ECOREGIONS 25 AND 26 – WESTERN HIGH PLAINS AND SOUTHWESTERN TABLELANDS

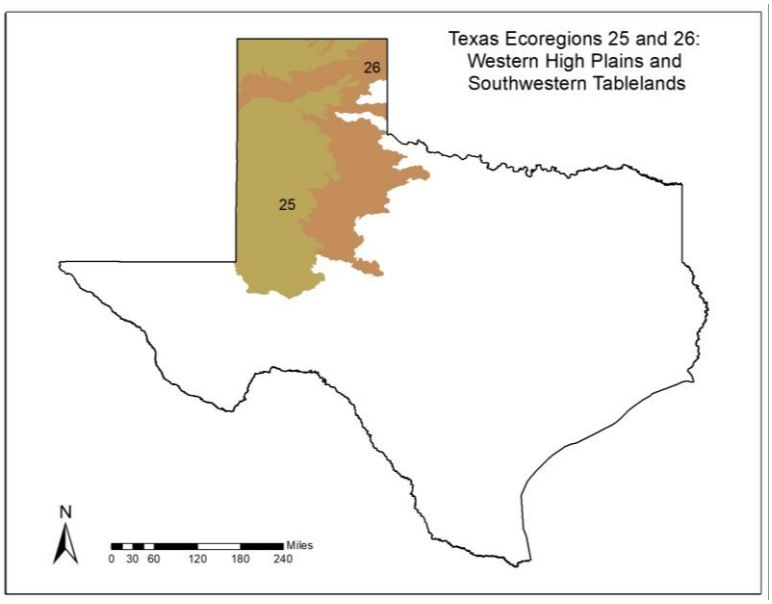

Figure 34. Map of Texas aggregate Ecoregions 25 and 26 – Western High Plains and Southwestern Tablelands.

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

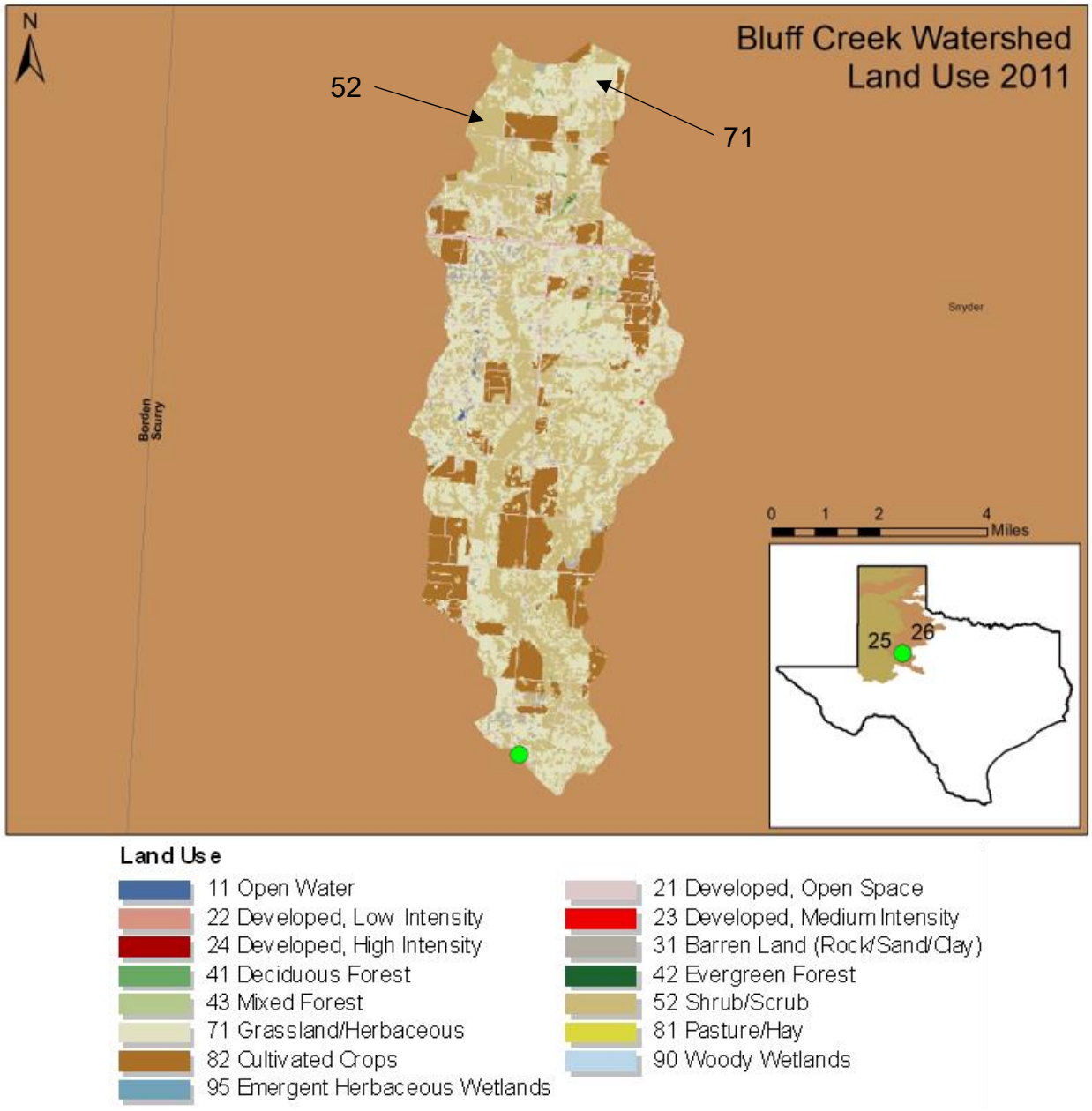

Figure 36. Map of Bluff Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

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.

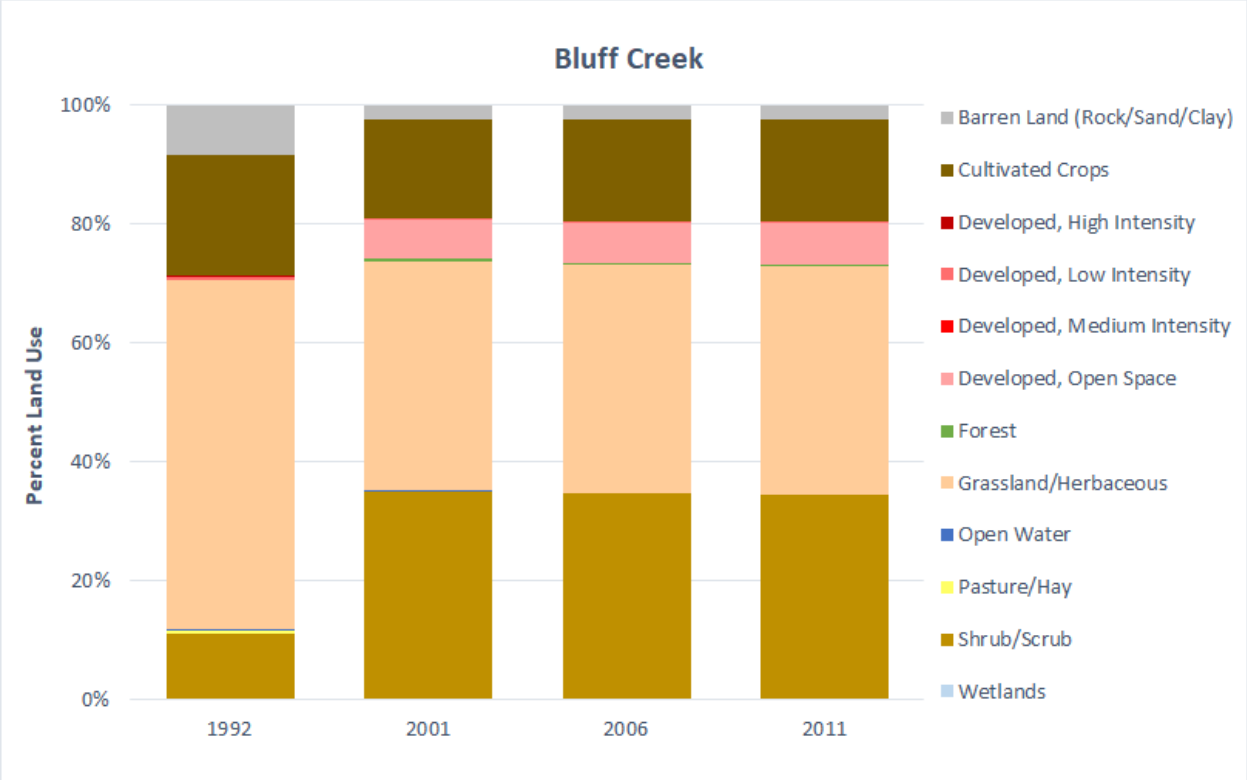

Figure 37. Percent land use in the Bluff Creek watershed from 1992-2011.

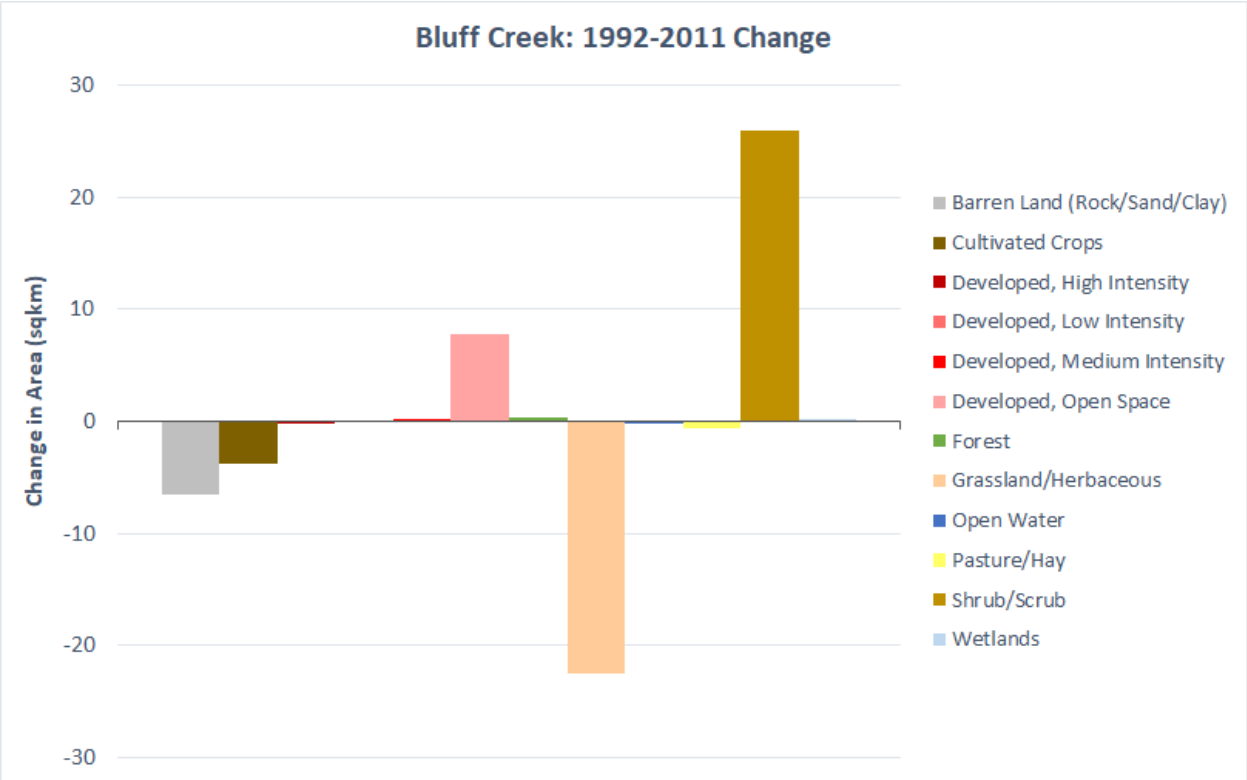

Figure 38. Land use change in area (sq km) from 1992-2011 for the Bluff Creek watershed.

BUCK CREEK

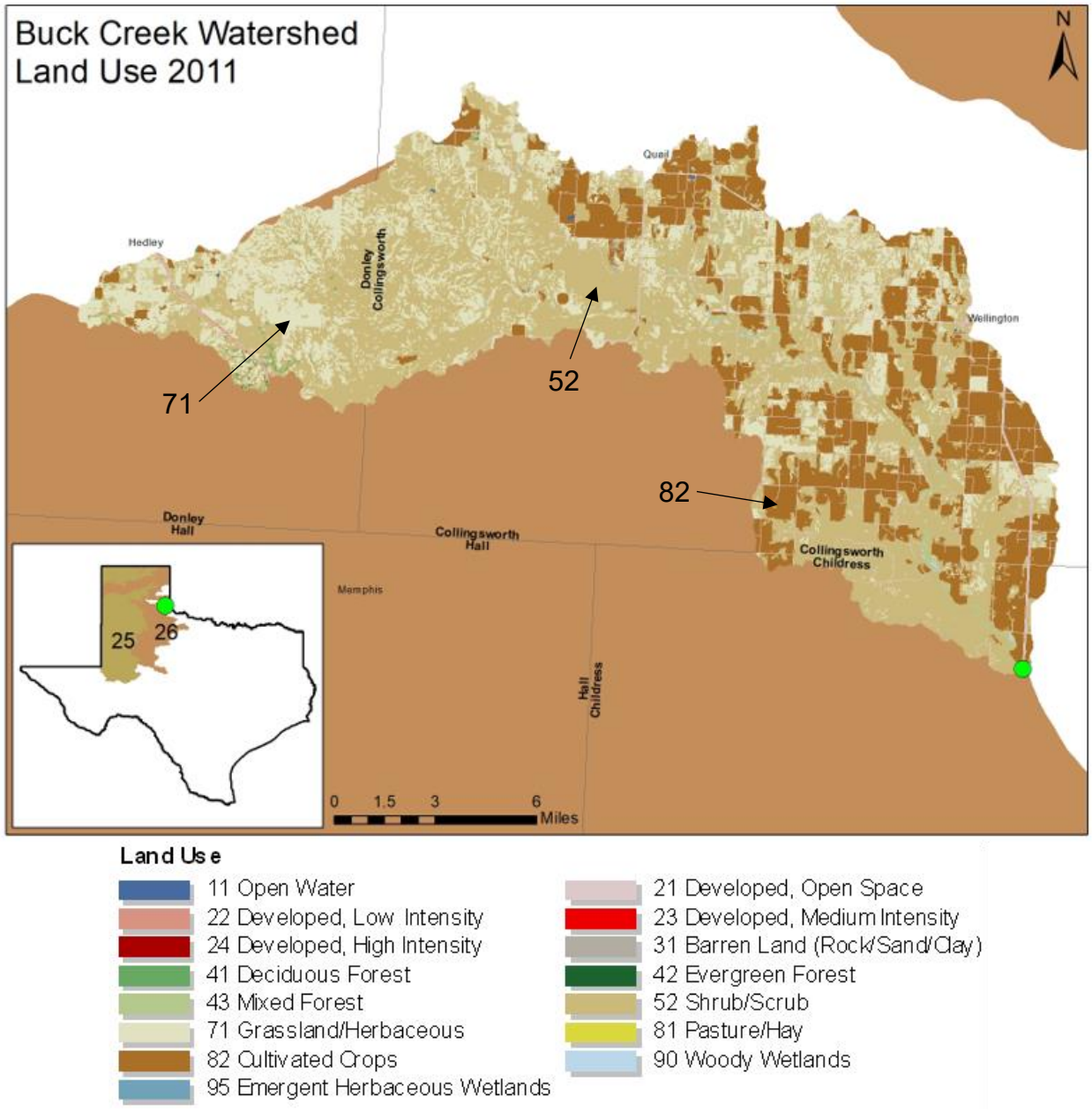

Figure 39. Map of Buck Creek watershed location and 2011 land use; shrub/scrub, grassland/herbaceous, and cultivated crops were the most common land uses.

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.

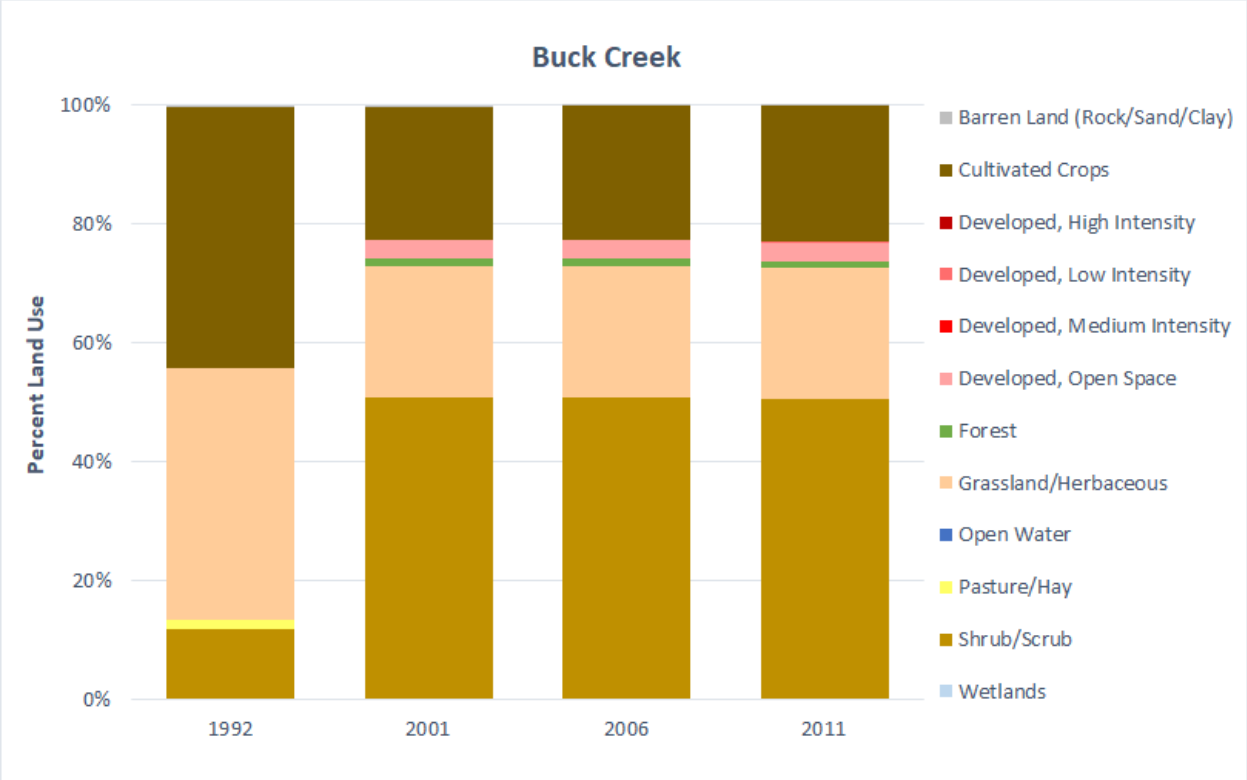

Figure 40. Percent land use in the Buck Creek watershed from 1992-2011.

