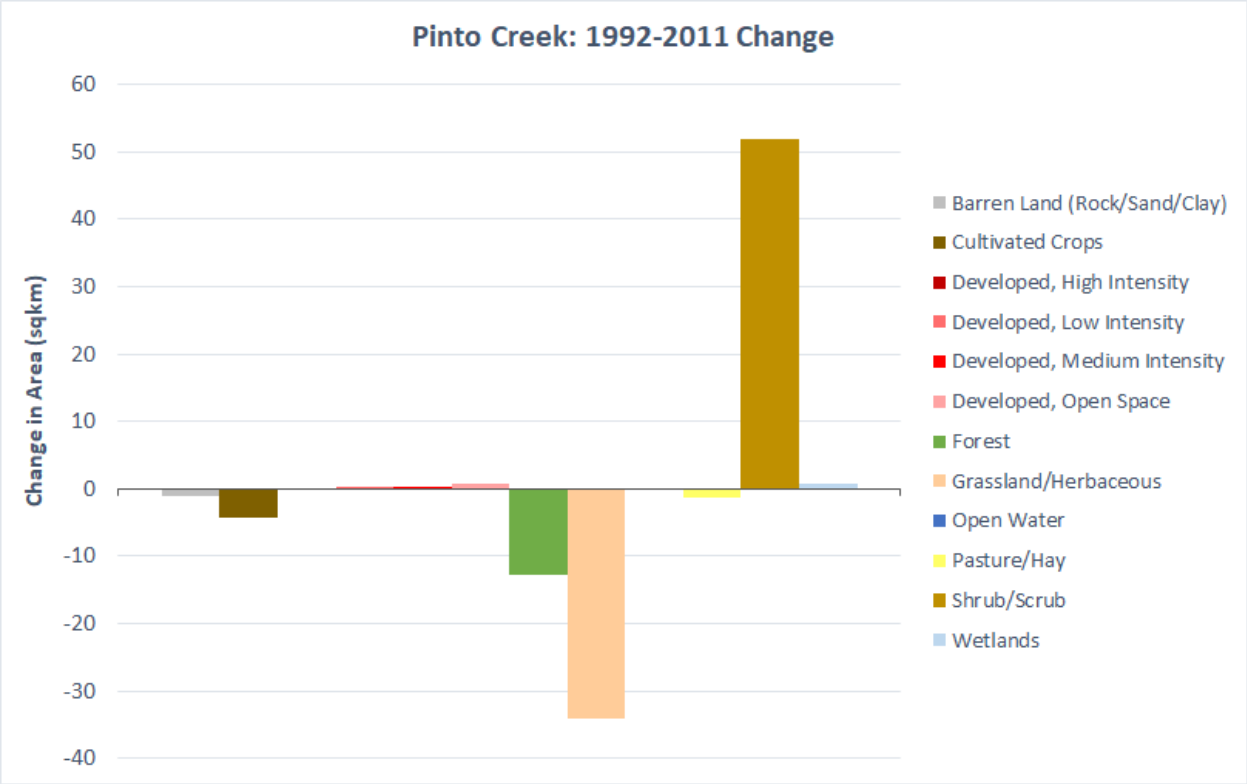

Figure 262. Land use change in area (sq km) from 1992-2011 for the Pinto Creek watershed.

SAN MIGUEL CREEK

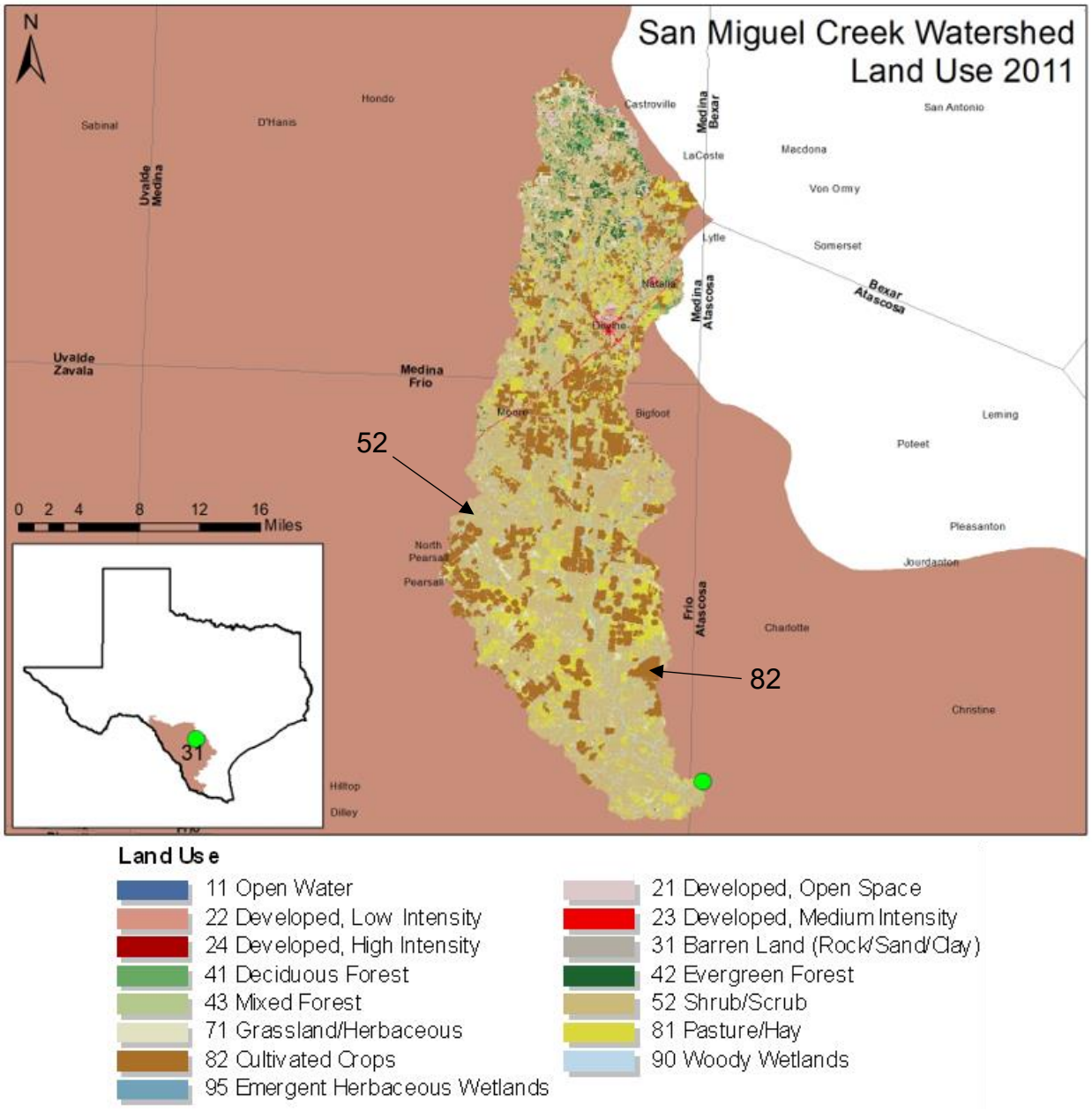

Figure 263. Map of San Miguel Creek watershed location and 2011 land use; shrub/scrub and cultivated crops were the most common land uses.

Sampling Dates

Physical Habitat:	July 31, 1990; June 13, 2018
Water Quality:	July 1990; July 1999; July 2018
Fish:	July 31, 1990; June 13, 2018
Benthic Invertebrates:	July 31, 1990; June 13, 2018

Physical Characterization

Watershed and Land Use

San Miguel Creek lies within the Nueces River Basin. Sample site 12984 is located at SH 97, approximately 19.31 km south of Charlotte in Atascosa County (Figure 263).

The San Miguel Creek watershed at site 12984 is approximately 1275.26 sq km. The station and lower watershed lie within Level IV Ecoregion 31c, the Texas-Tamaulipan Thornscrub, while the upper watershed lies in Level IV Ecoregion 31a, the Northern Nueces Alluvial Plains. The dominant land cover is shrub, present throughout 47.88% of the watershed (Homer et al. 2015; Figure 263 and Figure 264). Cultivated crop is the secondary land cover, encompassing 20.26%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 7.42%.

From 1992-2011 there was a 283.89 sq km decrease in pasture/hay and a 104.94 sq km decrease in forest. There was a 168.71 sq km increase in shrub and a 110.64 sq km increase in cultivated crops (Figure 265).

There are three domestic wastewater outfalls (discharging less than one million gallons per day) within the San Miguel Creek watershed. The domestic wastewater facilities are permitted to Moore Water Supply Company and the cities of Natalia and Devine. None of these facilities discharge directly into San Miguel Creek.

In Channel and Riparian Physical Habitat

Physical habitat for San Miguel Creek was evaluated on July 31, 1990, and again on June 13, 2018. San Miguel Creek is a perennial stream that drains to Choke Canyon Reservoir. The following summary information is based on data collected during the most recent sampling event in 2018. The Habitat Quality Index score of 17 indicates an intermediate aquatic life use rating. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was dominated by grasses, which make up an average of 70% of the total riparian species, followed by trees and shrubs (15% each). The average percentage of tree canopy cover was 66%. The dominant substrate was silt, and the average percent of substrate that was gravel size or larger was 29%. Average percent instream cover was 25%, and instream cover types included woody debris, boulders, and cobble. San Miguel Creek was 0.4 meters deep and 6.2 meters wide on average. The average stream bank slope was 44 degrees, and the average stream bank erosion potential was 74%. The deepest pool measured at San Miguel Creek was 1.07 meters. Stream flow at the site was measured at a minimum value of 0 cfs in 2018 and a maximum of 3.9 cfs in 1990. No riffles were observed at the site in 2018 due to low flow conditions, and there were three total stream bends.

Water Quality

Water samples were collected at both stations 12984 and 22085 on San Miguel Creek. Water samples were collected at station 12984 over two events: July 1990 and July 1999. Additionally, one set of water samples were collected in July 2018 at station 22085. Data were collected for

temperature, flow, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a. One 24 hour dissolved oxygen sample was collected on this segment during the June 2018 sampling event.

Routine monitoring data at other stations along this segment in 2017 found portions of the segment to be intermittent with pools.

Biological Characterization

Fish

Sixteen species (six families) were collected between the two sampling events. Centrarchidae had the most species of any family with eight species represented. Three species were unique to the 1990 collection - Black Bullhead *Ameiurus melas*, Red Shiner, and Bullhead Minnow. Their absence from the 2018 collection is likely a function of their relatively low abundance rather than a change in water quality or habitat. The same can be said of Golden Shiner, Redbreast Sunfish, and Sailfin Molly *Poecilia latipinna,* which were only collected in 2018. Western Mosquitofish was the most abundant species in both collections. The aquatic life use for the 1990 and 2018 fish collections were exceptional and high, respectively.

Benthic Macroinvertebrates

Considering the single Surber sample from July 31, 1990 and single RBP sample from June 13, 2018 together, a total of 217 individuals representing 41 taxa from 12 orders of macroinvertebrates were collected from San Miguel Creek (Appendix E). Ephemeroptera, Diptera, Coleoptera, Decapoda, Odonata, and Amphipoda were the most commonly collected orders, collectively accounting for 92.3 percent of the total number of individuals collected. Hemiptera, Oligochaeta, and Basommatophora were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the 1990 Surber sample fell in the high aquatic life use category. The statewide BIBI for the 2018 RBP sample fell in the intermediate aquatic life use category.

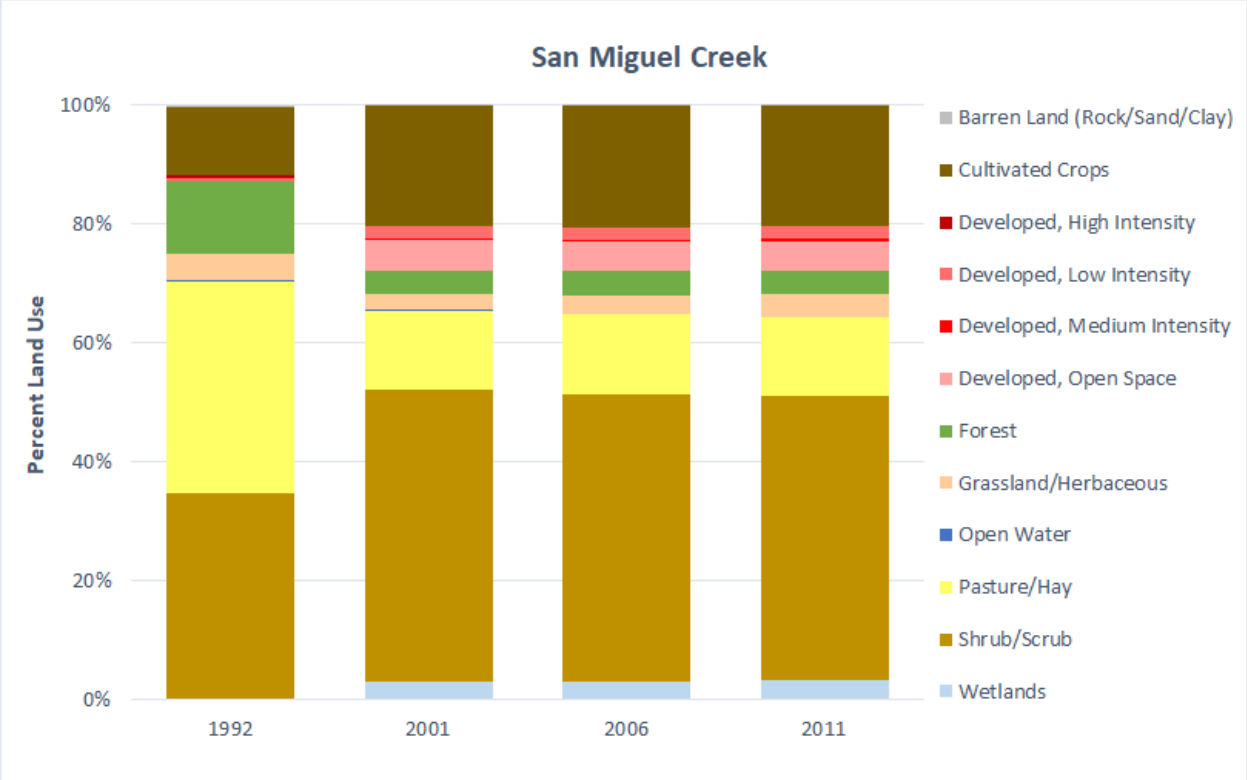

Figure 264. Percent land use in the San Miguel Creek watershed from 1992-2011.

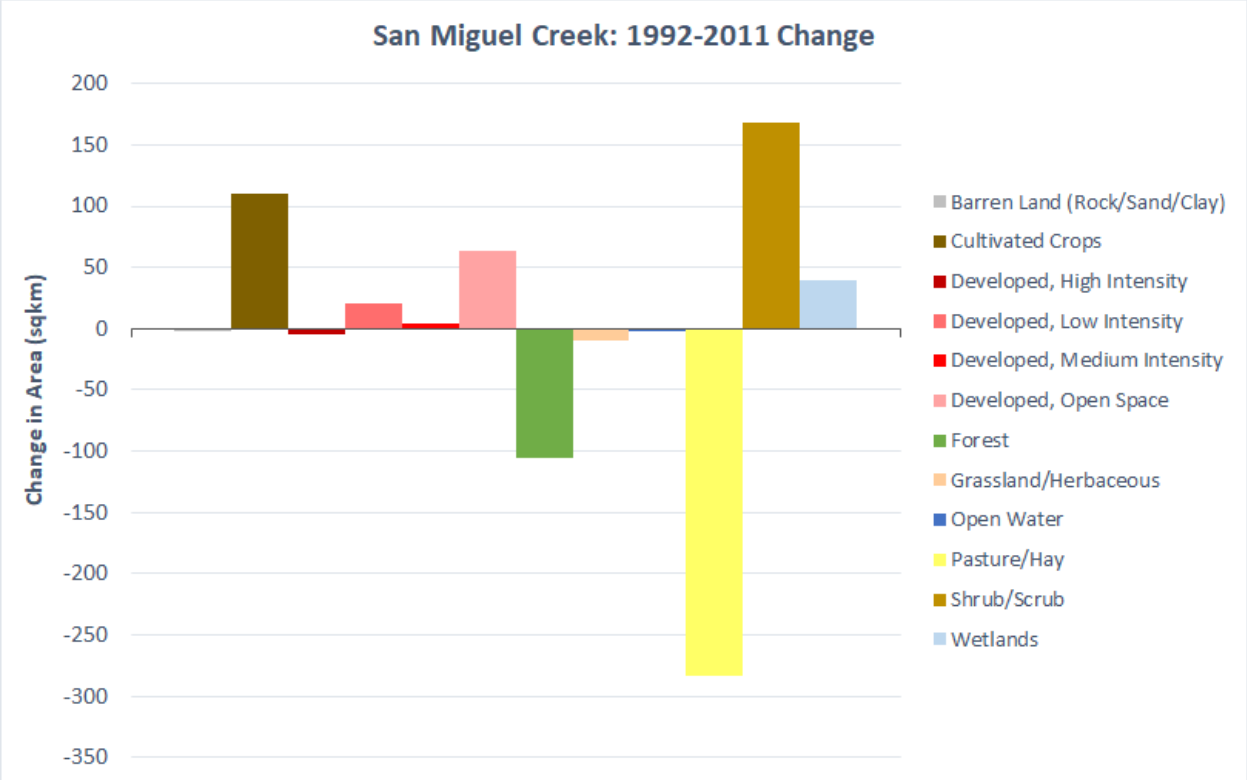

Figure 265. Land use change in area (sq km) from 1992-2011 for the San Miguel Creek watershed.

SYCAMORE CREEK

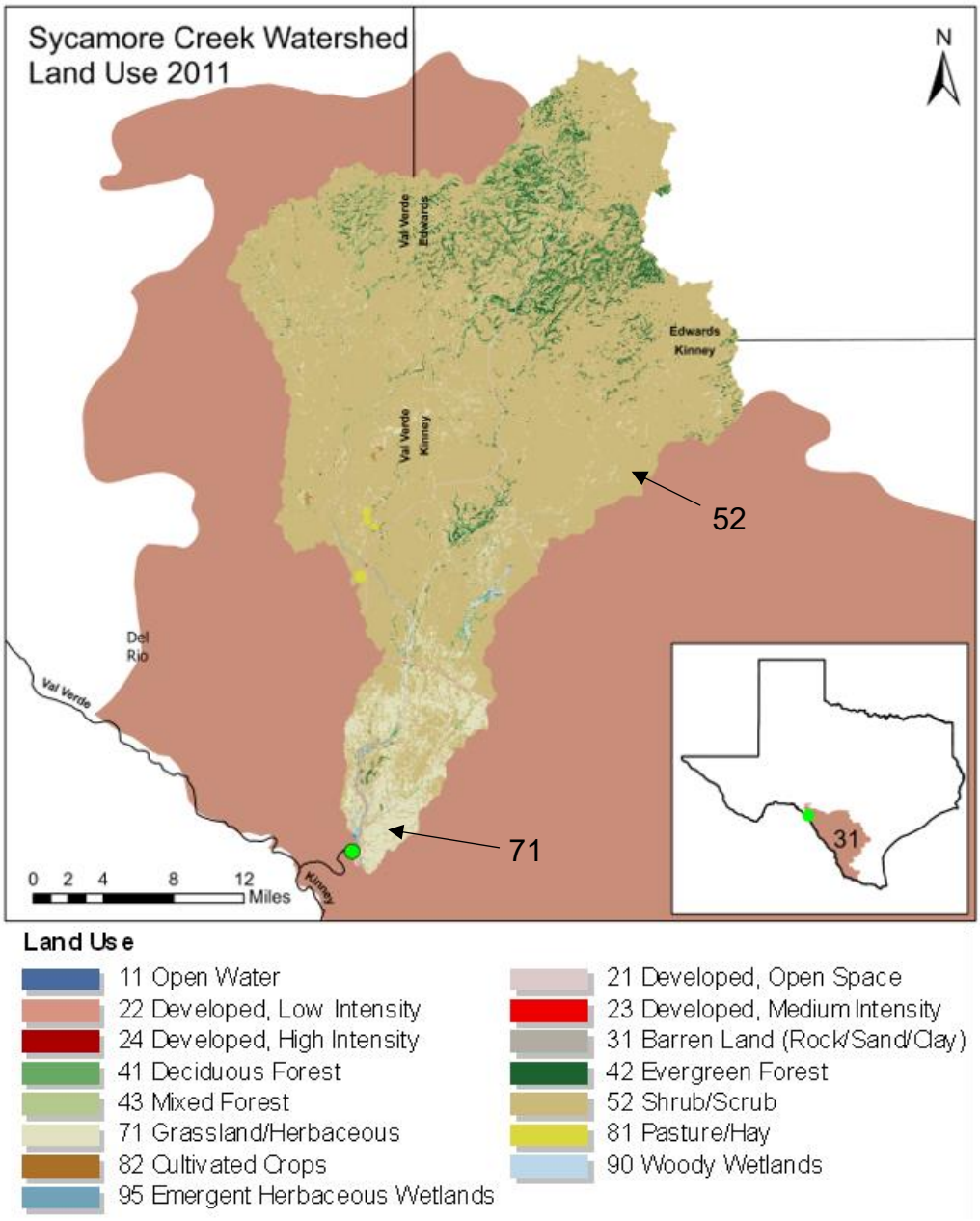

Figure 266. Map of Sycamore Creek watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat:	June 12, 1990; August 3, 2017
Water Quality:	12 sampling events
Fish:	June 12, 1990; August 3, 2017
Benthic Invertebrates:	June 12, 1990; August 3, 2017

Physical Characterization

Watershed and Land Use

Sycamore Creek lies within the Rio Grande Basin. Sample site 13135 is located upstream of US 277 approximately 18.5 km southeast of Del Rio in Val Verde County (Figure 266).

The Sycamore Creek watershed at site 13135 is approximately 1283.61 sq km. The station and a small portion of the lower watershed lie within Level IV Ecoregion 31c, the Texas-Tamaulipan Thornscrub. The middle portion of the watershed lies within Level IV Ecoregion 31b, the Semiarid Edwards Bajada, and the upper portion of the watershed lies within Ecoregion 30. The dominant land cover in the watershed is shrub at 83.87% and is present throughout the watershed (Homer et al. 2015; Figure 266 and Figure 267). Grassland/herbaceous is the secondary land cover encompassing 7.69%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 0.57% and total for cultivated crop is 0.05%.

From 1992-2011 there was a 304.13 sq km decrease in grassland and a 25.90 sq km decrease in pasture/hay. There was a 351.15 sq km increase in shrub and a 5.95 sq km increase in open space development (Figure 268).

There are no wastewater outfalls in the Sycamore Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Sycamore Creek was evaluated on June 12, 1990, and again on August 3, 2017. Sycamore Creek is a spring-fed perennial stream that drains to the Rio Grande River. The following summary information is based on data collected during the most recent sampling event in 2017. The Habitat Quality Index score of 25.5 indicates a high to exceptional aquatic life use rating. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was dominated by grasses, which make up an average of 40% of the total riparian species, followed by shrubs (35%) then trees (25%). The average percentage of tree canopy cover was 33%. The dominant substrate was gravel, and the average percent of substrate that was gravel size or larger was 69%. Average percent instream cover was 63% and instream cover types included undercut banks, macrophytes, algae, cobble/gravel, overhanging vegetation, root mats, woody debris, and bedrock ledges. Sycamore Creek was 0.5 meters deep on and 34.5 meters wide on average. Average stream bank slope was 21.5 degrees, and average stream bank erosion potential was 24%. The deepest pool measured at Sycamore Creek was 2 meters. Stream flow at the site was measured at a minimum value of 2.4 cfs in 1990 and a maximum of 13 cfs in 2017. Three riffles were observed at the site in 2017 and there were three total stream bends.

Water Quality

Water samples were collected at station 13135 over 12 sampling events from June 1990 to February 1993. Data were collected for temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus,

total organic carbon, chloride, sulfate, and chlorophyll-a. No 24-hour dissolved oxygen samples were collected on this segment.

Biological Characterization

Fish

Twenty-two species (seven families) were collected between the two sampling events. The family yielding the most species was Cyprinidae, with nine species present. Manantial Roundnose Minnow was the most abundant species in 1990 but was absent from the 2017 collection. The most abundant species in 2017 was Blacktail Shiner, which was only collected in relatively low numbers in 1990. Three state listed threatened species were collected in 1990 - Proserpine Shiner, Rio Grande Darter, and Headwater Catfish. Despite the 1990 sample yielding twice the number of species, both fish assemblages rated as having a high aquatic life use.

Benthic Macroinvertebrates

Considering the single Surber sample from June 12, 1990 and single RBP sample from August 3, 2017 together, a total of 2,826 individuals representing 84 taxa from 20 orders of macroinvertebrates were collected from Sycamore Creek (Appendix E). Diptera, Ephemeroptera, Neoophora, Trichoptera, Odonata, Neotaenioglossa, and Coleoptera were the most commonly collected orders, collectively accounting for 90.3 percent of the total number of individuals collected. Trombidiformes, Ostracoda, Oligochaeta, and Hirudinida were the only other orders which comprised at least one percent of the collections.

The Central Bioregion Surber BIBI for the 1990 Surber sample fell in the high aquatic life use category. The statewide BIBI for the 2017 RBP sample fell in the exceptional aquatic life use category.

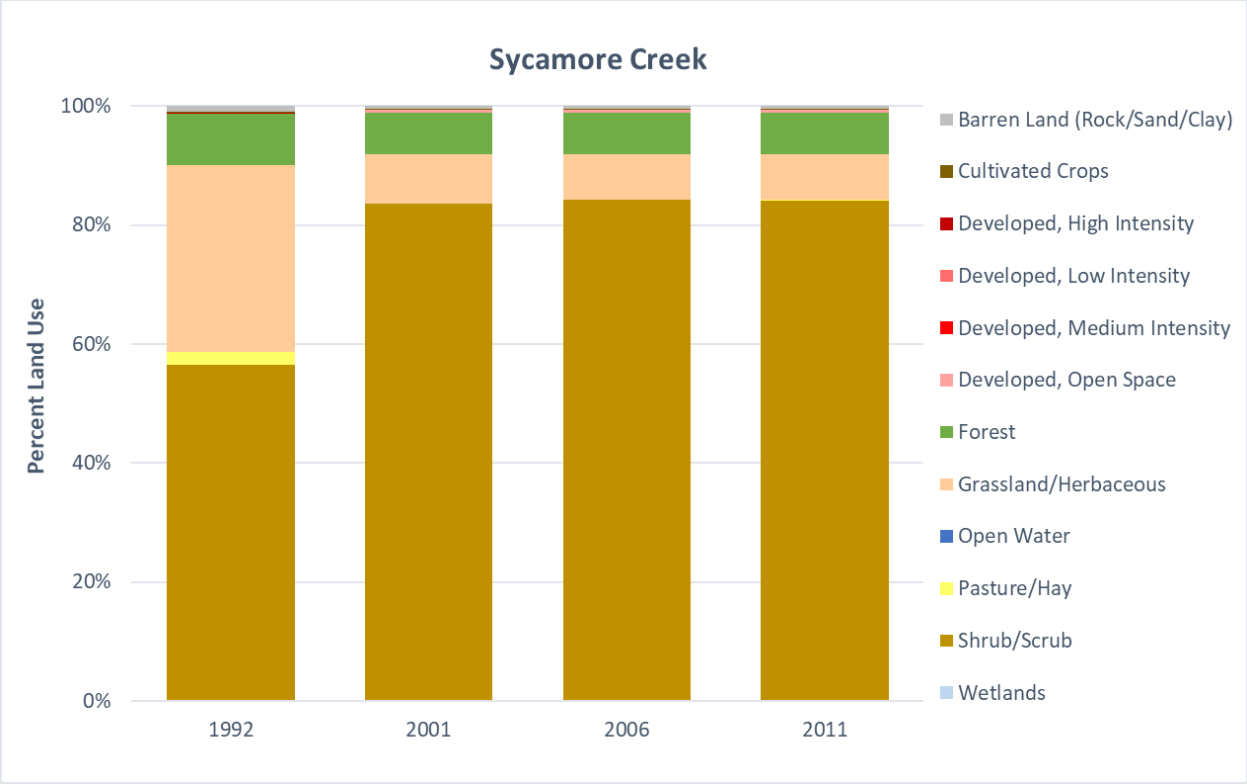

Figure 267. Percent land use in the Sycamore Creek watershed from 1992-2011.

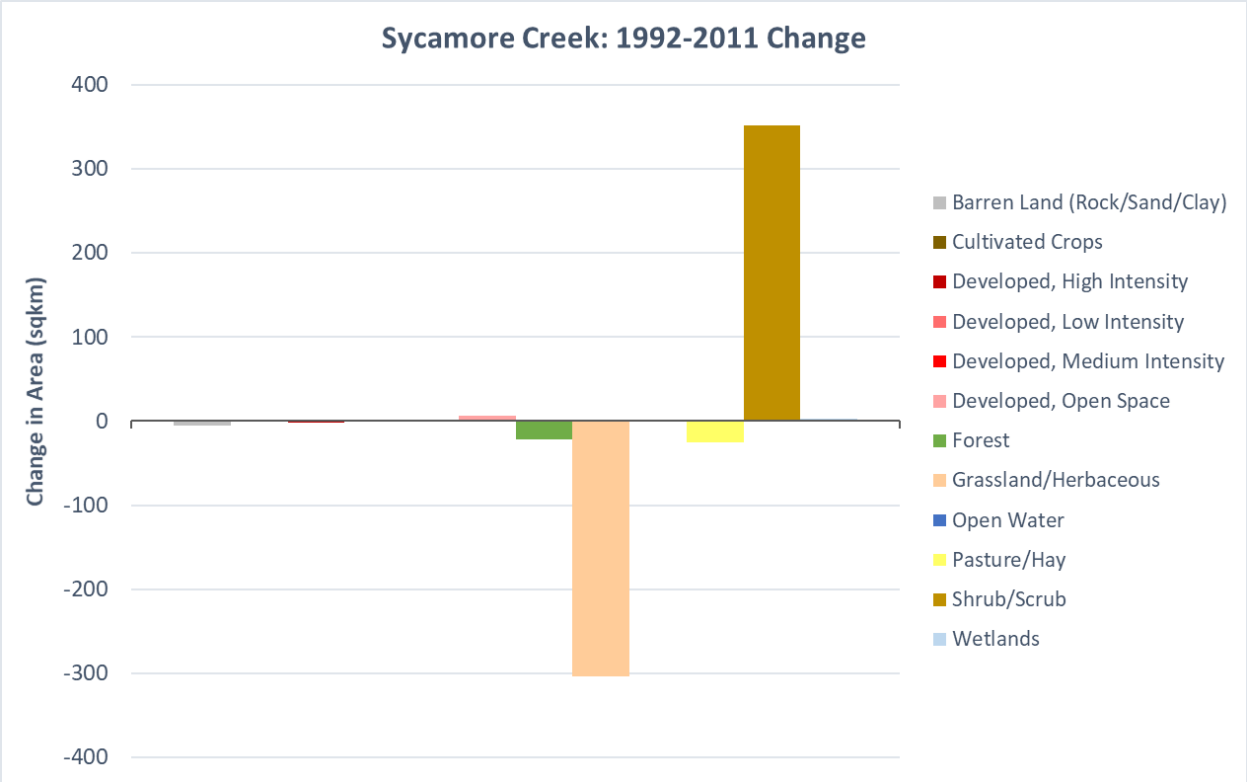

Figure 268. Land use change in area (sq km) from 1992-2011 for the Sycamore Creek watershed.

Ecoregion 31 Summary and Historical Characterization

Watershed and Land Use

Ecoregion 31 was historically covered by grassland and savanna vegetation; however, due to long continued grazing and fire suppression, this area is now predominantly thorny brush vegetation. The area contains a high diversity of animal life, and oil and gas production activities are widespread (Griffith et al. 2007). In 2011 the overall primary land cover in the study watersheds was shrub, and the secondary land cover was grassland. Between 1992-2011, forest experienced the largest decrease in combined land cover area across all watersheds (~856.54 sq km) and shrub experienced the largest increase (~2,050.86 sq km).

In Channel and Riparian Physical Habitat

Physical habitat for the Southern Texas Plains was evaluated at seven stream sites over 14 sampling events from 1990 to 2018. Watershed area varied from a minimum of 36 sq km at Mud Creek to a maximum of 5,160 sq km at the Upper Nueces River. The sites generally had well vegetated riparian zones, and the riparian buffer was 38 meters on average, with a minimum of 0 meters and maximum of 91 meters. Trees were the dominant riparian species (35% on average), followed by grasses (31%) and shrubs (31%), and average percent tree canopy coverage was 40%. Dominant substrate at the sites was generally silt or cobble/gravel. Average percentage of substrate gravel sized or larger was 44% and varied from a minimum of 0% to a maximum of 87%. Average percent instream cover was 42% and common instream cover types include macrophytes, cobble/gravel, woody debris, algae, overhanging vegetation, undercut banks, root mats, boulders and bedrock ledges. Average stream depth and width measurements were 0.5 meters and 16 meters, respectively. Average stream bank slope was 31 degrees and erosion potential was moderate, with an average of 41% which was reflected in the average bank stability HQI score (1.7) indicating moderately stable to moderately unstable stream banks. Maximum pool depth ranged from a minimum of 0.4 meters to a maximum of 3 meters. Total number of riffles varied from zero to six, and total number of stream bends ranged from one to ten. Additional in-channel and riparian physical habitat attributes are summarized in Appendix B.

HQI scores are available for eight events and range from a maximum score of 28 (exceptional) at the Upper Nueces River on La Pryor Ranch to a minimum score of 17 (intermediate) at San Miguel Creek on Las Lomas Ranch. Of the eight sampling events with an HQI score, two (25%) received a habitat assessment rating of exceptional, four (50%) received a rating of high, and the remaining two (25%) received a rating of intermediate. The highest scoring HQI metrics for the Southern Texas Plains were the dimensions of largest pool metric and the available instream cover metric. The lowest scoring HQI metrics on average were the channel sinuosity metric and the bank stability metric.

Water Quality

Water quality data from ecoregion 31 was similar between stations. Specific conductivity ranged between 315 and 1,810, with a median value of 488 microsiemens per centimeter (uS/cm) at 25° C. The transparency in the water column was higher than in the eastern part of the state, as indicated by the median Secchi value of one meter. The total organic carbon in ecoregion 31 was lower than other parts of the state and similar to concentrations in ecoregions 30 and 34. The pH values ranged from 7.09 to 8.4, with a median of 7.7. Nutrient concentrations in the streams were higher for nitrogen species than for total phosphorus. The median total phosphorus concentration of 0.03 mg/L and the median TKN concentration was 0.31 mg/L. Additional water quality variables are summarized in appendix C of the report.

Fish

A total of 9,345 individuals consisting of 10 families and 43 species have been documented in 20 sampling events across seven streams in the Southern Texas Plains from 1990 to 2018 (Appendix D - 5). For individual sites, taxa richness ranged from a high of 30 species at the Nueces River across 10 sampling events from 2002 to 2018, to a low of nine species at Las Moras, Metate, and Mud creeks from one sampling event each in 1990. The most abundant species collected across all sites and sampling events were Texas Shiner (n = 1,887), Longear Sunfish (n = 1,724), Western Mosquitofish (n = 1,266), Blacktail Shiner (n = 917), and Mexican Tetra (n = 588).

Index of biotic integrity scores across all sites and sampling events ranged from 25 to 47, resulting in aquatic life use categories of intermediate (n = 2), high (n = 10), and exceptional (n = 8; Figure 269). Of the 20 sampling events in this ecoregion, 90% received an ALU rating of high or exceptional; 10% received an ALU of intermediate. All sites received one ALU score of high or better except for Las Moras and Mud creeks which both received an ALU score of intermediate only.

Overall, IBI scores and individual metrics did not significantly change through time (Figure 270; Figure 271; Figure 272).

Benthic Macroinvertebrates

A total of 6,877 individuals representing 25 orders of aquatic macroinvertebrates were collected in the six Surber samples and six RBP samples collected at seven streams in the Southern Texas Plains ecoregion from June 1990 to June 2018 (Appendix E). Five orders (Basommatophora, Coleoptera, Diptera, Ephemeroptera and Odonata) were represented at all seven streams, which collectively represented 58 percent of the total number of individuals collected.

In terms of relative abundance, *Fallceon quilleri* (Ephemeroptera, Baetidae) was the most abundant taxon, representing almost 9 percent of the total number of individuals collected at all sites. Other relatively abundant taxa include the flatworm *Dugesia* sp., the black fly *Simulium* sp., the Asian clam *Corbicula fluminea*, the damselfly *Argia* sp., the caddisfly *Chimarra* sp., the microcaddisfly *Hydroptila* sp., the chironomid *Rheotanytarsus* sp., and the mayfly *Tricorythodes* sp.

The damselfly *Argia* sp. was the most widely distributed genus, and it was the only taxa collected at all seven streams. *Corbicula fluminea*, *Fallceon quilleri*, and *Simulium* sp. were also widely distributed genera/species, occurring in collections from six of the seven streams.

The BIBI scores for the Surber samples collected at Las Moras Creek and Pinto Creek in 1990 both fell in the exceptional aquatic life use category, while the BIBI scores for Surber samples from Mud Creek, San Miguel Creek, and Sycamore Creek fell in the high aquatic life use category, and the Surber sample from Metate Creek fell in the intermediate aquatic life use category (Figure 273). Results for the RBP IBI for the kicknet samples collected at Pinto Creek in 2017, Sycamore Creek in 2017, and the Upper Nueces River in 2017 and 2018 fell in the exceptional ALU category. The RBP IBI score for the Pinto Creek RBP sample collected in 2016 fell in the high aquatic life use category, while the results for San Miguel Creek in 2018 fell in the intermediate category. As was noted for fish, benthic macroinvertebrate biotic integrity, as indicated by the benthic IBI's, appeared to remain relatively constant over the interval from 1990 to 2018 (Figure 274).

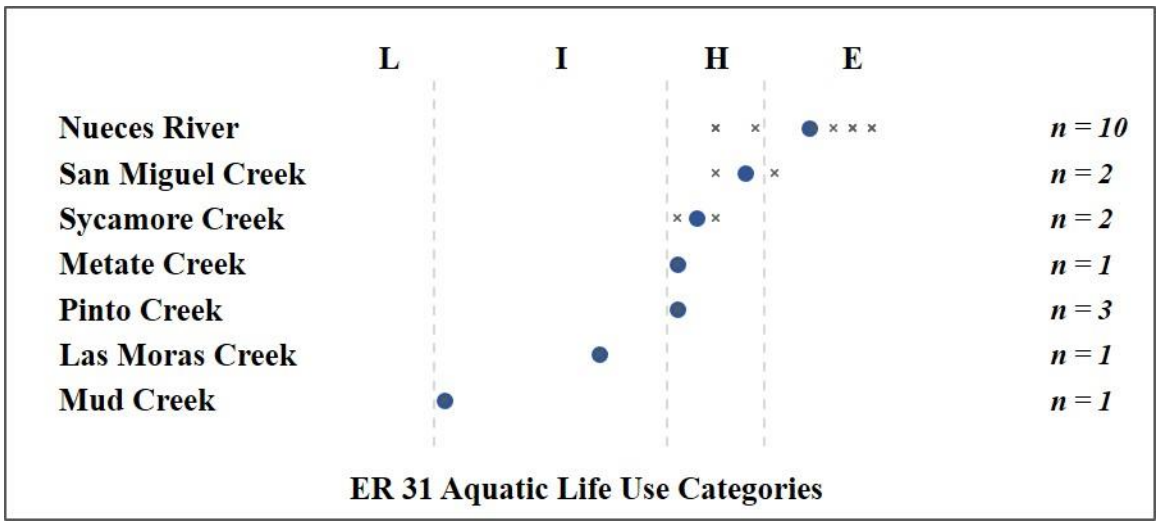

Figure 269. Aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all fish sampling events in Ecoregion 31 grouped by site and ranked by mean ALU score (blue dot); number of sampling events per site noted on right.

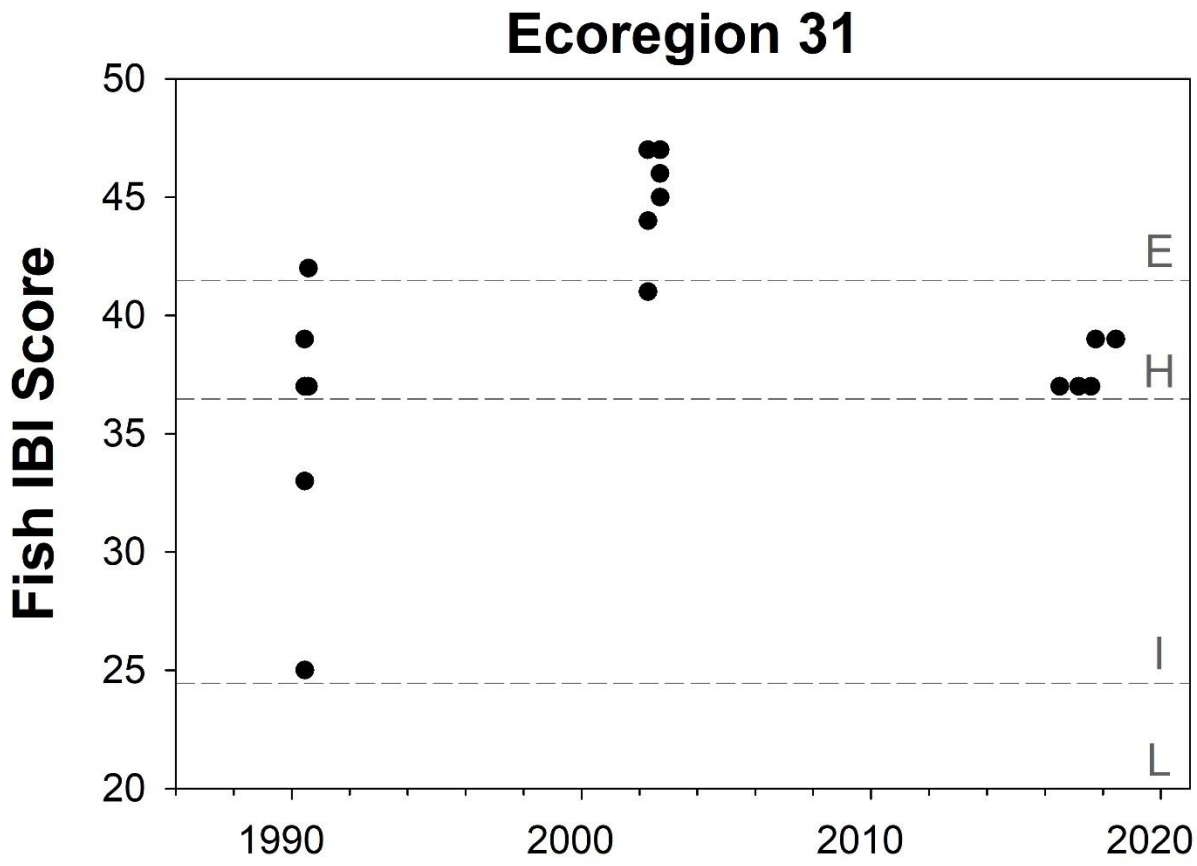

Figure 270. Fish index of biotic integrity scores through time for all sampling events in Ecoregion 31; break lines for aquatic life use categories (i.e., limited, intermediate, high, and exceptional) shown on each graph for reference (see Linam et al. 2002).

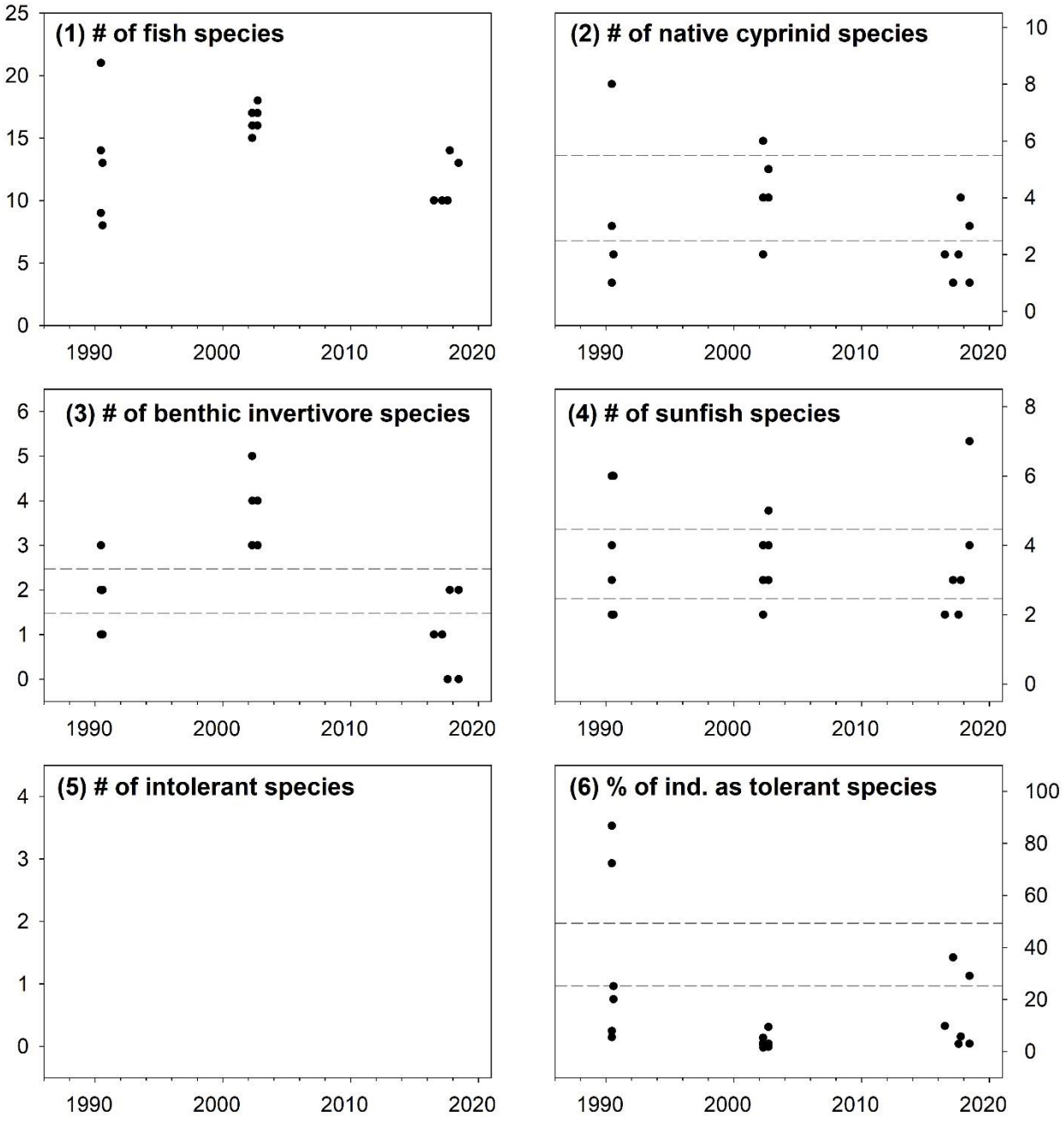

Figure 271. Raw values for fish index of biotic integrity metrics 1-6 through time for all sampling events in Ecoregion 31; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002); metrics that are not included in the IBI for this ecoregion are blank.

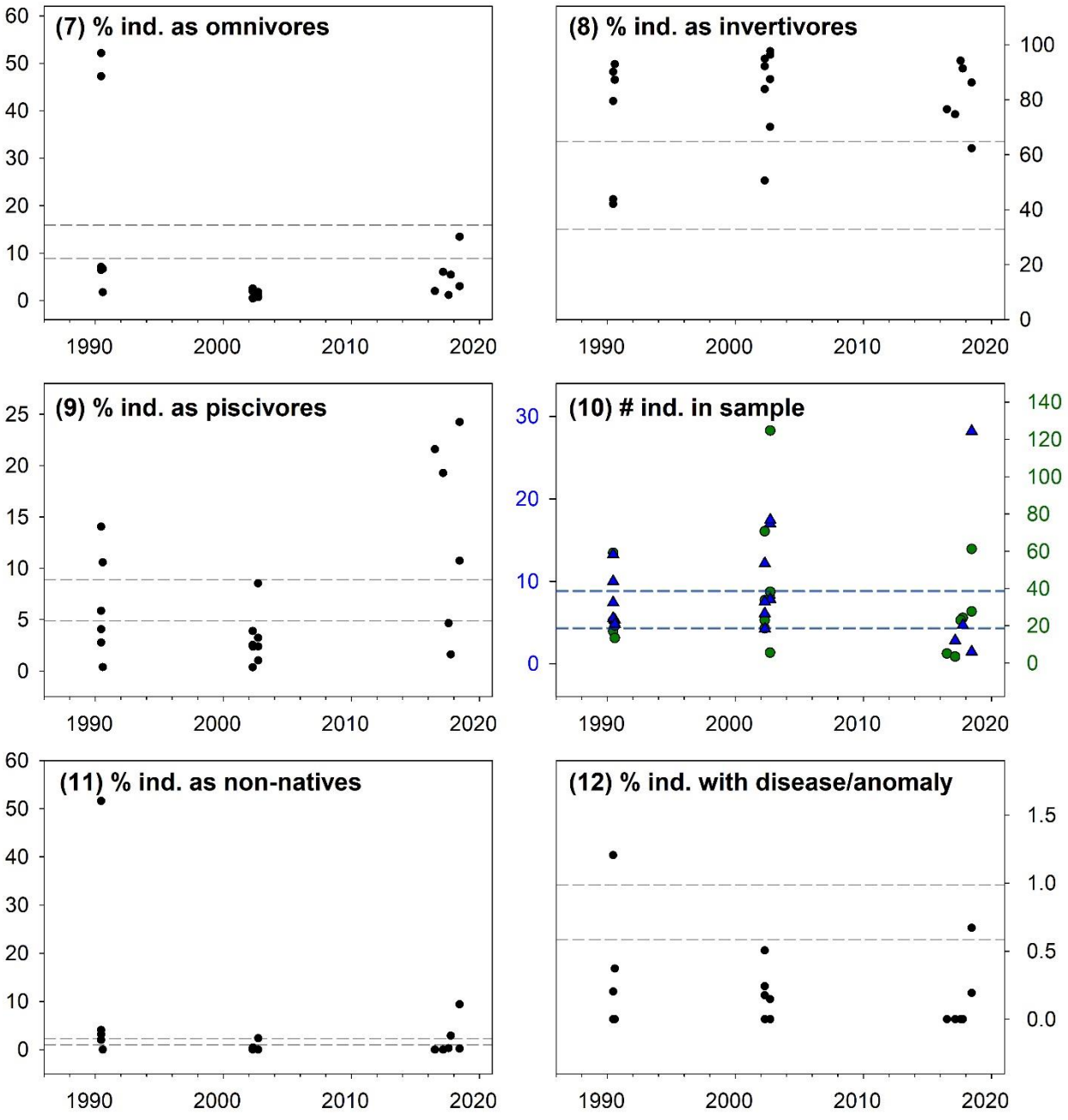

Figure 272. Raw values for fish index of biotic integrity metrics 7-12 through time for all sampling events in Ecoregion 31; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002); number of ind./seine haul represented by green circles and number of ind./min electrofishing represented by blue triangles for metric number 10.

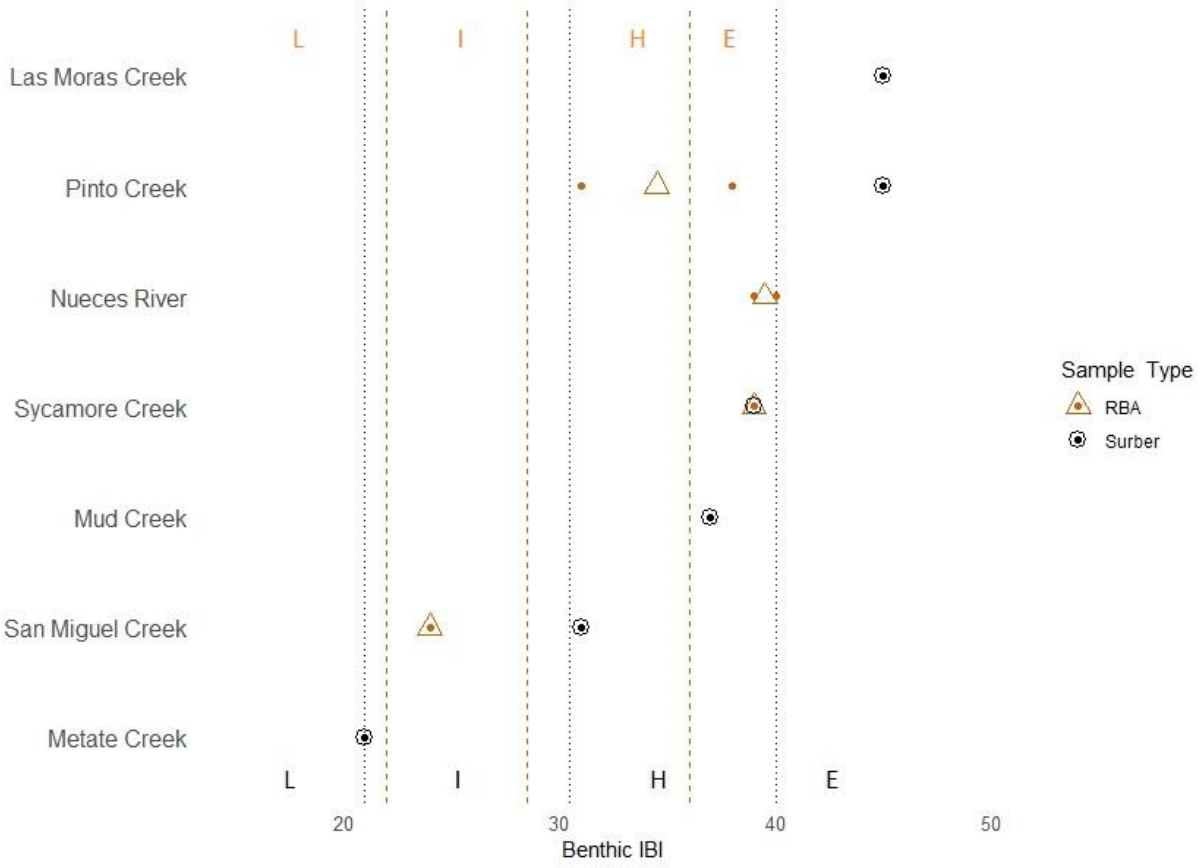

Figure 273. Benthic IBIs and aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all benthic sampling events in Ecoregion 31 grouped by site and ranked by mean IBI score. Site scores are solid circles, and mean scores are hollow circles for Surber IBI sample and hollow triangles for RBP IBI samples. RBP IBI ALU cut offs are red dashed lines and Surber ALU cutoffs are in black dotted lines.

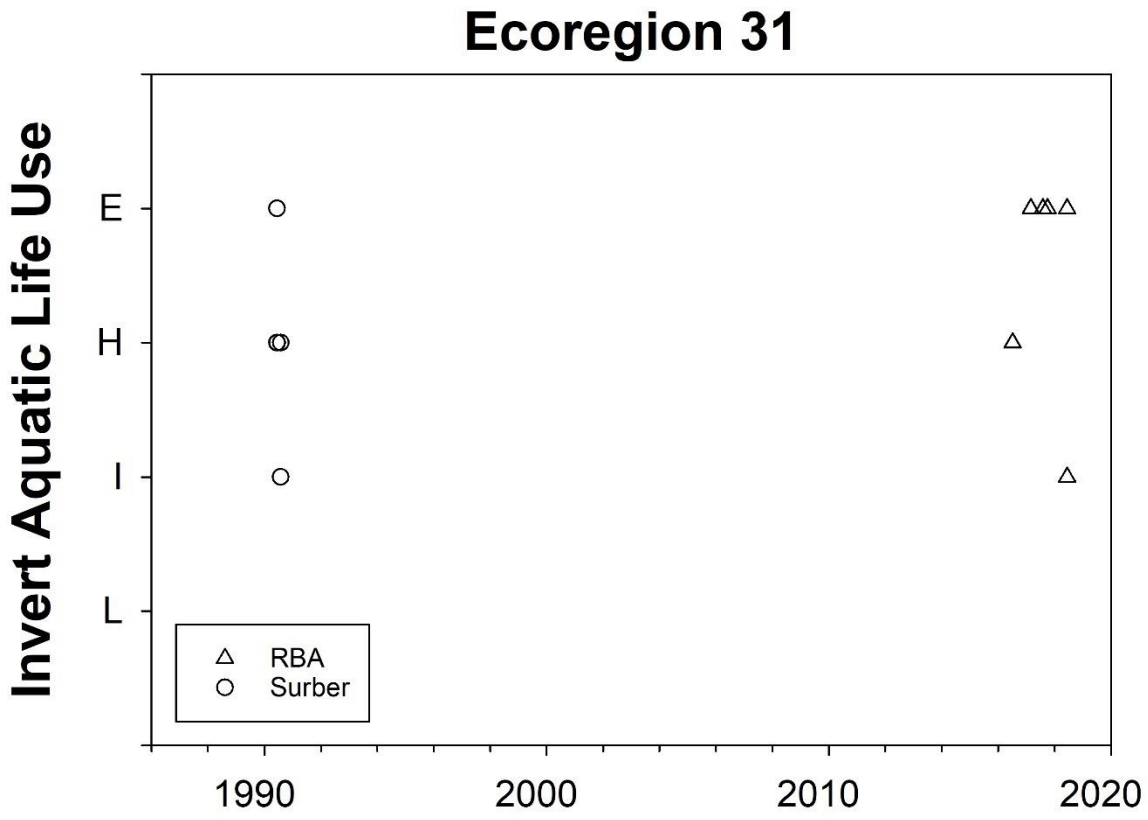

Figure 274. Benthic aquatic life use (ALU) categories through time for all sampling events in Ecoregion 31; Surber ALUs are noted by circles and RBP ALUs are noted by triangles.

ECOREGIONS 33 & 35 – SOUTH CENTRAL AND SOUTHERN HUMID, MIXED LAND USE REGION

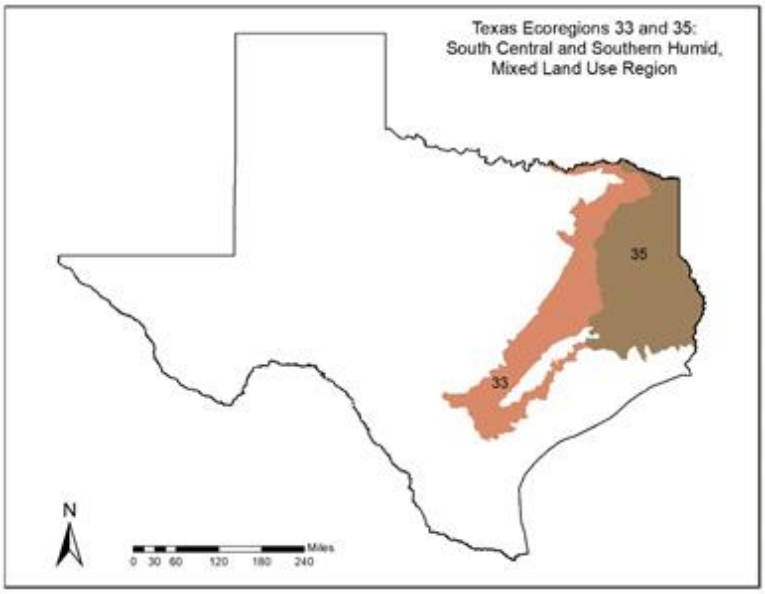

Figure 275. Map of Texas aggregate Ecoregions 33 and 35 – South Central and Southern Humid, Mixed Land Use Region.

Figure 276. Site photo from Frazier Creek.

Based on the results of the detrended correlation analysis from the 1992 report on the Texas Aquatic Ecoregion Project, fish assemblages in ecoregions 33 and 35 formed a distinct grouping as expressed by biological attributes such as species richness (Bayer et al. 1992). Subsequently, the two ecoregions were aggregated as the South Central and Southern Humid, Mixed Land Use Region for the purpose of identifying and evaluating levels of biotic integrity in fish and benthic macroinvertebrate assemblages (Linam et al. 2002).

Ecoregion 33 Characterization

Ecoregion 33, the East Central Plains, is generally characterized by gently rolling to hilly topography which is moderately dissected by drainages (TPWD Landscape Ecology Program webpage). Sandy to sandy loam soils, often with a marked clay subsurface horizon, are typical to Ecoregion 33. These soils are generally Alfisols and are typically acidic to neutral. Typical ecological sites include Claypan Savannah, Claypan Prairie, Sandy Loam, Sandy, and Deep Sand (TPWD Landscape Ecology Program webpage). Pasture and range typify land use in most of the region (Griffith et al. 2007). Mean annual precipitation varies from 71 cm in the south to 122 cm in the northern portions of the region. Griffith et al. (2007) identified six level IV ecoregions within level III Ecoregion 33 and provide more in-depth discussions of physiographic characteristics of the ecoregion. Greater detail on the physiographic characteristics of the region are also given in this report in the physical characterization for each sample site.

As noted by Griffith et al. (2007), the eastern boundary of Ecoregion 33 with the South Central Plains (Ecoregion 35) is a relatively difficult to define transition of soils and vegetation. The region essentially represents a transition from the woodlands and forests of East Texas to the prairies to the west, specifically the Blackland Prairie (Figure 275). Savannas and woodlands are typically dominated by post oak, blackjack oak *Q. marilandica*, and black hickory *Carya texana* (TPWD Landscape Ecology Program webpage).

The primary natural processes that affect this system include drought, grazing, and fire. A large portion of this system has been impacted by conversion to improved pasture for rangeland or crop production for agriculture. Overgrazing and fire suppression have led to increased woody cover and the invasion of some areas by problematic brush species such as eastern red cedar *Juniperus virgiana* to the north and mesquite *Prosopis glandulosa* to the south (TPWD Landscape Ecology Program).

Table 11. Streams in Ecoregion 33.

Blair Creek	Davidson Creek	Mill Creek
Catfish Creek	Kickapoo Creek	Ponds Creek
Cedar Creek	Little Mustang Creek	Smackover Creek
Cummins Creek	Lower Keechi Creek	Wheelock Creek
Cuthand Creek	Middle Yegua Creek	

BLAIR CREEK

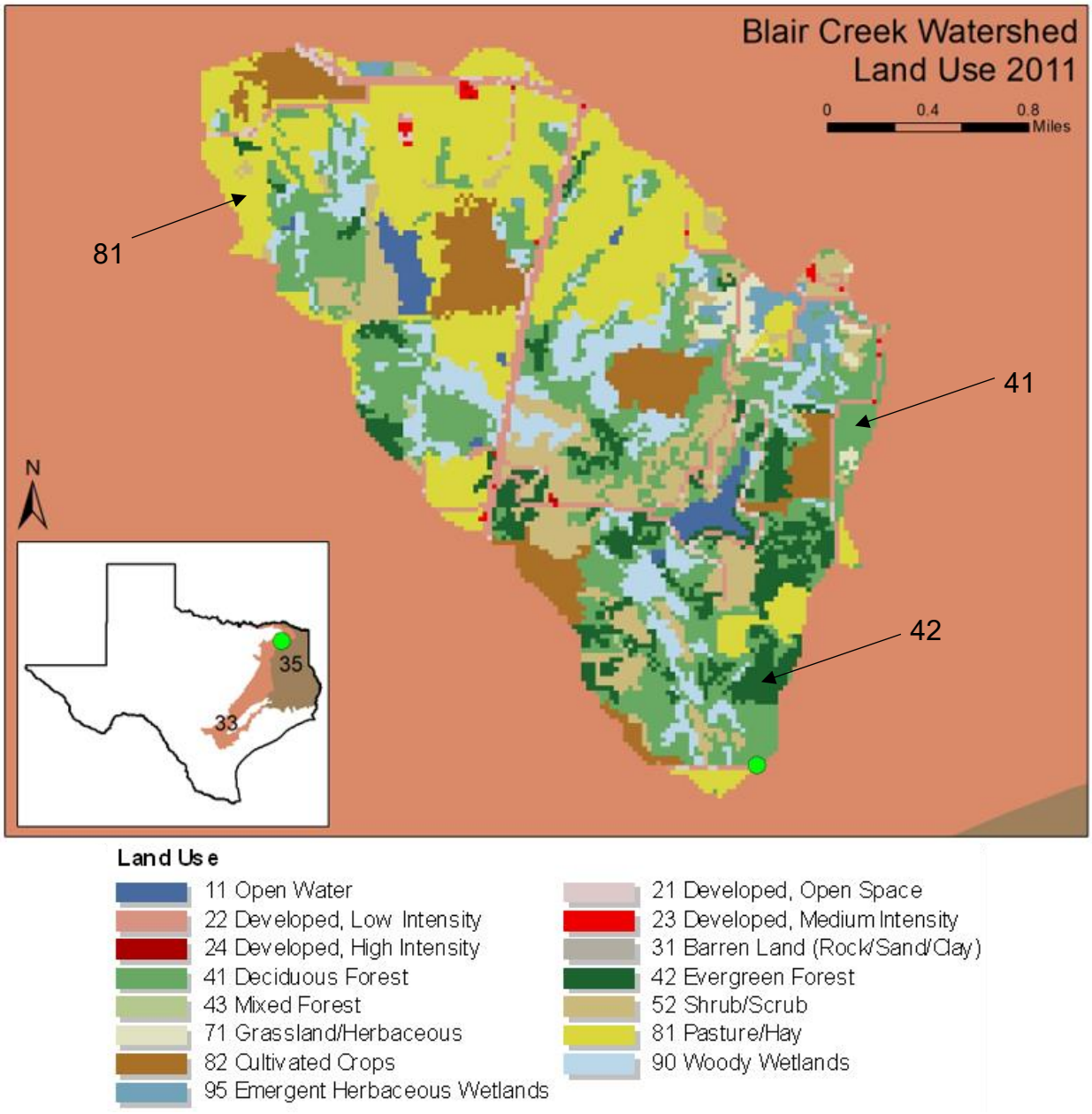

Figure 277. Map of Blair Creek watershed location and 2011 land use; forest and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	June 29, 2004; August 16, 2004
Water Quality:	10 sampling events
Fish:	June 29, 2004; August 16, 2004
Benthic Invertebrates:	June 29, 2004; August 16, 2004

Physical Characterization

Watershed and Land Use

Blair Creek lies within the Cypress Creek Basin. Sample site 17952 is located in Franklin County, 1.73 km west of SH 37 and 1.17 km north of Lake Cypress Springs (Figure 277).

The Blair Creek watershed at site 17952 is approximately 11.4 sq km. The watershed lies within the Level IV Ecoregion 33a, the Northern Post Oak Savanna. The dominant land cover in the watershed is forest at 32% and is most concentrated in the middle and lower part of the watershed. Pasture/hay is a secondary land cover encompassing 26% and is most concentrated in the upper portions of the watershed (Homer et al. 2015; Figure 277 and Figure 278). The combined land cover for developed land use (open space and low, medium, and high intensity) totals 6.96% and total cover for cultivated crops is 8.96%.

From 1992-2011 there was a 2 sq km decrease in pasture/hay and a 1.9 sq km decrease in forest. There was a 1.2 sq km increase in wetlands and a 1.2 sq km increase in shrub (Figure 279).

There are no permitted wastewater outfalls within the Blair Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Blair Creek was evaluated twice in 2004. Blair Creek is a second order perennial stream that is impounded upstream of the sampling site to form Zachry Lake. Downstream of the site, it drains into Lake Cypress Springs. Habitat Quality Index scores are available for both sample events and indicate a high aquatic life use rating (20). Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters for both sampling events. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover was 92%. The dominant stream substrate was sand, and the average percent of substrate gravel size or larger was 16%. Average percent instream cover was 27% to 31% and instream cover types include large and small woody debris, undercut banks, overhanging vegetation, root mats, and leaf packs. Blair Creek ranged from 0.07-0.13 meters deep on average and 2.5-3.7 meters wide. Average stream bank slope ranged from 45-48 degrees. Stream flow at the site was measured at a minimum value of 0.3 cfs and a maximum of 2.5 cfs. Average stream bank erosion potential was 33%-34%. The deepest pool measured at Blair Creek was 0.8 meters. No riffles were observed at the site and there were nine total stream bends.

Water Quality

Water samples were collected at station 17952 over 10 sampling events from October 2003 through August 2004. Parameters measured included temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a

Biological Characterization

Fish

Twenty-three species (eight families) were collected between the two sampling events. Centrarchidae was the richest family (eight species) with Longer Sunfish being the most abundant species collected. The aquatic life use, based on the fish assemblage, rated as exceptional.

Benthic Macroinvertebrates

A total of 436 individuals representing 11 orders of macroinvertebrates were collected during the two sampling events at Blair Creek (Appendix E). Mayflies (Ephemeroptera) were the most abundant order with taxa from six genera and four families representing 36.5% of the individuals collected. Odonata and Diptera were the next most abundant orders, representing 27.3% and 15.4%, respectively, of the individuals collected. The most abundant families collected were Gomphidae, Chironomidae, and Heptageniidae, representing 16.7%, 11.7%, and 11.2%, respectively, of the total number of individuals collected.

Considered collectively across both sample dates, the functional organization of the Blair Creek macroinvertebrate assemblage was dominated by predators, collector-gatherers, and scrapers which accounted for 36.7%, 34.2%, and 17.5%, respectively, of the total number of individuals collected. The filtering collectors (9.4%) and shredders (2.2%) functional groups represented a smaller proportion of individuals. The EPT for the two collections (9 in June 2004, 8 in August 2004) fall between the 25th and 50th percentile for the aggregated ecoregion. Tolerant taxa are well represented at Blair Creek as indicated by the results for the biotic index (4.9 and 5.0).

Results for the Ecoregions 33 and 35 BIBI for RBP samples were relatively consistent and indicated high aquatic life use for both samples. Both scores fall between the 50th and 75th percentile of all benthic RBP IBIs for the South Central and Southern Humid, Mixed Land Use Region.

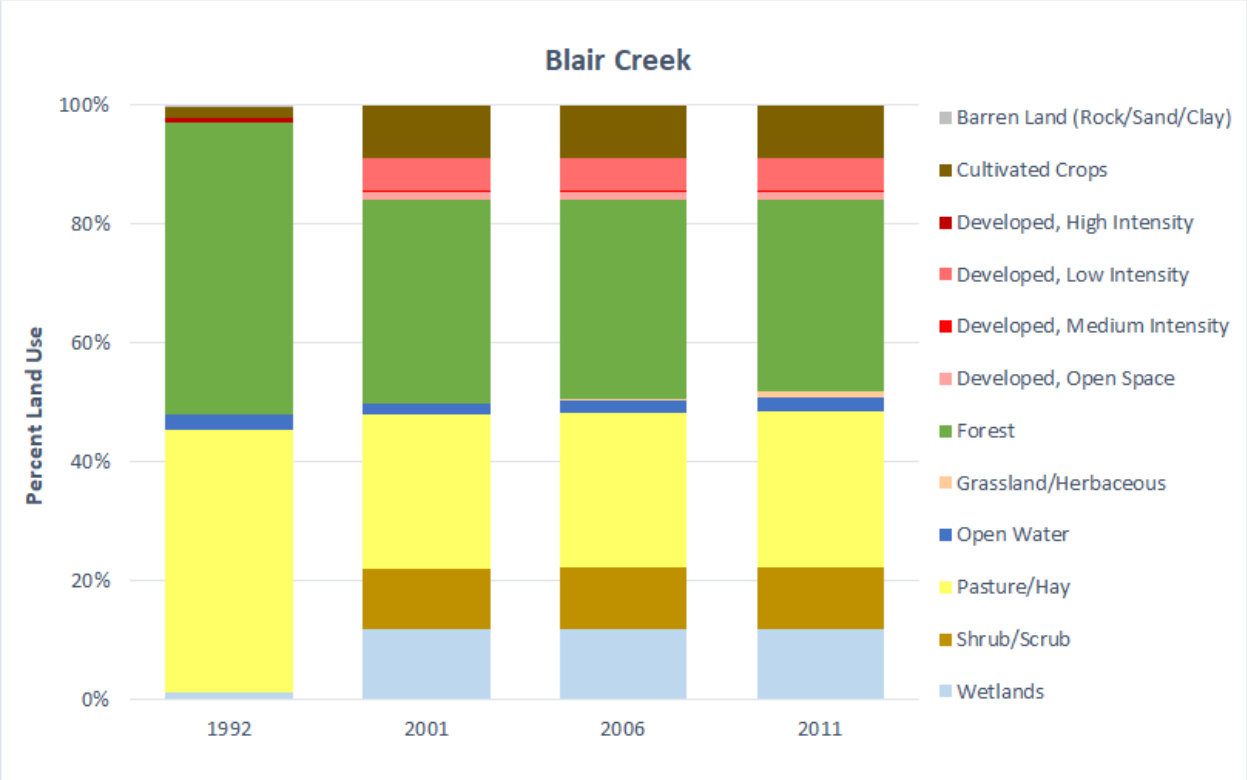

Figure 278. Percent land use in the Blair Creek watershed from 1992-2011.

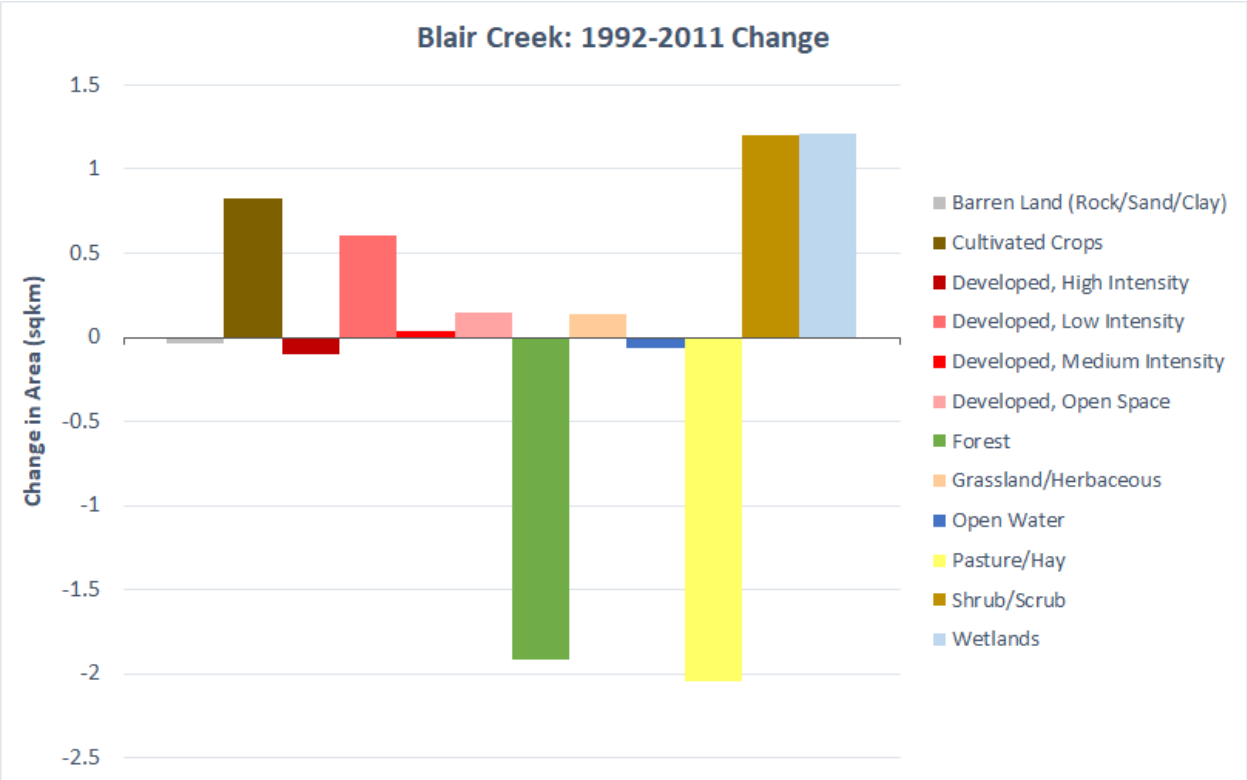

Figure 279. Land use change in area (sq km) from 1992-2011 for the Blair Creek watershed.

CATFISH CREEK

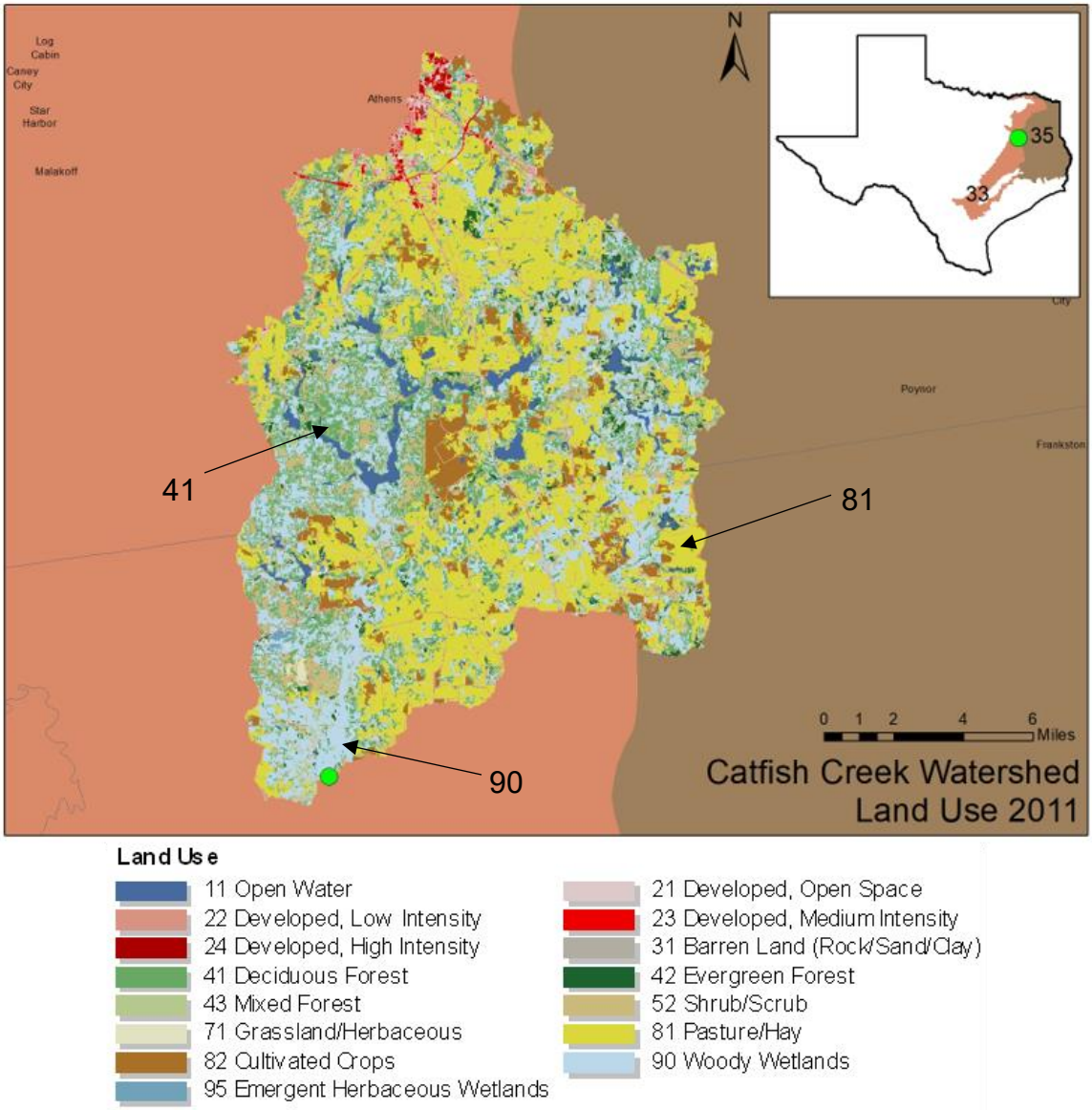

Figure 280. Map of Catfish Creek watershed location and 2011 land use; pasture/hay, forest, and wetlands were the most common land uses.

Sampling Dates

Physical Habitat:	August 16, 1988; April 11, 1989; June 10, 2003; August 25, 2003; August 13, 2004; September 16, 2014
Water Quality:	117 sampling events
Fish:	August 16, 1988; April 11, 1989; June 10, 2003; August 25, 2003; August 13, 2004; September 16, 2014
Benthic Invertebrates:	August 16, 1988; June 10, 2003; August 25, 2003; August 13, 2004; September 16, 2014

Physical Characterization

Watershed and Land Use

Catfish Creek lies within the Trinity River Basin. Sample site 10717 is located 1.70 km downstream of the confluence with Long Creek in the Gus Engeling Wildlife Management Area, 4.18 km east of Bethel in Anderson County (Figure 280).

The Catfish Creek watershed at site 10717 is approximately 505 sq km. Most of the watershed lies within the Level IV Ecoregion 33a, the Northern Post Oak Savanna. The dominant land cover in the watershed is pasture/hay at 33.65% and is present throughout the watershed (Homer et al. 2015; Table Y1, Figure 280 and Figure 281). Forest and wetlands are secondary land covers encompassing 20.70% and 20.37% of the Catfish Creek watershed, respectively. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 5.59% and total cover for cultivated crops is 6.28%.

From 1992-2011 there was a 124.58 sq km decrease in forest and a 56.62 sq km decrease in pasture/hay. There was a 93.2 sq km increase in wetlands, 46.47 sq km increase in shrub, and 13.0 sq km increase in open space development (Figure 282).

There are no permitted wastewater outfalls within the Catfish Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Catfish Creek was evaluated during five sampling events from 1988 to 2014. Catfish Creek is a fourth order perennial stream that drains to the Trinity River. Habitat Quality Index scores are available for four sample events and indicate an intermediate to high aquatic life use rating (17.5-21). Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters for all sampling events. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover ranged from 95% to 100%. The dominant stream substrate was sand and silt, and the average percent of substrate gravel size or larger varied from 0% to 9%. Average percent instream cover was 22% to 42% and instream cover types include large and small woody debris, undercut banks, leaf packs, and macrophytes. Catfish Creek ranged from 0.25-0.6 meters deep on average and 5-9 meters wide. Average stream bank slope ranged from 33-50 degrees. Stream flow at the site was measured at a minimum value of 4.7 cfs and a maximum of 24 cfs. Average stream bank erosion potential was 21%-83%. The deepest pool measured at Catfish Creek was 1.5 meters. Number of riffles observed at the site varied from zero to five, and total number of stream bends ranged from one to five.

Water Quality

Water samples were collected at station 10717 over 117 sampling events from August 1988 through January 2020. Parameters measured included temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

All aquatic life use ratings (based on the fish assemblage) rated as high, except for the September 2014 collection which rated as exceptional. Anomalies were fairly prevalent in the 1980s with 1.6% of the individuals collected in 1988 and 0.7% of the individuals collected in 1989 identified with some sort of physical anomaly, resulting in metric scores of 1 and 3, respectively. No anomalies were noted in the more recent collections. Thirty-five species (11 families) were collected over the course of the six sampling events. Centrarchidae yielded the most species (11). Blacktail Shiner*,* Weed Shiner *Notropis texanus,* Longear Sunfish, and Dusky Darter *Percina sciera* were present in every collection. Ribbon Shiner *Lythrurus fumeus* was common in the 1980 collections, absent in 2003 and 2004, and the most abundant fish species in the 2014 collection. Emerald Shiner *Notropis atherinoides* was first collected in June 2003, was the most abundant fish species by the August 2003 and 2004 collections but was absent in 2014. Given that both species were never identified together it is possible that one of the species was misidentified. Several species were only collected once. Single specimens of Channel Catfish, Red Shiner, and Dollar Sunfish *Lepomis marginatus* were collected in 1988, 1989, and 2003, respectively. Flier *Centrarchus macropterus* were only collected in 1989, Redear Sunfish *Lepomis microlophus* in 2003, and Blackspot Shiner *Notropis atrocaudalis* in 2014, but were represented by several individuals in each instance.

Benthic Macroinvertebrates

During the period from August 1988 to September 2014 five benthic macroinvertebrate samples were collected at Catfish Creek. A total of 894 individuals representing 16 orders and 75 macroinvertebrate taxa were collected (Appendix E). Taxa richness for individual samples ranged from a low of 13 in the collection made in June 2003 to a high of 32 in the collection made in September 2014. Caddisflies (Trichoptera) was the most commonly collected order representing 26.1% of the total individuals collected. Coleoptera (18.1%), Ephemeroptera (15.8%), Diptera (13.1%), Pelecypoda (8.9%), and Odonata (4.2%) were also commonly collected.

The median taxa richness across all collections was 20 which falls between the 25th and 50th percentiles for taxa richness in ecoregion 33, and below the 25th percentile taxa richness for ecoregion 35. Perhaps this result is a reflection of the geographic position of the Catfish Creek watershed straddling these two ecoregions. Though variable in abundance, the EPT taxa seem dominant in the assemblage, representing a range from 2% to 79.6% with a median of 41.3% of individuals across all collections. Similar to findings for taxa richness, the number of EPT taxa was relatively low relative to that found in other streams in ecoregions 33 and 35, with a median value of 9 across all collections. This value falls below the 25th percentile for ecoregion 35 and between the 25th and 50th percentiles for ecoregion 33.

Functionally, the Catfish Creek benthic macroinvertebrate assemblages were found to be relatively diverse, with the median percent dominant functional group (44.4%) across all collections falling between the 50th and 75th percentiles for the aggregated ecoregion. The collector-gatherer and filtering-collector taxa collectively were the dominant functional component and represented a median percentage of 65% across all collections. The scraper-collectors (median 15.6%) comprise a smaller component of the functional assemblage. These findings are consistent with the heavily canopied channel with large amounts of suspended and benthic fine and coarse particulate organic matter (FPOM and CPOM) that characterize Catfish Creek. Predators (median 15.2%) comprised the next most abundant functional group.

As a result of the naturally heavy canopy, high turbidity, high organic loads, and low gradient, Catfish Creek periodically experiences relatively low dissolved oxygen values, especially during the summer when water temperatures are warm. As a result, the median value for the biotic index of 5.5 exceeds the 75th percentile value for the biotic index in other samples from reference streams in the aggregated ecoregion.

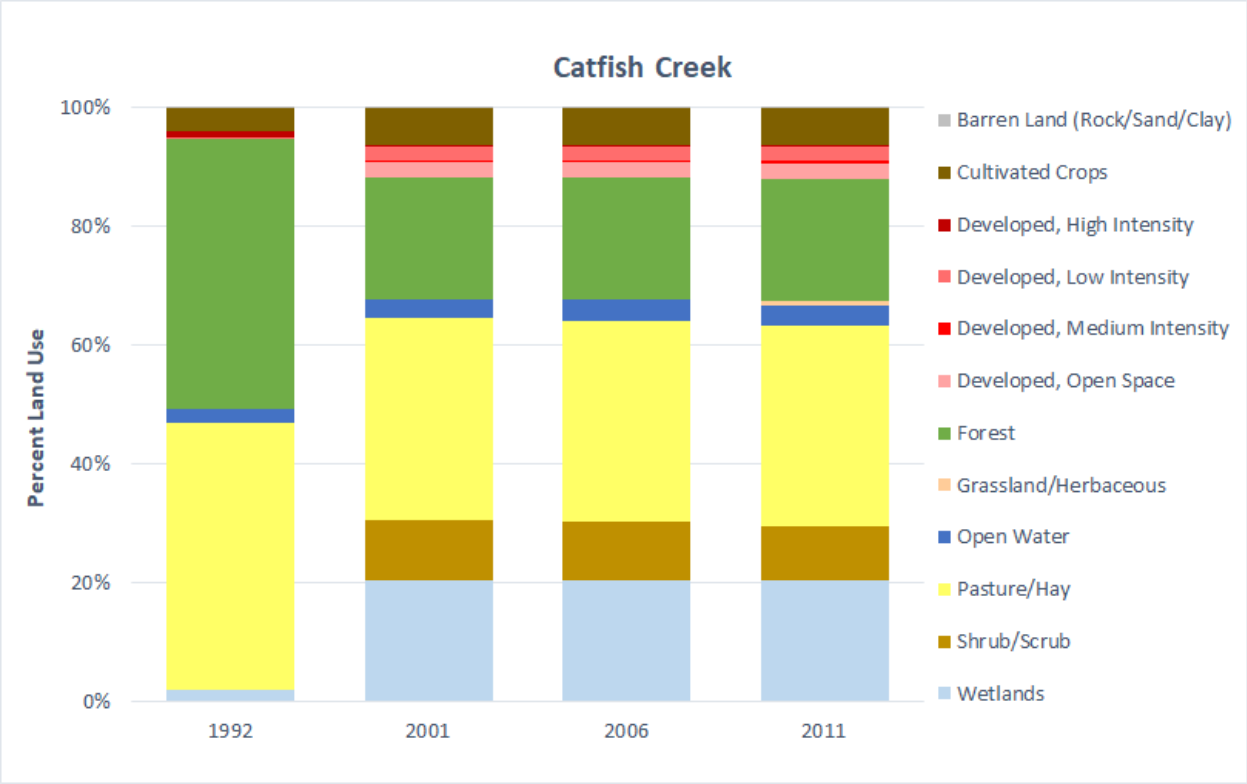

Figure 281. Percent land use in the Catfish Creek watershed from 1992-2011.

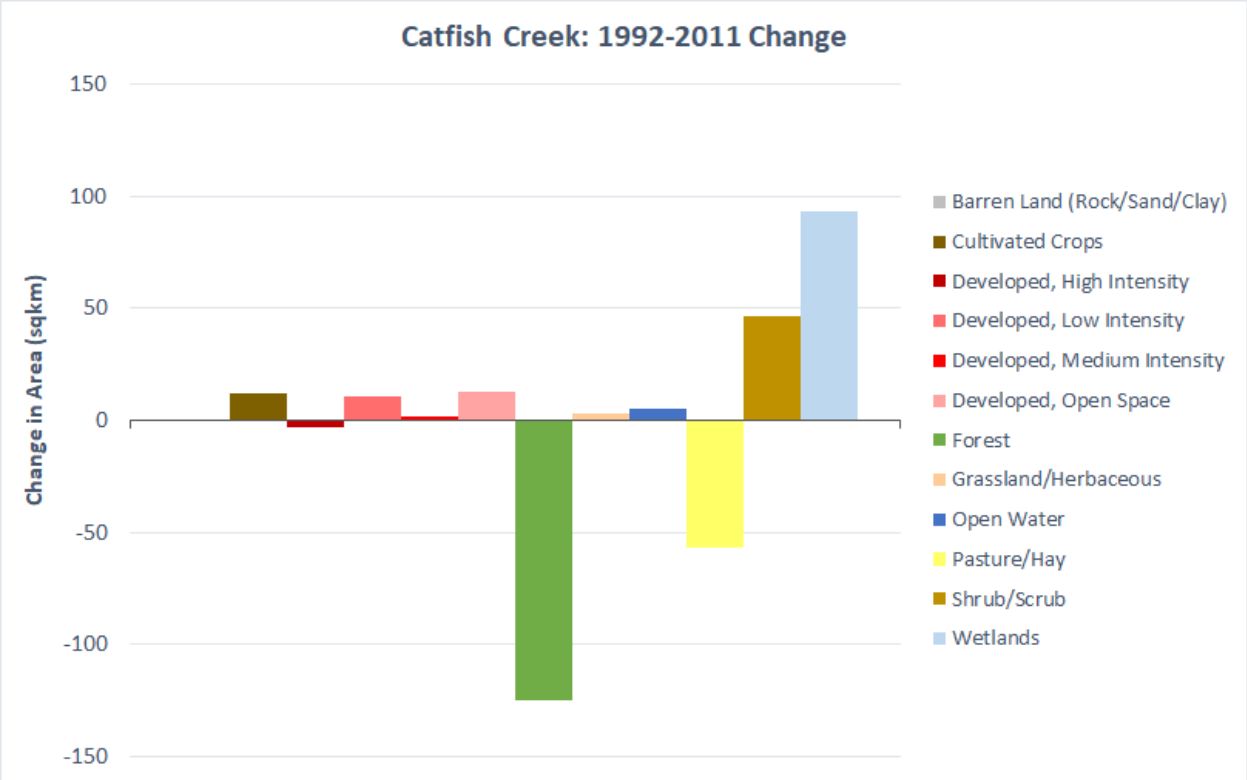

Figure 282. Land use change in area (sq km) from 1992-2011 for the Catfish Creek watershed.

CEDAR CREEK

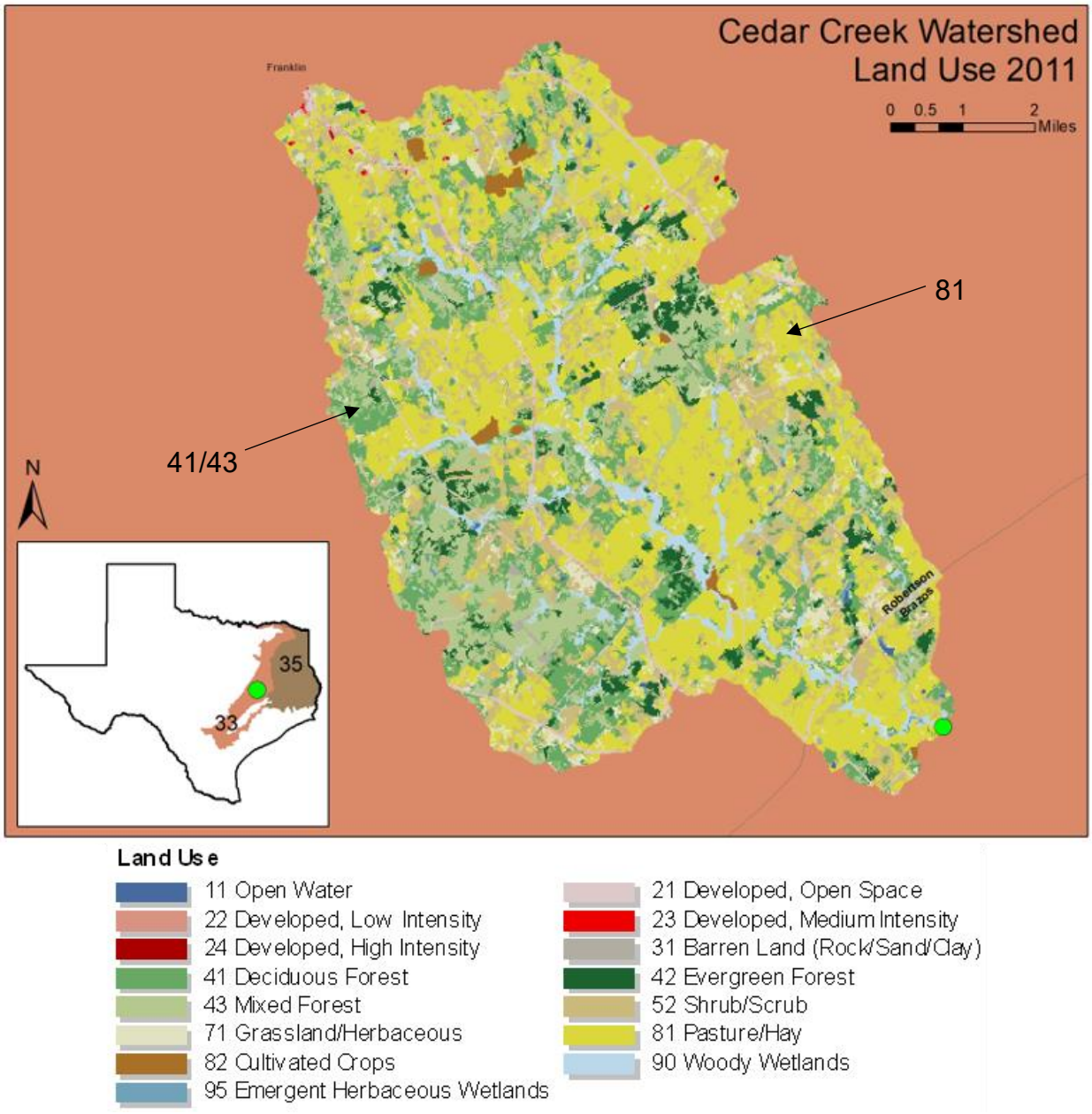

Figure 283. Map of Cedar Creek watershed location and 2011 land use; pasture/hay and forest were the most common land uses.

Sampling Dates

Physical Habitat:	August 31, 2004; October 12, 2004
Water Quality:	No samples
Fish:	August 31, 2004; October 12, 2004
Benthic Invertebrates:	August 31, 2004; October 12, 2004

Physical Characterization

Watershed and Land Use

Cedar Creek lies within the Brazos River Basin. Sample site 20529 is located 0.871 km downstream of the confluence with Smith Branch in Brazos County (Figure 283).

The Cedar Creek watershed at site 20529 is approximately 157 sq km. The sample site and lower watershed is located in Level IV Ecoregion 33c, the San Antonio Prairie; however, the majority of watershed lies within Level IV Ecoregion 33b, the Southern Post Oak Savanna. The dominant land cover in the watershed is pasture/hay at 36.85% and is present throughout the watershed (Homer et al. 2015; Figure 283 and Figure 284). Forest is a secondary land cover encompassing 32.84% of the Cedar Creek watershed. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 4.19% and total cover for cultivated crops is 0.84%.

From 1992-2011 there was a 30.27 sq km decrease in pasture/hay and a 6.29 sq km decrease in forest. There was a 23.65 sq km increase in shrub and 6 sq km increase in wetlands (Figure 285).

There are no permitted wastewater outfalls within the Cedar Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Cedar Creek was evaluated twice in 2004. Cedar Creek is a third order perennial stream that drains to the Navasota River. Habitat Quality Index scores are available for both sample events and indicate an intermediate aquatic life use rating (18.5-19). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 17 to 18 meters wide. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover ranged from 92% to 95%. The dominant stream substrate was sand, and the average percent of substrate gravel size or larger was 24%. Average percent instream cover was 16% to 18%. Cedar Creek ranged from 0.2-0.3 meters deep on average and 4-5 meters wide. Average stream bank slope ranged from 40-41 degrees. Stream flow at the site was measured at a minimum value of 2.3 cfs and a maximum of 3.3 cfs. Average stream bank erosion potential was 39%-50%. The deepest pool measured at Cedar Creek was 1.3 meters. Two riffles were observed at the site and there were three total stream bends.

Water Quality

No water quality data for this waterbody were available in SWQMIS as of March 2021.

Biological Characterization

Fish

The aquatic life use (based on the fish assemblage) rated as intermediate (August 2004) and high (October 2004); however, the August sample obtained a high rating when the coefficient of variability is applied. The metrics receiving the lowest rating were number of benthic invertivore species (two species), number of intolerant species (two species), and number of individuals. The

two benthic invertivore species collected were Slough Darter *Etheostoma gracile* and Dusky Darter. Intolerant species were Mimic Shiner and Dusky Darter. Twenty-two species (eight families) were collected between the two sampling events. The family Centrarchidae was represented by the greatest number of species (eight) closely followed by Cyprinidae (six).

Benthic Macroinvertebrates

A total of 326 individuals representing nine orders of macroinvertebrates were collected during the two sample events at Cedar Creek (Appendix E). Mayflies (Ephemeroptera) was the most abundant order with taxa from 10 genera and four families, representing 44.5% of the individuals collected across both sample dates. The Diptera and Trichoptera were the next most abundant orders, representing 27.3% and 12.9%, respectively, of the individuals collected. The most abundant families collected were Heptageniidae, Chironomidae, and Elmidae, representing 32.5%, 25.2%, and 7.9%, respectively, of the total number of individuals collected.

Considered collectively across both sample dates, the functional organization of the Cedar Creek macroinvertebrate assemblage was dominated by collector-gatherers, scrapers, and filtering collectors which accounted for 39.2%, 29.3%, and 16.2%, respectively, of the total number of individuals collected. The predators (13.6%) and shredders (1.8%) functional groups represented a smaller proportion of individuals.

The EPT for the two collections (14 in August 2004, 12 in October 2004) fall between the 75th and 95th percentile for the aggregated ecoregion. Tolerant taxa are well represented at Cedar Creek as indicated by the results for the biotic index (4.8 and 4.9).

Results for the Ecoregions 33 and 35 BIBI for RBP samples were relatively consistent and indicated high aquatic life use for both samples. Both scores fall between the 50th and 75th percentile of all benthic RBP IBIs for the South Central and Southern Humid, Mixed Land Use Region.

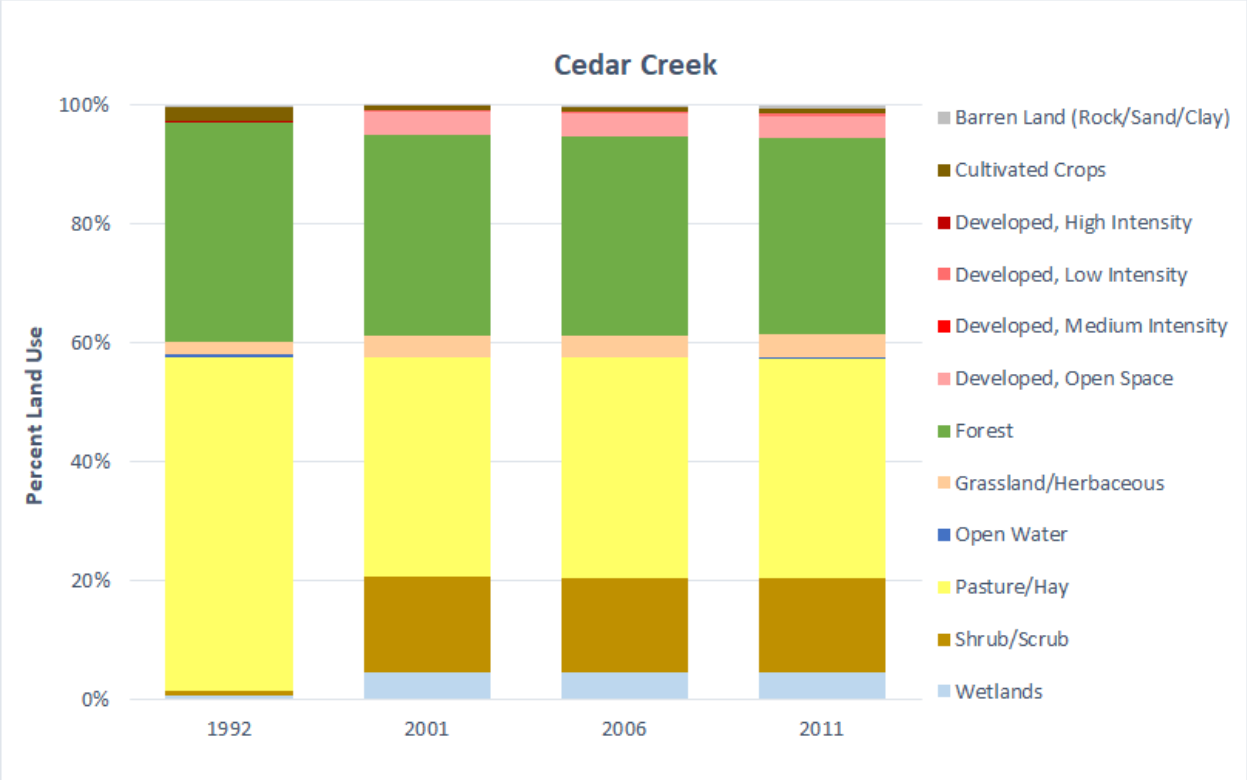

Figure 284. Percent land use in the Cedar Creek watershed from 1992-2011.

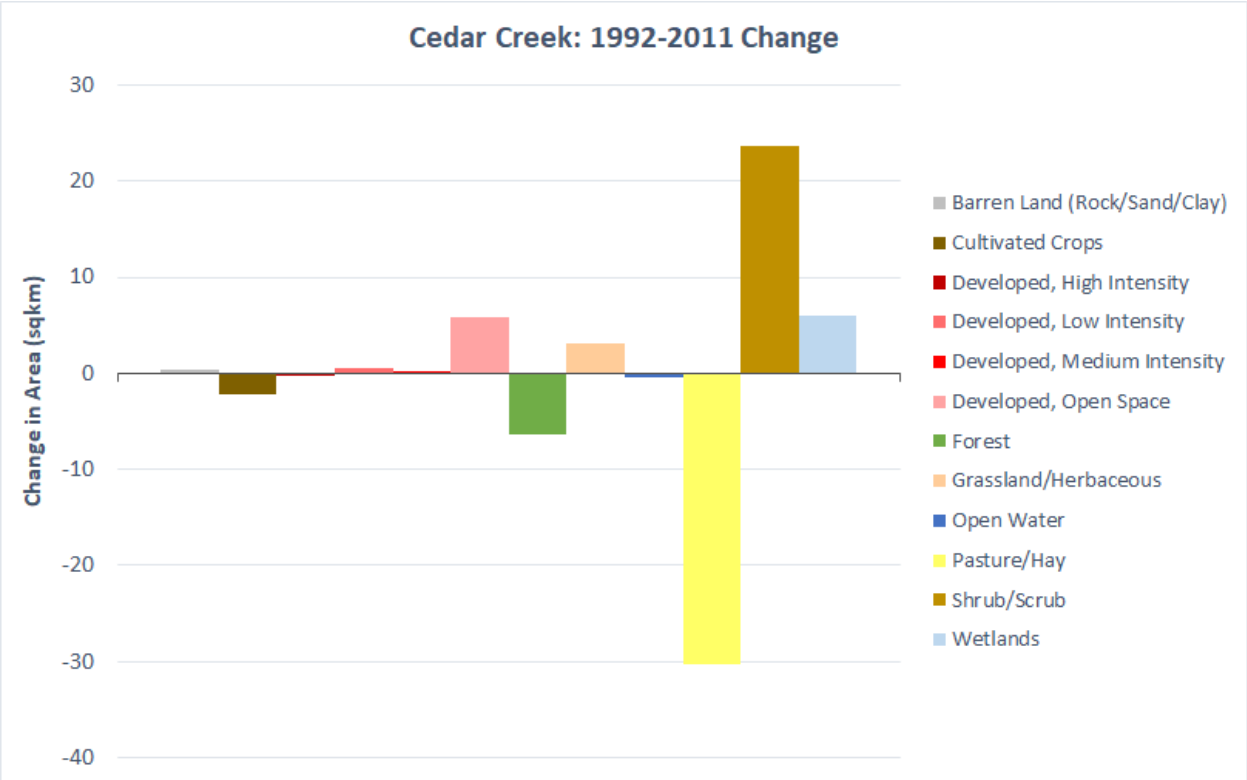

Figure 285. Land use change in area (sq km) from 1992-2011 for the Cedar Creek watershed.

CUMMINS CREEK

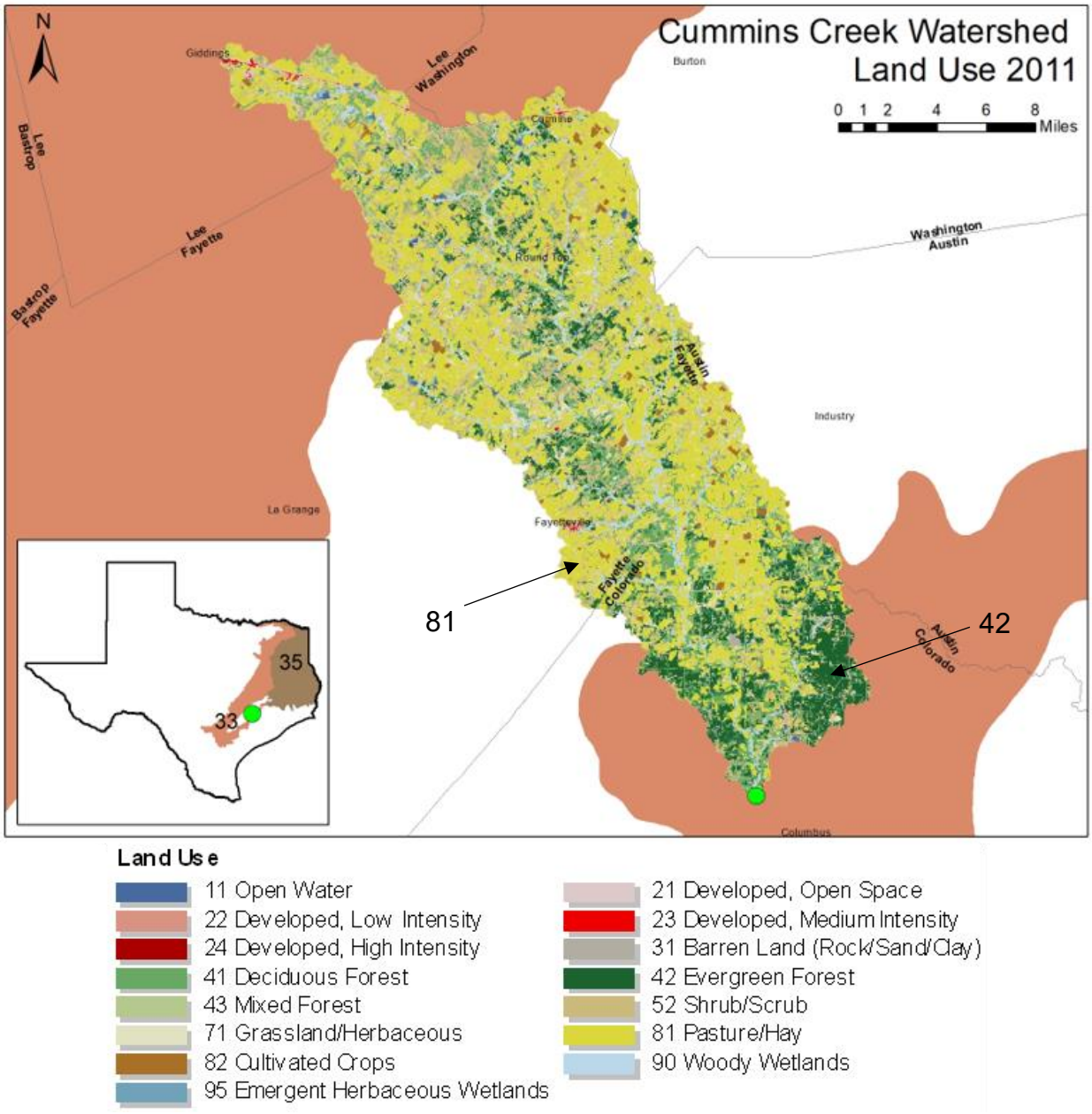

Figure 286. Map of Cummins Creek watershed location and 2011 land use; pasture/hay and forest were the most common land uses.

Sampling Dates

Physical Habitat: June 15, 1990; August 3, 2000; April 26, 2001; October 31, 2001; April 2, 2002; May 19, 2003; March 29, 2004; September 27, 2004; April 26, 2005; September 6, 2005; March 23, 2006; April 24, 2007; May 9, 2011; June 20, 2014; September 13, 2016

Water Quality: 270 sampling events

Fish:	June 25, 1990; August 3, 2000; April 26, 2001; October 31, 2001; April 2, 2002; May 19, 2003; October 1, 2003; March 29, 2004; September 27, 2004; April 26, 2005; September 6, 2005; March 23, 2006; April 24, 2007; May 9, 2011; September 13, 2016
Benthic Invertebrates:	June 25, 1990; March 22, 2000; August 3, 2000; April 26, 2001; October 31, 2001; April 2, 2002; May 19, 2003; October 1, 2003; March 29, 2004; September 27, 2004; April 26, 2005; September 6, 2005; March 23, 2006; April 24, 2007; May 9, 2011; June 20, 2014; September 13, 2016

Physical Characterization

Watershed and Land Use

Cummins Creek lies within the Colorado River Basin. Sample site 12249 is located 58 m downstream of FM 109, north of Columbus in Colorado County (Figure 286).

The Cummins Creek watershed at site 12249 is approximately 759.51 sq km. The sample site and upper watershed are located in Level IV Ecoregion 33b, the Southern Post Oak Savannah; however, the middle portion of the watershed lies within Level IV Ecoregion 32b, the Southern Blackland/Fayette Prairie. The dominant land cover in the watershed is pasture/hay at 42.63% and is present throughout the watershed but is concentrated in the middle and upper portions (Homer et al. 2015; Figure 286 and Figure 287). Forest and shrub are secondary land covers encompassing 26.32% and 14.4% of the Cummins Creek watershed, respectively. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 5.77% and total cover for cultivated crops is 1.18%.

From 1992-2011 there was a 60.76 sq km and 59.73 sq km decrease in grasslands and forest, respectively. There was a 47.67 sq km increase in pasture/hay, 37.4 sq km increase in open space development, and 35.38 sq km increase in wetlands (Figure 288).

There are three domestic wastewater outfalls (discharges < 1 million gallons per day), one permitted to the Town of Round Top, one permitted to the Falls Municipal Utility District, and one permitted to the City of Fayetteville. None of the wastewater outfalls discharge directly into Cummins Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Cummins Creek was evaluated during 15 sampling events from 1990 to 2016. Cummins Creek is a fourth order perennial stream that drains to the Colorado River. Habitat Quality Index scores are available for 12 sample events and indicate a high aquatic life use rating (22-24). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 14 meters wide to greater than 20 meters. The riparian zone was generally dominated by grasses followed by trees then shrubs and cultivated fields. The average percentage of tree canopy cover ranged from 17% to 80%. The dominant substrate type varies

from sand to gravel to cobble for the 15 sampling events, but gravel was identified as dominant most frequently followed by sand (7 and 6 events, respectively). The average percent of substrate gravel size or larger varied from 19% to 76%. Average percent instream cover was 20% to 54% and instream cover types include gravel, algae, macrophytes, overhanging vegetation, undercut banks, root mats, snags, leaf packs and artificial substrate. Cummins Creek ranged from 0.2-0.5 meters deep on average and 8-24 meters wide. Average stream bank slope ranged from 31-68 degrees. Stream flow at the site was measured at a minimum value of 0.8 cfs and a maximum of 27 cfs. Average stream bank erosion potential was 3%-82%. The deepest pool measured at Cummins Creek was 1.6 meters. Number of riffles observed at the site varied from one to four, and total number of stream bends ranged from two to four.

Water Quality

Water samples were collected at station 12249 over 270 sampling events from January 1984 through September 2016. Parameters measured included temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

The aquatic life use ratings for Cummins Creek (based on the fish assemblage) included one intermediate, nine high, and five exceptional ratings between 1990 and 2016. Four of the samples rating as high increase to exceptional (and the intermediate rating increases to high) when the coefficient of variability is applied, resulting in a total of nine exceptional ratings. All exceptional ratings (attained without the coefficient of variability) come from the earliest sampling events (prior to 2005). The reduction in aquatic life use rating is not related to any particular metric.

Species richness ranged from 18 to 28, with a total of 46 species (11 families) collected between the 15 samples. Species collected in every sample included: Blacktail Shiner, Warmouth, Bluegill, and Longear Sunfish. Species represented by individuals in all but one sampling event included: Red Shiner, Central Stoneroller, Blackstripe Topminnow, Western Mosquitofish, Channel Catfish, Green Sunfish, Redspotted Sunfish *Lepomis miniatus*, and Dusky Darter. Four species were only represented by one individual over the course of all the collections - Slough Darter, Pallid Shiner *Hybopsis amnis*, Pugnose Minnow *Opsopoeodus emiliae*, and Black Crappie *Pomoxis nigromaculatus*. Texas Shiner appears to be a relatively recent newcomer, with a single individual first being collected in 2005. In the two most recent collections it was the most abundant fish collected. Another recent addition is Orangespotted Sunfish which was only collected in 2016. Of particular note is the collection of three Blue Sucker, a state listed threatened species, in April 2007.

Benthic Macroinvertebrates

A total of 4156 individuals representing 19 orders of macroinvertebrates were collected during the seventeen sample events at Cummins Creek (Appendix E). Mayflies (Ephemeroptera) was the most abundant order representing 31.9% of the individuals collected across all sample dates. Diptera and Trichoptera were the next most abundant orders, representing 24.6% and 18.6%, respectively, of the individuals collected. The most abundant families collected were Simuliidae, Leptohyphidae, and Hydropsychidae representing 18.6%, 8.1%, and 7.8%, respectively, of the total number of individuals collected.

Considered collectively across all sample dates, the functional organization of the Cummins Creek macroinvertebrate assemblage was dominated by filtering collectors, collector gatherers, and scrapers which accounted for 39.5%, 27%, and 17%, respectively, of the total number of individuals collected. The predators (13.1%) and shredders (3.4%) functional groups represented a smaller proportion of individuals.

The EPT ranged from a minimum of 4 to a maximum of 16 with a median value of 8, which falls between the 25th and 50th percentile of all EPT values for least disturbed streams sampled in the aggregated ecoregion. The biotic index ranged from a minimum of 3.6 to a maximum of 5.6. The median value of the biotic index, 4.1, falls between the 5th and 25th percentile of all biotic index values for least disturbed streams sampled in the aggregated ecoregion. The maximum EPT value (16) and the median and minimum values for the biotic index indicate that sensitive species are relatively common in Cummins Creek.

The East Bioregion Surber BIBI for the 1990 Surber sample fell in the exceptional aquatic life use category. Results for the Ecoregions 33 and 35 BIBI for the sixteen RBP samples collected at Cummins Creek reflect a relatively high degree of variability (CV 11.4%) ranging from 22 (limited) to 33 (high). The median of the sixteen benthic IBI scores, 27, falls between the 25th and 50th percentile of all benthic RBP IBIs for the South Central and Southern Humid, Mixed Land Use Region.

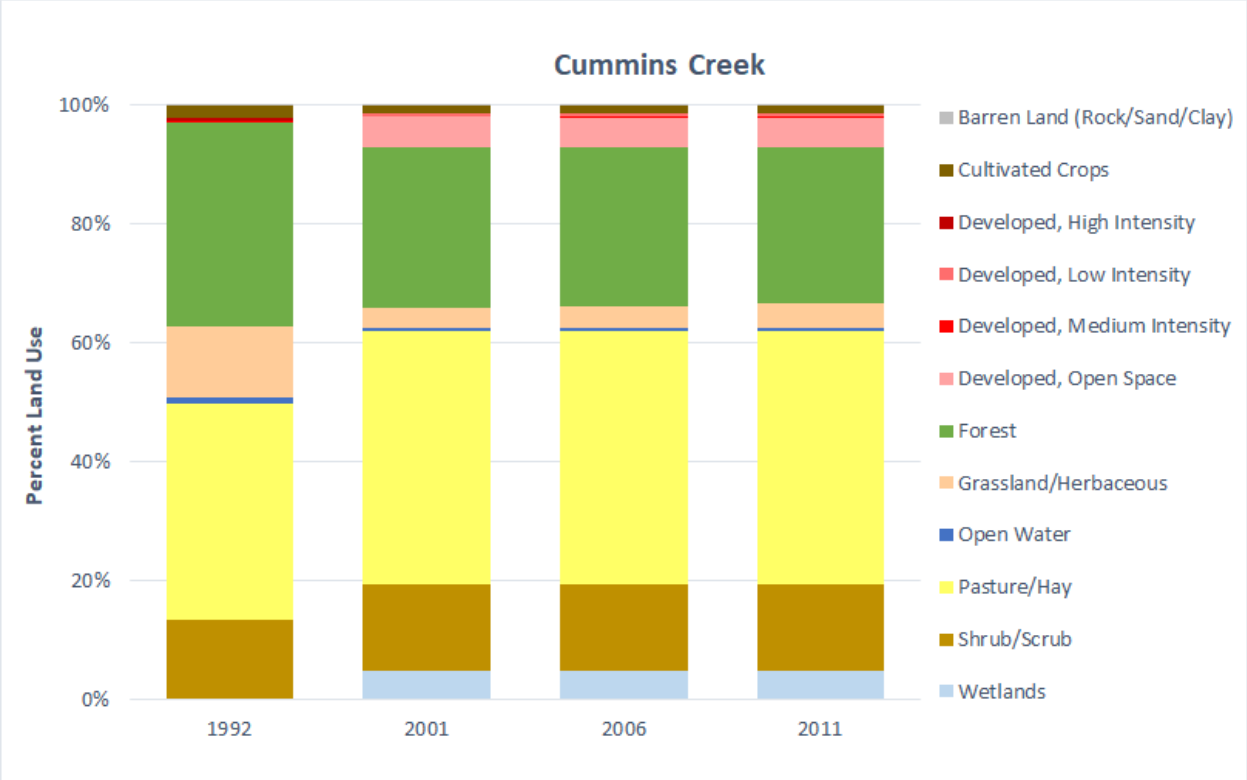

Figure 287. Percent land use in the Cummins Creek watershed from 1992-2011.

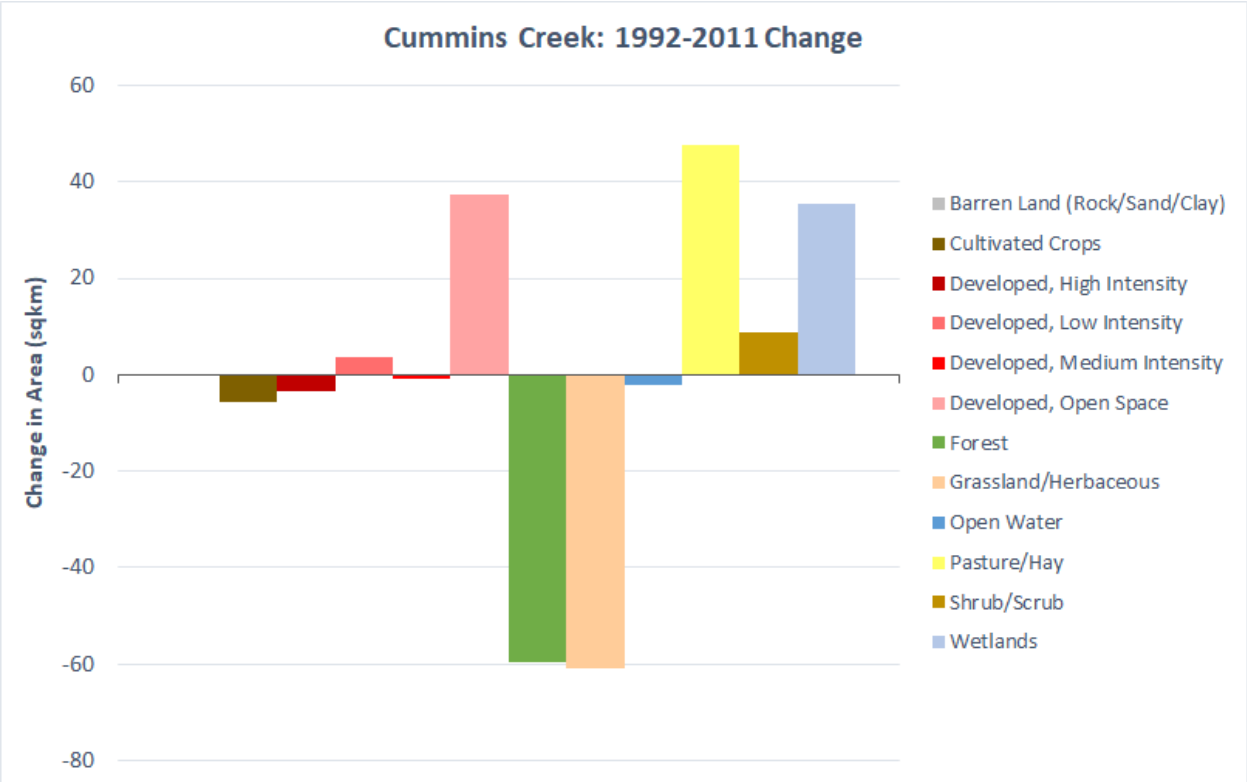

Figure 288. Land use change in area (sq km) from 1992-2011 for the Cummins Creek watershed.

CUTHAND CREEK

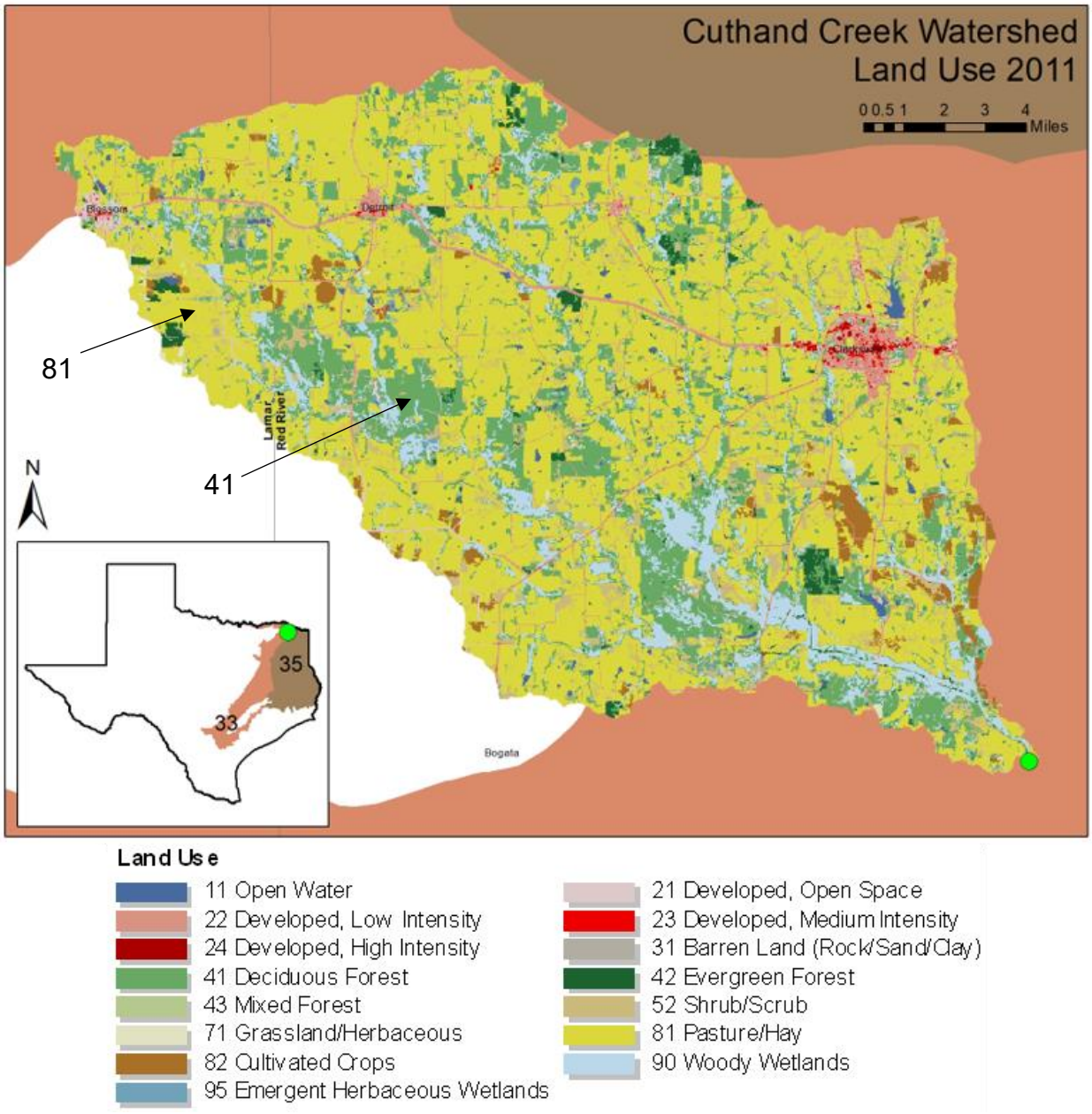

Figure 289. Map of Cuthand Creek watershed location and 2011 land use; pasture/hay and forest were the most common land uses.

Sampling Dates

Physical Habitat:	May 23, 2002
Water Quality:	7 sampling events
Fish:	May 23, 2002; July 5, 2002
Benthic Invertebrates:	May 23, 2002; July 5, 2002

Physical Characterization

Watershed and Land Use

Cuthand Creek lies within the Sulphur River Basin. Sample site 10202 is located east of Bogata, 230 m upstream of FM 1487 in Red River County (Figure 289).

The Cuthand Creek watershed at site 10202 is approximately 622.6 sq km. The sample site is located in Level IV Ecoregion 33f, the Floodplains and Low Terraces; however, the watershed spans Level IV Ecoregion 33a, the Northern Post Oak Savanna, and Ecoregion 33d, the Northern Prairie Outliers. The dominant land cover in the watershed is pasture/hay at 55.73% and is present throughout the watershed (Homer et al. 2015; Figure 289 and Figure 290). Forest is the secondary land cover encompassing 20.17% of the Cuthand Creek watershed. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 5.52% and total cover for cultivated crops is 2.4%.

From 1992-2011 there was a 52.05 sq km decrease in cultivated crops and 35.95 sq km decrease in forest. There was a 41.03 sq km increase in shrub, 19.65 sq km increase in wetlands, and 18.89 sq km increase in low intensity development (Figure 291).

There are three domestic wastewater outfalls (discharges < 1 million gallons per day), one permitted to the City of Detroit, one permitted to the City of Clarksville, and one permitted to the City of Blossom. The City of Blossom wastewater outfall discharges directly into Cuthand Creek in the upper watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Cuthand Creek was evaluated on May 23, 2002. Cuthand Creek is a fourth order intermittent stream with perennial pools that drains to the Sulphur River. The Habitat Quality Index score of 18 indicates an intermediate aquatic life use rating. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was dominated by grasses, which made up an average of 39% of the total riparian species, followed by shrubs (20%) then trees (19%). The average percentage of tree canopy cover was 13%. The dominant substrate was cobble and the average percent of substrate gravel size or larger was 32%. Average percent instream cover was 54%. Cuthand Creek was 0.3 meters deep on average and 12 meters wide. Average stream bank slope was 24 degrees and the average stream bank erosion potential was 73%. Stream flow at the site was 20 cfs. No pools were identified on Cuthand Creek at the time of sampling. One riffle was observed at the site and there was one poorly defined stream bend.

Water Quality

Water samples were collected at station 10202 over 7 sampling events from August 1984 through July 2002. Parameters measured included temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Seventeen species (nine families) were collected between the two sampling events. The families yielding the greatest number of species were Ictaluridae (four), Centrarchidae (four), and Cyprinidae (3). Red Shiner was the most abundant species in both collections. The aquatic life use rating for both fish collections was only intermediate. The fish assemblage was dominated by tolerant species (78-95% of the individuals collected), yielded a low number of benthic invertivore species, and had a low percentage of piscivores.

Benthic Macroinvertebrates

A total of 253 individuals representing 12 orders of macroinvertebrates were collected during the two sample events at Cuthand Creek (Appendix E). Caddisflies (Trichoptera) was the most abundant order with the family Hydropsychidae accounting for 37.9% of the individuals collected across both sample dates. Ephemeroptera and Odonata were the next most abundant orders, representing 28.4% and 12.6%, respectively, of the individuals collected. The most abundant families collected were Hydropsychidae, Caenidae, and Baetidae, representing 37.9%,12.6%, and 12.2%, respectively, of the total number of individuals collected.

Considered collectively across all sample dates, the functional organization of the Cuthand Creek macroinvertebrate assemblage was dominated by filtering collectors, collector gatherers, and predators which accounted for 42.3%, 20.6%, and 20.36%, respectively, of the total number of individuals collected. The scrapers (16.4%) and shredders (0.4%) functional groups represented a smaller proportion of individuals.

The EPT was 5 for the sample collected May 2002 and 4 for the sample collected July 2002. These values are relatively low, falling at and just below the 5th percentile for all EPT values for least disturbed streams sampled in the aggregated ecoregion. The biotic index was 4.8 for the May sample which falls between the 25th and 50th percentile for all biotic index values for least disturbed streams in the aggregated ecoregion. In July, the value obtained for the biotic index was 6.3, which exceeds the value obtained for 75% of the ecoregion 33/35 least disturbed streams samples. The relatively low EPT values and the relatively high values for the biotic index indicate that tolerant species are relatively common in Cuthand Creek.

Results for the Ecoregions 33 and 35 BIBI for the May 2002 RBP sample indicated limited aquatic life use, while the score for the July sample indicated intermediate aquatic life use. The two IBI scores fall between the 25th and 50th percentiles of all benthic RBP IBIs for the South Central and Southern Humid, Mixed Land Use Region.

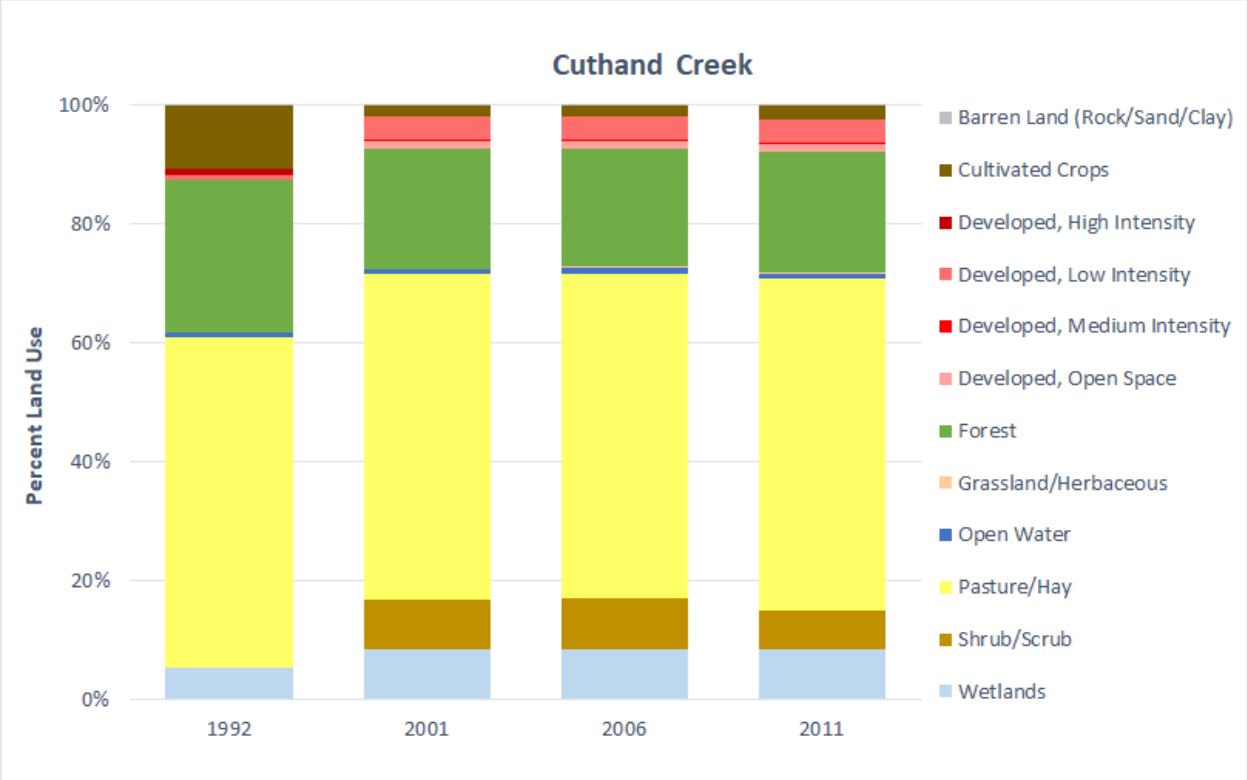

Figure 290. Percent land use in the Cuthand Creek watershed from 1992-2011.

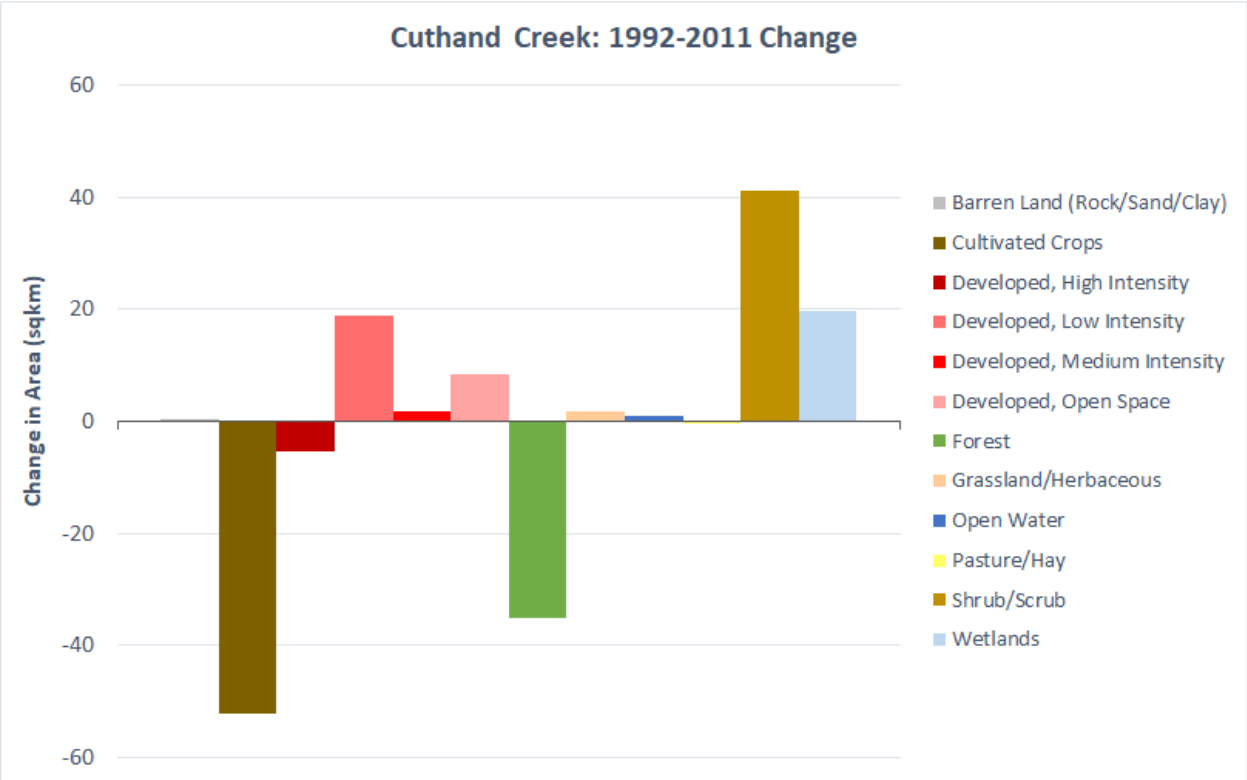

Figure 291. Land use change in area (sq km) from 1992-2011 for the Cuthand Creek watershed.

DAVIDSON CREEK

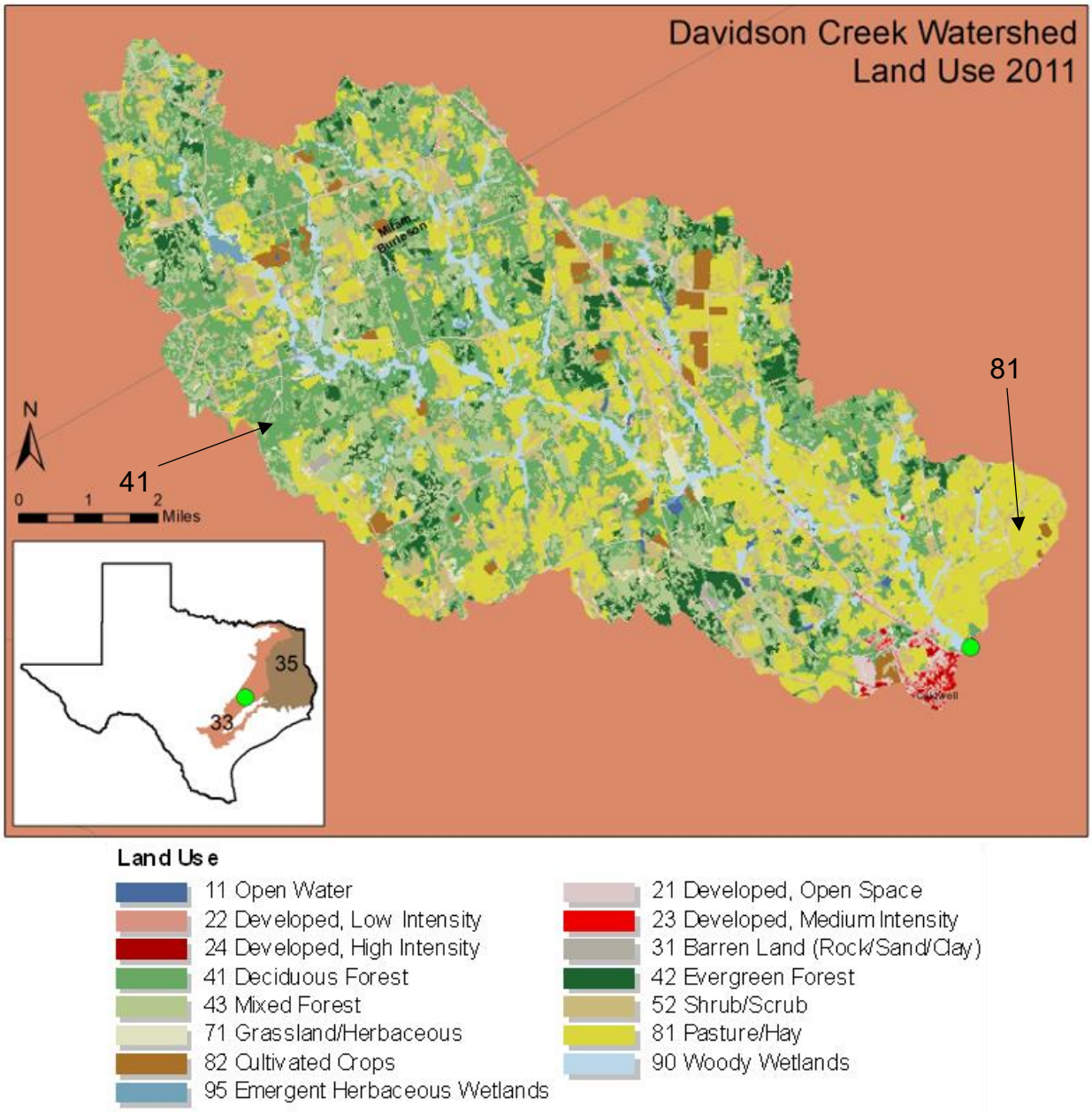

Figure 292. Map of Davidson Creek watershed location and 2011 land use; forest and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	August 18, 1988; June 30, 2003; September 10, 2003
Water Quality:	111 sampling events
Fish:	August 17, 1988; April 13, 1989; June 30, 2003; September 10, 2003
Benthic Invertebrates:	August 18, 1988; June 30, 2003; September 10, 2003

Physical Characterization

Watershed and Land Use

Davidson Creek lies within the Brazos River Basin. Sample site 11729 is located downstream of SH 21, 0.8 km northeast of Caldwell in Burleson County (Figure 292).

The Davidson Creek watershed at site 11729 is approximately 178.11 sq km. The sample site is located in Level IV Ecoregion 33c, the San Antonio Prairie, and the majority of the watershed lies within Level IV Ecoregion 33b, the Southern Post Oak Savanna. The dominant land cover in the watershed is forest at 44.33% and is most concentrated in the middle and upper watershed (Homer et al. 2015; Figure 292 and Figure 293). Pasture/hay and shrub are the secondary land covers encompassing 26.82% and 13.96% of the Davidson Creek watershed, respectively. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 5.19% and total cover for cultivated crops is 1.83%.

From 1992-2011 there was a 14.22 sq km decrease in grasslands and 8.18 sq km decrease in forest. There was a 9.33 sq km increase in wetlands and an 8.19 sq km increase in shrub (Figure 294).

There are no permitted wastewater outfalls within the Davidson Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Davidson Creek was evaluated during three sampling events from 1988 to 2003. Davidson Creek is an intermittent stream with perennial pools that drains to Yegua Creek below Somerville Lake. Habitat Quality Index scores are available for two sample events and indicate an intermediate aquatic life use rating (18-19). Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters for all sampling events. The riparian zone was generally dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 63% to 82%. The dominant stream substrate was silt, and the average percent of substrate gravel size or larger was 0%. Average percent instream cover was 37% to 59% and instream cover types include snags, large and small woody debris, and root mats. Davidson Creek ranged from 0.3-0.5 meters deep on average and 5-7 meters wide. Average stream bank slope ranged from 58-65 degrees. Stream flow at the site was 0 cfs in 1988, but it was not measured during the two sampling events in 2003. Average stream bank erosion potential was 47%-61%. The deepest pool measured at Davidson Creek was 0.6 meters. No riffles were observed at the site, and total number of stream bends ranged from two to six.

Water Quality

Water samples were collected at station 11729 over 111 sampling events from August 1988 through February 2020. Parameters measured included temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen,

phosphorus, total organic carbon, chloride, sulfate, and chlorophyll-a. Additional sampling events were initiated at station 20388 starting in 2018.

Biological Characterization

Fish

Nineteen species (eight families) were collected over the course of four sampling events. The family Centrarchidae yielded the greatest number of species (seven). Western Mosquitofish was the most abundant species in the collections from the 1980's, whereas Bluegill was the most abundant one in 2003. Species unique to the 2003 collections included Black Bullhead, Yellow Bullhead, Common Carp, and Redear Sunfish. No species were unique to the early collections. The aquatic life use rating (based upon the fish assemblage) was high (despite the paucity of benthic invertivore species and lack of intolerant species) for all the samples except the one from 1989 which rated intermediate; however, when the coefficient of variability is applied to the intermediate score, it also rates as high.

Benthic Macroinvertebrates

A total of 1,012 individuals representing eleven orders of macroinvertebrates (Appendix E) were collected during the three sample events at Davidson Creek. Oligochaetes and Diptera represented 94% of the individuals collected. Ephemeroptera and Odonata were the next most abundant orders, each representing 1.3% of the individuals collected.

Considered collectively across both sample dates, the functional organization of the Davidson Creek macroinvertebrate assemblage was dominated by collector-gatherers and predators which accounted for 65% and 33%, respectively, of the total number of individuals collected. The shredder and scraper functional groups each represented 1% of the total number collected. The EPT for individual samples varied from zero for the 1988 Surber sample to two for the sample collected in June 2003. These values are relatively low, falling below the 5th percentile for all EPT values for least disturbed streams sampled in the aggregated ecoregion. Two of the three values for biotic index exceed the 95th percentile for all biotic index values in the ecoregion reflecting a dominance of tolerant taxa.

The East Bioregion Surber BIBI for the 1988 Surber sample fell in the intermediate aquatic life use category, while the Ecoregions 33 and 35 BIBI for both samples from 2003 fell in the limited aquatic life use category.

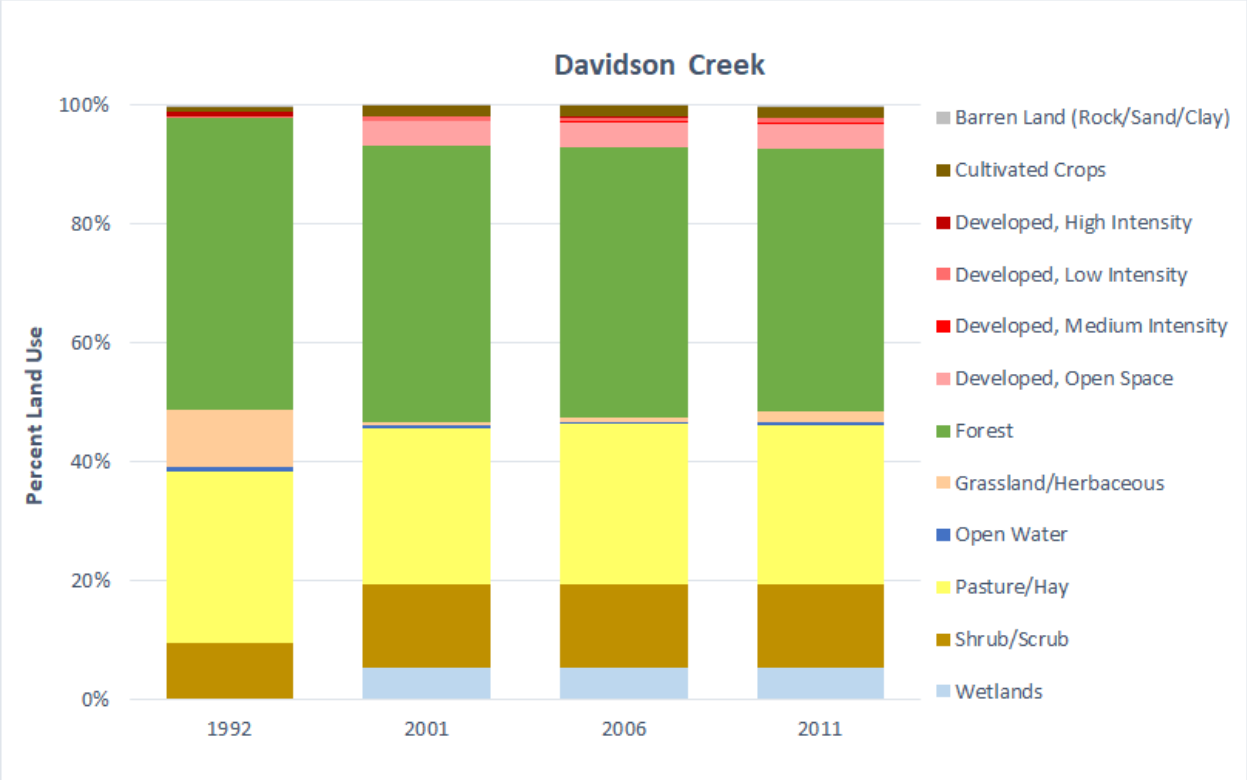

Figure 293. Percent land use in the Davidson Creek watershed from 1992-2011.

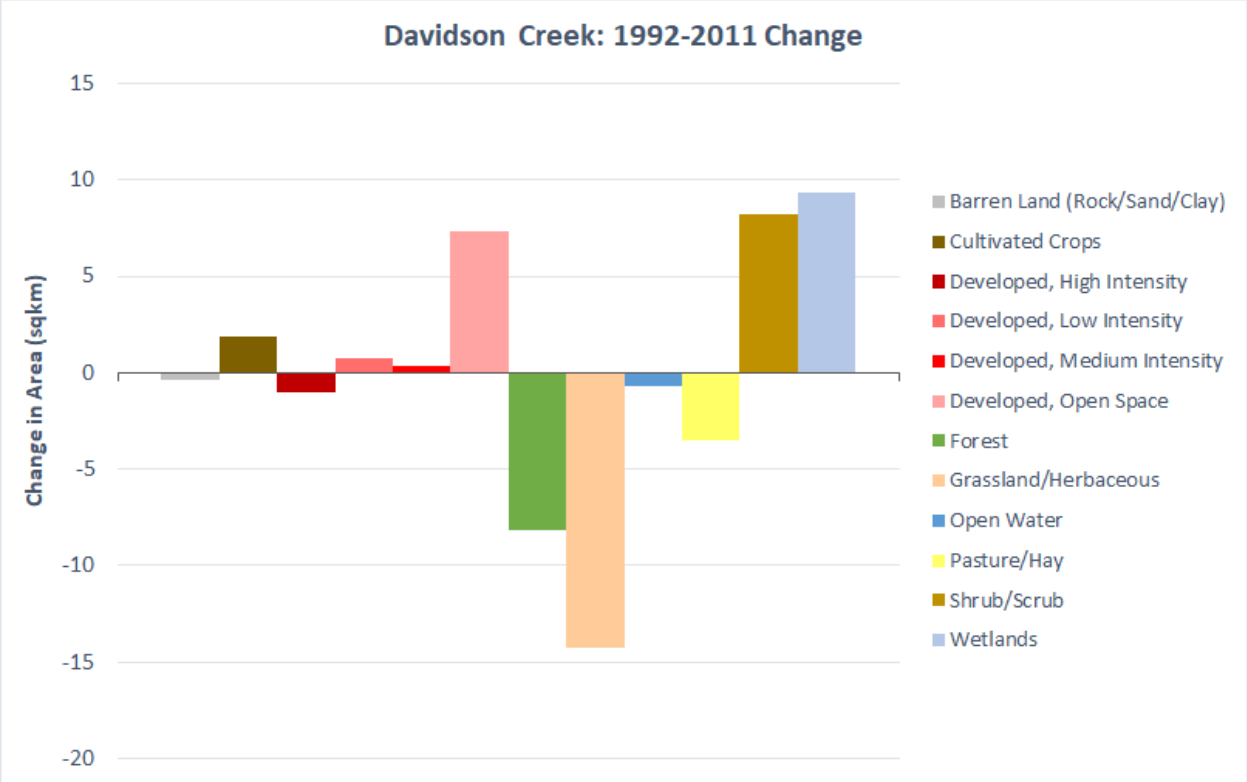

Figure 294. Land use change in area (sq km) from 1992-2011 for the Davidson Creek watershed.

