ECOREGION 30 – CENTRAL TEXAS PLATEAU

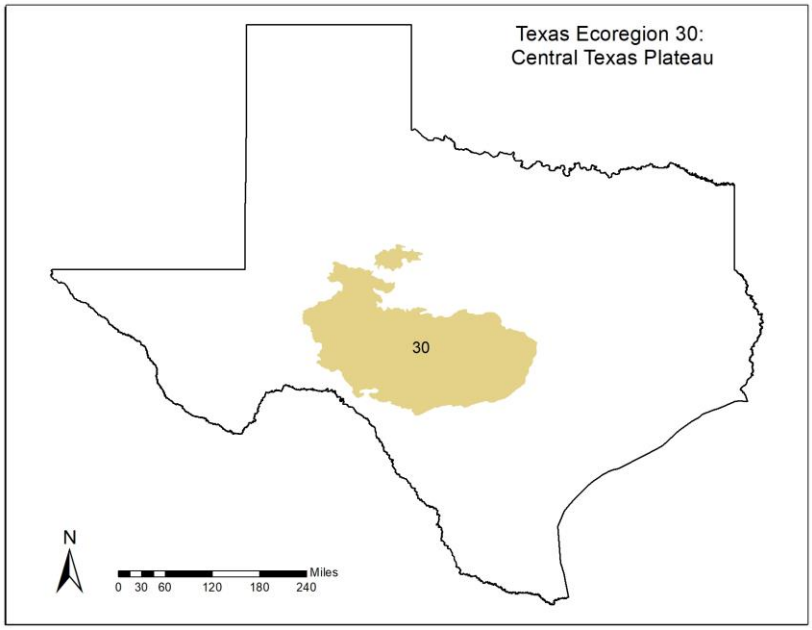

Figure 153. Map of Texas Ecoregion 30 – Central Texas Plateau.

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

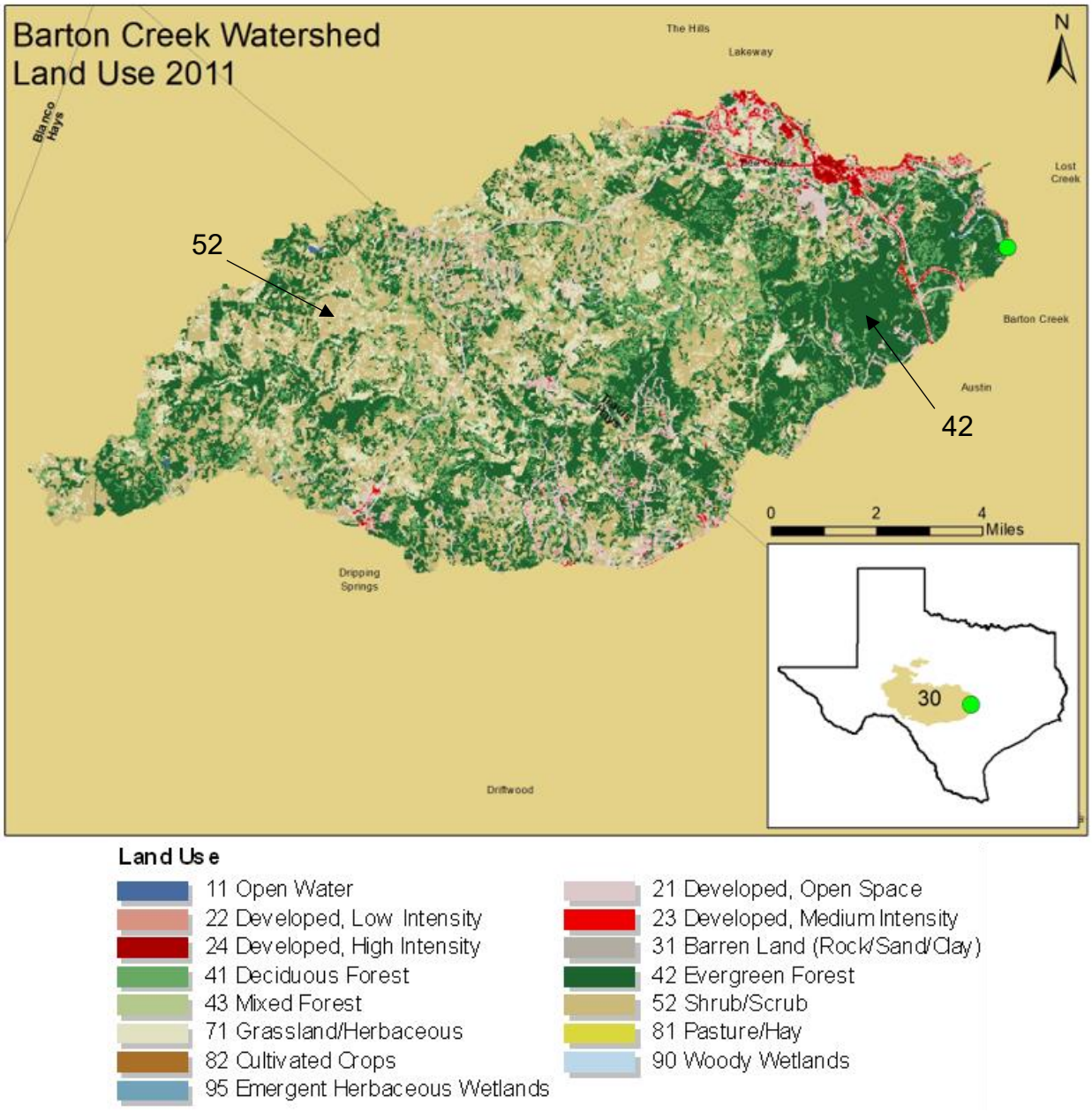

Figure 155. Map of Barton Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

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.

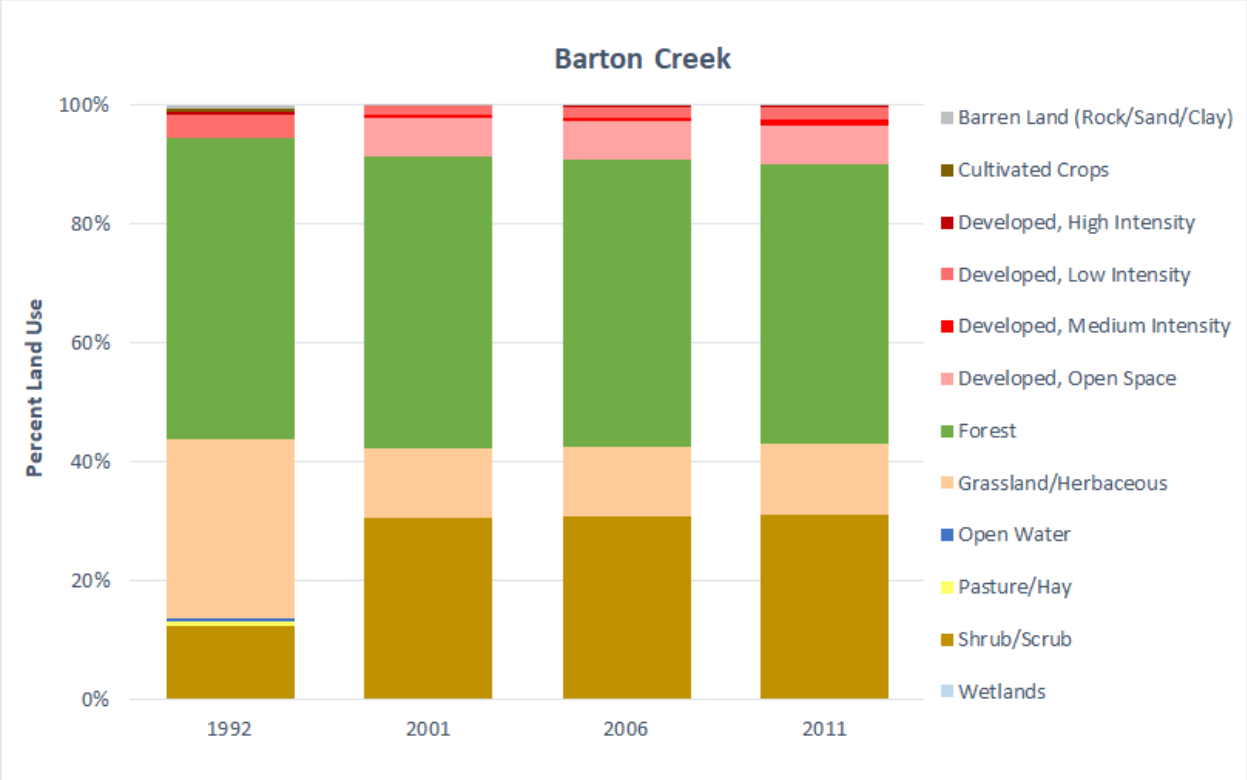

Figure 156. Percent land use in the Barton Creek watershed from 1992-2011.

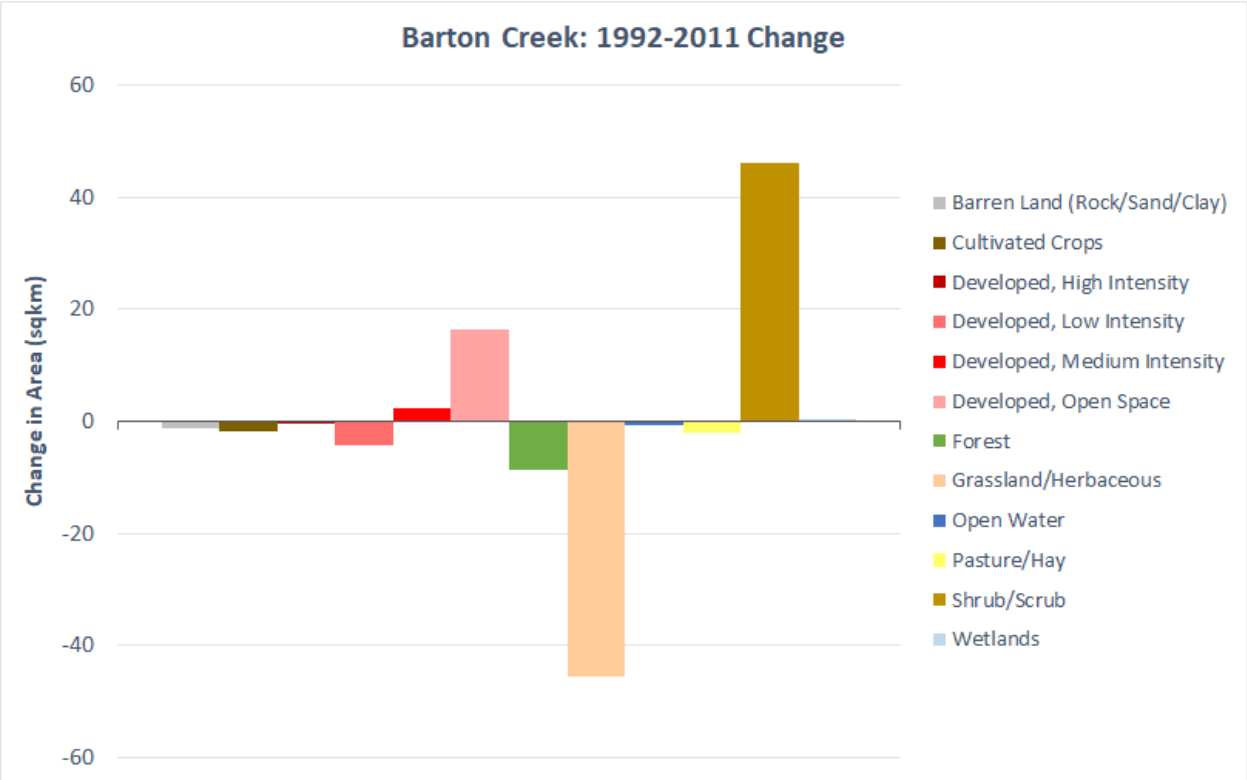

Figure 157. Land use change in area (sq km) from 1992-2011 for the Barton Creek watershed.

BRUSHY CREEK

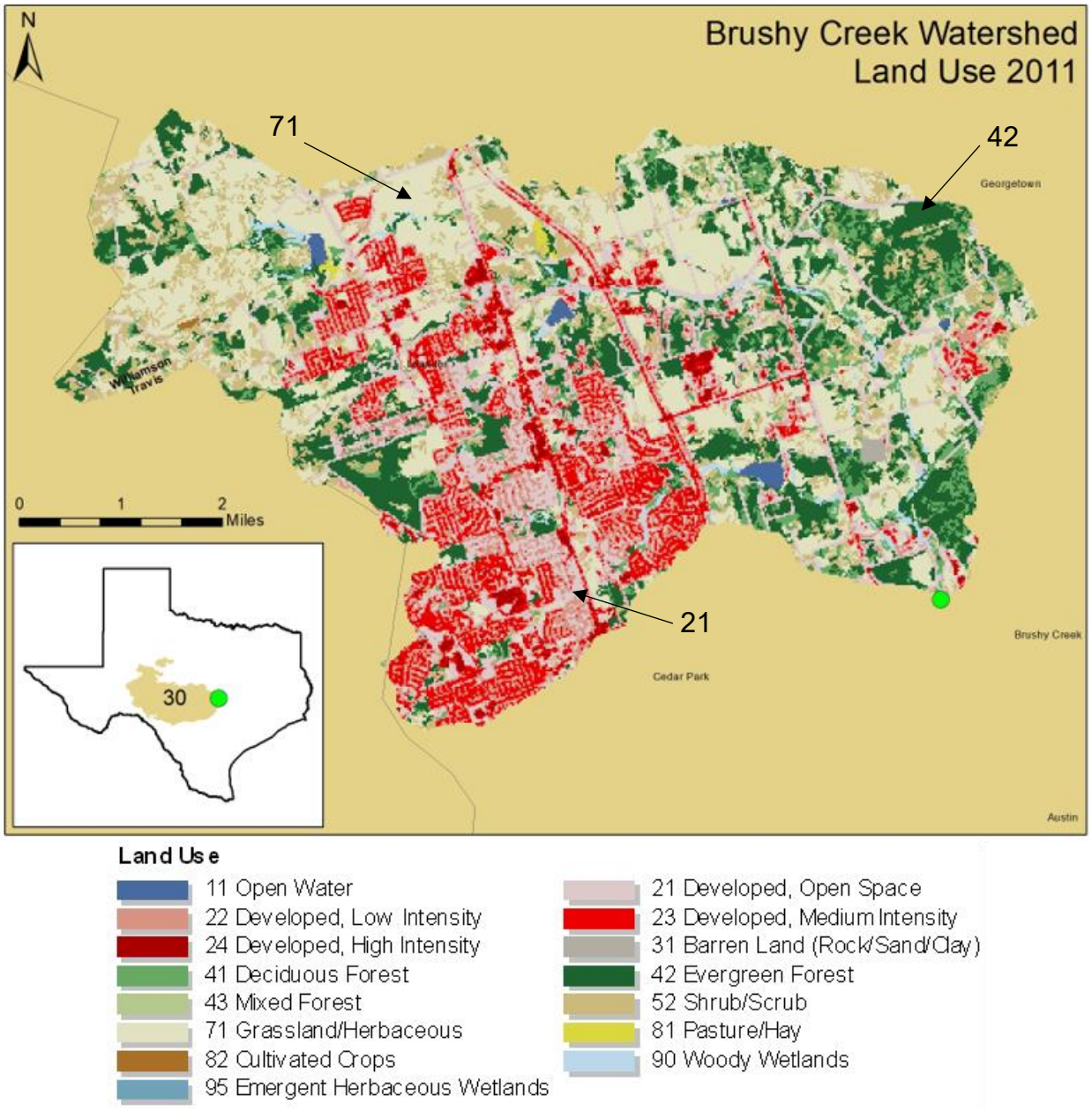

Figure 158. Map of Brushy Creek watershed location and 2011 land use; grassland/herbaceous, forest, and open space development were the most common land uses.

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 .

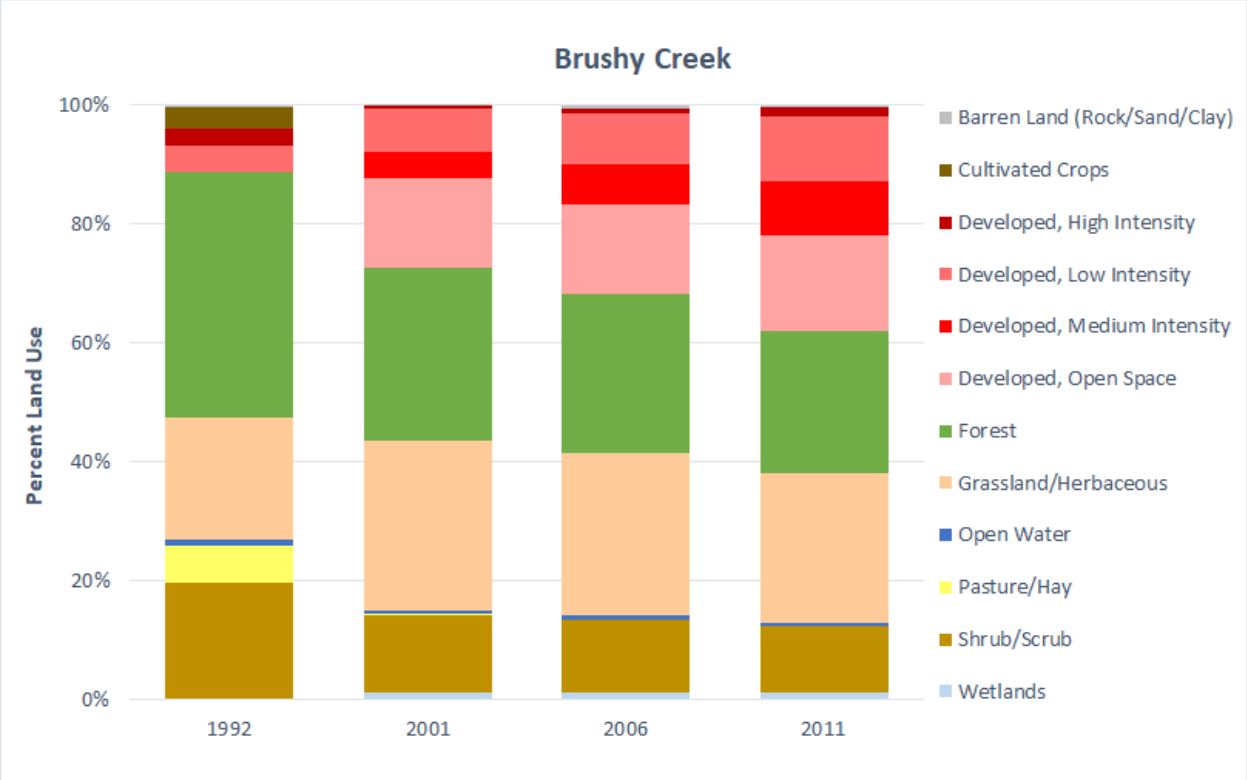

Figure 159. Percent land use in the Brushy Creek watershed from 1992-2011.

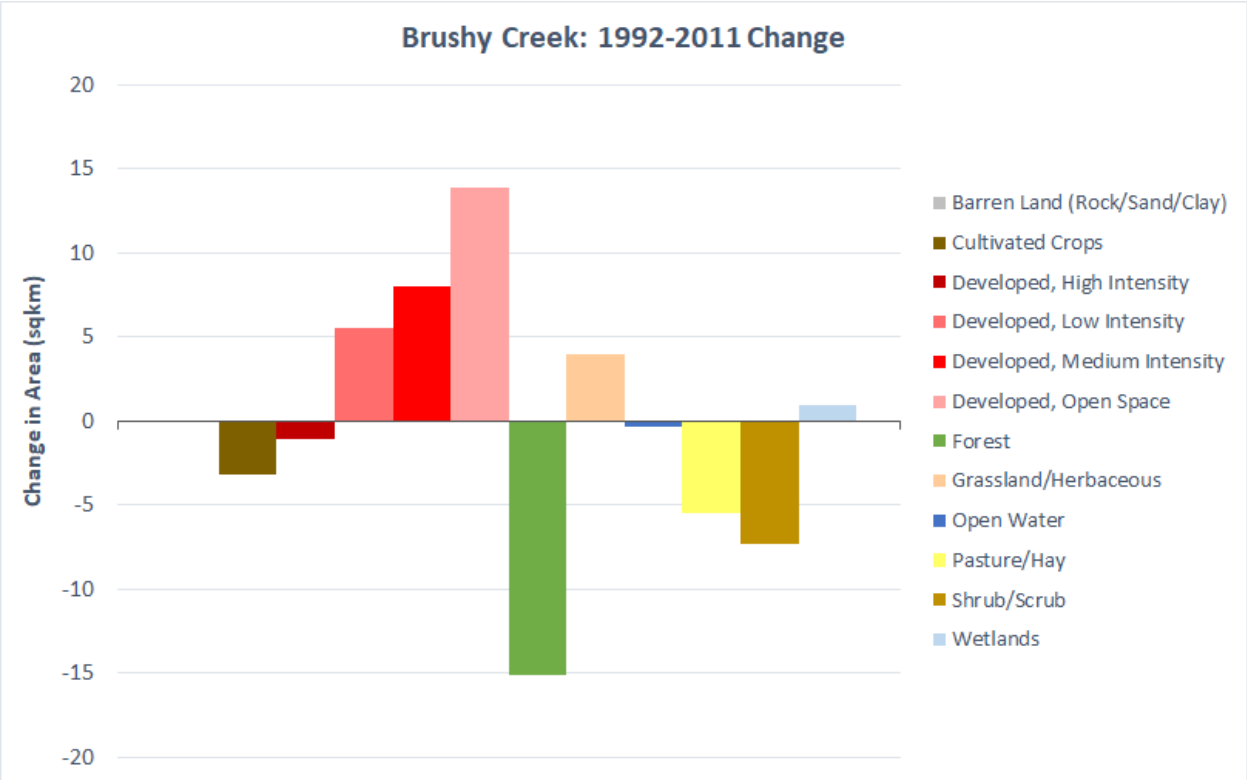

Figure 160. Land use change in area (sq km) from 1992-2011 for the Brushy Creek watershed.

BULL CREEK

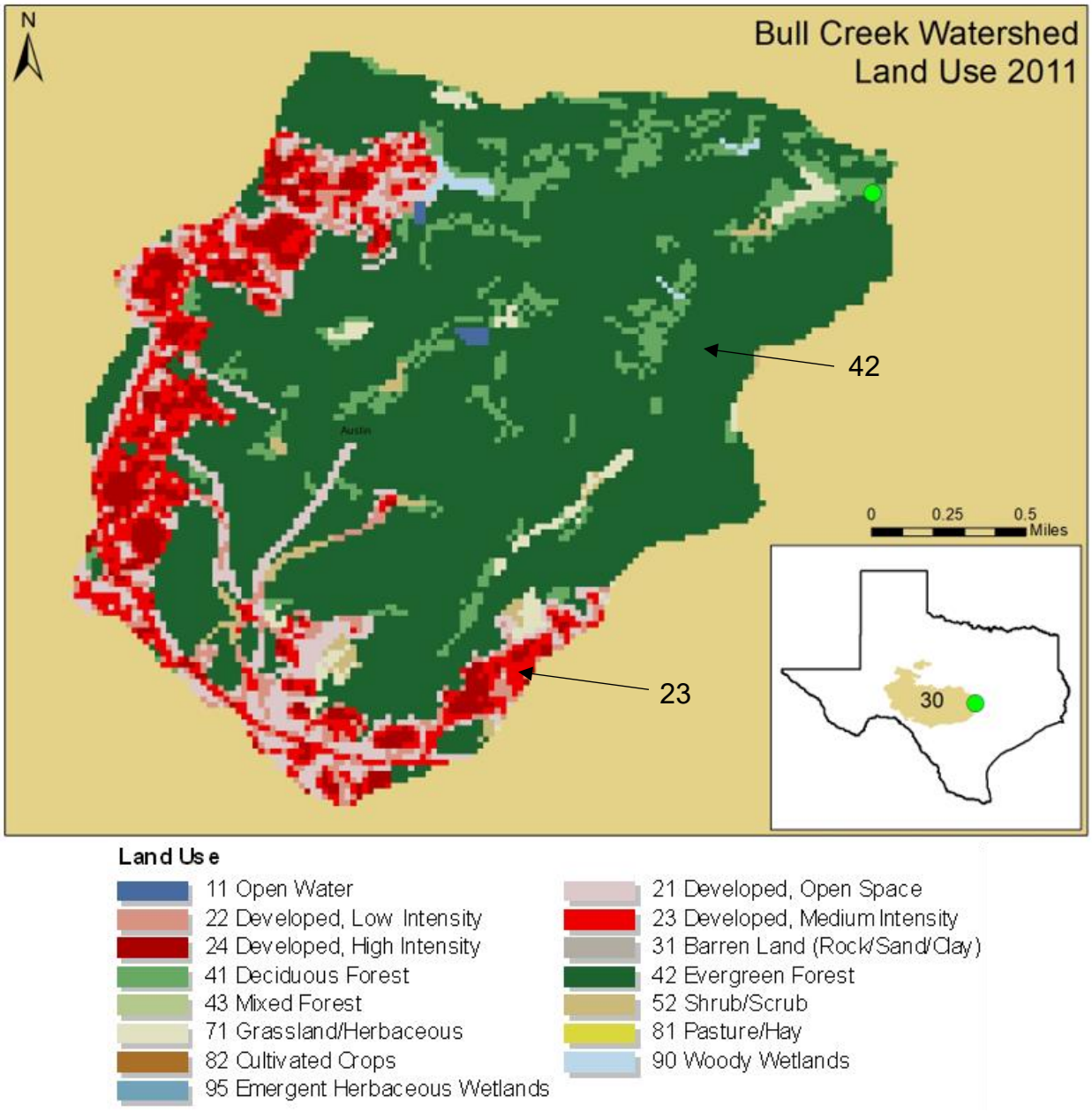

Figure 161. Map of Bull Creek watershed location and 2011 land use; forest and medium intensity development were the most common land uses.

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.

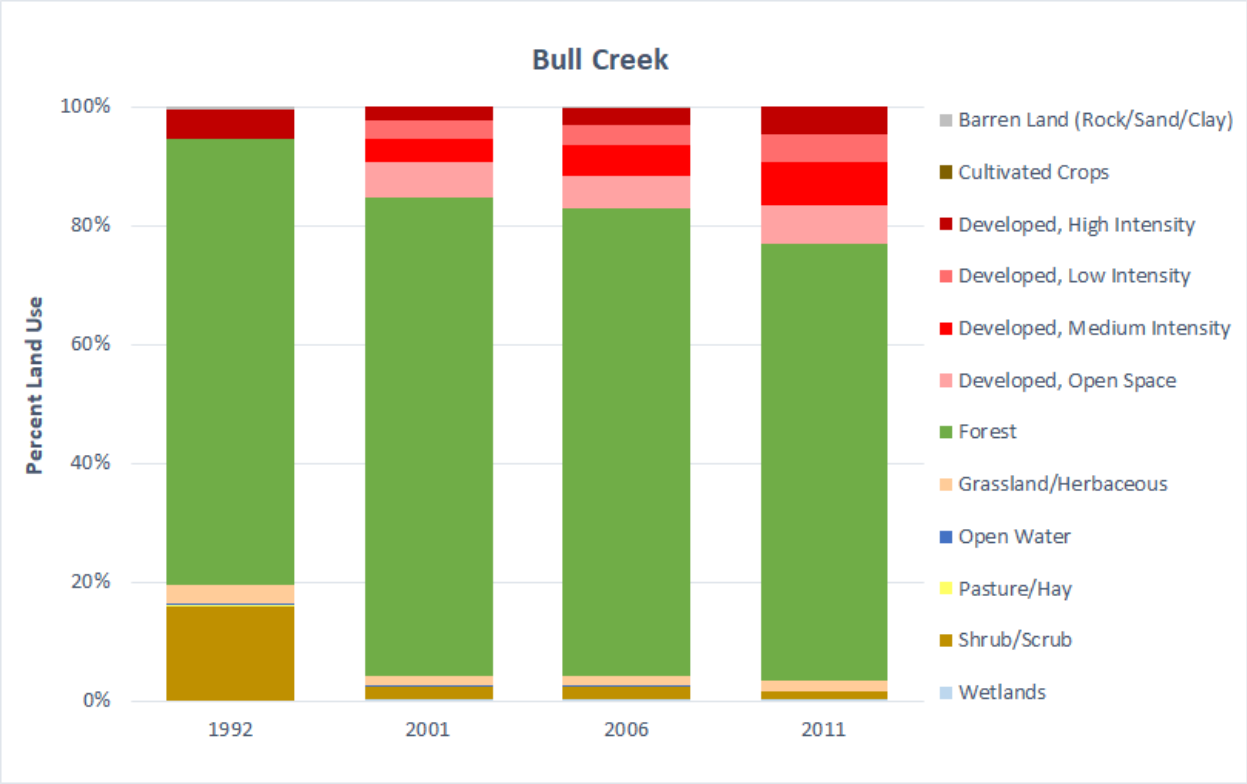

Figure 162. Percent land use in the Bull Creek watershed from 1992-2011.

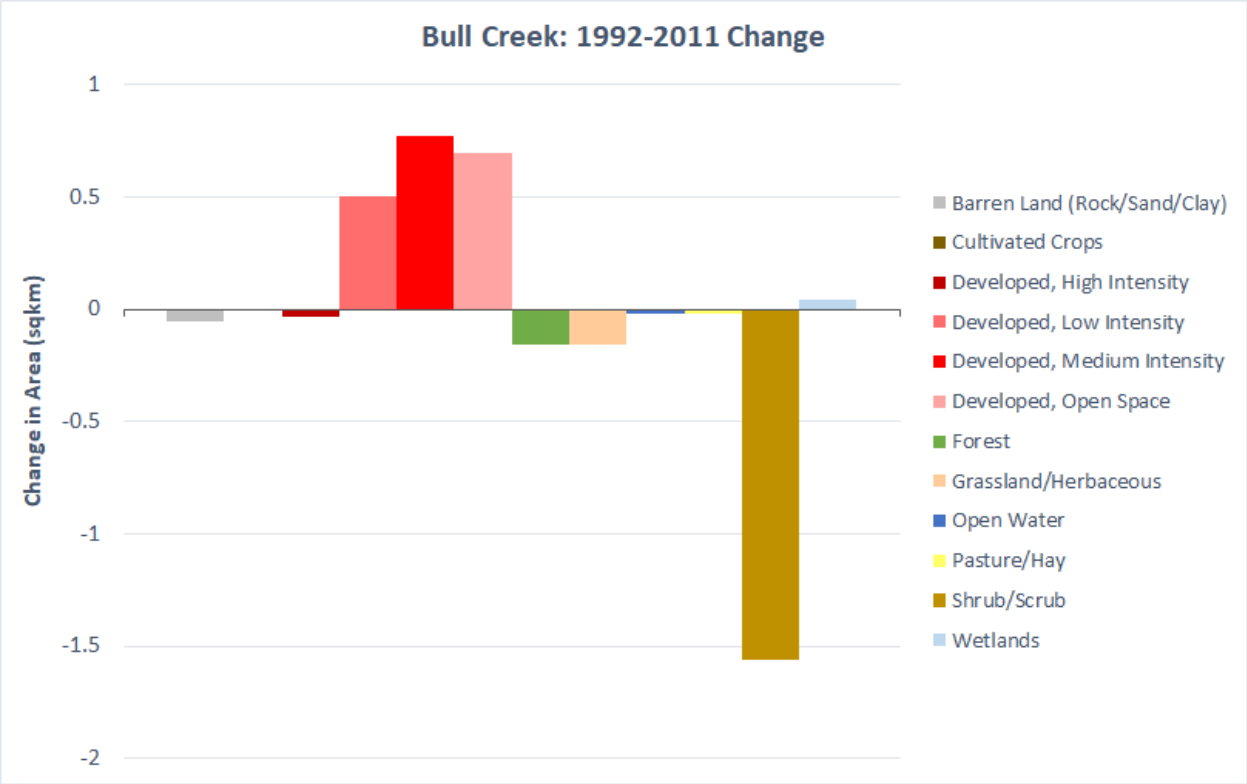

Figure 163. Land use change in area (sq km) from 1992-2011 for the Bull Creek watershed.

BULLHEAD CREEK

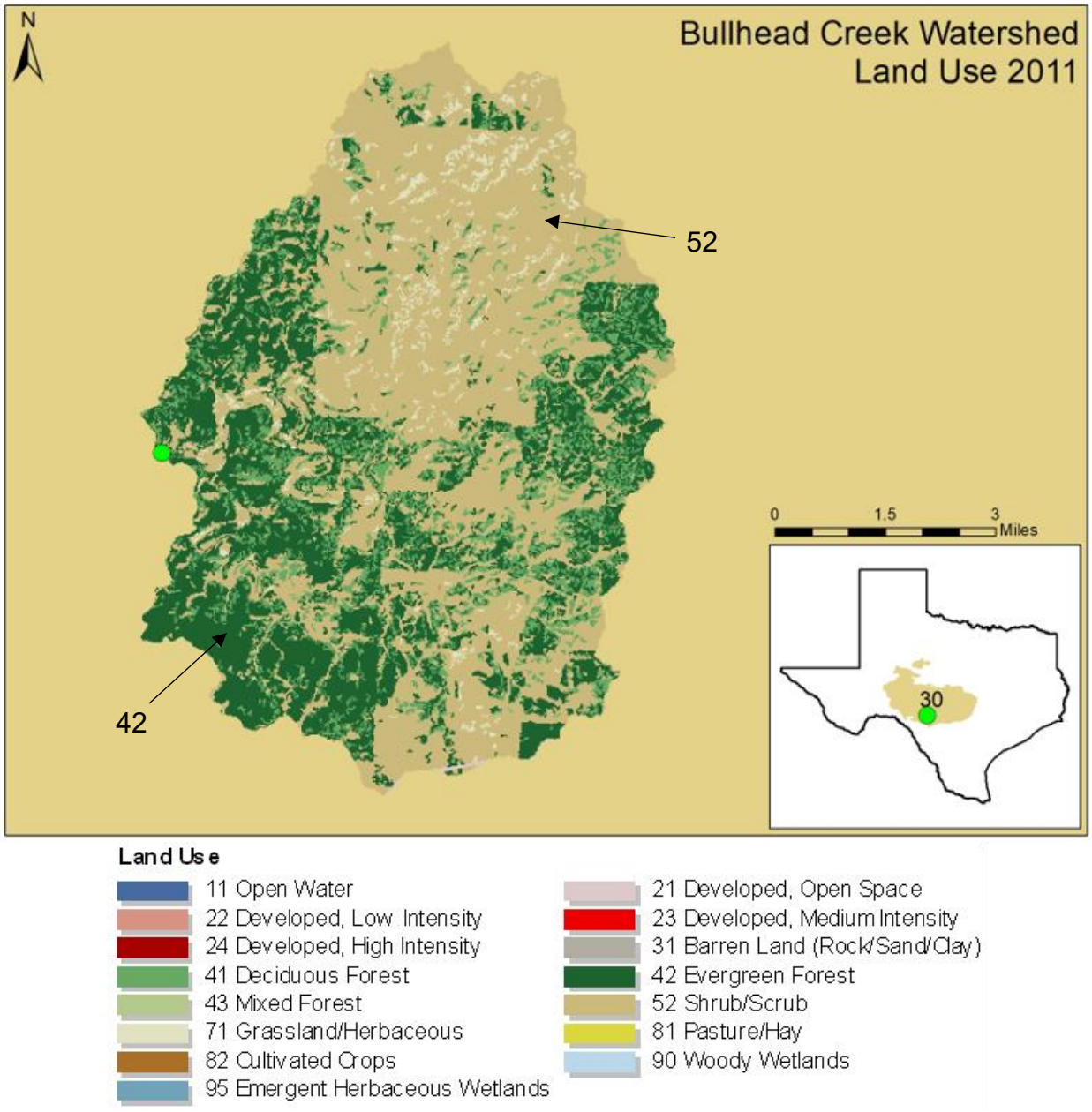

Figure 164. Map of Bullhead Creek watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

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.