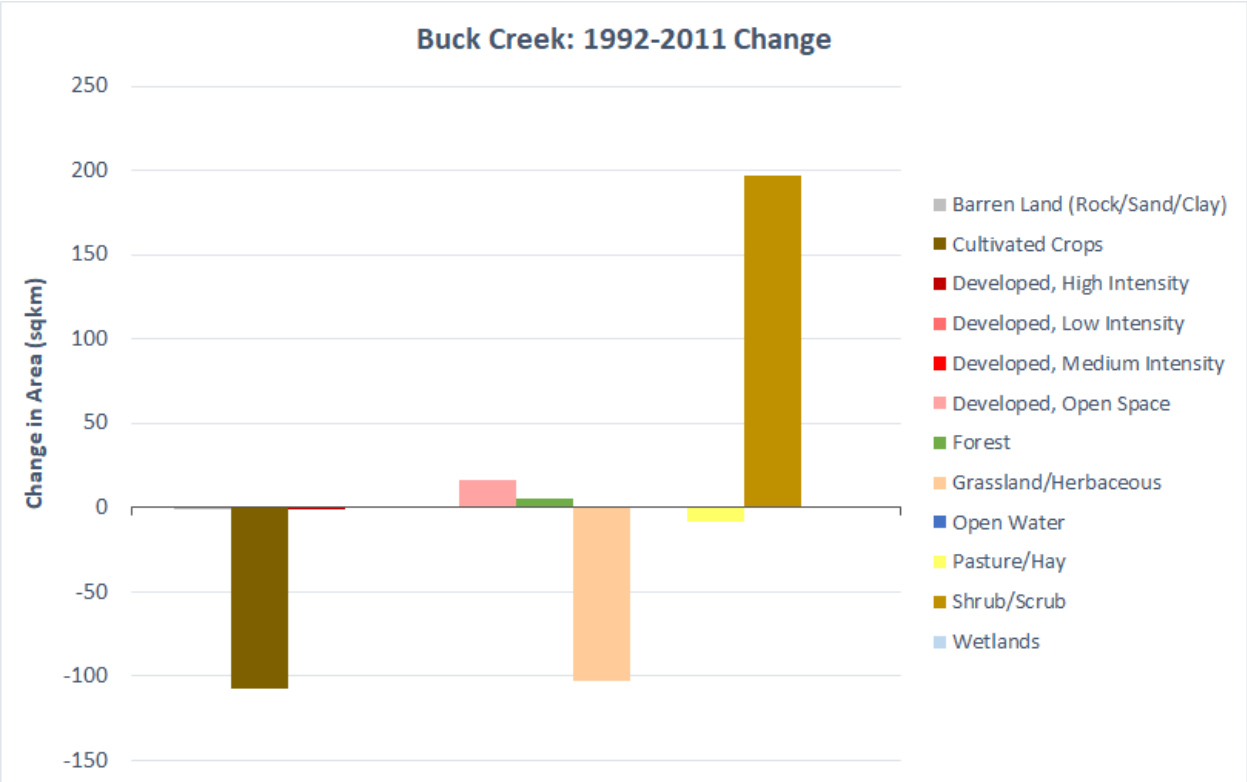

Figure 41. Land use change in area (sq km) from 1992-2011 for the Buck Creek watershed.

CANADIAN RIVER: US 385

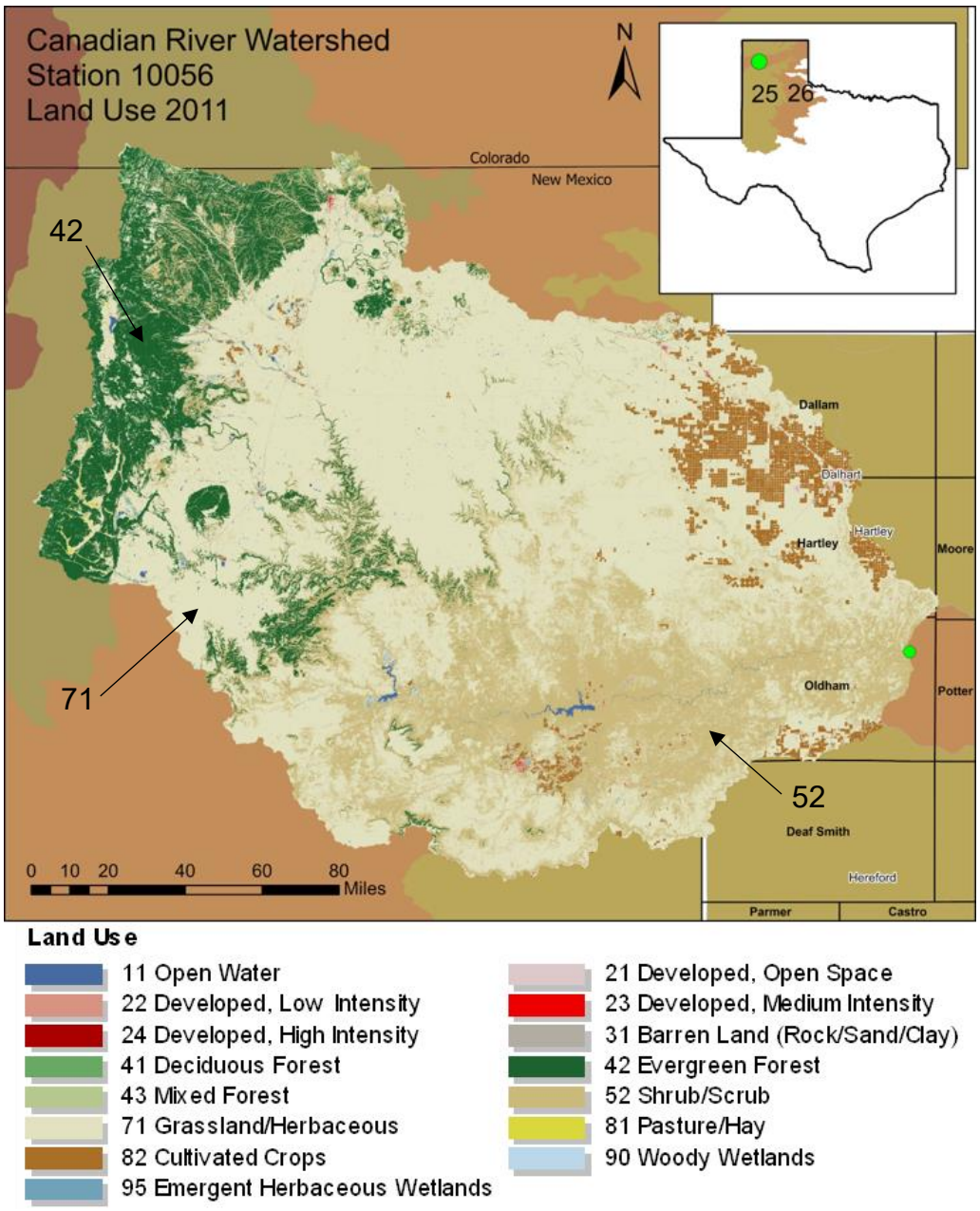

Figure 42. Map of Canadian River watershed at US 385 and 2011 land use; grassland/herbaceous, shrub/scrub, and forest were the most common land uses.

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.

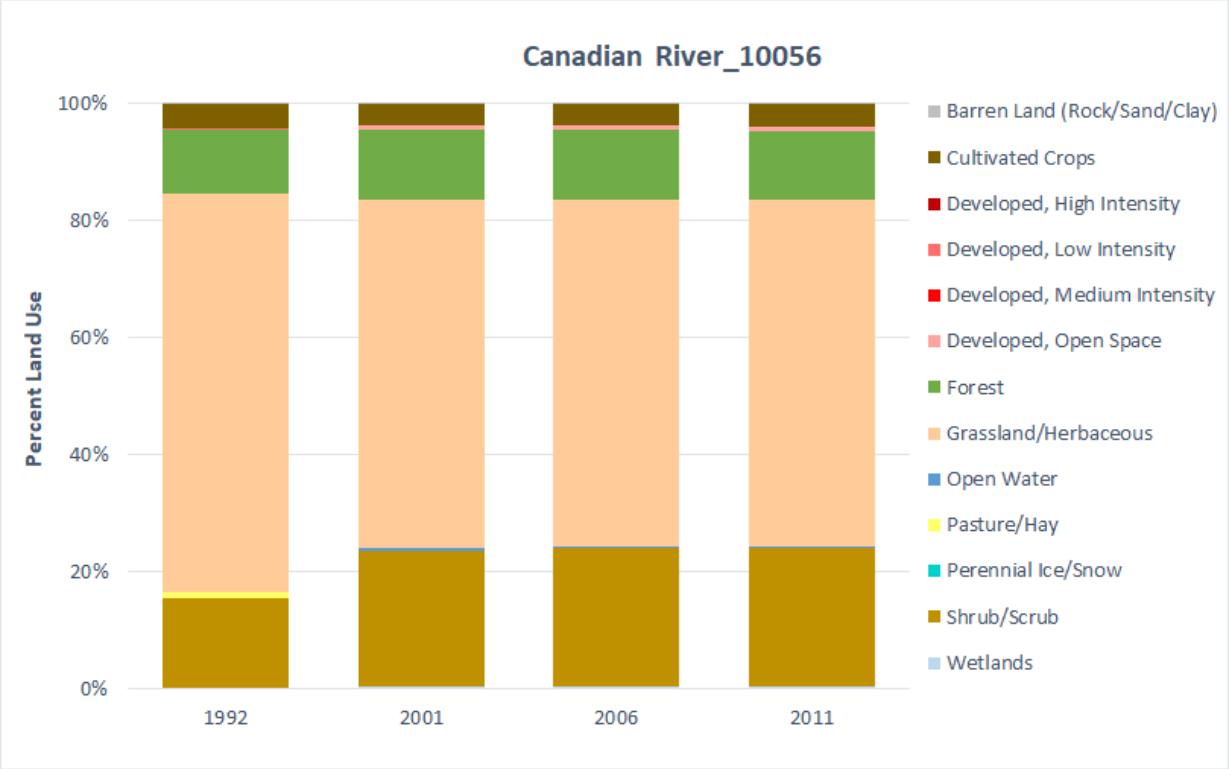

Figure 43. Percent land use in the Canadian River watershed at US 385 from 1992-2011.

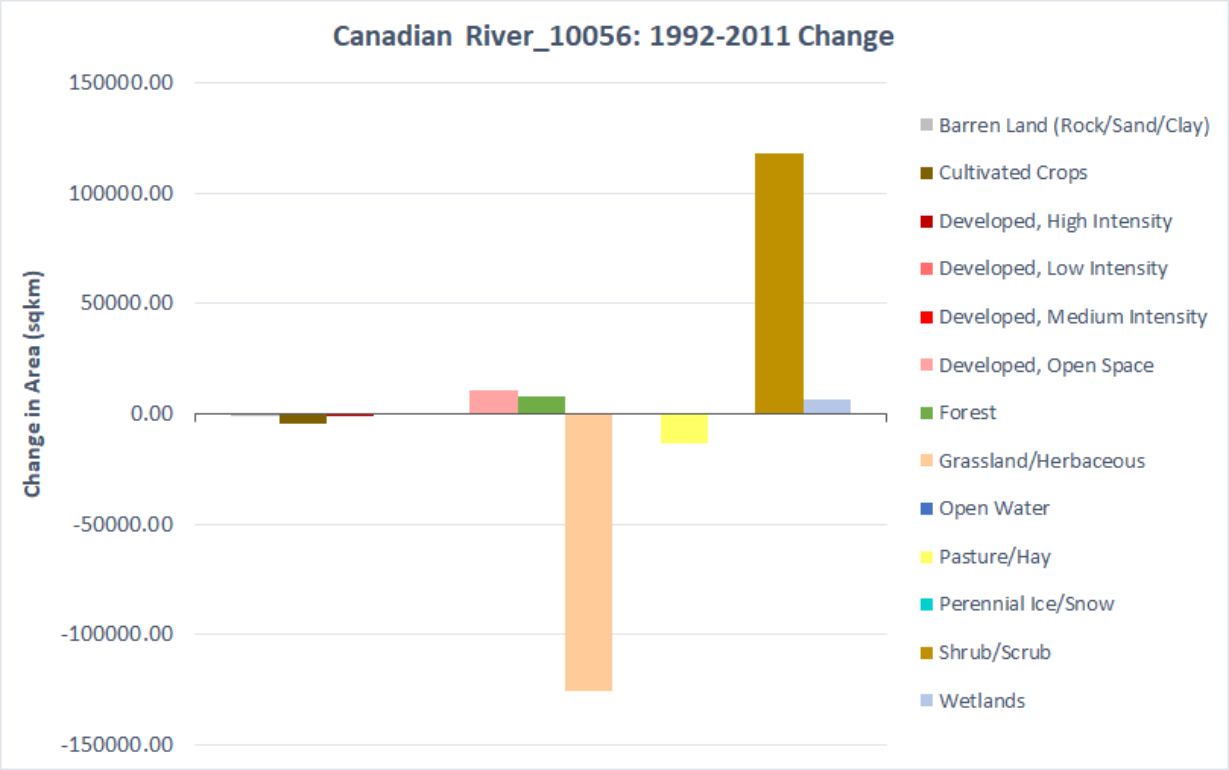

Figure 44. Land use change in area (sq km) from 1992-2011 for the Canadian River watershed at US 385.

CANADIAN RIVER: SH 70

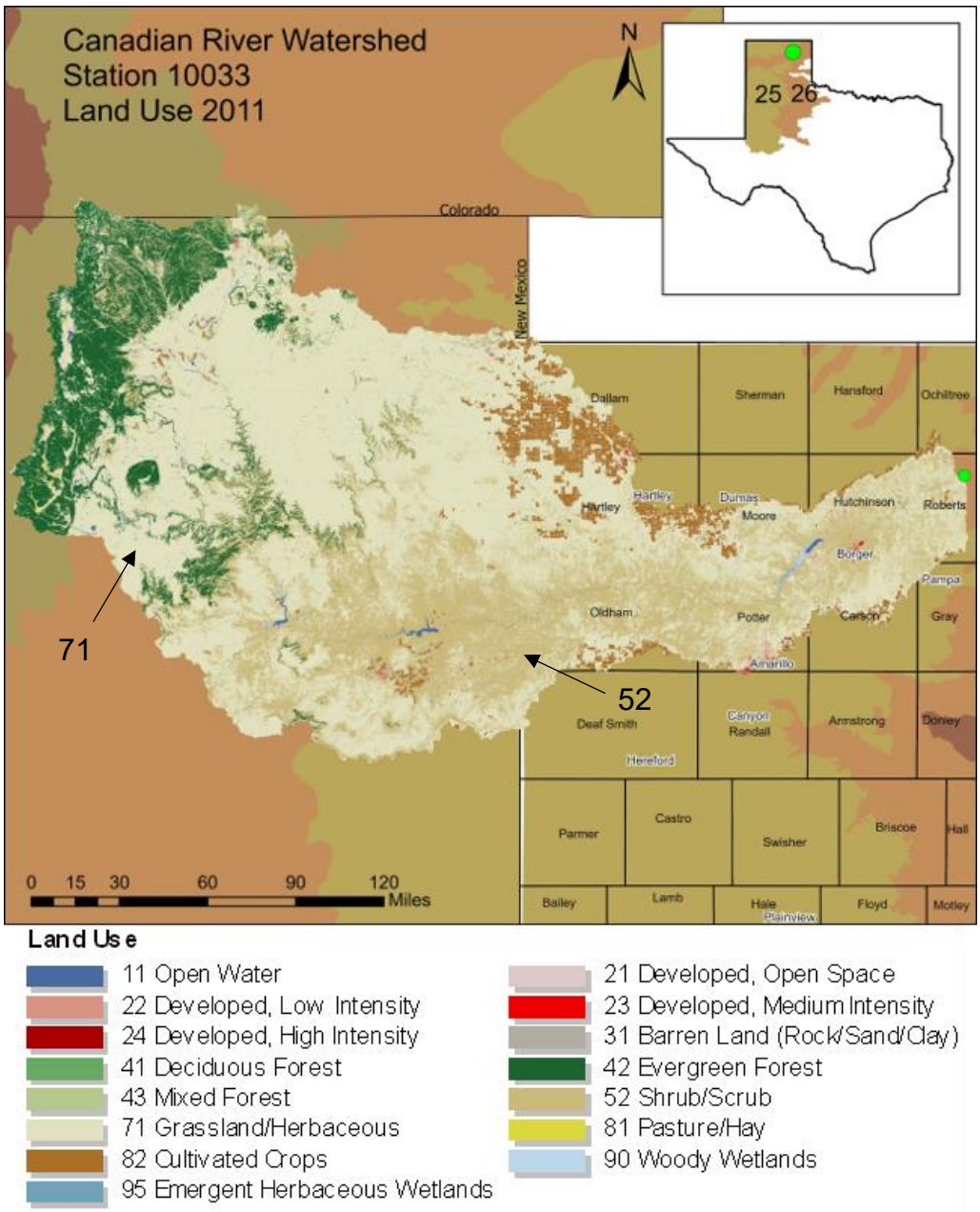

Figure 45. Map of Canadian River watershed at SH 70 and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

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.

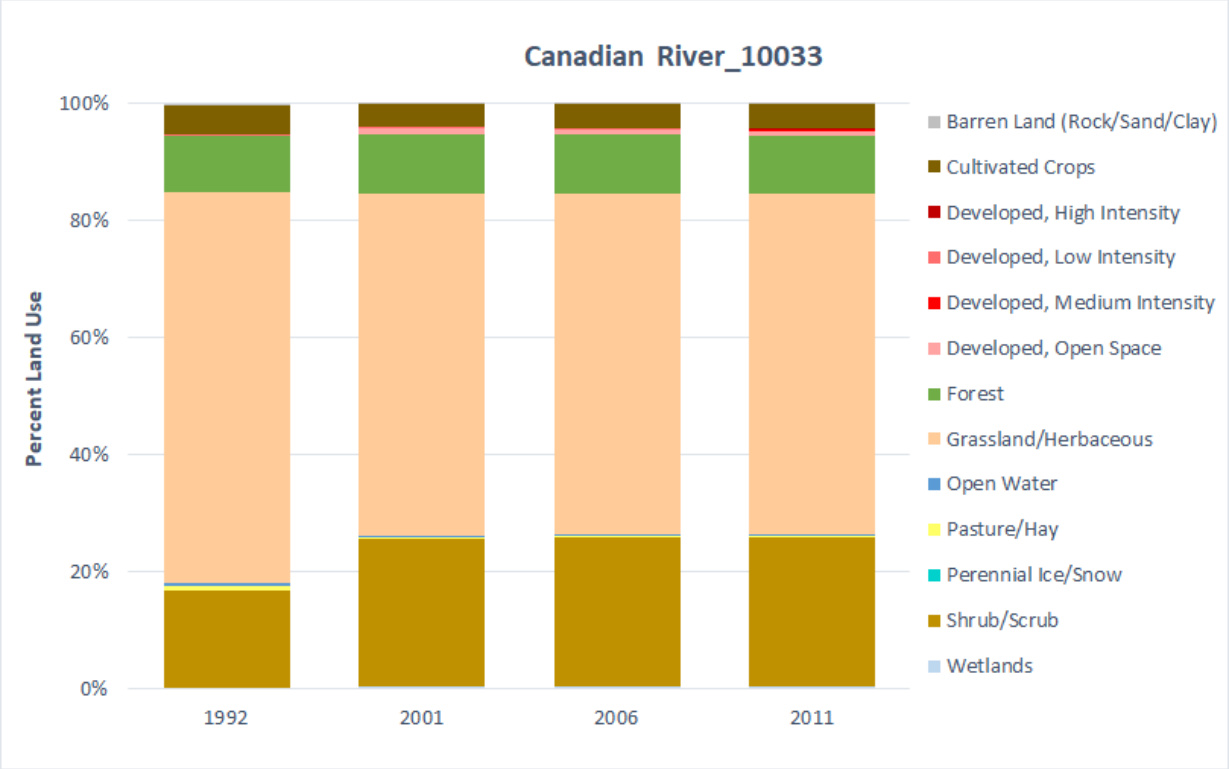

Figure 46. Percent land use in the Canadian River watershed at SH 70 from 1992-2011.