KICKAPOO CREEK

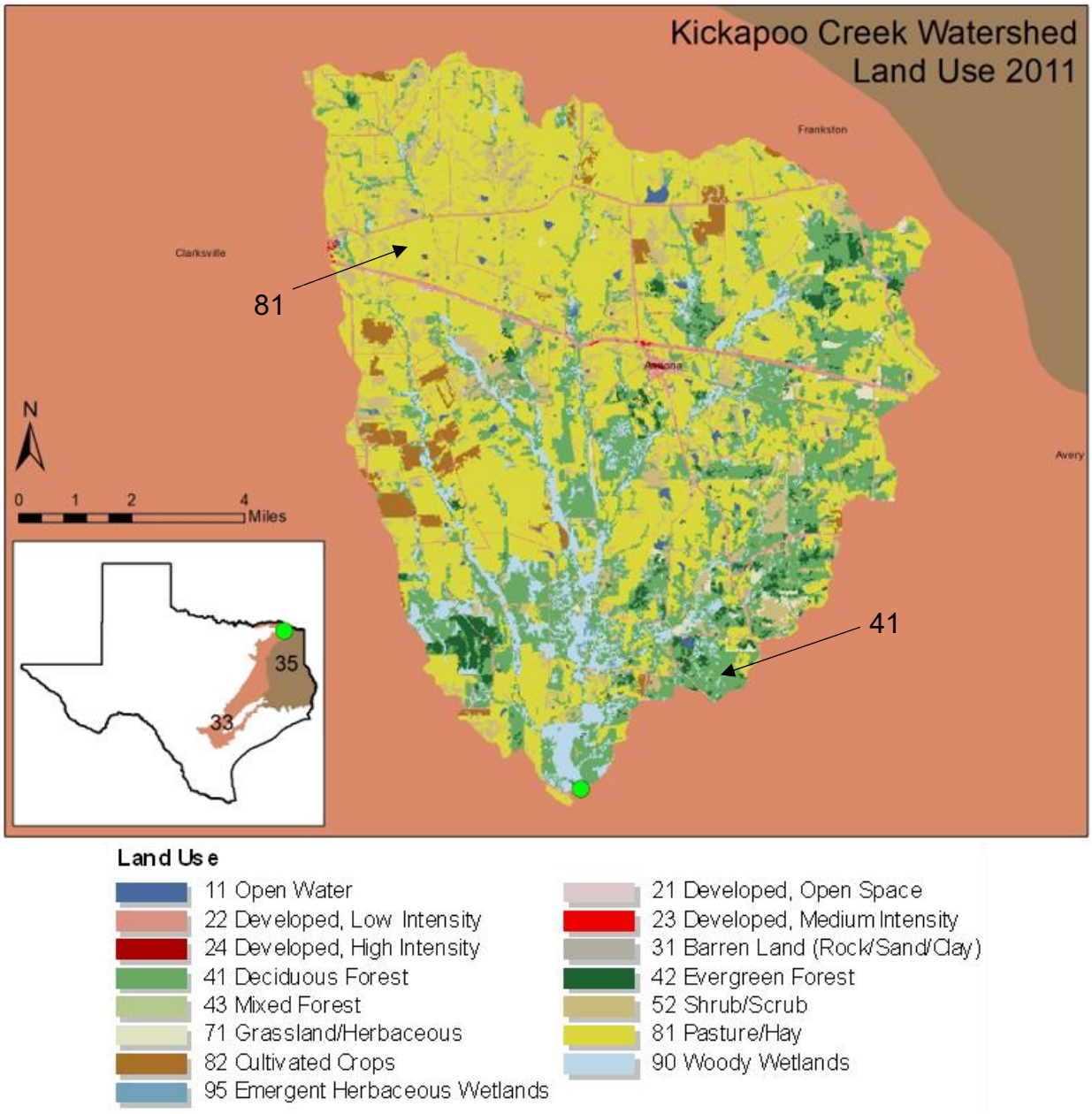

Figure 295. Map of Kickapoo Creek watershed location and 2011 land use; pasture/hay and forest were the most common land uses.

Sampling Dates

Physical Habitat:	May 23, 2002
Water Quality:	14 sampling events
Fish:	May 23, 2002; July 5, 2002
Benthic Invertebrates:	May 23, 2002; July 5, 2002

Physical Characterization

Watershed and Land Use

Kickapoo Creek lies within the Sulphur River Basin. Sample site 17342 is located at FM 412, approximately 11.27 km south of Annona in Red River County (Figure 295).

The Kickapoo Creek watershed at site 17342 is approximately 246.89 sq km. The sample site is located in Level IV Ecoregion 33f, the Floodplains and Low Terraces; however, the watershed spans Level IV Ecoregion 33a, the Northern Post Oak Savanna, and Ecoregion 33d, the Northern Prairie Outliers. The dominant land cover in the watershed is pasture/hay at 50.44% and is present throughout the watershed, but most concentrated in the middle and upper watershed (Homer et al. 2015; Figure 295 and Figure 296). Forest is the secondary land cover encompassing 25.03% of the Kickapoo Creek watershed. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 4.43% and total cover for cultivated crops is 2.43%.

From 1992-2011 there was a 14.35 sq km decrease in cultivated crops, 11.97 sq km decrease in forest, and 10.84 sq km decrease in pasture/hay. There was a 22.71 sq km increase in shrub and an 8.47 sq km increase in low intensity development (Figure 297).

There is one domestic wastewater outfall (discharges < 1 million gallons per day) permitted to the City of Annona and one larger wastewater outfall (discharges ≥ 1 million gallons per day) permitted to Ervin Don Crutcher to authorize the discharge of wet decking wastewater and stormwater. Neither of these wastewater outfalls discharge directly into Kickapoo Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Kickapoo Creek was evaluated on May 23, 2002. Kickapoo Creek is a perennial stream that drains to Cuthand Creek. The Habitat Quality Index score of 12 indicates a limited aquatic life use rating. The average riparian buffer was measured at 12.5 meters. The riparian zone was dominated by grasses, which made up an average of 38% of the total riparian species, followed by shrubs and trees (20% each). The average percentage of tree canopy cover was 43%. The dominant substrate was clay and the average percent of substrate gravel size or larger was 1%. Average percent instream cover was 9%. Kickapoo Creek was 0.4 meters deep on average and 7 meters wide. Average stream bank slope was 37 degrees, and the average stream bank erosion potential was 65%. Stream flow at the site was 5.7 cfs. The deepest pool measured at Kickapoo Creek was 1.8 meters. No riffles or stream bends were observed at the site.

Water Quality

Water samples were collected at station 17342 over 14 sampling events from February 2002 through July 2019. Parameters measured included temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Seventeen species (seven families) were collected between the two sampling events. The richest family was Centrarchidae with eight species. Cyprinidae was the only other family with more than one species, with a total of four. Red Shiner was the most abundant species. The aquatic life use rating for both fish collections was only intermediate. The creek had a low number of individuals, benthic invertivore species, and intolerant species. Greater than 50% of the individuals collected were tolerant species.

Benthic Macroinvertebrates

A total of 198 individuals representing nine orders of macroinvertebrates were collected during the two sample events at Kickapoo Creek (Appendix E). Ephemeroptera, Coleoptera, and Trichoptera were the three most abundant orders collected representing 27%, 18%, and 17%, respectively, of the individuals collected. Diptera (13%), Hemiptera (13%), and Decapoda (6.6%) were also relatively well represented in benthic samples from Kickapoo Creek.

Considered collectively across both sample dates, the functional organization of the macroinvertebrate assemblage was relatively balanced among collector-gatherers, predators, and filtering collectors which accounted for 35%, 23%, and 22%, respectively, of the total number of individuals collected. The shredder (1%) functional group was the least abundant.

The EPT was five for the May 2002 collection and three for the July 2002 sample, which are at and below the 5th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The value for the biotic index for the May 2002 sample (5.3) falls between the 50th and the 75th percentiles and the value for the July 2002 sample (6.9) is above the 95th percentile. Overall, these metrics reflect an assemblage that is tolerant relative to other macroinvertebrate assemblages in least disturbed streams in ecoregion aggregate 33/35.

Results for the Ecoregions 33 and 35 BIBI for the May 2002 RBP sample indicated limited aquatic life use, while the score for the July sample indicated intermediate aquatic life use.

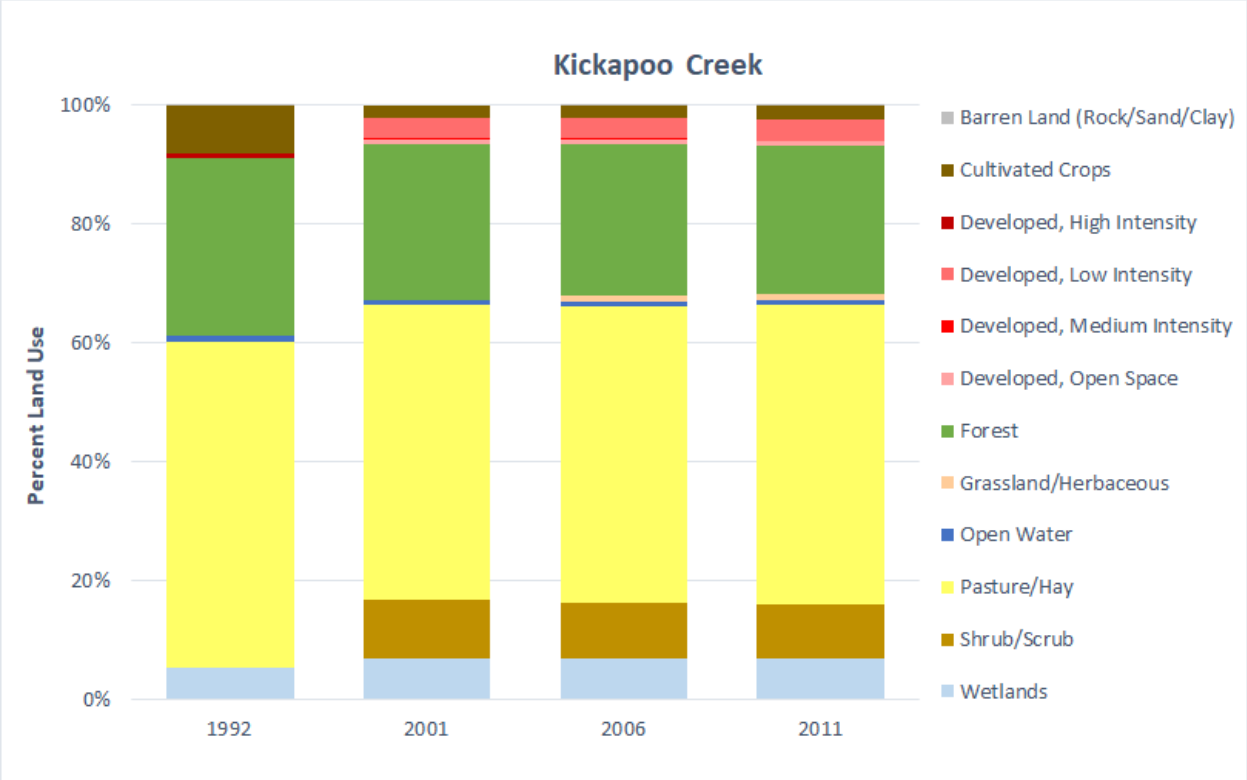

Figure 296. Percent land use in the Kickapoo Creek watershed from 1992-2011.

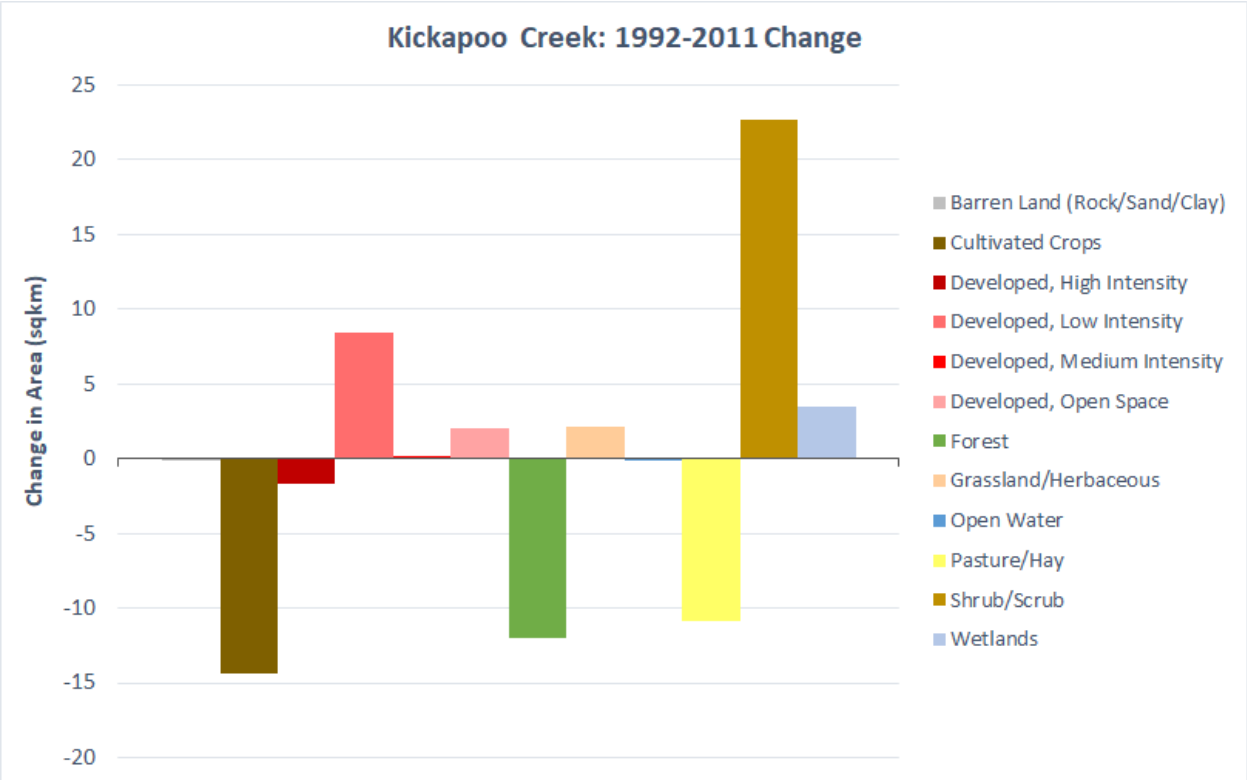

Figure 297. Land use change in area (sq km) from 1992-2011 for the Kickapoo Creek watershed.

LITTLE MUSTANG CREEK

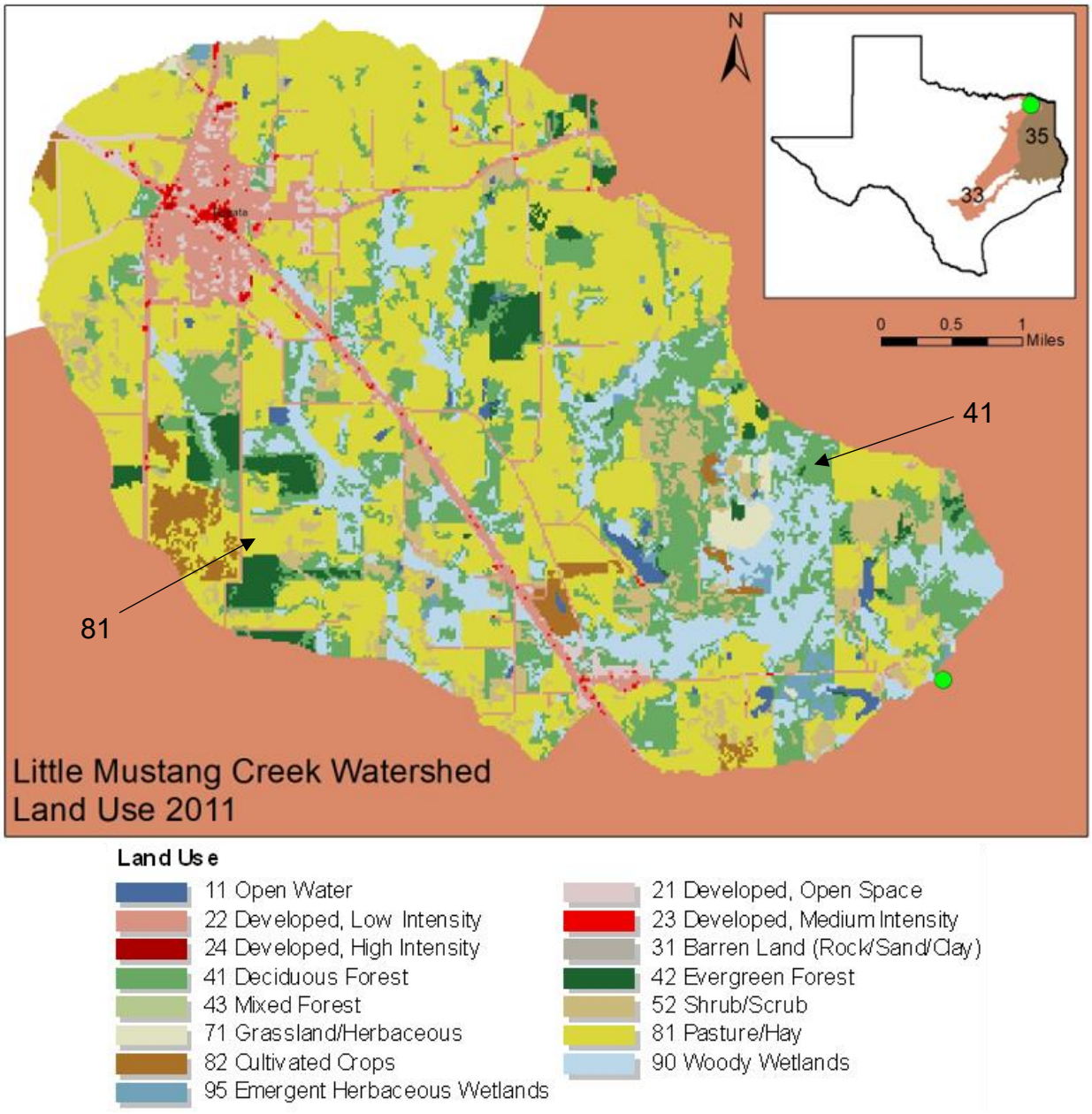

Figure 298. Map of Little Mustang Creek watershed location and 2011 land use; pasture/hay and forest were the most common land uses.

Sampling Dates

Physical Habitat:	May 23, 2002
Water Quality:	6 sampling events
Fish:	July 19, 2000; May 23, 2002; July 5, 2002
Benthic Invertebrates:	May 23, 2002; July 5, 2002

Physical Characterization

Watershed and Land Use

Little Mustang Creek lies within the Sulphur River Basin. Sample site 17343 is located at CR 1410, southeast of Bogata in Red River County (Figure 298).

The Little Mustang Creek watershed at site 17343 is approximately 59.23 sq km. The sample site and majority of the watershed are located in Level IV Ecoregion 33a, the Northern Post Oak Savanna, while the extreme upper portions of the watershed cross into Ecoregion 32a, the Northern Blackland Prairie. The dominant land cover in the watershed is pasture/hay at 45.71% and is present throughout the watershed (Homer et al. 2015; Figure 298 and Figure 299). Forest and wetlands are the secondary land covers encompassing 20.63% and 12.52% of the Little Mustang Creek watershed, respectively. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 10.02% and total cover for cultivated crops is 2.02%.

From 1992-2011 there was a 7.47 sq km decrease in forest and approximately 3 sq km decrease in both cultivated crops and pasture/hay cover. There was a 4.39 sq km increase in shrub, a 4.27 sq km increase in wetlands, and a 3.4 sq km increase in low intensity development (Figure 300).

There is one domestic wastewater outfall (discharges < 1 million gallons per day) permitted to the City of Bogata which does not discharge directly into Little Mustang Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Little Mustang Creek was evaluated on May 23, 2002. Little Mustang Creek is an intermittent stream with perennial pools that drains to the Sulphur River. The Habitat Quality Index score of 13 indicates a limited aquatic life use rating. The average riparian buffer was measured at 12.6 meters. The riparian zone was dominated by grasses, which made up an average of 42% of the total riparian species, followed by trees (26%) then shrubs (20%). The average percentage of tree canopy cover was 81%. The dominant substrate was silt and the average percent of substrate gravel size or larger was 3%. Average percent instream cover was 22%. Little Mustang Creek was 0.4 meters deep on average and 3.7 meters wide. Average stream bank slope was 37 degrees, and the average stream bank erosion potential was 62%. Stream flow at the site was 1.0 cfs. No pools were identified on Little Mustang Creek at the time of sampling. No riffles were observed at the site and there was one moderately defined stream bend.

Water Quality

Water samples were collected at station 17343 over 6 sampling events from February 2002 through July 2002. Parameters measured included temperature, flow, transparency, specific conductivity, dissolved oxygen, pH, ammonia, total Kjeldahl nitrogen, phosphorus, chloride, sulfate, and chlorophyll-a.

Biological Characterization

Fish

Twenty-three species (eight families) were collected over the three sampling events. The families with the greatest species richness were Centrarchidae with eight and Cyprinidae with six. Golden Shiner was the most abundant fish species in the earliest collection but was overtaken by Bluegill in the latter two collections. The fish assemblage in Little Mustang Creek appears to have declined since the original sample in 2000, when the aquatic life use rated as high. The 2002 collections yielded one-half the species richness collected in 2000 and subsequent reductions in native cyprinid richness and number of benthic invertivore species resulting in aquatic life use ratings of intermediate. Drought conditions in 2002 likely influenced the fish collections. Perhaps the assemblage has bounced back since.

Benthic Macroinvertebrates

A total of 394 individuals representing 11 orders of macroinvertebrates were collected during the two sample events at Little Mustang Creek (Appendix E). Trichoptera, Decapoda, and Ephemeroptera were the three most abundant orders observed, comprising 37.3%, 26.16%, and 21.1% of the total individuals collected, respectively. Coleoptera (8.9%), Diptera (2.0%), and Plecoptera (1.5%) were the three next most abundant taxa in the samples from Little Mustang Creek.

Considered collectively across both sample dates, the functional organization of the macroinvertebrate assemblage was dominated by filtering collectors, collector-gatherers, and scrapers which accounted for 39%, 16.2%, and 15%, respectively, of the total number of individuals collected. The predators functional group was the least abundant representing only 3.7% of the total number of individuals collected.

The EPT was four for both samples which is at and below the 25th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The value for the biotic index for the May 2002 sample (4.2) falls between the 5th and the 25th percentiles and the value for the July 2002 sample (5) falls between the 50th and the 75th percentiles for all biotic index values in the ecoregion reflecting a fair amount of variability in the relative tolerance of the Little Mustang Creek macroinvertebrate assemblage.

Results for the Ecoregions 33 and 35 BIBI for RBP samples indicated limited aquatic life use for both samples.

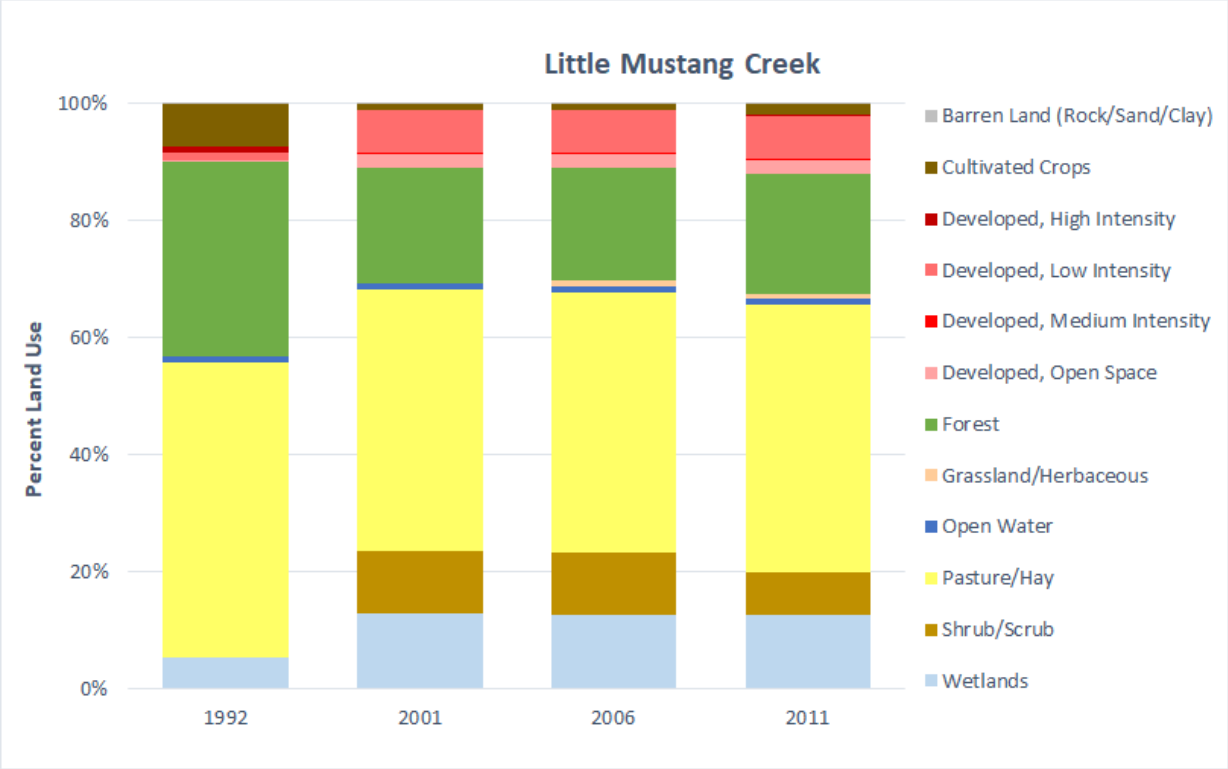

Figure 299. Percent land use in the Little Mustang Creek watershed from 1992-2011.

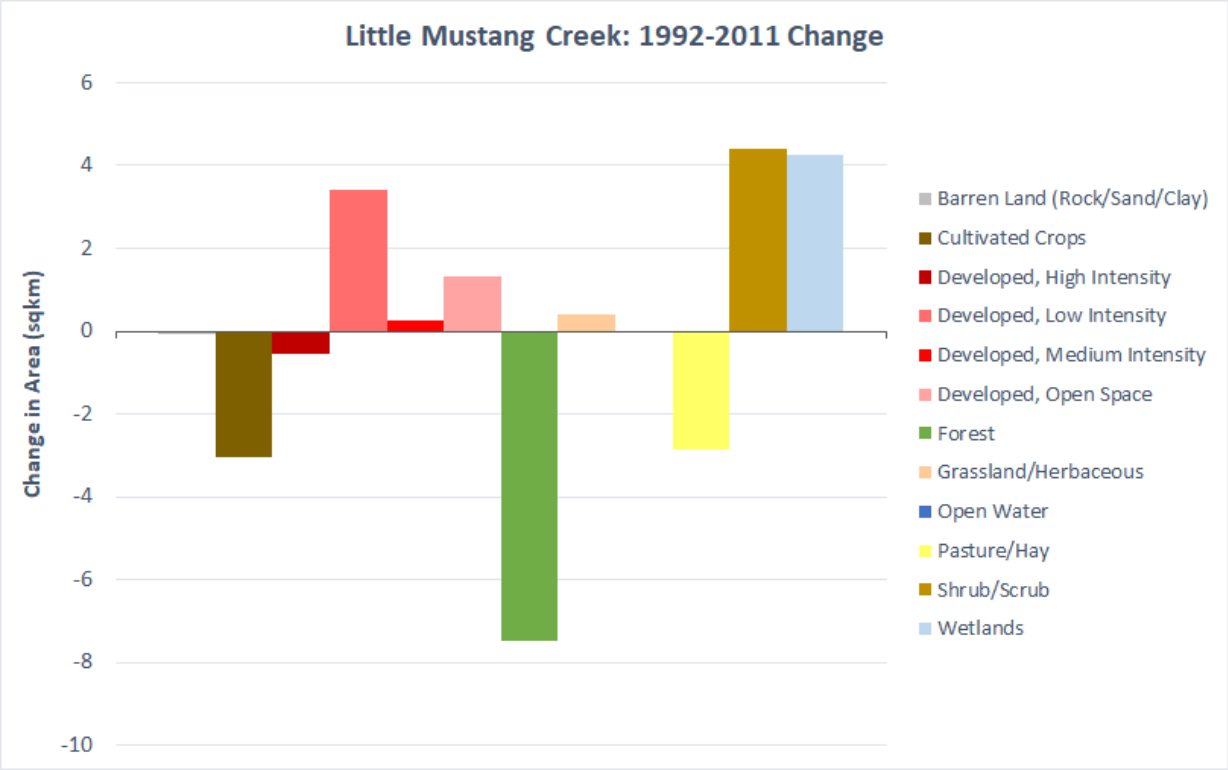

Figure 300. Land use change in area (sq km) from 1992-2011 for the Little Mustang Creek watershed.

LOWER KEECHI CREEK

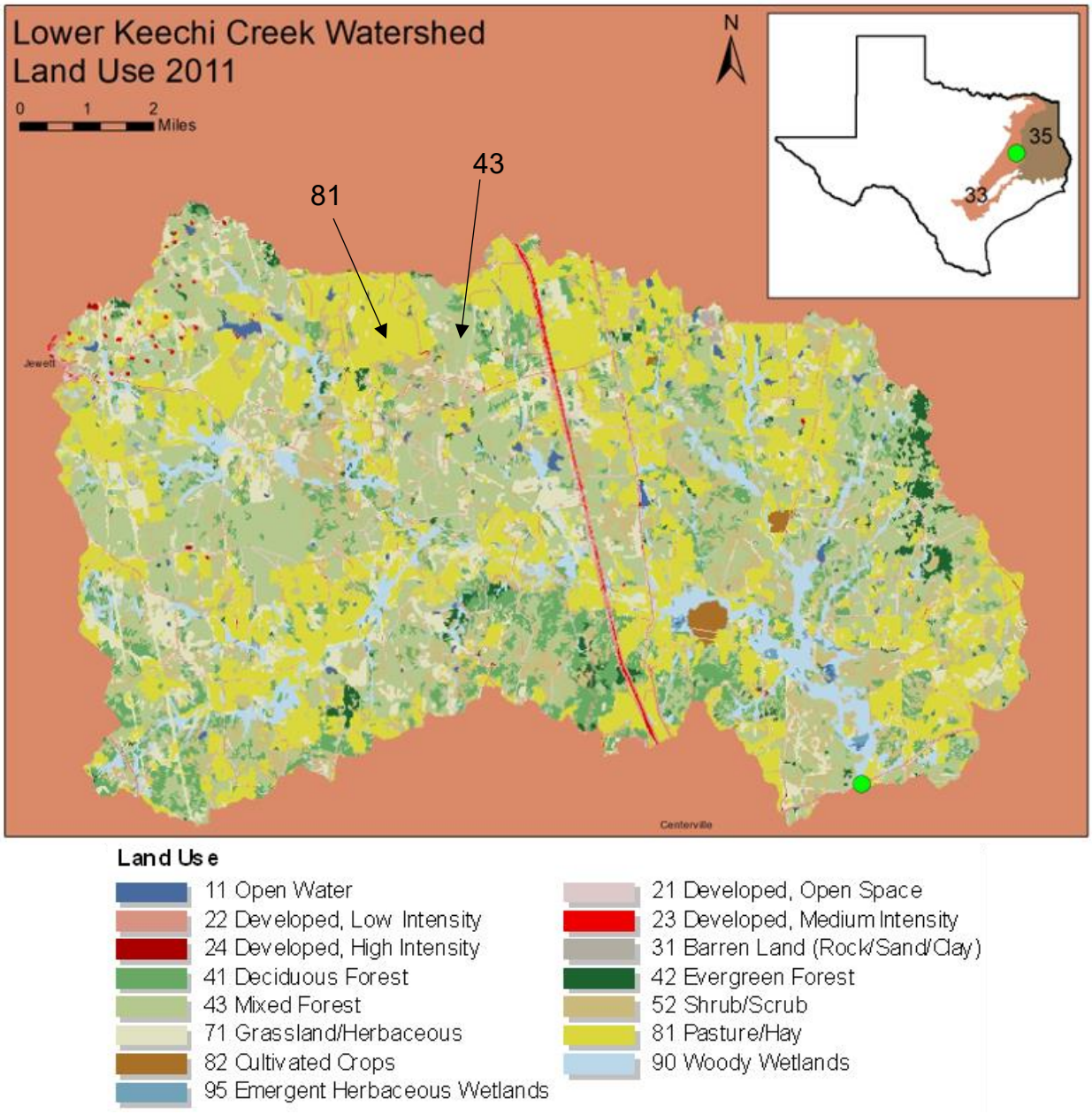

Figure 301. Map of Lower Keechi Creek watershed location and 2011 land use; forest and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	August 17, 1988
Water Quality:	4 sampling events
Fish:	August 17, 1988; April 12, 1989
Benthic Invertebrates:	August 17, 1988

Physical Characterization

Watershed and Land Use

Lower Keechi Creek lies within the Trinity River Basin. Sample site 10822 is located at SH 7, 4.18 km east of Centerville in Leon County (Figure 301).

The Lower Keechi Creek watershed at site 10822 is approximately 248.12 sq km. The entire watershed is located in Level IV Ecoregion 33b, the Southern Post Oak Savanna. The dominant land cover in the watershed is forest at 37.23% and is present throughout the watershed (Homer et al. 2015; Figure 301 and Figure 302). Pasture/hay is the secondary land cover encompassing 26.89%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 5.47% and total cover for cultivated crops is 0.39%.

From 1992-2011 there was a 60.06 sq km decrease in forest and a 22.93 sq km decrease in pasture/hay. There was a 29.14 sq km increase in shrub and a 25.54 sq km increase in grasslands (Figure 303).

There is one domestic wastewater outfall (discharges < 1 million gallons per day) permitted to the City of Jewett which discharges directly into Lower Keechi Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Lower Keechi Creek was evaluated on August 17, 1988. Lower Keechi Creek is a perennial stream that drains to the Trinity River above Lake Livingston. The riparian width was 18 meters. The riparian zone was dominated by trees, which made up an average of 50% of the total riparian species, followed by shrubs (25%) then grasses (15%). The average percentage of tree canopy cover was 48%. The dominant substrate was fine sand, and the average percent of substrate that was gravel size or larger was 12%. Average percent instream cover was 51%. Lower Keechi Creek had an average depth of 0.4 meters and a maximum depth of 1.3 meters. The average width was 6.5 meters and average stream bank slope was 52 degrees. Stream flow at the site was 0.9 cfs. Average stream bank erosion potential was 71%. Seven riffles were observed at the site and there was one stream bend.

Water Quality

Water samples were collected at station 10822 over 4 sampling events from August 1988 through July 1999. Parameters measured included temperature, flow, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate and chlorophyll-a.

Biological Characterization

Fish

Lower Keechi Creek was sampled for fish in the summer of 1988 and spring of 1989, wherein it received an aquatic life use rating of high and intermediate, respectively. When the coefficient of variability is applied to the spring sample, it also yields a high rating. Twenty-two species (11

families) were collected between the two sampling events. Centrarchidae and Cyprinidae were the richest families, yielding seven and five species, respectively. Blacktail and Ribbon shiner were the two most abundant species.

Benthic Macroinvertebrates

A total of 99 individuals representing seven orders of macroinvertebrates were collected during the sample event at Keechi Creek (Appendix E). Coleoptera, Diptera, and Pelecypoda (*Corbicula* sp.) were the three most abundant orders collected representing 50.5%, 24.2%, and 7.1%, respectively, of the individuals collected. Ephemeroptera (5.1%), Odonata (5.1%), Oligochaeta (5.1%), and Hemiptera were the only other orders represented in the sample.

The functional organization of the Keechi Creek macroinvertebrate assemblage was dominated by collector-gatherers, scrapers, and predators which accounted for 39.7%, 26.8%, and 15.5%, respectively, of the total number of individuals collected. The filtering collectors (10.6%) and shredders (7.4%) were present, but each represented lower relative abundance.

The EPT was four for the sample which is below the 25th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The value for the biotic index (6.7) is equal to the 95th percentile for all biotic index values in the ecoregion indicating a relatively tolerant macroinvertebrate assemblage in Keechi Creek.

Results for the Surber sample BIBI falls in the range indicating a high aquatic life use for the Keechi Creek macroinvertebrate assemblage.

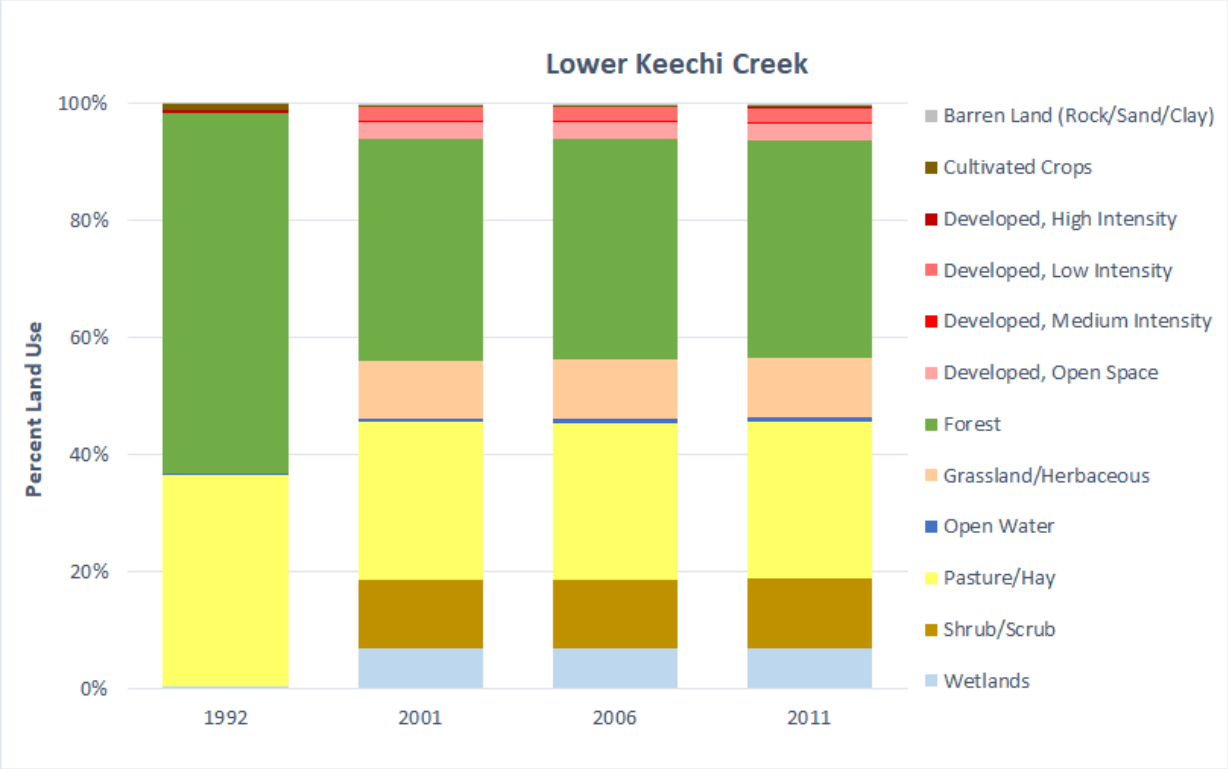

Figure 302. Percent land use in the Lower Keechi Creek watershed from 1992-2011.

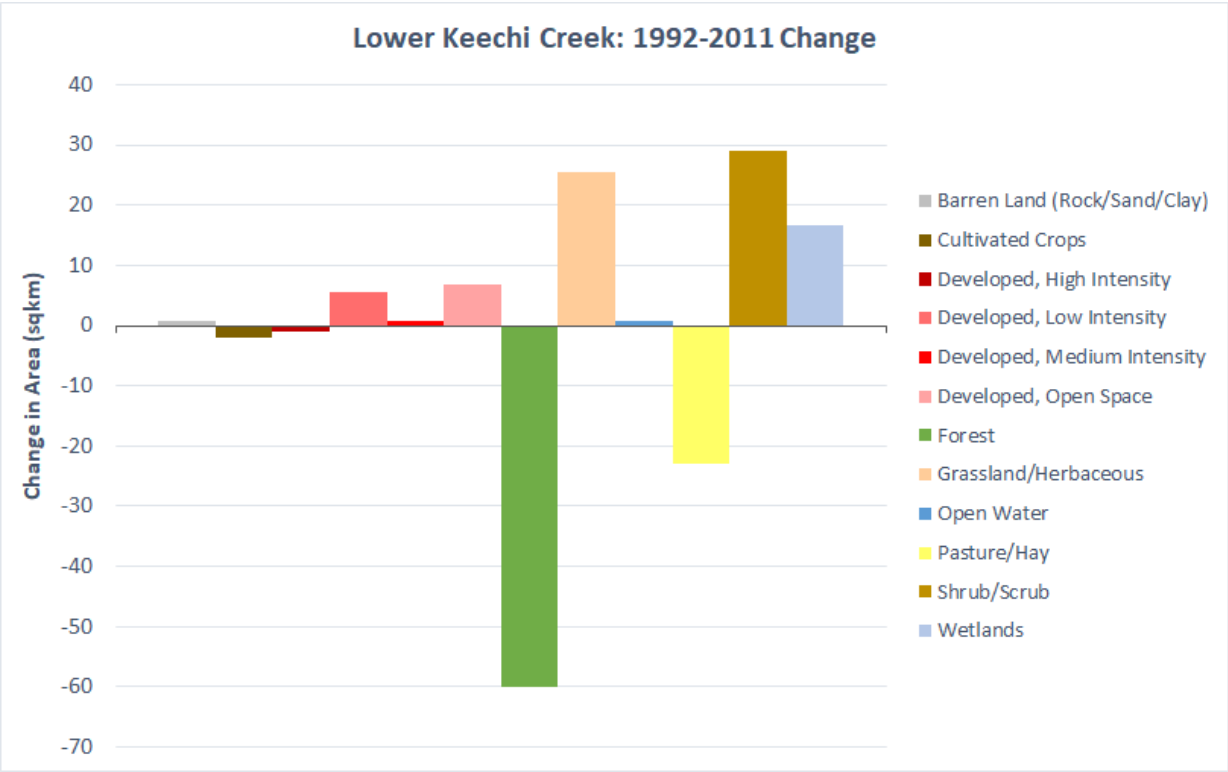

Figure 303. Land use change in area (sq km) from 1992-2011 for the Lower Keechi Creek watershed.

MIDDLE YEGUA CREEK

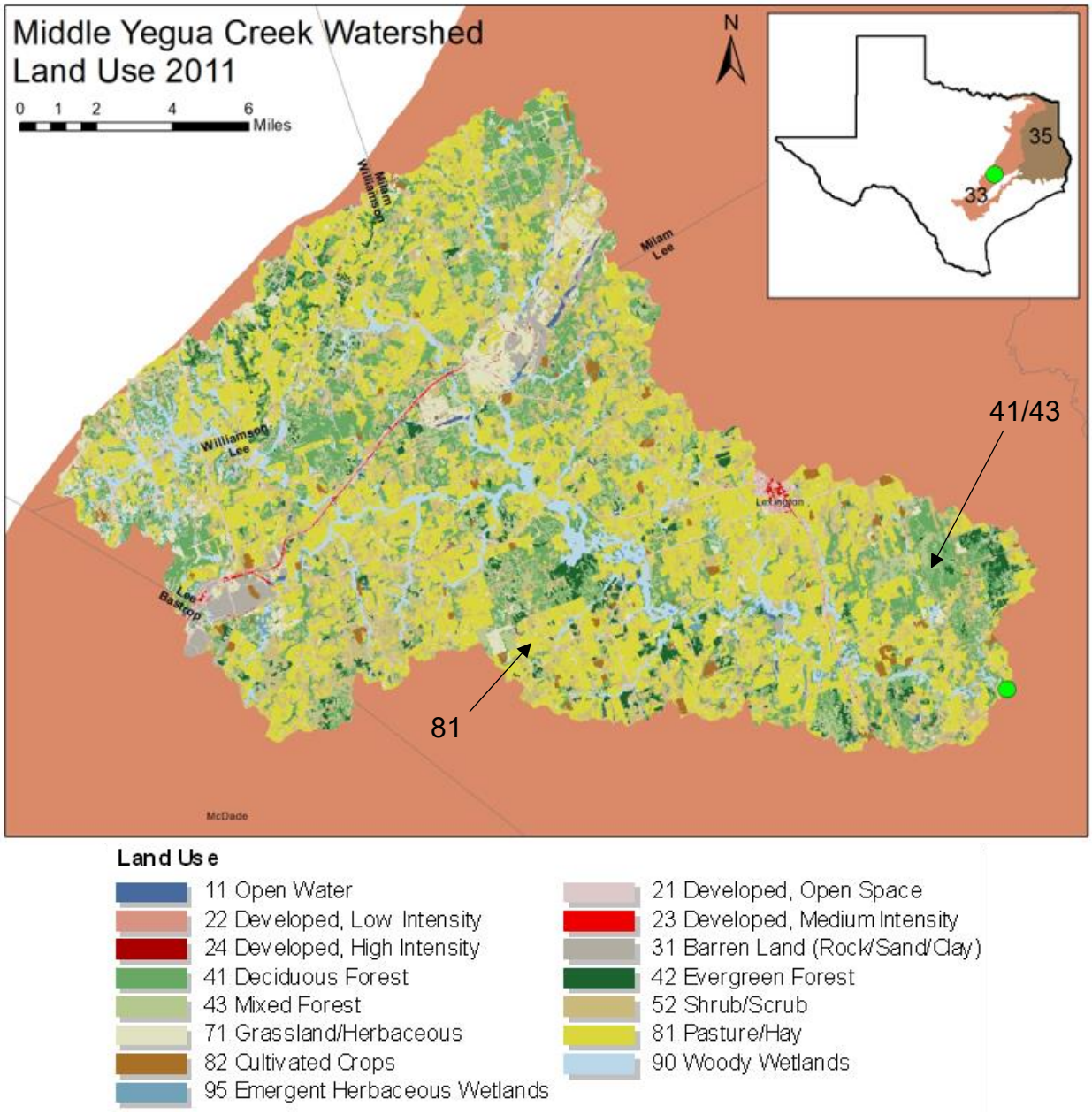

Figure 304. Map of Middle Yegua Creek watershed location and 2011 land use; pasture/hay and forest were the most common land uses.

Sampling Dates

Physical Habitat:	September 3, 1986
Water Quality:	29 sampling events
Fish:	September 4, 1986; August 21, 2000
Benthic Invertebrates:	October 13, 1987 (x2)

Physical Characterization

Watershed and Land Use

Middle Yegua Creek lies within the Brazos River Basin. Sample site 11839 is located at County Road 121, 7.72 km south of Dime Box in Lee County (Figure 304).

The Middle Yegua Creek watershed at site 11839 is approximately 1108.81 sq km. The station and most of the watershed are located in Level IV Ecoregion 33b, the Southern Post Oak Savanna, and a small part of the watershed crosses Level IV Ecoregion 33c, the San Antonio Prairie. The dominant land cover in the watershed is pasture/hay at 39.11% and is present throughout the watershed (Homer et al. 2015; Figure 304 and Figure 305). Forest is the secondary land cover encompassing 24.35%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 5.42% and total cover for cultivated crops is 2.33%.

From 1992-2011 there was a 190.64 sq km decrease in forest and an 88.59 sq km decrease in grassland. There was a 90.05 sq km increase in shrub and an 89.23 sq km increase in pasture/hay (Figure 306).

There are three domestic wastewater outfalls (discharges < 1 million gallons per day) and three industrial wastewater outfalls (discharges ≥ 1 million gallons per day) within the Middle Yegua Creek watershed. One domestic wastewater facility is permitted to the City of Lexington, one to Aqua Water Supply Corporation in the City of Bastrop, and one to Manville Water Supply Corporation. The three industrial wastewater facilities are permitted to Luminant Mining Co, LLC, a coal mining company. None of these facilities discharge directly into Middle Yegua Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Middle Yegua Creek was evaluated on September 3, 1986. Middle Yegua Creek is a perennial stream that drains to Yegua Creek upstream of the confluence with Somerville Lake. The riparian width was 23 meters. The riparian zone was dominated by trees, which made up an average of 60% of the total riparian species, followed by shrubs and grasses (20% each). The average percentage of tree canopy cover was 60%. The dominant substrate was fine sand, and the average percent of substrate that was gravel size or larger was 30%. Average percent instream cover was 43%. Middle Yegua Creek had an average depth of 0.5 meters and a maximum depth of 1.3 meters. The average width was 3.9 meters and the average stream bank slope was 40 degrees. Stream flow at the site was 0.9 cfs. Average stream bank erosion potential was 51%. Four riffles were observed at the site and there were two total stream bends.

Water Quality

Water samples were collected at stations 11838, 18750, 18751 over 29 sampling events from January 2000 through July 2008. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total

nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-a. Additional sampling events were initiated at stations 11838, 11840, 18750 starting in 2018 as part of routine monitoring and a special study. Continuous flow data associated with station 11840 is available from USGS gage 08109700 (Figure 307).

Biological Characterization

Fish

Twenty-five species (10 families) were collected between the two sampling events. Cyprinidae yielded the greatest species richness with ten. Western mosquitofish was the most abundant fish species in 1986. Blacktail Shiner was the most abundant fish species in 2000. The aquatic life use (based upon the fish assemblage) declined from high to intermediate between 1986 and 2000. The major reasons for the decline in score were a 50% reduction in native cyprinid species, collection of only one intolerant species (two were collected in 1988), and a reduction in percentage of piscivores from 7.1% to 2.3%. The minnow species missing from the 2000 collection were mostly comprised of common water quality tolerant species, except for Mimic Shiner which is considered intolerant of low dissolved oxygen conditions (Linam and Kleinsasser 1998). Tadpole Madtom, the other intolerant species collected in 1988, was also absent from the 2000 collection; however, Dusky Darter was added to the species list in 2000 making it the only water quality intolerant species. Though the number of piscivorous species remained relatively stable (three in 1988, two in 2000), the species composition changed significantly (only one species common to both collections) and the number of individuals declined dramatically.

Benthic Macroinvertebrates

A total of 493 individuals representing 11 orders of macroinvertebrates were collected at two sample sites on Middle Yegua Creek in 1987 (Appendix E). Oligochaeta, Pelecypoda (*Corbicula* sp.), and Diptera were the three most abundant orders collected representing 38.3%, 21.8%, and 19.8%, respectively, of the individuals collected. Ephemeroptera (6.9%), Coleoptera (5.7%), and Odonata (2.9%) were the three next most abundant orders. Caddisflies (Trichoptera) were relatively diverse, with five genera represented, but only accounted for 1.2% of total numbers of individuals collected.

Considered collectively across both sample sites, the functional organization of the Middle Yegua Creek macroinvertebrate assemblage was dominated by collector-gatherers, filtering collectors, and predators which accounted for 52.7%, 28.7%, and 10.6%, respectively, of the total number of individuals collected. Scrapers (6.5%) and shredders (1.5%) were present but in less relative abundance.

The EPT was five for the sample collected at site 11841 at US 77 and seven for the sample collected at site 11839 at Lee CR which fall at the 25th percentile and just below the 50th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The value for the biotic index at site 11841 was 7 which exceeds the 95th percentile for the ecoregion while

the index value at site 11839 was 5.8 which falls between the 75th and 95th percentile for all biotic index values in the ecoregion indicating a relatively tolerant macroinvertebrate assemblage in Middle Yegua Creek.

Results for the Surber sample BIBI were consistent across both sites, 39 for site 11841 and 43 for site 11839. The BIBI value for site 11841 indicates a high aquatic life use while site 11839 indicates an exceptional aquatic life use for the Middle Yegua Creek macroinvertebrate assemblage.

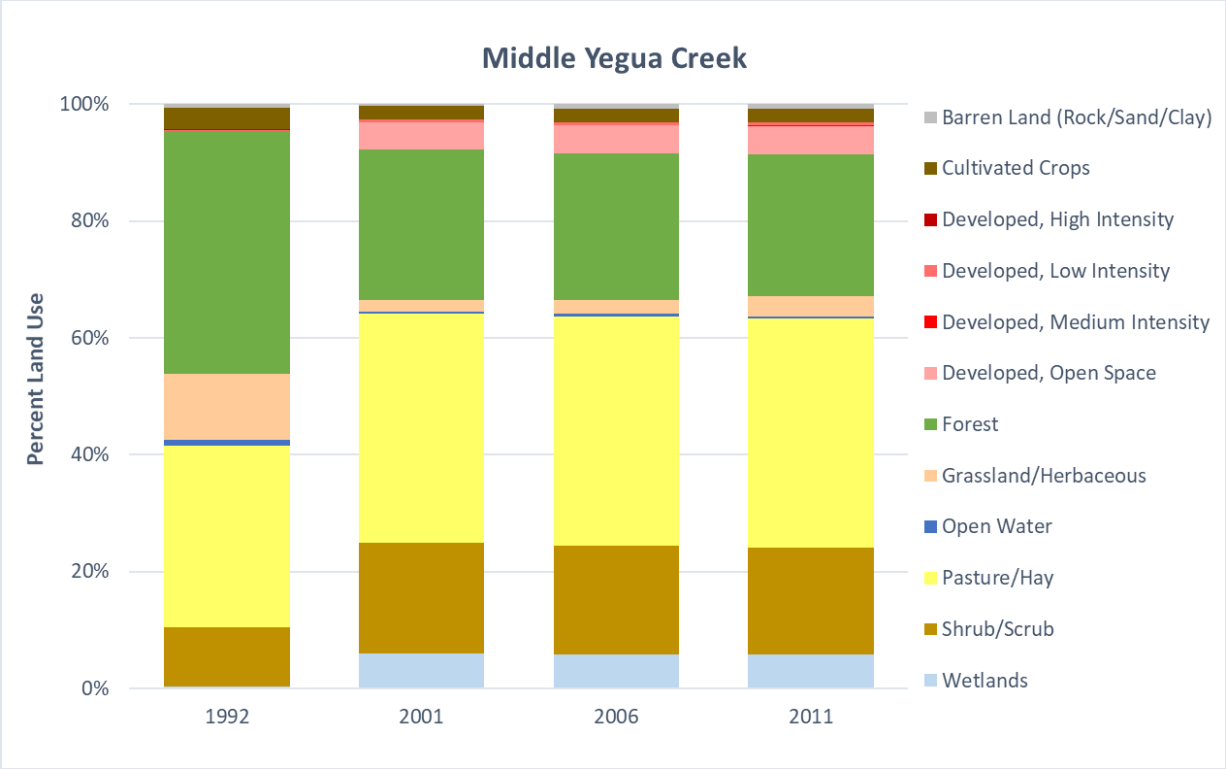

Figure 305. Percent land use in the Middle Yegua Creek watershed from 1992-2011.

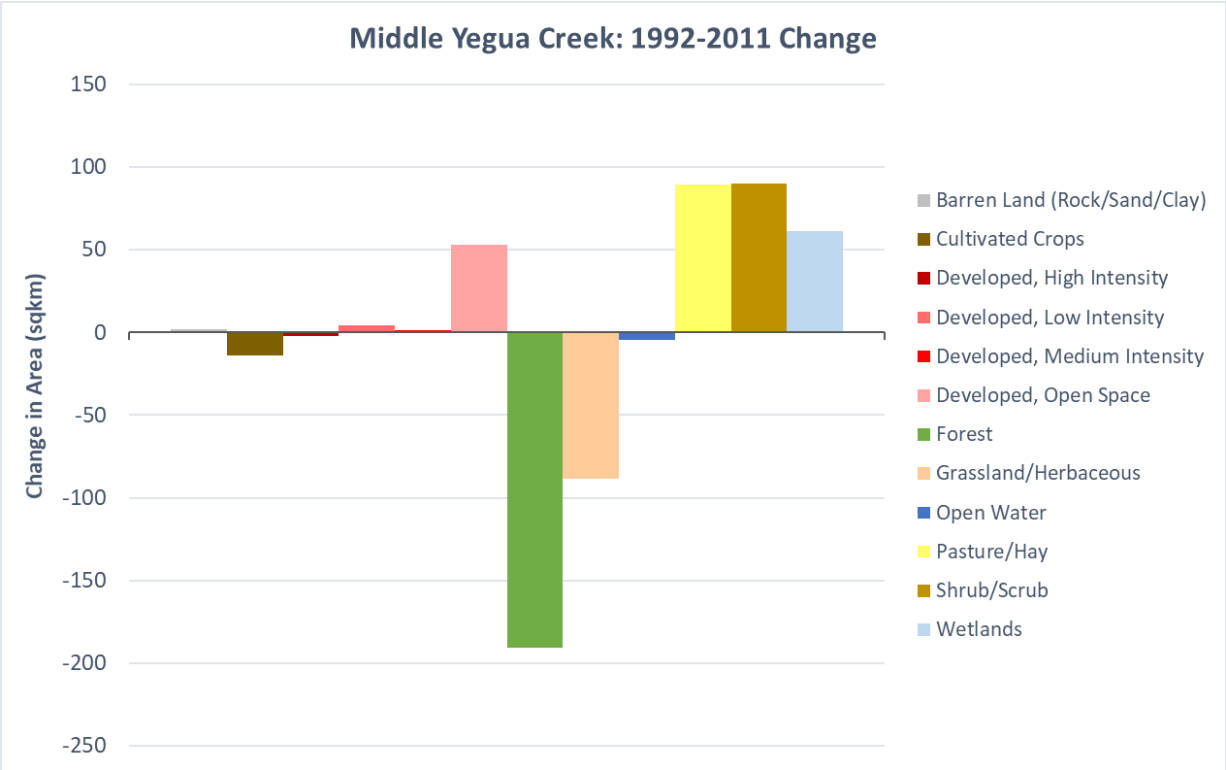

Figure 306. Land use change in area (sq km) from 1992-2011 for the Middle Yegua Creek watershed.

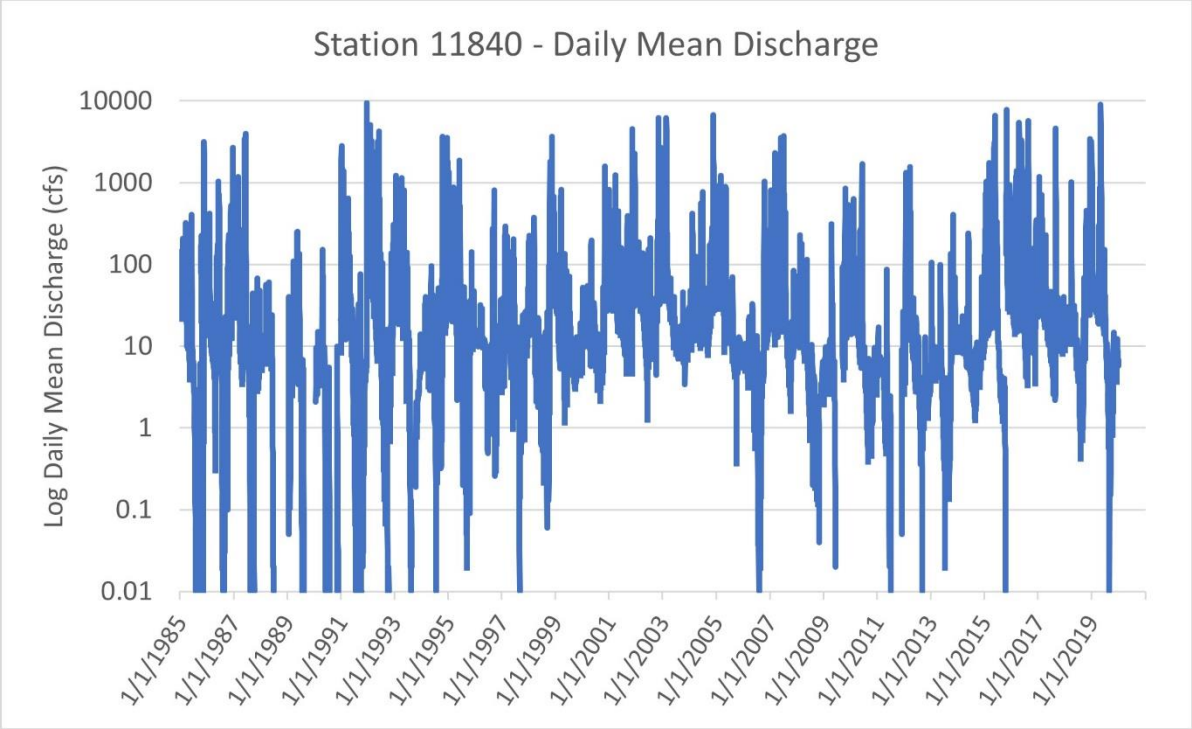

Figure 307. Log transformed daily mean discharge for Middle Yegua Creek at station 11840.

MILL CREEK

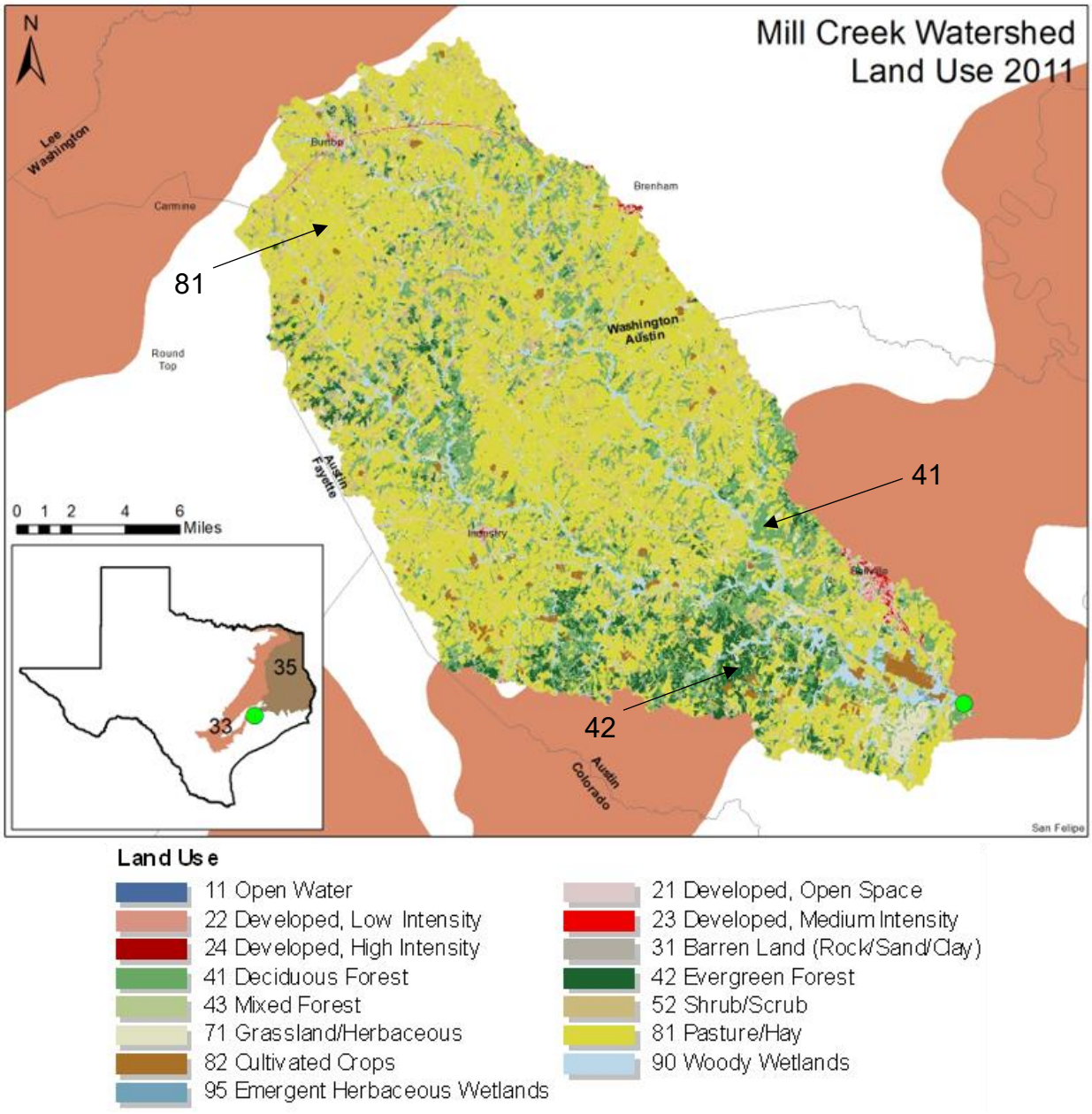

Figure 308. Map of Mill Creek watershed location and 2011 land use; pasture/hay and forest were the most common land uses.

Sampling Dates

Physical Habitat: July 19, 1988; April 5, 2004; May 19, 2005; May 17, 2006; August 15, 2007; July 1, 2008; June 10, 2009; April 27, 2010; July 22, 2010; May 10, 2011; April 17, 2012; April 16, 2013; May 12, 2014; July 29, 2014; August 4, 2015; October 3, 2016

Water Quality: 157 sampling events

Fish:	July 19, 1988; January 26, 2000; May 17, 2000; July 26, 2000; July 11, 2001; October 10, 2001; May 1, 2002; August 19, 2002; November 20, 2002; May 6, 2003; August 4, 2003; April 5, 2004; July 29, 2004; May 19, 2005; July 7, 2005; May 17, 2006; August 30, 2006; August 15, 2007; October 11, 2007; July 1, 2008; June 10, 2009; August 20, 2009; April 27, 2010; July 21, 2010; May 10, 2011; April 17, 2012; April 16, 2013; May 12, 2014; July 29, 2014; August 4, 2015; October 5, 2016; May 18, 2017; August 16, 2017
Benthic Invertebrates:	July 19, 1988; January 26, 2000; May 17, 2000; July 26, 2000; July 11, 2001; October 10, 2001; May 1, 2002; August 19, 2002; November 20, 2002; May 6, 2003; August 4, 2003; April 5, 2004; July 29, 2004; May 19, 2005; July 7, 2005; May 17, 2006; August 30, 2006; August 15, 2007; October 11, 2007; July 1, 2008; June 10, 2009; August 20, 2009; April 29, 2010; July 23, 2010; May 10, 2011; April 17, 2012; August 21, 2012; April 16, 2013; May 12, 2014; July 29, 2014; August 4, 2015; October 5, 2016

Physical Characterization

Watershed and Land Use

Mill Creek lies within the Brazos River Basin. Sample site 11576 is located at SH 36 southeast of Bellville in Austin County (Figure 308).

The Mill Creek watershed at site 11576 is approximately 975.78 sq km. The station and lower watershed are located in Level IV Ecoregion 33b, the Southern Post Oak Savannah, and the middle and upper watershed lay within Level IV Ecoregion 32b, the Southern Blackland/Fayette Prairie. The dominant land cover in the watershed is pasture/hay at 54.45% and is present throughout the watershed (Homer et al. 2015; Figure 308 and Figure 309). Forest is the secondary land cover encompassing 19.83%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 6.18% and total cover for cultivated crops is 1.46%.

From 1992-2011 there was a 69.41 sq km decrease in pasture/hay and a 34.16 sq km decrease in forest. There was a 52.77 sq km increase in wetlands and a 51.68 sq km increase in open space development (Figure 310).

There are four domestic wastewater outfalls (discharges < 1 million gallons per day) and one industrial wastewater outfall (discharges ≥ 1 million gallons per day) within the Mill Creek watershed. The domestic wastewater facilities are permitted to the City of Bellville, the City of Burton, the City of Industry, and U.S. Steel Tubular Productions Inc, which manufactures steel pipes. U.S. Steel Tubular Productions Inc. has a second permit for the industrial wastewater facility. None of these facilities discharge directly into Mill Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Mill Creek was evaluated at two sites during 16 sampling events from 1988 to 2016. Mill Creek is a perennial stream that drains to the Brazos River north of Sealy. Habitat Quality Index scores are available for 13 sample events and indicate an intermediate to high aquatic life use rating (14-23). Riparian areas were moderate throughout the reach with an average riparian buffer ranging from 4 to 15 meters wide. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover ranged from 8% to 94%. The dominant stream substrate was sand, and the average percent of substrate gravel size or larger varied from 0% to 34%. Average percent instream cover was 11% to 26% and instream cover types include overhanging vegetation, undercut banks, woody debris, root mats, algae, and gravel. Mill Creek ranged from 0.1-0.5 meters deep on average and 5-20 meters wide. Average stream bank slope ranged from 19-44 degrees. Stream flow at the site was measured at a minimum value of 1.4 cfs and a maximum of 55 cfs. Average stream bank erosion potential was 8%-54%. The deepest pool measured at Mill Creek was greater than two meters. Number of riffles observed at the site varied from zero to three, and total number of stream bends ranged from two to nine.

Water Quality

Water samples were collected at station 11576 over 150 sampling events from April 1982 through February 2020, and at station 11574 over 7 sampling events from July 1988 through July 1999. Parameters measured at both stations included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-a. Continuous 24-hour data was collected at station 11576.

Continuous flow data associated with station 11576 is available from USGS gage 08111700 (Figure 311). Between January 1985 through December 2019, the median flow was 22.8 cfs. Daily average flows ranged from 0 cfs to 65,700 cfs, though flows were greater than 1000 cfs about 3.7 percent during this time period. Data have been log transformed to better visualize flow patterns.

Biological Characterization

Fish

The thirty-three fish samples collected between 1988 and 2017 yielded the following aquatic life use ratings: exceptional (2), high (21), intermediate (7), and limited (3). The two exceptional ratings came from successive samples collected in July 2014 and August 2015. There never was an instance of successive ratings of intermediate or limited. These lower ratings were interspersed throughout the years and are most likely a reflection of natural variability. To that end, when the coefficient of variability is applied, two limited ratings increase to intermediate, four intermediates to high, and one high to exceptional.

The fish assemblage was fairly consistent throughout the years and ranged in richness from seven (November 2002, one of the dates receiving a limited aquatic life use) to 22. Mean species richness was 15. A total of 52 different species (13 families) were collected as part of the 33 sampling events. Centrarchidae and Cyprinidae were the richest families, each yielding 14 species. Orangespotted Sunfish was first collected in 2009 and became a fairly consistent part of the assemblage thereafter. Blacktail Shiner and Longear Sunfish were present in every collection. Mountain Mullet *Agonostomus monticola*, Black Bullhead, Bowfin *Amia calva*, Threadfin Shad *Dorosoma petenense*, Bantam Sunfish *Lepomis symmetricus*, Smallmouth Bass, Weed Shiner, and Common Carp were each collected once and, in each instance, represented by only one individual. Only three collections had non-native species. In addition to the single representatives of Smallmouth Bass (2000) and Common Carp (1988) already mentioned, two Redbreast Sunfish were collected in 2016.

Benthic Macroinvertebrates

Considering the one Surber sample and 31 RBP samples collectively, a total of 8184 individuals representing 149 taxa from 22 orders of macroinvertebrates were collected from Mill Creek (Appendix E). The Ephemeroptera, Trichoptera, Odonata, Diptera, Coleoptera, Veneroida, Amphipoda, and Megaloptera were the most commonly collected orders, collectively accounting for 95.5 percent of the total number of individuals collected. The Hemiptera and Decapoda were the only other orders which comprised at least one percent of the collections.

The East Bioregion Surber BIBI for the July 1988 Surber sample fell in the exceptional aquatic life use category. The Ecoregions 33 and 35 BIBIs for each of the RBP samples fell in the following aquatic life use categories:

- Exceptional (May 2002, April 2004, May 2006, July 2010, August 2012)
- High (July 2001, October 2001, August 2002, November 2002, May 2003, August 2003, July 2004, May 2005, July 2005, August 2006, August 2007, October 2007, July 2008, June 2009, August 2009, April 2010, May 2011, April 2013, July 2014, August 2015, October 2016)
- Intermediate (January 2000, May 2000, July 2000, April 2012, May 2014)

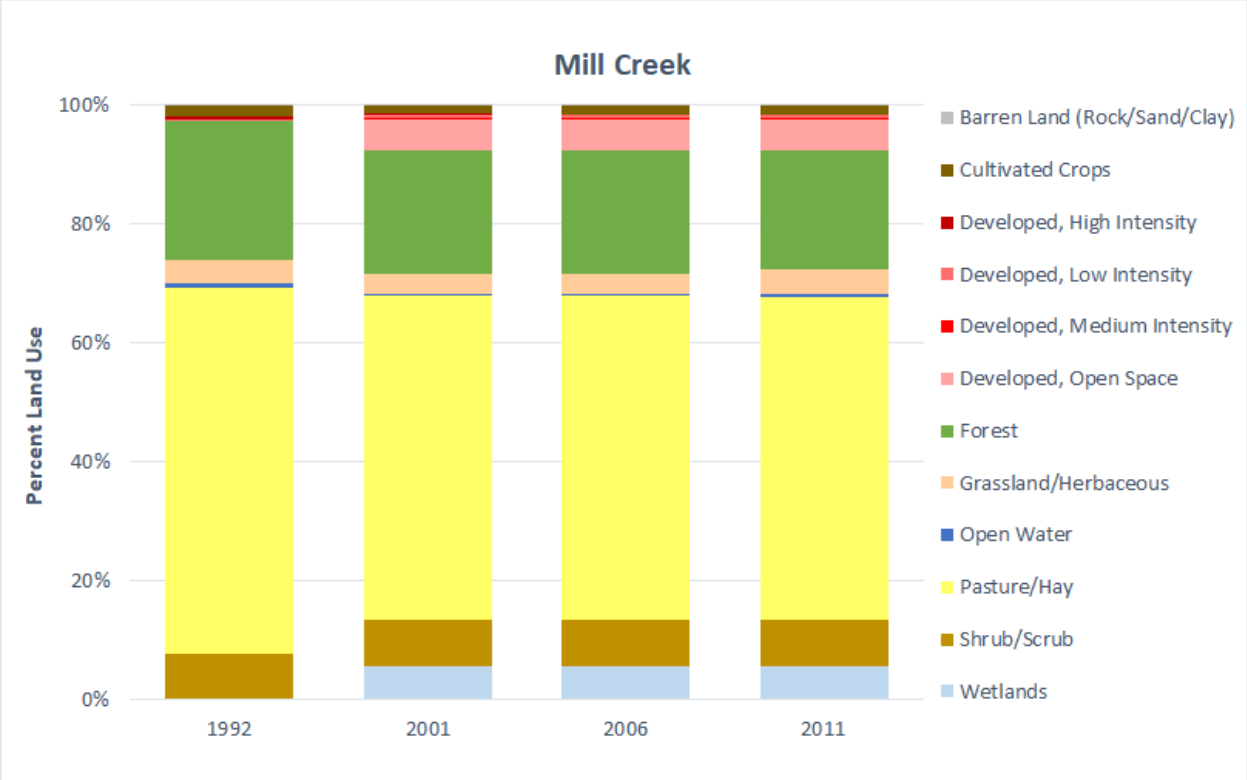

Figure 309. Percent land use in the Mill Creek watershed from 1992-2011.

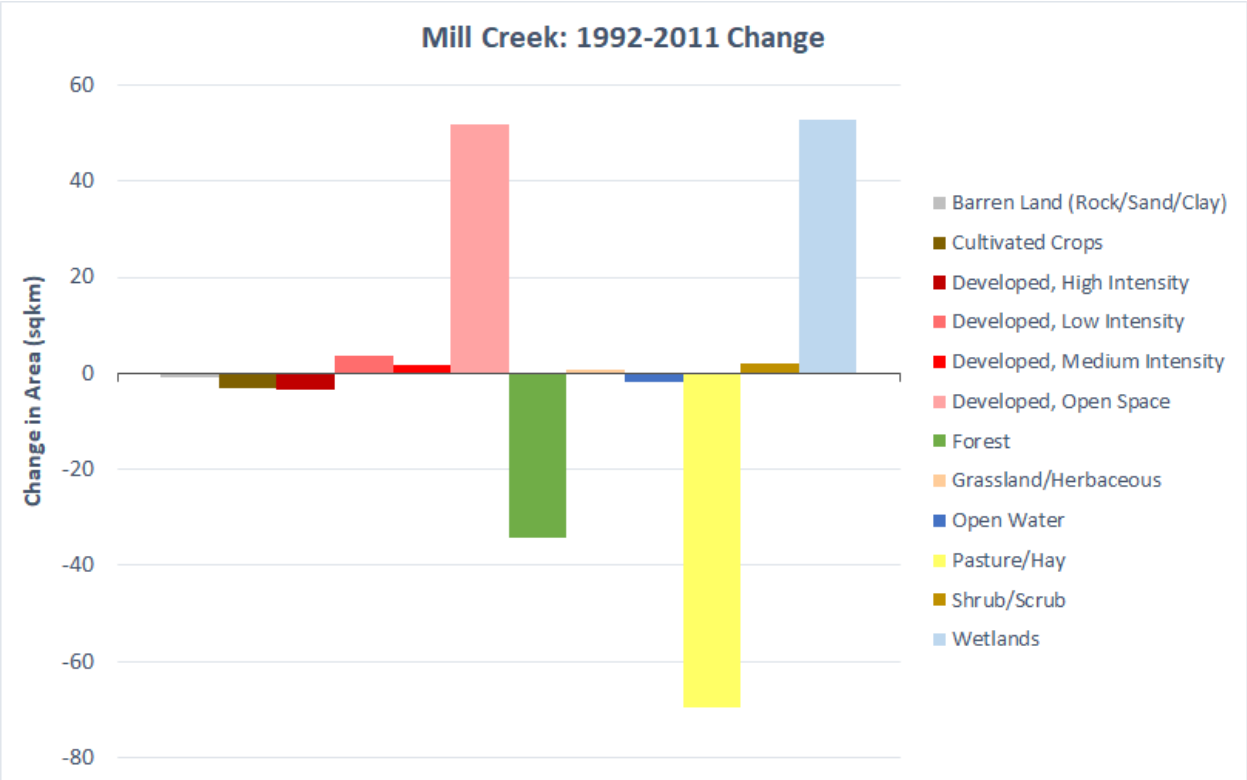

Figure 310. Land use change in area (sq km) from 1992-2011 for the Mill Creek watershed.

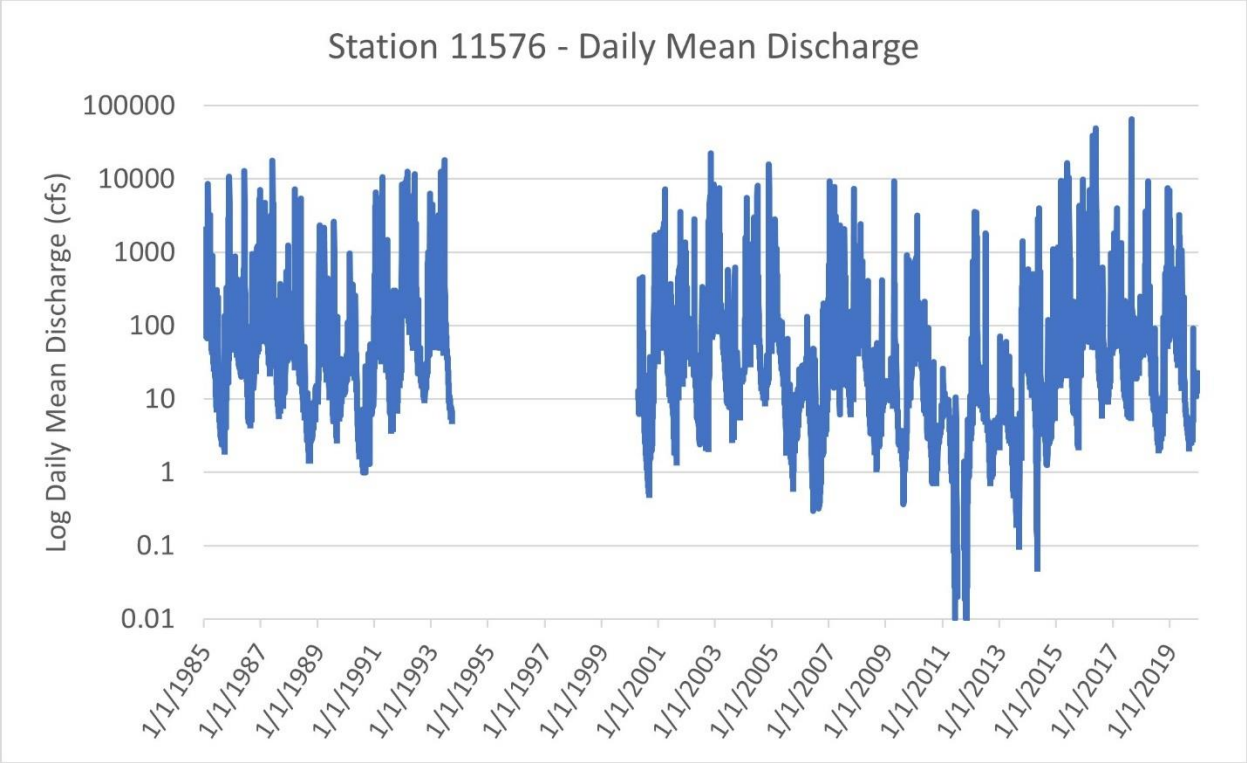

Figure 311. Log transformed daily mean discharge for Mill Creek at station 11576.

PONDS CREEK

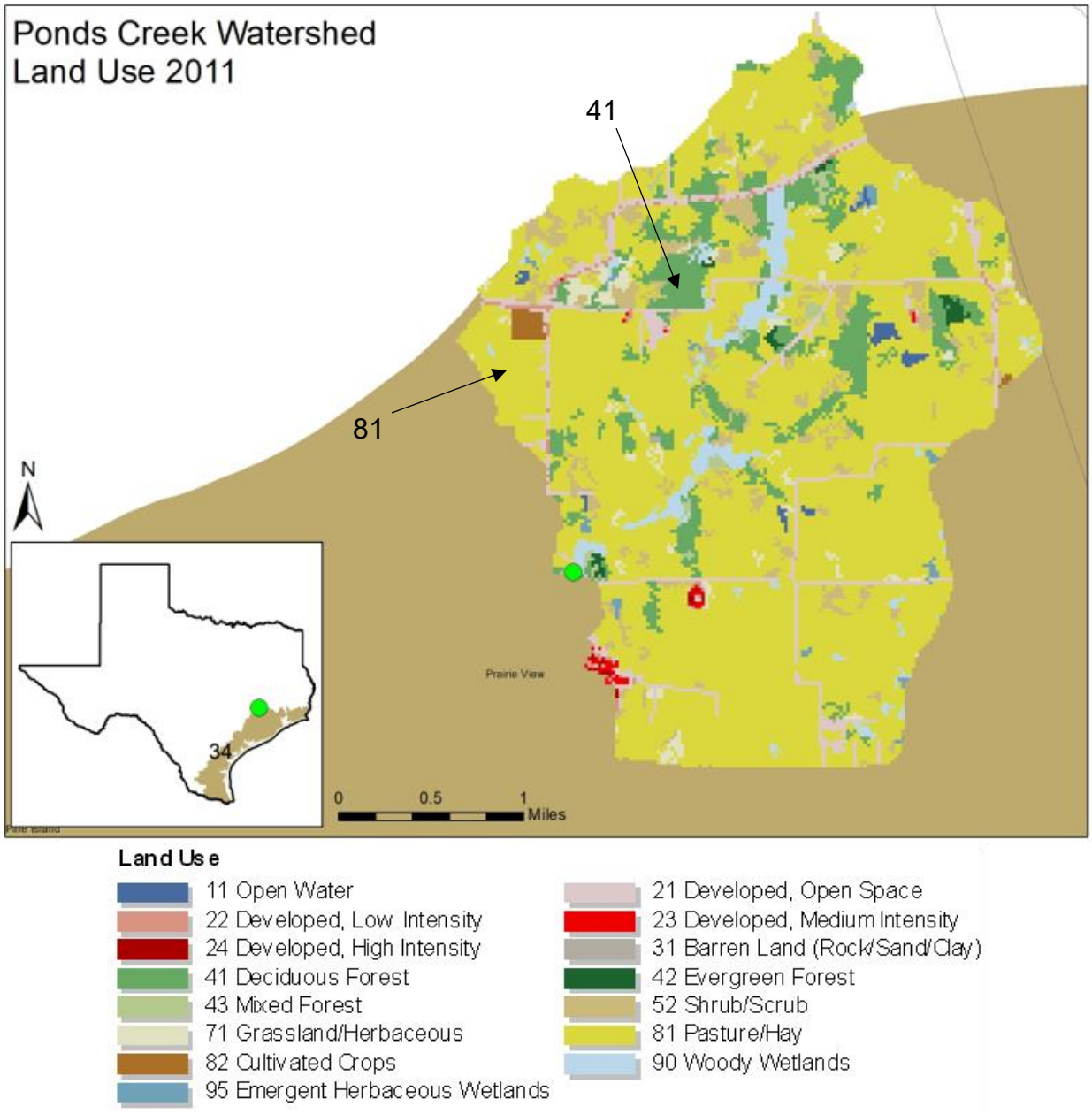

Figure 312. Map of Ponds Creek watershed location and 2011 land use; pasture/hay and forest were the most common land uses.

Sampling Dates

Physical Habitat:	July 19, 1988; June 13, 2003; August 18, 2003
Water Quality:	18 sampling events
Fish:	July 19, 1988; June 13, 2003; August 18, 2003
Benthic Invertebrates:	July 19, 1988; June 13, 2003; August 18, 2003

Physical Characterization

Watershed and Land Use

Ponds Creek lies within the Brazos River Basin. Sample site 11579 is located 69 m downstream of East Obannion Street in Prairie View, 3.54 km north of US 290 in Waller County (Figure 312).

The Ponds Creek watershed at site 11579 is approximately 20.21 sq km. The vast majority of the watershed lies within the Level IV Ecoregion 34a, the Northern Humid Gulf Coastal Prairies. A very small portion of the northeast watershed lies within the Level IV Ecoregion 33b, Southern Post Oak Savannah. The dominant land cover in the watershed is pasture/hay at 71.21% and present throughout the watershed (Homer et al. 2015; Figure 312 and Figure 313). Forest is the secondary land cover encompassing 10.48% and is most dense in the upper watershed. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 5.94% and cultivated crops cover 0.39% of the watershed.

From 1992-2011 there was a 1.51 sq km decrease in pasture/hay and a 1.04 sq km decrease in cultivated crops. There was a 1.14 sq km increase in shrub and a 1 sq km increase in open space development (Figure 314).

There are no permitted wastewater outfalls within the Ponds Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Ponds Creek was evaluated during three sampling events from 1988 to 2003. Ponds Creek is an intermittent stream with perennial pools that drains to Clear Creek, which is a tributary of the Brazos River below the Navasota River. Habitat Quality Index scores are available for two sample events and indicate a limited aquatic life use rating (11-13). Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at 20 meters or greater for all sampling events. The riparian zone was generally dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 56% to 87%. The dominant stream substrate was sand, and the average percent of substrate gravel size or larger varied from 0% to 27%. Average percent instream cover was 10% to 16% and instream cover types include snags, woody debris, undercut banks, and overhanging vegetation. Ponds Creek ranged from 0.1-0.2 meters deep on average and 2-4 meters wide. Average stream bank slope ranged from 24-55 degrees. Stream flow at the site was 0.01 cfs in 1988, but it was not measured during the two sampling events in 2003. Average stream bank erosion potential was 44%-58%. The deepest pool measured at Ponds Creek was 0.8 meters. Number of riffles observed at the site varied from zero to five, and there were two total stream bends.

Water Quality

Water samples were collected at station 11579 over 18 sampling events from July 1988 through August 2010. Parameters measured included temperature, flow, transparency, specific

conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-a.

Biological Characterization

Fish

Nineteen species (eight families) were collected over the course of the three sampling events. Centrarchidae yielded the greatest richness with six species. Western Mosquitofish was the most abundant species in 1988 and August 2003 while Blacktail Shiner yielded the greatest number of individuals in June 2003. One species, Grass Pickerel *Esox americanus vermiculatus*, was only collected in 1988; however, it was only represented by one individual. Species unique to the 2003 collections include Largemouth Bass, Slough Darter, Blackstripe Topminnow, and Blackspotted Topminnow *Fundulus olivaceus*. The aquatic life use (based upon the fish assemblage) rated high for each sample.

Benthic Macroinvertebrates

A total of 1,084 individuals representing 16 orders of macroinvertebrates were collected (Appendix E). The caddisfly (Trichoptera) genus *Cheumatopsyche* accounted for 33% of the total number of individuals collected. This genus and three others (*Oecetis*, *Chimarra*, and *Trianodes*), which were present in much lower relative abundance, collectively comprised 35.3% of total numbers.

Diptera and Pelecypoda (*Eupera cubensis, Pisidium* sp., and *Sphaerium* sp.) were the two next most abundant orders collected representing 14% and 11%, respectively, of the individuals collected. Odonata (10.8%), Ephemeroptera (9.5%), and Coleoptera (8.4%) were the three next most abundant orders.

The filtering collectors accounted for 45.5% of the individuals collected and dominated the functional organization of the Ponds Creek macroinvertebrate assemblage. The predators and collector gatherers were the next most abundant functional groups comprising 22.6% and 18.4%, respectively, of the total number of individuals collected. The scrapers (8.9%) and shredders (4.6%) were present but in less relative abundance.

For the two samples collected in June and August 2003 the EPT was four and zero, respectively. In contrast, the EPT was 12 for the Surber sample collected in 1988, which falls between the 50th percentile and the 75th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35. Notably, the mayfly *Centroptilum* sp. and the caddisfly *Trianodes* sp. (both of which are considered relatively intolerant) were collected in 1988, possibly reflecting favorable dissolved oxygen and flow conditions; however, the value for the biotic index was 5.7 which exceeds the 75th percentile for the ecoregion aggregate indicating a relatively tolerant macroinvertebrate assemblage in Ponds Creek.

The East Bioregion Surber BIBI for the 1988 sample fell in the exceptional aquatic life use category for the Ponds Creek macroinvertebrate assemblage. Results for the Ecoregions 33 and

35 BIBI for the June 2003 sample indicated an intermediate aquatic life use and the August 2003 sample fell in the limited aquatic life use category.

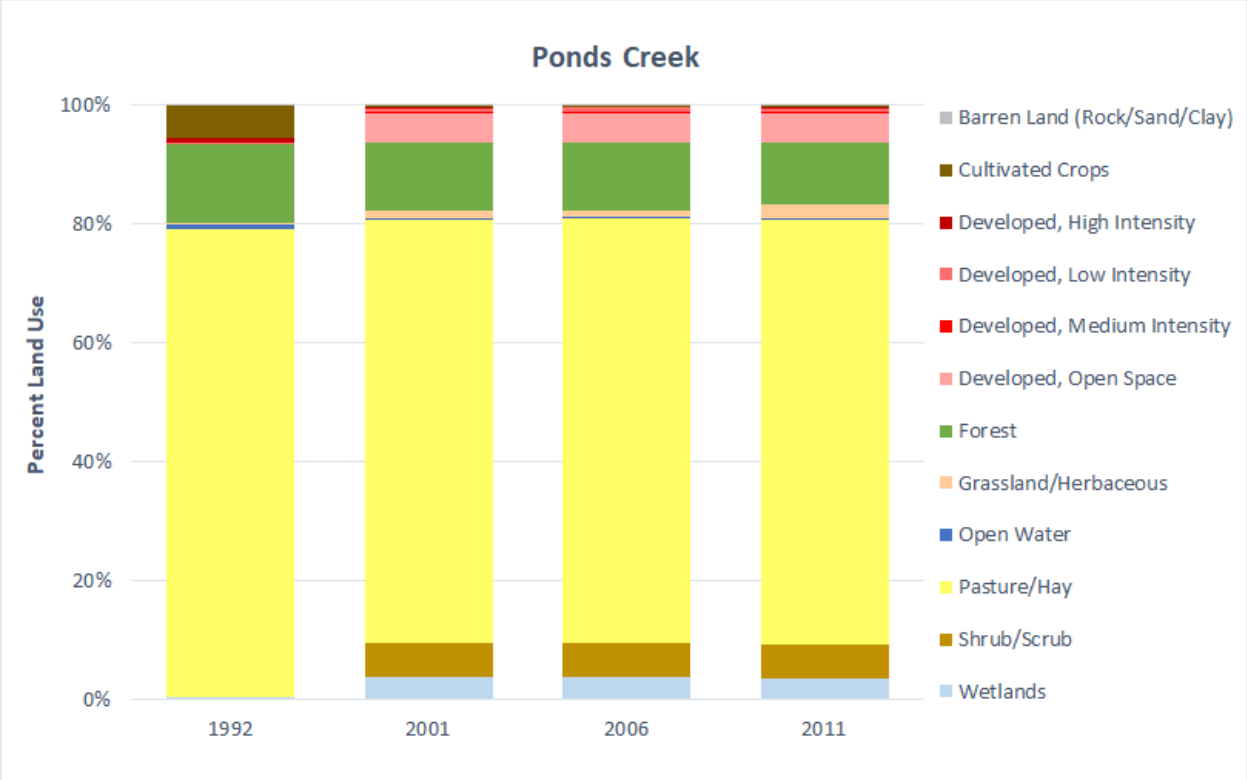

Figure 313. Percent land use in the Ponds Creek watershed from 1992-2011.

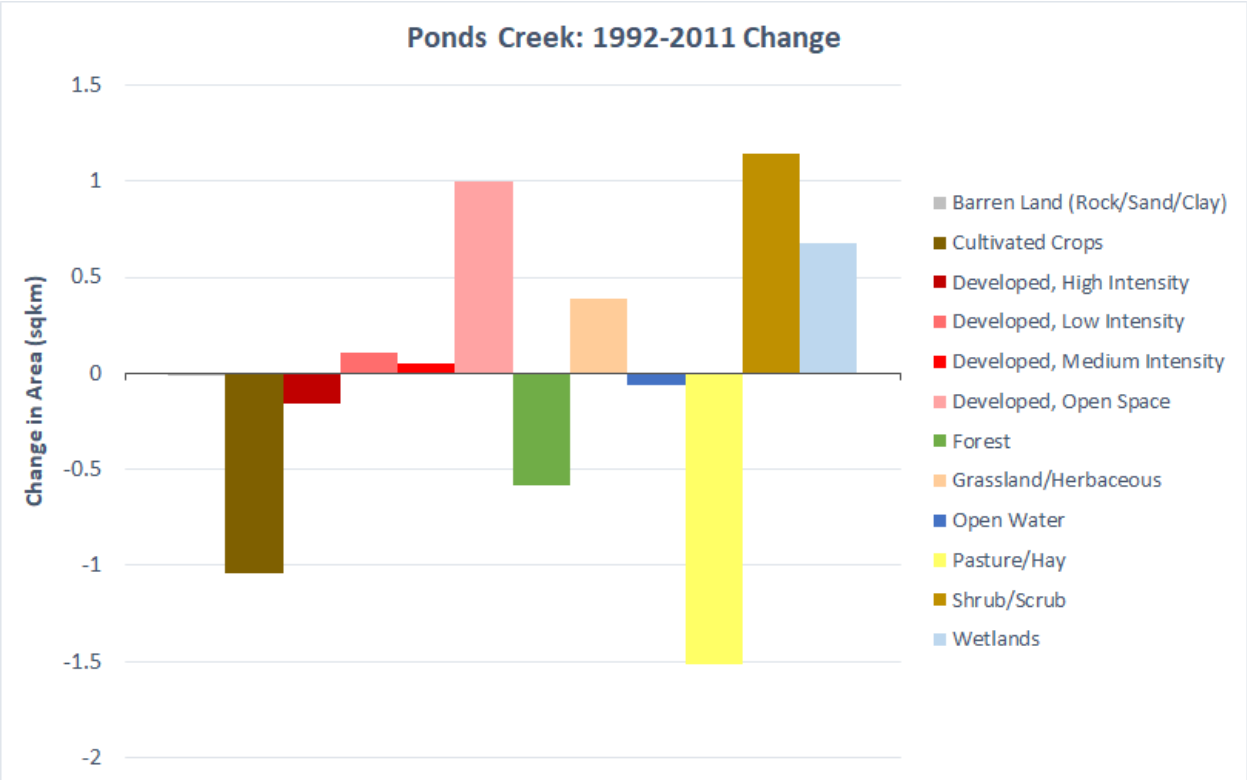

Figure 314. Land use change in area (sq km) from 1992-2011 for the Ponds Creek watershed.

SMACKOVER CREEK

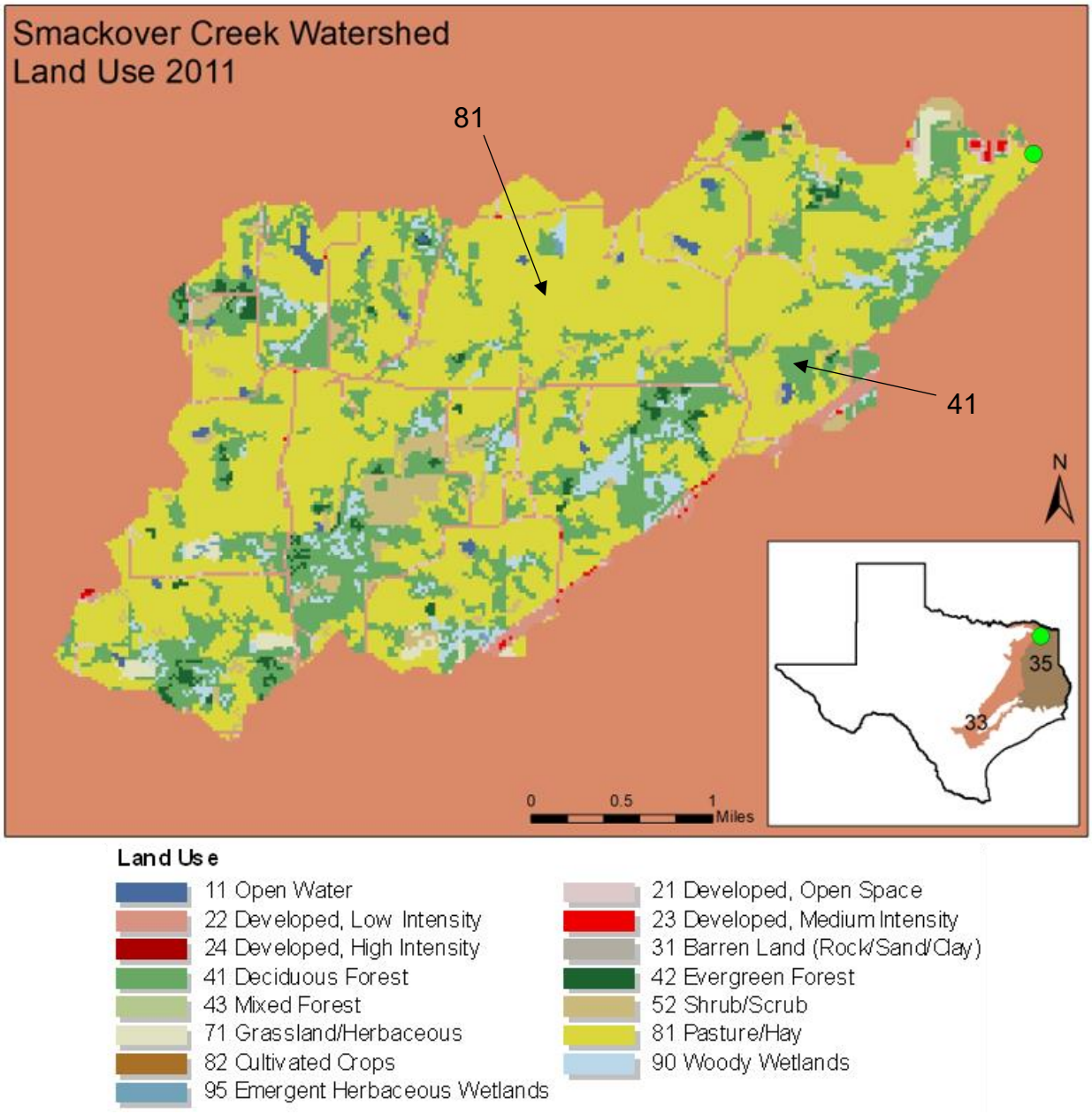

Figure 315. Map of Smackover Creek watershed location and 2011 land use; pasture/hay and forest were the most common land uses.

Sampling Dates

Physical Habitat:	June 2, 2008; July 14, 2008
Water Quality:	4 sampling events
Fish:	June 2, 2008; July 14, 2008
Benthic Invertebrates:	June 2, 2008; July 14, 2008

Physical Characterization

Watershed and Land Use

Smackover Creek lies within the Sulphur River Basin. Sample site 20101 is located at CR 3445, north of IH-30 in Titus County (Figure 315).

The Smackover Creek watershed at site 20101 is approximately 24.78 sq km. The entire watershed is located within Level IV Ecoregion 33a, the Northern Post Oak Savanna. The dominant land cover in the watershed is pasture/hay at 58.87% and is present throughout the watershed (Homer et al. 2015; Figure 315 and Figure 316). Forest is the secondary land cover encompassing 24.59%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 6.35% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 3.28 sq km decrease in pasture/hay, a 1.18 sq km increase in low intensity development, and a 1.07 sq km increase in shrub (Figure 317).

There are no permitted wastewater outfalls within the Smackover Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Smackover Creek was evaluated during two sampling events in 2008. Smackover Creek is a perennial stream that drains to White Oak Creek, which is a tributary to the South Sulphur River. Habitat Quality Index scores are available for both sample events and indicate an intermediate aquatic life use rating (17-18). Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover was 98%. The dominant stream substrate was silt, and the average percent of substrate gravel size or larger varied from 13% to 21%. Average percent instream cover was 21% and instream cover types include snags and woody debris. Smackover Creek ranged from 0.4-0.5 meters deep on average and 4-5 meters wide. Average stream bank slope ranged from 39-52 degrees. Stream flow at the site was measured at a minimum value of 0.4 cfs and a maximum of 0.8 cfs. Average stream bank erosion potential was 66%-81%. The deepest pool measured at Smackover Creek was 1.5 meters. Number of riffles observed at the site varied from zero to two, and there were two total stream bends.

Water Quality

Water samples were collected at station 20101 over 4 sampling events from November 2007 through July 2008. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, ammonia, total Kjeldahl nitrogen, phosphorus, chloride, sulfate and chlorophyll-a. Continuous 24-hour data was also collected at this site.

Biological Characterization

Fish

Two fish sampling events were conducted during the summer of 2008. The first one rated as having an intermediate aquatic life use, the second rated as high. When the coefficient of variability is applied the intermediate rating rises to high. A total of 15 species (seven families) were collected between the two samples. More than one-half of the species were members of the family Centrarchidae with Bluegill being the most abundant species present. No minnow species were collected as part of the June sample and only two were collected in July (one being a tolerant species - Golden Shiner). Benthic invertivore and intolerant species were represented by one Dusky Darter in June and catch per unit effort was low in both sampling events. Both samples yielded a high percentage of tolerant species.

Benthic Macroinvertebrates

Considering both sample dates, a total of 324 individuals representing 10 orders of macroinvertebrates were collected at Smackover Creek (Appendix E). Caddisfly (Trichoptera) genus *Hydropsyche* accounted for 34.9% of the total number of individuals collected. Diptera, Amphipoda, and Coleoptera were the next most abundant orders comprising 25.3%, 12%, and 11.4%, respectively, of the total number of individuals collected. Ephemeroptera (9.6%), Oligochaeta (2.8%), Pelecypoda (1.9%), Megaloptera (0.9%), Gastropoda (0.6%), and Hemiptera (0.6%) were also present in collections at lower relative abundance.

Considering both sample dates collectively, the filtering collectors accounted for 45.5% of the individuals collected and dominated the functional organization of the Smackover Creek macroinvertebrate assemblage. The collector gatherers and the predators were the next most abundant functional groups comprising 24.3% and 14.9%, respectively, of the total number of individuals collected. The scrapers (8%) and shredders (7.3%) were present but in less relative abundance.

The EPT was 3 for the June 2008 sample and 4 for the July sample, both of which falls below the 25th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The value for the biotic index was 5.2 for the June sample and 5 for the July sample, both of which are just above the 50th percentile of all biotic index values for least disturbed streams in ecoregion aggregate 33/35 indicating a moderately tolerant macroinvertebrate assemblage.

Both samples were collected using RBP protocols. The Ecoregions 33 and 35 BIBI was relatively consistent with results for both sample dates falling in the range indicating an intermediate aquatic life use for the Smackover Creek macroinvertebrate assemblage.

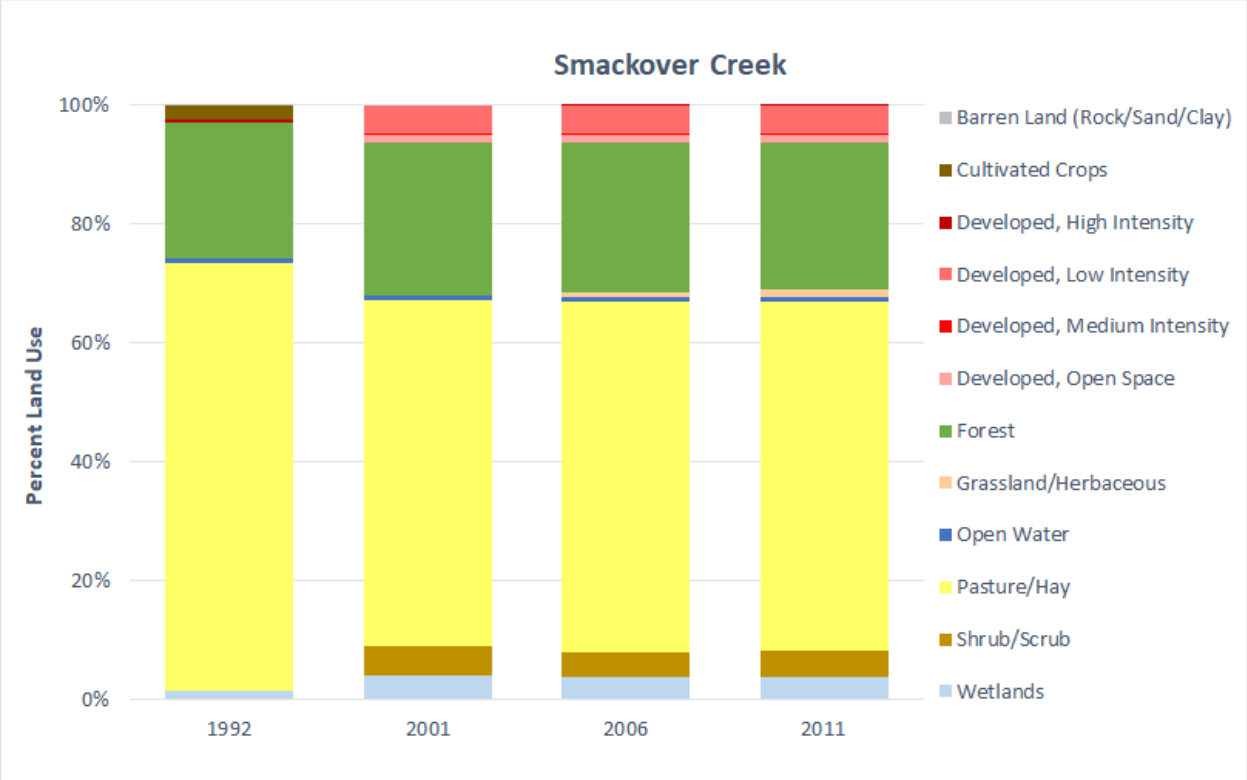

Figure 316. Percent land use in the Smackover Creek watershed from 1992-2011.

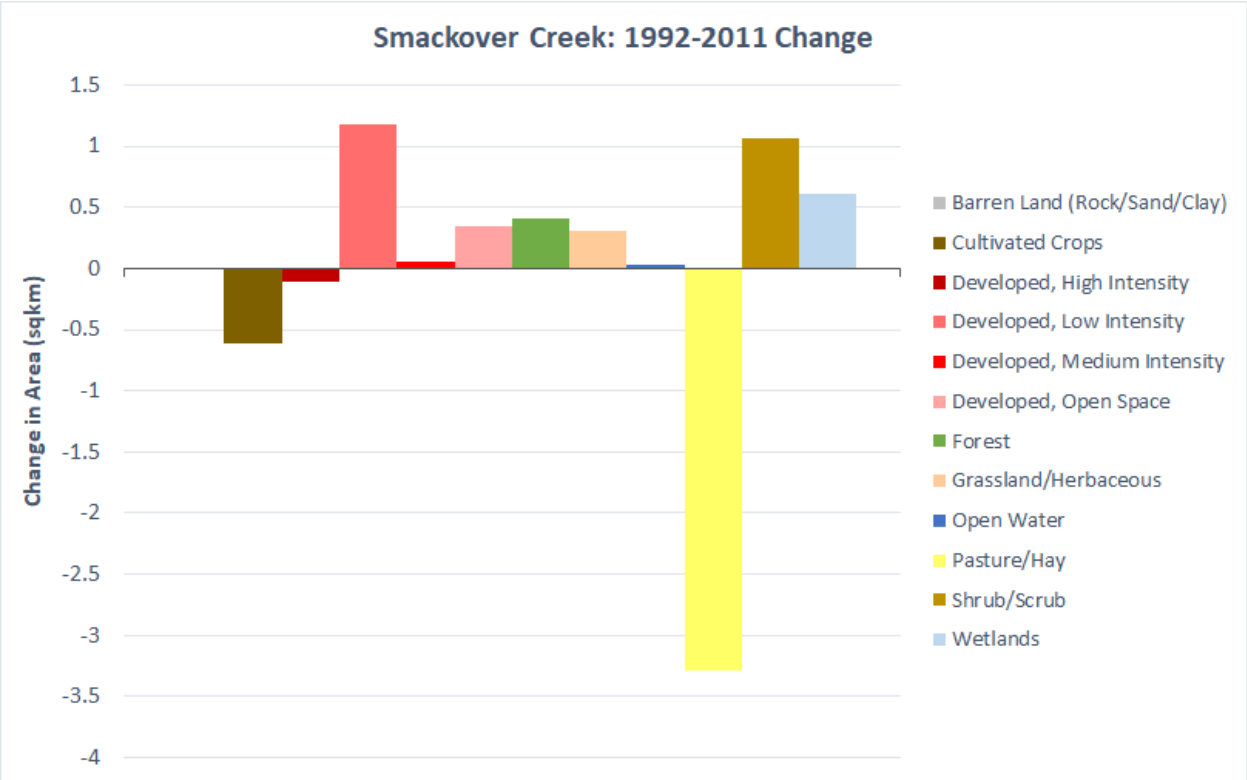

Figure 317. Land use change in area (sq km) from 1992-2011 for the Smackover Creek watershed.

WHEELOCK CREEK

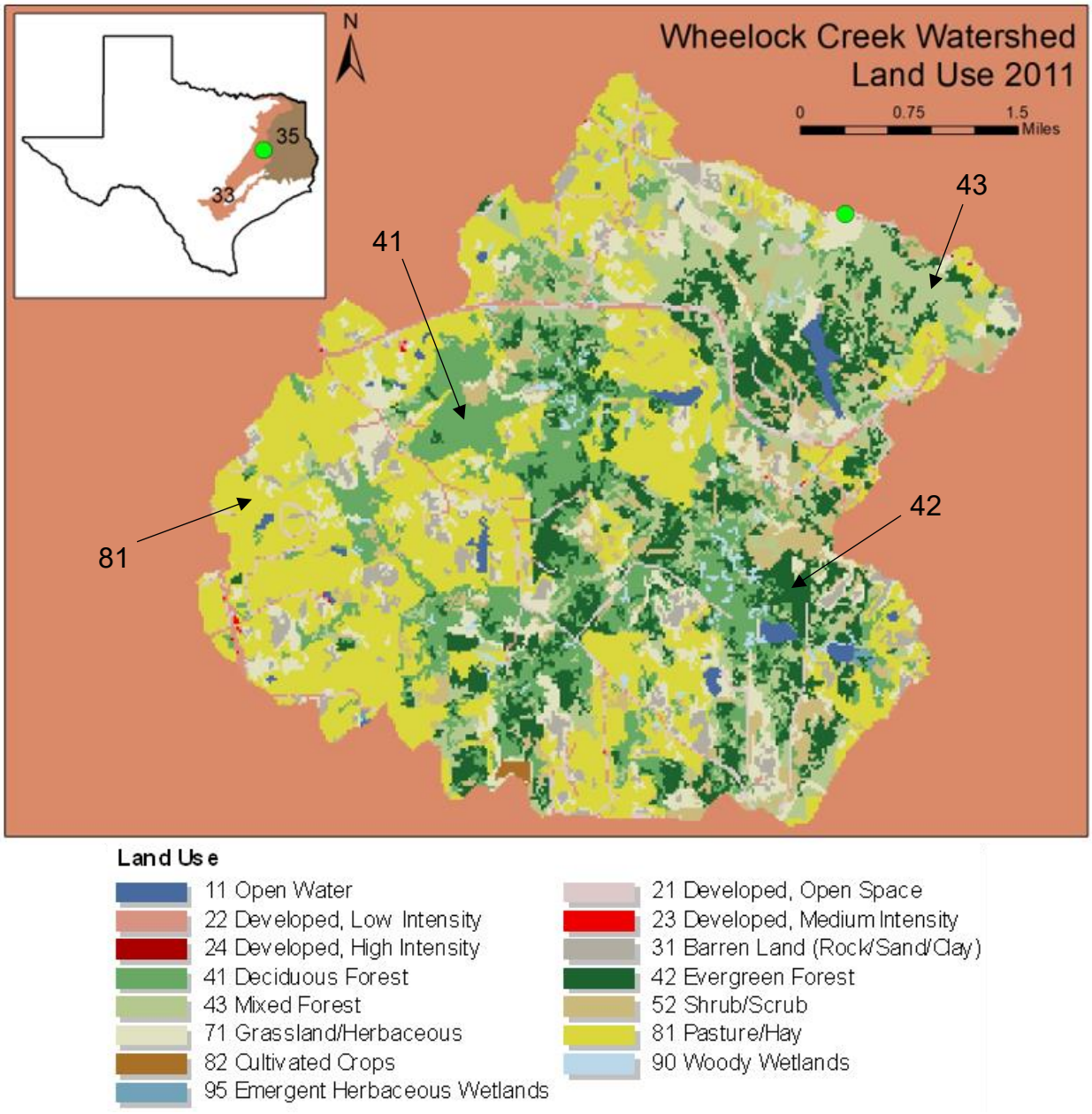

Figure 318. Map of Wheelock Creek watershed location and 2011 land use; forest and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	August 17, 1988
Water Quality:	4 sampling events
Fish:	August 17, 1988; April 12, 1989
Benthic Invertebrates:	August 17, 1988

Physical Characterization

Watershed and Land Use

Wheelock Creek lies within the Trinity River Basin. Sample site 10821 is located upstream of CR W 212, 12.23 km southeast of Buffalo in Leon County (Figure 318).

The Wheelock Creek watershed at site 10821 is approximately 46.25 sq km. The entire watershed is located within Level IV Ecoregion 33b, the Southern Post Oak Savanna. The dominant land cover in the watershed is forest at 40.55% and is present throughout the watershed (Homer et al. 2015; Figure 318 and Figure 319). Pasture/hay is the secondary land cover encompassing 31.8%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 4.78% and total cover for cultivated crops is 0.14%.

From 1992-2011 there was an 8.42 sq km decrease in pasture/hay and a 2.75 sq km decrease in forest. There was a 4.72 sq km increase in grassland and a 2.94 sq km increase in shrub (Figure 320).

There are no permitted wastewater outfalls within the Wheelock Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Wheelock Creek was evaluated on August 17, 1988. Wheelock Creek is a perennial stream that drains to Buffalo Creek, which is a tributary to Upper Keechi Creek in Leon County. The riparian width was 46 meters. The riparian zone was dominated by trees, which made up an average of 70% of the total riparian species, followed by shrubs and grasses (15% each). The average percentage of tree canopy cover was 58%. The dominant substrate was fine sand, and the average percent of substrate that was gravel size or larger was 18%. Average percent instream cover was 15%. Wheelock Creek had an average depth of 0.2 meters and a maximum depth of 0.5 meters. The average width was 2.7 meters and average stream bank slope was 42 degrees. Stream flow at the site was 0.8 cfs. Average stream bank erosion potential was 37%. Five riffles were observed at the site and there were two total stream bends.

Water Quality

Water samples were collected at station 10821 over 4 sampling events from August 1988 through July 1999. Parameters measured included temperature, flow, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, chloride, sulfate and chlorophyll-a.

Biological Characterization

Fish

Wheelock Creek was sampled for fish in the summer of 1988 and spring of 1989. On both occasions it received an aquatic life use rating of high. Twenty species (six families) were collected between the two sampling events. Centrarchidae and Cyprinidae were the richest families with six and five species, respectively. Blacktail Shiner was the most abundant species.

Benthic Macroinvertebrates

A total of 901 individuals representing 10 orders of macroinvertebrates were collected from Wheelock Creek (Appendix E). Diptera, Coleoptera, Ephemeroptera, and Trichoptera were the four most abundant orders comprising 28.9%, 22%, 21.1%, and 18.3%, respectively, of the total number of individuals collected. Odonata (6%), Oligochaeta (1.3%), Hemiptera (0.9%), Nematoda (0.9%), Megaloptera (0.4%), and Lepidoptera (0.1%) were also present in collections at lower relative abundance.

Collector gatherers (41.6%), scrapers (28.8%), and predators (18.6%) were the dominant functional groups. The EPT was 14 for the August 1988 sample which equals the 75th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The value for the biotic index was 4.3, which falls between the 5th and 25th percentiles of all biotic index values for least disturbed streams in ecoregion aggregate 33/35.

Results for the Surber sample BIBI for the August 1988 sample was 47 which falls in the range indicating an exceptional aquatic life use.

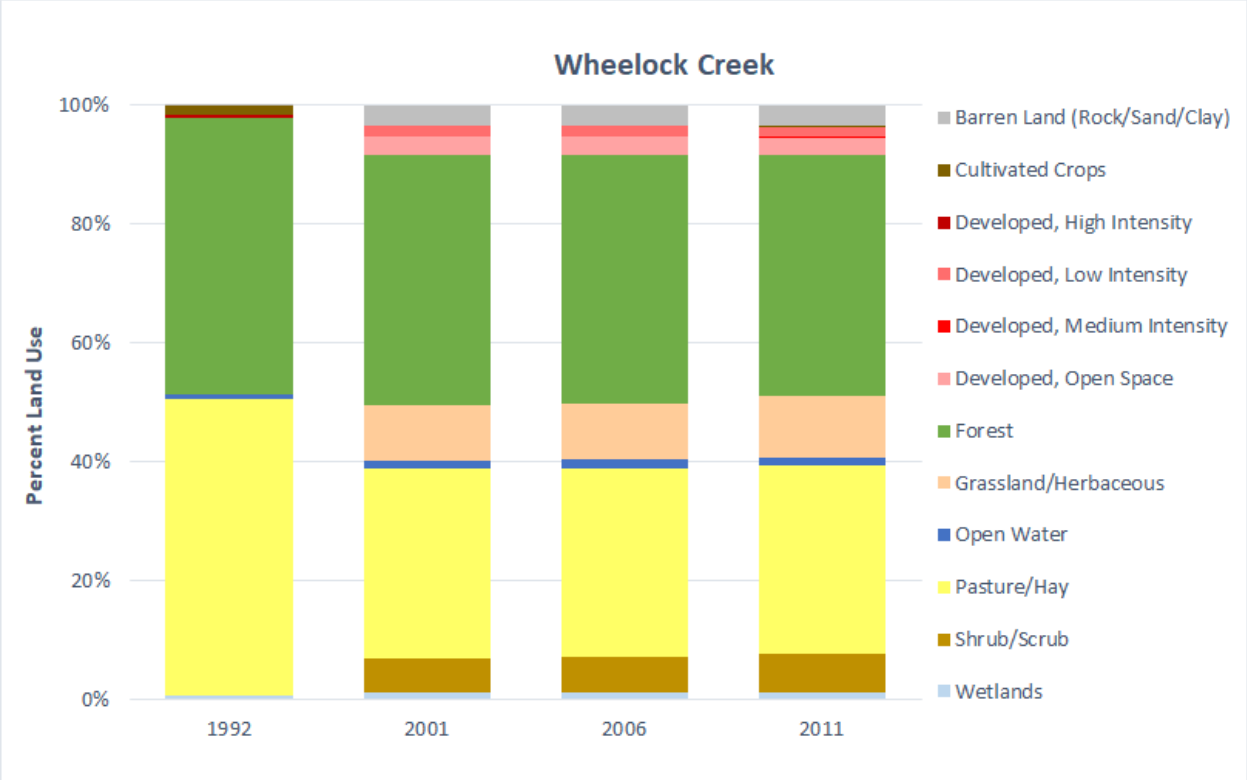

Figure 319. Percent land use in the Wheelock Creek watershed from 1992-2011.

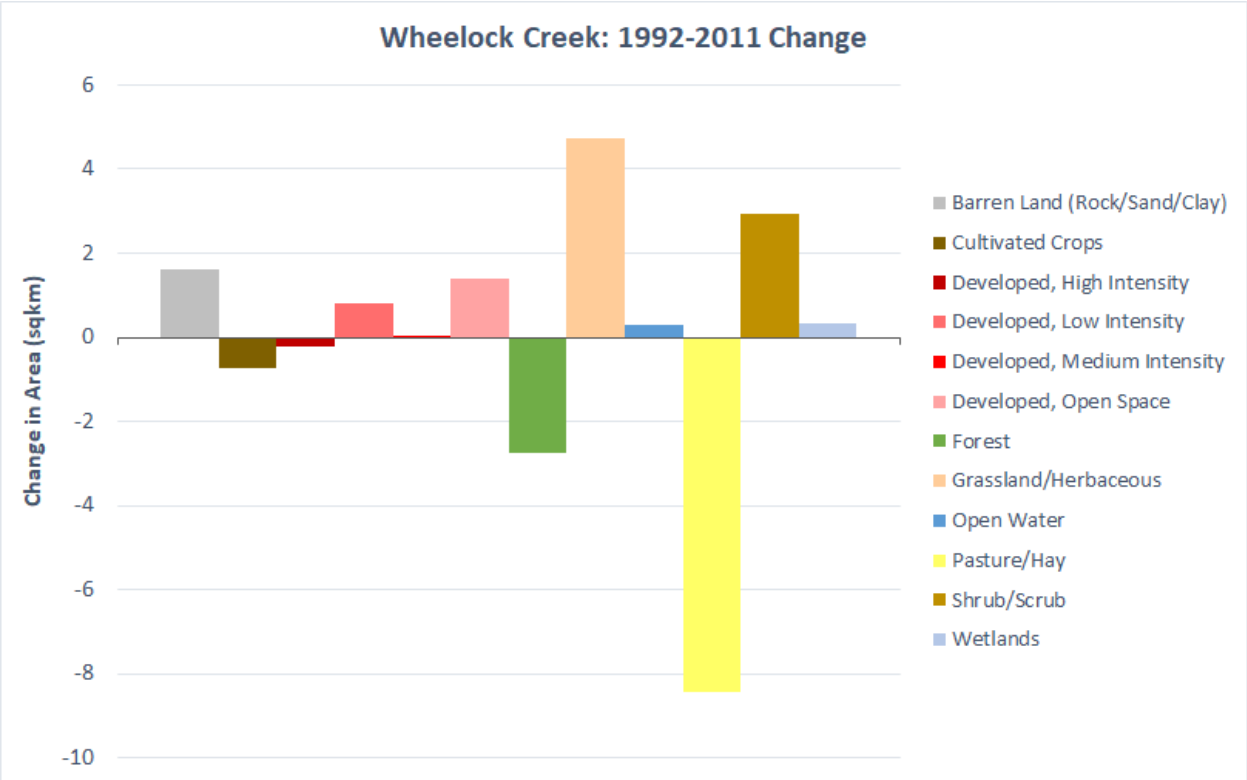

Figure 320. Land use change in area (sq km) from 1992-2011 for the Wheelock Creek watershed.

Ecoregion 35 Characterization

The South Central Plains Ecoregion (Ecoregion 35) is often referred to as the "piney woods" (Figure 275). This region is part of a much larger area of pine-hardwood forest that extends into Louisiana, Arkansas, and Oklahoma. Elevations range from 61 to 152 m above sea level (TPWD Landscape Ecology Program webpage).

Most of the region is characterized by irregular plains and represents the western extent of the coniferous forests of the southeastern U.S. (Griffith et al. 2007). Loblolly pine *Pinus taeda* and shortleaf pine *P. echinata* dominate forested areas of the ecoregion. Acidic sands and sandy loams are the most typical soils across the ecoregion (Griffith et al. 2007). Forests and woodland occupy approximately two thirds of the ecoregion. Cropland constitutes a relatively small portion of Ecoregion 35, primarily in the Red River floodplain (Griffith et al. 2007). Economic activities include lumber, pulpwood, and oil and gas production. Griffith et al. (2007) identified six Level IV ecoregions within the South Central Plains in Texas and provide greater details on the physiographic characteristics of this ecoregion. Greater detail on the physiographic characteristics of the region is also given in this report in the physical characterization for each sample site.

Table 12. Streams in Ecoregion 35.

Beach Creek	Frazier Creek	Peach Creek
Beech Creek	Irons Bayou	Piney Creek
Big Cypress Creek	James (Jim) Bayou	San Pedro Creek
Black Bayou	Lake Creek	West Fork San Jacinto River
Black Cypress Bayou	Little Cypress Bayou	White Oak Creek
East Fork San Jacinto River	Little Pine Island Bayou	

BEACH CREEK

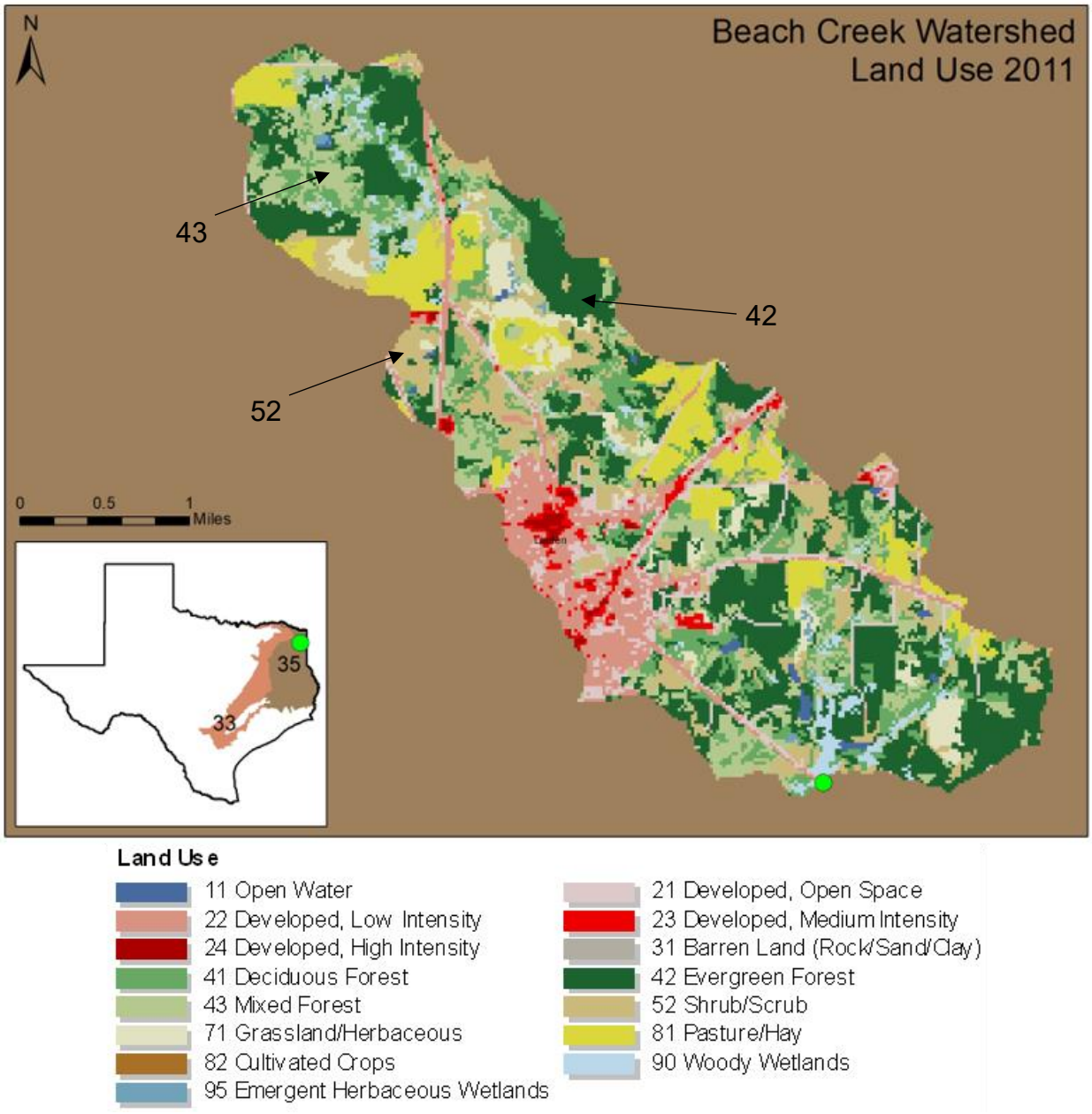

Figure 321. Map of Beach Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	June 29, 2004; August 17, 2004
Water Quality:	9 sampling events (Station 10256)
Fish:	June 29, 2004; August 17, 2004
Benthic Invertebrates:	June 29, 2004; August 17, 2004

Physical Characterization

Watershed and Land Use

Beach Creek lies within the Cypress Creek Basin. Sample site 10256 is located at FM 125 southeast of Linden in Cass County (Figure 321).

The Beach Creek watershed at site 10256 is approximately 21.43 sq km. The entire watershed is located within Level IV Ecoregion 35a, the Tertiary Uplands. The dominant land cover in the watershed is forest at 53.57% and is present throughout the watershed (Homer et al. 2015; Figure 321 and Figure 322). Shrub is the secondary land cover encompassing 11.83%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 17.19% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 3.76 sq km decrease in forest and a 1.93 sq km decrease in pasture/hay. There was a 2.54 sq km increase in shrub, 1.28 sq km increase in low intensity development, and a 1.24 sq km increase in open space development (Figure 323).

There is one domestic wastewater outfall (discharges < 1 million gallons per day) within the Beach Creek watershed permitted to the City of Linden that discharges directly into Beach Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Beach Creek was evaluated during two sampling events in 2004. Beach Creek is a perennial stream that drains to James Bayou southeast of Linden. Habitat Quality Index scores are available for both sample events and indicate a high aquatic life use rating (20-20.5). Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover was 100%. The dominant stream substrate was sand, and the average percent of substrate gravel size or larger was 0%. Average percent instream cover was 10% to 13% and instream cover types include overhanging vegetation, undercut banks, woody debris, and root mats. Beach Creek ranged from 0.2-0.5 meters deep on average and 4-5 meters wide. Average stream bank slope ranged from 42-50 degrees. Stream flow at the site was measured at a minimum value of 0.2 cfs and a maximum of 24 cfs. Average stream bank erosion potential was 25%. The deepest pool measured at Beach Creek was 1.2 meters. No riffles were observed at the site and there were five stream bends.

Water Quality

Water samples were collected at station 10256 over 9 sampling events from August 1981 through August 2004. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*. Continuous 24-hour data was also recorded at station 10256.

Biological Characterization

Fish

Twenty species (10 families) were collected between the two samples. Centrarchidae yielded the most species with six. Western Mosquitofish was the most abundant species in June while Pirate Perch *Aphredoderus sayanus* was the most abundant one in August. The aquatic life use (based upon the fish assemblage) scored as high.

Benthic Macroinvertebrates

Considering both samples collectively, a total of 353 individuals representing 12 orders of macroinvertebrates were collected at Beach Creek (Appendix E). Diptera, Amphipoda, Odonata, and Coleoptera were the four most abundant orders comprising 50.4%, 11.9%, 10.8%, and 9.1%, respectively, of the total number of individuals collected. Less abundant orders include Hemiptera (6.8%), Ephemeroptera (4%), Pelecypoda (2%), Decapoda (1.7%), and Oligochaeta (1.7%). Trichoptera, Hirudinea, and Turbellaria were also present in collections at lower relative abundance collectively representing 1.7% of total numbers collected.

The functional organization of the Beach Creek macroinvertebrate assemblage was relatively similar for both sample dates. Considering both dates collectively, predators, collector gatherers, and filtering collectors were the most abundant functional groups comprising 43%, 29%, and 19.2% of the individuals, respectively. Shredders (6.5%) and scrapers (2.3%) were the least abundant functional groups collected.

Considering both sample dates, a total of five EPT taxa were collected at Beach Creek. This just exceeds the 25th percentile (4.8) for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The value for the biotic index was relatively consistent for both samples with a maximum value of 6.6 for the sample collected in June 2004 and a minimum of 6.3 for the August 2004 sample. Both values fall between the 75th and 95 percentiles of all biotic index values for least disturbed streams in ecoregion aggregate 33/35 reflecting a relatively tolerant macroinvertebrate assemblage in Beach Creek.

The Ecoregions 33 and 35 BIBI scores for both the June and August 2004 samples fell in the range indicating a limited aquatic life use.

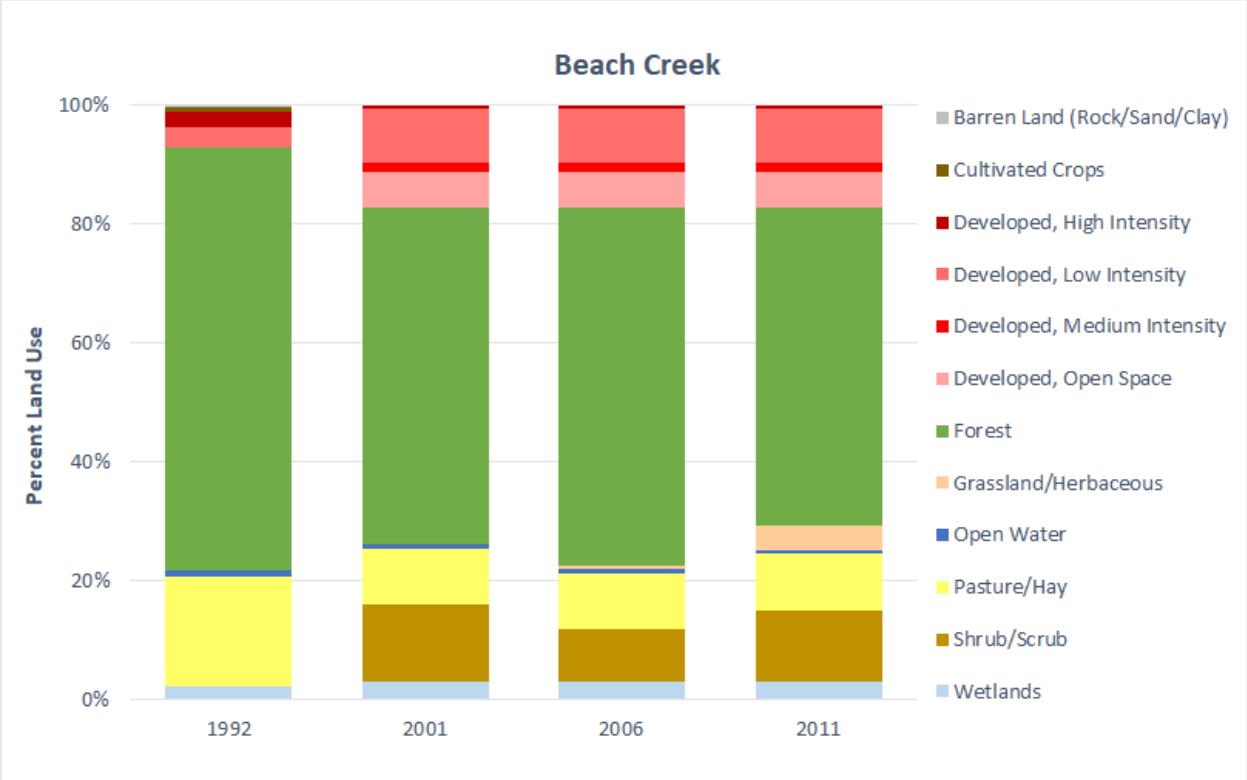

Figure 322. Percent land use in the Beach Creek watershed from 1992-2011.

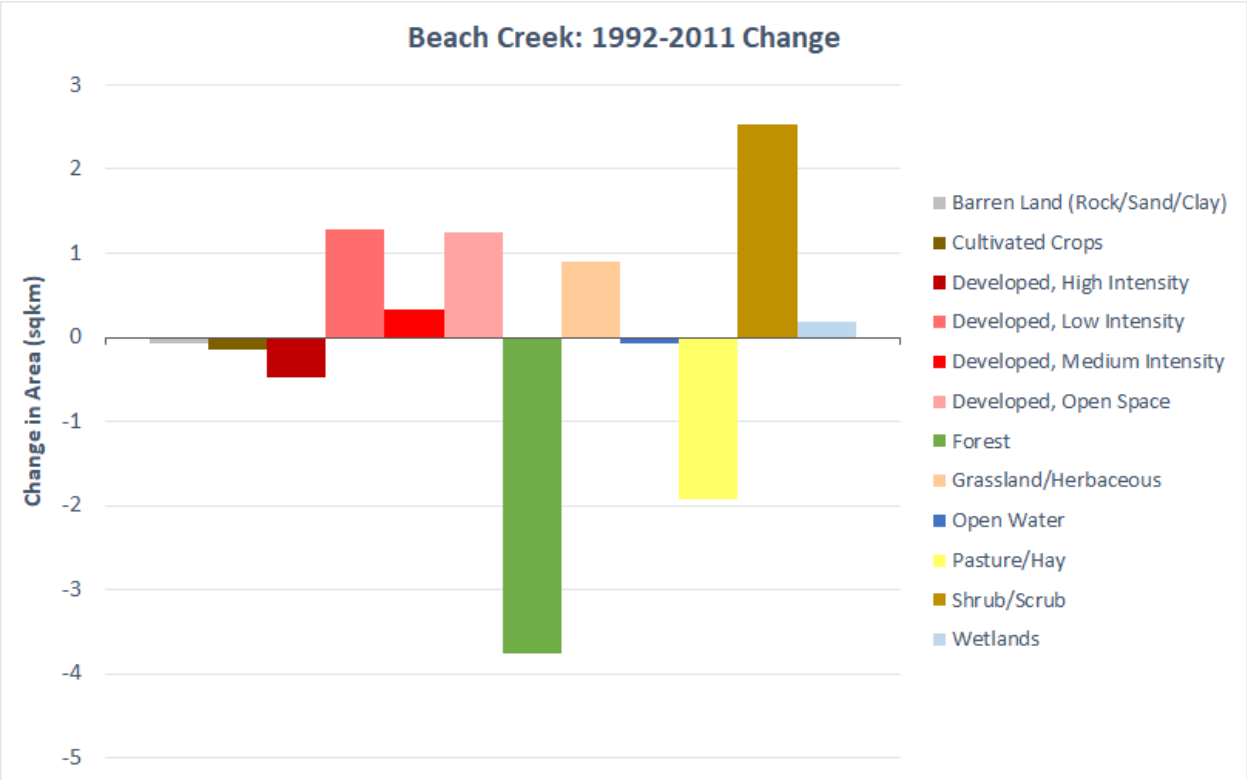

Figure 323. Land use change in area (sq km) from 1992-2011 for the Beach Creek watershed.

BEECH CREEK

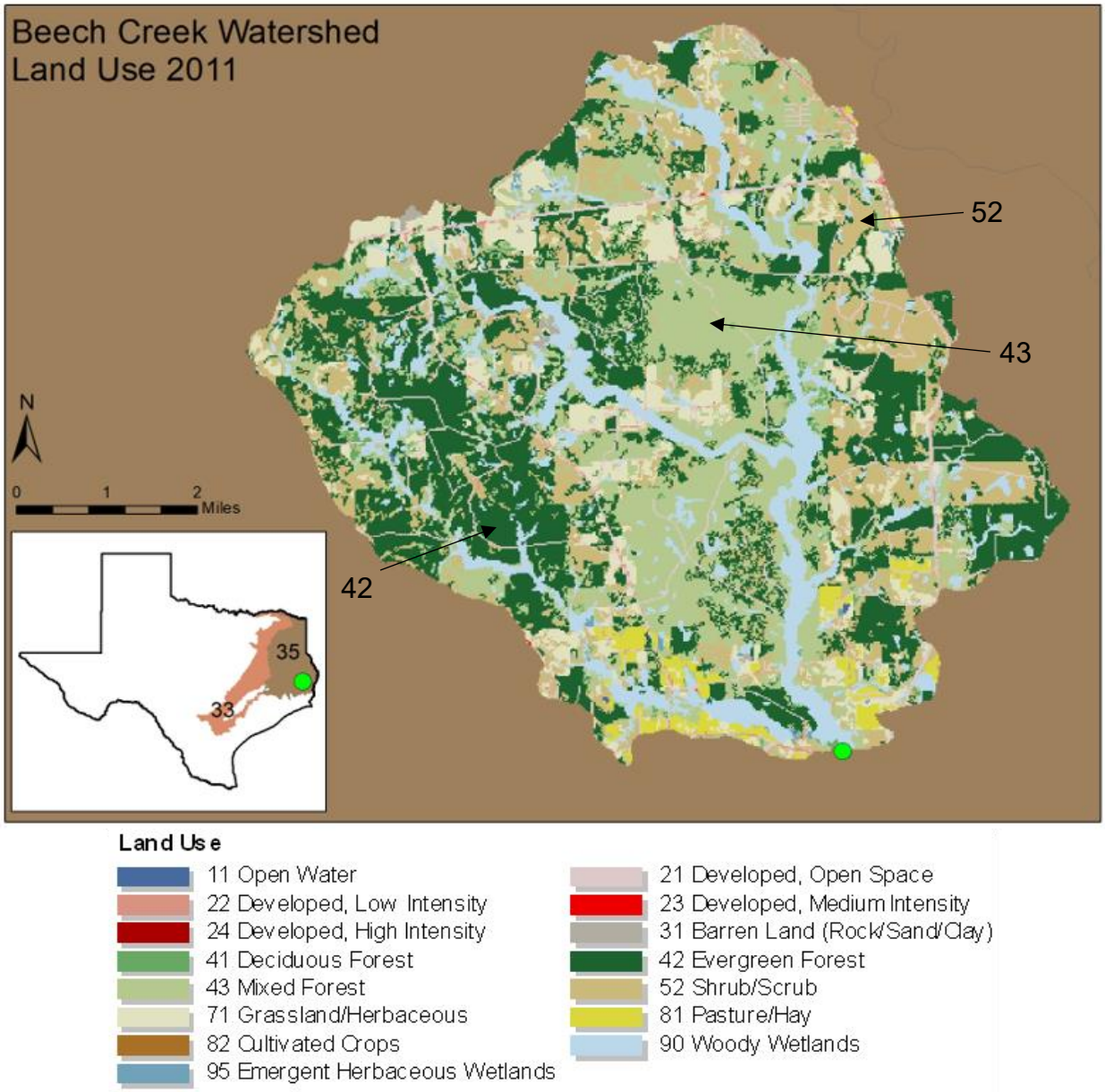

Figure 324. Map of Beech Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	Station 10529: September 12, 1989; June 26, 2003; August 20, 2003; Station 17903: June 24, 2003; August 20, 2003
Water Quality:	47 sampling events (Stations 17903 and 10529)
Fish:	September 12, 1989; June 26, 2003; August 20, 2003
Benthic Invertebrates:	Station 10529: September 13, 1989; June 26, 2003; August 20, 2003; Station 17903: June 24, 2003; August 20, 2003

Physical Characterization

Watershed and Land Use

Beech Creek lies within the Neches River Basin. Sample site 10529 is located at FM 1013 west of Spurger in Tyler County (Figure 324).

The Beech Creek watershed at site 10529 is approximately 117 sq km. The sampling location and majority of the watershed lay within Level IV Ecoregion 35f, the Flatwoods. The eastern portion of the watershed lies within Level IV Ecoregion 35e, the Southern Tertiary Uplands. The dominant land cover in the watershed is forest at 53.78% and is present throughout the watershed (Homer et al. 2015; Figure 324 and Figure 325). Shrub is the secondary land cover encompassing 17.31%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 5.12% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 41.35 sq km decrease in forest and a 6.25 sq km decrease in pasture/hay. There was a 20.25 sq km increase in shrub, 13.11 sq km increase in wetlands, and 10.5 sq km increase in grassland (Figure 326).

There are no permitted wastewater outfalls within the Beech Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Beech Creek was evaluated at two sites during five sampling events from 1989 to 2003. Beech Creek is a perennial stream that drains to Village Creek in Hardin County. Both sites are located near the southern boundary of the Beech Creek Unit within the Big Thicket National Preserve. Habitat Quality Index scores are available for four sample events and indicate a limited to high aquatic life use rating (11-20). Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was generally dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 73% to 94%. The dominant stream substrate was sand, and the average percent of substrate gravel size or larger was less than 1%. Average percent instream cover varied from 9% to 76% and instream cover types include overhanging vegetation, leaf packs, snags, woody debris, root mats, and algae. Beech Creek ranged from 0.2-0.3 meters deep on average and 3-5 meters wide. Average stream bank slope ranged from 19-32 degrees. Stream flow at the site was 2.2 cfs in 1989, but it was not measured during the sampling events in 2003. Average stream bank erosion potential was 10%-58%. The deepest pool measured at Beech Creek was 1.2 meters. Number of riffles observed at the site varied from zero to two, and total number of stream bends ranged from zero to six.

Water Quality

Water samples were collected at stations 17903 and 10529. Station 10529 was sampled 35 times from September 1989 through October 2018; station 17903 was sampled from May 2003 through September 2004 over 12 events. Parameters measured at both stations included

temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen (only station 10529), phosphorus, total organic carbon, chloride, sulfate and chlorophyll-a. Continuous 24-hour data was recorded at both stations 17903 and 10529.

Biological Characterization

Fish

Twenty-seven species (11 families) were collected over the course of the three samples. Centrarchidae yielded the greatest species richness with seven. Pirate Perch was the most numerous fish in 1989, while Western Mosquitofish and Ribbon Shiner took that position in June and August 2003, respectively. Five species were unique to the 1989 collection and included Blacktail Shiner, Slough Darter, Blackstripe Topminnow, Redfin Shiner *Lythrurus umbratilis*, and Tadpole Madtom. Ribbon Shiner and Pugnose Minnow were only collected in 2003. Based upon the fish assemblage, the 1989 and June 2003 samples rated as having a high aquatic life use while the August 2003 sample rated as exceptional.

Benthic Macroinvertebrates

A total of 1,483 individuals representing 18 orders of macroinvertebrates were collected during the five sample events at Beech Creek (Appendix E). Coleoptera, Diptera, and Oligochaeta were the three most abundant orders collected representing 28.5%, 25.8%, and 10.9%, respectively, of the individuals collected. Isopoda (7.6%), Trichoptera (6.6%), and Ephemeroptera (6%) were the only other orders which represented five or greater percent of the total individuals in the samples from Beech Creek.

The functional organization of the Beech Creek macroinvertebrate assemblage was dominated by collector-gatherers, scrapers, and predators which accounted for 48.5%, 17%, and 16.8%, respectively, of the total number of individuals collected. Filtering collectors (10.6%) and shredders (7.1%) were present, but each represented lower relative abundance.

The EPT varied from a minimum of zero for the August 2003 sample from Station 17903 to a maximum of 16 for the 1989 Surber sample, which equals the 95th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The average value for the biotic index (5.6) is between the 75th and the 95th percentile for all biotic index values in the ecoregion aggregate indicating a relatively tolerant macroinvertebrate assemblage in Beech Creek.

Results for the Surber sample (45) BIBI fall in the range indicating an exceptional aquatic life use for the Beech Creek macroinvertebrate assemblage. The Ecoregions 33 and 35 BIBI scores for the June and August 2003 samples from Station 10529 as well as the June 2003 sample from Station 17903 fell in the range indicating an intermediate aquatic life use category. The Ecoregions 33 and 35 BIBI score for the August 2003 sample from Station 17903 fell in the limited aquatic life use category.

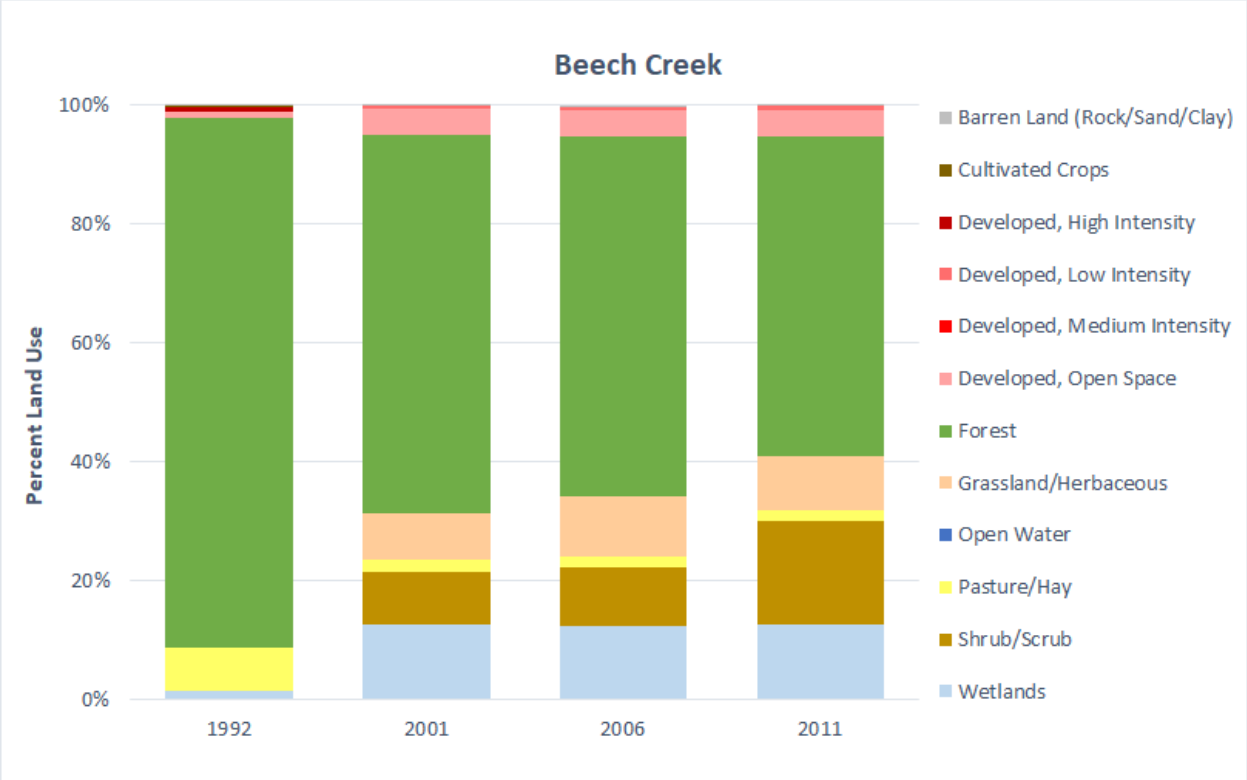

Figure 325. Percent land use in the Beech Creek watershed from 1992-2011.

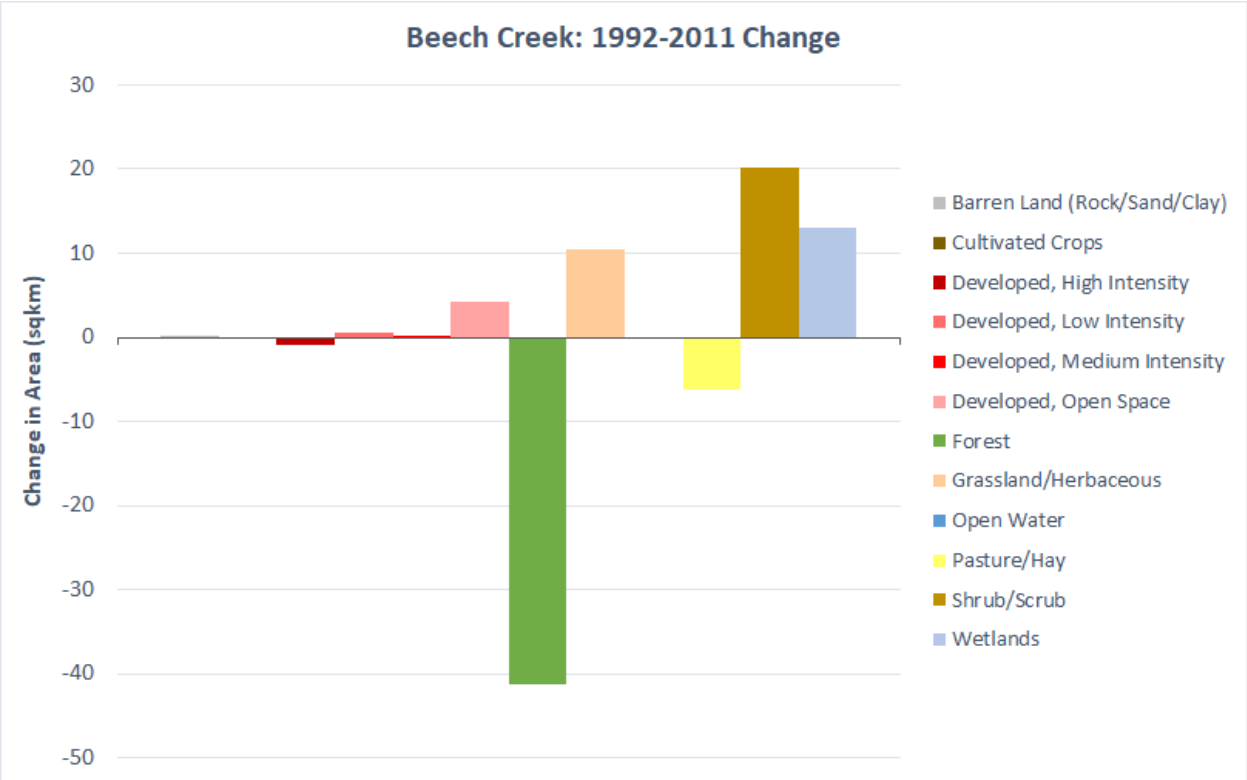

Figure 326. Land use change in area (sq km) from 1992-2011 for the Beech Creek watershed.