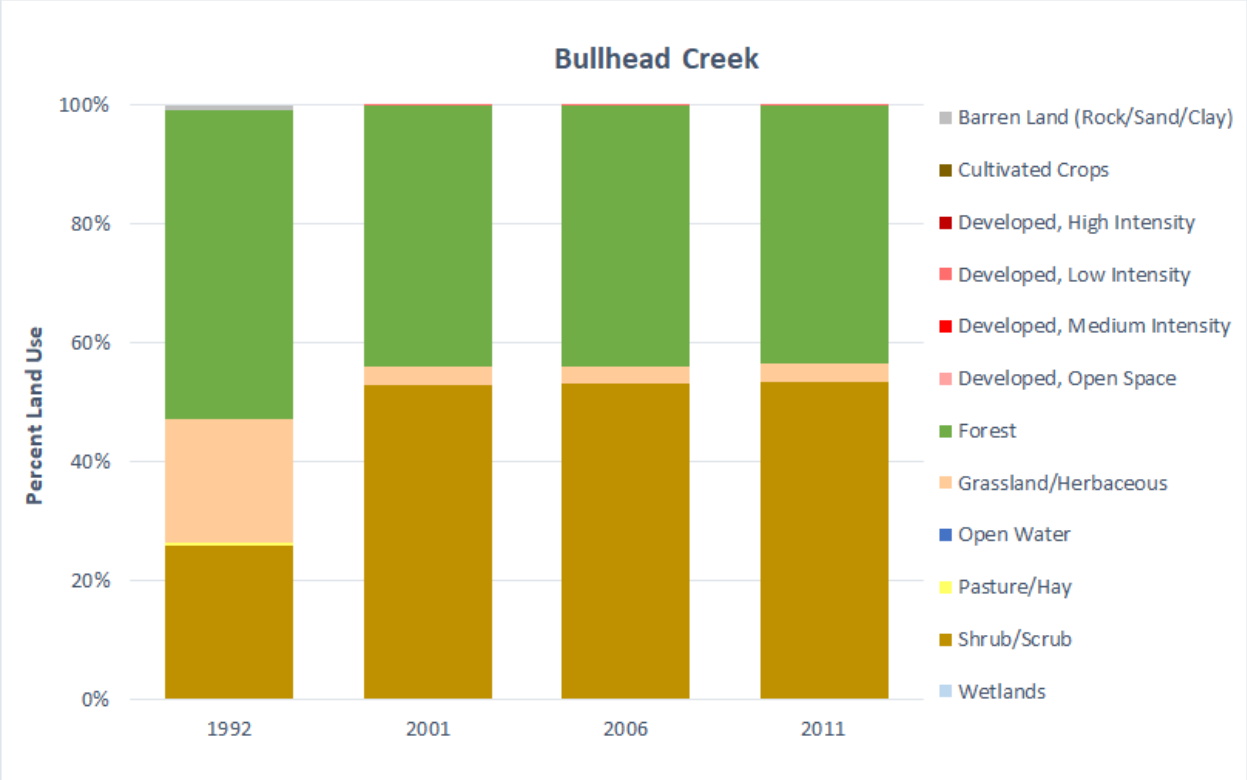

Figure 165. Percent land use in the Bullhead Creek watershed from 1992-2011.

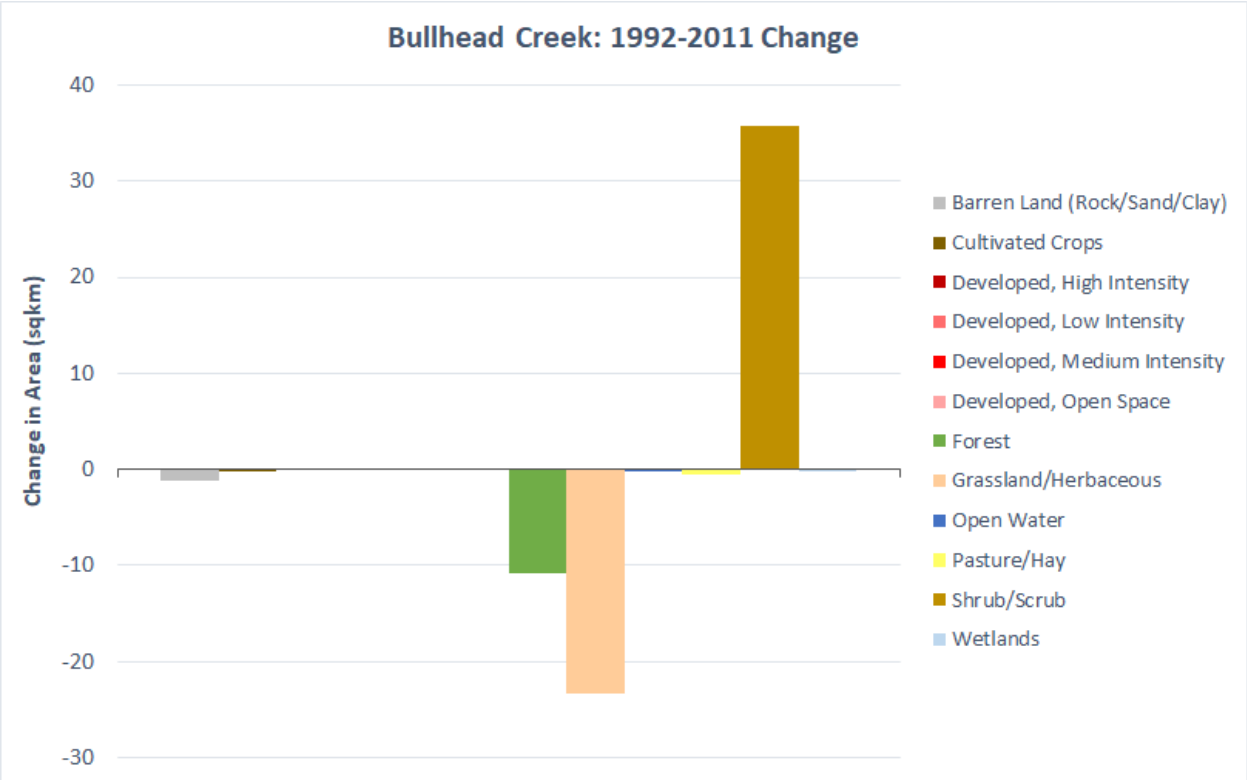

Figure 166. Land use change in area (sq km) from 1992-2011 for the Bullhead Creek watershed.

CARPERS CREEK

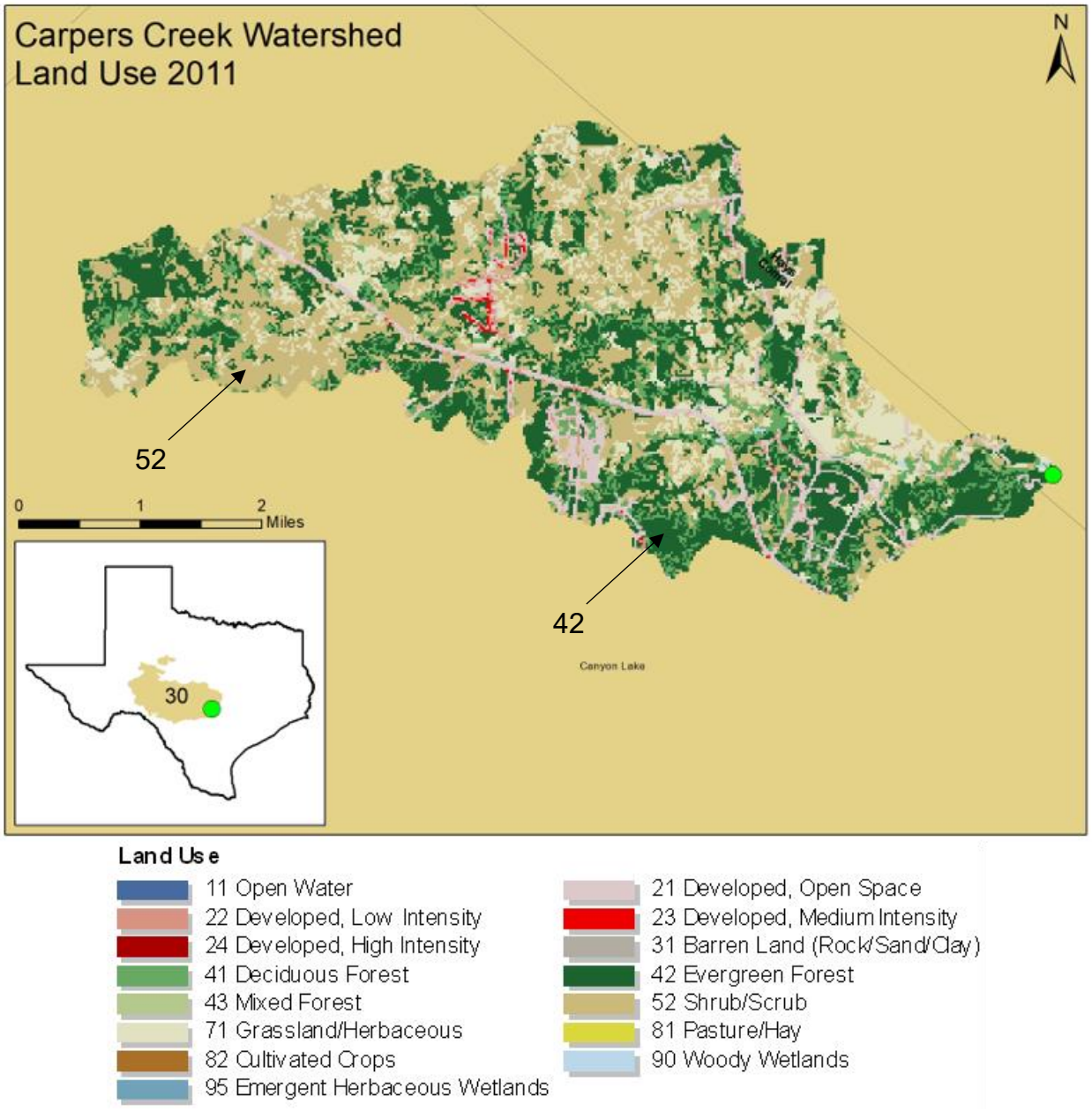

Figure 167. Map of Carpers Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

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.

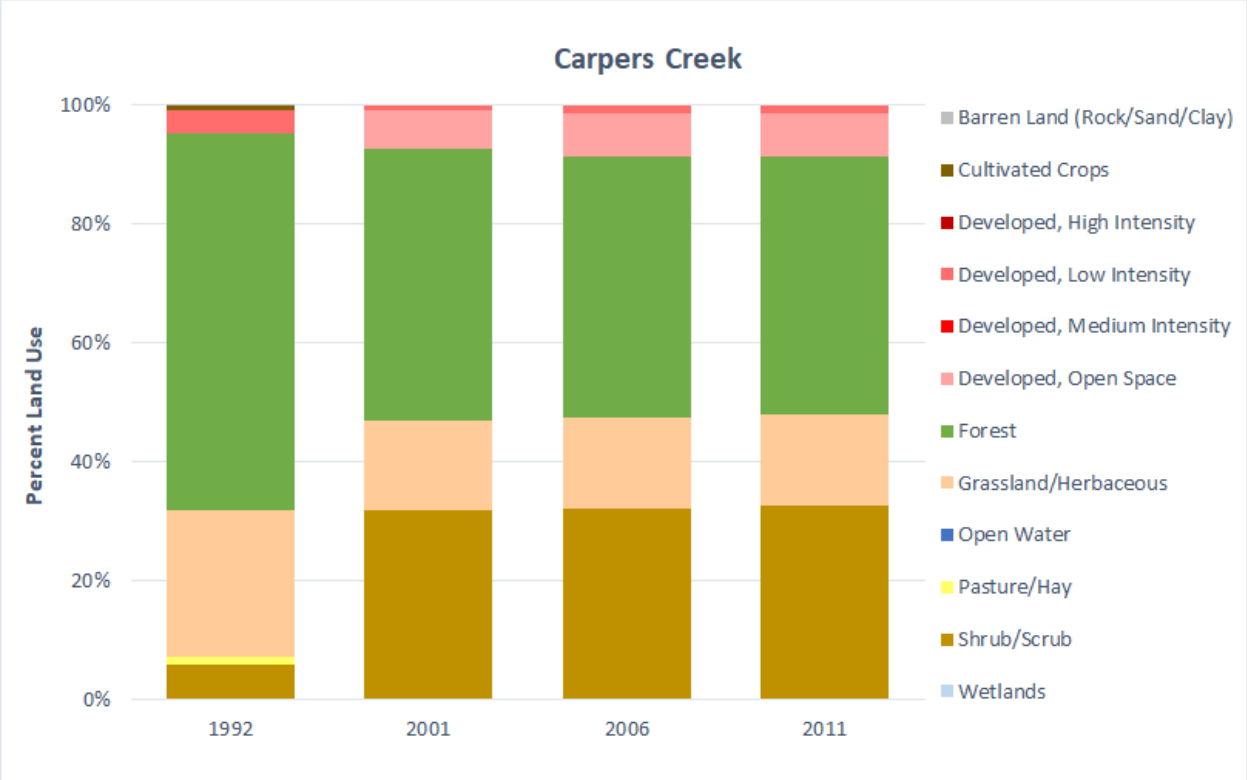

Figure 168. Percent land use in the Carpers Creek watershed from 1992-2011.

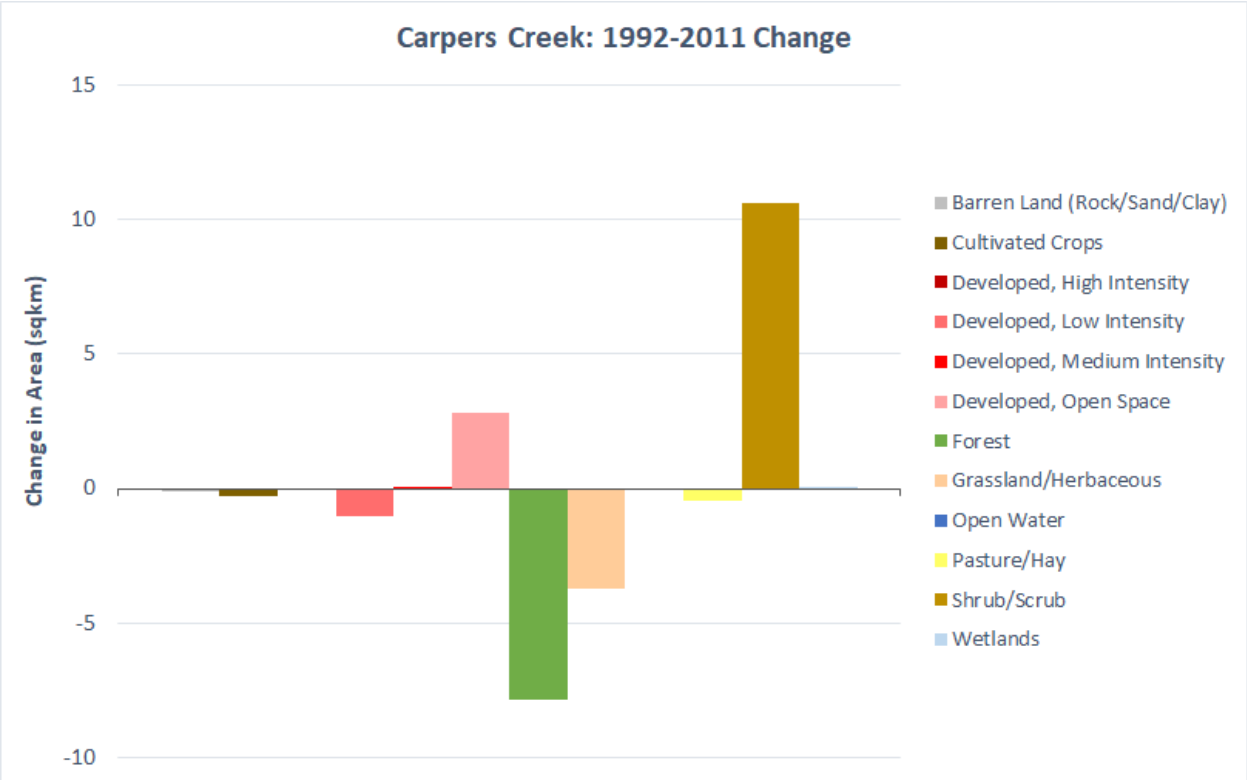

Figure 169. Land use change in area (sq km) from 1992-2011 for the Carpers Creek watershed.

COLORADO RIVER

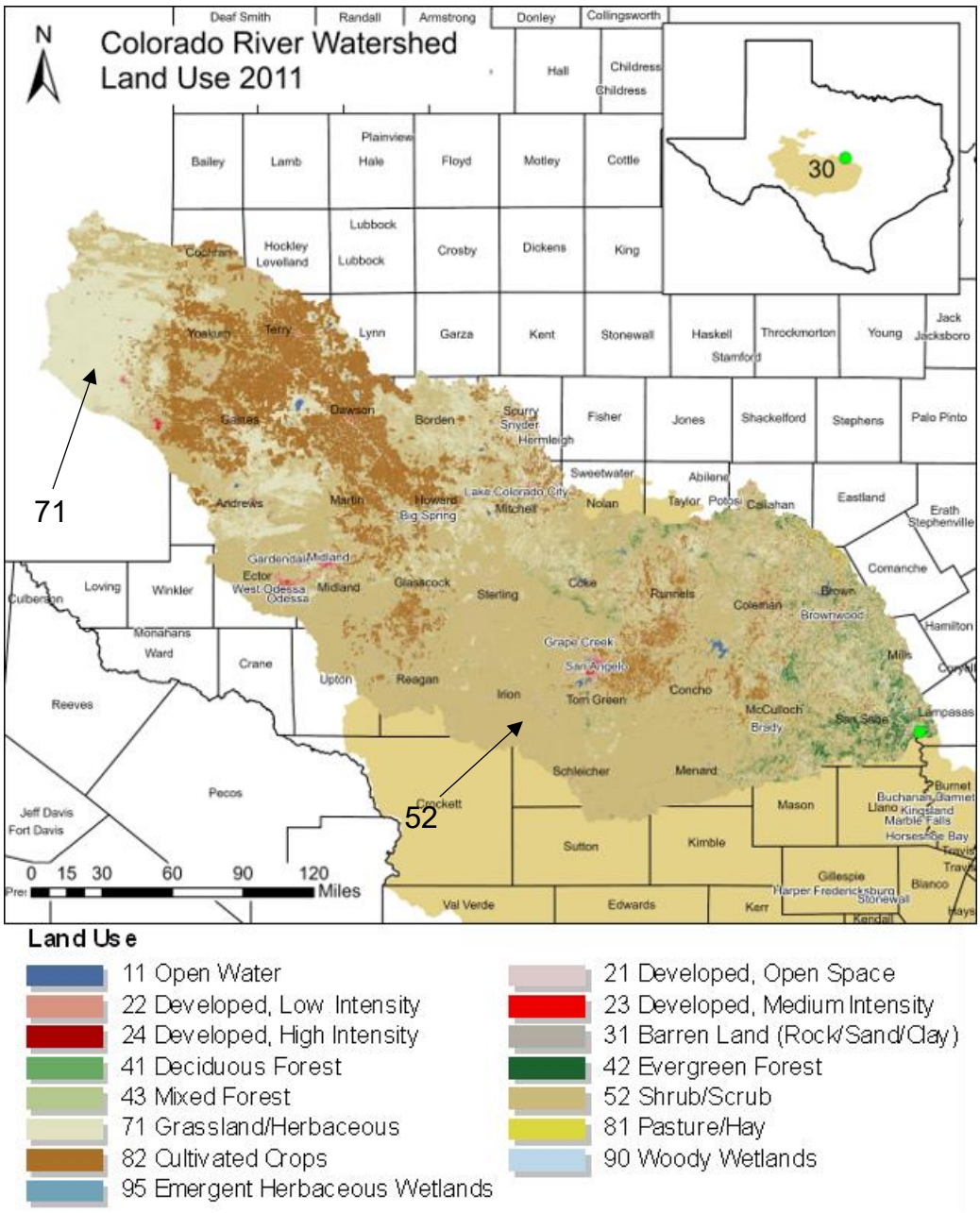

Figure 170. Map of Colorado River watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

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.

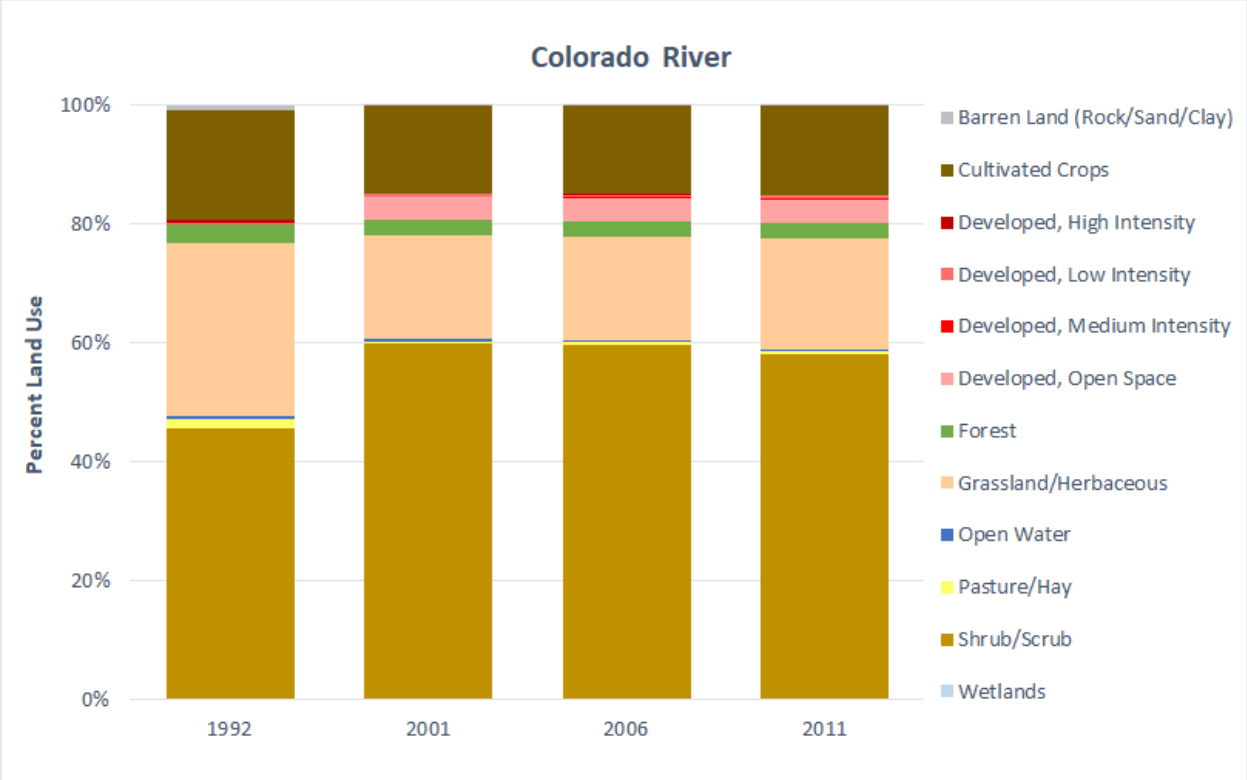

Figure 171. Percent land use in the Colorado River watershed from 1992-2011.

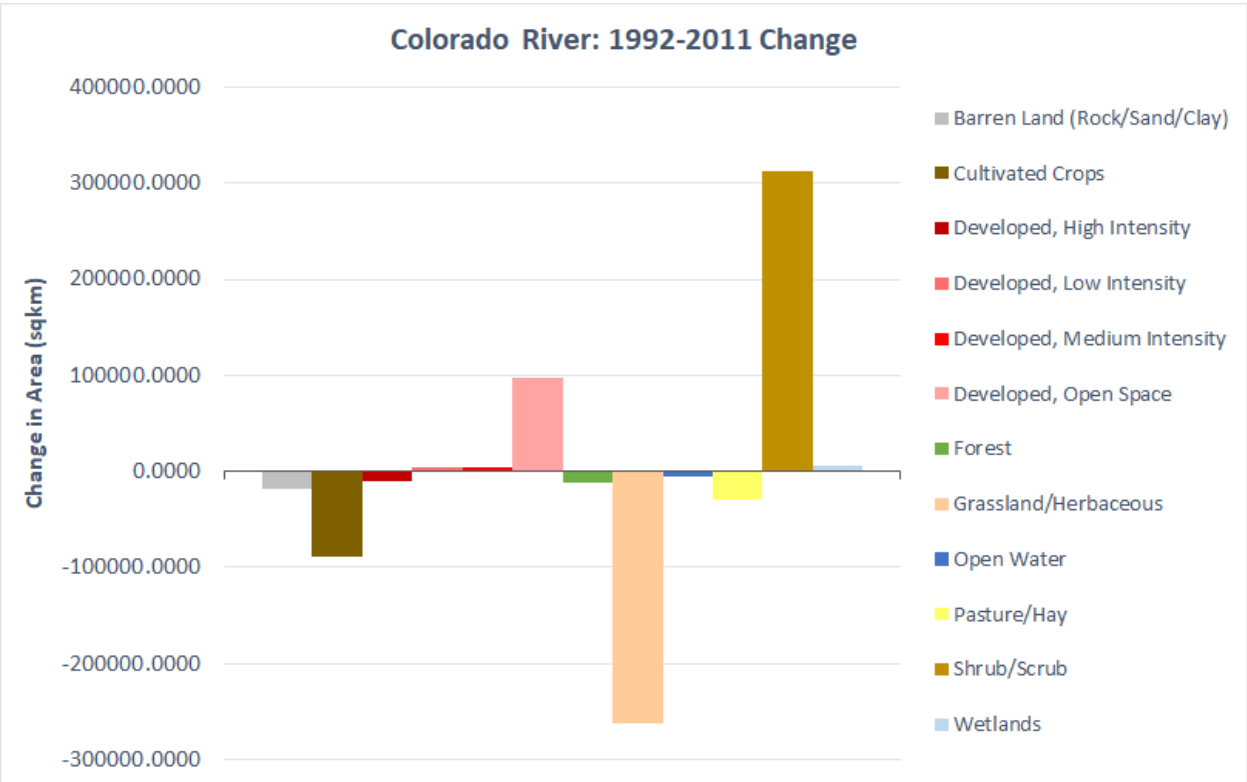

Figure 172. Land use change in area (sq km) from 1992-2011 for the Colorado River watershed.

CYPRESS CREEK

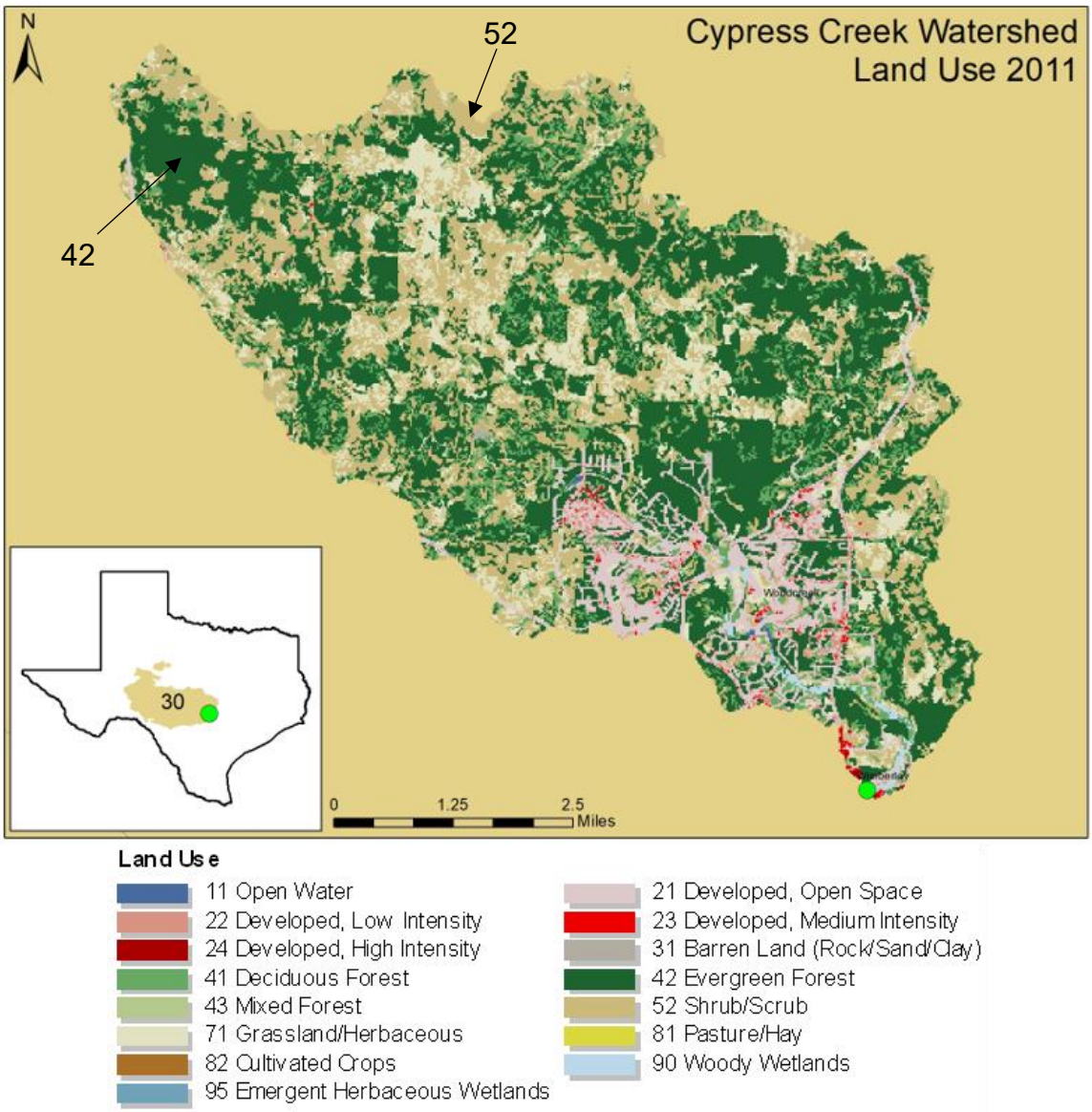

Figure 173. Map of Cypress Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

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.

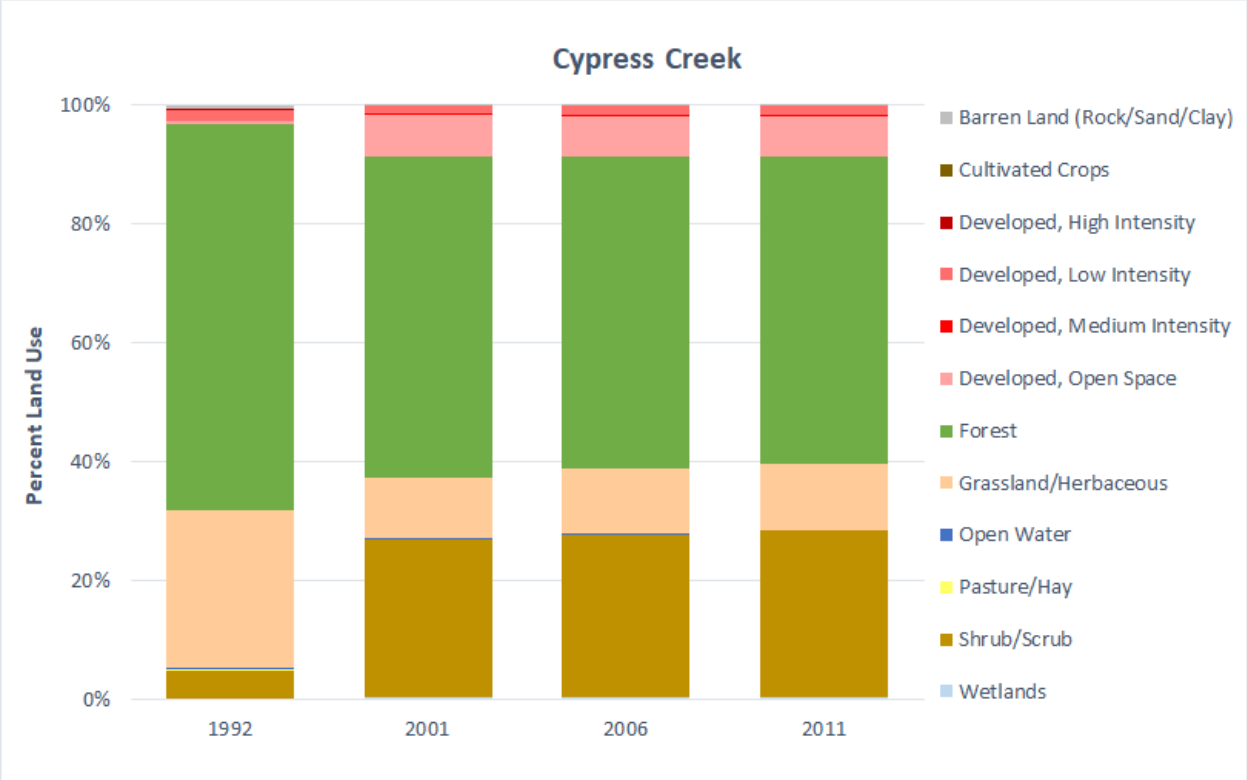

Figure 174. Percent land use in the Cypress Creek watershed from 1992-2011.