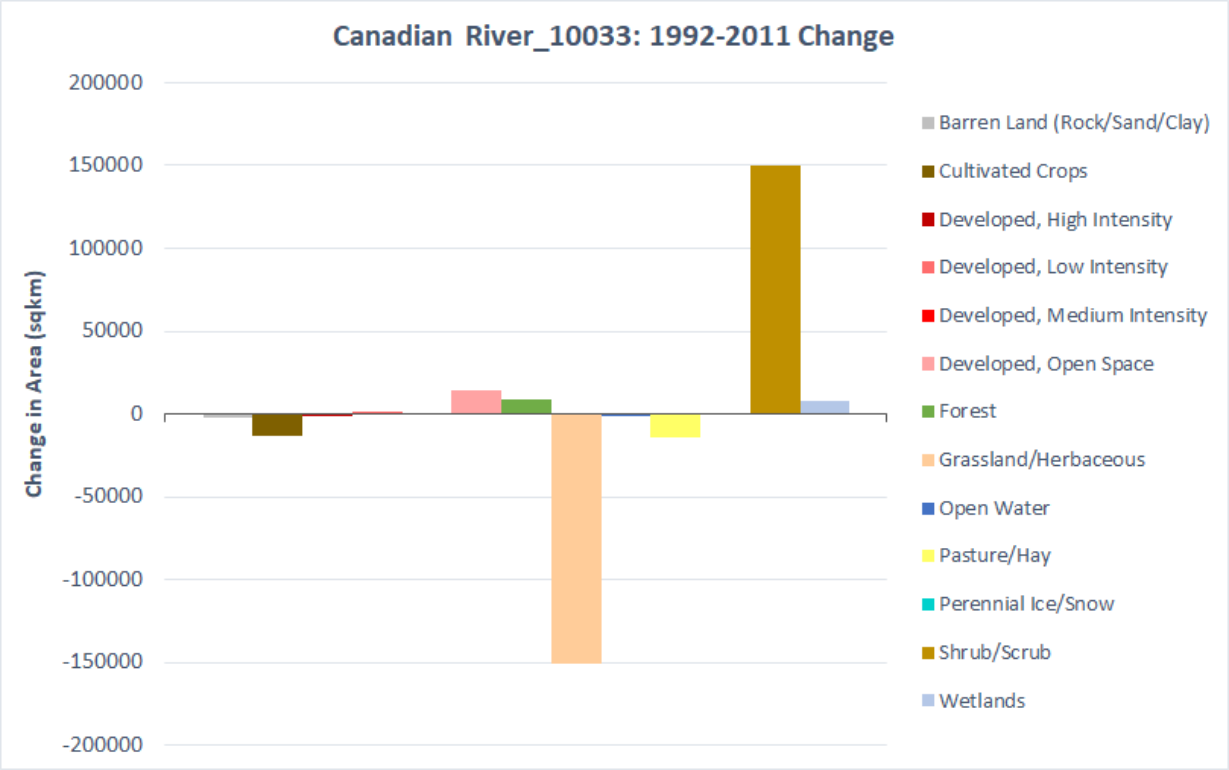

Figure 47. Land use change in area (sq km) from 1992-2011 for the Canadian River watershed at SH 70.

CHICKEN CREEK

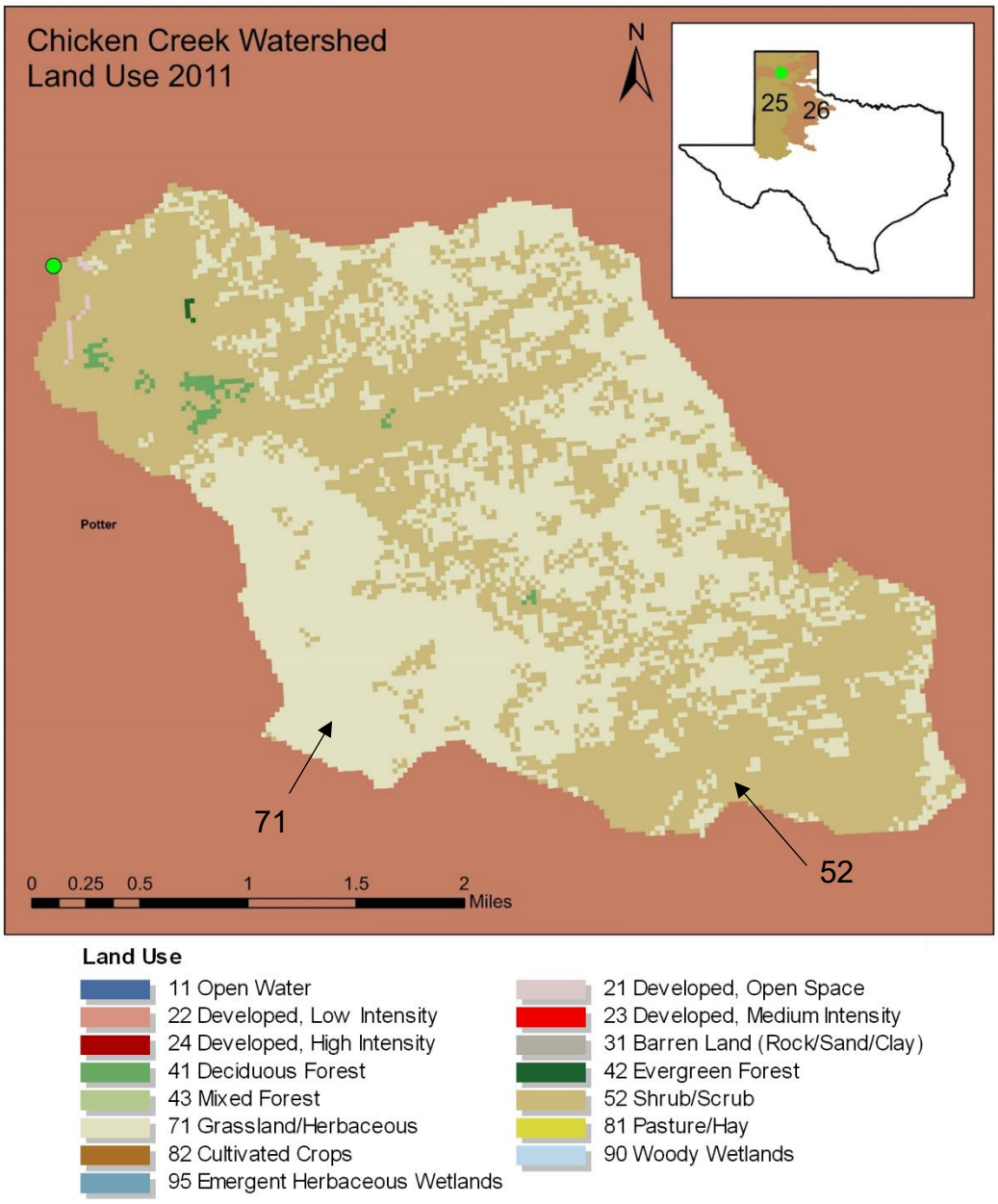

Figure 48. Map of Chicken Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

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.

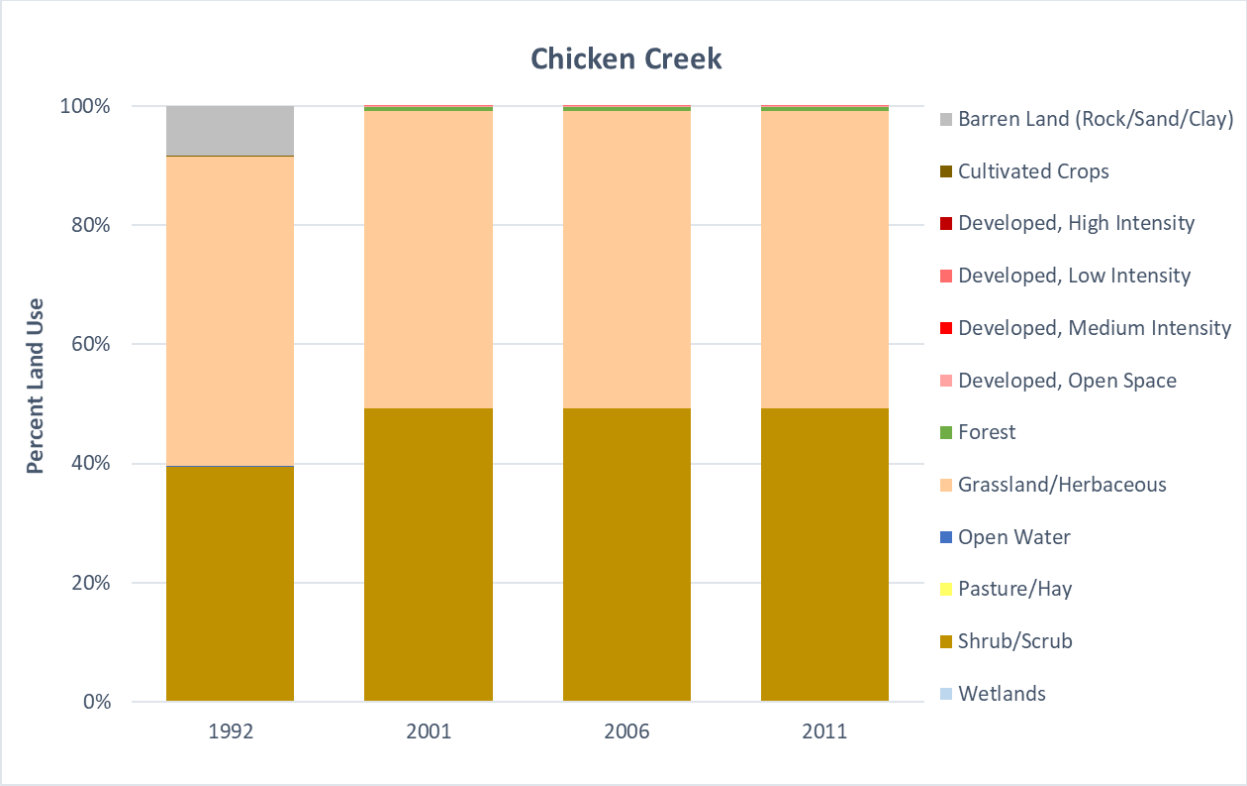

Figure 49. Percent land use in the Chicken Creek watershed from 1992-2011.

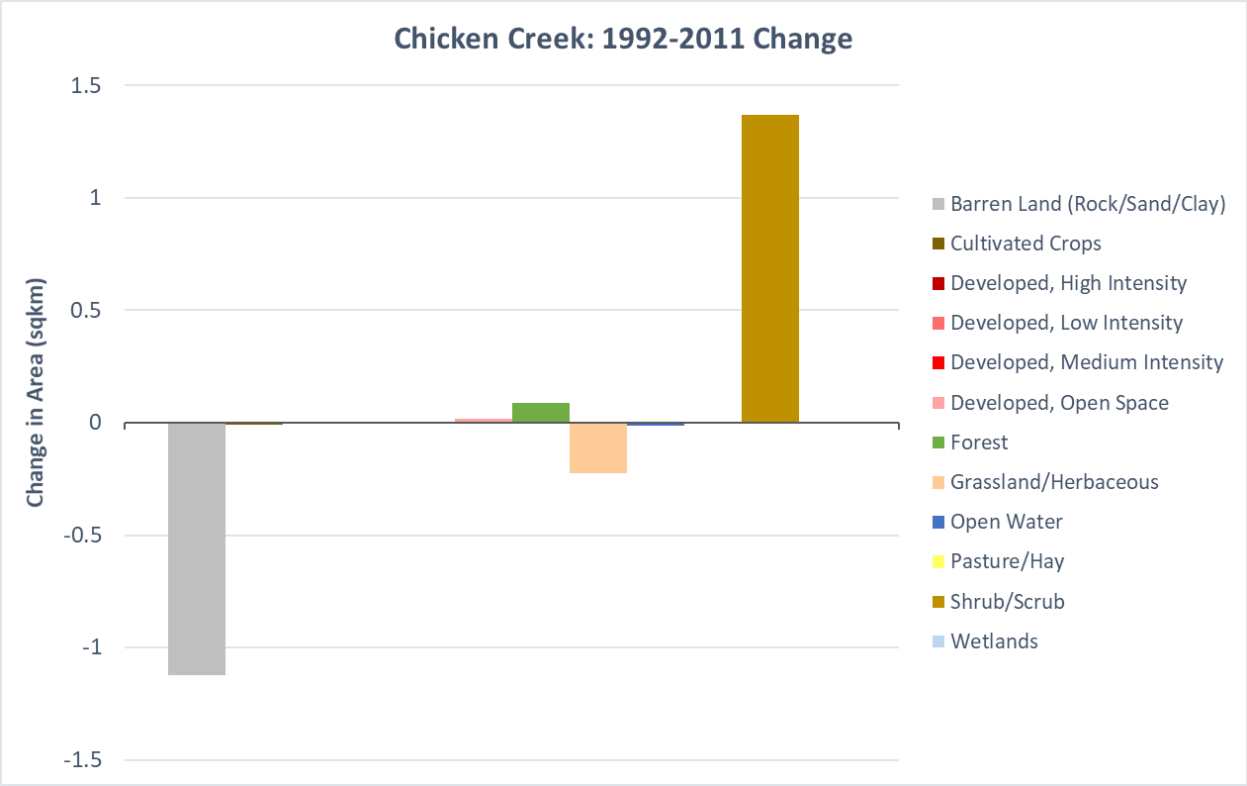

Figure 50. Land use change in area (sq km) from 1992-2011 for the Chicken Creek watershed.

McClellan Creek

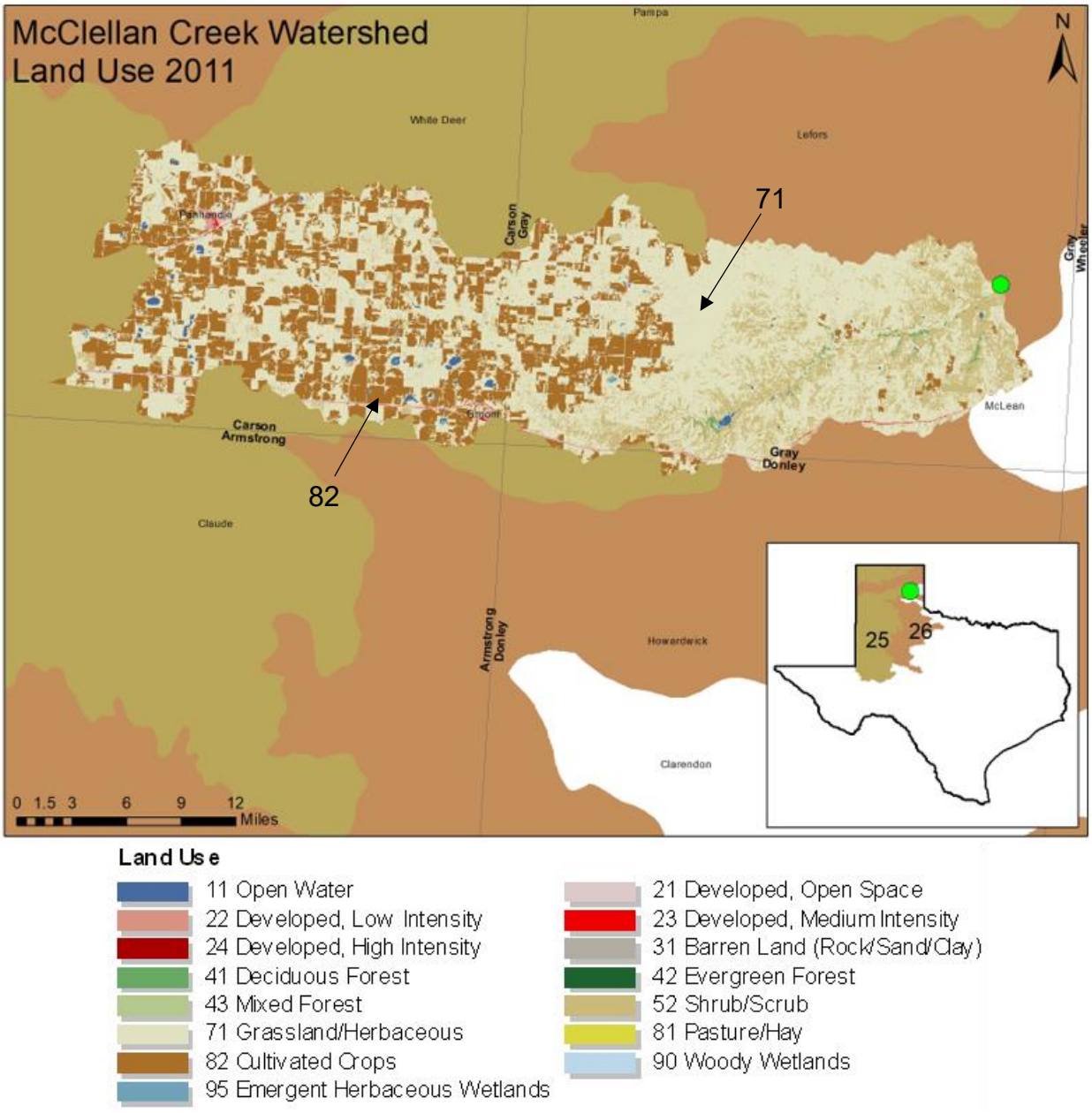

Figure 51. Map of McClellan Creek watershed location and 2011 land use; grassland/herbaceous and cultivated crops were the most common land uses.

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.