BIG CYPRESS CREEK

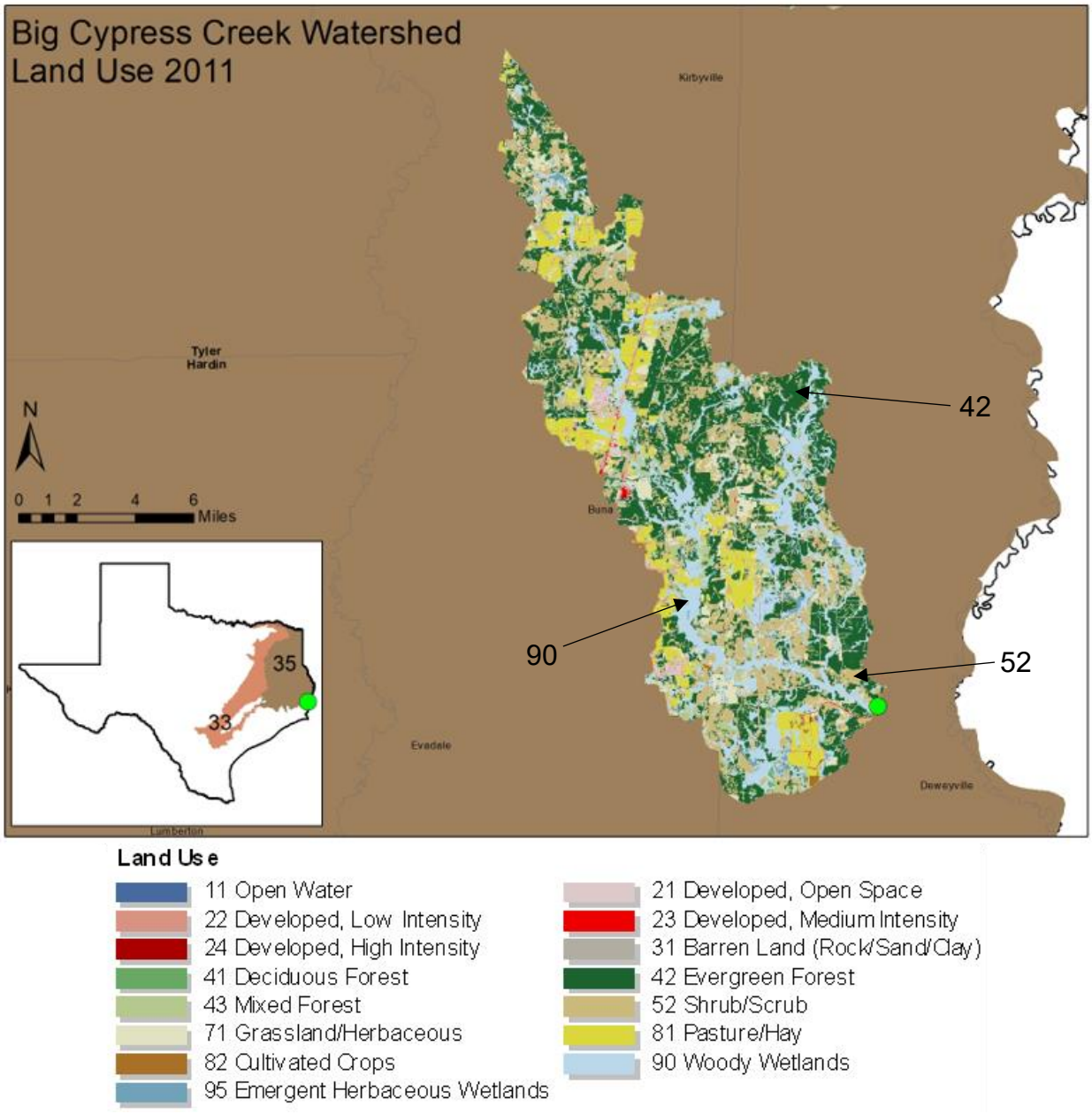

Figure 327. Map of Big Cypress Creek watershed location and 2011 land use; forest, shrub/scrub, and wetlands were the most common land uses.

Sampling Dates

Physical Habitat:	September 12, 1989; June 9, 2004; July 21, 2004
Water Quality:	19 sampling events
Fish:	September 12, 1989; June 9, 2004; July 21, 2004
Benthic Invertebrates:	September 12, 1989; June 9, 2004; July 21, 2004

Physical Characterization

Watershed and Land Use

Big Cypress Creek (also known as Cypress Creek) lies within the Sabine River Basin. Sample site 10342 is located downstream of SH 87 northwest of Deweyville in Newton County (Figure 327).

The Big Cypress Creek watershed at site 10342 is approximately 369.49 sq km. The entire watershed lies within Level IV Ecoregion 35f, the Flatwoods. The dominant land cover in the watershed is forest at 37.19% and is present throughout the watershed (Homer et al. 2015; Figure 327 and Figure 328). Secondary land covers include shrub at 20.7% and wetlands at 20.46%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 5.43% and total cover for cultivated crops is 0.21%.

From 1992-2011 there was a 102.93 sq km decrease in forest and a 25.86 sq km decrease in open space development. There was a 76.5 sq km increase in shrub and a 44.57 sq km increase in wetlands (Figure 329).

There are no permitted wastewater outfalls within the Big Cypress Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Big Cypress Creek was evaluated during three sampling events from 1989 to 2004. Big Cypress Creek is a perennial stream that drains to the Sabine River near Deweyville. Habitat Quality Index scores are available for two sample events and indicate an intermediate aquatic life use rating (17-19). Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters for all sampling events. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover ranged from 93% to 99%. The dominant stream substrate was silt, and the average percent of substrate gravel size or larger was 0%. Average percent instream cover was 54% to 70% and instream cover types include roots, woody debris, and leaf packs. Big Cypress Creek ranged from 0.3-0.4 meters deep on average and 20-21 meters wide. Average stream bank slope ranged from 6-10 degrees. Stream flow at the site was 0.2 cfs in 1989 and 2.9 cfs in June 2004. Average stream bank erosion potential was 46%-63%. The deepest pool measured at Big Cypress Creek was 1.8 meters. The stream channel was noted as low gradient and braided in both 1989 and 2004. No riffles were observed at the site during any sampling event, and total number of stream bends ranged from two to three.

Water Quality

Water samples were collected at station 10342 over 19 sampling events from September 1989 through September 2004. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*. Continuous 24-hour data was also recorded at station 10342.

Biological Characterization

Fish

Thirty-six species (13 families) were collected over the course of the three sampling events. Centrarchidae was the richest family with 13 species. The most numerous fish in the 1989 and July 2004 samples was Western Mosquitofish while Pirate Perch was the most abundant species in June 2004. Three species were unique to the 1989 fish assemblage and included Blackstripe Topminnow, Cypress Minnow *Hybognathus hayi*, and Bantam Sunfish. Species that were new additions in 2004 were Bowfin, Flier, Blacktail Shiner, Grass Pickerel, Blackspotted Topminnow, Pallid Shiner, Redear Sunfish, Spotted Bass, Spotted Sucker, Bullhead Minnow, and White Crappie. The aquatic life use (based upon the fish assemblage) rated as exceptional for every collection.

Benthic Macroinvertebrates

A total of 914 individuals representing 15 orders of macroinvertebrates were collected during the three sample events at Big Cypress Creek (Appendix E). Diptera, Oligochaeta, and Ephemeroptera were the three most abundant orders collected representing 38.7%, 20.2%, and 15%, respectively, of the individuals collected. Isopoda (10.3%), Trichoptera (4%), Coleoptera (3.8%), Decapoda (2%), Nematoda (1.9%), and Pelecypoda (1.4%) were the only other orders which represented one percent or greater of the total individuals in the sample.

The functional organization of the Big Cypress Creek macroinvertebrate assemblage was dominated by collector-gatherers, filtering collectors, and predators which accounted for 52.5%, 19.7%, and 10.5%, respectively, of the total number of individuals collected. The scrapers (10.2%) and shredders (7.1%) were present, but each represented lower relative abundance.

The EPT varied from a minimum of one for the June 2004 sample to a maximum of five for the 1989 Surber sample, which falls between the 5th and the 25th percentiles for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The relatively low EPT and the high average value for the biotic index (5.6), which falls between the 75th and 95th percentile for all biotic index values in the ecoregion aggregate, indicates a relatively tolerant macroinvertebrate assemblage in Big Cypress Creek.

Results for the Surber sample (39) BIBI falls in the range indicating a high aquatic life use for the Big Cypress Creek macroinvertebrate assemblage. The Ecoregions 33 and 35 BIBI score for the July 2004 sample fell in the intermediate aquatic life use category and the June 2004 sample fell in the limited aquatic life use category.

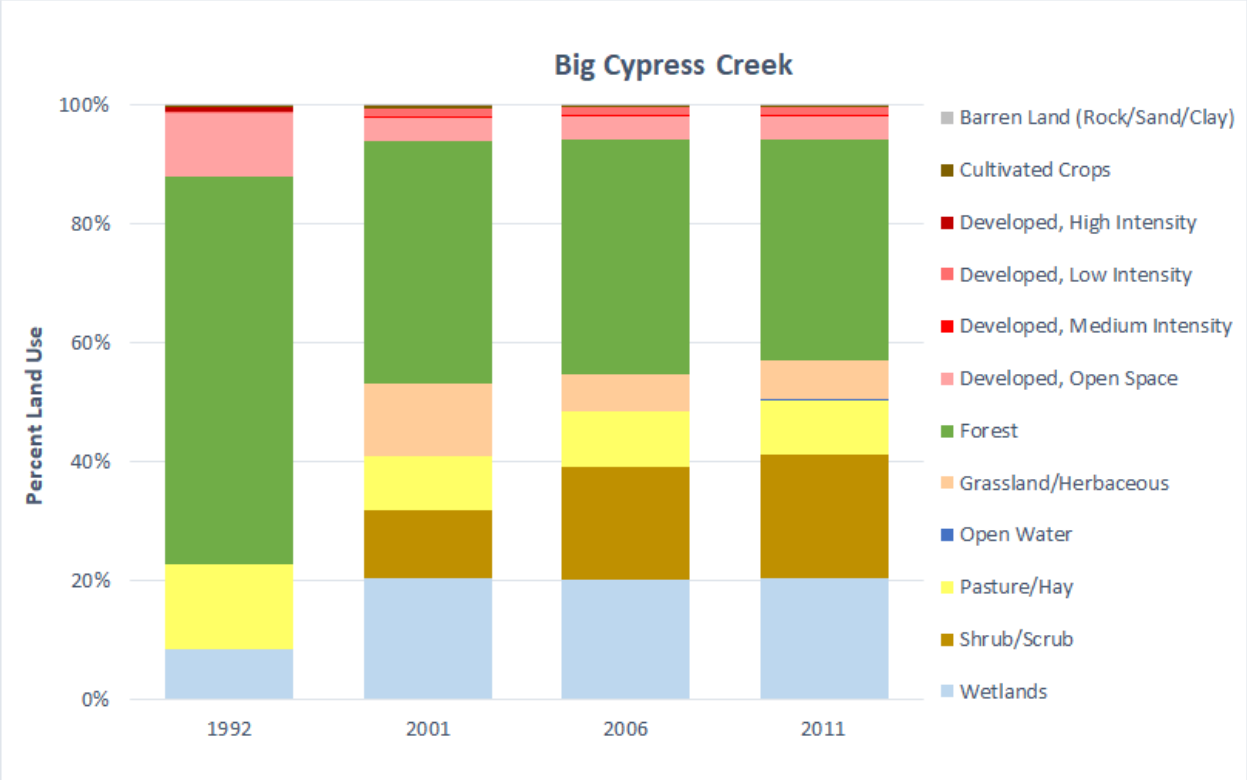

Figure 328. Percent land use in the Big Cypress Creek watershed from 1992-2011.

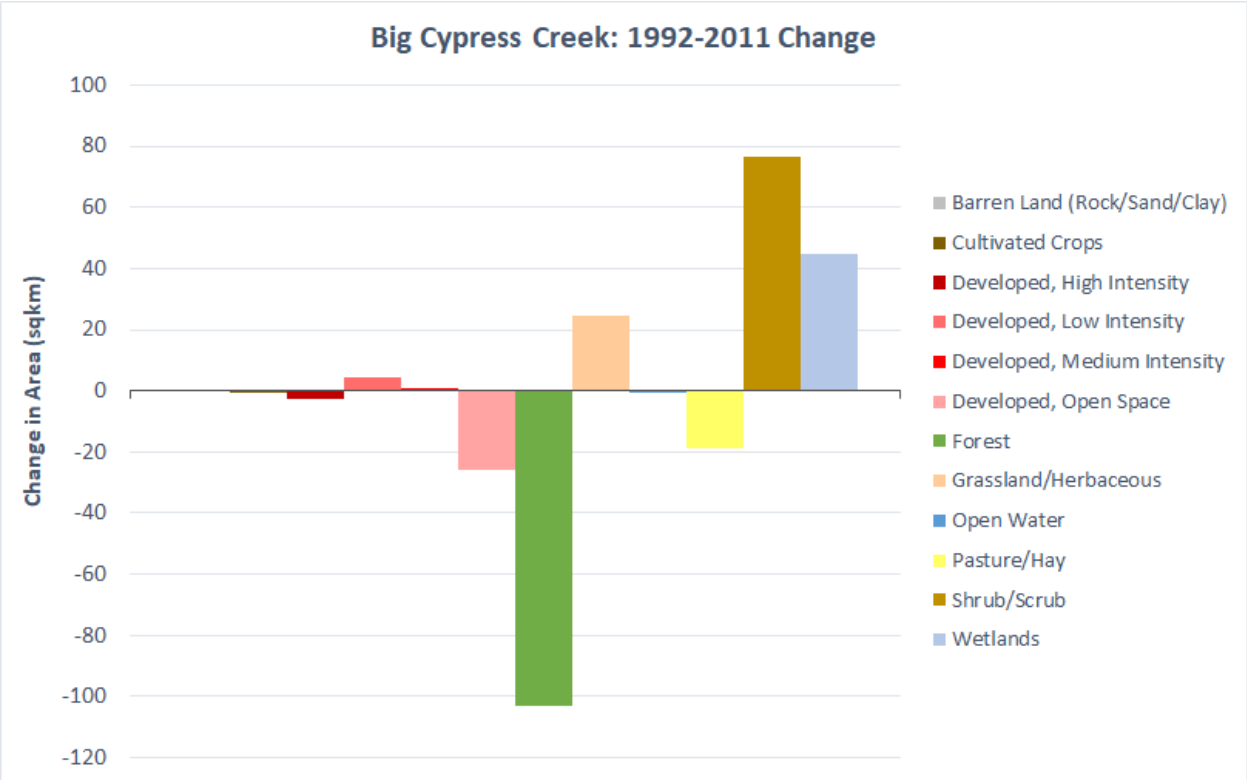

Figure 329. Land use change in area (sq km) from 1992-2011 for the Big Cypress Creek watershed.

BLACK BAYOU

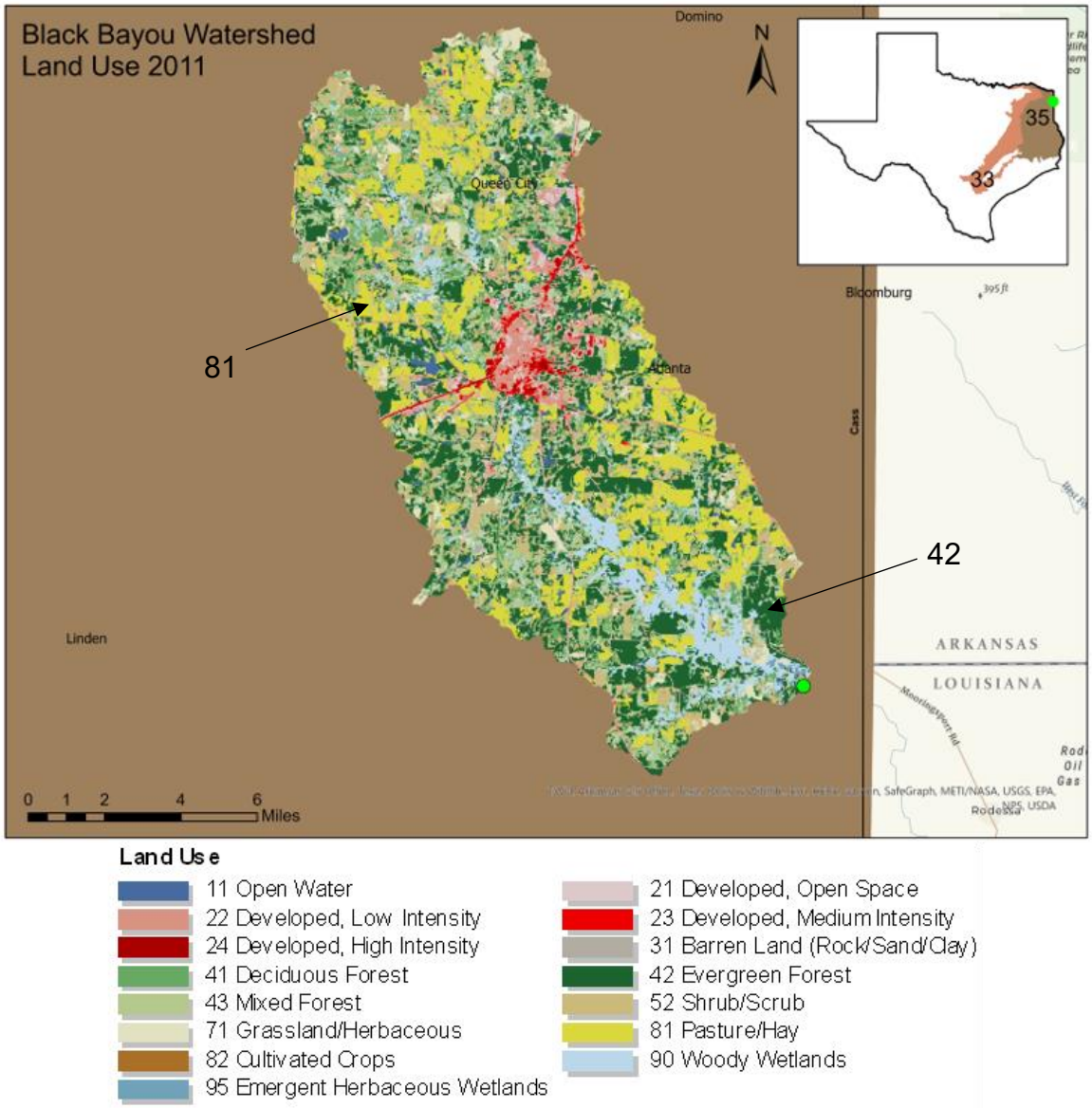

Figure 330. Map of Black Bayou watershed location and 2011 land use; forest and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	Station 10314: July 8, 2003; July 21, 2004; May 21, 2014; Station 16157: July 9, 2003; June 29, 2004
Water Quality:	343 sampling events (Stations 10314 and 16157)
Fish:	Station 10314: July 28, 1992; July 22, 1993; January 5, 1994; September 19, 1994; August 17, 1995; May 21, 2014
Benthic Invertebrates:	Station 10314: July 10, 1990; November 14, 1991; July 8, 2003; July 21, 2004; May 21, 2014; Station 16157: July 9, 2003; June 29, 2004

Physical Characterization

Watershed and Land Use

Black Bayou lies within the Cypress Creek Basin. Sample site 10314 is located at CR 4659, 6.44 km north of McLeod in Cass County (Figure 330).

The Black Bayou watershed at site 10314 is approximately 247.20 sq km. The entire watershed lies within Level IV Ecoregion 35a, the Tertiary Uplands. The dominant land cover in the watershed is forest at 46.58% and is present throughout the watershed (Homer et al. 2015; Figure 330 and Figure 331). Pasture/hay is the secondary land cover encompassing 17.40%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 10.17% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 44.59 sq km decrease in forest and a 17.47 sq km decrease in pasture/hay. There was a 30.38 sq km increase in shrub and a 10.56 sq km increase in open space development (Figure 332).

There is one industrial wastewater outfall (discharges ≥ 1 million gallons per day) within the Black Bayou watershed permitted to the City of Atlanta. This facility does not discharge directly into Black Bayou.

In Channel and Riparian Physical Habitat

Physical habitat for Black Bayou was evaluated at two sites during five sampling events from 2003 to 2014. Black Bayou is an intermittent stream with perennial pools that drains to Twelvemile Bayou north of Shreveport, LA. Habitat Quality Index scores are available for all five sample events and indicate an intermediate to high aquatic life use rating (15.5-23). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 19.7 meters wide to greater than 20 meters. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover ranged from 71% to 98%. The dominant stream substrate was silt followed by sand, and the average percent of substrate gravel size or larger was 0%. Average percent instream cover was 19% to 34% and instream cover types include extensive leaf packs, snags, cypress tree root mats, overhanging vegetation, and some algae and macrophytes. Black Bayou ranged from 0.3-0.5 meters deep on average and 10-25 meters wide. Average stream bank slope ranged from 7-16 degrees. Stream flow was measured at a minimum value of 0 cfs and a maximum of 29 cfs. Average stream bank erosion potential was 9%-12%. The deepest pool measured at Black Bayou was greater than 1.75 meters. No riffles were observed during any of the sampling events, and total number of stream bends ranged from one to six.

Water Quality

Water samples were collected at stations 10314 and 16157. Station 10314 was sampled 306 times from September 1968 through February 2020; station 16157 was sampled from November 1998 through July 2006 over 37 events. Parameters measured at both stations included

temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*. Continuous 24-hour data was recorded at both stations 10314 and 16157.

Biological Characterization

Fish

Thirty species (10 families) were collected over the course of the six sampling events. Centrarchidae was the richest family with 10 species. Twenty-one species were collected in the 1990s that were not part of the 2014 sample. These included Bowfin, Grass Pickerel, Brook Silverside *Labidesthes sicculus*, and two catfish, one darter, three topminnow, six sunfish, two sucker, and four minnow species. Bullhead Minnow was unique to the 2014 fish assemblage. The aquatic life use (based upon the fish assemblage) ranged from limited to high over the span of years evaluated. The most recent collection (2014) was the only one rating as intermediate. The consecutive collections of July 1993 and January 94 rated as limited but elevated to intermediate when the coefficient of variability was applied, while the other three received a high score.

Benthic Macroinvertebrates

Considered collectively, a total of 1,117 individuals representing 16 orders of macroinvertebrates were collected during the seven sample events at Black Bayou (Appendix E). Diptera was the most abundant order and accounted for 38.7% of the total numbers collected across all sites and dates. Amphipoda, Coleoptera, Odonata, Pelecypoda, Hemiptera, and Ephemeroptera were the next most abundant orders, accounting for 12%, 10.9%, 8.4%, 7.9%, 5.3%, and 4.9%, respectively, of the individuals collected. Other taxa, representing greater than 1% of the collections combined, include Isopoda, Hirudinea, Hydracarina, and Decapoda.

Considering both sites, and seven samples collectively, the functional organization of the Black Bayou macroinvertebrate assemblage was dominated by collector-gatherers, predators, and filtering collectors which accounted for 33.7%, 31.6%, and 17.9%, respectively, of the total number of individuals collected. The shredders (10.9%) and the scrapers (5.9%) were the least abundant functional groups. This functional organization was relatively constant across sample sites and dates except that the shredders were more abundant than filtering collectors on four dates, likely reflecting changes in the relative abundance of CPOM and suspended FPOM.

The EPT taxa were relatively depauperate with only four EPT taxa collected when all sites and dates are considered collectively. EPT values for individual samples ranged from zero to two. The average biotic index value for the collective Black Bayou benthic assemblage (6.4) falls between the 75th and the 95th percentile for all biotic index values in the ecoregion aggregate, indicating a relatively tolerant macroinvertebrate assemblage. The biotic index value for individual samples ranged from a low of 6 for the November 1991 sample to 6.8 for the June 2004 sample which exceeds the 95th percentile. This apparent high tolerance of the assemblage

likely reflects the harsh conditions as dictated by sluggish flow conditions which occasionally occur in Black Bayou combined with an inherently high organic load characteristic of the forested region.

Six of the seven Ecoregions 33 and 35 BIBIs for the Black Bayou RBP samples fell in the limited aquatic life use category, while the sample from July 2004 at Station 10314 fell in the intermediate aquatic life use category.

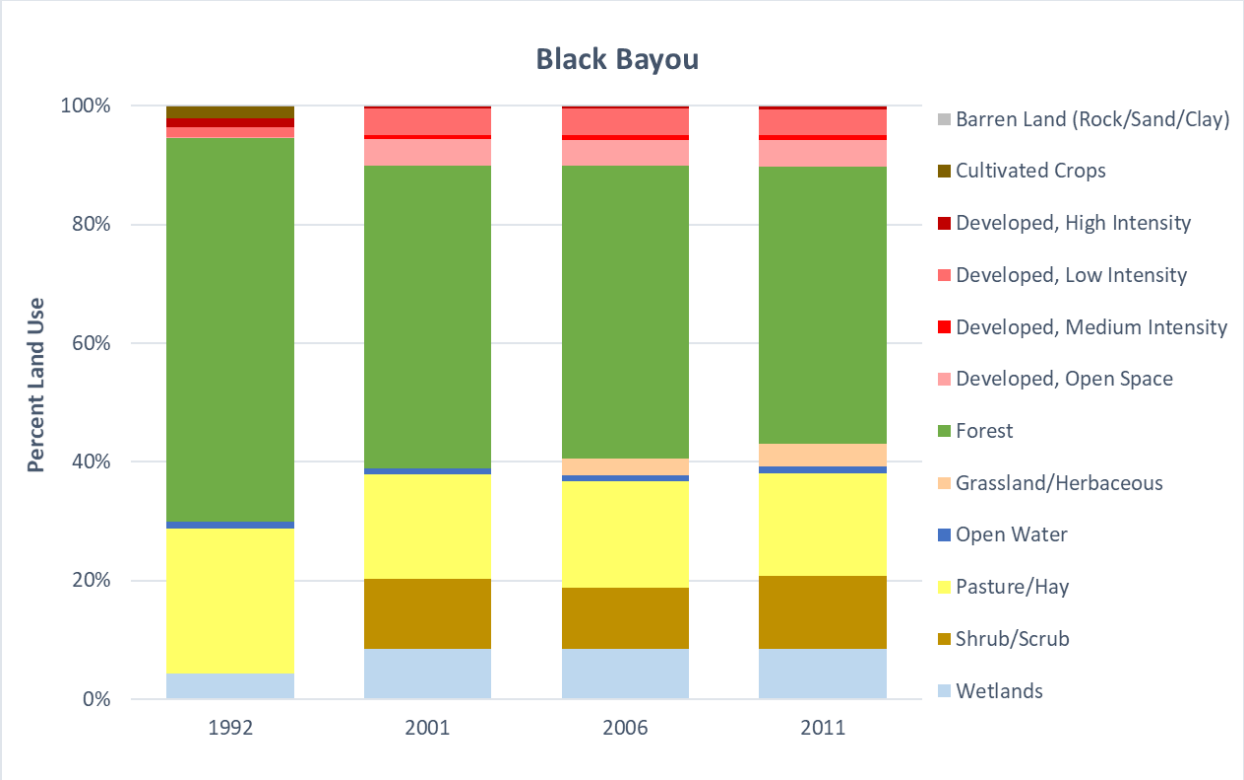

Figure 331. Percent land use in the Black Bayou watershed from 1992-2011.

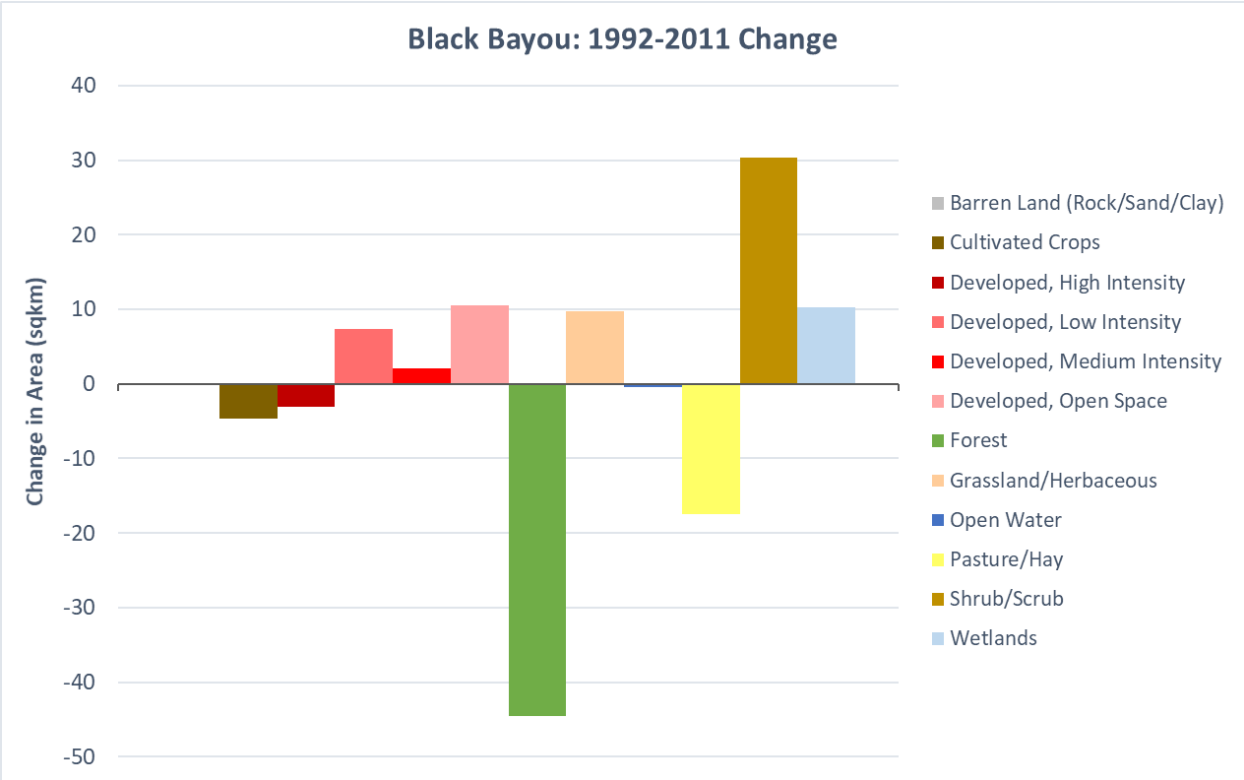

Figure 332. Land use change in area (sq km) from 1992-2011 for the Black Bayou watershed.

BLACK CYPRESS BAYOU

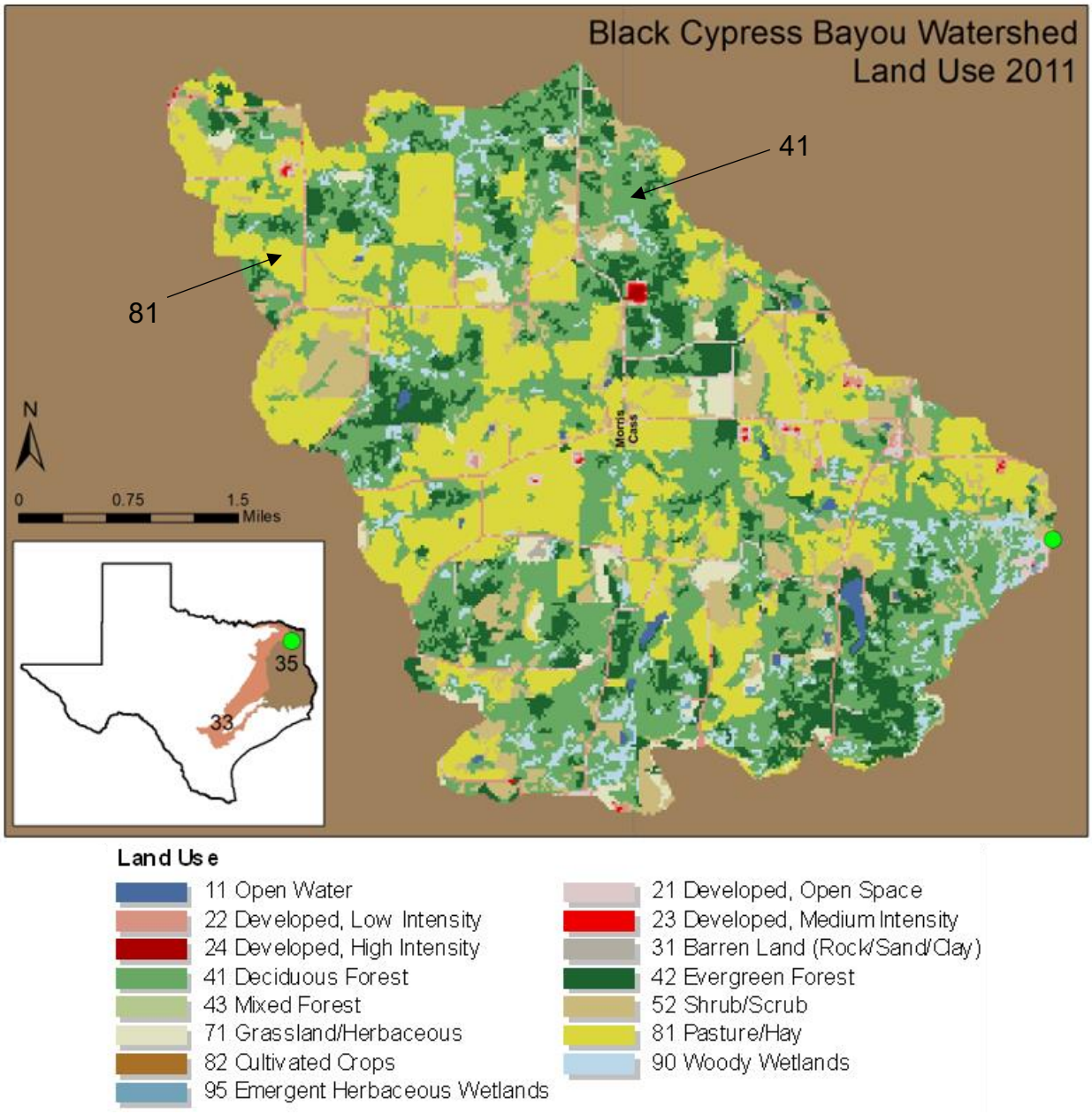

Figure 333. Map of Black Cypress Bayou watershed location and 2011 land use; forest and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	August 28, 1989
Water Quality:	63 sampling events
Fish:	August 30, 1989; July 27, 2000; August 21, 2000
Benthic Invertebrates:	August 30, 1989; July 27, 2000; August 21, 2000

Physical Characterization

Watershed and Land Use

Black Cypress Bayou lies within the Cypress Creek Basin. Sample site 10248 is located at FM 250, 6.44 km northeast of Hugh Springs in Cass County (Figure 333).

The Black Cypress Bayou watershed at site 10248 is approximately 46.96 sq km. The entire watershed lies within Level IV Ecoregion 35a, the Tertiary Uplands. The dominant land cover in the watershed is forest at 47.18% and is present throughout the watershed (Homer et al. 2015; Figure 333 and Figure 334). Pasture/hay is the secondary land cover encompassing 31.26%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 4.81% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 4.28 sq km decrease in pasture/hay and a 3.58 sq km decrease in forest. There was a 4.26 sq km increase in shrub and a 1.48 sq km increase in wetlands (Figure 335).

There are no permitted wastewater outfalls within the Black Cypress Bayou watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Black Cypress Bayou was evaluated on August 28, 1989. Black Cypress Bayou is an intermittent stream with perennial pools that drains to Big Cypress Creek below Lake O' the Pines east of Jefferson. The riparian width was 61 meters. The riparian zone was dominated by trees, which made up an average of 70% of the total riparian species, followed by shrubs (15%) then grasses (10%). The average percentage of tree canopy cover was 81%. The dominant substrate was clay and decaying organic material with some areas of fine sand, and the average percent of substrate that was gravel size or larger was 2%. Average percent instream cover was 36% and instream cover types included woody debris, undercut banks and overhanging vegetation. Black Cypress Bayou had an average depth of 0.3 meters and a maximum depth of 0.8 meters. The average width was 5.8 meters and average stream bank slope was 56 degrees. Stream flow at the site was 0.9 cfs. Average stream bank erosion potential was 91%. Six riffles were observed at the site and there were ten total stream bends.

Water Quality

Water samples were collected at station 10248 over 63 sampling events from August 1987 through March 2015. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*. Continuous 24-hour data was also recorded at station 10248.

Biological Characterization

Fish

Thirty-one species (10 families) were collected over the course of the three sampling events. Cyprinidae and Centrarchidae yielded the greatest species richness with nine and eight, respectively. Western Mosquitofish was the most abundant species in the 1989 and July 2000 collections but was slightly outnumbered by Longear Sunfish in August 2000. Based upon the fish assemblage, all three collections rated as having a high aquatic life use. When the coefficient of variability is applied, the 1989 collection rises to exceptional.

Benthic Macroinvertebrates

Considered collectively, a total of 691 individuals representing 18 orders of macroinvertebrates were collected during the three sample events at Black Cypress Bayou (Appendix E). Diptera, Ephemeroptera, Coleoptera, Trichoptera, and Oligochaeta were the five most abundant taxa representing 25.5%, 20.5%, 19.4%, 12.9%, and 4.5%, respectively, of the individuals collected. Other taxa, representing greater than 1% of the three collections combined include Pelecypoda, Turbellaria, Gastropoda, Hemiptera, Odonata, Hydracarina, and Decapoda.

Considering all three samples collectively, the functional organization of the Black Cypress Bayou macroinvertebrate assemblage was dominated by collector-gatherers, scrapers, filtering collectors, and predators which accounted for 34.3%, 21.8%, 20.8%, and 19%, respectively, of the total number of individuals collected. The shredders (4.1%) were the least abundant functional group. This functional structure was relatively consistent across individual sites and dates.

A total of seven EPT taxa were collected when all sites and dates are considered collectively, and the EPT for individual samples varied from three to five. These values fall between the 5th and the 25th percentile, respectively, for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The biotic index value for the collective Black Cypress Bayou benthic assemblage (6.2), which falls between the 75th and the 95th percentile for all biotic index values in the ecoregion aggregate, indicates a relatively tolerant macroinvertebrate assemblage. This apparent tolerance of the assemblage likely reflects the variably harsh conditions as dictated by sluggish flow conditions which occasionally occur in Black Cypress Bayou combined with an inherently high organic load characteristic of the forested region.

The East Bioregion Surber BIBI for the 1989 Surber sample fell in the exceptional aquatic life use category. Two of the three samples collected on Black Cypress Bayou were collected using RBP protocols. The Ecoregions 33 and 35 BIBIs for the two RBP samples both fell in the range indicating intermediate aquatic life use.

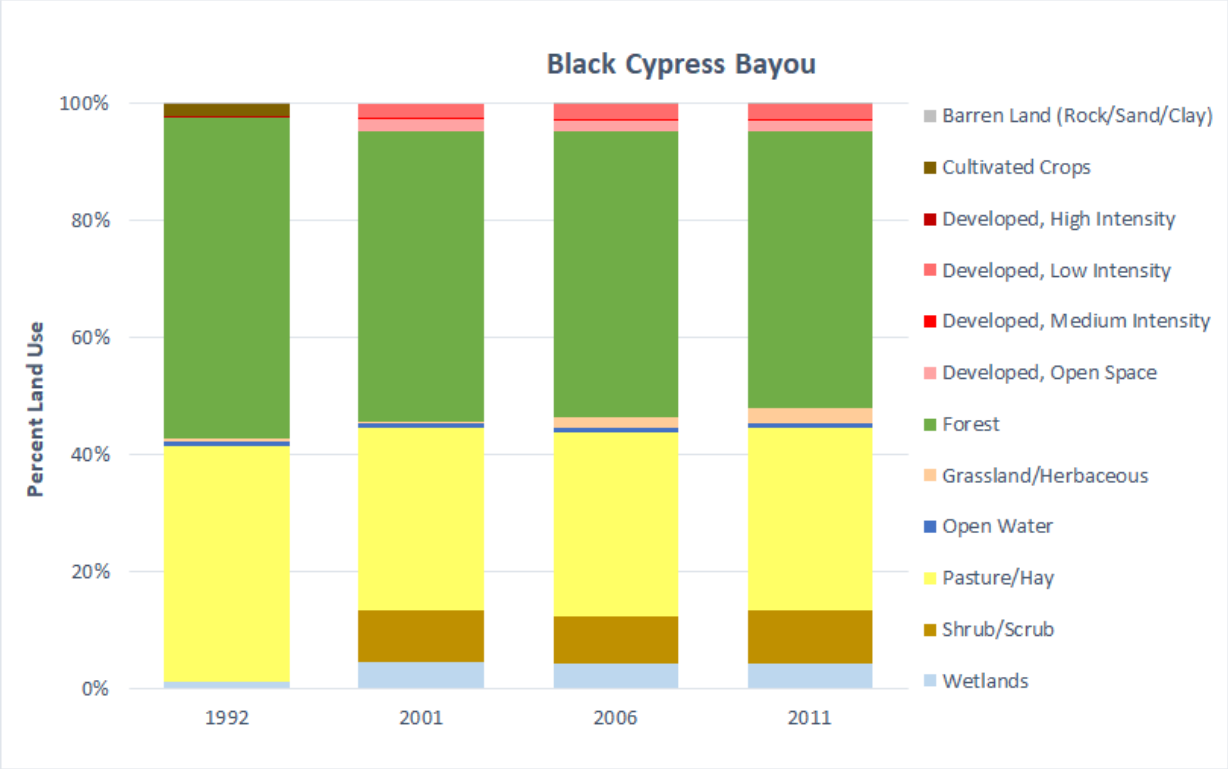

Figure 334. Percent land use in the Black Cypress Bayou watershed from 1992-2011.

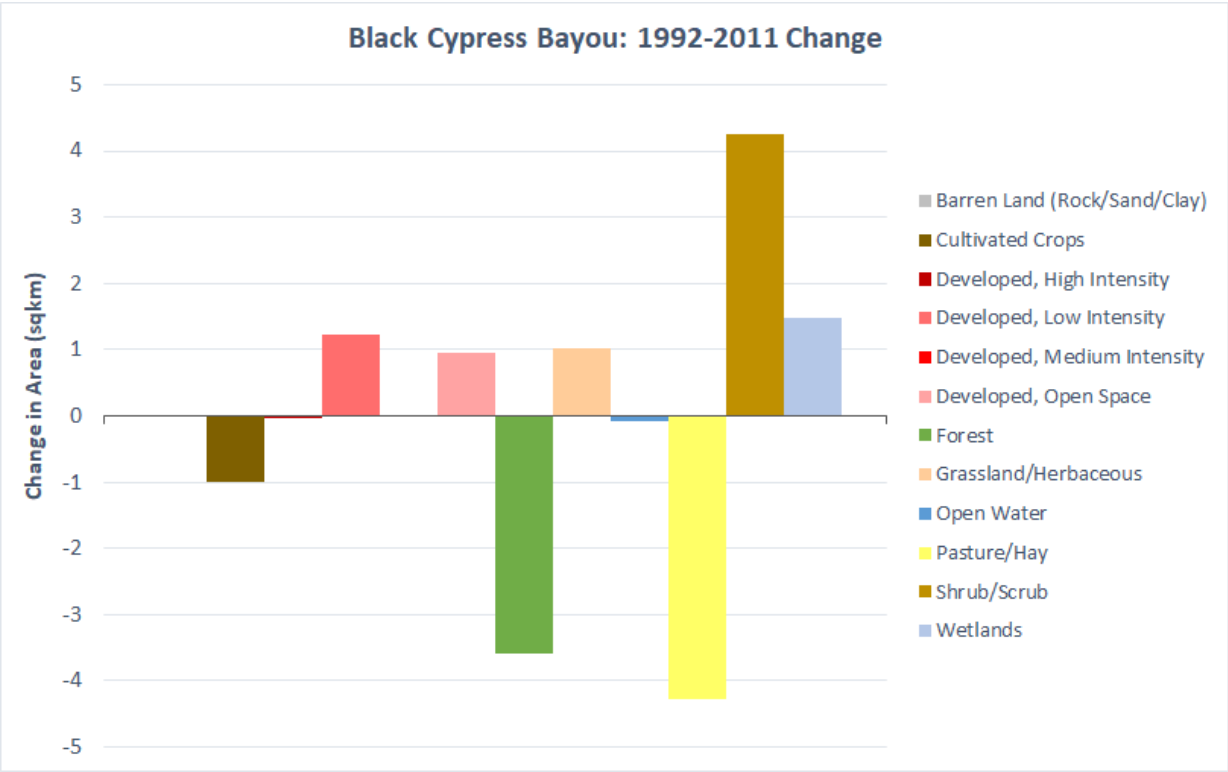

Figure 335. Land use change in area (sq km) from 1992-2011 for the Black Cypress Bayou watershed.

EAST FORK OF THE SAN JACINTO RIVER

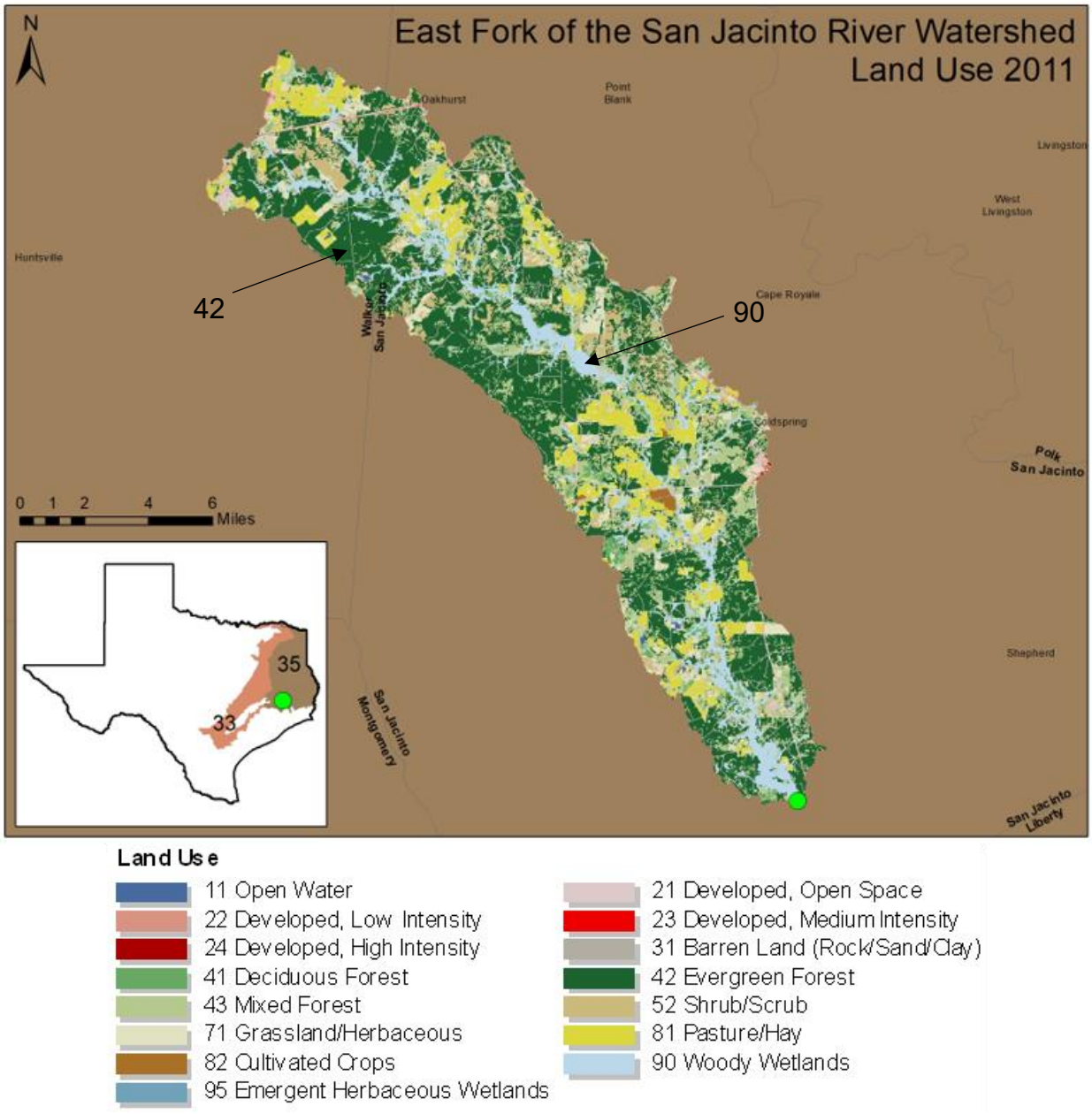

Figure 336. Map of East Fork of the San Jacinto River watershed location and 2011 land use; forest and wetland were the most common land uses.

Sampling Dates

Physical Habitat:	July 20, 1988; April 13, 2011; September 19, 2013
Water Quality:	36 sampling events
Fish:	July 20, 1988; April 14, 2011; July 13, 2011; September 19, 2013
Benthic Invertebrates:	July 20, 1988; April 13, 2011; July 12, 2011; June 19, 2013; September 19, 2013

Physical Characterization

Watershed and Land Use

The East Fork of the San Jacinto River lies within the San Jacinto River Basin. Sample site 11237 is located downstream of FM 945, 9.01 km north of Cleveland in San Jacinto County (Figure 336).

The East Fork of the San Jacinto River watershed at site 11237 is approximately 365.73 sq km. The sample location and extreme lower watershed lay within Level IV Ecoregion 35f, the Flatwoods, while the vast majority of the watershed lies within Level IV Ecoregion 35e, the Southern Tertiary Uplands. The dominant land cover in the watershed is forest at 57.59% and is present throughout the watershed (Homer et al. 2015; Figure 336 and Figure 337). Wetland is the secondary land cover encompassing 11.08%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 5.75% and total cover for cultivated crops is 0.3%.

From 1992-2011 there was a 65.44 sq km decrease in forest and a 22.4 sq km decrease in pasture/hay. There was a 34.46 sq km increase in wetlands, a 31.43 sq km increase in shrub, and a 24.3 sq km increase in grassland (Figure 338).

There are two domestic wastewater outfalls (discharges < 1 million gallons per day) within the East Fork of the San Jacinto River watershed. The facilities are permitted to the Sam Houston Area Council, Boy Scouts of America and Forest Glen Camps. Neither of these facilities discharge directly into the East Fork of the San Jacinto River.

In Channel and Riparian Physical Habitat

Physical habitat for the East Fork of the San Jacinto River was evaluated during three sampling events from 1988 to 2013. The East Fork of the San Jacinto River is a perennial stream that drains to Lake Houston. Habitat Quality Index scores are available for two sample events and indicate a high aquatic life use rating (22-23). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 16 meters wide to greater than 20 meters. The riparian zone was generally dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 72% to 99%. The dominant stream substrate was sand, and the average percent of substrate gravel size or larger varied from 14% to 23%. Average percent instream cover was 13% to 30% and instream cover types include woody debris, undercut banks, and gravel. The East Fork of the San Jacinto River ranged from 0.3-0.5 meters deep on average and 7-8 meters wide. Average stream bank slope ranged from 21-41 degrees. Stream flow at the site was measured at a minimum value of 2 cfs and a maximum of 7.8 cfs. Average stream bank erosion potential was 3%-35%. The deepest pool measured at the East Fork of the San Jacinto River was 1.5 meters. Two riffles were observed at the site and total number of stream bends ranged from four to eight.

Water Quality

Water samples were collected at station 11237 over 36 sampling events from July 1988 through August 2019. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*. Continuous 24-hour data was also recorded at station 11237.

Biological Characterization

Fish

Thirty-one species (11 families) were collected over the course of the four sampling events. Centrarchidae and Cyprinidae were the two richest families, with eight and seven species respectively. Blacktail Shiner was the most abundant species in all but the April 2011 sample, where it was outnumbered by Redfin Shiner. Based upon the fish assemblage, all four collections from the East Fork of the San Jacinto River received a high aquatic life use rating. When the coefficient of variability is applied, the 1988 and 2013 collections rise to exceptional.

Benthic Macroinvertebrates

A total of 1,471 individuals representing 18 orders of macroinvertebrates were collected during the five sample events at East Fork San Jacinto River (Appendix E). The mayflies (Ephemeroptera) were the most abundant order, with taxa from 13 genera and eight families representing 31.7% of the individuals collected across all sample dates. Trichoptera and Coleoptera were the next most abundant orders, representing 21.9% and 18.4%, respectively, of the individuals collected. The most abundant families collected were Elmidae, Hydroptilidae, and Chironomidae, representing 15%, 10.3%, and 10.1%, respectively, of the total number of individuals collected.

The EPT ranged from a minimum of 12 to a maximum of 19 with a median value of 15, which falls between the 75th and 95th percentile of all EPT values for least disturbed streams sampled in the aggregated ecoregion. The biotic index ranged from a minimum of 3.9 to a maximum of 5.6. The median value of the biotic index, 4.7, falls between the 25th and 50th percentile of all biotic index values for least disturbed streams sampled in the aggregated ecoregion. The maximum EPT value (19) and the median and minimum values for the biotic index indicate that sensitive species are relatively common in East Fork San Jacinto River.

Considered collectively across all sample dates, the functional organization of the East Fork San Jacinto River macroinvertebrate assemblage was dominated by collector gatherers, scrapers, and filtering collectors, which accounted for 36%, 31%, and 18.7%, respectively, of the total number of individuals collected. The predators (10.9%) and shredders (3.4%) functional groups represented a smaller proportion of individuals. Percent dominant functional group (FFG) is a macroinvertebrate community structure metric where low to moderate values reflect a balanced community, and higher values indicate a stressed community. Values for % Dominant FFG for East Fork San Jacinto River ranged from 35.4% to 45.8%. The median value of 42.8 % falls between the 25^{th} and 50^{th} percentile of all values for least disturbed streams sampled in the

aggregated ecoregion. These metrics indicate that East Fork San Jacinto River has a well-balanced community structure.

The East Bioregion Surber BIBI for the 1988 Surber sample fell in the exceptional aquatic life use category. Results for the Ecoregions 33 and 35 BIBI for the four RBP samples collected at East Fork San Jacinto River reflect a moderate degree of variability, ranging from 27 (intermediate) to 36 (exceptional).

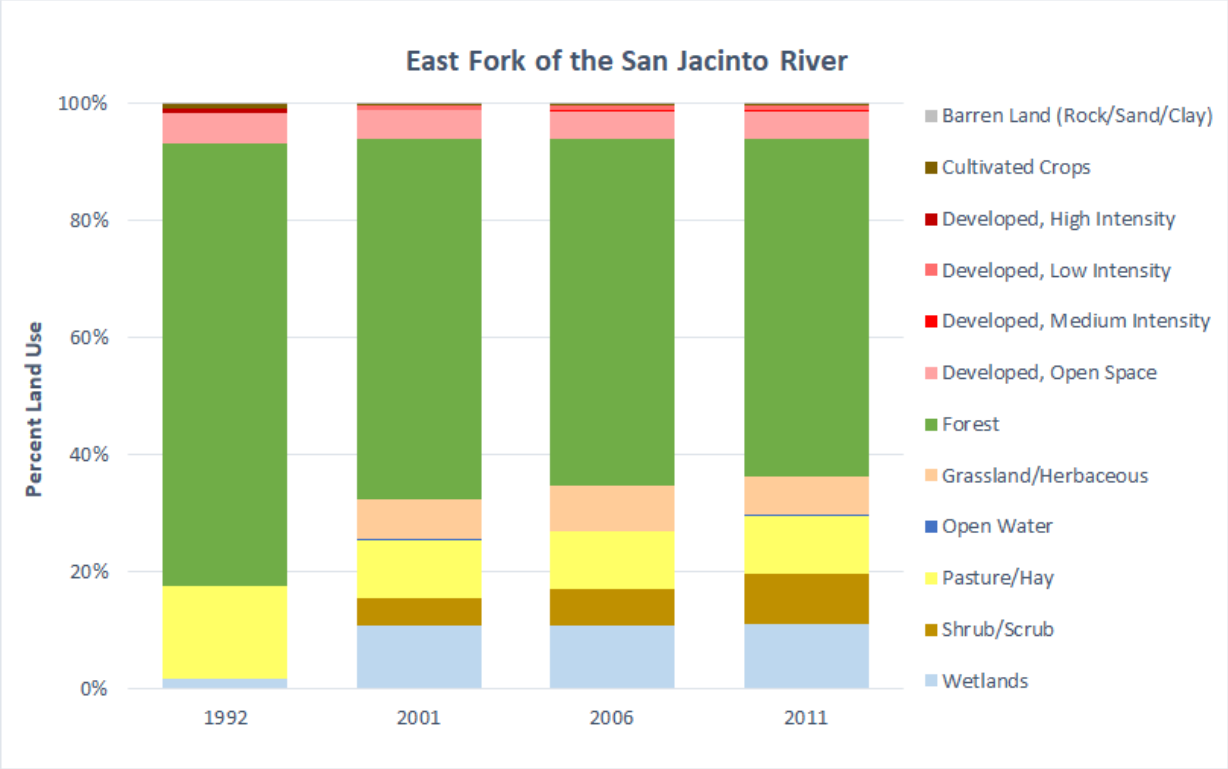

Figure 337. Percent land use in the East Fork of the San Jacinto River watershed from 1992-2011.

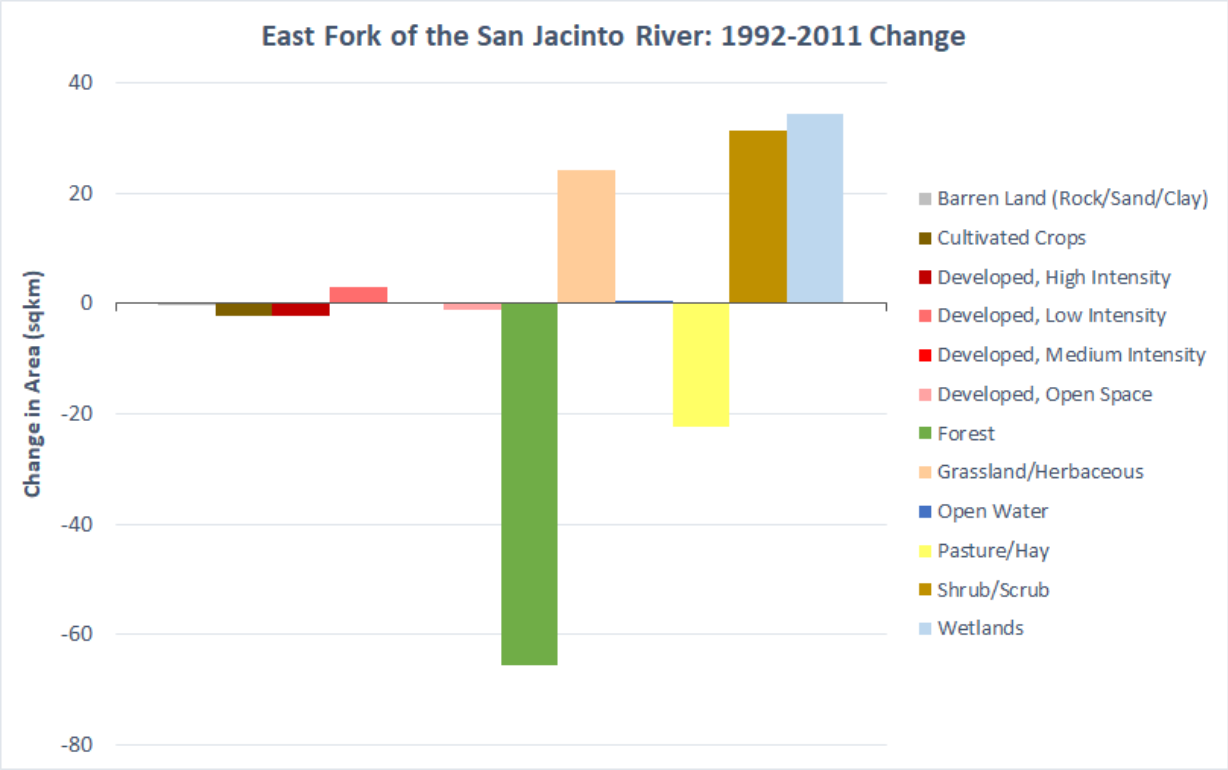

Figure 338. Land use change in area (sq km) from 1992-2011 for the East Fork of the San Jacinto River watershed.

FRAZIER CREEK

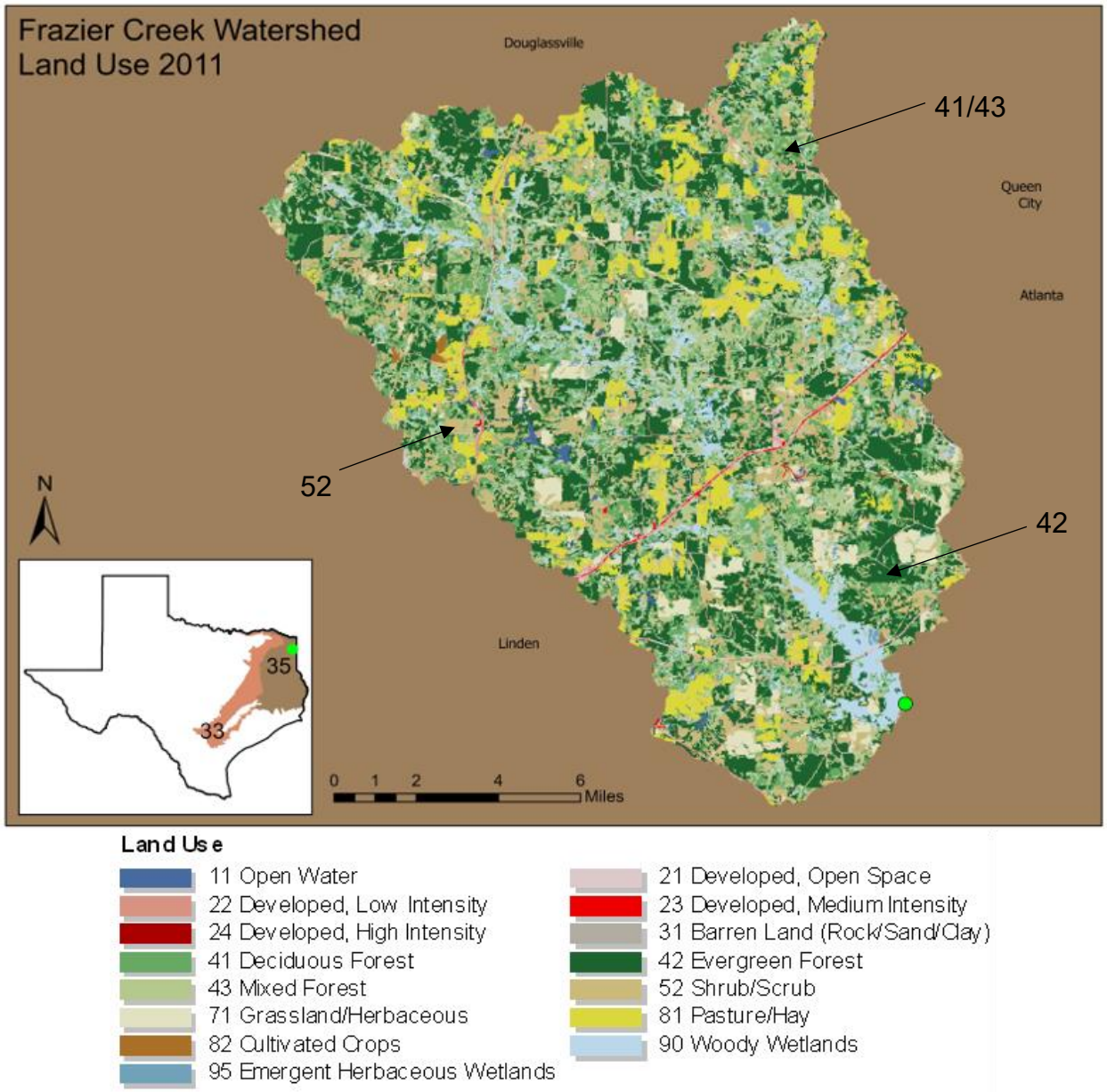

Figure 339. Map of Frazier Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	Station 10259: August 29, 1989; August 8, 2000; June 18, 2001; August 31, 2016; Station 17619: June 3, 2003; August 5, 2003
Water Quality:	85 sampling events (Stations 17619 and 10259)
Fish:	August 29, 1989; August 8, 2000; June 18, 2001; August 31, 2016
Benthic Invertebrates:	Station 10259: August 29, 1989; August 8, 2000; June 18, 2001, August 31, 2016; Station 17619: June 3, 2003; August 5, 2003

Physical Characterization

Watershed and Land Use

Frazier Creek lies within the Cypress Creek Basin. Sample site 17619 is located at FM 248, approximately 5 km north-northeast of Kildare in Cass County (Figure 339).

The Frazier Creek watershed at site 17619 is approximately 340.50 sq km. The entire watershed lies within the Level IV Ecoregion 35a, the Tertiary Uplands. The dominant land cover in the watershed is forest at 60.69% and is present throughout the watershed (Homer et al. 2015; Figure 339 and Figure 340). Shrub/scrub is the secondary land cover encompassing 12.71%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 4.65% and the total cover for cultivated crops 0.13%.

From 1992-2011 there was a 64.34 sq km decrease in forest and 12.06 sq km decrease in pasture/hay. There was a 43.27 sq km increase in shrub and a 16.05 sq km increase in grassland (Figure 341).

There is one domestic wastewater outfall (discharges < 1 million gallons per day) permitted to the Texas Department of Transportation which discharges into Frazier Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Frazier Creek was evaluated at two sites during six sampling events from 1989 to 2016. Frazier Creek is an intermittent stream with perennial pools that drains to James Bayou north of Caddo Lake. Habitat Quality Index scores are available for four sample events and indicate an intermediate to high aquatic life use rating (15-20.5). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 15 meters wide to greater than 20 meters. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover ranged from 8% to 95%. The dominant substrate type varies from clay to sand, with sand identified as dominant in four of the six events. The average percent of substrate gravel size or larger varied from 0% to 1%. Average percent instream cover was 5% to 31% and instream cover types include overhanging vegetation, undercut banks, leaf packs, woody debris, and root mats. Frazier Creek ranged from 0.2-0.6 meters deep on average and 3-9 meters wide. Average stream bank slope ranged from 32-68 degrees. Stream flow at the sites was measured at a minimum value of 0 cfs and a maximum of 26 cfs. Average stream bank erosion potential was 37%-60%. The deepest pool measured at Frazier Creek was 1.6 meters. Number of riffles observed at the site varied from zero to six, and total number of stream bends ranged from one to seven.

Water Quality

Water samples were collected at stations 10259 and 17619. Station 10259 was sampled 77 times from November 1988 through October 2019; station 17619 was sampled from October 2002 through August 2003 over 8 events. Parameters measured at both stations included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total

Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-a. Continuous 24-hour data was recorded at both stations.

Continuous flow data is available from USGS gage 07346140, located at station 10259 (Figure 342). Discharge was recorded from January 1985 through September 1991. In that time the median flow was 21 cfs, and flows ranged from 0 cfs to 3690 cfs. Flows increase sharply with rain events throughout the year; however only 0.5 percent of daily mean flows are greater than 1000 cfs. Data have been log transformed to better visualize flow patterns.

Biological Characterization

Fish

Thirty-five species (11 families) were collected over the course of the four sampling events. Centrarchidae yielded the most species (11) of any family. Frazier Creek received a high aquatic life use rating for three of the four fish collections evaluated during this study. The 2000 collection rated as exceptional. With the application of the coefficient of variability, the 1989 sample also achieves an exceptional rating. When comparing the oldest to the most recent collection, several metrics dropped in score between 1989 and 2016. The number of sunfish species declined from five to four (resulting in the metric score dropping from 5 to 3) and number of intolerant species went from three to one. Overall catch per unit effort also declined. Regarding sunfish, two species missing from the 2016 survey were Redear Sunfish and Redspotted Sunfish. Their absence from the 2016 collection is not particularly indicative of changes in the stream or watershed but is more likely due to their relatively low abundance. Only one individual of each of these sunfish species were collected in 1989. Warmouth (a species tolerant to organic enrichment and low dissolved oxygen concentrations) was added to the species list in 2016. The large reduction in number of intolerant species may reflect some disturbance or alteration. The greater than doubling of the percentage of tolerant individuals captured (even though the numbers did not result in a change to the metric score) may also support this supposition. None of the three intolerant species reported in 1989 were collected in 2016 even though 12 individuals were collected of the most abundant of the three species (Brook Silverside) in 1989. The 2016 collection was not without intolerant species but only included one individual Tadpole Madtom. This species was not collected in 1989. Decline in catch per unit effort could also be in response to changes in the watershed or stream.

Benthic Macroinvertebrates

Considered collectively, a total of 1,313 individuals representing 19 orders of macroinvertebrates were collected during the six sample events at Frazier Creek (Appendix E). Ephemeroptera was the most abundant order, representing 22.9% of the total number of individuals collected. The other orders that each accounted for greater than 10% of the total number of individuals collected were Coleoptera (17.1%), Trichoptera (16.1%), Diptera (13%), and Decapoda (10.4%). Other taxa, representing greater than 1% of the six collections combined include Hemiptera, Odonata, Hirudinea, Amphipoda, and Pelecypoda.

Considering both sites, and six samples collectively, the functional organization of the Frazier Creek macroinvertebrate assemblage was dominated by collector-gatherers, predators, filtering collectors, and scrapers which accounted for 34.4%, 27.1%, 22%, and 12.6%, respectively, of the total number of individuals collected. The shredders (3.9%) were the least abundant functional group. This functional structure was relatively consistent across individual sites and dates.

A total of 17 EPT taxa were collected when all sites and dates are considered collectively. The EPT for individual samples varied from three to seven. These values fall between the 5th and 50th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The biotic index value for the collective Frazier Creek benthic assemblage (5.4), which falls between the 50th and the 75th percentile for all biotic index values in the ecoregion aggregate, indicates a moderately tolerant macroinvertebrate assemblage.

The sample BIBI score for the August 1989 Surber sample collected at US 59 (41) falls in the range indicating an exceptional aquatic life use. The Ecoregions 33 and 35 BIBI scores for the RBP samples indicated intermediate aquatic life use category for all five samples. These results indicate a slight decrease in biotic integrity over the 27-year period between August 1989 and August 2016.

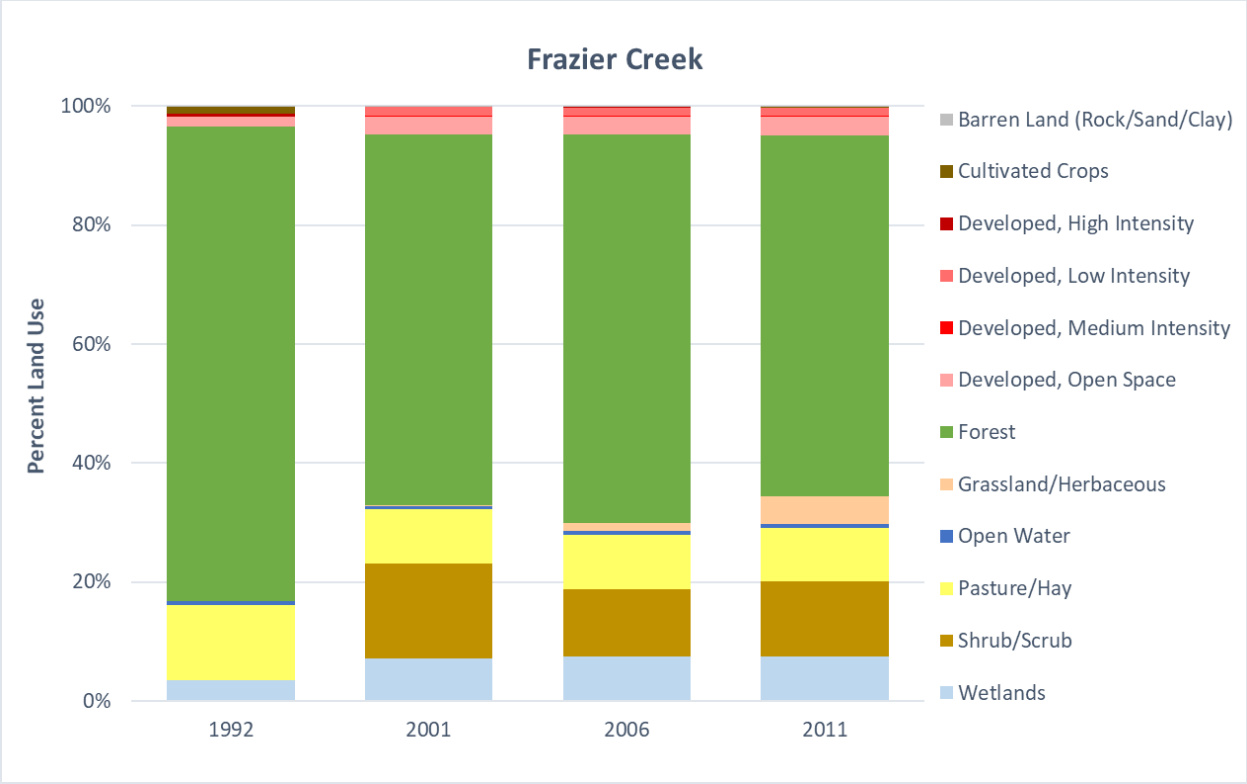

Figure 340. Percent land use in the Frazier Creek watershed from 1992-2011.

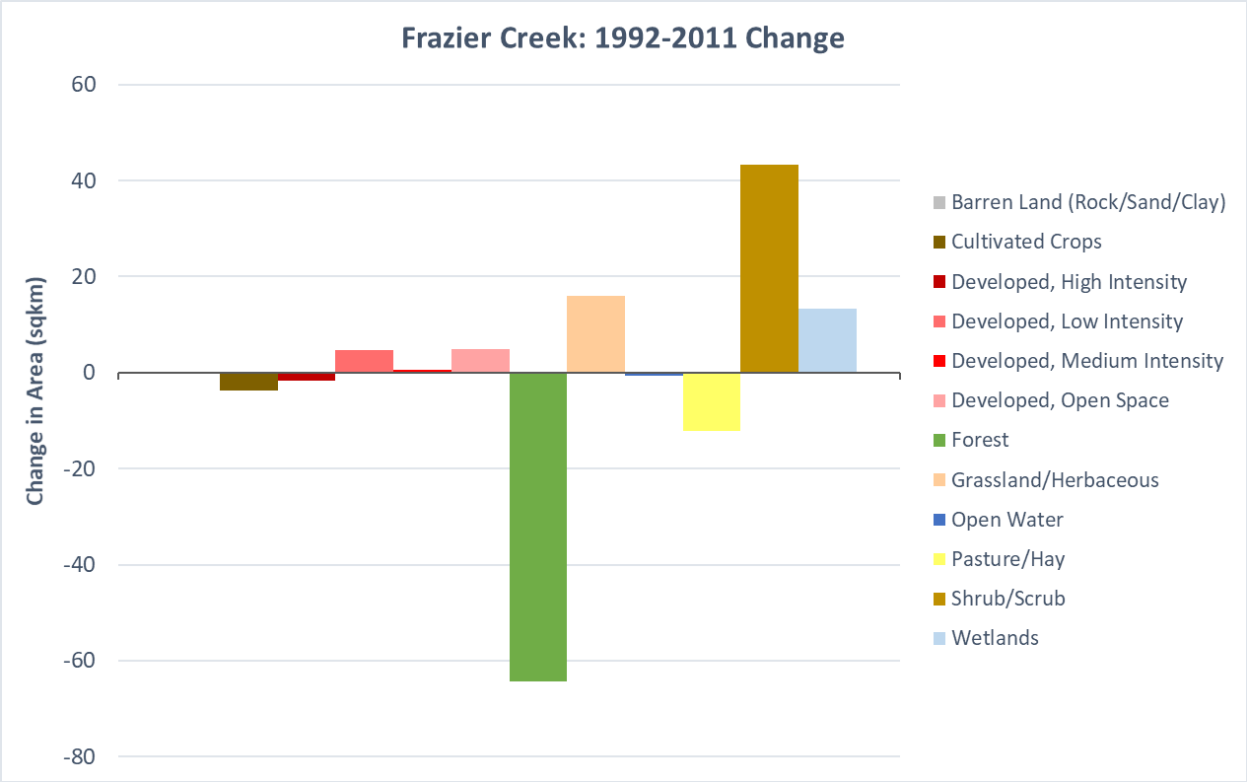

Figure 341. Land use change in area (sq km) from 1992-2011 for the Frazier Creek watershed.

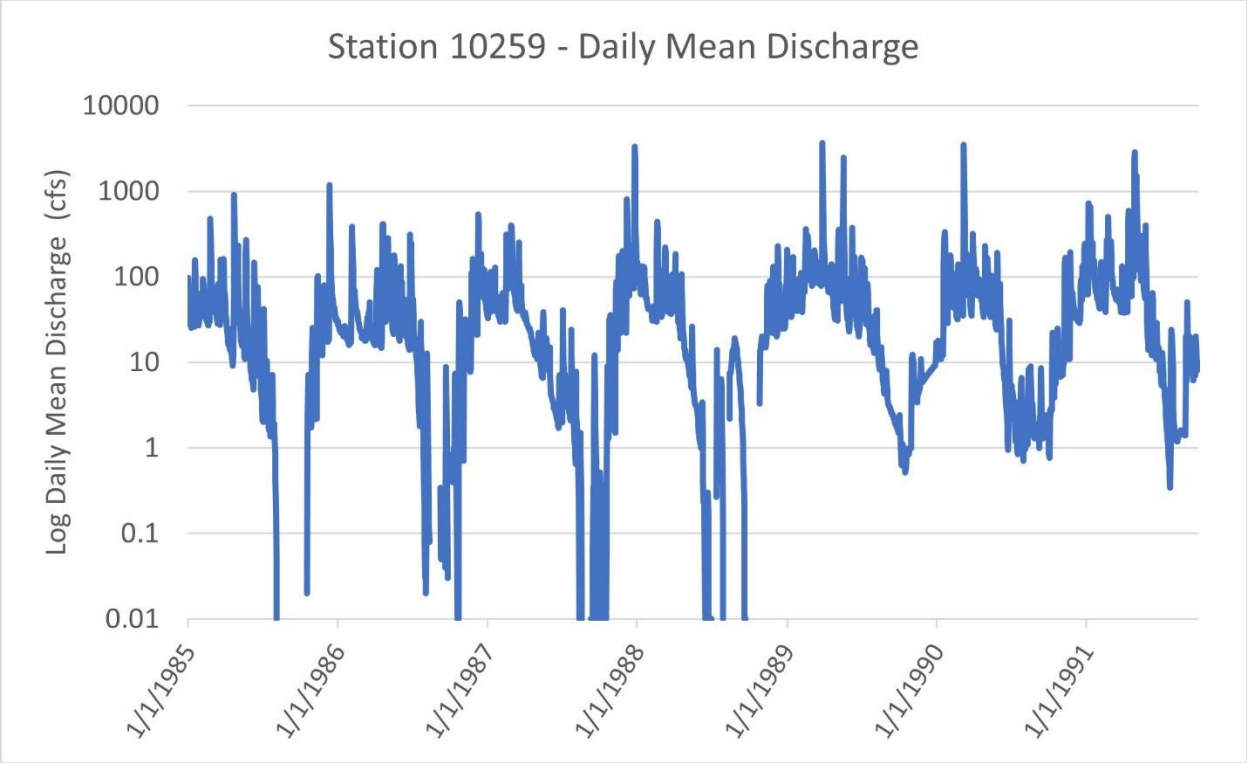

Figure 342. Log transformed daily mean discharge for Frazier Creek at station 10259.

IRONS BAYOU

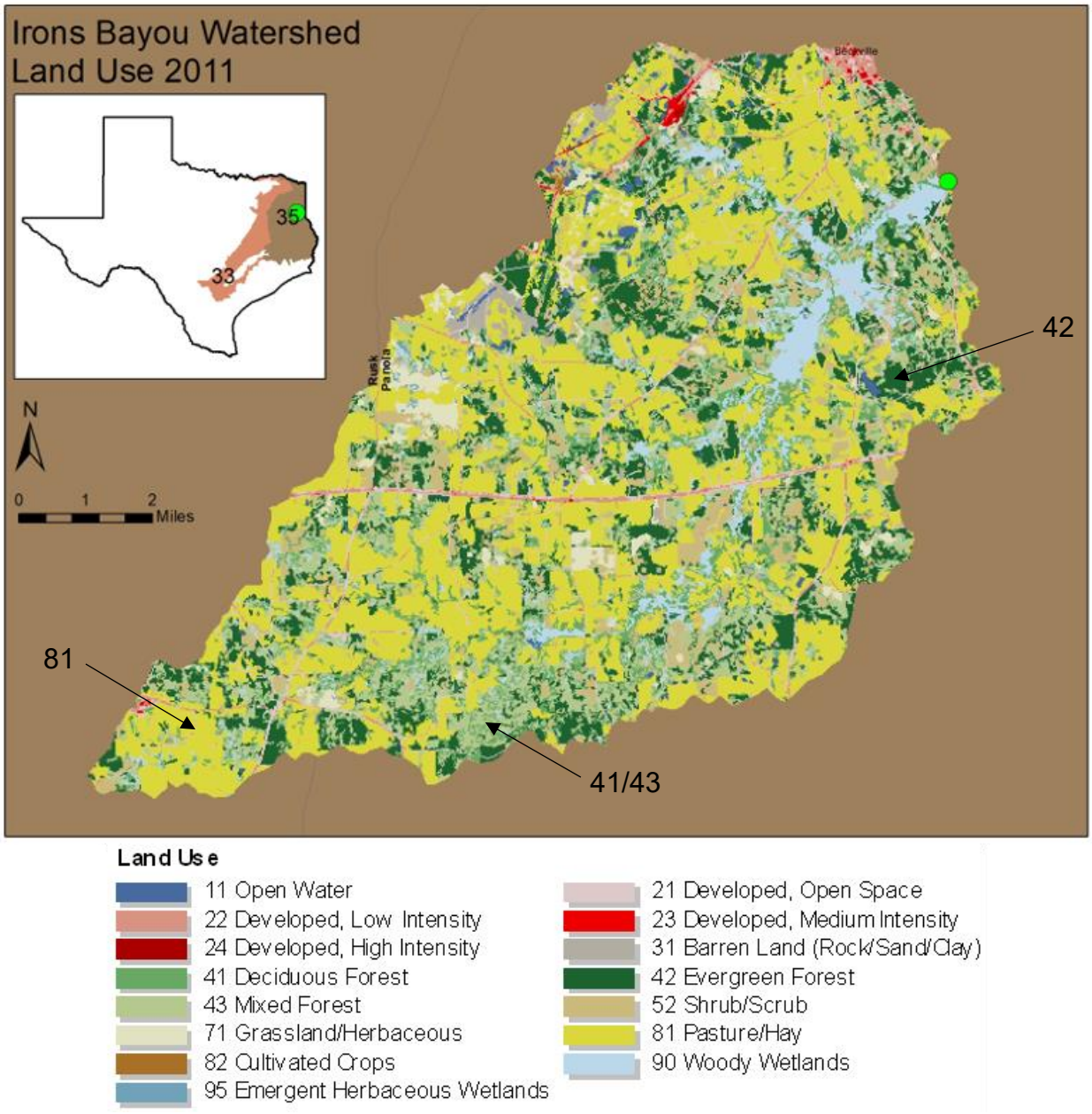

Figure 343. Map of Irons Bayou watershed location and 2011 land use; forest and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	August 31, 1989; August 10, 2004
Water Quality:	16 sampling events
Fish:	August 30, 1989; August 10, 2004
Benthic Invertebrates:	August 31, 1989; August 10, 2004

Physical Characterization

Watershed and Land Use

Irons Bayou lies within the Sabine River Basin. Sample site 10389 is located at SH 149 southeast of Beckville in Panola County (Figure 343).

The Irons Bayou watershed at site 10389 is approximately 220.22 sq km. The entire watershed lies within Level IV Ecoregion 35a, the Tertiary Uplands. The dominant land cover in the watershed is forest at 39.12% and is present throughout the watershed (Homer et al. 2015; Figure 343 and Figure 344). Pasture/hay is the secondary land cover encompassing 36.2%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 5.7% and total cover for cultivated crops is 0.06%.

From 1992-2011 there was a 19.16 sq km decrease in pasture/hay and a 9.25 sq km decrease in forest. There was a 19.9 sq km increase in shrub and a 6.38 sq km increase in open space development (Figure 345).

There are two domestic wastewater outfalls (discharges < 1 million gallons per day) within the Irons Bayou watershed. The facilities are permitted to the City of Beckville and Luminant Mining Co, LLC, a coal mining company. Neither of these facilities discharge directly into Irons Bayou.

In Channel and Riparian Physical Habitat

Physical habitat for Irons Bayou was evaluated on August 31, 1989 and again on August 10, 2004. The 2004 Habitat Quality Index score of 19 indicates an intermediate aquatic life use rating. Irons Bayou is an intermittent stream that drains to the Sabine River north of Carthage. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters for both sampling events. The riparian zone was dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover was 75%. The dominant substrate was clay and silt, and the average percent of substrate that was gravel size or larger was 0%. Average percent instream cover was 46% and instream cover types include snags, root mats, undercut banks, and woody debris. Irons Bayou ranges from 0.4-0.5 meters deep on average and 6-7 meters wide. Average stream bank slope was 43 degrees. Stream flow at the site was measured at a minimum value of 0.6 cfs and a maximum of 1.6 cfs. Average stream bank erosion potential was 74%. The deepest pool measured at Irons Bayou was 1 meter deep. A maximum of two riffles were observed at the site and there were six to seven total stream bends.

Water Quality

Water samples were collected at station 10389 over 16 sampling events from August 1989 through September 2011. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total

nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*. Continuous 24-hour data was also recorded at station 10389.

Biological Characterization

Fish

Twenty-six species (10 families) were collected between the two sampling events. A notable difference between the two collections was the rather large decline in native cyprinid species richness in 2004. Six native cyprinid species were collected in 1998, but only two in 2004. In addition to the four cyprinid species (Red Shiner, Blacktail Shiner, Weed Shiner, and Bullhead Minnow), Bluntnose Darter *Etheostoma chlorosomum*, Orangebelly Darter *E. radiosum*, and Tadpole Madtom were also absent from the 2004 sample. Species unique to the 2014 fish assemblage included Western Mosquitofish, Brook Silverside, Spotted Gar *Lepisosteus oculatus*, Spotted Bass, and Spotted Sucker. Ribbon Shiner was the most abundant fish species in both collections. Despite the fish assemblage changes, Irons Bayou received an exceptional aquatic life use rating in 1989 and a high rating in 2004; however, when the coefficient of variability was applied to the 2004 sample it also rated as exceptional.

Benthic Macroinvertebrates

A total of 2,091 individuals representing 17 orders of macroinvertebrates were collected in the two samples from Irons Bayou (Appendix E). Diptera and Trichoptera were the most abundant orders, representing 28.5% and 25.2% respectively of the total number of individuals collected. Amphipoda (13.9%) and Coleoptera (13.6%) were the only other orders which accounted for greater than 10% of the total number of individuals collected. Other taxa representing greater than 1% of the two collections combined, include Megaloptera (6.1%), Ephemeroptera (5.4%), Oligochaeta (3%), and Pelecypoda (2.6%).

The functional organization of the Irons Bayou macroinvertebrate assemblage was dominated by filtering collectors, collector gatherers, and predators which accounted for 31%, 29%, and 19%, respectively, of the total number of individuals collected. The shredders (11%) and scrapers (10%) were well represented at lower relative abundance.

A total of 12 EPT taxa were collected in the two Irons Bayou samples. This value falls between the 50th and 75th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The biotic index value for the benthic assemblage (5.6) equals the 75th percentile for all biotic index values in the ecoregion indicating a moderately tolerant macroinvertebrate assemblage in Irons Bayou.

The East Bioregion Surber BIBI score for the 1989 Surber sample falls in the range indicating an exceptional aquatic life use. The exceptional BIBI score is a result of maximum scores for the metrics total number of taxa, number of Diptera taxa, number of intolerant taxa, percent EPT, percent tolerant, and percent gatherers, and a low relative dominance of the three most abundant

taxa in the Surber sample. The Ecoregions 33 and 35 BIBI score for the August 2004 RBP sample fell in the range indicating an intermediate aquatic life use.

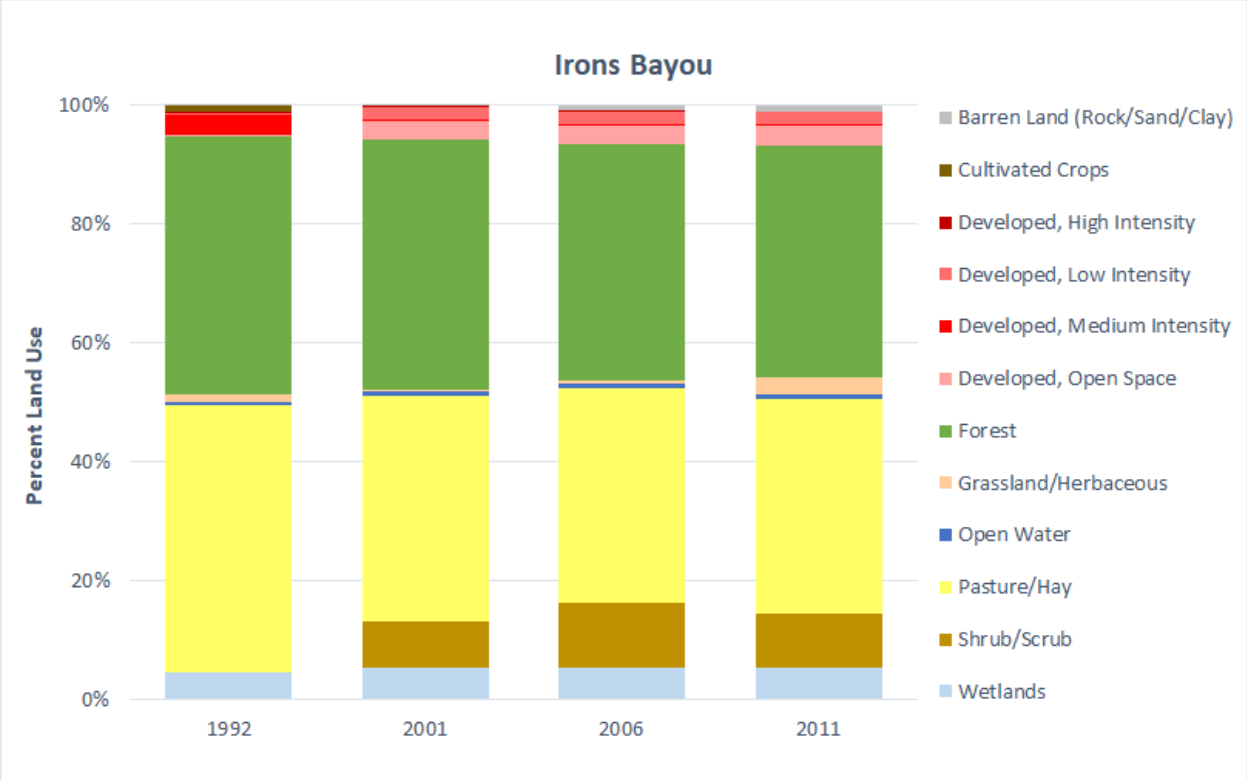

Figure 344. Percent land use in the Irons Bayou watershed from 1992-2011.

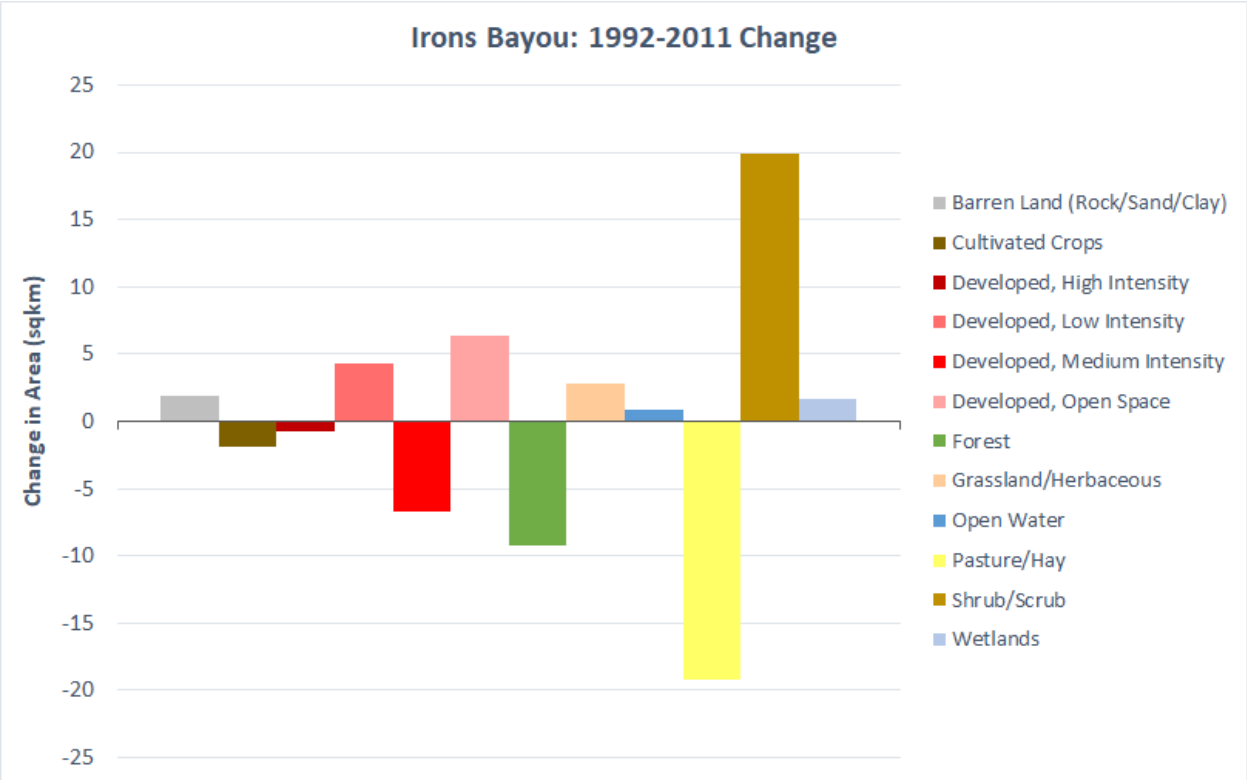

Figure 345. Land use change in area (sq km) from 1992-2011 for the Irons Bayou watershed.

JAMES (JIMS) BAYOU

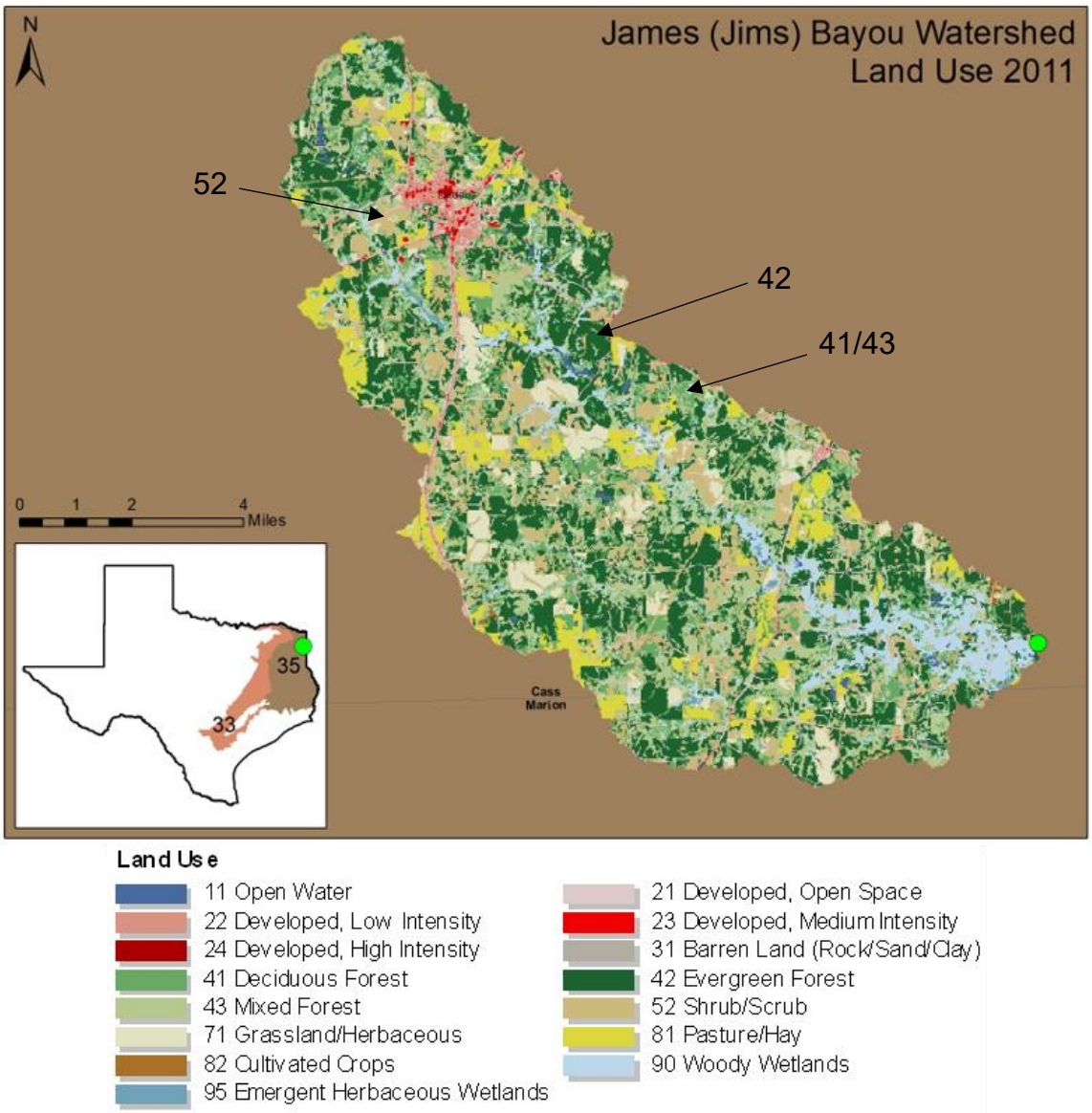

Figure 346. Map of James Bayou watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	Station 10321: August 8, 2000; June 19, 2001; June 12, 2002, August 13, 2002; June 3, 2003; August 5, 2003; July 16, 2004; August 17, 2004; June 14, 2005; June 21, 2006; August 8, 2006; Station 14976: June 21, 2006; August 8, 2006; June 16, 2016; August 2, 2016
Water Quality:	216 sampling events (Stations 10321 and 14976)
Fish:	CR 1775 (Station 10321) - August 19, 1997; August 8, 2000; June 19, 2001; June 12, 2002, August 13, 2002; June 3, 2003; August 5, 2003;

	July 16, 2004; August 17, 2004; June 14, 2005; June 21, 2006; August 8, 2006; CR 1779 - August 24, 1999; SH 43 (Station 14976) - June 21, 2006; August 8, 2006; June 16, 2016; August 2, 2016
Benthic Invertebrates:	Station 10321: August 8, 2000; June 19, 2001; June 12, 2002, August 13, 2002; June 3, 2003; August 5, 2003; July 16, 2004; August 17, 2004; June 14, 2005; June 21, 2006; August 8, 2006; Station 14976: June 21, 2006; August 8, 2006; June 16, 2016; August 2, 2016

Physical Characterization

Watershed and Land Use

James (Jims) Bayou lies within the Cypress Creek Basin. Sample site 14976 is located at SH 43, 19.31 km northeast of Jefferson in Cass County (Figure 346).

The James Bayou watershed at site 14976 is approximately 210.83 sq km. The entire watershed lies within Level IV Ecoregion 35a, the Tertiary Uplands. The dominant land cover in the watershed is forest at 57% and is present throughout the watershed (Homer et al. 2015; Figure 346 and Figure 347). Shrub is the secondary land cover encompassing 14.3%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 7.58% and total cover for cultivated crops is 0.08%.

From 1992-2011 there was a 50.02 sq km decrease in forest and a 7.46 sq km decrease in pasture/hay. There was a 30.15 sq km increase in shrub and an 11.42 sq km increase in grassland (Figure 348).

There are two domestic wastewater outfalls (discharges < 1 million gallons per day) within the James Bayou watershed, both permitted to the city of Linden. Neither of these facilities discharge directly into James Bayou.

In Channel and Riparian Physical Habitat

Physical habitat for James Bayou was evaluated at two sites during fifteen sampling events from 2000 to 2016. James Bayou is an intermittent stream with perennial pools that drains to Caddo Lake after crossing the Louisiana border. Habitat Quality Index scores are available for 14 sample events and indicate an intermediate to high aquatic life use rating (15-21.5). Riparian areas were generally well vegetated throughout the reach with an average riparian buffer ranging from 10 meters wide to greater than 20 meters. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover ranged from 60% to 100%. The dominant substrate type varies from clay to sand for the 15 sampling events, but clay was identified as dominant in 13 of 15 events. The average percent of substrate gravel size or larger varied from 0% to 13%. Average percent instream cover was 8% to 26% and instream cover types include overhanging vegetation, snags, woody debris, and root mats. James Bayou ranged from 0.1-0.7 meters deep on average and 3-12 meters wide. Average stream bank slope ranged from 10-45 degrees. Stream flow at the two sites was measured at a minimum value

of 0 cfs and a maximum of 34.5 cfs. Average stream bank erosion potential was 7%-91%. The deepest pool measured at James Bayou was 1.2 meters. Number of riffles observed at the sites varied from zero to one, and total number of stream bends ranged from two to seven.

Water Quality

Water samples were collected at stations 10321 and 14976. Station 10321 was sampled 154 times from October 1982 through July 2018; station 14976 was sampled from October 2005 through October 2019 over 62 events. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*. Continuous 24-hour data was recorded at both stations.

Biological Characterization

Fish

Fish collections from three sample stations (within about 16 km of each other) were used in the evaluation of this river reach. Most of the collections (12 of 17) were conducted at the most upstream station (CR 1775). The fish assemblage from seven of these collections rated as having an exceptional aquatic life use, three rated high (one elevates to exceptional with the application of the coefficient of variability), and two intermediate (both from 2006). No collections have been made at this station since 2006 making it difficult to know whether the aquatic life use has continued to decline or whether this sample was an anomaly. Overall, 44 species (14 families) were collected over the course of the 12 sampling events. Twenty species were unique to this site and included Black Bullhead, Tadpole Madtom, Gizzard Shad, Western Creek Chubsucker *Erimyzon claviformis*, Chain Pickerel *Esox niger*, Golden Topminnow *Fundulus chrysotus*, Orangespotted Sunfish, Dollar Sunfish, Bantam Sunfish, White Crappie, Black Crappie, Spotted Sucker, Striped Shiner *Luxilus chrysocephalus*, Golden Shiner, Emerald Shiner, Blackspot Shiner, Weed Shiner, Bullhead Minnow, Bigscale Logperch, and Dusky Darter.

Four fish samples were collected from SH 43, the most downstream station between 2006 and 2016. Twenty-two species (13 families) were collected over the course of the sampling events, including two species only found at this station - Freshwater Drum *Aplodinotus grunniens* and Channel Catfish. The aquatic life use ratings from 2006 rated as intermediate and limited, the 2016 ratings were intermediate and high. No fish data collected prior to 2006 was located for this sample station making it difficult to determine whether these lower ratings support the decline noted upstream or whether this station had declined conditions as early as 1997 (when sampling began at CR 1775).

One collection was made in 1999 at a location midway between the upper and lower stations (CR 1779). This station yielded 22 species (11 families), including one species unique to this site - Ironcolor Shiner *Notropis chalybaeus*. The fish assemblage rated high indicating that conditions, at least that far downstream, were still relatively good in 1999, but was lower than the

exceptional ratings consistently being seen upstream. It is only one sample, but when used in context of the ratings seen at SH 43, conditions appear to decline as one moves downstream.

Pirate Perch and Grass Pickerel were collected during each sampling event. Centrarchidae yielded the greatest species richness of all the families represented at each station; however, number of species within this family declined from 14 to 7 as one moved downstream.

Benthic Macroinvertebrates

Considered collectively, a total of 2,678 individuals representing 21 orders of macroinvertebrates were collected in the 15 sample events at James Bayou (Appendix E). Diptera was the most abundant order, representing 18% of the total number of individuals collected. Other orders that each accounted for greater than 10% of the total number of individuals collected were Ephemeroptera (16.1%), Hemiptera (15.7%), Coleoptera (15.1%), and Decapoda (11.4%). Other taxa, representing greater than 1% of the 15 collections combined, include Odonata, Trichoptera, Pelecypoda, Plecoptera, Amphipoda, Oligochaeta, and Gastropoda.

Considering all 15 samples collectively, the functional organization of the James Bayou macroinvertebrate assemblage was dominated by predators and collector-gatherers, which accounted for 41.8% and 36.7%, respectively, of the total number of individuals collected. The filtering collectors (11.9%), scrapers (7.7%), and shredders (1.9%) were present, but in lower relative abundance. This functional structure was relatively consistent across individual sample dates.

A total of 19 EPT taxa were collected when all dates are considered collectively. The EPT for individual samples varied from a minimum of zero to a maximum of 11. These values fall between the minimum and the 75th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The variability of the EPT is likely related to variable flow conditions and the sensitivity of the EPT taxa to low flow conditions.

The biotic index value for the collective James Bayou benthic assemblage (5.3) falls between the 50th and the 75th percentile for all biotic index values in the ecoregion aggregate indicating a moderately tolerant macroinvertebrate assemblage. The maximum biotic index value for individual samples was 7.3, which exceeds the 95th percentile for the ecoregion aggregate. The lowest biotic index value among the 15 samples (4.1) falls between the 5th and the 25th percentiles for the ecoregion aggregate.

The RBP IBI scores for the 15 samples ranged from limited to exceptional aquatic life use. These results likely indicate the response of the assemblage to less favorable flow conditions. The Ecoregions 33 and 35 BIBIs for each of the RBP samples fell in the following aquatic life use categories:

- Exceptional (Station 10321: June 2003)
- High (Station 10321: June 2002, August 2002, July 2004)

- Intermediate (Station 10321: August 2000, June 2001, August 2003, June 2005, June 2006, August 2006; Station 14976: June 2016, August 2016)
- Limited (Station 10321: August 2004; Station 14976: June 2006, August 2006)

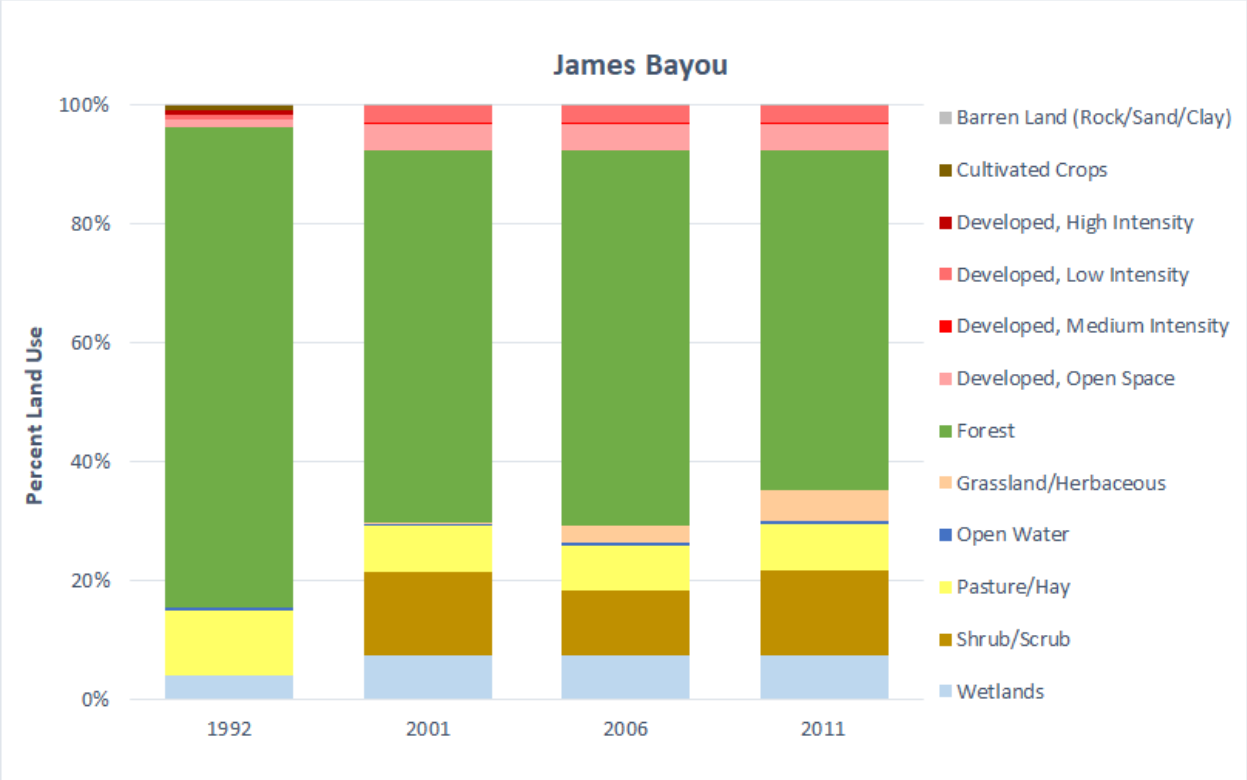

Figure 347. Percent land use in the James Bayou watershed from 1992-2011.

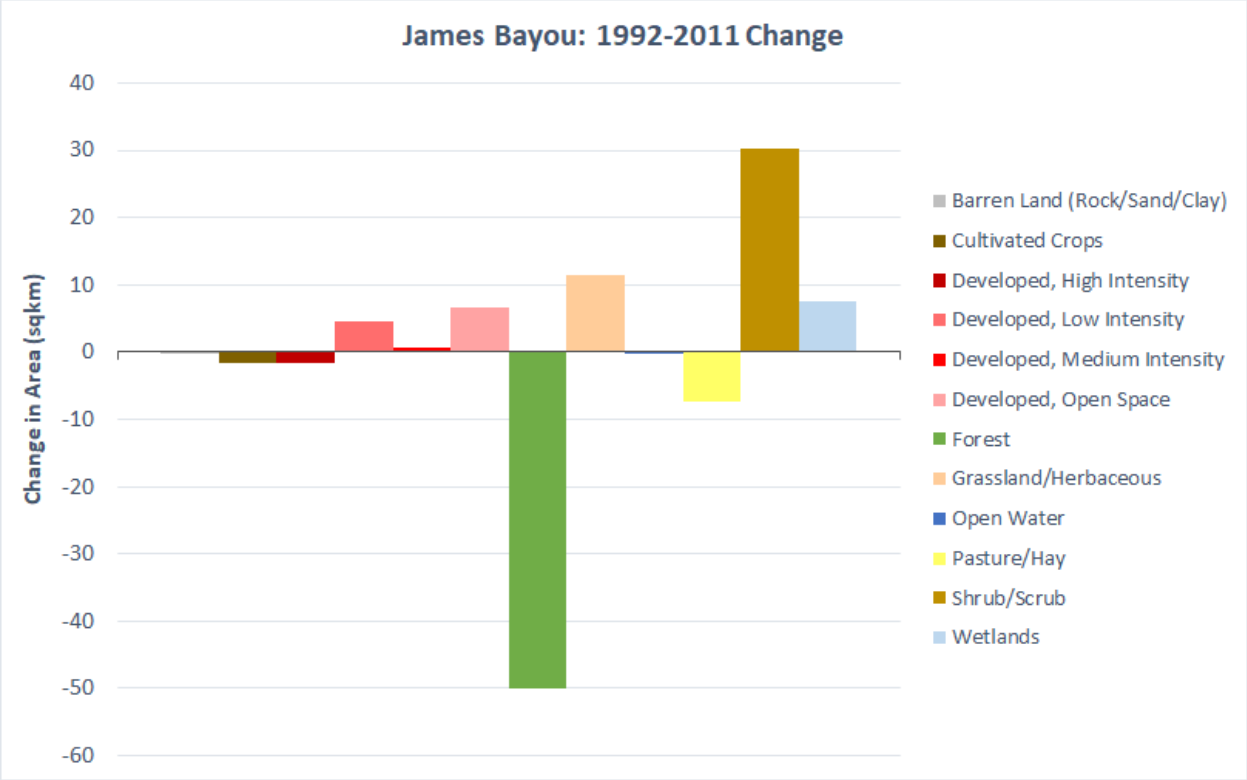

Figure 348. Land use change in area (sq km) from 1992-2011 for the James Bayou watershed.

LAKE CREEK

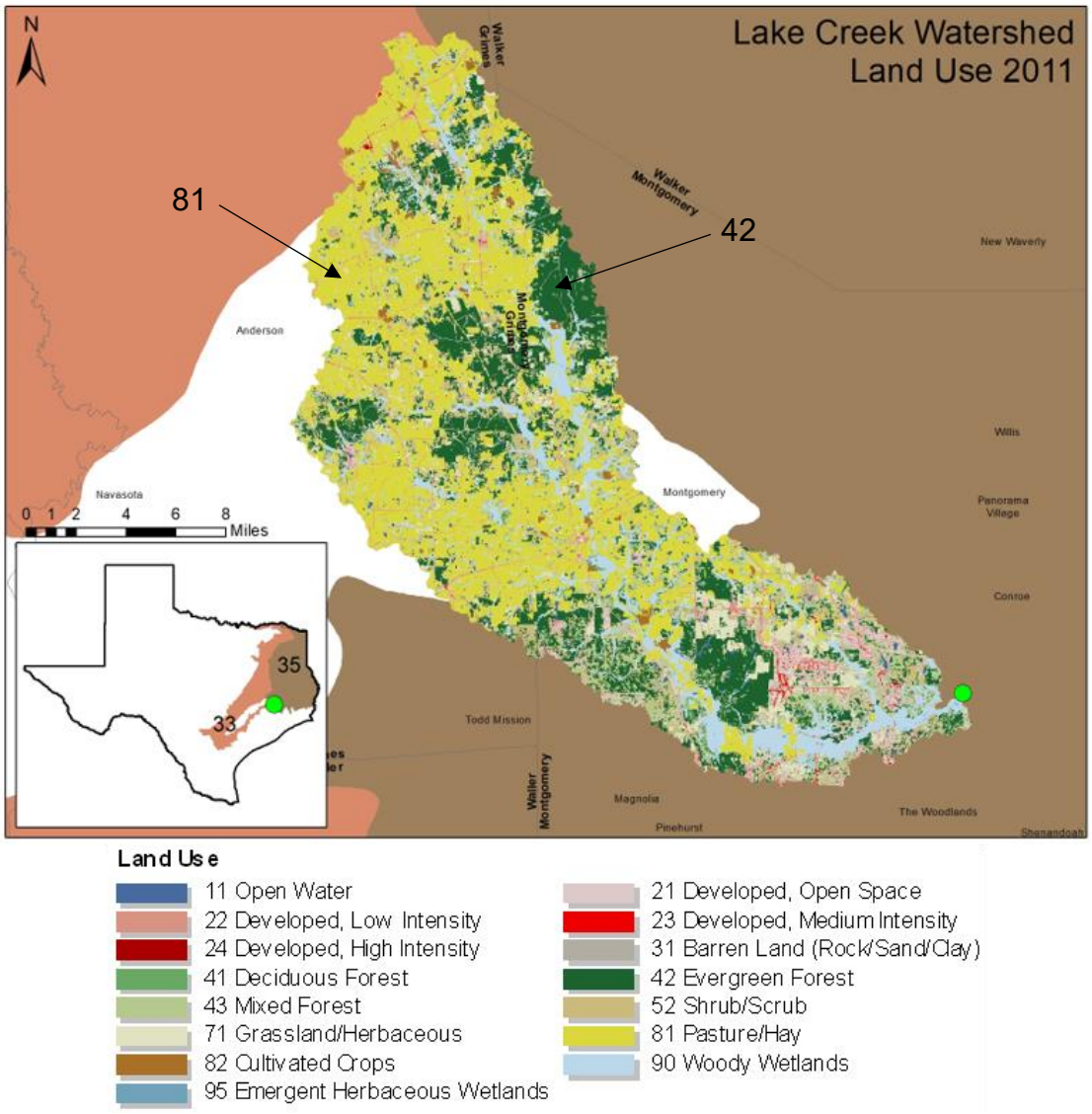

Figure 349. Map of Lake Creek watershed location and 2011 land use; pasture/hay and forest were the most common land uses.

Sampling Dates

Physical Habitat:	Station 11366: July 20, 1988; Station 11367: May 10, 2011; July 22, 2011; Station 17331: April 14, 2011; June 19, 2013; September 19, 2013
Water Quality:	139 sampling events (Stations 11366, 11367 and 17331)
Fish:	July 21, 1988; October 1, 1991; April 1, 1992; April 14, 2011; July 13, 2011; June 19, 2013; September 19, 2013

Benthic Invertebrates: Station 11366: July 20, 1988; Station 11367: May 10, 2011; July 22, 2011; Station 17331: April 14, 2011; July 13, 2011; June 19, 2013; September 19, 2013

Physical Characterization

Watershed and Land Use

Lake Creek lies within the San Jacinto River Basin. Sample site 11366 is located 2.99 km upstream of the West Fork of the San Jacinto River, north of The Woodlands in Montgomery County (Figure 349).

The Lake Creek watershed at site 11366 is approximately 850.14 sq km. The lower portion of the watershed and sections of the upper watershed lay within Level IV Ecoregion 35e, the Southern Tertiary Uplands. The remaining portion of the middle and upper watershed lay within Level IV Ecoregion 32b, the Southern Blackland/Fayette Prairie. The dominant land cover in the watershed is pasture/hay at 37.24% and is most concentrated within the portions of the watershed that lay within Ecoregion 32 (Homer et al. 2015; Figure 349 and Figure 350). The secondary land cover is forest at 28.39%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 8% and total cover for cultivated crops is 0.79%.

From 1992-2011 there was a 105.91 sq km decrease in forest and an 85.47 sq km decrease in pasture/hay. There was a 64.61 sq km increase in shrub and a 52.4 sq km increase in grassland (Figure 351).

There are 15 domestic wastewater outfalls (discharges < 1 million gallons per day) and one industrial wastewater outfall (discharges ≥ 1 million gallons per day) within the Lake Creek watershed. The domestic facilities are permitted to a golf course, industrial administrative offices, municipal utility districts, water and sewer utility companies, a private residence, and Richards ISD. The one industrial wastewater facility is permitted to Tenaska Roan's Prairie Partners, LLC (Tenaska Frontier Generating Station) which is an electric generating facility. Five of the domestic wastewater outfalls discharge directly into Lake Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Lake Creek was evaluated at three sites during six sampling events from 1988 to 2013. Lake Creek is a perennial stream that drains to the West Fork of the San Jacinto River below Lake Conroe. Habitat Quality Index scores are available for four sample events and indicate an intermediate to high aquatic life use rating (19-22). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 18 meters wide to greater than 20 meters. The riparian zone was generally dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 13% to 96%. The dominant stream substrate was sand, and the average percent of substrate gravel size or larger varied from 0% to 18%. Average percent instream cover was 12% to 89% and instream cover types include overhanging vegetation, woody debris, and gravel. Lake Creek ranged from 0.3-0.5

meters deep on average and 6-10 meters wide. Average stream bank slope ranged from 31-40 degrees. Stream flow at the site was measured at a minimum value of 0.4 cfs and a maximum of 7 cfs. Average stream bank erosion potential was 8%-38%. The deepest pool measured at Lake Creek was 2 meters. Number of riffles observed at the site varied from one to four, and total number of stream bends ranged from four to eight.

Water Quality

Water samples were collected at stations 11366, 11367 and 17331. Station 11366 was sampled 17 times between July 1988 and July 1999. Station 11367 was sampled 114 times from October 1981 through May 2020. Lastly, 8 sampling events occurred at station 17331 from October 2002 through August 2003. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen (except at station 17331), phosphorus (except at station 17331), total organic carbon, chloride, sulfate and chlorophyll-a. Continuous 24-hour data was recorded at stations 11366, 11367 and 17331.

Continuous flow data is available from USGS gage 08067900 (Figure 352). Discharge was recorded from September 2002 through January 2005; median flow was 37.75 cfs and flows ranged from 3.03 cfs to 15,700 cfs. Flows increase sharply with rain events throughout the year and 8.3 percent of daily mean flows were greater than 1000 cfs. Extremely high flows of up to 15,700 cfs were recorded on November 6 and 7, 2002. These high flows were related to heavy rainfall totals between 4 and 10 inches in southeast Texas. Data have been log transformed to better visualize flow patterns.

Biological Characterization

Fish

Thirty-four species (13 families) were collected over the course of the seven sampling events. Centrarchidae and Cyprinidae tied for having the most species with eight. Blacktail Shiner was collected in each sample and was the most abundant species in each collection except the one in 1991 where Bullhead Minnow outnumbered it. Other species represented in each sample were Blackstripe Topminnow, Western Mosquitofish, Bluegill, and Longear Sunfish. Every fish collection, except the 1988 one (which rated as exceptional), yielded a high aquatic life use rating. Trends noted over time include a general decline in cyprinid and benthic invertivore species richness and an increase in sunfish species richness. Cyprinid species that were only collected between 1988 and 1992 were Emerald and Ribbon shiners; however, both were rare (one and two individuals, respectively). Freckled Madtom *Noturus nocturnus*, Slough Darter, and Bigscale Logperch (all benthic invertivore species) were also only collected during the early time period. Sunfish species that were added during the latter time period were Green Sunfish and Redear Sunfish. Other fish species unique to the early collections include: Freshwater Drum, Alligator Gar *Atractosteus spatula*, River Carpsucker, Channel Catfish, and Flathead Catfish. Each of these species were represented by only one individual and/or in one collection.

Benthic Macroinvertebrates

A total of 2,110 individuals representing 23 orders of macroinvertebrates were collected in the seven sample events at Lake Creek between 1988 and 2013 (Appendix E). Ephemeroptera was the most abundant order, representing 36% of the total number of individuals collected. Other orders that each accounted for 10% or greater of the total number of individuals collected were Amphipoda (12%), Coleoptera (10.3%), and Diptera (10.1%). Trichoptera and Pelecypoda were the only other taxa representing greater than 5% of the individuals in the seven collections combined.

Considering all seven samples collectively, the functional organization of the Lake Creek macroinvertebrate assemblage was dominated by collector-gatherers, scrapers, and predators, which accounted for 49.7%, 17.3%, and 12.8%, respectively, of the total number of individuals collected. Filtering collectors (11.8%) and shredders (8.4%) were present, but in lower relative abundance. This functional structure was relatively consistent across individual sample dates.

A total of 21 EPT taxa were collected when all sites and dates are considered collectively. The EPT for individual samples varied from a minimum of two for both samples collected in 2011 at site 11367 to a maximum of 16 for the Surber sample collected July 20, 1988 at site 11366. These EPT values range from just above the 5th percentile to above the 75th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The variability of the EPT is likely related to variable flow conditions and the sensitivity of the EPT taxa to low flow conditions.

The biotic index value for the collective Lake Creek benthic assemblage (6) falls between the 75th and 95th percentile for all biotic index values in the ecoregion aggregate, indicating a tolerant macroinvertebrate assemblage. Three of the four highest biotic index values were obtained for samples collected in 2011 and coincide with the lowest EPT values, likely reflecting low flow conditions in 2011.

The BIBI score for the 1988 Surber sample collected at site 11366 falls in the range which indicates an exceptional aquatic life use. The Ecoregions 33 and 35 BIBI scores for the six RBP samples collected in 2011 and 2013 ranged from limited to high aquatic life use with an average that falls in the intermediate aquatic life use category. The RBP samples that scored in the high ALU category were collected in April 2011 and June 2013 which coincides with the second and third highest EPT values and the second and third lowest biotic index values. The sample dates also coincide with periods of relatively normal flow and good dissolved oxygen levels. Conversely, the May 2011 sample (which was collected during lower than normal flow conditions (0.8 cfs) and low dissolved oxygen) had the lowest RBP IBI score (21) and associated limited aquatic life use, the highest biotic index value, and lowest EPT. These results reflect the response of the assemblage to varying flow conditions.

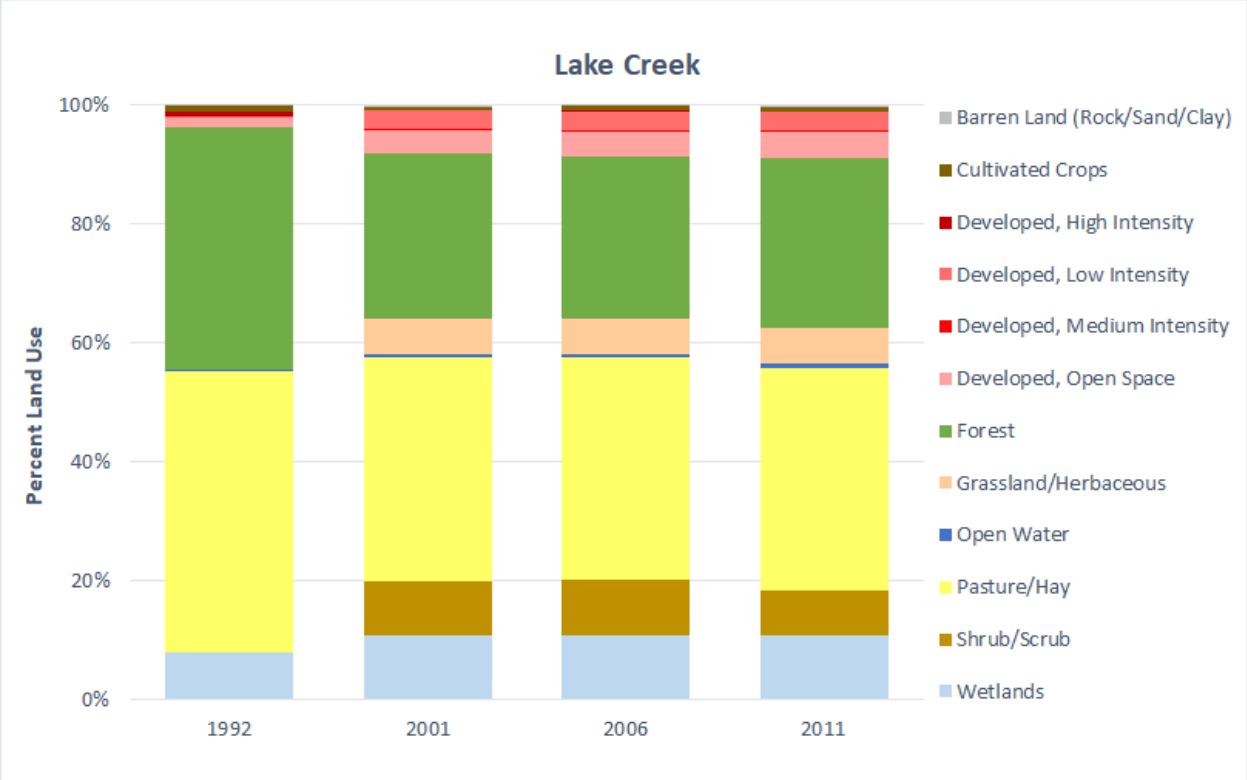

Figure 350. Percent land use in the Lake Creek watershed from 1992-2011.

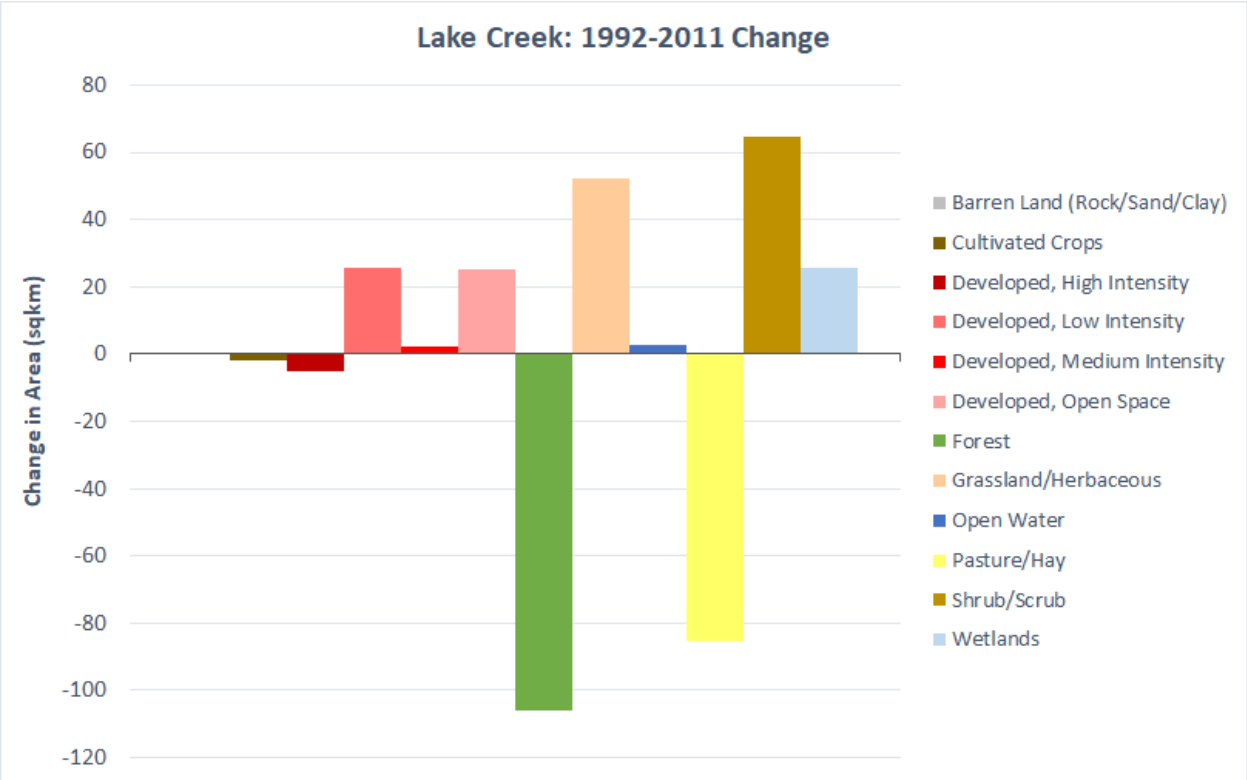

Figure 351. Land use change in area (sq km) from 1992-2011 for the Lake Creek watershed.

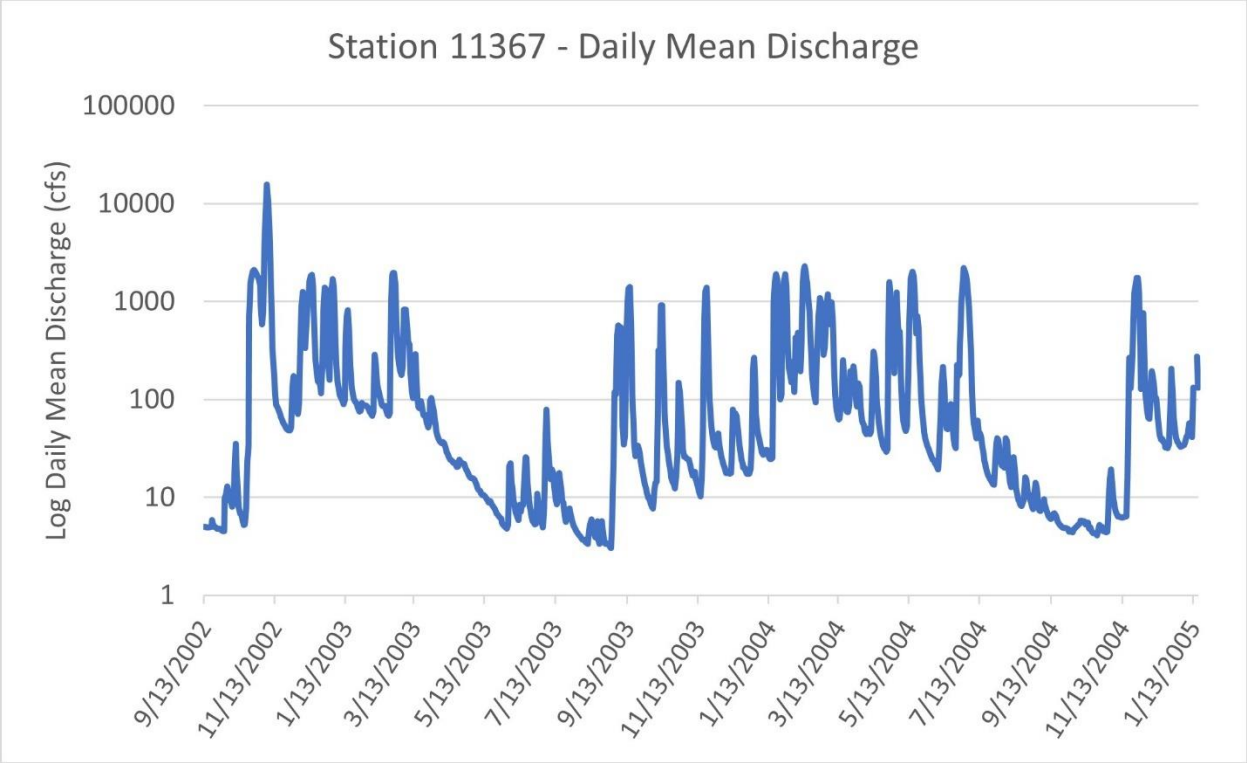

Figure 352. Log transformed daily mean discharge for Lake Creek at station 11367.

LITTLE CYPRESS BAYOU

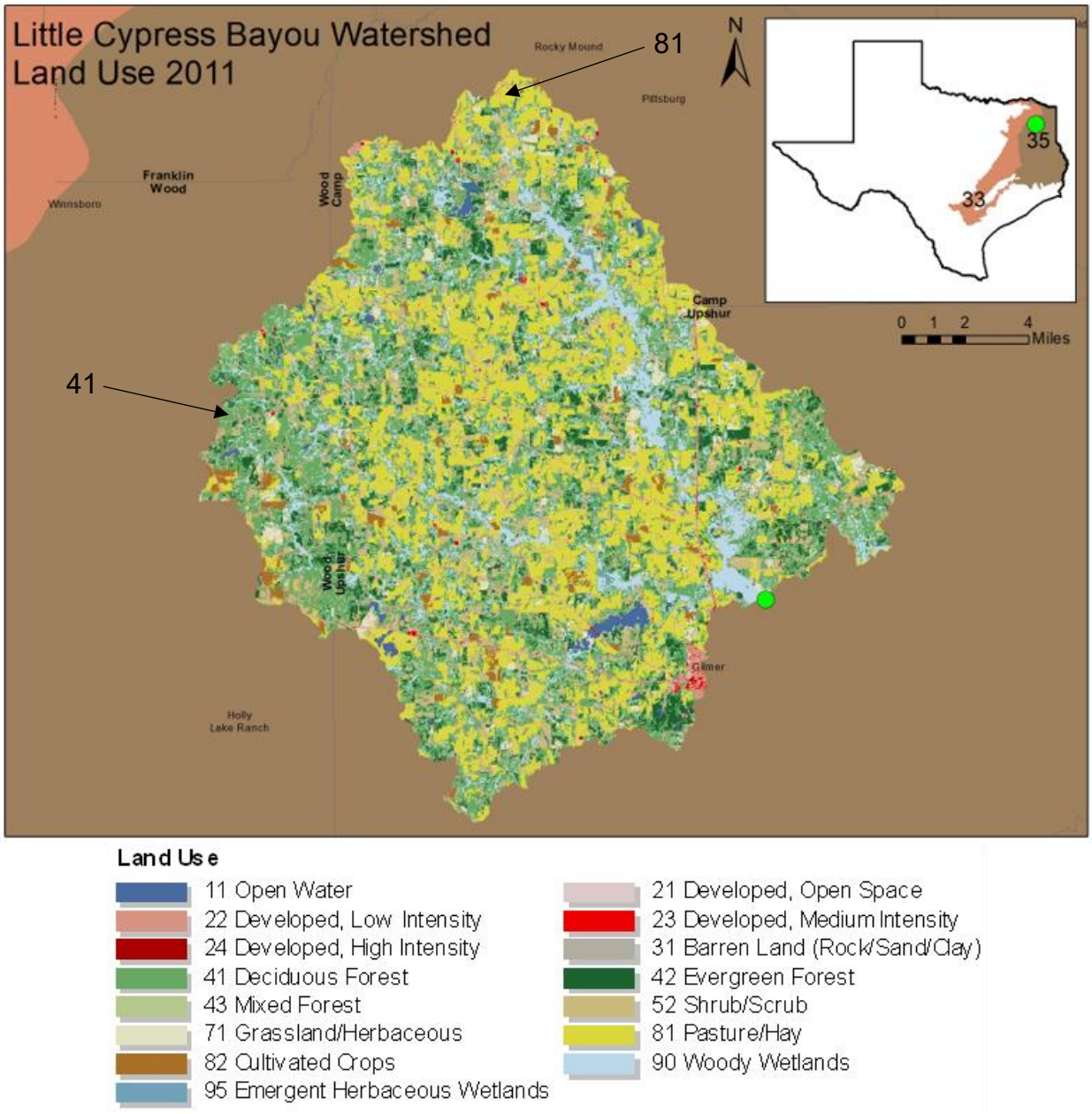

Figure 353. Map of Little Cypress Bayou watershed location and 2011 land use; forest and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	August 30, 1989; July 16, 2004; August 11, 2004; August 17, 2004
Water Quality:	22 sampling events
Fish:	August 31, 1989; July 16, 2004; August 11, 2004; August 17, 2004
Benthic Invertebrates:	August 30, 1989; July 16, 2004; August 11, 2004; August 17, 2004

Physical Characterization

Watershed and Land Use

Little Cypress Bayou lies within the Cypress Creek Basin. Sample site 10335 is located at SH 155 northeast of Gilmer in Upshur County (Figure 353).

The Little Cypress Bayou watershed at site 10335 is approximately 730.49 sq km. The entire watershed lies within Level IV Ecoregion 35a, the Tertiary Uplands. The dominant land cover in the watershed is forest at 40% and is present throughout the watershed (Homer et al. 2015; Figure 353 and Figure 354). Pasture/hay is the secondary land cover encompassing 27.89%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 6.18% and total cover for cultivated crops is 1.72%.

From 1992-2011 there was a 98.7 sq km decrease in forest and a 68.29 sq km decrease in pasture/hay. There was a 74.73 sq km increase in shrub and a 36.68 sq km increase in wetlands (Figure 355).

There are two domestic wastewater outfalls (discharges < 1 million gallons per day) and one industrial wastewater outfall (discharges ≥ 1 million gallons per day) within the Little Cypress Bayou watershed. One domestic facility is permitted to Union Hill ISD and the other to Harmony ISD. The industrial wastewater facility is permitted to Luminant Mining Co, LLC, a coal mining company. None of these facilities discharge directly into Little Cypress Bayou.

In Channel and Riparian Physical Habitat

Physical habitat for Little Cypress Bayou was evaluated during four sampling events from 1989 to 2004. Little Cypress Bayou is a perennial stream that drains to Big Cypress Creek below Lake O' the Pines east of Jefferson. Habitat Quality Index scores are available for three sample events and indicate an intermediate to high aquatic life use rating (17.5-21). Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters for all sampling events. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover ranged from 56% to 98%. The dominant stream substrate was sand, and the average percent of substrate gravel size or larger varied from 0% to 2%. Average percent instream cover was 28% to 38% and instream cover types include overhanging vegetation, woody debris, and root mats. Little Cypress Bayou ranged from 0.2-0.6 meters deep on average and 5-8 meters wide. Average stream bank slope ranged from 25-35 degrees. Stream flow at the site was measured at a minimum value of 1 cfs and a maximum of 14.7 cfs. Average stream bank erosion potential was 53%-79%. The deepest pool measured at Little Cypress Bayou was 1.3 meters. Number of riffles observed at the site varied from zero to four, and total number of stream bends ranged from three to eight.

Water Quality

Water samples were collected at station 10335 over 22 sampling events from August 1989 through July 2005. Parameters measured included temperature, flow, transparency, specific

conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*. Twenty-four-hour data were collected at this station.

Biological Characterization

Fish

Forty-six species (11 families) were collected over the course of the four sampling events. The most species rich family was Percidae with 11 species. Ribbon Shiner was the most abundant species in each collection. The aquatic life use (based upon the fish assemblage) increased from high to exceptional between 1989 and 2004. The metrics contributing to this increase were number of intolerant species and the proportion of individuals exhibiting a disease or other anomaly. Three intolerant fish species (Tadpole Madtom, Dusky Darter, and Cypress Darter *Etheostoma proeliare*) were collected in 1989 (metric score of 3). These same three species, plus five more (Brook Silverside, Goldstripe Darter *E. parvipinne*, Bigscale Logperch, Blackside Darter *Percina maculata*, and Freckled Madtom), were collected in 2004 (metric score of 5). No disease or anomalies were detected in 2014 (metric score of 5), in contrast to 1.3% of the individuals harboring some sort of anomaly in 1989 (metric score of 1).

Benthic Macroinvertebrates

Considering all four samples collected at Little Cypress Bayou in 1989 and 2004, a total of 1,880 individuals representing 14 orders of macroinvertebrates were collected (Appendix E). Trichoptera, Coleoptera, and Diptera were the most abundant orders, representing 31.7%, 15.4%, and 12.4%, respectively, of the total number of individuals collected. Other orders that each accounted for 5% or greater of the total number of individuals collected were Ephemeroptera (11.4%), Isopoda (9.2%), Pelecypoda (6.5%), and Oligochaeta (5.5%).

Considering all four samples collectively, the functional organization of the Little Cypress Bayou macroinvertebrate assemblage was dominated by filtering collectors and collector gatherers which accounted for 38.8% and 29.3%, respectively, of the total number of individuals collected. Scrapers (12.6%), predators (12.1%), and shredders (7.2%) were present, but in lower relative abundance. This functional structure was relatively consistent across individual sample dates with the exception of the August 2004 collection when collector gatherers and predators were the dominant functional groups.

A total of 14 EPT taxa were collected when all sites and dates are considered collectively. The EPT for individual samples varied from four for the August 11, 2004 sample to 11 for the Surber sample collected in August 1989. These EPT values fall between the 25th percentile and the 75th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35.

The biotic index value for the collective Little Cypress Bayou benthic assemblage (6) falls between the 75th and the 95th percentile for all biotic index values in the ecoregion aggregate, indicating a moderately tolerant macroinvertebrate assemblage. The highest biotic index value

for the four samples was for the August 1989 sample (6.2). The three samples collected in 2004 had lower biotic index values (average 4.7), perhaps reflecting less harsh conditions in 2004.

The BIBI score for the August 1989 Surber sample falls in the range which indicates an exceptional aquatic life use. The Ecoregions 33 and 35 BIBI scores for the July 16, 2004 and August 17, 2004 RBP samples fall in the range indicating a high aquatic life use, while the August 11, 2004 RBP sample falls in the intermediate aquatic life use category. These results indicate relative constancy of biotic integrity over the 15-year interval between 1989 and 2004.

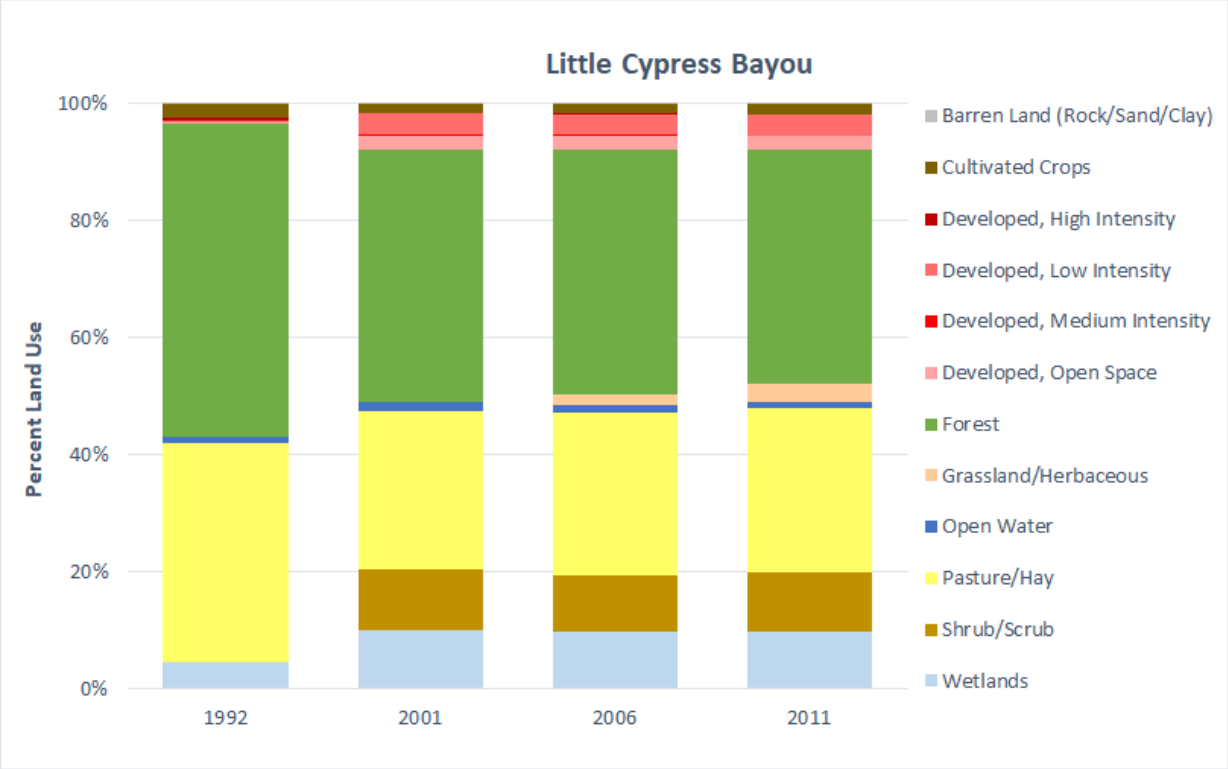

Figure 354. Percent land use in the Little Cypress Bayou watershed from 1992-2011.

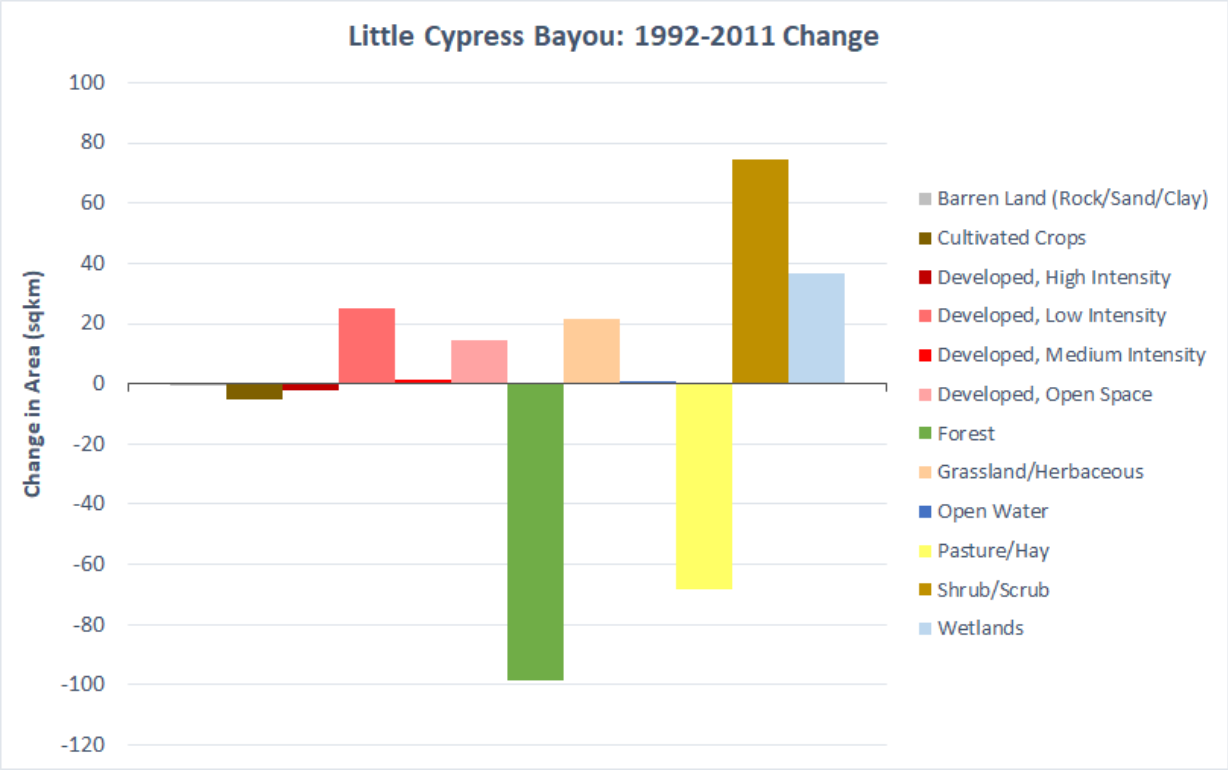

Figure 355. Land use change in area (sq km) from 1992-2011 for the Little Cypress Bayou watershed.

LITTLE PINE ISLAND BAYOU

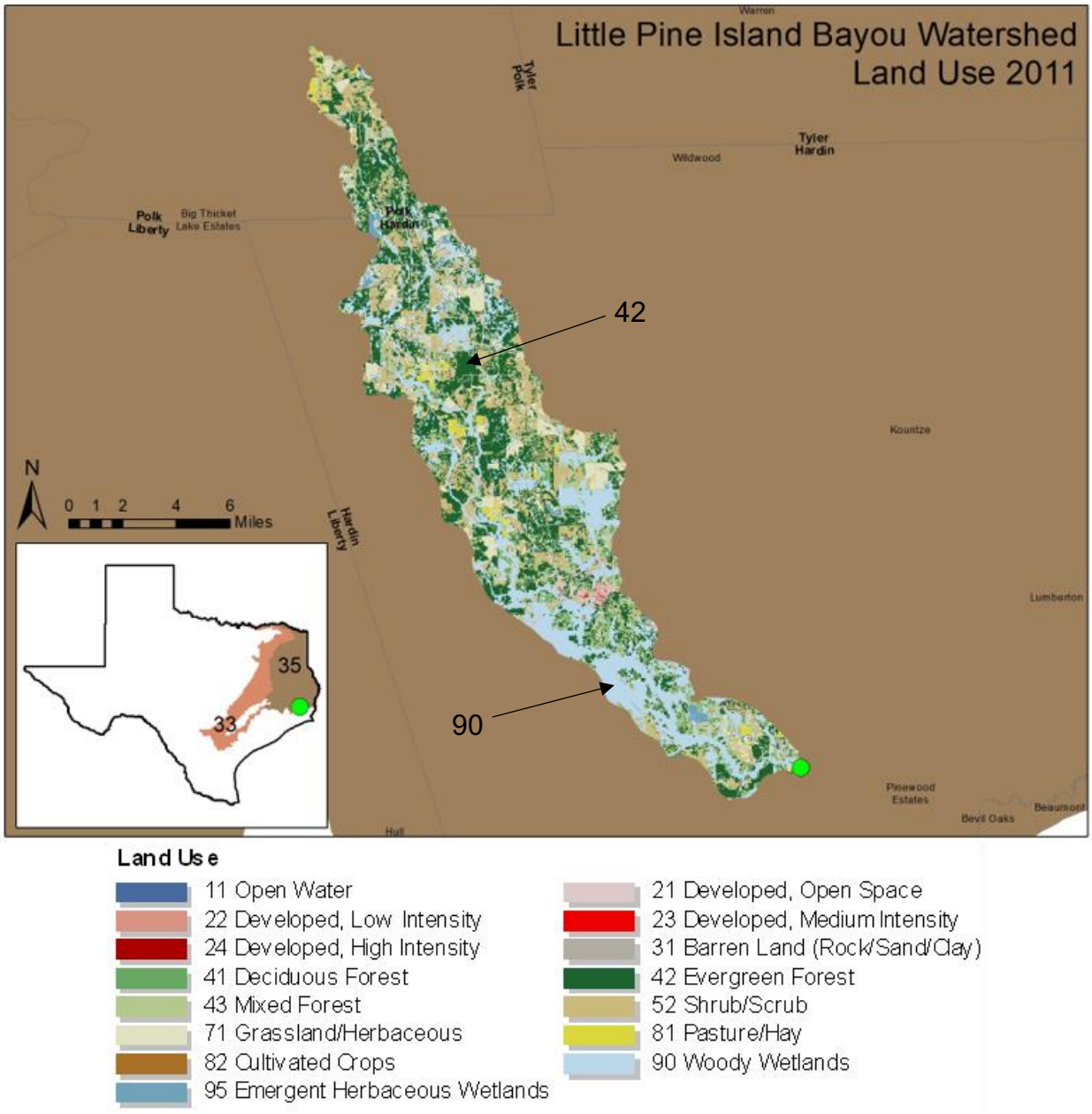

Figure 356. Map of Little Pine Island Bayou watershed location and 2011 land use; forest and wetland were the most common land uses.