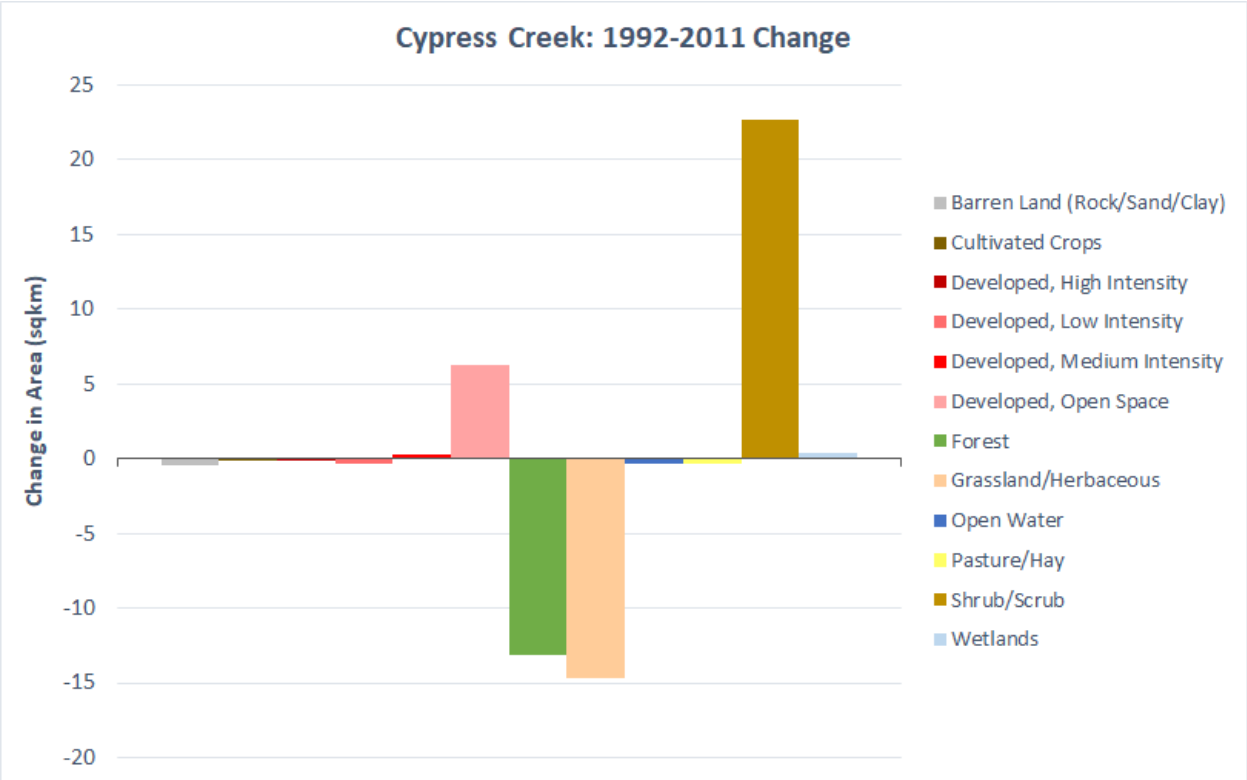

Figure 175. Land use change in area (sq km) from 1992-2011 for the Cypress Creek watershed.

DEVILS RIVER

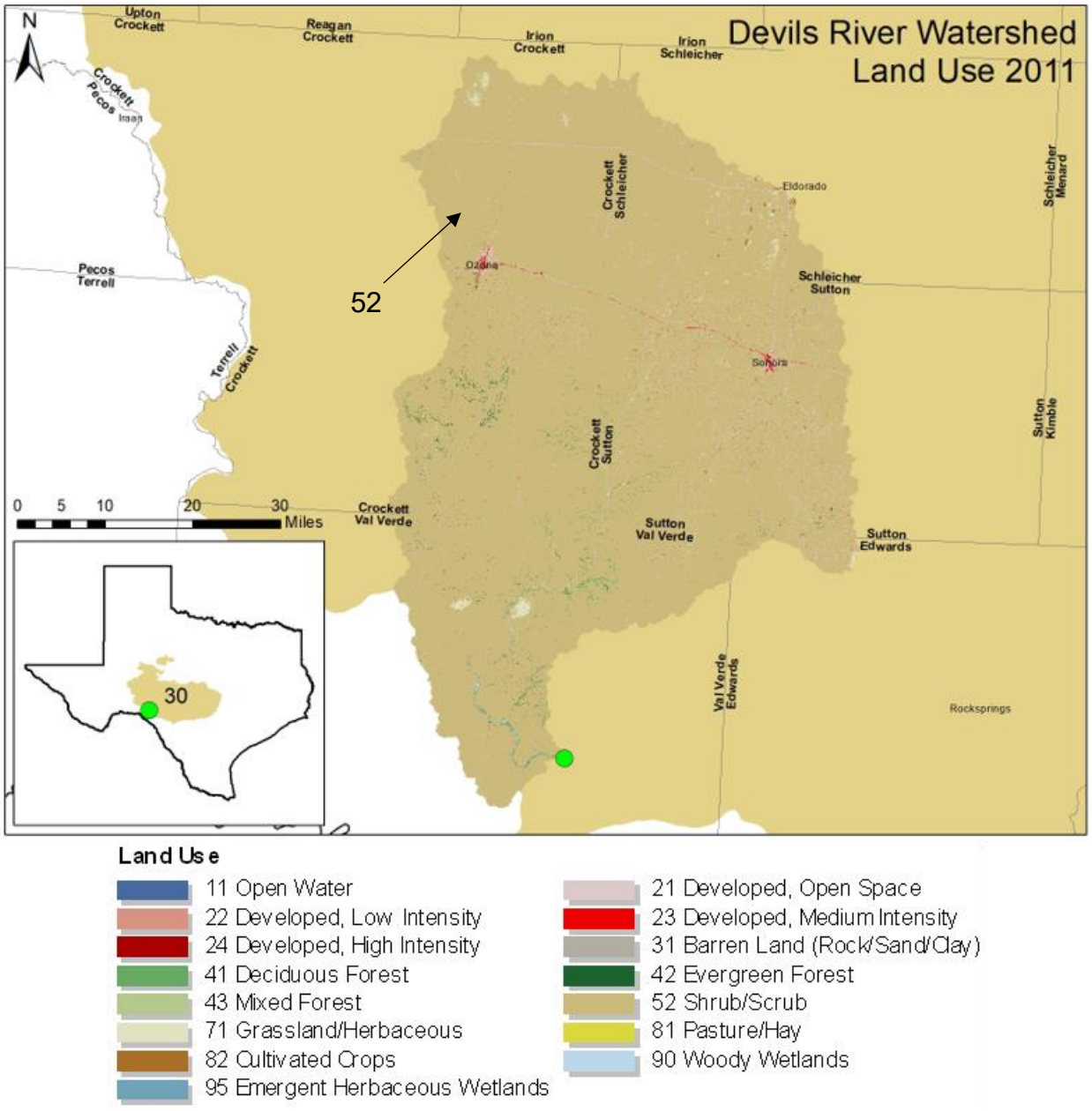

Figure 176. Map of Devils River watershed location and 2011 land use; shrub/scrub was the most common land use.

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.

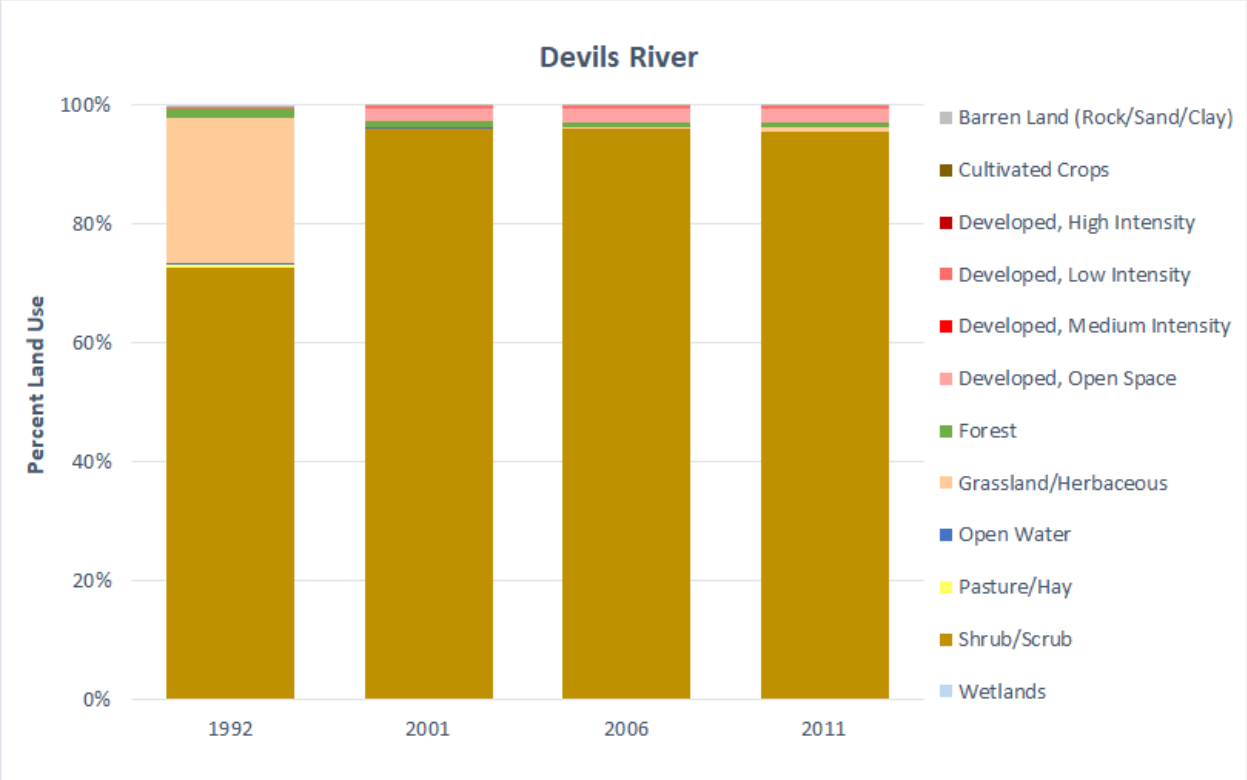

Figure 177. Percent land use in the Devils River watershed from 1992-2011.

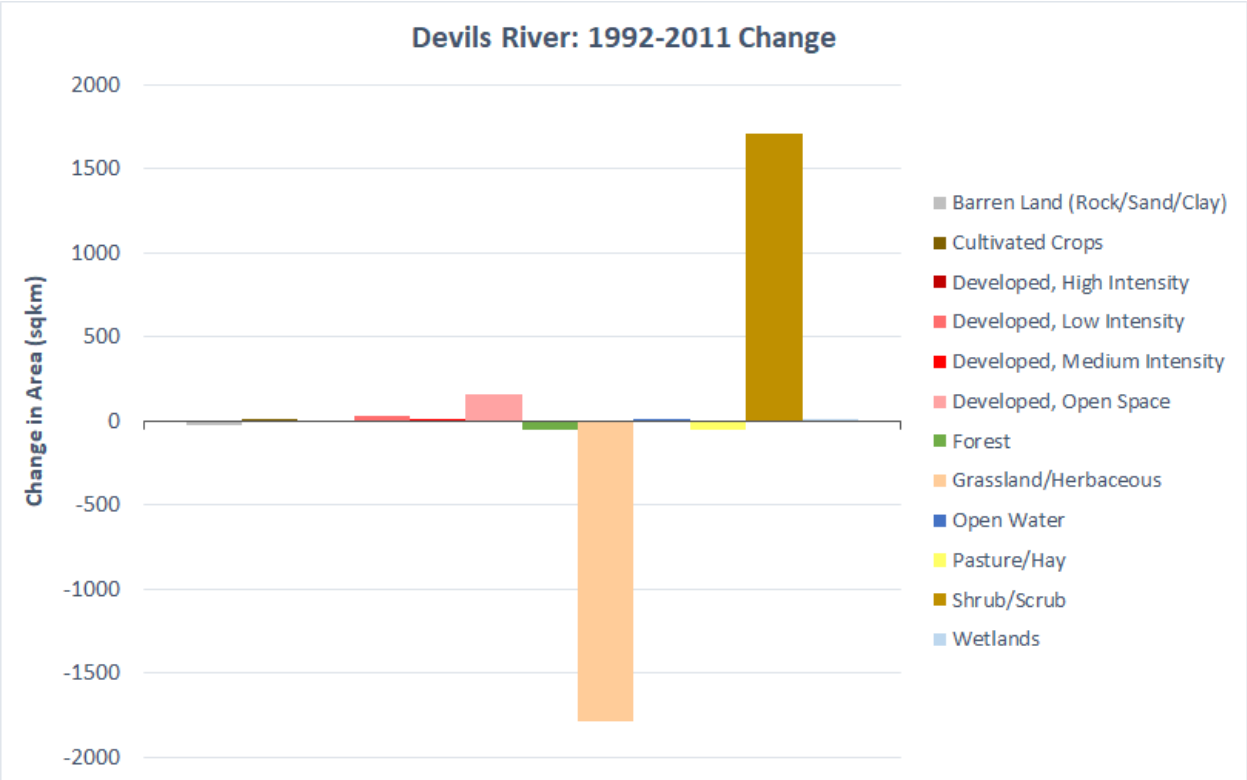

Figure 178. Land use change in area (sq km) from 1992-2011 for the Devils River watershed.

GUADALUPE RIVER

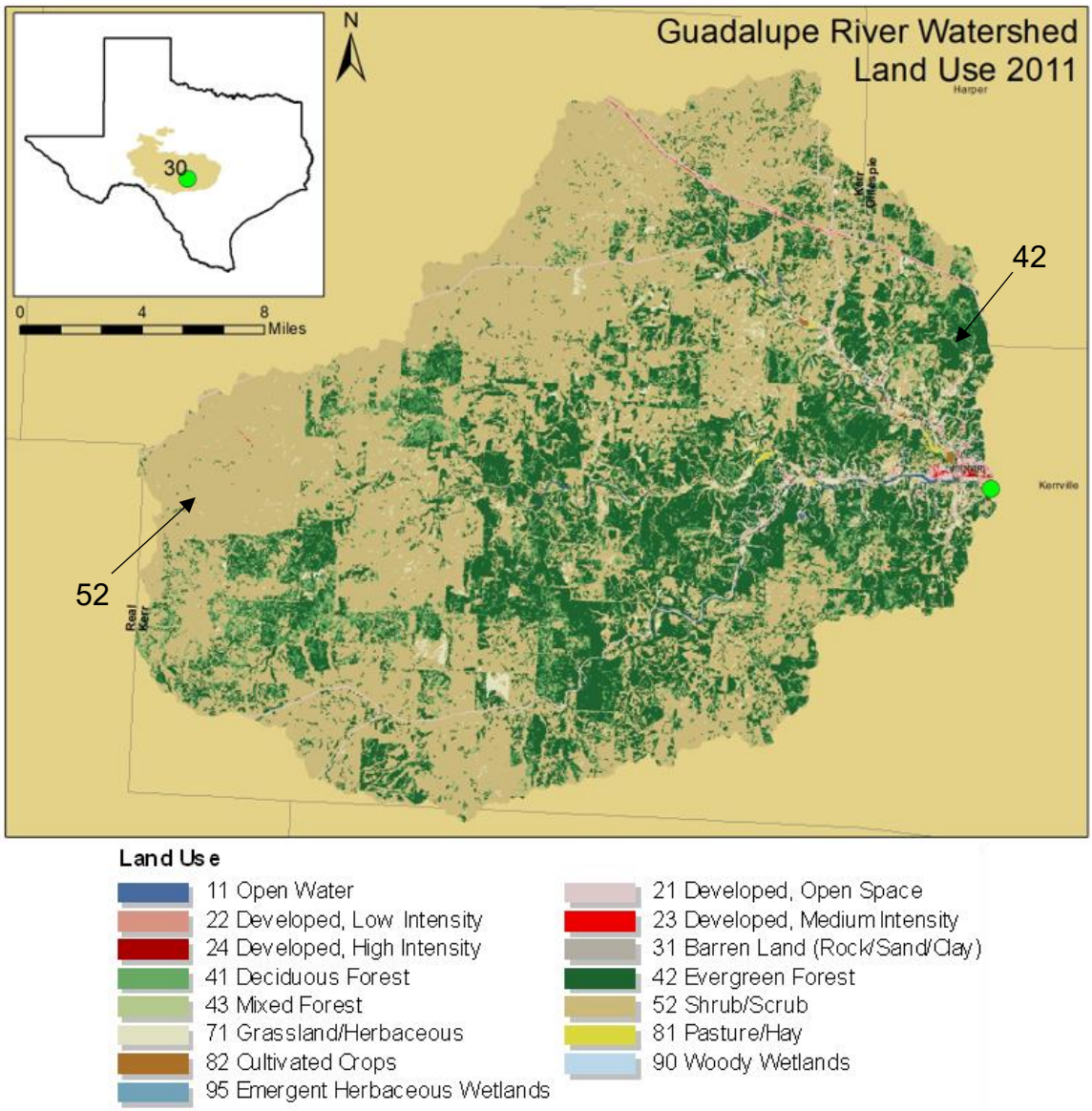

Figure 179. Map of Guadalupe River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

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.

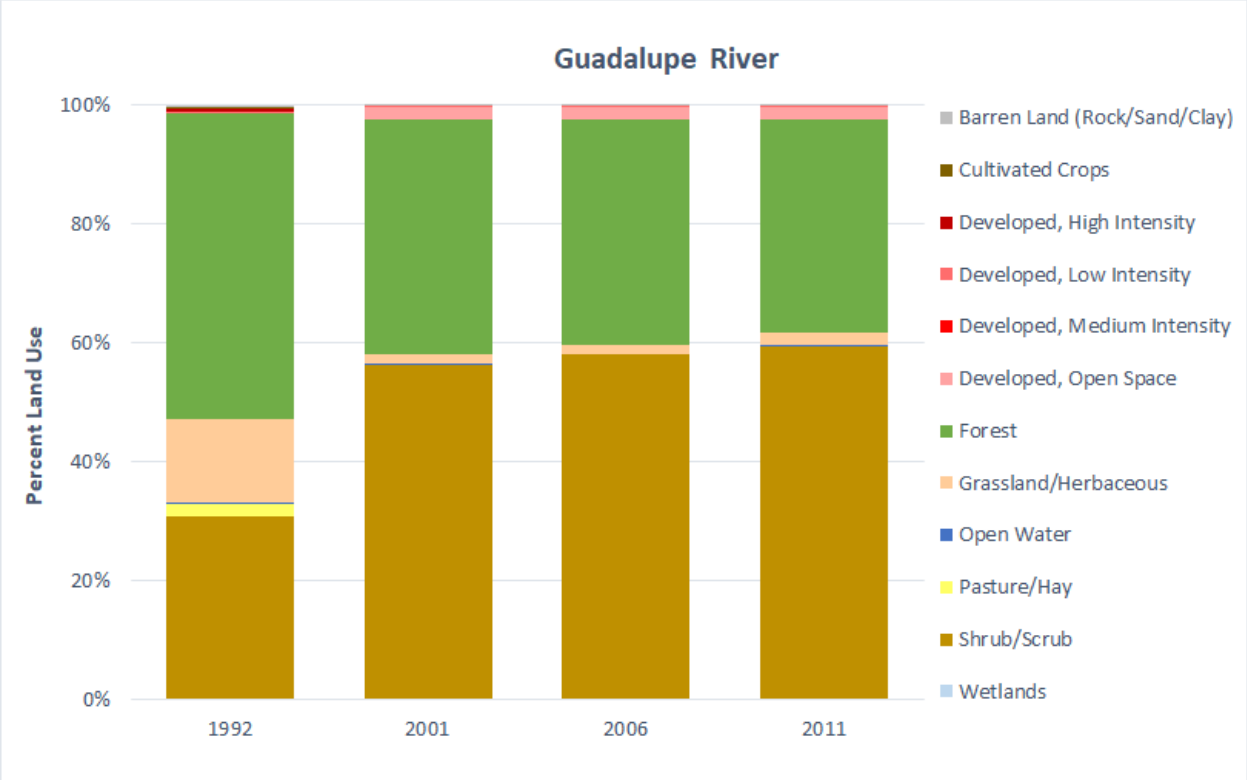

Figure 180. Percent land use in the Guadalupe River watershed from 1992-2011.

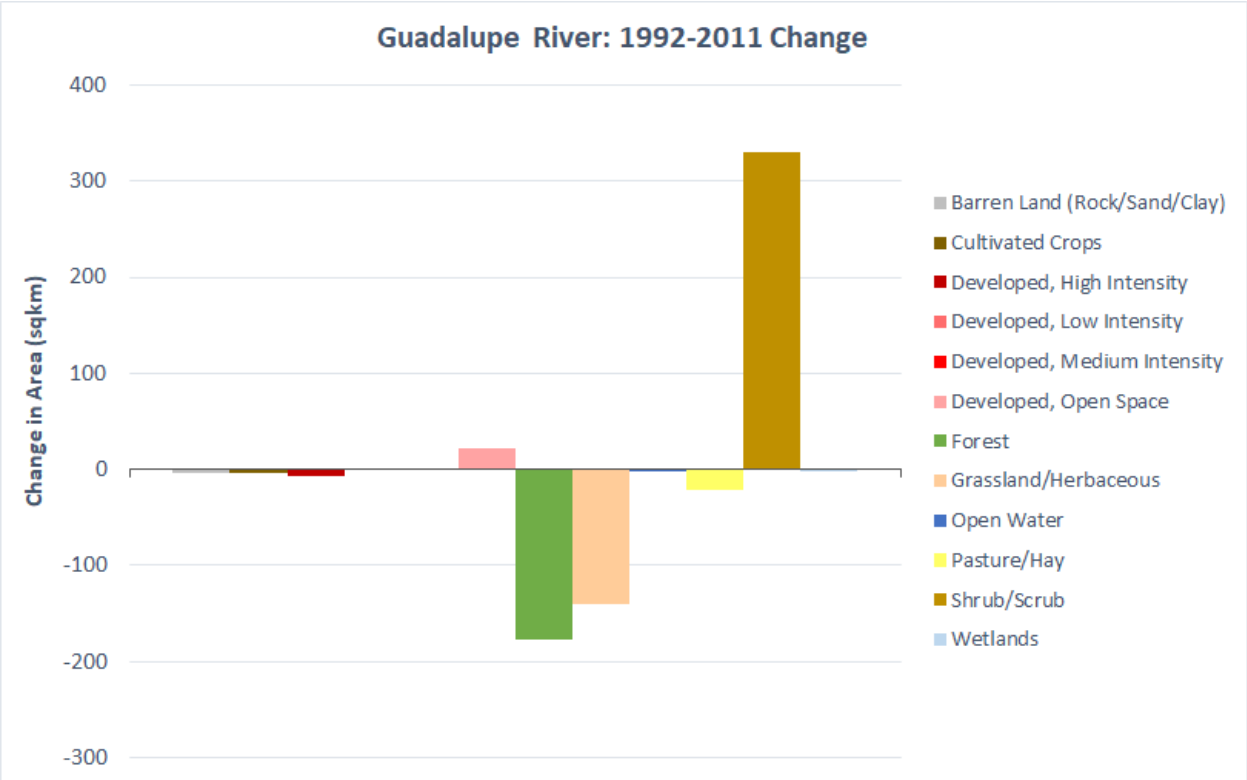

Figure 181. Land use change in area (sq km) from 1992-2011 for the Guadalupe River watershed.

JAMES RIVER

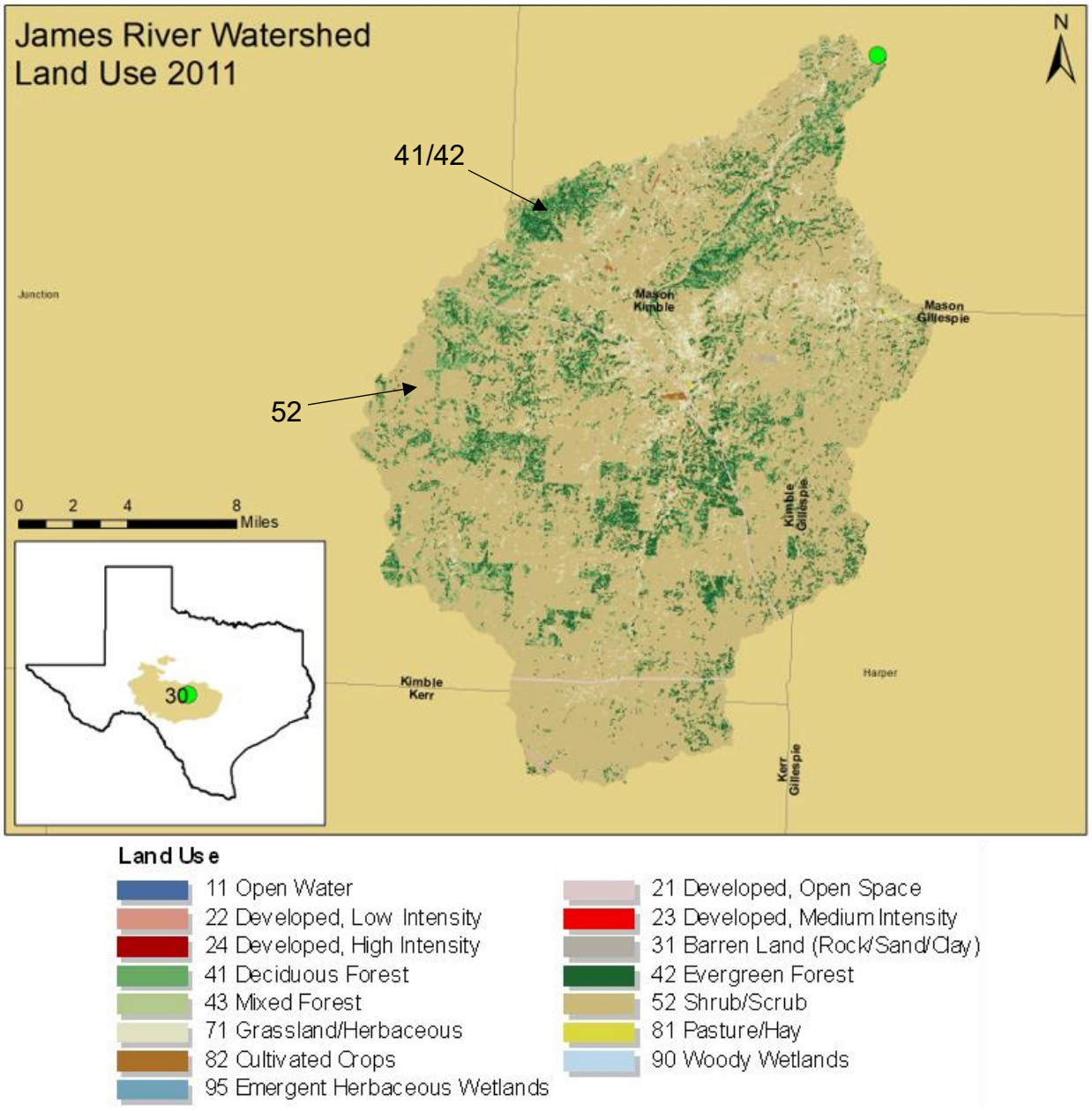

Figure 182. Map of James River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

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.

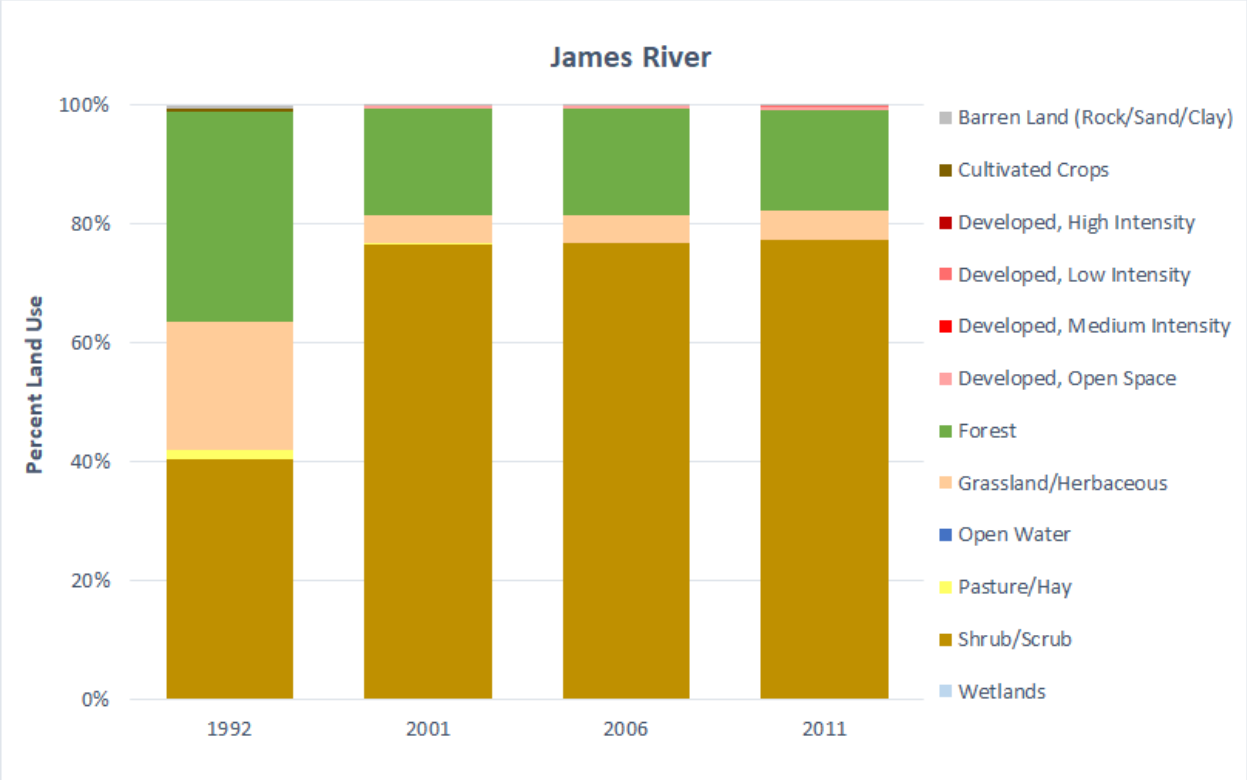

Figure 183. Percent land use in the James River watershed from 1992-2011.

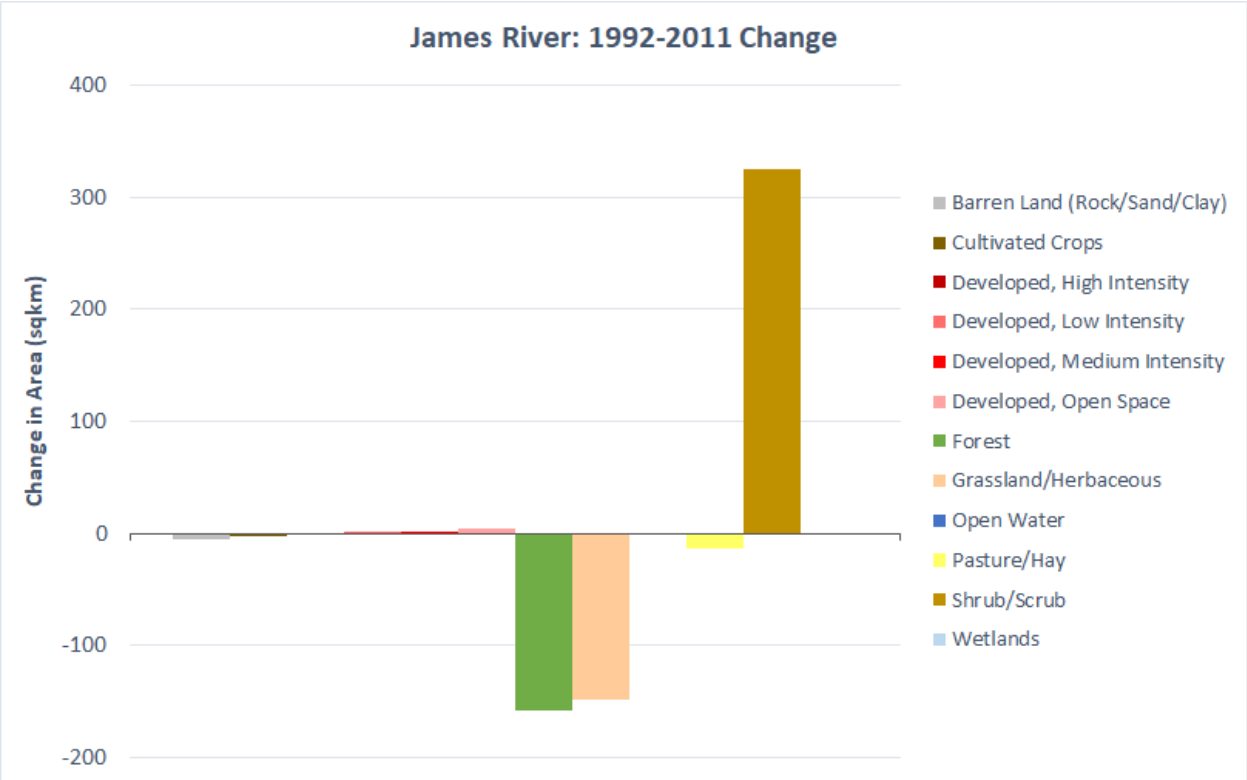

Figure 184. Land use change in area (sq km) from 1992-2011 for the James River watershed.

JOHNSON CREEK

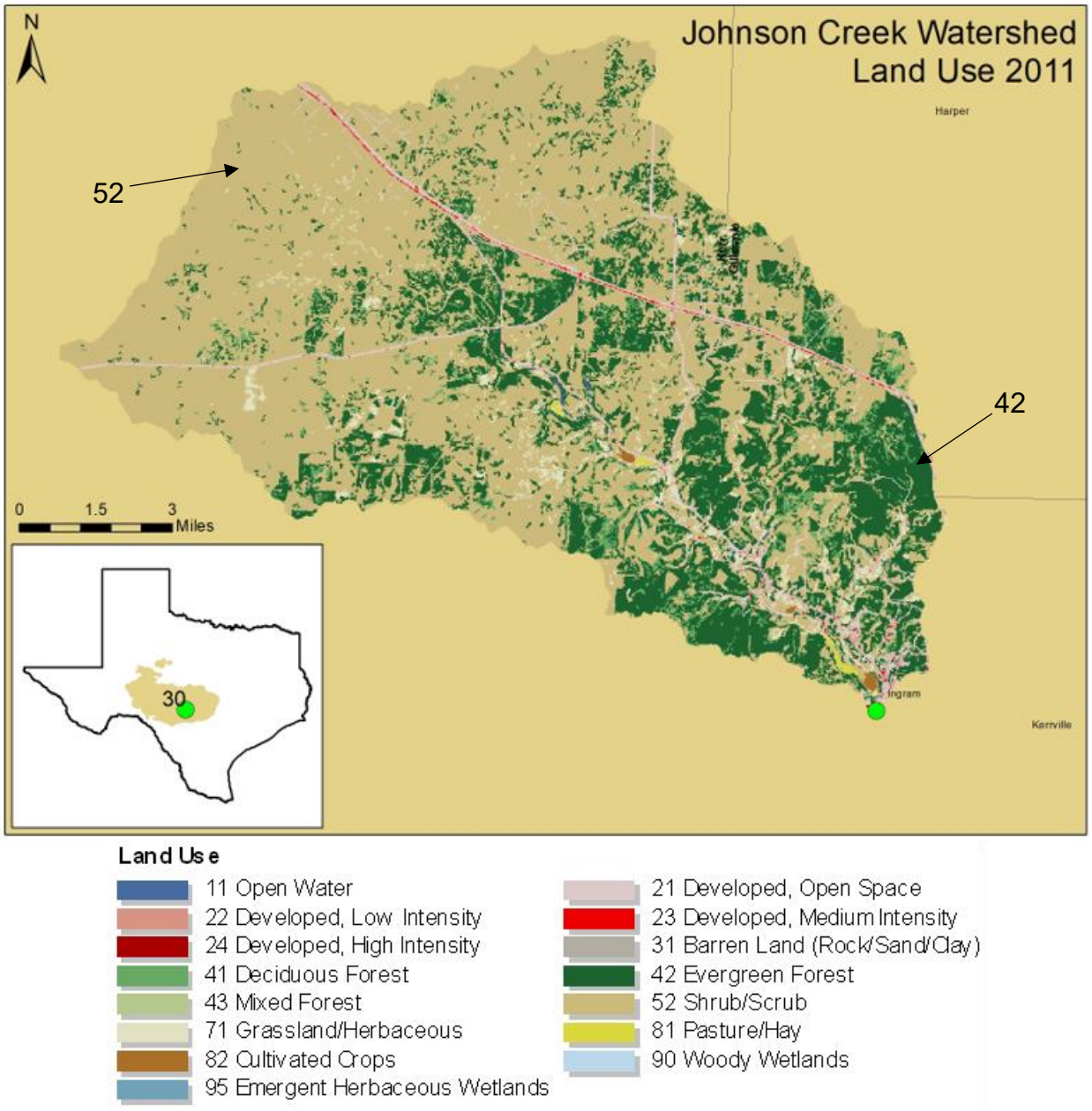

Figure 185. Map of Johnson Creek watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

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.