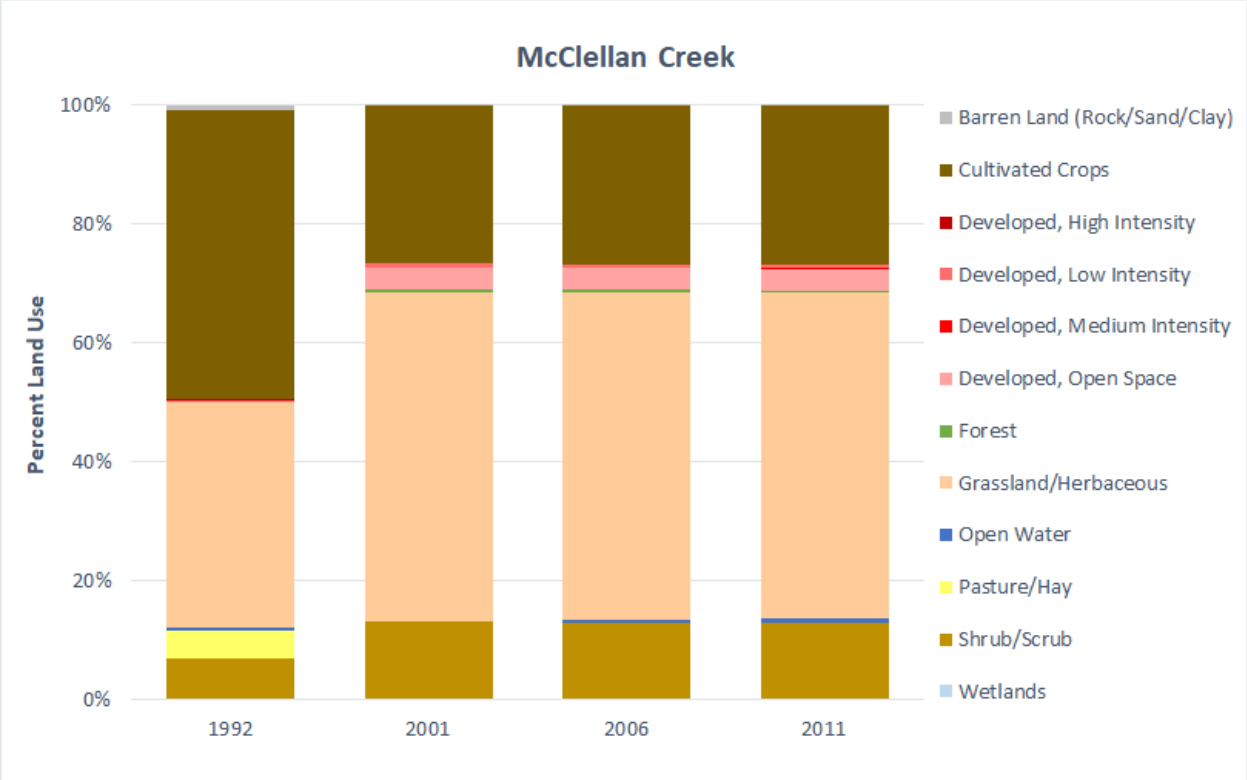

Figure 52. Percent land use in the McClellan Creek watershed from 1992-2011.

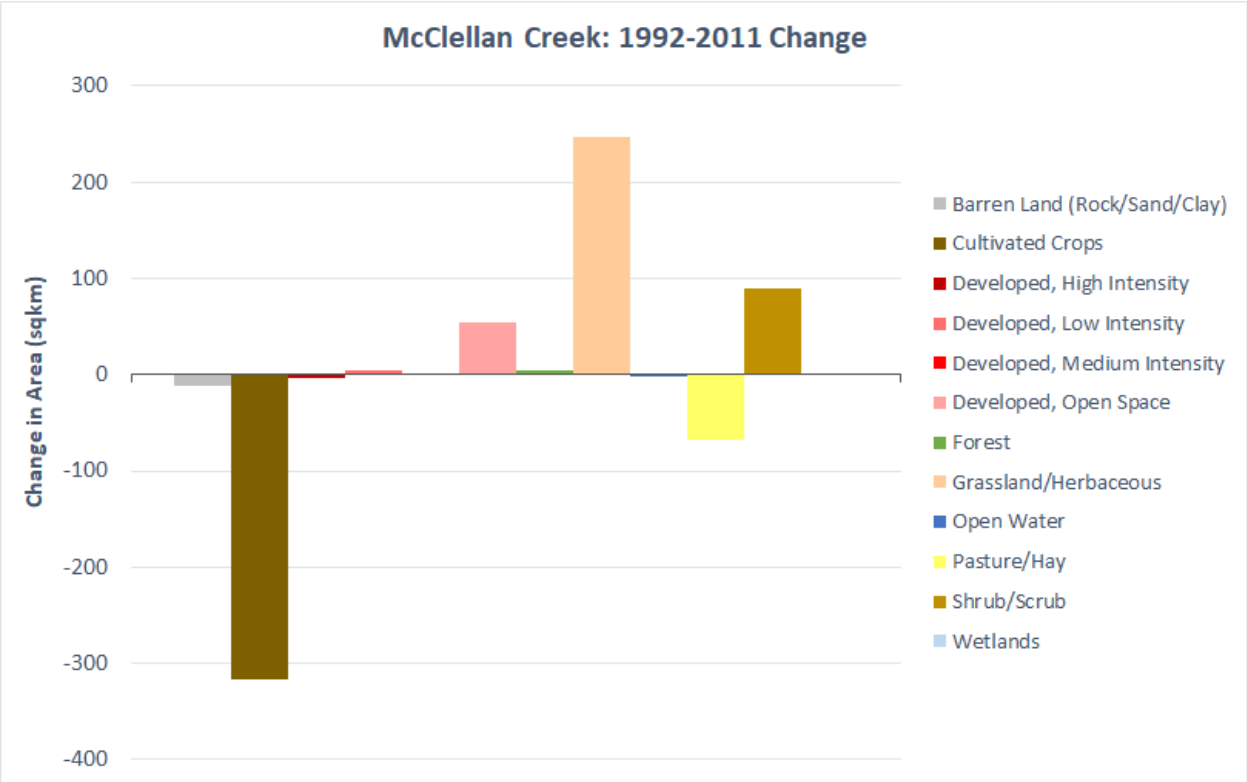

Figure 53. Land use change in area (sq km) from 1992-2011 for the McClellan Creek watershed.

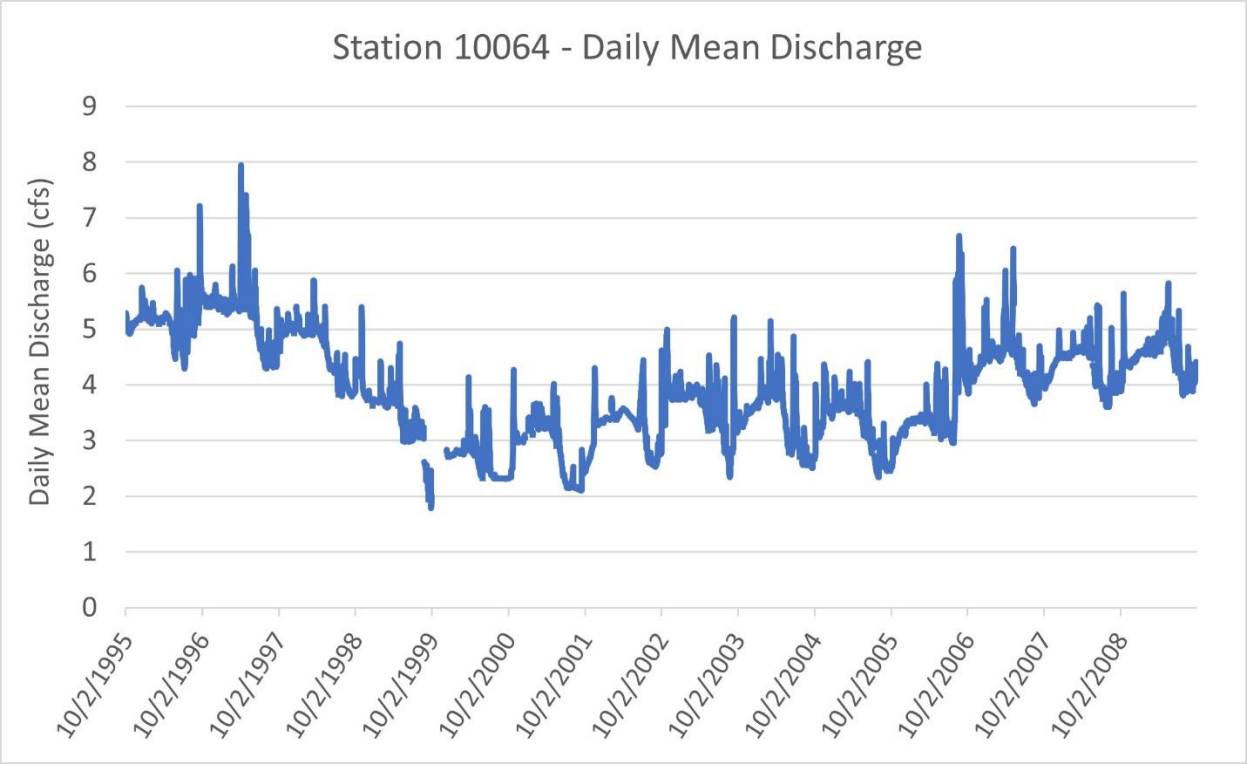

Figure 54. Daily mean discharge for McClellan Creek at station 10064.

NORTH FORK WICHITA RIVER

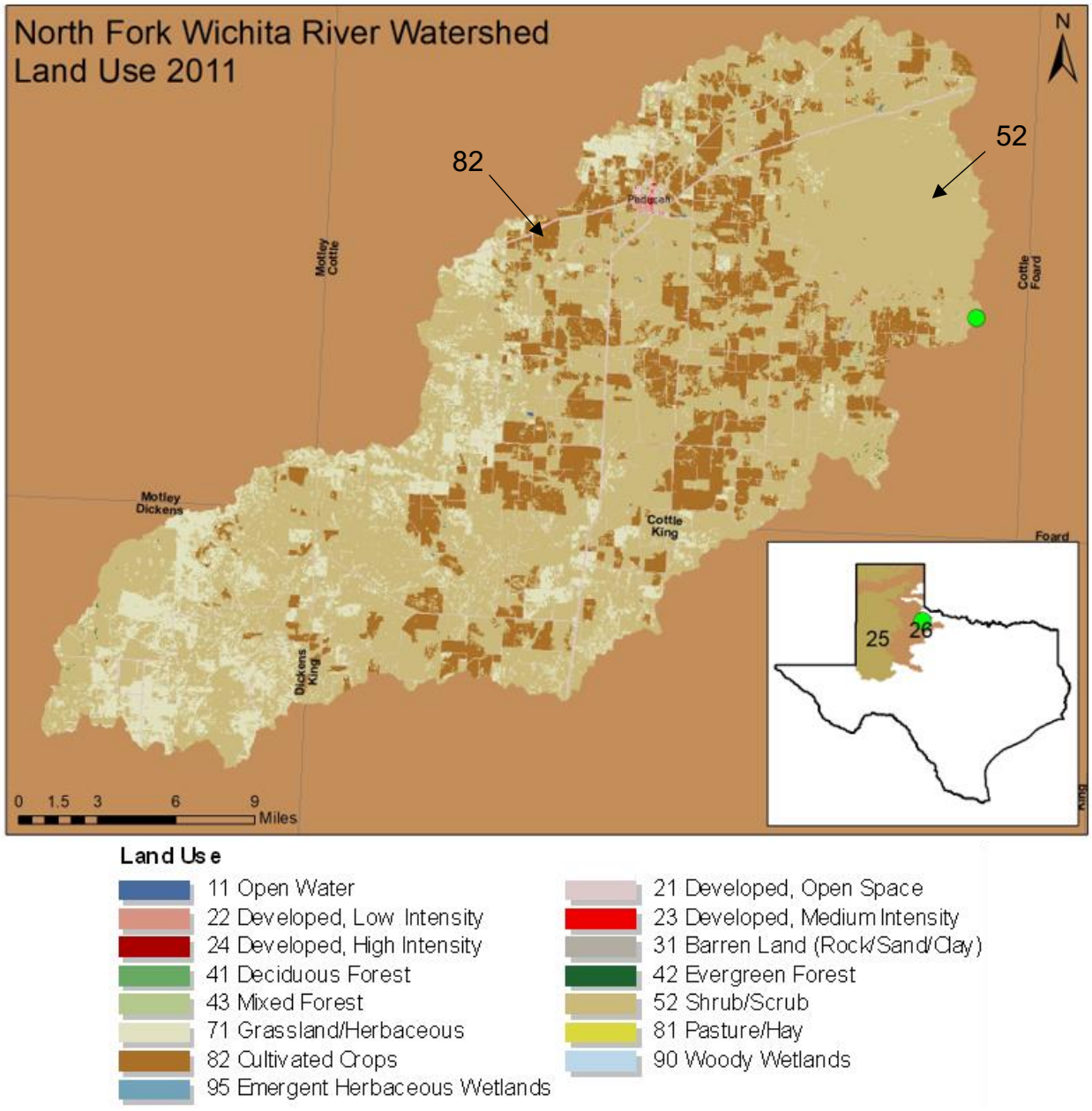

Figure 55. Map of North Fork Wichita River watershed location and 2011 land use; shrub/scrub and cultivated crops were the most common land uses.

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.

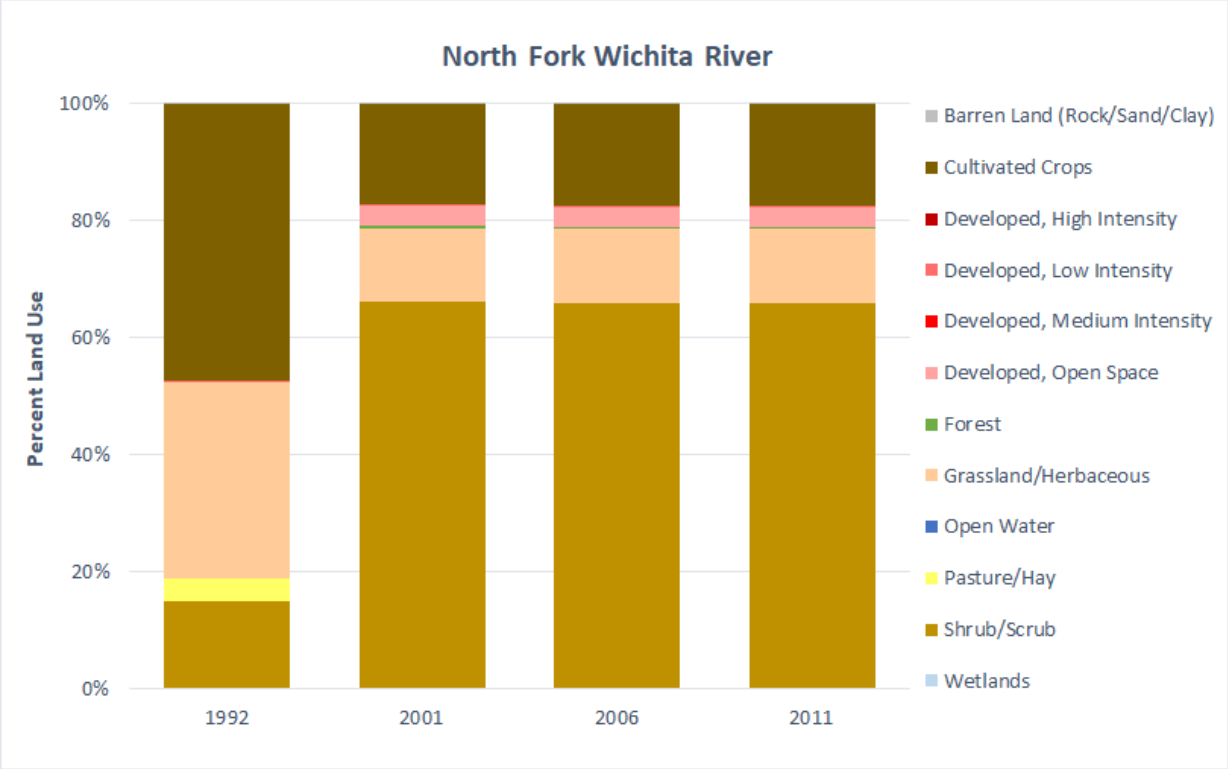

Figure 56. Percent land use in the North Fork Wichita River watershed from 1992-2011.

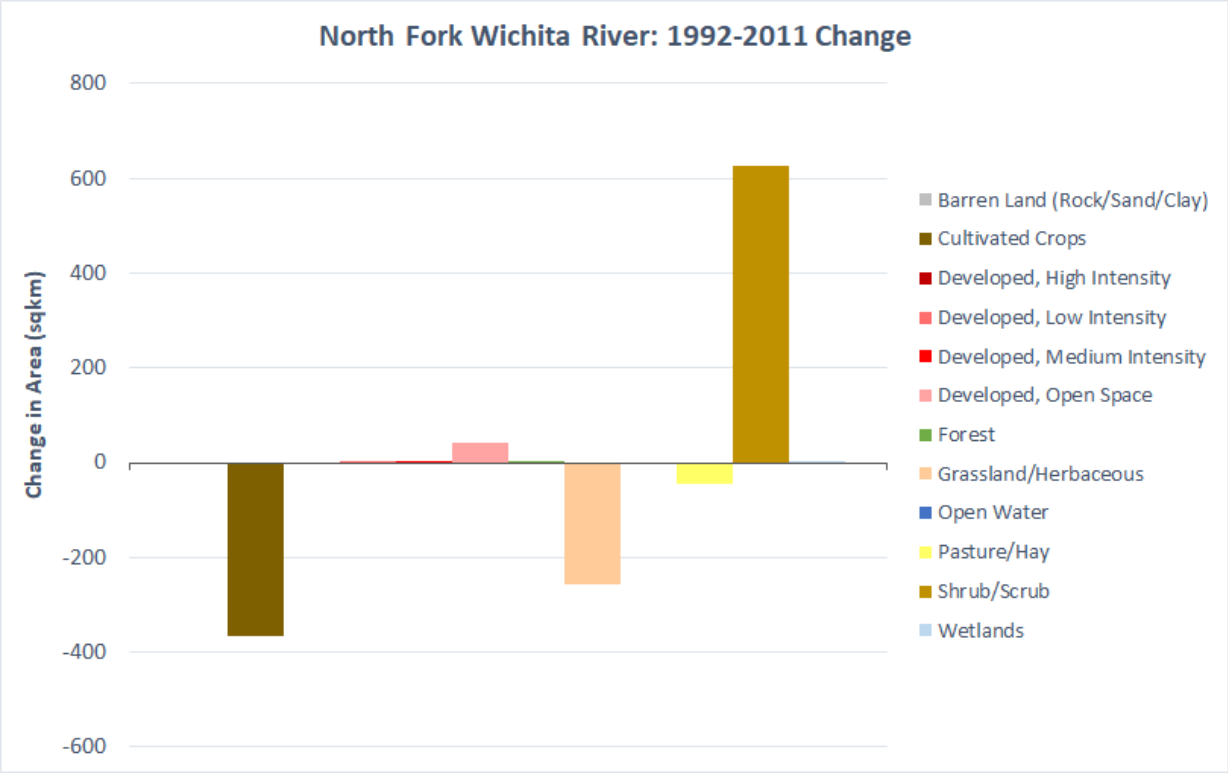

Figure 57. Land use change in area (sq km) from 1992-2011 for the North Fork Wichita River watershed.