Sampling Dates

Physical Habitat:	May 14, 2008; September 23, 2010
Water Quality:	116 sampling events
Fish:	May 14, 2008; September 23, 2010
Benthic Invertebrates:	May 14, 2008; September 23, 2010

Physical Characterization

Watershed and Land Use

Little Pine Island Bayou lies within the Neches River Basin. Sample site 15346 is located at SH 326, 5.68 km north of Sour Lake in Hardin County (Figure 356).

The Little Pine Island Bayou watershed at site 15346 is approximately 319.25 sq km. The entire watershed lies within Level IV Ecoregion 35f, the Flatwoods. The dominant land cover in the watershed is forest at 42.6% and is present throughout the watershed (Homer et al. 2015; Figure 356 and Figure 357). Wetlands is the secondary land cover encompassing 27.25%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 4.42% and total cover for cultivated crops is 0.01%.

From 1992-2011 there was a 157.18 sq km decrease in forest and an 11.36 sq km decrease in pasture/hay. There was an 85.12 sq km increase in wetlands and a 54.37 sq km increase in shrub (Figure 358).

There are no permitted wastewater outfalls within the Little Pine Island Bayou watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Little Pine Island Bayou was evaluated during two sampling events from 2008 to 2010. Little Pine Island Bayou is a perennial stream that drains to Pine Island Bayou northwest of Beaumont. Habitat Quality Index scores are available for both sample events and indicate a high aquatic life use rating (19.5-21.5). Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was generally dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 91% to 94%. The dominant stream substrate was silt and clay, and the average percent of substrate gravel size or larger was 0%. Average percent instream cover was 49% to 60% and instream cover types include overhanging vegetation, leaf packs, snags, woody debris, and root mats. Little Pine Island Bayou ranged from 0.1-0.2 meters deep on average and 4 meters wide. Average stream bank slope ranged from 22-23 degrees. Stream flow at the site was measured at a minimum value of 0.4 cfs and a maximum of 1.1 cfs. Average stream bank erosion potential was 21%-48%. The deepest pool measured at Little Pine Island Bayou was 0.6 meters. Number of riffles observed at the site varied from one to four, and total number of stream bends ranged from two to four.

Water Quality

Water samples were collected at station 15346 over 116 sampling events from January 1997 through October 2019. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*. Twenty-four-hour data were collected at this station.

Biological Characterization

Fish

Twenty-one species (eight families) were collected between the two sampling events. Cyprinidae and Centrarchidae were the most species rich families with six and five, respectively. Western Mosquitofish was the most abundant species. The aquatic life use scored as high and intermediate, based upon the 2008 and 2010 fish collections, respectively. When the coefficient of variability was applied, the ratings elevated to exceptional and high. The 2010 collection rated lower because of reduced overall species richness, subsequent lower numbers of benthic invertivore and intolerant species, and a much lower percentage of piscivorous individuals. Two species identified as being both benthic invertivores and intolerant, Tadpole Madtom and Dusky Darter, were collected in 2008, although in relatively low numbers. Neither species were collected in 2010; however, Cypress Darter (also a benthic invertivore and intolerant species) was collected in fairly abundant numbers. Slough Darter, another benthic invertivore species, was only collected in 2008. The main reason for the lower metric score for piscivores was the difference in number of Warmouth collected. Species unique to the 2008 collection were Blacktail Shiner, Ribbon Shiner, Bluegill, and Largemouth Bass. Golden Shiner and Emerald Shiner were only collected in 2010. The shift in presence and absence of these species is not especially indicative of major changes in water quality or habitat.

Benthic Macroinvertebrates

Considering both RBP samples collected at Little Pine Island Bayou, a total of 422 individuals representing 14 orders of macroinvertebrates were collected (Appendix E). Amphipoda, Diptera, and Ephemeroptera were the most abundant orders, representing 38.4%, 14.9%, and 12%, respectively, of the total number of individuals collected. Decapoda, Trichoptera, and Isopoda were present, but relatively less common in the collections with each order accounting for between 1% and 5% of the total number of individuals collected.

Considering both samples collectively, the functional organization of the Little Pine Island Bayou macroinvertebrate assemblage is dominated by collector gatherers and shredders which accounted for 40.8% and 22.1%, respectively, of the total number of individuals collected. Predators (12.7%), scrapers (10.7%), and filtering collectors (12.3%) were present, but in lower relative abundance. This functional organization was relatively consistent across dates, except that the scrapers were more abundant than the shredders in the September 2010 sample.

A total of seven EPT taxa were collected when both samples are considered collectively. The EPT for individual samples varied from three for the May 2008 sample to five for the sample collected in September 2010. These EPT values fall between the 5th percentile and the 50th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35.

The biotic index value for the collective Little Cypress Bayou benthic assemblage (4.7) falls between the 25th and the 50th percentile for all biotic index values in the ecoregion aggregate,

indicating a moderately tolerant macroinvertebrate assemblage. The biotic index value was 5 for the May 2008 sample and 5.5 for the sample collected in September 2010.

The Ecoregions 33 and 35 BIBI score for both the May 2008 sample and the September 2010 sample fell in the range indicating an intermediate aquatic life use.

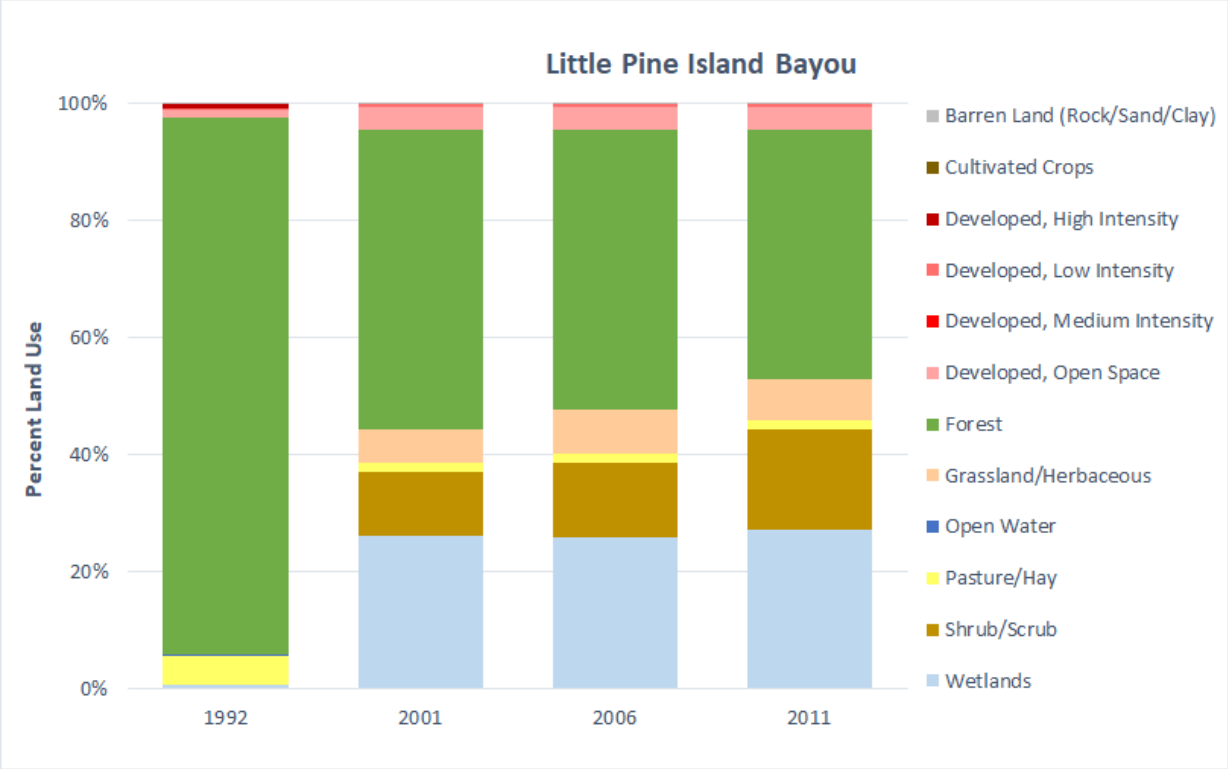

Figure 357. Percent land use in the Little Pine Island Bayou watershed from 1992-2011.

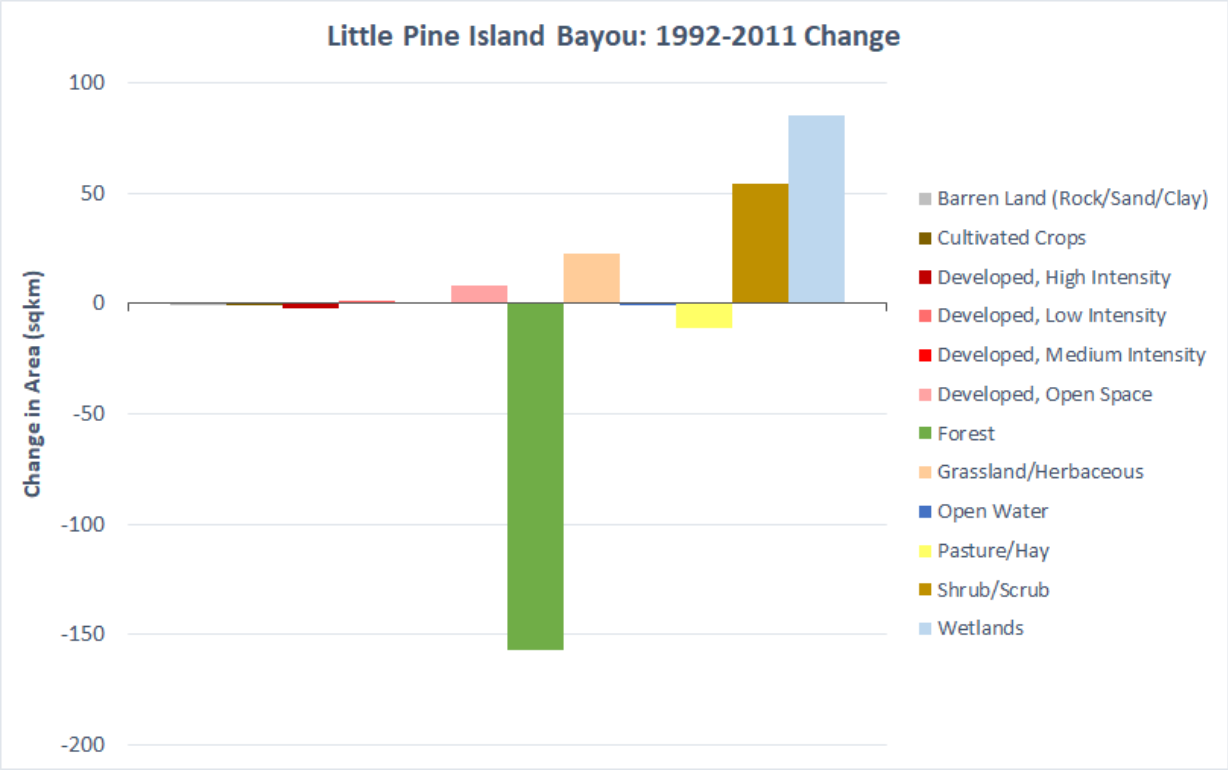

Figure 358. Land use change in area (sq km) from 1992-2011 for the Little Pine Island Bayou watershed.

PEACH CREEK

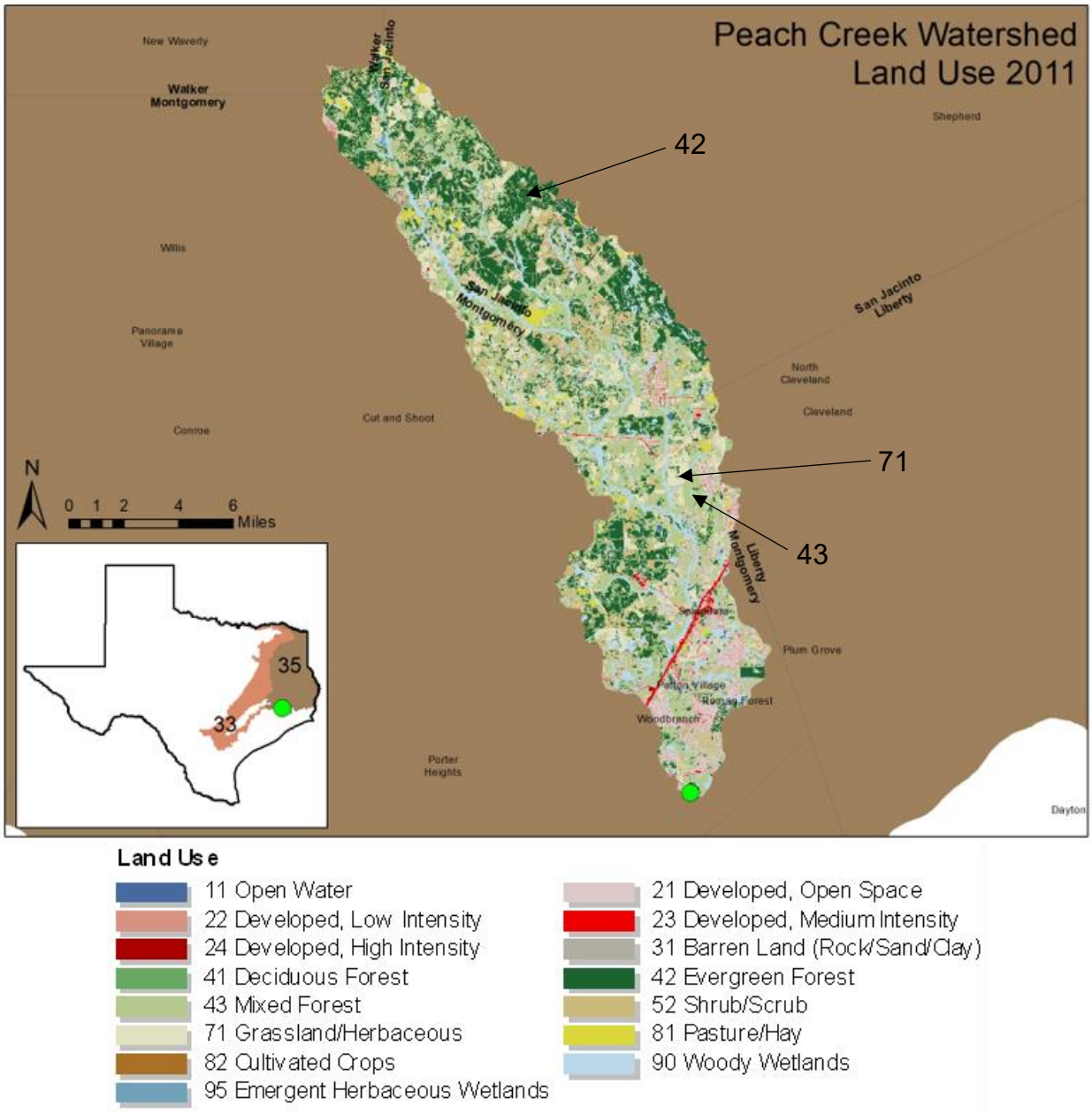

Figure 359. Map of Peach Creek watershed location and 2011 land use; forest and grassland/herbaceous were the most common land uses.

Sampling Dates

Physical Habitat: June 19, 2002; September 12, 2002; April 1, 2004; May 5, 2005; May 15, 2006; June 13, 2007; June 25, 2008; June 17, 2009; April 6, 2010; May 5, 2011; May 9, 2012; April 9, 2013; August 14, 2013; June 26, 2014; August 26, 2014; July 20, 2016; April 26, 2017; May 2, 2018; July 18, 2018

Water Quality:	78 sampling events
Fish:	June 17, 1998; June 19, 2002; September 12, 2002; May 22, 2003; August 7, 2003; April 12, 2004; August 17, 2004; May 5, 2005; July 22, 2005; May 15, 2006; August 24, 2006; June 17, 2007; September 26, 2007; June 25, 2008; June 17, 2009; August 18, 2009; April 6, 2010; August 17, 2010; May 11, 2011; July 12, 2011; August 7, 2012; April 9, 2013; August 14, 2013; July 14, 2015; July 20, 2016; April 27, 2017
Benthic Invertebrates:	June 19, 2002; September 12, 2002; May 22, 2003; August 7, 2003; April 1, 2004; August 17, 2004; May 5, 2005; July 22, 2005; May 15, 2006; August 24, 2006; June 13, 2007; September 26, 2007; June 25, 2008; June 17, 2009; August 18, 2009; April 5, 2010; August 17, 2010; May 4, 2011; July 12, 2011; May 9, 2012; August 7, 2012; April 8, 2013; August 13, 2013; June 24, 2014; August 28, 2014; July 14, 2015; July 20, 2016; April 26, 2017

Physical Characterization

Watershed and Land Use

Peach Creek lies within the San Jacinto River Basin. Sample site 17746 is located in Lake Houston State Park, 1.09 km downstream of FM 1485 in Montgomery County (Figure 359).

The Peach Creek watershed at site 17746 is approximately 399.89 sq km. The lower half of the watershed lies within Level IV Ecoregion 35f, the Flatwoods. The upper half of the watershed lies within Level IV Ecoregion 35e, the Southern Tertiary Uplands. The dominant land cover in the watershed is forest at 50.83% and is present throughout the watershed (Homer et al. 2015; Figure 359 and Figure 360). Grassland is the secondary land cover encompassing 12.3%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 12.33% and total cover for cultivated crops is 0.01%.

From 1992-2011 there was a 111.26 sq km decrease in forest and a 34.67 sq km decrease in pasture/hay. There was a 49.19 sq km increase in grassland and a 45.81 sq km increase in shrub (Figure 361).

There are nine domestic wastewater outfalls (discharges < 1 million gallons per day) and one industrial wastewater outfall (discharges ≥ 1 million gallons per day) within the Peach Creek watershed. One domestic facility is permitted to Splendora ISD, one permitted to Crystal Springs Water Utility Company, three permitted to the cities of Patton Village, Splendora, and Woodbranch Village, and four others permitted to municipal utility districts. The industrial wastewater facility is permitted to Bradbury Development Limited, a residential development company. Three of the domestic facilities discharge directly into Peach Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Peach Creek was evaluated at one site during 19 sampling events from 2002 to 2018. Peach Creek is a perennial stream that drains to Caney Creek before the confluence with Lake Houston. Habitat Quality Index scores are available for 18 sample events and indicate an intermediate to high aquatic life use rating (16-22). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 16 meters wide to greater than 20 meters. The riparian zone was generally dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 15% to 92%. The dominant stream substrate was sand, and the average percent of substrate gravel size or larger varied from 6% to 45%. Average percent instream cover was 6% to 28% and instream cover types include overhanging vegetation, leaf packs, macrophytes, undercut banks, snags, woody debris, root mats, and gravel. Peach Creek ranged from 0.1-0.3 meters deep on average and 6-20 meters wide. Average stream bank slope ranged from 30-60 degrees. Stream flow at the site was measured at a minimum value of 2.5 cfs and a maximum of 44 cfs. Average stream bank erosion potential was 6%-64%. The deepest pool measured at Peach Creek was 1.5 meters. Number of riffles observed at the site varied from zero to five, and total number of stream bends ranged from one to seven.

Water Quality

Water samples were collected at station 17746 over 78 sampling events from June 2002 through October 2019. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*. Twenty-four-hour data were collected at this station.

Biological Characterization

Fish

A total of 44 species (13 families) were collected over the 27 fish sampling events. Species richness ranged from 11 to 23 and averaged 17 species per sampling event. The richest family was Cyprinidae with 13 species represented. Blacktail Shiner, Longear Sunfish, and Blacktail Redhorse *Moxostoma poecilurum* were collected during every event. Blacktail Shiner was the most abundant fish in all but one collection where Longear Sunfish slightly outnumbered it. Four species were only collected once and in each case were represented by one individual. These species were Cypress Darter, Southern Brook Lamprey *Ichthyomyzon gagei*, Blue Catfish *Ictalurus furcatus*, and Golden Shiner.

Of the 27 fish collections, four rated as having an exceptional aquatic life use (May 2005, June 2008, August 2009, and July 12, 2011), 21 high, and two intermediate (April 2004 and June 2009). When the coefficient of variability is applied four assemblages rating as high rise to exceptional (May 2005, August 2006, September 2007, and August 2010) and one of the intermediate ratings rise to high (April 2004).

Benthic Macroinvertebrates

Considering the 28 RBP samples collectively, a total of 6096 individuals representing 101 taxa from 16 orders of macroinvertebrates were collected from Peach Creek (Appendix E). The Ephemeroptera, Trichoptera, Coleoptera, Odonata, and Diptera were the most commonly collected orders, collectively accounting for 92.2 percent of the total number of individuals collected. The Hemiptera, Decapoda, and Veneroida were the only other orders which comprised at least one percent of the collections.

The Ecoregions 33 and 35 BIBIs for the RBP samples fell in the either the exceptional aquatic life use category (September 2002, April 2004, May 2005, July 2005, May 2006, August 2006, June 2007, September 2007, June 2008, August 2009) or the high aquatic life use category (June 2002, May 2003, August 2003, August 2004, June 2009, April 2010, August 2010, May 2011, July 2011, May 2012, August 2012, April 2013, August 2013, June 2014, August 2014, July 2015, July 2016, April 2017).

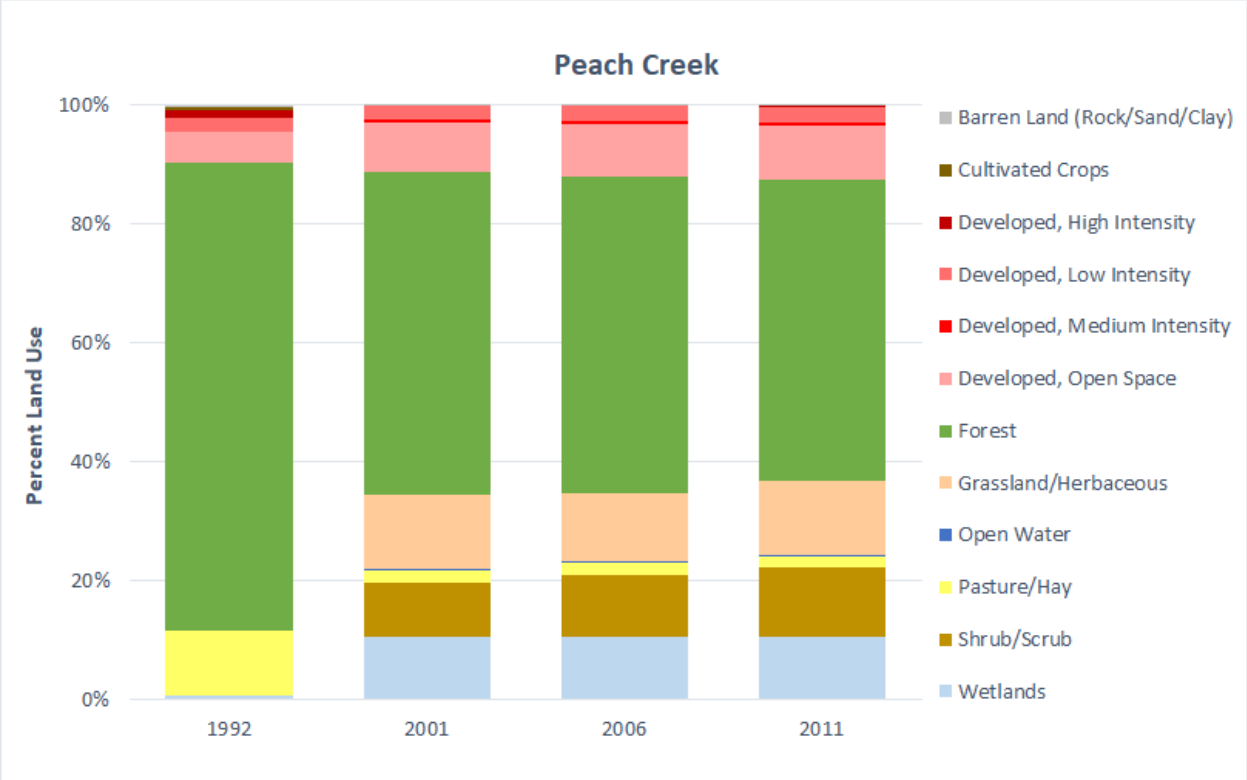

Figure 360. Percent land use in the Peach Creek watershed from 1992-2011.

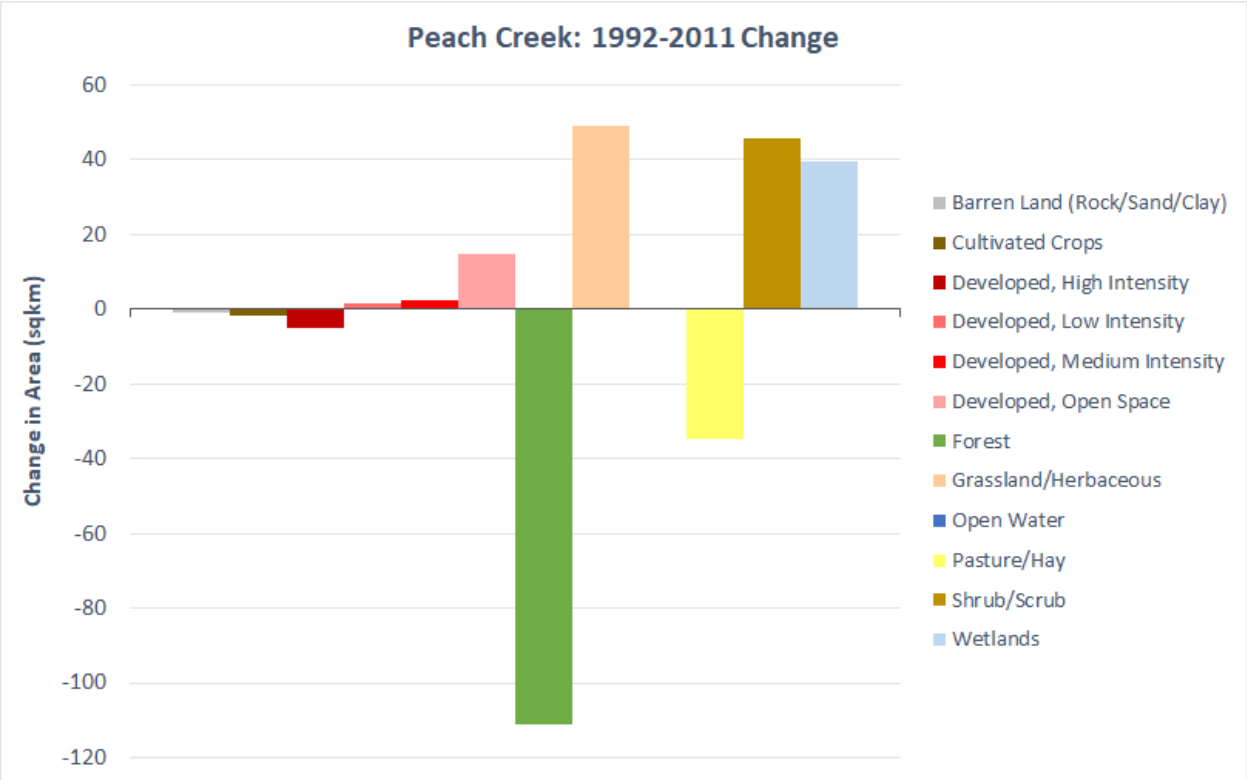

Figure 361. Land use change in area (sq km) from 1992-2011 for the Peach Creek watershed.

PINEY CREEK

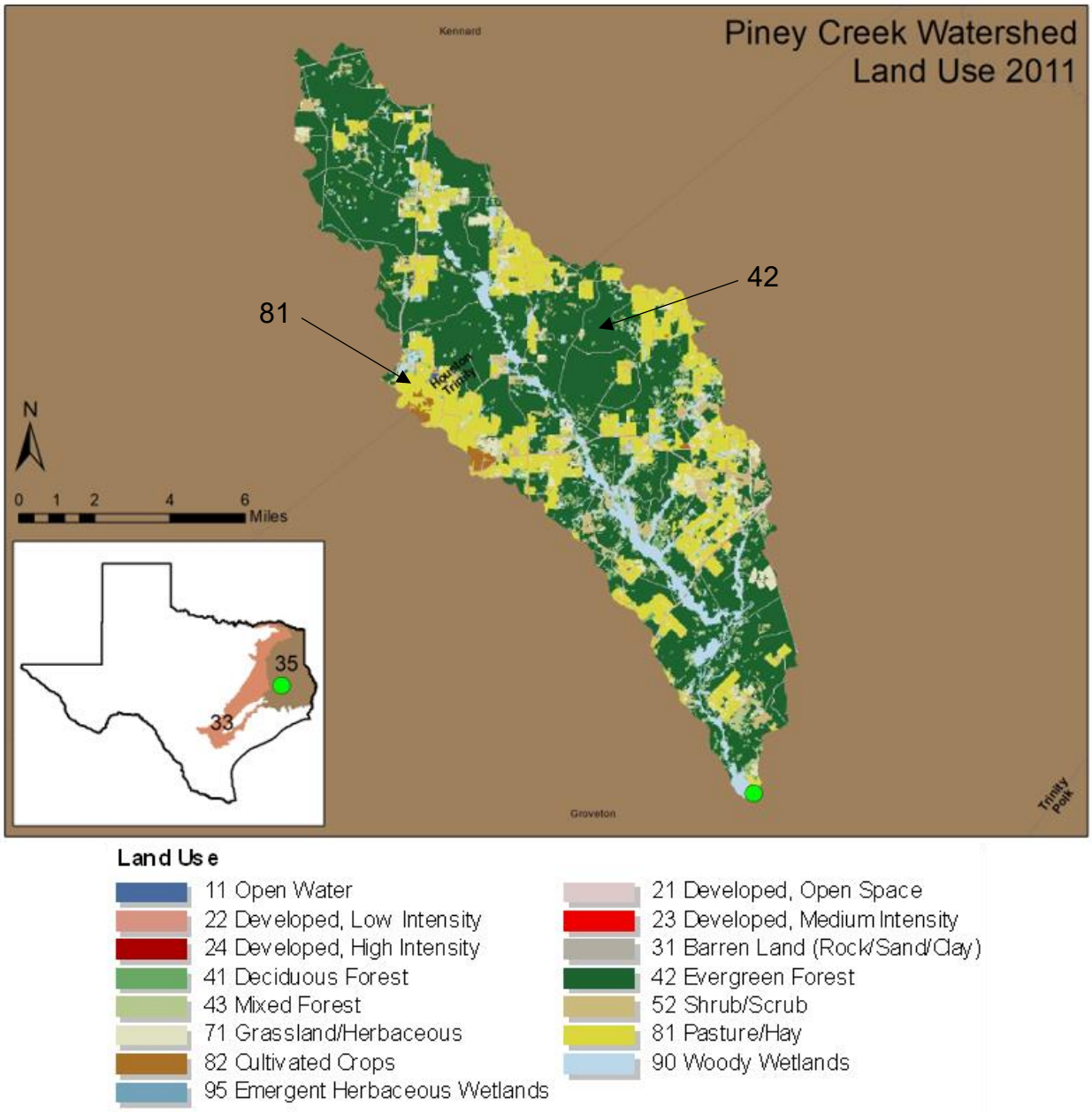

Figure 362. Map of Piney Creek watershed location and 2011 land use; forest and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	September 14, 1989; June 14, 2017; July 18, 2018
Water Quality:	22 sampling events
Fish:	September 14, 1989; June 14, 2017; July 26, 2017
Benthic Invertebrates:	September 14, 1989; June 14, 2017; July 26, 2017

Physical Characterization

Watershed and Land Use

Piney Creek lies within the Neches River Basin. Sample site 10530 is located at FM 2262, 6.9 km east northeast of Groveton in Trinity County (Figure 362).

The Piney Creek watershed at site 10530 is approximately 251.71 sq km. The entire watershed lies within Level IV Ecoregion 35e, the Southern Tertiary Uplands. The dominant land cover in the watershed is forest at 59.25% and is present throughout the watershed (Homer et al. 2015; Figure 362 and Figure 363). Pasture/hay is the secondary land cover encompassing 18.29%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.66% and total cover for cultivated crops is 0.58%.

From 1992-2011 there was a 31.62 sq km decrease in forest and a 10.98 sq km decrease in pasture/hay. There was a 16.87 sq km increase in shrub and a 10.69 sq km increase in wetlands (Figure 364).

There are no permitted wastewater outfalls within the Piney Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Piney Creek was evaluated during three sampling events from 1989 to 2018. Piney Creek is a perennial stream that drains to the Neches River below Lake Palestine. Habitat Quality Index scores are available for two sample events and indicate a high aquatic life use rating (21-22.5). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 16 meters wide to greater than 20 meters. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover ranged from 85% to 93%. The dominant stream substrate was sand, and the average percent of substrate gravel size or larger varied from 14% to 32%. Average percent instream cover was 26% to 36% and instream cover types include overhanging vegetation, macrophytes, woody debris, and gravel. Piney Creek ranged from 0.1-0.3 meters deep on average and 4-6 meters wide. Average stream bank slope ranged from 26-42 degrees. Stream flow at the site was measured at a minimum value of 0.2 cfs and a maximum of 2 cfs. Average stream bank erosion potential was 43%-62%. The deepest pool measured at Piney Creek was 1.4 meters. Number of riffles observed at the site varied from one to four, and total number of stream bends ranged from four to seven.

Water Quality

Water samples were collected at station 10530 over 22 sampling events from September 1989 through September 2019. Parameters measured included temperature, flow, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*. A use attainability analysis study was conducted by TCEQ's Water Quality Standards team and sampling took place at three sites from 2018 through 2019.

Biological Characterization

Fish

Twenty-nine species (nine families) were collected over the course of the three sampling events. Centrarchidae and Cyprinidae were the most species rich families yielding nine and eight species, respectively. Western Mosquitofish was the most abundant species in 1989, whereas Redbreast Sunfish was in 2017. The 1989 fish assemblage received an aquatic life use rating of high. The 2017 collections showed a decline with ratings of limited and intermediate; however, when the coefficient of variability was applied each elevated to the next aquatic life use. Those metrics showing the greatest decline are number of native cyprinid species, number of benthic invertivore species, and percentage of individuals as non-native species. Seven native cyprinid species were collected in 1989 whereas only three were collected in 2017 (including one not found in 1989 - Redfin Shiner). Minnow species not collected in the recent collections include: Mississippi Silvery Minnow *Hybognathus nuchalis*, Golden Shiner, Blackspot Shiner, Weed Shiner, and Bullhead Minnow. Benthic invertivore species declined from four to two, with Slough Darter and Spotted Sucker not being present in the 2017 samples. No non-native species were detected in 1988; however, by 2017 27.5% of the individuals collected were non-native (Redbreast Sunfish). Six other species in addition to Redbreast Sunfish were unique to the 2017 samples. In most instances these species were represented by one individual (Blue Catfish, Redfin Shiner, Black Bullhead, and Flier), except for Warmouth (five individuals) and Redspotted Sunfish which was the second most abundant member of the fish assemblage.

Benthic Macroinvertebrates

A total of 1,790 individuals representing 13 orders of macroinvertebrates were collected in the three samples from Piney Creek (Appendix E). Trichoptera, Diptera, Coleoptera, and Ephemeroptera were the most abundant orders, representing 42.5%, 20.7%, 13.2%, and 9.7%, respectively, of the total number of individuals collected. Oligochaeta (7.8%) and Pelecypoda (3.4%) were the only other orders which accounted for greater than 1% of the total number of individuals collected.

The functional organization of the Piney Creek macroinvertebrate assemblage was dominated by filtering collectors which accounted for 46.7% of the total number of individuals collected. The collector gatherers (23.7%), scrapers (15.7%), predators (11.5%) and shredders (2.4%) functional groups were represented at lower relative abundance.

The EPT ranged from a minimum of four to a maximum of 10 with a median value of six, which falls between the 25th and 50th percentile of all EPT values for least disturbed streams sampled in the aggregated ecoregion. The biotic index ranged from a minimum of 4.6 to a maximum of 5.9. The median value of the biotic index, 5.2, falls between the 50th and 75th percentile of all biotic index values for least disturbed streams sampled in the aggregated ecoregion, indicating a moderately tolerant macroinvertebrate assemblage.

The BIBI score for the 1989 Surber sample falls in the range indicating an exceptional aquatic life use. The exceptional BIBI score is a result of maximum scores for the metrics total number of taxa, number of Diptera taxa, number of intolerant taxa, percent EPT, percent tolerant, and percent gatherers, and a low relative dominance of the three most abundant taxa in the Surber sample. Results for the Ecoregions 33 and 35 BIBI for the two RBP samples collected in 2017 were relatively consistent and indicated intermediate aquatic life use for both samples.

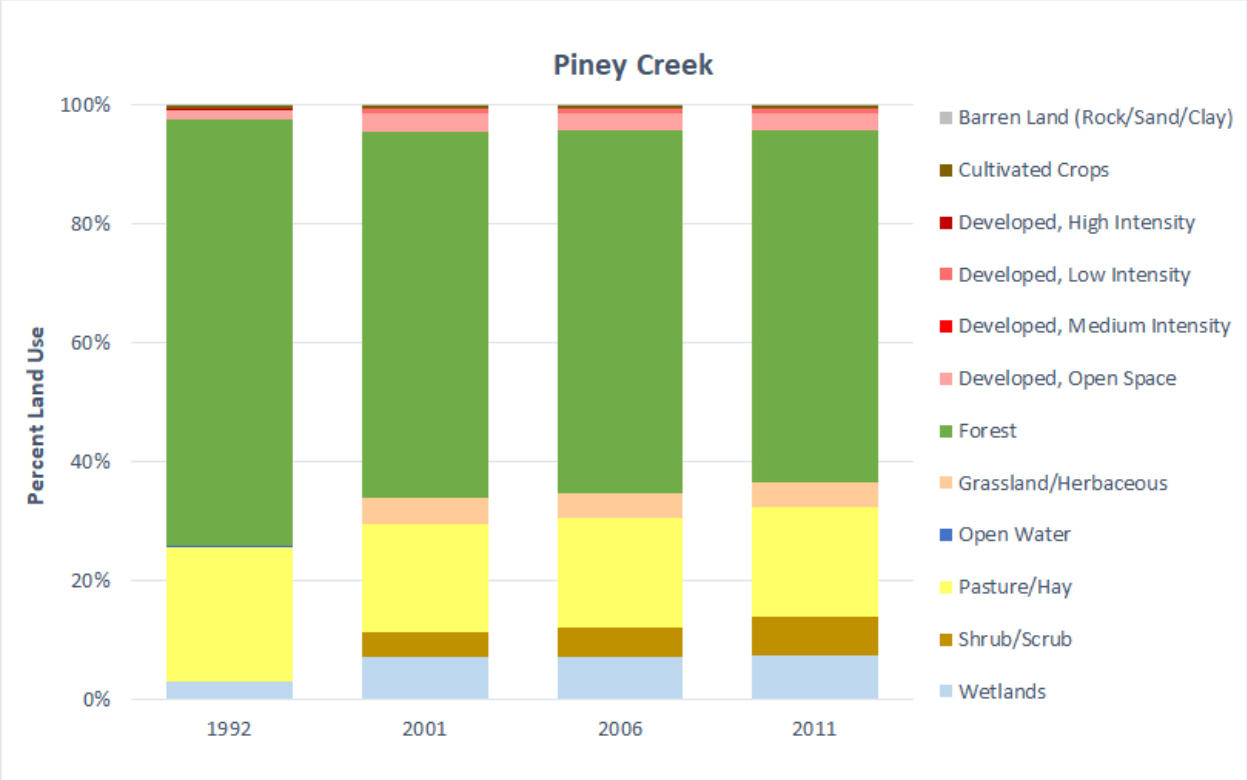

Figure 363. Percent land use in the Piney Creek watershed from 1992-2011.

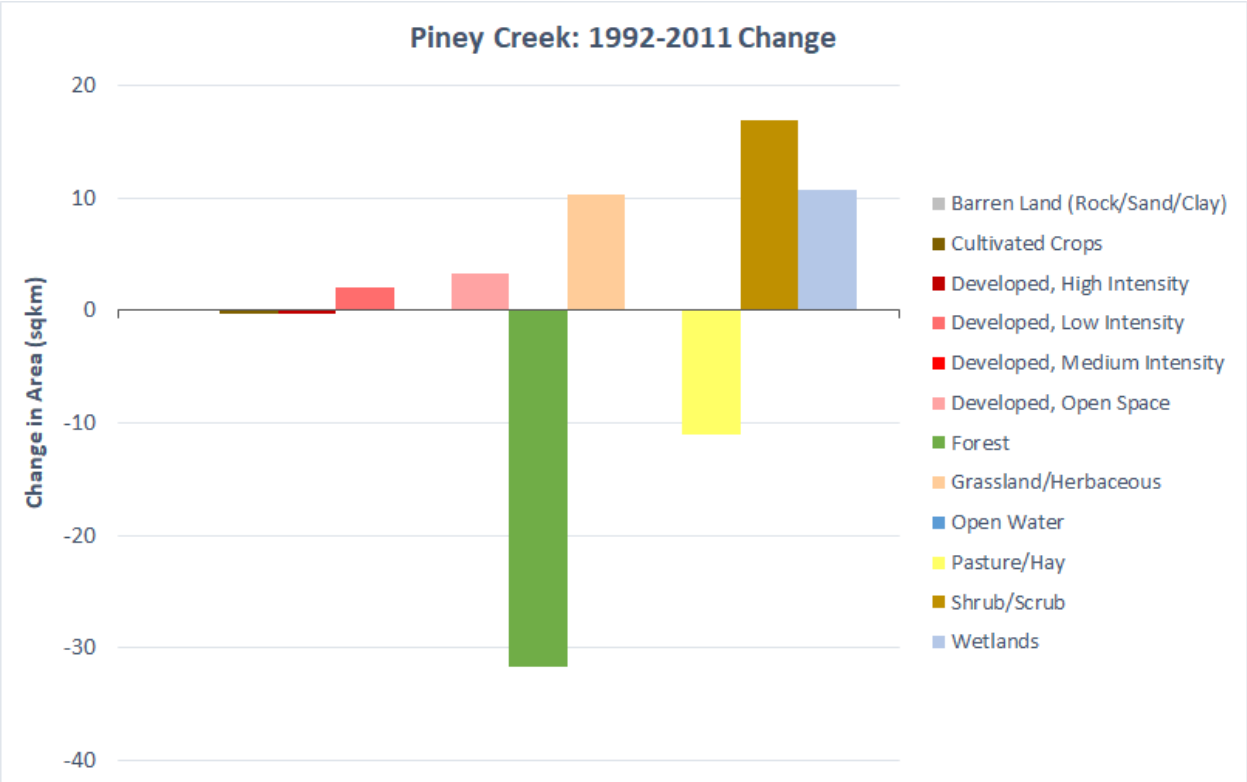

Figure 364. Land use change in area (sq km) from 1992-2011 for the Piney Creek watershed.

SAN PEDRO CREEK

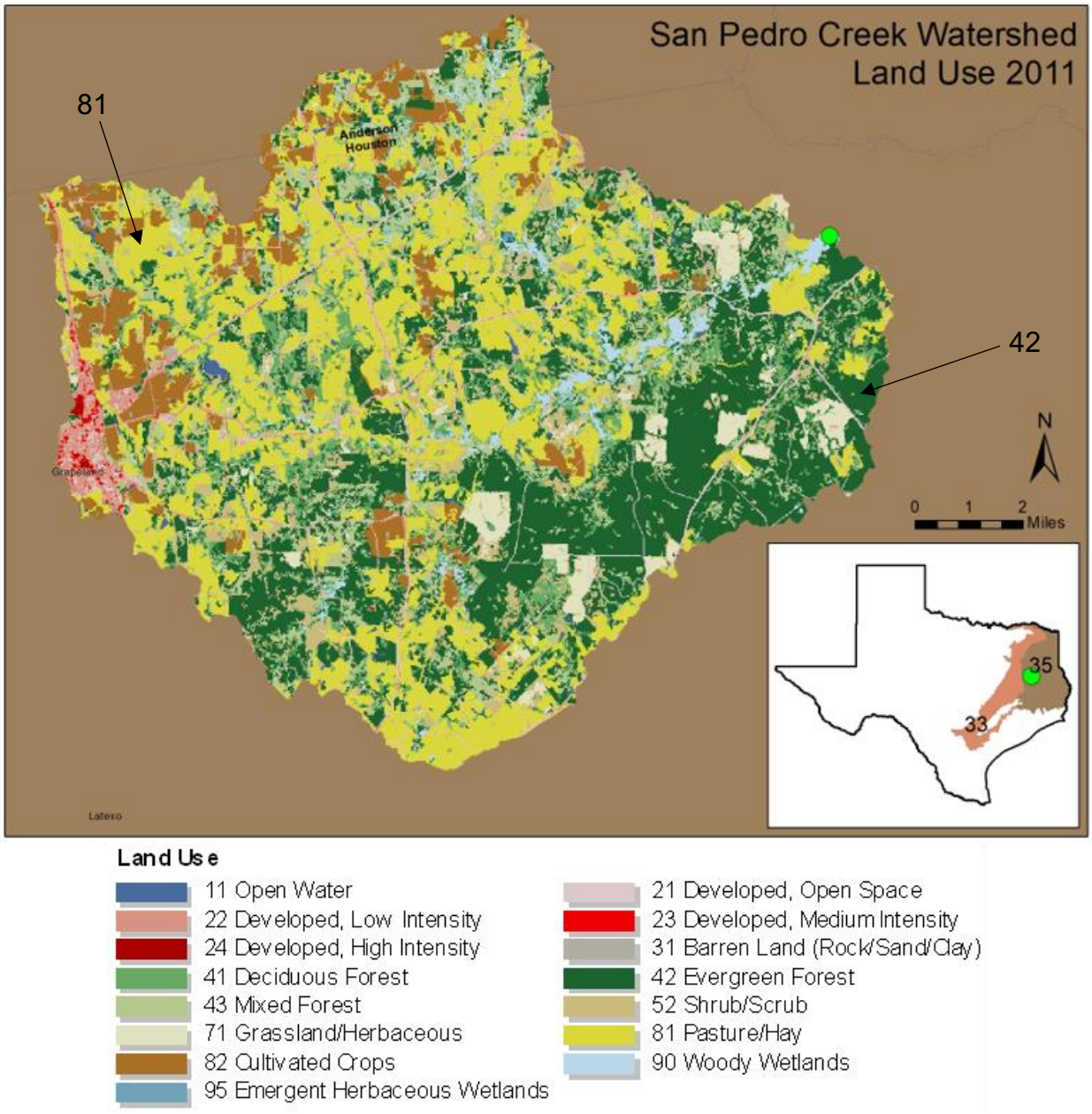

Figure 365. Map of San Pedro Creek watershed location and 2011 land use; forest and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	May 30, 2018
Water Quality:	1 sampling event
Fish:	May 30, 2018
Benthic Invertebrates:	May 30, 2018

Physical Characterization

Watershed and land use

San Pedro Creek lies within the Neches River Basin. Sample site 22071 is located in Mission Tejas State Park, 3 km upstream of the Neches River in Houston County (Figure 365).

The San Pedro Creek watershed at site 22071 is approximately 343.74 sq km. The entire watershed lies within Level IV Ecoregion 35a, the Tertiary Uplands. The dominant land cover in the watershed is forest at 45.79% and is most concentrated in the eastern portion of the watershed (Homer et al. 2015; Figure 365 and Figure 366). Pasture/hay is the secondary land cover encompassing 27.84%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 6.13% and total cover for cultivated crops is 6.8%.

From 1992-2011 there was a 51.1 sq km decrease in pasture/hay and a 3.9 sq km decrease in high intensity development. There was a 24.64 sq km increase in shrub, an 11.43 sq km increase in cultivated crops, and a 10.76 increase in grassland (Figure 367).

There is one industrial wastewater outfall (discharges ≥ 1 million gallons per day) within the San Pedro Creek watershed permitted to the City of Grapeland. This facility does not discharge directly into San Pedro Creek.

In Channel and Riparian Physical Habitat

Physical habitat for San Pedro Creek was evaluated on May 30, 2018. The Habitat Quality Index score of 19 indicates an intermediate aquatic life use rating. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was dominated by trees and grasses, which each made up an average of 40% of the total riparian species, followed by shrubs (20%). The average percentage of tree canopy cover was 97%. The dominant substrate was sand and the average percent of substrate gravel size or larger was 0%. Average percent instream cover was 13% and instream cover types include woody debris, root mats, leaf packs, overhanging vegetation, and undercut banks. San Pedro Creek was 0.3 meters deep on average and 7 meters wide. Average stream bank slope was 44 degrees and the average stream bank erosion potential was 69%. Stream flow at the site was 16 cfs. The deepest pool measured at San Pedro Creek was 1.5 meters. No riffles were observed at the site and there were two well defined stream bends.

Water Quality

Water samples were collected at station 22071 at one sampling event on May 30, 2018. Twenty-four-hour data were collected at this sampling event. Grab parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, and pH.

Biological Characterization

Fish

Nineteen species (seven families) were collected. Nearly all the species fell within three families - Cyprinidae (six species), Percidae (four species), and Centrarchidae (four species). Blacktail Shiner was the most abundant species. The aquatic life use (based upon the fish assemblage) rated as high. The low catch per unit effort and paucity of piscivores were the main reasons for the creek not obtaining an exceptional rating.

Benthic Macroinvertebrates

Considering the one RBP sample from 2018, a total of 191 individuals representing 28 taxa from 9 orders of macroinvertebrates were collected from San Pedro Creek (Appendix E). Coleoptera, Ephemeroptera, Amphipoda, Hemiptera, and Diptera were the most commonly collected orders, collectively accounting for 93 percent of the total number of individuals collected. The Odonata, Plecoptera, Trichoptera, and Decapoda were the other orders collected, all of which comprised at least one percent of the collection. The Ecoregions 33 and 35 BIBI for the May 2018 San Pedro Creek sample fell in the intermediate aquatic life use category.

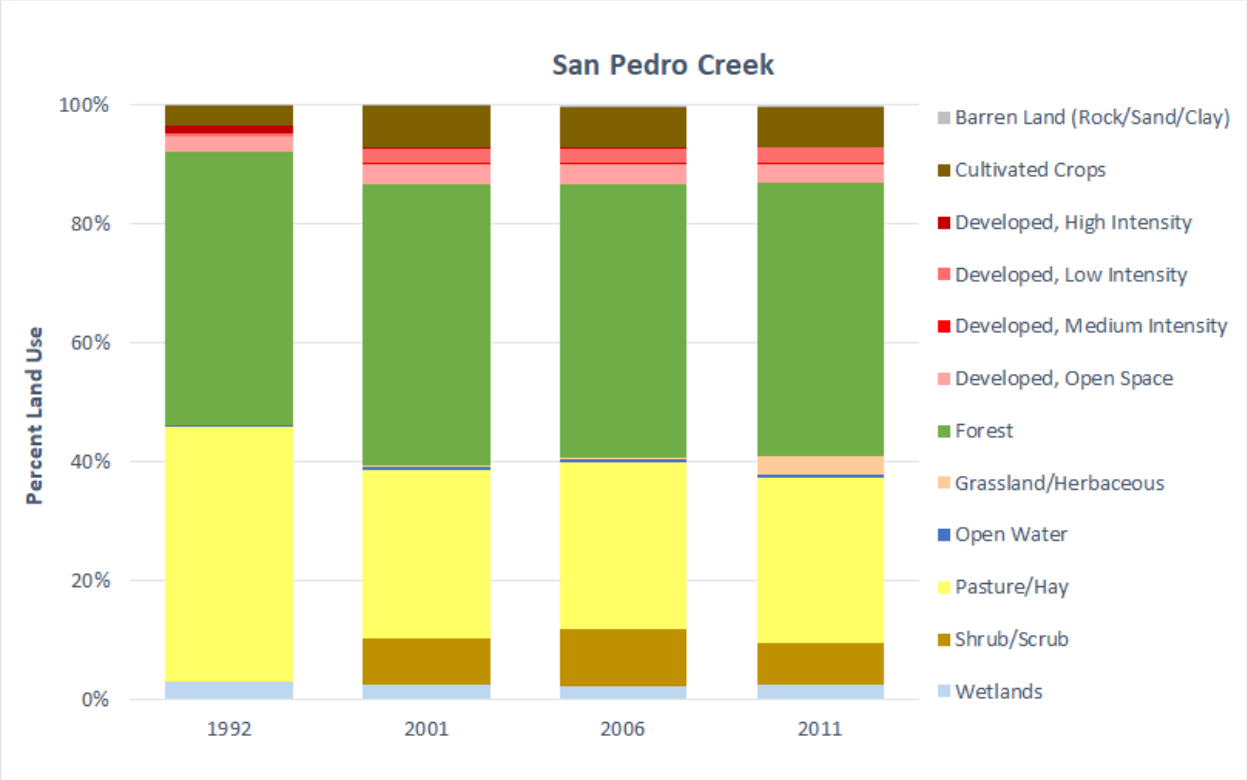

Figure 366. Percent land use in the San Pedro Creek watershed from 1992-2011.

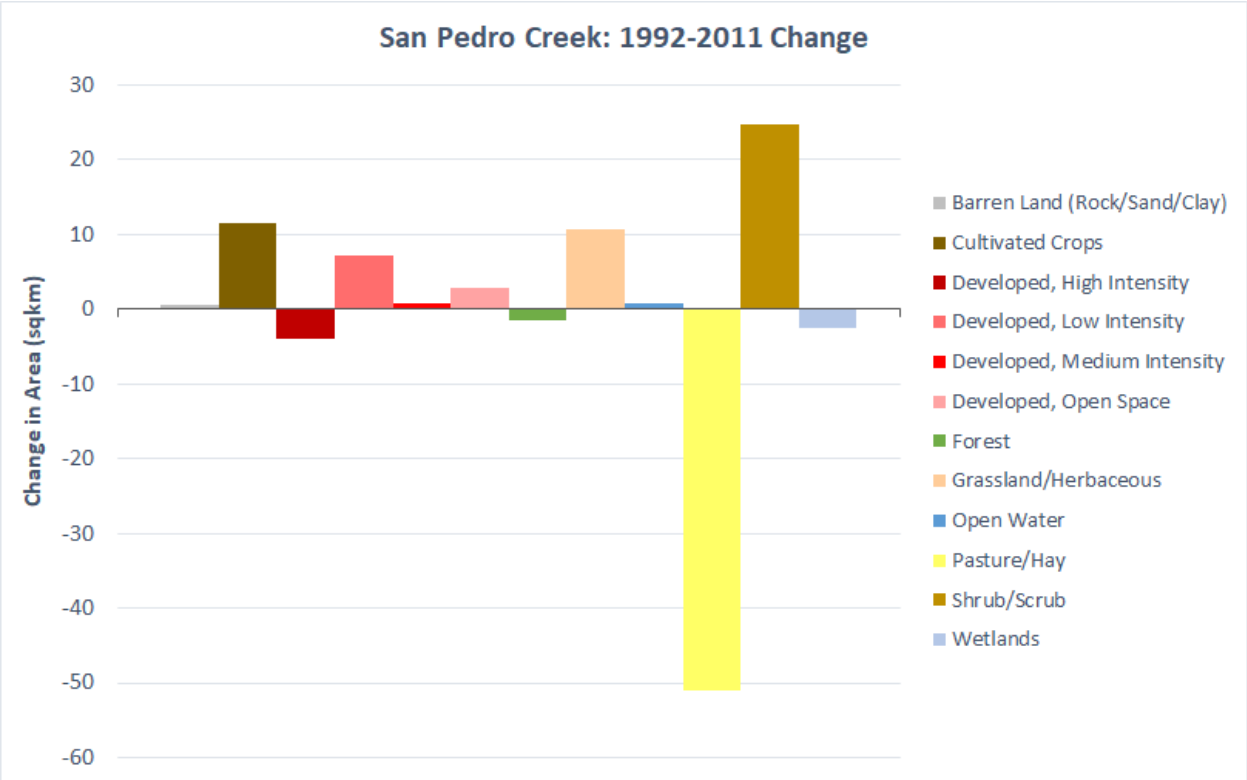

Figure 367. Land use change in area (sq km) from 1992-2011 for the San Pedro Creek watershed.

WEST FORK OF THE SAN JACINTO RIVER

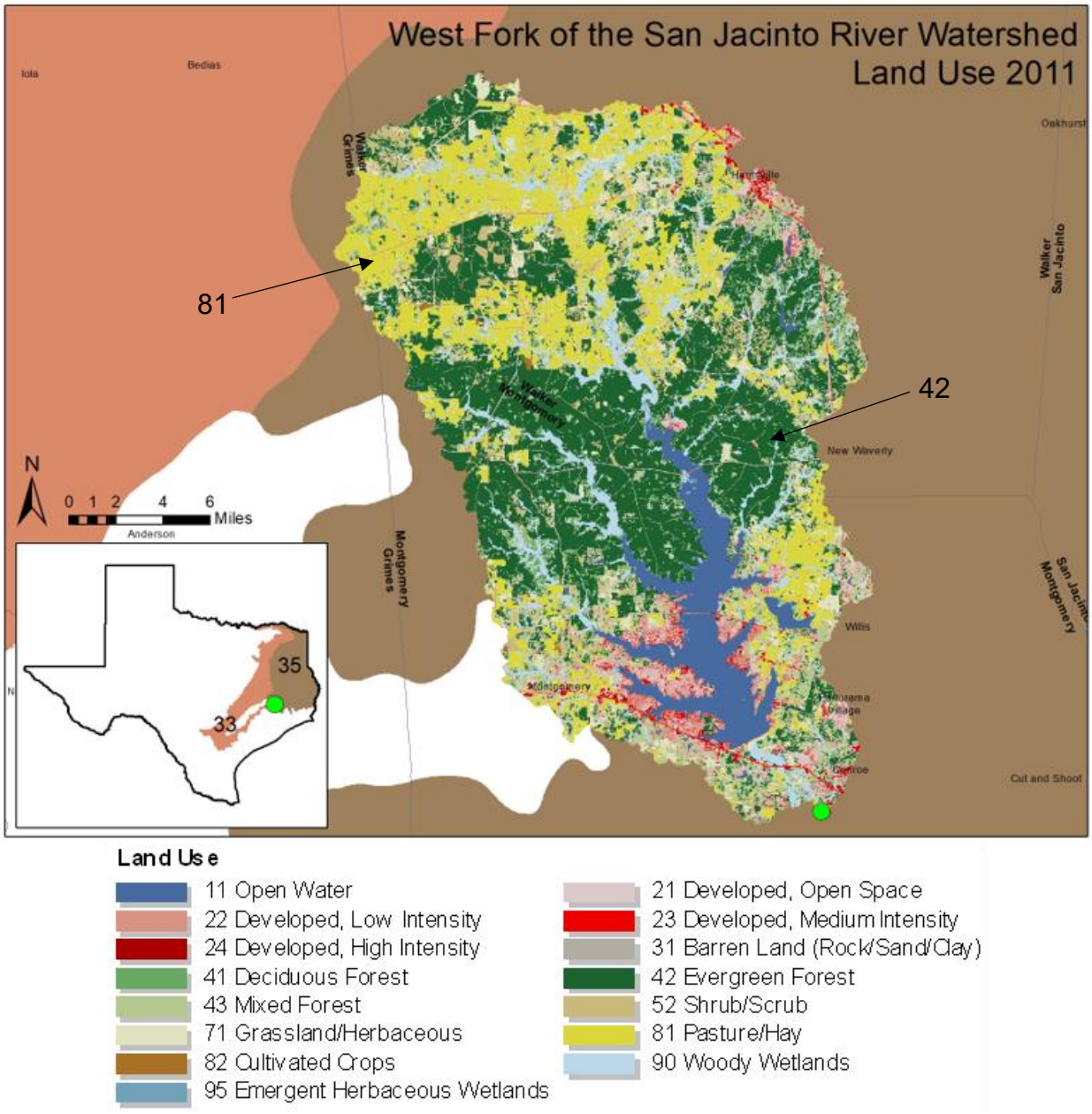

Figure 368. Map of West Fork of the San Jacinto River watershed location and 2011 land use; forest and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	June 3, 2002; September 16, 2002; April 26, 2005
Water Quality:	128 sampling events
Fish:	June 3, 2002; September 16, 2002; April 25, 2005; July 14, 2005
Benthic Invertebrates:	June 3, 2002; September 16, 2002; April 26, 2005; July 14, 2005

Physical Characterization

Watershed and Land Use

The West Fork of the San Jacinto River lies within the San Jacinto River Basin. Sample site 11250 is located at FM 2854 west of Conroe in Montgomery County (Figure 368).

The West Fork of the San Jacinto River watershed at site 11250 is approximately 1225.3 sq km. The watershed lies within Level IV Ecoregion 35e, the Southern Tertiary Uplands. The dominant land cover in the watershed is forest at 42.16% and is most concentrated in the middle portion of the watershed on the northern shores of Lake Conroe (Homer et al. 2015; Figure 368 and Figure 369). The secondary land cover is pasture/hay at 19.59%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 10.43% and total cover for cultivated crops is 0.1%.

From 1992-2011 there was a 144.66 sq km decrease in forest and a 114.51 sq km decrease in pasture/hay. There was a 78.33 sq km increase in grassland and a 75.53 sq km increase in shrub (Figure 370).

There are 41 domestic wastewater outfalls (discharges < 1 million gallons per day) and six industrial wastewater outfalls (discharges ≥ 1 million gallons per day) within the West Fork of the San Jacinto River watershed. The domestic facilities are permitted to the cities of Panorama Village and Montgomery, private residences, residential and commercial developers, municipal utility districts, water and sewer utility companies, Kampgrounds of America (KOA), a sporting goods store, and a few schools. One industrial wastewater facility is permitted to Montgomery County Municipal Utility District, two are permitted to the City of Huntsville, two are permitted to Entergy Texas, Inc - an electric power distribution company, and one is permitted to Lone Star Growers, Inc - a company that grows plants and produce. None of the facilities discharge directly into the West Fork of the San Jacinto River.

In Channel and Riparian Physical Habitat

Physical habitat for the West Fork of the San Jacinto River was evaluated during three sampling events from 2002 to 2005. The West Fork of the San Jacinto River is a perennial stream that drains to Lake Houston. Habitat Quality Index scores are available for all three sample events and indicate a high aquatic life use rating (20-22). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 16 meters wide to 127 meters. The riparian zone was generally dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 47% to 82%. The dominant stream substrate was sand, and the average percent of substrate gravel size or larger varied from 10% to 23%. Average percent instream cover was 7% to 21% and instream cover types include overhanging vegetation, undercut banks, and snags. The West Fork of the San Jacinto River ranged from 0.2-0.4 meters deep on average and 7-10 meters wide. Average stream bank slope ranged from 23-50 degrees. Stream flow at the site was measured at a minimum value of 7 cfs and a maximum of 15 cfs. Average stream bank erosion potential was 10%-19%. The deepest pool measured at the West

Fork of the San Jacinto River was greater than 1 meter. Number of riffles observed at the site varied from two to three, and total number of stream bends ranged from three to four.

Water Quality

Water samples were collected at station 11250 over 128 sampling events from December 1979 through October 2019. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*. No 24-hour dissolved oxygen data were collected at this station.

Biological Characterization

Fish

Thirty-six species (12 families) were collected over the course of the four sampling events. Cyprinidae was the most species rich family with 10 species. Blacktail Shiner was the most abundant species in every sample except the one from June 2002 where Fathead Minnow was most abundant. Each sample year had one fish collection that rated as having a high aquatic life use and one rating as exceptional. When the coefficient of variability was applied to the high ratings the one from 2002 rose to exceptional.

Benthic Macroinvertebrates

A total of 997 individuals, representing 14 orders of macroinvertebrates, were collected during the four sample events at West Fork San Jacinto River (Appendix E). The mayflies (Ephemeroptera) were the most abundant order, with taxa from nine genera and five families representing 38.9% of the individuals collected across all sample dates. Diptera and Trichoptera were the next most abundant orders, representing 18.3% and 15.3%, respectively, of the individuals collected. The most abundant families collected were Tricorythidae, Simuliidae, and Hydropsychidae, representing 23.8%, 16.5%, and 8.7%, respectively, of the total number of individuals collected.

The EPT ranged from a minimum of nine to a maximum of 12 with a median value of 10.5, which falls between the 50th and 75th percentile of all EPT values for least disturbed streams sampled in the aggregated ecoregion. The biotic index ranged from a minimum of 4.2 to a maximum of 5.4. The median value of the biotic index, 4.8, falls between the 25th and 50th percentile of all biotic index values for least disturbed streams sampled in the aggregated ecoregion. The maximum EPT value (12) and the median and minimum values for the biotic index indicate that sensitive species are relatively common in the West Fork San Jacinto River.

Considered collectively across all sample dates, the functional organization of the West Fork San Jacinto River macroinvertebrate assemblage was dominated by collector gatherers, filtering collectors, and predators which accounted for 40.1%, 28.6%, and 16.5%, respectively, of the total number of individuals collected. The grazers (8.7%) and shredders (6.1%) functional groups represented a smaller proportion of individuals. Percent dominant functional group is a

macroinvertebrate community structure metric where low to moderate values reflect a balanced community, and higher values indicate a stressed community. Values for % Dominant FFG for West Fork San Jacinto River ranged from 47.7% to 61.2%. The median value of 56.0 % falls between the 50th and 70th percentile of all values for least disturbed streams sampled in the aggregated ecoregion. These metrics indicate that the West Fork San Jacinto River has a moderately balanced community structure, with the maximum value of 61.2% dominant FFG skewed by the high proportion of filtering collectors (blackfly larvae) collected in the April 2005 sample.

Results for the Ecoregions 33 and 35 BIBI for the four RBP samples collected at the West Fork San Jacinto River reflect a somewhat high degree of variability (CV 11.5%), ranging from 26 (intermediate) to 34 (high). The median of the four benthic IBI scores, 29.5, falls between the 50th and 75th percentile of all benthic RBP IBIs for the South Central and Southern Humid, Mixed Land Use Region.

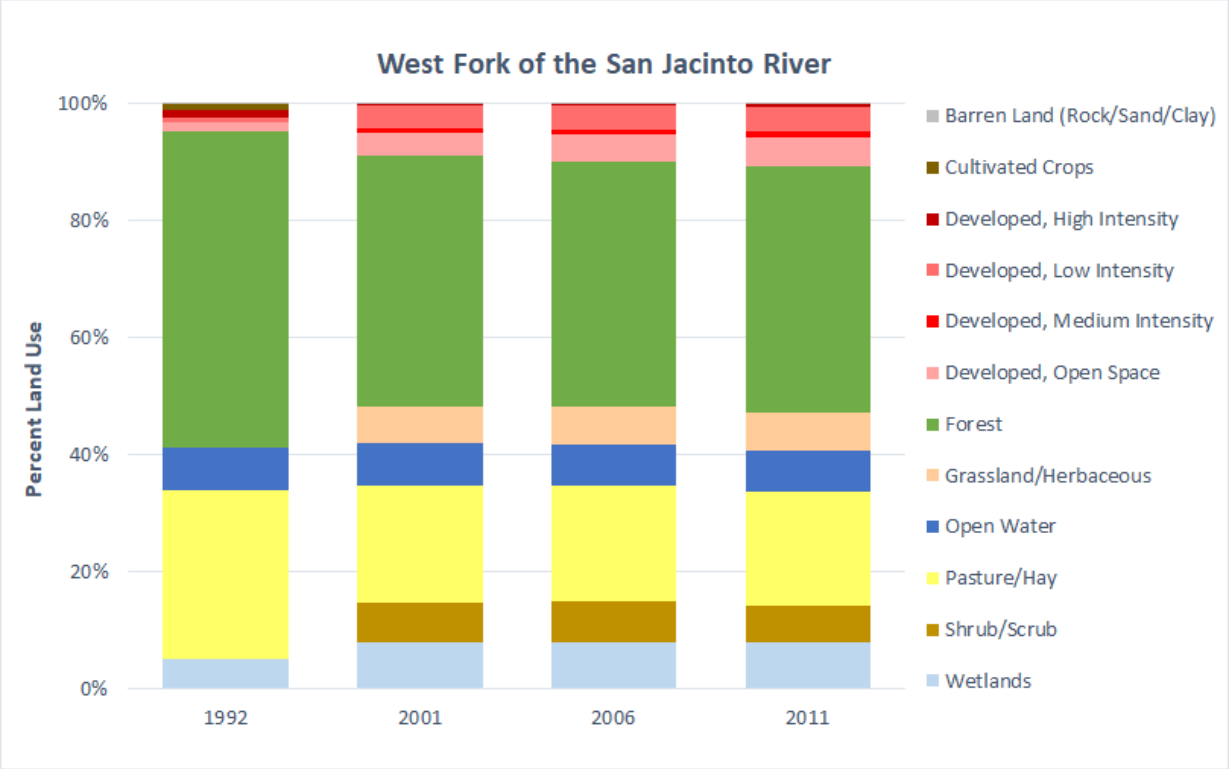

Figure 369. Percent land use in the West Fork of the San Jacinto River watershed from 1992-2011.

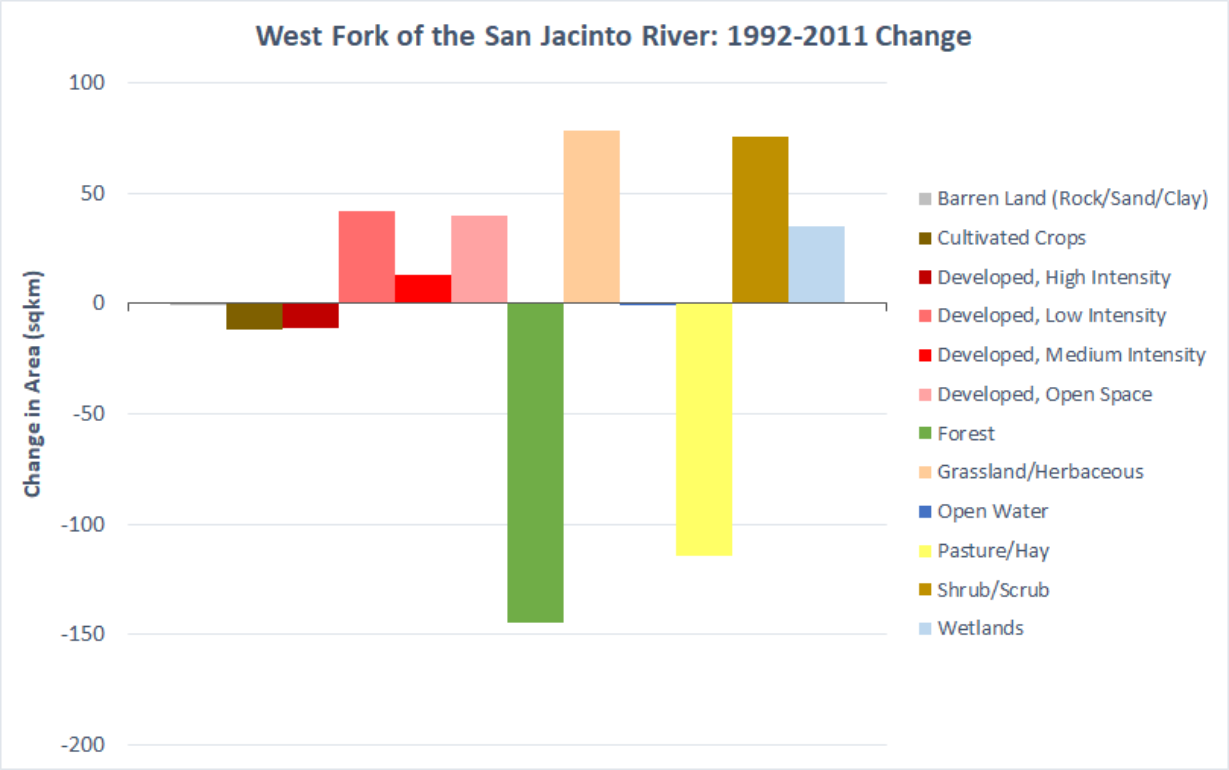

Figure 370. Land use change in area (sq km) from 1992-2011 for the West Fork of the San Jacinto River watershed.

WHITE OAK CREEK

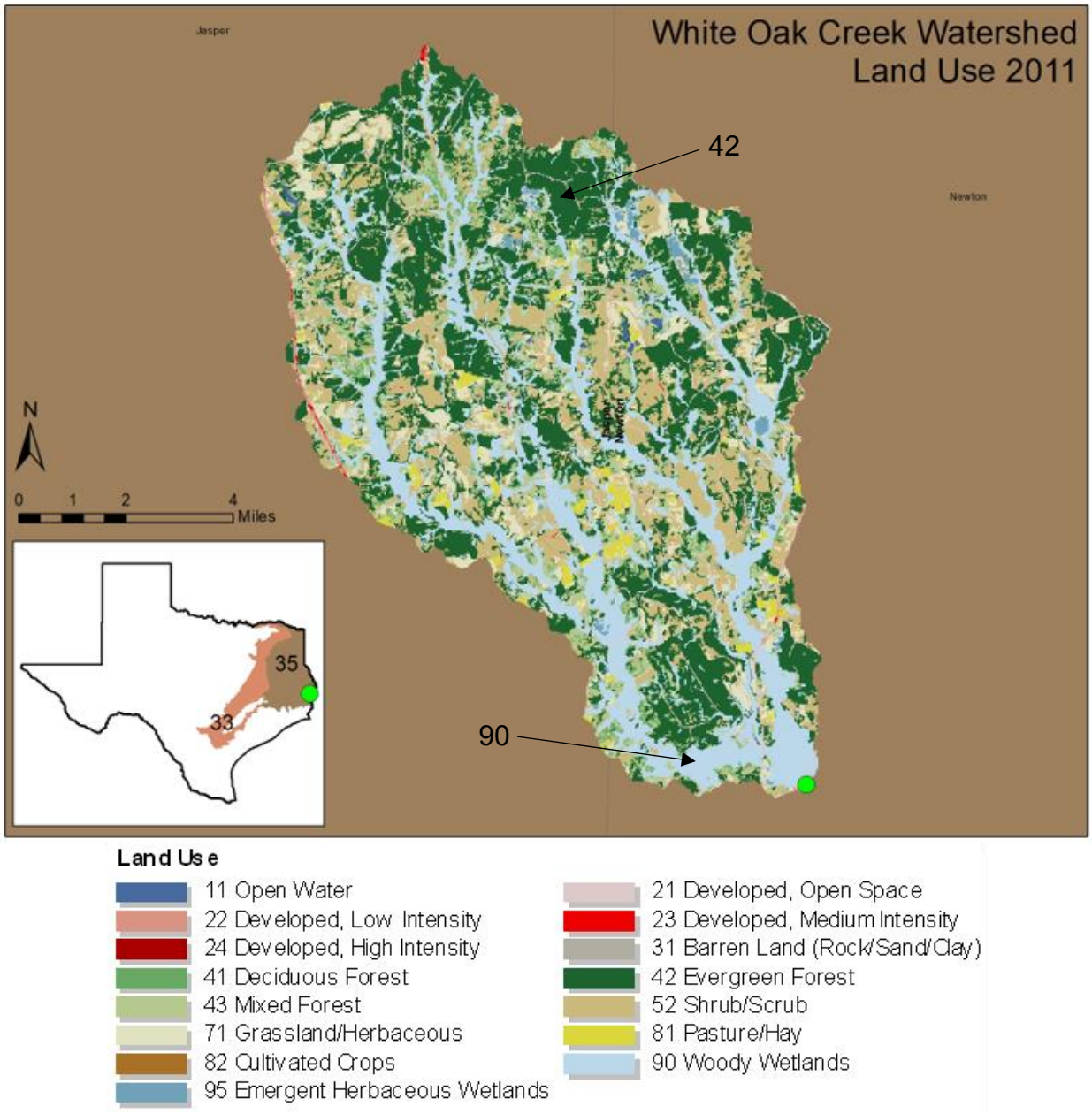

Figure 371. Map of White Oak Creek watershed location and 2011 land use; forest and wetlands were the most common land uses.

Sampling Dates

Physical Habitat:	September 13, 1989
Water Quality:	8 sampling events
Fish:	September 12, 1989
Benthic Invertebrates:	September 13, 1989

Physical Characterization

Watershed and Land Use

White Oak Creek lies within the Sabine River Basin. Sample site 10341 is located at FM 363 east of Bleakwood in Newton County (Figure 371).

The White Oak Creek watershed at site 10341 is approximately 233.25 sq km. The lower portion of the watershed lies within Level IV Ecoregion 35f, the Flatwoods, while the middle and upper portions of the watershed lay within Level IV Ecoregion 35e, the Southern Tertiary Uplands. The dominant land cover in the watershed is forest at 44.6% and is present throughout the watershed (Homer et al. 2015; Figure 371 and Figure 372). Wetlands is the secondary land cover encompassing 23.53%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.64% and there is no cultivated crop cover present within the watershed.

From 1992-2011 there was a 108.25 sq km decrease in forest and a 7.9 sq km decrease in pasture/hay. There was a 49.19 sq km increase in wetlands and a 45.17 sq km increase in shrub (Figure 373).

There are no permitted wastewater outfalls within the White Oak Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for White Oak Creek was evaluated on September 13, 1989. White Oak Creek drains to Big Cow Creek east of Kirbyville in Newton County. The riparian width was 91 meters. The riparian zone was dominated by trees, which made up an average of 80% of the total riparian species, followed by shrubs (15%) then grasses (5%). The average percentage of tree canopy cover was 82%. The dominant substrate was silty sand, and the average percent of substrate that was gravel size or larger was 2%. Average percent instream cover was 53% and instream cover types included fallen logs, undercut banks, root snags, cypress knees and overhanging vegetation. White Oak Creek had an average depth of 0.9 meters and a maximum depth of 1.9 meters. The average width was 8.5 meters and average stream bank slope was 50 degrees. Stream flow at the site was 26 cfs. Average stream bank erosion potential was 71%. Two riffles were observed at the site and there were six total stream bends.

Water Quality

Water samples were collected at station 10341 over 8 sampling events from September 1989 through July 1999. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*. No 24-hour dissolved oxygen data were collected at this station.

Biological Characterization

Fish

Twenty species (eight families) were collected from White Oak Creek. Only three families were represented by more than one species. Percidae, Cyprinidae, and Centrarchidae each yielded five species. Weed Shiner was the most abundant species. The aquatic life use rating (based upon the fish assemblage) rated as high.

Benthic Macroinvertebrates

A total of 186 individuals representing 13 orders of macroinvertebrates were collected in the Surber sample from White Oak Creek (Appendix E). Coleoptera, Diptera, Oligochaeta, and Trichoptera were the most abundant orders, representing 26.9%, 24.2%, 17.7%, and 10.2%, respectively, of the total number of individuals collected. Gastropoda (5.9%), Pelecypoda (5.4%), and Ephemeroptera (4.3%) were also well represented in the collection. Other taxa, representing greater than 1% of the nine collections combined, include Hemiptera (1.6%), Lepidoptera (1.1%), and Decapoda (1.1%).

The functional organization of the White Oak Creek macroinvertebrate assemblage is dominated by collector gatherers, scrapers, and filtering collectors, which accounted for 47.1%, 23.4%, and 15.6%, respectively, of the total number of individuals collected. Predators (7.1%) and shredders (6.3%) were represented at lower relative abundance.

Nine EPT taxa were collected in White Oak Creek. This value falls between the 50th and 75th percentile for all EPT values for least disturbed streams in ecoregion aggregate 33/35. The biotic index value for the White Oak Creek benthic assemblage (6) falls between the 75th and 95th percentiles for all biotic index values in the ecoregion aggregate indicating a moderately tolerant macroinvertebrate assemblage.

The sample BIBI score falls in the range indicating an exceptional aquatic life use. The exceptional BIBI score is a result of maximum scores for the metrics total number of taxa, number of Diptera taxa, number of intolerant taxa, percent tolerant, percent grazers, and percent gatherers, and a low relative dominance of the three most abundant taxa in the Surber sample.

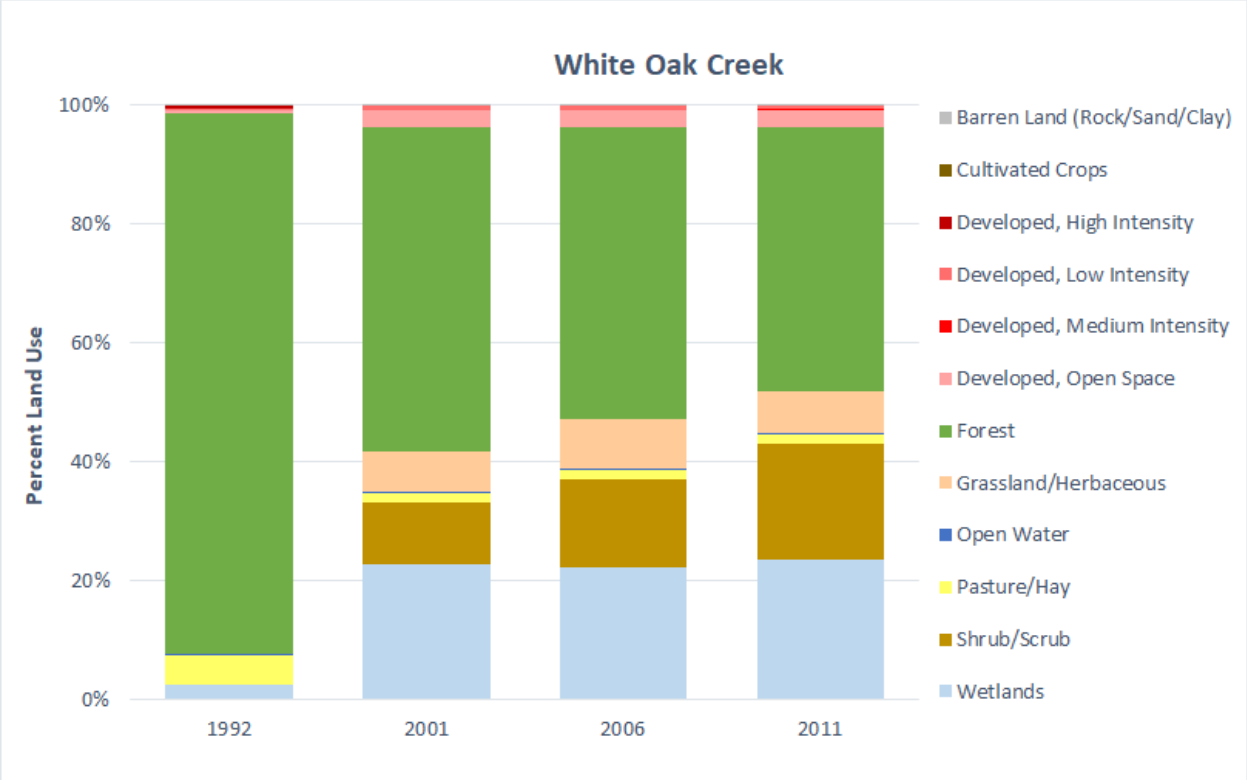

Figure 372. Percent land use in the White Oak Creek watershed from 1992-2011.

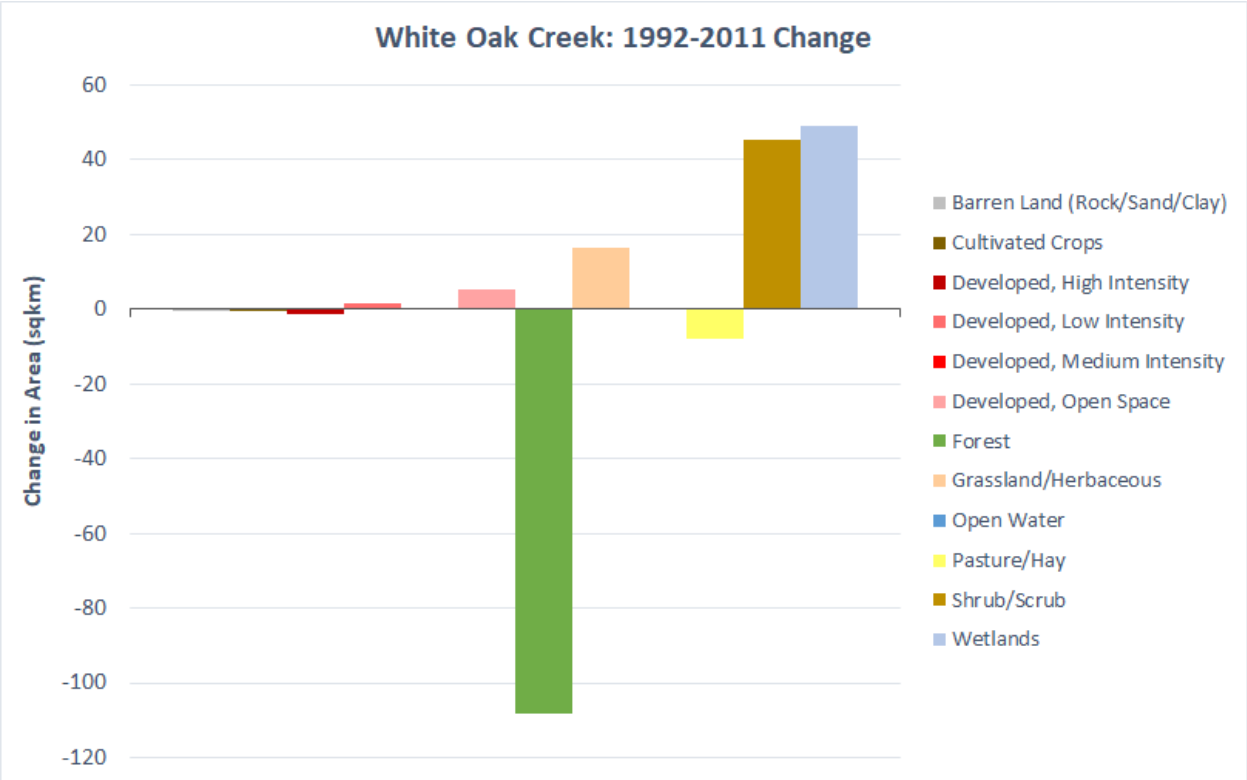

Figure 373. Land use change in area (sq km) from 1992-2011 for the White Oak Creek watershed.

Ecoregions 33 and 35 Summary and Historical Characterization

Watershed and Land Use

Ecoregion 33 was historically covered by post oak savannas with a dense underlying clay pan. Much of this area is now used for pasture and rangeland (Griffith et al. 2007). In 2011 the overall primary land cover in the study watersheds was pasture/hay and the secondary land cover was forest. Between 1992-2011, forest experienced the largest decrease in combined land cover area across all watersheds (~382.75 sq km) and shrub experienced the largest increase (~212.11 sq km).

Ecoregion 35 was historically a mix of pine and hardwood forests, but due to timber production much of the area has been replanted to loblolly and shortleaf pine plantations. Lumber and pulpwood production, livestock grazing, poultry production, as well as oil and gas production are major economic activities (Griffith et al. 2007). In 2011 the overall primary land cover in the study watersheds was forest and the secondary land cover was pasture/hay. Between 1992-2011, forest experienced the largest decrease in combined land cover across all watersheds (~1,130.01 sq km) and shrub experienced the largest increase (~408.10 sq km).

In Channel and Riparian Physical Habitat

Physical habitat for the South Central and Southern Humid, Mixed Land Use Region was evaluated at 31 streams over 135 sampling events from 1986 to 2018. Watershed area varied from a minimum of 11 sq km at Blair Creek to a maximum of 1,225 sq km at the West Fork of the San Jacinto River. The sites generally had well vegetated riparian zones, and the riparian buffer was measured at a minimum of 4 meters and maximum of 250 meters. Trees were the dominant riparian species, followed by grasses then shrubs, and average percent tree canopy coverage was 73%. Dominant substrate at the sites was generally sand followed by clay then silt. Average percentage of substrate gravel sized or larger was 14% and varied from a minimum of 0% to a maximum of 76%. Average percent instream cover was 26% and common instream cover types include large and small woody debris, undercut banks, overhanging vegetation, root mats, leaf packs, snags, macrophytes, algae, and gravel. Average stream depth and width measurements were 0.3 meters and 9 meters, respectively. Average stream bank slope was 37 degrees and erosion potential was moderate, with an average of 40% which was reflected in the average bank stability HQI score (1.7) indicating moderately stable to moderately unstable stream banks. Maximum pool depth ranged from a minimum of 0 meters to a maximum of 2 meters. Total number of riffles varied from zero to seven, and total number of stream bends ranged from zero to ten. Additional in-channel and riparian physical habitat attributes are summarized in Appendix B.

HQI scores are available for 110 events and range from a maximum score of 24 (high) for four Cummins Creek samples to a minimum score of 11 (limited) at Ponds Creek and Beech Creek. Of the 110 sampling events with an HQI score, 64 (58%) received a habitat assessment rating of high, 40 (36%) received a rating of intermediate, and the remaining six (6%) received a rating of limited. The highest scoring HQI metrics for the South Central and Southern Humid, Mixed Land Use

Region were the dimensions of largest pool metric, the channel sinuosity metric, and the riparian buffer vegetation metric. The lowest scoring HQI metrics on average were the bottom substrate stability metric and the bank stability metric.

Water Quality

Water quality data from ecoregions 33 and 35 were similar between stations. Specific conductivity was low in these freshwater systems with a range between 16 and 1908 with a median value of 160 us/cm at 25C. The transparency in the water column had a median secchi value of 0.43 m. Transparency values were low in these ecoregions, indicative of the muddy slow-moving streams that characterize these ecoregions. The pH values ranged from 6.7 to 9.61. Nutrient concentrations in the streams were higher for nitrogen species than for total phosphorus. The median total phosphorus concentration of 0.009 mg/L and the median TKN concentration was 0.61 mg/L. Additional water quality variables are summarized in appendix C of the report.

Fish

A total of 57,398 individuals consisting of 18 families and 95 species have been documented in 173 sampling events across 31 streams in the South Central and Southern Humid, Mixed Land Use Region from 1986 to 2018 (Appendix D - 6). For individual sites, taxa richness ranged from 56 species at Mill Creek across 33 sampling events from 1988 to 2017 to a low of 15 species at Smackover Creek during two sampling events in 2008. Taxa richness at each site was heavily correlated with the number of sampling events during the period of record. The most abundant species collected across all sites and sampling events were Blacktail Shiner (n = 16,031), Western Mosquitofish (n = 6,903), Longear Sunfish (n = 4,774), Red Shiner (n = 3,025), and Blackstripe Topminnow (n = 2,960).

Index of biotic integrity scores across all sites and sampling events ranged from 29 to 58 resulting in aquatic life use categories of limited (n = 7), intermediate (n = 26), high (n = 107), and exceptional (n = 33; Figure 374). Of the 173 sampling events in this ecoregion, 81% received an ALU rating of high or exceptional; 19% received an ALU of intermediate or limited. Most sites that were sampled multiple times received ALUs in at least two different categories. All sites received one ALU score of high or better except for Kickapoo and Cuthand creeks which both received ALU scores of intermediate only.

Overall, IBI scores and individual metrics 1-2, 4-8, and 10-11 did not change through time (Figure 375; Figure 376; Figure 377); however, the number of benthic invertivores, percentage of individuals as piscivores and the percentage of individuals with disease/anomaly significantly decreased through time (Figure 376(3): $R^2 = 0.03$, $p = 0.03$; Figure 377(9): $R^2 = 0.02$, $p = 0.049$; Figure 377(12): $R^2 = 0.11$, $p < 0.01$). Although these were significant relationships, R^2 values were very low.

The decrease in number of benthic invertivores could be due to a slight decrease in benthic invertivore taxa which are primarily native catostomids and percids. The decrease in the percentage of individuals as piscivores is likely due to a few samples that were collected on

Black Bayou in the early 1990s where only a backpack shocker was used which probably resulted in an increase in larger-bodied piscivores resulting in elevated metric scores. The decrease in the proportion of individuals with a disease/anomaly is likely due to sampler bias rather than a significant change in disease/anomaly. This is a characteristic that is often overlooked while in the field.

Benthic Macroinvertebrates

The aquatic macroinvertebrate assemblage in this region is highly diverse. A total of 44,537 individuals representing 509 taxa from 24 orders were present across 174 sampling events in least disturbed streams in the South Central and Southern Humid, Mixed Land Use region (Aggregated Ecoregions 33 and 35) over the time period from 1987 to 2018 (Appendix E). This includes 10 of 13 insect orders, as well as representatives of Oligochaeta, Amphipoda, Pelecypoda, Gastropoda, Isopoda, Hirudinea, Hydracarina, Turbellaria, Nematoda, Ostracoda, and Nemertea. For individual sites, taxa richness ranged from a total of 106 in a Surber sample and eight RBP samples collected over the period from 1989 to 2016 at Frazier Creek to a low of 11 in single RBP samples collected at Little Mustang and Davidson creeks.

This finding reflects the relative permanence of wetted channel in the region as a result of typical annual rainfall ranging from 71 to 102 cm in the western and southern portions to 112 to 147 cm in the eastern and central portions of the region. Also, most of the streams are characterized by relatively abundant instream cover such as logs, snags, leaf pack, and undercut banks which provide excellent habitat for aquatic invertebrates. Instream food resources, primarily allochthonous due to shading, are also abundant in the form of leaf litter and associated microbial growth as well as suspended organic matter from the surrounding forests which characterize large portions of the region.

Mayflies (Ephemeroptera) were the most abundant taxa overall, representing 23% of the total number of individuals collected.

Overall, the results of the regionalized IBI’s for the 174 benthic macroinvertebrate samples collected over the interval from 1987 to 2018 indicate relatively constant benthic macroinvertebrate biotic integrity (Figure 378; Figure 379).

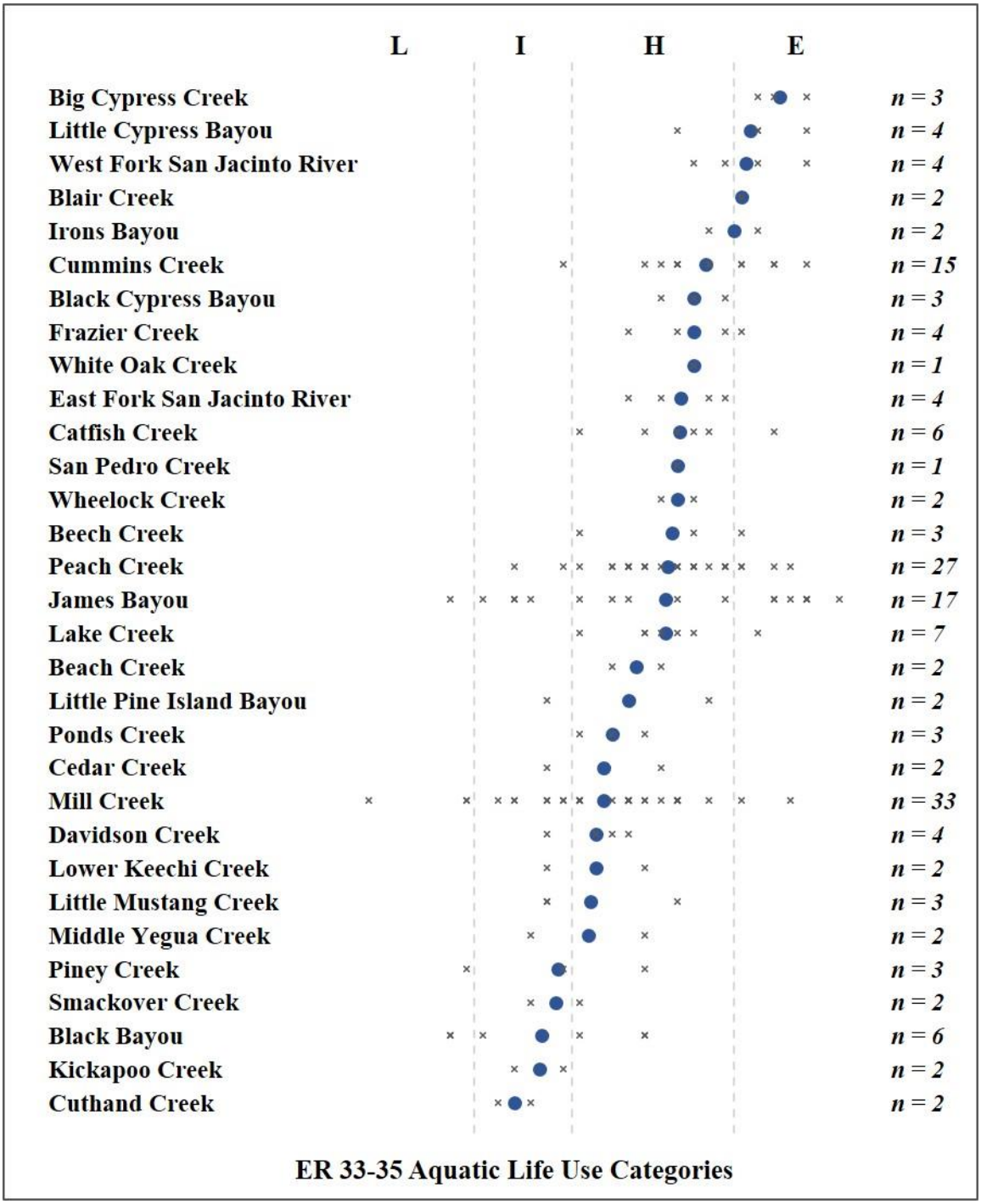

Figure 374. Aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all fish sampling events in Ecoregions 33 and 35 grouped by site and ranked by mean ALU score (blue dot); number of sampling events per site noted on right.

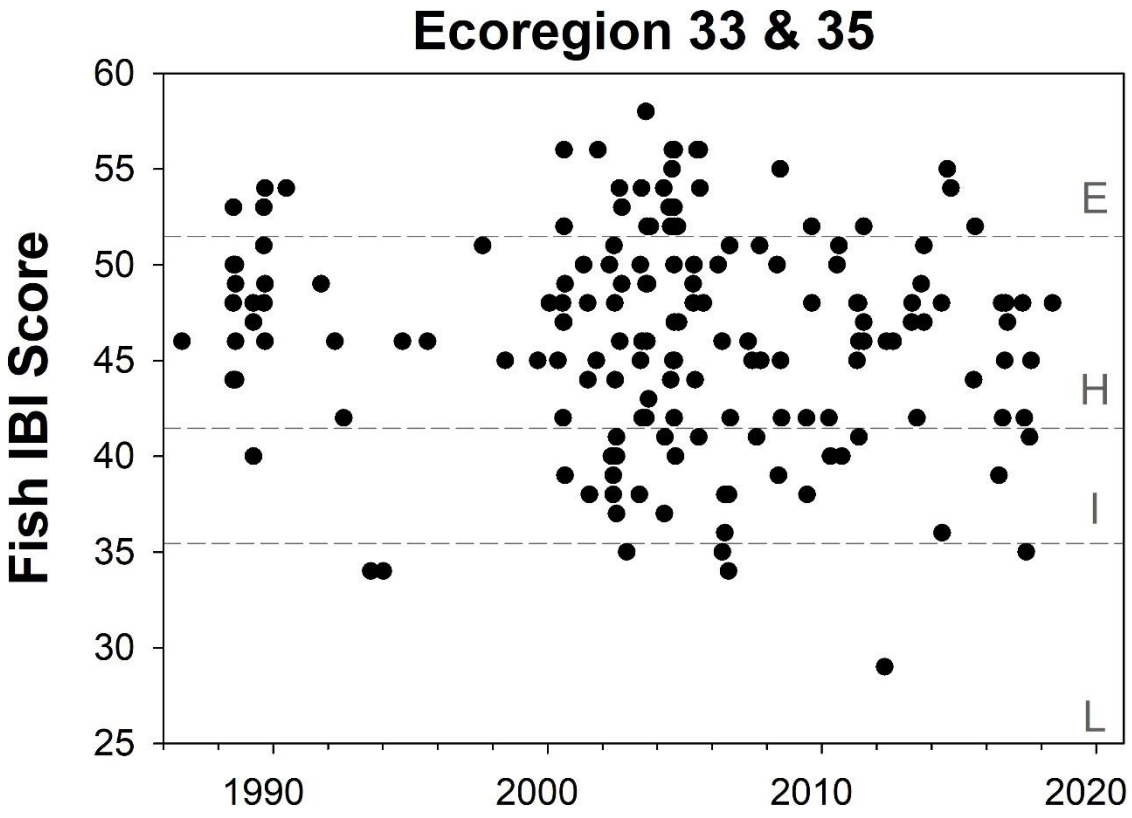

Figure 375. Fish index of biotic integrity scores through time for all sampling events in Ecoregions 33 and 35; break lines for aquatic life use categories (i.e., limited, intermediate, high, and exceptional) shown on each graph for reference (see Linam et al. 2002).

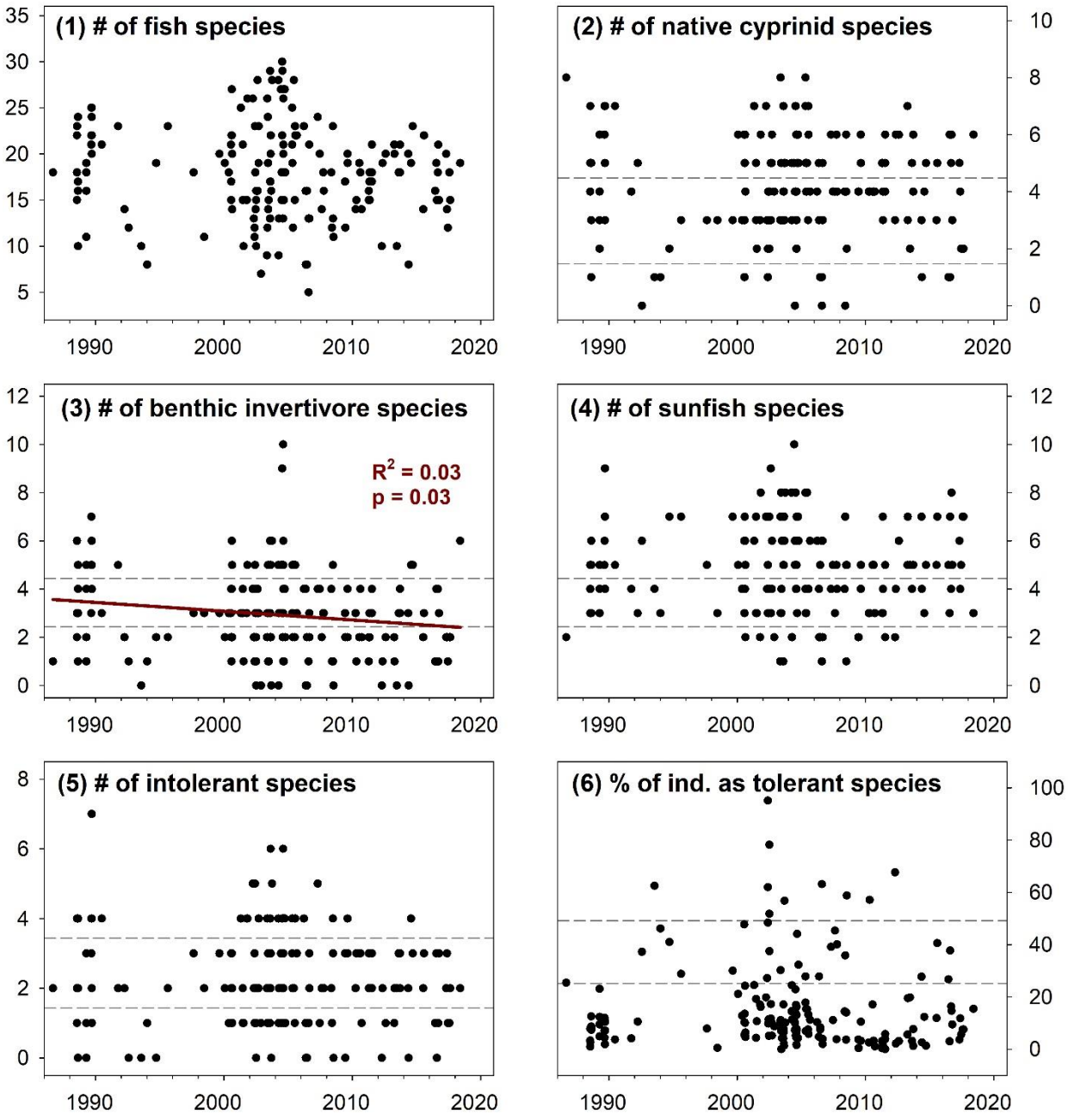

Figure 376. Raw values for fish index of biotic integrity metrics 1-6 through time for all sampling events in Ecoregions 33 and 35; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002).

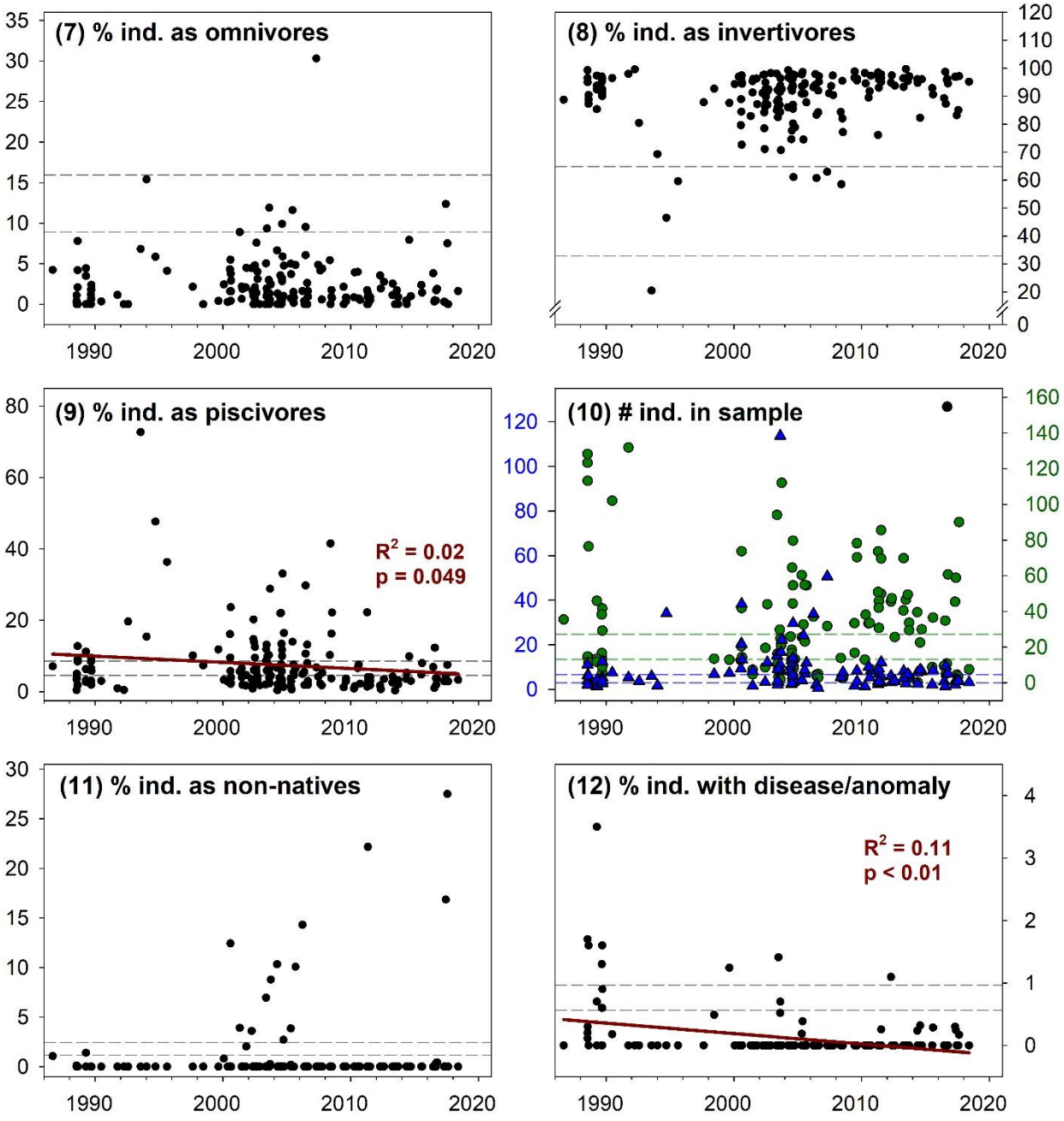

Figure 377. Raw values for fish index of biotic integrity metrics 7-12 through time for all sampling events in Ecoregions 33 and 35; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002); number of ind./seine haul represented by green circles and number of ind./min electrofishing represented by blue triangles for metric number 10.

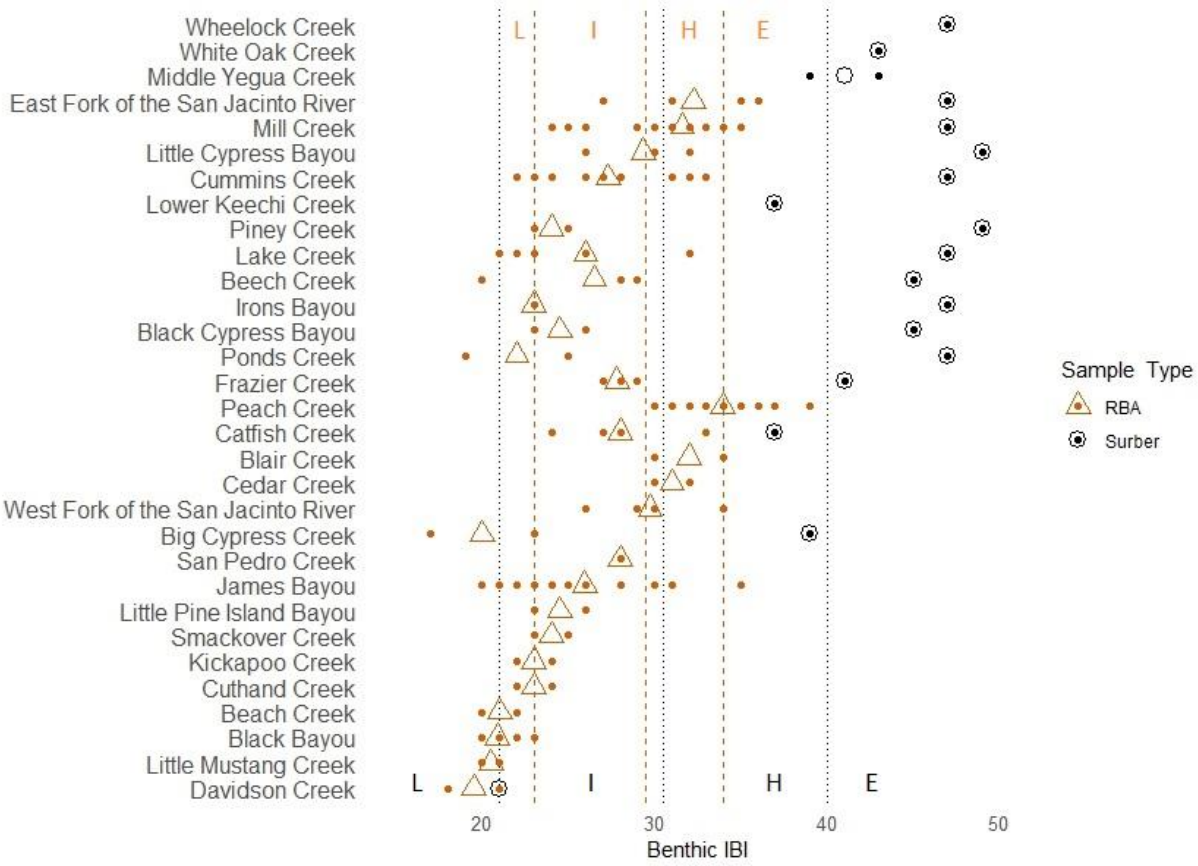

Figure 378. Benthic IBIs and aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all benthic sampling events in Ecoregions 33 and 35 grouped by site and ranked by mean IBI score. Site scores are solid circles, and mean scores are hollow circles for Surber IBI sample and hollow triangles for RBP IBI samples. RBP IBI ALU cut offs are red dashed lines and Surber ALU cutoffs are in black dotted lines.

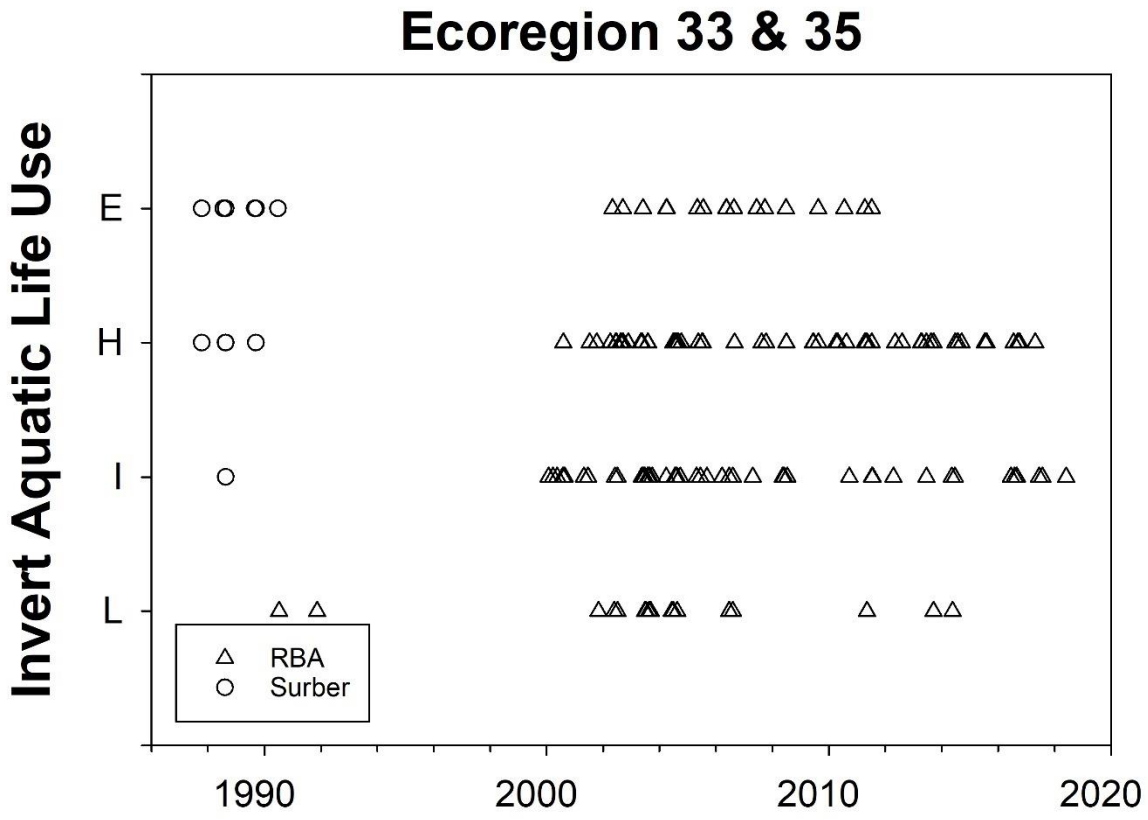

Figure 379. Benthic aquatic life use (ALU) categories through time for all sampling events in Ecoregions 33 and 35; Surber ALUs are noted by circles and RBP ALUs are noted by triangles.

ECOREGION 34 – WESTERN GULF COASTAL PLAIN

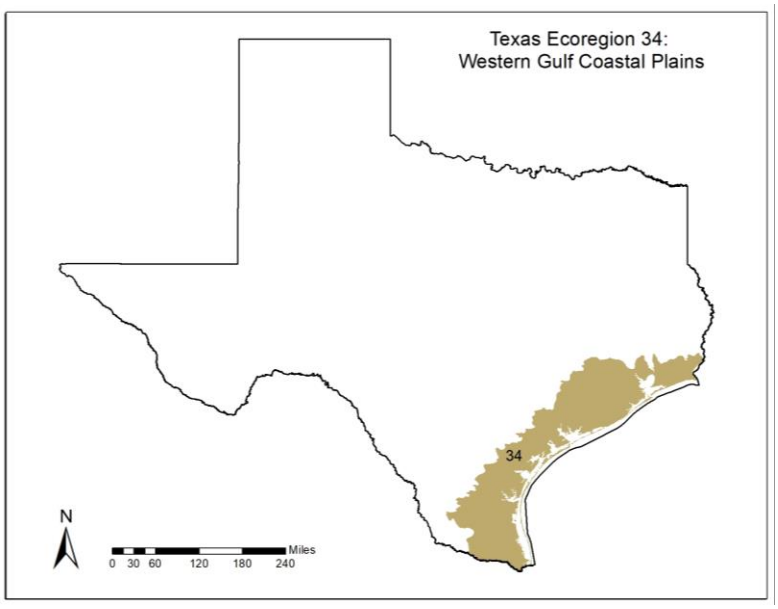

Figure 380. Map of Texas Ecoregion 34 – Western Gulf Coastal Plain.

Figure 381. Site photo from Garcitas Creek.

Ecoregion 34 Characterization

The Gulf Coastal Plains Ecoregion (Ecoregion 34) is relatively flat and narrow, ranging from 80 to 145 km wide along the Gulf of Mexico coast extending from southeastern Louisiana through Texas and into the Mexican state of Tamaulipas (Figure 380). In Louisiana the region is often referred to as the "Cajun Prairie" and in Texas as the "Coastal Prairie". The ecoregion is relatively diverse and includes coastal marshes, barrier islands, and dunes as well as tidally influenced and freshwater streams. Only freshwater streams above the extent of tidal influence were sampled for this project. The freshwater streams in the ecoregion may be found in forested or prairie-like watersheds.

Most of the region, especially close to the gulf coast, is characterized by relatively flat topography and mainly grassland potential natural vegetation (Griffith et al. 2007). Inland from the gulf coast, the plains become more irregular and forested or savannah-like. These characteristics result in a larger proportion of the land being in cropland than in adjacent ecoregions. Soybeans, rice, and grain sorghum constitute the main crops. Urban and industrial land uses as well as oil and gas production are common in the region.

Vegetation in the ecoregion is relatively diverse and includes hackberry, cedar elm, ash, pecan, live oak (*Quercus virginiana)*, and mesquite trees as well as a wide variety of grasses. Griffin et al. (2007) identified nine Level IV ecoregions within the Western Gulf Plains in Texas and provide greater details on the physiographic characteristics, soils, geology, and vegetation of this ecoregion. Greater detail on the physiographic characteristics of the region is also given in this report under the physical characterization for each sample site.

Streams sampled in Ecoregion 34.

Arenosa Creek	Placedo Creek	West Carancahua Creek
Big Creek	San Bernard River	West Mustang Creek
Garcitas Creek	West Bernard Creek	

ARENOSA CREEK

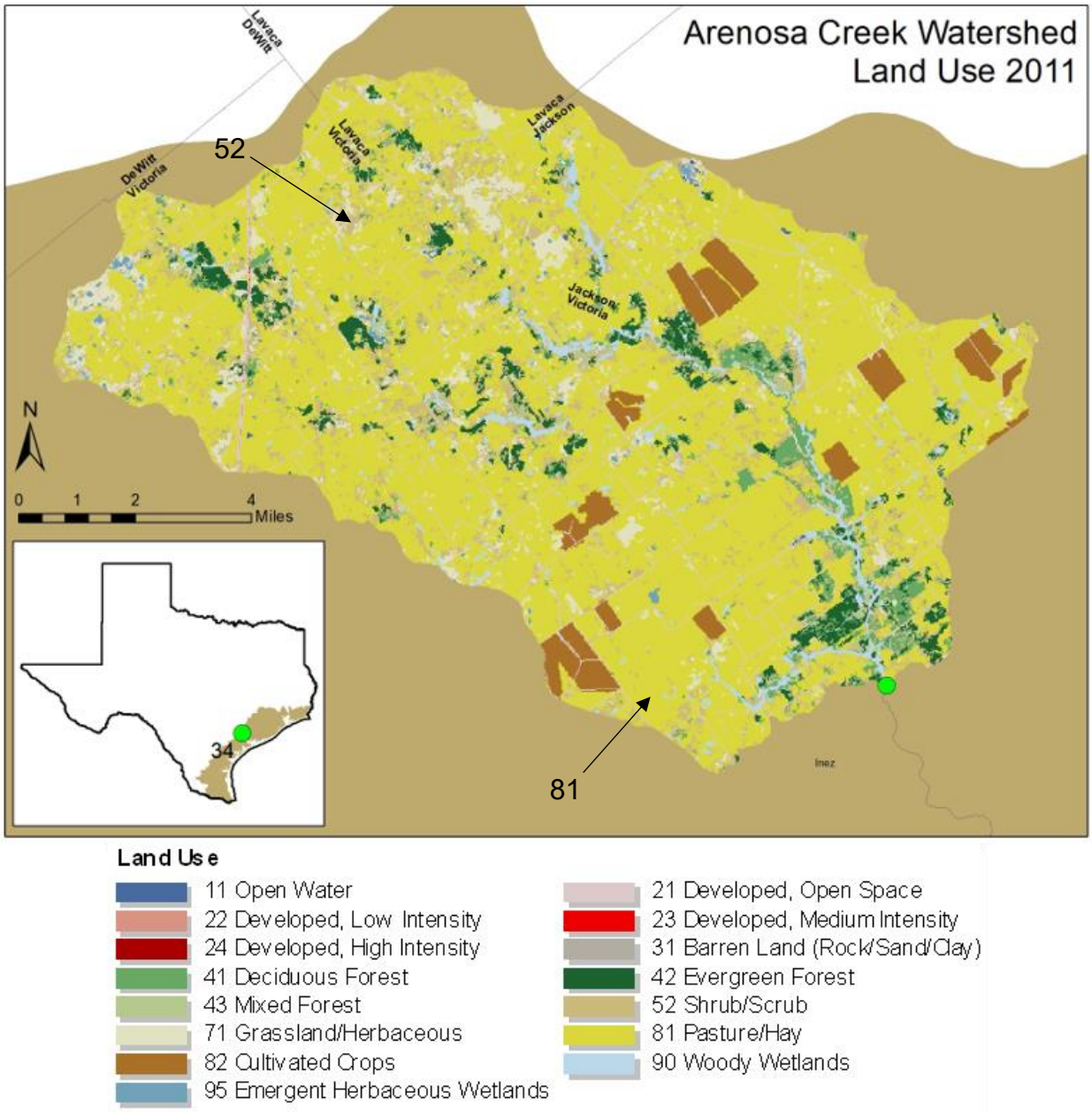

Figure 382. Map of Arenosa Creek watershed and 2011 land use; pasture/hay and shrub/scrub were the most common land uses.

Sampling Dates for Arenosa Creek

Physical Habitat:	September 6, 1988; September 17, 2015; July 13, 2016; July 11, 2017
Water Quality:	51 sampling events
Fish:	September 8, 1988; March 27, 1989; September 1, 2015; July 1, 2016; July 11, 2017
Benthic Invertebrates:	September 6, 1988; September 17, 2015; July 13, 2016; July 11, 2017

Physical Characterization

Watershed and Land Use

Arenosa Creek lies within the Lavaca-Guadalupe Coastal Basin. Sample site 13295 is located at CR 103 north of Victoria, near Inez, on the border of Victoria and Jackson counties (Figure 382).

The Arenosa Creek watershed at site 13295 is approximately 293.99 sq km. The entire watershed lies within the Level IV Ecoregion 34a, the Northern Humid Gulf Coastal Prairies. The watershed is dominated by pasture/hay at 65.68% (Homer et al. 2015; Figure 382 and Figure 383). Shrub/scrub is the secondary land cover encompassing 10.52%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.58% and total cover for cultivated crops is 3.84%.

From 1992-2011 there was a 78.04 sq km decrease in grassland and a 51.66 sq km decrease in shrub. There was a 143.28 sq km increase in pasture/hay and a 10.33 sq km increase in open space development (Figure 384). Cattle were observed in the creek bed during the 2016 sampling event.

As of October 2024 there are no wastewater outfalls within the Arenosa Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Arenosa Creek was evaluated during four sampling events from 1988 to 2017. Arenosa Creek is a perennial stream that drains to the tidal portion of Garcitas Creek. Habitat Quality Index scores are available for three sample events and indicate intermediate to high aquatic life use ratings (16.5-22). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 19.5 meters wide to greater than 20 meters. The riparian zone was generally dominated by shrubs followed by trees then grasses. The average percentage of tree canopy cover ranged from 54% to 85%.

The dominant stream substrate was sand, and the average percent of substrate gravel size or larger varied from 0% to 14%. Average percent instream cover was 28% to 39%; instream cover types consisted of overhanging vegetation, leaf packs, snags, woody debris, root mats, algae, and gravel. Arenosa Creek ranged from 0.1-0.2 meters deep on average and 6-10 meters wide. Average stream bank slope ranged from 20-27 degrees. Stream flow at the site was measured at a minimum value of 0 cfs and a maximum of 1.4 cfs. Average stream bank erosion potential was 37%-41.5%. The deepest pool measured at Arenosa Creek was 1.6 meters. Number of riffles observed at the site varied from zero to four, and total number of stream bends ranged from four to five.

Water Quality

Water samples were collected at station 13295 over 51 sampling events from September 1988 through July 2017. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen,

phosphorus, chloride, sulfate and chlorophyll-*a*. Between the July 2016 and July 2017 sampling events there was a sludge application event upstream of station 13295.

Biological Characterization

Fish

Arenosa Creek was sampled for fish in September 1988 and March 1989, where it received an aquatic life use rating of high and intermediate, respectively. Recent sampling shows a much-improved waterbody. The fish assemblage rated high in September 2015 and exceptional in July 2016 and 2017. Species richness of fish overall and particularly sunfish had doubled since the early collections.

Overall, 25 species (nine families) were collected over the five sampling events. Centrarchidae yielded the most species (10) followed by Cyprinidae with five. Western Mosquitofish was the most abundant species in every collection but the 2015 one where Longear Sunfish outnumbered it. The metric score for number of native cyprinid species rose from three to five. Only Red Shiner and Pugnose Minnow were collected in the samples from the 1980s. No Red Shiner were collected in the recent collections; however, two other native cyprinids were collected along with Pugnose Minnow. These minnows were Golden Shiner and Weed Shiner.

Early samples did not yield any benthic invertivore or intolerant species. Recent samples picked up three benthic invertivore species (one which is classified as an intolerant species) - Slough Darter, Bluntnose Darter, and Tadpole Madtom (intolerant). Number of individuals collected was also slightly higher in the recent collections, resulting in a metric score increase from two to three.

Though neither case resulted in a decrease in respective metric score, a very small incidence of anomalies was detected in recent years and non-native fish species were collected in 2015 and 2016. The non-native species collected were Common Carp and Redbreast Sunfish. In 1988 and 1989 no non-native species were collected, and no anomalies were detected.

Of special significance is the presence of American Eel from three of the five collections. There has been recent concern over the status of this migratory species throughout the United States.

Benthic Macroinvertebrates

A total of 1,635 individuals representing 14 orders of macroinvertebrates were identified in the Surber sample collected on September 6, 1988 and the three RBP kicknet samples collected September 17, 2015, July 13, 2016 and July 11, 2017 (Appendix E). Diptera and Ephemeroptera were the most abundant orders, representing 36.9% and 28.2%, respectively, of the total number of individuals collected. Odonata (9.3%), Pelecypoda (5.5%), Coleoptera (5%), and Oligochaeta (5.3%) were also well represented in the collection. Other taxa, representing greater than 1% of the samples combined, include Amphipoda (3.8%), Decapoda (2%), Gastropoda (1.5%), and Ostracoda (1.2%).

Results for Ecoregion 34 BIBI ranged from intermediate aquatic life use for the samples collected on July 13, 2016 and July 11, 2017 to high aquatic life use for the sample collected

September 17, 2015. The differences are likely related to the highly variable flow which greatly affects the available instream habitat.

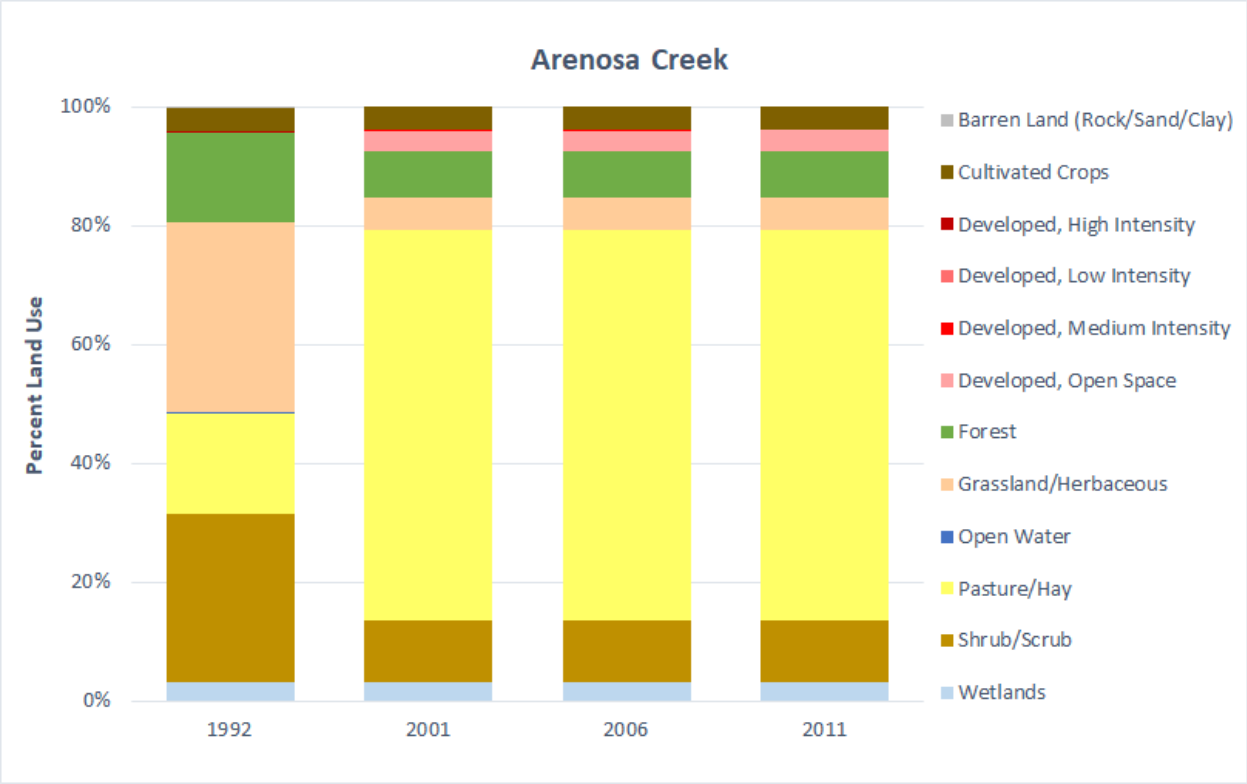

Figure 383. Percent land use in the Arenosa Creek watershed from 1992-2011.

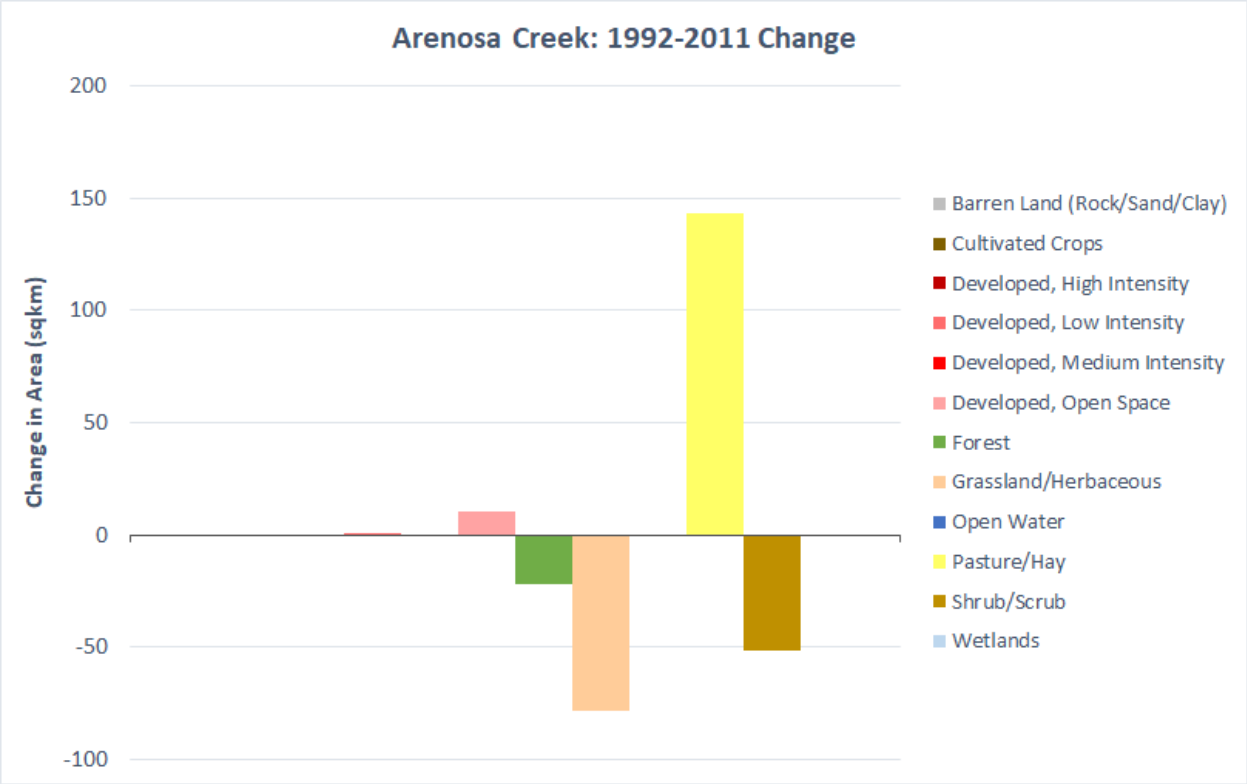

Figure 384. Land use change in area (sq km) from 1992-2011 for the Arenosa Creek watershed.

BIG CREEK

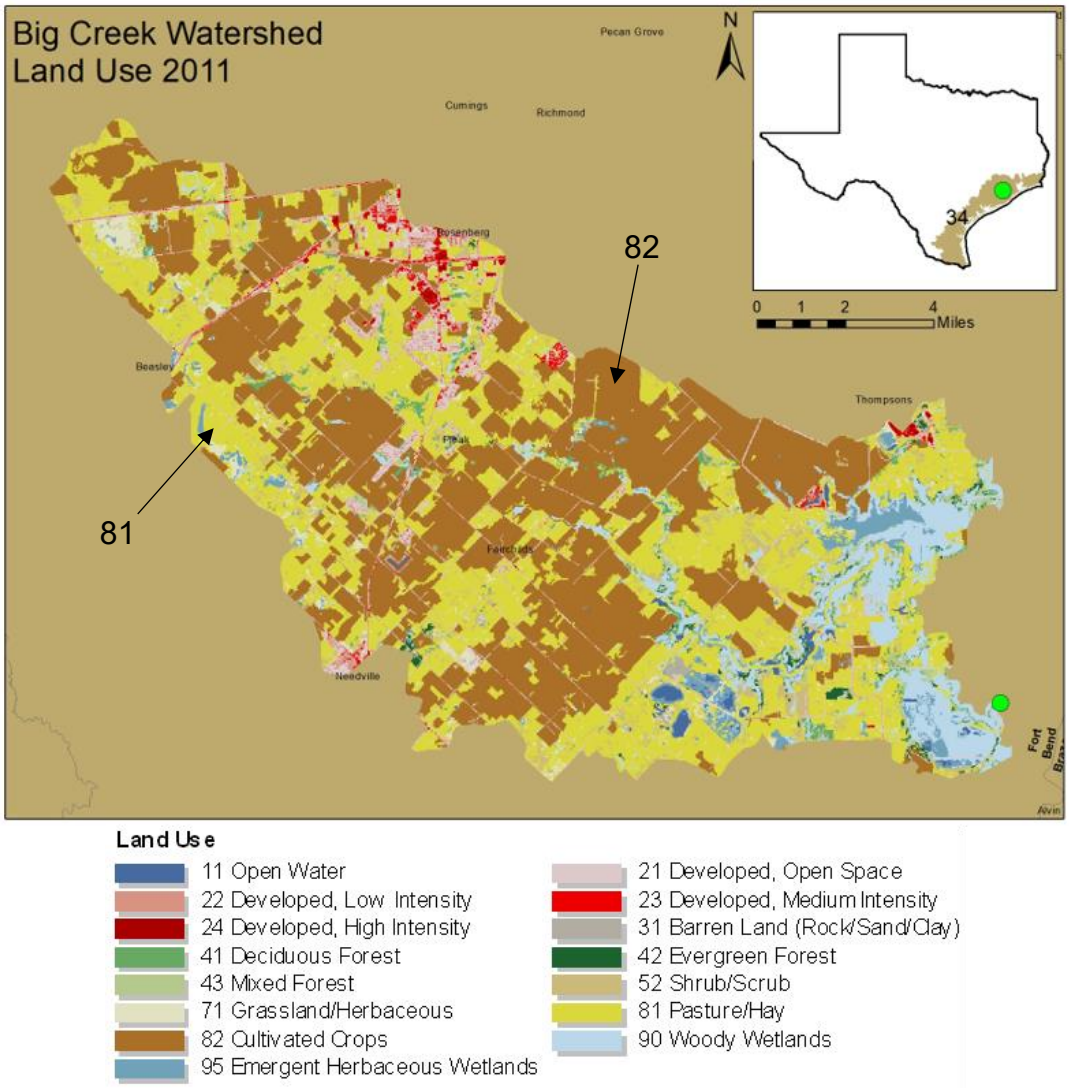

Figure 385. Map of Big Creek watershed and 2011 land use; cultivated crops and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	Station 11518 - June 20, 1990; Station 16353 - June 4, 2009; April 29, 2010; Station 17932 - May 12, 2003; August 13, 2003; April 6, 2004; June 9, 2005; April 18, 2006
Water Quality:	144 sampling events at stations 11518 (38 events), 16353 (79 events and 17932 (27 events)
Fish:	Station 11518 - June 20, 1990; Station 16353 - June 4, 2009; September 3, 2009; April 29, 2010; October 6, 2010; Station 17932 - May 12, 2003; August 13, 2003; April 6, 2004; September 3, 2004; June 9, 2005; July 29, 2005; April 18, 2006; October 15, 2006

Benthic Invertebrates: Station 11518 - June 20, 1990; Station 16353 - June 6, 2009; September 3, 2009; April 29, 2010; October 7, 2010; Station 17932 - May 12, 2003; August 13, 2003; April 6, 2004; September 3, 2004; June 9, 2005; July 29, 2005; April 18, 2006; October 5, 2006

Physical Characterization

Watershed and Land Use

Big Creek lies within the Brazos River Basin. Sample site 17932 is located in Brazos Bend State Park, 0.8 km upstream of the confluence with Waters Lake Bayou in Fort Bend County (Figure 385).

The Big Creek watershed at site 17932 is approximately 429.77 sq km. The station and a very small portion of the lower watershed lies within Level IV Ecoregion 34c, the Floodplains and Low Terraces, while the majority of the watershed lies within Level IV Ecoregion 34a, the Northern Humid Gulf Coastal Prairies. The dominant land cover in the watershed is cultivated crop at 37.33% and is present throughout the middle and upper watershed (Homer et al. 2015; Figure 385 and Figure 386). Pasture/hay is the secondary land cover encompassing 35.6% and is present throughout the watershed. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 7.45% of the watershed.

From 1992-2011 there was a 45.18 sq km decrease in forest and a 30.43 sq km decrease in pasture/hay. There was a 49.47 sq km increase in cultivated crops and an 18.6 sq km increase in open space development (Figure 387).

As of October 2024, there are a total of twelve domestic wastewater outfalls: 10 of which each discharge < 1 million gallons per day, and two larger wastewater outfalls (each discharges ≥ 1 million gallons per day) within the Big Creek watershed. Additionally, permits for two wastewater facilities are pending.

Alligators and seven species of freshwater mussels have been observed in Big Creek.

In Channel and Riparian Physical Habitat

Physical habitat for Big Creek was evaluated at three sites over eight sampling events from 1990 to 2010. Big Creek is a perennial stream that drains to the Brazos River at Brazos Bend State Park. Habitat Quality Index scores are available for seven sample events, three indicate an intermediate aquatic life use (14 – 18) and four indicate a high aquatic life use rating (20-25). Riparian areas were generally well vegetated throughout the reach with an average riparian buffer ranging from 8 meters wide to greater than 20 meters. The riparian zone was generally dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 21% to 51%.

The dominant stream substrate was clay, and the average percent of substrate gravel size or larger varied from 0% to 40%. Average percent instream cover was 4% to 20% and instream cover types include overhanging vegetation, woody debris, root mats, undercut banks,

logs/snags, and gravel. Big Creek ranged from 0.04-0.70 meters deep on average and 5-10 meters wide. Average stream bank slope ranged from 25-46 degrees. Stream flow at the sites was measured at a minimum value of 0.6 cfs and a maximum of 17 cfs. Average stream bank erosion potential was 15%-47%. The deepest pool measured at Big Creek was 1.75 meters. Number of riffles observed at the sites varied from zero to five, and count of total number of stream bends within the reach ranged from one to six.

Water Quality

Water samples were collected at three stations: 11518, 16353 and 17932. Sampling at 11518 consisted of 38 sampling events from June 1990 through May 2002. Samples at 16353 were collected at 79 events from January 2009 through November 2019. Samples at station 17932 were collected at 27 events from May 2003 through August 2008. Parameters measured included temperature, flow, transparency (except at station 11518), specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon (except at station 11518), chloride, sulfate and chlorophyll-*a*.

Biological Characterization

Fish

Fish collections from three sample stations (within approximately 28 km of each other) were used in the evaluation of this river reach. Overall, 44 species (15 families) were collected over the 13 sampling events. Cyprinidae yielded the most species (14) followed by Centrarchidae with ten. Red Shiner, Western Mosquitofish, and Bullhead Minnow were found in every collection. Red Shiner was the most numerous fish in all but two collections, June 1990 and April 2010, where Western Mosquitofish and Striped Mullet (*Mugil cephalus*) outnumbered them, respectively. Of the 13 collections, four rated a high aquatic life use (all within station 17932), seven intermediate, and one limited (August 2003 - also within station 17932). The percentage of individuals classified as tolerant species was very high in 11 of the 13 collections (as high as 85%), intolerant species and benthic invertivores were absent in over one-half of the collections, trophic structure was out of balance, and low numbers of individuals were collected.

Benthic Macroinvertebrates

A total of 3,426 individuals representing 12 orders of macroinvertebrates were collected from three sites on Big Creek on 13 sample dates (Appendix E). Ephemeroptera, Trichoptera, and Coleoptera were the three most abundant orders. Odonata, Amphipoda, Gastropoda, and Diptera were also well represented in the collections.

The results for the Ecoregion 34 BIBI for the Big Creek benthic assemblage ranged from intermediate to exceptional, with two samples falling in the exceptional aquatic life use category, ten samples falling in the high aquatic life use category, and one sample falling in the intermediate aquatic life use category.

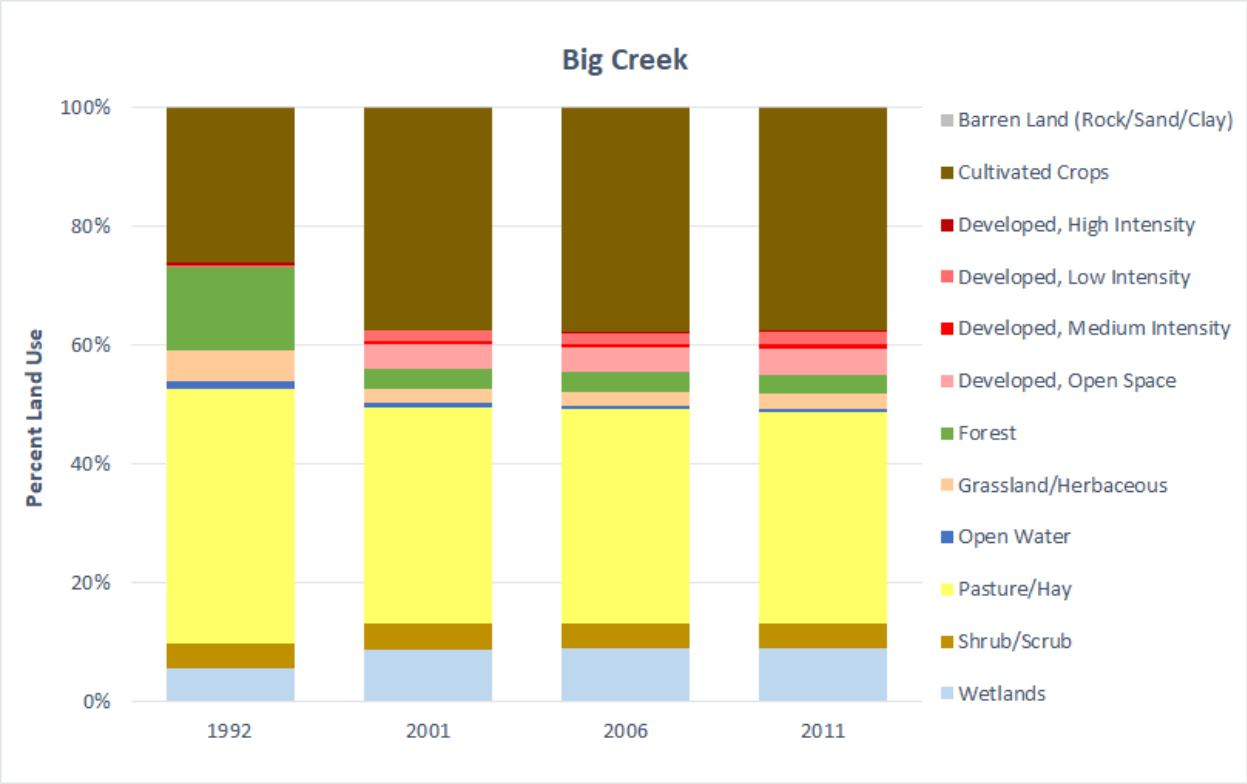

Figure 386. Percent land use in the Big Creek watershed from 1992-2011.

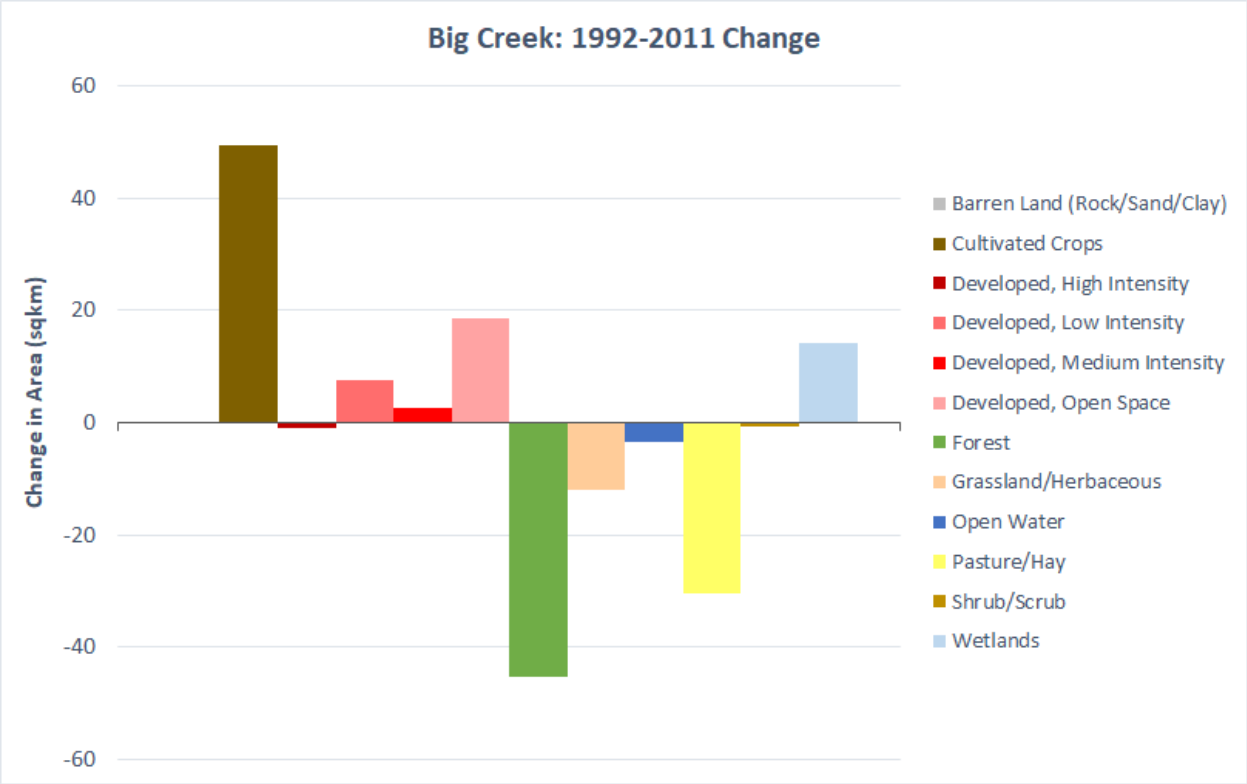

Figure 387. Land use change in area (sq km) from 1992-2011 for the Big Creek watershed.

GARCITAS CREEK

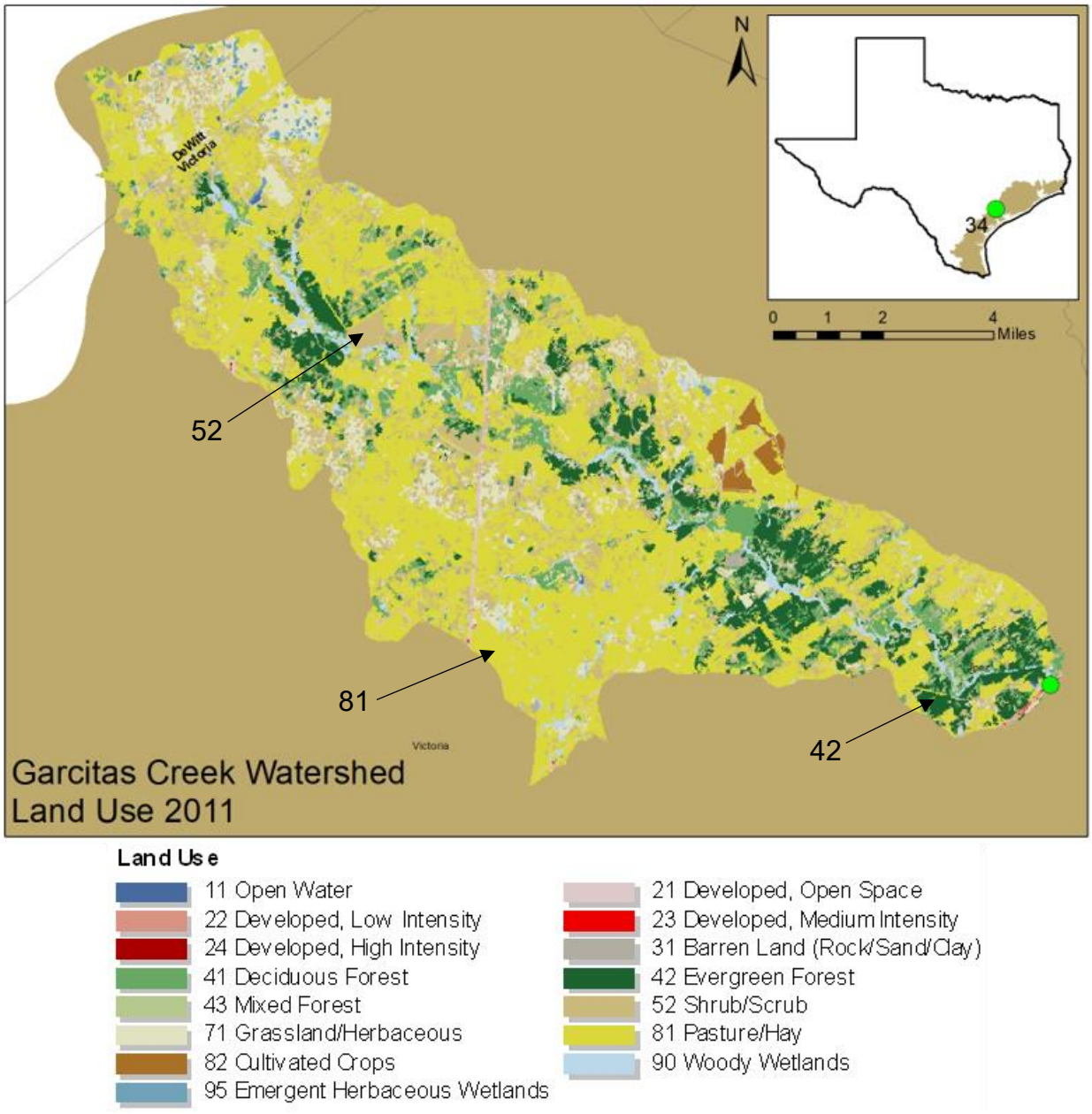

Figure 388. Map of Garcitas Creek watershed and 2011 land use; pasture/hay, forest, and shrub/scrub were the most common land uses.