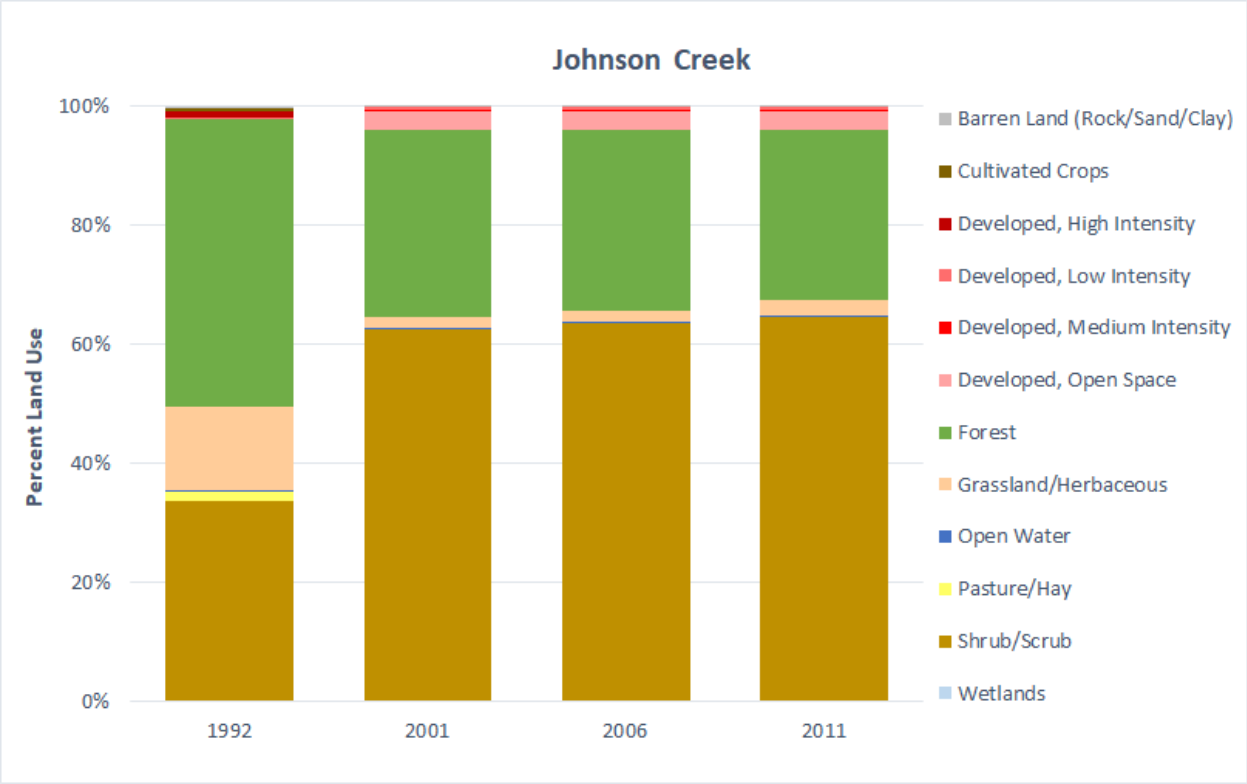

Figure 186. Percent land use in the Johnson Creek watershed from 1992-2011.

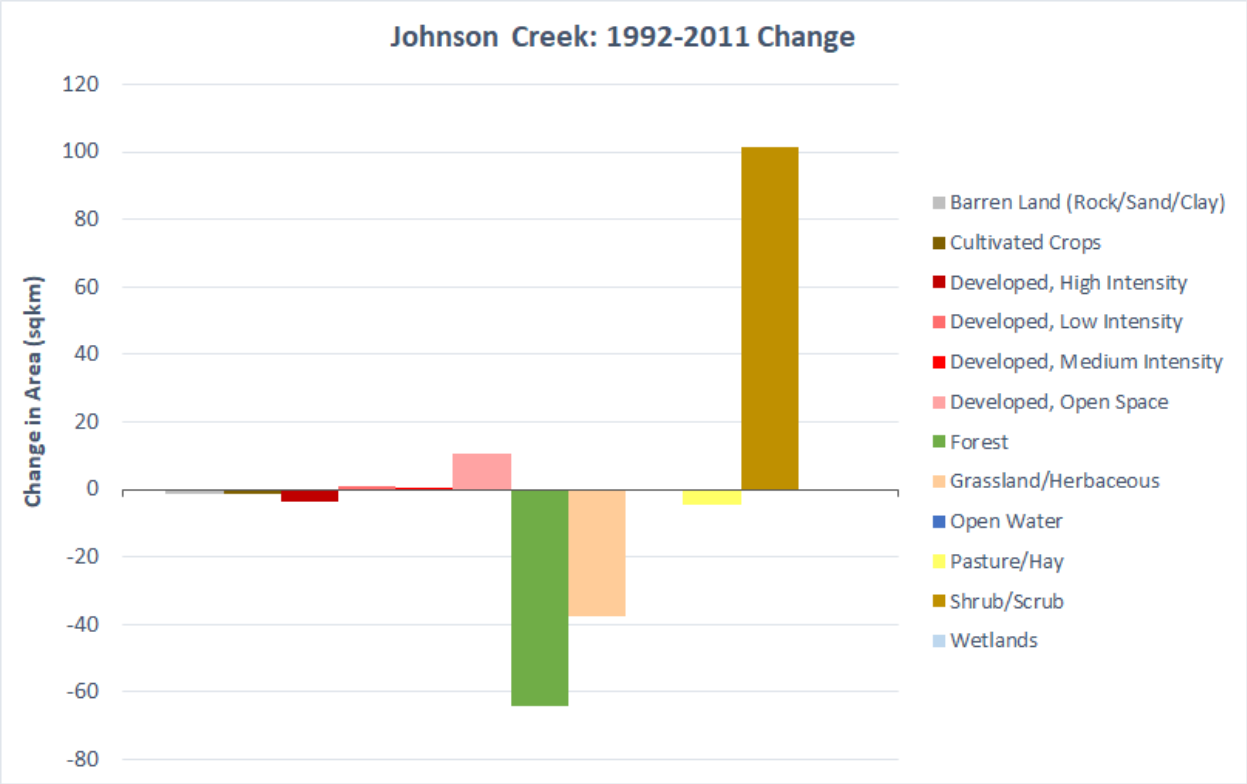

Figure 187. Land use change in area (sq km) from 1992-2011 for the Johnson Creek watershed.

LITTLE BARTON CREEK

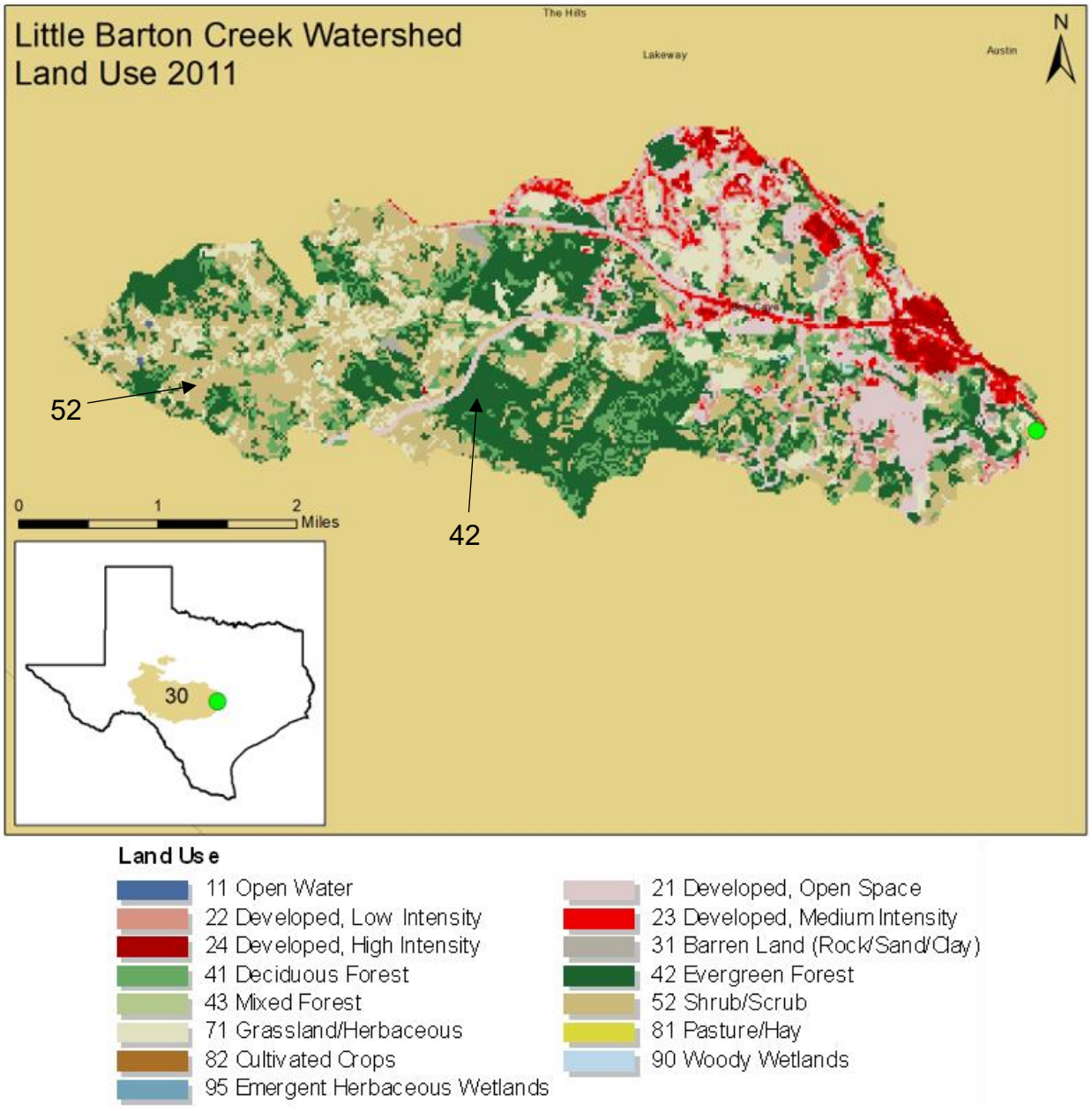

Figure 188. Map of Little Barton Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

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.

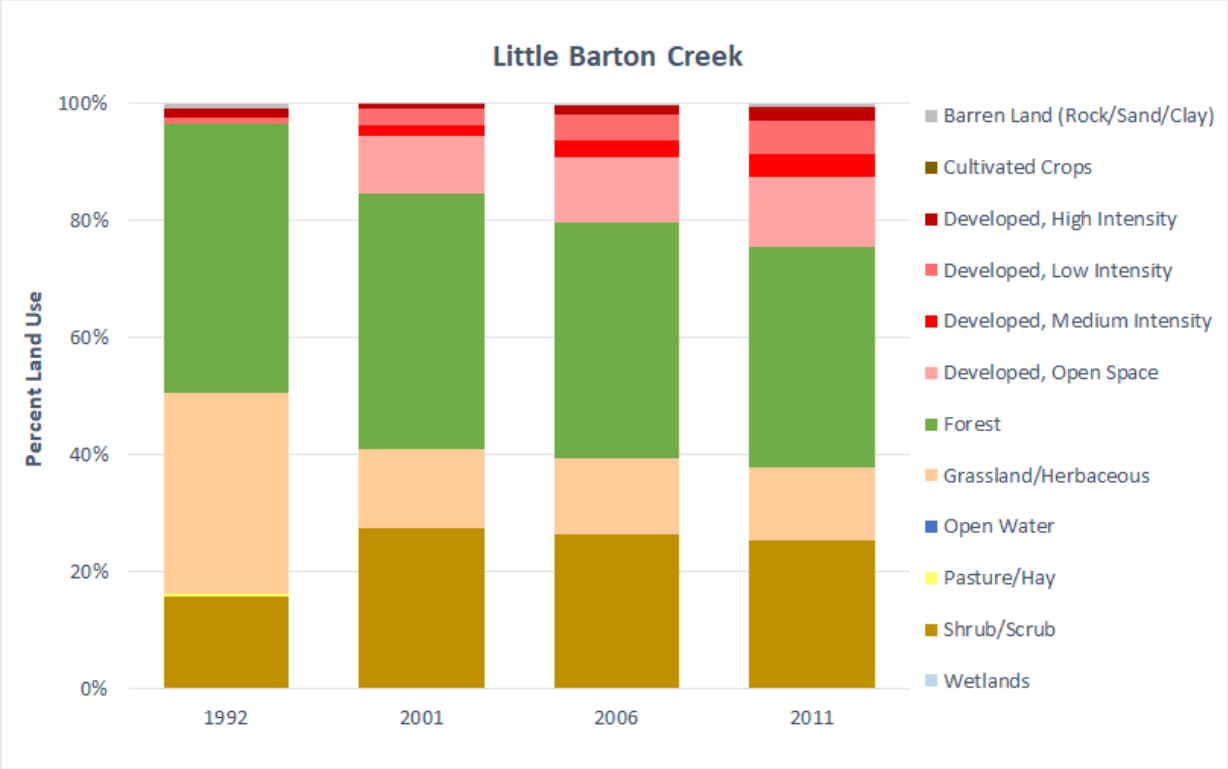

Figure 189. Percent land use in the Little Barton Creek watershed from 1992-2011.

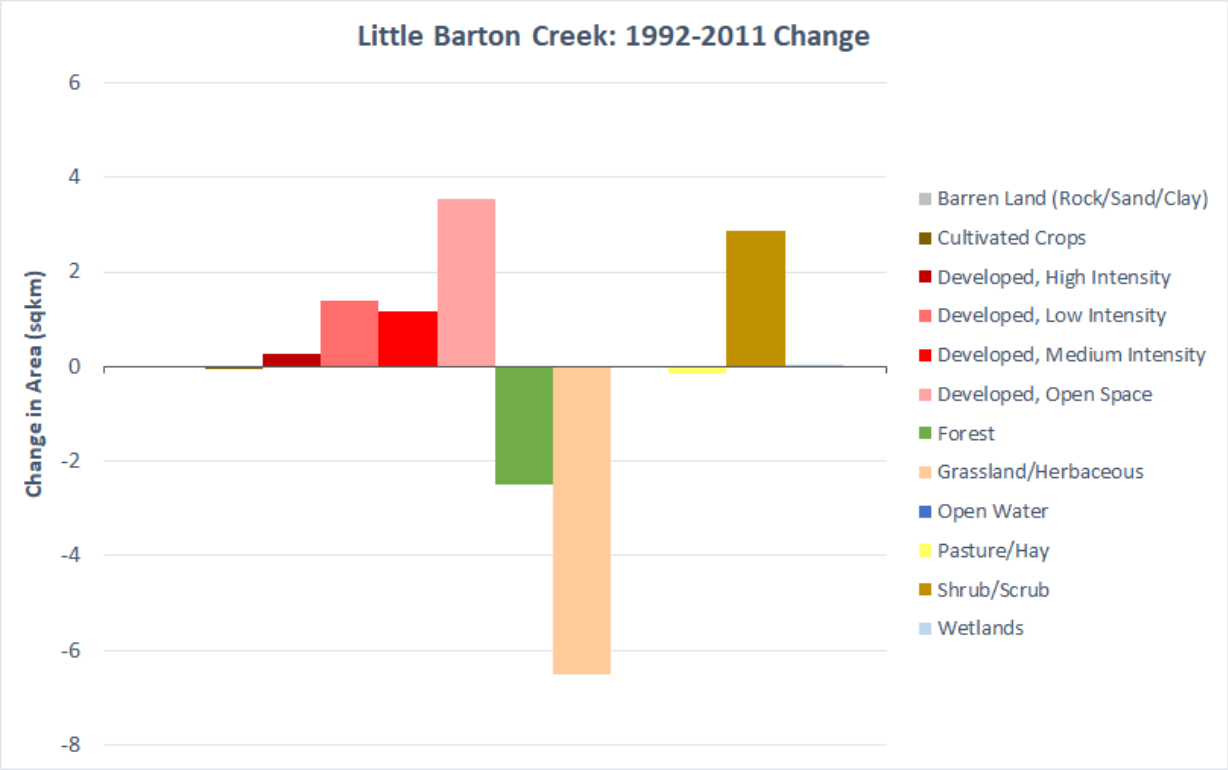

Figure 190. Land use change in area (sq km) from 1992-2011 for the Little Barton Creek watershed.

LITTLE BLANCO RIVER

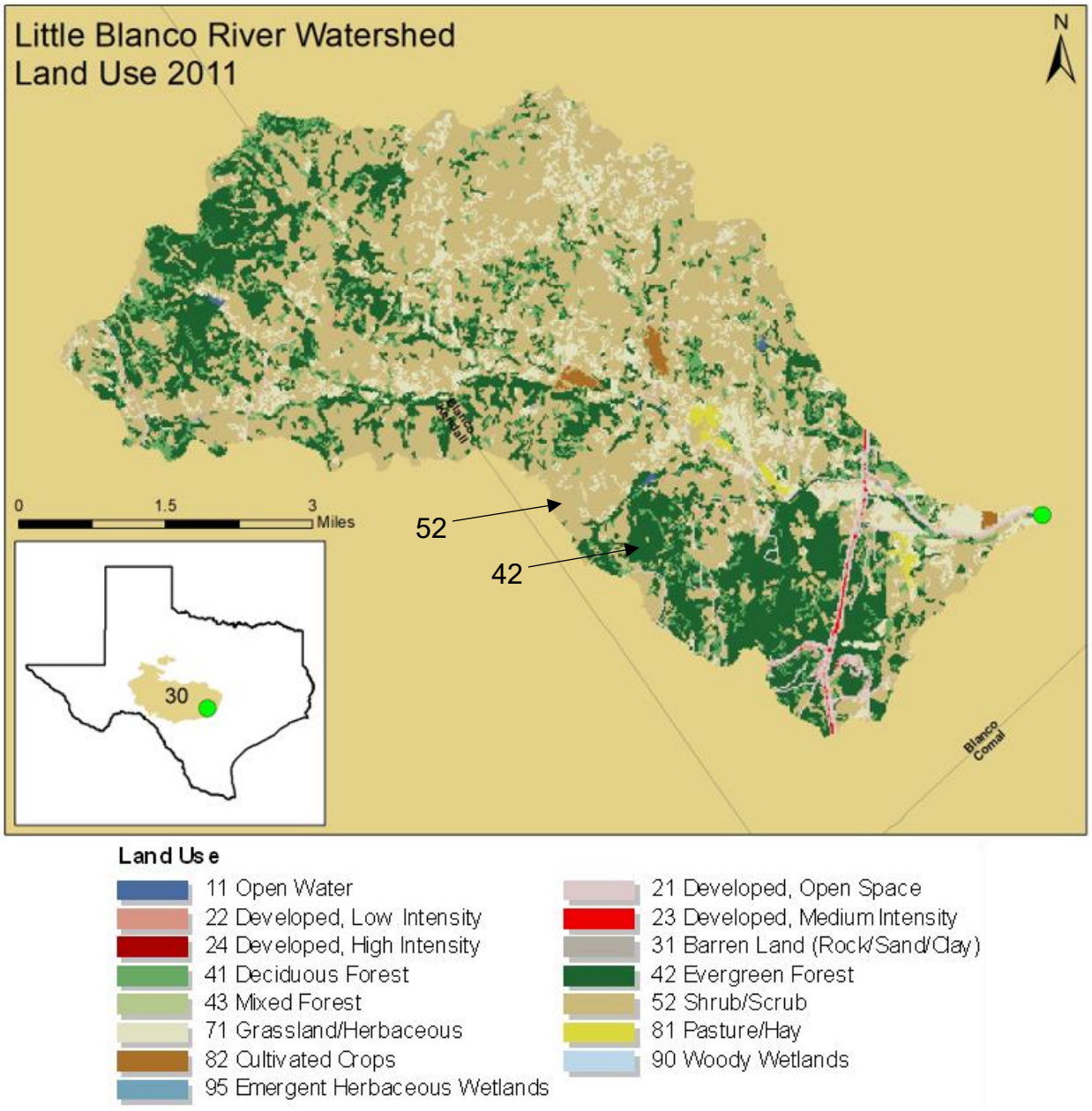

Figure 191. Map of Little Blanco River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

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.

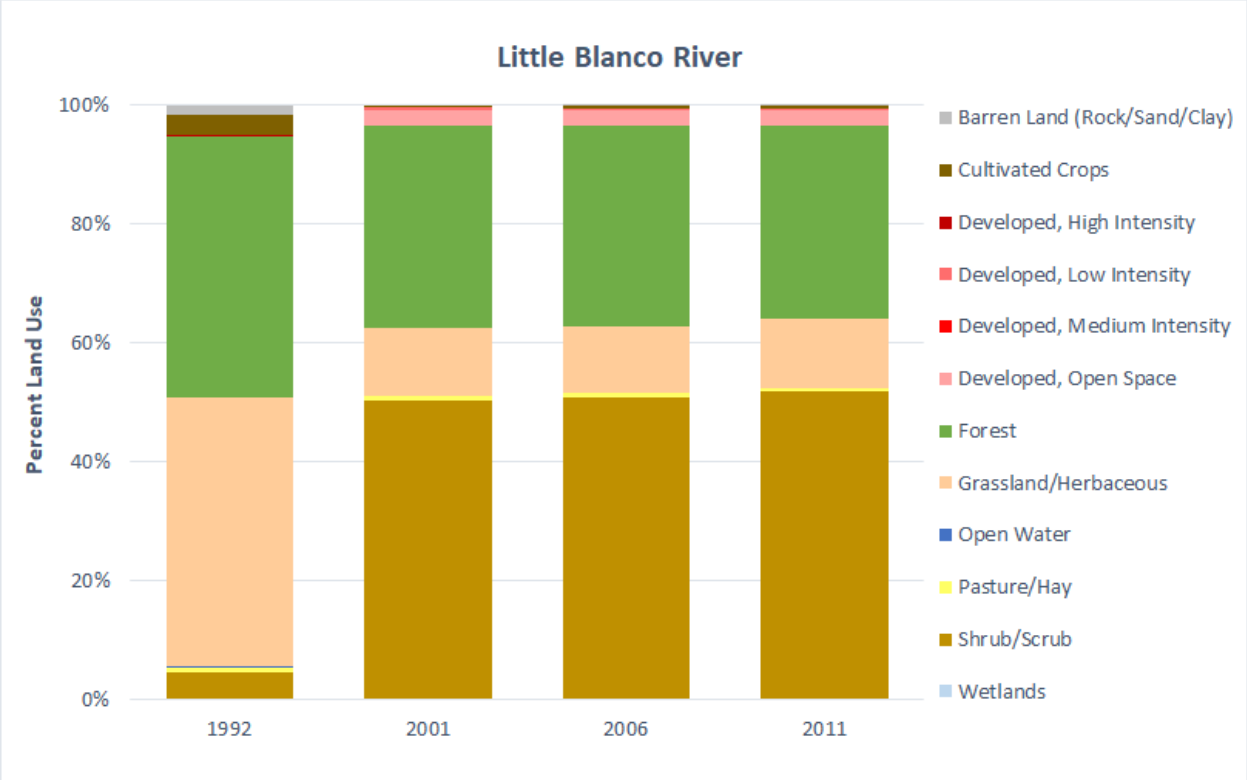

Figure 192. Percent land use in the Little Blanco River watershed from 1992-2011.

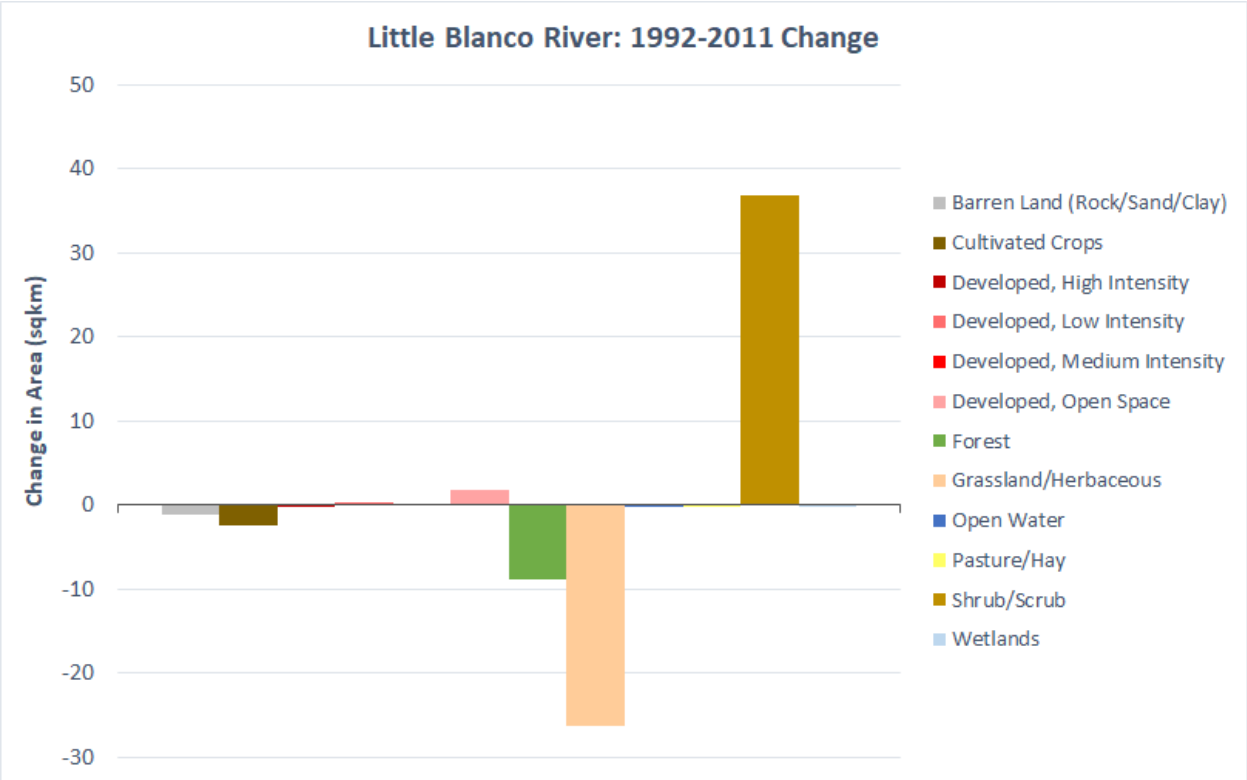

Figure 193. Land use change in area (sq km) from 1992-2011 for the Little Blanco River watershed.

LIVE OAK CREEK

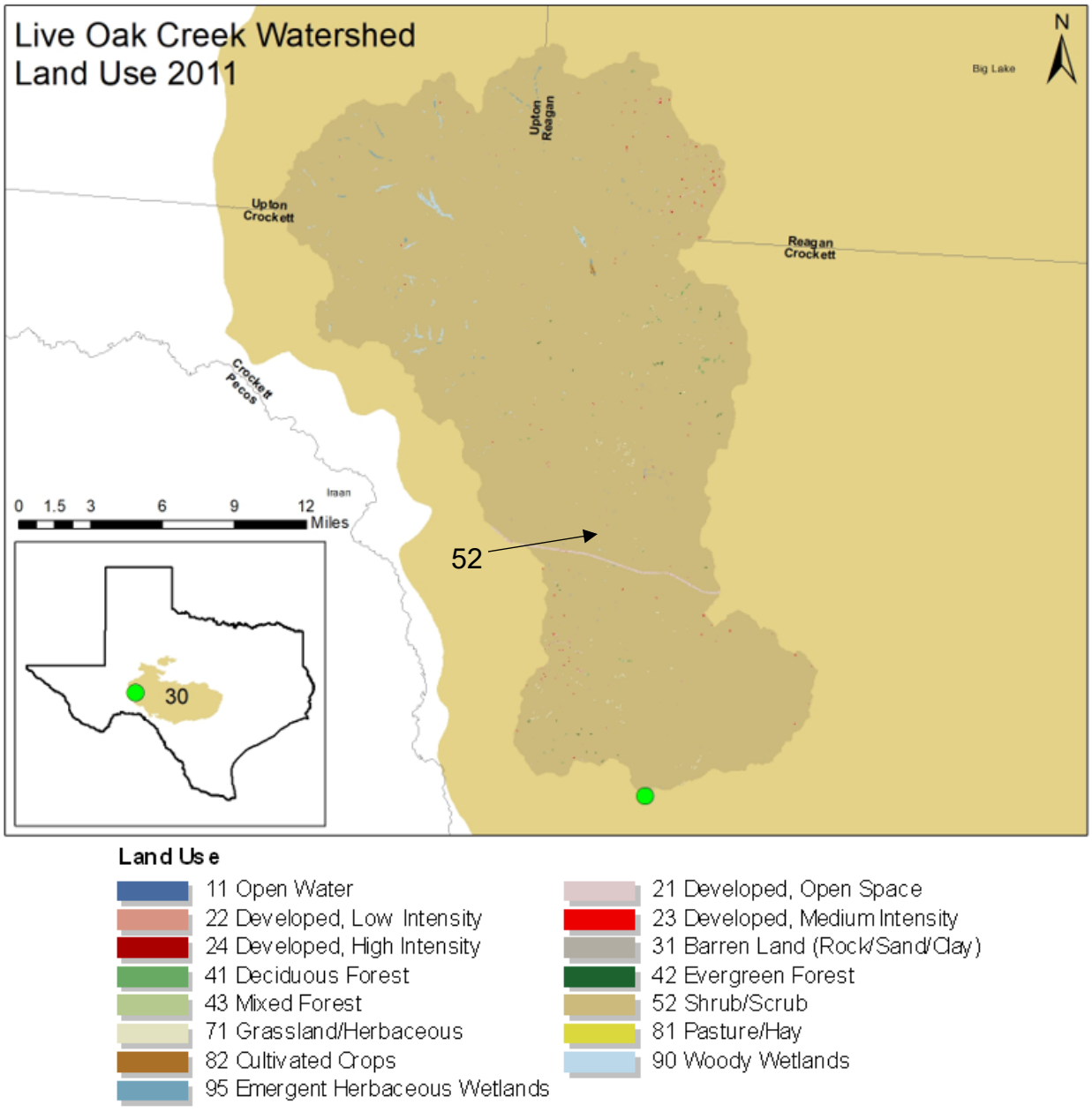

Figure 194. Map of Live Oak Creek watershed location and 2011 land use; shrub/scrub was the most common land use.

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.

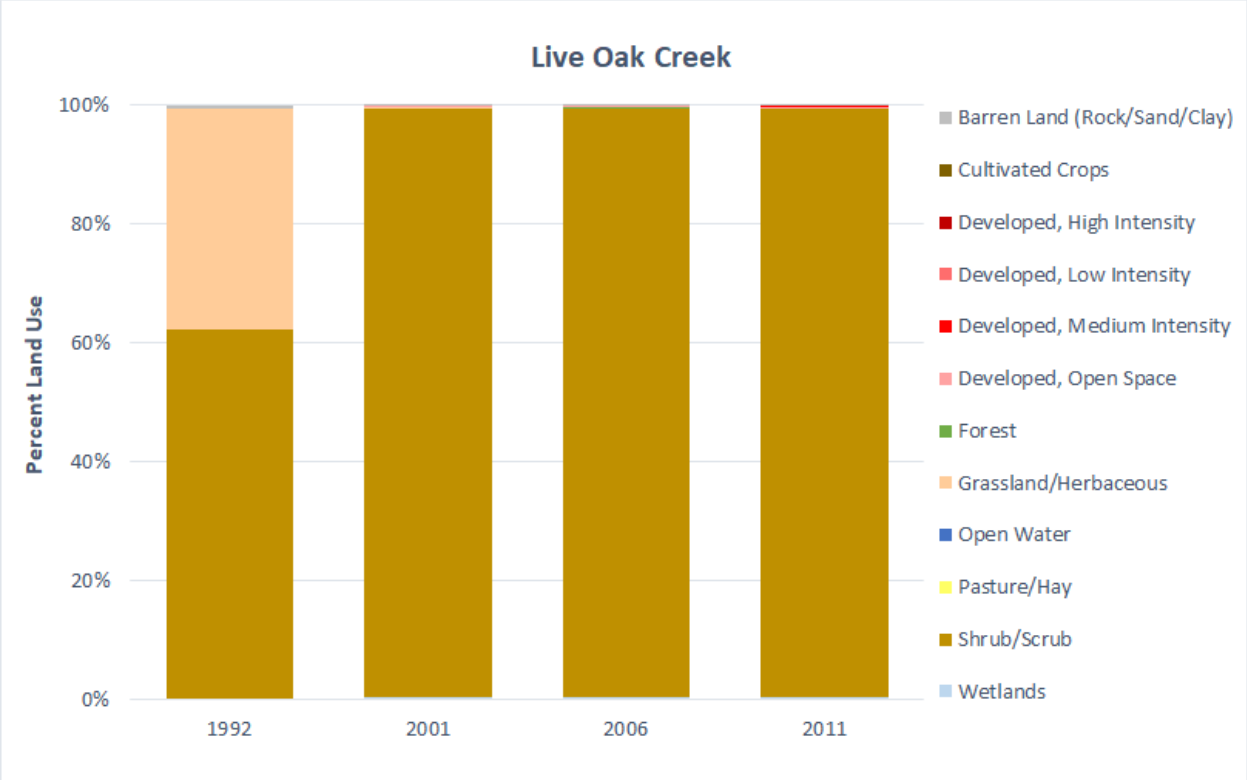

Figure 195. Percent land use in the Live Oak Creek watershed from 1992-2011.