SADDLERS CREEK

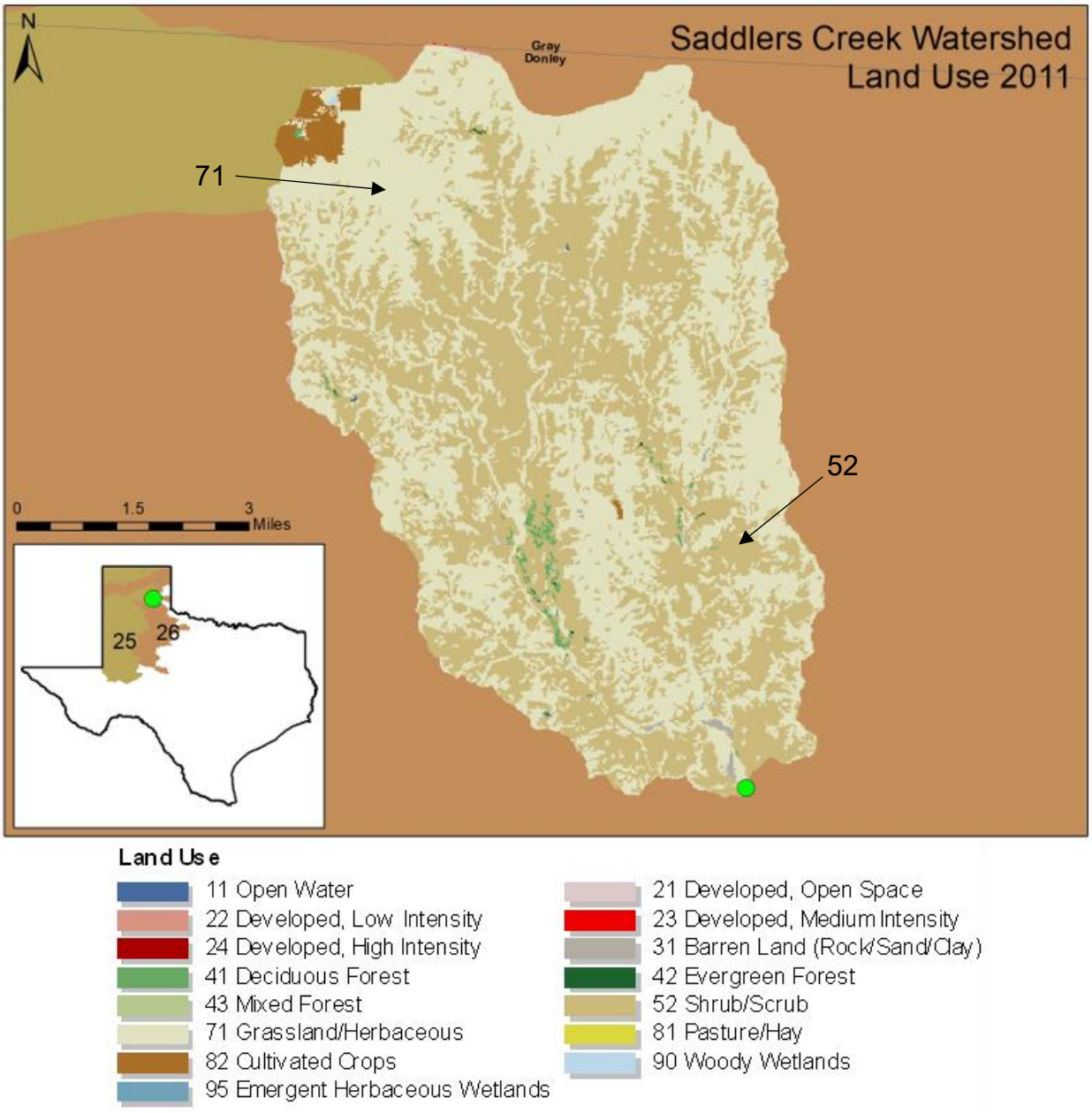

Figure 58. Map of Saddlers Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

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.

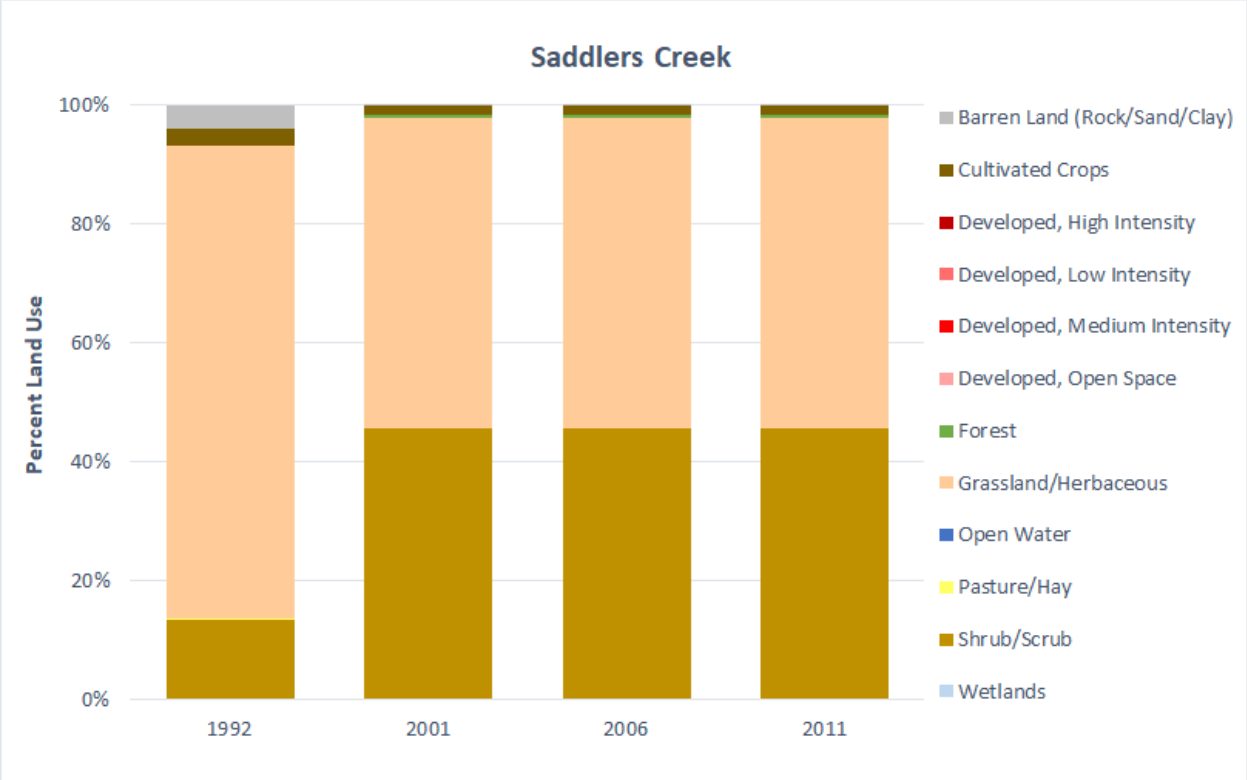

Figure 59. Percent land use in the Saddlers Creek watershed from 1992-2011.

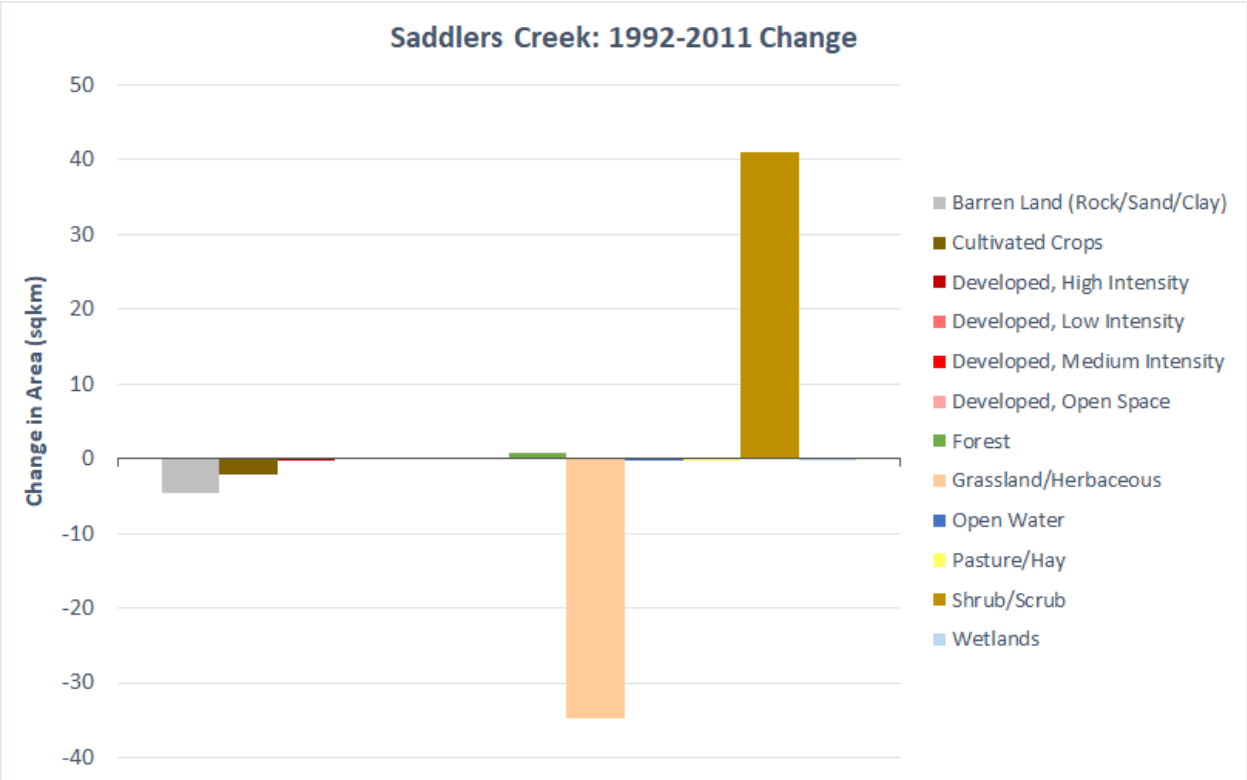

Figure 60. Land use change in area (sq km) from 1992-2011 for the Saddlers Creek watershed.

SALT FORK RED RIVER

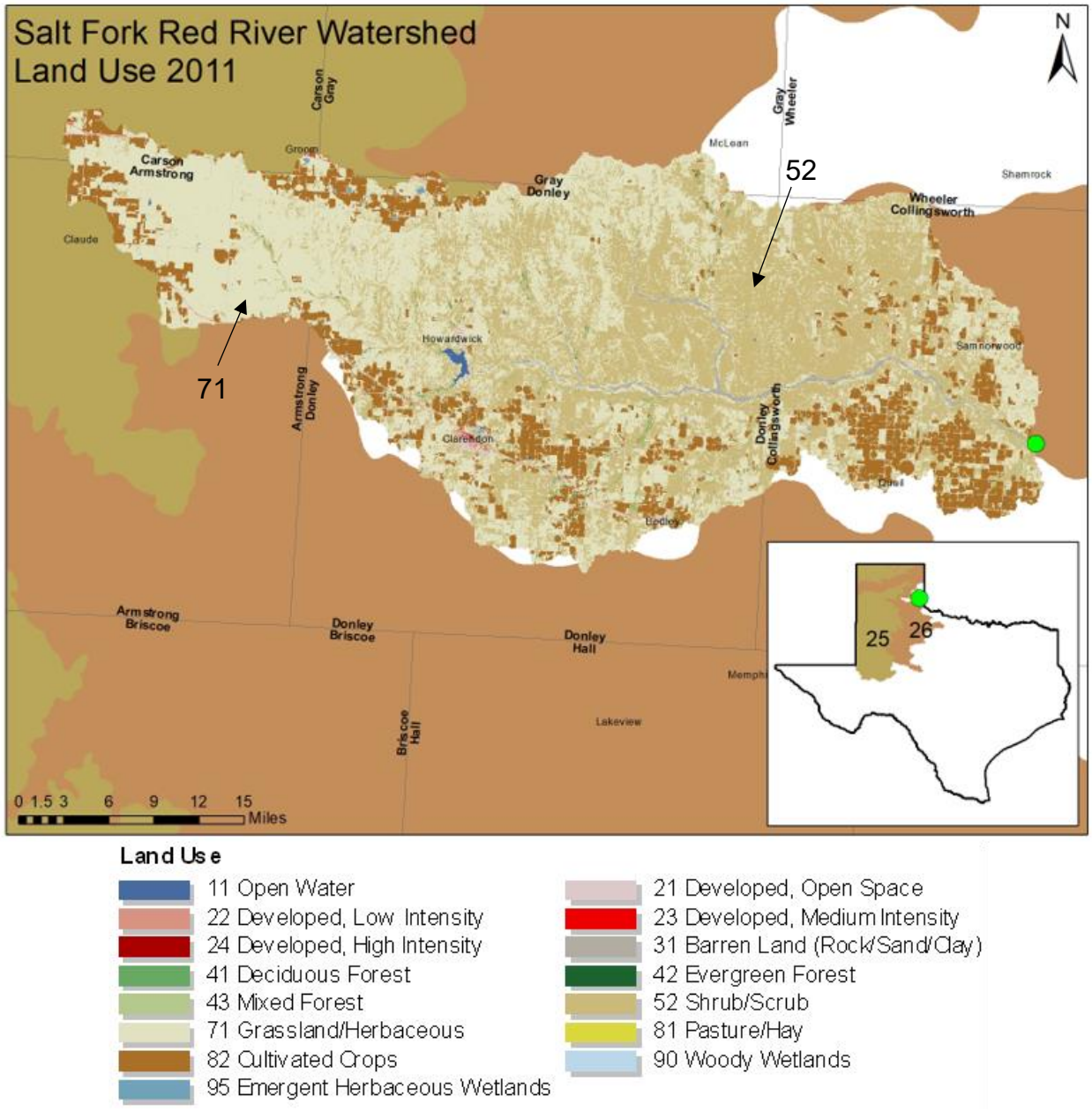

Figure 61. Map of Salt Fork Red River watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

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.

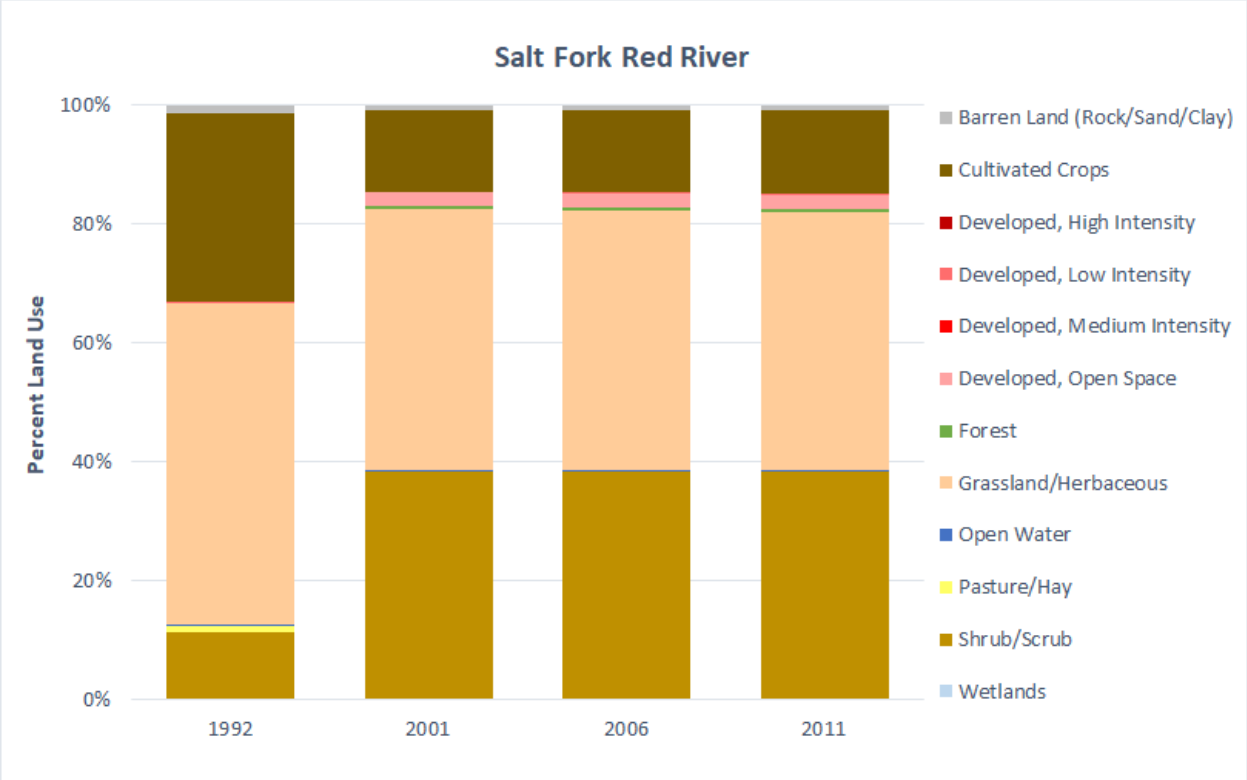

Figure 62. Percent land use in the Salt Fork Red River watershed from 1992-2011.