Sampling Dates

Physical Habitat:	August 21, 1987; September 17, 2015; July 13, 2016
Water Quality:	67 sample events
Fish:	August 12, 1987; September 17, 2015; July 13, 2016
Benthic Invertebrates:	August 13, 1988; September 17, 2015; July 13, 2016

Physical Characterization

Watershed and Land Use

Garcitas Creek lies within the Lavaca-Guadalupe Coastal Basin. Sample site 13291 is located at US Highway 59 north of Victoria, near Inez, in northern Victoria County (Figure 388).

The Garcitas Creek watershed at site 13291 is approximately 239.54 sq km. The entire watershed lies within the Level IV Ecoregion 34a, the Northern Humid Gulf Coastal Prairies. The watershed is dominated by pasture/hay at 48.47% (Homer et al. 2015; Figure 388 and Figure 389). Forest and shrub are the secondary land cover types, encompassing 18.5% and 17.56% of the watershed, respectively. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.04% and total cover for cultivated crops is 0.82%.

From 1992-2011 there was a 59.77 sq km decrease in shrub and a 24.91 sq km decrease in grassland. There was a 98.55 sq km increase in pasture/hay (Figure 390).

As of October 2024, there is one domestic wastewater outfall (discharges < 1 million gallons per day) permitted to the Texas Department of Transportation which is located right at the access point to the sample site. Sampling occurred upstream of the wastewater outfall.

In Channel and Riparian Physical Habitat

Physical habitat for Garcitas Creek was evaluated during three sampling events from 1987 to 2016. Garcitas Creek is an intermittent stream with perennial pools that drains to Garcitas Cove in Lavaca Bay. Habitat Quality Index scores are available for two sample events and both indicate a high aquatic life use rating (21.5 and 24). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 20 meters wide to greater than 20 meters. The riparian zone was generally dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 66% to 96%.

The dominant stream substrate was sand, and the average percent of substrate gravel size or larger varied from 27% to 39%. Average percent instream cover was 46% to 71% and instream cover types include overhanging vegetation, leaf packs, snags, woody debris, root mats, algae, undercut banks, and gravel. Garcitas Creek was 0.2 meters deep on average and 5.5-6.4 meters wide. Average stream bank slope ranged from 26-35 degrees. Stream flow at the site was measured at a minimum value of 0.9 cfs and a maximum of 6.9 cfs. Average stream bank erosion potential was 46%-53%. The deepest pool measured at Garcitas Creek was 1.3 meters. Number of riffles observed at the site varied from one to six, and total number of stream bends ranged from four to nine.

Water Quality

Water samples were collected at station 13291 over 67 sampling events from November 1986 through July 2016. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen,

phosphorus, total organic carbon, chloride, sulfate and chlorophyll-a. Data include two biological sampling events which were conducted in September 2015 and July 2016.

Continuous flow data is available from USGS gage 08164600 (Figure 391). Between January 1985 through December 2019, the median flow was 2.14 cfs and daily average flows range from 0 cfs to 13,100 cfs. Flows increase sharply with rain events throughout the year and 1.1 percent of daily mean flows are greater than 1000 cfs. Data have been log transformed to better visualize flow patterns.

Biological Characterization

Fish

Twenty-four species (nine families) were collected over the course of the three sampling events. Centrarchidae yielded the greatest number of species (eight), followed by Cyprinidae with five. Blacktail Shiner was the most abundant species in the 1987 collection, Bluegill in 2015, and Weed Shiner in 2016. The fish assemblage reflected a slight depression in quality between 1987 and the two most recent collections, declining from a high aquatic life use to intermediate. The main reasons for this decline are the large decrease in native cyprinid species, absence of intolerant species, and the presence of non-native species.

Five native cyprinid species were collected in 1987. In recent collections only one was collected, Weed Shiner (which was also present in the early collection). There was one intolerant species (Dusky Darter) present in the 1987 collection, which was not collected in the 2015 or 2016 sample events.

Non-native species were not found in 1987; however, 10% of the catch in 2015 and 5% of the catch in 2016 was comprised of Redbreast Sunfish. One metric showed an increase in the most recent collections but could signal a shift in overall habitat and flow conditions.

Only three sunfish species were collected in 1987 compared to more than twice that in recent collections. This typically indicates the system has become more lentic in nature. Another indication of this is the apparent loss of Burrhead Chub (*Macrhybopsis marconis*). Burrhead Chub are broadcast spawners, requiring flowing water to successfully reproduce. Being a short-lived species, the absence of optimum flow conditions for two to three successive years can eliminate a population.

Benthic Macroinvertebrates

Considering all three samples, a total of 564 individuals representing 15 orders of macroinvertebrates were collected from Garcitas Creek (Appendix E). Trichoptera, Ephemeroptera, Odonata, Diptera, Pelecypoda, and Coleoptera were the most commonly collected orders.

The results for the Surber BIBI sample collected in 1988 and the Ecoregion 34 BIBI sample collected in 2015 fell in the exceptional aquatic life use category. The 2016 sample indicated a high aquatic life use category. In contrast to the results for the fish assemblage, which seem to

reflect a slight decline in integrity over time, these results indicate that the biological integrity of the benthic macroinvertebrate assemblage in Garcitas Creek has remained constant or improved slightly over the 22-year period that the three sample events span.

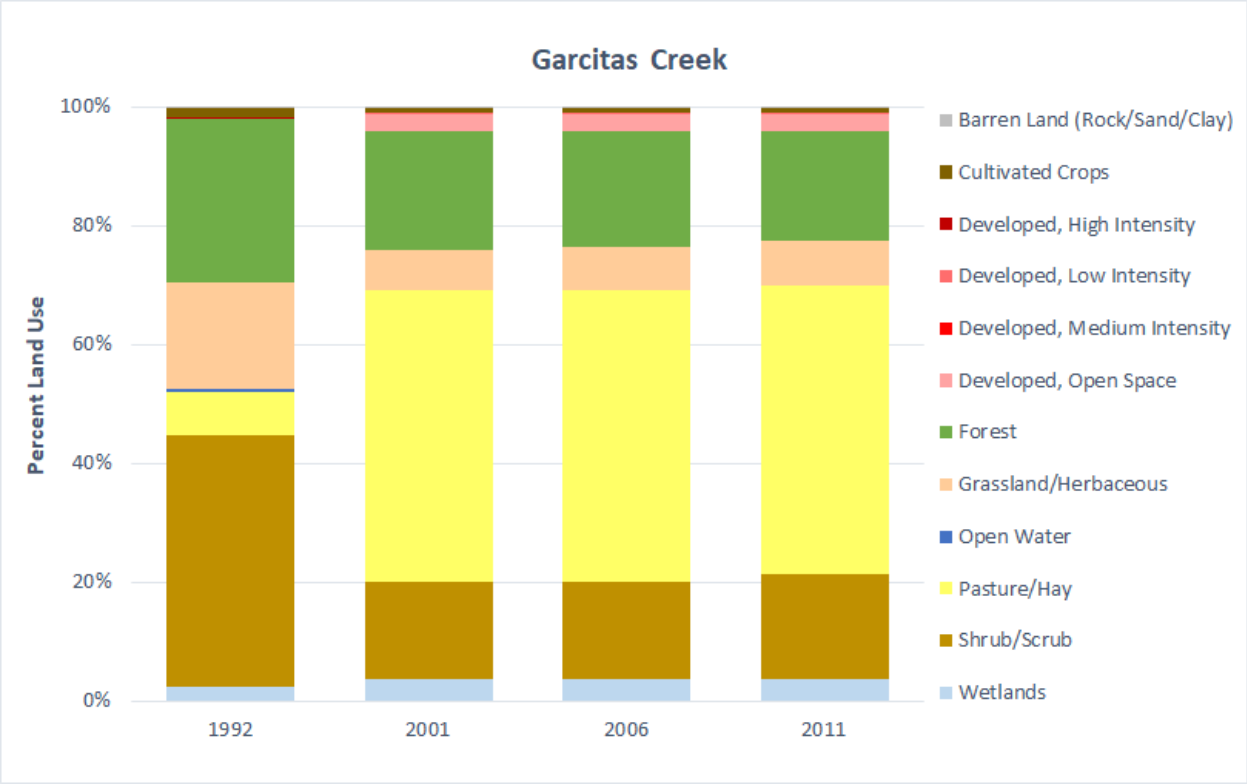

Figure 389. Percent land use in the Garcitas Creek watershed from 1992-2011.

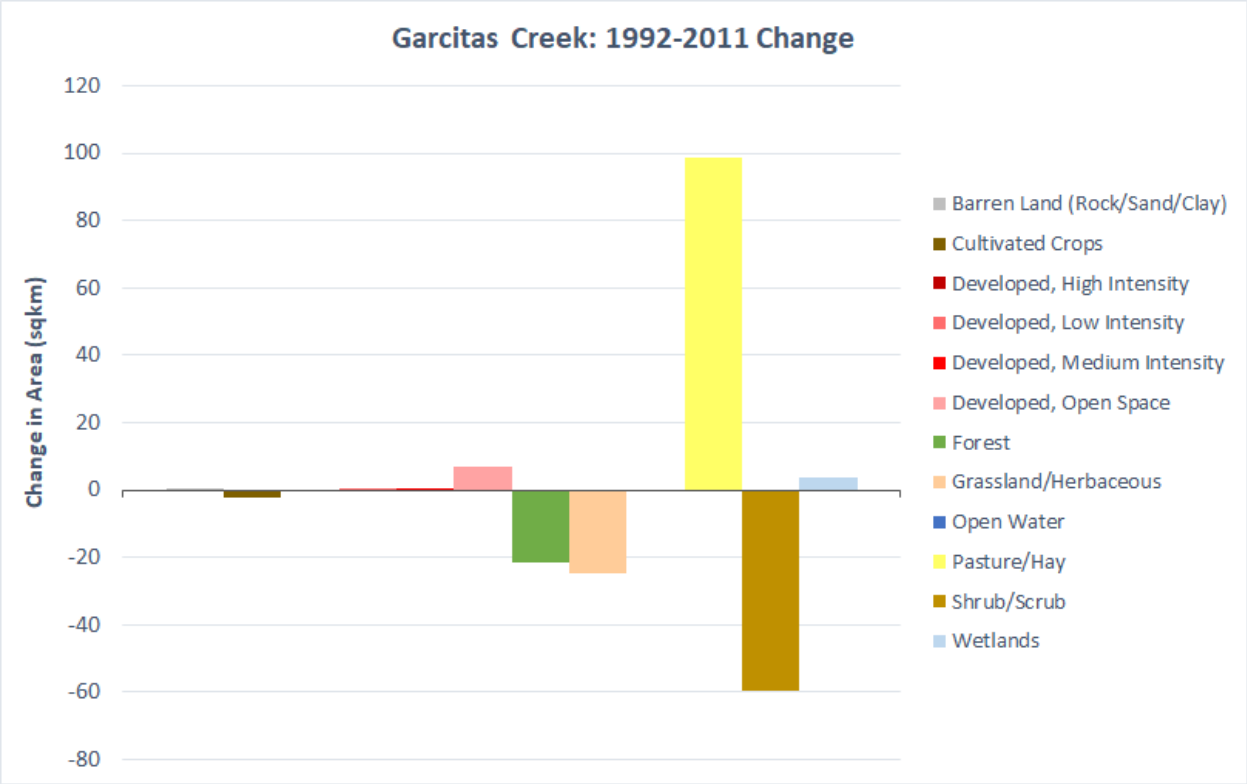

Figure 390. Land use change in area (sq km) from 1992-2011 for the Garcitas Creek watershed.

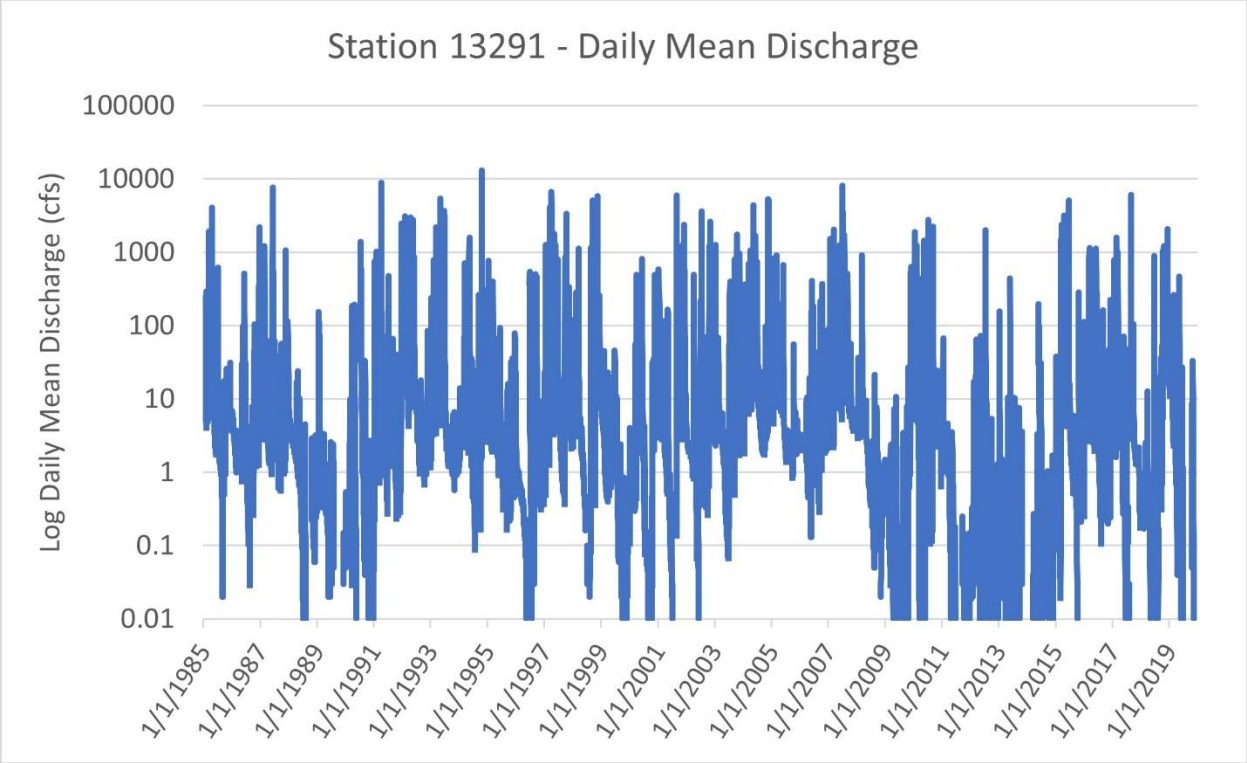

Figure 391. Log transformed daily mean discharge for Garcitas Creek at station 13291.

PLACEDO CREEK

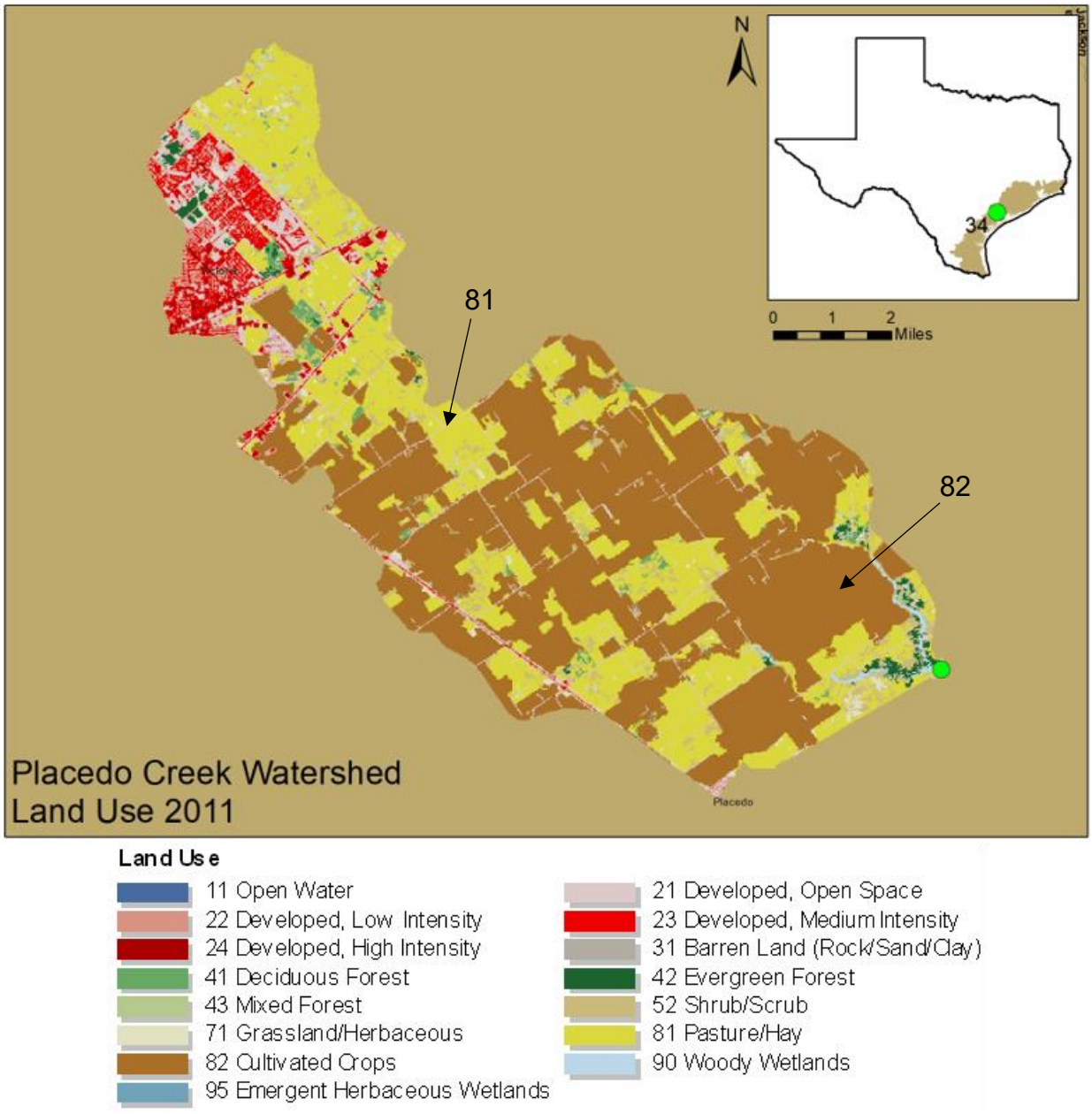

Figure 392. Map of Placedo Creek watershed location and 2011 land use; cultivated crops and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	September 6, 1988; July 11, 2017
Water Quality:	19 sampling events
Fish:	September 7, 1988; March 28, 1989; July 11, 2017
Benthic Invertebrates:	September 7, 1988; July 11, 2017

Physical Characterization

Watershed and Land Use

Placedo Creek lies within the Lavaca-Guadalupe River Coastal Basin. Sample site 13288 is located at FM 616 northeast of Placedo in Victoria County (Figure 392).

The Placedo Creek watershed at site 13288 is approximately 176.07 sq km. The entire watershed lies within the Level IV Ecoregion 34a, the Northern Humid Gulf Coastal Prairies. The dominant land cover in the watershed is cultivated crop at 47.82% and is most dense in the middle and lower portions of the watershed (Homer et al. 2015; Figure 392 and Figure 393). Pasture/hay is the secondary land cover encompassing 30% and is present throughout the watershed. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 12.74% of the watershed.

From 1992-2011 there was a 16.78 sq km decrease in grassland and a 10.17 sq km decrease in forest. There was a 14 sq km increase in cultivated crops and a 9.14 sq km increase in pasture/hay (Figure 394).

As of October 2024, there are no permitted wastewater outfalls within the Placedo Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for Placedo Creek was evaluated on September 6, 1988 and again on July 11, 2017. Placedo Creek is a coastal stream that drains to Lavaca Bay. The following summary is based on data collected during the sampling event in 2017. The Habitat Quality Index score of 16 indicates an intermediate aquatic life use rating. Riparian areas were well vegetated throughout the reach with an average riparian buffer measured at greater than 20 meters. The riparian zone was dominated by grasses, which make up an average of 75% of the total riparian species, followed by shrubs (15%) then trees (10%). The average percentage of tree canopy cover was 95%.

The dominant substrate was silt, and the average percent of substrate that was gravel size or larger was 11%. Average percent instream cover was 86% and instream cover types include woody debris, undercut banks, and tree roots. Placedo Creek was 0.25 meters deep on average and 5 meters wide. Average stream bank slope was 42 degrees, and average stream bank erosion potential was 26%. The deepest pool measured at Placedo Creek was 0.97 meters. Stream flow at the site was measured at a minimum value of 0 cfs in 1988 and a maximum of 1 cfs in 2017. One riffle was observed at the site and there were three total stream bends within the reach.

Water Quality

Water samples were collected at station 13288 over 19 sampling events from September 1988 through July 2017. Parameters measured included temperature, flow, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*.

Continuous flow data is available from USGS gage 08164800 (Figure 395). Between January 1985 through December 2019, the median flow was 10.2 cfs and daily average flows range from 0 cfs to 10,100 cfs. Flows increase sharply with rain events throughout the year and 1.2 percent of daily mean flows are greater than 1000 cfs. Data have been log transformed to better visualize flow patterns.

Biological Characterization

Fish

Only 13 species (eight families) were collected over the course of the three sampling events. Centrarchidae was the richest family, yielding five species. Western Mosquitofish was the most abundant species in each collection. All three fish collections yielded an intermediate aquatic life use rating. No intolerant or benthic invertivore species were collected. Only one cyprinid species (Red Shiner) was in the assemblage, and low numbers of individuals were collected.

Of special significance, however, was the collection of four American Eel in 1988. There has been recent concern over the status of this migratory species throughout the United States.

Benthic Macroinvertebrates

A total of 16,585 individuals representing 77 macroinvertebrate taxa from 14 orders were identified in the Surber sample collected in 1988 and the RBP kicknet sample collected in 2017 from Placedo Creek (Appendix E). Oligochaeta and Ostracoda were collected in large numbers in the Surber sample, representing 99% of the individuals collected. Other groups well represented in both samples included the Gastropoda, Diptera, Coleoptera, Odonata, Trichoptera, and Ephemeroptera.

Despite the predominance of oligochaetes in the sample, the quantitative Surber BIBI score for the sample falls in the range indicating a high aquatic life use. A relatively high taxa richness, high number of intolerant taxa, and high percent collector-gatherer taxa contributed to the sample BIBI falling in the high aquatic life use category. There was more even distribution of individuals among taxa in the RBP kicknet sample. The result for the Ecoregion 34 RBP BIBI also indicated that the benthic assemblage in Placedo Creek falls in the high aquatic life use category. These results indicate that the integrity of the benthic assemblage in Placedo Creek has remained high over the 29-year interim period between collections.

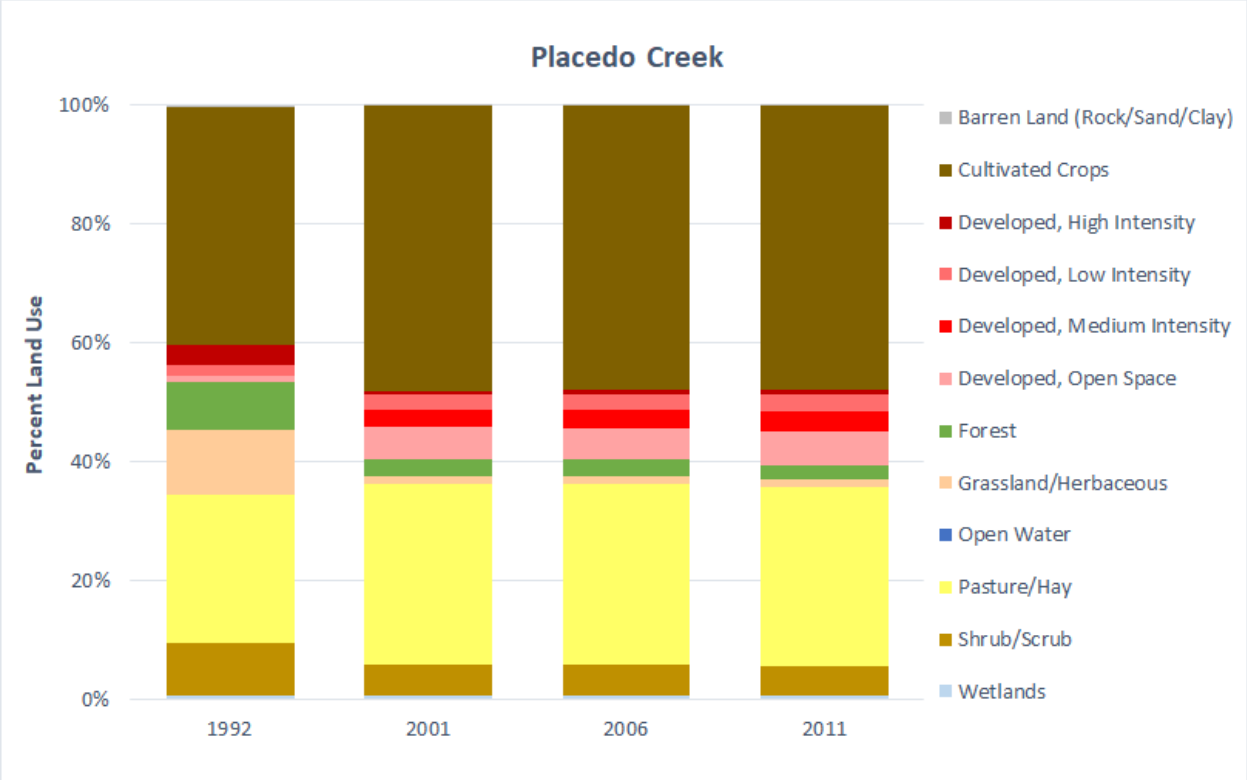

Figure 393. Percent land use in the Placedo Creek watershed from 1992-2011.

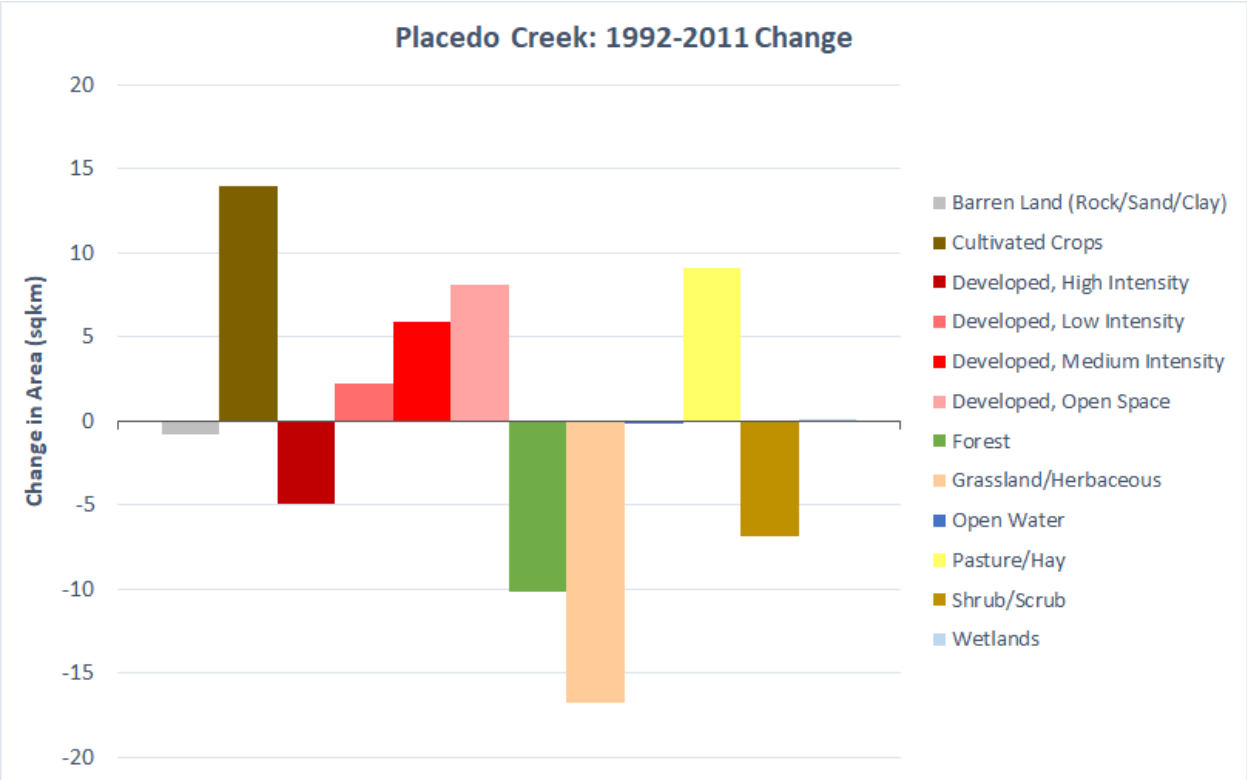

Figure 394. Land use change in area (sq km) from 1992-2011 for the Placedo Creek watershed.

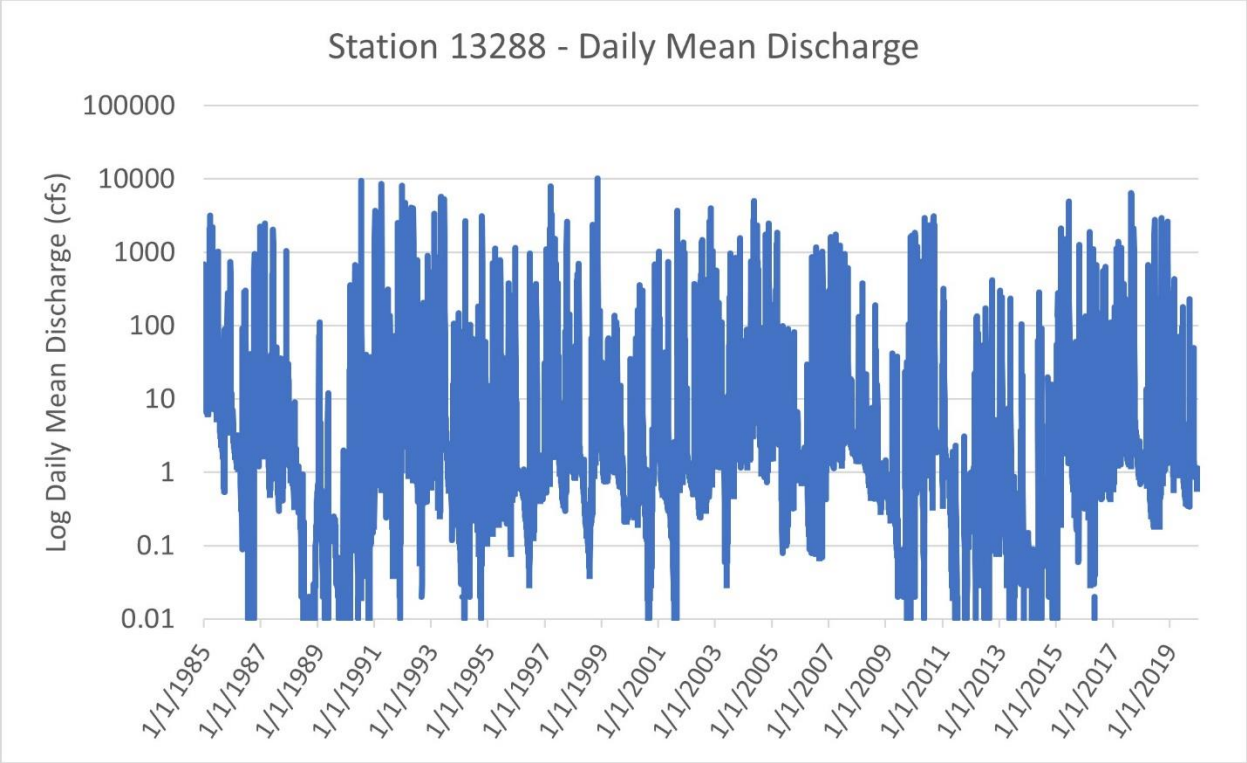

Figure 395. Log transformed daily mean discharge for Placedo Creek at station 13288.

SAN BERNARD RIVER

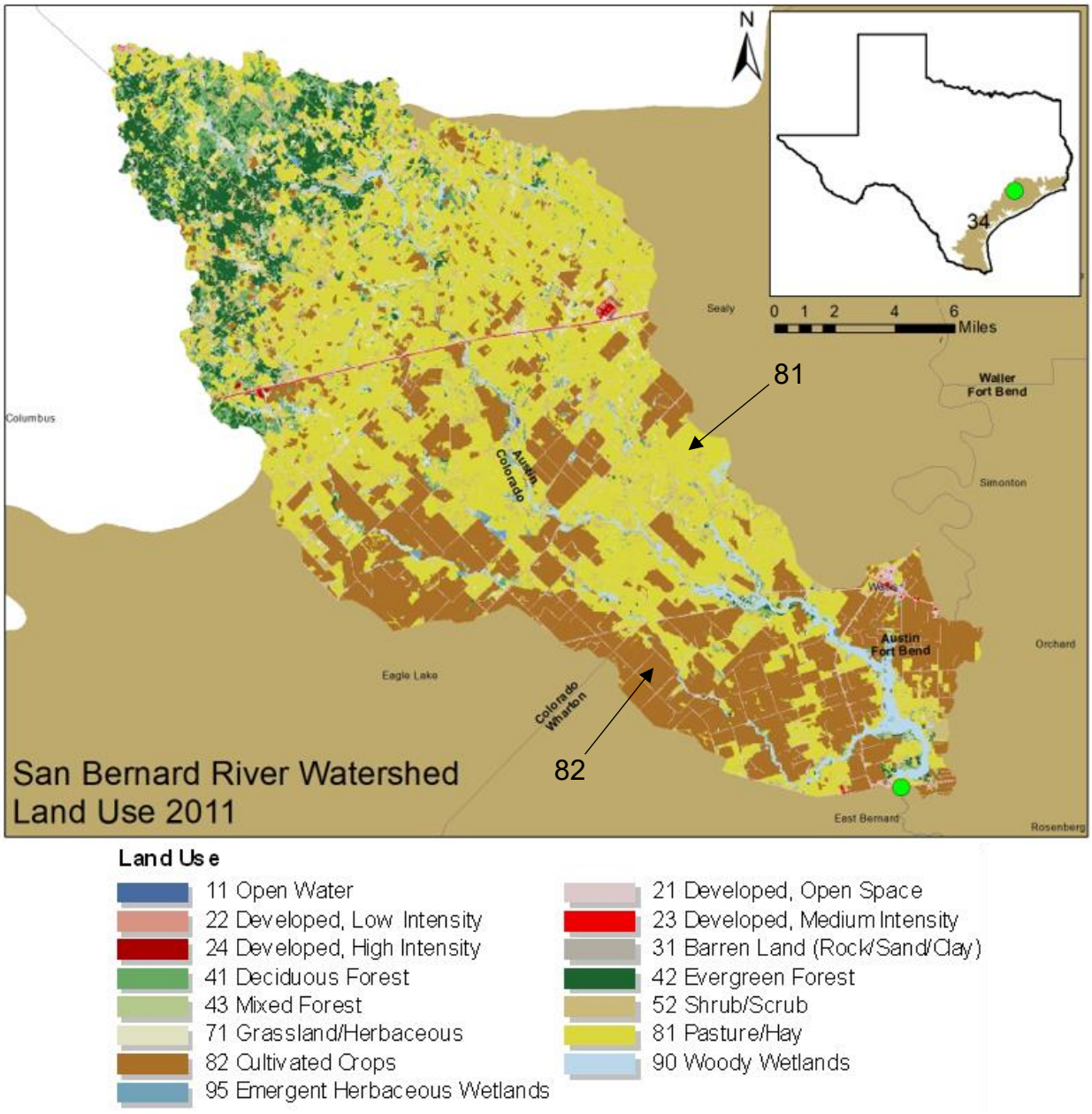

Figure 396. Map of San Bernard River watershed and 2011 land use; pasture/hay and cultivated crops were the most common land uses.

Sampling Dates

Physical Habitat:	June 23, 2003; August 26, 2003; May 17, 2006
Water Quality:	99 sampling events
Fish:	June 23, 2003; August 26, 2003; May 17, 2006; October 5, 2006
Benthic Invertebrates:	June 23, 2003; August 26, 2003; May 17, 2006; October 5, 2006

Physical Characterization

Watershed and Land Use

The San Bernard River lies within the Brazos-Colorado River Coastal Basin. Sample site 16373 is located downstream of US 90A in East Bernard in Wharton County (Figure 396).

The San Bernard River watershed at site 16373 is approximately 885.18 sq km. Most of the watershed lies within the Level IV Ecoregion 34a, the Northern Humid Gulf Coastal Prairies. The upper watershed lies within the Level IV Ecoregion 33b, the Southern Post Oak Savannah. The dominant land cover in the watershed is pasture/hay at 44.56% and is most dense in the middle of the watershed (Homer et al. 2015; Figure 396 and Figure 397). Cultivated crop is the secondary land cover encompassing 26.44% and is most dense in the lower watershed. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 4.7% of the watershed.

From 1992-2011 there was a 127.76 sq km decrease in pasture/hay and a 24.56 sq km decrease in forest. There was a 112.09 sq km increase in cultivated crops and a 35.51 sq km increase in open space development (Figure 398).

As of October 2024, there are four domestic wastewater outfalls (discharges < 1 million gallons per day) and one pending permit within the San Bernard River watershed. None of these facilities discharge directly into the San Bernard River.

In Channel and Riparian Physical Habitat

Physical habitat for the San Bernard River was evaluated during three sampling events from 2003 to 2006. The San Bernard River is a perennial stream that drains to the Gulf of Mexico. Habitat Quality Index scores for all three events indicate an intermediate to high aquatic life use rating (18-21). Riparian areas were generally well vegetated throughout the reach with an average riparian buffer ranging from 9.5 meters wide to greater than 20 meters. The riparian zone was dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 75% to 98%.

The dominant stream substrate was sand, and the average percent of substrate gravel size or larger varied from 6% to 16%. Average percent instream cover was 5% to 27% and instream cover types include undercut banks, woody debris, tree roots, and gravel. The San Bernard River ranged from 0.15-0.53 meters deep on average and 5.4-9.4 meters wide. Average stream bank slope ranged from 28-53 degrees. Stream flow at the site was measured at a minimum value of 2.4 cfs and a maximum of 20 cfs. Average stream bank erosion potential was 11%-38%. The deepest pool measured at the San Bernard River was 1.3 meters. Number of riffles observed at the site varied from one to two, and total number of stream bends ranged from four to five.

Water Quality

Water samples were collected at station 16373 over 99 sampling events from July 1997 through October 2019. Parameters measured included temperature, flow, transparency, specific

conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*.

Biological Characterization

Fish

Twenty-five species (eight families) were collected over the course of four sampling events. Cyprinidae and Centrarchidae were the two richest families, yielding seven and six species, respectively. Blacktail Shiner was the most abundant species in June 2003 and May 2006 whereas Western Mosquitofish and Ribbon Shiner were the most abundant species in August 2003 and October 2006, respectively. Three of the four fish assemblages scored as having an exceptional aquatic life use. When the coefficient of variability is applied, all score as exceptional.

Benthic Macroinvertebrates

Forty-eight taxa representing 13 orders of macroinvertebrates were collected in the four RBP kicknet samples (Appendix E). Taxa richness for individual samples ranged from 25 for the sample collected in June 2003, to 30 in the sample collected in October 2006. Ephemeroptera, Trichoptera, Odonata, and Coleoptera were the most common taxa in the samples, collectively representing approximately 80% of the total number of individuals collected over the four sample dates. Other groups well represented in the samples included class Bivalvia (primarily *Corbicula fluminea* and *Eupera cubensis*), Decapoda (primarily Cambaridae and *Palaemonetes*), and the amphipod *Hyallela azteca*.

Results for the Ecoregion 34 macroinvertebrate IBI fell in the exceptional aquatic life use category for all four samples.

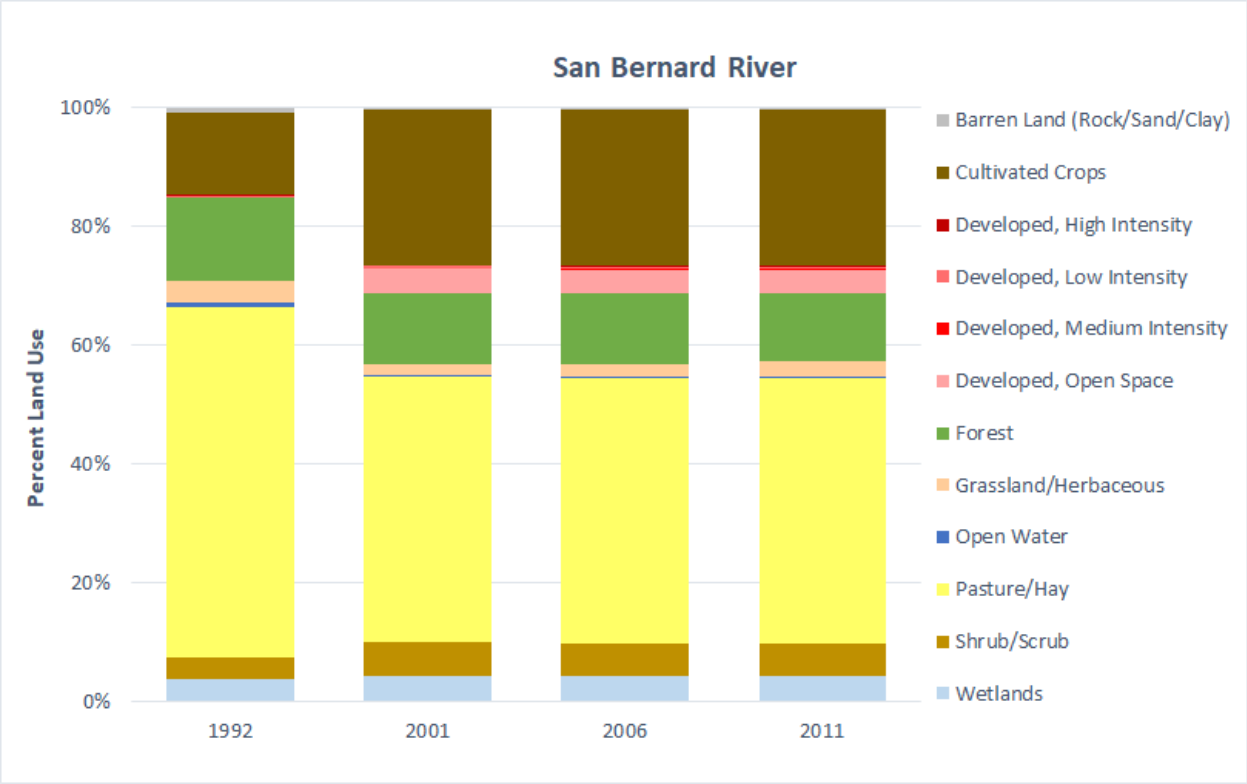

Figure 397. Percent land use in the San Bernard River watershed from 1992-2011.

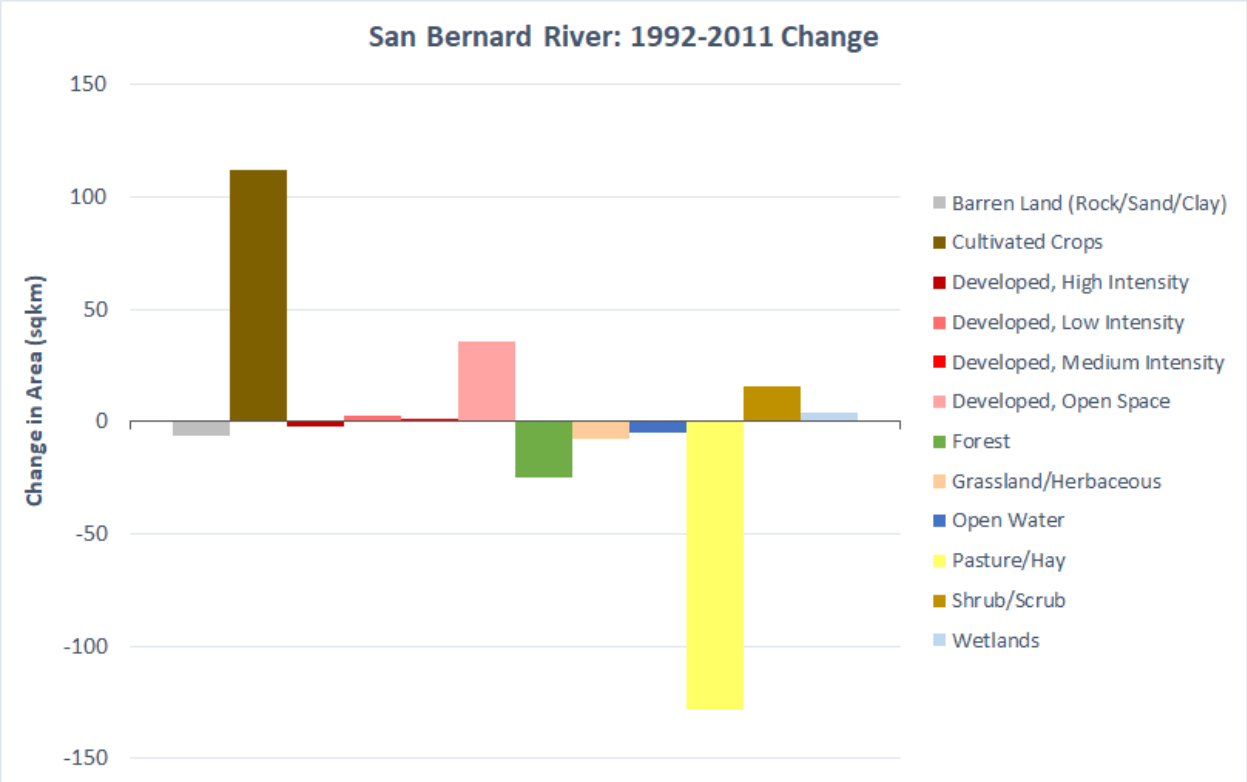

Figure 398. Land use change in area (sq km) from 1992-2011 for the San Bernard River watershed.

WEST BERNARD CREEK

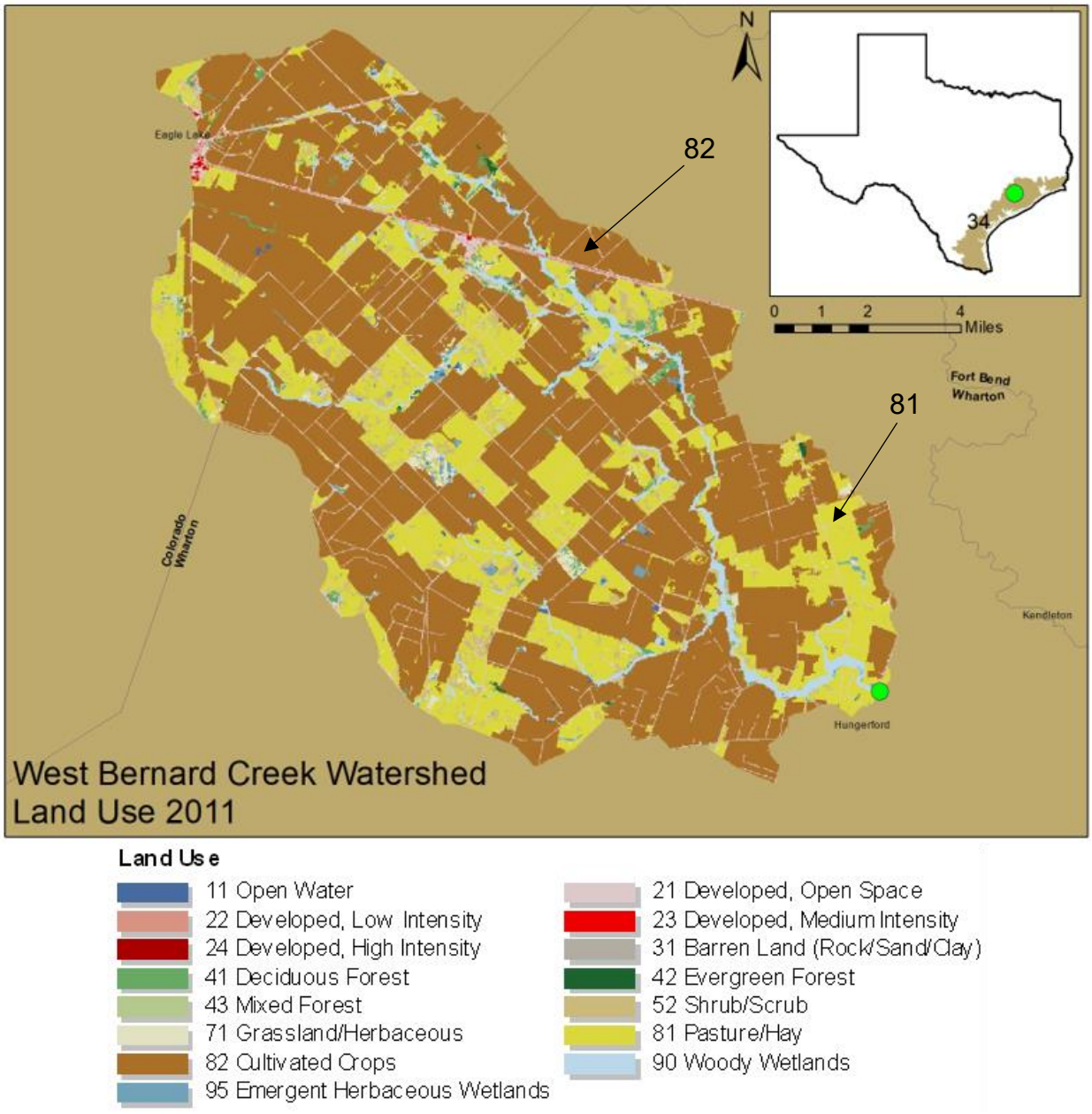

Figure 399. Map of West Bernard Creek watershed and 2011 land use; cultivated crops and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	June 20, 1990; August 26, 2008; April 14, 2009, June 15, 2010
Water Quality:	20 sampling events
Fish:	June 20, 1990; August 26, 2008; April 14, 2009, June 15, 2010
Benthic Invertebrates:	June 20, 1990; August 26, 2008; April 14, 2009, June 15, 2010

Physical Characterization

Watershed and Land Use

West Bernard Creek lies within the Brazos-Colorado River Coastal Basin. Sample site 12131 is located 50 m downstream of SH 60, 4.8 km north of Hungerford in Wharton County (Figure 399).

The West Bernard Creek watershed at site 12131 is approximately 387.15 sq km. The entire watershed lies within the Level IV Ecoregion 34a, the Northern Humid Gulf Coastal Prairies. The dominant land cover in the watershed is cultivated crop at 61.74% and is present throughout the watershed (Homer et al. 2015; Figure 399 and Figure 400). Pasture/hay is the secondary land cover encompassing 23.43%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 4.81% of the watershed.

From 1992-2011 there was a 70.72 sq km decrease in forest and a 20.33 sq km decrease in grassland. There was a 118.28 sq km increase in cultivated crops and a 15.98 sq km increase in open space development (Figure 401).

As of October 2024, there are no permitted wastewater outfalls within the West Bernard Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for West Bernard Creek was evaluated during four sampling events from 1990 to 2010. West Bernard Creek is a perennial stream that drains to the San Bernard River. Habitat Quality Index scores are available for three sample events and indicate an intermediate aquatic life use rating (16-18). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 16 meters wide to greater than 20 meters. The riparian zone was generally dominated by trees followed by grasses then shrubs. The average percentage of tree canopy cover ranged from 65% to 94%.

The dominant stream substrate was clay, and the average percent of substrate gravel size or larger varied from 0% to 15%. Average percent instream cover was 20% to 29% and instream cover types include overhanging vegetation, woody debris, undercut banks, logs, and gravel. West Bernard Creek ranged from 0.4-0.7 meters deep on average and 4-14 meters wide. Average stream bank slope ranged from 33-39 degrees. Stream flow at the site was measured at a minimum value of 9.3 cfs and a maximum of 78 cfs. Average stream bank erosion potential was 10%-31%. The deepest pool measured at West Bernard Creek was 1 meter deep in 1990, and no pools were documented during later sampling events. Number of riffles observed at the site varied from zero to one, and total number of stream bends ranged from one to seven.

Water Quality

Water samples were collected at station 12131 over 20 sampling events from June 1990 through September 2012. Parameters measured included temperature, flow, transparency, specific

conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*.

Biological Characterization

Fish

Thirty species (10 families) were collected over the course of the four sampling events. Centrarchidae and Cyprinidae yielded most of the species with nine and eight, respectively. Western Mosquitofish was the most abundant species collected in 1990, 2008 (equally abundant with Blacktail Shiner), and 2010. Longear Sunfish was the most abundant species in 2009. Based on the fish assemblage, the aquatic life use rated as exceptional in 1990 and 2010, and high in 2008 and 2009; however, when the coefficient of variability is applied, the 2009 sample also rates as exceptional. Non-native fish species were only collected in one sample (2010), when Common Carp comprised 1.3% of the individuals. Number of individuals collected was consistently low and percentage of individuals classified as tolerant species was moderately high in three of the four samples, mostly due to the moderately large numbers of Green Sunfish.

Of special significance was the collection of one American Eel in 2010. There has been recent concern over the status of this migratory species throughout the United States.

Benthic Macroinvertebrates

A total of 2,436 individuals representing 77 taxa from 16 orders of benthic macroinvertebrates were collected over the four sample dates (Appendix E). Taxa richness for the 1990 Surber sample was 49, while the RBP kicknet samples collected in 2008, 2009 and 2010 yielded taxa richness values of 21,19, and 22, respectively. Across all four sample dates, Trichoptera, Coleoptera, Ephemeroptera, Diptera, and Gastropoda were the most abundant groups, representing approximately 63.4% of total numbers collected. Oligochaetes represented approximately 29.7% of the total number of individuals collected; however, they were all collected in the 1990 Surber sample and were not represented in the three RBP kicknet samples.

The aquatic life use characterization, based on the Ecoregion 34 quantitative Surber BIBI, fell in the exceptional category. The Ecoregion 34 RBP BIBI results for both the 2008 and the 2010 samples also indicated an exceptional aquatic life category, while the results for the 2009 RBP sample fell in the high aquatic life use category. These results indicate that the biological integrity of West Bernard Creek has remained relatively constant in the high to exceptional aquatic life use category over the 20-year span covered by the four samples.

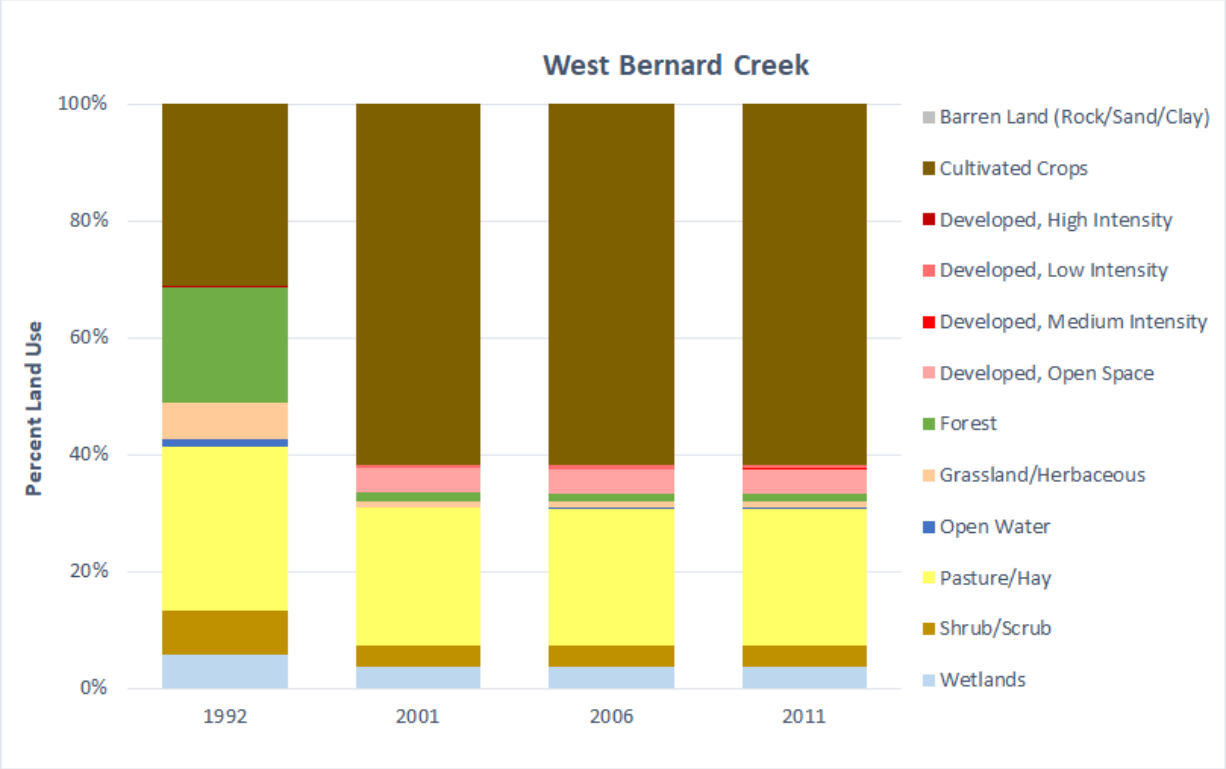

Figure 400. Percent land use in the West Bernard Creek watershed from 1992-2011.

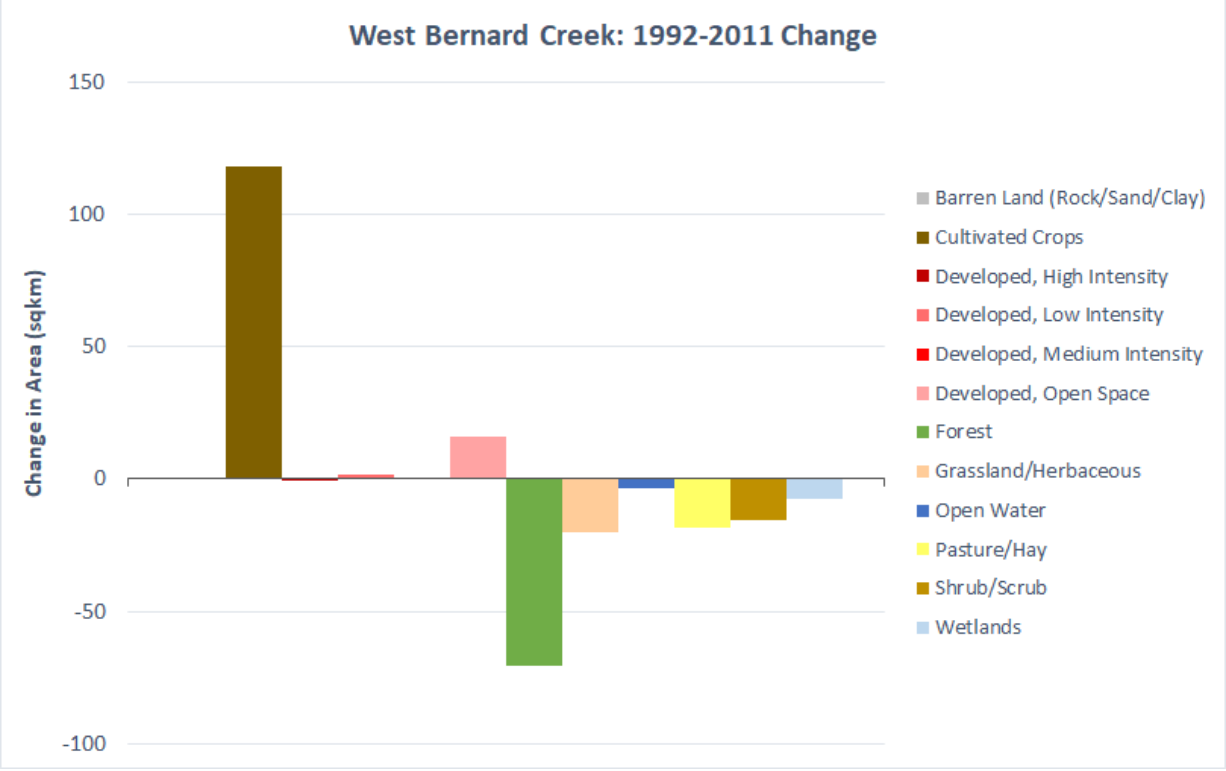

Figure 401. Land use change in area (sq km) from 1992-2011 for the West Bernard Creek watershed.

WEST CARANCAHUA CREEK

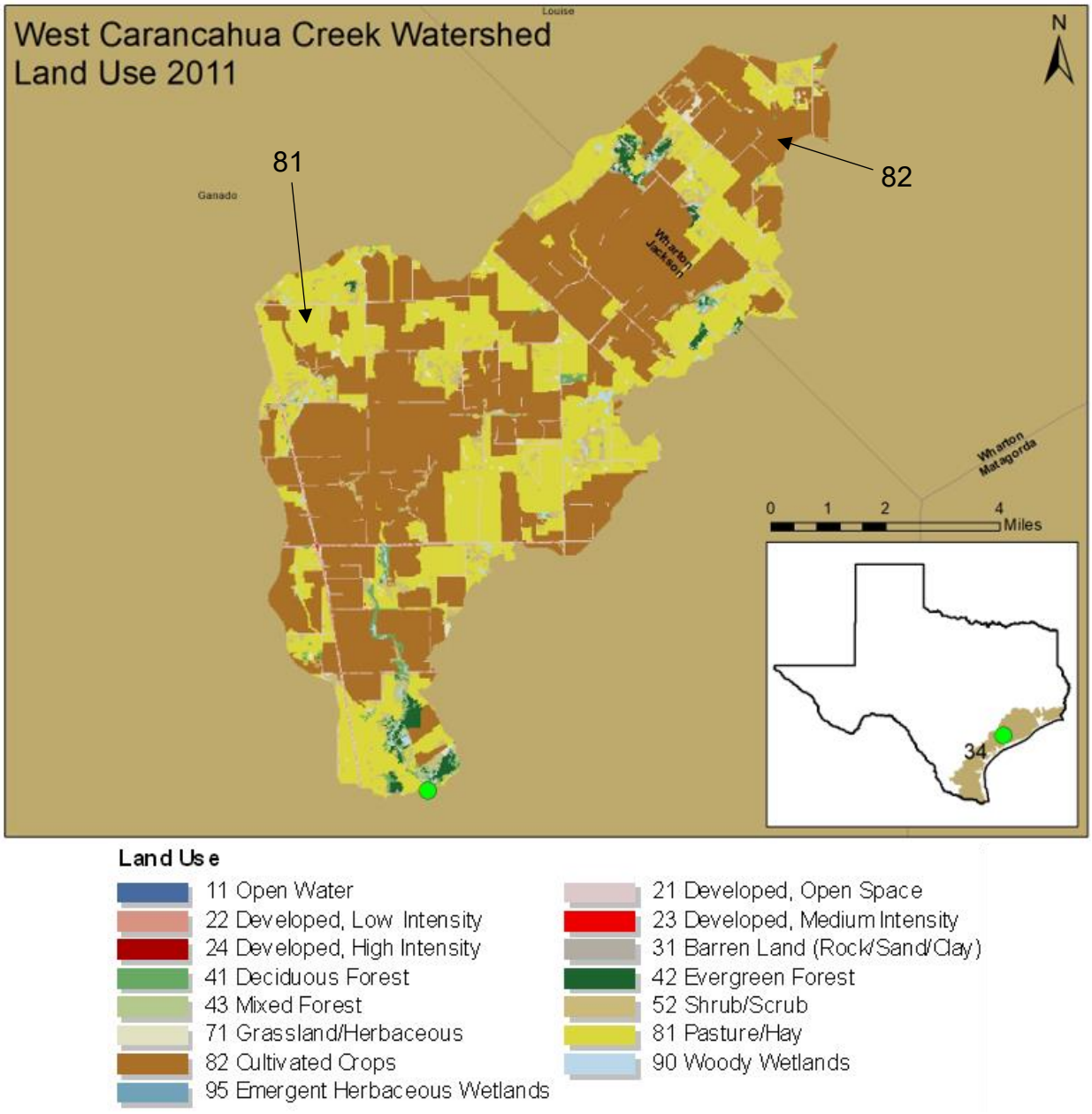

Figure 402. Map of West Carancahua Creek watershed and 2011 land use; cultivated crops and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	September 6, 1988; June 15, 2010; June 7, 2012
Water Quality:	25 sampling events
Fish:	September 7, 1988; March 28, 1989; June 15, 2010; June 7, 2012
Benthic Invertebrates:	September 7, 1988; June 15, 2010; June 7, 2012

Physical Characterization

Watershed and Land Use

West Carancahua Creek lies within the Colorado-Lavaca River Coastal Basin. Sample site 13293 is located at CR 440, 5.6 km northeast of La Ward in Jackson County (Figure 402).

The West Carancahua Creek watershed at site 13293 is approximately 154.82 sq km. The entire watershed lies within the Level IV Ecoregion 34a, the Northern Humid Gulf Coastal Prairies. The dominant land cover in the watershed is cultivated crop at 54.46% and is present throughout the watershed (Homer et al. 2015; Figure 402 and Figure 403). Pasture/hay is the secondary land cover encompassing 33.32%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.7% of the watershed.

From 1992-2011 there was a 4.98 sq km decrease in grassland and a 4.69 sq km decrease in forest. There was a 5.26 sq km increase in open space development and a 4.61 sq km increase in cultivated crops (Figure 404).

As of October 2024, there are no permitted wastewater outfalls within the West Carancahua Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for West Carancahua Creek was evaluated during three sampling events from 1988 to 2012. West Carancahua Creek is a stream that drains to Carancahua Bay. Habitat Quality Index scores are available for two sample events and indicate an intermediate aquatic life use rating (16 and 18). Riparian areas were generally well vegetated throughout the reach with an average riparian buffer ranging from 13 to 14 meters wide. The riparian zone was dominated by trees followed by shrubs and grasses. The average percentage of tree canopy cover ranged from 74% to 97%.

The dominant stream substrate was sand, and the average percent of substrate gravel size or larger varied from 2% to 10%. Average percent instream cover was 8% to 19% and instream cover types include overhanging vegetation, woody debris, and root mats. West Carancahua Creek ranged from 0.1-0.2 meters deep on average and 2.7-4.3 meters wide. Average stream bank slope was 32.5 degrees. Stream flow at the site was measured at a minimum value of 0.3 cfs and a maximum of 0.6 cfs. Average stream bank erosion potential was 38%-48%. The deepest pool measured at West Carancahua Creek was 1.5 meters. Number of riffles observed at the site varied from zero to three, and total number of stream bends ranged from two to seven.

Water Quality

Water samples were collected at station 13293 over 25 sampling events from September 1988 through June 2012. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*.

Biological Characterization

Fish

Twenty-five species (10 families) were collected over the course of the four sampling events. Cyprinidae and Centrarchidae were the richest families, each yielding seven species. Red Shiner was the most abundant species in the two earliest collections. Western Mosquitofish was the most abundant species in the two most recent samples. All four fish collections rated as having a high aquatic life use. Two of those ratings increase to exceptional when the coefficient of variability is applied (1988 and 2012 samples).

The samples taken in 1988 and 1989 came from FM 453, which is about 13 km downstream of CR 440 where the 2010 and 2012 samples were collected. The biggest differences noted between the fish assemblages in the 1980s and those observed in the 2010s were the large decline in the percentage of individuals identified as tolerant species and a subsequent increase in species richness. Over 70% of the individuals collected in the early samples consisted of tolerant species (mostly Red Shiner), resulting in metric scores of 1. Only 15% or less of the individuals in the latter samples were tolerant species (metric scores of 5). Even though species richness increased by 35%, the metric scores for the 1980s samples were already at 5 thus the scores could not increase.

Most of the 11 species added in the 2010s consisted of either one individual or limited numbers except in the 2010 collection where Mimic Shiner made up 24% of the catch. Three species - American Eel, Blacktail Shiner, and Bullhead Minnow - were unique to the 1980s samples. In each instance the species was represented by only one individual.

Benthic Macroinvertebrates

A total of 1,686 individuals representing 59 taxa from 15 orders of macroinvertebrates were collected in the 1988 Surber sample and the RBP samples from 2010 and 2012 (Appendix E). Ephemeroptera, Diptera, Coleoptera, and Bivalvia were the most abundant taxa, collectively representing approximately 83% of the total number of individuals collected.

The Surber BIBI results for the sample collected in 1988 fell in the exceptional aquatic life use category, while the ecoregion 34 BIBI results for the 2010 and 2012 RBP samples fell in the intermediate aquatic life use category. The apparent difference in the indicated aquatic life use category between the 1988 sample and the 2010 and 2012 RBP samples may be related to changes in land use patterns in the watershed, i.e., the increase in cultivated crops and the decrease in forest, noted above in the land use analysis.

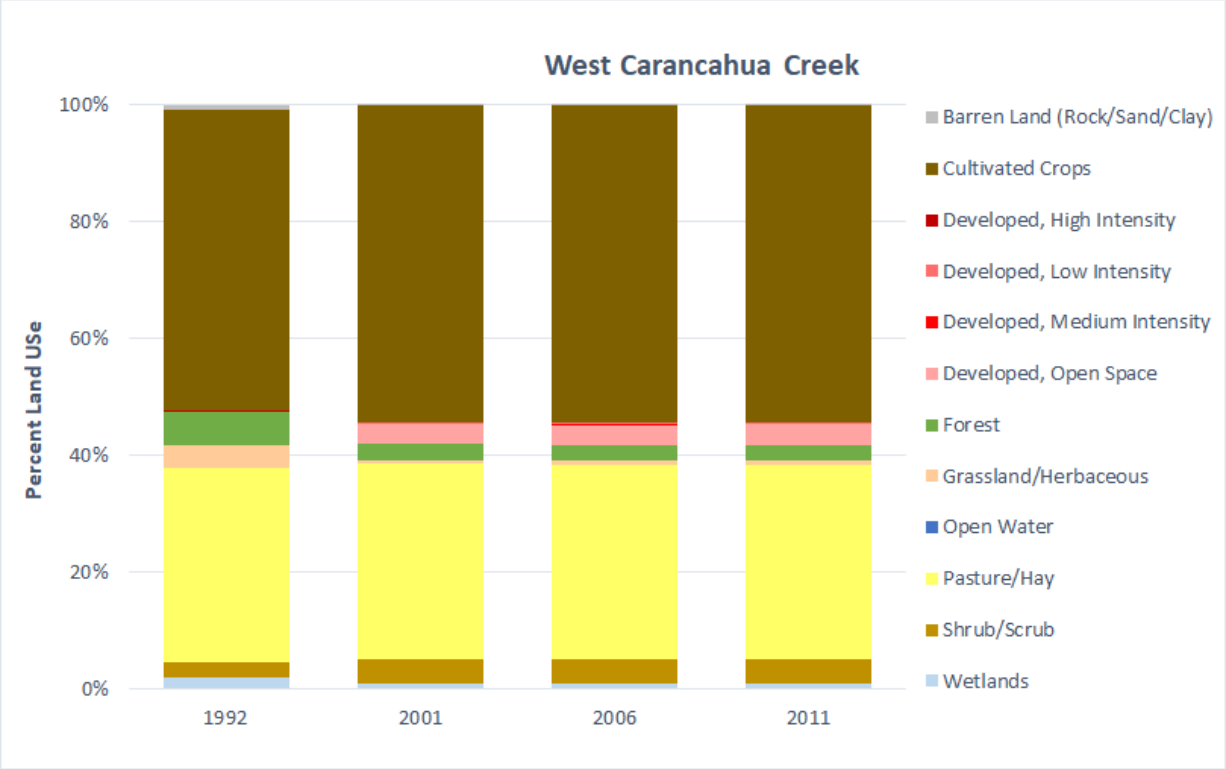

Figure 403. Percent land use in the West Carancahua Creek watershed from 1992-2011.

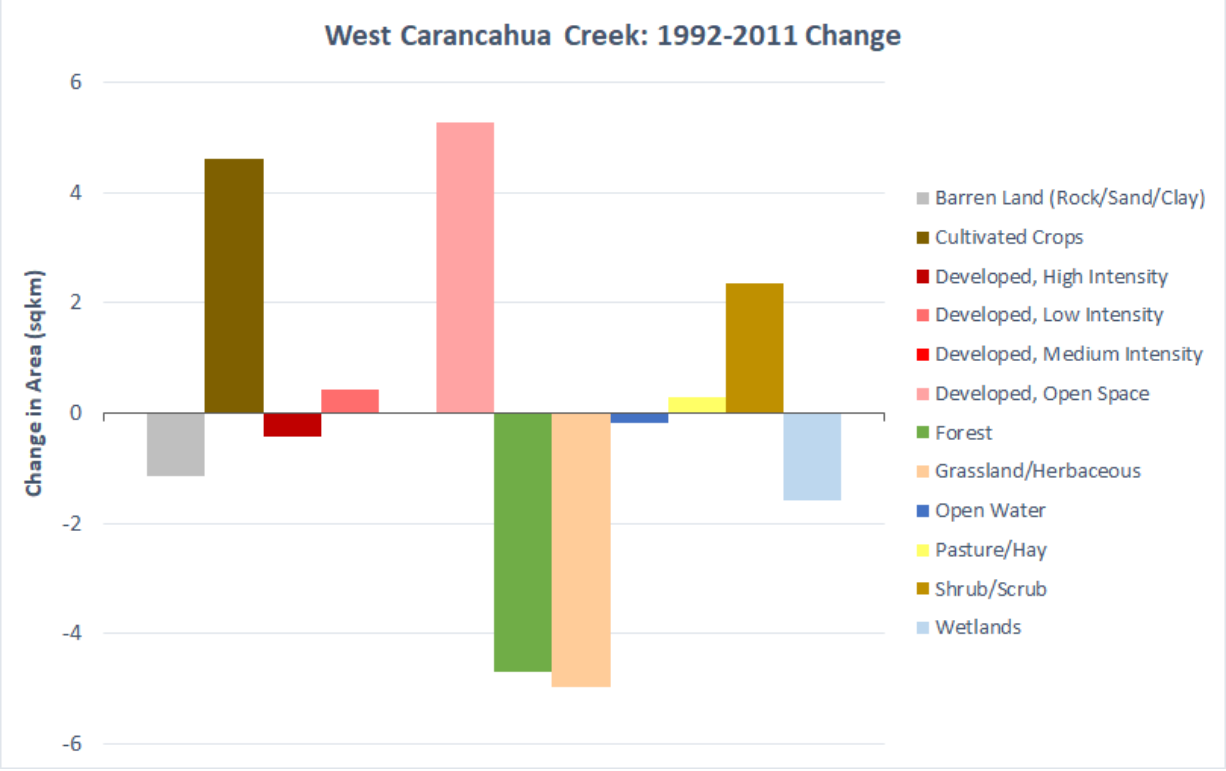

Figure 404. Land use change in area (sq km) from 1992-2011 for the West Carancahua Creek watershed.

WEST MUSTANG CREEK

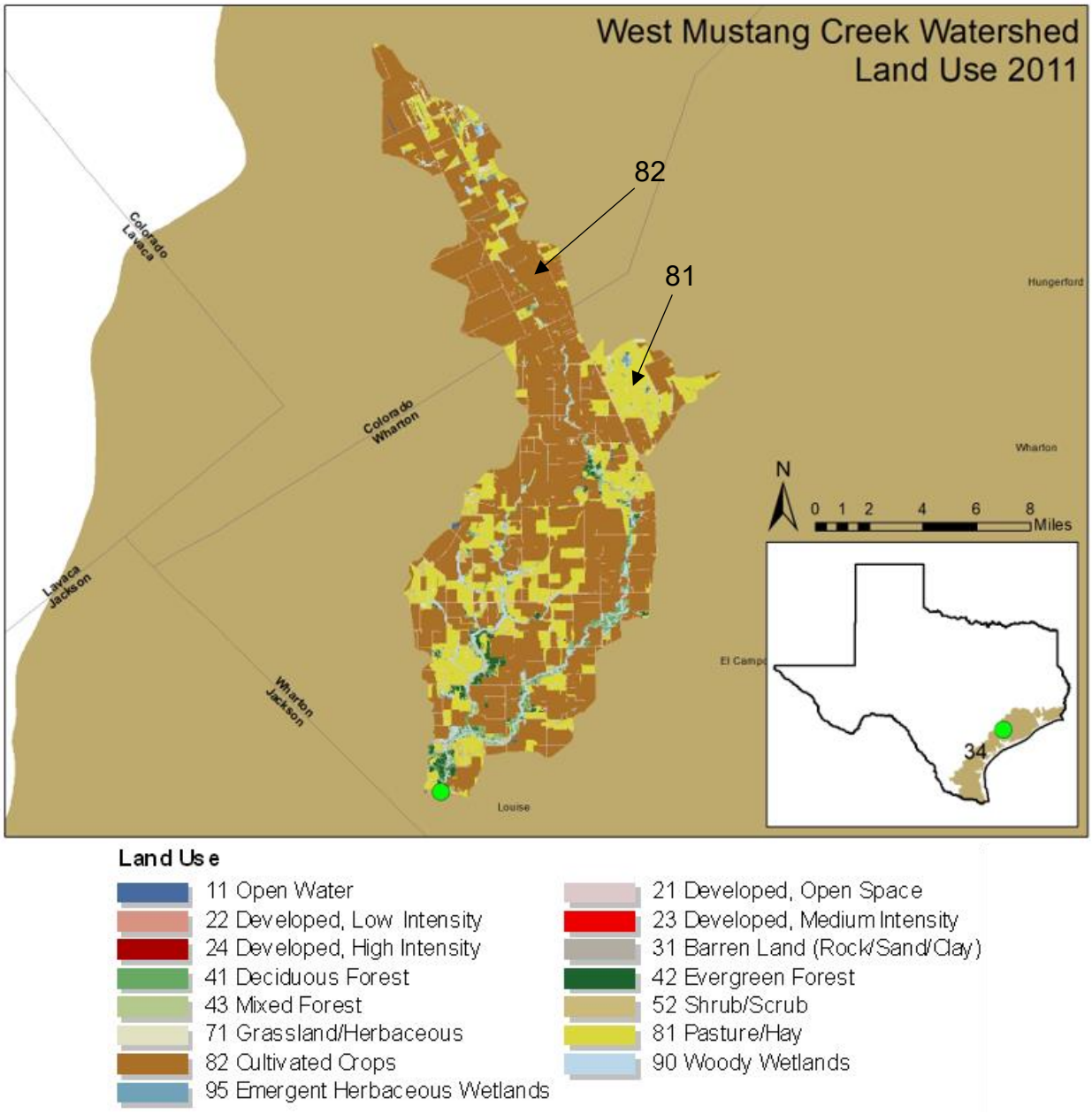

Figure 405. Map of West Mustang Creek watershed and 2011 land use; cultivated crops and pasture/hay were the most common land uses.

Sampling Dates

Physical Habitat:	June 21, 1990; June 17, 2010; June 6, 2012; September 12, 2012
Water Quality:	June 19, 1990; July 14, 1999; June 16, 2010
Fish:	June 21, 1990; June 17, 2010; June 6, 2012; September 12, 2012
Benthic Invertebrates:	June 21, 1990; June 17, 2010; June 6, 2012; September 12, 2012

Physical Characterization

Watershed and Land Use

West Mustang Creek lies within the Lavaca River Basin. Sample site 12522 is located downstream of CR 328, 11.3 km northwest of Louise in Wharton County (Figure 405).

The West Mustang Creek watershed at site 12522 is approximately 360.64 sq km. The entire watershed lies within the Level IV Ecoregion 34a, the Northern Humid Gulf Coastal Prairies. The dominant land cover in the watershed is cultivated crop at 63.55% and is present throughout the watershed (Homer et al. 2015; Figure 405 and Figure 406). Pasture/hay is the secondary land cover encompassing 21.18%. The combined land cover for developed land use (open space and low, medium, and high intensity) totals 3.59% of the watershed.

From 1992-2011 there was a 30.13 sq km decrease in forest and an 18.66 sq km decrease in grassland. There was a 71.8 sq km increase in cultivated crops and a 12.34 sq km increase in open space development (Figure 407).

As of October 2024, there are no permitted wastewater outfalls within the West Mustang Creek watershed.

In Channel and Riparian Physical Habitat

Physical habitat for West Mustang Creek was evaluated during four sampling events from 1990 to 2012. West Mustang Creek is a perennial stream that drains to the East Mustang Creek arm of Lake Texana. Habitat Quality Index scores are available for three sample events and indicate an intermediate to high aquatic life use rating (14-21). Riparian areas were well vegetated throughout the reach with an average riparian buffer ranging from 16 meters wide to greater than 20 meters. The riparian zone was generally dominated by trees followed by shrubs then grasses. The average percentage of tree canopy cover ranged from 70% to 86%.

The dominant stream substrate was sand, and the average percent of substrate gravel sized or larger was zero for all sampling events. Average percent instream cover was 22% to 27% and instream cover types include snags, woody debris, root mats, and undercut banks. West Mustang Creek ranged from 0.2-0.6 meters deep on average and 6-10 meters wide. Average stream bank slope ranged from 23-44 degrees. Stream flow at the site was measured at a minimum value of 0.2 cfs and a maximum of 5.5 cfs. Average stream bank erosion potential was 27%-35%. The deepest pool measured at West Mustang Creek was greater than 1.5 meters. Number of riffles observed at the site varied from zero to two, and total number of stream bends ranged from five to six.

Water Quality

Water samples were collected at station 12522 over 3 sampling events from June 1990 through June 2010. Parameters measured included temperature, flow, transparency, specific conductance, dissolved oxygen, pH, alkalinity, ammonia, total Kjeldahl nitrogen, total nitrogen, phosphorus, total organic carbon, chloride, sulfate and chlorophyll-*a*.

Biological Characterization

Fish

Twenty-nine species representing nine families were collected in the four sampling events. Centrarchidae was the richest family, represented by nine species. The two early fish collections (1990 and 2010) rated as having high aquatic life uses. Both collections from 2012 rated as exceptional. The 1990 sample yielded the lowest aquatic life use score with only seven of the individual metrics scoring as a five. All but one metric (number of individuals) in the September 2012 sample received a five. Number of individuals was lacking in all four collections.

The top three species (by numbers) were identical in the 1990 and 2010 collections with Western Mosquitofish being most abundant followed by Red and Blacktail shiners. Western Mosquitofish was also the most abundant species in the September 2012 sample; however, Bullhead Minnow (which was second most abundant in September 2012) was greatest in June of that year. Longear Sunfish was the only sunfish species collected in 1990, likely due to no electrofishing being performed. Seven additional species were added over the next three collections (Longear Sunfish was always the most abundant) when both electrofishing and seining was employed.

Benthic Macroinvertebrates

A total of 3,154 individuals representing 81 taxa from 15 orders of macroinvertebrates were collected in the 1990 Surber sample and the RBP samples from 2010 and 2012 (Appendix E). Trichoptera, Diptera, and Ephemeroptera were the most abundant orders in the collections, collectively representing approximately 87% of the total number of individuals collected. Other orders representing greater than 1% of the collections were Coleoptera, Odonata, Amphipoda, and Gastropoda.

The Surber BIBI results for the sample collected in 1990 fell in the exceptional aquatic life use category. The Ecoregion 34 BIBI results for the RBP samples collected June 17, 2010, and September 12, 2012, were in the high aquatic life use category, and in the intermediate aquatic life use category for the RBP sample collected June 6, 2012. These results represent relative stability in the condition of the benthic assemblage over the 22-year interval between 1990 and 2012.

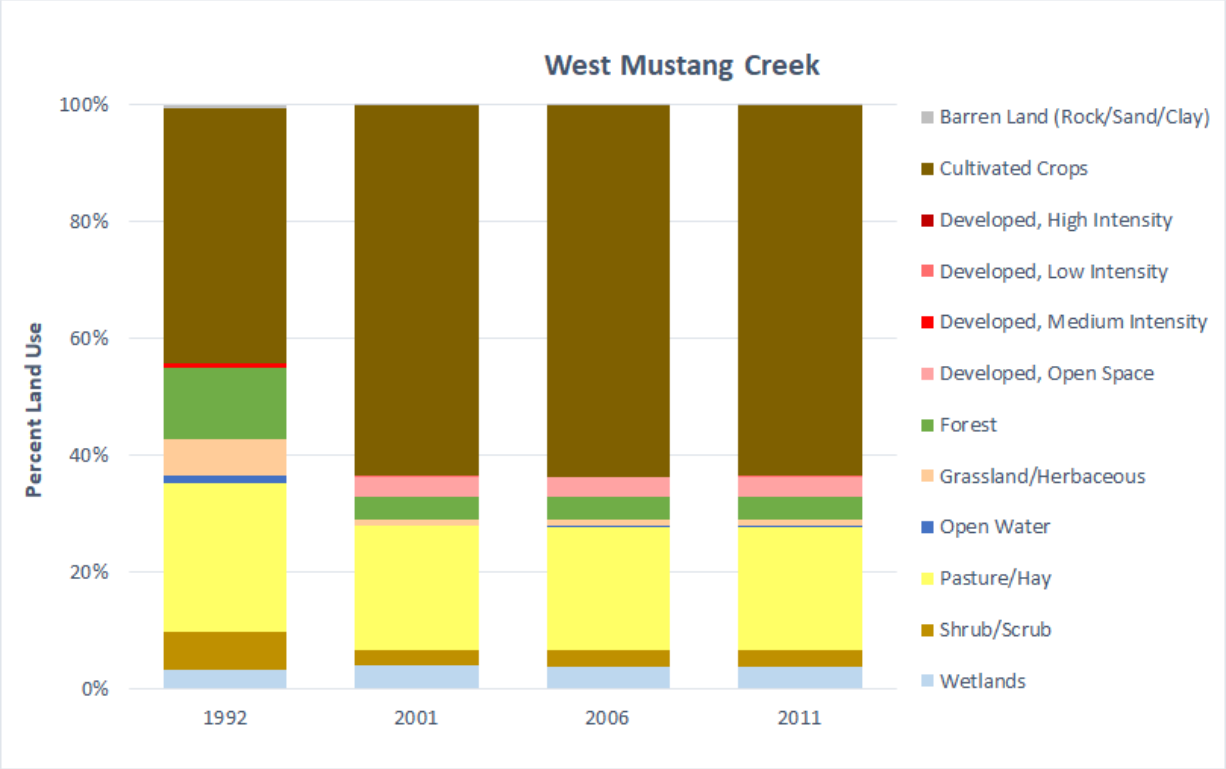

Figure 406. Percent land use in the West Mustang Creek watershed from 1992-2011.

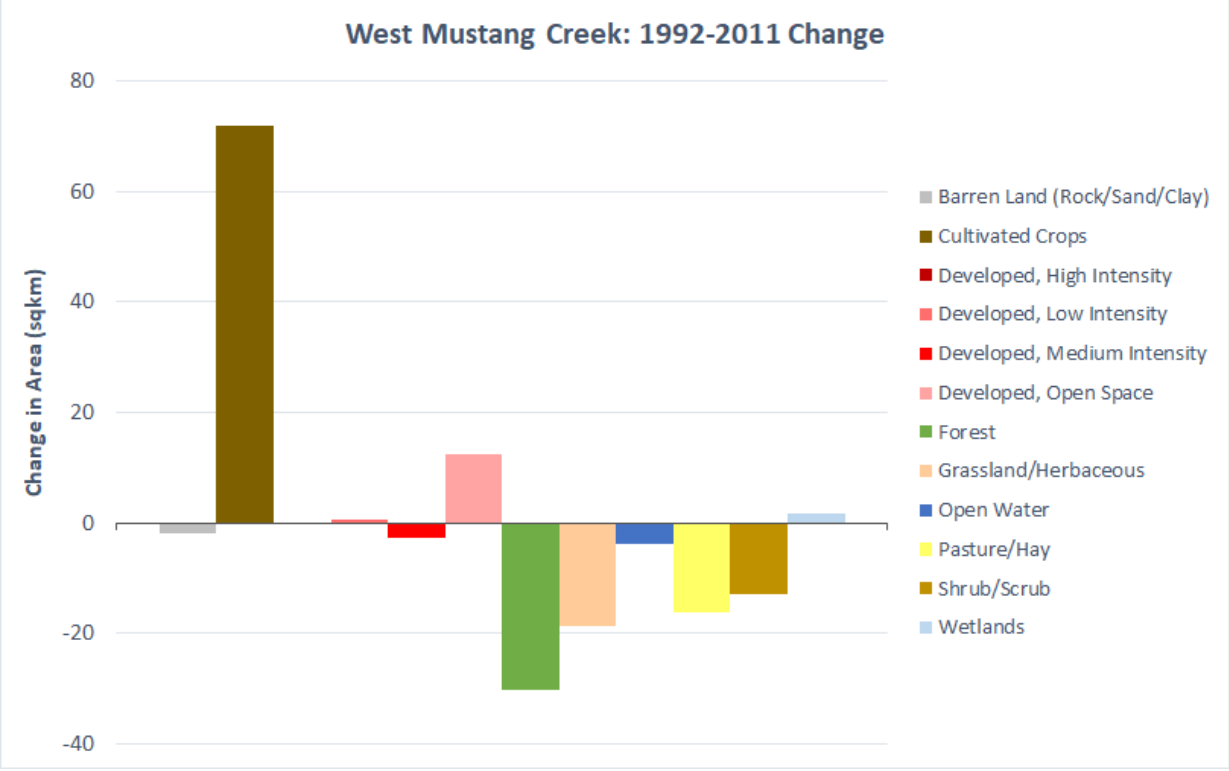

Figure 407. Land use change in area (sq km) from 1992-2011 for the West Mustang Creek watershed.

Ecoregion 34 Summary and Historical Characterization

Watershed and Land Use

Ecoregion 34 is primarily flat topography with grasslands. A high percentage of the land encompasses croplands, such as rice, grain sorghum, cotton, and soybeans. In recent decades, urban and industrial land uses have expanded, especially oil and gas production (Griffith et al. 2007). In 2011 the overall primary land cover in the study watersheds was cultivated crop and the secondary land cover was pasture/hay. Between 1992-2011, forest experienced the largest decrease in combined land cover area across all watersheds (~146.03 sq km) and cultivated crop experienced the largest increase (~365.64 sq km).

In Channel and Riparian Physical Habitat

Physical habitat for the Western Gulf Coastal Plain was evaluated at eight streams over 31 sampling events from 1987 to 2017. Watershed area varied from a minimum of 155 sq km at West Carancahua Creek to a maximum of 885 sq km at the San Bernard River. The sites generally had well vegetated riparian zones, and the riparian buffer was 32 meters on average with a minimum of 6 meters and maximum of 107 meters. Trees were the dominant riparian species (51% on average), followed by shrubs (21%) then grasses (20%), and average percent tree canopy coverage was 64%.

Dominant substrate at the sites was generally sand or clay. Average percentage of substrate gravel sized or larger was 10%, and varied from a minimum of 0% to a maximum of 40%. Average percent instream cover was 25% and common instream cover types include overhanging vegetation, leaf packs, snags, woody debris, root mats, algae, gravel and undercut banks. Average stream depth and width measurements were 0.3 meters and 7 meters, respectively. Average stream bank slope was 35 degrees and erosion potential was moderate, with an average of 35% which was reflected in the average bank stability HQI score (1.9) indicating moderately stable to moderately unstable stream banks. Maximum pool depth ranged from a minimum of 0.5 meters to a maximum of 1.8 meters. Total number of riffles varied from zero to six, and total number of stream bends ranged from one to nine. Additional in-channel and riparian physical habitat attributes are summarized in Appendix B.

HQI scores are available for 24 events and range from a maximum score of 25 (high) at Big Creek in May 2003 to a minimum score of 14 (intermediate) at Big Creek in 2010 and West Mustang Creek in 2012. Of the 24 sampling events with an HQI score, 11 (46%) received a habitat assessment rating of high and the remaining 13 (54%) received a rating of intermediate. The highest scoring HQI metrics for the Western Gulf Coastal Plain were the dimensions of largest pool metric and the riparian buffer vegetation metric. The lowest scoring HQI metrics on average were the bottom substrate stability metric, the aesthetics of reach metric, and the channel flow status metric.

Water Quality

Water quality data from Ecoregion 34 is primarily represented by the northern half of the ecoregion, as there were more streams available to sample in that portion of the ecoregion. As this ecoregion encompasses both tidally influenced and freshwater streams, specific conductivity had the largest range of any ecoregion, and ranged from 39 to 101,800 us/cm. The secchi values observed were indicative of turbid waters with a median value of 0.2 meters and 95% of the secchi values were at or below 0.64 meters. The pH values had a median of 7.65 and ranged from 5.9 to 9.54. Chlorophyll-a data was highly variable between stations with a range of 0.5 to 346.3 ug/L. Additional water quality variables are summarized in Appendix C of the report.

Fish

A total of 22,225 individuals consisting of 20 families and 64 species have been documented in 40 sampling events across eight streams in the Western Gulf Coast Plain from 1987 to 2017 (Appendix D - 7). For individual sites, taxa richness ranged from 44 species at Big Creek across 13 sampling events from 1990 to 2009 to a low of 14 species at Placedo Creek across three sampling events from 1988 to 2017. Taxa richness at each site was heavily correlated with the number of sampling events during the period of record. The most abundant species collected across all sites and sampling events were Red Shiner (n = 8,346), Western Mosquitofish (n = 7,753), Longear Sunfish (n = 828), Striped Mullet (n = 780), and Bullhead Minnow (n = 643).

IBI scores across all sites and sampling events ranged from 30 to 53 resulting in aquatic life use categories of limited (n = 1), intermediate (n = 14), high (n = 16), and exceptional (n = 9; Figure 408). Of the 40 sampling events in this ecoregion, 62.5% received an ALU rating of high or exceptional; 37.5% received an ALU of intermediate or limited. Most sites that were sampled multiple times received ALUs in at least two different categories. All sites received one ALU score of high or better except for Placedo Creek which received ALU scores of intermediate only.

Overall, IBI scores and individual metrics 2-3, 5-8, and 11-12 did not change through time (Figure 409; Figure 410; Figure 411); however, the number of fish species and the number of sunfish species significantly increased through time (Figure 410(1): $R^2 = 0.17$, $p < 0.01$; Figure 410(4): $R^2 = 0.13$, $p = 0.02$) and the number of individuals per seine haul significantly decreased through time (Figure 411(10): $R^2 = 0.29$, $p < 0.01$). Although these were significant relationships, R^2 values were very low.

It is difficult to discern why the number of fish and sunfish species significantly increased over time. It is likely related to additional sampling effort rather than a change in water quality or habitat, given that IBI scores did not change over the sampling period. The decrease in the number of individuals per seine haul is likely due to several isolated sampling events that occurred in 1988-89 at a single site with unusually large numbers of cyprinids which were collected using a seine.

Benthic Macroinvertebrates

A total of 30,207 individuals representing 26 orders of aquatic macroinvertebrates were collected in seven Surber samples and 30 RBP samples collected at eight streams in the Western Gulf Coastal Plain ecoregion from August 1988 to July 2017 (Appendix E). Eleven orders (Amphipoda, Basommatophora, Coleoptera, Decapoda, Diptera, Ephemeroptera, Hemiptera, Hirudinida, Odonata, Trichoptera, and Veneroida) were represented at all eight streams, which collectively represented 45% of the total number of individuals collected.

In terms of relative abundance, the aquatic worm *Aulodrilus pigueti* (Tubificida, Naididae) was the most abundant species, representing 15.8% of the total number of individuals collected at all sites. However, it should be noted that 4,682 individuals of this taxon were collected in a single Surber sample at Placedo Creek. Other taxa that were relatively abundant include the aquatic worms *Limnodrilus hoffmeisteri* and *Dero digitata*, the ostracod *Limnocythere* sp., the caddisfly *Cheumatopsyche* sp., the mayfly *Fallceon quilleri*, and the riffle beetle *Stenelmis* sp.

Stenelmis sp., *Hyalella* sp., *Palaemonetes* sp., *Cheumatopsyche* sp., *Fallceon quilleri*, *Caenis* sp., *Argia* sp., and *Hydroptila* sp. were the most widely distributed taxa, each occurring in at least one collection from all eight streams. *Tricorythodes* sp., *Nectopsyche* sp., *Oecetis* sp., *Limnodrilus* sp., *Polypedilum* sp., *Stenacron* sp., *Corbicula fluminea*, *Rhagovelia* sp., *Scirtes* sp., and *Physa* sp. were also widely distributed genera/species, occurring in collections from seven of eight streams. This abundance of widely distributed taxa in the Western Gulf Coastal Plain may be a result of the proximity of sites in this ecoregion compared to other aggregated ecoregions.

The BIBI scores for six of the seven Surber samples collected from August 1988 to June 1990 fell in the exceptional aquatic life use category, while the BIBI score for the Surber sample collected on Placedo Creek in September 1988 fell in the high category (Figure 412). Eight of 30 RBP IBI scores for kicknet samples fell in the exceptional aquatic life use category, 16 RBP IBI scores indicated high, and six ranked in the intermediate category. Overall, results for the regionalized benthic macroinvertebrate IBI's indicate relatively constant benthic biotic integrity over the interval from 1988 to 2017 (Figure 413).

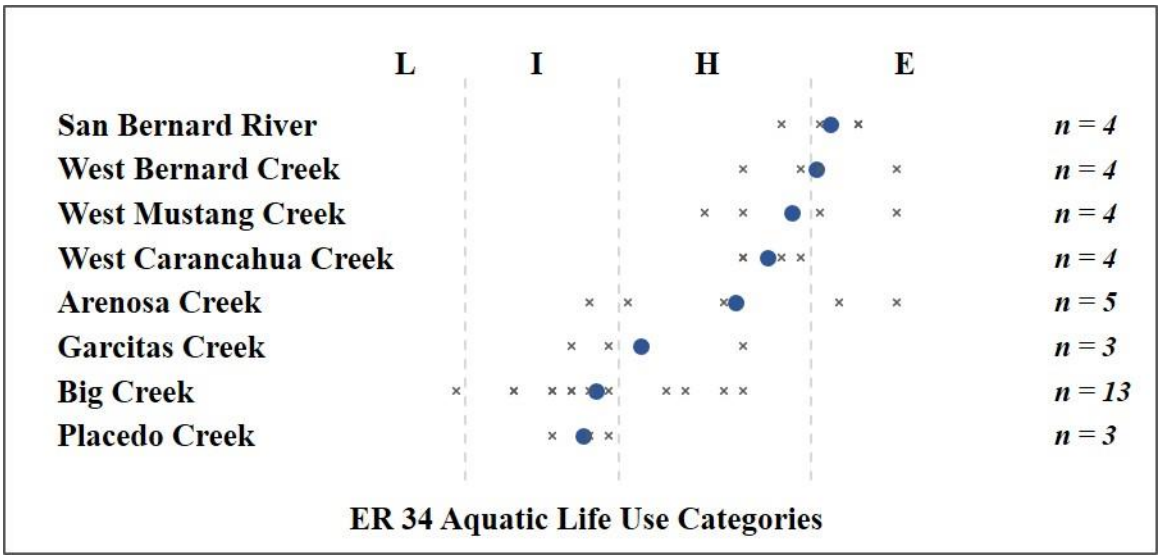

Figure 408. Aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all fish sampling events in Ecoregion 34 grouped by site and ranked by mean ALU score (blue dot); number of sampling events per site noted on right.

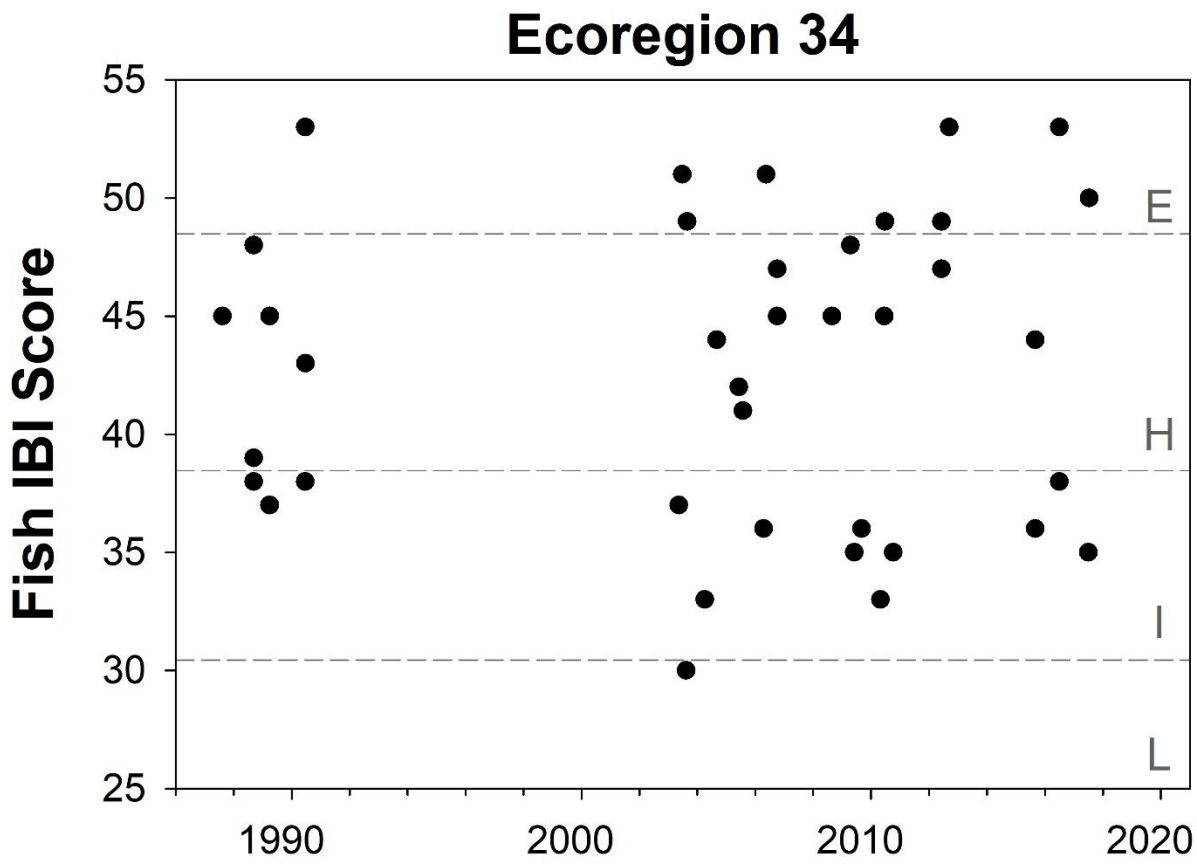

Figure 409. Fish index of biotic integrity scores through time for all sampling events in Ecoregion 34; break lines for aquatic life use categories (i.e., limited, intermediate, high, and exceptional) shown on each graph for reference (see Linam et al. 2002).

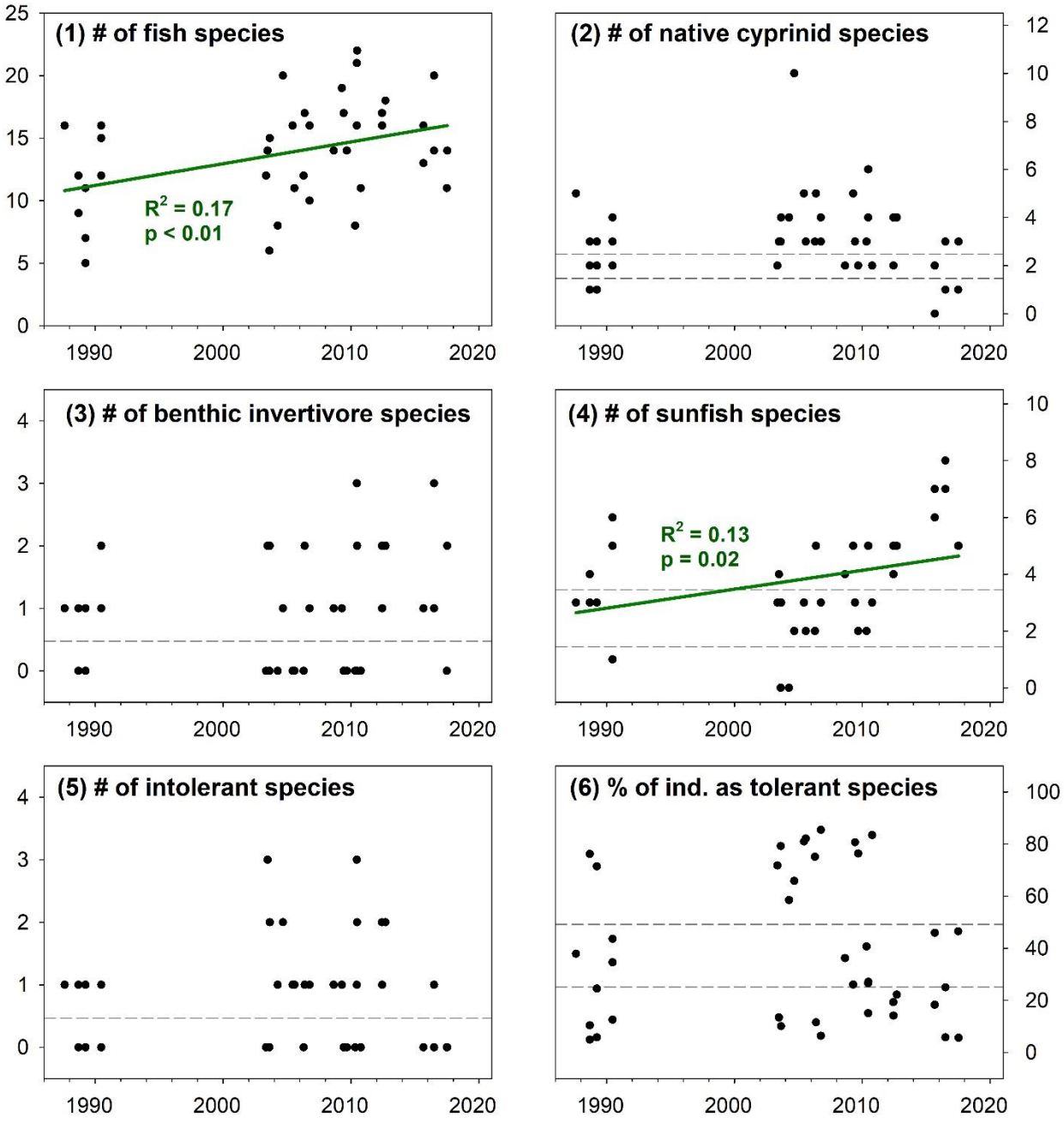

Figure 410. Raw values for fish index of biotic integrity metrics 1-6 through time for all sampling events in Ecoregion 34; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002).

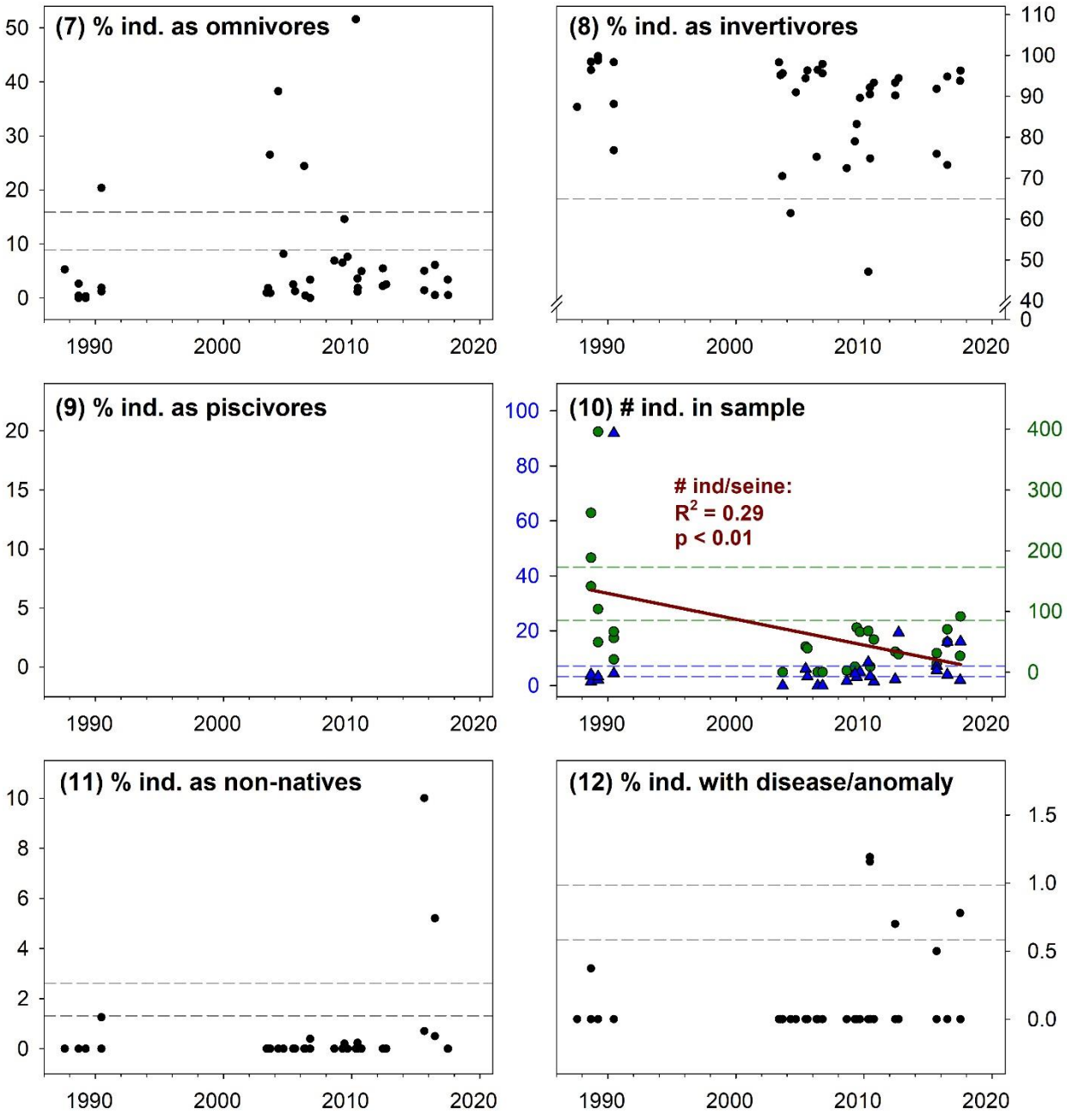

Figure 411. Raw values for fish index of biotic integrity metrics 7-12 through time for all sampling events in Ecoregion 34; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002); metrics with no data are not included in the IBI for this ecoregion; number of ind./seine haul represented by green circles and number of ind./min electrofishing represented by blue triangles for metric number 10; metrics that are not included in the IBI for this ecoregion are blank.

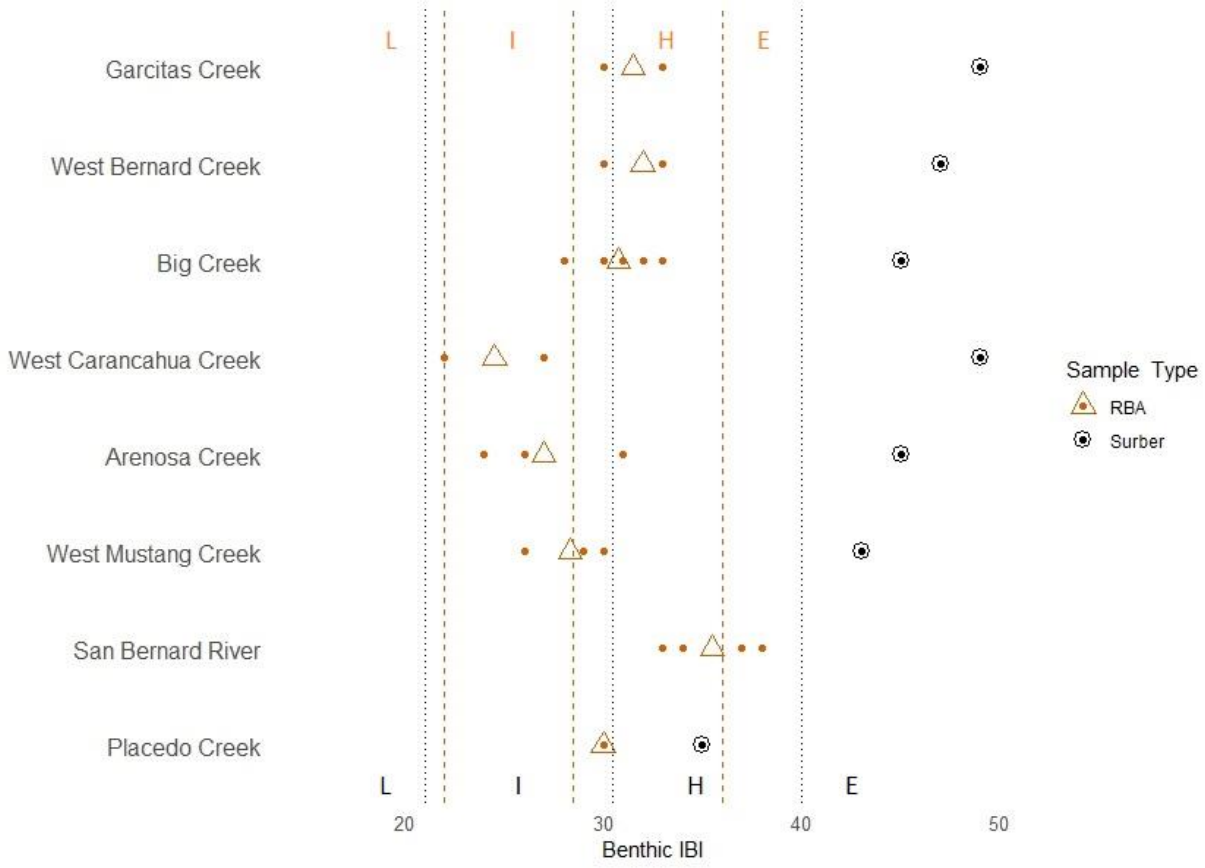

Figure 412. Benthic IBIs and aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all benthic sampling events in Ecoregion 34 grouped by site and ranked by mean IBI score. Site scores are solid circles, and mean scores are hollow circles for Surber IBI sample and hollow triangles for RBP IBI samples. RBP IBI ALU cut offs are red dashed lines and Surber ALU cutoffs are in black dotted lines.

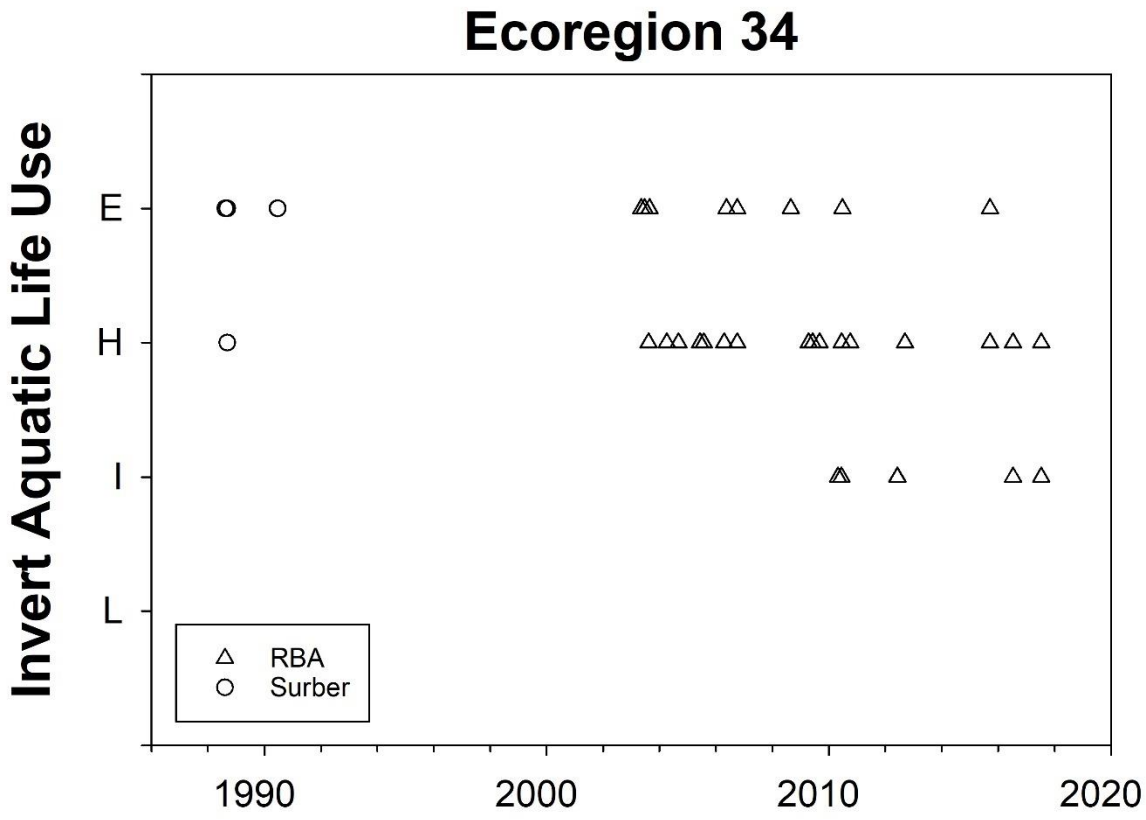

Figure 413. Benthic aquatic life use (ALU) categories through time for all sampling events in Ecoregion 34; Surber ALUs are noted by circles and RBP ALUs are noted by triangles.

SUMMARY AND CONCLUSION

From 1986 to 2018, data pertaining to watershed characteristics, site-specific physical habitat, physicochemical water quality and biological characteristics of 114 least disturbed streams have been collected and summarized in this report. Since the release of Bayer et al. 1992, a total of 101 sampling events were conducted across 11 ecoregions (Appendix A-1). Additionally, 42 historic least disturbed streams (i.e., streams sampled from 1986 to 1990 in Bayer et al. 1992) were revisited to gain a better understanding of variation among least disturbed streams and patterns within each biological aggregated ecoregion. Twenty-nine streams were sampled in Bayer et al. 1992 but were not revisited. These streams are still included in this report; however, it is important to note that their status as least disturbed might have changed. Several of these streams, specifically in Central Texas, have experienced high levels of development that have increased the combined land cover for developed land use (open space and low, medium, and high intensity) to proportions that are significantly higher than they were when sites were first sampled in Bayer et al. 1992. These sites should be revisited to assess their status as least disturbed streams.

Data from historical streams provide information for identifying trends over time. The major purpose of the aquatic ecoregion project and least disturbed streams project is to establish baselines for the development of indices designed to evaluate aquatic life use established in the Texas Surface Water Quality Standards. Data collected through these projects and others have established the regionalized fish index of biotic integrity for every ecoregion in Texas as well as the regionalized macrobenthic index of biotic integrity for all ecoregions except Ecoregion 31 and aggregated Ecoregions 25 and 26. Future phases of this study will aim to collect data to regionalize the final macrobenthic indices for Ecoregion 31 and aggregated Ecoregions 25 and 26 and refine regionalized fish and macrobenthic indices if necessary. There is a need to revisit a subset of least disturbed streams to evaluate conditions overtime and detect any changes in biological communities, especially as it pertains to shifting environmental conditions.

This study provides a list of least disturbed streams for each of the Texas Ecoregions that have been evaluated as being appropriate reference streams based on having little urban and industrial development, little high intensity agriculture, no major point sources of pollution, no atypical sources of non-point source pollution, and are not channelized or have no other major physical habitat modifications. Streams such as Croton Creek, North Fork of the Wichita River, and Palo Duro Creek meet these physical characteristics of least disturbed streams but do not support biological communities to attain the presumed high aquatic life use due to natural conditions. There is still a need to adjust site-specific aquatic life uses and supporting criteria for some streams, especially in Ecoregion 26. Ecoregion habitat attributes may be found in Appendix B, water quality parameters may be found in Appendix C, and a list of fish and macrobenthic species collected at each site are summarized in Appendix D and Appendix E, respectively.

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APPENDIX A - STATUS OF WATERBODIES IN CURRENT STUDY

Appendix A - 1. Status of waterbodies in current study (ecoregions are listed in order as they appear in this report).

Ecoregion	Waterbody	Type of Site	Revisit?	Comments
24	Alamito Creek	Historical	No	
	Independence Creek	Historical	Yes	
	Pecos River	New		
	Rio Grande: Presidio	New		
	Rio Grande: Contrabando	New		
	Rio Grande: Johnson Ranch	New		
	Terlingua Creek	Historical	No	
26	Bluff Creek	Historical	No	
	Buck Creek	New		
	Canadian River: US 385	New		
	Canadian River: SH 70	New		
	Chicken Creek	New		
	Croton Creek	Historical	No	Not Included in Report[ab]
	McClellan Creek	Historical	Yes	
	N. Fork Wichita River	New		Not Representative[b]
	Palo Duro Creek	Historical	No	Not Included in Report[ab]
	Saddlers Creek	Historical	No	
	Salt Fork Red River	New		
	White Deer Creek	New		
	Whitefish Creek	Historical	No	
	Wolf Creek	Historical	Yes	
27	Cottonwood Creek	Historical	No	
	Deadman Creek	Historical	Yes	
	Elm Creek	Historical	No	
	Lelia Lake Creek	Historical	No	Fish[c]
	Sweetwater Creek	Historical	Yes	
29	Bluff Creek	Historical	No	
	Clear Creek	Historical	Yes	
	Colony Creek	Historical	No	
	Cowhouse Creek	Historical	No	
	Ioni Creek	Historical	No	
	Neils Creek	Historical	Yes	
	Reese Creek	New		
	Rocky Creek	Historical	Yes	
	S. Fork Rocky Creek	New		
	Steele Creek	Historical	No	
32	Auds Creek	Historical	Yes	
	Cow Bayou	Historical	Yes	
	Deer Creek	Historical	Yes	
	Geronimo Creek	Historical	Yes	
	Willis Creek	Historical	Yes	
	Wilson Creek	Historical	Yes	

Ecoregion	Waterbody	Type of Site	Revisit?	Comments
30	Barton Creek	Historical	No	
	Brushy Creek	New		
	Bull Creek	New		
	Bullhead Creek	New		
	Carpers Creek	Historical	No	
	Colorado River	New		
	Cypress Creek	New		
	Devils River	Historical	Yes	
	Guadalupe River	New		
	James River	Historical	No	
	Johnson Creek	New		
	Little Barton Creek	Historical	No	
	Little Blanco River	Historical	No	
	Live Oak Creek	Historical	No	
	Llano River	New		
	Medina River	Historical	No	
	Montell Creek	New		
	N. Prong Medina River	New		
	Nueces River	New		
	Oatmeal Creek	Historical	No	
	Onion Creek	Historical	Yes	
	Pedernales River	New		
	San Saba River	New		
	Slaughter Creek	New		
	South Concho River	New		
	South Llano River	Historical	Yes	
	Spring Creek	Historical	No	
	West Rocky Creek	Historical	No	
31	Las Moras Creek	Historical	No	
	Metate Creek	Historical	No	
	Mud Creek	Historical	No	
	Nueces River	New		
	Pinto Creek	Historical	Yes	
	San Miguel Creek	Historical	Yes	
	Sycamore Creek	Historical	Yes	
33	Blair Creek	New		
	Catfish Creek	Historical	Yes	
	Cedar Creek	New		
	Cummins Creek	Historical	Yes	
	Cuthand Creek	New		
	Davidson Creek	Historical	Yes	
	Kickapoo Creek	New		
	Little Mustang Creek	New		
	Lower Keechi Creek	Historical	No	
	Middle Yegua Creek	Historical	Yes	
	Mill Creek	Historical	Yes	

Ecoregion	Waterbody	Type of Site	Revisit?	Comments
	Ponds Creek	Historical	Yes	
	Smackover Creek	New		
	Wheelock Creek	Historical	No	
35	Beach Creek	New		
	Beech Creek	Historical	Yes	
	Big Cypress Creek	Historical	Yes	
	Black Bayou	New		
	Black Cypress Bayou	Historical	Yes	
	E. Fork of the San Jacinto River	Historical	Yes	
	Frazier Creek	Historical	Yes	
	Irons Bayou	Historical	Yes	
	James Bayou	New		
	Lake Creek	Historical	Yes	
	Little Cypress Bayou	Historical	Yes	
	Little Pine Island Bayou	New		
	Peach Creek	New		
	Piney Creek	Historical	Yes	
	San Pedro Creek	New		
	W. Fork of the San Jacinto River	New		
	White Oak Creek	Historical	No	
34	Arenosa Creek	Historical	Yes	
	Big Creek	Historical	Yes	
	Garcitas Creek	Historical	Yes	
	Placedo Creek	Historical	Yes	
	San Bernard River	New		
	West Bernard Creek	Historical	Yes	
	West Carancahua Creek	Historical	Yes	
	West Mustang Creek	Historical	Yes	

Type of Site: Historical sites were sampled in Bayer et al. 1992

[a]Site is not representative of least disturbed conditions and no new data was collected for this report.

[b]Site is recommended as least disturbed based on watershed characterization; however, water quality, physical habitat and/or biological communities were not similar to other least disturbed sites due to hypersaline and/or intermittent conditions.

[c]Fish community not similar to other least disturbed sites within the ecoregion.

APPENDIX B – IN-CHANNEL & RIPARIAN PHYSICAL HABITAT

Appendix B - 1. Stream physical habitat attributes for Ecoregion 24. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 24 Stream	Sample Size	Watershed Size (km^2)	Flow (cfs)	Average Width (m)	Average Depth (m)	Maximum Pool Depth (m)	Stream Bank Slope (degrees)	Stream Bank Erosion (%)	Total Riffles (no.)	Total Stream Bends (no.)	Instream Cover (%)
Alamito Creek*	1	3,605	0.7	0.7	0.1	0.4	39	70	3	2	10
Independence Creek*	1	1,521	17.4	8.6	0.3	0.7	19	39	6	1	25
Independence Creek	1	1,997	21	12.7	0.1	0.5	12.4	29.2	11	3	100
Pecos River	1	3,613,943	101	21.8	0.4	0.5	36.4	30.8	4	4	44
Rio Grande: Contrabando	1	5,300,670		35.9	0.4	1.3	49.9	26.7	5	3	50
Rio Grande: Johnson Ranch	1	5,510,981	56.9	23.1	0.4	2.6	45.2	50.8	3	4	20.8
Rio Grande: Presidio	1	5,201,993	63	30.7	0.3	1.0	29.5	36.3	1	2	29.2
Average		2,804,959	43.3	19.1	0.3	1.0	33.1	40.4	5	3	40
Maximum		5,510,981	101.0	35.9	0.4	2.6	49.9	70.0	11	4	100
Minimum		1,521	0.7	0.7	0.1	0.4	12.4	26.7	1	1	10

*Historic data from Bayer et al. 1992

Note: Physical habitat data is not available for Terlingua Creek

Appendix B – 1 CONT. Stream physical habitat attributes for Ecoregion 24. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 24 Stream	Sample Size	Dominant Substrate Type	Substrate Gravel Size or Larger (%)	Tree Canopy (%)	Average Riparian Width (m)	Riparian Vegetation - Trees (%)	Riparian Vegetation - Shrubs (%)	Riparian Vegetation - Grass (%)	Riparian Vegetation - Cultivated Fields (%)	Riparian Vegetation - Other (%)
Alamito Creek*	1		40	8	19	40	40	20	0	0
Independence Creek*	1		65	0	61	10	20	50	0	20
Independence Creek	1	cobble	99.7	6.4	20	12.5	75	12.5	0	0
Pecos River	1	boulder	56	29.2	20	5	90	5	0	0
Rio Grande: Contrabando	1	cobble	92.5	36.5	20	0	55	40	0	5
Rio Grande: Johnson Ranch	1	silt	52.5	38.0	20	5	82.5	12.5	0	0
Rio Grande: Presidio	1	cobble	65	18.6	15.3	5	35	35	0	25
Average			67.2	19.5	25	11	57	25	0	7
Maximum			99.7	38.0	61	40	90	50	0	25
Minimum			40.0	0.0	15	0	20	5	0	0

*Historic data from Bayer et al. 1992
Note: physical habitat data is not available for Terlingua Creek

Appendix B - 2. Stream physical habitat attributes for Ecoregions 25 and 26. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 26 Stream	Sample Size	Watershed Size (km²)	Flow (cfs)	Average Width (m)	Average Depth (m)	Maximum Pool Depth (m)	Stream Bank Slope (degrees)	Stream Bank Erosion (%)	Total Riffles (no.)	Total Stream Bends (no.)	Instream Cover (%)
Bluff Creek*	1	111.6	0.2	4.1	0.4	0.7	40	22	5	3	39
Buck Creek	1	509.7	0.8	5.2	0.3	0.9	15	20	2	7	49
Canadian River: SH 70	1	1,717,422	34.4	7.9	0.3	1.0	22.3	6	0	5	12
Canadian River: US 385	1	1,466,289	3.9	13.6	0.1	0.8	19.7	85	4	4	1.5
Chicken Creek	1	13.5	0.03	1.5	0.1	0.5	42.6	29	2	9	81
McClellan Creek*	1	1,457	2.1	5.5	0.1	0.1	30	61	3	4	4
McClellan Creek	1	1,457	3.2	3.9	0.2	0.6	21.2	19.5	2	4	55
N. Fork Wichita River	1	1,230	5.2	18.2	0.3	1.6	13.5	26.3	2	5	54.2
Saddlers Creek*	1	127.3	2.8	8.2	0.1	0.1	21	80	6	1	5
Salt Fork Red River	1	2,880	7.8	16.5	0.1	0.4	24.7	26.3	6	5	19.2
White Deer Creek	3	346.4	2.1 ±1.7	4.9 ±0.3	0.3 ±0.1	1.2 ±0.2	20.7 ±0.8	21.7 ±7.4	0.0	4.3 ±2.5	34.5 ±11.3
Whitefish Creek*	1	270.8	1.2	7.1	0.1	0.2	39	53	6	2	1
Wolf Creek*	1	2,533	2.3	2.5	0.1	0.2	27	23	0	8	14
Wolf Creek	1	2,533	2.4	5.0	0.2	2.6	17.7	39.4	0	5	55
Average		228,370	4.5	7.1	0.2	0.8	24.7	34.7	2.4	4.7	30.8
Maximum		1,717,422	34.4	18.2	0.4	2.6	42.6	85	6	9	81
Minimum		13.5	0.03	1.5	0.1	0.1	13.5	6	0	1	1

*Historic data from Bayer et al. 1992

Appendix B – 2 CONT. Stream physical habitat attributes for Ecoregions 25 and 26. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 26 Stream	Sample Size	Dominant Substrate Type	Substrate Gravel Size or Larger (%)	Tree Canopy (%)	Average Riparian Width (m)	Riparian Vegetation - Trees (%)	Riparian Vegetation - Shrubs (%)	Riparian Vegetation - Grass (%)	Riparian Vegetation - Cultivated Fields (%)	Riparian Vegetation - Other (%)
Bluff Creek*	1		19	65	46	65	10	25	0	0
Buck Creek	1	sand	7	22.9	>20	42.5	25	32.5	0	0
Canadian River: SH 70	1	sand	0	59.4	>20	5	90	5	0	0
Canadian River: US 385	1	sand	0.2	6.6	18.3	7.5	32.5	60	0	0
Chicken Creek	1	gravel	83	52.1	18.5	17.5	45	37.5	0	0
McClellan Creek*	1		6	0	107	5	10	85	0	0
McClellan Creek	1	sand	3.2	70.6	>20	32.5	17.5	50	0	0
N. Fork Wichita River	1	silt	28.3	41.3	>20	15	55	30	0	0
Saddlers Creek*	1		2	5	30	0	0	100	0	0
Salt Fork Red River	1	sand	1.2	35.3	17.1	40	27.5	32.5	0	0
White Deer Creek	3	sand	3 ±5.2	21.7 ±14.3	15.2 ±4.2	15.8 ±3.8	9.2 ±7.2	75 ±5	0	0
Whitefish Creek*	1		11	0	30	2	3	95	0	0
Wolf Creek*	1		1	0	107	1	50	49	0	0
Wolf Creek	1	sand	6	31.4	20	25	37.5	37.5	0	0
Average			11.1	28.4	36.6	19.1	26.9	54	0	0
Maximum			83	70.6	107	65	90	100	0	0
Minimum			0	0	12.4	0	0	5	0	0

*Historic data from Bayer et al. 1992

Appendix B - 3. Stream physical habitat attributes for Ecoregions 27, 29, and 32. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 27 Stream	Sample Size	Watershed Size (km^2)	Flow (cfs)	Average Width (m)	Average Depth (m)	Maximum Pool Depth (m)	Stream Bank Slope (degrees)	Stream Bank Erosion (%)	Total Riffles (no.)	Total Stream Bends (no.)	Instream Cover (%)
Cottonwood Creek*	1	536.8	0.4	2.5	0.2	0.5	37	23	6	2	30
Deadman Creek*	1		0.1	8.1	0.2	0.6	27	39	2	3	26
Deadman Creek	3	422.2 ±58.3	4.5 ±7.4	19.2 ±7.7	0.5 ±0.2	0.8 ±0.4	54.7 ±23.6	16.9 ±4.2	1.3 ±0.6	1.7 ±1.2	31.9 ±30.6
Elm Creek*	1	1,145.7	0.1	14	0.6	1.8	53	54	3	2	25
Lelia Lake Creek*	1	249.4	4.5	7.4	0.1	0.1	25	75	4	1	2
Sweetwater Creek*	1	433.2	5.1	6.9	0.5	0.9	42	31	4	2	28
Sweetwater Creek	1	433.2	1.2	5.5	0.2	0.6	18.6	40.5	0	6	87.8
Average		508.1	2.8	11.3	0.4	0.8	40.8	34.8	2.6	2.3	32.7
Maximum		1,145.7	13	23.7	0.6	1.8	75.9	75	6	6	87.8
Minimum		249.4	0.1	2.5	0.1	0.1	18.6	12.8	0	1	2

*Historic data from Bayer et al. 1992

Appendix B – 3 CONT. Stream physical habitat attributes for Ecoregions 27, 29, and 32. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 27 Stream	Sample Size	Dominant Substrate Type	Substrate Gravel Size or Larger (%)	Tree Canopy (%)	Average Riparian Width (m)	Riparian Vegetation - Trees (%)	Riparian Vegetation - Shrubs (%)	Riparian Vegetation - Grass (%)	Riparian Vegetation - Cultivated Fields (%)	Riparian Vegetation - Other (%)
Cottonwood Creek*	1		24	20	30	10	10	80	0	0
Deadman Creek*	1		25	9	8	40	20	40	0	0
Deadman Creek	3	silt	34.3 ±14.8	43.5 ±10.7	18.5 ±1.3	27.6 ±8.8	16.1 ±6.5	56.3 ±14.6	0	0
Elm Creek*	1		25	14	23	80	5	15	0	0
Lelia Lake Creek*	1	sand	27	0	16	20	20	60	0	0
Sweetwater Creek*	1		35	5	14	10	25	65	0	0
Sweetwater Creek	1	sand	0	36.8	>20	25	15	60	0	0
Average			26.5	23.9	18.3	29.8	15.9	54.3	0	0
Maximum			51.4	55.9	30	80	25	80	0	0
Minimum			0	0	8	10	5	15	0	0

*Historic data from Bayer et al. 1992

Appendix B – 3 CONT. Stream physical habitat attributes for Ecoregions 27, 29, and 32. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 29 Stream	Sample Size	Watershed Size (km^2)	Flow (cfs)	Average Width (m)	Average Depth (m)	Maximum Pool Depth (m)	Stream Bank Slope (degrees)	Stream Bank Erosion (%)	Total Riffles (no.)	Total Stream Bends (no.)	Instream Cover (%)
Bluff Creek*	1	67.2	0.04	5.7	0.2	0.5	36	22	6	4	42
Clear Creek*	1	634.5	22.7	11.8	0.6	2.1	41	61	5	3	21
Colony Creek*	1	158.2	1.4	11.2	0.6	1.6	48	27	4	2	29
Cowhouse Creek*	1	1,180.2	51.7	17.2	0.8	1.6	54	49	4	3	11
Ioni Creek*	1	146.1	0.0	15	1.1	2.1	49	28	0	0	10
Neils Creek*	1	355.4	7.9	15.8	0.3	0.7	46	13	10	4	16
Neils Creek	1		1.2	18.1	0.4	1.5	32.1	59.6	4	3	35
Reese Creek	2	25.9	0.1	3.7 ±0.6	0.2 ±0.1	0.7 ±0.2	36.1 ±19.9	22.5 ±11.9	7	5 ±1.4	32.9 ±17.2
Rocky Creek*	1	295.0	1.2	8.3	0.3	1	24	41	6	3	36
Rocky Creek	5	295.0	22.6 ±30.5	12.4 ±3.5	0.2 ±0.1	0.6 ±0.1	42.6 ±3.4	28.6 ±8.8	4.4 ±1.3	3	41.4 ±15.9
South Fork Rocky Creek	4	120.7	7.7 ±8.8	9.5 ±2.2	0.3 ±0.1	1.4 ±0.4	41.1 ±7.5	35.6 ±9.6	4.5 ±2.5	3.3 ±0.5	44.5 ±29.2
Steele Creek*	1	113.5	0.7	10.5	0.4	0.8	30	28	5	2	8
Average		261.0	11.6	11.0	0.4	1.1	40.5	32.9	4.9	3.1	32.9
Maximum		1,180.2	74.7	18.1	1.1	2.1	54	61	10	6	82
Minimum		25.9	0.0	3.2	0.1	0.5	22	13	0	0	8

*Historic data from Bayer et al. 1992

Appendix B – 3 CONT. Stream physical habitat attributes for Ecoregions 27, 29, and 32. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 29 Stream	Sample Size	Dominant Substrate Type	Substrate Gravel Size or Larger (%)	Tree Canopy (%)	Average Riparian Width (m)	Riparian Vegetation - Trees (%)	Riparian Vegetation - Shrubs (%)	Riparian Vegetation - Grass (%)	Riparian Vegetation - Cultivated Fields (%)	Riparian Vegetation - Other (%)
Bluff Creek*	1		50	43	76	60	30	10	0	0
Clear Creek*	1		36	25	5	50	30	20	0	0
Colony Creek*	1	bedrock	50	13	38	30	40	30	0	0
Cowhouse Creek*	1	gravel	57	45	28	70	20	10	0	0
Ioni Creek*	1		50	40	46	70	20	10	0	0
Neils Creek*	1	gravel	37	30	20	60	10	30	0	0
Neils Creek	1	gravel	90.8	68.9	4.8	30	22.5	35	12.5	0
Reese Creek	2	cobble/ bedrock	49.9 ±14	55.2 ±27.3	15.3 ±4.2	68.7 ±4	11.5 ±2.1	18.7 ±5	0	1.2 ±1
Rocky Creek*	1		38	21	24	50	30	20	0	0
Rocky Creek	5	bedrock	82 ±17.9	31.8 ±5.6	16.2 ±1.1	57.5 ±10	24 ±11.4	14.5 ±4.5	0	4 ±4.2
South Fork Rocky Creek	4	cobble	73.6 ±26.6	14.6 ±10.1	14.8 ±9.9	39.5 ±22.8	29.8 ±14.3	23.6 ±10.8	0.0	7.2 ±4.5
Steele Creek*	1	bedrock	18	10	30	40	30	30	0	0
Average			61.5	31.2	22.5	52.1	24.7	20.0	0.6	2.6
Maximum			90.8	74.5	76	71.5	50	35	12.5	10
Minimum			18	5	3.4	12	10	7.5	0	0

*Historic data from Bayer et al. 1992

Appendix B – 3 CONT. Stream physical habitat attributes for Ecoregions 27, 29, and 32. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 32 Stream	Sample Size	Watershed Size (km^2)	Flow (cfs)	Average Width (m)	Average Depth (m)	Maximum Pool Depth (m)	Stream Bank Slope (degrees)	Stream Bank Erosion (%)	Total Riffles (no.)	Total Stream Bends (no.)	Instream Cover (%)
Auds Creek*	1	103.9	1.3	5	0.2	0.6	53	49	3	4	20
Auds Creek	1	103.9	2.6	8.9	0.3		26.7	53	2	2	30
Cow Bayou*	1	289.1	6.7	4.5	0.5	1.3	44	38	5	2	36
Cow Bayou	1	289.1	32	8.2	0.3	1.2	32.1	33.9	2	4	6
Deer Creek*	1	296.9	1.6	15	0.5	1.4	43	58	5	3	11
Deer Creek	2	286.4	7.3 ±1.8	15.1 ±0.4	0.4 ±0.01	1 ±0.1	37.8 ±3.1	42.3 ±8.9	5.5 ±0.7	1	5.4 ±4.5
Geronimo Creek*	1	106.9	8.6	9.3	1.1	2.7	35	34	4	3	35
Geronimo Creek	5	106.9	3.8 ±1.4	6 ±0.7	0.5 ±0.1	0.9 ±0.1	109.9 ±12.9	22.6 ±8.6	2.4 ±0.5	3	43.6 ±6.2
Willis Creek*	1	55.8	0.01	4	0.2	0.5	46	59	3	3	9
Willis Creek	5	124.8 ±63.8	3.2 ±3.6	4.4 ±1.1	0.3 ±0.1	1.2 ±0.7	35.7 ±5.7	56.1 ±7.3	5 ±2.5	8.2 ±1.1	13.3 ±6
Wilson Creek*	1	80.3	4.8	5.1	0.4	1	49	49	9	5	21
Wilson Creek	2	80.3	6.8	5.7 ±1.4	0.3		45.5 ±4.9	54 ±12.7	3	4	37.5 ±6.4
Average		146.3	5.4	7.0	0.4	1.1	55.6	43.6	4	4.2	24.5
Maximum		296.9	32	15.4	1.1	2.7	122.2	63	9	9	54
Minimum		54.9	0.01	3.1	0.2	0.4	26.7	12	1	1	2.2

*Historic data from Bayer et al. 1992

Appendix B – 3 CONT. Stream physical habitat attributes for Ecoregions 27, 29, and 32. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 32 Stream	Sample Size	Dominant Substrate Type	Substrate Gravel Size or Larger (%)	Tree Canopy (%)	Average Riparian Width (m)	Riparian Vegetation - Trees (%)	Riparian Vegetation - Shrubs (%)	Riparian Vegetation - Grass (%)	Riparian Vegetation - Cultivated Fields (%)	Riparian Vegetation - Other (%)
Auds Creek*	1	clay	11	4	8	40	10	30	20	0
Auds Creek	1	silt	39.2	8.3	13.1	20	17.9	37.9	0	24.1
Cow Bayou*	1		65	50	37	60	30	10	0	0
Cow Bayou	1	sand	28	64.1	17.9	17.9	14.9	61.9	0	4.4
Deer Creek*	1	gravel	21	7	5	40	10	40	10	0
Deer Creek	2	clay/ bedrock	18.9 ±12.3	18.1 ±1.4	19.2 ±2.6	25.0	62.5	12.5	0	0
Geronimo Creek*	1		50	63	35	60	20	10	10	0
Geronimo Creek	5	cobble/ gravel	79.8 ±11	88.9 ±6.2	17.9 ±2.1	34.7 ±4.3	20.5 ±2.7	34.2 ±5.6	0	10.6 ±6.2
Willis Creek*	1	sand	23	76	15	50	20	20	10	0
Willis Creek	5	gravel	57.9 ±12.4	85.4 ±6.9	19.8 ±0.7	57.3 ±21.7	22.8 ±15	20.5 ±6.4	0	0
Wilson Creek*	1	gravel	38	80	30	40	10	10	40	0
Wilson Creek	2	gravel/ cobble	48.5 ±4.9	76.3 ±12.4	38.3	21.4 ±23.2	11.4 ±16.1	36.9 ±8.6	0	31.4 ±29.1
Average			49.9	64.2	20.7	39.9	20.6	28.0	4.5	7.2
Maximum			91	95.3	38.3	72	62.5	61.9	40	52
Minimum			10.2	4	5	5	0	10	0	0

*Historic data from Bayer et al. 1992

Appendix B - 4. Stream physical habitat attributes for Ecoregion 30. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 30 Stream	Sample Size	Watershed Size (km^2)	Flow (cfs)	Average Width (m)	Average Depth (m)	Maximum Pool Depth (m)	Stream Bank Slope (degrees)	Stream Bank Erosion (%)	Total Riffles (no.)	Total Stream Bends (no.)	Instream Cover (%)
Barton Creek*	1	249.2	0.5	6	0.5	1.1	33	12	5	2	11
Brushy Creek	3	67 ±35.1	12.7 ±11.5	10 ±4.5	0.5 ±0.1	1.1 ±0.1	32.9 ±15	16.4 ±7.9	3 ±1.7	3.3 ±0.6	18.8 ±21.5
Bull Creek	2	22 ±16.2	1.8 ±0.8	7.9 ±5.7	0.3 ±0.1	1 ±0.3	31.5 ±14.4	17	3	2.5 ±2.1	42 ±24
Carpers Creek*	1	39.6	0.05	8	0.6	1.7	35	46	6	3	44
Colorado River	8	2,538,770	81.6 ±90.1	49.5 ±8.2	0.6 ±0.1	2.3 ±0.2	42.6 ±13.4	35.7 ±17.8	2.1 ±1.1	0.9 ±1	25 ±12.5
Cypress Creek	8	97.7	3.3 ±5.5	12.3 ±3.7	0.5 ±0.2	1.2 ±0.1	49.1 ±18.6	17.7 ±4.9	1.5 ±1.1	3.6 ±1.4	40.1 ±7.4
Devils River*	1	7490	110	111.7	0.7	2.3	30	34	4	2	9
Devils River	1	7490	63.4	52.1	0.5	1.7	22.8	7.7	9	4	64.38
Guadalupe River	6	1161	52 ±29.7	21.6 ±3	0.7 ±0.2	1.8 ±0.2	31.4 ±5.9	17.7 ±2.2	3.5 ±0.5	2.5 ±0.5	39 ±3.6
James River*	1	876.6	18.8	19.1	0.5	2	26	20	4	2	25
Johnson Creek	2	329	30.5 ±16.3	33.1 ±6.8	0.6 ±0.01	2.4 ±0.2	43.5 ±13.9	21.9 ±1.5	4	3	28.8 ±4.1
Little Barton Creek*	1	29.8	0.2	8	0.4	1.2	29	26	5	4	26
Little Blanco River*	1	78.2	2.4	9.4	0.7	1.6	33	36	5	2	25
Live Oak Creek*	1	959.8	2.0	16.4	0.2	0.7	34	31	5	0	13
Llano River	21	7398 ±2081	128.7 ±67.9	45.8 ±14	0.6 ±0.1	2.1 ±0.7	42.6 ±11	61.3 ±17.3	1.8 ±1.2	1.5 ±0.7	36.3 ±11.8
Medina River*	1	788.0	19.6	11.1	0.7	1.9	32	30	6	2	16
North Prong Medina River	5	369	6 ±4.9	8.7 ±1.3	0.2 ±0.05	1.9 ±0.2	17 ±3.3	25.3 ±6.4	4.8 ±3.9	3.2 ±2.7	41.3 ±11.9
Oatmeal Creek*	1	31.8	0.1	6.6	0.6	1.5	56	20	4	2	26
Onion Creek*	1	321	1.8	9.1	0.4	1.4	19	34	6	2	52
Onion Creek	1		1.1	7.5	0.7	1.2	31.9	14.5	3	4	55
Pedernales River	9	956.5	14.6 ±29.5	14.9 ±4.8	0.3 ±0.1	1.5 ±0.4	25.7 ±6.8	66.2 ±15.7	1.8 ±0.4	3.3 ±1	29.1 ±9.8
San Saba River	8	7219	60.4 ±47.2	40.8 ±11.7	1 ±0.1	3.4 ±0.4	54.5 ±8.8	47.1 ±10.8	1.4 ±0.5	3.3 ±0.7	39.1 ±9.2
Slaughter Creek	6	51 ±29.6	0.5 ±0.3	9.4 ±3	0.6 ±0.3	1.3 ±0.3	58 ±48.7	34.1 ±13.2	2 ±1.7	1	31.2 ±8.6
South Llano River*	1	492.1	73.5	32.3	1.0	2.2	24	9	4	2	32
South Llano River	10	2248	86.2 ±26.9	20.9 ±2.3	0.7 ±0.1	1.8 ±0.2	47.5 ±11	68.5 ±13.4	2 ±0.7	2.2 ±0.8	34.5 ±10.3
Spring Creek*	1	992.7	17.4	19.8	0.4	1.9	21	4	4	0	13
West Rocky Creek*	1	292.2	1.6	10.9	0.9	1.5	26	7	2	0	7
Average		201,817	55.9	27.2	0.6	1.9	39.7	41.4	2.6	2.3	33.5
Maximum		2,538,770	291.0	111.7	1.2	3.8	133.0	89.0	9.0	7.0	65.0
Minimum		10.59	0.0	3.5	0.1	0.7	9.5	4.0	0.0	0.0	2.0

*Historic data from Bayer et al. 1992

Note: physical habitat data is not available for Bullhead Creek, Montell Creek, upper Nueces River and the South Concho River

Appendix B – 4 CONT. Stream physical habitat attributes for Ecoregion 30. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 30 Stream	Sample Size	Dominant Substrate Type	Substrate Gravel Size or Larger (%)	Tree Canopy (%)	Average Riparian Width (m)	Riparian Vegetation - Trees (%)	Riparian Vegetation - Shrubs (%)	Riparian Vegetation - Grass (%)	Riparian Vegetation - Cultivated Fields (%)	Riparian Vegetation - Other (%)
Barton Creek*	1		50	10	20	40	30	30	0	0
Brushy Creek	3	gravel	55.7 ±32.1	33.1 ±15.1	19.5 ±2.3	19.2 ±1.4	29.5 ±19.6	51.3 ±20.8	0	0
Bull Creek	2	cobble/ sand	87 ±8.5	67.5 ±6.4	20	35 ±21.2	50 ±28.3	15 ±7.1	0	0
Carpers Creek*	1		65	83	21	60	10	30	0	0
Colorado River	8	cobble/ gravel	67.4 ±11.1	29.7 ±8.4	14.6 ±2.7	16.7 ±6.6	1.2 ±1.4	67.5 ±11.5	0	14.6 ±5.7
Cypress Creek	8	gravel/ bedrock	41.6 ±18.5	93.3 ±5.8	6.1 ±4.9	32.7 ±5.7	8.6 ±3.8	55.3 ±10.9	0	4.8 ±6.2
Devils River*	1		4	0	18	30	60	10	0	0
Devils River	1	bedrock	32.8	49.3	>20	20	35	45	0	0
Guadalupe River	6	bedrock	38.6 ±12	64.9 ±13.9	15.2 ±2.1	36.5 ±3.8	11.7 ±5.1	47.1 ±6.5	0	5.6 ±6.6
James River*	1		90	0	15	25	40	35	0	0
Johnson Creek	2	bedrock	28.8 ±25.3	70.7 ±7.5	16.8 ±2.2	21.3 ±2.9	12.5 ±5.9	53.8 ±2.9	0	12.5 ±5.9
Little Barton Creek*	1		50	14	18	40	40	20	0	0
Little Blanco River*	1		30	0	15	20	50	30	0	0
Live Oak Creek*	1		49	0	65	30	60	10	0	0
Llano River	21	sand/ gravel	55.4 ±23.9	11.6 ±16.2	121 ±272.4	8.3 ±7.4	4.9 ±8	53.6 ±22.9	4.8 ±21.2	25.4 ±19.7
Medina River*	1		57	18	7	60	20	20	0	0
North Prong Medina River	5	cobble/ gravel	93.7 ±5	78.7 ±6.9	16.5 ±6.1	46.6 ±5	4.2 ±5.3	49 ±6.1	0	0
Oatmeal Creek*	1	bedrock	31	20	15	30	40	30	0	0
Onion Creek*	1		44	50	23	50	25	25	0	0
Onion Creek	1	cobble	47	65.6	>20	36.5	22	41.5	0	0
Pedernales River	9	gravel	51.2 ±11.6	8.1 ±4.9	18.8 ±1.8	4.6 ±2.4	8.5 ±7.5	46 ±18.8	0	40.9 ±19.2
San Saba River	8	silt	35 ±15.1	35.7 ±7.3	>20	12.7 ±4.8	4 ±4.5	57.5 ±15.3	0	25.8 ±14.8
Slaughter Creek	6	bedrock	94.5 ±10.2	56.3 ±41.5	>20	35.3 ±18.4	15.3 ±11.3	44.9 ±19.3	0.8 ±2	3.7 ±5.7
South Llano River*	1		82	11	12	40	40	20	0	0
South Llano River	10	cobble/ gravel	75.5 ±13.9	2.7 ±3.3	30.7 ±21.8	3.6 ±2.5	9.5 ±9.6	52 ±26.5	8.5 ±26.9	23.8 ±21.4
Spring Creek*	1		82	0	23	15	20	65	0	0
West Rocky Creek*	1		83	6	30	40	20	40	0	0
Average			58.2	33.4	39.9	20.7	12.6	48.9	1.8	15.3
Maximum			100.0	100.0	955.8	60.0	70.0	96.7	94.8	64.5
Minimum			4.0	0.0	1.7	0.0	0.0	0.2	0.0	0.0

*Historic data from Bayer et al. 1992

Note: physical habitat data is not available for Bullhead Creek, Montell Creek, upper Nueces River and the South Concho River

Appendix B - 5. Stream physical habitat attributes for Ecoregion 31. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 31 Stream	Sample Size	Watershed Size (km^2)	Flow (cfs)	Average Width (m)	Average Depth (m)	Maximum Pool Depth (m)	Stream Bank Slope (degrees)	Stream Bank Erosion (%)	Total Riffles (no.)	Total Stream Bends (no.)	Instream Cover (%)
Las Moras Creek*	1	70	35.1	4.4	0.5	0.9	22	35	1	10	24
Metate Creek*	1	197.7	0.04	5.1	0.4	0.7	48	50	2	1	42
Mud Creek*	1	36.2	0.9	8.5	0.2	0.4	8	22	0	1	39
Nueces River	4	5,160.4	36.1 ±30.9	25 ±15.4	0.4 ±0.1	1.9 ±0.5	31.1 ±6.5	57.1 ±21.3	4.5 ±1.3	2.5 ±1.3	53.7 ±24.7
Pinto Creek*	1	309.4	13.8	16.7	1.1	2.8	25	13	6	2	33
Pinto Creek	2		19.2 ±13.9	20.6 ±2.5	0.9 ±0.3	2.7 ±0.4	24.8 ±4.1	19 ±5.6	1.5 ±0.7	3 ±1.4	50.3 ±5.2
San Miguel Creek*	1	1,275.3	3.9	4.5	0.4	0.7	61	57	2	3	21
San Miguel Creek	1		0	6.2	0.4	1.1	44	74	0	3	25
Sycamore Creek*	1	1,283.6	2.4	8	0.4	0.6	24	31	6	3	27
Sycamore Creek	1	1,283.6	13	34.5	0.5	2	21.5	23.8	3	3	63.3
Average		1,202.0	18.0	16.4	0.5	1.6	30.5	40.9	2.9	3	42.1
Maximum		5,160.4	80.2	38.6	1.1	3	61	79.3	6	10	86
Minimum		36.2	0	4.4	0.2	0.4	8	13	0	1	21

*Historic data from Bayer et al. 1992

Appendix B – 5 CONT. Stream physical habitat attributes for Ecoregion 31. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 31 Stream	Sample Size	Dominant Substrate Type	Substrate Gravel Size or Larger (%)	Tree Canopy (%)	Average Riparian Width (m)	Riparian Vegetation - Trees (%)	Riparian Vegetation - Shrubs (%)	Riparian Vegetation - Grass (%)	Riparian Vegetation - Cultivated Fields (%)	Riparian Vegetation - Other (%)
Las Moras Creek*	1		0	88	42	50	5	45	0	0
Metate Creek*	1		0	45	49	50	30	20	0	0
Mud Creek*	1		6	0	36	10	20	70	0	0
Nueces River	4	cobble	76.1 ±11.3	41 ±26.6	0.0	38.1 ±19.7	31.3 ±17	18.1 ±13.1	0	12.5 ±25
Pinto Creek*	1		40	6	49	20	50	30	0	0
Pinto Creek	2	silt	22.4 ±8.4	40 ±1.1	11.8	53.8 ±12.4	22.5 ±3.5	23.8 ±8.8	0	0
San Miguel Creek*	1		41	62	91	50	30	20	0	0
San Miguel Creek	1	silt	29	66	>20	15	15	70	0	0
Sycamore Creek*	1		86	14	61	5	75	20	0	0
Sycamore Creek	1	gravel	69.2	33.3	>20	25	35	40	0	0
Average			44.3	39.9	37.8	34.6	30.7	31.1	0	3.6
Maximum			86.7	88	91	62.5	75	70	0	50
Minimum			0	0	0	5	5	10	0	0

*Historic data from Bayer et al. 1992

Appendix B - 6. Stream physical habitat attributes for Ecoregions 33 and 35. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 33 Stream	Sample Size	Watershed Size (km^2)	Flow (cfs)	Average Width (m)	Average Depth (m)	Maximum Pool Depth (m)	Stream Bank Slope (degrees)	Stream Bank Erosion (%)	Total Riffles (no.)	Total Stream Bends (no.)	Instream Cover (%)
Blair Creek	2	11.4	1.4 ±1.5	3.1 ±0.8	0.1 ±0.04	0.7 ±0.1	46.5 ±2.1	33.5 ±0.7	0	9	29 ±2.8
Catfish Creek*	1	505.1	4.7	7.2	0.4	1.1	50	83	5	4	42
Catfish Creek	4	505	11.9 ±10.5	7.4 ±1.9	0.4 ±0.1	1.2 ±0.5	34.9 ±1.1	26.8 ±4.2	1 ±0.8	4 ±2	28 ±4.9
Cedar Creek	2	157	2.8 ±0.7	4.4 ±0.4	0.2 ±0.04	1.3 ±0.04	40.3 ±0.4	44.3 ±8.1	2	3	17.1 ±1.8
Cummins Creek*	1	759.5	0.8	7.7	0.3	0.9	44	22	4	2	31
Cummins Creek	14	759.5	10.1 ±7.3	17.9 ±3.5	0.4 ±0.1	1 ±0.3	50.4 ±10.8	54.6 ±23.1	2.4 ±0.8	2.7 ±0.8	35.7 ±10.8
Cuthand Creek	1	622.3	19.9	12.2	0.3		23.7	73	1	1	54.2
Davidson Creek*	1	178.1	0	5.0	0.3	0.6	61	61	0	2	40
Davidson Creek	2	178		5.8 ±1.7	0.4 ±0.1		61 ±5	48.6 ±2.7	0	6	48.1 ±15.7
Kickapoo Creek	1	247	5.7	6.6	0.4	1.8	36.6	65	0	0	8.7
Little Mustang Creek	1	60.8	1.0	3.7	0.4		37.3	62.1	0	1	21.7
Lower Keechi Creek*	1	248.1	0.9	6.5	0.4	1.3	52	71	7	1	51
Middle Yegua Creek*	1	1,108.8	0.9	3.9	0.5	1.3	40	51	4	2	43
Mill Creek*	1		3.4	11	0.5	1.6	44	53	3	2	16
Mill Creek	15	975.7	12.6 ±14.1	9 ±3.4	0.2 ±0.1	1.3 ±0.7	27.3 ±5.5	28.4 ±16	1.4 ±0.9	5.8 ±1.5	15.8 ±4.8
Ponds Creek*	1	20.2	0.0	3.5	0.2	0.3	51	44	5	2	16
Ponds Creek	2	20.2		2.4 ±0.3	0.1 ±0.1	0.8	39.4 ±22.1	51.3 ±8.8	0		10.5 ±0.7
Smackover Creek	2	24.8	0.6 ±0.3	4.6 ±0.6	0.4 ±0.1	1.2 ±0.5	45.5 ±9.6	73.3 ±10.6	1 ±1.4	2	20.8 ±0.02
Wheelock Creek*	1	46.3	0.8	2.7	0.2	0.5	42	37	5	2	15
Average		601.3	8.4	9.7	0.3	1.1	40.8	44.9	1.8	3.8	26.6
Maximum		1,108.8	55.2	23.8	0.6	2.0	67.9	83.0	7.0	9.0	59.2
Minimum		11.4	0.0	2.2	0.1	0.3	18.5	2.8	0.0	0.0	8.7

*Historic data from Bayer et al. 1992

Appendix B – 6 CONT. Stream physical habitat attributes for Ecoregions 33 and 35. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 33 Stream	Sample Size	Dominant Substrate Type	Substrate Gravel Size or Larger (%)	Tree Canopy (%)	Average Riparian Width (m)	Riparian Vegetation - Trees (%)	Riparian Vegetation - Shrubs (%)	Riparian Vegetation - Grass (%)	Riparian Vegetation - Cultivated Fields (%)	Riparian Vegetation - Other (%)
Blair Creek	2	sand	16	92	25	40.3 ±0.4	13.5 ±3.5	38.5 ±7.1	0	7.8 ±3.9
Catfish Creek*	1	silt	2	95	91.4	70	10	20	0	0
Catfish Creek	4	sand	3.1 ±4.4	99.8 ±0.5	>20	63.8 ±12.4	10	26.3 ±12.4	0	0
Cedar Creek	2	sand	23.8	93.4 ±2.5	17.3 ±1	47.5	12.5	37.5	0	1.3 ±1.8
Cummins Creek*	1	sand	19	32	91.4	70	20	0	0	10
Cummins Creek	14	gravel/ sand	51.5 ±13.2	42 ±16.7	37.4 ±58	28.4 ±26.9	6.9 ±7.6	43.8 ±26.7	8 ±22.1	13 ±12.7
Cuthand Creek	1	cobble	31.7	13.2	20.5	18.7	20	38.7	0	22.6
Davidson Creek*	1	clay	0	82	25.9	80	15	5	0	0
Davidson Creek	2	silt	0	65.3 ±3.9	>20	32.5 ±4.9	43.8 ±1.2	7.7 ±0.9	0	16 ±2.8
Kickapoo Creek	1	clay	1.2	43.2	12.5	20	20	37.5	0	25
Little Mustang Creek	1	silt	2.5	81.3	12.6	26.2	20	42.3	0	11.5
Lower Keechi Creek*	1	sand	12	48	18	50	25	15	10	0
Middle Yegua Creek*	1	sand	30	60	23	60	20	20	0	0
Mill Creek*	1	sand	5	75	30.5	60	30	5	0	5
Mill Creek	15	sand	11.6 ±10.7	60.4 ±21.9	9 ±2.9	53 ±10	18.9 ±10.5	21.4 ±12.1	3 ±7	3.7 ±6.7
Ponds Creek*	1	sand	20	87	23	70	20	10	0	0
Ponds Creek	2	sand	13.3 ±18.9	57.1 ±1.7	20	46.3 ±65.4	50 ±70.7	0	0	3.8 ±5.3
Smackover Creek	2	silt	17.1 ±5.3	98 ±0.7	>20	38.1 ±5.2	7.3 ±1.4	18.8 ±8.8	0	36 ±2.2
Wheelock Creek*	1	sand	18	58	46	70	15	15	0	0
Average			22.0	62.6	25.7	45.7	16.7	26.6	3.0	8.1
Maximum			76.0	100.0	237.1	92.5	100.0	74.0	79.8	37.5
Minimum			0.0	7.7	4.0	0.0	0.0	0.0	0.0	0.0

*Historic data from Bayer et al. 1992

Appendix B – 6 CONT. Stream physical habitat attributes for Ecoregions 33 and 35. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 35 Stream	Sample Size	Watershed Size (km²)	Flow (cfs)	Average Width (m)	Average Depth (m)	Maximum Pool Depth (m)	Stream Bank Slope (degrees)	Stream Bank Erosion (%)	Total Riffles (no.)	Total Stream Bends (no.)	Instream Cover (%)
Beach Creek	2	21.4	12.2 ±17	4.6 ±1.1	0.4 ±0.2	1 ±0.3	46 ±5.7	25	0	5	11.5 ±2.1
Beech Creek*	1	117	2.2	5.2	0.3	0.9	19	20	2	0	72
Beech Creek	4	103 ±16.2		4.2 ±0.9	0.2 ±0.02	1.2 ±0.1	24.9 ±4.9	31.5 ±22	0	4.8 ±1.3	50.3 ±30.6
Big Cypress Creek*	1	369.5	0.2	4.1	0.3	0.6	23	84	0	2	53
Big Cypress Creek	2	369.5	2.9	20.3 ±0.5	0.4 ±0.1	1.8	8.1 ±2.7	54.6 ±11.8	0	3	62.1 ±11.2
Black Bayou	5	165.5 ±111.8	13.4 ±14.6	13.8 ±6.3	0.4 ±0.1	1.1 ±0.1	11.1 ±3.5	9.7 ±1.4	0	3.8 ±1.9	28.1 ±7.4
Black Cypress Bayou*	1	47.0	0.9	5.8	0.3	0.8	56	91	6	10	36
East Fork of the San Jacinto River*	1	365.7	7.8	7.4	0.5	1.5	39	35	2	4	17
East Fork of the San Jacinto River	2	365.7	3.3 ±1.8	8.4 ±0.3	0.4 ±0.1	1.3 ±0.1	31.1 ±14.4	4.6 ±1.9	2	8	21.5 ±12
Frazier Creek*	1	126	3.2	6.2	0.6	1.3	49	60	6	3	29
Frazier Creek	5	211.8 ±117.5	9.8 ±11.3	6.6 ±2.2	0.4 ±0.2	1.3 ±0.2	44.8 ±14.1	50.8 ±9.9	0.4 ±0.5	4.8 ±2.3	19.9 ±10
Irons Bayou*	1	220.2	1.6	5.9	0.5	1.0	45	92	2	7	45
Irons Bayou	1	220.2	0.6	6.7	0.4		41.2	55	0	6	46
James Bayou	15	131.3 ±49.6	7 ±11.5	5.9 ±2.7	0.3 ±0.2	0.7 ±0.4	24.5 ±9	44.4 ±19.3	0.1 ±0.4	4.7 ±1.2	16.2 ±7
Lake Creek*	1	852.8	6.9	9.7	0.3	0.9	32	28	3	4	16
Lake Creek	5	789.9 ±31.6	1.3 ±0.9	6.8 ±0.5	0.4 ±0.1	1.8 ±0.3	33.4 ±3.6	20.5 ±13	2 ±1.2	5.8 ±2	37.8 ±30.1
Little Cypress Bayou*	1	730.5	5.6	7.4	0.6	1.2	34	79	2	3	31
Little Cypress Bayou	3	730.5	8.9 ±7.1	6.8 ±1.5	0.3 ±0.1	1 ±0.5	30.8 ±4.9	56.7 ±3.2	1.3 ±2.3	6 ±1.7	32.3 ±5.1
Little Pine Island Bayou	2	319.3	0.8 ±0.5	4 ±0.1	0.2 ±0.1	0.4 ±0.3	22.4 ±0.8	34.7 ±19.3	2.5 ±2.1	3 ±1.4	54.5 ±7.8
Peach Creek	19	399.9	19.6 ±10.7	12.8 ±3.4	0.2 ±0.1	0.9 ±0.4	44.5 ±8.8	22 ±15.7	2.1 ±1.3	4.8 ±1.8	14.8 ±6
Piney Creek*	1	251.7	1.2	6.2	0.2	1.2	42	62	4	5	26
Piney Creek	2	251.7	1.1 ±1.3	4.8 ±0.9	0.2 ±0.1	1.2 ±0.3	33.4 ±11	48.5 ±7.8	1.5 ±0.7	5.5 ±2.1	33 ±4.2
San Pedro Creek	1	343.7	15.9	7.0	0.3	1.5	43.9	69	0	2	13
West Fork of the San Jacinto River	3	1,225.3	11.1 ±5.5	8.4 ±1.2	0.3 ±0.1	0.7 ±0.3	40.6 ±15.1	15.5 ±5.2	2.3 ±0.6	3.3 ±0.6	12.5 ±7.6
White Oak Creek*	1	233.3	26.0	8.5	0.9	1.9	50	71	2	6	53
Average		348.3	10.2	8.6	0.3	1.0	33.7	36.0	1.3	4.7	25.8
Maximum		1,225.3	43.7	24.6	0.9	2.0	68.1	92.0	6.0	10.0	89.0
Minimum		21.4	0.0	2.5	0.1	0.0	6.2	3.3	0.0	0.0	5.0

*Historic data from Bayer et al. 1992

Appendix B – 6 CONT. Stream physical habitat attributes for Ecoregions 33 and 35. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 35 Stream	Sample Size	Dominant Substrate Type	Substrate Gravel Size or Larger (%)	Tree Canopy (%)	Average Riparian Width (m)	Riparian Vegetation - Trees (%)	Riparian Vegetation - Shrubs (%)	Riparian Vegetation - Grass (%)	Riparian Vegetation - Cultivated Fields (%)	Riparian Vegetation - Other (%)
Beach Creek	2	sand	0	100	89	43.5 ±2.8	18.5 ±1.4	34 ±1.4	0	4 ±2.8
Beech Creek*	1	sand	2	82	91.4	75	25	0	0	0
Beech Creek	4	sand	0	86.8 ±9.5	>20	35 ±15.4	31.7 ±21.3	5.4 ±5	0	27.9 ±21
Big Cypress Creek*	1		0	98	91.4	85	10	5	0	0
Big Cypress Creek	2	silt	0	96.1 ±4.2	>20	71.3 ±27.7	0	21.7 ±20	0	7.1 ±7.7
Black Bayou	5	silt	0	82 ±14.1	19.7	62 ±16	18 ±9.7	20 ±7.9	0	0
Black Cypress Bayou*	1	clay	2	81	61	70	15	10	5	0
East Fork of the San Jacinto River*	1	sand	14	72	107	80	15	5	0	0
East Fork of the San Jacinto River	2	sand	21.9 ±0.8	97 ±2.1	17.6 ±2.3	77.5 ±3.5	10	12.5 ±3.5	0	0
Frazier Creek*	1	sand	1	36	64	70	20	10	0	0
Frazier Creek	5	sand	0	62.7 ±38.5	44.6 ±25.8	38.4 ±22.4	11.9 ±10.6	41 ±29.8	1 ±2.2	7.7 ±13
Irons Bayou*	1	clay	0	67	106.7	90	5	5	0	0
Irons Bayou	1	silt	0	83.5	72	30	10	34	0	26
James Bayou	15	clay	2.2 ±4.4	91.9 ±10.9	159.3 ±78.4	58.4 ±18.2	5.1 ±5	17.3 ±9.3	0	20.5 ±16.5
Lake Creek*	1	sand	2	13	45.7	70	20	10	0	0
Lake Creek	5	sand	10.6 ±9.7	70.3 ±17.3	18.6 ±1	49.5 ±28.1	25.5 ±15.7	23 ±16	0	1 ±2.2
Little Cypress Bayou*	1	clay	2	56	107	70	10	20	0	0
Little Cypress Bayou	3	sand	0	97.2 ±0.4	75.3 ±23.6	34.5 ±5.6	8	22.3 ±8.9	0	35.2 ±14.4
Little Pine Island Bayou	2	clay/ silt	0	92.5 ±2.4	>20	38.5 ±37.5	35 ±14.1	14.5 ±6.4	0	12 ±17
Peach Creek	19	sand	21.4 ±11.2	73.4 ±22.7	17.7 ±1.5	67.4 ±15.2	18.9 ±13.8	10.3 ±8.2	0.0	3.4 ±6.4
Piney Creek*	1	sand	16	93	44.2	70	25	5	0	0
Piney Creek	2	silt/sand	23 ±12.7	88.8 ±5	18.5 ±3.6	62 ±0.7	1 ±1.4	37 ±0.7	0	0
San Pedro Creek	1	sand	0	97.1	> 20	40	20	40	0	0
West Fork of the San Jacinto River	3	sand	15.8 ±6.3	65.5 ±17.4	66.7 ±56.1	58.3 ±14.4	20	7.5 ±4.3	0	14.2 ±10.1
White Oak Creek*	1	sand	2	82	91.4	80	15	5	0	0
Average			8.4	80.2	84.5	58.4	15.3	17.1	0.1	9.2
Maximum			45.0	100.0	250.0	100.0	50.8	86.3	5.0	58.3
Minimum			0.0	8.0	10.0	8.8	0.0	0.0	0.0	0.0

*Historic data from Bayer et al. 1992

Appendix B - 7. Stream physical habitat attributes for Ecoregion 34. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 34 Stream	Sample Size	Watershed Size (km²)	Flow (cfs)	Average Width (m)	Average Depth (m)	Maximum Pool Depth (m)	Stream Bank Slope (degrees)	Stream Bank Erosion (%)	Total Riffles (no.)	Total Stream Bends (no.)	Instream Cover (%)
Arenosa Creek*	1	294	1.4	5.6	0.2	0.9	33	65	5	2	24
Arenosa Creek	3	294	0	7.6 ±1.8	0.2 ±0.04	1.1 ±0.5	23.8 ±3.3	38.8 ±2.4	2.3 ±2.1	4.3 ±0.6	33.2 ±5.4
Big Creek*	1	436.4	0.6	6.1	0.4	0.6	26	23	1	1	7
Big Creek	7	435.7 ±10.2	11.3 ±3.5	6.4 ±2	0.3 ±0.2	1.1 ±0.6	33.6 ±7.1	24.4 ±11.9	1.7 ±1.6	3.9 ±1.6	11.7 ±6.2
Garcitas Creek*	1	239.5	6.9	6.7	0.5	0.8	55	78	3	2	32
Garcitas Creek	2	239.5	2.2 ±1.8	5.9 ±0.7	0.2	1.1 ±0.3	30.6 ±6.5	49.6 ±4.8	3.5 ±3.5	6.5 ±3.5	58.4 ±17.8
Placedo Creek*	1	176.1	0	5.7	0.6	1.3	50	82	0	1	35
Placedo Creek	1	176.1	1	5.0	0.3	1.0	41.6	26	1	3	86
San Bernard River	3	885.2	13.8 ±9.9	7.5 ±2	0.4 ±0.2	1.2 ±0.1	37.1 ±13.9	22 ±13.9	1.3 ±0.6	4.3 ±0.6	15.3 ±11.1
West Bernard Creek*	1	387.2	9.4	4.3	0.4	1	50	52	1	3	25
West Bernard Creek	3	387.2	49.7 ±24.6	12.9 ±1.3	0.5 ±0.2		37 ±3.5	19.2 ±10.7	0.3 ±0.6	3 ±3.5	23 ±5.2
West Carancahua Creek*	1	154.8	0.6	4.3	0.2	0.6	36	33	3	2	16
West Carancahua Creek	2	154.8	0.3	2.8 ±0.1	0.1 ±0.1	1.5	32.5 ±0.4	43.3 ±7.4	1 ±1.4	5 ±2.8	13.5 ±7.8
West Mustang Creek*	1	360.6	0.3	4.8	0.4	0.7	41	39	2	6	22
West Mustang Creek	3	360.6	4.1 ±1.9	7.8 ±2.2	0.4 ±0.2	1.4	34.4 ±10.4	31.2 ±3.8	0.3 ±0.6	5.3 ±0.6	24.7 ±2.5
Average		382.1	10.2	6.8	0.3	1.0	35.2	35.1	1.6	3.9	24.6
Maximum		885.2	78	14.2	0.7	1.8	55	82	6	9	86
Minimum		154.8	0	2.7	0.04	0.5	20.2	10	0	1	4

*Historic data from Bayer et al. 1992

Appendix B – 7 CONT. Stream physical habitat attributes for Ecoregion 34. For parameters with multiple samples, the mean and standard deviation (mean ± SD) are reported.