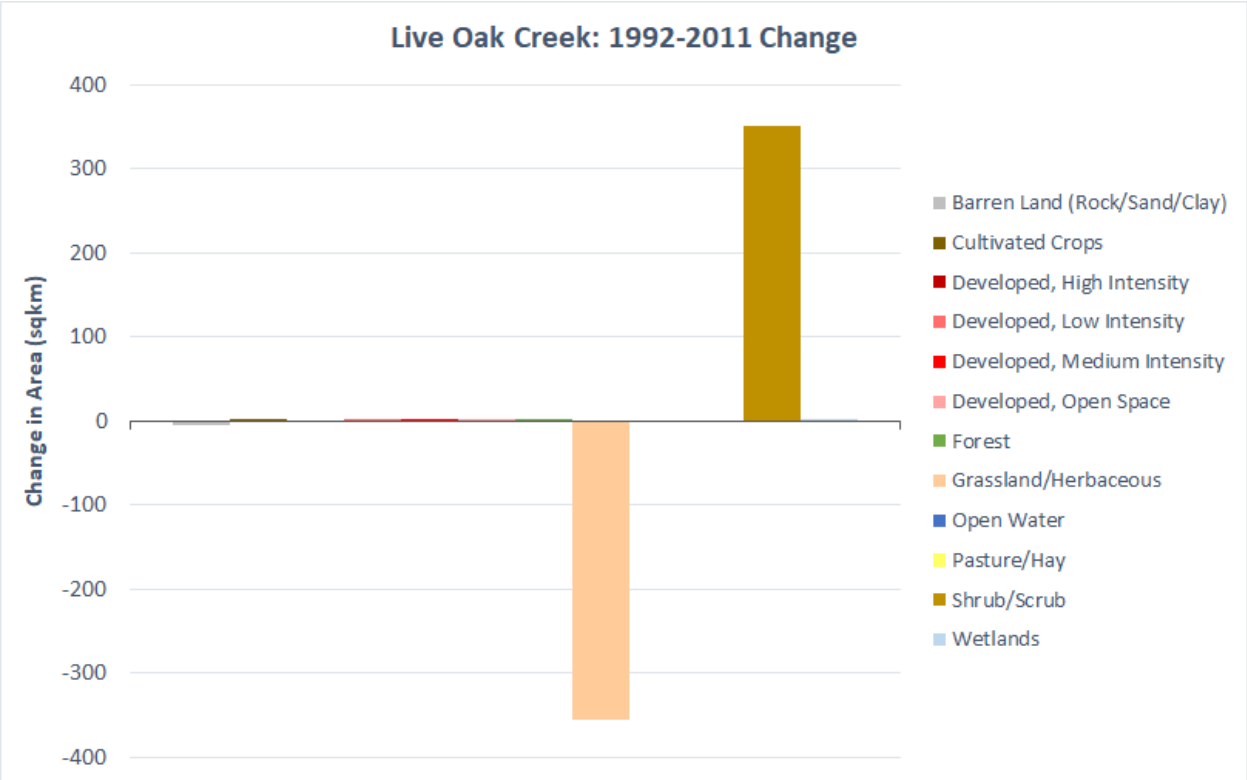

Figure 196. Land use change in area (sq km) from 1992-2011 for the Live Oak Creek watershed.

LLANO RIVER

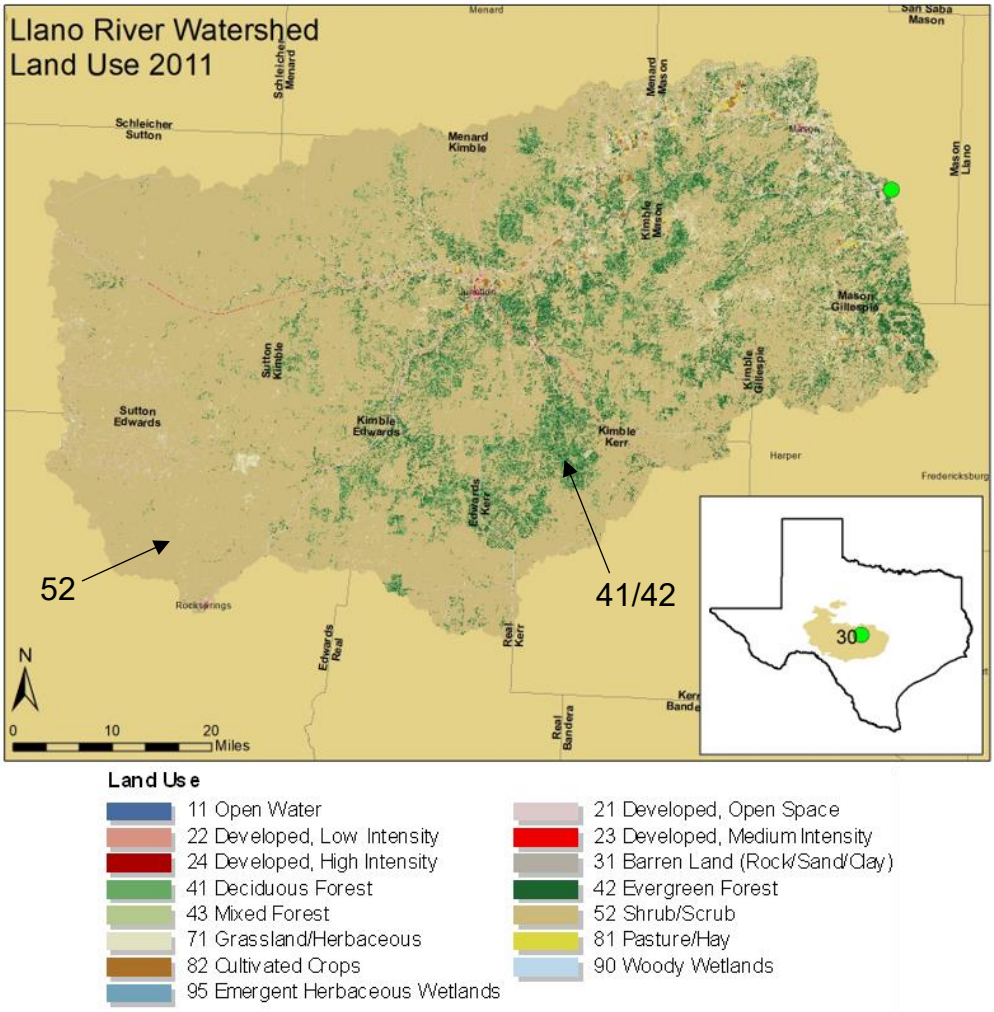

Figure 197. Map of Llano River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

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)

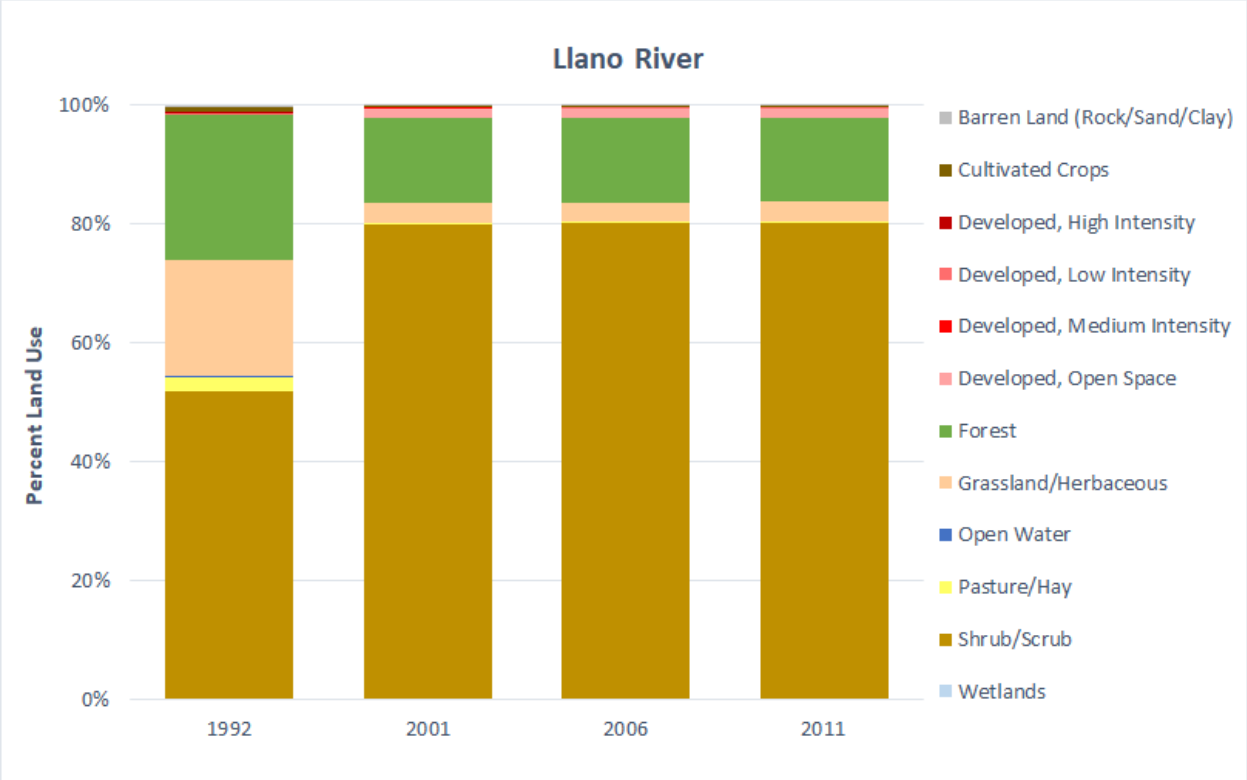

Figure 198. Percent land use in the Llano River watershed from 1992-2011.

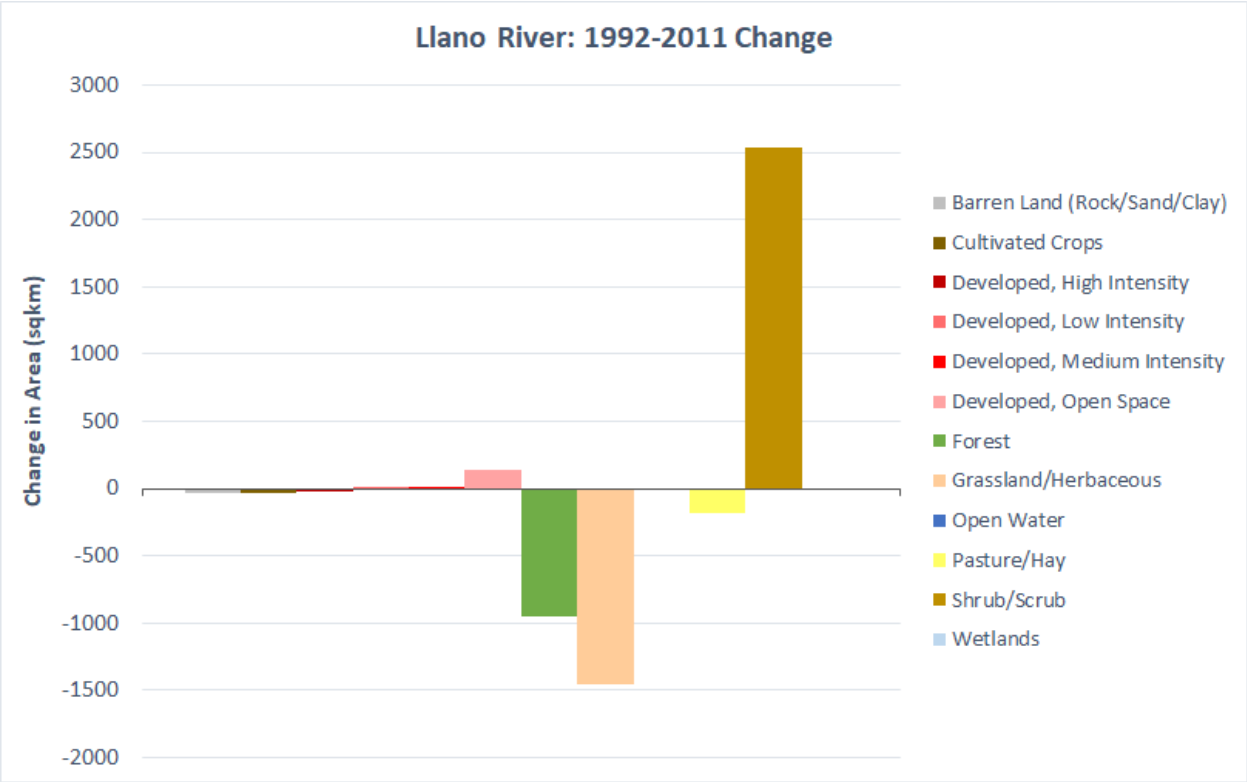

Figure 199. Land use change in area (sq km) from 1992-2011 for the Llano River watershed.

MEDINA RIVER

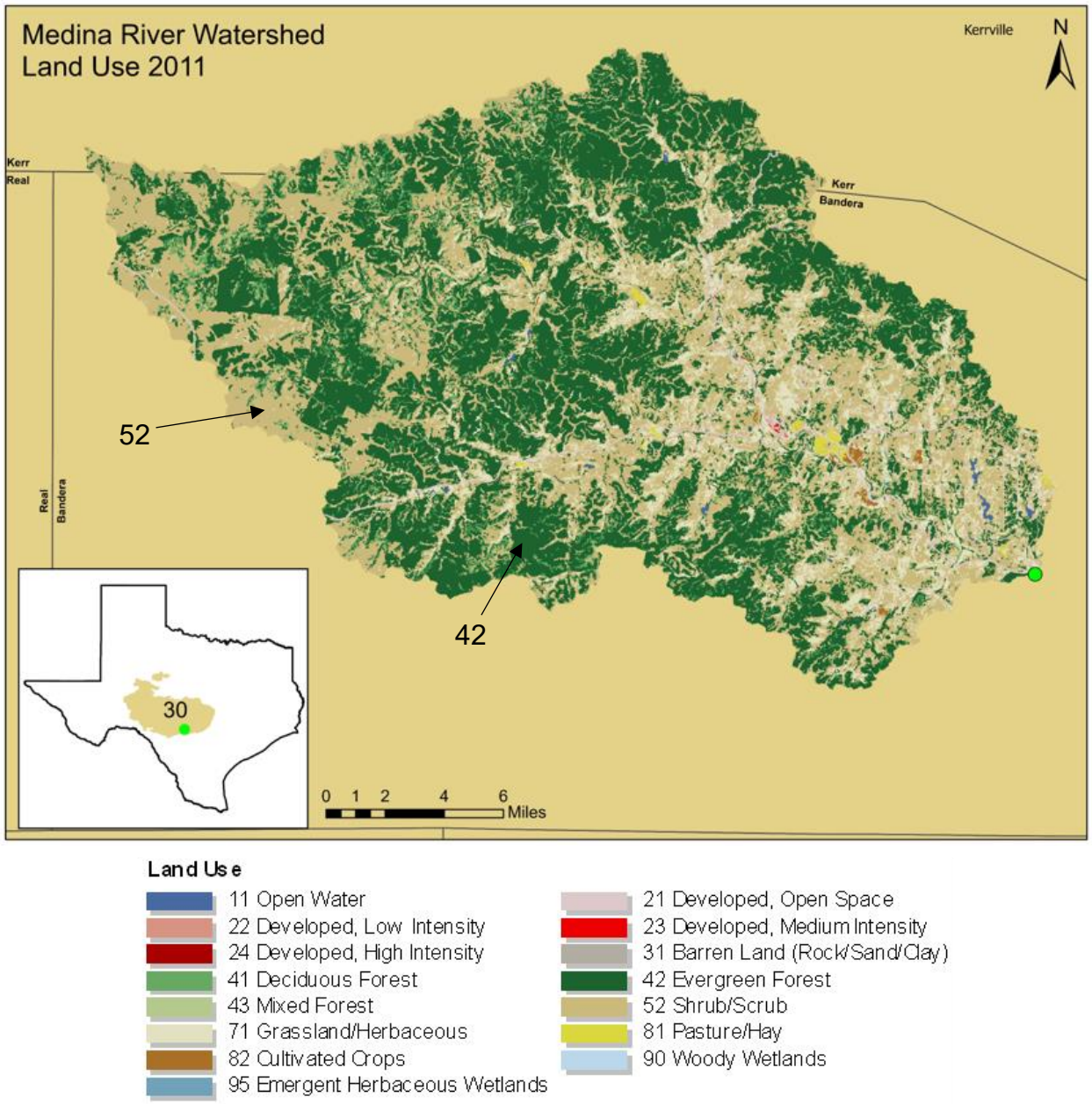

Figure 200. Map of Medina River watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

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.

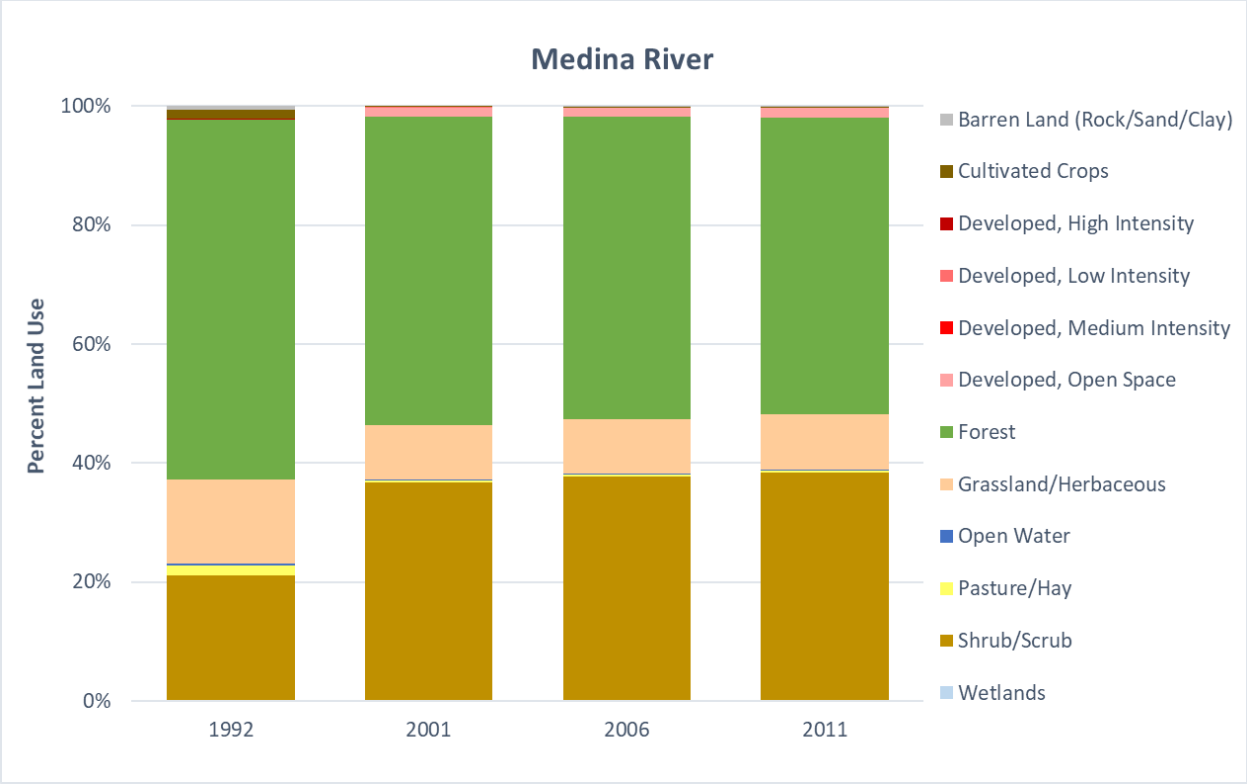

Figure 201. Percent land use in the Medina River watershed from 1992-2011.

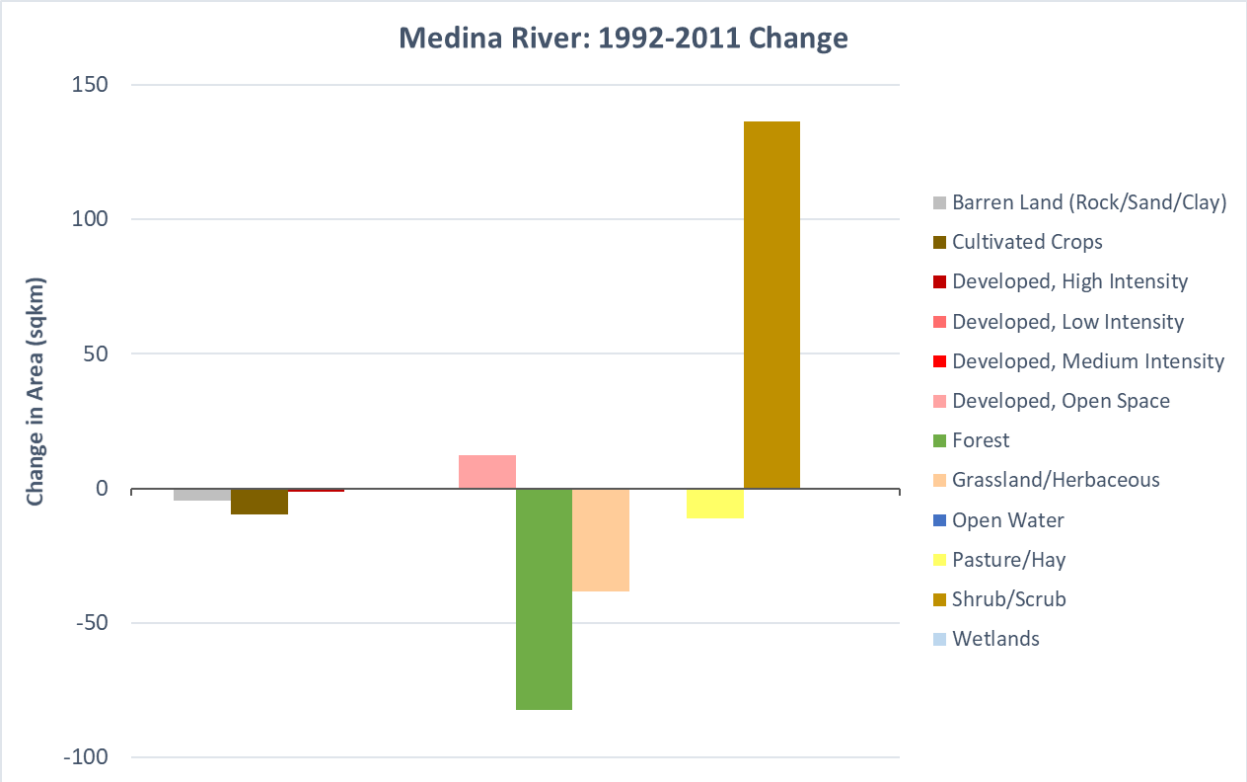

Figure 202. Land use change in area (sq km) from 1992-2011 for the Medina River watershed.

MONTELL CREEK

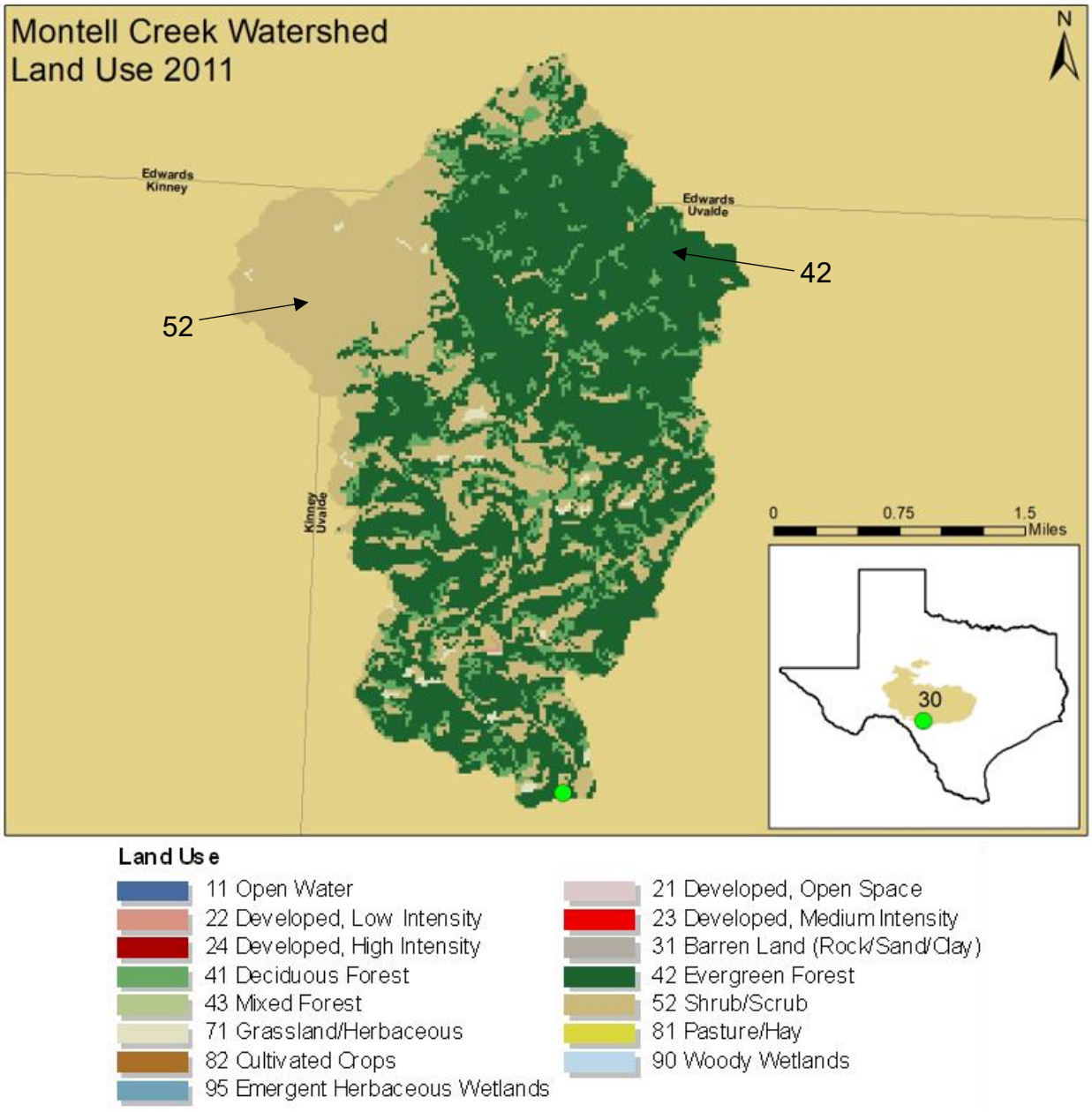

Figure 203. Map of Montell Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

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.

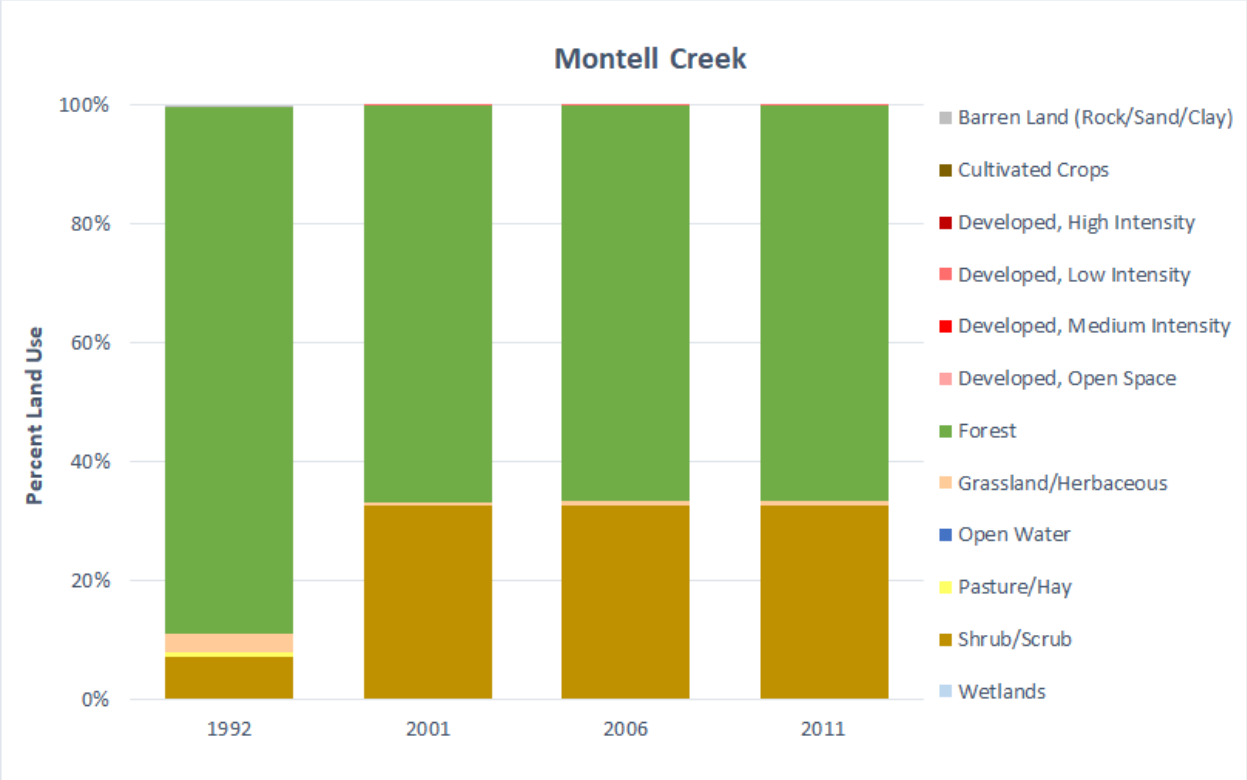

Figure 204. Percent land use in the Montell Creek watershed from 1992-2011.

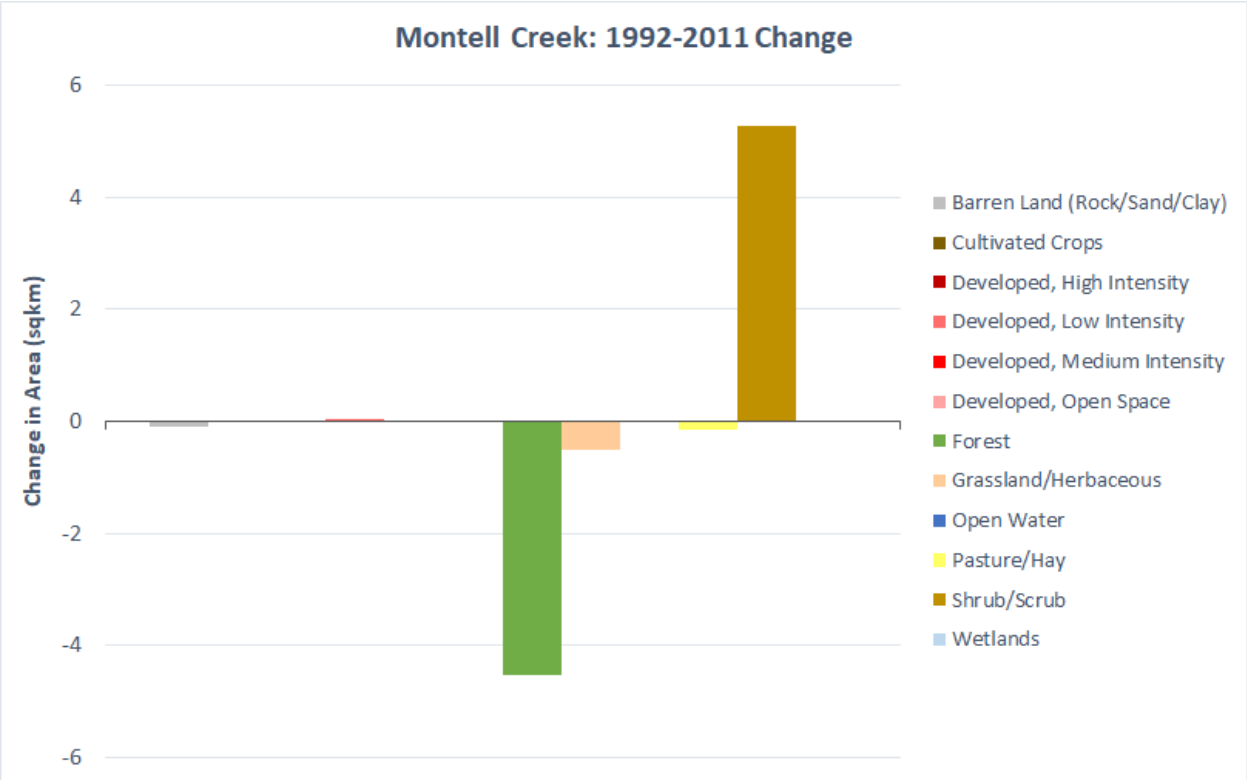

Figure 205. Land use change in area (sq km) from 1992-2011 for the Montell Creek watershed.

NORTH PRONG MEDINA RIVER

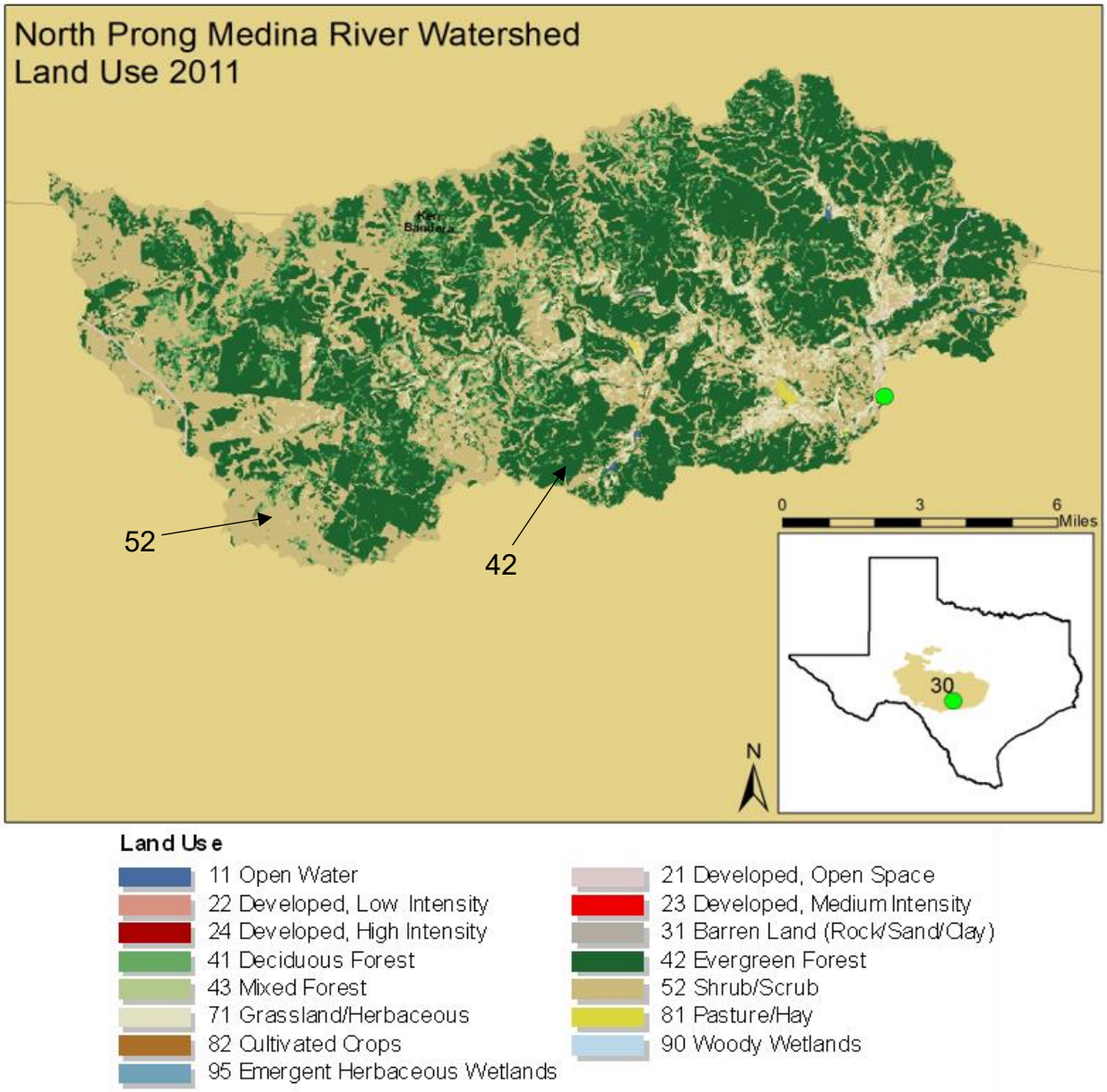

Figure 206. Map of North Prong Medina River watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

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.