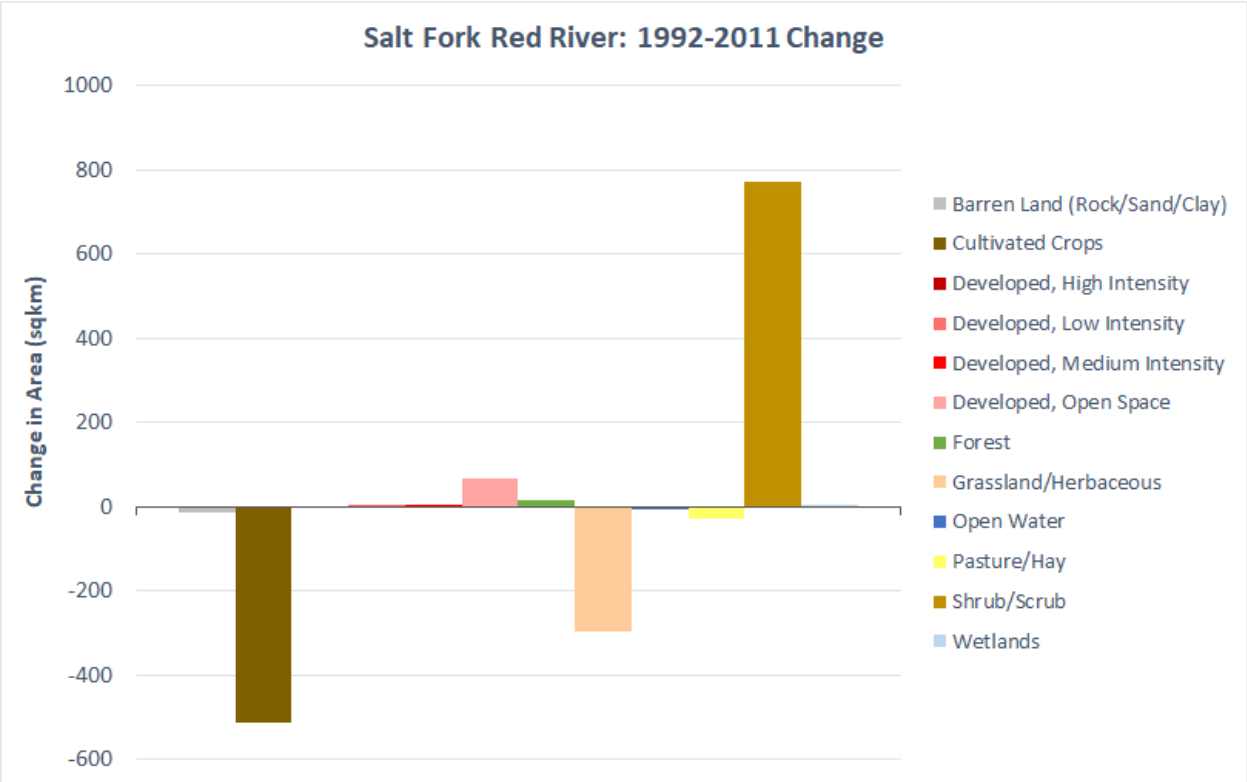

Figure 63. Land use change in area (sq km) from 1992-2011 for the Salt Fork Red River watershed.

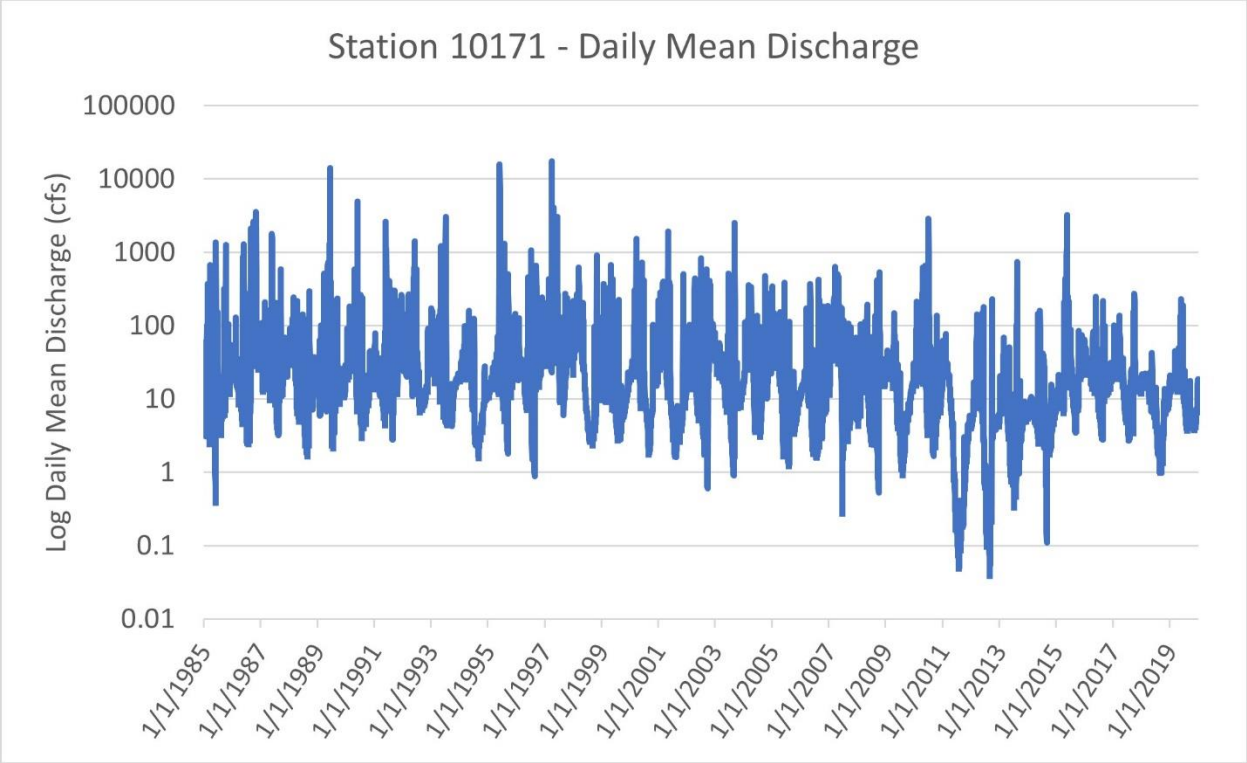

Figure 64. Log transformed daily mean discharge for Salt Fork Red River at station 10171.

WHITE DEER CREEK

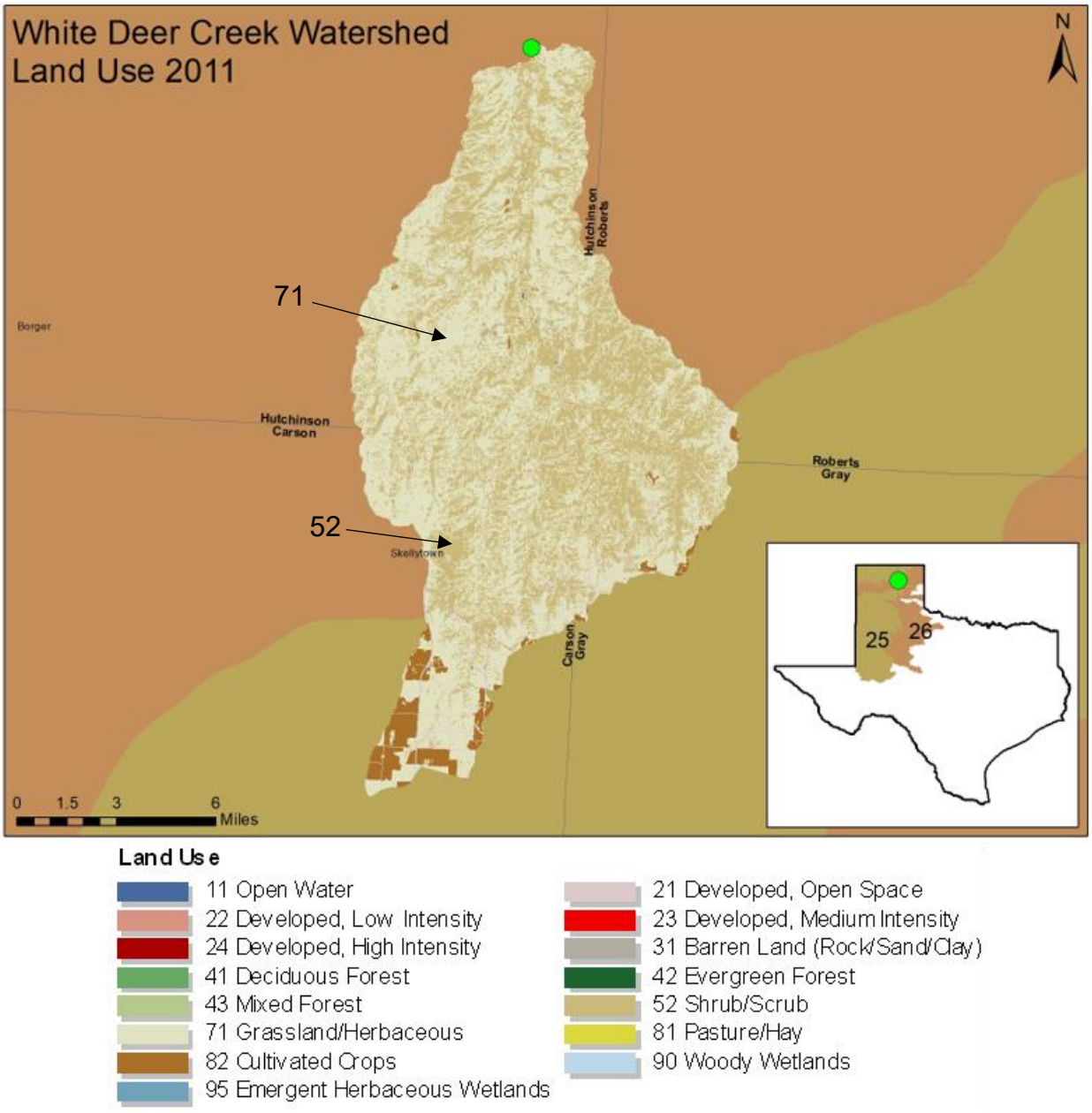

Figure 65. Map of White Deer Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

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.

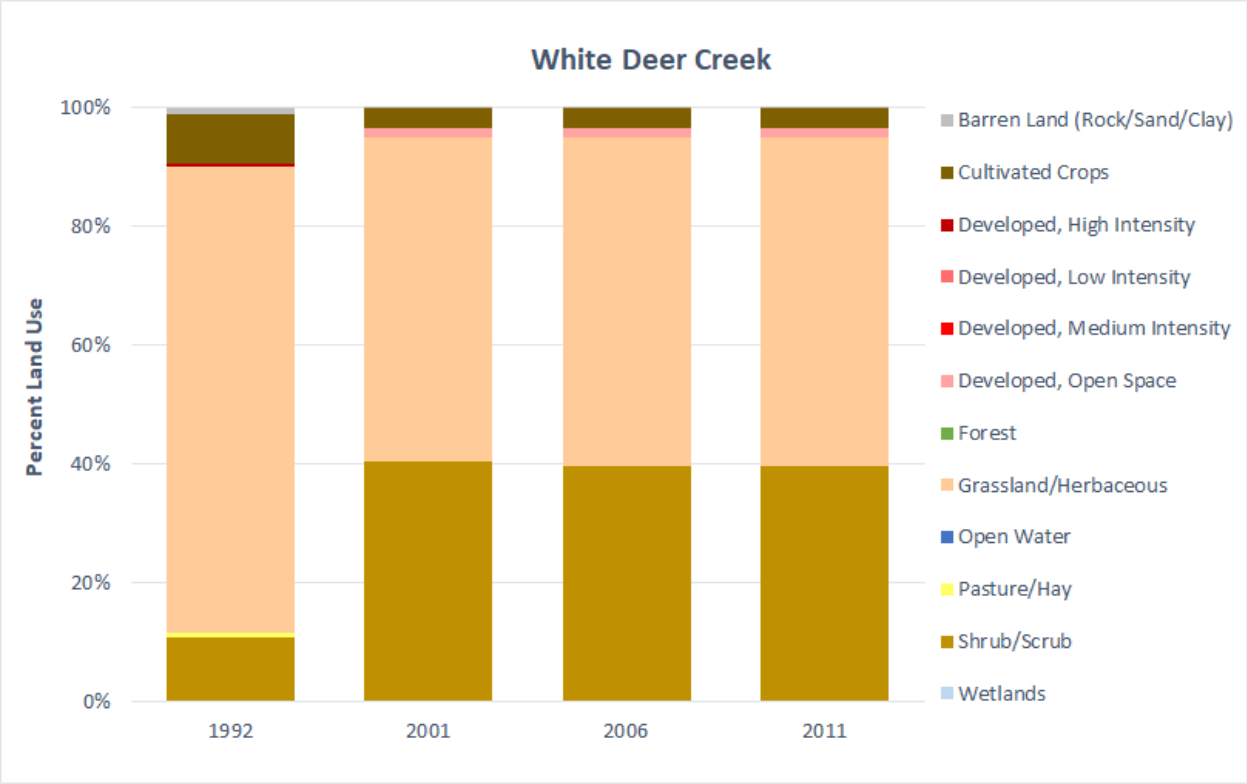

Figure 66. Percent land use in the White Deer Creek watershed from 1992-2011.

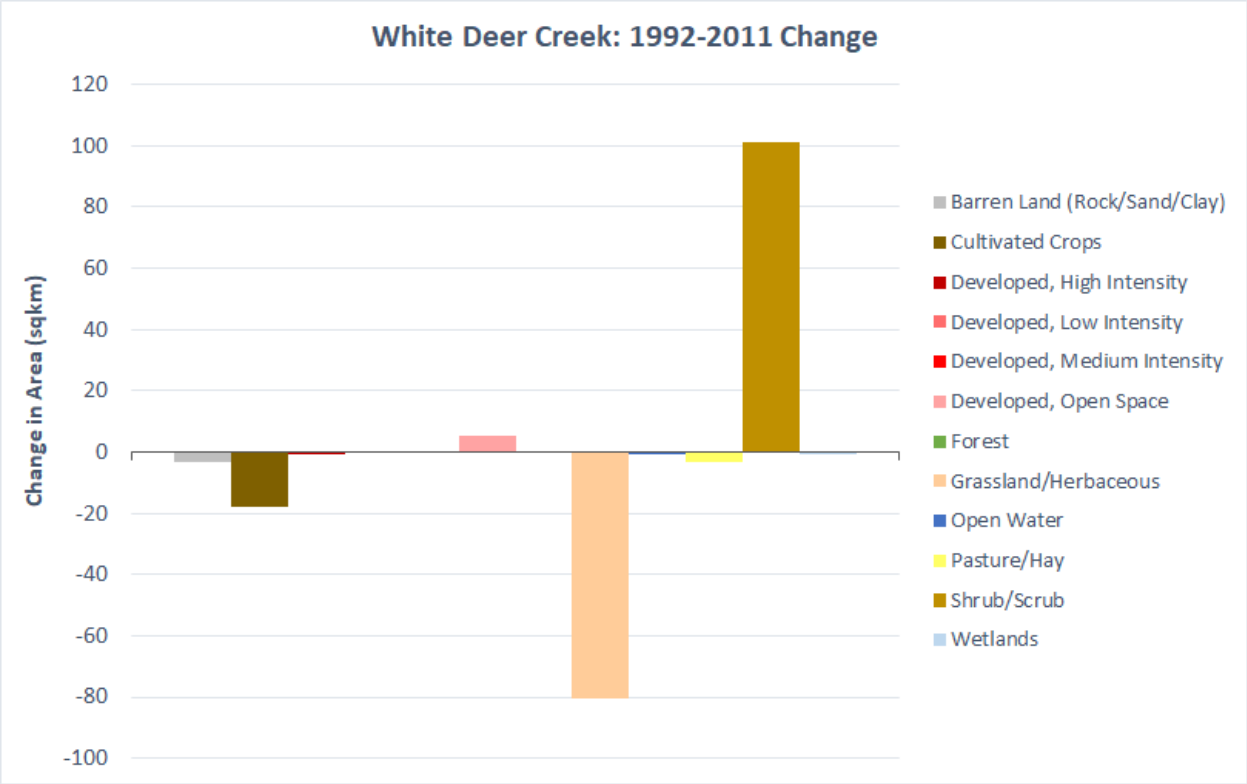

Figure 67. Land use change in area (sq km) from 1992-2011 for the White Deer Creek watershed.

WHITEFISH CREEK

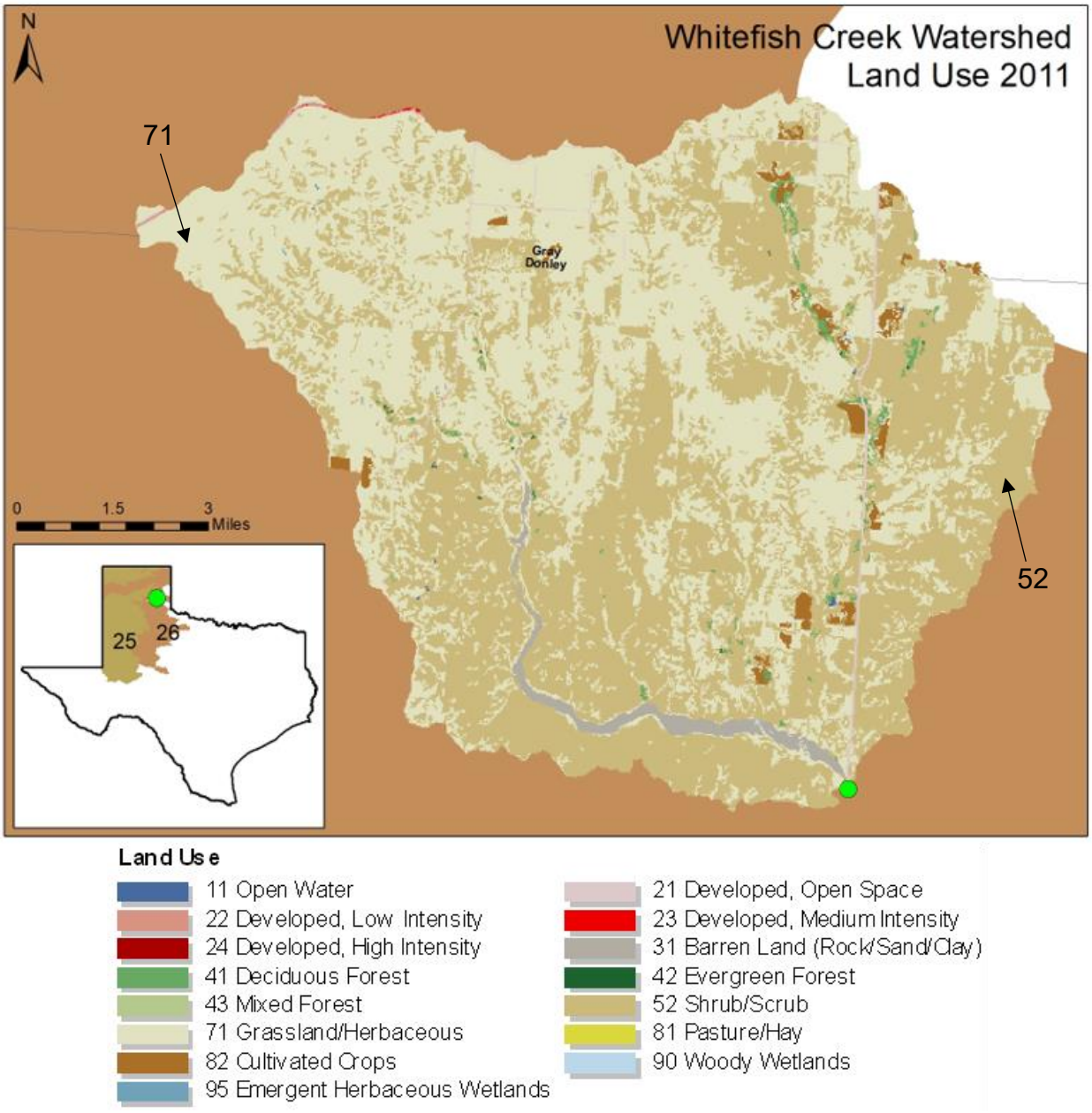

Figure 68. Map of Whitefish Creek watershed location and 2011 land use; grassland/herbaceous and shrub/scrub were the most common land uses.