Ecoregion 34 Stream	Sample Size	Dominant Substrate Type	Substrate Gravel Size or Larger (%)	Tree Canopy (%)	Average Riparian Width (m)	Riparian Vegetation - Trees (%)	Riparian Vegetation - Shrubs (%)	Riparian Vegetation - Grass (%)	Riparian Vegetation - Cultivated Fields (%)	Riparian Vegetation - Other (%)
Arenosa Creek*	1	sand	10	78	91.4	70	15	15	0	0
Arenosa Creek	3	sand	4.8 ±8	66.2 ±16.3	19.8 ±0.4	37.5 ±19.8	50.8 ±25	11.7 ±5.2	0	0
Big Creek*	1	sand	10	3	6.1	0	0	0	100	0
Big Creek	7	clay	16.7 ±15.8	35.4 ±11.3	9.8 ±2.5	50.7 ±22.4	23.3 ±13.4	16 ±23	4.3 ±11.3	5.7 ±10.2
Garcitas Creek*	1		5	60	46	70	20	10	0	0
Garcitas Creek	2	sand	32.9 ±8.7	81 ±20.9	20	41.3 ±15.9	32.5 ±38.9	26.3 ±23	0	0
Placedo Creek*	1		2	95	91	60	15	25	0	0
Placedo Creek	1	silt	11	95	> 20	10	15	75	0	0
San Bernard River	3	sand	10 ±5.3	89.7 ±12.8	12.8 ±4.6	61.7 ±18.9	21.7 ±16.1	11.7 ±5.8	0	5 ±8.7
West Bernard Creek*	1		0	58	52	70	25	5	0	0
West Bernard Creek	3	clay	5 ±8.7	80.3 ±14.7	16	43.3 ±25.2	5 ±5	51.7 ±20.2	0	0
West Carancahua Creek*	1	sand	2	13	23	12	8	30	50	0
West Carancahua Creek	2	sand	6 ±5.7	85.3 ±15.8	13.4 ±0.8	67.5 ±10.6	15 ±7.1	15 ±7.1	0	2.5 ±3.5
West Mustang Creek*	1		0	59	107	80	0	5	15	0
West Mustang Creek	3	sand	0	80.5 ±9.1	17.5 ±2.1	68.3 ±14.4	16.7 ±5.8	8.3 ±2.9	0	6.7 ±5.8
Average			9.5	64.2	31.5	50.9	20.6	19.7	6.3	2.6
Maximum			40	98	107	85	70	75	100	25
Minimum			0	3	6.1	0	0	0	0	0

*Historic data from Bayer et al. 1992

APPENDIX C – WATER QUALITY

Appendix C - 1. Water quality parameters for ecoregion 24.

		Ecoregion 24	Alamito Creek	Independence Creek	Pecos River	Rio Grande: Johnson Ranch	Rio Grande: Presidio	Terlingua Creek
			13108	13109, 13110	18801	13227	13229	13714
Dissolved Oxygen (mg/L)	5th percentile	5.4	1.94	6.77	7.54	5.68	5.7	6.52*
	95th percentile	11.2	11.9	10.82	10.42	10.67	11.24	8.68*
	mean	8.30	7.13	8.66	8.94	8.37	8.29	7.6*
Total Phosphorus (mg/L)	5th percentile	0.01	0.03	0.005	0.01	0.016*	0.028	0.08*
	95th percentile	0.90	0.86	0.04	0.05	0.91*	1.39	0.08*
	median	0.11	0.15	0.02	0.02	0.047*	0.16	0.08*
Ammonia (mg/L)	5th percentile	0.01	0.0075	0.005	0.025	0.05*	0.01	0.012*
	95th percentile	0.22	0.16	0.055	0.06	0.17*	0.29	0.039*
	median	0.025	0.01	0.025	0.025	0.05*	0.05	0.025*
Chlorophyll-a (µg/L)	5th percentile	0.5	0.7*	0.25	1.12	2.0*	1.5	0.5*
	95th percentile	85.5	7.6*	5.0	13.27	5.4*	100.35	0.5*
	median	5.0	2.0*	1.04	3.06	2.0*	11.0	0.5*
pH	5th percentile	7.2	7.32	7.3	7.9	7.87	7.1	7.63*
	95th percentile	8.4	8.3	8.3	8.2	8.5	8.5	8.075*
	median	8.0	7.9	8.0	8.0	8.3	7.9	7.85*
Secchi Depth (m)	5th percentile	0.04	0.3	0.6	0.28	n/a	0.03	0.2*
	95th percentile	1.00	0.95	1.2	1.0	n/a	0.4	0.2*
	median	0.24	0.49	1.0	0.6	n/a	0.17	0.2*

* = less than 10 samples
n/a= no data

Appendix C - 2. Water quality parameters for ecoregion 26.

		Ecoregion 26	Bluff Creek	Buck Creek	Canadian River: SH 70	Canadian River: US 385	McClellan Creek	N. Fork Wichita River	Saddlers Creek	Salt Fork Red River	White Deer Creek	Whitefish Creek	Wolf Creek
			12205	15811	10033	10056	10064	15119	10078	10171	21174	10077	10059
Dissolved Oxygen (mg/L)	5th percentile	6.0	5.67	6.50	7.0	6.0	5.94	5.4	6.13	7.0	6.18	6.3	6.45
	95th percentile	12.8	11.9	13.6	12.4	12.38	12.3	12.63	7.9	13.8	12.51	12.1	12.9
	mean	9.099	8.11	10.39	9.43	8.88	8.33	8.69	7.23	9.55	9.22	8.15	9.52
Total Phosphorus (mg/L)	5th percentile	0.0005	0.011*	0.01	0.03	0.011	0.01	0.005	0.04*	0.005	0.01	0.0078	0.01
	95th percentile	0.54	0.029*	0.14	0.17	7.028	0.12	0.081	0.04*	0.11	0.12	0.17	0.14
	median	0.03	0.02*	0.028	0.07	0.09	0.03	0.02	0.04*	0.02	0.047	0.31	0.06
Ammonia (mg/L)	5th percentile	0.01	0.021*	0.01	0.02	0.01	0.005	0.025	0.01*	0.01	0.025	0.01	0.01
	95th percentile	0.17	0.039*	0.11	0.15	0.14	0.05	0.07	0.01*	0.2	0.059	0.18	0.067
	median	0.05	0.03*	0.025	0.05	0.025	0.025	0.025	0.01*	0.05	0.05	0.055	0.045
Chlorophyll-a (µg/L)	5th percentile	0.5	2.1*	1.0	1.0	0.5	0.5	1.0	1.0*	0.5	1.0	0.5	1.0
	95th percentile	29.06	3.9*	5.0	29.5	35.2	2.5	28.83	1.0*	5.36	20.49	14.62	4.93
	median	2.5	3.0*	2.5	5.81	4.73	1.0	4.03	1.0*	1.0	4.77	0.5	2.1
pH	5th percentile	7.4	7.68	7.51	7.71	7.5	7.68	7.4	7.34	7.42	7.65	7.45	7.56
	95th percentile	8.43	8.26	8.5	8.59	8.6	8.2	8.0	7.4	8.3	8.5	8.33	8.4
	median	8.0	7.81	7.9	8.2	8.2	7.9	7.7	7.385	8.0	8.05	7.88	8.17
Secchi Depth (m)	5th percentile	0.02	n/a	0.16	0.33	0.008	0.3	0.11	n/a	0.2	0.18	0.018*	0.2
	95th percentile	1.2	n/a	1.2	1.2	1.2	1.25	1.2	n/a	1.2	1.14	0.23*	1.2
	median	0.4	n/a	0.91	1.2	0.2	1.2	0.81	n/a	0.5	0.34	0.08*	1.2

* = less than 10 samples

n/a= no data

Appendix C - 3. Water quality parameters for ecoregions 27, 29 and 32.

		Ecoregion 27	Cottonwood Creek	Deadman Creek	Elm Creek	Lelia Lake Creek	Sweetwater Creek
			11710	11697, 11696, 11699	12207	10076	10072
Dissolved Oxygen (mg/L)	5th percentile	3.3	3.86	2.81	5.61	3.62	5.22
	95th percentile	13.39	11.92	14.2	12.21	13.7	13.17
	mean	8.81	7.86	8.57	8.49	9.45	9.29
Total Phosphorus (mg/L)	5th percentile	0.01	0.083*	0.12	0.03*	0.01	0.01
	95th percentile	7.2	0.14*	9.11	0.044*	0.057	0.17
	median	0.07	0.11*	2.98	0.03*	0.005	0.065
Ammonia (mg/L)	5th percentile	0.01	0.033*	0.025	0.01*	0.01	0.01
	95th percentile	0.75	0.087*	9.44	0.063*	0.078	0.11
	median	0.025	0.06*	0.06	0.03*	0.025	0.03
Chlorophyll-a (µg/L)	5th percentile	0.5	32	0.94	2.35	0.42	1.0
	95th percentile	28.24	180.59	22.98	21.47	5.0	40.23
	median	3.09	129.5	3.39	7.85	1.5	4.15
pH	5th percentile	7.5	7.34	7.42	7.76	7.5	7.72
	95th percentile	8.5	8.09	8.69	8.33	8.3	8.4
	median	8.0	7.78	8.1	8.08	8.0	8.1
Secchi Depth (m)	5th percentile	0.17	n/a	0.16	0.15	0.4	0.2
	95th percentile	1.2	n/a	0.6	0.90	1.2	1.2
	median	0.51	n/a	0.36	0.38	1.2	0.78

* = less than 10 samples
n/a= no data

Appendix C - 3 CONT. Water quality parameters for ecoregions 27, 29 and 32.

		Ecoregion 29	Bluff Creek	Clear Creek	Colony Creek	Cowhouse Creek	Ioni Creek	Neils Creek	Reese Creek	Rocky Creek	South Fork Rocky Creek	Steele Creek
			11832	10859	11837	11805	11716	11826, 21999	18850	11724	18333	11836
Dissolved Oxygen (mg/L)	5th percentile	5.4	4.067	5.2	5.83	6.35	5.26	5.66	n/a	5.62	7.30	6.38
	95th percentile	12.09	11.90	12.32	9.52	11.96	7.64	12.4	n/a	10.54	10.80	9.40
	mean	8.52	7.56	8.47	7.46	8.76	6.33	9.16	n/a	8.081	8.91	7.83
Total Phosphorus (mg/L)	5th percentile	0.01	0.006*	0.01	0.01	0.015*	0.005	0.015	0.06*	0.017	0.016	0.012*
	95th percentile	0.34	0.029*	0.22	0.12	0.20*	0.05	0.38	0.06*	0.08	0.075	0.039*
	median	0.06	0.018*	0.03	0.04	0.03*	0.02	0.067	0.06*	0.03	0.058	0.025*
Ammonia (mg/L)	5th percentile	0.01	0.01*	0.01	0.008	0.02*	0.008	0.0085	n/a	0.01	0.01	0.01*
	95th percentile	0.08	0.01*	0.05	0.17	0.02*	0.09	0.056	n/a	0.073	0.090	0.01*
	median	0.025	0.01*	0.025	0.05	0.02*	0.03	0.03	n/a	0.03	0.028	0.01*
Chlorophyll-a (µg/L)	5th percentile	0.5	1.0*	0.61	0.5	1.5	0.5	0.47	1.51*	1.5	1.5*	1.0*
	95th percentile	10.2	1.0*	21.08	21.88	8.7	8.26	8.12	1.64*	3.2	1.5*	1.0*
	median	1.5	1.0*	3.12	1.2	1.65	1.0	1.5	1.58*	1.5	1.5*	1.0*
pH	5th percentile	7.4	7.18	7.6	7.62	7.44	7.52	7.36	n/a	7.66	7.42	7.72
	95th percentile	8.3	8.26	8.3	8.069	8.31	7.91	8.3	n/a	8.2	8.13	8.15
	median	7.99	7.79	8.0	7.91	8.08	7.77	8.0	n/a	7.93	7.87	8.02
Secchi Depth (m)	5th percentile	0.15	n/a	0.097	0.23*	0.22	0.19	0.53	1.2*	0.59	0.91	n/a
	95th percentile	1.2	n/a	1.1	0.85*	1.2	1.37	1.22	1.2*	1.2	1.51	n/a
	median	1.0	n/a	0.52	0.5*	1.2	0.33	1.0	1.2*	1.2	1.1	n/a

* = less than 10 samples
n/a= no data

Appendix C - 3 CONT. Water quality parameters for ecoregions 27, 29 and 32.

		Ecoregion 32	Auds Creek	Cow Bayou	Deer Creek	Geronimo Creek	Willis Creek	Wilson Creek
			10197	11717	16407, 11723	12576	11573, 20022	10777
Dissolved Oxygen (mg/L)	5th percentile	5.38	6.17	6.62	5.06	6.7	5.23	3.7
	95th percentile	11.1	8.87	8.58	11.92	10.91	9.9	11.95
	mean	7.88	7.42	7.52	8.36	8.43	7.35	7.32
Total Phosphorus (mg/L)	5th percentile	0.01	0.0095*	0.012*	0.051*	0.01	0.01	0.01
	95th percentile	0.14	0.15*	0.075*	0.087*	0.13	0.25	0.11
	median	0.025	0.05*	0.03*	0.06*	0.025	0.03	0.03
Ammonia (mg/L)	5th percentile	0.01	0.016*	0.01*	0.021*	0.02	0.0055*	0.01
	95th percentile	0.2	0.48*	0.019*	0.075*	0.24	0.069*	0.094
	median	0.05	0.077*	0.01*	0.03*	0.05	0.029*	0.025
Chlorophyll-a (µg/L)	5th percentile	0.5	1.0*	1.0*	2.6*	0.5	0.93	0.5
	95th percentile	9.82	7.66*	1.0*	13.4*	3.48	13.13	15.31
	median	1.2	2.0*	1.0*	8.0*	0.5	1.65	3.52
pH	5th percentile	7.4	7.56	7.59	7.5	7.5	7.37	7.25
	95th percentile	8.1	8.17	8.13	8.2	7.96	8.0	8.0
	median	7.8	7.99	7.68	7.9	7.76	7.8	7.7
Secchi Depth (m)	5th percentile	0.071	0.14*	n/a	0.032	0.47*	0.31	0.18
	95th percentile	1.2	0.55*	n/a	0.75	1.08*	1.2	0.99
	median	0.4	0.32*	n/a	0.18	0.77*	1.1	0.50

* = less than 10 samples
n/a= no data

Appendix C - 4. Water quality parameters for ecoregion 30.

		Ecoregion 30	Barton Creek	Brushy Creek	Bull Creek	Bullhead Creek	Carpers Creek	Cypress Creek	Devils River	Guadalupe River	James River
			12494	17374	16322	20832	12540	12674	13239	15111	12208
Dissolved Oxygen (mg/L)	5th percentile	4.09	6.79	5.03	4.05	n/a	4.9	6.42	6.88	6.1	6.73
	95th percentile	10.9	9.17	14.36	9.10	n/a	10.48	10.50	11.43	11.15	9.33
	mean	7.81	8.22	9.21	6.77	n/a	7.14	8.39	8.71	8.4	7.89
Total Phosphorus (mg/L)	5th percentile	0.005	0.005	0.025	0.01	0.01*	0.005*	0.005	0.01	0.006	0.01*
	95th percentile	0.08	0.02	0.4	0.08	0.01*	0.005*	0.11	0.03	0.025	0.01*
	median	0.02	0.015	0.04	0.01	0.01*	0.005*	0.01	0.025	0.02	0.01*
Ammonia (mg/L)	5th percentile	0.0062	0.005	n/a	0.01	0.025*	0.01*	0.01	0.025	n/a	0.01*
	95th percentile	0.11	0.11	n/a	0.12	0.025*	0.01*	0.17	0.045	n/a	0.01*
	median	0.025	0.02	n/a	0.01	0.025*	0.01*	0.05	0.025	n/a	0.01*
Chlorophyll-a (µg/L)	5th percentile	0.3	0.5	1.5	n/a	0.32*	2.0*	0.5	0.43	0.5	2.0*
	95th percentile	6.11	2.24	9.45	n/a	0.32*	2.0*	2.85	5.0	1.97	2.0*
	median	1.0	1.0	1.65	n/a	0.32*	2.0*	0.5	1.5	0.5	2.0*
pH	5th percentile	7.2	7.33	7.38	6.77	n/a	7.45	7.32	7.32	7.52	7.96
	95th percentile	8.2	8.04	8.53	8.04	n/a	7.81	8.1	8.1	8.20	8.4
	median	7.82	7.99	7.8	7.5	n/a	7.62	7.8	7.8	8.1	8.13
Secchi Depth (m)	5th percentile	0.3	3.0*	0.26	n/a	n/a	n/a	1.0*	1.0	0.53	n/a
	95th percentile	1.5	3.0*	1.2	n/a	n/a	n/a	2.0*	1.95	1.2	n/a
	median	1.1	3.0*	1.2	n/a	n/a	n/a	1.5*	1.2	0.84	n/a

* = less than 10 samples
n/a= no data

Appendix C - 4 CONT. Water quality parameters for ecoregion 30.

		Ecoregion 30	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River	Nueces River
			12678	12252	12560	13112	17471	12832	20831	18447	13005
Dissolved Oxygen (mg/L)	5th percentile	4.09	6.3	2.19	6.2	5.30	6.24	6.35	6.6*	4.43	5.69
	95th percentile	10.9	10.9	10.09	9.1	11.88	11.36	10.05	6.6*	9.09	10.61
	mean	7.81	8.29	7.17	7.61	8.30	8.02	8.45	6.6*	7.13	8.24
Total Phosphorus (mg/L)	5th percentile	0.005	0.0045	0.0068*	0.005*	0.02*	0.01	0.01	0.01*	0.01	0.002
	95th percentile	0.08	0.026	0.067*	0.070*	0.02*	0.03	0.02	0.01*	0.024	0.06
	median	0.02	0.02	0.015	0.02*	0.02*	0.01	0.02	0.01*	0.01	0.02
Ammonia (mg/L)	5th percentile	0.0062	0.0015	0.005	0.007*	0.01*	0.01	0.08	0.025*	0.05	0.02
	95th percentile	0.11	0.18	0.12	0.092*	0.01*	0.028	0.1	0.025*	0.05	0.14
	median	0.025	0.025	0.02	0.035*	0.01*	0.01	0.1	0.025*	0.05	0.02
Chlorophyll-a (µg/L)	5th percentile	0.3	0.157	0.68*	0.5*	1.0*	1.0	4.0	0.23*	0.5	2.0
	95th percentile	6.11	1.36	2.2*	4.6*	1.0*	1.0	4.0	0.23*	1.85	2.82
	median	1.0	0.5	1.0*	0.75*	1.0*	1.0	4.0	0.23*	0.5	2.0
pH	5th percentile	7.2	7.60	7.15	7.5	7.24	7.44	7.55	n/a	7.23	7.4
	95th percentile	8.2	8.33	8.15	8.05	7.45	8.18	8.2	n/a	8.1	8.0
	median	7.82	8.1	7.95	7.86	7.32	7.9	7.9	n/a	7.6	7.8
Secchi Depth (m)	5th percentile	0.3	1.0*	n/a	0.79*	n/a	0.17	1.2	n/a	1.2	0.31
	95th percentile	1.5	1.0*	n/a	1.7*	n/a	0.74	1.2	n/a	1.2	0.97
	median	1.1	1.0*	n/a	1.0*	n/a	0.4	1.2	n/a	1.2	0.6

* = less than 10 samples
n/a= no data

Appendix C - 4 CONT. Water quality parameters for ecoregion 30.

		Ecoregion 30	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Concho River	South Llano River	Spring Creek	West Rocky Creek
			11726	21941	17472	20662	12186, 12185	18869	17009, 18197	12162	12165
Dissolved Oxygen (mg/L)	5th percentile	4.09	3.90	9.2*	5.43	7.5*	3.61	n/a	6.2	6.0	3.95
	95th percentile	10.9	8.09	9.2*	11.19	13.12*	12.6	n/a	9.65	10.69	9.66
	mean	7.81	6.44	9.2*	7.86	9.54*	8.45	n/a	7.86	7.93	6.48
Total Phosphorus (mg/L)	5th percentile	0.005	0.0073	0.02*	0.01	0.01*	0.005	0.01*	0.01	0.01	0.01
	95th percentile	0.08	0.047	0.02*	0.08	0.07*	0.11	0.01*	0.06	0.07	0.043
	median	0.02	0.015	0.02*	0.02	0.02*	0.02	0.01*	0.01	0.025	0.02
Ammonia (mg/L)	5th percentile	0.0062	0.005	n/a	0.01	0.025*	0.005	0.025*	0.01	0.01	0.005
	95th percentile	0.11	0.036	n/a	0.066	0.082*	0.09	0.025*	0.094	0.072	0.074
	median	0.025	0.015	n/a	0.01	0.025*	0.025	0.025*	0.028	0.03	0.01
Chlorophyll-a (µg/L)	5th percentile	0.3	0.5	1.79*	1.0	0.42	0.5	1.5*	0.44	0.5	0.5
	95th percentile	6.11	16.91	1.79*	6.73	15	19.2	1.5*	1.59	4.24	8.69
	median	1.0	0.75	1.79*	1.0	2.54	3.0	1.5*	1.0	1.0	1.0
pH	5th percentile	7.2	7.56	8.0*	7.52	7.91	7.2	n/a	7.65	7.62	7.18
	95th percentile	8.2	7.71	8.0*	8.23	8.15	8.1	n/a	8.15	8.16	8.1
	median	7.82	7.65	8.0*	8.05	8.0	7.7	n/a	8.0	7.73	7.5
Secchi Depth (m)	5th percentile	0.3	n/a	n/a	0.22	0.31	0.23	n/a	0.47*	0.47*	0.25
	95th percentile	1.5	n/a	n/a	1.13	1.05	1.2	n/a	0.75*	0.89*	1.5
	median	1.1	n/a	n/a	0.58	0.67	1.2	n/a	0.67*	0.61*	1.0

* = less than 10 samples
n/a= no data

Appendix C - 5. Water quality parameters for ecoregion 31.

		Ecoregion 31	Las Moras Creek	Metate Creek	Mud Creek	Pinto Creek	San Miguel Creek	Sycamore Creek	Nueces River
			13129, 14941, 22310	12954	13136	13137	12984	13135	22083
Dissolved Oxygen (mg/L)	5th percentile	3.95	6.42*	3.76	6.56	4.64	5.04	5.11	8.5*
	95th percentile	8.68	11.5*	5.94	8.08	7.96	8.41	9.50	8.5*
	mean	6.53	9.2*	4.64	7.30	5.83	6.61	6.30	8.5*
Total Phosphorus (mg/L)	5th percentile	0.006	0.02*	0.33*	0.03*	0.01*	0.10*	0.01*	0.02*
	95th percentile	0.096	0.09*	0.33*	0.08*	0.02*	0.10*	0.04*	0.02*
	median	0.03	0.05*	0.33*	0.04*	0.02*	0.10*	0.02*	0.02*
Ammonia (mg/L)	5th percentile	0.005	0.02*	0.01*	0.01*	0.01*	0.04*	0.01*	0.05*
	95th percentile	0.86	0.11*	0.01*	0.91*	0.94*	0.04*	0.03*	0.05*
	median	0.01	0.05*	0.01*	0.01*	0.01*	0.04*	0.01*	0.05*
Chlorophyll-a (µg/L)	5th percentile	0.50	0.83*	27.0*	0.55*	0.5*	6.00*	0.5*	0.56*
	95th percentile	5.44	13.4*	27.0*	2.31*	1.85*	6.00*	2.17*	0.56*
	median	1.0	1.95*	27.0*	1.00*	0.5*	6.00*	0.5*	0.56*
pH	5th percentile	7.13	7.21*	7.94	7.59	7.27	7.30	7.10*	7.7*
	95th percentile	8.08	8.76*	8.11	7.86	7.64	7.78	7.90*	7.7*
	median	7.7	7.85*	7.99	7.65	7.39	7.58	7.13*	7.7*
Secchi Depth (m)	5th percentile	0.25	0.55*	n/a	0.25*	1.00*	n/a	1.00*	1.2*
	95th percentile	1.08	0.55*	n/a	0.3*	1.00*	n/a	1.00*	1.2*
	median	1.0	0.55*	n/a	0.28*	1.00*	n/a	1.00*	1.2*

* = less than 10 samples
n/a= no data

Appendix C - 6. Water quality parameters for ecoregions 33 and 35.

		Ecoregion 33	Blair Creek	Catfish Creek	Cummins Creek	Cuthand Creek	Davidson Creek	Kickapoo Creek	Little Mustang Creek
			17952	10717	12249	10202	11729	17342	17343
Dissolved Oxygen (mg/L)	5th percentile	1.25	7.41*	3.02	5.29	6.17*	0.71	5.30	3.16*
	95th percentile	10.50	8.78*	9.96	10.95	11.49*	9.08	10.70	9.93*
	mean	6.33	8.23*	6.99	8.02	8.73*	3.74	8.51	5.97*
Total Phosphorus (mg/L)	5th percentile	0.01	0.02*	0.03	0.01	0.05*	0.01	0.03	0.13*
	95th percentile	0.32	0.16*	0.12	0.32	0.17*	0.28	0.38	0.19*
	median	0.07	0.13*	0.07	0.04	0.11*	0.09	0.12	0.14*
Ammonia (mg/L)	5th percentile	0.01	0.01*	0.03	0.01	0.01*	0.03	0.04	0.08*
	95th percentile	0.18	0.14*	0.16	0.09	0.38*	0.52	0.37	0.46*
	median	0.05	0.07*	0.05	0.02	0.09*	0.10	0.06	0.19*
Chlorophyll-a (µg/L)	5th percentile	0.67	1.00*	1.00	0.56	1.00*	1.92	2.00	1.00*
	95th percentile	11.2	2.28*	10.00	9.45	19.7*	24.7	8.44	6.30*
	median	2.0	1.00*	3.81	2.00	5.30*	4.63	2.70	2.50*
pH	5th percentile	6.00	6.10*	6.10	7.11	7.49	6.39	7.26	6.82*
	95th percentile	8.00	7.19*	7.00	8.10	7.83	7.36	7.66	7.15*
	median	7.20	6.70*	6.37	7.70	7.58	6.97	7.44	7.04*
Secchi Depth (m)	5th percentile	0.12	0.17	0.22	0.14	0.32*	0.10	0.30	0.27*
	95th percentile	0.91	0.85	0.97	0.91	0.57*	0.55	0.62	0.50*
	median	0.40	0.30	0.50	0.47	0.42*	0.28	0.44	0.30*

* = less than 10 samples
n/a= no data

Appendix C - 6 CONT. Water quality parameters for ecoregions 33 and 35.

		Ecoregion 33	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Ponds Creek	Smackover Creek	Wheelock Creek
			10822	11838, 11840, 18750, 18751	11576, 11574	11579	20101	10821
Dissolved Oxygen (mg/L)	5th percentile	1.25	4.47	2.1	6.19	2.78	2.96*	4.61
	95th percentile	10.50	10.24	10.3	11.02	6.90	9.64*	10.97
	mean	6.33	7.11	6.52	7.99	5.75	5.48*	8.11
Total Phosphorus (mg/L)	5th percentile	0.01	0.07*	0.02	0.03	0.12	0.11*	0.03*
	95th percentile	0.32	0.08*	0.18	0.32	1.65	0.58*	0.04*
	median	0.07	0.08*	0.06	0.10	0.30	0.24*	0.03*
Ammonia (mg/L)	5th percentile	0.01	0.02*	0.02*	0.01	0.01*	0.03*	0.01*
	95th percentile	0.18	0.06*	0.05*	0.10	0.88*	0.19*	0.06*
	median	0.05	0.04*	0.05*	0.03	0.06*	0.05*	0.01*
Chlorophyll-a (µg/L)	5th percentile	0.5	1.00*	0.65	1.00	1.17	1.18*	1.00*
	95th percentile	12.36	1.00*	39.4	10.00	67.5	8.39*	19.90*
	median	2.43	1.00*	4.38	4.09	5.0	2.21*	1.00*
pH	5th percentile	6.00	6.81	6.7	7.60	6.62	6.90*	6.26
	95th percentile	8.00	7.61	7.8	8.20	7.49	7.38*	6.65
	median	7.20	6.92	7.2	7.90	6.84	7.10*	6.36
Secchi Depth (m)	5th percentile	0.12	n/a	0.12	0.09	0.13	0.13*	n/a
	95th percentile	0.91	n/a	0.99	1.20	0.45	0.43*	n/a
	median	0.40	n/a	0.43	0.40	0.20	0.27*	n/a

* = less than 10 samples
n/a= no data

Appendix C - 6 CONT. Water quality parameters for ecoregions 33 and 35.

		Ecoregion 35	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	East Fork of the San Jacinto River	Frazier Creek	Irons Bayou	James Bayou
			10256	10529, 17903	10342	10314, 16157	10248	11237	10259, 17619	10389	10321, 14976
Dissolved Oxygen (mg/L)	5th percentile	1.71	2.9	5.94	0.92	1.0	3.07	5.38	3.45	1.31	1.62
	95th percentile	10.7	9.18	2.84	6.07	10.5	10.41	9.58	12.08	5.9	11.86
	mean	6.85	4.94	9.4	2.81	5.66	8.09	7.2	6.93	2.93	6.13
Total Phosphorus (mg/L)	5th percentile	0.03	0.16*	0.03	0.05	0.03	0.07	0.02	0.005	0.09	0.005
	95th percentile	0.38	0.61*	0.35	0.11	0.33	0.28	0.17	0.23	0.34	0.4
	median	0.1	0.56*	0.04	0.07	0.12	0.13	0.07	0.05	0.19	0.08
Ammonia (mg/L)	5th percentile	0.01	0.03*	0.006	0.02	0.005	0.03	0.05	0.01	0.02*	0.01
	95th percentile	0.27	0.20*	0.19	0.19	0.03	0.17	0.19	0.36	0.14*	0.36
	median	0.05	0.17*	0.05	0.06	0.02	0.07	0.05	0.09	0.08*	0.05
Chlorophyll-a (µg/L)	5th percentile	0.50	2.5*	0.5	1.1	0.5	1.33	0.92*	0.5	0.5	0.5
	95th percentile	20.8	13.6*	7.68	21.8	30.8	69.7	1.0*	16.12	10.8	16.3
	median	2.5	5.92*	2.5	2.7	4.05	2.75	0.96*	1.0	2.5	2.5
pH	5th percentile	5.7	5.79	5.32	5.5	5.8	5.73	6.3	5.23	6.76	5.6
	95th percentile	7.5	7.04	7.2	6.63	7.2	6.83	7.43	7.2	7.29	7.2
	median	6.43	6.55	5.9	6.03	6.5	6.23	6.5	6.1	6.99	6.6
Secchi Depth (m)	5th percentile	0.18	0.35	0.15	0.12	0.2	0.2	0.22	0.27	0.37	0.21
	95th percentile	0.9	0.57	0.71	0.46	1.0	0.98	1.0	0.79	0.96	0.84
	median	0.44	0.44	0.4	0.27	0.5	0.4	0.63	0.5	0.48	0.45

* = less than 10 samples
n/a= no data

Appendix C - 6 CONT. Water quality parameters for ecoregions 33 and 35.

		Ecoregion 35	Lake Creek	Little Cypress Bayou	Little Pine Island Bayou	Peach Creek	Piney Creek	San Pedro Creek	West Fork of the San Jacinto River	White Oak Creek
			11366, 11367, 17331	10335	15346	17746	10530	22071	11250	10341
Dissolved Oxygen (mg/L)	5th percentile	1.71	5.2	2.9	1.11	6.88	3.6	6.8*	6.1	6.8
	95th percentile	10.7	10.4	6.5	9.18	11.28	7.77	6.8*	11.2	8.9
	mean	6.85	7.59	4.5	4.85	8.7	4.63	6.8*	8.45	7.1
Total Phosphorus (mg/L)	5th percentile	0.03	0.04	0.08	0.03	0.03	0.09*	n/a	0.03	0.02*
	95th percentile	0.38	0.43	0.43	0.48	0.15	0.24*	n/a	0.38	0.05*
	median	0.1	0.13	0.2	0.07	0.07	0.18*	n/a	0.1	0.03*
Ammonia (mg/L)	5th percentile	0.01	0.01	0.01	0.03	0.01	0.02*	n/a	0.01	0.005*
	95th percentile	0.27	0.2	0.29	0.3	0.07	0.12*	n/a	0.2	0.14*
	median	0.05	0.05	0.07	0.06	0.03	0.07*	n/a	0.05	0.02*
Chlorophyll-a (µg/L)	5th percentile	0.50	0.5	0.04	1.29	0.6	1.27*	n/a	0.5	0.5*
	95th percentile	20.8	7.4	117	4.14	7.54	6.14*	n/a	22.15	7.44*
	median	2.5	1.7	2.5	1.5	1.5	2.5*	n/a	5.0	1.33*
pH	5th percentile	5.7	6.4	5.7	5.52	6.5	6.24	7.3*	6.89	6.11
	95th percentile	7.5	7.75	7	7	7.6	6.94	7.3*	8.1	6.88
	median	6.43	7.3	6.31	6.4	7	6.85	7.3*	7.45	6.14
Secchi Depth (m)	5th percentile	0.18	0.15	0.18	0.18	0.12	n/a	0.32*	0.13	0.32*
	95th percentile	0.9	0.85	0.65	0.76	0.94	n/a	0.32*	0.79	0.57*
	median	0.44	0.35	0.33	0.39	0.47	n/a	0.32*	0.45	0.38*

* = less than 10 samples
n/a= no data

Appendix C - 7. Water quality parameters for ecoregion 34.

		Ecoregion 34	Arenosa Creek	Big Creek	Garcitas Creek	Placedo Creek	West Bernard Creek	West Carancahua Creek	West Mustang Creek
			13295	11518, 16353, 17932	13291	13288	12131	13293	12522
Dissolved Oxygen (mg/L)	5th percentile	2.01	3.50	1.09	5.79	1.03	3.99	6.13	4.12
	95th percentile	10.21	9.85	10.43	10.91	6.07	10.71	9.91	8.24
	mean	5.61	4.95	6.72	7.33	3.24	5.39	7.59	5.64
Total Phosphorus (mg/L)	5th percentile	0.02	0.09	0.12	0.01	0.07*	0.08	0.10	0.16*
	95th percentile	0.67	0.51	0.76	0.12	0.40*	0.49	0.60	0.37*
	median	0.23	0.22	0.29	0.03	0.15*	0.23	0.29	0.27*
Ammonia (mg/L)	5th percentile	0.01	0.01	0.03	0.01	0.01*	0.03	0.03	0.02*
	95th percentile	0.38	0.91	0.30	0.19	0.30*	0.43	0.16	0.06*
	median	0.06	0.03	0.07	0.04	0.02*	0.06	0.06	0.04*
Chlorophyll-a (µg/L)	5th percentile	0.50	0.50	1.50	0.83	1.25*	1.21	0.50	6.36*
	95th percentile	65.90	52.12	39.86	22.50	10.80*	19.38	30.88	11.70*
	median	5.00	4.45	5.60	2.65	3.50*	4.52	5.08	9.03*
pH	5th percentile	6.80	6.85	7.00	5.79	6.85	6.45	7.53	7.29
	95th percentile	8.54	8.18	8.40	10.91	7.60	7.90	8.71	7.44
	median	7.65	7.64	7.80	8.00	7.19	7.30	7.34	7.35
Secchi Depth (m)	5th percentile	0.05	0.15	0.03	0.20*	n/a	0.09	0.02	0.22*
	95th percentile	0.64	0.47	0.45	0.81*	n/a	0.89	0.37	0.22*
	median	0.20	0.34	0.17	0.30*	n/a	0.27	0.10	0.22*

* = less than 10 samples

n/a= no data

APPENDIX D - FISH SPECIES LIST

Appendix D - 1. Fish species list by stream for Ecoregion 24; number of samples collected at each stream noted below the stream name (n = x); fish species listed phylogenetically and shaded by family.

Scientific Name	Common Name	Alamito Creek	Independence Creek	Pecos River	Rio Grande: Presidio	Rio Grande: Contrabando	Rio Grande: Johnson Ranch	Terlingua Creek
Lepisosteidae sp.	Gar Species				X			
Campostoma ornatum	Mexican Stoneroller	X						X
Cyprinella lutrensis	Red Shiner	X		X	X	X	X	X
Cyprinella proserpina	Proserpine Shiner		X	X				
Cyprinella venusta	Blacktail Shiner			X				
Cyprinus carpio	Common Carp		X	X		X		X
Dionda argentosa	Manantial Roundnose Minnow		X					
Macrhybopsis aestivalis	Speckled Chub				X	X	X	X
Notropis amabilis	Texas Shiner		X					
Notropis braytoni	Tamaulipas Shiner	X		X	X	X		X
Notropis chihuahua	Chihuahua Shiner	X						X
Pimephales promelas	Fathead Minnow							X
Pimephales vigilax	Bullhead Minnow			X	X			
Rhinichthys cataractae	Longnose Dace				X	X	X	
Carpiodes carpio	River Carpsucker	X			X	X	X	X
Cycleptus elongatus	Blue Sucker				X	X	X	
Moxostoma congestum	Gray Redhorse		X	X				
Astyanax mexicanus	Mexican Tetra	X	X	X	X	X		
Ictalurus furcatus	Blue Catfish						X	X
Ictalurus lupus	Headwater Catfish		X	X				
Ictalurus punctatus	Channel Catfish		X					
Pylodictis olivaris	Flathead Catfish		X	X		X	X	
Menidia beryllina	Inland Silverside			X				
Fundulus grandis	Gulf Killifish			X			X	
Fundulus zebrinus	Plains Killifish		X					X
Lucania parva	Rainwater Killifish		X					
Gambusia affinis	Western Mosquitofish	X	X	X	X			
Gambusia geiseri	Largespring Gambusia		X					
Cyprinodon eximius	Conchos Pupfish	X						
Cyprinodon pecosensis x variegatus	Pecos Pupfish Hybrid		X	X				
Lepomis auritus	Redbreast Sunfish		X	X				
Lepomis cyanellus	Green Sunfish	X						
Lepomis macrochirus	Bluegill			X				

Scientific Name	Common Name	Alamito Creek	Independence Creek	Pecos River	Rio Grande: Presidio	Rio Grande: Contrabando	Rio Grande: Johnson Ranch	Terlingua Creek
Lepomis megalotis	Longear Sunfish		X	X				
Micropterus salmoides	Largemouth Bass		X	X				
Etheostoma grahami	Rio Grande Darter		X	X				
Herichthys cyanoguttatus	Rio Grande Cichlid		X	X				
	Species Richness	9	19	20	10	9	8	10
	Total N Individuals	1,601	1,624	2,582	671	242	71	374
	Number of Samples	n = 1	n = 2	n = 1	n = 1	n = 1	n = 1	n = 1

Appendix D - 2. Fish species list by stream for Ecoregions 25 and 26; number of samples collected at each stream noted below the stream name (n = x); fish species listed phylogenetically and shaded by family.

Scientific Name	Common Name	Bluff Creek	Buck Creek	Canadian River: US 385	Canadian River: SH 70	Chicken Creek	McClellan Creek	North Fork Wichita River	Saddlers Creek	Salt Fork Red River	White Deer Creek	Whitefish Creek	Wolf Creek
Dorosoma cepedianum	Gizzard Shad			X									
Cyprinella lutrensis	Red Shiner	X	X	X	X	X	X		X	X	X	X	X
Cyprinus carpio	Common Carp		X	X			X				X		X
Hybognathus placitus	Plains Minnow			X					X				
Macrhybopsis tetranema	Peppered Chub			X									
Notemigonus crysoleucas	Golden Shiner	X											
Notropis bairdi	Red River Shiner								X				
Notropis girardi	Arkansas River Shiner			X									
Notropis stramineus	Sand Shiner				X		X			X	X		X
Phenacobius mirabilis	Suckermouth Minnow												X
Pimephales promelas	Fathead Minnow	X				X	X						
Pimephales vigilax	Bullhead Minnow	X		X									
Ameiurus melas	Black Bullhead		X										
Ameiurus natalis	Yellow Bullhead		X			X	X				X		
Ictalurus punctatus	Channel Catfish			X									
Fundulus zebrinus	Plains Killifish		X	X		X	X	X	X	X		X	X
Gambusia affinis	Western Mosquitofish	X	X	X	X	X	X		X	X	X	X	X
Cyprinodon rubrofluviatilis	Red River Pupfish						X	X	X	X		X	
Lepomis cyanellus	Green Sunfish	X	X	X			X		X	X	X	X	X
Lepomis gulosus	Warmouth										X		
Lepomis macrochirus	Bluegill	X	X			X	X			X	X	X	X
Lepomis megalotis	Longear Sunfish	X	X				X				X		X
Lepomis sp.	Sunfish Species										X		
Micropterus salmoides	Largemouth Bass	X			X		X			X	X		X
	Species Richness	9	9	11	4	6	12	2	7	8	11	6	10
	Total N Individuals	404	193	303	142	342	315	278	235	248	1,035	438	142
	Number of Samples	n = 2	n = 1	n = 1	n = 1	n = 1	n = 2	n = 1	n = 1	n = 1	n = 3	n = 1	n = 2

Appendix D - 3. Fish species list by stream for Ecoregions 27, 29, and 32; number of samples collected at each stream noted below the stream name (n = x); fish species listed phylogenetically and shaded by family.

Scientific Name	Common Name	Auds Creek	Bluff Creek	Clear Creek	Colony Creek	Cottonwood Creek	Cow Bayou	Cowhouse Creek	Deadman Creek	Deer Creek	Elm Creek	Geronimo Creek
Lepisosteus oculatus	Spotted Gar											
Lepisosteus osseus	Longnose Gar			X					X	X	X	
Dorosoma cepedianum	Gizzard Shad			X		X			X	X	X	
Dorosoma petenense	Threadfin Shad				X							
Campostoma anomalum	Central Stoneroller		X	X	X	X	X	X		X		X
Cyprinella lutrensis	Red Shiner	X		X	X	X	X	X	X	X	X	X
Cyprinella venusta	Blacktail Shiner				X		X	X		X		
Cyprinus carpio	Common Carp								X		X	
Hybognathus placitus	Plains Minnow					X						
Macrhybopsis hyostoma	Shoal Chub						X					
Notemigonus crysoleucas	Golden Shiner	X					X					
Notropis amabilis	Texas Shiner											X
Notropis atrocaudalis	Blackspot Shiner	X										
Notropis bairdi	Red River Shiner											
Notropis buchanani	Ghost Shiner						X					
Notropis stramineus	Sand Shiner											X
Notropis volucellus	Mimic Shiner						X			X		X
Phenacobius mirabilis	Suckermouth Minnow	X										
Pimephales promelas	Fathead Minnow					X			X			
Pimephales vigilax	Bullhead Minnow	X		X	X	X	X	X	X	X	X	X
Carpiodes carpio	River Carpsucker			X			X		X		X	
Ictiobus bubalus	Smallmouth Buffalo									X		
Minytrema melanops	Spotted Sucker											
Moxostoma congestum	Gray Redhorse						X			X		X
Astyanax mexicanus	Mexican Tetra											X
Ameiurus melas	Black Bullhead	X										
Ameiurus natalis	Yellow Bullhead	X	X	X	X		X			X		X
Ictalurus punctatus	Channel Catfish	X		X	X	X	X	X	X	X	X	X
Noturus gyrinus	Tadpole Madtom						X					
Noturus nocturnus	Freckled Madtom			X								
Pylodictis olivaris	Flathead Catfish			X			X		X	X		X
Menidia beryllina	Inland Silverside										X	
Fundulus notatus	Blackstripe Topminnow			X	X		X					X

Scientific Name	Common Name	Auds Creek	Bluff Creek	Clear Creek	Colony Creek	Cottonwood Creek	Cow Bayou	Cowhouse Creek	Deadman Creek	Deer Creek	Elm Creek	Geronimo Creek
Fundulus zebrinus	Plains Killifish											
Gambusia affinis	Western Mosquitofish	X	X	X	X	X	X		X	X	X	X
Morone chrysops	White Bass											
Lepomis auritus	Redbreast Sunfish											X
Lepomis cyanellus	Green Sunfish	X	X	X	X	X	X	X	X	X	X	X
Lepomis gulosus	Warmouth	X				X	X		X			X
Lepomis humilis	Orangespotted Sunfish	X			X	X	X	X		X		X
Lepomis macrochirus	Bluegill	X	X	X	X	X	X	X	X	X	X	X
Lepomis megalotis	Longear Sunfish	X	X	X	X	X	X	X	X	X	X	X
Lepomis microlophus	Redear Sunfish											
Lepomis miniatus	Redspotted Sunfish	X										X
Lepomis sp. (hybrid)	Sunfish Hybrid				X							
Lepomis sp.	Sunfish Species			X								
Micropterus punctulatus	Spotted Bass						X	X		X		X
Micropterus salmoides	Largemouth Bass	X	X	X	X	X	X		X	X	X	X
Micropterus treculii	Guadalupe Bass											X
Pomoxis annularis	White Crappie			X					X		X	
Etheostoma gracile	Slough Darter						X					
Etheostoma pulchellum	Orangethroat Darter		X	X			X	X		X	X	X
Percina carbonaria	Texas Logperch											X
Percina macrolepida	Bigscale Logperch			X							X	
Percina sciera	Dusky Darter						X			X		
Aplodinotus grunniens	Freshwater Drum						X					
Herichthys cyanoguttatus	Rio Grande Cichlid											X
	Species Richness	16	8	20	15	14	27	11	16	21	16	26
	Total N Individuals	797	485	453	1,203	5,043	2,494	225	874	1,444	1,791	632
	Number of Samples	n = 3	n = 2	n = 2	n = 2	n = 2	n = 3	n = 1	n = 2	n = 3	n = 2	n = 6

Appendix D - 3 CONT. Fish species list by stream for Ecoregions 27, 29, and 32; number of samples collected at each stream noted below the stream name (n = x); fish species listed phylogenetically and shaded by family.

Scientific Name	Common Name	Ioni Creek	Lelia Lake Creek	Neils Creek	Reese Creek	Rocky Creek	South Fork Rocky Creek	Steele Creek	Sweetwater Creek	Willis Creek	Wilson Creek
Lepisosteus oculatus	Spotted Gar				X					X	
Lepisosteus osseus	Longnose Gar										
Dorosoma cepedianum	Gizzard Shad									X	
Dorosoma petenense	Threadfin Shad	X									
Campostoma anomalum	Central Stoneroller			X	X	X	X	X		X	X
Cyprinella lutrensis	Red Shiner		X	X	X	X			X	X	X
Cyprinella venusta	Blacktail Shiner	X		X	X	X	X	X	X	X	
Cyprinus carpio	Common Carp					X			X	X	
Hybognathus placitus	Plains Minnow										
Macrhybopsis hyostoma	Shoal Chub										
Notemigonus crysoleucas	Golden Shiner					X			X	X	
Notropis amabilis	Texas Shiner										
Notropis atrocaudalis	Blackspot Shiner										
Notropis bairdi	Red River Shiner								X		
Notropis buchanani	Ghost Shiner										
Notropis stramineus	Sand Shiner										X
Notropis volucellus	Mimic Shiner			X	X	X				X	
Phenacobius mirabilis	Suckermouth Minnow										
Pimephales promelas	Fathead Minnow	X	X					X			
Pimephales vigilax	Bullhead Minnow	X		X		X		X	X	X	X
Carpiodes carpio	River Carpsucker	X									X
Ictiobus bubalus	Smallmouth Buffalo						X				
Minytrema melanops	Spotted Sucker										X
Moxostoma congestum	Gray Redhorse	X				X	X			X	
Astyanax mexicanus	Mexican Tetra					X					
Ameiurus melas	Black Bullhead		X					X		X	
Ameiurus natalis	Yellow Bullhead		X	X		X	X	X		X	X
Ictalurus punctatus	Channel Catfish	X		X		X	X	X		X	X
Noturus gyrinus	Tadpole Madtom										X
Noturus nocturnus	Freckled Madtom										
Pylodictis olivaris	Flathead Catfish				X	X				X	
Menidia beryllina	Inland Silverside										
Fundulus notatus	Blackstripe Topminnow	X		X		X		X			X

Scientific Name	Common Name	Ioni Creek	Lelia Lake Creek	Neils Creek	Reese Creek	Rocky Creek	South Fork Rocky Creek	Steele Creek	Sweetwater Creek	Willis Creek	Wilson Creek
Fundulus zebrinus	Plains Killifish		X						X		
Gambusia affinis	Western Mosquitofish	X		X		X	X	X	X	X	X
Morone chrysops	White Bass									X	
Lepomis auritus	Redbreast Sunfish										
Lepomis cyanellus	Green Sunfish	X	X	X	X	X	X	X	X	X	X
Lepomis gulosus	Warmouth					X			X	X	
Lepomis humilis	Orangespotted Sunfish					X	X		X	X	X
Lepomis macrochirus	Bluegill	X		X	X	X	X	X	X	X	X
Lepomis megalotis	Longear Sunfish	X		X	X	X	X	X	X	X	X
Lepomis microlophus	Redear Sunfish			X		X	X	X		X	
Lepomis miniatus	Redspotted Sunfish										
Lepomis sp. (hybrid)	Sunfish Hybrid			X							
Lepomis sp.	Sunfish Species	X				X					
Micropterus punctulatus	Spotted Bass			X	X						
Micropterus salmoides	Largemouth Bass	X		X		X	X	X	X	X	X
Micropterus treculii	Guadalupe Bass					X	X				
Pomoxis annularis	White Crappie										
Etheostoma gracile	Slough Darter										
Etheostoma pulchellum	Orangethroat Darter			X	X	X	X	X		X	
Percina carbonaria	Texas Logperch										
Percina macrolepida	Bigscale Logperch										
Percina sciera	Dusky Darter					X				X	
Aplodinotus grunniens	Freshwater Drum										
Herichthys cyanoguttatus	Rio Grande Cichlid										
	Species Richness	14	6	17	11	25	15	15	14	25	16
	Total N Individuals	844	265	1,433	648	4,196	1,077	712	157	2,599	1,042
	Number of Samples	n = 2	n = 1	n = 2	n = 2	n = 7	n = 4	n = 2	n = 2	n = 7	n = 5

Appendix D - 4. Fish species list by stream for Ecoregions 30; number of samples collected at each stream noted below the stream name (n = x); fish species listed phylogenetically and shaded by family.

Scientific Name	Common Name	Barton Creek	Brushy Creek	Bull Creek	Bull-head Creek	Carpers Creek	Colorado River	Cypress Creek	Devils River	Guadalupe River	James River
Lepisosteus oculatus	Spotted Gar										
Lepisosteus osseus	Longnose Gar						X				
Lepisosteidae sp.	Gar Species										
Anguilla rostrata	American Eel					X					
Dorosoma cepedianum	Gizzard Shad						X				X
Dorosoma petenense	Threadfin Shad						X				
Campostoma anomalum	Central Stoneroller	X	X	X	X		X	X		X	X
Carassius auratus	Goldfish						X				
Cyprinella sp. (hybrid)	Minnow Hybrid				X						
Cyprinella lepida	Plateau Shiner				X						
Cyprinella lutrensis	Red Shiner						X				X
Cyprinella proserpina	Proserpine Shiner								X		
Cyprinella venusta	Blacktail Shiner	X	X		X	X	X	X	X	X	X
Cyprinus carpio	Common Carp						X		X		X
Dionda argentosa	Manantial Roundnose Minnow								X		
Dionda diaboli	Devils River Minnow								X		
Dionda flavipinnis	Roundnose Minnow sp.					X					X
*Dionda texensis**	Roundnose Minnow sp.				X						
Dionda sp. 3*	Colorado Roundnose Minnow										
Macrhybopsis marconis	Burrhead Chub										
Notemigonus crysoleucas	Golden Shiner						X				
Notropis amabilis	Texas Shiner				X	X		X	X	X	X
Notropis buchanani	Ghost Shiner									X	
Notropis stramineus	Sand Shiner							X	X	X	X
Notropis texanus	Weed Shiner										
Notropis volucellus	Mimic Shiner		X				X	X		X	X
Pimephales promelas	Fathead Minnow						X				
Pimephales vigilax	Bullhead Minnow	X					X			X	X
Carpiodes carpio	River Carpsucker						X				
Ictiobus bubalus	Smallmouth Buffalo						X				X
Minytrema melanops	Spotted Sucker										
Moxostoma congestum	Gray Redhorse	X				X	X	X	X		
Astyanax mexicanus	Mexican Tetra				X			X	X		
Ameiurus melas	Black Bullhead										
Ameiurus natalis	Yellow Bullhead		X	X	X		X	X			X

Scientific Name	Common Name	Barton Creek	Brushy Creek	Bull Creek	Bull-head Creek	Carpers Creek	Colorado River	Cypress Creek	Devils River	Guadalupe River	James River
Ictalurus lupus	Headwater Catfish								X		
Ictalurus punctatus	Channel Catfish	X				X	X	X	X		X	
Pylodictis olivaris	Flathead Catfish						X	X	X	X	
Oncorhynchus mykiss	Rainbow Trout										
Aphredoderus sayanus	Pirate Perch										
Menidia beryllina	Inland Silverside						X				
Fundulus notatus	Blackstripe Topminnow						X				
Fundulus zebrinus	Plains Killifish										X
Gambusia affinis	Western Mosquitofish	X	X		X	X	X	X	X	X	X
Gambusia geiseri	Largespring Gambusia										
Gambusia sp.	Gambusia Species								X		
Cyprinodon pecosensis x *variegatus*	Pecos Pupfish Hybrid										
Morone chrysops	White Bass						X				
Lepomis auritus	Redbreast Sunfish	X	X		X	X	X	X	X	X	
Lepomis cyanellus	Green Sunfish	X	X	X	X	X	X	X			X
Lepomis gulosus	Warmouth		X			X	X	X		X	X
Lepomis humilis	Orangespotted Sunfish						X	X		X	
Lepomis macrochirus	Bluegill	X	X	X		X	X	X		X	X
Lepomis megalotis	Longear Sunfish	X	X	X	X	X	X	X	X	X	X
Lepomis microlophus	Redear Sunfish	X	X					X			
Lepomis miniatus	Redspotted Sunfish		X			X		X			
Lepomis sp. (hybrid)	Sunfish Hybrid										
Lepomis sp.	Sunfish Species					X			X		
Micropterus dolomieu	Smallmouth Bass								X	X	
Micropterus punctulatus	Spotted Bass							X			
Micropterus salmoides	Largemouth Bass	X	X	X	X		X	X	X	X	
Micropterus treculii	Guadalupe Bass	X					X	X		X	
Micropterus sp.	Bass Species					X					
Pomoxis annularis	White Crappie						X				
Pomoxis nigromaculatus	Black Crappie						X	X			
Etheostoma gracile	Slough Darter										
Etheostoma grahami	Rio Grande Darter								X		
Etheostoma lepidum	Greenthroat Darter				X			X		X	X
Etheostoma pulchellum	Orangethroat Darter		X		X		X	X		X	X
Percina carbonaria	Texas Logperch						X			X	
Percina sciera	Dusky Darter										
Aplodinotus grunniens	Freshwater Drum						X				
Herichthys cyanoguttatus	Rio Grande Cichlid				X			X	X	X	X

Scientific Name	Common Name	Barton Creek	Brushy Creek	Bull Creek	Bull-head Creek	Carpers Creek	Colorado River	Cypress Creek	Devils River	Guadalupe River	James River
Oreochromis aureus	Blue Tilapia								X		
	Species Richness	13	14	6	17	15	35	26	21	22	21
	Total N Individuals	534	881	53	1,970	125	6,847	1,804	1,312	2,503	197
	Number of Samples	n = 2	n = 2	n = 1	n = 2	n = 1	n = 8	n = 8	n = 2	n = 6	n = 1

Appendix D - 4 CONT. Fish species list by stream for Ecoregions 30; number of samples collected at each stream noted below the stream name (n = x); fish species listed phylogenetically and shaded by family.

Scientific Name	Common Name	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River	Nueces River
Lepisosteus oculatus	Spotted Gar					X				X
Lepisosteus osseus	Longnose Gar					X				
Lepisosteidae sp.	Gar Species									
Anguilla rostrata	American Eel									
Dorosoma cepedianum	Gizzard Shad					X				
Dorosoma petenense	Threadfin Shad									
Campostoma anomalum	Central Stoneroller	X	X	X		X	X	X	X	X
Carassius auratus	Goldfish									
Cyprinella sp. (hybrid)	Minnow Hybrid									
Cyprinella lepida	Plateau Shiner							X		X
Cyprinella lutrensis	Red Shiner			X		X			X	
Cyprinella proserpina	Proserpine Shiner				X					
Cyprinella venusta	Blacktail Shiner	X	X	X		X	X		X	
Cyprinus carpio	Common Carp					X				
Dionda argentosa	Manantial Roundnose Minnow				X					
Dionda diaboli	Devils River Minnow									
Dionda flavipinnis	Roundnose Minnow sp.					X				
*Dionda texensis**	Roundnose Minnow sp.							X		X
Dionda sp. 3*	Colorado Roundnose Minnow									
Macrhybopsis marconis	Burrhead Chub					X				
Notemigonus crysoleucas	Golden Shiner									
Notropis amabilis	Texas Shiner	X				X	X	X	X	X
Notropis buchanani	Ghost Shiner									
Notropis stramineus	Sand Shiner			X		X	X			X
Notropis texanus	Weed Shiner									
Notropis volucellus	Mimic Shiner	X				X	X		X	
Pimephales promelas	Fathead Minnow									
Pimephales vigilax	Bullhead Minnow	X				X				
Carpiodes carpio	River Carpsucker					X				
Ictiobus bubalus	Smallmouth Buffalo									
Minytrema melanops	Spotted Sucker					X				
Moxostoma congestum	Gray Redhorse	X	X			X	X		X	
Astyanax mexicanus	Mexican Tetra				X				X	X
Ameiurus melas	Black Bullhead									

Scientific Name	Common Name	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River	Nueces River
Ameiurus natalis	Yellow Bullhead		X					X	X	X
Ictalurus lupus	Headwater Catfish									
Ictalurus punctatus	Channel Catfish		X	X	X	X	X		X	X
Pylodictis olivaris	Flathead Catfish	X				X				X
Oncorhynchus mykiss	Rainbow Trout									
Aphredoderus sayanus	Pirate Perch			X						
Menidia beryllina	Inland Silverside									
Fundulus notatus	Blackstripe Topminnow					X				
Fundulus zebrinus	Plains Killifish				X					
Gambusia affinis	Western Mosquitofish	X	X	X	X	X	X	X	X	X
Gambusia geiseri	Largespring Gambusia					X				
Gambusia sp.	Gambusia Species									
Cyprinodon pecosensis x *variegatus*	Pecos Pupfish Hybrid				X					
Morone chrysops	White Bass									
Lepomis auritus	Redbreast Sunfish		X	X		X	X	X	X	
Lepomis cyanellus	Green Sunfish	X	X	X		X	X		X	
Lepomis gulosus	Warmouth	X		X		X	X			
Lepomis humilis	Orangespotted Sunfish									
Lepomis macrochirus	Bluegill	X	X	X		X	X	X	X	X
Lepomis megalotis	Longear Sunfish	X	X	X	X	X	X	X	X	X
Lepomis microlophus	Redear Sunfish	X				X		X	X	
Lepomis miniatus	Redspotted Sunfish	X								
Lepomis sp. (hybrid)	Sunfish Hybrid			X			X	X		
Lepomis sp.	Sunfish Species			X						
Micropterus dolomieu	Smallmouth Bass									
Micropterus punctulatus	Spotted Bass								X	
Micropterus salmoides	Largemouth Bass	X	X	X		X		X	X	X
Micropterus treculii	Guadalupe Bass	X	X			X	X		X	X
Micropterus sp.	Bass Species							X		X
Pomoxis annularis	White Crappie					X				
Pomoxis nigromaculatus	Black Crappie									
Etheostoma gracile	Slough Darter									
Etheostoma grahami	Rio Grande Darter									
Etheostoma lepidum	Greenthroat Darter					X			X	X
Etheostoma pulchellum	Orangethroat Darter	X				X		X	X	X
Percina carbonaria	Texas Logperch	X				X			X	
Percina sciera	Dusky Darter									
Aplodinotus grunniens	Freshwater Drum									

Scientific Name	Common Name	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River	Nueces River
Herichthys cyanoguttatus	Rio Grande Cichlid				X	X	X	X	X	X
Oreochromis aureus	Blue Tilapia									
	Species Richness	18	12	15	9	34	16	15	22	19
	Total N Individuals	415	798	407	1,322	16,908	384	316	859	1,805
	Number of Samples	n = 2	n = 2	n = 2	n = 1	n = 22	n = 1	n = 2	n = 7	n = 2

*Schonhuth et al. 2012; Dionda classification based on this publication

Appendix D - 4 CONT. Fish species list by stream for Ecoregions 30; number of samples collected at each stream noted below the stream name (n = x); fish species listed phylogenetically and shaded by family.

Scientific Name	Common Name	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Concho River	South Llano River	Spring Creek	West Rocky Creek
Lepisosteus oculatus	Spotted Gar							X		
Lepisosteus osseus	Longnose Gar				X			X		
Lepisosteidae sp.(unknown)	Gar Species							X		
Anguilla rostrata	American Eel									
Dorosoma cepedianum	Gizzard Shad			X	X			X		
Dorosoma petenense	Threadfin Shad									
Campostoma anomalum	Central Stoneroller	X	X	X	X	X	X	X	X	X
Carassius auratus	Goldfish									
Cyprinella sp. (hybrid)	Minnow Hybrid									
Cyprinella lepida	Plateau Shiner									
Cyprinella lutrensis	Red Shiner			X	X					
Cyprinella proserpina	Proserpine Shiner									
Cyprinella venusta	Blacktail Shiner	X	X	X	X	X	X	X	X	X
Cyprinus carpio	Common Carp			X	X			X		
Dionda argentosa	Manantial Roundnose Minnow									
Dionda diaboli	Devils River Minnow									
Dionda flavipinnis	Roundnose Minnow sp.							X		
*Dionda texensis**	Roundnose Minnow sp.									
Dionda sp. 3	Colorado Roundnose Minnow						X			
Macrhybopsis marconis	Burrhead Chub									
Notemigonus crysoleucas	Golden Shiner		X							
Notropis amabilis	Texas Shiner			X	X	X	X	X	X	
Notropis buchanani	Ghost Shiner									
Notropis stramineus	Sand Shiner								X	
Notropis texanus	Weed Shiner					X				
Notropis volucellus	Mimic Shiner	X		X	X	X	X	X		
Pimephales promelas	Fathead Minnow									
Pimephales vigilax	Bullhead Minnow			X	X					
Carpiodes carpio	River Carpsucker			X	X					
Ictiobus bubalus	Smallmouth Buffalo				X					
Minytrema melanops	Spotted Sucker							X		
Moxostoma congestum	Gray Redhorse	X		X	X		X	X		X
Astyanax mexicanus	Mexican Tetra				X		X			
Ameiurus melas	Black Bullhead		X			X				
Ameiurus natalis	Yellow Bullhead	X	X	X		X	X	X		

Scientific Name	Common Name	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Concho River	South Llano River	Spring Creek	West Rocky Creek
Ictalurus lupus	Headwater Catfish									
Ictalurus punctatus	Channel Catfish	X	X	X	X			X	X	X
Pylodictis olivaris	Flathead Catfish			X	X			X		
Oncorhynchus mykiss	Rainbow Trout							X		
Aphredoderus sayanus	Pirate Perch									
Menidia beryllina	Inland Silverside									
Fundulus notatus	Blackstripe Topminnow				X					
Fundulus zebrinus	Plains Killifish									
Gambusia affinis	Western Mosquitofish		X	X	X	X		X	X	X
Gambusia geiseri	Largespring Gambusia						X			
Gambusia sp.	Gambusia Species									
Cyprinodon pecosensis x *variegatus*	Pecos Pupfish Hybrid									
Morone chrysops	White Bass									
Lepomis auritus	Redbreast Sunfish		X	X	X		X	X	X	
Lepomis cyanellus	Green Sunfish	X	X	X	X	X	X	X		X
Lepomis gulosus	Warmouth			X	X	X		X	X	
Lepomis humilis	Orangespotted Sunfish				X			X		
Lepomis macrochirus	Bluegill	X	X	X	X	X	X	X	X	X
Lepomis megalotis	Longear Sunfish	X	X	X	X	X	X	X	X	X
Lepomis microlophus	Redear Sunfish		X	X	X	X	X	X		
Lepomis miniatus	Redspotted Sunfish					X	X			X
Lepomis sp. (hybrid)	Sunfish Hybrid		X			X				
Lepomis sp.	Sunfish Species		X			X	X			
Micropterus dolomieu	Smallmouth Bass									
Micropterus punctulatus	Spotted Bass									
Micropterus salmoides	Largemouth Bass	X	X	X	X	X	X	X	X	X
Micropterus treculii	Guadalupe Bass			X	X			X		
Micropterus sp.	Bass Species							X		
Pomoxis annularis	White Crappie									
Pomoxis nigromaculatus	Black Crappie				X					
Etheostoma gracile	Slough Darter					X				
Etheostoma grahami	Rio Grande Darter									
Etheostoma lepidum	Greenthroat Darter	X		X			X	X		
Etheostoma pulchellum	Orangethroat Darter	X		X	X		X	X		X
Percina carbonaria	Texas Logperch			X	X			X		
Percina sciera	Dusky Darter			X						
Aplodinotus grunniens	Freshwater Drum				X					
Herichthys cyanoguttatus	Rio Grande Cichlid							X	X	
Oreochromis aureus	Blue Tilapia									

Scientific Name	Common Name	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Concho River	South Llano River	Spring Creek	West Rocky Creek
	Species Richness	12	15	26	30	18	19	31	12	11
	Total N Individuals	438	918	5,676	4,456	1,216	1,202	13,602	317	201
	Number of Samples	n = 2	n = 3	n = 9	n = 8	n = 6	n = 2	n = 19	n = 1	n = 1

*Schonhuth et al. 2012; Dionda classification based on this publication

Appendix D - 5. Fish species list by stream for Ecoregion 31; number of samples collected at each stream noted below the stream name (n = x); fish species listed phylogenetically and shaded by family.

Scientific Name	Common Name	Las Moras Creek	Metate Creek	Mud Creek	Nueces River	Pinto Creek	San Miguel Creek	Sycamore Creek
Lepisosteus oculatus	Spotted Gar				X	X	X	
Lepisosteus osseus	Longnose Gar				X			
Dorosoma cepedianum	Gizzard Shad						X	
Campostoma anomalum	Central Stoneroller				X			X
Cyprinella lepida	Plateau Shiner				X			
Cyprinella lutrensis	Red Shiner		X	X		X	X	X
Cyprinella proserpina	Proserpine Shiner							X
Cyprinella venusta	Blacktail Shiner	X			X	X		X
Cyprinus carpio	Common Carp	X		X				X
Dionda argentosa	Manantial Roundnose Minnow							X
Dionda diaboli	Devils River Minnow					X		
*Dionda texensis**	Roundnose Minnow sp.				X			
Notemigonus crysoleucas	Golden Shiner						X	
Notropis amabilis	Texas Shiner				X	X		X
Notropis stramineus	Sand Shiner				X			X
Notropis texanus	Weed Shiner				X			
Pimephales vigilax	Bullhead Minnow		X				X	X
Ictiobus bubalus	Smallmouth Buffalo		X					
Moxostoma congestum	Gray Redhorse				X			
Astyanax mexicanus	Mexican Tetra	X		X	X	X		X
Ameiurus melas	Black Bullhead		X				X	
Ameiurus natalis	Yellow Bullhead	X			X			X
Ictalurus lupus	Headwater Catfish					X		X
Ictalurus punctatus	Channel Catfish	X		X	X	X		
Noturus gyrinus	Tadpole Madtom				X			
Pylodictis olivaris	Flathead Catfish				X			
Gambusia affinis	Western Mosquitofish	X	X	X	X	X	X	X
Poecilia latipinna	Sailfin Molly		X		X	X	X	X
Lepomis auritus	Redbreast Sunfish				X	X	X	X
Lepomis cyanellus	Green Sunfish	X		X	X	X	X	X
Lepomis gulosus	Warmouth		X		X	X	X	
Lepomis humilis	Orangespotted Sunfish						X	
Lepomis macrochirus	Bluegill		X	X	X	X	X	X

Scientific Name	Common Name	Las Moras Creek	Metate Creek	Mud Creek	Nueces River	Pinto Creek	San Miguel Creek	Sycamore Creek
Lepomis megalotis	Longear Sunfish	X		X	X	X	X	X
Lepomis microlophus	Redear Sunfish				X	X		
Lepomis miniatus	Redspotted Sunfish				X			
Lepomis sp. (hybrid)	Sunfish Hybrid						X	
Lepomis sp.	Sunfish Species		X		X	X	X	
Micropterus salmoides	Largemouth Bass	X		X	X	X	X	X
Micropterus treculii	Guadalupe Bass				X			
Pomoxis annularis	White Crappie						X	
Etheostoma grahami	Rio Grande Darter							X
Etheostoma lepidum	Greenthroat Darter				X			
Herichthys cyanoguttatus	Rio Grande Cichlid				X	X		X
Oreochromis aureus	Blue Tilapia				X			X
	Species Richness	9	9	9	30	19	18	22
	Total N Individuals	254	269	188	6,151	383	1,262	838
	Number of Samples	n = 1	n = 1	n = 1	n = 10	n = 3	n = 2	n = 2

*Schonhuth et al. 2012; Dionda classification based on this publication

Appendix D - 6. Fish species list by stream for Ecoregions 33 and 35; number of samples collected at each stream noted below the stream name (n = x); fish species listed phylogenetically and shaded by family.

Scientific Name	Common Name	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Creek	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Ichthyomyzon castaneus	Chestnut Lamprey										
Ichthyomyzon gagei	Southern Brook Lamprey										
Atractosteus spatula	Alligator Gar										
Lepisosteus oculatus	Spotted Gar			X				X	X	X	
Lepisosteus osseus	Longnose Gar										X
Lepisosteidae sp.	Gar Species										
Amia calva	Bowfin			X	X						
Dorosoma cepedianum	Gizzard Shad								X	X	
Dorosoma petenense	Threadfin Shad										
Campostoma anomalum	Central Stoneroller									X	
Cyprinella lutrensis	Red Shiner							X		X	X
Cyprinella venusta	Blacktail Shiner		X	X			X	X	X	X	
Cyprinus carpio	Common Carp									X	
Hybognathus hayi	Cypress Minnow			X							
Hybognathus nuchalis	Mississippi Silvery Minnow								X		
Hybopsis amnis	Pallid Shiner			X						X	
Luxilus chrysocephalus	Striped Shiner					X					
Lythrurus fumeus	Ribbon Shiner	X	X	X		X	X	X	X	X	
Lythrurus umbratilis	Redfin Shiner	X	X			X	X				
Macrhybopsis hyostoma	Shoal Chub									X	
Notemigonus crysoleucas	Golden Shiner			X	X	X					
Notropis amabilis	Texas Shiner									X	
Notropis atherinoides	Emerald Shiner				X	X		X			
Notropis atrocaudalis	Blackspot Shiner				X		X	X	X		X
Notropis buchanani	Ghost Shiner										
Notropis chalybaeus	Ironcolor Shiner		X		X						
Notropis sabinae	Sabine Shiner										
Notropis shumardi	Silverband Shiner					X					
Notropis stramineus	Sand Shiner									X	
Notropis texanus	Weed Shiner	X		X		X		X		X	
Notropis volucellus	Mimic Shiner								X	X	
Notropis sp.	Minnow Species				X	X		X			
Opsopoeodus emiliae	Pugnose Minnow		X	X		X	X	X		X	
Phenacobius mirabilis	Suckermouth Minnow									X	

Scientific Name	Common Name	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Creek	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Pimephales promelas	Fathead Minnow										
Pimephales vigilax	Bullhead Minnow			X	X	X		X	X	X	X
Carpiodes carpio	River Carpsucker									X	
Cycleptus elongatus	Blue Sucker									X	
Erimyzon claviformis	Western Creek Chubsucker	X			X	X					
Erimyzon sucetta	Lake Chubsucker							X			
Ictiobus bubalus	Smallmouth Buffalo							X			
Minytrema melanops	Spotted Sucker	X	X	X	X	X		X		X	
Moxostoma congestum	Gray Redhorse									X	
Moxostoma poecilurum	Blacktail Redhorse				X						
Ameiurus melas	Black Bullhead				X				X		
Ameiurus natalis	Yellow Bullhead	X	X	X	X	X	X	X	X	X	X
Ictalurus furcatus	Blue Catfish										
Ictalurus punctatus	Channel Catfish							X		X	X
Noturus gyrinus	Tadpole Madtom		X	X		X				X	
Noturus nocturnus	Freckled Madtom		X					X			X
Pylodictis olivaris	Flathead Catfish							X		X	X
Esox americanus vermiculatus	Grass Pickerel	X	X	X	X	X	X	X			X
Esox niger	Chain Pickerel										
Aphredoderus sayanus	Pirate Perch	X	X	X	X	X	X	X		X	
Agonostomus monticola	Mountain Mullet										
Mugil cephalus	Striped Mullet										
Labidesthes sicculus	Brook Silverside		X	X	X	X		X			X
Fundulus chrysotus	Golden Topminnow				X						
Fundulus notatus	Blackstripe Topminnow	X	X	X	X	X	X	X	X	X	X
Fundulus olivaceus	Blackspotted Topminnow		X	X	X			X			
Gambusia affinis	Western Mosquitofish	X	X	X	X	X	X	X	X	X	X
Poecilia latipinna	Sailfin Molly									X	
Centrarchus macropterus	Flier	X		X	X	X		X			
Lepomis auritus	Redbreast Sunfish									X	
Lepomis cyanellus	Green Sunfish		X	X	X	X	X	X	X	X	X
Lepomis gulosus	Warmouth	X	X	X	X	X	X	X	X	X	
Lepomis humilus	Orangespotted Sunfish								X	X	
Lepomis macrochirus	Bluegill	X	X	X	X	X	X	X	X	X	X
Lepomis marginatus	Dollar Sunfish		X	X	X			X			
Lepomis megalotis	Longear Sunfish	X	X	X	X	X	X	X	X	X	X
Lepomis microlophus	Redear Sunfish			X	X		X	X		X	
Lepomis miniatus	Redspotted Sunfish	X	X	X	X	X	X	X		X	X

Scientific Name	Common Name	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Creek	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Lepomis symmetricus	Bantam Sunfish			X							
Lepomis sp. (hybrid)	Sunfish Hybrid										
Lepomis sp.	Sunfish Species		X		X			X			
Micropterus dolomieu	Smallmouth Bass										
Micropterus punctulatus	Spotted Bass	X		X	X	X	X	X	X	X	
Micropterus salmoides	Largemouth Bass		X	X	X	X	X	X	X	X	
Micropterus treculii	Guadalupe Bass									X	
Micropterus sp.	Bass Species				X			X			
Pomoxis annularis	White Crappie			X				X	X	X	
Pomoxis nigromaculatus	Black Crappie			X				X		X	
Ammocrypta vivax	Scaly Sand Darter										
Etheostoma artesiae	Redspot Darter										
Etheostoma asprigene	Mud Darter			X							
Etheostoma chlorosoma	Bluntnose Darter	X	X	X		X	X	X	X	X	
Etheostoma fusiforme	Swamp Darter										
Etheostoma gracile	Slough Darter	X	X	X	X	X	X	X		X	
Etheostoma histrio	Harlequin Darter										
Etheostoma parvipinne	Goldstripe Darter						X				
Etheostoma proeliare	Cypress Darter	X	X			X	X				
Etheostoma radiosum	Orangebelly Darter										
Etheostoma whipplei	Redfin Darter					X					
Etheostoma sp.	Darter Species										
Percina carbonaria	Texas Logperch									X	X
Percina macrolepida	Bigscale Logperch						X				
Percina maculata	Blackside Darter										
Percina sciera	Dusky Darter		X			X		X	X	X	
Aplodinotus grunniens	Freshwater Drum										
Elassoma zonatum	Banded Pygmy Sunfish	X	X	X	X						
Herichthys cyanoguttatus	Rio Grande Cichlid									X	
	Species Richness	20	28	36	33	32	23	40	22	46	17
	Total N Individuals	248	339	1,367	713	484	429	1,264	325	11,235	433
	Number of Samples	n = 2	n = 3	n = 3	n = 6	n = 3	n = 2	n = 6	n = 2	n = 15	n = 2

Appendix D - 6 CONT. Fish species list by stream for Ecoregions 33 and 35; number of samples collected at each stream noted below the stream name (n = x); fish species listed phylogenetically and shaded by family.

Scientific Name	Common Name	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Creek	Little Mustang Creek	Little Pine Island Bayou
Ichthyomyzon castaneus	Chestnut Lamprey		X								
Ichthyomyzon gagei	Southern Brook Lamprey		X								
Atractosteus spatula	Alligator Gar							X			
Lepisosteus oculatus	Spotted Gar	X			X	X		X	X		
Lepisosteus osseus	Longnose Gar										
Lepisosteidae sp.	Gar Species										
Amia calva	Bowfin					X					
Dorosoma cepedianum	Gizzard Shad					X	X	X			
Dorosoma petenense	Threadfin Shad										
Campostoma anomalum	Central Stoneroller										
Cyprinella lutrensis	Red Shiner				X		X	X		X	
Cyprinella venusta	Blacktail Shiner		X	X	X			X	X		X
Cyprinus carpio	Common Carp	X									
Hybognathus hayi	Cypress Minnow										
Hybognathus nuchalis	Mississippi Silvery Minnow									X	
Hybopsis amnis	Pallid Shiner								X		
Luxilus chrysocephalus	Striped Shiner			X		X			X		
Lythrurus fumeus	Ribbon Shiner	X	X	X	X	X		X	X		X
Lythrurus umbratilis	Redfin Shiner		X	X		X		X	X		
Macrhybopsis hyostoma	Shoal Chub										
Notemigonus crysoleucas	Golden Shiner	X		X		X	X		X	X	X
Notropis amabilis	Texas Shiner										
Notropis atherinoides	Emerald Shiner					X		X			X
Notropis atrocaudalis	Blackspot Shiner					X	X			X	
Notropis buchanani	Ghost Shiner										
Notropis chalybaeus	Ironcolor Shiner					X					
Notropis sabinae	Sabine Shiner		X					X			
Notropis shumardi	Silverband Shiner										
Notropis stramineus	Sand Shiner										
Notropis texanus	Weed Shiner			X	X	X			X		
Notropis volucellus	Mimic Shiner		X					X			
Notropis sp.	Minnow Species										
Opsopoeodus emiliae	Pugnose Minnow	X	X	X	X	X			X	X	X

Scientific Name	Common Name	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Creek	Little Mustang Creek	Little Pine Island Bayou
Phenacobius mirabilis	Suckermouth Minnow										
Pimephales promelas	Fathead Minnow										
Pimephales vigilax	Bullhead Minnow		X	X	X	X	X	X	X	X	X
Carpiodes carpio	River Carpsucker							X			
Cycleptus elongatus	Blue Sucker										
Erimyzon claviformis	Western Creek Chubsucker			X		X					
Erimyzon sucetta	Lake Chubsucker					X					
Ictiobus bubalus	Smallmouth Buffalo									X	
Minytrema melanops	Spotted Sucker		X	X	X	X			X		
Moxostoma congestum	Gray Redhorse										
Moxostoma poecilurum	Blacktail Redhorse		X					X			
Ameiurus melas	Black Bullhead	X		X		X					
Ameiurus natalis	Yellow Bullhead	X	X	X	X	X			X	X	X
Ictalurus furcatus	Blue Catfish										
Ictalurus punctatus	Channel Catfish		X			X		X	X		
Noturus gyrinus	Tadpole Madtom		X	X	X	X			X	X	X
Noturus nocturnus	Freckled Madtom							X	X	X	
Pylodictis olivaris	Flathead Catfish							X	X		
Esox americanus vermiculatus	Grass Pickerel		X	X		X	X		X		X
Esox niger	Chain Pickerel					X					
Aphredoderus sayanus	Pirate Perch	X	X	X	X	X		X	X	X	X
Agonostomus monticola	Mountain Mullet										
Mugil cephalus	Striped Mullet										
Labidesthes sicculus	Brook Silverside			X	X	X		X	X		
Fundulus chrysotus	Golden Topminnow					X			X		
Fundulus notatus	Blackstripe Topminnow	X	X	X		X	X	X	X	X	X
Fundulus olivaceus	Blackspotted Topminnow				X						
Gambusia affinis	Western Mosquitofish	X	X	X	X	X	X	X	X	X	X
Poecilia latipinna	Sailfin Molly										
Centrarchus macropterus	Flier			X		X			X		
Lepomis auritus	Redbreast Sunfish										
Lepomis cyanellus	Green Sunfish	X	X	X	X	X	X	X	X	X	
Lepomis gulosus	Warmouth	X	X	X	X	X	X	X	X	X	X
Lepomis humilus	Orangespotted Sunfish					X	X				
Lepomis macrochirus	Bluegill	X	X	X	X	X	X	X	X	X	X
Lepomis marginatus	Dollar Sunfish			X		X					
Lepomis megalotis	Longear Sunfish	X	X	X	X	X	X	X	X	X	X

Scientific Name	Common Name	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Creek	Little Mustang Creek	Little Pine Island Bayou
Lepomis microlophus	Redear Sunfish	X		X	X	X	X	X	X	X	
Lepomis miniatus	Redspotted Sunfish		X	X	X	X	X	X	X		X
Lepomis symmetricus	Bantam Sunfish					X				X	
Lepomis sp. (hybrid)	Sunfish Hybrid					X					
Lepomis sp.	Sunfish Species			X	X			X			
Micropterus dolomieu	Smallmouth Bass										
Micropterus punctulatus	Spotted Bass		X	X	X	X		X	X		
Micropterus salmoides	Largemouth Bass	X	X	X	X	X	X	X	X	X	X
Micropterus treculii	Guadalupe Bass										
Micropterus sp.	Bass Species										
Pomoxis annularis	White Crappie	X		X		X				X	
Pomoxis nigromaculatus	Black Crappie		X			X			X	X	
Ammocrypta vivax	Scaly Sand Darter		X					X			
Etheostoma artesiae	Redspot Darter								X		
Etheostoma asprigene	Mud Darter								X		
Etheostoma chlorosoma	Bluntnose Darter	X	X	X	X	X		X	X	X	X
Etheostoma fusiforme	Swamp Darter								X		
Etheostoma gracile	Slough Darter	X		X	X	X		X	X	X	X
Etheostoma histrio	Harlequin Darter								X		
Etheostoma parvipinne	Goldstripe Darter								X		
Etheostoma proeliare	Cypress Darter			X		X			X		X
Etheostoma radiosum	Orangebelly Darter				X						
Etheostoma whipplei	Redfin Darter								X		
Etheostoma sp.	Darter Species										
Percina carbonaria	Texas Logperch			X			X				
Percina macrolepida	Bigscale Logperch		X			X		X	X		
Percina maculata	Blackside Darter			X					X		
Percina sciera	Dusky Darter		X	X	X	X		X	X		X
Aplodinotus grunniens	Freshwater Drum		X			X		X			
Elassoma zonatum	Banded Pygmy Sunfish			X		X		X			
Herichthys cyanoguttatus	Rio Grande Cichlid										
	Species Richness	19	31	37	27	49	17	36	44	24	21
	Total N Individuals	1,535	1,507	1,081	343	5,029	216	3,692	1,560	490	349
	Number of Samples	n = 4	n = 4	n = 4	n = 2	n = 17	n = 2	n = 7	n = 4	n = 3	n = 2

Appendix D - 6 CONT. Fish species list by stream for Ecoregions 33 and 35; number of samples collected at each stream noted below the stream name (n = x); fish species listed phylogenetically and shaded by family.

Scientific Name	Common Name	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Ichthyomyzon castaneus	Chestnut Lamprey				X							
Ichthyomyzon gagei	Southern Brook Lamprey				X							
Atractosteus spatula	Alligator Gar											
Lepisosteus oculatus	Spotted Gar		X	X	X							
Lepisosteus osseus	Longnose Gar		X							X		
Lepisosteidae sp.	Gar Species	X										
Amia calva	Bowfin			X								
Dorosoma cepedianum	Gizzard Shad	X	X							X		
Dorosoma petenense	Threadfin Shad			X								
Campostoma anomalum	Central Stoneroller											
Cyprinella lutrensis	Red Shiner	X	X	X	X			X		X		
Cyprinella venusta	Blacktail Shiner	X	X	X	X	X	X	X		X	X	X
Cyprinus carpio	Common Carp	X	X	X						X		
Hybognathus hayi	Cypress Minnow											
Hybognathus nuchalis	Mississippi Silvery Minnow			X		X		X				X
Hybopsis amnis	Pallid Shiner											
Luxilus chrysocephalus	Striped Shiner											
Lythrurus fumeus	Ribbon Shiner	X	X	X	X	X	X	X		X	X	X
Lythrurus umbratilis	Redfin Shiner				X	X				X		
Macrhybopsis hyostoma	Shoal Chub			X								
Notemigonus crysoleucas	Golden Shiner		X		X	X			X			
Notropis amabilis	Texas Shiner			X								
Notropis atherinoides	Emerald Shiner				X					X		
Notropis atrocaudalis	Blackspot Shiner			X	X	X	X		X		X	
Notropis buchanani	Ghost Shiner			X								
Notropis chalybaeus	Ironcolor Shiner											
Notropis sabinae	Sabine Shiner				X					X		
Notropis shumardi	Silverband Shiner		X									
Notropis stramineus	Sand Shiner											
Notropis texanus	Weed Shiner			X	X	X		X			X	X
Notropis volucellus	Mimic Shiner		X	X	X					X		X
Notropis sp.	Minnow Species			X	X		X					
Opsopoeodus emiliae	Pugnose Minnow		X	X	X							

Scientific Name	Common Name	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Phenacobius mirabilis	Suckermouth Minnow											
Pimephales promelas	Fathead Minnow		X	X	X					X		
Pimephales vigilax	Bullhead Minnow	X	X	X	X	X		X		X	X	
Carpiodes carpio	River Carpsucker			X								
Cycleptus elongatus	Blue Sucker											
Erimyzon claviformis	Western Creek Chubsucker				X	X						
Erimyzon sucetta	Lake Chubsucker										X	
Ictiobus bubalus	Smallmouth Buffalo		X									
Minytrema melanops	Spotted Sucker			X	X	X					X	
Moxostoma congestum	Gray Redhorse			X								
Moxostoma poecilurum	Blacktail Redhorse	X		X	X			X		X		
Ameiurus melas	Black Bullhead			X	X	X	X			X		
Ameiurus natalis	Yellow Bullhead			X	X	X	X	X	X	X	X	X
Ictalurus furcatus	Blue Catfish				X	X						
Ictalurus punctatus	Channel Catfish		X	X	X					X		
Noturus gyrinus	Tadpole Madtom		X	X	X		X			X		
Noturus nocturnus	Freckled Madtom	X		X	X			X		X	X	
Pylodictis olivaris	Flathead Catfish		X	X	X					X		
Esox americanus vermiculatus	Grass Pickerel	X				X	X		X			
Esox niger	Chain Pickerel											
Aphredoderus sayanus	Pirate Perch	X	X	X	X	X	X		X	X		X
Agonostomus monticola	Mountain Mullet			X								
Mugil cephalus	Striped Mullet			X								
Labidesthes sicculus	Brook Silverside			X	X					X		
Fundulus chrysotus	Golden Topminnow											
Fundulus notatus	Blackstripe Topminnow	X	X	X	X	X	X	X		X	X	
Fundulus olivaceus	Blackspotted Topminnow			X			X				X	X
Gambusia affinis	Western Mosquitofish	X	X	X	X	X	X	X	X	X		X
Poecilia latipinna	Sailfin Molly											
Centrarchus macropterus	Flier					X						
Lepomis auritus	Redbreast Sunfish			X		X						
Lepomis cyanellus	Green Sunfish	X	X	X	X	X	X		X		X	
Lepomis gulosus	Warmouth	X		X	X	X	X	X	X	X		
Lepomis humilus	Orangespotted Sunfish			X					X			
Lepomis macrochirus	Bluegill	X	X	X	X	X	X	X	X	X	X	X
Lepomis marginatus	Dollar Sunfish					X						
Lepomis megalotis	Longear Sunfish	X	X	X	X	X	X	X	X	X	X	X

Scientific Name	Common Name	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Lepomis microlophus	Redear Sunfish			X	X		X		X	X	X	X
Lepomis miniatus	Redspotted Sunfish	X		X	X	X				X	X	
Lepomis symmetricus	Bantam Sunfish			X	X							
Lepomis sp. (hybrid)	Sunfish Hybrid			X	X					X		
Lepomis sp.	Sunfish Species			X		X	X					
Micropterus dolomieu	Smallmouth Bass			X								
Micropterus punctulatus	Spotted Bass	X		X	X			X		X		X
Micropterus salmoides	Largemouth Bass	X		X	X	X	X		X	X	X	X
Micropterus treculii	Guadalupe Bass											
Micropterus sp.	Bass Species											
Pomoxis annularis	White Crappie			X					X	X		
Pomoxis nigromaculatus	Black Crappie			X								
Ammocrypta vivax	Scaly Sand Darter				X			X		X		X
Etheostoma artesiae	Redspot Darter											
Etheostoma asprigene	Mud Darter											
Etheostoma chlorosoma	Bluntnose Darter			X	X	X		X		X	X	X
Etheostoma fusiforme	Swamp Darter											
Etheostoma gracile	Slough Darter	X	X	X	X	X	X	X				X
Etheostoma histrio	Harlequin Darter											
Etheostoma parvipinne	Goldstripe Darter										X	X
Etheostoma proeliare	Cypress Darter				X					X		
Etheostoma radiosum	Orangebelly Darter											
Etheostoma whipplei	Redfin Darter											
Etheostoma sp.	Darter Species	X		X			X					
Percina carbonaria	Texas Logperch											
Percina macrolepida	Bigscale Logperch			X								
Percina maculata	Blackside Darter											
Percina sciera	Dusky Darter	X	X	X	X	X		X	X	X	X	X
Aplodinotus grunniens	Freshwater Drum				X							
Elassoma zonatum	Banded Pygmy Sunfish				X		X			X		X
Herichthys cyanoguttatus	Rio Grande Cichlid											
	Species Richness	23	25	56	48	30	22	19	15	37	20	20
	Total N Individuals	262	627	11,725	7,612	393	1,604	123	237	1,642	377	157
	Number of Samples	n = 2	n = 2	n = 33	n = 27	n = 3	n = 3	n = 1	n = 2	n = 4	n = 2	n = 1

Appendix D - 7. Fish species list by stream for Ecoregion 34; number of samples collected at each stream noted below the stream name (n = x); fish species listed phylogenetically and shaded by family.

Scientific Name	Common Name	Arenosa Creek	Big Creek	Garcitas Creek	Placedo Creek	San Bernard River	West Bernard Creek	West Carancahua Creek	West Mustang Creek
Lepisosteus oculatus	Spotted Gar	X	X	X	X	X	X	X	X
Lepisosteus osseus	Longnose Gar			X			X		X
Anguilla rostrata	American Eel	X			X		X	X	
Dorosoma cepedianum	Gizzard Shad		X		X		X	X	X
Dorosoma petenense	Threadfin Shad		X						
Cyprinella lutrensis	Red Shiner	X	X	X	X	X	X	X	X
Cyprinella venusta	Blacktail Shiner		X	X		X	X	X	X
Cyprinus carpio	Common Carp	X	X				X	X	
Hybopsis amnis	Pallid Shiner		X			X			
Luxilus chrysocephalus	Striped Shiner						X		
Lythrurus fumeus	Ribbon Shiner		X			X			
Lythrurus umbratilis	Redfin Shiner		X			X			X
Macrhybopsis hyostoma	Shoal Chub		X						
Macrhybopsis marconis	Burrhead Chub			X					
Notemigonus crysoleucas	Golden Shiner	X		X					
Notropis atherinoides	Emerald Shiner		X						
Notropis atrocaudalis	Blackspot Shiner		X						
Notropis buchanani	Ghost Shiner		X					X	
Notropis shumardi	Silverband Shiner		X				X		
Notropis texanus	Weed Shiner	X		X					
Notropis volucellus	Mimic Shiner		X			X	X	X	X
Opsopoeodus emiliae	Pugnose Minnow	X	X				X	X	X
Pimephales vigilax	Bullhead Minnow		X			X	X	X	X
Carpiodes carpio	River Carpsucker							X	
Ictiobus bubalus	Smallmouth Buffalo	X		X			X		
Ameiurus natalis	Yellow Bullhead	X	X	X	X			X	X
Ictalurus furcatus	Blue Catfish		X					X	X
Ictalurus punctatus	Channel Catfish	X	X	X	X	X	X	X	X
Noturus gyrinus	Tadpole Madtom	X				X	X	X	X
Noturus nocturnus	Freckled Madtom		X						X
Pylodictis olivaris	Flathead Catfish		X			X	X		X
Hypostomus plecostomus	Suckermouth Catfish		X						
Aphredoderus sayanus	Pirate Perch		X			X	X	X	X
Mugil cephalus	Striped Mullet		X						
Mugil curema	White Mullet		X						
Labidesthes sicculus	Brook Silverside					X			

Scientific Name	Common Name	Arenosa Creek	Big Creek	Garcitas Creek	Placedo Creek	San Bernard River	West Bernard Creek	West Carancahua Creek	West Mustang Creek
Menidia beryllina	Inland Silverside		X			X			X
Fundulus chrysotus	Golden Topminnow	X		X					
Fundulus notatus	Blackstripe Topminnow						X		
Gambusia affinis	Western Mosquitofish	X	X	X	X	X	X	X	X
Poecilia latipinna	Sailfin Molly		X			X	X		
Cyprinodon variegatus	Sheepshead Minnow		X	X					
Morone chrysops	White Bass		X						
Lepomis auritus	Redbreast Sunfish	X		X					
Lepomis cyanellus	Green Sunfish	X	X	X	X	X	X	X	X
Lepomis gulosus	Warmouth	X	X	X	X	X	X	X	X
Lepomis humilis	Orangespotted Sunfish		X				X		
Lepomis macrochirus	Bluegill	X	X	X	X	X	X	X	X
Lepomis marginatus	Dollar Sunfish		X						X
Lepomis megalotis	Longear Sunfish	X	X	X	X	X	X	X	X
Lepomis microlophus	Redear Sunfish	X	X	X					
Lepomis miniatus	Redspotted Sunfish	X		X			X	X	
Lepomis symmetricus	Bantam Sunfish	X							X
Lepomis sp. (hybrid)	Sunfish Hybrid					X			
Lepomis sp.	Sunfish Species	X		X	X		X	X	
Micropterus punctulatus	Spotted Bass		X			X	X		X
Micropterus salmoides	Largemouth Bass	X	X	X			X	X	
Pomoxis annularis	White Crappie	X	X		X		X	X	X
Pomoxis nigromaculatus	Black Crappie					X			X
Etheostoma chlorosoma	Bluntnose Darter	X		X		X			
Etheostoma gracile	Slough Darter	X	X	X		X	X		X
Percina sciera	Dusky Darter			X		X	X		X
Oreochromis aureus	Blue Tilapia		X						
Dormitator maculatus	Fat Sleeper		X						
Microgobius gulosus	Clown Goby							X	
Trinectes maculatus	Hogchoker				X				
	Species Richness	26	44	25	14	26	32	26	29
	Total N Individuals	4,021	6,842	869	2,069	711	622	5,171	1,920
	Number of Samples	n = 5	n = 13	n = 3	n = 3	n = 4	n = 4	n = 4	n = 4

APPENDIX E - BENTHIC MACROINVERTEBRATE SPECIES LIST

Appendix E - 1. Benthic macroinvertebrate taxa list by stream for Ecoregion 24; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	Alamito Creek	Independence Creek	Pecos River	Rio Grande: Presidio	Rio Grande: Contrabando	Rio Grande: Johnson Ranch
Amphipoda	Gammaridae	*Gammarus* sp.		210				
Amphipoda	Hyalellidae	*Hyalella azteca*		1				
Basommatophora	Ancylidae	*Ferrissia rivularis*		3				
Basommatophora	Physidae	*Physella* sp.			3			
Basommatophora	Physidae	*Physella virgata*	124					
Basommatophora	Planorbidae	*Biomphalaria obstructus*	24					
Basommatophora	Planorbidae	*Helisoma anceps*	2					
Coleoptera	Dryopidae	*Helichus immsi*	4					
Coleoptera	Dryopidae	*Helichus* sp.					21	3
Coleoptera	Dryopidae	*Postelichus* sp.					11	
Coleoptera	Dytiscidae	*Neobidessus* sp.	5					
Coleoptera	Elmidae	*Hexacylloepus ferrugineus*		3				
Coleoptera	Elmidae	*Hexacylloepus* sp.		2	9			
Coleoptera	Elmidae	*Macrelmis* sp.		12	62		1	
Coleoptera	Elmidae	*Macrelmis texana*		10				
Coleoptera	Elmidae	*Microcylloepus pusillus*		7				
Coleoptera	Elmidae	*Microcylloepus* sp.		3	7		9	22
Coleoptera	Elmidae	*Neoelmis caesa*		2				
Coleoptera	Elmidae	*Neoelmis* sp.		7				
Coleoptera	Elmidae	*Phanocerus clavicornis*		11				
Coleoptera	Elmidae	*Stenelmis* sp.		1	11			
Coleoptera	Gyrinidae	*Gyretes* sp.				1		12
Coleoptera	Hydraenidae	*Gymnochthebius* sp.						1
Coleoptera	Hydraenidae	*Ochthebius* sp.		1				
Coleoptera	Hydrophilidae	*Berosus* sp.			3			
Coleoptera	Hydrophilidae	*Enochrus* sp.	36	1				
Coleoptera	Hydrophilidae	*Tropisternus* sp.	4			1		
Coleoptera	Psephenidae	*Psephenus* sp.		2				
Coleoptera	Psephenidae	*Psephenus texanus*		135				
Diptera	Athericidae	*Atherix* sp.				1		1
Diptera	Ceratopogonidae	*Bezzia* sp.		1				
Diptera	Ceratopogonidae	*Dasyhelea* sp.	26					
Diptera	Ceratopogonidae	*Palpomyia tibialis*	8					

Order	Family	Taxon	Alamito Creek	Independence Creek	Pecos River	Rio Grande: Presidio	Rio Grande: Contrabando	Rio Grande: Johnson Ranch
Diptera	Ceratopogonidae	*Probezzia* sp.	14	2				
Diptera	Chironomidae	*Ablabesmyia mallochi*	4					
Diptera	Chironomidae	*Cardiocladius* sp.		3				
Diptera	Chironomidae	*Cladopelma* sp.						1
Diptera	Chironomidae	*Cladotanytarsus mancus* gr.	21					
Diptera	Chironomidae	*Cladotanytarsus* sp.				1		
Diptera	Chironomidae	*Conchapelopia* sp.	119			4		
Diptera	Chironomidae	*Corynoneura* nr. *taris*		2				
Diptera	Chironomidae	*Cricotopus* sp.				2		
Diptera	Chironomidae	*Cryptochironomus* sp.					1	2
Diptera	Chironomidae	*Dicrotendipes neomodestus*	14					
Diptera	Chironomidae	*Einfeldia* sp.		5				
Diptera	Chironomidae	*Labrundinia neopilosella*	4					
Diptera	Chironomidae	*Larsia* sp.				6		
Diptera	Chironomidae	*Microtendipes pedellus* gr.	4					
Diptera	Chironomidae	*Microtendipes rydalensis* gr.	4					
Diptera	Chironomidae	*Orthocladius* sp.		3				
Diptera	Chironomidae	*Paracladius* sp.		2				
Diptera	Chironomidae	*Pentaneura* sp.	7					
Diptera	Chironomidae	*Polypedilum convictum*	25	3				
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. A	4					
Diptera	Chironomidae	*Polypedilum* sp.		1		5		
Diptera	Chironomidae	*Pseudochironomus* sp.	7	3				
Diptera	Chironomidae	*Rheocricotopus fuscipes* gr.		2				
Diptera	Chironomidae	*Rheotanytarsus exiguus* gr.		14				
Diptera	Chironomidae	*Saetheria* sp.	21					
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.	7					
Diptera	Chironomidae	*Tanytarsus guerlus* gr.	14					
Diptera	Chironomidae	*Tanytarsus* sp.				1		
Diptera	Chironomidae	*Thienemanniella* nr. *xena*	4					
Diptera	Chironomidae	*Thienemannimyia* sp.				1	2	
Diptera	Chironomidae	*Zavrelimyia* sp.	14					
Diptera	Ephydridae	*Ephydra* sp.	13					
Diptera	Simuliidae	*Simulium* sp.	8	1	6	9		2
Diptera	Stratiomyidae	*Caloparyphus* sp.		2				
Diptera	Stratiomyidae	*Euparyphus* sp.	7					
Diptera	Stratiomyidae	*Stratiomyia* sp.	4					

Order	Family	Taxon	Alamito Creek	Independence Creek	Pecos River	Rio Grande: Presidio	Rio Grande: Contrabando	Rio Grande: Johnson Ranch
Diptera	Stratiomyidae	*Stratiomys* sp.		1				
Diptera	Tabanidae	*Silvius* sp.						1
Diptera	Tabanidae	*Tabanus* sp.		5	11		2	
Diptera	Tipulidae	*Hexatoma* sp.	227	9				
Ephemeroptera	Baetidae	*Baetodes edmundsi*		4				
Ephemeroptera	Baetidae	*Camelobaetidius mexicanus*		1				
Ephemeroptera	Baetidae	*Camelobaetidius* sp.		13	5	5	6	5
Ephemeroptera	Baetidae	*Fallceon quilleri*	504	38	9	4		15
Ephemeroptera	Baetidae	*Paracloeodes* sp.	61					
Ephemeroptera	Caenidae	*Caenis* sp.			1			
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.			9	8		
Ephemeroptera	Leptohyphidae	*Vacupernius packeri*		33		6		
Ephemeroptera	Leptophlebiidae	*Choroterpes mexicanus*	18	2				
Ephemeroptera	Leptophlebiidae	*Choroterpes* sp.		52	128			
Ephemeroptera	Leptophlebiidae	*Neochoroterpes* sp.				4	4	
Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.		2			21	9
Ephemeroptera	Leptophlebiidae	*Traverella* sp.				88	63	111
Ephemeroptera	Tricorythidae	*Leptohyphes vescus*		1				
Ephemeroptera	Tricorythidae	*Tricorythodes albilineatus* gr.	43					
Hemiptera	Corixidae	*Graptocorixa* sp.	3					
Hemiptera	Naucoridae	*Ambrysus buenoi*	5					
Hemiptera	Naucoridae	*Ambrysus circumcinctus*		1				
Hemiptera	Naucoridae	*Ambrysus lunatus*		1				
Hemiptera	Naucoridae	*Ambrysus* sp.		12	3	3	3	6
Hemiptera	Naucoridae	*Cryphocricos hungerfordi*		57				
Hemiptera	Naucoridae	*Cryphocricos* sp.			6		18	4
Hemiptera	Naucoridae	*Limnocoris* sp.			4			
Hemiptera	Veliidae	*Rhagovelia* sp.						2
Hirudinida	Glossiphoniidae	*Helobdella elongata*	83					
Hirudinida	Glossiphoniidae	*Helobdella triserialis*	64	3				
Hoplonemertea	Tetrastemmatidae	*Prostoma rubrum*	11					
Lepidoptera	Pyralidae	*Petrophila* sp.	2	3				
Lumbriculida	Lumbriculidae	Lumbriculidae		2				
Megaloptera	Corydalidae	*Corydalus cornutus*		5	1		4	
Neoophora	Dugesiidae	*Dugesia dorotocephala*		116				
Neoophora	Dugesiidae	*Dugesia* sp.		3	16			
Neoophora	Dugesiidae	*Dugesia tigrina*		4				

Order	Family	Taxon	Alamito Creek	Independence Creek	Pecos River	Rio Grande: Presidio	Rio Grande: Contrabando	Rio Grande: Johnson Ranch
Neotaenioglossa	Hydrobiidae	*Cochliopina riograndensis*		304				
Neotaenioglossa	Hydrobiidae	*Pyrgulopsis texana*		1,373				
Neotaenioglossa	Pleuroceridae	*Elimia comalensis*		310				
Odonata	Calopterygidae	*Hetaerina* sp.						7
Odonata	Coenagrionidae	*Argia* sp.	1	1	6	1	2	
Odonata	Coenagrionidae	*Argia* sp. B		1				
Odonata	Coenagrionidae	Coenagrionidae						1
Odonata	Coenagrionidae	*Enallagma* sp.		1				
Odonata	Gomphidae	*Erpetogomphus* sp.		3	2	8	2	18
Odonata	Gomphidae	*Gomphus* sp.				1	1	
Odonata	Gomphidae	*Progomphus obscurus*	2					
Odonata	Lestidae	*Lestes* sp.	1					
Odonata	Libellulidae	*Brechmorhoga mendax*		4				
Odonata	Libellulidae	*Brechmorhoga* sp.		3			1	2
Odonata	Libellulidae	*Sympetrum corruptum*	3					
Oligochaeta		Oligochaeta		1	3	2	4	1
Opisthopora	Sparganophilidae	*Sparganophilus tamesis*	3	1				
Ostracoda		Ostracoda		3	2			
Podocopida	Cyprididae	*Cypridopsis vidua*	11					
Podocopida	Cyprididae	*Eucypris* sp.	34					
Podocopida	Cyprididae	*Stenocypris* sp.	23					
Podocopida	Limnocytheridae	*Limnocythere* sp.		2				
Trichoptera	Helicopsychidae	*Helicopsyche* sp.	452	159				
Trichoptera	Hydrobiosidae	*Atopsyche erigia*		1				
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.		58	9	55	52	18
Trichoptera	Hydropsychidae	*Hydropsyche* sp.			3			
Trichoptera	Hydropsychidae	*Smicridea* sp.			3	20	20	21
Trichoptera	Hydroptilidae	*Hydroptila* sp.	30	46		3		1
Trichoptera	Hydroptilidae	*Ithytrichia* sp.			1			
Trichoptera	Hydroptilidae	*Leucotrichia* sp.		16				
Trichoptera	Hydroptilidae	*Mayatrichia* sp.					2	
Trichoptera	Hydroptilidae	*Ochrotrichia* sp.		18				
Trichoptera	Hydroptilidae	*Oxyethira* sp.	1	1				
Trichoptera	Leptoceridae	*Nectopsyche gracilis*		5				
Trichoptera	Odontoceridae	*Marilia nobsca*	19					
Trichoptera	Philopotamidae	*Chimarra* sp.		15	4			
Trichoptera	Polycentropodidae	*Polyplectropus charlesi*		6				

Order	Family	Taxon	Alamito Creek	Independence Creek	Pecos River	Rio Grande: Presidio	Rio Grande: Contrabando	Rio Grande: Johnson Ranch
Trombidiformes	Sperchontidae	*Sperchon* sp.		1				
Trombidiformes	Torrenticolidae	*Torrenticola* sp.		3				
Trombidiformes		Hydracarina (Hydrachnidia)		7				
Tubificida	Naididae	*Chaetogaster diaphanus*	27					
Tubificida	Naididae	*Chaetogaster diastrophus*	9					
Tubificida	Naididae	*Dero trifida*	25					
Tubificida	Naididae	*Limnodrilus* sp.		1				
Tubificida	Naididae	*Pristina leidyi*	123					
Veneroida	Corbiculidae	*Corbicula fluminea*			6			3
Veneroida	Pisidiidae	*Pisidium nitidum*		1				
		Taxa Richness	57	82	28	25	22	25
		Total N Individuals	2,337	3,168	333	240	250	269
		Number of Samples	n = 1	n = 2	n = 1	n = 1	n = 1	n = 1

Appendix E - 2. Benthic macroinvertebrate taxa list by stream for Ecoregions 25 and 26; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	Bluff Creek	Buck Creek	Canadian River: US 385	Canadian River: SH 70	Chicken Creek	McClellan Creek
Amphipoda	Hyalellidae	*Hyalella azteca*	3					
Amphipoda	Hyalellidae	*Hyalella* sp.		8	1	16	1	63
Basommatophora	Lymnaeidae	*Fossaria parva*						
Basommatophora	Lymnaeidae	*Pseudosuccinea columella*						
Basommatophora	Physidae	*Physa* sp.		15		4	27	
Basommatophora	Physidae	*Physella* sp.						
Basommatophora	Physidae	*Physella virgata*	1					2
Branchiobdellida		Branchiobdellida						
Coleoptera	Curculionidae	Curculionidae		1				
Coleoptera	Dryopidae	*Helichus* sp.						
Coleoptera	Dryopidae	*Helichus suturalis*						2
Coleoptera	Dryopidae	*Postelichus* sp.						
Coleoptera	Dytiscidae	*Hygrotus* sp.						1
Coleoptera	Dytiscidae	*Laccophilus* sp.						
Coleoptera	Dytiscidae	*Neoporus* sp.		1				
Coleoptera	Dytiscidae	*Oreodytes* sp.						
Coleoptera	Elmidae	*Dubiraphia* sp.	1	1		1		
Coleoptera	Elmidae	*Microcylloepus pusillus*						1
Coleoptera	Elmidae	*Microcylloepus* sp.		6			5	46
Coleoptera	Elmidae	*Neoelmis* sp.			1			
Coleoptera	Elmidae	*Stenelmis occidentalis*	37					
Coleoptera	Elmidae	*Stenelmis* sp.						
Coleoptera	Gyrinidae	*Dineutus* sp.						
Coleoptera	Haliplidae	*Haliplus* sp.		1				
Coleoptera	Haliplidae	*Peltodytes* sp.		1	1			
Coleoptera	Helophoridae	*Helophorus* sp.						
Coleoptera	Hydraenidae	*Gymnochthebius* sp.			1			
Coleoptera	Hydraenidae	*Ochthebius* sp.						
Coleoptera	Hydrophilidae	*Ametor* sp.						
Coleoptera	Hydrophilidae	*Berosus* sp.	10		4		1	1
Coleoptera	Hydrophilidae	*Cymbiodyta* sp.						
Coleoptera	Hydrophilidae	*Derallus* sp.					11	
Coleoptera	Hydrophilidae	*Enochrus* sp.						3

Order	Family	Taxon	Bluff Creek	Buck Creek	Canadian River: US 385	Canadian River: SH 70	Chicken Creek	McClellan Creek
Coleoptera	Hydrophilidae	*Paracymus* sp.					1	
Coleoptera	Hydrophilidae	*Tropisternus* sp.				2		
Coleoptera	Scirtidae	*Scirtes* sp.						
Collembola		Collembola						
Copepoda		Copepoda						7
Decapoda	Cambaridae	Cambaridae						
Decapoda	Cambaridae	*Faxonella* sp.					9	
Decapoda	Cambaridae	*Procambarus* sp.						
Diptera	Ceratopogonidae	*Alluaudomyia* sp.						
Diptera	Ceratopogonidae	*Atrichopogon* sp.						
Diptera	Ceratopogonidae	*Bezzia* sp.						
Diptera	Ceratopogonidae	*Ceratopogon* sp.						
Diptera	Ceratopogonidae	Ceratopogonidae		1				7
Diptera	Ceratopogonidae	*Palpomyia tibialis*	10					8
Diptera	Ceratopogonidae	*Probezzia* sp.	22					1
Diptera	Chironomidae	Chironomidae						
Diptera	Chironomidae	*Chironomus decorus* gr.						34
Diptera	Chironomidae	*Cladotanytarsus mancus* gr.						68
Diptera	Chironomidae	*Cladotanytarsus* sp.				36		
Diptera	Chironomidae	*Clinotanypus* sp.						
Diptera	Chironomidae	*Conchapelopia* sp.			1			238
Diptera	Chironomidae	*Cricotopus tremulus* gr.						238
Diptera	Chironomidae	*Cricotopus trifascia* gr.						136
Diptera	Chironomidae	*Cryptochironomus fulvus* gr.	8					
Diptera	Chironomidae	*Cryptochironomus* sp.				2		
Diptera	Chironomidae	*Dicrotendipes neomodestus*	8					34
Diptera	Chironomidae	*Dicrotendipes* sp.						
Diptera	Chironomidae	*Endochironomus* sp.						
Diptera	Chironomidae	*Labrundinia* sp.					3	
Diptera	Chironomidae	*Larsia* sp.	45				2	
Diptera	Chironomidae	*Lopescladius* sp.						
Diptera	Chironomidae	*Meropelopia* sp.						68
Diptera	Chironomidae	*Orthocladius* sp.				1		
Diptera	Chironomidae	*Paracladopelma* sp.				2		
Diptera	Chironomidae	*Paracricotopus* sp.						
Diptera	Chironomidae	*Parametriocnemus* sp.	15				1	

Order	Family	Taxon	Bluff Creek	Buck Creek	Canadian River: US 385	Canadian River: SH 70	Chicken Creek	McClellan Creek
Diptera	Chironomidae	*Paratanytarsus* sp.	8					
Diptera	Chironomidae	*Paratendipes* nr. *nudisquama*	53					
Diptera	Chironomidae	*Paratendipes* sp.					3	
Diptera	Chironomidae	*Pedionomus* sp.	15					
Diptera	Chironomidae	*Pentaneura* sp.	23			6		307
Diptera	Chironomidae	*Phaenopsectra* sp.						
Diptera	Chironomidae	*Polypedilum convictum*	8					204
Diptera	Chironomidae	*Polypedilum illinoense*	53					
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. A	8					
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. B						
Diptera	Chironomidae	*Polypedilum* sp.					4	
Diptera	Chironomidae	*Procladius* sp.				1		
Diptera	Chironomidae	*Pseudochironomus* sp.						204
Diptera	Chironomidae	*Rheocricotopus fusdpes* gr.						34
Diptera	Chironomidae	*Rheocricotopus* sp.				3		
Diptera	Chironomidae	*Rheotanytarsus exiguus* gr.	60					749
Diptera	Chironomidae	*Rheotanytarsus* sp.						
Diptera	Chironomidae	*Robackia* sp.						
Diptera	Chironomidae	*Saetheria* sp.						
Diptera	Chironomidae	Subfamily: Chironominae		3				25
Diptera	Chironomidae	Subfamily: Orthocladiinae		2				33
Diptera	Chironomidae	Subfamily: Tanypodinae		7				3
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.	23					
Diptera	Chironomidae	*Tanytarsus guerlus* gr.	38					
Diptera	Chironomidae	*Tanytarsus* sp.			5		1	
Diptera	Chironomidae	*Telopelopia* sp.			2			
Diptera	Chironomidae	*Thienemanniella* nr. *xena*						34
Diptera	Culicidae	*Anopheles* sp.						
Diptera	Dixidae	*Dixella* sp.					1	
Diptera	Dolichopodidae	Dolichopodidae	1					
Diptera	Empididae	*Hemerodromia* sp.						1
Diptera	Ephydridae	*Ephydra* sp.						
Diptera	Simuliidae	*Simulium* nr. *vittatum*						10
Diptera	Simuliidae	*Simulium* sp.	1		13	1		2
Diptera	Stratiomyidae	*Odontomyia* sp.						
Diptera	Stratiomyidae	*Stratiomys* sp.					2	

Order	Family	Taxon	Bluff Creek	Buck Creek	Canadian River: US 385	Canadian River: SH 70	Chicken Creek	McClellan Creek
Diptera	Tabanidae	*Tabanus* sp.	7					
Diptera	Tipulidae	*Limnophila* sp.						16
Diptera	Tipulidae	*Tipula* sp.						
Enchytraeida	Enchytraeidae	Enchytraeidae	73					
Ephemeroptera	Baetidae	*Baetis ephippiatus*						
Ephemeroptera	Baetidae	*Callibaetis* sp.			1			1
Ephemeroptera	Baetidae	*Fallceon quilleri*	31	114		65	25	363
Ephemeroptera	Baetidae	*Paracloeodes* sp.		2				
Ephemeroptera	Baetidae	*Pseudocloeon* sp.			28	2		
Ephemeroptera	Caenidae	*Brachycercus* sp.			1			
Ephemeroptera	Caenidae	*Caenis* sp.	3	77	13			3
Ephemeroptera	Caenidae	*Caenis* sp. A						
Ephemeroptera	Caenidae	*Caenis* sp. B						
Ephemeroptera	Caenidae	*Cercobrachys* sp.			5			
Ephemeroptera	Ephemeridae	*Hexagenia* sp.		1				
Ephemeroptera	Heptageniidae	*Heptagenia* sp.						2
Ephemeroptera	Isonychiidae	*Isonychia sicca manca*						1
Ephemeroptera	Isonychiidae	*Isonychia* sp.						
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr.						
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.			9	1		
Ephemeroptera	Leptophlebiidae	*Choroterpes mexicanus*	1					
Gordioidea	Gordiidae	*Gordius* sp.						
Hemiptera	Belostomatidae	*Belostoma* sp.					2	
Hemiptera	Belostomatidae	*Lethocerus* sp.						
Hemiptera	Corixidae	Corixidae			1			
Hemiptera	Corixidae	*Trichocorixa* sp.						
Hemiptera	Gerridae	*Gerris* sp.						
Hemiptera	Gerridae	*Neogerris* sp.		1				
Hemiptera	Pleidae	*Paraplea* sp.			3			
Hemiptera	Veliidae	*Platyvelia* sp.						
Hemiptera	Veliidae	*Rhagovelia* sp.						2
Hemiptera		Hemiptera						
Hirudinida	Erpobdellidae	*Mooreobdella microstoma*						
Hirudinida	Erpobdellidae	*Mooreobdella* sp.				1		
Hirudinida	Glossiphoniidae	*Placobdella omata*						1
Hoplonemertea	Tetrastemmatidae	*Prostoma rubrum*						11

Order	Family	Taxon	Bluff Creek	Buck Creek	Canadian River: US 385	Canadian River: SH 70	Chicken Creek	McClellan Creek
Megaloptera	Sialidae	*Sialis* sp.						1
Nematoda		Nematoda	26					
Neoophora	Dugesiidae	*Cura* sp.						3
Neoophora	Dugesiidae	*Dugesia* sp.				1		
Neoophora	Dugesiidae	*Dugesia tigrina*	1					28
Odonata	Aeschnidae	*Aeshna* sp.						
Odonata	Calopterygidae	*Hetaerina* sp.	8	2	66	1	24	49
Odonata	Coenagrionidae	*Argia* sp.		10	11		38	4
Odonata	Coenagrionidae	*Argia* sp. A	33					
Odonata	Coenagrionidae	*Argia* sp. B	25					1
Odonata	Coenagrionidae	*Enallagma* sp.	16	7	7			
Odonata	Coenagrionidae	*Ischnura* sp.						
Odonata	Corduliidae	*Macromia* sp.		1				
Odonata	Gomphidae	*Arigomphus* sp.						
Odonata	Gomphidae	*Erpetogomphus* sp.	5	13	13		13	2
Odonata	Gomphidae	Gomphidae						2
Odonata	Gomphidae	*Gomphus externus*						
Odonata	Gomphidae	*Progomphus obscurus*						
Odonata	Gomphidae	*Progomphus* sp.		1	4			
Odonata	Libellulidae	*Brechmorhoga* sp.						
Odonata	Libellulidae	*Libellula* sp.						
Odonata	Libellulidae	*Sympetrum* sp.						
Odonata	Macromiidae	Macromiidae						1
Oligochaeta		Oligochaeta		2	1	3	5	7
Ostracoda		Ostracoda				1	1	10
Plecoptera	Perlidae	*Perlesta* sp.						15
Podocopida	Cyprididae	*Cypridopsis vidua*	9					
Podocopida	Cyprididae	*Stenocypris* sp.						1
Podocopida	Cyprididae	*Cypria* sp.	1					
Trichoptera	Brachycentridae	*Brachycentrus* sp.						
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.	285	1	8	8	18	81
Trichoptera	Hydropsychidae	*Hydropsyche* sp.				12		
Trichoptera	Hydropsychidae	*Smicridea* sp.				24		4
Trichoptera	Hydroptilidae	*Hydroptila* sp.	2			4	2	93
Trichoptera	Hydroptilidae	*lthytrichia* sp.	53					
Trichoptera	Hydroptilidae	*Mayatrichia* sp.						1

Order	Family	Taxon	Bluff Creek	Buck Creek	Canadian River: US 385	Canadian River: SH 70	Chicken Creek	McClellan Creek
Trichoptera	Hydroptilidae	*Oxyethira* sp.						1
Trichoptera	Leptoceridae	*Nectopsyche diarina*						115
Trichoptera	Leptoceridae	*Nectopsyche* sp.						3
Trichoptera	Leptoceridae	*Oecetis* sp.						
Trichoptera	Philopotamidae	*Chimarra* sp.	12				29	
Trombidiformes	Arrenuridae	*Arrenurus* sp.	1					
Trombidiformes	Limnesiidae	*Tyrrellia* sp.						
Trombidiformes	Limnocharidae	*Limnochares* sp.						
Trombidiformes		Hydracarina (Hydrachnidia)						
Tubificida	Naididae	*Bratislavia unidentata*	363					
Tubificida	Naididae	*Limnodrilus hoffmeisteri*	725					
Tubificida	Naididae	*Limnodrilus* sp.	73					
Tubificida	Naididae	*Nais pardalis*						
Tubificida	Naididae	*Slavina appendiculata*						
Veneroida	Corbiculidae	*Corbicula fluminea*						7
Veneroida	Pisidiidae	*Pisidium nitidum*						1
Veneroida	Pisidiidae	*Pisidium* sp.						32
Veneroida	Pisidiidae	*Sphaerium transversum*	3,338					
		Taxa Richness	46	25	24	24	25	63
		Total N Individuals	5,542	279	200	198	229	3,426
		Number of Samples	n = 1	n = 1	n = 1	n = 1	n = 1	n = 2

Appendix E – 2 CONT. Benthic macroinvertebrate taxa list by stream for Ecoregions 25 and 26; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	North Fork Wichita River	Saddlers Creek	Salt Fork Red River	White Deer Creek	Whitefish Creek	Wolf Creek
Amphipoda	Hyalellidae	*Hyalella azteca*				58		34
Amphipoda	Hyalellidae	*Hyalella* sp.			1			
Basommatophora	Lymnaeidae	*Fossaria parva*						1
Basommatophora	Lymnaeidae	*Pseudosuccinea columella*				1		
Basommatophora	Physidae	*Physa* sp.			6			
Basommatophora	Physidae	*Physella* sp.				24		
Basommatophora	Physidae	*Physella virgata*						5
Branchiobdellida		Branchiobdellida						4
Coleoptera	Curculionidae	Curculionidae						
Coleoptera	Dryopidae	*Helichus* sp.			10			
Coleoptera	Dryopidae	*Helichus suturalis*						17
Coleoptera	Dryopidae	*Postelichus* sp.				1		
Coleoptera	Dytiscidae	*Hygrotus* sp.			1			
Coleoptera	Dytiscidae	*Laccophilus* sp.						1
Coleoptera	Dytiscidae	*Neoporus* sp.			1			
Coleoptera	Dytiscidae	*Oreodytes* sp.				1		
Coleoptera	Elmidae	*Dubiraphia* sp.				4		4
Coleoptera	Elmidae	*Microcylloepus pusillus*						31
Coleoptera	Elmidae	*Microcylloepus* sp.				1		
Coleoptera	Elmidae	*Neoelmis* sp.						
Coleoptera	Elmidae	*Stenelmis occidentalis*						
Coleoptera	Elmidae	*Stenelmis* sp.			1			
Coleoptera	Gyrinidae	*Dineutus* sp.						8
Coleoptera	Haliplidae	*Haliplus* sp.						
Coleoptera	Haliplidae	*Peltodytes* sp.				4		
Coleoptera	Helophoridae	*Helophorus* sp.			2			
Coleoptera	Hydraenidae	*Gymnochthebius* sp.						
Coleoptera	Hydraenidae	*Ochthebius* sp.			1			
Coleoptera	Hydrophilidae	*Ametor* sp.						1
Coleoptera	Hydrophilidae	*Berosus* sp.	17		3	9		5
Coleoptera	Hydrophilidae	*Cymbiodyta* sp.	2					
Coleoptera	Hydrophilidae	*Derallus* sp.						
Coleoptera	Hydrophilidae	*Enochrus* sp.						

Order	Family	Taxon	North Fork Wichita River	Saddlers Creek	Salt Fork Red River	White Deer Creek	Whitefish Creek	Wolf Creek
Coleoptera	Hydrophilidae	*Paracymus* sp.						
Coleoptera	Hydrophilidae	*Tropisternus* sp.	3		4	8		
Coleoptera	Scirtidae	*Scirtes* sp.				4		
Collembola		Collembola				1		
Copepoda		Copepoda						
Decapoda	Cambaridae	Cambaridae	4		2			
Decapoda	Cambaridae	*Faxonella* sp.						
Decapoda	Cambaridae	*Procambarus* sp.						5
Diptera	Ceratopogonidae	*Alluaudomyia* sp.				1		
Diptera	Ceratopogonidae	*Atrichopogon* sp.						1
Diptera	Ceratopogonidae	*Bezzia* sp.				1		
Diptera	Ceratopogonidae	*Ceratopogon* sp.				1		
Diptera	Ceratopogonidae	Ceratopogonidae	46		1			
Diptera	Ceratopogonidae	*Palpomyia tibialis*						
Diptera	Ceratopogonidae	*Probezzia* sp.						37
Diptera	Chironomidae	Chironomidae				8		
Diptera	Chironomidae	*Chironomus decorus* gr.						
Diptera	Chironomidae	*Cladotanytarsus mancus* gr.						7
Diptera	Chironomidae	*Cladotanytarsus* sp.						
Diptera	Chironomidae	*Clinotanypus* sp.				1		
Diptera	Chironomidae	*Conchapelopia* sp.						
Diptera	Chironomidae	*Cricotopus tremulus* gr.						15
Diptera	Chironomidae	*Cricotopus trifascia* gr.						
Diptera	Chironomidae	*Cryptochironomus fulvus* gr.					2	
Diptera	Chironomidae	*Cryptochironomus* sp.						2
Diptera	Chironomidae	*Dicrotendipes neomodestus*						
Diptera	Chironomidae	*Dicrotendipes* sp.						2
Diptera	Chironomidae	*Endochironomus* sp.						1
Diptera	Chironomidae	*Labrundinia* sp.						
Diptera	Chironomidae	*Larsia* sp.						1
Diptera	Chironomidae	*Lopescladius* sp.		1				22
Diptera	Chironomidae	*Meropelopia* sp.						
Diptera	Chironomidae	*Orthocladius* sp.				4		3
Diptera	Chironomidae	*Paracladopelma* sp.						
Diptera	Chironomidae	*Paracricotopus* sp.				5		
Diptera	Chironomidae	*Parametriocnemus* sp.						

Order	Family	Taxon	North Fork Wichita River	Saddlers Creek	Salt Fork Red River	White Deer Creek	Whitefish Creek	Wolf Creek
Diptera	Chironomidae	*Paratanytarsus* sp.						
Diptera	Chironomidae	*Paratendipes* nr. *nudisquama*					1	
Diptera	Chironomidae	*Paratendipes* sp.						
Diptera	Chironomidae	*Pedionomus* sp.						
Diptera	Chironomidae	*Pentaneura* sp.				3		48
Diptera	Chironomidae	*Phaenopsectra* sp.						50
Diptera	Chironomidae	*Polypedilum convictum*						84
Diptera	Chironomidae	*Polypedilum illinoense*						7
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. A						
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. B						2
Diptera	Chironomidae	*Polypedilum* sp.				5		
Diptera	Chironomidae	*Procladius* sp.						1
Diptera	Chironomidae	*Pseudochironomus* sp.						2
Diptera	Chironomidae	*Rheocricotopus fusdpes* gr.						47
Diptera	Chironomidae	*Rheocricotopus* sp.				2		
Diptera	Chironomidae	*Rheotanytarsus exiguus* gr.						2
Diptera	Chironomidae	*Rheotanytarsus* sp.				7		
Diptera	Chironomidae	*Robackia* sp.		3				
Diptera	Chironomidae	*Saetheria* sp.				1		
Diptera	Chironomidae	Subfamily: Chironominae	4		1	1		1
Diptera	Chironomidae	Subfamily: Orthocladiinae	63		20			
Diptera	Chironomidae	Subfamily: Tanypodinae			4			
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.						
Diptera	Chironomidae	*Tanytarsus guerlus* gr.						
Diptera	Chironomidae	*Tanytarsus* sp.				4		26
Diptera	Chironomidae	*Telopelopia* sp.						
Diptera	Chironomidae	*Thienemanniella* nr. *xena*						5
Diptera	Culicidae	*Anopheles* sp.				6		
Diptera	Dixidae	*Dixella* sp.						
Diptera	Dolichopodidae	Dolichopodidae						
Diptera	Empididae	*Hemerodromia* sp.						
Diptera	Ephydridae	*Ephydra* sp.	2					
Diptera	Simuliidae	*Simulium* nr. *vittatum*						
Diptera	Simuliidae	*Simulium* sp.			20	31		68
Diptera	Stratiomyidae	*Odontomyia* sp.				2		1
Diptera	Stratiomyidae	*Stratiomys* sp.						