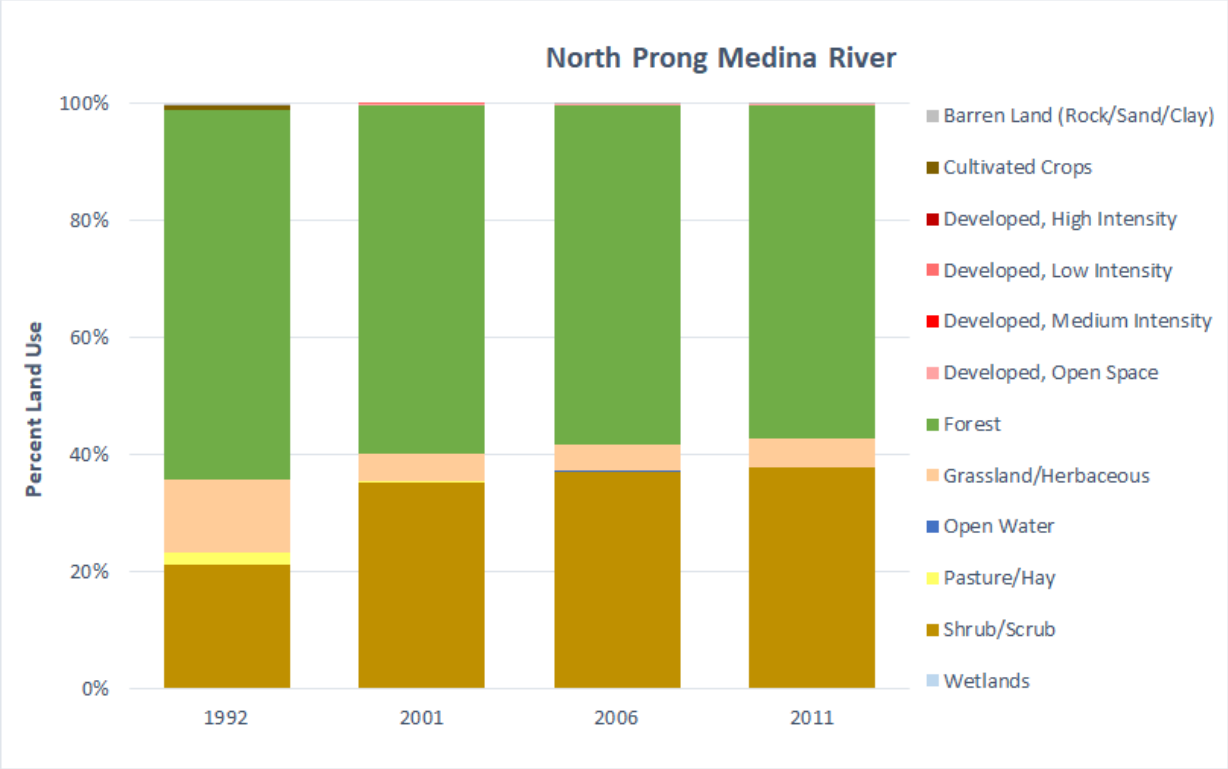

Figure 207. Percent land use in the North Prong Medina River watershed from 1992-2011.

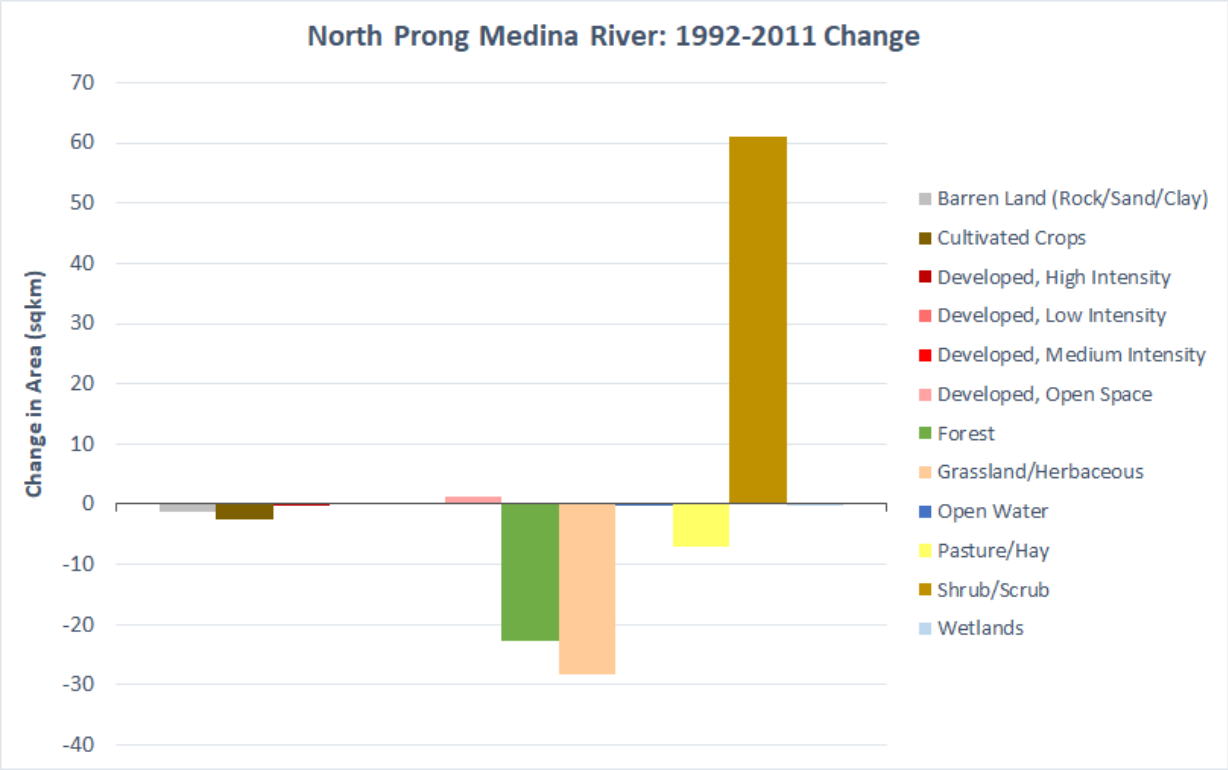

Figure 208. Land use change in area (sq km) from 1992-2011 for the North Prong Medina River watershed.

NUECES RIVER

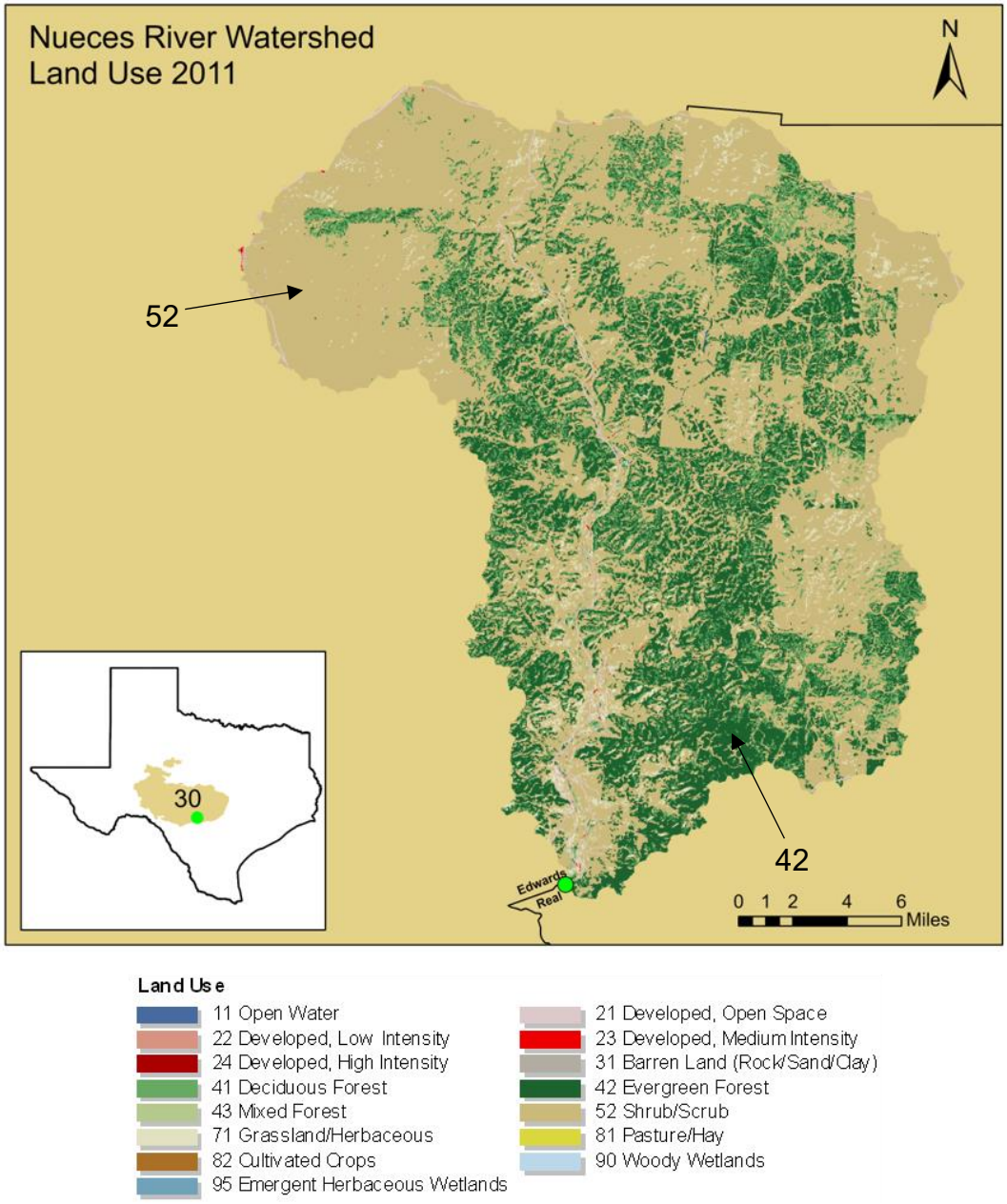

Figure 209. Map of Nueces River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

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.

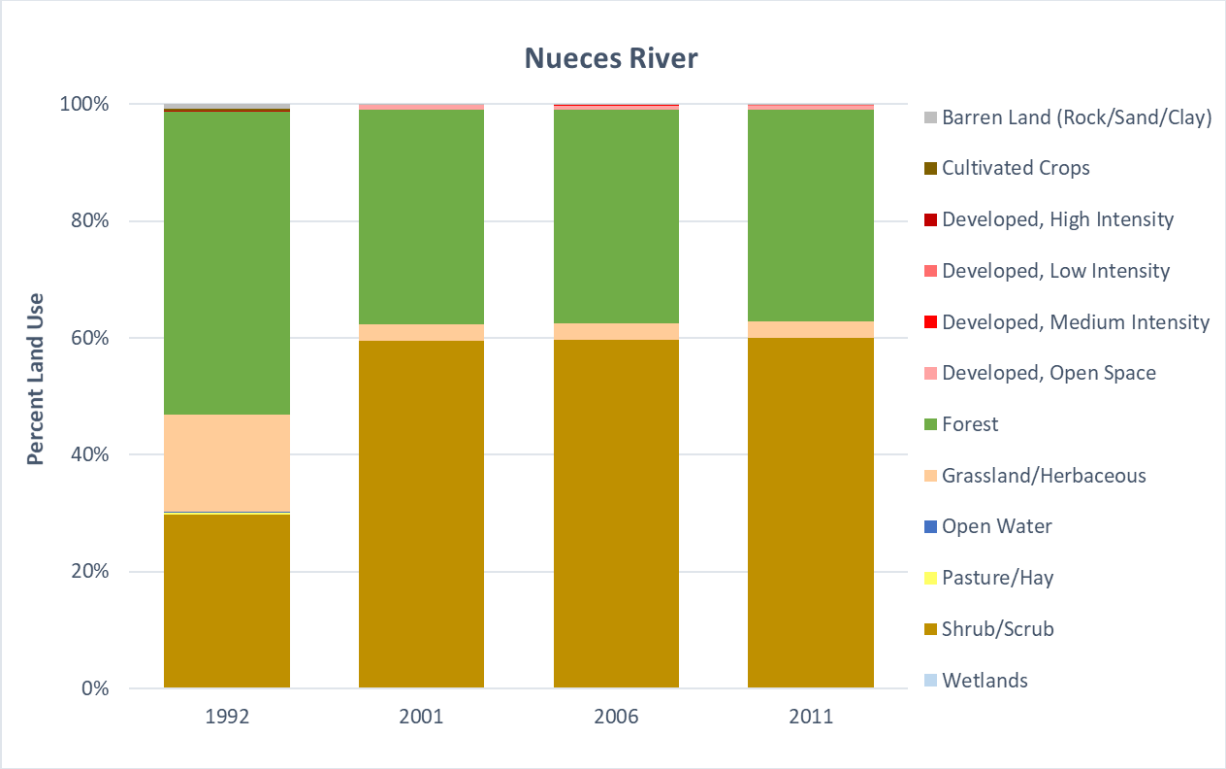

Figure 210. Percent land use in the upper Nueces River watershed from 1992-2011.

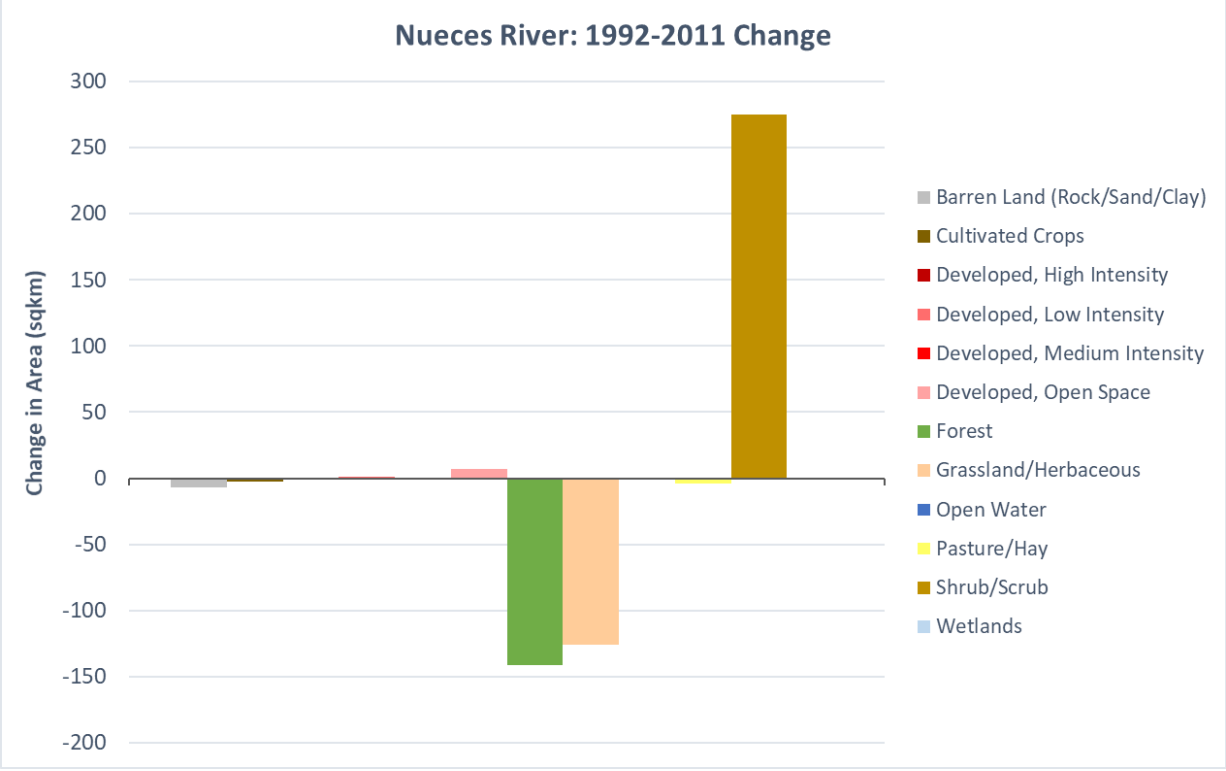

Figure 211. Land use change in area (sq km) from 1992-2011 for the upper Nueces River watershed.

OATMEAL CREEK

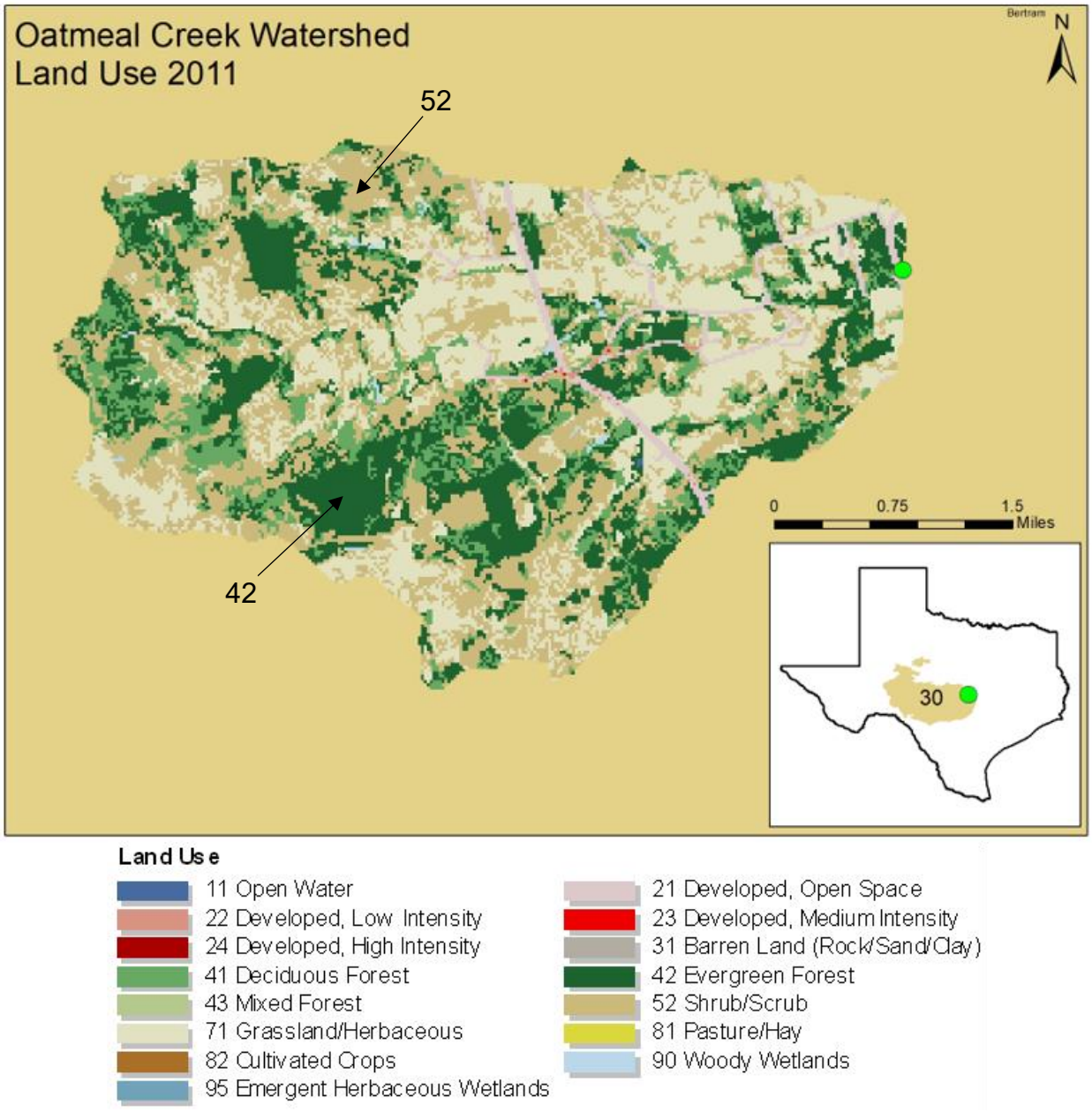

Figure 212. Map of Oatmeal Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

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.

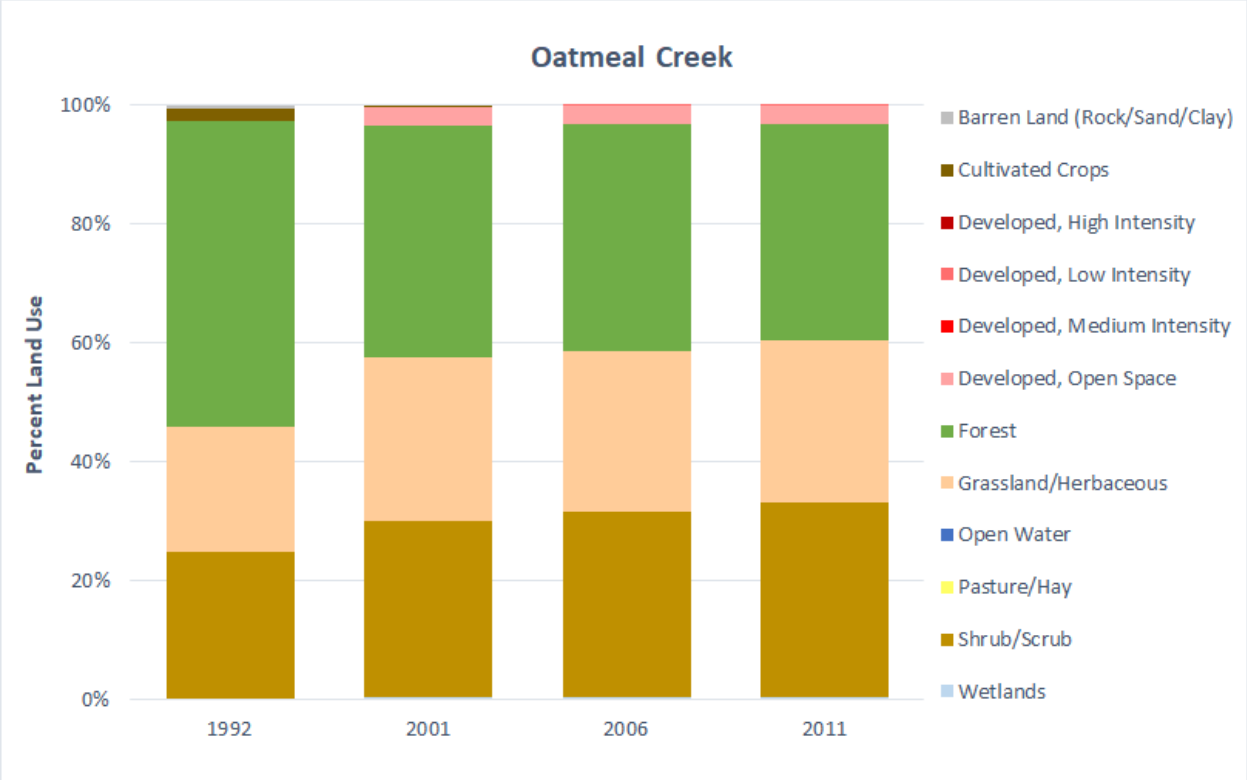

Figure 213. Percent land use in the Oatmeal Creek watershed from 1992-2011.

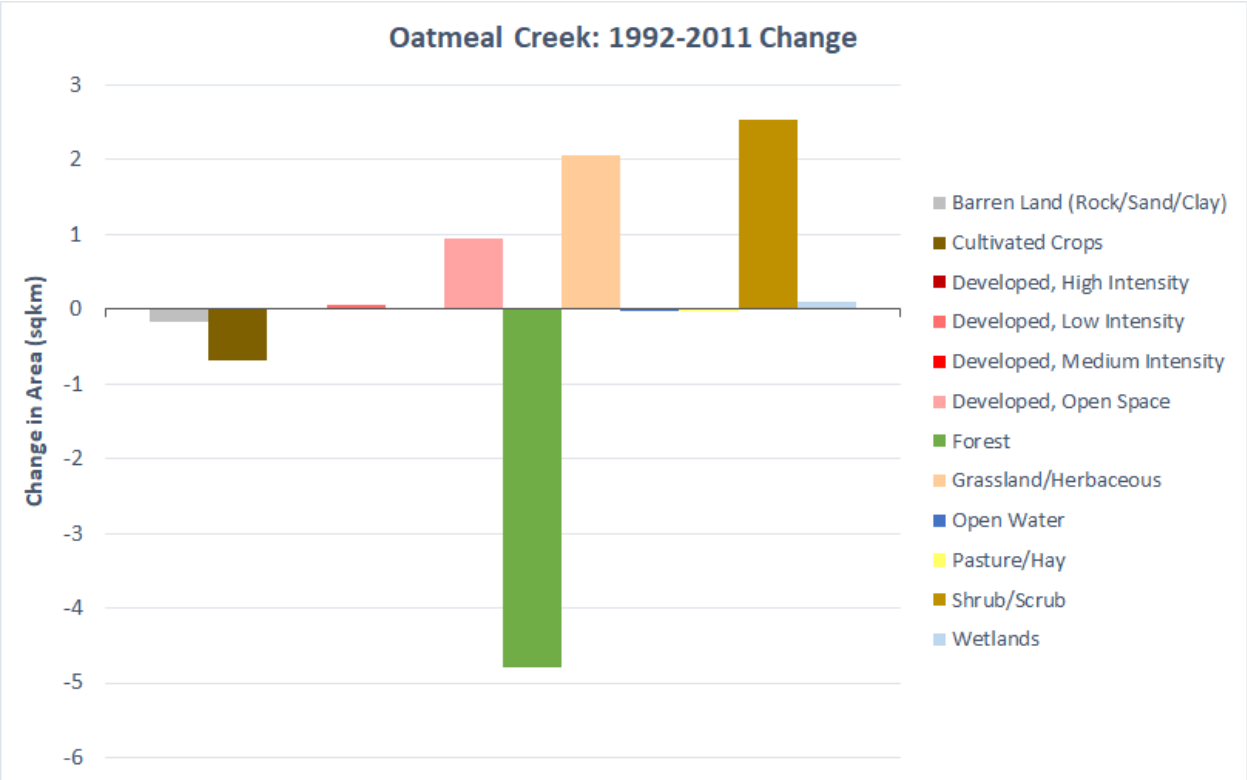

Figure 214. Land use change in area (sq km) from 1992-2011 for the Oatmeal Creek watershed.

ONION CREEK

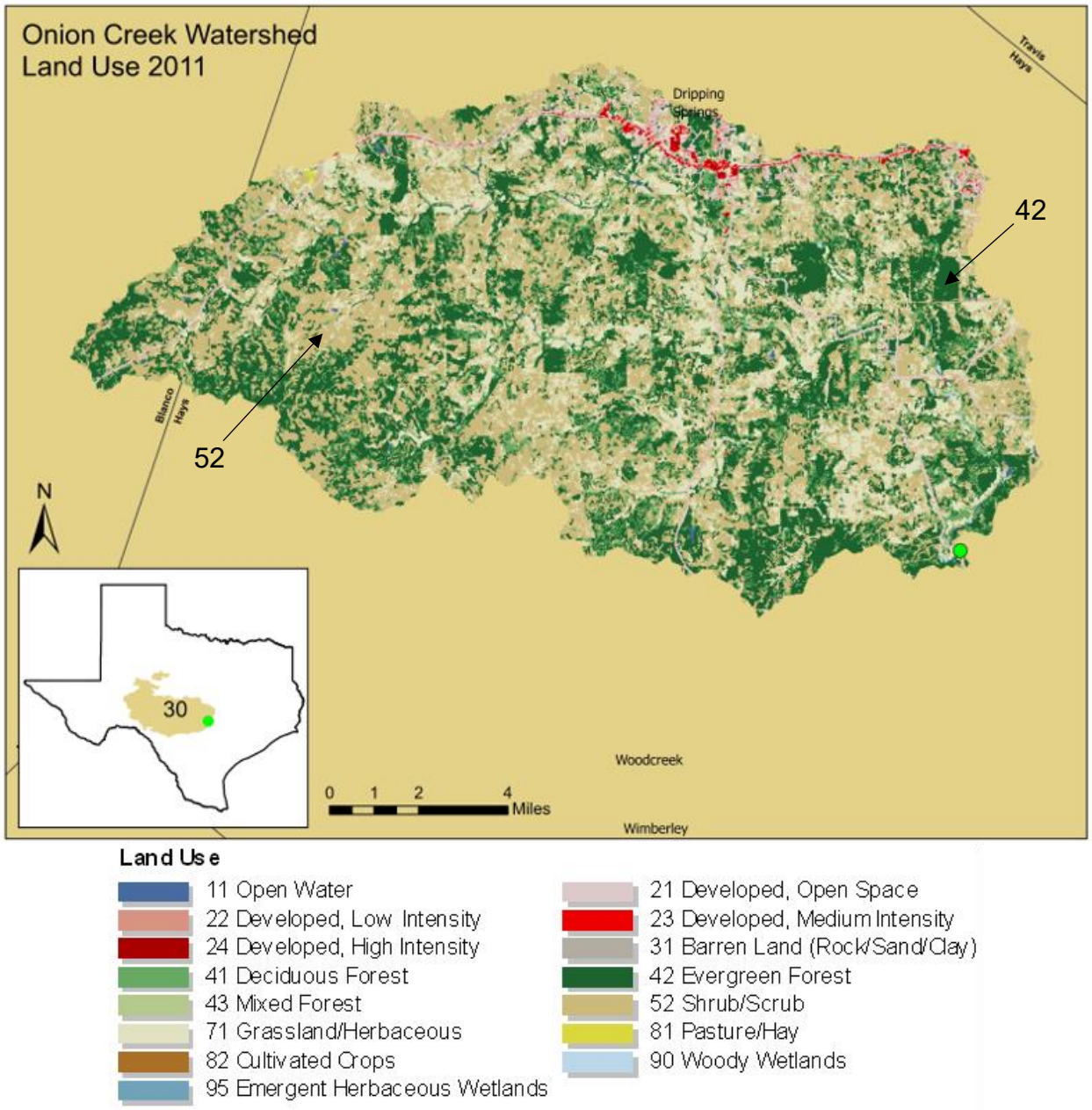

Figure 215. Map of Onion Creek watershed location and 2011 land use; forest and shrub/scrub were the most common land uses.

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.

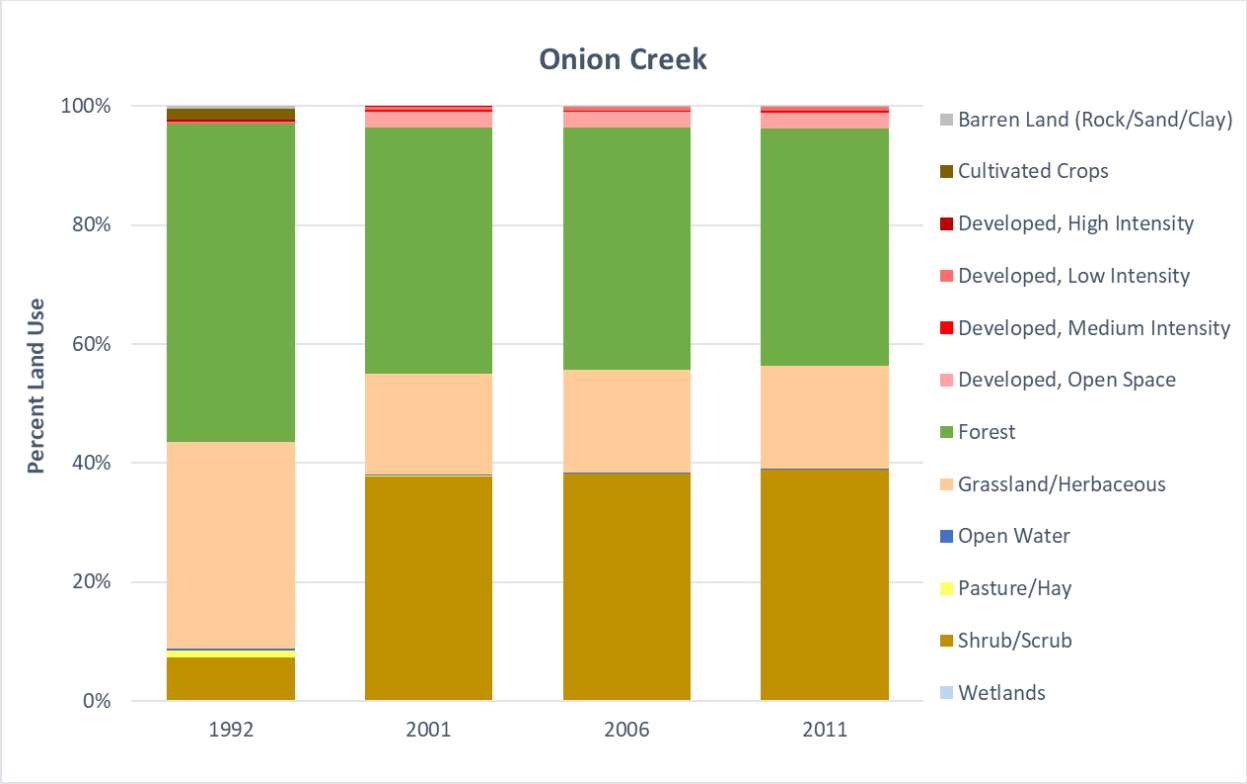

Figure 216. Percent land use in the Onion Creek watershed from 1992-2011.