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.

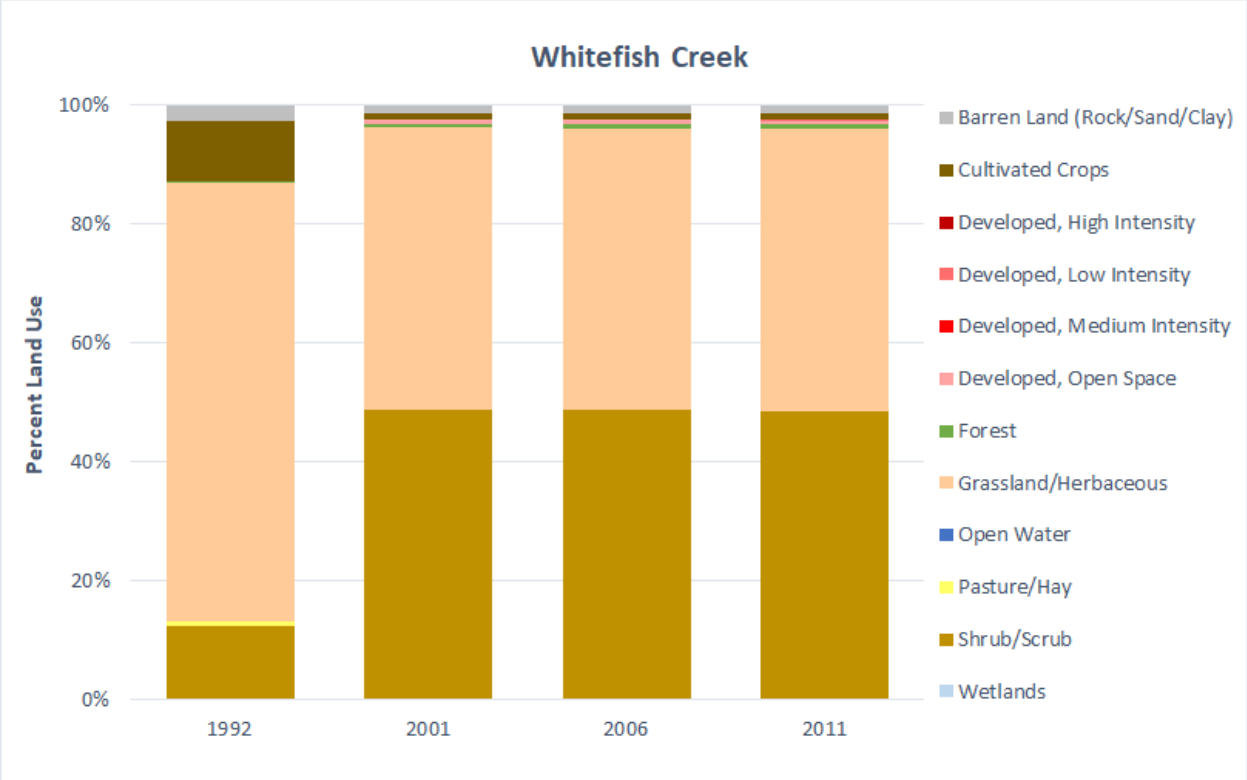

Figure 69. Percent land use in the Whitefish Creek watershed from 1992-2011.

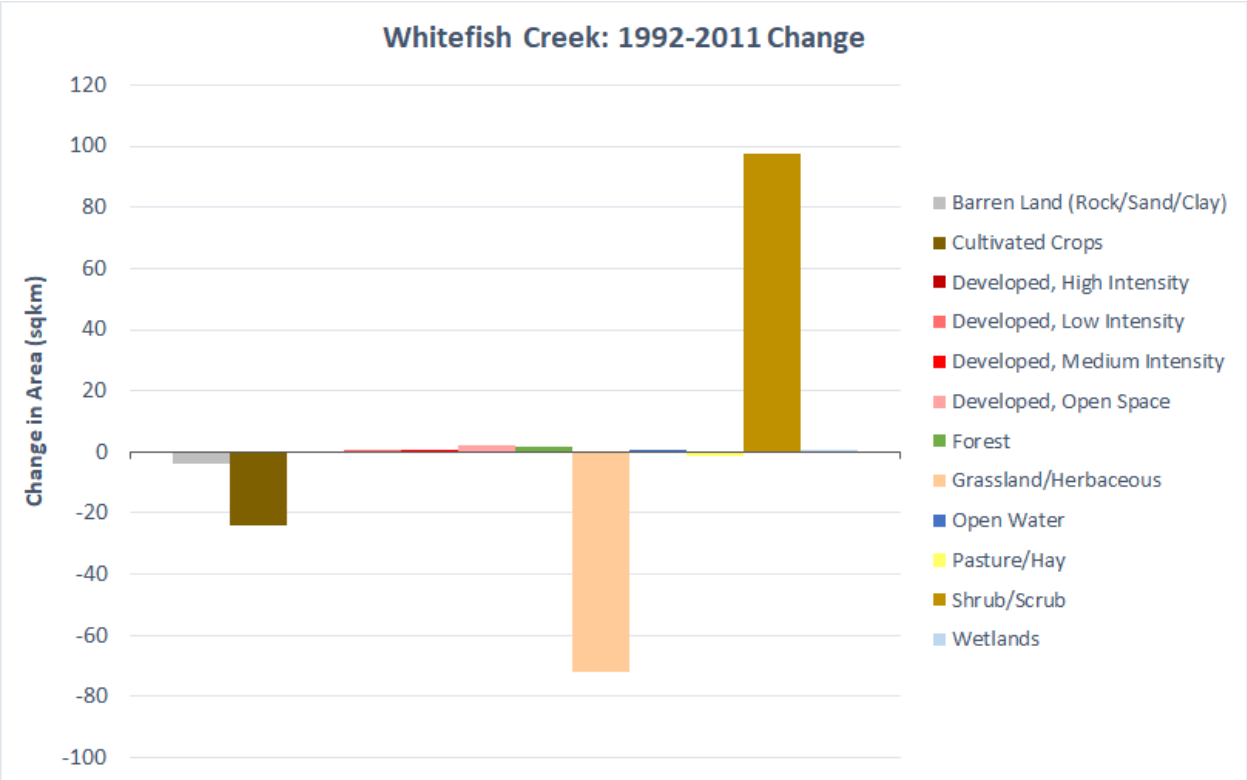

Figure 70. Land use change in area (sq km) from 1992-2011 for the Whitefish Creek watershed.

WOLF CREEK

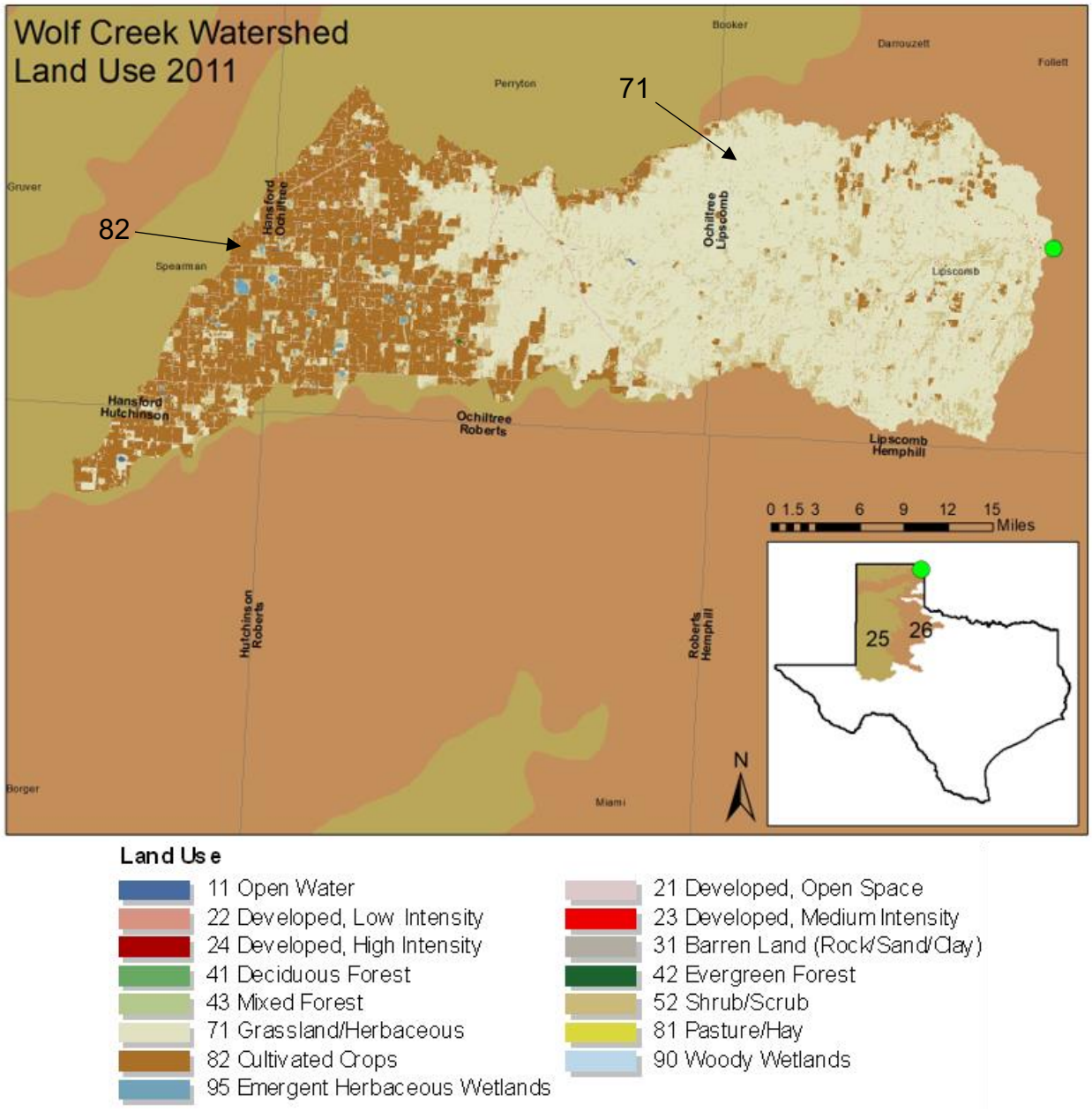

Figure 71. Map of Wolf Creek watershed location and 2011 land use; grassland/herbaceous and cultivated crops were the most common land uses.

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.

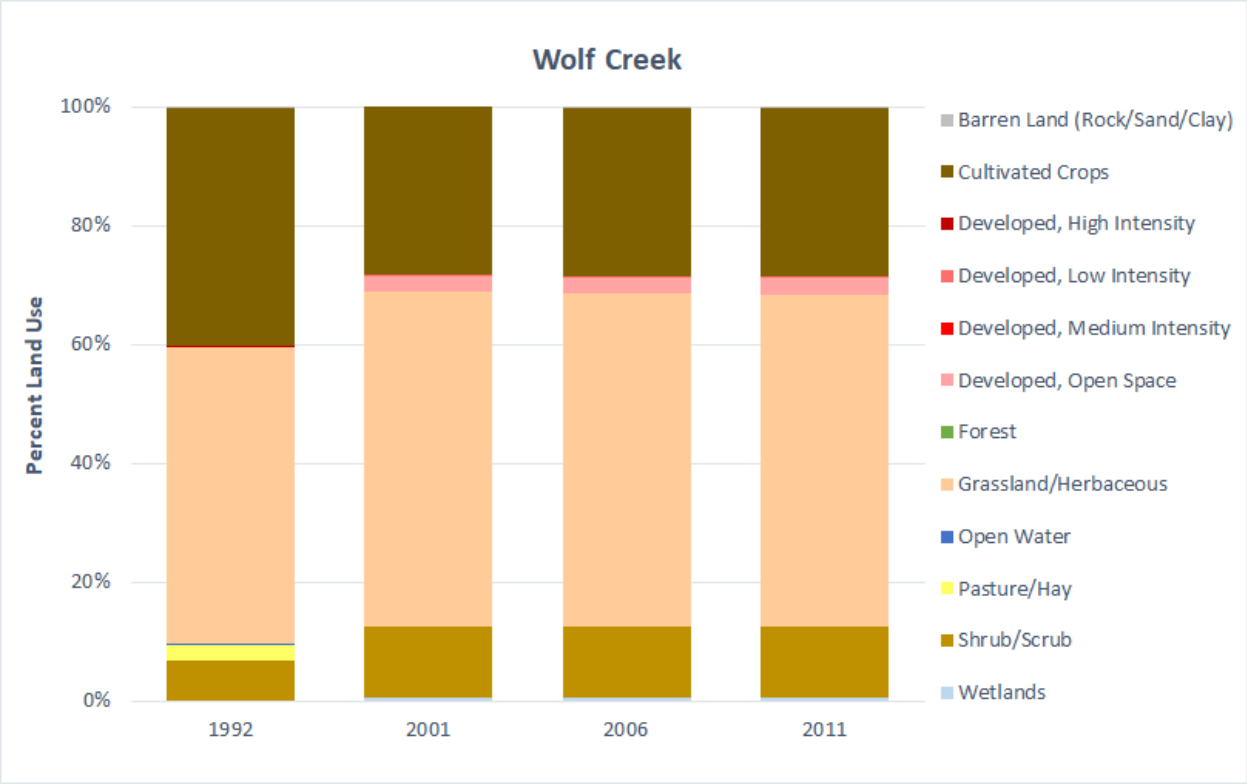

Figure 72. Percent land use in the Wolf Creek watershed from 1992-2011.

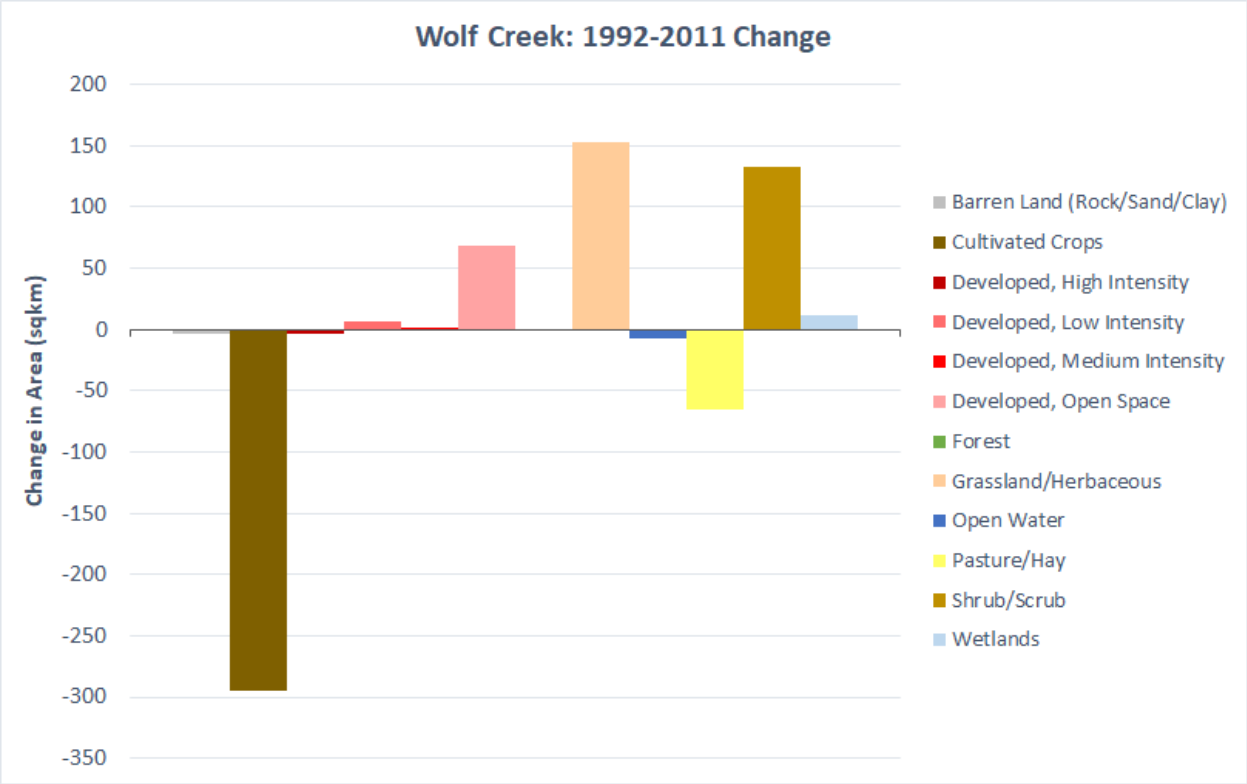

Figure 73. Land use change in area (sq km) from 1992-2011 for the Wolf Creek watershed.

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).

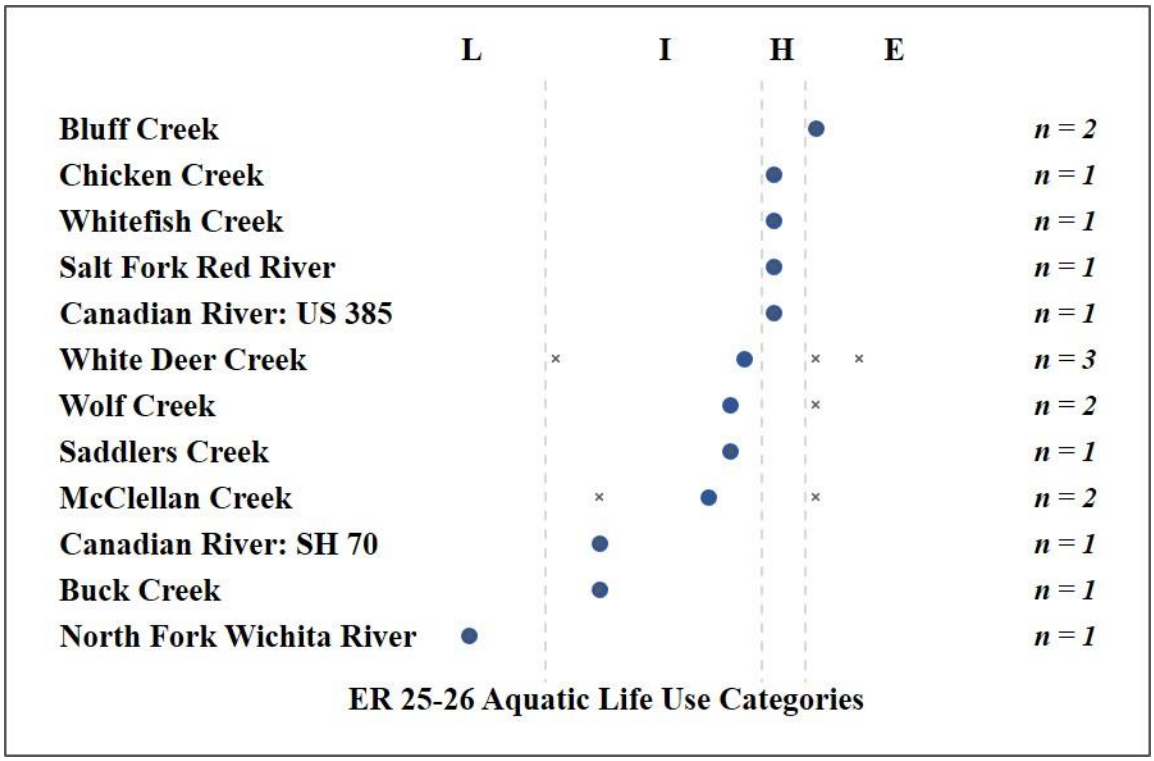

Figure 74. Aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all fish sampling events in Ecoregions 25 and 26 grouped by site and ranked by mean ALU score (blue dot); number of sampling events per site noted on right.