Order	Family	Taxon	North Fork Wichita River	Saddlers Creek	Salt Fork Red River	White Deer Creek	Whitefish Creek	Wolf Creek
Diptera	Tabanidae	*Tabanus* sp.						
Diptera	Tipulidae	*Limnophila* sp.		1				2
Diptera	Tipulidae	*Tipula* sp.						1
Enchytraeida	Enchytraeidae	Enchytraeidae						5
Ephemeroptera	Baetidae	*Baetis ephippiatus*						2
Ephemeroptera	Baetidae	*Callibaetis* sp.			1	32		5
Ephemeroptera	Baetidae	*Fallceon quilleri*			124	37		113
Ephemeroptera	Baetidae	*Paracloeodes* sp.			1			43
Ephemeroptera	Baetidae	*Pseudocloeon* sp.						9
Ephemeroptera	Caenidae	*Brachycercus* sp.						1
Ephemeroptera	Caenidae	*Caenis* sp.			12	4		1
Ephemeroptera	Caenidae	*Caenis* sp. A						6
Ephemeroptera	Caenidae	*Caenis* sp. B		1				7
Ephemeroptera	Caenidae	*Cercobrachys* sp.						
Ephemeroptera	Ephemeridae	*Hexagenia* sp.						4
Ephemeroptera	Heptageniidae	*Heptagenia* sp.				2		1
Ephemeroptera	Isonychiidae	*Isonychia sicca manca*						14
Ephemeroptera	Isonychiidae	*Isonychia* sp.				8		
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr.						612
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.				18		
Ephemeroptera	Leptophlebiidae	*Choroterpes mexicanus*						
Gordioidea	Gordiidae	*Gordius* sp.						6
Hemiptera	Belostomatidae	*Belostoma* sp.				1		
Hemiptera	Belostomatidae	*Lethocerus* sp.				1		
Hemiptera	Corixidae	Corixidae	46			5		1
Hemiptera	Corixidae	*Trichocorixa* sp.	90			1		
Hemiptera	Gerridae	*Gerris* sp.				2		
Hemiptera	Gerridae	*Neogerris* sp.						
Hemiptera	Pleidae	*Paraplea* sp.						
Hemiptera	Veliidae	*Platyvelia* sp.			1			
Hemiptera	Veliidae	*Rhagovelia* sp.			1	4		1
Hemiptera		Hemiptera				3		
Hirudinida	Erpobdellidae	*Mooreobdella microstoma*						1
Hirudinida	Erpobdellidae	*Mooreobdella* sp.						
Hirudinida	Glossiphoniidae	*Placobdella omata*						4
Hoplonemertea	Tetrastemmatidae	*Prostoma rubrum*						1

Order	Family	Taxon	North Fork Wichita River	Saddlers Creek	Salt Fork Red River	White Deer Creek	Whitefish Creek	Wolf Creek
Megaloptera	Sialidae	*Sialis* sp.						
Nematoda		Nematoda						10
Neoophora	Dugesiidae	*Cura* sp.						
Neoophora	Dugesiidae	*Dugesia* sp.				13		
Neoophora	Dugesiidae	*Dugesia tigrina*						44
Odonata	Aeschnidae	*Aeshna* sp.				2		
Odonata	Calopterygidae	*Hetaerina* sp.			1	21		30
Odonata	Coenagrionidae	*Argia* sp.			1	7		
Odonata	Coenagrionidae	*Argia* sp. A						
Odonata	Coenagrionidae	*Argia* sp. B						
Odonata	Coenagrionidae	*Enallagma* sp.	9			13		
Odonata	Coenagrionidae	*Ischnura* sp.	16			1		8
Odonata	Corduliidae	*Macromia* sp.						
Odonata	Gomphidae	*Arigomphus* sp.			1			
Odonata	Gomphidae	*Erpetogomphus* sp.		2	5	1		40
Odonata	Gomphidae	Gomphidae						
Odonata	Gomphidae	*Gomphus externus*						2
Odonata	Gomphidae	*Progomphus obscurus*		1			1	1
Odonata	Gomphidae	*Progomphus* sp.			9	2		
Odonata	Libellulidae	*Brechmorhoga* sp.				1		
Odonata	Libellulidae	*Libellula* sp.				1		
Odonata	Libellulidae	*Sympetrum* sp.						3
Odonata	Macromiidae	Macromiidae						
Oligochaeta		Oligochaeta	2			10		6
Ostracoda		Ostracoda	6					
Plecoptera	Perlidae	*Perlesta* sp.						3
Podocopida	Cyprididae	*Cypridopsis vidua*						1
Podocopida	Cyprididae	*Stenocypris* sp.						1
Podocopida	Cyprididae	*Cypria* sp.						
Trichoptera	Brachycentridae	*Brachycentrus* sp.						1
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.			1	41		46
Trichoptera	Hydropsychidae	*Hydropsyche* sp.						51
Trichoptera	Hydropsychidae	*Smicridea* sp.						103
Trichoptera	Hydroptilidae	*Hydroptila* sp.						11
Trichoptera	Hydroptilidae	*lthytrichia* sp.						
Trichoptera	Hydroptilidae	*Mayatrichia* sp.						

Order	Family	Taxon	North Fork Wichita River	Saddlers Creek	Salt Fork Red River	White Deer Creek	Whitefish Creek	Wolf Creek
Trichoptera	Hydroptilidae	*Oxyethira* sp.						
Trichoptera	Leptoceridae	*Nectopsyche diarina*					1	24
Trichoptera	Leptoceridae	*Nectopsyche* sp.			14	20		1
Trichoptera	Leptoceridae	*Oecetis* sp.				4		
Trichoptera	Philopotamidae	*Chimarra* sp.						1
Trombidiformes	Arrenuridae	*Arrenurus* sp.						
Trombidiformes	Limnesiidae	*Tyrrellia* sp.						1
Trombidiformes	Limnocharidae	*Limnochares* sp.						1
Trombidiformes		Hydracarina (Hydrachnidia)			1	3		1
Tubificida	Naididae	*Bratislavia unidentata*						
Tubificida	Naididae	*Limnodrilus hoffmeisteri*						
Tubificida	Naididae	*Limnodrilus* sp.						67
Tubificida	Naididae	*Nais pardalis*						24
Tubificida	Naididae	*Slavina appendiculata*						5
Veneroida	Corbiculidae	*Corbicula fluminea*						
Veneroida	Pisidiidae	*Pisidium nitidum*						
Veneroida	Pisidiidae	*Pisidium* sp.						
Veneroida	Pisidiidae	*Sphaerium transversum*						2
		Taxa Richness	14	6	30	57	4	85
		Total N Individuals	310	9	251	457	5	1,879
		Number of Samples	n = 1	n = 1	n = 1	n = 3	n = 1	n = 2

Appendix E - 3. Benthic macroinvertebrate taxa list by stream for Ecoregions 27, 29, and 32; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	Auds Creek	Bluff Creek	Clear Creek	Colony Creek	Cottonwood Creek	Cow Bayou	Cowhouse Creek
Amphipoda	Hyalellidae	*Hyalella azteca*		4					
Amphipoda	Hyalellidae	*Hyalella* sp.							
Anthoathecata	Hydridae	*Hydra* sp.				10		1	
Basommatophora	Ancylidae	*Ferrissia fragilis*				23			
Basommatophora	Ancylidae	*Ferrissia rivularis*				51			
Basommatophora	Lymnaeidae	*Fossaria dalli*							
Basommatophora	Lymnaeidae	*Fossaria* sp.							
Basommatophora	Lymnaeidae	*Pseudosuccinea columella*							
Basommatophora	Lymnaeidae	*Pseudosuccinea* sp.							
Basommatophora	Physidae	*Physa* sp.							
Basommatophora	Physidae	*Physella* sp.	2					1	
Basommatophora	Physidae	*Physella virgata*		10		213	50	1	1
Basommatophora	Planorbidae	*Biomphalaria obstructus*							1
Basommatophora	Planorbidae	*Biomphalaria* sp.							
Basommatophora	Planorbidae	*Gyraulus parvus*							
Basommatophora	Planorbidae	*Gyraulus* sp.							
Basommatophora	Planorbidae	*Helisoma anceps*		5					1
Basommatophora	Planorbidae	*Helisoma* sp.							
Basommatophora	Planorbidae	*Planorbella* sp.							
Basommatophora	Planorbidae	*Planorbella trivolvis*	1	1					
Basommatophora	Planorbidae	*Planorbula* sp.							
Coleoptera	Dryopidae	*Helichus* sp.							
Coleoptera	Dryopidae	*Helichus suturalis*					10		1
Coleoptera	Dytiscidae	*Heterosternuta* sp.							
Coleoptera	Dytiscidae	*Hydroporus* sp.	6						
Coleoptera	Dytiscidae	*Neoporus* sp.							
Coleoptera	Dytiscidae	*Uvarus* sp.							
Coleoptera	Elmidae	*Dubiraphia* sp.							
Coleoptera	Elmidae	*Elsianus texanus*							4
Coleoptera	Elmidae	*Heterelmis* sp.							
Coleoptera	Elmidae	*Hexacylloepus ferrugineus*							1
Coleoptera	Elmidae	*Hexacylloepus* sp.							

Order	Family	Taxon	Auds Creek	Bluff Creek	Clear Creek	Colony Creek	Cottonwood Creek	Cow Bayou	Cowhouse Creek
Coleoptera	Elmidae	*Macrelmis* sp.							
Coleoptera	Elmidae	*Macronychus* sp.							
Coleoptera	Elmidae	*Microcylloepus pusillus*		1	1				7
Coleoptera	Elmidae	*Microcylloepus* sp.							
Coleoptera	Elmidae	*Neoelmis caesa*						7	
Coleoptera	Elmidae	*Neoelmis* sp.							
Coleoptera	Elmidae	*Stenelmis cheryl*			4	38		4	24
Coleoptera	Elmidae	*Stenelmis grossa*							
Coleoptera	Elmidae	*Stenelmis occidentalis*			2		19	2	
Coleoptera	Elmidae	*Stenelmis sexlineata*				9	56		
Coleoptera	Elmidae	*Stenelmis* sp.	2					4	
Coleoptera	Gyrinidae	*Gyretes* sp.							
Coleoptera	Haliplidae	*Haliplus* sp.							
Coleoptera	Haliplidae	*Peltodytes* sp.	2						
Coleoptera	Hydraenidae	*Hydraena* sp.							
Coleoptera	Hydraenidae	*Ochthebius* sp.					2		
Coleoptera	Hydrochidae	*Hydrochus* sp.							
Coleoptera	Hydrophilidae	*Berosus infuscatus*							
Coleoptera	Hydrophilidae	*Berosus* sp.	1	3		2		1	
Coleoptera	Hydrophilidae	*Berosus subsignatus*					20		
Coleoptera	Hydrophilidae	*Cymbiodyta* sp.							
Coleoptera	Hydrophilidae	*Enochrus* sp.			8				
Coleoptera	Hydrophilidae	*Hydrophilus* sp.							
Coleoptera	Hydrophilidae	*Laccobius* sp.				2			
Coleoptera	Hydrophilidae	*Tropisternus* sp.		4					
Coleoptera	Lutrochidae	*Lutrochus luteus*							
Coleoptera	Lutrochidae	*Lutrochus* sp.							
Coleoptera	Noteridae	*Pronoterus* sp.							
Coleoptera	Psephenidae	*Psephenus* sp.							
Coleoptera	Psephenidae	*Psephenus texanus*		195					
Coleoptera	Scirtidae	*Cyphon* sp.							
Coleoptera	Scirtidae	*Scirtes* sp.					9		
Coleoptera	Staphylinidae	Staphylinidae						1	
Coleoptera	Staphylinidae	*Stenus* sp.							
Collembola	Isotomidae	*Isotomurus palustris*							
Copepoda		Copepoda							

Order	Family	Taxon	Auds Creek	Bluff Creek	Clear Creek	Colony Creek	Cottonwood Creek	Cow Bayou	Cowhouse Creek
Decapoda	Palaemonidae	*Palaemonetes kadiakensis*							
Decapoda	Palaemonidae	*Palaemonetes* sp.	2						
Diplostraca	Daphniidae	*Ceriodaphnia* sp.							
Diptera	Ceratopogonidae	*Atrichopogon* sp.							1
Diptera	Ceratopogonidae	*Atrichopogon* sp. A				1			
Diptera	Ceratopogonidae	*Atrichopogon* sp. B				2			
Diptera	Ceratopogonidae	*Bezzia* sp.	3	10	1			3	
Diptera	Ceratopogonidae	Ceratopogonidae							
Diptera	Ceratopogonidae	*Dasyhelea* sp.		2					
Diptera	Ceratopogonidae	*Palpomyia tibialis*		43					1
Diptera	Ceratopogonidae	*Probezzia* sp.	1			3	10		17
Diptera	Ceratopogonidae	*Stilobezzia* sp.							
Diptera	Chironomidae	*Ablabesmyia mallochi*							
Diptera	Chironomidae	*Ablabesmyia* sp.							
Diptera	Chironomidae	*Axarus* sp.						1	
Diptera	Chironomidae	Chironomidae	27					31	
Diptera	Chironomidae	*Cladotanytarsus mancus* gr.					7		
Diptera	Chironomidae	*Cladotanytarsus* sp. gr. A						2	
Diptera	Chironomidae	*Conchapelopia* sp.			2	12		1	6
Diptera	Chironomidae	*Corynocera* sp.							
Diptera	Chironomidae	*Corynoneura* nr. *lacustris*		13					
Diptera	Chironomidae	*Corynoneura* nr. *taris*		4					
Diptera	Chironomidae	*Corynoneura* sp.						2	
Diptera	Chironomidae	*Cricotopus bicinctus*					49		
Diptera	Chironomidae	*Cricotopus* sp.							
Diptera	Chironomidae	*Cricotopus tremulus* gr.							
Diptera	Chironomidae	*Cricotopus trifascia* gr.							
Diptera	Chironomidae	*Cryptochironomus fulvus* gr.					35		
Diptera	Chironomidae	*Cryptochironomus* sp.						2	
Diptera	Chironomidae	*Cryptotendipes* sp.							
Diptera	Chironomidae	*Dicrotendipes neomodestus*				24	56		1
Diptera	Chironomidae	*Einfeldia* nr. *pagana*							
Diptera	Chironomidae	*Glyptotendipes* sp. gr. A							1
Diptera	Chironomidae	*Glyptotendipes* sp. gr. B					35		
Diptera	Chironomidae	*Glyptotendipes* sp. gr. C							
Diptera	Chironomidae	*Larsia* sp.			2				

Order	Family	Taxon	Auds Creek	Bluff Creek	Clear Creek	Colony Creek	Cottonwood Creek	Cow Bayou	Cowhouse Creek
Diptera	Chironomidae	*Lauterborniella agrayloides*		4					1
Diptera	Chironomidae	*Lithotanytarsus emarginatus*							
Diptera	Chironomidae	*Lopescladius* sp.							
Diptera	Chironomidae	*Meropelopia* sp.		4	8				
Diptera	Chironomidae	*Micropsectra* sp.							
Diptera	Chironomidae	*Microtendipes pedellus* gr.							
Diptera	Chironomidae	*Nanocladius distinctus*							24
Diptera	Chironomidae	*Nanocladius rectinervis*							
Diptera	Chironomidae	*Nanocladius* sp.							
Diptera	Chironomidae	*Nilotanypus* nr. *dubius*							
Diptera	Chironomidae	*Nilotanypus* sp.							3
Diptera	Chironomidae	*Nilothauma* sp							
Diptera	Chironomidae	*Orthocladius* sp.		43		12	7		1
Diptera	Chironomidae	*Orthocladius* sp. A							
Diptera	Chironomidae	*Orthocladius* sp. B							
Diptera	Chironomidae	*Orthocladius* sp. C							
Diptera	Chironomidae	*Paracladopelma* sp.							
Diptera	Chironomidae	*Paratendipes* nr. *nudisquama*							
Diptera	Chironomidae	*Paratendipes* sp.		4					
Diptera	Chironomidae	*Pentaneura* sp.		9		12	21	8	3
Diptera	Chironomidae	*Phaenopsectra* nr. *flavipes*		4					
Diptera	Chironomidae	*Polypedilum convictum*	3		63	18	63	3	5
Diptera	Chironomidae	*Polypedilum illinoense*			6	55		6	4
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. A							
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. B						8	
Diptera	Chironomidae	*Polypedilum* sp.							
Diptera	Chironomidae	*Procladius* sp.							
Diptera	Chironomidae	*Pseudochironomus* sp.		9			49		4
Diptera	Chironomidae	*Rheocricotopus fuscipes* gr.		17	2				
Diptera	Chironomidae	*Rheocricotopus* sp.						3	
Diptera	Chironomidae	*Rheopelopia* sp.							
Diptera	Chironomidae	*Rheotanytarsus exiguus* gr.	3	107	14	30	98	8	27
Diptera	Chironomidae	*Rheotanytarsus* sp.							
Diptera	Chironomidae	*Saetheria* sp.	1						
Diptera	Chironomidae	Subfamily: Chironominae							
Diptera	Chironomidae	Subfamily: Orthocladiinae							

Order	Family	Taxon	Auds Creek	Bluff Creek	Clear Creek	Colony Creek	Cottonwood Creek	Cow Bayou	Cowhouse Creek
Diptera	Chironomidae	Subfamily: Tanypodinae							
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.		4		85		2	32
Diptera	Chironomidae	*Tanytarsus guerlus* gr.		9				10	
Diptera	Chironomidae	*Tanytarsus* sp.							
Diptera	Chironomidae	*Telopelopia* sp.					7		
Diptera	Chironomidae	*Thienemanniella* nr. *xena*		4			7		
Diptera	Chironomidae	*Thienemanniella* sp.							
Diptera	Chironomidae	*Thienemannimyia* sp.							
Diptera	Chironomidae	Tribe: Chironomini							
Diptera	Chironomidae	*Trissocladius* sp.		4					
Diptera	Dolichopodidae	*Hydrophorus* sp.						1	
Diptera	Empididae	*Hemerodromia* sp.		1	2			8	
Diptera	Psychodidae	*Pericoma* sp.		1					
Diptera	Sciomyzidae	Sciomyzidae							
Diptera	Simuliidae	*Simulium* nr. *argus*							3
Diptera	Simuliidae	*Simulium* nr. *bivittatum*			14				3
Diptera	Simuliidae	*Simulium* nr. *trivittatum*							9
Diptera	Simuliidae	*Simulium* nr. *vittatum*							
Diptera	Simuliidae	*Simulium* sp.	35					4	
Diptera	Stratiomyidae	*Euparyphus* sp.		28					
Diptera	Stratiomyidae	*Myxosargus* sp.							
Diptera	Stratiomyidae	*Nemotelus* sp.						1	
Diptera	Stratiomyidae	*Stratiomyia* sp.							
Diptera	Tabanidae	*Chrysops* sp.							
Diptera	Tabanidae	*Tabanus* sp.		1	2	3	5	7	2
Diptera	Tipulidae	*Eriocera* sp.							1
Diptera	Tipulidae	*Hexatoma* sp.						34	
Diptera	Tipulidae	*Limnophila* sp.							
Diptera	Tipulidae	*Ormosia* sp.							
Diptera	Tipulidae	*Pseudolimnophila* sp.							
Diptera	Tipulidae	*Tipula* sp.							
Ephemeroptera	Baetidae	*Acentrella* sp.						6	
Ephemeroptera	Baetidae	*Baetis ephippiatus*	7						
Ephemeroptera	Baetidae	*Baetis intercalaris*	1		11				
Ephemeroptera	Baetidae	*Baetis pygmaeus*	4						
Ephemeroptera	Baetidae	*Baetis* sp.	77					3	

Order	Family	Taxon	Auds Creek	Bluff Creek	Clear Creek	Colony Creek	Cottonwood Creek	Cow Bayou	Cowhouse Creek
Ephemeroptera	Baetidae	*Baetodes* sp.							
Ephemeroptera	Baetidae	*Callibaetis montanus*							
Ephemeroptera	Baetidae	*Callibaetis* sp.							
Ephemeroptera	Baetidae	*Camelobaetidius mexicanus*				2			
Ephemeroptera	Baetidae	*Camelobaetidius* sp.							
Ephemeroptera	Baetidae	*Cloeon alamance*							
Ephemeroptera	Baetidae	*Fallceon quilleri*	4	25				50	11
Ephemeroptera	Baetidae	*Paracloeodes* sp.						2	
Ephemeroptera	Baetidae	*Plauditus* sp.							
Ephemeroptera	Baetidae	*Procloeon* sp.							
Ephemeroptera	Baetidae	*Pseudocloeon* sp.							
Ephemeroptera	Caenidae	*Brachycercus lacustris*							
Ephemeroptera	Caenidae	*Caenis* sp.	98		1	2	12	3	12
Ephemeroptera	Caenidae	*Caenis* sp. A							
Ephemeroptera	Ephemeridae	*Hexagenia* sp.	8						
Ephemeroptera	Heptageniidae	*Heptagenia* sp.			109			2	4
Ephemeroptera	Heptageniidae	*Leucrocuta* sp.							
Ephemeroptera	Heptageniidae	*Stenacron* sp.	10		1				
Ephemeroptera	Heptageniidae	*Stenonema* sp.			3			1	4
Ephemeroptera	Isonychiidae	*Isonychia sicca manca*		1	177			4	5
Ephemeroptera	Isonychiidae	*Isonychia* sp.							
Ephemeroptera	Leptohyphidae	*Leptohyphes packeri*						14	3
Ephemeroptera	Leptohyphidae	*Leptohyphes* sp.							
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr.		9	12	1		30	27
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.						6	
Ephemeroptera	Leptophlebiidae	*Choroterpes mexicanus*			17		1	14	61
Ephemeroptera	Leptophlebiidae	*Farrodes texanus*							1
Ephemeroptera	Leptophlebiidae	*Neochoroterpes* sp.							
Ephemeroptera	Leptophlebiidae	*Thraulodes gonzalesi*						3	135
Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.							
Ephemeroptera	Leptophlebiidae	*Traverella presidiana*							57
Ephemeroptera	Leptophlebiidae	*Traverella* sp.							
Hemiptera	Belostomatidae	*Belostoma* sp.							
Hemiptera	Belostomatidae	*Lethocerus* sp.							
Hemiptera	Corixidae	*Sigara* sp.							
Hemiptera	Corixidae	*Trichocorixa* sp.							

Order	Family	Taxon	Auds Creek	Bluff Creek	Clear Creek	Colony Creek	Cottonwood Creek	Cow Bayou	Cowhouse Creek
Hemiptera	Gerridae	*Aquarius* sp.							
Hemiptera	Gerridae	Gerridae							
Hemiptera	Gerridae	*Gerris* sp.	2						
Hemiptera	Gerridae	*Rheumatobates* sp.			1				
Hemiptera	Hebridae	*Hebrus* sp.		1					
Hemiptera	Hebridae	*Lipogomphus* sp.	1						
Hemiptera	Hebridae	*Merragata* sp.					1		
Hemiptera	Hydrometridae	*Hydrometra* sp.							
Hemiptera	Mesoveliidae	*Mesovelia* sp.			4				
Hemiptera	Naucoridae	*Ambrysus circumcinctus*							3
Hemiptera	Naucoridae	*Ambrysus lunatus*							
Hemiptera	Naucoridae	*Ambrysus pulchellus*							
Hemiptera	Naucoridae	*Ambrysus* sp.							
Hemiptera	Naucoridae	*Cryphocricos* sp.							
Hemiptera	Naucoridae	*Limnocoris* sp.							
Hemiptera	Nepidae	Nepidae							
Hemiptera	Nepidae	*Ranatra* sp.							
Hemiptera	Veliidae	*Microvelia* sp.							1
Hemiptera	Veliidae	*Rhagovelia* sp.	1					1	
Heterostropha	Valvatidae	*Valvata* sp.	1						
Hirudinea		Hirudinea							
Hirudinida	Erpobdellidae	*Mooreobdella melanostoma*					1		
Hirudinida	Erpobdellidae	*Mooreobdella microstoma*		3					
Hirudinida	Glossiphoniidae	*Helobdella triserialis*		1		2			
Hoplonemertea	Tetrastemmatidae	*Prostoma* sp.							
Hoplonemertea	Tetrastemmatidae	*Prostoma rubrum*		1		12			2
Isopoda		Isopoda						2	
Lepidoptera	Crambidae	*Parargyractis* sp.				8			
Lepidoptera	Crambidae	*Petrophila* sp.							
Lepidoptera	Pyralidae	Pyralidae							
Lepidoptera		Lepidoptera							1
Megaloptera	Corydalidae	*Corydalus cornutus*			1			10	40
Megaloptera	Sialidae	*Sialis* sp.							
Nematoda		Nematoda							
Nematomorpha		Nematomorpha							
Neoophora	Dugesiidae	*Cura* sp.							

Order	Family	Taxon	Auds Creek	Bluff Creek	Clear Creek	Colony Creek	Cottonwood Creek	Cow Bayou	Cowhouse Creek
Neoophora	Dugesiidae	*Dugesia* sp.	2						
Neoophora	Dugesiidae	*Dugesia tigrina*			1			14	2
Neoophora	Typhloplanidae	*Mesostoma* sp.				8	2		
Neotaenioglossa	Amnicolidae	*Amnicola limosa limosa*							
Neotaenioglossa	Amnicolidae	*Amnicola* sp.						1	
Neotaenioglossa	Hydrobiidae	*Cincinnatia cincinnatiensis*							
Neotaenioglossa	Thiaridae	*Melanoides tuberculata*							
Odonata	Aeschnidae	*Basiaeschna* sp.							
Odonata	Aeschnidae	*Boyeria* sp.							
Odonata	Calopterygidae	*Hetaerina* sp.					1		1
Odonata	Coenagrionidae	*Argia* sp.			3			13	47
Odonata	Coenagrionidae	*Argia* sp. A				11	9		
Odonata	Coenagrionidae	*Argia* sp. B				6	4		
Odonata	Coenagrionidae	*Enallagma* sp.	16						
Odonata	Coenagrionidae	*Ischnura* sp.					2		
Odonata	Corduliidae	*Epicordulia* sp.							
Odonata	Corduliidae	*Macromia* sp.						1	
Odonata	Gomphidae	*Erpetogomphus* sp.			2	6		60	6
Odonata	Gomphidae	*Gomphus externus*						1	
Odonata	Gomphidae	*Gomphus* sp.	2						
Odonata	Gomphidae	*Gomphus vastus*			1				
Odonata	Gomphidae	*Hagenius* sp.							
Odonata	Gomphidae	*Progomphus obscurus*							
Odonata	Gomphidae	*Progomphus* sp.						3	
Odonata	Lestidae	*Lestes* sp.							
Odonata	Libellulidae	*Brechmorhoga mendax*						31	1
Odonata	Libellulidae	*Brechmorhoga* sp.						7	
Odonata	Libellulidae	*Orthemis ferruginea*							
Odonata	Libellulidae	*Pachydiplax* sp.							
Odonata	Libellulidae	*Perithemis* sp.							
Oligochaeta		Oligochaeta	2					1	
Opisthopora	Sparganophilidae	*Sparganophilus tamesis*							
Ostracoda		Ostracoda							
Plecoptera	Perlidae	*Neoperla clymene*		8					1
Plecoptera	Perlidae	*Neoperla* sp.							
Plecoptera	Perlidae	*Perlesta placida*		10	1				

Order	Family	Taxon	Auds Creek	Bluff Creek	Clear Creek	Colony Creek	Cottonwood Creek	Cow Bayou	Cowhouse Creek
Plecoptera	Perlidae	*Perlesta* sp.						33	
Plecoptera	Perlodidae	*Hydroperla crosbyi*							
Podocopida	Cyclocyprididae	*Cypria lacustris*							
Podocopida	Cyprididae	*Chlamydotheca arcuata*							1
Podocopida	Cyprididae	*Cypridopsis vidua*		1					
Podocopida	Cyprididae	*Eucypris* sp.							
Podocopida	Cyprididae	*Stenocypris* nr. *malcolmsoni*							
Podocopida	Limnocytheridae	*Limnocythere sancti-patrici*					85		
Trichoptera	Glossosomatidae	*Protoptila* sp.							
Trichoptera	Helicopsychidae	*Helicopsyche* sp.		11	1	1			3
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.	38	1	330	271	1,272	67	79
Trichoptera	Hydropsychidae	*Hydropsyche* sp.	35		14			1	
Trichoptera	Hydropsychidae	*Potamyia flava*			7				
Trichoptera	Hydropsychidae	*Potamyia* sp.							
Trichoptera	Hydropsychidae	*Smicridea* sp.						47	4
Trichoptera	Hydroptilidae	*Hydroptila* sp.		73	1	11	12	3	6
Trichoptera	Hydroptilidae	*Ithytrichia* sp.				26	35		10
Trichoptera	Hydroptilidae	*Neotrichia* sp.		13					1
Trichoptera	Hydroptilidae	*Ochrotrichia* sp.		3					
Trichoptera	Hydroptilidae	*Oxyethira* sp.				8			30
Trichoptera	Leptoceridae	*Nectopsyche candida*			3				
Trichoptera	Leptoceridae	*Nectopsyche diarina*							
Trichoptera	Leptoceridae	*Nectopsyche gracilis*						17	
Trichoptera	Leptoceridae	*Nectopsyche* sp.						6	
Trichoptera	Leptoceridae	*Oecetis* sp.				12		1	
Trichoptera	Leptoceridae	*Oecetis* sp. A							1
Trichoptera	Leptoceridae	*Triaenodes* sp.							
Trichoptera	Odontoceridae	*Marilia flexuosa*		15					
Trichoptera	Odontoceridae	*Marilia* sp.							
Trichoptera	Philopotamidae	*Chimarra* sp.			89	42	8	3	103
Trichoptera	Philopotamidae	*Dolophilodes* sp.							
Trichoptera	Polycentropodidae	*Cernotina* sp.							
Trichoptera	Polycentropodidae	*Neureclipsis* sp.							
Trichoptera	Polycentropodidae	*Polycentropus* sp.		1					
Trichoptera	Polycentropodidae	*Polyplectropus charlesi*							
Trichoptera	Polycentropodidae	*Polyplectropus* sp.							

Order	Family	Taxon	Auds Creek	Bluff Creek	Clear Creek	Colony Creek	Cottonwood Creek	Cow Bayou	Cowhouse Creek
Trichoptera	Psychomyiidae	*Psychomyia* sp.							
Trombidiformes	Hydrodromidae	*Hydrodroma despiciens*						1	
Trombidiformes		Hydracarina (Hydrachnidia)							
Trombidiformes	Hygrobatidae	*Atractides* sp.							
Tubificida	Naididae	*Aulodrilus pigueti*							
Tubificida	Naididae	*Branchiura sowerbyi*				29			
Tubificida	Naididae	*Dero digitata*							
Tubificida	Naididae	*Dero pectinata*							
Tubificida	Naididae	*Dero trifida*		8					
Tubificida	Naididae	*Ilyodrilus templetoni*							
Tubificida	Naididae	*Limnodrilus hoffmeisteri*					137		
Tubificida	Naididae	*Limnodrilus* sp.			1			2	
Tubificida	Naididae	*Limnodrilus udekemianus*							
Tubificida	Naididae	*Nais communis*		2					
Tubificida	Naididae	*Nais pardalis*		8					
Tubificida	Naididae	*Nais variabilis*		6					
Tubificida	Naididae	*Pristina aequiseta*		2					
Tubificida	Naididae	*Pristina americana*					11		1
Tubificida	Naididae	*Pristina foreli*							
Tubificida	Naididae	*Pristina leidyi*		35					1
Tubificida	Naididae	*Pristina sima*		4					
Tubificida	Naididae	*Slavina appendiculata*							
Unionida	Unionidae	*Strophitus undulatus*							
Veneroida	Corbiculidae	*Corbicula fluminea*				13		35	
Veneroida	Pisidiidae	*Eupera cubensis*			12			1	4
Veneroida	Pisidiidae	*Pisidium casertanum*							
Veneroida	Pisidiidae	*Pisidium nitidum*	1						
Veneroida	Pisidiidae	*Pisidium* sp.							
Veneroida	Pisidiidae	*Sphaerium* sp.	4						
Veneroida	Pisidiidae	*Sphaerium transversum*				117			
		Taxa Richness	34	54	40	40	37	69	64
		Total N Individuals	403	790	934	1,193	2,208	667	858
		Number of Samples	n = 3	n = 1	n = 1	n = 1	n = 1	n = 4	n = 2

Appendix E – 3 CONT. Benthic macroinvertebrate taxa list by stream for Ecoregions 27, 29, and 32; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	Deadman Creek	Deer Creek	Elm Creek	Geronimo Creek	Ioni Creek	Lelia Lake Creek	Neils Creek
Amphipoda	Hyalellidae	*Hyalella azteca*	13			4	19		
Amphipoda	Hyalellidae	*Hyalella* sp.	72						
Anthoathecata	Hydridae	*Hydra* sp.							
Basommatophora	Ancylidae	*Ferrissia fragilis*							
Basommatophora	Ancylidae	*Ferrissia rivularis*							
Basommatophora	Lymnaeidae	*Fossaria dalli*							
Basommatophora	Lymnaeidae	*Fossaria* sp.							
Basommatophora	Lymnaeidae	*Pseudosuccinea columella*							1
Basommatophora	Lymnaeidae	*Pseudosuccinea* sp.							
Basommatophora	Physidae	*Physa* sp.	8						
Basommatophora	Physidae	*Physella* sp.	13			1			
Basommatophora	Physidae	*Physella virgata*	16		61		2	4	
Basommatophora	Planorbidae	*Biomphalaria obstructus*							1
Basommatophora	Planorbidae	*Biomphalaria* sp.	2						
Basommatophora	Planorbidae	*Gyraulus parvus*						2	
Basommatophora	Planorbidae	*Gyraulus* sp.							
Basommatophora	Planorbidae	*Helisoma anceps*							
Basommatophora	Planorbidae	*Helisoma* sp.							
Basommatophora	Planorbidae	*Planorbella* sp.				1			
Basommatophora	Planorbidae	*Planorbella trivolvis*							
Basommatophora	Planorbidae	*Planorbula* sp.							
Coleoptera	Dryopidae	*Helichus* sp.	3			1			
Coleoptera	Dryopidae	*Helichus suturalis*			11			3	
Coleoptera	Dytiscidae	*Heterosternuta* sp.	1						
Coleoptera	Dytiscidae	*Hydroporus* sp.							
Coleoptera	Dytiscidae	*Neoporus* sp.							
Coleoptera	Dytiscidae	*Uvarus* sp.							
Coleoptera	Elmidae	*Dubiraphia* sp.	1						
Coleoptera	Elmidae	*Elsianus texanus*				4			
Coleoptera	Elmidae	*Heterelmis* sp.	3			15			
Coleoptera	Elmidae	*Hexacylloepus ferrugineus*			309	60			1
Coleoptera	Elmidae	*Hexacylloepus* sp.	13			196			

Order	Family	Taxon	Deadman Creek	Deer Creek	Elm Creek	Geronimo Creek	Ioni Creek	Lelia Lake Creek	Neils Creek
Coleoptera	Elmidae	*Macrelmis* sp.				35			
Coleoptera	Elmidae	*Macronychus* sp.				11			
Coleoptera	Elmidae	*Microcylloepus pusillus*	3		198	4			
Coleoptera	Elmidae	*Microcylloepus* sp.	13			53			3
Coleoptera	Elmidae	*Neoelmis caesa*							
Coleoptera	Elmidae	*Neoelmis* sp.							
Coleoptera	Elmidae	*Stenelmis cheryl*			369				3
Coleoptera	Elmidae	*Stenelmis grossa*							
Coleoptera	Elmidae	*Stenelmis occidentalis*	328	2	185	1	11		1
Coleoptera	Elmidae	*Stenelmis sexlineata*				1	11		
Coleoptera	Elmidae	*Stenelmis* sp.	137	3		17			
Coleoptera	Gyrinidae	*Gyretes* sp.		1					
Coleoptera	Haliplidae	*Haliplus* sp.							
Coleoptera	Haliplidae	*Peltodytes* sp.				3			
Coleoptera	Hydraenidae	*Hydraena* sp.							
Coleoptera	Hydraenidae	*Ochthebius* sp.	8		1				
Coleoptera	Hydrochidae	*Hydrochus* sp.							
Coleoptera	Hydrophilidae	*Berosus infuscatus*							
Coleoptera	Hydrophilidae	*Berosus* sp.					38		
Coleoptera	Hydrophilidae	*Berosus subsignatus*	36						
Coleoptera	Hydrophilidae	*Cymbiodyta* sp.							
Coleoptera	Hydrophilidae	*Enochrus* sp.							
Coleoptera	Hydrophilidae	*Hydrophilus* sp.				1			
Coleoptera	Hydrophilidae	*Laccobius* sp.							
Coleoptera	Hydrophilidae	*Tropisternus* sp.	2						
Coleoptera	Lutrochidae	*Lutrochus luteus*							
Coleoptera	Lutrochidae	*Lutrochus* sp.				1			
Coleoptera	Noteridae	*Pronoterus* sp.					2		
Coleoptera	Psephenidae	*Psephenus* sp.				7			
Coleoptera	Psephenidae	*Psephenus texanus*							
Coleoptera	Scirtidae	*Cyphon* sp.				1			
Coleoptera	Scirtidae	*Scirtes* sp.	1			3			
Coleoptera	Staphylinidae	Staphylinidae							
Coleoptera	Staphylinidae	*Stenus* sp.				2			
Collembola	Isotomidae	*Isotomurus palustris*			1				
Copepoda		Copepoda							

Order	Family	Taxon	Deadman Creek	Deer Creek	Elm Creek	Geronimo Creek	Ioni Creek	Lelia Lake Creek	Neils Creek
Decapoda	Palaemonidae	*Palaemonetes kadiakensis*	1						
Decapoda	Palaemonidae	*Palaemonetes* sp.							
Diplostraca	Daphniidae	*Ceriodaphnia* sp.					3		
Diptera	Ceratopogonidae	*Atrichopogon* sp.							
Diptera	Ceratopogonidae	*Atrichopogon* sp. A							
Diptera	Ceratopogonidae	*Atrichopogon* sp. B							
Diptera	Ceratopogonidae	*Bezzia* sp.	1				15		
Diptera	Ceratopogonidae	Ceratopogonidae							
Diptera	Ceratopogonidae	*Dasyhelea* sp.							
Diptera	Ceratopogonidae	*Palpomyia tibialis*					88		
Diptera	Ceratopogonidae	*Probezzia* sp.				1	7		
Diptera	Ceratopogonidae	*Stilobezzia* sp.							
Diptera	Chironomidae	*Ablabesmyia mallochi*			14		10		
Diptera	Chironomidae	*Ablabesmyia* sp.							
Diptera	Chironomidae	*Axarus* sp.							
Diptera	Chironomidae	Chironomidae	35	28		7			
Diptera	Chironomidae	*Cladotanytarsus mancus* gr.							
Diptera	Chironomidae	*Cladotanytarsus* sp. gr. A					1		
Diptera	Chironomidae	*Conchapelopia* sp.	107		95				
Diptera	Chironomidae	*Corynocera* sp.							
Diptera	Chironomidae	*Corynoneura* nr. *lacustris*							
Diptera	Chironomidae	*Corynoneura* nr. *taris*							
Diptera	Chironomidae	*Corynoneura* sp.							
Diptera	Chironomidae	*Cricotopus bicinctus*	43			2			
Diptera	Chironomidae	*Cricotopus* sp.				2			
Diptera	Chironomidae	*Cricotopus tremulus* gr.						14	
Diptera	Chironomidae	*Cricotopus trifascia* gr.							
Diptera	Chironomidae	*Cryptochironomus fulvus* gr.							
Diptera	Chironomidae	*Cryptochironomus* sp.							
Diptera	Chironomidae	*Cryptotendipes* sp.					1		
Diptera	Chironomidae	*Dicrotendipes neomodestus*	21		108		1		
Diptera	Chironomidae	*Einfeldia* nr. *pagana*							
Diptera	Chironomidae	*Glyptotendipes* sp. gr. A			14				
Diptera	Chironomidae	*Glyptotendipes* sp. gr. B							
Diptera	Chironomidae	*Glyptotendipes* sp. gr. C			27				
Diptera	Chironomidae	*Larsia* sp.							

Order	Family	Taxon	Deadman Creek	Deer Creek	Elm Creek	Geronimo Creek	Ioni Creek	Lelia Lake Creek	Neils Creek
Diptera	Chironomidae	*Lauterborniella agrayloides*							
Diptera	Chironomidae	*Lithotanytarsus emarginatus*							
Diptera	Chironomidae	*Lopescladius* sp.							
Diptera	Chironomidae	*Meropelopia* sp.		33				3	
Diptera	Chironomidae	*Micropsectra* sp.							
Diptera	Chironomidae	*Microtendipes pedellus* gr.							
Diptera	Chironomidae	*Nanocladius distinctus*							
Diptera	Chironomidae	*Nanocladius rectinervis*							1
Diptera	Chironomidae	*Nanocladius* sp.							
Diptera	Chironomidae	*Nilotanypus* nr. *dubius*		1					
Diptera	Chironomidae	*Nilotanypus* sp.							
Diptera	Chironomidae	*Nilothauma* sp							
Diptera	Chironomidae	*Orthocladius* sp.	54		14				
Diptera	Chironomidae	*Orthocladius* sp. A				12			
Diptera	Chironomidae	*Orthocladius* sp. B				4			
Diptera	Chironomidae	*Orthocladius* sp. C				2			
Diptera	Chironomidae	*Paracladopelma* sp.							
Diptera	Chironomidae	*Paratendipes* nr. *nudisquama*		2					
Diptera	Chironomidae	*Paratendipes* sp.							
Diptera	Chironomidae	*Pentaneura* sp.	11	1					
Diptera	Chironomidae	*Phaenopsectra* nr. *flavipes*							
Diptera	Chironomidae	*Polypedilum convictum*	150	51	176			1	1
Diptera	Chironomidae	*Polypedilum illinoense*		2				1	
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. A		1					
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. B	11		14		1		
Diptera	Chironomidae	*Polypedilum* sp.							
Diptera	Chironomidae	*Procladius* sp.					7		
Diptera	Chironomidae	*Pseudochironomus* sp.			54	8	19	1	
Diptera	Chironomidae	*Rheocricotopus fuscipes* gr.				2			
Diptera	Chironomidae	*Rheocricotopus* sp.							
Diptera	Chironomidae	*Rheopelopia* sp.							
Diptera	Chironomidae	*Rheotanytarsus exiguus* gr.		3				7	6
Diptera	Chironomidae	*Rheotanytarsus* sp.							
Diptera	Chironomidae	*Saetheria* sp.		2				1	
Diptera	Chironomidae	Subfamily: Chironominae	2						14
Diptera	Chironomidae	Subfamily: Orthocladiinae	1						2

Order	Family	Taxon	Deadman Creek	Deer Creek	Elm Creek	Geronimo Creek	Ioni Creek	Lelia Lake Creek	Neils Creek
Diptera	Chironomidae	Subfamily: Tanypodinae							2
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.		2	14		4		
Diptera	Chironomidae	*Tanytarsus guerlus* gr.							
Diptera	Chironomidae	*Tanytarsus* sp.							
Diptera	Chironomidae	*Telopelopia* sp.							
Diptera	Chironomidae	*Thienemanniella* nr. *xena*							
Diptera	Chironomidae	*Thienemanniella* sp.							
Diptera	Chironomidae	*Thienemannimyia* sp.							2
Diptera	Chironomidae	Tribe: Chironomini							
Diptera	Chironomidae	*Trissocladius* sp.							
Diptera	Dolichopodidae	*Hydrophorus* sp.							
Diptera	Empididae	*Hemerodromia* sp.				4			
Diptera	Psychodidae	*Pericoma* sp.							
Diptera	Sciomyzidae	Sciomyzidae							
Diptera	Simuliidae	*Simulium* nr. *argus*							
Diptera	Simuliidae	*Simulium* nr. *bivittatum*		263					7
Diptera	Simuliidae	*Simulium* nr. *trivittatum*							
Diptera	Simuliidae	*Simulium* nr. *vittatum*						4	
Diptera	Simuliidae	*Simulium* sp.		31		1			15
Diptera	Stratiomyidae	*Euparyphus* sp.							
Diptera	Stratiomyidae	*Myxosargus* sp.							
Diptera	Stratiomyidae	*Nemotelus* sp.							
Diptera	Stratiomyidae	*Stratiomyia* sp.	1						
Diptera	Tabanidae	*Chrysops* sp.							
Diptera	Tabanidae	*Tabanus* sp.			2	2			7
Diptera	Tipulidae	*Eriocera* sp.							
Diptera	Tipulidae	*Hexatoma* sp.							2
Diptera	Tipulidae	*Limnophila* sp.						5	
Diptera	Tipulidae	*Ormosia* sp.							
Diptera	Tipulidae	*Pseudolimnophila* sp.							
Diptera	Tipulidae	*Tipula* sp.							
Ephemeroptera	Baetidae	*Acentrella* sp.		17					
Ephemeroptera	Baetidae	*Baetis ephippiatus*		1					
Ephemeroptera	Baetidae	*Baetis intercalaris*							
Ephemeroptera	Baetidae	*Baetis pygmaeus*							
Ephemeroptera	Baetidae	*Baetis* sp.			2	6			

Order	Family	Taxon	Deadman Creek	Deer Creek	Elm Creek	Geronimo Creek	Ioni Creek	Lelia Lake Creek	Neils Creek
Ephemeroptera	Baetidae	*Baetodes* sp.				1			
Ephemeroptera	Baetidae	*Callibaetis montanus*					32		
Ephemeroptera	Baetidae	*Callibaetis* sp.				1			
Ephemeroptera	Baetidae	*Camelobaetidius mexicanus*			4	11			2
Ephemeroptera	Baetidae	*Camelobaetidius* sp.	13			1			3
Ephemeroptera	Baetidae	*Cloeon alamance*					6		
Ephemeroptera	Baetidae	*Fallceon quilleri*	14	14	19	2		49	5
Ephemeroptera	Baetidae	*Paracloeodes* sp.							
Ephemeroptera	Baetidae	*Plauditus* sp.							
Ephemeroptera	Baetidae	*Procloeon* sp.							
Ephemeroptera	Baetidae	*Pseudocloeon* sp.							
Ephemeroptera	Caenidae	*Brachycercus lacustris*					12		
Ephemeroptera	Caenidae	*Caenis* sp.		3	27	1	239	1	1
Ephemeroptera	Caenidae	*Caenis* sp. A							
Ephemeroptera	Ephemeridae	*Hexagenia* sp.							
Ephemeroptera	Heptageniidae	*Heptagenia* sp.		7					1
Ephemeroptera	Heptageniidae	*Leucrocuta* sp.	2	3					
Ephemeroptera	Heptageniidae	*Stenacron* sp.							
Ephemeroptera	Heptageniidae	*Stenonema* sp.			2		61		8
Ephemeroptera	Isonychiidae	*Isonychia sicca manca*			5	3			2
Ephemeroptera	Isonychiidae	*Isonychia* sp.	6	15		57			6
Ephemeroptera	Leptohyphidae	*Leptohyphes packeri*				2			
Ephemeroptera	Leptohyphidae	*Leptohyphes* sp.				22			
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr.	2	10	444	13		2	1
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.	105	17		11			3
Ephemeroptera	Leptophlebiidae	*Choroterpes mexicanus*		7	104				19
Ephemeroptera	Leptophlebiidae	*Farrodes texanus*							
Ephemeroptera	Leptophlebiidae	*Neochoroterpes* sp.	15	4					25
Ephemeroptera	Leptophlebiidae	*Thraulodes gonzalesi*		1		9			3
Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.				104			13
Ephemeroptera	Leptophlebiidae	*Traverella presidiana*		1		3			
Ephemeroptera	Leptophlebiidae	*Traverella* sp.				129			4
Hemiptera	Belostomatidae	*Belostoma* sp.							
Hemiptera	Belostomatidae	*Lethocerus* sp.	2						
Hemiptera	Corixidae	*Sigara* sp.							
Hemiptera	Corixidae	*Trichocorixa* sp.							

Order	Family	Taxon	Deadman Creek	Deer Creek	Elm Creek	Geronimo Creek	Ioni Creek	Lelia Lake Creek	Neils Creek
Hemiptera	Gerridae	*Aquarius* sp.							
Hemiptera	Gerridae	Gerridae							
Hemiptera	Gerridae	*Gerris* sp.							
Hemiptera	Gerridae	*Rheumatobates* sp.							
Hemiptera	Hebridae	*Hebrus* sp.							
Hemiptera	Hebridae	*Lipogomphus* sp.							
Hemiptera	Hebridae	*Merragata* sp.							
Hemiptera	Hydrometridae	*Hydrometra* sp.				1			
Hemiptera	Mesoveliidae	*Mesovelia* sp.							1
Hemiptera	Naucoridae	*Ambrysus circumcinctus*			26	1			
Hemiptera	Naucoridae	*Ambrysus lunatus*			5				
Hemiptera	Naucoridae	*Ambrysus pulchellus*							
Hemiptera	Naucoridae	*Ambrysus* sp.				29			9
Hemiptera	Naucoridae	*Cryphocricos* sp.				51			
Hemiptera	Naucoridae	*Limnocoris* sp.				20			
Hemiptera	Nepidae	Nepidae							
Hemiptera	Nepidae	*Ranatra* sp.	1						
Hemiptera	Veliidae	*Microvelia* sp.	8		2				
Hemiptera	Veliidae	*Rhagovelia* sp.				17			
Heterostropha	Valvatidae	*Valvata* sp.							
Hirudinea		Hirudinea	1						
Hirudinida	Erpobdellidae	*Mooreobdella melanostoma*							
Hirudinida	Erpobdellidae	*Mooreobdella microstoma*	4				2		
Hirudinida	Glossiphoniidae	*Helobdella triserialis*					1		
Hoplonemertea	Tetrastemmatidae	*Prostoma* sp.							
Hoplonemertea	Tetrastemmatidae	*Prostoma rubrum*				2	8		
Isopoda		Isopoda							
Lepidoptera	Crambidae	*Parargyractis* sp.	27		26	4			
Lepidoptera	Crambidae	*Petrophila* sp.	3						
Lepidoptera	Pyralidae	Pyralidae							1
Lepidoptera		Lepidoptera							
Megaloptera	Corydalidae	*Corydalus cornutus*		3	37	10			2
Megaloptera	Sialidae	*Sialis* sp.					1		
Nematoda		Nematoda					9		
Nematomorpha		Nematomorpha							
Neoophora	Dugesiidae	*Cura* sp.	13						2

Order	Family	Taxon	Deadman Creek	Deer Creek	Elm Creek	Geronimo Creek	Ioni Creek	Lelia Lake Creek	Neils Creek
Neoophora	Dugesiidae	*Dugesia* sp.	10			2			
Neoophora	Dugesiidae	*Dugesia tigrina*	150		82	4	21		1
Neoophora	Typhloplanidae	*Mesostoma* sp.							
Neotaenioglossa	Amnicolidae	*Amnicola limosa limosa*		1					
Neotaenioglossa	Amnicolidae	*Amnicola* sp.							
Neotaenioglossa	Hydrobiidae	*Cincinnatia cincinnatiensis*				2			1
Neotaenioglossa	Thiaridae	*Melanoides tuberculata*				10			
Odonata	Aeschnidae	*Basiaeschna* sp.							
Odonata	Aeschnidae	*Boyeria* sp.							
Odonata	Calopterygidae	*Hetaerina* sp.	15			5		2	8
Odonata	Coenagrionidae	*Argia* sp.	81	3	56	17	18		35
Odonata	Coenagrionidae	*Argia* sp. A	20						
Odonata	Coenagrionidae	*Argia* sp. B	20						
Odonata	Coenagrionidae	*Enallagma* sp.	1			1			
Odonata	Coenagrionidae	*Ischnura* sp.							
Odonata	Corduliidae	*Epicordulia* sp.							
Odonata	Corduliidae	*Macromia* sp.							
Odonata	Gomphidae	*Erpetogomphus* sp.	2	1	3	14			
Odonata	Gomphidae	*Gomphus externus*							
Odonata	Gomphidae	*Gomphus* sp.							
Odonata	Gomphidae	*Gomphus vastus*							
Odonata	Gomphidae	*Hagenius* sp.				1			
Odonata	Gomphidae	*Progomphus obscurus*						2	
Odonata	Gomphidae	*Progomphus* sp.							
Odonata	Lestidae	*Lestes* sp.					1		
Odonata	Libellulidae	*Brechmorhoga mendax*				1			
Odonata	Libellulidae	*Brechmorhoga* sp.		1		10			5
Odonata	Libellulidae	*Orthemis ferruginea*					1		
Odonata	Libellulidae	*Pachydiplax* sp.							
Odonata	Libellulidae	*Perithemis* sp.				5			
Oligochaeta		Oligochaeta	1	3		7			
Opisthopora	Sparganophilidae	*Sparganophilus tamesis*	5						
Ostracoda		Ostracoda	2						
Plecoptera	Perlidae	*Neoperla clymene*							
Plecoptera	Perlidae	*Neoperla* sp.							
Plecoptera	Perlidae	*Perlesta placida*							

Order	Family	Taxon	Deadman Creek	Deer Creek	Elm Creek	Geronimo Creek	Ioni Creek	Lelia Lake Creek	Neils Creek
Plecoptera	Perlidae	*Perlesta* sp.		6					
Plecoptera	Perlodidae	*Hydroperla crosbyi*		2					
Podocopida	Cyclocyprididae	*Cypria lacustris*			9				
Podocopida	Cyprididae	*Chlamydotheca arcuata*					15		
Podocopida	Cyprididae	*Cypridopsis vidua*	66						
Podocopida	Cyprididae	*Eucypris* sp.							
Podocopida	Cyprididae	*Stenocypris* nr. *malcolmsoni*					6		
Podocopida	Limnocytheridae	*Limnocythere sancti-patrici*	110		44				
Trichoptera	Glossosomatidae	*Protoptila* sp.	2						
Trichoptera	Helicopsychidae	*Helicopsyche* sp.	24		3	3			
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.	773	478	1,152	2	7		3
Trichoptera	Hydropsychidae	*Hydropsyche* sp.	166		221	12			10
Trichoptera	Hydropsychidae	*Potamyia flava*							
Trichoptera	Hydropsychidae	*Potamyia* sp.		2					
Trichoptera	Hydropsychidae	*Smicridea* sp.	3	38	133	24			16
Trichoptera	Hydroptilidae	*Hydroptila* sp.	54			30		2	
Trichoptera	Hydroptilidae	*Ithytrichia* sp.	5	1	44				
Trichoptera	Hydroptilidae	*Neotrichia* sp.							1
Trichoptera	Hydroptilidae	*Ochrotrichia* sp.	1						
Trichoptera	Hydroptilidae	*Oxyethira* sp.					1		
Trichoptera	Leptoceridae	*Nectopsyche candida*							
Trichoptera	Leptoceridae	*Nectopsyche diarina*						15	
Trichoptera	Leptoceridae	*Nectopsyche gracilis*							
Trichoptera	Leptoceridae	*Nectopsyche* sp.							
Trichoptera	Leptoceridae	*Oecetis* sp.	20		17		92		
Trichoptera	Leptoceridae	*Oecetis* sp. A							
Trichoptera	Leptoceridae	*Triaenodes* sp.							
Trichoptera	Odontoceridae	*Marilia flexuosa*							
Trichoptera	Odontoceridae	*Marilia* sp.							
Trichoptera	Philopotamidae	*Chimarra* sp.		3	44	43			77
Trichoptera	Philopotamidae	*Dolophilodes* sp.				3			
Trichoptera	Polycentropodidae	*Cernotina* sp.							
Trichoptera	Polycentropodidae	*Neureclipsis* sp.				1			
Trichoptera	Polycentropodidae	*Polycentropus* sp.					14		
Trichoptera	Polycentropodidae	*Polyplectropus charlesi*				6			
Trichoptera	Polycentropodidae	*Polyplectropus* sp.				2			

Order	Family	Taxon	Deadman Creek	Deer Creek	Elm Creek	Geronimo Creek	Ioni Creek	Lelia Lake Creek	Neils Creek
Trichoptera	Psychomyiidae	*Psychomyia* sp.				3			
Trombidiformes	Hydrodromidae	*Hydrodroma despiciens*							
Trombidiformes		Hydracarina (Hydrachnidia)					2		
Trombidiformes	Hygrobatidae	*Atractides* sp.							
Tubificida	Naididae	*Aulodrilus pigueti*	14				46		
Tubificida	Naididae	*Branchiura sowerbyi*			65		29		
Tubificida	Naididae	*Dero digitata*	41				36		
Tubificida	Naididae	*Dero pectinata*	14						
Tubificida	Naididae	*Dero trifida*	41				5		
Tubificida	Naididae	*Ilyodrilus templetoni*					10		
Tubificida	Naididae	*Limnodrilus hoffmeisteri*	151						
Tubificida	Naididae	*Limnodrilus* sp.			31		41		
Tubificida	Naididae	*Limnodrilus udekemianus*	110						
Tubificida	Naididae	*Nais communis*							
Tubificida	Naididae	*Nais pardalis*							
Tubificida	Naididae	*Nais variabilis*					5		
Tubificida	Naididae	*Pristina aequiseta*							
Tubificida	Naididae	*Pristina americana*	137				10		
Tubificida	Naididae	*Pristina foreli*							
Tubificida	Naididae	*Pristina leidyi*	27						
Tubificida	Naididae	*Pristina sima*							
Tubificida	Naididae	*Slavina appendiculata*					36		
Unionida	Unionidae	*Strophitus undulatus*			1				
Veneroida	Corbiculidae	*Corbicula fluminea*	10	2		24			4
Veneroida	Pisidiidae	*Eupera cubensis*							
Veneroida	Pisidiidae	*Pisidium casertanum*							
Veneroida	Pisidiidae	*Pisidium nitidum*						1	
Veneroida	Pisidiidae	*Pisidium* sp.							
Veneroida	Pisidiidae	*Sphaerium* sp.							
Veneroida	Pisidiidae	*Sphaerium transversum*	2,954	1	105				
		Taxa Richness	79	44	48	85	48	20	48
		Total N Individuals	6,357	1,071	4,380	1,212	1,007	120	341
		Number of Samples	n = 4	n = 3	n = 1	n = 6	n = 1	n = 1	n = 2

Appendix E – 3 CONT. Benthic macroinvertebrate taxa list by stream for Ecoregions 27, 29, and 32; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	Reese Creek	Rocky Creek	South Fork Rocky Creek	Steele Creek	Sweetwater Creek	Willis Creek	Wilson Creek
Amphipoda	Hyalellidae	*Hyalella azteca*		3	2			42	3
Amphipoda	Hyalellidae	*Hyalella* sp.					8		
Anthoathecata	Hydridae	*Hydra* sp.							
Basommatophora	Ancylidae	*Ferrissia fragilis*							
Basommatophora	Ancylidae	*Ferrissia rivularis*						3	
Basommatophora	Lymnaeidae	*Fossaria dalli*		3					
Basommatophora	Lymnaeidae	*Fossaria* sp.						1	
Basommatophora	Lymnaeidae	*Pseudosuccinea columella*							
Basommatophora	Lymnaeidae	*Pseudosuccinea* sp.					1		
Basommatophora	Physidae	*Physa* sp.					10		
Basommatophora	Physidae	*Physella* sp.		16	2			21	1
Basommatophora	Physidae	*Physella virgata*		10		11	2		
Basommatophora	Planorbidae	*Biomphalaria obstructus*		23				2	
Basommatophora	Planorbidae	*Biomphalaria* sp.							
Basommatophora	Planorbidae	*Gyraulus parvus*							
Basommatophora	Planorbidae	*Gyraulus* sp.		26					
Basommatophora	Planorbidae	*Helisoma anceps*		18		1			
Basommatophora	Planorbidae	*Helisoma* sp.		12	1				
Basommatophora	Planorbidae	*Planorbella* sp.							
Basommatophora	Planorbidae	*Planorbella trivolvis*							
Basommatophora	Planorbidae	*Planorbula* sp.							1
Coleoptera	Dryopidae	*Helichus* sp.						2	
Coleoptera	Dryopidae	*Helichus suturalis*		1			6		
Coleoptera	Dytiscidae	*Heterosternuta* sp.							
Coleoptera	Dytiscidae	*Hydroporus* sp.							
Coleoptera	Dytiscidae	*Neoporus* sp.					15		
Coleoptera	Dytiscidae	*Uvarus* sp.					1		1
Coleoptera	Elmidae	*Dubiraphia* sp.							
Coleoptera	Elmidae	*Elsianus texanus*							
Coleoptera	Elmidae	*Heterelmis* sp.		1			2		
Coleoptera	Elmidae	*Hexacylloepus ferrugineus*		4					
Coleoptera	Elmidae	*Hexacylloepus* sp.						2	

Order	Family	Taxon	Reese Creek	Rocky Creek	South Fork Rocky Creek	Steele Creek	Sweetwater Creek	Willis Creek	Wilson Creek
Coleoptera	Elmidae	*Macrelmis* sp.		1				1	
Coleoptera	Elmidae	*Macronychus* sp.							
Coleoptera	Elmidae	*Microcylloepus pusillus*		8			12	5	
Coleoptera	Elmidae	*Microcylloepus* sp.	1	11	2			3	
Coleoptera	Elmidae	*Neoelmis caesa*		9				1	
Coleoptera	Elmidae	*Neoelmis* sp.						2	
Coleoptera	Elmidae	*Stenelmis cheryl*		6		1		10	
Coleoptera	Elmidae	*Stenelmis grossa*					83		
Coleoptera	Elmidae	*Stenelmis occidentalis*						3	
Coleoptera	Elmidae	*Stenelmis sexlineata*				3			2
Coleoptera	Elmidae	*Stenelmis* sp.	3	8	4			14	6
Coleoptera	Gyrinidae	*Gyretes* sp.						1	
Coleoptera	Haliplidae	*Haliplus* sp.		8					
Coleoptera	Haliplidae	*Peltodytes* sp.		1			1		
Coleoptera	Hydraenidae	*Hydraena* sp.				1			
Coleoptera	Hydraenidae	*Ochthebius* sp.							
Coleoptera	Hydrochidae	*Hydrochus* sp.		1				1	
Coleoptera	Hydrophilidae	*Berosus infuscatus*					4		
Coleoptera	Hydrophilidae	*Berosus* sp.		6	1		10	6	3
Coleoptera	Hydrophilidae	*Berosus subsignatus*				6			
Coleoptera	Hydrophilidae	*Cymbiodyta* sp.		1					
Coleoptera	Hydrophilidae	*Enochrus* sp.		2					
Coleoptera	Hydrophilidae	*Hydrophilus* sp.							
Coleoptera	Hydrophilidae	*Laccobius* sp.							
Coleoptera	Hydrophilidae	*Tropisternus* sp.					4	1	
Coleoptera	Lutrochidae	*Lutrochus luteus*		2					
Coleoptera	Lutrochidae	*Lutrochus* sp.	2						
Coleoptera	Noteridae	*Pronoterus* sp.							
Coleoptera	Psephenidae	*Psephenus* sp.						1	
Coleoptera	Psephenidae	*Psephenus texanus*				1		1	
Coleoptera	Scirtidae	*Cyphon* sp.				1		11	
Coleoptera	Scirtidae	*Scirtes* sp.						1	5
Coleoptera	Staphylinidae	Staphylinidae						1	
Coleoptera	Staphylinidae	*Stenus* sp.							
Collembola	Isotomidae	*Isotomurus palustris*							
Copepoda		Copepoda					1		

Order	Family	Taxon	Reese Creek	Rocky Creek	South Fork Rocky Creek	Steele Creek	Sweetwater Creek	Willis Creek	Wilson Creek
Decapoda	Palaemonidae	*Palaemonetes kadiakensis*							
Decapoda	Palaemonidae	*Palaemonetes* sp.							
Diplostraca	Daphniidae	*Ceriodaphnia* sp.							
Diptera	Ceratopogonidae	*Atrichopogon* sp.							
Diptera	Ceratopogonidae	*Atrichopogon* sp. A							
Diptera	Ceratopogonidae	*Atrichopogon* sp. B							
Diptera	Ceratopogonidae	*Bezzia* sp.							1
Diptera	Ceratopogonidae	Ceratopogonidae					6		
Diptera	Ceratopogonidae	*Dasyhelea* sp.							
Diptera	Ceratopogonidae	*Palpomyia tibialis*		3		2		1	
Diptera	Ceratopogonidae	*Probezzia* sp.		13	5			2	1
Diptera	Ceratopogonidae	*Stilobezzia* sp.					1		
Diptera	Chironomidae	*Ablabesmyia mallochi*							
Diptera	Chironomidae	*Ablabesmyia* sp.		1					
Diptera	Chironomidae	*Axarus* sp.						7	
Diptera	Chironomidae	Chironomidae	102		11			24	
Diptera	Chironomidae	*Cladotanytarsus mancus* gr.							
Diptera	Chironomidae	*Cladotanytarsus* sp. gr. A						2	
Diptera	Chironomidae	*Conchapelopia* sp.				5	2	18	
Diptera	Chironomidae	*Corynocera* sp.					6		
Diptera	Chironomidae	*Corynoneura* nr. *lacustris*							
Diptera	Chironomidae	*Corynoneura* nr. *taris*				3			
Diptera	Chironomidae	*Corynoneura* sp.							
Diptera	Chironomidae	*Cricotopus bicinctus*				14	2		
Diptera	Chironomidae	*Cricotopus* sp.					1		
Diptera	Chironomidae	*Cricotopus tremulus* gr.							
Diptera	Chironomidae	*Cricotopus trifascia* gr.						2	
Diptera	Chironomidae	*Cryptochironomus fulvus* gr.							
Diptera	Chironomidae	*Cryptochironomus* sp.							
Diptera	Chironomidae	*Cryptotendipes* sp.							1
Diptera	Chironomidae	*Dicrotendipes neomodestus*		14		15	1	16	
Diptera	Chironomidae	*Einfeldia* nr. *pagana*				2			
Diptera	Chironomidae	*Glyptotendipes* sp. gr. A							
Diptera	Chironomidae	*Glyptotendipes* sp. gr. B							
Diptera	Chironomidae	*Glyptotendipes* sp. gr. C							
Diptera	Chironomidae	*Larsia* sp.						9	

Order	Family	Taxon	Reese Creek	Rocky Creek	South Fork Rocky Creek	Steele Creek	Sweetwater Creek	Willis Creek	Wilson Creek
Diptera	Chironomidae	*Lauterborniella agrayloides*				2			
Diptera	Chironomidae	*Lithotanytarsus emarginatus*		43					
Diptera	Chironomidae	*Lopescladius* sp.					3		
Diptera	Chironomidae	*Meropelopia* sp.		6	1				
Diptera	Chironomidae	*Micropsectra* sp.				9			
Diptera	Chironomidae	*Microtendipes pedellus* gr.		4					
Diptera	Chironomidae	*Nanocladius distinctus*							
Diptera	Chironomidae	*Nanocladius rectinervis*							
Diptera	Chironomidae	*Nanocladius* sp.					3		
Diptera	Chironomidae	*Nilotanypus* nr. *dubius*						20	
Diptera	Chironomidae	*Nilotanypus* sp.							
Diptera	Chironomidae	*Nilothauma* sp		4					
Diptera	Chironomidae	*Orthocladius* sp.		11		2	3		
Diptera	Chironomidae	*Orthocladius* sp. A							
Diptera	Chironomidae	*Orthocladius* sp. B							
Diptera	Chironomidae	*Orthocladius* sp. C							
Diptera	Chironomidae	*Paracladopelma* sp.					1		
Diptera	Chironomidae	*Paratendipes* nr. *nudisquama*						7	
Diptera	Chironomidae	*Paratendipes* sp.							
Diptera	Chironomidae	*Pentaneura* sp.		11			2	32	
Diptera	Chironomidae	*Phaenopsectra* nr. *flavipes*							
Diptera	Chironomidae	*Polypedilum convictum*		4		3	89	16	7
Diptera	Chironomidae	*Polypedilum illinoense*				48		9	
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. A						2	
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. B							
Diptera	Chironomidae	*Polypedilum* sp.		9	20				
Diptera	Chironomidae	*Procladius* sp.							
Diptera	Chironomidae	*Pseudochironomus* sp.		11			1		
Diptera	Chironomidae	*Rheocricotopus fuscipes* gr.						7	
Diptera	Chironomidae	*Rheocricotopus* sp.							
Diptera	Chironomidae	*Rheopelopia* sp.				2			
Diptera	Chironomidae	*Rheotanytarsus exiguus* gr.		4		9		45	2
Diptera	Chironomidae	*Rheotanytarsus* sp.			2				
Diptera	Chironomidae	*Saetheria* sp.							
Diptera	Chironomidae	Subfamily: Chironominae					62		
Diptera	Chironomidae	Subfamily: Orthocladiinae					58		

Order	Family	Taxon	Reese Creek	Rocky Creek	South Fork Rocky Creek	Steele Creek	Sweetwater Creek	Willis Creek	Wilson Creek
Diptera	Chironomidae	Subfamily: Tanypodinae					5		2
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.		87		5		11	
Diptera	Chironomidae	*Tanytarsus guerlus* gr.		4		14		11	
Diptera	Chironomidae	*Tanytarsus* sp.			13				
Diptera	Chironomidae	*Telopelopia* sp.				2			
Diptera	Chironomidae	*Thienemanniella* nr. *xena*							
Diptera	Chironomidae	*Thienemanniella* sp.						2	
Diptera	Chironomidae	*Thienemannimyia* sp.							
Diptera	Chironomidae	Tribe: Chironomini							83
Diptera	Chironomidae	*Trissocladius* sp.							
Diptera	Dolichopodidae	*Hydrophorus* sp.	1						
Diptera	Empididae	*Hemerodromia* sp.	1				1	1	
Diptera	Psychodidae	*Pericoma* sp.							
Diptera	Sciomyzidae	Sciomyzidae					1		
Diptera	Simuliidae	*Simulium* nr. *argus*							
Diptera	Simuliidae	*Simulium* nr. *bivittatum*							
Diptera	Simuliidae	*Simulium* nr. *trivittatum*							
Diptera	Simuliidae	*Simulium* nr. *vittatum*							
Diptera	Simuliidae	*Simulium* sp.	13	24	25		8	12	1
Diptera	Stratiomyidae	*Euparyphus* sp.							
Diptera	Stratiomyidae	*Myxosargus* sp.					1		
Diptera	Stratiomyidae	*Nemotelus* sp.							
Diptera	Stratiomyidae	*Stratiomyia* sp.							
Diptera	Tabanidae	*Chrysops* sp.				10	1		
Diptera	Tabanidae	*Tabanus* sp.	7	3	9			8	1
Diptera	Tipulidae	*Eriocera* sp.							
Diptera	Tipulidae	*Hexatoma* sp.							
Diptera	Tipulidae	*Limnophila* sp.	2		23				
Diptera	Tipulidae	*Ormosia* sp.		8	2				
Diptera	Tipulidae	*Pseudolimnophila* sp.						1	
Diptera	Tipulidae	*Tipula* sp.		3					
Ephemeroptera	Baetidae	*Acentrella* sp.						8	
Ephemeroptera	Baetidae	*Baetis ephippiatus*							
Ephemeroptera	Baetidae	*Baetis intercalaris*							
Ephemeroptera	Baetidae	*Baetis pygmaeus*							
Ephemeroptera	Baetidae	*Baetis* sp.							

Order	Family	Taxon	Reese Creek	Rocky Creek	South Fork Rocky Creek	Steele Creek	Sweetwater Creek	Willis Creek	Wilson Creek
Ephemeroptera	Baetidae	*Baetodes* sp.			1				
Ephemeroptera	Baetidae	*Callibaetis montanus*							
Ephemeroptera	Baetidae	*Callibaetis* sp.		1	10	1	5	4	
Ephemeroptera	Baetidae	*Camelobaetidius mexicanus*		1				1	
Ephemeroptera	Baetidae	*Camelobaetidius* sp.	18	3	3			4	
Ephemeroptera	Baetidae	*Cloeon alamance*							
Ephemeroptera	Baetidae	*Fallceon quilleri*	49	31	25	3	72	127	8
Ephemeroptera	Baetidae	*Paracloeodes* sp.			1		1		
Ephemeroptera	Baetidae	*Plauditus* sp.		41	4				
Ephemeroptera	Baetidae	*Procloeon* sp.			3				
Ephemeroptera	Baetidae	*Pseudocloeon* sp.		1	1				
Ephemeroptera	Caenidae	*Brachycercus lacustris*							
Ephemeroptera	Caenidae	*Caenis* sp.		2	10	7	39	83	49
Ephemeroptera	Caenidae	*Caenis* sp. A					5		
Ephemeroptera	Ephemeridae	*Hexagenia* sp.							
Ephemeroptera	Heptageniidae	*Heptagenia* sp.						2	4
Ephemeroptera	Heptageniidae	*Leucrocuta* sp.							
Ephemeroptera	Heptageniidae	*Stenacron* sp.					4	5	1
Ephemeroptera	Heptageniidae	*Stenonema* sp.		6	30	10		3	7
Ephemeroptera	Isonychiidae	*Isonychia sicca manca*					7		
Ephemeroptera	Isonychiidae	*Isonychia* sp.		6	10			16	
Ephemeroptera	Leptohyphidae	*Leptohyphes packeri*				1		4	
Ephemeroptera	Leptohyphidae	*Leptohyphes* sp.						54	
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr.		11		3	2	31	
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.	1	13	2			26	
Ephemeroptera	Leptophlebiidae	*Choroterpes mexicanus*		1		12		127	6
Ephemeroptera	Leptophlebiidae	*Farrodes texanus*						19	
Ephemeroptera	Leptophlebiidae	*Neochoroterpes* sp.	20		12			140	
Ephemeroptera	Leptophlebiidae	*Thraulodes gonzalesi*							
Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.	2	7	44			31	
Ephemeroptera	Leptophlebiidae	*Traverella presidiana*							
Ephemeroptera	Leptophlebiidae	*Traverella* sp.			23				
Hemiptera	Belostomatidae	*Belostoma* sp.		1					
Hemiptera	Belostomatidae	*Lethocerus* sp.							
Hemiptera	Corixidae	*Sigara* sp.					1		
Hemiptera	Corixidae	*Trichocorixa* sp.					2	1	

Order	Family	Taxon	Reese Creek	Rocky Creek	South Fork Rocky Creek	Steele Creek	Sweetwater Creek	Willis Creek	Wilson Creek
Hemiptera	Gerridae	*Aquarius* sp.		1					
Hemiptera	Gerridae	Gerridae					1		
Hemiptera	Gerridae	*Gerris* sp.		3					
Hemiptera	Gerridae	*Rheumatobates* sp.							
Hemiptera	Hebridae	*Hebrus* sp.							2
Hemiptera	Hebridae	*Lipogomphus* sp.							
Hemiptera	Hebridae	*Merragata* sp.					1		
Hemiptera	Hydrometridae	*Hydrometra* sp.		1			2		
Hemiptera	Mesoveliidae	*Mesovelia* sp.							
Hemiptera	Naucoridae	*Ambrysus circumcinctus*						1	
Hemiptera	Naucoridae	*Ambrysus lunatus*							
Hemiptera	Naucoridae	*Ambrysus pulchellus*						1	
Hemiptera	Naucoridae	*Ambrysus* sp.		6	8			13	
Hemiptera	Naucoridae	*Cryphocricos* sp.							
Hemiptera	Naucoridae	*Limnocoris* sp.							
Hemiptera	Nepidae	Nepidae		3					
Hemiptera	Nepidae	*Ranatra* sp.							
Hemiptera	Veliidae	*Microvelia* sp.					1	1	
Hemiptera	Veliidae	*Rhagovelia* sp.		140	21			4	
Heterostropha	Valvatidae	*Valvata* sp.							
Hirudinea		Hirudinea							3
Hirudinida	Erpobdellidae	*Mooreobdella melanostoma*							
Hirudinida	Erpobdellidae	*Mooreobdella microstoma*							
Hirudinida	Glossiphoniidae	*Helobdella triserialis*							
Hoplonemertea	Tetrastemmatidae	*Prostoma* sp.			1				
Hoplonemertea	Tetrastemmatidae	*Prostoma rubrum*		5		7	2		
Isopoda		Isopoda						1	
Lepidoptera	Crambidae	*Parargyractis* sp.						2	
Lepidoptera	Crambidae	*Petrophila* sp.							
Lepidoptera	Pyralidae	Pyralidae							
Lepidoptera		Lepidoptera							
Megaloptera	Corydalidae	*Corydalus cornutus*	1	13	3	1	19		
Megaloptera	Sialidae	*Sialis* sp.							
Nematoda		Nematoda						1	
Nematomorpha		Nematomorpha						1	
Neoophora	Dugesiidae	*Cura* sp.					4		

Order	Family	Taxon	Reese Creek	Rocky Creek	South Fork Rocky Creek	Steele Creek	Sweetwater Creek	Willis Creek	Wilson Creek
Neoophora	Dugesiidae	*Dugesia* sp.	2	3	10			3	
Neoophora	Dugesiidae	*Dugesia tigrina*		1				19	
Neoophora	Typhloplanidae	*Mesostoma* sp.							
Neotaenioglossa	Amnicolidae	*Amnicola limosa limosa*							
Neotaenioglossa	Amnicolidae	*Amnicola* sp.							
Neotaenioglossa	Hydrobiidae	*Cincinnatia cincinnatiensis*				1			
Neotaenioglossa	Thiaridae	*Melanoides tuberculata*							
Odonata	Aeschnidae	*Basiaeschna* sp.		1	2				
Odonata	Aeschnidae	*Boyeria* sp.							1
Odonata	Calopterygidae	*Hetaerina* sp.	1	1	4		3	2	
Odonata	Coenagrionidae	*Argia* sp.	44	19	43	23	9	36	9
Odonata	Coenagrionidae	*Argia* sp. A						7	
Odonata	Coenagrionidae	*Argia* sp. B						6	
Odonata	Coenagrionidae	*Enallagma* sp.					24	1	
Odonata	Coenagrionidae	*Ischnura* sp.		17	14	1	1		
Odonata	Corduliidae	*Epicordulia* sp.		2	8				
Odonata	Corduliidae	*Macromia* sp.							1
Odonata	Gomphidae	*Erpetogomphus* sp.		7	5		43	41	
Odonata	Gomphidae	*Gomphus externus*							
Odonata	Gomphidae	*Gomphus* sp.							
Odonata	Gomphidae	*Gomphus vastus*							
Odonata	Gomphidae	*Hagenius* sp.							
Odonata	Gomphidae	*Progomphus obscurus*					5		
Odonata	Gomphidae	*Progomphus* sp.							
Odonata	Lestidae	*Lestes* sp.							
Odonata	Libellulidae	*Brechmorhoga mendax*				1		5	
Odonata	Libellulidae	*Brechmorhoga* sp.	32		8			56	
Odonata	Libellulidae	*Orthemis ferruginea*							
Odonata	Libellulidae	*Pachydiplax* sp.					1		
Odonata	Libellulidae	*Perithemis* sp.							
Oligochaeta		Oligochaeta	1	10	7			14	2
Opisthopora	Sparganophilidae	*Sparganophilus tamesis*		1				11	
Ostracoda		Ostracoda	1		1		3		
Plecoptera	Perlidae	*Neoperla clymene*							
Plecoptera	Perlidae	*Neoperla* sp.			1				
Plecoptera	Perlidae	*Perlesta placida*							

Order	Family	Taxon	Reese Creek	Rocky Creek	South Fork Rocky Creek	Steele Creek	Sweetwater Creek	Willis Creek	Wilson Creek
Plecoptera	Perlidae	*Perlesta* sp.		24	12			25	4
Plecoptera	Perlodidae	*Hydroperla crosbyi*							
Podocopida	Cyclocyprididae	*Cypria lacustris*							
Podocopida	Cyprididae	*Chlamydotheca arcuata*		2					
Podocopida	Cyprididae	*Cypridopsis vidua*							
Podocopida	Cyprididae	*Eucypris* sp.						1	
Podocopida	Cyprididae	*Stenocypris* nr. *malcolmsoni*							
Podocopida	Limnocytheridae	*Limnocythere sancti-patrici*							
Trichoptera	Glossosomatidae	*Protoptila* sp.							
Trichoptera	Helicopsychidae	*Helicopsyche* sp.		3				11	
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.	73	32	73		9	192	128
Trichoptera	Hydropsychidae	*Hydropsyche* sp.			7		12		
Trichoptera	Hydropsychidae	*Potamyia flava*							
Trichoptera	Hydropsychidae	*Potamyia* sp.							
Trichoptera	Hydropsychidae	*Smicridea* sp.			2			14	
Trichoptera	Hydroptilidae	*Hydroptila* sp.		39			4	3	1
Trichoptera	Hydroptilidae	*Ithytrichia* sp.		2					
Trichoptera	Hydroptilidae	*Neotrichia* sp.		8					
Trichoptera	Hydroptilidae	*Ochrotrichia* sp.	2				1	1	1
Trichoptera	Hydroptilidae	*Oxyethira* sp.	1	3					
Trichoptera	Leptoceridae	*Nectopsyche candida*							
Trichoptera	Leptoceridae	*Nectopsyche diarina*					14		
Trichoptera	Leptoceridae	*Nectopsyche gracilis*						2	
Trichoptera	Leptoceridae	*Nectopsyche* sp.						2	
Trichoptera	Leptoceridae	*Oecetis* sp.		10	2				
Trichoptera	Leptoceridae	*Oecetis* sp. A							
Trichoptera	Leptoceridae	*Triaenodes* sp.		1					
Trichoptera	Odontoceridae	*Marilia flexuosa*							
Trichoptera	Odontoceridae	*Marilia* sp.						1	
Trichoptera	Philopotamidae	*Chimarra* sp.	76	26	82	25		29	
Trichoptera	Philopotamidae	*Dolophilodes* sp.							
Trichoptera	Polycentropodidae	*Cernotina* sp.							1
Trichoptera	Polycentropodidae	*Neureclipsis* sp.							
Trichoptera	Polycentropodidae	*Polycentropus* sp.						1	
Trichoptera	Polycentropodidae	*Polyplectropus charlesi*							
Trichoptera	Polycentropodidae	*Polyplectropus* sp.							

Order	Family	Taxon	Reese Creek	Rocky Creek	South Fork Rocky Creek	Steele Creek	Sweetwater Creek	Willis Creek	Wilson Creek
Trichoptera	Psychomyiidae	*Psychomyia* sp.							
Trombidiformes	Hydrodromidae	*Hydrodroma despiciens*						2	
Trombidiformes		Hydracarina (Hydrachnidia)	1	2	2		1	2	
Trombidiformes	Hygrobatidae	*Atractides* sp.		1				3	
Tubificida	Naididae	*Aulodrilus pigueti*							
Tubificida	Naididae	*Branchiura sowerbyi*		4					
Tubificida	Naididae	*Dero digitata*							
Tubificida	Naididae	*Dero pectinata*							
Tubificida	Naididae	*Dero trifida*							
Tubificida	Naididae	*Ilyodrilus templetoni*							
Tubificida	Naididae	*Limnodrilus hoffmeisteri*					1		
Tubificida	Naididae	*Limnodrilus* sp.					62	79	
Tubificida	Naididae	*Limnodrilus udekemianus*							
Tubificida	Naididae	*Nais communis*							
Tubificida	Naididae	*Nais pardalis*							
Tubificida	Naididae	*Nais variabilis*				1			
Tubificida	Naididae	*Pristina aequiseta*							
Tubificida	Naididae	*Pristina americana*							
Tubificida	Naididae	*Pristina foreli*					1		
Tubificida	Naididae	*Pristina leidyi*							
Tubificida	Naididae	*Pristina sima*							
Tubificida	Naididae	*Slavina appendiculata*		1		1			
Unionida	Unionidae	*Strophitus undulatus*							
Veneroida	Corbiculidae	*Corbicula fluminea*		12	2			22	
Veneroida	Pisidiidae	*Eupera cubensis*							
Veneroida	Pisidiidae	*Pisidium casertanum*		2				3	
Veneroida	Pisidiidae	*Pisidium nitidum*							
Veneroida	Pisidiidae	*Pisidium* sp.					2		
Veneroida	Pisidiidae	*Sphaerium* sp.							
Veneroida	Pisidiidae	*Sphaerium transversum*					2		
		Taxa Richness	26	93	54	41	73	106	34
		Total N Individuals	457	979	620	270	784	1,706	349
		Number of Samples	n = 2	n = 6	n = 5	n = 1	n = 3	n = 6	n = 3

Appendix E - 4. Benthic macroinvertebrate taxa list by stream for Ecoregion 30; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	Barton Creek	Brushy Creek	Bull Creek	Bullhead Creek	Carpers Creek	Colorado River	Cypress Creek	Devils River	Guadalupe River
Amphipoda	Hyalellidae	*Hyalella azteca*				1	44		1	54	1
Amphipoda	Hyalellidae	*Hyalella* sp.								32	
Anthoathecata	Hydridae	*Hydra* sp.									
Basommatophora	Ancylidae	*Ferrissia rivularis*					22			2	
Basommatophora	Ancylidae	*Ferrissia* sp.									
Basommatophora	Lymnaeidae	*Fossaria dalli*									
Basommatophora	Lymnaeidae	*Fossaria parva*					1				
Basommatophora	Lymnaeidae	*Fossaria* sp.							2		
Basommatophora	Lymnaeidae	*Lymnaea* sp.									
Basommatophora	Lymnaeidae	*Pseudosuccinea columella*									
Basommatophora	Lymnaeidae	*Pseudosuccinea* sp.									
Basommatophora	Physidae	*Physa* sp.				4		16	16		3
Basommatophora	Physidae	*Physella* sp.		2							
Basommatophora	Physidae	*Physella virgata*	2				11			21	
Basommatophora	Planorbidae	*Biomphalaria obstructus*	2				3			1	
Basommatophora	Planorbidae	*Gyraulus parvus*									
Basommatophora	Planorbidae	*Gyraulus* sp.							4		1
Basommatophora	Planorbidae	*Helisoma anceps*	2							3	
Basommatophora	Planorbidae	*Helisoma* sp.									3
Basommatophora	Planorbidae	*Planorbella* sp.							18		1
Basommatophora	Planorbidae	*Planorbula* sp.									2
Coleoptera	Dryopidae	*Helichus* sp.									5
Coleoptera	Dryopidae	*Helichus suturalis*								1	
Coleoptera	Dryopidae	*Pelonomus* sp.							1		
Coleoptera	Dytiscidae	*Celina* sp.									
Coleoptera	Dytiscidae	*Hydrovatus* sp.									
Coleoptera	Dytiscidae	*Uvarus* sp.									
Coleoptera	Elmidae	*Dubiraphia* sp.							2		
Coleoptera	Elmidae	*Dubiraphia vittata*									
Coleoptera	Elmidae	*Heterelmis* sp.									5
Coleoptera	Elmidae	*Hexacylloepus ferrugineus*	22				114			34	
Coleoptera	Elmidae	*Hexacylloepus* sp.		9		2		17		27	90
Coleoptera	Elmidae	*Macrelmis* sp.		23		41				6	26

Order	Family	Taxon	Barton Creek	Brushy Creek	Bull Creek	Bullhead Creek	Carpers Creek	Colorado River	Cypress Creek	Devils River	Guadalupe River
Coleoptera	Elmidae	*Macrelmis texana*					57			18	
Coleoptera	Elmidae	*Macronychus* sp.									
Coleoptera	Elmidae	*Microcylloepus pusillus*	4				125			29	
Coleoptera	Elmidae	*Microcylloepus* sp.		3		9		9		8	34
Coleoptera	Elmidae	*Neocylloepus* sp.									
Coleoptera	Elmidae	*Neoelmis caesa*					11				
Coleoptera	Elmidae	*Neoelmis* sp.		5						1	2
Coleoptera	Elmidae	*Phanocerus clavicornis*								2	
Coleoptera	Elmidae	*Stenelmis cheryl*									
Coleoptera	Elmidae	*Stenelmis occidentalis*									
Coleoptera	Elmidae	*Stenelmis* sp.		9		3		87		1	14
Coleoptera	Gyrinidae	*Gyretes* sp.									
Coleoptera	Haliplidae	*Haliplus* sp.									
Coleoptera	Haliplidae	*Peltodytes* sp.							4		
Coleoptera	Hydrochidae	*Hydrochus* sp.									
Coleoptera	Hydrophilidae	*Berosus* sp.	2					3			
Coleoptera	Hydrophilidae	*Derallus* sp.									
Coleoptera	Hydrophilidae	*Enochrus* sp.					1				
Coleoptera	Hydrophilidae	*Helochares* sp.									
Coleoptera	Hydrophilidae	*Laccobius* sp.							1	4	
Coleoptera	Hydrophilidae	*Paracymus* sp.									
Coleoptera	Hydrophilidae	*Tropisternus* sp.									
Coleoptera	Lutrochidae	*Lutrochus luteus*	4							25	
Coleoptera	Lutrochidae	*Lutrochus* sp.			5	5			1		4
Coleoptera	Psephenidae	*Psephenus* sp.		74	18					4	
Coleoptera	Psephenidae	*Psephenus texanus*	8								
Coleoptera	Scirtidae	*Cyphon* sp.							1		
Coleoptera	Staphylinidae	Staphylinidae			2			3			
Coleoptera	Staphylinidae	*Stenus* sp.							1		
Collembola		Collembola									
Copepoda		Copepoda									
Decapoda	Cambaridae	Cambaridae								1	
Decapoda	Cambaridae	*Faxonella* sp.									
Decapoda	Palaemonidae	*Palaemonetes* sp.									
Diptera	Athericidae	*Atherix* sp.			30	2			12		
Diptera	Athericidae	*Atherix variegata*									

Order	Family	Taxon	Barton Creek	Brushy Creek	Bull Creek	Bullhead Creek	Carpers Creek	Colorado River	Cypress Creek	Devils River	Guadalupe River
Diptera	Athericidae	*Suragina* sp.							1		
Diptera	Ceratopogonidae	*Alluaudomyia* sp.									
Diptera	Ceratopogonidae	*Atrichopogon* sp.	2								
Diptera	Ceratopogonidae	*Bezzia* sp.						3			
Diptera	Ceratopogonidae	*Culicoides* sp.				1					
Diptera	Ceratopogonidae	*Dasyhelea* sp.	1						1		
Diptera	Ceratopogonidae	*Forcipomyia* sp.									
Diptera	Ceratopogonidae	*Mallochohelea* sp.				3					
Diptera	Ceratopogonidae	*Palpomyia tibialis*	58				4			1	
Diptera	Ceratopogonidae	*Probezzia* sp.	68			6	7			1	
Diptera	Ceratopogonidae	*Probezzia* sp. A									
Diptera	Ceratopogonidae	*Probezzia* sp. B									
Diptera	Ceratopogonidae	*Serromyia* sp.				1					
Diptera	Ceratopogonidae	*Stilobezzia* sp.	1								
Diptera	Chironomidae	*Ablabesmyia cinctipes*									
Diptera	Chironomidae	*Ablabesmyia* sp.									
Diptera	Chironomidae	*Axarus* sp.									
Diptera	Chironomidae	*Cardiocladius* sp.								8	
Diptera	Chironomidae	Chironomidae		80	1			48	58		23
Diptera	Chironomidae	*Chironomus* sp.									
Diptera	Chironomidae	*Cladotanytarsus* sp.									
Diptera	Chironomidae	*Cladotanytarsus vanderwulpi* gr.									
Diptera	Chironomidae	*Conchapelopia* sp.	15		1					6	
Diptera	Chironomidae	*Corynocera* sp.									
Diptera	Chironomidae	*Corynoneura* nr. *taris*									
Diptera	Chironomidae	*Cricotopus bicinctus*									
Diptera	Chironomidae	*Cricotopus* sp.									
Diptera	Chironomidae	*Dicrotendipes neomodestus*	5								
Diptera	Chironomidae	*Dicrotendipes* nr. *notatus*					3				
Diptera	Chironomidae	*Endochironomus* nr. *tendens*									
Diptera	Chironomidae	*Eukiefferiella* sp.								1	
Diptera	Chironomidae	*Fittkauimyia* sp.									
Diptera	Chironomidae	*Hydrobaenus* sp.									
Diptera	Chironomidae	*Labrundinia neopilosella*									
Diptera	Chironomidae	*Labrundinia* sp.									
Diptera	Chironomidae	*Larsia* sp.					3				

Order	Family	Taxon	Barton Creek	Brushy Creek	Bull Creek	Bullhead Creek	Carpers Creek	Colorado River	Cypress Creek	Devils River	Guadalupe River
Diptera	Chironomidae	*Lauterborniella agrayloides*	2				19				
Diptera	Chironomidae	*Micropsectra* sp.									
Diptera	Chironomidae	*Microtendipes pedellus* gr.									
Diptera	Chironomidae	*Nanocladius rectinervis*									
Diptera	Chironomidae	*Natarsia punctata*					8				
Diptera	Chironomidae	*Nilotanypus* sp.									
Diptera	Chironomidae	*Nilothauma* sp.									
Diptera	Chironomidae	*Orthocladius* sp.					6				
Diptera	Chironomidae	*Paracladius* sp.								3	
Diptera	Chironomidae	*Paracladopelma* sp.									
Diptera	Chironomidae	*Paralauterborniella* sp.				2					
Diptera	Chironomidae	*Paramerina* sp.									
Diptera	Chironomidae	*Parametriocnemus* sp.					10				
Diptera	Chironomidae	*Paratanytarsus* sp.				1					
Diptera	Chironomidae	*Pentaneura* sp.					26			3	
Diptera	Chironomidae	*Phaenopsectra* sp.									
Diptera	Chironomidae	*Polypedilum convictum*					113			6	
Diptera	Chironomidae	*Polypedilum illinoense*								3	
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. B									
Diptera	Chironomidae	*Polypedilum* sp.			2	4					1
Diptera	Chironomidae	*Procladius* sp.				2					
Diptera	Chironomidae	*Pseudochironomus* sp.								18	
Diptera	Chironomidae	*Rheocricotopus fuscipes* gr.									
Diptera	Chironomidae	*Rheocricotopus* sp.			1	1					
Diptera	Chironomidae	*Rheotanytarsus exiguus* gr.					3			50	
Diptera	Chironomidae	*Rheotanytarsus* sp.			3	5				1	1
Diptera	Chironomidae	*Saetheria* sp.				1					
Diptera	Chironomidae	*Stictochironomus devinctus*									
Diptera	Chironomidae	Subfamily: Orthocladiinae									
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.									
Diptera	Chironomidae	*Tanytarsus guerlus* gr.					13				
Diptera	Chironomidae	*Tanytarsus* sp.				3					2
Diptera	Chironomidae	*Thienemanniella* nr. *xena*								6	
Diptera	Chironomidae	*Thienemanniella* sp.								14	
Diptera	Chironomidae	*Virgatanytarsus* sp.									
Diptera	Chironomidae	*Xenochironomus xenolabis*									

Order	Family	Taxon	Barton Creek	Brushy Creek	Bull Creek	Bullhead Creek	Carpers Creek	Colorado River	Cypress Creek	Devils River	Guadalupe River
Diptera	Culicidae	*Anopheles* sp.									
Diptera	Culicidae	*Culex* sp.					1				
Diptera	Culicidae	Culicidae									
Diptera	Empididae	*Hemerodromia* sp.								2	
Diptera	Sarcophagidae	*Sarcophaga dux*	1								
Diptera	Simuliidae	*Simulium* nr. *argus*									
Diptera	Simuliidae	*Simulium* nr. *bivittatum*								12	
Diptera	Simuliidae	*Simulium* nr. *trivittatum*	1							71	
Diptera	Simuliidae	*Simulium* sp.		6	31	32		134	24	20	7
Diptera	Stratiomyidae	*Caloparyphus* sp.									
Diptera	Stratiomyidae	*Euparyphus* sp.			7	6				1	
Diptera	Stratiomyidae	*Nemotelus* sp.									
Diptera	Stratiomyidae	*Odontomyia* sp.									
Diptera	Stratiomyidae	*Stratiomys* sp.									
Diptera	Tabanidae	*Haematopota* sp.									
Diptera	Tabanidae	*Tabanus* sp.					2	1			
Diptera	Tipulidae	*Cryptolabis* sp.									
Diptera	Tipulidae	*Dicranota* sp.									
Diptera	Tipulidae	*Geranomyia* sp.					1				
Diptera	Tipulidae	*Hexatoma* sp.						1			
Diptera	Tipulidae	*Pedicia* sp.									
Diptera	Tipulidae	*Tipula* sp.							1		
Ephemeroptera	Baetidae	*Acentrella* sp.						1			
Ephemeroptera	Baetidae	*Baetis* sp.							5		13
Ephemeroptera	Baetidae	*Baetodes edmundsi*								1	
Ephemeroptera	Baetidae	*Baetodes* sp.		23		4					
Ephemeroptera	Baetidae	*Callibaetis* sp.									
Ephemeroptera	Baetidae	*Camelobaetidius mexicanus*								26	
Ephemeroptera	Baetidae	*Camelobaetidius* sp.		4	10	13		55		2	2
Ephemeroptera	Baetidae	*Centroptilum* sp.									
Ephemeroptera	Baetidae	*Cloeon* sp.									1
Ephemeroptera	Baetidae	*Fallceon quilleri*	26	17	9		2			2	
Ephemeroptera	Baetidae	*Fallceon* sp.				33		199		38	13
Ephemeroptera	Baetidae	*Paracloeodes* sp.						4			
Ephemeroptera	Baetidae	*Plauditus* sp.						50			
Ephemeroptera	Baetidae	*Procloeon* sp.						1			

Order	Family	Taxon	Barton Creek	Brushy Creek	Bull Creek	Bullhead Creek	Carpers Creek	Colorado River	Cypress Creek	Devils River	Guadalupe River
Ephemeroptera	Baetidae	*Pseudocloeon* sp.							1	1	
Ephemeroptera	Caenidae	*Brachycercus* sp.									
Ephemeroptera	Caenidae	*Caenis* sp.				2	3	15	3		4
Ephemeroptera	Ephemeridae	*Hexagenia* sp.						1			2
Ephemeroptera	Heptageniidae	*Maccaffertium* sp.				6					
Ephemeroptera	Heptageniidae	*Stenacron* sp.									27
Ephemeroptera	Heptageniidae	*Stenonema femoratum*									
Ephemeroptera	Heptageniidae	*Stenonema* sp.				17		12			
Ephemeroptera	Isonychiidae	*Isonychia sicca manca*	2							15	
Ephemeroptera	Isonychiidae	*Isonychia* sp.				41		171		12	31
Ephemeroptera	Leptohyphidae	*Asioplax* sp.				27					
Ephemeroptera	Leptohyphidae	*Leptohyphes michaeli*									
Ephemeroptera	Leptohyphidae	*Leptohyphes packeri*									
Ephemeroptera	Leptohyphidae	*Leptohyphes* sp.				20		92	5		46
Ephemeroptera	Leptohyphidae	*Leptohyphes succinus*									
Ephemeroptera	Leptohyphidae	*Leptohyphes vescus*	2							6	
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr.	94				22			4	
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr. sp. B									
Ephemeroptera	Leptohyphidae	*Tricorythodes curvatus* gr.									
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.		1	19	75		164	15	2	16
Ephemeroptera	Leptohyphidae	*Vacupernius packeri*				55				31	
Ephemeroptera	Leptophlebiidae	*Choroterpes mexicanus*	22								
Ephemeroptera	Leptophlebiidae	*Farrodes texanus*								22	
Ephemeroptera	Leptophlebiidae	*Neochoroterpes* sp.				11		22			
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia* sp.									
Ephemeroptera	Leptophlebiidae	*Thraulodes gonzalesi*	4							27	
Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.						13		18	75
Ephemeroptera	Leptophlebiidae	*Traverella presidiana*									
Ephemeroptera	Leptophlebiidae	*Traverella* sp.						3	5		68
Hemiptera	Belostomatidae	*Belostoma* sp.								1	
Hemiptera	Corixidae	*Trichocorixa* sp.									5
Hemiptera	Gerridae	*Rheumatobates* sp.									
Hemiptera	Gerridae	*Trepobates* sp.									
Hemiptera	Hebridae	*Hebrus* sp.									
Hemiptera	Hebridae	*Merragata* sp.					1				
Hemiptera	Naucoridae	*Ambrysus circumcinctus*					6			23	

Order	Family	Taxon	Barton Creek	Brushy Creek	Bull Creek	Bullhead Creek	Carpers Creek	Colorado River	Cypress Creek	Devils River	Guadalupe River
Hemiptera	Naucoridae	*Ambrysus lunatus*								2	
Hemiptera	Naucoridae	*Ambrysus* sp.		4		73		10		43	61
Hemiptera	Naucoridae	*Cryphocricos* sp.									56
Hemiptera	Naucoridae	*Limnocoris lutzi*									
Hemiptera	Naucoridae	*Limnocoris* sp.									
Hemiptera	Naucoridae	*Pelocoris* sp.							2		
Hemiptera	Nepidae	*Ranatra* sp.									
Hemiptera	Saldidae	*Saldula* sp.									
Hemiptera	Veliidae	*Microvelia* sp.	1								
Hemiptera	Veliidae	*Rhagovelia* sp.	2		2	2			82	3	5
Hemiptera	Veliidae	*Steinovelia* sp.									
Hirudinea		Hirudinea						14		2	
Hirudinida	Erpobdellidae	*Mooreobdella microstoma*									
Hirudinida	Glossiphoniidae	*Helobdella elongata*					2				
Hirudinida	Glossiphoniidae	*Helobdella* sp.									
Hirudinida	Glossiphoniidae	*Helobdella stagnalis*					11				
Hirudinida	Glossiphoniidae	*Helobdella triserialis*									
Hirudinida	Glossiphoniidae	*Placobdella* sp.									
Hoplonemertea	Tetrastemmatidae	*Prostoma rubrum*	52				12			10	
Lepidoptera	Crambidae	*Parapoynx* sp.									
Lepidoptera	Crambidae	*Petrophila* sp.	1	5	2	1	1			4	
Lepidoptera	Crambidae	*Synclita* sp.								6	
Megaloptera	Corydalidae	*Corydalus cornutus*		1	4	1		11	6	4	64
Nematoda		Nematoda	1				11	1			
Neoophora	Dugesiidae	*Dugesia dorotocephala*									
Neoophora	Dugesiidae	*Dugesia* sp.		4	1	24			10	16	5
Neoophora	Dugesiidae	*Dugesia tigrina*	1				61			34	
Neotaenioglossa	Amnicolidae	*Amnicola* sp.									1
Neotaenioglossa	Hydrobiidae	*Cincinnatia cincinnatiensis*		2			7				4
Neotaenioglossa	Hydrobiidae	*Cochliopina riograndensis*								26	
Neotaenioglossa	Pleuroceridae	*Elimia* sp.								2	
Neotaenioglossa	Thiaridae	*Melanoides tuberculata*								14	
Neuroptera	Sisyridae	*Climacia areolaris*									
Odonata	Aeschnidae	*Basiaeschna janata*					12				
Odonata	Aeschnidae	*Basiaeschna* sp.									
Odonata	Calopterygidae	*Hetaerina* sp.		1	2		3	5	1	8	10

Order	Family	Taxon	Barton Creek	Brushy Creek	Bull Creek	Bullhead Creek	Carpers Creek	Colorado River	Cypress Creek	Devils River	Guadalupe River
Odonata	Coenagrionidae	*Argia* sp.	42	12	4	9		30	54	28	55
Odonata	Coenagrionidae	*Argia* sp. A									
Odonata	Coenagrionidae	*Argia* sp. B								12	
Odonata	Coenagrionidae	*Enallagma* sp.						1			
Odonata	Coenagrionidae	*Ischnura* sp.									
Odonata	Corduliidae	*Epitheca* sp.									
Odonata	Corduliidae	*Macromia* sp.									1
Odonata	Corduliidae	*Neurocordulia* sp.									7
Odonata	Gomphidae	*Erpetogomphus* sp.				11		1	6	3	15
Odonata	Gomphidae	*Phyllogomphoides* sp.							1		
Odonata	Gomphidae	*Progomphus* sp.									
Odonata	Lestidae	*Lestes* sp.									
Odonata	Libellulidae	*Brechmorhoga mendax*								1	
Odonata	Libellulidae	*Brechmorhoga* sp.		1	9					7	12
Odonata	Libellulidae	*Erythemis* sp.									
Odonata	Libellulidae	*Erythrodiplax* sp.									1
Odonata	Libellulidae	*Libellula* sp.									
Odonata	Libellulidae	Libellulidae				1					
Odonata	Libellulidae	*Macrothemis* sp.									
Odonata	Libellulidae	*Pachydiplax* sp.							3		
Odonata	Libellulidae	*Perithemis* sp.							4		
Oligochaeta		Oligochaeta				5		1	94	4	35
Opisthopora	Lumbricidae	Lumbricidae								1	
Opisthopora	Sparganophilidae	*Sparganophilus tamesis*					42			4	
Ostracoda		Ostracoda						6		8	
Plecoptera	Perlidae	*Neoperla clymene*									
Plecoptera	Perlidae	*Perlesta* sp.						7			
Plecoptera	Perlidae	*Perlinella* sp.									
Podocopida	Candonidae	*Candona* sp.									
Podocopida	Cyprididae	*Chlamydotheca arcuata*					2			2	
Podocopida	Cyprididae	*Cypridopsis vidua*									
Podocopida	Cyprididae	*Herpetocypris* nr. *reptans*									
Podocopida	Cyprididae	*Herpetocypris* sp.	1								
Podocopida	Cyprididae	*Stenocypris* nr. *malcolmsoni*					1				
Podocopida	Cyprididae	*Stenocypris* sp.	17								
Sarcoptiformes	Hydrozetidae	*Hydrozetes* sp.	2								

Order	Family	Taxon	Barton Creek	Brushy Creek	Bull Creek	Bullhead Creek	Carpers Creek	Colorado River	Cypress Creek	Devils River	Guadalupe River
Trichoptera	Ecnomidae	*Austrotinodes* sp.				1					
Trichoptera	Glossosomatidae	*Protoptila* sp.									1
Trichoptera	Helicopsychidae	*Helicopsyche* sp.		4			2	2		2	2
Trichoptera	Hydrobiosidae	*Atopsyche* sp.								1	
Trichoptera	Hydropsychidae	*Ceratopsyche* sp.									
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.	6	75	33	356	49	117	69	17	11
Trichoptera	Hydropsychidae	*Hydropsyche* sp.		1				20	38	17	18
Trichoptera	Hydropsychidae	*Smicridea* sp.		1		3		5		1	22
Trichoptera	Hydroptilidae	*Hydroptila* sp.	3			1	9	2		31	2
Trichoptera	Hydroptilidae	*Hydroptila* sp. A									
Trichoptera	Hydroptilidae	*Hydroptila* sp. B									
Trichoptera	Hydroptilidae	*Ithytrichia* sp.									
Trichoptera	Hydroptilidae	*Mayatrichia* nr. *ayama*								1	
Trichoptera	Hydroptilidae	*Mayatrichia* nr. *ponta*	1							4	
Trichoptera	Hydroptilidae	*Metrichia* sp.									
Trichoptera	Hydroptilidae	*Neotrichia* sp.	1				8				1
Trichoptera	Hydroptilidae	*Ochrotrichia* sp.				1				12	
Trichoptera	Hydroptilidae	*Orthotrichia* sp.									
Trichoptera	Hydroptilidae	*Oxyethira* sp.	51							1	
Trichoptera	Hydroptilidae	*Stactobiella* sp.									
Trichoptera	Leptoceridae	*Nectopsyche gracilis*					10			3	
Trichoptera	Leptoceridae	*Nectopsyche* sp.		1							
Trichoptera	Leptoceridae	*Oecetis* sp.				1		3			
Trichoptera	Leptoceridae	*Oecetis* sp. A					3				
Trichoptera	Leptoceridae	*Oecetis* sp. B					2				
Trichoptera	Leptoceridae	*Triaenodes* sp.								1	
Trichoptera	Odontoceridae	*Marilia flexuosa*									
Trichoptera	Odontoceridae	*Marilia* sp.		3						4	
Trichoptera	Philopotamidae	*Chimarra* sp.	1	9	26	61	51	117	157	75	112
Trichoptera	Philopotamidae	*Chimarra* sp. A									
Trichoptera	Philopotamidae	*Chimarra* sp. B									
Trichoptera	Philopotamidae	*Dolophilodes* sp.				1			22		1
Trichoptera	Philopotamidae	*Wormaldia* sp.									
Trichoptera	Polycentropodidae	*Cernotina* sp.									
Trichoptera	Polycentropodidae	*Neureclipsis* sp.				8					
Trichoptera	Polycentropodidae	*Polycentropus* sp.									

Order	Family	Taxon	Barton Creek	Brushy Creek	Bull Creek	Bullhead Creek	Carpers Creek	Colorado River	Cypress Creek	Devils River	Guadalupe River
Trichoptera	Polycentropodidae	*Polyplectropus charlesi*								1	
Trichoptera	Polycentropodidae	*Polyplectropus proditus*					1				
Trichoptera	Polycentropodidae	*Polyplectropus* sp.									
Trombidiformes	Arrenuridae	*Arrenurus* sp.	1								
Trombidiformes		Hydracarina (Hydrachnidia)				5		4		5	
Trombidiformes	Hydrodromidae	*Hydrodroma despiciens*									
Trombidiformes	Limnocharidae	*Limnochares* sp.									
Trombidiformes	Sperchontidae	*Sperchon* sp.								1	
Trombidiformes	Sperchontidae	*Sperchon texana*									
Trombidiformes	Torrenticolidae	*Torrenticola* sp.									
Tubificida	Naididae	*Aulodrilus pigueti*									
Tubificida	Naididae	*Branchiura sowerbyi*									
Tubificida	Naididae	*Bratislavia unidentata*									
Tubificida	Naididae	*Chaetogaster diaphanus*								1	
Tubificida	Naididae	*Dero nivea*									
Tubificida	Naididae	*Dero trifida*									
Tubificida	Naididae	*Limnodrilus hoffmeisteri*									
Tubificida	Naididae	*Limnodrilus* sp.					38				
Tubificida	Naididae	*Nais pardalis*									
Tubificida	Naididae	*Nais variabilis*								2	
Tubificida	Naididae	*Pristina americana*									
Tubificida	Naididae	*Pristina leidyi*									
Tubificida	Naididae	*Pristina osborni*									
Tubificida	Naididae	*Pristina sima*									
Tubificida	Naididae	*Slavina appendiculata*	5				10				
Turbellaria		Turbellaria						36			
Veneroida	Corbiculidae	*Corbicula fluminea*		2			1	13	43	13	55
Veneroida	Pisidiidae	*Eupera cubensis*					12			1	
Veneroida	Pisidiidae	*Pisidium compressum*									
Veneroida	Pisidiidae	*Pisidium nitidum*					1				
Veneroida	Pisidiidae	*Pisidium* sp.		1				4			1
Veneroida	Pisidiidae	*Sphaerium* sp.						4			18
Veneroida	Sphaeriidae	Sphaeriidae						2			
		Taxa Richness	42	30	23	53	56	50	40	101	59
		Total N Individuals	539	383	222	1,004	1,004	1,541	775	1,170	1,104
		Number of Samples	n = 1	n = 2	n = 1	n = 4	n = 1	n = 7	n = 6	n = 2	n = 6

Appendix E - 4 CONT. Benthic macroinvertebrate taxa list by stream for Ecoregion 30; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	James River	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River
Amphipoda	Hyalellidae	*Hyalella azteca*		42			3	37			
Amphipoda	Hyalellidae	*Hyalella* sp.									
Anthoathecata	Hydridae	*Hydra* sp.									
Basommatophora	Ancylidae	*Ferrissia rivularis*			2						
Basommatophora	Ancylidae	*Ferrissia* sp.									
Basommatophora	Lymnaeidae	*Fossaria dalli*			2						
Basommatophora	Lymnaeidae	*Fossaria parva*									
Basommatophora	Lymnaeidae	*Fossaria* sp.						4			
Basommatophora	Lymnaeidae	*Lymnaea* sp.		1							
Basommatophora	Lymnaeidae	*Pseudosuccinea columella*									
Basommatophora	Lymnaeidae	*Pseudosuccinea* sp.									
Basommatophora	Physidae	*Physa* sp.						45			1
Basommatophora	Physidae	*Physella* sp.								1	
Basommatophora	Physidae	*Physella virgata*	2		9	2	2				
Basommatophora	Planorbidae	*Biomphalaria obstructus*			2	1					
Basommatophora	Planorbidae	*Gyraulus parvus*	5								
Basommatophora	Planorbidae	*Gyraulus* sp.									
Basommatophora	Planorbidae	*Helisoma anceps*	5		1	2					
Basommatophora	Planorbidae	*Helisoma* sp.						1		1	
Basommatophora	Planorbidae	*Planorbella* sp.	1								
Basommatophora	Planorbidae	*Planorbula* sp.									
Coleoptera	Dryopidae	*Helichus* sp.		1				6			1
Coleoptera	Dryopidae	*Helichus suturalis*	2			2			4		
Coleoptera	Dryopidae	*Pelonomus* sp.									
Coleoptera	Dytiscidae	*Celina* sp.									
Coleoptera	Dytiscidae	*Hydrovatus* sp.									
Coleoptera	Dytiscidae	*Uvarus* sp.									
Coleoptera	Elmidae	*Dubiraphia* sp.									
Coleoptera	Elmidae	*Dubiraphia vittata*									
Coleoptera	Elmidae	*Heterelmis* sp.									3
Coleoptera	Elmidae	*Hexacylloepus ferrugineus*	4		1	1			5		
Coleoptera	Elmidae	*Hexacylloepus* sp.		52				258		2	60

Order	Family	Taxon	James River	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River
Coleoptera	Elmidae	*Macrelmis* sp.						21		55	1
Coleoptera	Elmidae	*Macrelmis texana*				5					
Coleoptera	Elmidae	*Macronychus* sp.						1			
Coleoptera	Elmidae	*Microcylloepus pusillus*	3			14			25		
Coleoptera	Elmidae	*Microcylloepus* sp.		10				342		25	5
Coleoptera	Elmidae	*Neocylloepus* sp.									2
Coleoptera	Elmidae	*Neoelmis caesa*	1			28			5		
Coleoptera	Elmidae	*Neoelmis* sp.						26			1
Coleoptera	Elmidae	*Phanocerus clavicornis*									
Coleoptera	Elmidae	*Stenelmis cheryl*	7								
Coleoptera	Elmidae	*Stenelmis occidentalis*							1		
Coleoptera	Elmidae	*Stenelmis* sp.					42	39		4	25
Coleoptera	Gyrinidae	*Gyretes* sp.									
Coleoptera	Haliplidae	*Haliplus* sp.									
Coleoptera	Haliplidae	*Peltodytes* sp.									
Coleoptera	Hydrochidae	*Hydrochus* sp.									
Coleoptera	Hydrophilidae	*Berosus* sp.			1			1			6
Coleoptera	Hydrophilidae	*Derallus* sp.								8	
Coleoptera	Hydrophilidae	*Enochrus* sp.					2	1			
Coleoptera	Hydrophilidae	*Helochares* sp.									
Coleoptera	Hydrophilidae	*Laccobius* sp.									
Coleoptera	Hydrophilidae	*Paracymus* sp.					1				1
Coleoptera	Hydrophilidae	*Tropisternus* sp.					1				
Coleoptera	Lutrochidae	*Lutrochus luteus*	8			8			17		
Coleoptera	Lutrochidae	*Lutrochus* sp.		3				18		2	
Coleoptera	Psephenidae	*Psephenus* sp.									3
Coleoptera	Psephenidae	*Psephenus texanus*					3				
Coleoptera	Scirtidae	*Cyphon* sp.									
Coleoptera	Staphylinidae	Staphylinidae									
Coleoptera	Staphylinidae	*Stenus* sp.									
Collembola		Collembola									
Copepoda		Copepoda									
Decapoda	Cambaridae	Cambaridae									
Decapoda	Cambaridae	*Faxonella* sp.		4							
Decapoda	Palaemonidae	*Palaemonetes* sp.		2							

Order	Family	Taxon	James River	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River
Diptera	Athericidae	*Atherix* sp.								9	16
Diptera	Athericidae	*Atherix variegata*									
Diptera	Athericidae	*Suragina* sp.									
Diptera	Ceratopogonidae	*Alluaudomyia* sp.									
Diptera	Ceratopogonidae	*Atrichopogon* sp.			2						
Diptera	Ceratopogonidae	*Bezzia* sp.						2	1		
Diptera	Ceratopogonidae	*Culicoides* sp.									
Diptera	Ceratopogonidae	*Dasyhelea* sp.									
Diptera	Ceratopogonidae	*Forcipomyia* sp.									
Diptera	Ceratopogonidae	*Mallochohelea* sp.						1			
Diptera	Ceratopogonidae	*Palpomyia tibialis*	29		34	10	7		4		
Diptera	Ceratopogonidae	*Probezzia* sp.			17	3	21	4	1		
Diptera	Ceratopogonidae	*Probezzia* sp. A	3								
Diptera	Ceratopogonidae	*Probezzia* sp. B	1								
Diptera	Ceratopogonidae	*Serromyia* sp.									
Diptera	Ceratopogonidae	*Stilobezzia* sp.									
Diptera	Chironomidae	*Ablabesmyia cinctipes*	1								
Diptera	Chironomidae	*Ablabesmyia* sp.		1							
Diptera	Chironomidae	*Axarus* sp.									
Diptera	Chironomidae	*Cardiocladius* sp.			2				5		2
Diptera	Chironomidae	Chironomidae		1				105			16
Diptera	Chironomidae	*Chironomus* sp.									
Diptera	Chironomidae	*Cladotanytarsus* sp.								4	
Diptera	Chironomidae	*Cladotanytarsus vanderwulpi* gr.	1			2					
Diptera	Chironomidae	*Conchapelopia* sp.		5	4		7				
Diptera	Chironomidae	*Corynocera* sp.	21								
Diptera	Chironomidae	*Corynoneura* nr. *taris*									
Diptera	Chironomidae	*Cricotopus bicinctus*	2				4				
Diptera	Chironomidae	*Cricotopus* sp.							14		
Diptera	Chironomidae	*Dicrotendipes neomodestus*	13		2	2	7				
Diptera	Chironomidae	*Dicrotendipes* nr. *notatus*									
Diptera	Chironomidae	*Endochironomus* nr. *tendens*				2					
Diptera	Chironomidae	*Eukiefferiella* sp.									
Diptera	Chironomidae	*Fittkauimyia* sp.									
Diptera	Chironomidae	*Hydrobaenus* sp.			7						

Order	Family	Taxon	James River	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River
Diptera	Chironomidae	*Labrundinia neopilosella*	1								
Diptera	Chironomidae	*Labrundinia* sp.									
Diptera	Chironomidae	*Larsia* sp.									
Diptera	Chironomidae	*Lauterborniella agrayloides*	6		7						
Diptera	Chironomidae	*Micropsectra* sp.	1			2					
Diptera	Chironomidae	*Microtendipes pedellus* gr.	4				4				
Diptera	Chironomidae	*Nanocladius rectinervis*							3		
Diptera	Chironomidae	*Natarsia punctata*									
Diptera	Chironomidae	*Nilotanypus* sp.					22				
Diptera	Chironomidae	*Nilothauma* sp.	1								
Diptera	Chironomidae	*Orthocladius* sp.	1			2	47		3	2	
Diptera	Chironomidae	*Paracladius* sp.									
Diptera	Chironomidae	*Paracladopelma* sp.		2							
Diptera	Chironomidae	*Paralauterborniella* sp.									
Diptera	Chironomidae	*Paramerina* sp.									
Diptera	Chironomidae	*Parametriocnemus* sp.									
Diptera	Chironomidae	*Paratanytarsus* sp.	1								
Diptera	Chironomidae	*Pentaneura* sp.	1		4	2				1	2
Diptera	Chironomidae	*Phaenopsectra* sp.				2					
Diptera	Chironomidae	*Polypedilum convictum*	11		11						
Diptera	Chironomidae	*Polypedilum illinoense*			4	9	4				
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. B									
Diptera	Chironomidae	*Polypedilum* sp.								4	1
Diptera	Chironomidae	*Procladius* sp.								1	
Diptera	Chironomidae	*Pseudochironomus* sp.	34				14		3	3	
Diptera	Chironomidae	*Rheocricotopus fuscipes* gr.			13				2		
Diptera	Chironomidae	*Rheocricotopus* sp.		2							
Diptera	Chironomidae	*Rheotanytarsus exiguus* gr.	6		2		36		17		
Diptera	Chironomidae	*Rheotanytarsus* sp.		1							5
Diptera	Chironomidae	*Saetheria* sp.									
Diptera	Chironomidae	*Stictochironomus devinctus*	1								
Diptera	Chironomidae	Subfamily: Orthocladiinae									
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.	5		4		14				
Diptera	Chironomidae	*Tanytarsus guerlus* gr.	3		9	4	7				
Diptera	Chironomidae	*Tanytarsus* sp.		2						3	

Order	Family	Taxon	James River	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River
Diptera	Chironomidae	*Thienemanniella* nr. *xena*					7		2		
Diptera	Chironomidae	*Thienemanniella* sp.									
Diptera	Chironomidae	*Virgatanytarsus* sp.			2	2	25				
Diptera	Chironomidae	*Xenochironomus xenolabis*									
Diptera	Culicidae	*Anopheles* sp.									
Diptera	Culicidae	*Culex* sp.									1
Diptera	Culicidae	Culicidae									
Diptera	Empididae	*Hemerodromia* sp.	1		1		2	1	13		
Diptera	Sarcophagidae	*Sarcophaga dux*									
Diptera	Simuliidae	*Simulium* nr. *argus*					2				
Diptera	Simuliidae	*Simulium* nr. *bivittatum*									
Diptera	Simuliidae	*Simulium* nr. *trivittatum*					1		7		
Diptera	Simuliidae	*Simulium* sp.		7	2			57		21	39
Diptera	Stratiomyidae	*Caloparyphus* sp.									
Diptera	Stratiomyidae	*Euparyphus* sp.			1		5			6	
Diptera	Stratiomyidae	*Nemotelus* sp.									
Diptera	Stratiomyidae	*Odontomyia* sp.								1	
Diptera	Stratiomyidae	*Stratiomys* sp.									
Diptera	Tabanidae	*Haematopota* sp.						1			
Diptera	Tabanidae	*Tabanus* sp.					8	21		5	
Diptera	Tipulidae	*Cryptolabis* sp.						13			
Diptera	Tipulidae	*Dicranota* sp.									
Diptera	Tipulidae	*Geranomyia* sp.			1						
Diptera	Tipulidae	*Hexatoma* sp.						41			
Diptera	Tipulidae	*Pedicia* sp.			5						
Diptera	Tipulidae	*Tipula* sp.						14		4	
Ephemeroptera	Baetidae	*Acentrella* sp.						2			
Ephemeroptera	Baetidae	*Baetis* sp.						17			70
Ephemeroptera	Baetidae	*Baetodes edmundsi*				1			13		
Ephemeroptera	Baetidae	*Baetodes* sp.						5			2
Ephemeroptera	Baetidae	*Callibaetis* sp.	2								
Ephemeroptera	Baetidae	*Camelobaetidius mexicanus*					4		27		
Ephemeroptera	Baetidae	*Camelobaetidius* sp.						28		14	19
Ephemeroptera	Baetidae	*Centroptilum* sp.				2					36
Ephemeroptera	Baetidae	*Cloeon* sp.									

Order	Family	Taxon	James River	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River
Ephemeroptera	Baetidae	*Fallceon quilleri*			4	1	36	9	2	6	41
Ephemeroptera	Baetidae	*Fallceon* sp.		36				64			
Ephemeroptera	Baetidae	*Paracloeodes* sp.									
Ephemeroptera	Baetidae	*Plauditus* sp.						41			
Ephemeroptera	Baetidae	*Procloeon* sp.									
Ephemeroptera	Baetidae	*Pseudocloeon* sp.		1							
Ephemeroptera	Caenidae	*Brachycercus* sp.	39								
Ephemeroptera	Caenidae	*Caenis* sp.	12	9		3	8	3			
Ephemeroptera	Ephemeridae	*Hexagenia* sp.		1				1			
Ephemeroptera	Heptageniidae	*Maccaffertium* sp.								15	
Ephemeroptera	Heptageniidae	*Stenacron* sp.									3
Ephemeroptera	Heptageniidae	*Stenonema femoratum*									
Ephemeroptera	Heptageniidae	*Stenonema* sp.	6							29	2
Ephemeroptera	Isonychiidae	*Isonychia sicca manca*	2		4				3		
Ephemeroptera	Isonychiidae	*Isonychia* sp.		19				291			2
Ephemeroptera	Leptohyphidae	*Asioplax* sp.						1			
Ephemeroptera	Leptohyphidae	*Leptohyphes michaeli*			9	3					
Ephemeroptera	Leptohyphidae	*Leptohyphes packeri*									
Ephemeroptera	Leptohyphidae	*Leptohyphes* sp.						209			
Ephemeroptera	Leptohyphidae	*Leptohyphes succinus*				1			17		
Ephemeroptera	Leptohyphidae	*Leptohyphes vescus*	3		4	1			24		
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr.	26		11	47	10		17		
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr. sp. B									
Ephemeroptera	Leptohyphidae	*Tricorythodes curvatus* gr.							23		
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.		6				66		18	7
Ephemeroptera	Leptohyphidae	*Vacupernius packeri*		15							1
Ephemeroptera	Leptophlebiidae	*Choroterpes mexicanus*	39		34	31	117				
Ephemeroptera	Leptophlebiidae	*Farrodes texanus*									
Ephemeroptera	Leptophlebiidae	*Neochoroterpes* sp.						13		1	21
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia* sp.									
Ephemeroptera	Leptophlebiidae	*Thraulodes gonzalesi*	23		12	3			7		
Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.		18				465			35
Ephemeroptera	Leptophlebiidae	*Traverella presidiana*	88						13		
Ephemeroptera	Leptophlebiidae	*Traverella* sp.		55				319			
Hemiptera	Belostomatidae	*Belostoma* sp.									

Order	Family	Taxon	James River	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River
Hemiptera	Corixidae	*Trichocorixa* sp.									
Hemiptera	Gerridae	*Rheumatobates* sp.						1			
Hemiptera	Gerridae	*Trepobates* sp.									1
Hemiptera	Hebridae	*Hebrus* sp.			1	1					
Hemiptera	Hebridae	*Merragata* sp.			1						
Hemiptera	Naucoridae	*Ambrysus circumcinctus*	5			21	2		1		
Hemiptera	Naucoridae	*Ambrysus lunatus*					2				
Hemiptera	Naucoridae	*Ambrysus* sp.		13				104		12	1
Hemiptera	Naucoridae	*Cryphocricos* sp.						131			
Hemiptera	Naucoridae	*Limnocoris lutzi*									
Hemiptera	Naucoridae	*Limnocoris* sp.						59			
Hemiptera	Naucoridae	*Pelocoris* sp.									
Hemiptera	Nepidae	*Ranatra* sp.									
Hemiptera	Saldidae	*Saldula* sp.									
Hemiptera	Veliidae	*Microvelia* sp.				1	3	1			
Hemiptera	Veliidae	*Rhagovelia* sp.		14						4	
Hemiptera	Veliidae	*Steinovelia* sp.									
Hirudinea		Hirudinea						5			
Hirudinida	Erpobdellidae	*Mooreobdella microstoma*									
Hirudinida	Glossiphoniidae	*Helobdella elongata*					1				
Hirudinida	Glossiphoniidae	*Helobdella* sp.									
Hirudinida	Glossiphoniidae	*Helobdella stagnalis*									
Hirudinida	Glossiphoniidae	*Helobdella triserialis*									
Hirudinida	Glossiphoniidae	*Placobdella* sp.									
Hoplonemertea	Tetrastemmatidae	*Prostoma rubrum*			19	1	21		1		
Lepidoptera	Crambidae	*Parapoynx* sp.						1			
Lepidoptera	Crambidae	*Petrophila* sp.	3		2		45	6	12		
Lepidoptera	Crambidae	*Synclita* sp.									
Megaloptera	Corydalidae	*Corydalus cornutus*	7	5	2	1		50	5	4	
Nematoda		Nematoda						4			
Neoophora	Dugesiidae	*Dugesia dorotocephala*				13					
Neoophora	Dugesiidae	*Dugesia* sp.		2				22		9	
Neoophora	Dugesiidae	*Dugesia tigrina*	8		11		20		1		
Neotaenioglossa	Amnicolidae	*Amnicola* sp.									
Neotaenioglossa	Hydrobiidae	*Cincinnatia cincinnatiensis*	3								

Order	Family	Taxon	James River	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River
Neotaenioglossa	Hydrobiidae	*Cochliopina riograndensis*									
Neotaenioglossa	Pleuroceridae	*Elimia* sp.						1			
Neotaenioglossa	Thiaridae	*Melanoides tuberculata*									1
Neuroptera	Sisyridae	*Climacia areolaris*									
Odonata	Aeschnidae	*Basiaeschna janata*									
Odonata	Aeschnidae	*Basiaeschna* sp.									
Odonata	Calopterygidae	*Hetaerina* sp.	3	1				13	1	1	5
Odonata	Coenagrionidae	*Argia* sp.	31	10		3		51		14	10
Odonata	Coenagrionidae	*Argia* sp. A			2		2		8		
Odonata	Coenagrionidae	*Argia* sp. B			2		5		7		
Odonata	Coenagrionidae	*Enallagma* sp.									
Odonata	Coenagrionidae	*Ischnura* sp.				3					
Odonata	Corduliidae	*Epitheca* sp.									
Odonata	Corduliidae	*Macromia* sp.									
Odonata	Corduliidae	*Neurocordulia* sp.						3			
Odonata	Gomphidae	*Erpetogomphus* sp.	4	4			11	76		5	3
Odonata	Gomphidae	*Phyllogomphoides* sp.									
Odonata	Gomphidae	*Progomphus* sp.						1			
Odonata	Lestidae	*Lestes* sp.									
Odonata	Libellulidae	*Brechmorhoga mendax*			3	1			2		
Odonata	Libellulidae	*Brechmorhoga* sp.		3				17		5	6
Odonata	Libellulidae	*Erythemis* sp.									
Odonata	Libellulidae	*Erythrodiplax* sp.									
Odonata	Libellulidae	*Libellula* sp.									
Odonata	Libellulidae	Libellulidae									
Odonata	Libellulidae	*Macrothemis* sp.									
Odonata	Libellulidae	*Pachydiplax* sp.									
Odonata	Libellulidae	*Perithemis* sp.									
Oligochaeta		Oligochaeta		6				7		3	3
Opisthopora	Lumbricidae	Lumbricidae			11						
Opisthopora	Sparganophilidae	*Sparganophilus tamesis*	1						7		
Ostracoda		Ostracoda						16			
Plecoptera	Perlidae	*Neoperla clymene*				3					
Plecoptera	Perlidae	*Perlesta* sp.						18			
Plecoptera	Perlidae	*Perlinella* sp.									6

Order	Family	Taxon	James River	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River
Podocopida	Candonidae	*Candona* sp.									
Podocopida	Cyprididae	*Chlamydotheca arcuata*			1						
Podocopida	Cyprididae	*Cypridopsis vidua*									
Podocopida	Cyprididae	*Herpetocypris* nr. *reptans*							1		
Podocopida	Cyprididae	*Herpetocypris* sp.									
Podocopida	Cyprididae	*Stenocypris* nr. *malcolmsoni*									
Podocopida	Cyprididae	*Stenocypris* sp.									
Sarcoptiformes	Hydrozetidae	*Hydrozetes* sp.	1								
Trichoptera	Ecnomidae	*Austrotinodes* sp.									
Trichoptera	Glossosomatidae	*Protoptila* sp.						1			1
Trichoptera	Helicopsychidae	*Helicopsyche* sp.	11				10	10			3
Trichoptera	Hydrobiosidae	*Atopsyche* sp.									
Trichoptera	Hydropsychidae	*Ceratopsyche* sp.						1			
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.	5		117	10		43	15	59	22
Trichoptera	Hydropsychidae	*Hydropsyche* sp.	3	11				12	3		31
Trichoptera	Hydropsychidae	*Smicridea* sp.	5	10	9			31	5		1
Trichoptera	Hydroptilidae	*Hydroptila* sp.	4	6	20	44	108	4	62		2
Trichoptera	Hydroptilidae	*Hydroptila* sp. A									
Trichoptera	Hydroptilidae	*Hydroptila* sp. B									
Trichoptera	Hydroptilidae	*Ithytrichia* sp.	3				19				
Trichoptera	Hydroptilidae	*Mayatrichia* nr. *ayama*							1		
Trichoptera	Hydroptilidae	*Mayatrichia* nr. *ponta*			1	2			3		
Trichoptera	Hydroptilidae	*Metrichia* sp.						2			
Trichoptera	Hydroptilidae	*Neotrichia* sp.		1		8			4		
Trichoptera	Hydroptilidae	*Ochrotrichia* sp.					14		5		1
Trichoptera	Hydroptilidae	*Orthotrichia* sp.									
Trichoptera	Hydroptilidae	*Oxyethira* sp.	3	1	2	25	19		5		
Trichoptera	Hydroptilidae	*Stactobiella* sp.									1
Trichoptera	Leptoceridae	*Nectopsyche gracilis*	1								
Trichoptera	Leptoceridae	*Nectopsyche* sp.						1			
Trichoptera	Leptoceridae	*Oecetis* sp.	1					1			1
Trichoptera	Leptoceridae	*Oecetis* sp. A							1		
Trichoptera	Leptoceridae	*Oecetis* sp. B									
Trichoptera	Leptoceridae	*Triaenodes* sp.									
Trichoptera	Odontoceridae	*Marilia flexuosa*									

Order	Family	Taxon	James River	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River
Trichoptera	Odontoceridae	*Marilia* sp.								1	
Trichoptera	Philopotamidae	*Chimarra* sp.	10	15			3	338	43	92	42
Trichoptera	Philopotamidae	*Chimarra* sp. A			29	12					
Trichoptera	Philopotamidae	*Chimarra* sp. B			85	1					
Trichoptera	Philopotamidae	*Dolophilodes* sp.								16	
Trichoptera	Philopotamidae	*Wormaldia* sp.									
Trichoptera	Polycentropodidae	*Cernotina* sp.									4
Trichoptera	Polycentropodidae	*Neureclipsis* sp.	1							1	9
Trichoptera	Polycentropodidae	*Polycentropus* sp.			11	2			1		
Trichoptera	Polycentropodidae	*Polyplectropus charlesi*				1					
Trichoptera	Polycentropodidae	*Polyplectropus proditus*							2		
Trichoptera	Polycentropodidae	*Polyplectropus* sp.									
Trombidiformes	Arrenuridae	*Arrenurus* sp.									
Trombidiformes		Hydracarina (Hydrachnidia)						9		3	2
Trombidiformes	Hydrodromidae	*Hydrodroma despiciens*									
Trombidiformes	Limnocharidae	*Limnochares* sp.							2		
Trombidiformes	Sperchontidae	*Sperchon* sp.									
Trombidiformes	Sperchontidae	*Sperchon texana*									
Trombidiformes	Torrenticolidae	*Torrenticola* sp.									
Tubificida	Naididae	*Aulodrilus pigueti*									
Tubificida	Naididae	*Branchiura sowerbyi*	6								
Tubificida	Naididae	*Bratislavia unidentata*	3								
Tubificida	Naididae	*Chaetogaster diaphanus*									
Tubificida	Naididae	*Dero nivea*	1								
Tubificida	Naididae	*Dero trifida*									
Tubificida	Naididae	*Limnodrilus hoffmeisteri*									
Tubificida	Naididae	*Limnodrilus* sp.	4								
Tubificida	Naididae	*Nais pardalis*									
Tubificida	Naididae	*Nais variabilis*									
Tubificida	Naididae	*Pristina americana*	3								
Tubificida	Naididae	*Pristina leidyi*			2		16				
Tubificida	Naididae	*Pristina osborni*									
Tubificida	Naididae	*Pristina sima*			2						
Tubificida	Naididae	*Slavina appendiculata*	1		45	14			2		
Turbellaria		Turbellaria						69			

Order	Family	Taxon	James River	Johnson Creek	Little Barton Creek	Little Blanco River	Live Oak Creek	Llano River	Medina River	Montell Creek	North Prong Medina River
Veneroida	Corbiculidae	*Corbicula fluminea*	4	7		1		70	9		3
Veneroida	Pisidiidae	*Eupera cubensis*									
Veneroida	Pisidiidae	*Pisidium compressum*									
Veneroida	Pisidiidae	*Pisidium nitidum*									
Veneroida	Pisidiidae	*Pisidium* sp.									
Veneroida	Pisidiidae	*Sphaerium* sp.						2			
Veneroida	Sphaeriidae	Sphaeriidae		1							
		Taxa Richness	71	42	57	52	49	77	56	42	55
		Total N Individuals	561	406	608	366	774	3,775	487	474	589
		Number of Samples	n = 2	n = 2	n = 1	n = 1	n = 1	n = 25	n = 1	n = 2	n = 3

Appendix E - 4 CONT. Benthic macroinvertebrate taxa list by stream for Ecoregion 30; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	Nueces River	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Llano River	Spring Creek	West Rocky Creek
Amphipoda	Hyalellidae	*Hyalella azteca*	37			23	3	48			3
Amphipoda	Hyalellidae	*Hyalella* sp.									
Anthoathecata	Hydridae	*Hydra* sp.		3	8						
Basommatophora	Ancylidae	*Ferrissia rivularis*								1	2
Basommatophora	Ancylidae	*Ferrissia* sp.						2			
Basommatophora	Lymnaeidae	*Fossaria dalli*									
Basommatophora	Lymnaeidae	*Fossaria parva*		3	7					1	
Basommatophora	Lymnaeidae	*Fossaria* sp.						1			
Basommatophora	Lymnaeidae	*Lymnaea* sp.									
Basommatophora	Lymnaeidae	*Pseudosuccinea columella*									1
Basommatophora	Lymnaeidae	*Pseudosuccinea* sp.						6			
Basommatophora	Physidae	*Physa* sp.				3	4				
Basommatophora	Physidae	*Physella* sp.			1			25	2		
Basommatophora	Physidae	*Physella virgata*		1	2					5	
Basommatophora	Planorbidae	*Biomphalaria obstructus*			7					1	
Basommatophora	Planorbidae	*Gyraulus parvus*									
Basommatophora	Planorbidae	*Gyraulus* sp.				1		1			
Basommatophora	Planorbidae	*Helisoma anceps*		2	2					1	
Basommatophora	Planorbidae	*Helisoma* sp.				5		7	1		
Basommatophora	Planorbidae	*Planorbella* sp.						4			
Basommatophora	Planorbidae	*Planorbula* sp.							1		
Coleoptera	Dryopidae	*Helichus* sp.				14	7	5	1		
Coleoptera	Dryopidae	*Helichus suturalis*		1							
Coleoptera	Dryopidae	*Pelonomus* sp.									
Coleoptera	Dytiscidae	*Celina* sp.						1			
Coleoptera	Dytiscidae	*Hydrovatus* sp.						1			
Coleoptera	Dytiscidae	*Uvarus* sp.						7			
Coleoptera	Elmidae	*Dubiraphia* sp.									
Coleoptera	Elmidae	*Dubiraphia vittata*									1
Coleoptera	Elmidae	*Heterelmis* sp.									
Coleoptera	Elmidae	*Hexacylloepus ferrugineus*		21	74				25	167	37
Coleoptera	Elmidae	*Hexacylloepus* sp.			6	245	60	2	154		

Order	Family	Taxon	Nueces River	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Llano River	Spring Creek	West Rocky Creek
Coleoptera	Elmidae	*Macrelmis* sp.	10		1	2	10		19		
Coleoptera	Elmidae	*Macrelmis texana*			68				10		1
Coleoptera	Elmidae	*Macronychus* sp.									
Coleoptera	Elmidae	*Microcylloepus pusillus*		9	159				25	28	79
Coleoptera	Elmidae	*Microcylloepus* sp.	3		8	189	96	7	65		
Coleoptera	Elmidae	*Neocylloepus* sp.									
Coleoptera	Elmidae	*Neoelmis caesa*			1				5	9	28
Coleoptera	Elmidae	*Neoelmis* sp.	1			19		1	2		
Coleoptera	Elmidae	*Phanocerus clavicornis*									
Coleoptera	Elmidae	*Stenelmis cheryl*								2	2
Coleoptera	Elmidae	*Stenelmis occidentalis*									
Coleoptera	Elmidae	*Stenelmis* sp.		6	1	26	35	18	21		
Coleoptera	Gyrinidae	*Gyretes* sp.							1		
Coleoptera	Haliplidae	*Haliplus* sp.				1					
Coleoptera	Haliplidae	*Peltodytes* sp.				2		1		11	
Coleoptera	Hydrochidae	*Hydrochus* sp.				3					
Coleoptera	Hydrophilidae	*Berosus* sp.			2	4	1	1		1	
Coleoptera	Hydrophilidae	*Derallus* sp.			2						
Coleoptera	Hydrophilidae	*Enochrus* sp.									
Coleoptera	Hydrophilidae	*Helochares* sp.						1			
Coleoptera	Hydrophilidae	*Laccobius* sp.									
Coleoptera	Hydrophilidae	*Paracymus* sp.									
Coleoptera	Hydrophilidae	*Tropisternus* sp.									
Coleoptera	Lutrochidae	*Lutrochus luteus*		2	12				3	5	
Coleoptera	Lutrochidae	*Lutrochus* sp.			2	12	1		4		
Coleoptera	Psephenidae	*Psephenus* sp.	1			1		68			
Coleoptera	Psephenidae	*Psephenus texanus*									5
Coleoptera	Scirtidae	*Cyphon* sp.									
Coleoptera	Staphylinidae	Staphylinidae				9					
Coleoptera	Staphylinidae	*Stenus* sp.									
Collembola		Collembola						1			
Copepoda		Copepoda					1				
Decapoda	Cambaridae	Cambaridae									
Decapoda	Cambaridae	*Faxonella* sp.									
Decapoda	Palaemonidae	*Palaemonetes* sp.									

Order	Family	Taxon	Nueces River	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Llano River	Spring Creek	West Rocky Creek
Diptera	Athericidae	*Atherix* sp.	11		1				1		
Diptera	Athericidae	*Atherix variegata*			4						
Diptera	Athericidae	*Suragina* sp.									
Diptera	Ceratopogonidae	*Alluaudomyia* sp.						1			
Diptera	Ceratopogonidae	*Atrichopogon* sp.		8							
Diptera	Ceratopogonidae	*Bezzia* sp.	2			4	2	14	1		
Diptera	Ceratopogonidae	*Culicoides* sp.				2					
Diptera	Ceratopogonidae	*Dasyhelea* sp.									
Diptera	Ceratopogonidae	*Forcipomyia* sp.					1				
Diptera	Ceratopogonidae	*Mallochohelea* sp.									
Diptera	Ceratopogonidae	*Palpomyia tibialis*		2	43				2		
Diptera	Ceratopogonidae	*Probezzia* sp.		30	3	1			8	9	1
Diptera	Ceratopogonidae	*Probezzia* sp. A									
Diptera	Ceratopogonidae	*Probezzia* sp. B									
Diptera	Ceratopogonidae	*Serromyia* sp.						1			
Diptera	Ceratopogonidae	*Stilobezzia* sp.									
Diptera	Chironomidae	*Ablabesmyia cinctipes*									
Diptera	Chironomidae	*Ablabesmyia* sp.	2								
Diptera	Chironomidae	*Axarus* sp.								2	
Diptera	Chironomidae	*Cardiocladius* sp.									
Diptera	Chironomidae	Chironomidae	1			36	77	100	45		
Diptera	Chironomidae	*Chironomus* sp.						3			
Diptera	Chironomidae	*Cladotanytarsus* sp.									
Diptera	Chironomidae	*Cladotanytarsus vanderwulpi* gr.									
Diptera	Chironomidae	*Conchapelopia* sp.	10	1	1				6	10	3
Diptera	Chironomidae	*Corynocera* sp.									
Diptera	Chironomidae	*Corynoneura* nr. *taris*			1						
Diptera	Chironomidae	*Cricotopus bicinctus*								10	
Diptera	Chironomidae	*Cricotopus* sp.									
Diptera	Chironomidae	*Dicrotendipes neomodestus*								3	17
Diptera	Chironomidae	*Dicrotendipes* nr. *notatus*									
Diptera	Chironomidae	*Endochironomus* nr. *tendens*									
Diptera	Chironomidae	*Eukiefferiella* sp.									
Diptera	Chironomidae	*Fittkauimyia* sp.						2			
Diptera	Chironomidae	*Hydrobaenus* sp.									

Order	Family	Taxon	Nueces River	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Llano River	Spring Creek	West Rocky Creek
Diptera	Chironomidae	*Labrundinia neopilosella*									
Diptera	Chironomidae	*Labrundinia* sp.						1			
Diptera	Chironomidae	*Larsia* sp.						1			
Diptera	Chironomidae	*Lauterborniella agrayloides*		3							3
Diptera	Chironomidae	*Micropsectra* sp.									
Diptera	Chironomidae	*Microtendipes pedellus* gr.									
Diptera	Chironomidae	*Nanocladius rectinervis*									
Diptera	Chironomidae	*Natarsia punctata*									
Diptera	Chironomidae	*Nilotanypus* sp.									
Diptera	Chironomidae	*Nilothauma* sp.								2	
Diptera	Chironomidae	*Orthocladius* sp.	2							2	
Diptera	Chironomidae	*Paracladius* sp.									
Diptera	Chironomidae	*Paracladopelma* sp.									
Diptera	Chironomidae	*Paralauterborniella* sp.									
Diptera	Chironomidae	*Paramerina* sp.		1							
Diptera	Chironomidae	*Parametriocnemus* sp.						1			
Diptera	Chironomidae	*Paratanytarsus* sp.									
Diptera	Chironomidae	*Pentaneura* sp.	5		1			1	3	5	3
Diptera	Chironomidae	*Phaenopsectra* sp.									
Diptera	Chironomidae	*Polypedilum convictum*							9	14	88
Diptera	Chironomidae	*Polypedilum illinoense*		1						5	
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. B									14
Diptera	Chironomidae	*Polypedilum* sp.	3		8			4			
Diptera	Chironomidae	*Procladius* sp.									
Diptera	Chironomidae	*Pseudochironomus* sp.			6				6	6	34
Diptera	Chironomidae	*Rheocricotopus fuscipes* gr.			13				3		
Diptera	Chironomidae	*Rheocricotopus* sp.									
Diptera	Chironomidae	*Rheotanytarsus exiguus* gr.			1				32	24	19
Diptera	Chironomidae	*Rheotanytarsus* sp.			4						
Diptera	Chironomidae	*Saetheria* sp.									
Diptera	Chironomidae	*Stictochironomus devinctus*									
Diptera	Chironomidae	Subfamily: Orthocladiinae							3		
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.			1					2	10
Diptera	Chironomidae	*Tanytarsus guerlus* gr.		1	1						10
Diptera	Chironomidae	*Tanytarsus* sp.	1					2			

Order	Family	Taxon	Nueces River	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Llano River	Spring Creek	West Rocky Creek
Diptera	Chironomidae	*Thienemanniella* nr. *xena*								2	3
Diptera	Chironomidae	*Thienemanniella* sp.									
Diptera	Chironomidae	*Virgatanytarsus* sp.									
Diptera	Chironomidae	*Xenochironomus xenolabis*			1						
Diptera	Culicidae	*Anopheles* sp.				4					
Diptera	Culicidae	*Culex* sp.									
Diptera	Culicidae	Culicidae				1					
Diptera	Empididae	*Hemerodromia* sp.							2		
Diptera	Sarcophagidae	*Sarcophaga dux*									
Diptera	Simuliidae	*Simulium* nr. *argus*									
Diptera	Simuliidae	*Simulium* nr. *bivittatum*							12	8	13
Diptera	Simuliidae	*Simulium* nr. *trivittatum*							35		
Diptera	Simuliidae	*Simulium* sp.			22	5	12	5	6		
Diptera	Stratiomyidae	*Caloparyphus* sp.	9								
Diptera	Stratiomyidae	*Euparyphus* sp.			1						
Diptera	Stratiomyidae	*Nemotelus* sp.			1						
Diptera	Stratiomyidae	*Odontomyia* sp.						1			
Diptera	Stratiomyidae	*Stratiomys* sp.				1		2			
Diptera	Tabanidae	*Haematopota* sp.							2		
Diptera	Tabanidae	*Tabanus* sp.		5	2	13	2		8		
Diptera	Tipulidae	*Cryptolabis* sp.				2			2		
Diptera	Tipulidae	*Dicranota* sp.						1			
Diptera	Tipulidae	*Geranomyia* sp.					1				
Diptera	Tipulidae	*Hexatoma* sp.							2		
Diptera	Tipulidae	*Pedicia* sp.									
Diptera	Tipulidae	*Tipula* sp.				8			1		
Ephemeroptera	Baetidae	*Acentrella* sp.	18								
Ephemeroptera	Baetidae	*Baetis* sp.				40	1	1	28		
Ephemeroptera	Baetidae	*Baetodes edmundsi*									2
Ephemeroptera	Baetidae	*Baetodes* sp.					2				
Ephemeroptera	Baetidae	*Callibaetis* sp.				5		7			
Ephemeroptera	Baetidae	*Camelobaetidius mexicanus*			8					22	1
Ephemeroptera	Baetidae	*Camelobaetidius* sp.	23		4	8	15		26		
Ephemeroptera	Baetidae	*Centroptilum* sp.									
Ephemeroptera	Baetidae	*Cloeon* sp.									

Order	Family	Taxon	Nueces River	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Llano River	Spring Creek	West Rocky Creek
Ephemeroptera	Baetidae	*Fallceon quilleri*	84	4	17			34	58	22	9
Ephemeroptera	Baetidae	*Fallceon* sp.				117	49				
Ephemeroptera	Baetidae	*Paracloeodes* sp.									
Ephemeroptera	Baetidae	*Plauditus* sp.				77	41		6		
Ephemeroptera	Baetidae	*Procloeon* sp.									
Ephemeroptera	Baetidae	*Pseudocloeon* sp.									
Ephemeroptera	Caenidae	*Brachycercus* sp.							1		
Ephemeroptera	Caenidae	*Caenis* sp.		1	1	25	1	33		1	12
Ephemeroptera	Ephemeridae	*Hexagenia* sp.									
Ephemeroptera	Heptageniidae	*Maccaffertium* sp.									
Ephemeroptera	Heptageniidae	*Stenacron* sp.						7			
Ephemeroptera	Heptageniidae	*Stenonema femoratum*									6
Ephemeroptera	Heptageniidae	*Stenonema* sp.						3	1		
Ephemeroptera	Isonychiidae	*Isonychia sicca manca*		2	16				7	7	1
Ephemeroptera	Isonychiidae	*Isonychia* sp.			77	224	172		137		
Ephemeroptera	Leptohyphidae	*Asioplax* sp.	1								
Ephemeroptera	Leptohyphidae	*Leptohyphes michaeli*									
Ephemeroptera	Leptohyphidae	*Leptohyphes packeri*								3	
Ephemeroptera	Leptohyphidae	*Leptohyphes* sp.	11			57	40		104		
Ephemeroptera	Leptohyphidae	*Leptohyphes succinus*									
Ephemeroptera	Leptohyphidae	*Leptohyphes vescus*							15	1	20
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr.			12				9		18
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr. sp. B									11
Ephemeroptera	Leptohyphidae	*Tricorythodes curvatus* gr.									
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.	57		29	79	7	44	23		
Ephemeroptera	Leptohyphidae	*Vacupernius packeri*	6		36						
Ephemeroptera	Leptophlebiidae	*Choroterpes mexicanus*		20						2	97
Ephemeroptera	Leptophlebiidae	*Farrodes texanus*									
Ephemeroptera	Leptophlebiidae	*Neochoroterpes* sp.	36						19		
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia* sp.						1			
Ephemeroptera	Leptophlebiidae	*Thraulodes gonzalesi*			3				26	31	
Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.			4	60	164		527		
Ephemeroptera	Leptophlebiidae	*Traverella presidiana*			1				63	1	
Ephemeroptera	Leptophlebiidae	*Traverella* sp.				8	391		148		
Hemiptera	Belostomatidae	*Belostoma* sp.						3			

Order	Family	Taxon	Nueces River	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Llano River	Spring Creek	West Rocky Creek
Hemiptera	Corixidae	*Trichocorixa* sp.									
Hemiptera	Gerridae	*Rheumatobates* sp.			1			1			
Hemiptera	Gerridae	*Trepobates* sp.								1	
Hemiptera	Hebridae	*Hebrus* sp.									
Hemiptera	Hebridae	*Merragata* sp.				2					
Hemiptera	Naucoridae	*Ambrysus circumcinctus*		2					1	10	14
Hemiptera	Naucoridae	*Ambrysus lunatus*								2	
Hemiptera	Naucoridae	*Ambrysus* sp.	4			51	72	4	60		
Hemiptera	Naucoridae	*Cryphocricos* sp.	14			2			78		
Hemiptera	Naucoridae	*Limnocoris lutzi*							1		
Hemiptera	Naucoridae	*Limnocoris* sp.				4			12		
Hemiptera	Naucoridae	*Pelocoris* sp.									
Hemiptera	Nepidae	*Ranatra* sp.								1	
Hemiptera	Saldidae	*Saldula* sp.					1				
Hemiptera	Veliidae	*Microvelia* sp.									
Hemiptera	Veliidae	*Rhagovelia* sp.		11	3		3	22	2	1	2
Hemiptera	Veliidae	*Steinovelia* sp.						1			
Hirudinea		Hirudinea					5		2	1	
Hirudinida	Erpobdellidae	*Mooreobdella microstoma*									2
Hirudinida	Glossiphoniidae	*Helobdella elongata*									
Hirudinida	Glossiphoniidae	*Helobdella* sp.						2			
Hirudinida	Glossiphoniidae	*Helobdella stagnalis*									
Hirudinida	Glossiphoniidae	*Helobdella triserialis*								2	
Hirudinida	Glossiphoniidae	*Placobdella* sp.						1			
Hoplonemertea	Tetrastemmatidae	*Prostoma rubrum*		5	2					1	1
Lepidoptera	Crambidae	*Parapoynx* sp.									
Lepidoptera	Crambidae	*Petrophila* sp.	2		2	1	1		21	10	5
Lepidoptera	Crambidae	*Synclita* sp.								1	
Megaloptera	Corydalidae	*Corydalus cornutus*	1	5	77	5	9		47	4	9
Nematoda		Nematoda			1					1	2
Neoophora	Dugesiidae	*Dugesia dorotocephala*									
Neoophora	Dugesiidae	*Dugesia* sp.	25		1	12	1	107	26		
Neoophora	Dugesiidae	*Dugesia tigrina*		28	17				10	2	22
Neotaenioglossa	Amnicolidae	*Amnicola* sp.				3		4			
Neotaenioglossa	Hydrobiidae	*Cincinnatia cincinnatiensis*									

Order	Family	Taxon	Nueces River	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Llano River	Spring Creek	West Rocky Creek
Neotaenioglossa	Hydrobiidae	*Cochliopina riograndensis*									
Neotaenioglossa	Pleuroceridae	*Elimia* sp.									
Neotaenioglossa	Thiaridae	*Melanoides tuberculata*									
Neuroptera	Sisyridae	*Climacia areolaris*									2
Odonata	Aeschnidae	*Basiaeschna janata*									
Odonata	Aeschnidae	*Basiaeschna* sp.						3			
Odonata	Calopterygidae	*Hetaerina* sp.			10	26	6	8	2		
Odonata	Coenagrionidae	*Argia* sp.	14	5	44	55	12	202	103		
Odonata	Coenagrionidae	*Argia* sp. A			1					33	4
Odonata	Coenagrionidae	*Argia* sp. B			17					22	2
Odonata	Coenagrionidae	*Enallagma* sp.				22		15			
Odonata	Coenagrionidae	*Ischnura* sp.							1		
Odonata	Corduliidae	*Epitheca* sp.						1			
Odonata	Corduliidae	*Macromia* sp.									
Odonata	Corduliidae	*Neurocordulia* sp.									
Odonata	Gomphidae	*Erpetogomphus* sp.		10	6	45	1	3	6	1	
Odonata	Gomphidae	*Phyllogomphoides* sp.									
Odonata	Gomphidae	*Progomphus* sp.									
Odonata	Lestidae	*Lestes* sp.			1						
Odonata	Libellulidae	*Brechmorhoga mendax*			3				2	1	
Odonata	Libellulidae	*Brechmorhoga* sp.	1		17	8	4	11	7		
Odonata	Libellulidae	*Erythemis* sp.				3					
Odonata	Libellulidae	*Erythrodiplax* sp.									
Odonata	Libellulidae	*Libellula* sp.						2			
Odonata	Libellulidae	Libellulidae						2			
Odonata	Libellulidae	*Macrothemis* sp.						1			
Odonata	Libellulidae	*Pachydiplax* sp.									
Odonata	Libellulidae	*Perithemis* sp.									
Oligochaeta		Oligochaeta	3		20	1	7	5	3		
Opisthopora	Lumbricidae	Lumbricidae			4						
Opisthopora	Sparganophilidae	*Sparganophilus tamesis*							2	10	
Ostracoda		Ostracoda	2			2					
Plecoptera	Perlidae	*Neoperla clymene*									
Plecoptera	Perlidae	*Perlesta* sp.				11	12	3	10		
Plecoptera	Perlidae	*Perlinella* sp.									