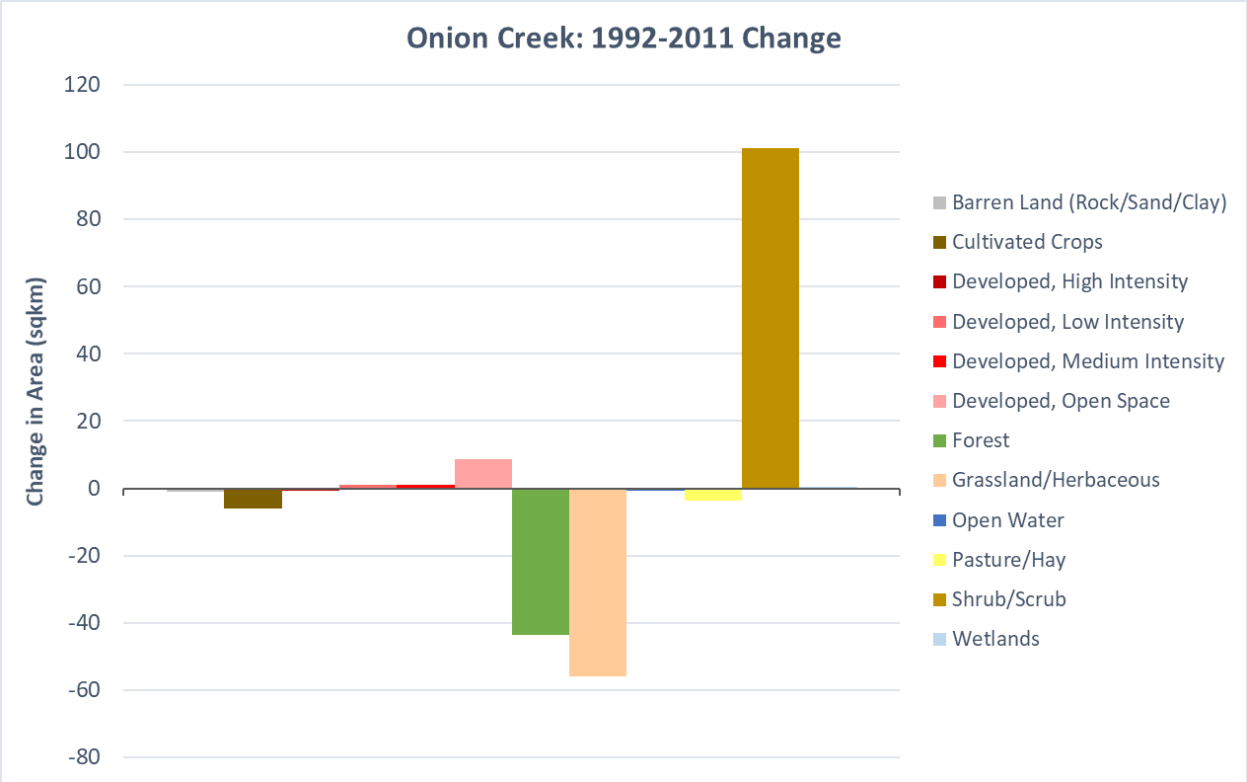

Figure 217. Land use change in area (sq km) from 1992-2011 for the Onion Creek watershed.

PEDERNALES RIVER

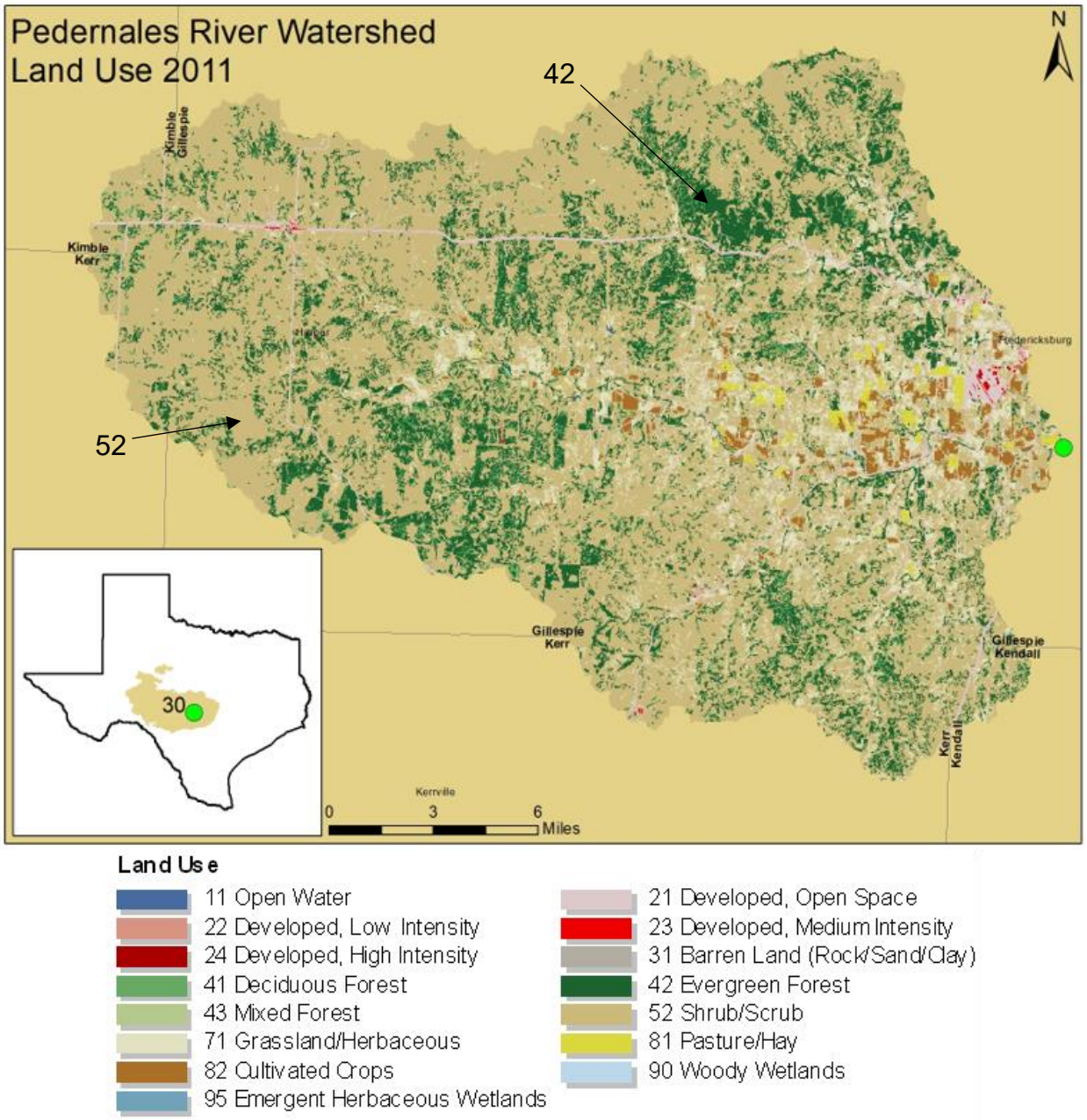

Figure 218. Map of Pedernales River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

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)

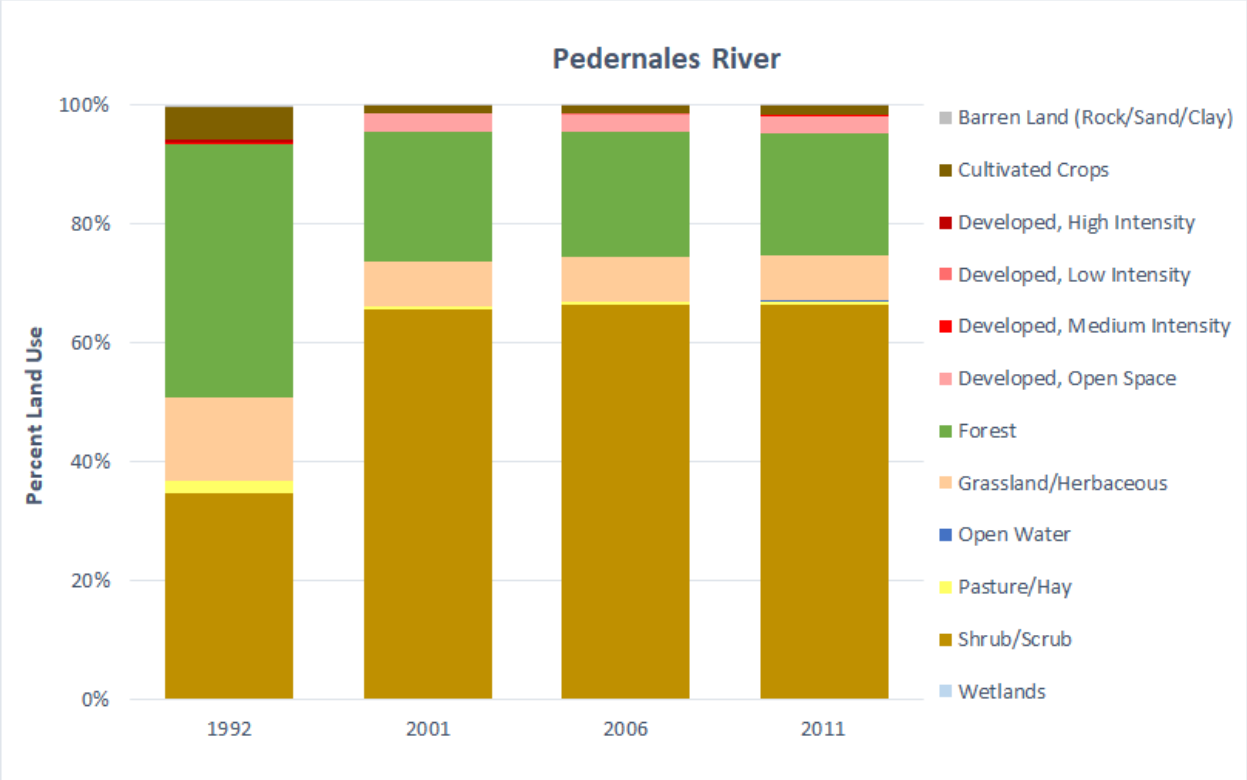

Figure 219. Percent land use in the Pedernales River watershed from 1992-2011.

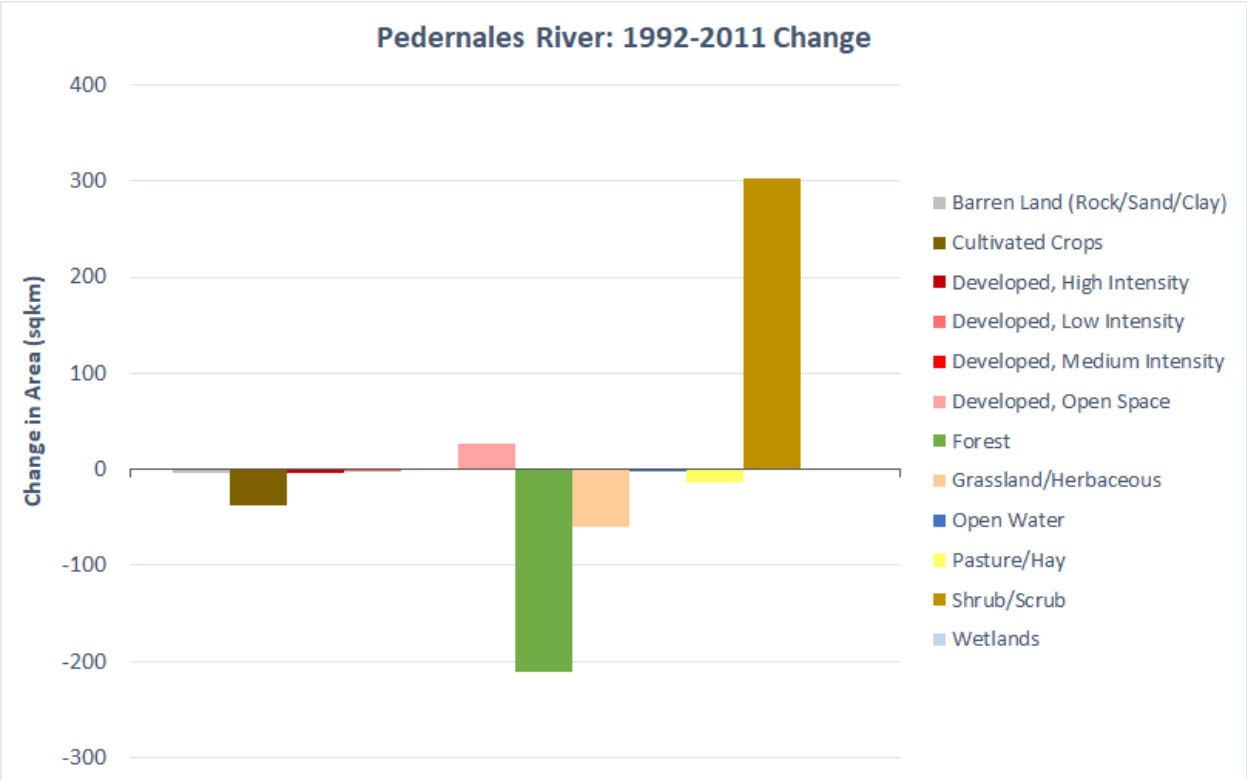

Figure 220. Land use change in area (sq km) from 1992-2011 for the Pedernales River watershed.

SAN SABA RIVER

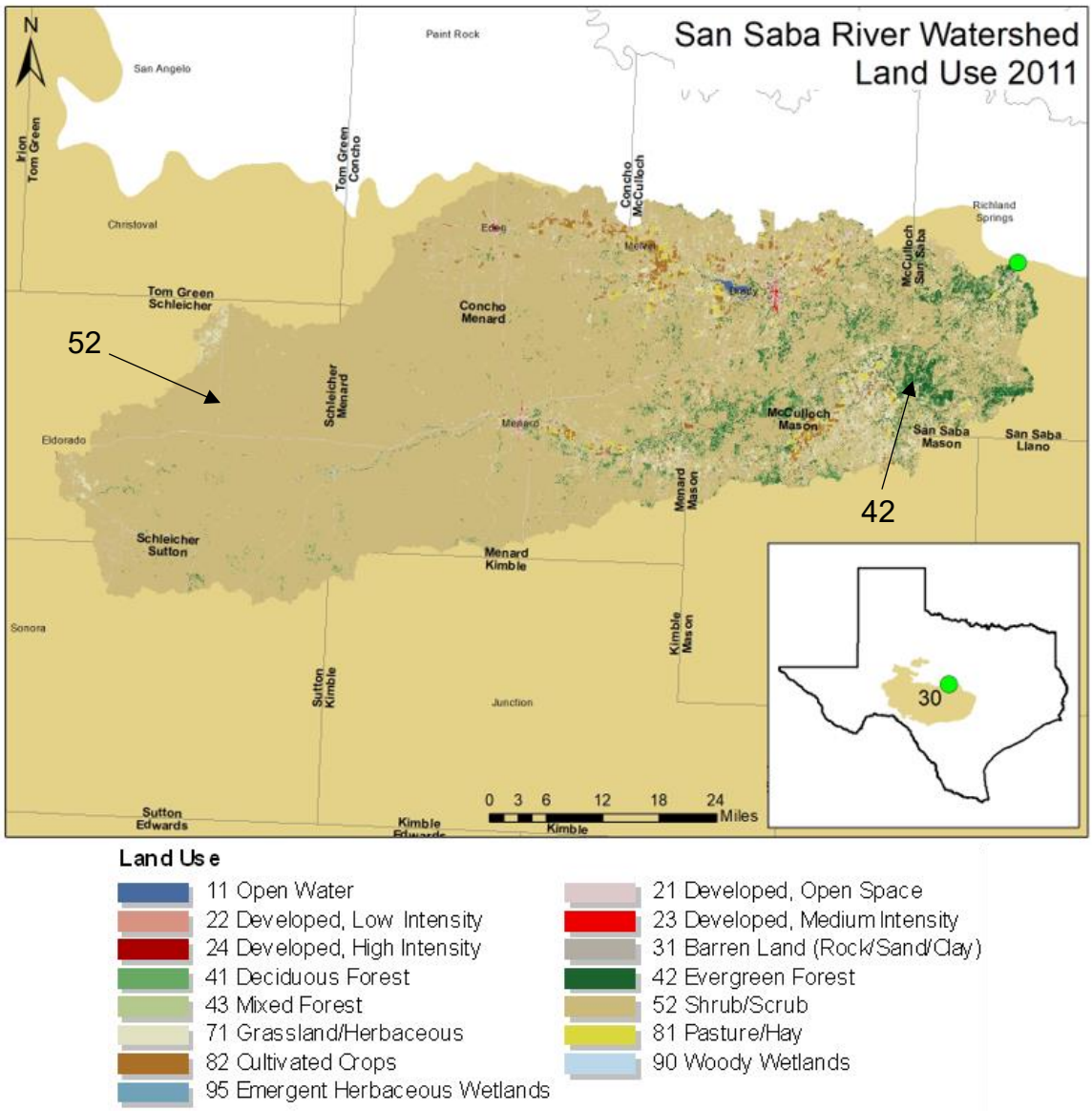

Figure 221. Map of San Saba River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

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).

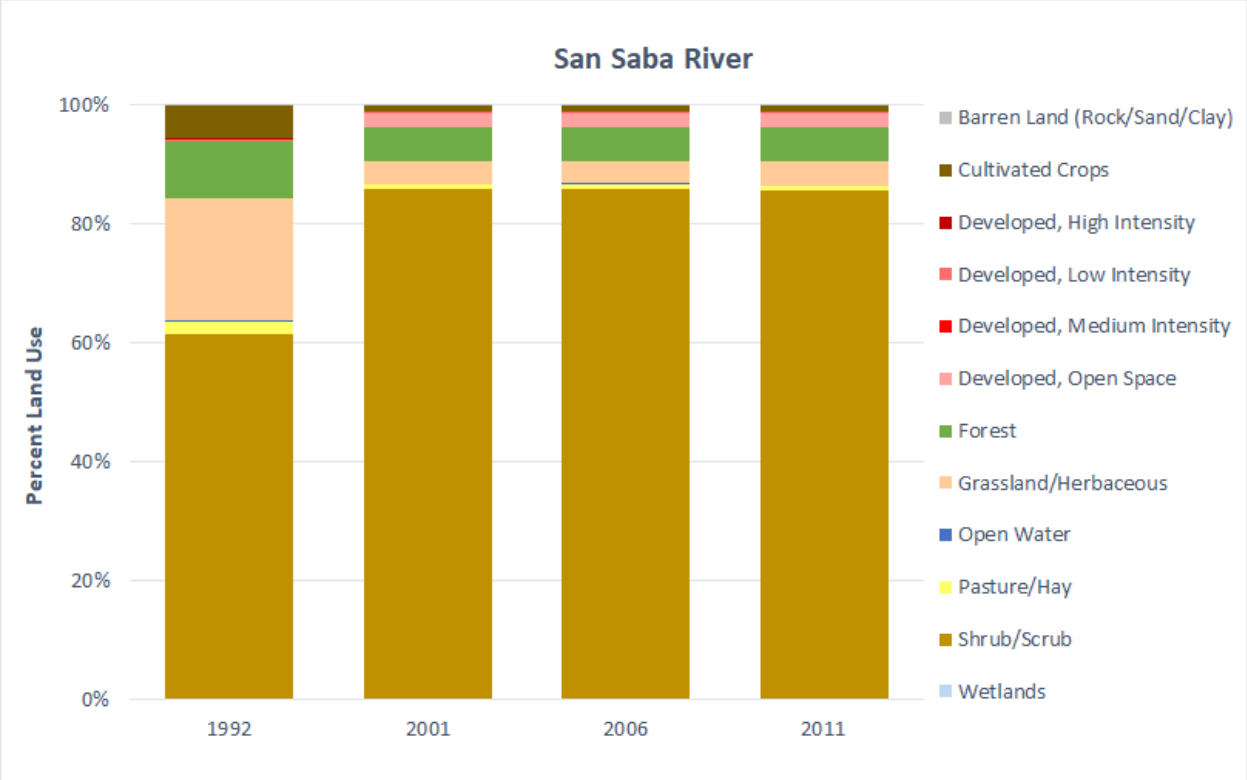

Figure 222. Percent land use in the San Saba River watershed from 1992-2011.

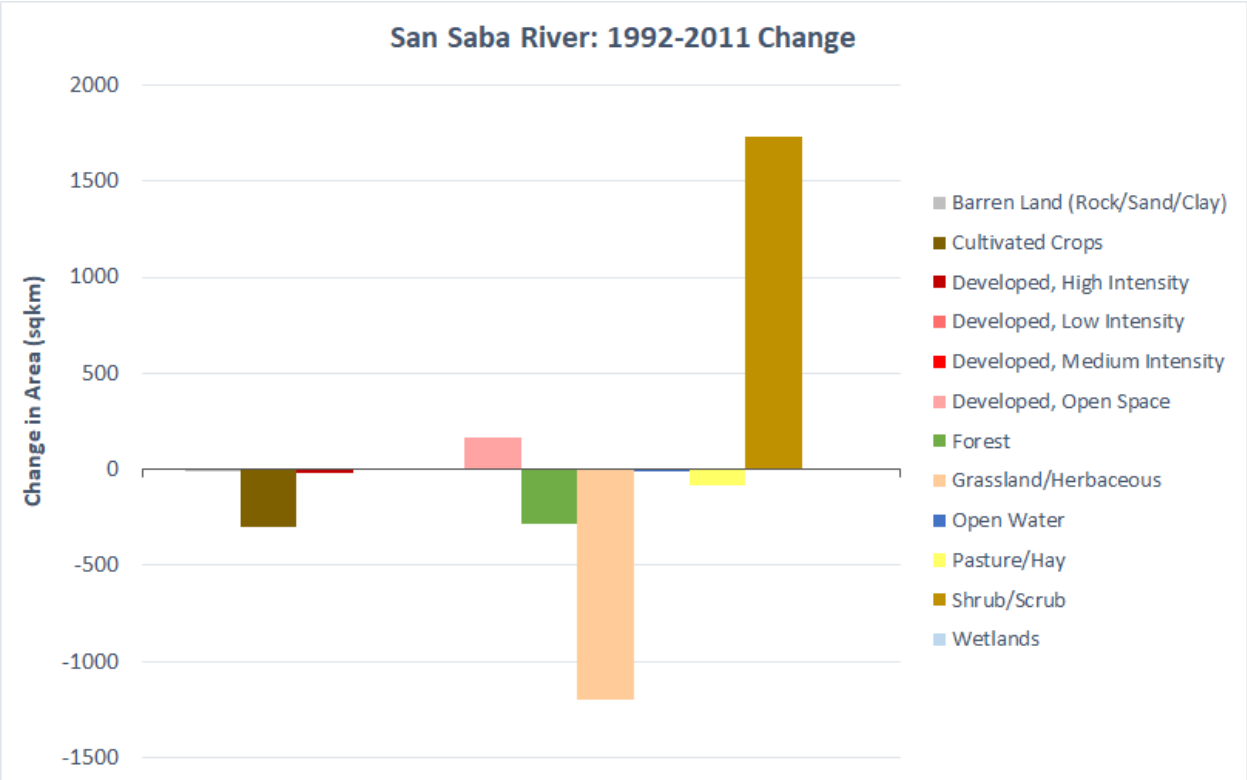

Figure 223. Land use change in area (sq km) from 1992-2011 for the San Saba River watershed.

SLAUGHTER CREEK

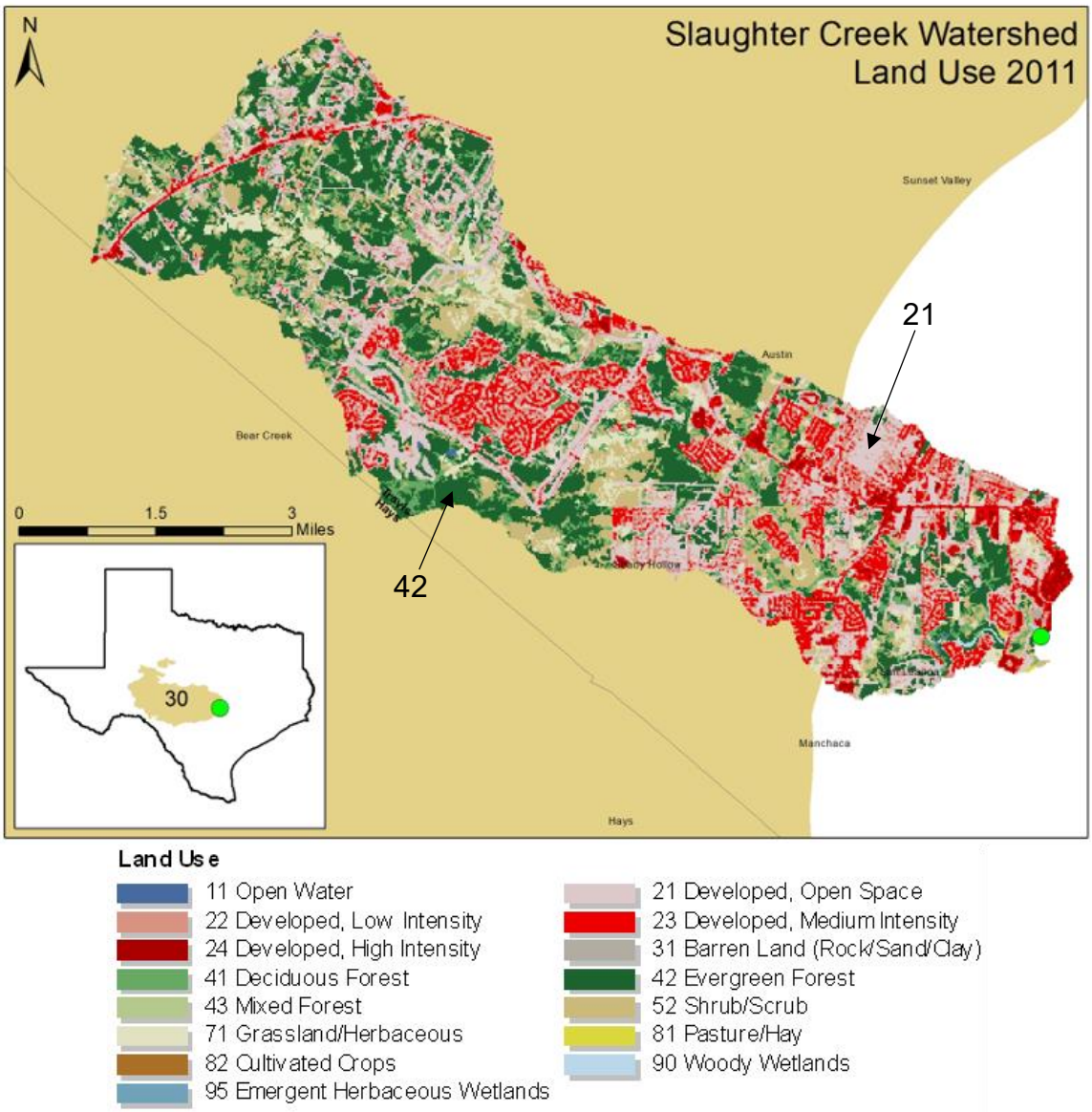

Figure 224. Map of Slaughter Creek watershed location and 2011 land use; forest and open space development were the most common land uses.

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.

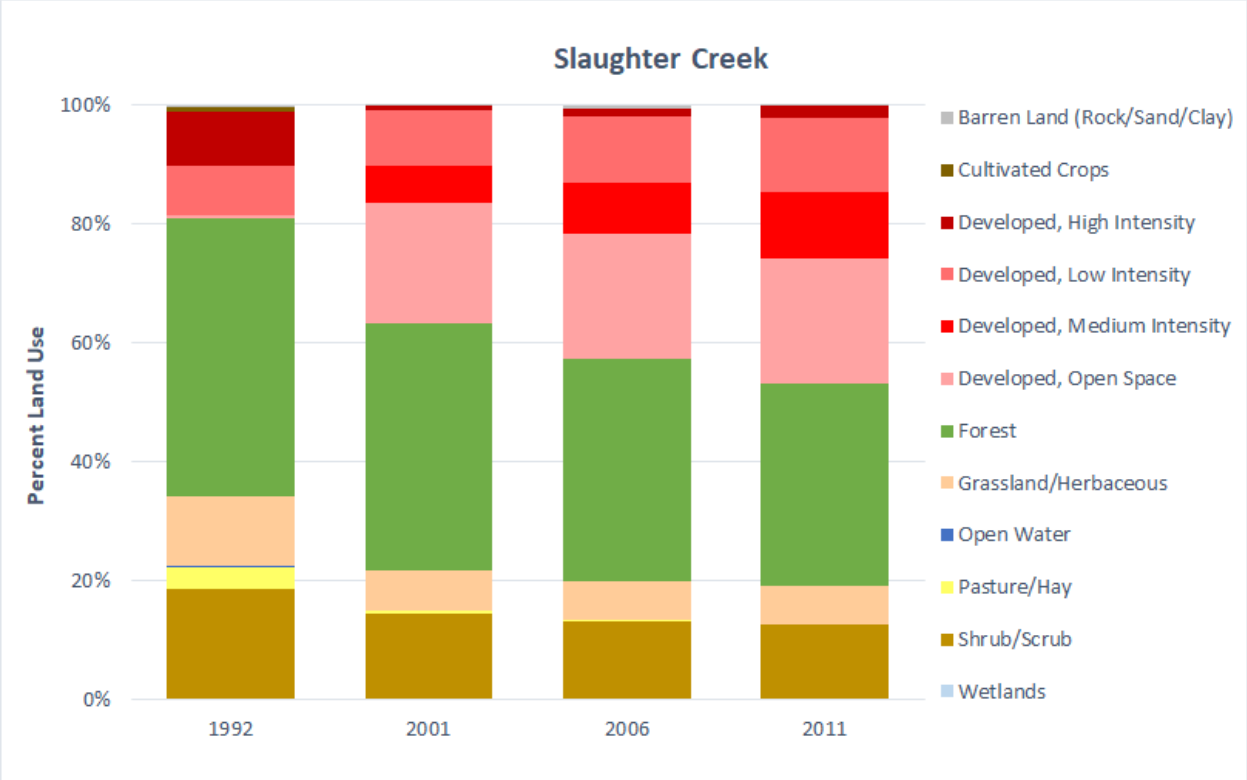

Figure 225. Percent land use in the Slaughter Creek watershed from 1992-2011.

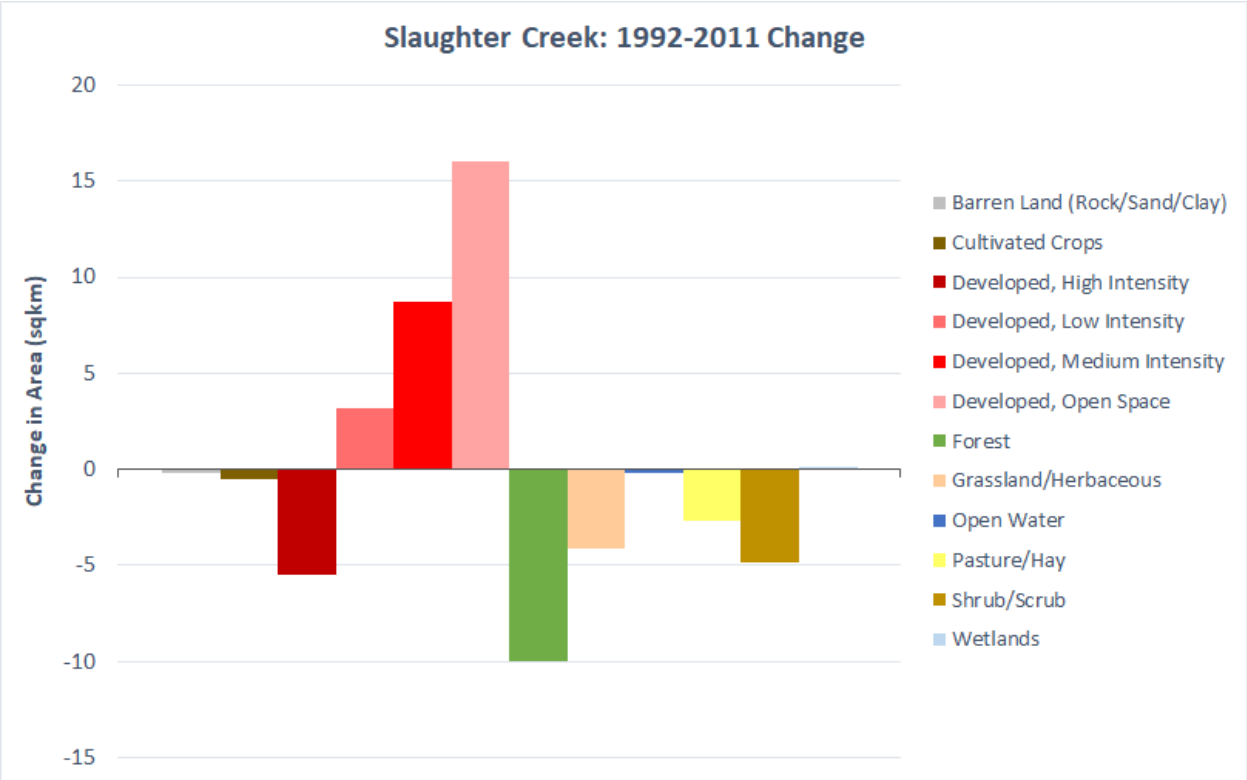

Figure 226. Land use change in area (sq km) from 1992-2011 for the Slaughter Creek watershed.

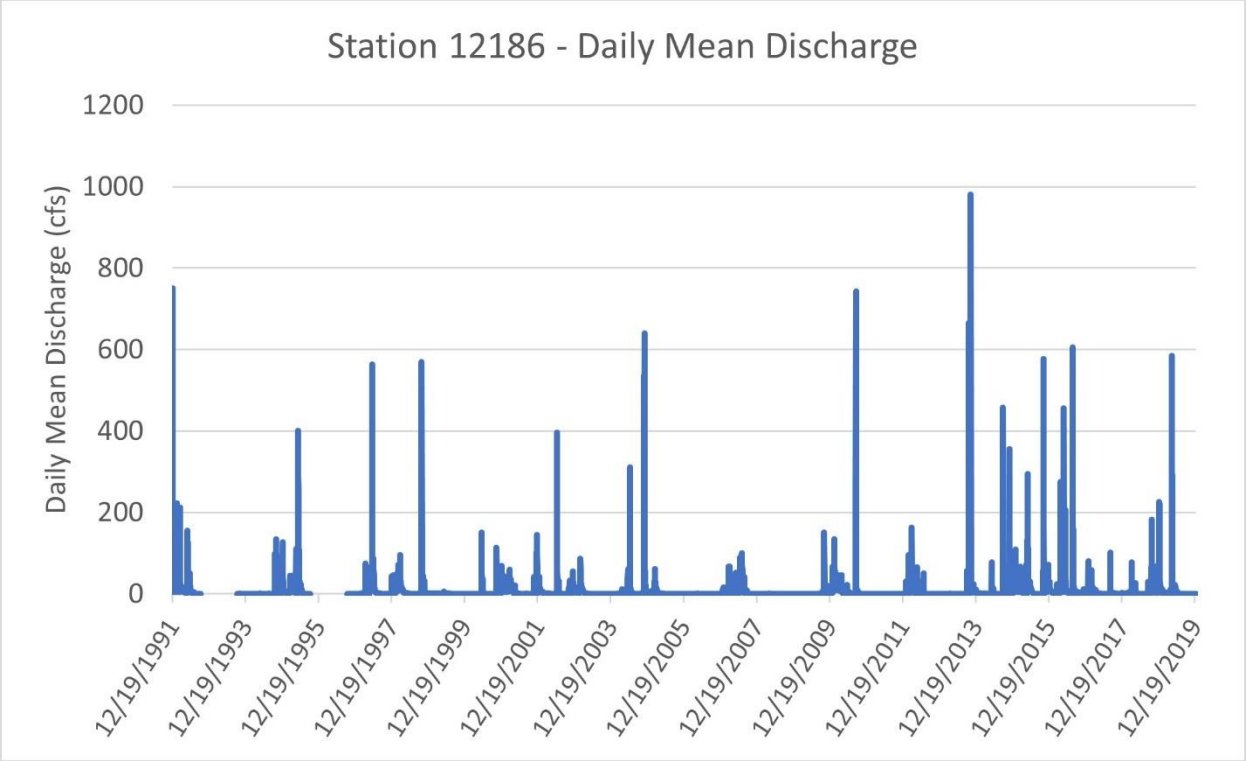

Figure 227. Daily mean discharge for Slaughter Creek at station 12186.