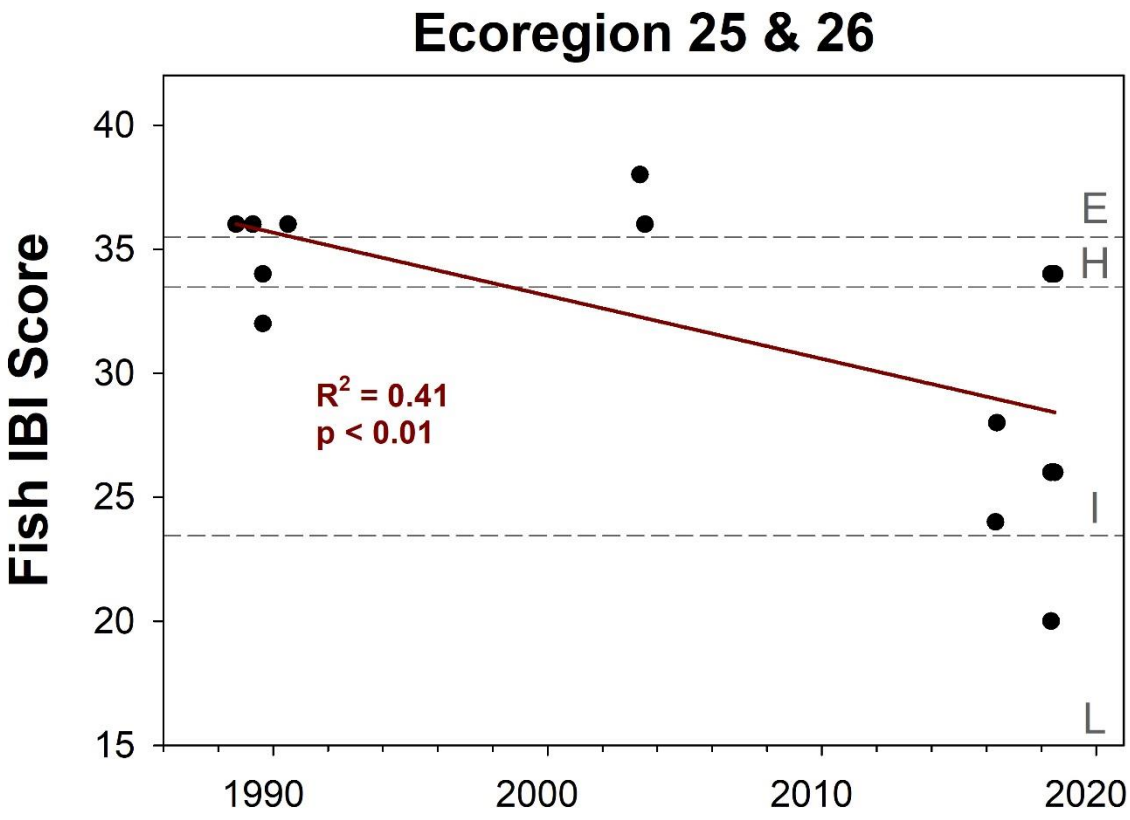

Figure 75. Fish index of biotic integrity scores through time for all sampling events in Ecoregions 25 and 26; break lines for aquatic life use categories (i.e., limited, intermediate, high, and exceptional) shown on each graph for reference (see Linam et al. 2002).

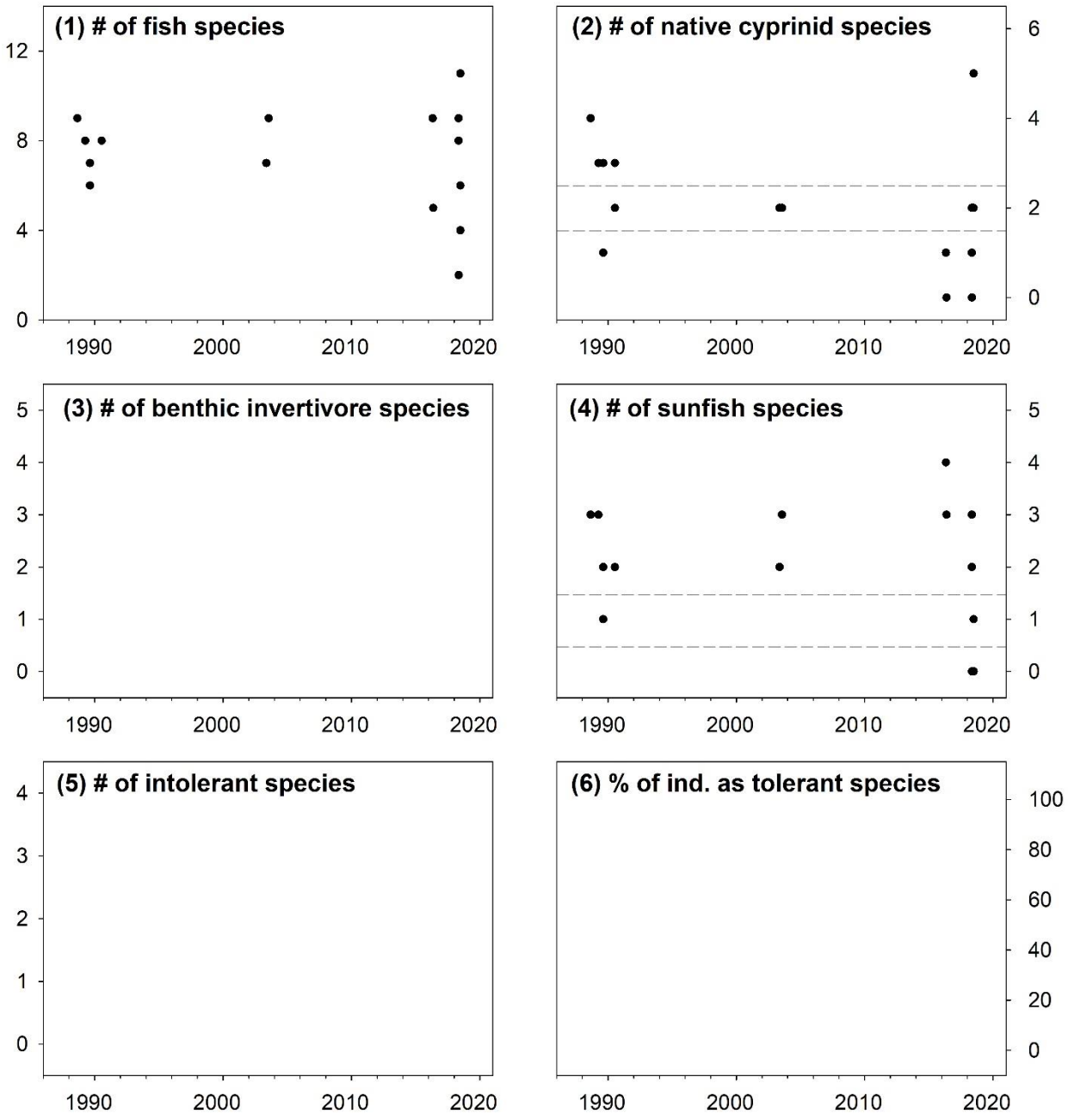

Figure 76. Raw values for fish index of biotic integrity metrics 1-6 through time for all sampling events in Ecoregions 25 and 26; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002); metrics that are not included in the IBI for this aggregated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

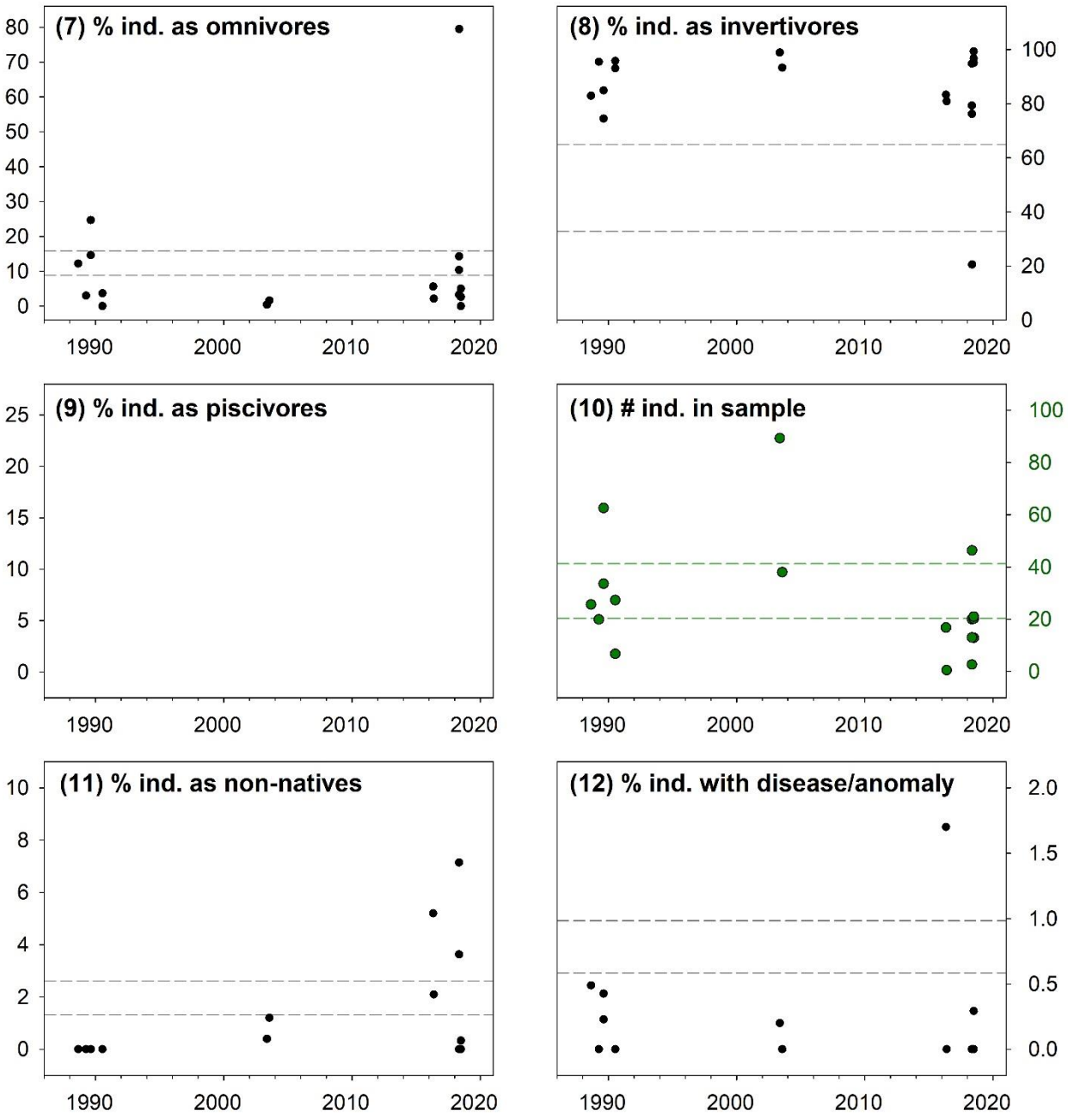

Figure 77. Raw values for fish index of biotic integrity metrics 7-12 through time for all sampling events in Ecoregions 25 and 26; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002); number of ind./seine haul represented by green circles and 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.

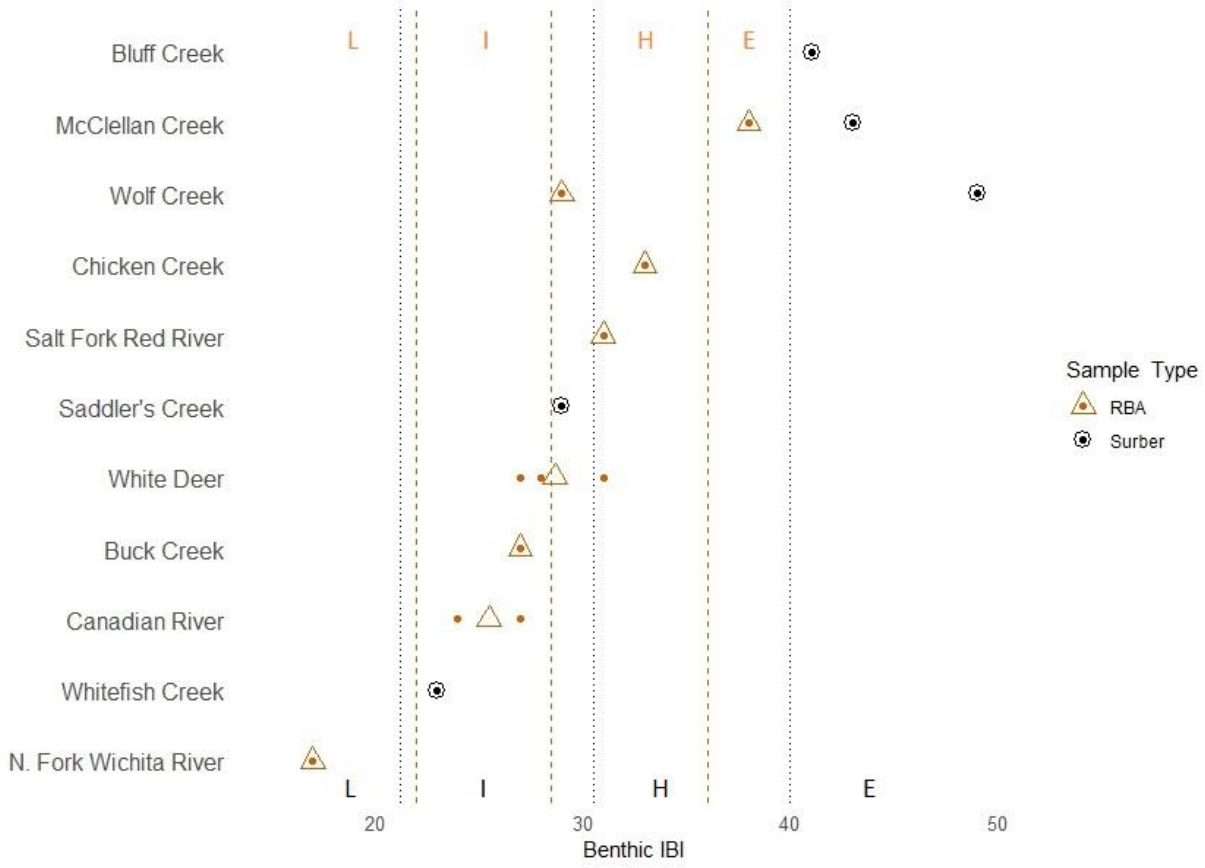

Figure 78. Benthic IBIs and aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all benthic sampling events in Ecoregions 25 and 26 grouped by site and ranked by mean IBI score. Site scores are solid circles, and mean scores are hollow circles for Surber IBI sample 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.

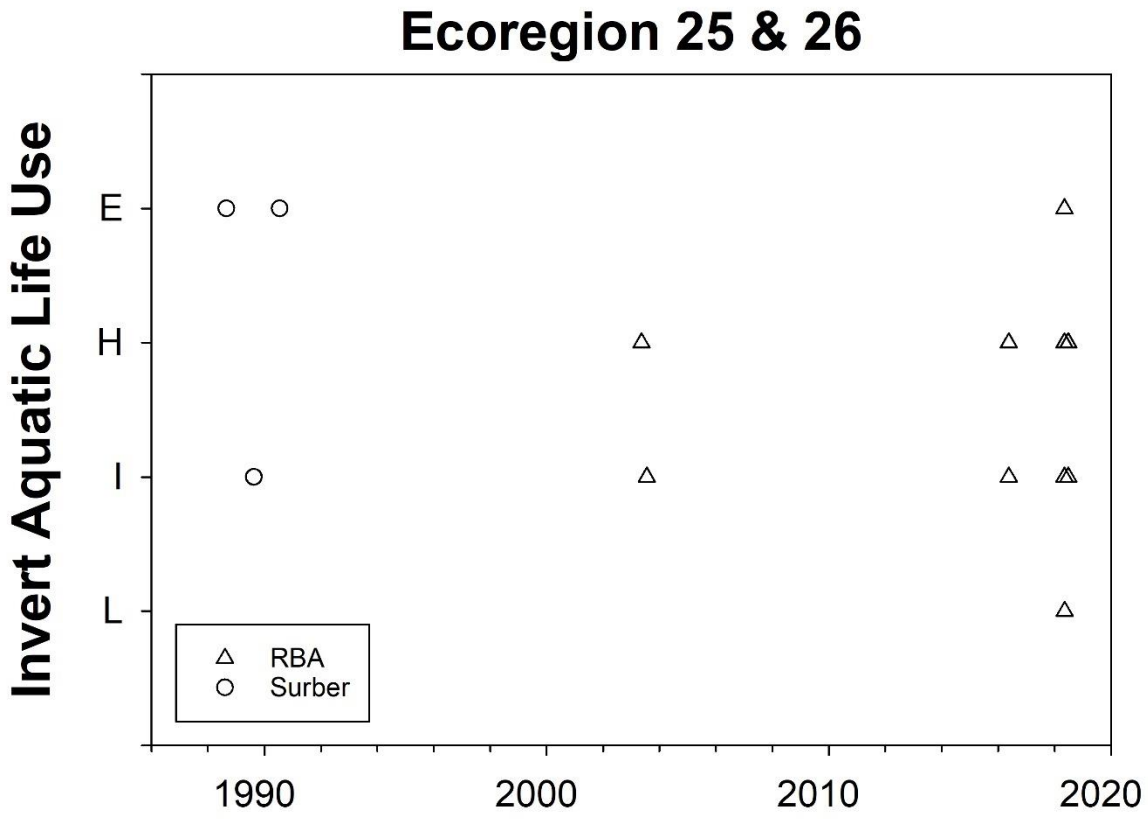

Figure 79. Benthic aquatic life use (ALU) categories through time for all sampling events in Ecoregions 25 and 26; Surber ALUs are noted by circles and RBP ALUs are noted by triangles.