Order	Family	Taxon	Nueces River	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Llano River	Spring Creek	West Rocky Creek
Podocopida	Candonidae	*Candona* sp.							1		
Podocopida	Cyprididae	*Chlamydotheca arcuata*		1	1					1	1
Podocopida	Cyprididae	*Cypridopsis vidua*		2							
Podocopida	Cyprididae	*Herpetocypris* nr. *reptans*									
Podocopida	Cyprididae	*Herpetocypris* sp.			9						
Podocopida	Cyprididae	*Stenocypris* nr. *malcolmsoni*									1
Podocopida	Cyprididae	*Stenocypris* sp.									
Sarcoptiformes	Hydrozetidae	*Hydrozetes* sp.									
Trichoptera	Ecnomidae	*Austrotinodes* sp.									
Trichoptera	Glossosomatidae	*Protoptila* sp.									
Trichoptera	Helicopsychidae	*Helicopsyche* sp.					5			1	58
Trichoptera	Hydrobiosidae	*Atopsyche* sp.									
Trichoptera	Hydropsychidae	*Ceratopsyche* sp.									
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.	25	1	178	11	20	112	54	8	30
Trichoptera	Hydropsychidae	*Hydropsyche* sp.			55	1	16		11		12
Trichoptera	Hydropsychidae	*Smicridea* sp.			1	7	38		24	10	41
Trichoptera	Hydroptilidae	*Hydroptila* sp.	1	1	68	3		1	52	44	
Trichoptera	Hydroptilidae	*Hydroptila* sp. A									54
Trichoptera	Hydroptilidae	*Hydroptila* sp. B									9
Trichoptera	Hydroptilidae	*Ithytrichia* sp.							1	3	3
Trichoptera	Hydroptilidae	*Mayatrichia* nr. *ayama*							1		
Trichoptera	Hydroptilidae	*Mayatrichia* nr. *ponta*		1	1				3		
Trichoptera	Hydroptilidae	*Metrichia* sp.									
Trichoptera	Hydroptilidae	*Neotrichia* sp.		3	1				1		
Trichoptera	Hydroptilidae	*Ochrotrichia* sp.			3			1			27
Trichoptera	Hydroptilidae	*Orthotrichia* sp.				1					
Trichoptera	Hydroptilidae	*Oxyethira* sp.	1		2				1	10	38
Trichoptera	Hydroptilidae	*Stactobiella* sp.									
Trichoptera	Leptoceridae	*Nectopsyche gracilis*									
Trichoptera	Leptoceridae	*Nectopsyche* sp.									
Trichoptera	Leptoceridae	*Oecetis* sp.					1	1	1		
Trichoptera	Leptoceridae	*Oecetis* sp. A								1	1
Trichoptera	Leptoceridae	*Oecetis* sp. B									
Trichoptera	Leptoceridae	*Triaenodes* sp.									
Trichoptera	Odontoceridae	*Marilia flexuosa*		19						2	99

Order	Family	Taxon	Nueces River	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Llano River	Spring Creek	West Rocky Creek
Trichoptera	Odontoceridae	*Marilia* sp.	51						1		
Trichoptera	Philopotamidae	*Chimarra* sp.		9	26	136	120	39	173	4	
Trichoptera	Philopotamidae	*Chimarra* sp. A			73						10
Trichoptera	Philopotamidae	*Chimarra* sp. B			12						2
Trichoptera	Philopotamidae	*Dolophilodes* sp.									
Trichoptera	Philopotamidae	*Wormaldia* sp.			1						
Trichoptera	Polycentropodidae	*Cernotina* sp.									
Trichoptera	Polycentropodidae	*Neureclipsis* sp.									
Trichoptera	Polycentropodidae	*Polycentropus* sp.	11		3				5		
Trichoptera	Polycentropodidae	*Polyplectropus charlesi*			2						
Trichoptera	Polycentropodidae	*Polyplectropus proditus*							2		
Trichoptera	Polycentropodidae	*Polyplectropus* sp.	7						1		
Trombidiformes	Arrenuridae	*Arrenurus* sp.									
Trombidiformes		Hydracarina (Hydrachnidia)	1		1	2	4	17			
Trombidiformes	Hydrodromidae	*Hydrodroma despiciens*		9							
Trombidiformes	Limnocharidae	*Limnochares* sp.									
Trombidiformes	Sperchontidae	*Sperchon* sp.								1	
Trombidiformes	Sperchontidae	*Sperchon texana*			1						
Trombidiformes	Torrenticolidae	*Torrenticola* sp.		1	18				2		
Tubificida	Naididae	*Aulodrilus pigueti*									5
Tubificida	Naididae	*Branchiura sowerbyi*		1					2		
Tubificida	Naididae	*Bratislavia unidentata*									
Tubificida	Naididae	*Chaetogaster diaphanus*									
Tubificida	Naididae	*Dero nivea*								1	
Tubificida	Naididae	*Dero trifida*									26
Tubificida	Naididae	*Limnodrilus hoffmeisteri*									21
Tubificida	Naididae	*Limnodrilus* sp.		2						2	
Tubificida	Naididae	*Nais pardalis*								1	
Tubificida	Naididae	*Nais variabilis*									
Tubificida	Naididae	*Pristina americana*									
Tubificida	Naididae	*Pristina leidyi*								2	7
Tubificida	Naididae	*Pristina osborni*									5
Tubificida	Naididae	*Pristina sima*									5
Tubificida	Naididae	*Slavina appendiculata*		2							
Turbellaria		Turbellaria				38	46				

Order	Family	Taxon	Nueces River	Oatmeal Creek	Onion Creek	Pedernales River	San Saba River	Slaughter Creek	South Llano River	Spring Creek	West Rocky Creek
Veneroida	Corbiculidae	*Corbicula fluminea*			111	12	29	4	21	37	23
Veneroida	Pisidiidae	*Eupera cubensis*								1	
Veneroida	Pisidiidae	*Pisidium compressum*									41
Veneroida	Pisidiidae	*Pisidium nitidum*									97
Veneroida	Pisidiidae	*Pisidium* sp.					2				
Veneroida	Pisidiidae	*Sphaerium* sp.					23				
Veneroida	Sphaeriidae	Sphaeriidae					10				
		Taxa Richness	39	42	87	65	52	73	93	71	68
		Total N Individuals	497	245	1,480	1,800	1,644	1,054	2,479	659	1,235
		Number of Samples	n = 2	n = 1	n = 2	n = 9	n = 8	n = 6	n = 14	n = 1	n = 1

Appendix E - 5. Benthic macroinvertebrate taxa list by stream for Ecoregion 31; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	Las Moras Creek	Metate Creek	Mud Creek	Nueces River	Pinto Creek	San Miguel Creek	Sycamore Creek
Amphipoda	Hyalellidae	*Hyalella azteca*					101		1
Amphipoda	Hyalellidae	*Hyalella* sp.				5		13	
Anthoathecata	Hydridae	*Hydra* sp.							1
Basommatophora	Ancylidae	*Ferrissia rivularis*	3		1		10		1
Basommatophora	Lymnaeidae	*Fossaria parva*		3			1		
Basommatophora	Lymnaeidae	*Pseudosuccinea columella*		5	2				
Basommatophora	Physidae	*Physa* sp.				3		4	
Basommatophora	Physidae	*Physella* sp.					14		
Basommatophora	Physidae	*Physella virgata*	2	1	5		12		4
Basommatophora	Planorbidae	*Biomphalaria obstructus*	2		1		12		4
Basommatophora	Planorbidae	*Gyraulus parvus*		2					
Basommatophora	Planorbidae	*Hebetancylus excentricus*				1			
Basommatophora	Planorbidae	*Helisoma anceps*					1		18
Basommatophora	Planorbidae	*Planorbella trivolvis*		1					
Coleoptera	Chrysomelidae	*Donacia* sp.	3						
Coleoptera	Dryopidae	*Helichus* sp.				3			
Coleoptera	Dytiscidae	*Brachyvatus* sp.						2	
Coleoptera	Dytiscidae	*Hydroporus* sp.		1					
Coleoptera	Elmidae	*Heterelmis glabra*	23		4				
Coleoptera	Elmidae	*Heterelmis* sp.				4			
Coleoptera	Elmidae	*Hexacylloepus ferrugineus*	4		27		100		16
Coleoptera	Elmidae	*Hexacylloepus* sp.					1		
Coleoptera	Elmidae	*Macrelmis* sp.				15			7
Coleoptera	Elmidae	*Macrelmis texana*			1		11		2
Coleoptera	Elmidae	*Microcylloepus pusillus*	89		22		27		19
Coleoptera	Elmidae	*Microcylloepus* sp.				36	1		
Coleoptera	Elmidae	*Neoelmis* sp.				1			
Coleoptera	Elmidae	*Stenelmis occidentalis*			8		1		9
Coleoptera	Elmidae	*Stenelmis* sp.	1			2	1		
Coleoptera	Gyrinidae	*Dineutus* sp.						9	
Coleoptera	Haliplidae	*Peltodytes* sp.					1	7	
Coleoptera	Hydraenidae	*Hydraena* sp.						1	

Order	Family	Taxon	Las Moras Creek	Metate Creek	Mud Creek	Nueces River	Pinto Creek	San Miguel Creek	Sycamore Creek
Coleoptera	Hydrochidae	*Hydrochus* sp.				2		2	
Coleoptera	Hydrophilidae	*Berosus* sp.	1		2		1	4	3
Coleoptera	Hydrophilidae	*Berosus subsignatus*					11		
Coleoptera	Hydrophilidae	*Hydrobius* sp.						1	
Coleoptera	Lutrochidae	*Lutrochus luteus*			11		3		
Coleoptera	Psephenidae	*Psephenus* sp.				1			2
Coleoptera	Scirtidae	*Cyphon* sp.		8			1		3
Coleoptera	Scirtidae	*Scirtes* sp.						4	
Coleoptera	Staphylinidae	Staphylinidae				1	1		
Decapoda	Cambaridae	Cambaridae				1			
Decapoda	Palaemonidae	*Palaemonetes* sp.						24	
Diptera	Ceratopogonidae	*Atrichopogon* sp.				1			
Diptera	Ceratopogonidae	*Bezzia* sp.							1
Diptera	Ceratopogonidae	Ceratopogonidae				1			
Diptera	Ceratopogonidae	*Culicoides* sp.							4
Diptera	Ceratopogonidae	*Palpomyia tibialis*					18		
Diptera	Ceratopogonidae	*Probezzia* sp.	1				1		
Diptera	Chironomidae	*Ablabesmyia mallochi*					3		
Diptera	Chironomidae	Chironomidae				14			
Diptera	Chironomidae	*Chironomus riparius* gr.		2					
Diptera	Chironomidae	*Chironomus* sp.						1	
Diptera	Chironomidae	*Cladotanytarsus mancus* gr.		10					
Diptera	Chironomidae	*Clinotanypus* sp.						1	
Diptera	Chironomidae	*Coelotanypus* sp.						10	
Diptera	Chironomidae	*Conchapelopia* sp.					5		
Diptera	Chironomidae	*Cricotopus bicinctus*			3				
Diptera	Chironomidae	*Cricotopus* sp.			1				
Diptera	Chironomidae	*Cricotopus tremulus* gr.							21
Diptera	Chironomidae	*Cryptochironomus* sp.					1	4	
Diptera	Chironomidae	*Dicrotendipes neomodestus*		6	3		3		
Diptera	Chironomidae	*Dicrotendipes* sp.		2			4	1	
Diptera	Chironomidae	*Glyptotendipes* sp. gr. A		2					
Diptera	Chironomidae	*Goeldichironomus holoprasinus*		2					
Diptera	Chironomidae	*Labrundinia* sp.							1
Diptera	Chironomidae	*Larsia* sp.					3	1	
Diptera	Chironomidae	*Microtendipes* sp.					3		

Order	Family	Taxon	Las Moras Creek	Metate Creek	Mud Creek	Nueces River	Pinto Creek	San Miguel Creek	Sycamore Creek
Diptera	Chironomidae	*Nilotanypus* sp.			1				
Diptera	Chironomidae	*Orthocladius* sp.	1						21
Diptera	Chironomidae	*Parachironomus arcuatus* gr.		2					
Diptera	Chironomidae	*Paracladius* sp.					10		
Diptera	Chironomidae	*Parametriocnemus* sp.			1				
Diptera	Chironomidae	*Pentaneura* sp.			3		33		114
Diptera	Chironomidae	*Phaenopsectra* sp.		2					
Diptera	Chironomidae	*Polypedilum convictum*	1		8		17		62
Diptera	Chironomidae	*Polypedilum illinoense*			17			2	21
Diptera	Chironomidae	*Polypedilum* sp.					3	4	5
Diptera	Chironomidae	*Procladius* sp.					4	1	
Diptera	Chironomidae	*Pseudochironomus* sp.					7		83
Diptera	Chironomidae	*Rheocricotopus fuscipes* gr.					7		52
Diptera	Chironomidae	*Rheopelopia* sp.					13		
Diptera	Chironomidae	*Rheotanytarsus exiguus* gr.			13		37		165
Diptera	Chironomidae	*Rheotanytarsus* sp.					8	2	
Diptera	Chironomidae	Subfamily: Chironominae				17			
Diptera	Chironomidae	Subfamily: Orthocladiinae				12			
Diptera	Chironomidae	Subfamily: Tanypodinae				1			
Diptera	Chironomidae	*Tanypus* sp.						1	
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.			1		3		
Diptera	Chironomidae	*Tanytarsus guerlus* gr.		2			13		
Diptera	Chironomidae	*Tanytarsus* sp.					6		
Diptera	Chironomidae	*Thienemanniella* nr. *xena*		2					21
Diptera	Chironomidae	*Thienemanniella* sp.					10		
Diptera	Chironomidae	*Thienemannimyia* sp.			3		7		2
Diptera	Empididae	*Hemerodromia* sp.	12			2	9		16
Diptera	Muscidae	*Limnophora* sp.							1
Diptera	Simuliidae	*Simulium* nr. *argus*					2		142
Diptera	Simuliidae	*Simulium* nr. *bivittatum*			27		1	7	143
Diptera	Simuliidae	*Simulium* sp.	2			6	31		
Diptera	Stratiomyidae	*Euparyphus* sp.					8		
Diptera	Tabanidae	*Silvius* sp.							2
Diptera	Tabanidae	*Tabanus* sp.			1	10			
Diptera	Tipulidae	*Hexatoma* sp.				4			
Enchytraeida	Enchytraeidae	Enchytraeidae						1	

Order	Family	Taxon	Las Moras Creek	Metate Creek	Mud Creek	Nueces River	Pinto Creek	San Miguel Creek	Sycamore Creek
Ephemeroptera	Baetidae	*Baetodes edmundsi*					1		
Ephemeroptera	Baetidae	*Callibaetis* sp.						1	
Ephemeroptera	Baetidae	*Camelobaetidius mexicanus*	13		9		14		95
Ephemeroptera	Baetidae	*Camelobaetidius* sp.				10	9		2
Ephemeroptera	Baetidae	*Centroptilum* sp.					4		
Ephemeroptera	Baetidae	*Fallceon quilleri*	8		9	12	100	2	473
Ephemeroptera	Baetidae	*Fallceon* sp.							8
Ephemeroptera	Caenidae	*Caenis* sp.		1	2		51	74	
Ephemeroptera	Heptageniidae	*Stenonema* sp.					9		2
Ephemeroptera	Isonychiidae	*Isonychia sicca manca*	12		3		2		
Ephemeroptera	Isonychiidae	*Isonychia* sp.				23	2		4
Ephemeroptera	Leptohyphidae	*Asioplax* sp.					1		
Ephemeroptera	Leptohyphidae	*Leptohyphes packeri*	4				32		
Ephemeroptera	Leptohyphidae	*Leptohyphes vescus*					6		
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr.	2				182		11
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.				1	7		6
Ephemeroptera	Leptohyphidae	*Vacupernius packeri*				29	12		
Ephemeroptera	Leptophlebiidae	*Neochoroterpes* sp.				3	4		159
Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.				81	17		12
Ephemeroptera	Leptophlebiidae	*Traverella presidiana*	11						
Hemiptera	Belostomatidae	*Belostoma* sp.					2		
Hemiptera	Corixidae	*Hesperocorixa* sp.						1	
Hemiptera	Gerridae	*Rheumatobates* sp.						4	
Hemiptera	Gerridae	*Trepobates* sp.						1	
Hemiptera	Mesoveliidae	*Mesovelia* sp.					1		
Hemiptera	Naucoridae	*Ambrysus circumcinctus*			3		20		2
Hemiptera	Naucoridae	*Ambrysus lunatus*							4
Hemiptera	Naucoridae	*Ambrysus pulchellus*			1				
Hemiptera	Naucoridae	*Ambrysus* sp.				31	3		14
Hemiptera	Nepidae	*Curicta* sp.						1	
Hemiptera	Nepidae	*Ranatra* sp.					1		
Hemiptera	Veliidae	*Microvelia* sp.			2				2
Hemiptera	Veliidae	*Rhagovelia* sp.				4	1		
Hirudinea		Hirudinea				1			
Hirudinida	Glossiphoniidae	*Helobdella elongata*							19
Hirudinida	Glossiphoniidae	*Helobdella triserialis*							11

Order	Family	Taxon	Las Moras Creek	Metate Creek	Mud Creek	Nueces River	Pinto Creek	San Miguel Creek	Sycamore Creek
Hoplonemertea	Tetrastemmatidae	*Prostoma rubrum*			1		33		19
Lepidoptera	Crambidae	*Parapoynx* sp.							2
Lepidoptera	Crambidae	*Petrophila* sp.	4			6	4		20
Megaloptera	Corydalidae	*Corydalus cornutus*	1				1		
Nematoda		Nematoda			2				1
Neoophora	Dugesiidae	*Cura* sp.				17			
Neoophora	Dugesiidae	*Dugesia* sp.					2		27
Neoophora	Dugesiidae	*Dugesia tigrina*					109		463
Neotaenioglossa	Amnicolidae	*Amnicola limosa limosa*					2		
Neotaenioglossa	Hydrobiidae	*Cincinnatia cincinnatiensis*	1						
Neotaenioglossa	Hydrobiidae	*Cochliopa texana*					14		
Neotaenioglossa	Hydrobiidae	*Cochliopina riograndensis*	1				1		78
Neotaenioglossa	Hydrobiidae	*Pyrgophorus spinosus*		3					
Neotaenioglossa	Thiaridae	*Melanoides tuberculata*				11			
Odonata	Aeshnidae	*Anax junius*					1		
Odonata	Calopterygidae	*Hetaerina* sp.				10	16		
Odonata	Coenagrionidae	*Argia* sp.		1		21	69	12	17
Odonata	Coenagrionidae	*Argia* sp. A			26		18		1
Odonata	Coenagrionidae	*Argia* sp. B	20				18		81
Odonata	Coenagrionidae	*Argia* sp. C					6		
Odonata	Coenagrionidae	*Enallagma* sp.					3	1	
Odonata	Coenagrionidae	*Ischnura* sp.		1			24		
Odonata	Corduliidae	*Macromia* sp.					1	2	
Odonata	Gomphidae	*Dromogomphus* sp.				3			
Odonata	Gomphidae	*Dromogomphus spoliatus*	1						
Odonata	Gomphidae	*Erpetogomphus* sp.	1			21	13	2	1
Odonata	Libellulidae	*Brechmorhoga mendax*	1		1		2		2
Odonata	Libellulidae	*Brechmorhoga* sp.				4	2		
Odonata	Libellulidae	Libellulidae				1			
Odonata	Libellulidae	*Perithemis* sp.						2	
Oligochaeta		Oligochaeta				7		1	
Opisthopora	Sparganophilidae	*Sparganophilus tamesis*	14		17		15		38
Ostracoda		Ostracoda				4		1	1
Podocopida	Cyprididae	*Chlamydotheca arcuata*					9		
Podocopida	Cyprididae	*Cypridopsis vidua*							6
Podocopida	Cyprididae	*Herpetocypris* sp.					12		11

Order	Family	Taxon	Las Moras Creek	Metate Creek	Mud Creek	Nueces River	Pinto Creek	San Miguel Creek	Sycamore Creek
Podocopida	Cyprididae	*Stenocypris* sp.					3		17
Podocopida	Darwinulidae	*Darwinula stevensoni*		1					
Podocopida	Limnocytheridae	*Limnocythere* sp.		3	1				6
Trichoptera	Helicopsychidae	*Helicopsyche* sp.	3			3			4
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.	7		5	31	13		28
Trichoptera	Hydropsychidae	*Hydropsyche* sp.	1			10	98		5
Trichoptera	Hydropsychidae	*Smicridea* sp.	7			8	107		3
Trichoptera	Hydroptilidae	*Hydroptila* sp.			1	1	3		121
Trichoptera	Hydroptilidae	*Hydroptila* sp. A					110		
Trichoptera	Hydroptilidae	*Hydroptila* sp. B					7		
Trichoptera	Hydroptilidae	*Ithytrichia* sp.			1		10		1
Trichoptera	Hydroptilidae	*Leucotrichia* sp.	1						
Trichoptera	Hydroptilidae	*Mayatrichia* nr. *ayama*	1						1
Trichoptera	Hydroptilidae	*Mayatrichia* nr. *ponta*			1				
Trichoptera	Hydroptilidae	*Neotrichia* sp.					3		
Trichoptera	Hydroptilidae	*Ochrotrichia* sp.	3			1	21		
Trichoptera	Hydroptilidae	*Oxyethira* sp.					41		2
Trichoptera	Leptoceridae	*Nectopsyche gracilis*	11				2		
Trichoptera	Leptoceridae	*Nectopsyche* sp.				5	23		
Trichoptera	Leptoceridae	*Oecetis* sp.	1				6		5
Trichoptera	Leptoceridae	*Oecetis* sp. A					7		
Trichoptera	Leptoceridae	*Oecetis* sp. C					7		
Trichoptera	Leptoceridae	*Triaenodes* sp.					1		
Trichoptera	Odontoceridae	*Marilia* sp.				2			1
Trichoptera	Philopotamidae	*Chimarra* sp.			2	70	10		11
Trichoptera	Philopotamidae	*Chimarra* sp. A					109		14
Trichoptera	Philopotamidae	*Chimarra* sp. B					47		1
Trichoptera	Polycentropodidae	*Cernotina* sp.					1		
Trichoptera	Polycentropodidae	*Polyplectropus* sp.					2		3
Trombidiformes	Pionidae	*Piona* sp.					1		
Trombidiformes	Sperchontidae	*Sperchon texana*	1				1		42
Trombidiformes		Hydracarina (Hydrachnidia)				2	7	1	
Tubificida	Naididae	*Aulodrilus limnobius*					5		
Tubificida	Naididae	*Limnodrilus hoffmeisteri*		106					
Tubificida	Naididae	*Limnodrilus* sp.	12					3	
Tubificida	Naididae	*Pristina americana*			1				

Order	Family	Taxon	Las Moras Creek	Metate Creek	Mud Creek	Nueces River	Pinto Creek	San Miguel Creek	Sycamore Creek
Tubificida	Naididae	*Pristina sima*			1				
Tubificida	Naididae	*Slavina appendiculata*					139		
Veneroida	Corbiculidae	*Corbicula fluminea*	1		3	8	295	1	1
Veneroida	Pisidiidae	*Pisidium nitidum*	1				18		1
		Taxa Richness	42	24	45	55	124	41	84
		Total N Individuals	289	169	258	584	2,534	217	2,826
		Number of Samples	n = 1	n = 1	n = 1	n = 2	n = 3	n = 2	n = 2

Appendix E - 6. Benthic macroinvertebrate taxa list by stream for Ecoregions 33 and 35; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Amphipoda	Gammaridae	*Gammarus lacustris*										
Amphipoda	Gammaridae	*Gammarus* sp.		14	7	8	2		12		1	2
Amphipoda	Hyalellidae	*Hyalella azteca*	42			126			5		103	
Amphipoda	Hyalellidae	*Hyalella* sp.		2			2				17	
Architaenioglossa	Viviparidae	*Campeloma decisum*										
Basommatophora	Ancylidae	*Ferrissia rivularis*			1		21				3	
Basommatophora	Ancylidae	*Ferrissia* sp.				1				2		
Basommatophora	Ancylidae	*Hebetancylus* sp.		1								
Basommatophora	Lymnaeidae	*Pseudosuccinea columella*				1						
Basommatophora	Lymnaeidae	*Pseudosuccinea* sp.										
Basommatophora	Physidae	*Physa* sp.				1			1		1	
Basommatophora	Physidae	*Physella* sp.				2		1	3	2	9	1
Basommatophora	Physidae	*Physella virgata*									6	
Basommatophora	Physidae	Physidae									2	
Basommatophora	Planorbidae	*Biomphalaria obstructus*									6	
Basommatophora	Planorbidae	*Gyraulus parvus*		2								
Basommatophora	Planorbidae	*Gyraulus* sp.									3	
Basommatophora	Planorbidae	*Helisoma anceps*									29	
Basommatophora	Planorbidae	*Helisoma* sp.									6	
Basommatophora	Planorbidae	*Planorbella* sp.										
Basommatophora	Planorbidae	*Planorbella trivolvis*									1	
Basommatophora	Planorbidae	Planorbidae										
Basommatophora	Planorbidae	*Planorbula* sp.									4	
Branchiobdellida	Branchiobdellidae	*Branchiobdella* sp.										
Branchiobdellida	Branchiobdellidae	Branchiobdellidae										
Coleoptera	Curculionidae	Curculionidae										
Coleoptera	Curculionidae	*Phytonomus* sp.										
Coleoptera	Dryopidae	*Helichus lithophilus*										
Coleoptera	Dryopidae	*Helichus* sp.						1		9	6	
Coleoptera	Dytiscidae	*Acilius* sp.				10						
Coleoptera	Dytiscidae	*Bidessonotus* sp.				2						

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Coleoptera	Dytiscidae	*Brachyvatus* sp.				1						
Coleoptera	Dytiscidae	*Celina* sp.				2						
Coleoptera	Dytiscidae	*Copelatus* sp.										
Coleoptera	Dytiscidae	*Coptotomus* sp.										
Coleoptera	Dytiscidae	*Cybister* sp.										
Coleoptera	Dytiscidae	Dytiscidae										
Coleoptera	Dytiscidae	*Hydaticus* sp.										
Coleoptera	Dytiscidae	*Hydroporus* sp.	21			2						1
Coleoptera	Dytiscidae	*Laccodytes* sp.				1						
Coleoptera	Dytiscidae	*Laccophilus* sp.				2						
Coleoptera	Dytiscidae	*Liodessus* sp.										
Coleoptera	Dytiscidae	*Neobidessus* sp.	1									
Coleoptera	Dytiscidae	*Neoporus* sp.										
Coleoptera	Dytiscidae	*Rhantus* sp.			1							
Coleoptera	Dytiscidae	*Thermonectus* sp.										
Coleoptera	Dytiscidae	*Uvarus* sp.		16				2				
Coleoptera	Elmidae	*Ancyronyx* sp.		25			8	14	5	1		
Coleoptera	Elmidae	*Ancyronyx variegata*		11			5					
Coleoptera	Elmidae	*Dubiraphia parva*										
Coleoptera	Elmidae	*Dubiraphia* sp.		1							2	
Coleoptera	Elmidae	*Dubiraphia vittata*			2							
Coleoptera	Elmidae	Elmidae										
Coleoptera	Elmidae	*Heterelmis* sp.								2		
Coleoptera	Elmidae	*Heterelmis vulnerata*									1	
Coleoptera	Elmidae	*Hexacylloepus* sp.									4	
Coleoptera	Elmidae	*Macronychus glabratus*		107								
Coleoptera	Elmidae	*Macronychus* sp.		2					3	8		
Coleoptera	Elmidae	*Microcylloepus pusillus*		9							2	
Coleoptera	Elmidae	*Microcylloepus* sp.			6						22	
Coleoptera	Elmidae	*Neoelmis* sp.									1	
Coleoptera	Elmidae	*Stenelmis cheryl*										
Coleoptera	Elmidae	*Stenelmis decorata*							116			
Coleoptera	Elmidae	*Stenelmis grossa*		202			100					
Coleoptera	Elmidae	*Stenelmis occidentalis*							12		68	
Coleoptera	Elmidae	*Stenelmis sexlineata*										

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Coleoptera	Elmidae	*Stenelmis* sp.		30	12	37	8	10	117	15	81	9
Coleoptera	Gyrinidae	*Dineutus* sp.	1	17	8	7	10	7	9		2	
Coleoptera	Gyrinidae	*Gyretes* sp.									4	
Coleoptera	Gyrinidae	*Gyrinus* sp.	3		4	45						
Coleoptera	Haliplidae	*Peltodytes* sp.				4						
Coleoptera	Helophoridae	*Helophorus* sp.										
Coleoptera	Hydraenidae	*Hydraena* sp.									1	
Coleoptera	Hydraenidae	*Limnebius* sp.										
Coleoptera	Hydrochidae	*Hydrochus* sp.				3			1			
Coleoptera	Hydrophilidae	*Berosus* nr. *californicus*										
Coleoptera	Hydrophilidae	*Berosus* sp.										1
Coleoptera	Hydrophilidae	*Cercyon* sp.										
Coleoptera	Hydrophilidae	*Derallus* sp.										
Coleoptera	Hydrophilidae	*Enochrus* sp.										
Coleoptera	Hydrophilidae	*Helochares* sp.										
Coleoptera	Hydrophilidae	*Hydrobiomorpha* sp.				1						
Coleoptera	Hydrophilidae	*Hydrobius* sp.										
Coleoptera	Hydrophilidae	Hydrophilidae										
Coleoptera	Hydrophilidae	*Hydrophilus* sp.				1						
Coleoptera	Hydrophilidae	*Laccobius* sp.										
Coleoptera	Hydrophilidae	*Paracymus* sp.										
Coleoptera	Hydrophilidae	*Sperchopsis* sp.										
Coleoptera	Hydrophilidae	*Tropisternus* sp.				2						
Coleoptera	Noteridae	*Hydrocanthus* sp.					2					
Coleoptera	Noteridae	*Pronoterus* sp.										
Coleoptera	Noteridae	*Suphisellus* sp.				1						
Coleoptera	Psephenidae	*Ectopria nervosa*										
Coleoptera	Psephenidae	Psephenidae										
Coleoptera	Scirtidae	*Cyphon* sp.	6				1	11			1	
Coleoptera	Scirtidae	*Elodes* sp.										
Coleoptera	Scirtidae	*Scirtes* sp.			1							
Coleoptera	Scirtidae	Scirtidae										
Coleoptera	Staphylinidae	Staphylinidae		2	1							
Coleoptera	Staphylinidae	*Stenus* sp.		1		1						
Coleoptera		Coleoptera										

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Collembola	Isotomidae	*Isotomurus palustris*										
Copepoda		Copepoda										
Cyclopoida	Cyclopidae	*Macrocyclops* sp.										
Decapoda	Cambaridae	*Cambarellus shufeldtii*			6		2					
Decapoda	Cambaridae	*Cambarellus* sp.										
Decapoda	Cambaridae	Cambaridae		7		2	4	10	1			1
Decapoda	Cambaridae	*Cambarus* sp.				6						
Decapoda	Cambaridae	*Orconectes* sp.										
Decapoda	Cambaridae	*Procambarus* sp.				5						
Decapoda	Palaemonidae	*Palaemonetes kadiakensis*		5	12	5			2		2	
Decapoda	Palaemonidae	*Palaemonetes* sp.	6	10		8	10					
Decapoda	Palaemonidae	Palaemonidae										
Decapoda		Decapoda		1								
Diplostraca		Cladocera										
Diptera	Athericidae	*Atherix* sp.										
Diptera	Ceratopogonidae	*Alluaudomyia* sp.										
Diptera	Ceratopogonidae	*Atrichopogon* sp.		1						1		
Diptera	Ceratopogonidae	*Bezzia* sp.		10	1	2	2		1		11	
Diptera	Ceratopogonidae	Ceratopogonidae										
Diptera	Ceratopogonidae	*Dasyhelea* sp.									17	
Diptera	Ceratopogonidae	*Forcipomyia* sp.										
Diptera	Ceratopogonidae	*Probezzia* sp.	1					1			3	
Diptera	Ceratopogonidae	*Probezzia* sp. A									14	
Diptera	Ceratopogonidae	*Probezzia* sp. B									3	
Diptera	Ceratopogonidae	*Serromyia* sp.				8						
Diptera	Ceratopogonidae	*Stilobezzia* sp.										
Diptera	Chaoboridae	*Chaoborus* sp.				1						
Diptera	Chironomidae	*Ablabesmyia annulata* gr.										
Diptera	Chironomidae	*Ablabesmyia mallochi*										
Diptera	Chironomidae	*Ablabesmyia parajanta*		11	15							
Diptera	Chironomidae	*Ablabesmyia* sp.				1						
Diptera	Chironomidae	*Acamptocladius* sp.					1					
Diptera	Chironomidae	*Alotanypus* sp.										
Diptera	Chironomidae	*Axarus* sp.										
Diptera	Chironomidae	Chironomidae	175			28		51	38	82	99	24

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Diptera	Chironomidae	*Chironomus decorus* gr.										
Diptera	Chironomidae	*Chironomus riparius* gr.										
Diptera	Chironomidae	*Chironomus* sp.				38			1			
Diptera	Chironomidae	*Cladotanytarsus* sp.										
Diptera	Chironomidae	*Cladotanytarsus* sp. gr. A		7					2			
Diptera	Chironomidae	*Cladotanytarsus vanderwulpi* gr.		4								
Diptera	Chironomidae	*Clinotanypus* sp.			10	1						
Diptera	Chironomidae	*Conchapelopia* sp.			3				4		8	
Diptera	Chironomidae	*Cricotopus bicinctus*										
Diptera	Chironomidae	*Cricotopus festivellus* gr.										
Diptera	Chironomidae	*Cricotopus* sp.										
Diptera	Chironomidae	*Cryptochironomus fulvus* gr.			3		5		2			
Diptera	Chironomidae	*Cryptochironomus* sp.				1			2			
Diptera	Chironomidae	*Demicryptochironomus* sp.		7								
Diptera	Chironomidae	*Dicrotendipes neomodestus*										
Diptera	Chironomidae	*Dicrotendipes* sp.				32						
Diptera	Chironomidae	*Einfeldia* sp.				22						
Diptera	Chironomidae	*Endochironomus* sp.				3						
Diptera	Chironomidae	*Gillotia* sp.										
Diptera	Chironomidae	*Glyptotendipes* sp.				12						
Diptera	Chironomidae	*Goeldichironomus* sp.										
Diptera	Chironomidae	*Guttipelopia* sp.				17						
Diptera	Chironomidae	*Kiefferulus* sp.				61						
Diptera	Chironomidae	*Krenopelopia* sp.				1						
Diptera	Chironomidae	*Labrundinia floridana*			8							
Diptera	Chironomidae	*Labrundinia neopilosella*										
Diptera	Chironomidae	*Labrundinia* sp.				10						
Diptera	Chironomidae	*Larsia* sp.				14					15	
Diptera	Chironomidae	*Lauterborniella agrayloides*		11								
Diptera	Chironomidae	*Micropsectra aristata*										
Diptera	Chironomidae	*Micropsectra* sp.										
Diptera	Chironomidae	*Microtendipes pedellus* gr.		22								
Diptera	Chironomidae	*Microtendipes* sp.										
Diptera	Chironomidae	*Nanocladius crassicornus*										
Diptera	Chironomidae	*Nanocladius minimus*										

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Diptera	Chironomidae	*Nanocladius rectinervis*									3	
Diptera	Chironomidae	*Natarsia punctata*					5					
Diptera	Chironomidae	*Natarsia* sp.										
Diptera	Chironomidae	*Nilotanypus* nr. *dubius*							2		2	
Diptera	Chironomidae	*Nilothauma* sp.		4								
Diptera	Chironomidae	*Nimbocera pinderi*		11	5							
Diptera	Chironomidae	*Orthocladius* sp.		4					4		6	
Diptera	Chironomidae	*Parachironomus* sp.				2						
Diptera	Chironomidae	*Paracladopelma* sp.				25						
Diptera	Chironomidae	*Paratanytarsus* sp.									2	
Diptera	Chironomidae	*Paratendipes* nr. *nudisquama*										
Diptera	Chironomidae	*Paratendipes* sp.										
Diptera	Chironomidae	*Pentaneura* sp.		4	3		1				14	
Diptera	Chironomidae	*Phaenopsectra* sp.			15	39	1		1			
Diptera	Chironomidae	*Polypedilum convictum*		48			5				5	
Diptera	Chironomidae	*Polypedilum fallax* gr.		4								
Diptera	Chironomidae	*Polypedilum illinoense*					1					
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. A		34	18						5	
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. B		19			38		4		2	
Diptera	Chironomidae	*Polypedilum* sp.				15			7			
Diptera	Chironomidae	*Potthastia* sp.										
Diptera	Chironomidae	*Procladius* sp.				9			2		3	
Diptera	Chironomidae	*Pseudochironomus* sp.									2	
Diptera	Chironomidae	*Rheocricotopus fuscipes* gr.					13					
Diptera	Chironomidae	*Rheocricotopus* sp.										
Diptera	Chironomidae	*Rheotanytarsus exiguus* gr.			112		13		2			
Diptera	Chironomidae	*Rheotanytarsus* sp.							1			
Diptera	Chironomidae	*Robackia* sp.										
Diptera	Chironomidae	*Saetheria* sp.										
Diptera	Chironomidae	*Stelechomyia perpulchra*		4			4					
Diptera	Chironomidae	*Stelechomyia* sp.										
Diptera	Chironomidae	*Stempellinella* sp.		4	13				2			
Diptera	Chironomidae	*Stenochironomus* sp.			3	2	10					
Diptera	Chironomidae	*Stictochironomus* sp.		7					22		2	
Diptera	Chironomidae	Subfamily: Chironominae					25					

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Diptera	Chironomidae	Subfamily: Orthocladiinae										
Diptera	Chironomidae	Subfamily: Tanypodinae		2	10							
Diptera	Chironomidae	*Tanypus* nr. *clavatus*										
Diptera	Chironomidae	*Tanypus* sp.				1						
Diptera	Chironomidae	*Tanytarsus chinyensis* gr.			18		6					
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.					2				20	
Diptera	Chironomidae	*Tanytarsus guerlus* gr.		19	28		4		8		5	
Diptera	Chironomidae	*Tanytarsus* sp.				3			2			
Diptera	Chironomidae	*Telopelopia* sp.										
Diptera	Chironomidae	*Thienemanniella* nr. *xena*										
Diptera	Chironomidae	*Thienemanniella* sp.										
Diptera	Chironomidae	*Thienemannimyia* sp.		15		3	22					
Diptera	Chironomidae	Tribe: Chironomini		98	89							
Diptera	Chironomidae	Tribe: Tanytarsini										
Diptera	Chironomidae	*Tribelos* sp.		11			2					
Diptera	Chironomidae	*Xenochironomus xenolabis*										
Diptera	Chironomidae	*Xylotopus par*		15			5		2			
Diptera	Chironomidae	*Zavrelia* sp.										
Diptera	Culicidae	*Anopheles* sp.				1						
Diptera	Culicidae	*Culex* sp.										
Diptera	Culicidae	Culicidae				1						
Diptera	Dixidae	*Dixella* sp.						10				
Diptera	Empididae	*Hemerodromia* sp.		4			2		8	4		
Diptera	Ptychopteridae	Ptychopteridae										
Diptera	Simuliidae	*Cnephia* sp.				78						
Diptera	Simuliidae	*Simulium* nr. *argus*										
Diptera	Simuliidae	*Simulium* sp.					8	5		1	772	
Diptera	Stratiomyidae	*Odontomyia* sp.									1	
Diptera	Stratiomyidae	Stratiomyidae										
Diptera	Stratiomyidae	*Stratiomys* sp.									1	
Diptera	Syrphidae	*Myolepta* sp.										
Diptera	Syrphidae	Syrphidae										
Diptera	Tabanidae	*Chrysops* sp.					1					
Diptera	Tabanidae	Tabanidae										
Diptera	Tabanidae	*Tabanus* sp.				1					7	

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Diptera	Tipulidae	*Geranomyia* sp.								1		
Diptera	Tipulidae	*Hexatoma* sp.		1								
Diptera	Tipulidae	*Limnophila* sp.	2									
Diptera	Tipulidae	*Pseudolimnophila* sp.										
Diptera	Tipulidae	*Tipula* sp.		1					3			
Ephemeroptera	Baetidae	*Acentrella* sp.								1		
Ephemeroptera	Baetidae	*Acerpenna* sp.								10		
Ephemeroptera	Baetidae	Baetidae										
Ephemeroptera	Baetidae	*Baetis ephippiatus*										
Ephemeroptera	Baetidae	*Baetis intercalaris*					6					
Ephemeroptera	Baetidae	*Baetis pygmaeus*		8								
Ephemeroptera	Baetidae	*Baetis* sp.					16	37	4	22	104	31
Ephemeroptera	Baetidae	*Callibaetis* sp.	2			9		3			1	
Ephemeroptera	Baetidae	*Camelobaetidius* sp.									8	
Ephemeroptera	Baetidae	*Centroptilum* sp.										
Ephemeroptera	Baetidae	*Cloeon* sp.										
Ephemeroptera	Baetidae	*Fallceon quilleri*									104	
Ephemeroptera	Baetidae	*Fallceon* sp.									67	
Ephemeroptera	Baetidae	*Labiobaetis* sp.								3		
Ephemeroptera	Baetidae	*Paracloeodes* sp.										
Ephemeroptera	Baetidae	*Plauditus* sp.									36	
Ephemeroptera	Baetidae	*Procloeon* sp.								1		
Ephemeroptera	Baetidae	*Pseudocloeon* sp.							1		1	
Ephemeroptera	Caenidae	*Brachycercus* sp.									8	
Ephemeroptera	Caenidae	*Caenis* sp.	4	1	37	42	45	32	19	1	137	32
Ephemeroptera	Ephemerellidae	*Ephemerella* sp.										
Ephemeroptera	Ephemerellidae	*Eurylophella* sp.										
Ephemeroptera	Ephemeridae	*Hexagenia limbata*		5	1							
Ephemeroptera	Ephemeridae	*Hexagenia* sp.					4	38				
Ephemeroptera	Heptageniidae	*Leucrocuta* sp.									33	
Ephemeroptera	Heptageniidae	*Maccaffertium* sp.							8			
Ephemeroptera	Heptageniidae	*Stenacron* sp.	8	30	99	4	64	24	64	44	3	9
Ephemeroptera	Heptageniidae	*Stenonema* sp.		15			7	25	30	62	90	
Ephemeroptera	Isonychiidae	*Isonychia sicca manca*									3	
Ephemeroptera	Isonychiidae	*Isonychia* sp.							2		186	

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Ephemeroptera	Leptohyphidae	*Leptohyphes* sp.									1	
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr.									181	
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.								1	155	
Ephemeroptera	Leptophlebiidae	*Choroterpes mexicanus*									3	
Ephemeroptera	Leptophlebiidae	*Choroterpes* sp.		29								
Ephemeroptera	Leptophlebiidae	*Farrodes texanus*									38	
Ephemeroptera	Leptophlebiidae	*Leptophlebia* sp.		1								
Ephemeroptera	Leptophlebiidae	Leptophlebiidae										
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia* sp.									117	
Ephemeroptera	Leptophlebiidae	*Thraulodes gonzalesi*									16	
Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.									32	
Ephemeroptera	Leptophlebiidae	*Traverella* sp.									1	
Ephemeroptera	Polymitarcyidae	*Ephoron* sp.										
Ephemeroptera	Polymitarcyidae	*Tortopus circumfluus*										
Gordioidea	Gordiidae	*Gordius* sp.										
Hemiptera	Belostomatidae	*Belostoma* sp.	2			1						
Hemiptera	Corixidae	Corixidae				2	1					3
Hemiptera	Corixidae	*Hesperocorixa* sp.										
Hemiptera	Corixidae	*Palmacorixa* sp.				2						
Hemiptera	Corixidae	*Trichocorixa* sp.	2	1		36					2	
Hemiptera	Gerridae	*Aquarius* sp.				1						
Hemiptera	Gerridae	Gerridae										
Hemiptera	Gerridae	*Limnoporus* sp.										
Hemiptera	Gerridae	*Metrobates* sp.										
Hemiptera	Gerridae	*Rheumatobates* sp.	7			1		2				
Hemiptera	Gerridae	*Trepobates* sp.	7			1						
Hemiptera	Hebridae	Hebridae										
Hemiptera	Hebridae	*Hebrus* sp.					3					
Hemiptera	Hebridae	*Lipogomphus* sp.										
Hemiptera	Hebridae	*Merragata* sp.										
Hemiptera	Hydrometridae	*Hydrometra* sp.				1	1	1			1	
Hemiptera	Mesoveliidae	*Mesovelia* sp.					2					
Hemiptera	Naucoridae	*Ambrysus pulchellus*									2	
Hemiptera	Naucoridae	*Ambrysus* sp.										
Hemiptera	Naucoridae	Naucoridae										

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Hemiptera	Naucoridae	*Pelocoris* sp.				1						
Hemiptera	Nepidae	*Curicta* sp.										
Hemiptera	Nepidae	Nepidae										
Hemiptera	Nepidae	*Ranatra* sp.				10						
Hemiptera	Notonectidae	*Buenoa* sp.										
Hemiptera	Notonectidae	*Notonecta* sp.	1									
Hemiptera	Pleidae	*Neoplea* sp.				3						
Hemiptera	Pleidae	*Neoplea striola*										
Hemiptera	Veliidae	*Microvelia* sp.	5					3				
Hemiptera	Veliidae	*Rhagovelia* sp.		1			1	2	1		17	
Hirudinea		Hirudinea		12	2	12	1		3			
Hirudinida	Erpobdellidae	*Erpobdella* sp.				3						
Hirudinida	Erpobdellidae	*Mooreobdella microstoma*					1					
Hirudinida	Erpobdellidae	*Mooreobdella* sp.				12						
Hirudinida	Glossiphoniidae	*Batracobdella phalera*			1							
Hirudinida	Glossiphoniidae	*Batracobdella picta*										
Hirudinida	Glossiphoniidae	Glossiphoniidae										
Hirudinida	Glossiphoniidae	*Helobdella* sp.	2									
Hirudinida	Glossiphoniidae	*Helobdella stagnalis*			4							
Hirudinida	Glossiphoniidae	*Helobdella triserialis*									1	
Hirudinida	Glossiphoniidae	*Placobdella parasitica*					1					
Hirudinida	Glossiphoniidae	*Placobdella* sp.				3			5			
Hoplonemertea	Tetrastemmatidae	*Prostoma rubrum*					1				10	
Isopoda	Asellidae	*Asellus laticaudatus*			78							
Isopoda	Asellidae	*Asellus* sp.		2		1						
Isopoda	Asellidae	*Caecidotea* sp.		105	8							
Isopoda	Asellidae	*Lirceus garmani*		5	2		4					
Isopoda	Asellidae	*Lirceus* sp.			6	35						
Isopoda	Sphaeromatidae	*Sphaeroma terebrans*										
Lepidoptera	Crambidae	*Acentria* sp.				1						
Lepidoptera	Crambidae	Crambidae				1						
Lepidoptera	Crambidae	*Crambus* sp.				1						
Lepidoptera	Crambidae	*Paraponyx* sp.										
Lepidoptera		Lepidoptera										
Lumbriculida	Lumbriculidae	Lumbriculidae		15	4		22					

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Megaloptera	Corydalidae	*Chauliodes* sp.				1						
Megaloptera	Corydalidae	*Corydalus cornutus*		4			1	2	11	2	44	4
Megaloptera	Sialidae	*Sialis* sp.		14	1	1	3	2				
Nematoda		Nematoda			17				13			
Nematomorpha		Nematomorpha		1								
Nemertea		Nemertea								3		
Neoophora	Dugesiidae	*Dugesia* sp.	1								9	
Neoophora	Dugesiidae	*Dugesia tigrina*		10			9				12	
Neotaenioglossa	Hydrobiidae	*Amnicola limosa limosa*		12	7						25	
Neotaenioglossa	Hydrobiidae	Hydrobiidae									2	
Neotaenioglossa	Hydrobiidae	*Pyrgophorus* sp.										
Neotaenioglossa	Hydrobiidae	*Pyrgulopsis* sp.										
Neuroptera	Sisyridae	*Climacia areolaris*										
Odonata	Aeschnidae	*Aeshna* sp.				4			1			
Odonata	Aeschnidae	*Basiaeschna janata*					1		2			
Odonata	Aeschnidae	*Basiaeschna* sp.				1						
Odonata	Aeschnidae	*Boyeria* sp.	1	13				6	9	1		
Odonata	Aeschnidae	*Boyeria vinosa*		1								
Odonata	Aeschnidae	*Coryphaeschna* sp.										
Odonata	Aeschnidae	*Nasiaeschna pentacantha*				4						
Odonata	Calopterygidae	*Calopteryx* sp.	1	5				19	4			
Odonata	Calopterygidae	*Hetaerina* sp.		2							5	
Odonata	Coenagrionidae	*Argia* sp.		16			2	2	2		143	
Odonata	Coenagrionidae	*Argia* sp. A									51	
Odonata	Coenagrionidae	*Argia* sp. C									15	
Odonata	Coenagrionidae	Coenagrionidae										
Odonata	Coenagrionidae	*Enallagma* sp.	14	9		23			1		1	4
Odonata	Coenagrionidae	*Ischnura* sp.		2		16						24
Odonata	Corduliidae	*Didymops* sp.		1								
Odonata	Corduliidae	*Epicordulia* sp.										
Odonata	Corduliidae	*Epitheca* sp.	1	6								
Odonata	Corduliidae	*Macromia caderita*										
Odonata	Corduliidae	*Macromia* sp.	2	2				19			3	
Odonata	Corduliidae	*Neurocordulia* sp.		2		1						
Odonata	Corduliidae	*Somatochlora* sp.					6					

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Odonata	Gomphidae	*Arigomphus lentulus*			1							
Odonata	Gomphidae	*Arigomphus* sp.		1							1	
Odonata	Gomphidae	*Dromogomphus* sp.										
Odonata	Gomphidae	*Dromogomphus spinosus*		2								
Odonata	Gomphidae	*Dromogomphus spoliatus*		1								
Odonata	Gomphidae	*Erpetogomphus* sp.	2					16			51	
Odonata	Gomphidae	Gomphidae					1					
Odonata	Gomphidae	*Gomphus externus*		1								
Odonata	Gomphidae	*Gomphus graslinellus*										
Odonata	Gomphidae	*Gomphus oklahomensis*										
Odonata	Gomphidae	*Gomphus* sp.		2					11			3
Odonata	Gomphidae	*Hagenius brevistylus*										
Odonata	Gomphidae	*Hagenius* sp.										
Odonata	Gomphidae	*Phyllogomphoides* sp.										
Odonata	Gomphidae	*Progomphus obscurus*									11	
Odonata	Gomphidae	*Progomphus* sp.						57	1		2	1
Odonata	Gomphidae	*Stylurus plagiatus*		1								
Odonata	Lestidae	*Lestes* sp.										
Odonata	Libellulidae	*Brechmorhoga mendax*									1	
Odonata	Libellulidae	*Brechmorhoga* sp.									3	
Odonata	Libellulidae	*Erythemis* sp.										
Odonata	Libellulidae	*Erythrodiplax* sp.				1						
Odonata	Libellulidae	*Libellula* sp.	5			3						
Odonata	Libellulidae	Libellulidae										
Odonata	Libellulidae	*Macrothemis* sp.				3						
Odonata	Libellulidae	*Miathyria* sp.	5									
Odonata	Libellulidae	*Orthemis* sp.	2									
Odonata	Libellulidae	*Pachydiplax* sp.	5			24						
Odonata	Libellulidae	*Perithemis* sp.				14						
Odonata	Libellulidae	*Tramea* sp.										
Oligochaeta		Oligochaeta	6	4		2	2	1	5	5	9	
Opisthopora	Lumbricidae	Lumbricidae			26							
Opisthopora	Sparganophilidae	*Sparganophilus tamesis*		10								
Orthoptera	Tridactylidae	*Ellipes* sp.										
Ostracoda		Ostracoda										

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Plecoptera	Perlidae	*Anacroneuria* sp.										4
Plecoptera	Perlidae	*Neoperla* sp.										
Plecoptera	Perlidae	*Paragnetina* sp.										
Plecoptera	Perlidae	*Perlesta* sp.		1							25	
Plecoptera	Perlodidae	*Isoperla* sp.										
Podocopida	Cyprididae	*Stenocypris* sp.									3	
Sarcoptiformes	Hydrozetidae	*Hydrozetes* sp.							1			
Trichoptera	Brachycentridae	*Brachycentrus* sp.							2			
Trichoptera	Dipseudopsidae	*Phylocentropus* sp.		1			12					
Trichoptera	Helicopsychidae	*Helicopsyche* sp.									181	
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.	2	18	23		77	6	138	7	292	
Trichoptera	Hydropsychidae	*Hydropsyche* sp.		15				1	9	14	9	96
Trichoptera	Hydropsychidae	Hydropsychidae										
Trichoptera	Hydropsychidae	*Macrostemum carolina*							2			
Trichoptera	Hydropsychidae	*Macrostemum* sp.							6			
Trichoptera	Hydropsychidae	*Potamyia flava*										
Trichoptera	Hydropsychidae	*Potamyia* sp.									20	
Trichoptera	Hydropsychidae	*Smicridea* sp.		1							4	
Trichoptera	Hydroptilidae	*Agraylea* sp.									2	
Trichoptera	Hydroptilidae	*Hydroptila* sp.		1					8	2	9	
Trichoptera	Hydroptilidae	*Hydroptila* sp. A										
Trichoptera	Hydroptilidae	*Hydroptila* sp. B										
Trichoptera	Hydroptilidae	*Neotrichia* sp.		1								
Trichoptera	Hydroptilidae	*Ochrotrichia* sp.								2	1	
Trichoptera	Hydroptilidae	*Oxyethira* sp.		1							1	
Trichoptera	Leptoceridae	*Ceraclea* sp.								1		
Trichoptera	Leptoceridae	*Leptocerus* sp.										
Trichoptera	Leptoceridae	*Nectopsyche candida*										
Trichoptera	Leptoceridae	*Nectopsyche gracilis*									22	
Trichoptera	Leptoceridae	*Nectopsyche* sp.									4	
Trichoptera	Leptoceridae	*Nectopsyche texana*										
Trichoptera	Leptoceridae	*Oecetis* sp.						2	22	7	18	
Trichoptera	Leptoceridae	*Oecetis* sp. A										
Trichoptera	Leptoceridae	*Oecetis* sp. B		4	2							
Trichoptera	Leptoceridae	*Oecetis* sp. C			12							

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Trichoptera	Leptoceridae	*Triaenodes* sp.		3							1	
Trichoptera	Limnephilidae	*Pycnopsyche* sp.										
Trichoptera	Philopotamidae	*Chimarra* sp.		28					3		208	
Trichoptera	Polycentropodidae	*Cernotina* sp.		13					3			
Trichoptera	Polycentropodidae	*Neureclipsis* sp.							7	6		
Trichoptera	Polycentropodidae	*Nyctiophylax* sp.		7					4			
Trichoptera	Polycentropodidae	Polycentropodidae										
Trichoptera	Polycentropodidae	*Polycentropus* sp.	1	5				2	1	3		
Trichoptera	Polycentropodidae	*Polyplectropus* sp.										
Trichoptera	Rhyacophilidae	*Rhyacophila* sp.				1						
Trichoptera	Sericostomatidae	*Agarodes* sp.										
Trichoptera		Trichoptera										
Trombidiformes	Hydrachnidae	*Hydrachna* sp.					1					
Trombidiformes	Hydrodromidae	*Hydrodroma despiciens*									1	
Trombidiformes	Hydryphantidae	*Hydryphantes* sp.										
Trombidiformes	Hygrobatidae	*Atractides* sp.					19					
Trombidiformes	Sperchontidae	*Sperchonopsis verrucosa*		1								
Trombidiformes	Torrenticolidae	*Torrenticola* sp.										
Trombidiformes		Hydracarina (Hydrachnidia)		1		28					5	
Tubificida	Naididae	*Aulodrilus limnobius*							2			
Tubificida	Naididae	*Aulodrilus pigueti*			7				2		21	
Tubificida	Naididae	*Bothrioneurum vejdovskyanum*										
Tubificida	Naididae	*Branchiura sowerbyi*									1	
Tubificida	Naididae	*Dero digitata*									4	
Tubificida	Naididae	*Dero trifida*										
Tubificida	Naididae	*Haemonais waldvogeli*										
Tubificida	Naididae	*Ilyodrilus templetoni*										
Tubificida	Naididae	*Limnodrilus angustipenis*		93								
Tubificida	Naididae	*Limnodrilus cervix*			7							
Tubificida	Naididae	*Limnodrilus hoffmeisteri*		19	100							
Tubificida	Naididae	*Limnodrilus maumeensis*										
Tubificida	Naididae	*Limnodrilus* sp.					7		28			
Tubificida	Naididae	*Limnodrilus udekemianus*										
Tubificida	Naididae	*Nais communis*										
Tubificida	Naididae	*Nais pardalis*										

Order	Family	Taxon	Beach Creek	Beech Creek	Big Cypress Creek	Black Bayou	Black Cypress Bayou	Blair Creek	Catfish Creek	Cedar Creek	Cummins Creek	Cuthand Creek
Tubificida	Naididae	*Nais variabilis*		9								
Tubificida	Naididae	*Pristina aequiseta*										
Tubificida	Naididae	*Pristina americana*		9								
Tubificida	Naididae	*Pristina leidyi*									70	
Tubificida	Naididae	*Pristina longidentata*										
Tubificida	Naididae	*Pristina longiseta*			4							
Tubificida	Naididae	*Pristina sima*										
Tubificida	Naididae	*Quistadrilus multisetosus*			7							
Tubificida	Naididae	*Slavina appendiculata*			19							
Tubificida	Naididae	*Specaria josinae*			11							
Turbellaria		Turbellaria		1							1	
Unionoida	Unionidae	*Lampsilis* sp.										
Unionoida	Unionidae	Unionidae										
Unionoida	Unionidae	*Villosa* sp.					1					
Veneroida	Corbiculidae	*Corbicula fluminea*	7					11	9		88	
Veneroida	Pisidiidae	*Eupera cubensis*										
Veneroida	Pisidiidae	*Musculium* sp.										
Veneroida	Pisidiidae	*Pisidium casertanum*		52	11		13				8	
Veneroida	Pisidiidae	*Pisidium nitidum*										
Veneroida	Pisidiidae	*Pisidium* sp.				87			2			
Veneroida	Pisidiidae	*Sphaerium* sp.				1			41			3
Veneroida	Pisidiidae	*Sphaerium transversum*			2		5				1	
Veneroida	Sphaeriidae	Sphaeriidae										
		Taxa Richness	35	108	57	99	69	36	75	33	126	19
		Total N Individuals	353	1,483	914	1,117	691	436	894	326	4,156	253
		Number of Samples	n = 2	n = 5	n = 3	n = 7	n = 3	n = 2	n = 5	n = 2	n = 17	n = 2

Appendix E - 6 CONT. Benthic macroinvertebrate taxa list by stream for Ecoregions 33 and 35; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Amphipoda	Gammaridae	*Gammarus lacustris*		2					6			
Amphipoda	Gammaridae	*Gammarus* sp.		2	1	290	11		109	32		163
Amphipoda	Hyalellidae	*Hyalella azteca*		40	14		39		139	1		
Amphipoda	Hyalellidae	*Hyalella* sp.					2					
Architaenioglossa	Viviparidae	*Campeloma decisum*										
Basommatophora	Ancylidae	*Ferrissia rivularis*		28	1	3			1			
Basommatophora	Ancylidae	*Ferrissia* sp.							1			
Basommatophora	Ancylidae	*Hebetancylus* sp.										
Basommatophora	Lymnaeidae	*Pseudosuccinea columella*							1			
Basommatophora	Lymnaeidae	*Pseudosuccinea* sp.	1									
Basommatophora	Physidae	*Physa* sp.			1		1		1			
Basommatophora	Physidae	*Physella* sp.	1				25					
Basommatophora	Physidae	*Physella virgata*							6			
Basommatophora	Physidae	Physidae										
Basommatophora	Planorbidae	*Biomphalaria obstructus*										
Basommatophora	Planorbidae	*Gyraulus parvus*										
Basommatophora	Planorbidae	*Gyraulus* sp.		1					2			
Basommatophora	Planorbidae	*Helisoma anceps*										
Basommatophora	Planorbidae	*Helisoma* sp.					4					
Basommatophora	Planorbidae	*Planorbella* sp.			1							
Basommatophora	Planorbidae	*Planorbella trivolvis*										
Basommatophora	Planorbidae	Planorbidae										
Basommatophora	Planorbidae	*Planorbula* sp.										
Branchiobdellida	Branchiobdellidae	*Branchiobdella* sp.			21		18					
Branchiobdellida	Branchiobdellidae	Branchiobdellidae				1						
Coleoptera	Curculionidae	Curculionidae										
Coleoptera	Curculionidae	*Phytonomus* sp.	1									
Coleoptera	Dryopidae	*Helichus lithophilus*				8			9			
Coleoptera	Dryopidae	*Helichus* sp.		41					18			
Coleoptera	Dytiscidae	*Acilius* sp.								2		
Coleoptera	Dytiscidae	*Bidessonotus* sp.										

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Coleoptera	Dytiscidae	*Brachyvatus* sp.										
Coleoptera	Dytiscidae	*Celina* sp.										
Coleoptera	Dytiscidae	*Copelatus* sp.					1					
Coleoptera	Dytiscidae	*Coptotomus* sp.			3		5			10		
Coleoptera	Dytiscidae	*Cybister* sp.										
Coleoptera	Dytiscidae	Dytiscidae					6					
Coleoptera	Dytiscidae	*Hydaticus* sp.					3					
Coleoptera	Dytiscidae	*Hydroporus* sp.			10		95	1		1		
Coleoptera	Dytiscidae	*Laccodytes* sp.										
Coleoptera	Dytiscidae	*Laccophilus* sp.			3		10					
Coleoptera	Dytiscidae	*Liodessus* sp.					5					
Coleoptera	Dytiscidae	*Neobidessus* sp.					1					
Coleoptera	Dytiscidae	*Neoporus* sp.		1	5							
Coleoptera	Dytiscidae	*Rhantus* sp.										
Coleoptera	Dytiscidae	*Thermonectus* sp.										
Coleoptera	Dytiscidae	*Uvarus* sp.										
Coleoptera	Elmidae	*Ancyronyx* sp.				7	2			7		
Coleoptera	Elmidae	*Ancyronyx variegata*			2							
Coleoptera	Elmidae	*Dubiraphia parva*								1		
Coleoptera	Elmidae	*Dubiraphia* sp.		51					7			
Coleoptera	Elmidae	*Dubiraphia vittata*										
Coleoptera	Elmidae	Elmidae										
Coleoptera	Elmidae	*Heterelmis* sp.										
Coleoptera	Elmidae	*Heterelmis vulnerata*										
Coleoptera	Elmidae	*Hexacylloepus* sp.					1					
Coleoptera	Elmidae	*Macronychus glabratus*							1			
Coleoptera	Elmidae	*Macronychus* sp.	1	16					1			
Coleoptera	Elmidae	*Microcylloepus pusillus*										
Coleoptera	Elmidae	*Microcylloepus* sp.		2								1
Coleoptera	Elmidae	*Neoelmis* sp.										
Coleoptera	Elmidae	*Stenelmis cheryl*										
Coleoptera	Elmidae	*Stenelmis decorata*										
Coleoptera	Elmidae	*Stenelmis grossa*			45	243				178		
Coleoptera	Elmidae	*Stenelmis occidentalis*										
Coleoptera	Elmidae	*Stenelmis sexlineata*										

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Coleoptera	Elmidae	*Stenelmis* sp.		151	34	19	39	22	163	57	35	9
Coleoptera	Gyrinidae	*Dineutus* sp.		7	65	1	104	2		20		19
Coleoptera	Gyrinidae	*Gyretes* sp.					24		5	11		3
Coleoptera	Gyrinidae	*Gyrinus* sp.			1		79	2		3		
Coleoptera	Haliplidae	*Peltodytes* sp.			42		9	3	3			
Coleoptera	Helophoridae	*Helophorus* sp.							2			
Coleoptera	Hydraenidae	*Hydraena* sp.			1							
Coleoptera	Hydraenidae	*Limnebius* sp.				1						
Coleoptera	Hydrochidae	*Hydrochus* sp.			4	1	10					
Coleoptera	Hydrophilidae	*Berosus* nr. *californicus*				1			5			
Coleoptera	Hydrophilidae	*Berosus* sp.			1	3	2	6	1			
Coleoptera	Hydrophilidae	*Cercyon* sp.							1			
Coleoptera	Hydrophilidae	*Derallus* sp.										
Coleoptera	Hydrophilidae	*Enochrus* sp.			1		1					
Coleoptera	Hydrophilidae	*Helochares* sp.	1									
Coleoptera	Hydrophilidae	*Hydrobiomorpha* sp.					1					
Coleoptera	Hydrophilidae	*Hydrobius* sp.					1					
Coleoptera	Hydrophilidae	Hydrophilidae										
Coleoptera	Hydrophilidae	*Hydrophilus* sp.										
Coleoptera	Hydrophilidae	*Laccobius* sp.		1								
Coleoptera	Hydrophilidae	*Paracymus* sp.										
Coleoptera	Hydrophilidae	*Sperchopsis* sp.										
Coleoptera	Hydrophilidae	*Tropisternus* sp.	1		3		4		2			
Coleoptera	Noteridae	*Hydrocanthus* sp.										1
Coleoptera	Noteridae	*Pronoterus* sp.										
Coleoptera	Noteridae	*Suphisellus* sp.										
Coleoptera	Psephenidae	*Ectopria nervosa*										
Coleoptera	Psephenidae	Psephenidae										
Coleoptera	Scirtidae	*Cyphon* sp.					1					
Coleoptera	Scirtidae	*Elodes* sp.				1						
Coleoptera	Scirtidae	*Scirtes* sp.	5		3							
Coleoptera	Scirtidae	Scirtidae										
Coleoptera	Staphylinidae	Staphylinidae			1							
Coleoptera	Staphylinidae	*Stenus* sp.										
Coleoptera		Coleoptera					1					

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Collembola	Isotomidae	*Isotomurus palustris*			1	1			1			
Copepoda		Copepoda							8			
Cyclopoida	Cyclopidae	*Macrocyclops* sp.	8									
Decapoda	Cambaridae	*Cambarellus shufeldtii*								1		
Decapoda	Cambaridae	*Cambarellus* sp.				3						
Decapoda	Cambaridae	Cambaridae		5	27		87		4	14		
Decapoda	Cambaridae	*Cambarus* sp.										
Decapoda	Cambaridae	*Orconectes* sp.		2			3					5
Decapoda	Cambaridae	*Procambarus* sp.		1		1	22		1			
Decapoda	Palaemonidae	*Palaemonetes kadiakensis*		27	1				3			
Decapoda	Palaemonidae	*Palaemonetes* sp.	7		109		191			36		17
Decapoda	Palaemonidae	Palaemonidae						13			103	
Decapoda		Decapoda					3					
Diplostraca		Cladocera					2		8			
Diptera	Athericidae	*Atherix* sp.			1					1		
Diptera	Ceratopogonidae	*Alluaudomyia* sp.										
Diptera	Ceratopogonidae	*Atrichopogon* sp.				1						1
Diptera	Ceratopogonidae	*Bezzia* sp.		1			3		4			
Diptera	Ceratopogonidae	Ceratopogonidae					1					
Diptera	Ceratopogonidae	*Dasyhelea* sp.							2			
Diptera	Ceratopogonidae	*Forcipomyia* sp.	1									
Diptera	Ceratopogonidae	*Probezzia* sp.		1		52	2		10	4		1
Diptera	Ceratopogonidae	*Probezzia* sp. A										
Diptera	Ceratopogonidae	*Probezzia* sp. B										
Diptera	Ceratopogonidae	*Serromyia* sp.										
Diptera	Ceratopogonidae	*Stilobezzia* sp.				2			4			
Diptera	Chaoboridae	*Chaoborus* sp.	295				1					
Diptera	Chironomidae	*Ablabesmyia annulata* gr.										
Diptera	Chironomidae	*Ablabesmyia mallochi*				4				3		
Diptera	Chironomidae	*Ablabesmyia parajanta*				16						
Diptera	Chironomidae	*Ablabesmyia* sp.										1
Diptera	Chironomidae	*Acamptocladius* sp.										
Diptera	Chironomidae	*Alotanypus* sp.										1
Diptera	Chironomidae	*Axarus* sp.										
Diptera	Chironomidae	Chironomidae		24	61		472	22	95	31	8	

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Diptera	Chironomidae	*Chironomus decorus* gr.	10						56			
Diptera	Chironomidae	*Chironomus riparius* gr.										
Diptera	Chironomidae	*Chironomus* sp.										
Diptera	Chironomidae	*Cladotanytarsus* sp.										1
Diptera	Chironomidae	*Cladotanytarsus* sp. gr. A		1								
Diptera	Chironomidae	*Cladotanytarsus vanderwulpi* gr.		33					2			
Diptera	Chironomidae	*Clinotanypus* sp.										4
Diptera	Chironomidae	*Conchapelopia* sp.		8	6				4			1
Diptera	Chironomidae	*Cricotopus bicinctus*		3	4							
Diptera	Chironomidae	*Cricotopus festivellus* gr.		3								
Diptera	Chironomidae	*Cricotopus* sp.										
Diptera	Chironomidae	*Cryptochironomus fulvus* gr.		15		8			2	6		
Diptera	Chironomidae	*Cryptochironomus* sp.										2
Diptera	Chironomidae	*Demicryptochironomus* sp.										
Diptera	Chironomidae	*Dicrotendipes neomodestus*		8					2			
Diptera	Chironomidae	*Dicrotendipes* sp.										
Diptera	Chironomidae	*Einfeldia* sp.										
Diptera	Chironomidae	*Endochironomus* sp.										
Diptera	Chironomidae	*Gillotia* sp.							2			
Diptera	Chironomidae	*Glyptotendipes* sp.										
Diptera	Chironomidae	*Goeldichironomus* sp.			5							
Diptera	Chironomidae	*Guttipelopia* sp.										
Diptera	Chironomidae	*Kiefferulus* sp.										
Diptera	Chironomidae	*Krenopelopia* sp.										
Diptera	Chironomidae	*Labrundinia floridana*										
Diptera	Chironomidae	*Labrundinia neopilosella*										
Diptera	Chironomidae	*Labrundinia* sp.										
Diptera	Chironomidae	*Larsia* sp.				4						
Diptera	Chironomidae	*Lauterborniella agrayloides*										
Diptera	Chironomidae	*Micropsectra aristata*										
Diptera	Chironomidae	*Micropsectra* sp.										
Diptera	Chironomidae	*Microtendipes pedellus* gr.							5			
Diptera	Chironomidae	*Microtendipes* sp.										
Diptera	Chironomidae	*Nanocladius crassicornus*										

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Diptera	Chironomidae	*Nanocladius minimus*										
Diptera	Chironomidae	*Nanocladius rectinervis*										
Diptera	Chironomidae	*Natarsia punctata*				12				3		
Diptera	Chironomidae	*Natarsia* sp.										
Diptera	Chironomidae	*Nilotanypus* nr. *dubius*										
Diptera	Chironomidae	*Nilothauma* sp.		9		4						
Diptera	Chironomidae	*Nimbocera pinderi*										
Diptera	Chironomidae	*Orthocladius* sp.		1		4						
Diptera	Chironomidae	*Parachironomus* sp.										
Diptera	Chironomidae	*Paracladopelma* sp.										
Diptera	Chironomidae	*Paratanytarsus* sp.										
Diptera	Chironomidae	*Paratendipes* nr. *nudisquama*										
Diptera	Chironomidae	*Paratendipes* sp.			2							
Diptera	Chironomidae	*Pentaneura* sp.				16				6		
Diptera	Chironomidae	*Phaenopsectra* sp.		1	4	12						25
Diptera	Chironomidae	*Polypedilum convictum*		11	6	86				31		
Diptera	Chironomidae	*Polypedilum fallax* gr.										
Diptera	Chironomidae	*Polypedilum illinoense*			4	16				3		
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. A		3								
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. B		5		49			2	34		
Diptera	Chironomidae	*Polypedilum* sp.			9							16
Diptera	Chironomidae	*Potthastia* sp.										
Diptera	Chironomidae	*Procladius* sp.	5									1
Diptera	Chironomidae	*Pseudochironomus* sp.		1					2			
Diptera	Chironomidae	*Rheocricotopus fuscipes* gr.		3		37				6		
Diptera	Chironomidae	*Rheocricotopus* sp.			1							
Diptera	Chironomidae	*Rheotanytarsus exiguus* gr.		3	30					34		
Diptera	Chironomidae	*Rheotanytarsus* sp.			3							2
Diptera	Chironomidae	*Robackia* sp.							9			
Diptera	Chironomidae	*Saetheria* sp.										
Diptera	Chironomidae	*Stelechomyia perpulchra*										
Diptera	Chironomidae	*Stelechomyia* sp.			1							
Diptera	Chironomidae	*Stempellinella* sp.										
Diptera	Chironomidae	*Stenochironomus* sp.			6	4				3		2

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Diptera	Chironomidae	*Stictochironomus* sp.										
Diptera	Chironomidae	Subfamily: Chironominae										
Diptera	Chironomidae	Subfamily: Orthocladiinae										
Diptera	Chironomidae	Subfamily: Tanypodinae	5							2		
Diptera	Chironomidae	*Tanypus* nr. *clavatus*	8									
Diptera	Chironomidae	*Tanypus* sp.										
Diptera	Chironomidae	*Tanytarsus chinyensis* gr.										
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.		15		110			2	3		
Diptera	Chironomidae	*Tanytarsus guerlus* gr.				78				3		
Diptera	Chironomidae	*Tanytarsus* sp.			1							3
Diptera	Chironomidae	*Telopelopia* sp.							2			
Diptera	Chironomidae	*Thienemanniella* nr. *xena*		1								
Diptera	Chironomidae	*Thienemanniella* sp.							2			
Diptera	Chironomidae	*Thienemannimyia* sp.				65				46		
Diptera	Chironomidae	Tribe: Chironomini	87			11				2		
Diptera	Chironomidae	Tribe: Tanytarsini										
Diptera	Chironomidae	*Tribelos* sp.										
Diptera	Chironomidae	*Xenochironomus xenolabis*										
Diptera	Chironomidae	*Xylotopus par*			2							
Diptera	Chironomidae	*Zavrelia* sp.				4				9		
Diptera	Culicidae	*Anopheles* sp.			1		1					
Diptera	Culicidae	*Culex* sp.			2							
Diptera	Culicidae	Culicidae										
Diptera	Dixidae	*Dixella* sp.										
Diptera	Empididae	*Hemerodromia* sp.		12						1		
Diptera	Ptychopteridae	Ptychopteridae										
Diptera	Simuliidae	*Cnephia* sp.										
Diptera	Simuliidae	*Simulium* nr. *argus*			14							
Diptera	Simuliidae	*Simulium* sp.		5	3			4	1			
Diptera	Stratiomyidae	*Odontomyia* sp.										
Diptera	Stratiomyidae	Stratiomyidae										
Diptera	Stratiomyidae	*Stratiomys* sp.										
Diptera	Syrphidae	*Myolepta* sp.										
Diptera	Syrphidae	Syrphidae					1					
Diptera	Tabanidae	*Chrysops* sp.			2					1		

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Diptera	Tabanidae	Tabanidae										
Diptera	Tabanidae	*Tabanus* sp.	1		2					1		
Diptera	Tipulidae	*Geranomyia* sp.										
Diptera	Tipulidae	*Hexatoma* sp.		15		1			5			
Diptera	Tipulidae	*Limnophila* sp.			1		2					
Diptera	Tipulidae	*Pseudolimnophila* sp.		1								
Diptera	Tipulidae	*Tipula* sp.	1	1						1		
Ephemeroptera	Baetidae	*Acentrella* sp.							2			
Ephemeroptera	Baetidae	*Acerpenna* sp.							28			
Ephemeroptera	Baetidae	Baetidae							1			
Ephemeroptera	Baetidae	*Baetis ephippiatus*							2			
Ephemeroptera	Baetidae	*Baetis intercalaris*			24	26			1	5		
Ephemeroptera	Baetidae	*Baetis pygmaeus*				4			1			
Ephemeroptera	Baetidae	*Baetis* sp.		50	11		22	33	16	21	15	2
Ephemeroptera	Baetidae	*Callibaetis* sp.			5	1	7		30	1		
Ephemeroptera	Baetidae	*Camelobaetidius* sp.										
Ephemeroptera	Baetidae	*Centroptilum* sp.					3					
Ephemeroptera	Baetidae	*Cloeon* sp.							7			
Ephemeroptera	Baetidae	*Fallceon quilleri*					4					1
Ephemeroptera	Baetidae	*Fallceon* sp.		6					31			
Ephemeroptera	Baetidae	*Labiobaetis* sp.					15					
Ephemeroptera	Baetidae	*Paracloeodes* sp.	1						3			
Ephemeroptera	Baetidae	*Plauditus* sp.										
Ephemeroptera	Baetidae	*Procloeon* sp.		2			1		1			
Ephemeroptera	Baetidae	*Pseudocloeon* sp.		58	20				5			
Ephemeroptera	Caenidae	*Brachycercus* sp.										
Ephemeroptera	Caenidae	*Caenis* sp.	7	43	16		32	18	241	10	2	31
Ephemeroptera	Ephemerellidae	*Ephemerella* sp.				1						
Ephemeroptera	Ephemerellidae	*Eurylophella* sp.										
Ephemeroptera	Ephemeridae	*Hexagenia limbata*										
Ephemeroptera	Ephemeridae	*Hexagenia* sp.		8	63		112			6		1
Ephemeroptera	Heptageniidae	*Leucrocuta* sp.										
Ephemeroptera	Heptageniidae	*Maccaffertium* sp.			2							
Ephemeroptera	Heptageniidae	*Stenacron* sp.	5	1	63	80	85	2	1	127	66	16
Ephemeroptera	Heptageniidae	*Stenonema* sp.		92	96		129		35	45		

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Ephemeroptera	Isonychiidae	*Isonychia sicca manca*										
Ephemeroptera	Isonychiidae	*Isonychia* sp.		66			1					
Ephemeroptera	Leptohyphidae	*Leptohyphes* sp.										
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr.		76					239			
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.		39					114			
Ephemeroptera	Leptophlebiidae	*Choroterpes mexicanus*										
Ephemeroptera	Leptophlebiidae	*Choroterpes* sp.		3	1		20					
Ephemeroptera	Leptophlebiidae	*Farrodes texanus*										
Ephemeroptera	Leptophlebiidae	*Leptophlebia* sp.										
Ephemeroptera	Leptophlebiidae	Leptophlebiidae										
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia* sp.		18					1			
Ephemeroptera	Leptophlebiidae	*Thraulodes gonzalesi*										
Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.										
Ephemeroptera	Leptophlebiidae	*Traverella* sp.										
Ephemeroptera	Polymitarcyidae	*Ephoron* sp.		5								
Ephemeroptera	Polymitarcyidae	*Tortopus circumfluus*										
Gordioidea	Gordiidae	*Gordius* sp.							1			
Hemiptera	Belostomatidae	*Belostoma* sp.	1		4		27	1	1			
Hemiptera	Corixidae	Corixidae					16	22				
Hemiptera	Corixidae	*Hesperocorixa* sp.			4		17					
Hemiptera	Corixidae	*Palmacorixa* sp.					3					
Hemiptera	Corixidae	*Trichocorixa* sp.	1		48		273		12	2		1
Hemiptera	Gerridae	*Aquarius* sp.										
Hemiptera	Gerridae	Gerridae							1			
Hemiptera	Gerridae	*Limnoporus* sp.			1		1					
Hemiptera	Gerridae	*Metrobates* sp.		1						3		
Hemiptera	Gerridae	*Rheumatobates* sp.			4		34	2		7		
Hemiptera	Gerridae	*Trepobates* sp.		2	7		10				1	
Hemiptera	Hebridae	Hebridae	1									
Hemiptera	Hebridae	*Hebrus* sp.										
Hemiptera	Hebridae	*Lipogomphus* sp.									1	
Hemiptera	Hebridae	*Merragata* sp.			1							
Hemiptera	Hydrometridae	*Hydrometra* sp.			1		2		1			
Hemiptera	Mesoveliidae	*Mesovelia* sp.										
Hemiptera	Naucoridae	*Ambrysus pulchellus*										

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Hemiptera	Naucoridae	*Ambrysus* sp.										
Hemiptera	Naucoridae	Naucoridae										
Hemiptera	Naucoridae	*Pelocoris* sp.										
Hemiptera	Nepidae	*Curicta* sp.										
Hemiptera	Nepidae	Nepidae										
Hemiptera	Nepidae	*Ranatra* sp.			6		19		1	3		
Hemiptera	Notonectidae	*Buenoa* sp.			1							
Hemiptera	Notonectidae	*Notonecta* sp.			6		18					
Hemiptera	Pleidae	*Neoplea* sp.			1		1					
Hemiptera	Pleidae	*Neoplea striola*			1							
Hemiptera	Veliidae	*Microvelia* sp.						1				
Hemiptera	Veliidae	*Rhagovelia* sp.		10		3			34	3		
Hirudinea		Hirudinea	3	1			22	1	4		2	
Hirudinida	Erpobdellidae	*Erpobdella* sp.										1
Hirudinida	Erpobdellidae	*Mooreobdella microstoma*								1		
Hirudinida	Erpobdellidae	*Mooreobdella* sp.										
Hirudinida	Glossiphoniidae	*Batracobdella phalera*										
Hirudinida	Glossiphoniidae	*Batracobdella picta*										
Hirudinida	Glossiphoniidae	Glossiphoniidae										
Hirudinida	Glossiphoniidae	*Helobdella* sp.			5		4			1		
Hirudinida	Glossiphoniidae	*Helobdella stagnalis*										
Hirudinida	Glossiphoniidae	*Helobdella triserialis*										
Hirudinida	Glossiphoniidae	*Placobdella parasitica*										
Hirudinida	Glossiphoniidae	*Placobdella* sp.										3
Hoplonemertea	Tetrastemmatidae	*Prostoma rubrum*		3					1			
Isopoda	Asellidae	*Asellus laticaudatus*										
Isopoda	Asellidae	*Asellus* sp.										
Isopoda	Asellidae	*Caecidotea* sp.										
Isopoda	Asellidae	*Lirceus garmani*								172		
Isopoda	Asellidae	*Lirceus* sp.					14			1		12
Isopoda	Sphaeromatidae	*Sphaeroma terebrans*		1								
Lepidoptera	Crambidae	*Acentria* sp.										
Lepidoptera	Crambidae	Crambidae							1			
Lepidoptera	Crambidae	*Crambus* sp.					1					
Lepidoptera	Crambidae	*Paraponyx* sp.										

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Lepidoptera		Lepidoptera							1			
Lumbriculida	Lumbriculidae	Lumbriculidae										
Megaloptera	Corydalidae	*Chauliodes* sp.	4				1					
Megaloptera	Corydalidae	*Corydalus cornutus*		20		128	1		18	2		
Megaloptera	Sialidae	*Sialis* sp.		1	10		8			7		6
Nematoda		Nematoda		1					1			
Nematomorpha		Nematomorpha					1					
Nemertea		Nemertea										
Neoophora	Dugesiidae	*Dugesia* sp.							11			
Neoophora	Dugesiidae	*Dugesia tigrina*				2			4			
Neotaenioglossa	Hydrobiidae	*Amnicola limosa limosa*				5				8		
Neotaenioglossa	Hydrobiidae	Hydrobiidae							26			
Neotaenioglossa	Hydrobiidae	*Pyrgophorus* sp.							21			
Neotaenioglossa	Hydrobiidae	*Pyrgulopsis* sp.										3
Neuroptera	Sisyridae	*Climacia areolaris*										
Odonata	Aeschnidae	*Aeshna* sp.						3			1	
Odonata	Aeschnidae	*Basiaeschna janata*										
Odonata	Aeschnidae	*Basiaeschna* sp.					1			1		
Odonata	Aeschnidae	*Boyeria* sp.		3	7		6					
Odonata	Aeschnidae	*Boyeria vinosa*			2							
Odonata	Aeschnidae	*Coryphaeschna* sp.										6
Odonata	Aeschnidae	*Nasiaeschna pentacantha*	6		5		5					
Odonata	Calopterygidae	*Calopteryx* sp.			3							
Odonata	Calopterygidae	*Hetaerina* sp.		1								
Odonata	Coenagrionidae	*Argia* sp.		5	2	8	5		23	12	1	1
Odonata	Coenagrionidae	*Argia* sp. A										
Odonata	Coenagrionidae	*Argia* sp. C										
Odonata	Coenagrionidae	Coenagrionidae					1					
Odonata	Coenagrionidae	*Enallagma* sp.	2	1	5		32		25	2		
Odonata	Coenagrionidae	*Ischnura* sp.	1			3	6	4	10			
Odonata	Corduliidae	*Didymops* sp.										
Odonata	Corduliidae	*Epicordulia* sp.										
Odonata	Corduliidae	*Epitheca* sp.			2		11					
Odonata	Corduliidae	*Macromia caderita*							1			
Odonata	Corduliidae	*Macromia* sp.		5	25	1	25					

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Odonata	Corduliidae	*Neurocordulia* sp.										
Odonata	Corduliidae	*Somatochlora* sp.										
Odonata	Gomphidae	*Arigomphus lentulus*										
Odonata	Gomphidae	*Arigomphus* sp.										4
Odonata	Gomphidae	*Dromogomphus* sp.			39		58		5	5		
Odonata	Gomphidae	*Dromogomphus spinosus*				2				2		
Odonata	Gomphidae	*Dromogomphus spoliatus*										
Odonata	Gomphidae	*Erpetogomphus* sp.					17					
Odonata	Gomphidae	Gomphidae										
Odonata	Gomphidae	*Gomphus externus*										
Odonata	Gomphidae	*Gomphus graslinellus*										
Odonata	Gomphidae	*Gomphus oklahomensis*										
Odonata	Gomphidae	*Gomphus* sp.			9			1				
Odonata	Gomphidae	*Hagenius brevistylus*		1								
Odonata	Gomphidae	*Hagenius* sp.					1		1	2		
Odonata	Gomphidae	*Phyllogomphoides* sp.										
Odonata	Gomphidae	*Progomphus obscurus*		3		1			3			
Odonata	Gomphidae	*Progomphus* sp.		1					3			
Odonata	Gomphidae	*Stylurus plagiatus*										
Odonata	Lestidae	*Lestes* sp.			1		1					
Odonata	Libellulidae	*Brechmorhoga mendax*										
Odonata	Libellulidae	*Brechmorhoga* sp.										
Odonata	Libellulidae	*Erythemis* sp.							4			
Odonata	Libellulidae	*Erythrodiplax* sp.					2					
Odonata	Libellulidae	*Libellula* sp.			5		49					
Odonata	Libellulidae	Libellulidae					6		4			
Odonata	Libellulidae	*Macrothemis* sp.										
Odonata	Libellulidae	*Miathyria* sp.					2					
Odonata	Libellulidae	*Orthemis* sp.										
Odonata	Libellulidae	*Pachydiplax* sp.	3				2		2			
Odonata	Libellulidae	*Perithemis* sp.					6					
Odonata	Libellulidae	*Tramea* sp.	1									
Oligochaeta		Oligochaeta		1	3		30		69		2	7
Opisthopora	Lumbricidae	Lumbricidae										
Opisthopora	Sparganophilidae	*Sparganophilus tamesis*		6						12		

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Orthoptera	Tridactylidae	*Ellipes* sp.			2							
Ostracoda		Ostracoda							9			
Plecoptera	Perlidae	*Anacroneuria* sp.						2			6	
Plecoptera	Perlidae	*Neoperla* sp.		1								
Plecoptera	Perlidae	*Paragnetina* sp.										
Plecoptera	Perlidae	*Perlesta* sp.		1			43					
Plecoptera	Perlodidae	*Isoperla* sp.										
Podocopida	Cyprididae	*Stenocypris* sp.										
Sarcoptiformes	Hydrozetidae	*Hydrozetes* sp.										
Trichoptera	Brachycentridae	*Brachycentrus* sp.		1								
Trichoptera	Dipseudopsidae	*Phylocentropus* sp.			1							
Trichoptera	Helicopsychidae	*Helicopsyche* sp.		16								
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.		51	149	238	50		96	474		12
Trichoptera	Hydropsychidae	*Hydropsyche* sp.		47	44	264	7	33	5	63	147	4
Trichoptera	Hydropsychidae	Hydropsychidae										
Trichoptera	Hydropsychidae	*Macrostemum carolina*										
Trichoptera	Hydropsychidae	*Macrostemum* sp.										
Trichoptera	Hydropsychidae	*Potamyia flava*										
Trichoptera	Hydropsychidae	*Potamyia* sp.										
Trichoptera	Hydropsychidae	*Smicridea* sp.										
Trichoptera	Hydroptilidae	*Agraylea* sp.										
Trichoptera	Hydroptilidae	*Hydroptila* sp.		2	3	2			2			
Trichoptera	Hydroptilidae	*Hydroptila* sp. A		143					8			
Trichoptera	Hydroptilidae	*Hydroptila* sp. B		4					1			
Trichoptera	Hydroptilidae	*Neotrichia* sp.		2		1			1	3		
Trichoptera	Hydroptilidae	*Ochrotrichia* sp.								8		
Trichoptera	Hydroptilidae	*Oxyethira* sp.		1								
Trichoptera	Leptoceridae	*Ceraclea* sp.							1			
Trichoptera	Leptoceridae	*Leptocerus* sp.			1							
Trichoptera	Leptoceridae	*Nectopsyche candida*							5			
Trichoptera	Leptoceridae	*Nectopsyche gracilis*										
Trichoptera	Leptoceridae	*Nectopsyche* sp.		9	1		1		1			
Trichoptera	Leptoceridae	*Nectopsyche texana*										
Trichoptera	Leptoceridae	*Oecetis* sp.		11	5		2		2			
Trichoptera	Leptoceridae	*Oecetis* sp. A		1		1			18			

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Trichoptera	Leptoceridae	*Oecetis* sp. B		3		16				11		
Trichoptera	Leptoceridae	*Oecetis* sp. C										
Trichoptera	Leptoceridae	*Triaenodes* sp.		15					6	18		
Trichoptera	Limnephilidae	*Pycnopsyche* sp.										
Trichoptera	Philopotamidae	*Chimarra* sp.		14	7	1				18		
Trichoptera	Polycentropodidae	*Cernotina* sp.				2						
Trichoptera	Polycentropodidae	*Neureclipsis* sp.				2						
Trichoptera	Polycentropodidae	*Nyctiophylax* sp.		1								
Trichoptera	Polycentropodidae	Polycentropodidae										
Trichoptera	Polycentropodidae	*Polycentropus* sp.		1			1			1		
Trichoptera	Polycentropodidae	*Polyplectropus* sp.					1					
Trichoptera	Rhyacophilidae	*Rhyacophila* sp.										
Trichoptera	Sericostomatidae	*Agarodes* sp.										
Trichoptera		Trichoptera										
Trombidiformes	Hydrachnidae	*Hydrachna* sp.							2			
Trombidiformes	Hydrodromidae	*Hydrodroma despiciens*										
Trombidiformes	Hydryphantidae	*Hydryphantes* sp.										
Trombidiformes	Hygrobatidae	*Atractides* sp.			2	2			1			
Trombidiformes	Sperchontidae	*Sperchonopsis verrucosa*										
Trombidiformes	Torrenticolidae	*Torrenticola* sp.							1			
Trombidiformes		Hydracarina (Hydrachnidia)			2		6		10			
Tubificida	Naididae	*Aulodrilus limnobius*										
Tubificida	Naididae	*Aulodrilus pigueti*	16									
Tubificida	Naididae	*Bothrioneurum vejdovskyanum*										
Tubificida	Naididae	*Branchiura sowerbyi*				17						
Tubificida	Naididae	*Dero digitata*	33									
Tubificida	Naididae	*Dero trifida*							15			
Tubificida	Naididae	*Haemonais waldvogeli*	16									
Tubificida	Naididae	*Ilyodrilus templetoni*	16						1	7		
Tubificida	Naididae	*Limnodrilus angustipenis*										
Tubificida	Naididae	*Limnodrilus cervix*										
Tubificida	Naididae	*Limnodrilus hoffmeisteri*	121			46						
Tubificida	Naididae	*Limnodrilus maumeensis*	302									
Tubificida	Naididae	*Limnodrilus* sp.		2	1				5	72		
Tubificida	Naididae	*Limnodrilus udekemianus*							4			

Order	Family	Taxon	Davidson Creek	East Fork San Jacinto River	Frazier Creek	Irons Bayou	James Bayou	Kickapoo Creek	Lake Creek	Little Cypress Bayou	Little Mustang Creek	Little Pine Island Bayou
Tubificida	Naididae	*Nais communis*							4			
Tubificida	Naididae	*Nais pardalis*		2					3			
Tubificida	Naididae	*Nais variabilis*		2								
Tubificida	Naididae	*Pristina aequiseta*							17			
Tubificida	Naididae	*Pristina americana*							12			
Tubificida	Naididae	*Pristina leidyi*										
Tubificida	Naididae	*Pristina longidentata*								14		
Tubificida	Naididae	*Pristina longiseta*										
Tubificida	Naididae	*Pristina sima*							1			
Tubificida	Naididae	*Quistadrilus multisetosus*	33									
Tubificida	Naididae	*Slavina appendiculata*										
Tubificida	Naididae	*Specaria josinae*										
Turbellaria		Turbellaria		1								
Unionoida	Unionidae	*Lampsilis* sp.					1					1
Unionoida	Unionidae	Unionidae			13		24					
Unionoida	Unionidae	*Villosa* sp.										
Veneroida	Corbiculidae	*Corbicula fluminea*		44		36	17		97	25		
Veneroida	Pisidiidae	*Eupera cubensis*				12			9			
Veneroida	Pisidiidae	*Musculium* sp.										
Veneroida	Pisidiidae	*Pisidium casertanum*								43		
Veneroida	Pisidiidae	*Pisidium nitidum*										
Veneroida	Pisidiidae	*Pisidium* sp.			1		40		2			
Veneroida	Pisidiidae	*Sphaerium* sp.					16		1		4	31
Veneroida	Pisidiidae	*Sphaerium transversum*				6				54		
Veneroida	Sphaeriidae	Sphaeriidae					3					
		Taxa Richness	38	100	103	68	110	22	126	78	15	41
		Total N Individuals	1,012	1,471	1,313	2,091	2,678	198	2,110	1,880	394	422
		Number of Samples	n = 3	n = 5	n = 6	n = 2	n = 15	n = 2	n = 7	n = 4	n = 2	n = 2

Appendix E - 6 CONT. Benthic macroinvertebrate taxa list by stream for Ecoregions 33 and 35; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Amphipoda	Gammaridae	*Gammarus lacustris*									37		
Amphipoda	Gammaridae	*Gammarus* sp.				1			29	39	6		
Amphipoda	Hyalellidae	*Hyalella azteca*			180	16		17			28		
Amphipoda	Hyalellidae	*Hyalella* sp.											
Architaenioglossa	Viviparidae	*Campeloma decisum*											11
Basommatophora	Ancylidae	*Ferrissia rivularis*		1		1	10	4					
Basommatophora	Ancylidae	*Ferrissia* sp.											
Basommatophora	Ancylidae	*Hebetancylus* sp.											
Basommatophora	Lymnaeidae	*Pseudosuccinea columella*				1							
Basommatophora	Lymnaeidae	*Pseudosuccinea* sp.											
Basommatophora	Physidae	*Physa* sp.			11	2				1	2		
Basommatophora	Physidae	*Physella* sp.				3							
Basommatophora	Physidae	*Physella virgata*		3			1	3					
Basommatophora	Physidae	Physidae			9								
Basommatophora	Planorbidae	*Biomphalaria obstructus*											
Basommatophora	Planorbidae	*Gyraulus parvus*						5					
Basommatophora	Planorbidae	*Gyraulus* sp.								1			
Basommatophora	Planorbidae	*Helisoma anceps*											
Basommatophora	Planorbidae	*Helisoma* sp.											
Basommatophora	Planorbidae	*Planorbella* sp.						1					
Basommatophora	Planorbidae	*Planorbella trivolvis*											
Basommatophora	Planorbidae	Planorbidae				1	2						
Basommatophora	Planorbidae	*Planorbula* sp.											
Branchiobdellida	Branchiobdellidae	*Branchiobdella* sp.											
Branchiobdellida	Branchiobdellidae	Branchiobdellidae											
Coleoptera	Curculionidae	Curculionidae			1								
Coleoptera	Curculionidae	*Phytonomus* sp.											
Coleoptera	Dryopidae	*Helichus lithophilus*											
Coleoptera	Dryopidae	*Helichus* sp.			50	37	1		3		16		
Coleoptera	Dytiscidae	*Acilius* sp.					2						
Coleoptera	Dytiscidae	*Bidessonotus* sp.											

Order	Family	Taxon	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Coleoptera	Dytiscidae	*Brachyvatus* sp.											
Coleoptera	Dytiscidae	*Celina* sp.						1					
Coleoptera	Dytiscidae	*Copelatus* sp.											
Coleoptera	Dytiscidae	*Coptotomus* sp.											
Coleoptera	Dytiscidae	*Cybister* sp.					2						
Coleoptera	Dytiscidae	Dytiscidae											
Coleoptera	Dytiscidae	*Hydaticus* sp.											
Coleoptera	Dytiscidae	*Hydroporus* sp.			6								
Coleoptera	Dytiscidae	*Laccodytes* sp.											
Coleoptera	Dytiscidae	*Laccophilus* sp.			3	2							
Coleoptera	Dytiscidae	*Liodessus* sp.											
Coleoptera	Dytiscidae	*Neobidessus* sp.											
Coleoptera	Dytiscidae	*Neoporus* sp.			2	1							
Coleoptera	Dytiscidae	*Rhantus* sp.											
Coleoptera	Dytiscidae	*Thermonectus* sp.			1								
Coleoptera	Dytiscidae	*Uvarus* sp.				1							
Coleoptera	Elmidae	*Ancyronyx* sp.				36			4		1		
Coleoptera	Elmidae	*Ancyronyx variegata*											
Coleoptera	Elmidae	*Dubiraphia parva*											
Coleoptera	Elmidae	*Dubiraphia* sp.		15	100	122	1						1
Coleoptera	Elmidae	*Dubiraphia vittata*											
Coleoptera	Elmidae	Elmidae			7								
Coleoptera	Elmidae	*Heterelmis* sp.			2								
Coleoptera	Elmidae	*Heterelmis vulnerata*											
Coleoptera	Elmidae	*Hexacylloepus* sp.											
Coleoptera	Elmidae	*Macronychus glabratus*											13
Coleoptera	Elmidae	*Macronychus* sp.				44			7		1		
Coleoptera	Elmidae	*Microcylloepus pusillus*			1								
Coleoptera	Elmidae	*Microcylloepus* sp.			26	38							
Coleoptera	Elmidae	*Neoelmis* sp.											
Coleoptera	Elmidae	*Stenelmis cheryl*		4									
Coleoptera	Elmidae	*Stenelmis decorata*	50									206	
Coleoptera	Elmidae	*Stenelmis grossa*					96						
Coleoptera	Elmidae	*Stenelmis occidentalis*		4	4		64	61					
Coleoptera	Elmidae	*Stenelmis sexlineata*			24								

Order	Family	Taxon	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Coleoptera	Elmidae	*Stenelmis* sp.			168	391	58	3	52	17	7		35
Coleoptera	Gyrinidae	*Dineutus* sp.		4	34		12			5	14		
Coleoptera	Gyrinidae	*Gyretes* sp.			6	16							
Coleoptera	Gyrinidae	*Gyrinus* sp.			1	3		1		11			
Coleoptera	Haliplidae	*Peltodytes* sp.			42	3		2			8		
Coleoptera	Helophoridae	*Helophorus* sp.			8	1							
Coleoptera	Hydraenidae	*Hydraena* sp.			2								
Coleoptera	Hydraenidae	*Limnebius* sp.											
Coleoptera	Hydrochidae	*Hydrochus* sp.											
Coleoptera	Hydrophilidae	*Berosus* nr. *californicus*											
Coleoptera	Hydrophilidae	*Berosus* sp.			16	5					2		
Coleoptera	Hydrophilidae	*Cercyon* sp.											
Coleoptera	Hydrophilidae	*Derallus* sp.			2	1							
Coleoptera	Hydrophilidae	*Enochrus* sp.											
Coleoptera	Hydrophilidae	*Helochares* sp.			3			2					
Coleoptera	Hydrophilidae	*Hydrobiomorpha* sp.											
Coleoptera	Hydrophilidae	*Hydrobius* sp.											
Coleoptera	Hydrophilidae	Hydrophilidae				1							
Coleoptera	Hydrophilidae	*Hydrophilus* sp.											
Coleoptera	Hydrophilidae	*Laccobius* sp.			2								
Coleoptera	Hydrophilidae	*Paracymus* sp.										13	
Coleoptera	Hydrophilidae	*Sperchopsis* sp.				1							
Coleoptera	Hydrophilidae	*Tropisternus* sp.			1								
Coleoptera	Noteridae	*Hydrocanthus* sp.											
Coleoptera	Noteridae	*Pronoterus* sp.		1									
Coleoptera	Noteridae	*Suphisellus* sp.											
Coleoptera	Psephenidae	*Ectopria nervosa*											1
Coleoptera	Psephenidae	Psephenidae			1								
Coleoptera	Scirtidae	*Cyphon* sp.											
Coleoptera	Scirtidae	*Elodes* sp.											
Coleoptera	Scirtidae	*Scirtes* sp.			4	3		21		4			
Coleoptera	Scirtidae	Scirtidae			1								
Coleoptera	Staphylinidae	Staphylinidae							1				
Coleoptera	Staphylinidae	*Stenus* sp.											
Coleoptera		Coleoptera		1									

Order	Family	Taxon	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Collembola	Isotomidae	*Isotomurus palustris*											
Copepoda		Copepoda											
Cyclopoida	Cyclopidae	*Macrocyclops* sp.											
Decapoda	Cambaridae	*Cambarellus shufeldtii*											
Decapoda	Cambaridae	*Cambarellus* sp.											2
Decapoda	Cambaridae	Cambaridae			16	22	1				2		
Decapoda	Cambaridae	*Cambarus* sp.			1								
Decapoda	Cambaridae	*Orconectes* sp.				5					2		
Decapoda	Cambaridae	*Procambarus* sp.			13	1			1		1		
Decapoda	Palaemonidae	*Palaemonetes kadiakensis*		1	93	79	1				1		
Decapoda	Palaemonidae	*Palaemonetes* sp.						16	1				
Decapoda	Palaemonidae	Palaemonidae											
Decapoda		Decapoda						1					
Diplostraca		Cladocera											
Diptera	Athericidae	*Atherix* sp.											
Diptera	Ceratopogonidae	*Alluaudomyia* sp.					1						
Diptera	Ceratopogonidae	*Atrichopogon* sp.											
Diptera	Ceratopogonidae	*Bezzia* sp.	3			9		1		1	1	2	1
Diptera	Ceratopogonidae	Ceratopogonidae											
Diptera	Ceratopogonidae	*Dasyhelea* sp.											
Diptera	Ceratopogonidae	*Forcipomyia* sp.			1								
Diptera	Ceratopogonidae	*Probezzia* sp.	1	1	13	4		10	1			2	
Diptera	Ceratopogonidae	*Probezzia* sp. A											
Diptera	Ceratopogonidae	*Probezzia* sp. B											
Diptera	Ceratopogonidae	*Serromyia* sp.											
Diptera	Ceratopogonidae	*Stilobezzia* sp.											
Diptera	Chaoboridae	*Chaoborus* sp.					44						
Diptera	Chironomidae	*Ablabesmyia annulata* gr.					5						
Diptera	Chironomidae	*Ablabesmyia mallochi*		3									
Diptera	Chironomidae	*Ablabesmyia parajanta*					2	3					
Diptera	Chironomidae	*Ablabesmyia* sp.											
Diptera	Chironomidae	*Acamptocladius* sp.											
Diptera	Chironomidae	*Alotanypus* sp.											
Diptera	Chironomidae	*Axarus* sp.					1						
Diptera	Chironomidae	Chironomidae			208	169				79	19		

Order	Family	Taxon	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Diptera	Chironomidae	*Chironomus decorus* gr.		2									
Diptera	Chironomidae	*Chironomus riparius* gr.						2					
Diptera	Chironomidae	*Chironomus* sp.											
Diptera	Chironomidae	*Cladotanytarsus* sp.			4								
Diptera	Chironomidae	*Cladotanytarsus* sp. gr. A	1	14				3				4	8
Diptera	Chironomidae	*Cladotanytarsus vanderwulpi* gr.						2					
Diptera	Chironomidae	*Clinotanypus* sp.											
Diptera	Chironomidae	*Conchapelopia* sp.			51		12	30				4	
Diptera	Chironomidae	*Cricotopus bicinctus*											
Diptera	Chironomidae	*Cricotopus festivellus* gr.											
Diptera	Chironomidae	*Cricotopus* sp.					1						
Diptera	Chironomidae	*Cryptochironomus fulvus* gr.		9			5						1
Diptera	Chironomidae	*Cryptochironomus* sp.											
Diptera	Chironomidae	*Demicryptochironomus* sp.											8
Diptera	Chironomidae	*Dicrotendipes neomodestus*		9	8		5	7					
Diptera	Chironomidae	*Dicrotendipes* sp.					2						
Diptera	Chironomidae	*Einfeldia* sp.											
Diptera	Chironomidae	*Endochironomus* sp.											
Diptera	Chironomidae	*Gillotia* sp.											
Diptera	Chironomidae	*Glyptotendipes* sp.											
Diptera	Chironomidae	*Goeldichironomus* sp.											
Diptera	Chironomidae	*Guttipelopia* sp.											
Diptera	Chironomidae	*Kiefferulus* sp.											
Diptera	Chironomidae	*Krenopelopia* sp.											
Diptera	Chironomidae	*Labrundinia floridana*											
Diptera	Chironomidae	*Labrundinia neopilosella*						2					
Diptera	Chironomidae	*Labrundinia* sp.											
Diptera	Chironomidae	*Larsia* sp.						3					
Diptera	Chironomidae	*Lauterborniella agrayloides*											
Diptera	Chironomidae	*Micropsectra aristata*					2						
Diptera	Chironomidae	*Micropsectra* sp.						2					
Diptera	Chironomidae	*Microtendipes pedellus* gr.											
Diptera	Chironomidae	*Microtendipes* sp.							1				
Diptera	Chironomidae	*Nanocladius crassicornus*		2									

Order	Family	Taxon	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Diptera	Chironomidae	*Nanocladius minimus*			4								
Diptera	Chironomidae	*Nanocladius rectinervis*											
Diptera	Chironomidae	*Natarsia punctata*					12						1
Diptera	Chironomidae	*Natarsia* sp.					5						
Diptera	Chironomidae	*Nilotanypus* nr. *dubius*					2						1
Diptera	Chironomidae	*Nilothauma* sp.					2						
Diptera	Chironomidae	*Nimbocera pinderi*					2						
Diptera	Chironomidae	*Orthocladius* sp.			23							51	
Diptera	Chironomidae	*Parachironomus* sp.											
Diptera	Chironomidae	*Paracladopelma* sp.										4	
Diptera	Chironomidae	*Paratanytarsus* sp.											
Diptera	Chironomidae	*Paratendipes* nr. *nudisquama*											1
Diptera	Chironomidae	*Paratendipes* sp.											
Diptera	Chironomidae	*Pentaneura* sp.					17	2					
Diptera	Chironomidae	*Phaenopsectra* sp.					3	2				4	2
Diptera	Chironomidae	*Polypedilum convictum*	3		12		76	10				44	
Diptera	Chironomidae	*Polypedilum fallax* gr.											
Diptera	Chironomidae	*Polypedilum illinoense*	2	6			10	3					
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. A	1									92	5
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. B	1	9	4		12	10				11	3
Diptera	Chironomidae	*Polypedilum* sp.			9		7		6				
Diptera	Chironomidae	*Potthastia* sp.				1							
Diptera	Chironomidae	*Procladius* sp.											
Diptera	Chironomidae	*Pseudochironomus* sp.			4		1					4	
Diptera	Chironomidae	*Rheocricotopus fuscipes* gr.		1			17					18	
Diptera	Chironomidae	*Rheocricotopus* sp.											
Diptera	Chironomidae	*Rheotanytarsus exiguus* gr.	1				52					15	
Diptera	Chironomidae	*Rheotanytarsus* sp.					5						
Diptera	Chironomidae	*Robackia* sp.											
Diptera	Chironomidae	*Saetheria* sp.		2				2					
Diptera	Chironomidae	*Stelechomyia perpulchra*											
Diptera	Chironomidae	*Stelechomyia* sp.											
Diptera	Chironomidae	*Stempellinella* sp.											
Diptera	Chironomidae	*Stenochironomus* sp.	2				2						12

Order	Family	Taxon	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Diptera	Chironomidae	*Stictochironomus* sp.	8										
Diptera	Chironomidae	Subfamily: Chironominae			56								
Diptera	Chironomidae	Subfamily: Orthocladiinae			2						1		
Diptera	Chironomidae	Subfamily: Tanypodinae			3			6					
Diptera	Chironomidae	*Tanypus* nr. *clavatus*											
Diptera	Chironomidae	*Tanypus* sp.											
Diptera	Chironomidae	*Tanytarsus chinyensis* gr.											
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.		6	136		27	10				22	
Diptera	Chironomidae	*Tanytarsus guerlus* gr.		32	12		5	5				4	
Diptera	Chironomidae	*Tanytarsus* sp.					1						
Diptera	Chironomidae	*Telopelopia* sp.			4								
Diptera	Chironomidae	*Thienemanniella* nr. *xena*											
Diptera	Chironomidae	*Thienemanniella* sp.			4								
Diptera	Chironomidae	*Thienemannimyia* sp.					7						
Diptera	Chironomidae	Tribe: Chironomini						34					
Diptera	Chironomidae	Tribe: Tanytarsini						1					
Diptera	Chironomidae	*Tribelos* sp.											
Diptera	Chironomidae	*Xenochironomus xenolabis*					5						
Diptera	Chironomidae	*Xylotopus par*											
Diptera	Chironomidae	*Zavrelia* sp.						2					
Diptera	Culicidae	*Anopheles* sp.											
Diptera	Culicidae	*Culex* sp.											
Diptera	Culicidae	Culicidae											
Diptera	Dixidae	*Dixella* sp.											
Diptera	Empididae	*Hemerodromia* sp.			1		18					1	2
Diptera	Ptychopteridae	Ptychopteridae			1								
Diptera	Simuliidae	*Cnephia* sp.			4								
Diptera	Simuliidae	*Simulium* nr. *argus*											
Diptera	Simuliidae	*Simulium* sp.			192	128			2	2	194		
Diptera	Stratiomyidae	*Odontomyia* sp.											
Diptera	Stratiomyidae	Stratiomyidae			1								
Diptera	Stratiomyidae	*Stratiomys* sp.			2								
Diptera	Syrphidae	*Myolepta* sp.		1									
Diptera	Syrphidae	Syrphidae											
Diptera	Tabanidae	*Chrysops* sp.										10	

Order	Family	Taxon	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Diptera	Tabanidae	Tabanidae			1		2						
Diptera	Tabanidae	*Tabanus* sp.	1	1	1		1	1					
Diptera	Tipulidae	*Geranomyia* sp.											
Diptera	Tipulidae	*Hexatoma* sp.				1						2	2
Diptera	Tipulidae	*Limnophila* sp.											
Diptera	Tipulidae	*Pseudolimnophila* sp.											
Diptera	Tipulidae	*Tipula* sp.			1	4							
Ephemeroptera	Baetidae	*Acentrella* sp.			74	77					7		
Ephemeroptera	Baetidae	*Acerpenna* sp.				10	9						
Ephemeroptera	Baetidae	Baetidae				3							
Ephemeroptera	Baetidae	*Baetis ephippiatus*											
Ephemeroptera	Baetidae	*Baetis intercalaris*					4					8	1
Ephemeroptera	Baetidae	*Baetis pygmaeus*			3		4	34				21	
Ephemeroptera	Baetidae	*Baetis* sp.			157	420	2		16	26	26		
Ephemeroptera	Baetidae	*Callibaetis* sp.			7	1							
Ephemeroptera	Baetidae	*Camelobaetidius* sp.											
Ephemeroptera	Baetidae	*Centroptilum* sp.	1		8			3				1	
Ephemeroptera	Baetidae	*Cloeon* sp.											
Ephemeroptera	Baetidae	*Fallceon quilleri*			149	2	11	2	2				
Ephemeroptera	Baetidae	*Fallceon* sp.			259	15							
Ephemeroptera	Baetidae	*Labiobaetis* sp.											
Ephemeroptera	Baetidae	*Paracloeodes* sp.			14	28		5			1		
Ephemeroptera	Baetidae	*Plauditus* sp.											
Ephemeroptera	Baetidae	*Procloeon* sp.			3	28							
Ephemeroptera	Baetidae	*Pseudocloeon* sp.			185	407					20		
Ephemeroptera	Caenidae	*Brachycercus* sp.			1							1	
Ephemeroptera	Caenidae	*Caenis* sp.		1	221	103	27	26	1	2	13	154	
Ephemeroptera	Ephemerellidae	*Ephemerella* sp.				8							
Ephemeroptera	Ephemerellidae	*Eurylophella* sp.				2							
Ephemeroptera	Ephemeridae	*Hexagenia limbata*											
Ephemeroptera	Ephemeridae	*Hexagenia* sp.			1	7							
Ephemeroptera	Heptageniidae	*Leucrocuta* sp.											
Ephemeroptera	Heptageniidae	*Maccaffertium* sp.							22				
Ephemeroptera	Heptageniidae	*Stenacron* sp.	1	29	67	21	117	19	2	3	7		1
Ephemeroptera	Heptageniidae	*Stenonema* sp.	1		464	273		11			27	31	6

Order	Family	Taxon	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Ephemeroptera	Isonychiidae	*Isonychia sicca manca*		1	8								
Ephemeroptera	Isonychiidae	*Isonychia* sp.	2		362	686			2		4		
Ephemeroptera	Leptohyphidae	*Leptohyphes* sp.											
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr.		2	29			3				1	
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.			1,526	950			7		279		
Ephemeroptera	Leptophlebiidae	*Choroterpes mexicanus*											
Ephemeroptera	Leptophlebiidae	*Choroterpes* sp.				2							
Ephemeroptera	Leptophlebiidae	*Farrodes texanus*		1									
Ephemeroptera	Leptophlebiidae	*Leptophlebia* sp.											
Ephemeroptera	Leptophlebiidae	Leptophlebiidae			42								
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia* sp.			418	119							
Ephemeroptera	Leptophlebiidae	*Thraulodes gonzalesi*											
Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.											
Ephemeroptera	Leptophlebiidae	*Traverella* sp.			9								
Ephemeroptera	Polymitarcyidae	*Ephoron* sp.			2								
Ephemeroptera	Polymitarcyidae	*Tortopus circumfluus*			1								
Gordioidea	Gordiidae	*Gordius* sp.											
Hemiptera	Belostomatidae	*Belostoma* sp.			12	2							
Hemiptera	Corixidae	Corixidae											
Hemiptera	Corixidae	*Hesperocorixa* sp.											
Hemiptera	Corixidae	*Palmacorixa* sp.											
Hemiptera	Corixidae	*Trichocorixa* sp.			10	2		5			1	1	
Hemiptera	Gerridae	*Aquarius* sp.											
Hemiptera	Gerridae	Gerridae											
Hemiptera	Gerridae	*Limnoporus* sp.											
Hemiptera	Gerridae	*Metrobates* sp.											
Hemiptera	Gerridae	*Rheumatobates* sp.			1								
Hemiptera	Gerridae	*Trepobates* sp.				12		1				1	
Hemiptera	Hebridae	Hebridae											
Hemiptera	Hebridae	*Hebrus* sp.		8									
Hemiptera	Hebridae	*Lipogomphus* sp.											
Hemiptera	Hebridae	*Merragata* sp.						1					
Hemiptera	Hydrometridae	*Hydrometra* sp.			1	3	2						
Hemiptera	Mesoveliidae	*Mesovelia* sp.				1							
Hemiptera	Naucoridae	*Ambrysus pulchellus*						11					

Order	Family	Taxon	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Hemiptera	Naucoridae	*Ambrysus* sp.			3								
Hemiptera	Naucoridae	Naucoridae			1								
Hemiptera	Naucoridae	*Pelocoris* sp.			2								
Hemiptera	Nepidae	*Curicta* sp.			2			2					
Hemiptera	Nepidae	Nepidae						1					
Hemiptera	Nepidae	*Ranatra* sp.			9	2	1				1		
Hemiptera	Notonectidae	*Buenoa* sp.											
Hemiptera	Notonectidae	*Notonecta* sp.					5						
Hemiptera	Pleidae	*Neoplea* sp.											
Hemiptera	Pleidae	*Neoplea striola*											
Hemiptera	Veliidae	*Microvelia* sp.			1	2				2			
Hemiptera	Veliidae	*Rhagovelia* sp.	3	2	116	142		13	20		19	3	3
Hirudinea		Hirudinea			2			15					
Hirudinida	Erpobdellidae	*Erpobdella* sp.											
Hirudinida	Erpobdellidae	*Mooreobdella microstoma*											
Hirudinida	Erpobdellidae	*Mooreobdella* sp.											
Hirudinida	Glossiphoniidae	*Batracobdella phalera*											
Hirudinida	Glossiphoniidae	*Batracobdella picta*			1								
Hirudinida	Glossiphoniidae	Glossiphoniidae					8						
Hirudinida	Glossiphoniidae	*Helobdella* sp.											
Hirudinida	Glossiphoniidae	*Helobdella stagnalis*											
Hirudinida	Glossiphoniidae	*Helobdella triserialis*						4					
Hirudinida	Glossiphoniidae	*Placobdella parasitica*											
Hirudinida	Glossiphoniidae	*Placobdella* sp.											
Hoplonemertea	Tetrastemmatidae	*Prostoma rubrum*			1			1					
Isopoda	Asellidae	*Asellus laticaudatus*											
Isopoda	Asellidae	*Asellus* sp.											
Isopoda	Asellidae	*Caecidotea* sp.			5	1							
Isopoda	Asellidae	*Lirceus garmani*											1
Isopoda	Asellidae	*Lirceus* sp.											
Isopoda	Sphaeromatidae	*Sphaeroma terebrans*											
Lepidoptera	Crambidae	*Acentria* sp.											
Lepidoptera	Crambidae	Crambidae											
Lepidoptera	Crambidae	*Crambus* sp.											
Lepidoptera	Crambidae	*Paraponyx* sp.										1	

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Lepidoptera		Lepidoptera											
Lumbriculida	Lumbriculidae	Lumbriculidae		6									
Megaloptera	Corydalidae	*Chauliodes* sp.											
Megaloptera	Corydalidae	*Corydalus cornutus*		2	172	29				3	24	1	1
Megaloptera	Sialidae	*Sialis* sp.			1								
Nematoda		Nematoda			3		2					9	
Nematomorpha		Nematomorpha											
Nemertea		Nemertea											
Neoophora	Dugesiidae	*Dugesia* sp.			1	1							
Neoophora	Dugesiidae	*Dugesia tigrina*						9					
Neotaenioglossa	Hydrobiidae	*Amnicola limosa limosa*					6						
Neotaenioglossa	Hydrobiidae	Hydrobiidae			12		1				1		
Neotaenioglossa	Hydrobiidae	*Pyrgophorus* sp.											
Neotaenioglossa	Hydrobiidae	*Pyrgulopsis* sp.											
Neuroptera	Sisyridae	*Climacia areolaris*						1					
Odonata	Aeschnidae	*Aeshna* sp.											
Odonata	Aeschnidae	*Basiaeschna janata*					1						
Odonata	Aeschnidae	*Basiaeschna* sp.											
Odonata	Aeschnidae	*Boyeria* sp.			14	56	1	2	1		1		
Odonata	Aeschnidae	*Boyeria vinosa*											
Odonata	Aeschnidae	*Coryphaeschna* sp.											
Odonata	Aeschnidae	*Nasiaeschna pentacantha*			1								
Odonata	Calopterygidae	*Calopteryx* sp.						5					
Odonata	Calopterygidae	*Hetaerina* sp.			166	70	1	2	1		15	1	
Odonata	Coenagrionidae	*Argia* sp.	2	9	152	90	1	3	1		13		
Odonata	Coenagrionidae	*Argia* sp. A											
Odonata	Coenagrionidae	*Argia* sp. C											
Odonata	Coenagrionidae	Coenagrionidae					1						
Odonata	Coenagrionidae	*Enallagma* sp.			54	61	1	1			1		
Odonata	Coenagrionidae	*Ischnura* sp.		2	1	2		1					
Odonata	Corduliidae	*Didymops* sp.						1					
Odonata	Corduliidae	*Epicordulia* sp.						52					
Odonata	Corduliidae	*Epitheca* sp.											
Odonata	Corduliidae	*Macromia caderita*					1						
Odonata	Corduliidae	*Macromia* sp.		2	43	49	2	12			2	2	

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Odonata	Corduliidae	*Neurocordulia* sp.											
Odonata	Corduliidae	*Somatochlora* sp.											
Odonata	Gomphidae	*Arigomphus lentulus*											
Odonata	Gomphidae	*Arigomphus* sp.			2			6					
Odonata	Gomphidae	*Dromogomphus* sp.			7	6		1			1		
Odonata	Gomphidae	*Dromogomphus spinosus*											
Odonata	Gomphidae	*Dromogomphus spoliatus*		1									
Odonata	Gomphidae	*Erpetogomphus* sp.			358	7		1			3		
Odonata	Gomphidae	Gomphidae			66	1							
Odonata	Gomphidae	*Gomphus externus*											
Odonata	Gomphidae	*Gomphus graslinellus*											1
Odonata	Gomphidae	*Gomphus oklahomensis*					1						
Odonata	Gomphidae	*Gomphus* sp.			10	19		3			1		
Odonata	Gomphidae	*Hagenius brevistylus*											
Odonata	Gomphidae	*Hagenius* sp.			1	4					1		
Odonata	Gomphidae	*Phyllogomphoides* sp.			2								
Odonata	Gomphidae	*Progomphus obscurus*	3		1			5				57	
Odonata	Gomphidae	*Progomphus* sp.			103	28		21	1		4		
Odonata	Gomphidae	*Stylurus plagiatus*											
Odonata	Lestidae	*Lestes* sp.											
Odonata	Libellulidae	*Brechmorhoga mendax*											
Odonata	Libellulidae	*Brechmorhoga* sp.											
Odonata	Libellulidae	*Erythemis* sp.											
Odonata	Libellulidae	*Erythrodiplax* sp.											
Odonata	Libellulidae	*Libellula* sp.						1					
Odonata	Libellulidae	Libellulidae											
Odonata	Libellulidae	*Macrothemis* sp.											
Odonata	Libellulidae	*Miathyria* sp.			1								
Odonata	Libellulidae	*Orthemis* sp.											
Odonata	Libellulidae	*Pachydiplax* sp.											
Odonata	Libellulidae	*Perithemis* sp.											
Odonata	Libellulidae	*Tramea* sp.											
Oligochaeta		Oligochaeta			9	13	14			9	3		
Opisthopora	Lumbricidae	Lumbricidae						2					
Opisthopora	Sparganophilidae	*Sparganophilus tamesis*					3						

Order	Family	Taxon	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Orthoptera	Tridactylidae	*Ellipes* sp.											
Ostracoda		Ostracoda											
Plecoptera	Perlidae	*Anacroneuria* sp.							1				
Plecoptera	Perlidae	*Neoperla* sp.				18							
Plecoptera	Perlidae	*Paragnetina* sp.				3							
Plecoptera	Perlidae	*Perlesta* sp.			17	3			3				
Plecoptera	Perlodidae	*Isoperla* sp.				4							
Podocopida	Cyprididae	*Stenocypris* sp.											
Sarcoptiformes	Hydrozetidae	*Hydrozetes* sp.											
Trichoptera	Brachycentridae	*Brachycentrus* sp.				37							
Trichoptera	Dipseudopsidae	*Phylocentropus* sp.											
Trichoptera	Helicopsychidae	*Helicopsyche* sp.			1	59						8	
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.		1	406	87	382	356	2		101	1	10
Trichoptera	Hydropsychidae	*Hydropsyche* sp.			154	117	89		1	113	1		
Trichoptera	Hydropsychidae	Hydropsychidae					69						
Trichoptera	Hydropsychidae	*Macrostemum carolina*											
Trichoptera	Hydropsychidae	*Macrostemum* sp.											
Trichoptera	Hydropsychidae	*Potamyia flava*			1								
Trichoptera	Hydropsychidae	*Potamyia* sp.											
Trichoptera	Hydropsychidae	*Smicridea* sp.			10								
Trichoptera	Hydroptilidae	*Agraylea* sp.											
Trichoptera	Hydroptilidae	*Hydroptila* sp.		1	49	3	61				4	38	1
Trichoptera	Hydroptilidae	*Hydroptila* sp. A											
Trichoptera	Hydroptilidae	*Hydroptila* sp. B											
Trichoptera	Hydroptilidae	*Neotrichia* sp.					1						1
Trichoptera	Hydroptilidae	*Ochrotrichia* sp.											
Trichoptera	Hydroptilidae	*Oxyethira* sp.											
Trichoptera	Leptoceridae	*Ceraclea* sp.											
Trichoptera	Leptoceridae	*Leptocerus* sp.											
Trichoptera	Leptoceridae	*Nectopsyche candida*											
Trichoptera	Leptoceridae	*Nectopsyche gracilis*											
Trichoptera	Leptoceridae	*Nectopsyche* sp.			299	393					13		
Trichoptera	Leptoceridae	*Nectopsyche texana*										22	
Trichoptera	Leptoceridae	*Oecetis* sp.		2	25	69	1				10		
Trichoptera	Leptoceridae	*Oecetis* sp. A						9				1	

Order	Family	Taxon	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Trichoptera	Leptoceridae	*Oecetis* sp. B					1	14				11	1
Trichoptera	Leptoceridae	*Oecetis* sp. C											
Trichoptera	Leptoceridae	*Triaenodes* sp.			18	197		1			24		
Trichoptera	Limnephilidae	*Pycnopsyche* sp.				2							
Trichoptera	Philopotamidae	*Chimarra* sp.		1	42	55	157	3				2	5
Trichoptera	Polycentropodidae	*Cernotina* sp.				4							
Trichoptera	Polycentropodidae	*Neureclipsis* sp.				1							
Trichoptera	Polycentropodidae	*Nyctiophylax* sp.			1	2							
Trichoptera	Polycentropodidae	Polycentropodidae			1								
Trichoptera	Polycentropodidae	*Polycentropus* sp.		1		19							
Trichoptera	Polycentropodidae	*Polyplectropus* sp.											
Trichoptera	Rhyacophilidae	*Rhyacophila* sp.											
Trichoptera	Sericostomatidae	*Agarodes* sp.											1
Trichoptera		Trichoptera			2								
Trombidiformes	Hydrachnidae	*Hydrachna* sp.											
Trombidiformes	Hydrodromidae	*Hydrodroma despiciens*											
Trombidiformes	Hydryphantidae	*Hydryphantes* sp.						1					
Trombidiformes	Hygrobatidae	*Atractides* sp.			3								
Trombidiformes	Sperchontidae	*Sperchonopsis verrucosa*											
Trombidiformes	Torrenticolidae	*Torrenticola* sp.			1								
Trombidiformes		Hydracarina (Hydrachnidia)			1	25					1		
Tubificida	Naididae	*Aulodrilus limnobius*											
Tubificida	Naididae	*Aulodrilus pigueti*		6									
Tubificida	Naididae	*Bothrioneurum vejdovskyanum*											15
Tubificida	Naididae	*Branchiura sowerbyi*		8									
Tubificida	Naididae	*Dero digitata*		111									
Tubificida	Naididae	*Dero trifida*		6				2					
Tubificida	Naididae	*Haemonais waldvogeli*											
Tubificida	Naididae	*Ilyodrilus templetoni*											
Tubificida	Naididae	*Limnodrilus angustipenis*					106						4
Tubificida	Naididae	*Limnodrilus cervix*											
Tubificida	Naididae	*Limnodrilus hoffmeisteri*		50									
Tubificida	Naididae	*Limnodrilus maumeensis*											
Tubificida	Naididae	*Limnodrilus* sp.	4		4							12	9
Tubificida	Naididae	*Limnodrilus udekemianus*		1			5						4

Order	Family	Taxon	Lower Keechi Creek	Middle Yegua Creek	Mill Creek	Peach Creek	Piney Creek	Ponds Creek	San Pedro Creek	Smackover Creek	West Fork San Jacinto River	Wheelock Creek	White Oak Creek
Tubificida	Naididae	*Nais communis*	1										
Tubificida	Naididae	*Nais pardalis*			7								
Tubificida	Naididae	*Nais variabilis*											
Tubificida	Naididae	*Pristina aequiseta*											
Tubificida	Naididae	*Pristina americana*					10						
Tubificida	Naididae	*Pristina leidyi*											
Tubificida	Naididae	*Pristina longidentata*											1
Tubificida	Naididae	*Pristina longiseta*											
Tubificida	Naididae	*Pristina sima*											
Tubificida	Naididae	*Quistadrilus multisetosus*											
Tubificida	Naididae	*Slavina appendiculata*											
Tubificida	Naididae	*Specaria josinae*											
Turbellaria		Turbellaria						2					
Unionoida	Unionidae	*Lampsilis* sp.											
Unionoida	Unionidae	Unionidae											
Unionoida	Unionidae	*Villosa* sp.											
Veneroida	Corbiculidae	*Corbicula fluminea*	7	107	170	78					11		9
Veneroida	Pisidiidae	*Eupera cubensis*			9	1	2	4					
Veneroida	Pisidiidae	*Musculium* sp.			1								
Veneroida	Pisidiidae	*Pisidium casertanum*					4						
Veneroida	Pisidiidae	*Pisidium nitidum*						6					
Veneroida	Pisidiidae	*Pisidium* sp.											
Veneroida	Pisidiidae	*Sphaerium* sp.			1		27			6	14		
Veneroida	Pisidiidae	*Sphaerium transversum*					27	109					1
Veneroida	Sphaeriidae	Sphaeriidae			1								
		Taxa Richness	22	49	149	101	88	86	28	18	53	44	39
		Total N Individuals	99	493	8,184	6,096	1,790	1,084	191	324	997	901	186
		Number of Samples	n = 1	n = 2	n = 32	n = 28	n = 3	n = 3	n = 1	n = 2	n = 4	n = 1	n = 1

Appendix E - 7. Benthic macroinvertebrate taxa list by stream for Ecoregion 34; number of samples collected at each stream noted below the stream name (n = x); benthic taxa listed alphabetically by order and shaded by family.

Order	Family	Taxon	Arenosa Creek	Big Creek	Garcitas Creek	Placedo Creek	San Bernard River	West Bernard Creek	West Carancahua Creek	West Mustang Creek
Amphipoda	Crangonyctidae	*Crangonyx* sp.						4		
Amphipoda	Hyalellidae	*Hyalella azteca*	51	166		7	19	49	64	77
Amphipoda	Hyalellidae	*Hyalella* sp.	1		22	2				
Anthoathecata	Hydridae	*Hydra* sp.							1	
Arguloida	Argulidae	*Argulus* sp.		1						
Basommatophora	Ancylidae	*Laevapex fuscus*						67		
Basommatophora	Ancylidae	*Ferrissia rivularis*	1	26	2	71		33		1
Basommatophora	Lymnaeidae	*Pseudosuccinea columella*		1						
Basommatophora	Physidae	*Physa* sp.	4	3	1	3	3	3		11
Basommatophora	Physidae	*Physella virgata*	2	2		1			1	8
Basommatophora	Planorbidae	*Biomphalaria obstructus*				5				
Basommatophora	Planorbidae	*Gyraulus parvus*	2	1						
Basommatophora	Planorbidae	*Gyraulus* sp.		1						1
Basommatophora	Planorbidae	*Hebetancylus excentricus*					1			2
Basommatophora	Planorbidae	*Helisoma anceps*	1	1		6				1
Coleoptera	Chrysomelidae	Chrysomelidae						1		
Coleoptera	Dryopidae	*Helichus* sp.		9		2	1		1	
Coleoptera	Dryopidae	*Helichus suturalis*								7
Coleoptera	Dytiscidae	*Bidessonotus* sp.			1					
Coleoptera	Dytiscidae	*Copelatus* sp.					1			
Coleoptera	Dytiscidae	*Coptotomus* sp	1	3			1			
Coleoptera	Dytiscidae	*Desmopachria* nr. *latissima*				1				
Coleoptera	Dytiscidae	*Hydroporus* nr. *hirtellus*				61				
Coleoptera	Dytiscidae	*Hydrovatus* sp.	1							
Coleoptera	Dytiscidae	*Laccodytes* sp.						1		1
Coleoptera	Dytiscidae	*Laccophilus* nr. *terminalis*				17				
Coleoptera	Dytiscidae	*Laccophilus* sp.		1						1
Coleoptera	Dytiscidae	*Neobidessus* nr. *affinis*				1				
Coleoptera	Dytiscidae	*Neobidessus* nr. *subtilis*				3				
Coleoptera	Dytiscidae	*Pachydrus* sp.			1					
Coleoptera	Elmidae	*Dubiraphia* sp.	1			5			7	8
Coleoptera	Elmidae	*Heterelmis* sp.						110		

Order	Family	Taxon	Arenosa Creek	Big Creek	Garcitas Creek	Placedo Creek	San Bernard River	West Bernard Creek	West Carancahua Creek	West Mustang Creek
Coleoptera	Elmidae	*Heterelmis vulnerata*						2		12
Coleoptera	Elmidae	*Microcylloepus pusillus*				1			2	
Coleoptera	Elmidae	*Microcylloepus* sp.		1			3	15		1
Coleoptera	Elmidae	*Stenelmis grossa*								15
Coleoptera	Elmidae	*Stenelmis occidentalis*	15	149				203	290	17
Coleoptera	Elmidae	*Stenelmis* sp.		290	7	38	25	45	11	31
Coleoptera	Gyrinidae	*Dineutus* sp.	10	4	3		5			8
Coleoptera	Gyrinidae	*Gyretes* sp.		9				7		
Coleoptera	Gyrinidae	*Gyrinus* sp.				1				
Coleoptera	Haliplidae	*Haliplus* sp.				4				
Coleoptera	Haliplidae	*Peltodytes* sp.	2	19	1	4	2			
Coleoptera	Helophoridae	*Helophorus* sp.		1				2		1
Coleoptera	Hydrochidae	*Hydrochus* sp.	7	5						
Coleoptera	Hydrophilidae	*Berosus* sp.	3	18		1			3	
Coleoptera	Hydrophilidae	*Berosus subsignatus*				12				
Coleoptera	Hydrophilidae	*Enochrus* sp.	1	1						
Coleoptera	Hydrophilidae	*Helochares* sp.	1	1						
Coleoptera	Hydrophilidae	*Paracymus* sp.		1				1		1
Coleoptera	Hydrophilidae	*Tropisternus* sp.	4	5						
Coleoptera	Noteridae	*Suphisellus bicolor bicolor*								1
Coleoptera	Noteridae	*Suphisellus* sp.		1						
Coleoptera	Scirtidae	*Cyphon* sp.		1		1		3		
Coleoptera	Scirtidae	*Prionocyphon* sp.	12							
Coleoptera	Scirtidae	*Scirtes* sp.	14	5	19		3	1	2	19
Coleoptera	Scirtidae	Scirtidae						6		
Coleoptera	Staphylinidae	Staphylinidae			3					
Decapoda	Cambaridae	Cambaridae	2	8			7		1	2
Decapoda	Cambaridae	*Cambarus* sp.							2	
Decapoda	Cambaridae	*Procambarus* sp.	1	2						
Decapoda	Palaemonidae	*Macrobrachium* sp.		14			3			
Decapoda	Palaemonidae	*Palaemonetes kadiakensis*		35		8	41	10	24	19
Decapoda	Palaemonidae	*Palaemonetes paludosus*		2						
Decapoda	Palaemonidae	*Palaemonetes* sp.	26		3	14				
Diptera	Athericidae	*Atherix* sp.		1						
Diptera	Ceratopogonidae	*Atrichopogon* sp.						1		
Diptera	Ceratopogonidae	*Bezzia* sp.	4		4					

Order	Family	Taxon	Arenosa Creek	Big Creek	Garcitas Creek	Placedo Creek	San Bernard River	West Bernard Creek	West Carancahua Creek	West Mustang Creek
Diptera	Ceratopogonidae	*Palpomyia* sp.				83				
Diptera	Ceratopogonidae	*Probezzia* sp.			6					9
Diptera	Ceratopogonidae	*Probezzia* sp. A	1							
Diptera	Ceratopogonidae	*Probezzia* sp. B	1							
Diptera	Ceratopogonidae	*Stilobezzia* sp.				55				
Diptera	Chironomidae	*Ablabesmyia cinctipes*			1					
Diptera	Chironomidae	*Ablabesmyia parajanta*			1					6
Diptera	Chironomidae	*Ablabesmyia* sp.			1					
Diptera	Chironomidae	*Axarus* sp.		4						
Diptera	Chironomidae	Chironomidae		74			12	61	9	32
Diptera	Chironomidae	*Chironomus decorus* gr.								32
Diptera	Chironomidae	*Chironomus* sp.	5							
Diptera	Chironomidae	*Cladotanytarsus mancus* gr.	80		7	18		17		13
Diptera	Chironomidae	*Cladotanytarsus* sp.	5							
Diptera	Chironomidae	*Cladotanytarsus* sp. gr. A	8		3				17	25
Diptera	Chironomidae	*Clinotanypus* nr. *pinguis*				18				
Diptera	Chironomidae	*Conchapelopia* sp.		18				6	56	25
Diptera	Chironomidae	*Cricotopus bicinctus*						28		19
Diptera	Chironomidae	*Cricotopus trifascia* gr.		8					26	
Diptera	Chironomidae	*Cryptochironomus fulvus* gr.							13	
Diptera	Chironomidae	*Cryptochironomus* sp.	2							
Diptera	Chironomidae	*Cryptotendipes* sp.	4							
Diptera	Chironomidae	*Dicrotendipes neomodestus*	56	19						171
Diptera	Chironomidae	*Dicrotendipes nervosus*						11		
Diptera	Chironomidae	*Dicrotendipes* sp.	6							
Diptera	Chironomidae	*Goeldichironomus holoprasinus*				37				
Diptera	Chironomidae	*Guttipelopia* sp.	2							
Diptera	Chironomidae	*Larsia* sp.	59			18				
Diptera	Chironomidae	*Parachironomus* sp.	1							
Diptera	Chironomidae	*Paracladopelma doris* gr.								25
Diptera	Chironomidae	*Paratendipes* nr. *nudisquama*	16							
Diptera	Chironomidae	*Paratendipes* sp.	3							
Diptera	Chironomidae	*Pentaneura* sp.						6		
Diptera	Chironomidae	*Phaenopsectra* sp.								6
Diptera	Chironomidae	*Polypedilum convictum*		19	2			6	77	13
Diptera	Chironomidae	*Polypedilum illinoense*	4	39	2			40	4	95

Order	Family	Taxon	Arenosa Creek	Big Creek	Garcitas Creek	Placedo Creek	San Bernard River	West Bernard Creek	West Carancahua Creek	West Mustang Creek
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. A	4							51
Diptera	Chironomidae	*Polypedilum* nr. *scalaenum* sp. B	12		2	73		40	17	13
Diptera	Chironomidae	*Polypedilum* sp.	7							
Diptera	Chironomidae	*Pseudochironomus* sp.							94	
Diptera	Chironomidae	*Rheotanytarsus distinctissimus* gr.			7					
Diptera	Chironomidae	*Rheotanytarsus* sp.	2							
Diptera	Chironomidae	*Saetheria* sp.							4	25
Diptera	Chironomidae	*Stictochironomus* sp.	4							
Diptera	Chironomidae	Subfamily: Chironominae				27				
Diptera	Chironomidae	Subfamily: Tanypodinae				5				
Diptera	Chironomidae	*Tanypus carinatus*				73				
Diptera	Chironomidae	*Tanypus neopunctipennis*				73				
Diptera	Chironomidae	*Tanytarsus glabrescens* gr.	128	6				40	39	82
Diptera	Chironomidae	*Tanytarsus guerlus* gr.	68	2		37				
Diptera	Chironomidae	*Tanytarsus* sp.	20		1	83		11	4	13
Diptera	Chironomidae	*Thienemanniella* sp.			1				13	
Diptera	Empididae	Empididae		2				2		
Diptera	Empididae	*Hemerodromia* sp.						2		
Diptera	Simuliidae	*Simulium* sp.	1	24	7					
Diptera	Tabanidae	*Chlorotabanus* sp.			1					
Diptera	Tabanidae	*Chrysops* sp.								1
Diptera	Tipulidae	*Erioptera* sp.	3							
Diptera	Tipulidae	*Hexatoma* sp.	6							
Diptera	Tipulidae	*Ormosia* sp.	6							
Diptera	Tipulidae	*Tipula* sp.			1					
Ephemeroptera	Baetidae	*Acerpenna* sp.	96		11					
Ephemeroptera	Baetidae	*Apobaetis* sp.	3							
Ephemeroptera	Baetidae	*Baetis ephippiatus*							1	
Ephemeroptera	Baetidae	*Baetis* sp.		62	15		17	58	1	6
Ephemeroptera	Baetidae	*Callibaetis* sp.		7		1				
Ephemeroptera	Baetidae	*Centroptilum* sp.	7							
Ephemeroptera	Baetidae	*Cloeon* sp.							1	
Ephemeroptera	Baetidae	*Fallceon quilleri*	81	683	35	4	93	24	33	146
Ephemeroptera	Baetidae	*Paracloeodes* sp.	45	2			2		2	
Ephemeroptera	Baetidae	*Procloeon* sp.	2			1	2			2
Ephemeroptera	Baetidae	*Pseudocentroptiloides* sp.	69							

Order	Family	Taxon	Arenosa Creek	Big Creek	Garcitas Creek	Placedo Creek	San Bernard River	West Bernard Creek	West Carancahua Creek	West Mustang Creek
Ephemeroptera	Baetidae	*Pseudocloeon* sp.	71	14	3		114			5
Ephemeroptera	Caenidae	*Brachycercus* sp.	4							
Ephemeroptera	Caenidae	*Caenis* sp.	33	47	7	13	2	95	229	208
Ephemeroptera	Caenidae	*Caenis* sp. A	93							
Ephemeroptera	Caenidae	*Caenis* sp. B	108							
Ephemeroptera	Ephemeridae	*Hexagenia* sp.		2						
Ephemeroptera	Heptageniidae	*Stenacron* sp.	7	45	14	1	46	126		28
Ephemeroptera	Heptageniidae	*Stenonema* sp.	1	1			21			11
Ephemeroptera	Isonychiidae	*Isonychia* sp.			6		19	1		
Ephemeroptera	Leptohyphidae	*Tricorythodes albilineatus* gr.		30					255	5
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.	1	344		2	29	45		5
Ephemeroptera	Leptophlebiidae	*Farrodes texanus*	1		44			7		81
Ephemeroptera	Leptophlebiidae	*Neochoroterpes* sp.	2							
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia* sp.		5			31			15
Ephemeroptera	Leptophlebiidae	*Traverella presidiana*			1					
Hemiptera	Belostomatidae	*Belostoma* sp.	1	4			1			
Hemiptera	Corixidae	*Trichocorixa* sp.		44		1	2		1	3
Hemiptera	Gerridae	*Rheumatobates* sp.	1	2					1	
Hemiptera	Gerridae	*Trepobates* sp.		1						
Hemiptera	Hydrometridae	*Hydrometra* sp.		2						1
Hemiptera	Naucoridae	*Pelocoris* sp.		1						
Hemiptera	Nepidae	*Curicta* sp.	1	2		1			2	
Hemiptera	Nepidae	*Ranatra* sp.		2					1	
Hemiptera	Veliidae	*Rhagovelia* sp.		29	5	9	11	10	1	9
Hirudinea		Hirudinea		2		3	1		1	2
Hirudinida	Erpobdellidae	*Erpobdella* sp.			1					
Hirudinida	Erpobdellidae	*Mooreobdella* sp.	1		3					
Hirudinida	Glossiphoniidae	*Helobdella elongata*		1		2		11		
Hirudinida	Glossiphoniidae	*Helobdella* sp.	3							
Isopoda	Asellidae	*Caecidotea* sp.							1	
Lepidoptera	Crambidae	*Crambus* sp.								1
Lepidoptera	Crambidae	*Synclita* sp.				6				
Lumbriculida	Lumbriculidae	Lumbriculidae			1					
Megaloptera	Corydalidae	*Corydalus cornutus*		10						1
Nematoda		Nematoda			2					1
Neoophora	Dugesiidae	*Dugesia* sp.			4		1			

Order	Family	Taxon	Arenosa Creek	Big Creek	Garcitas Creek	Placedo Creek	San Bernard River	West Bernard Creek	West Carancahua Creek	West Mustang Creek
Neoophora	Dugesiidae	*Dugesia tigrina*						1	1	
Neotaenioglossa	Amnicolidae	*Amnicola limosa limosa*	10	1		635				
Neotaenioglossa	Hydrobiidae	Hydrobiidae		51		2	3	18	9	47
Neotaenioglossa	Hydrobiidae	*Pyrgophorus spinosus*				353				
Neotaenioglossa	Pleuroceridae	*Elimia* sp.		17						
Odonata	Aeschnidae	*Boyeria* sp.					2			
Odonata	Aeschnidae	*Nasiaeschna pentacantha*	1	1		7		1		1
Odonata	Calopterygidae	*Hetaerina* sp.		18	2		16	2		
Odonata	Coenagrionidae	*Argia* sp.	13	105	2	8	24	20	50	87
Odonata	Coenagrionidae	*Enallagma* sp.		20		1			15	3
Odonata	Coenagrionidae	*Ischnura* sp.		8				2		5
Odonata	Corduliidae	*Macromia* sp.		2		1	4			
Odonata	Corduliidae	*Neurocordulia* sp.		1						
Odonata	Gomphidae	*Arigomphus lentulus*				22				
Odonata	Gomphidae	*Arigomphus* sp.		1						1
Odonata	Gomphidae	*Dromogomphus* sp.					1			
Odonata	Gomphidae	*Erpetogomphus* sp.		1	7		2		3	
Odonata	Gomphidae	*Gomphus modestus*						1		
Odonata	Gomphidae	*Gomphus* sp.		1	1		2			
Odonata	Gomphidae	*Phyllogomphoides stigmatus*				7				
Odonata	Gomphidae	*Progomphus obscurus*	5		8				3	
Odonata	Gomphidae	*Progomphus* sp.	116		13	5	1			3
Odonata	Libellulidae	*Brechmorhoga* sp.			1					
Odonata	Libellulidae	*Dythemis nigrescens*				37				
Odonata	Libellulidae	*Pantala* sp.	1							
Odonata	Libellulidae	*Perithemis* sp.		1					1	1
Oligochaeta		Oligochaeta	2	3	1	3	4		1	2
Opisthopora	Sparganophilidae	*Sparganophilus tamesis*	1	1	1	1				
Podocopida	Cyprididae	*Cypridopsis vidua*	2							
Podocopida	Cyprididae	*Eucypris* sp.	14						2	
Podocopida	Limnocytheridae	*Limnocythere* sp.				4,046		8		
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.	2	550	98	22	57	206	61	1,548
Trichoptera	Hydropsychidae	*Hydropsyche* sp.		25	36		39	118		1
Trichoptera	Hydropsychidae	*Hydropsyche* sp. A			2					
Trichoptera	Hydropsychidae	*Hydropsyche* sp. B			1					
Trichoptera	Hydropsychidae	*Smicridea* sp.			11					

Order	Family	Taxon	Arenosa Creek	Big Creek	Garcitas Creek	Placedo Creek	San Bernard River	West Bernard Creek	West Carancahua Creek	West Mustang Creek
Trichoptera	Hydroptilidae	*Hydroptila* sp.	1	26	2	2	2	2	18	4
Trichoptera	Hydroptilidae	*Hydroptila* sp. A						22		
Trichoptera	Hydroptilidae	*Hydroptila* sp. B						15		
Trichoptera	Hydroptilidae	*Neotrichia* sp.						2		1
Trichoptera	Leptoceridae	*Nectopsyche* sp.	2	166		9	5	1		8
Trichoptera	Leptoceridae	*Nectopsyche spiloma*			1					
Trichoptera	Leptoceridae	*Oecetis* sp.		7	1		4	3	2	
Trichoptera	Leptoceridae	*Oecetis* sp. A						2		1
Trichoptera	Leptoceridae	*Oecetis* sp. B	2					2	1	
Trichoptera	Leptoceridae	*Triaenodes* sp.		2						
Trichoptera	Philopotamidae	*Chimarra* sp.	1		68					
Trichoptera	Polycentropodidae	*Cernotina* sp.						1		
Trichoptera	Polycentropodidae	*Cyrnellus fraternus*		3				12		1
Trichoptera	Polycentropodidae	*Neureclipsis* sp.	1							
Trichoptera	Polycentropodidae	*Polycentropus* sp.						12		
Trombidiformes	Hygrobatidae	*Atractides* sp.			1					
Trombidiformes	Limnesiidae	*Limnesia* sp.	1							
Trombidiformes		Hydracarina (Hydrachnidia)	2		2			1		
Tubificida	Naididae	*Aulodrilus limnobius*						18		
Tubificida	Naididae	*Aulodrilus pigueti*	42	1		4,682		35	2	
Tubificida	Naididae	*Branchiura sowerbyi*		1						1
Tubificida	Naididae	*Bratislavia unidentata*						35		
Tubificida	Naididae	*Dero digitata*	2			936		18		
Tubificida	Naididae	*Dero pectinatus*		2		187				
Tubificida	Naididae	*Dero trifida*				187		53		
Tubificida	Naididae	*Limnodrilus hoffmeisteri*	14			3,933		176	11	
Tubificida	Naididae	*Limnodrilus* sp.		7	2					1
Tubificida	Naididae	*Limnodrilus udekemianus*							11	
Tubificida	Naididae	*Nais communis*						88		
Tubificida	Naididae	*Nais pardalis*						264		
Tubificida	Naididae	*Nais variabilis*			2					
Tubificida	Naididae	*Pristina americana*	12					35		
Tubificida	Naididae	*Pristina foreli*			1					
Tubificida	Naididae	*Pristina leidyi*		1		562				
Tubificida	Naididae	*Pristina sima*			1					
Unionoida	Unionidae	*Tritogonia verrucosa*						1		

Order	Family	Taxon	Arenosa Creek	Big Creek	Garcitas Creek	Placedo Creek	San Bernard River	West Bernard Creek	West Carancahua Creek	West Mustang Creek
Veneroida	Corbiculidae	*Corbicula fluminea*	4	29	37	11	12	46		3
Veneroida	Pisidiidae	*Eupera cubensis*		7		1	24	2	1	3
Veneroida	Pisidiidae	*Musculium* sp.								1
Veneroida	Pisidiidae	*Pisidium casertanum*	51						29	
Veneroida	Pisidiidae	*Pisidium nitidum*				2				
Veneroida	Pisidiidae	*Sphaerium* sp.	1	5		4				
Veneroida	Pisidiidae	*Sphaerium transversum*	20	17		6		2	153	
		Taxa Richness	100	101	67	77	48	77	59	81
		Total N Individuals	1,635	3,426	564	16,585	721	2,436	1,686	3,154
		Number of Samples	n = 4	n = 13	n = 3	n = 2	n = 4	n = 4	n = 3	n = 4

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