SOUTH CONCHO RIVER

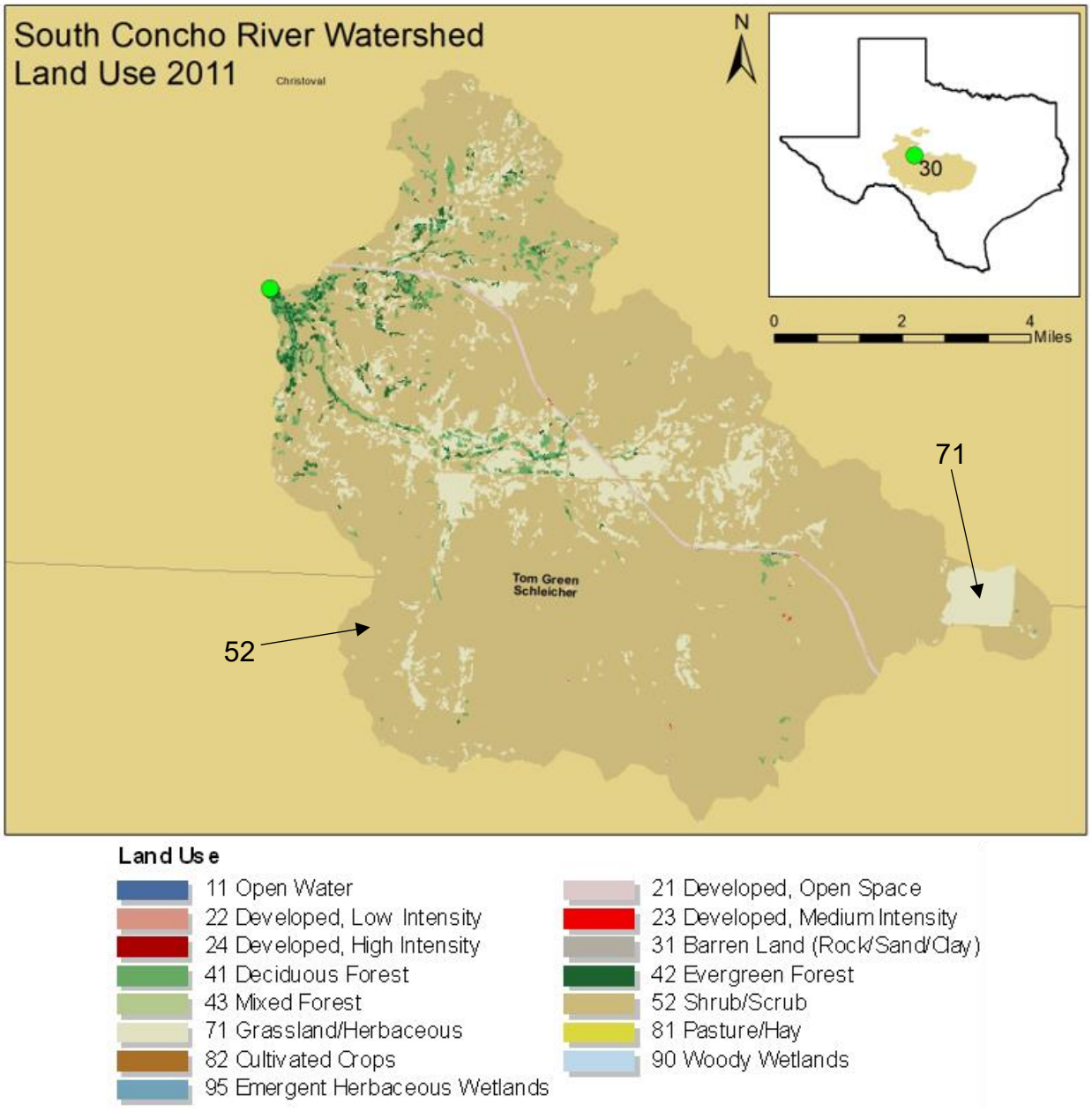

Figure 228. Map of South Concho River watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

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.

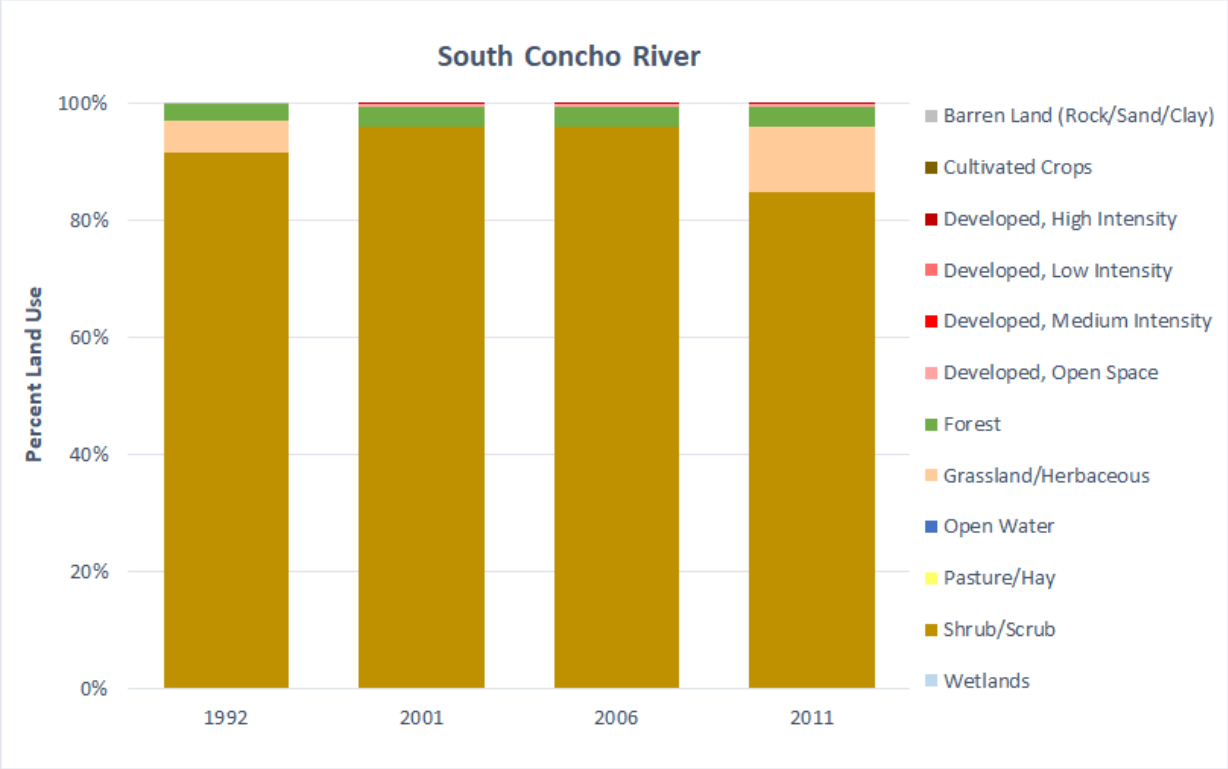

Figure 229. Percent land use in the South Concho River watershed from 1992-2011.

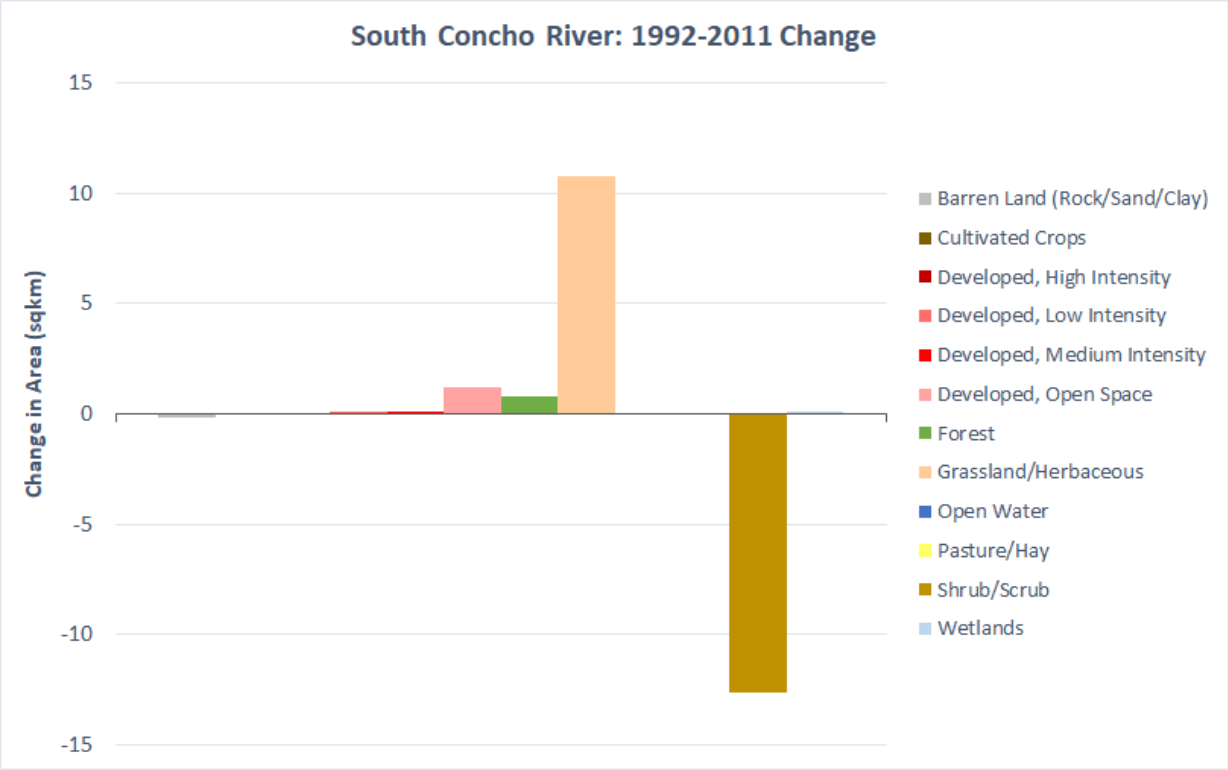

Figure 230. Land use change in area (sq km) from 1992-2011 for the South Concho River watershed.

SOUTH LLANO RIVER

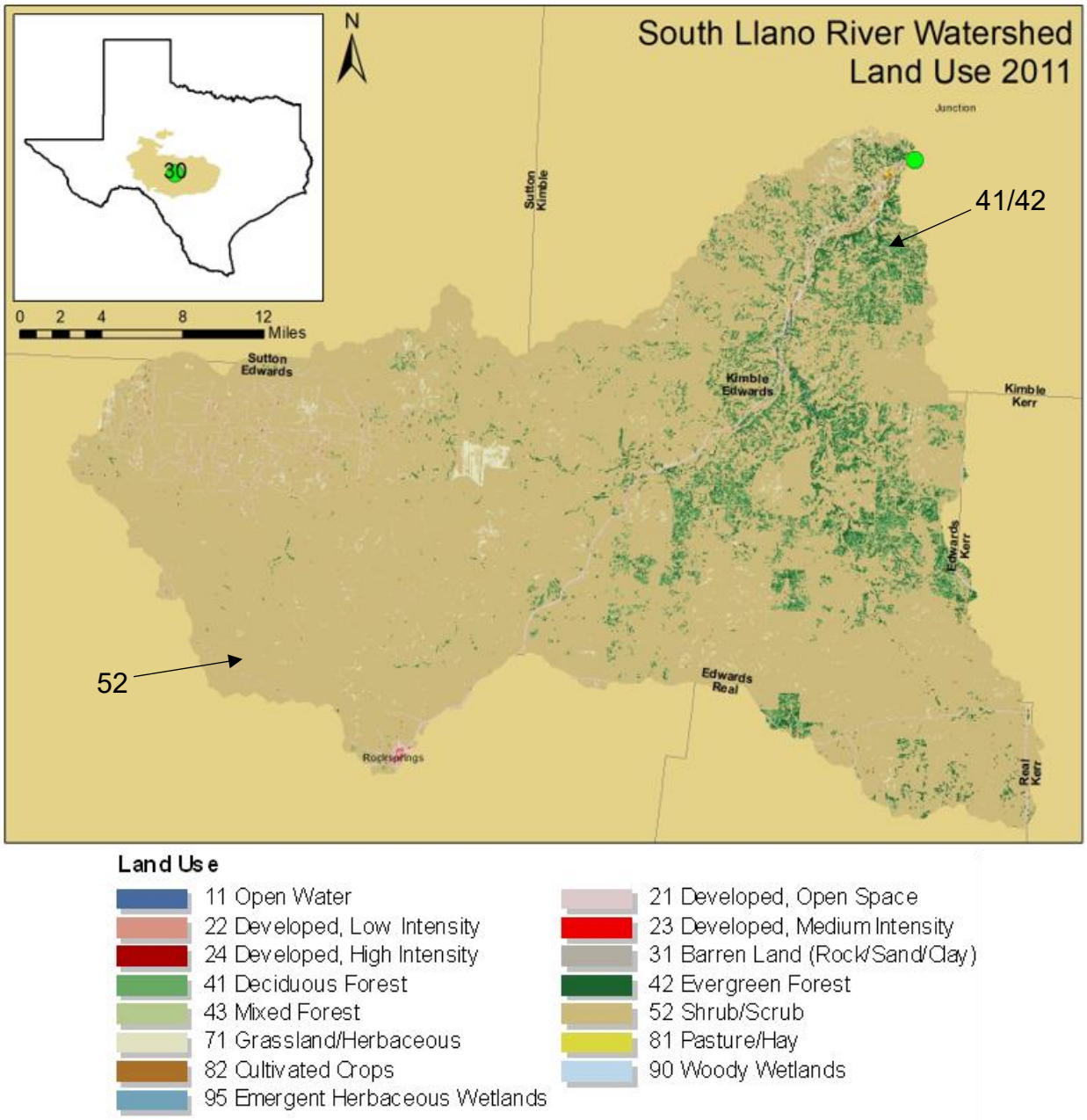

Figure 231. Map of South Llano River watershed location and 2011 land use; shrub/scrub and forest were the most common land uses.

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.

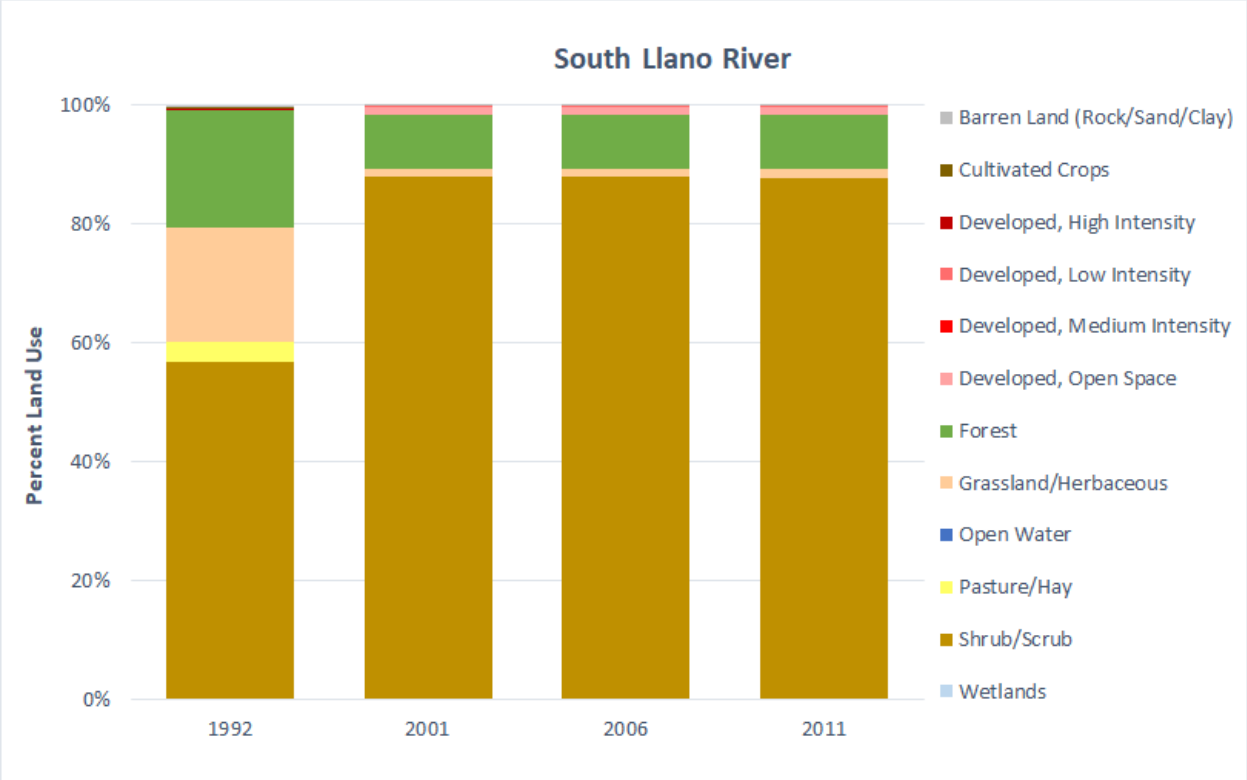

Figure 232. Percent land use in the South Llano River watershed from 1992-2011.

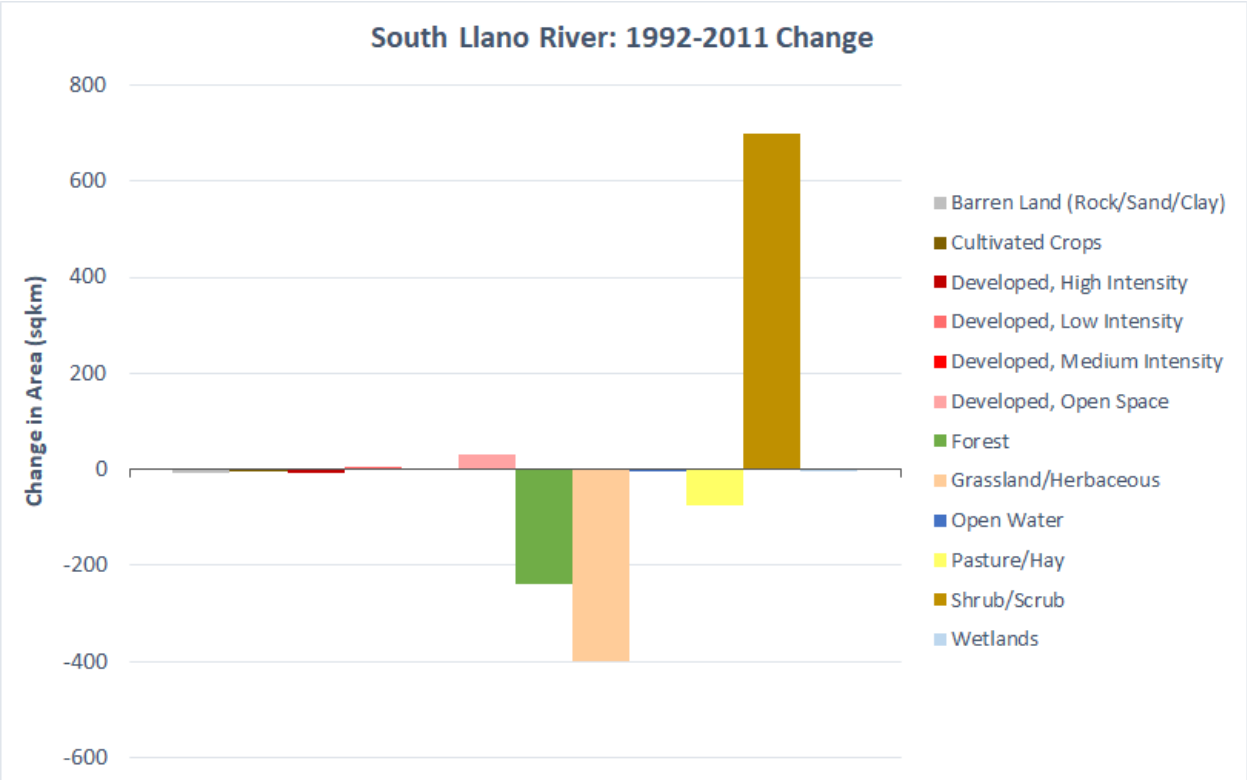

Figure 233. Land use change in area (sq km) from 1992-2011 for the South Llano River watershed.

SPRING CREEK

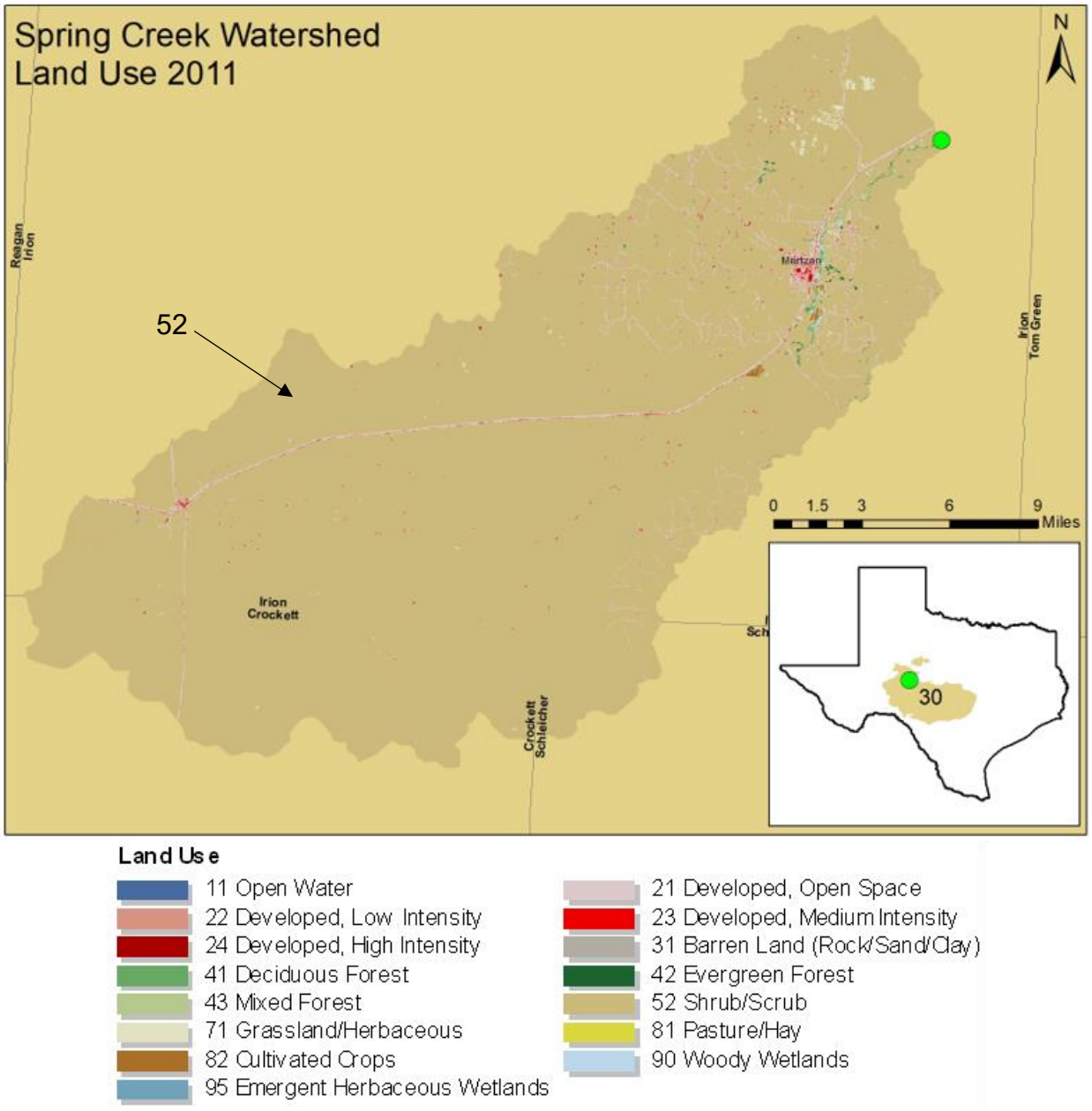

Figure 234. Map of Spring Creek watershed location and 2011 land use; shrub/scrub was the most common land use.

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.

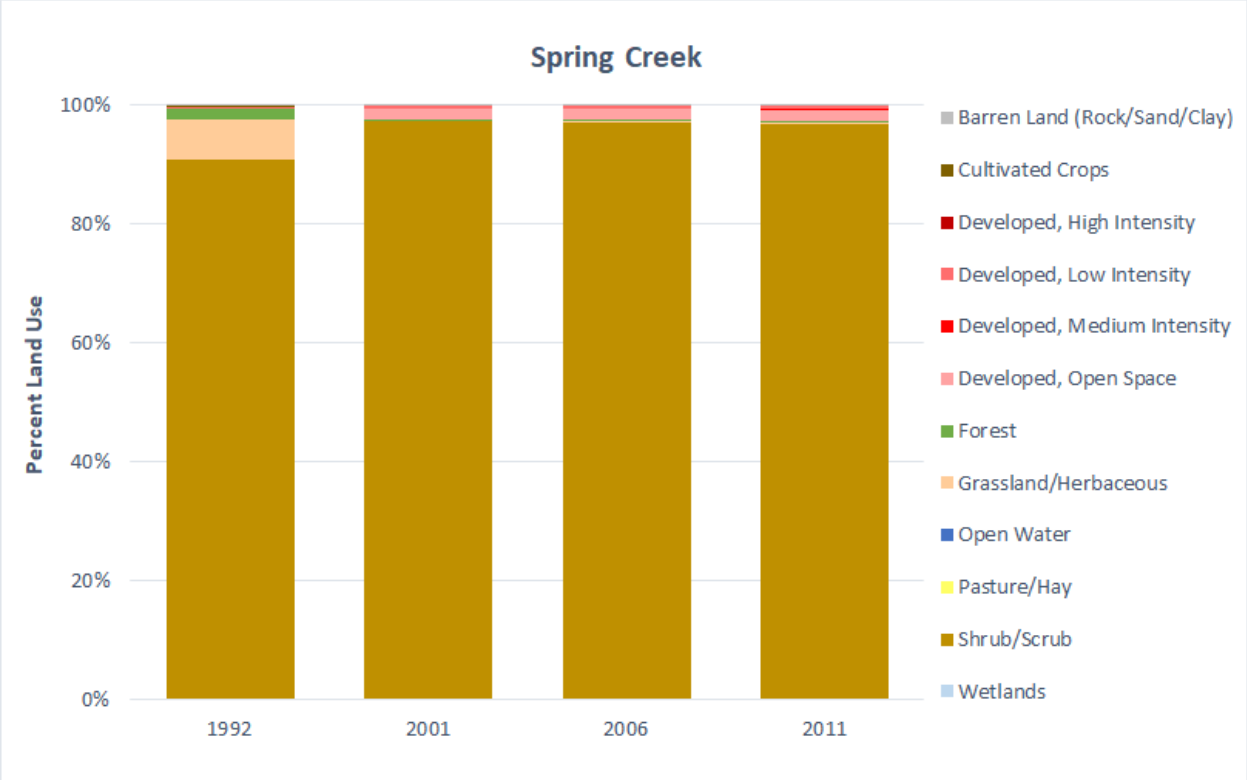

Figure 235. Percent land use in the Spring Creek watershed from 1992-2011.

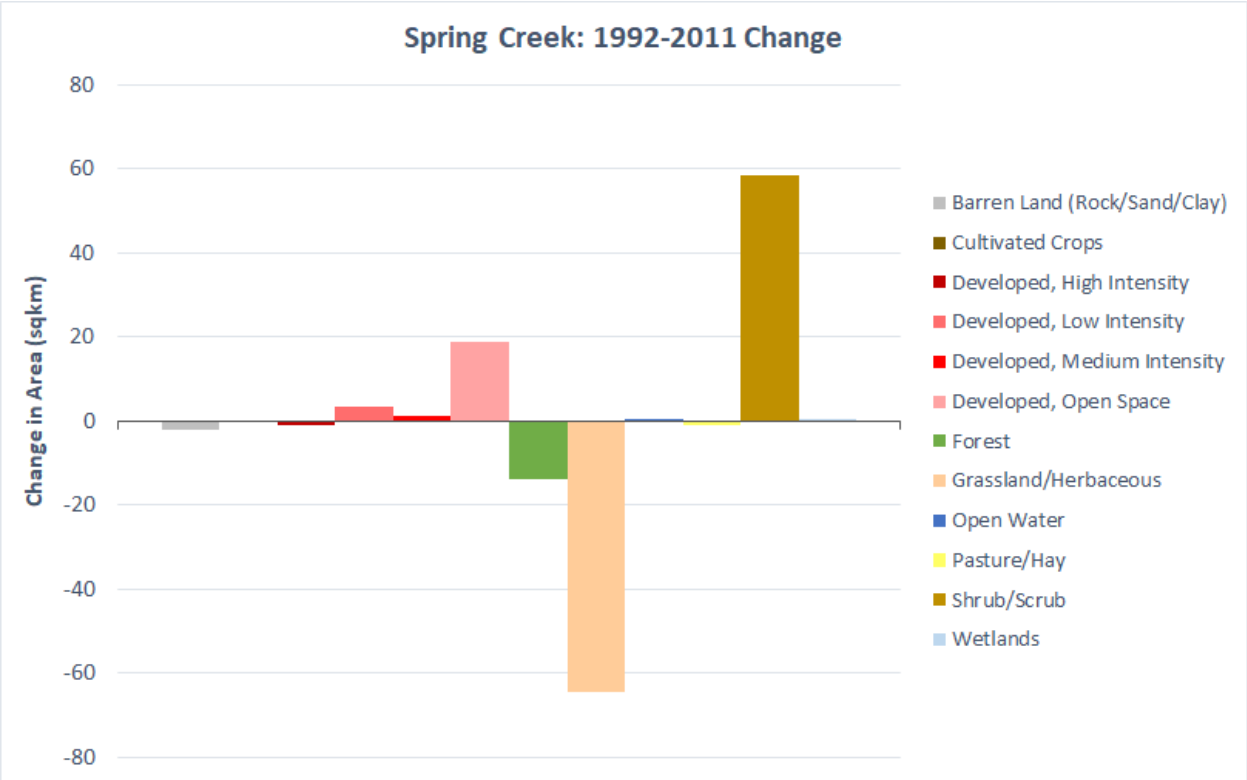

Figure 236. Land use change in area (sq km) from 1992-2011 for the Spring Creek watershed.

WEST ROCKY CREEK

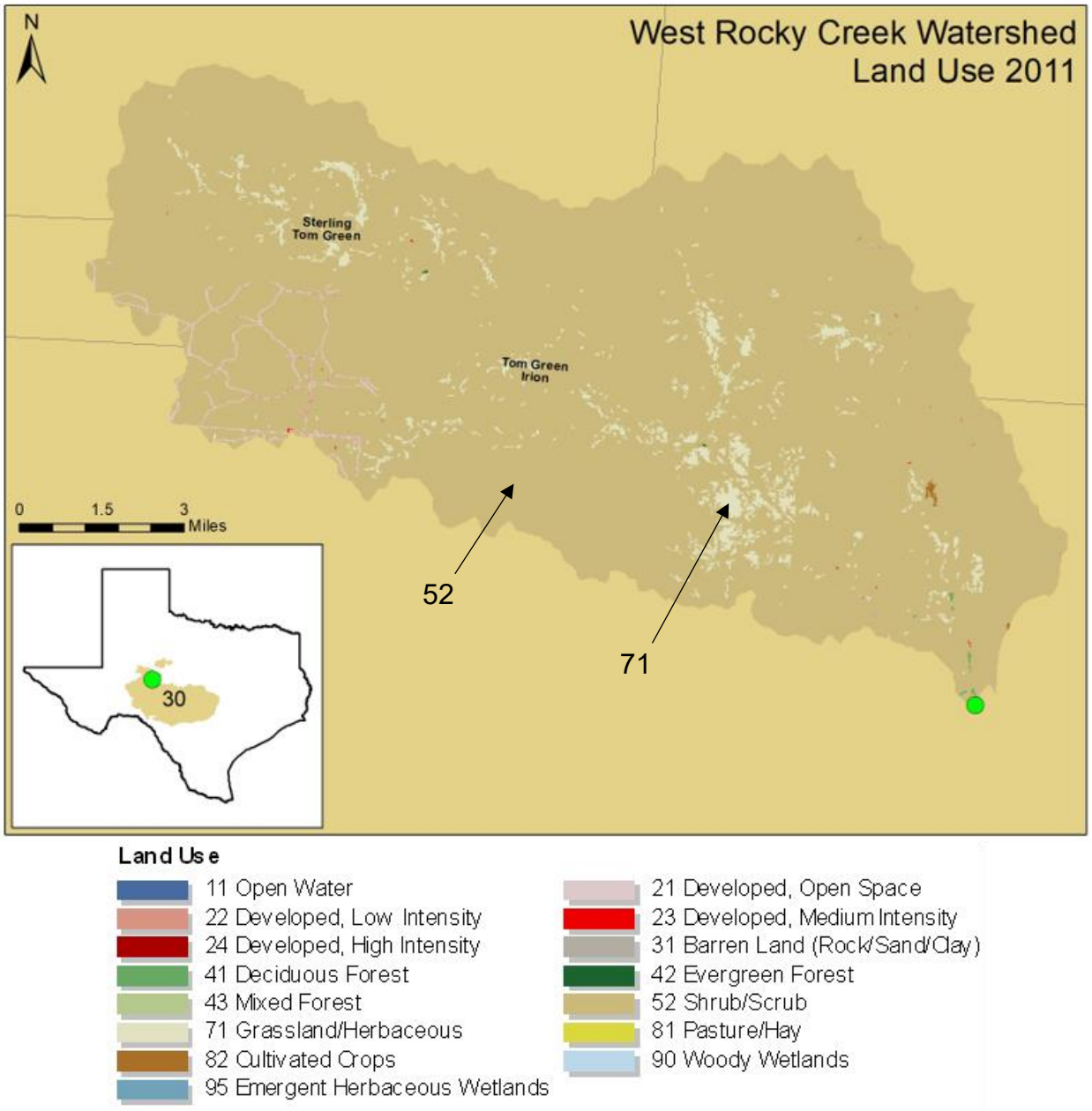

Figure 237. Map of West Rocky Creek watershed location and 2011 land use; shrub/scrub and grassland/herbaceous were the most common land uses.

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.

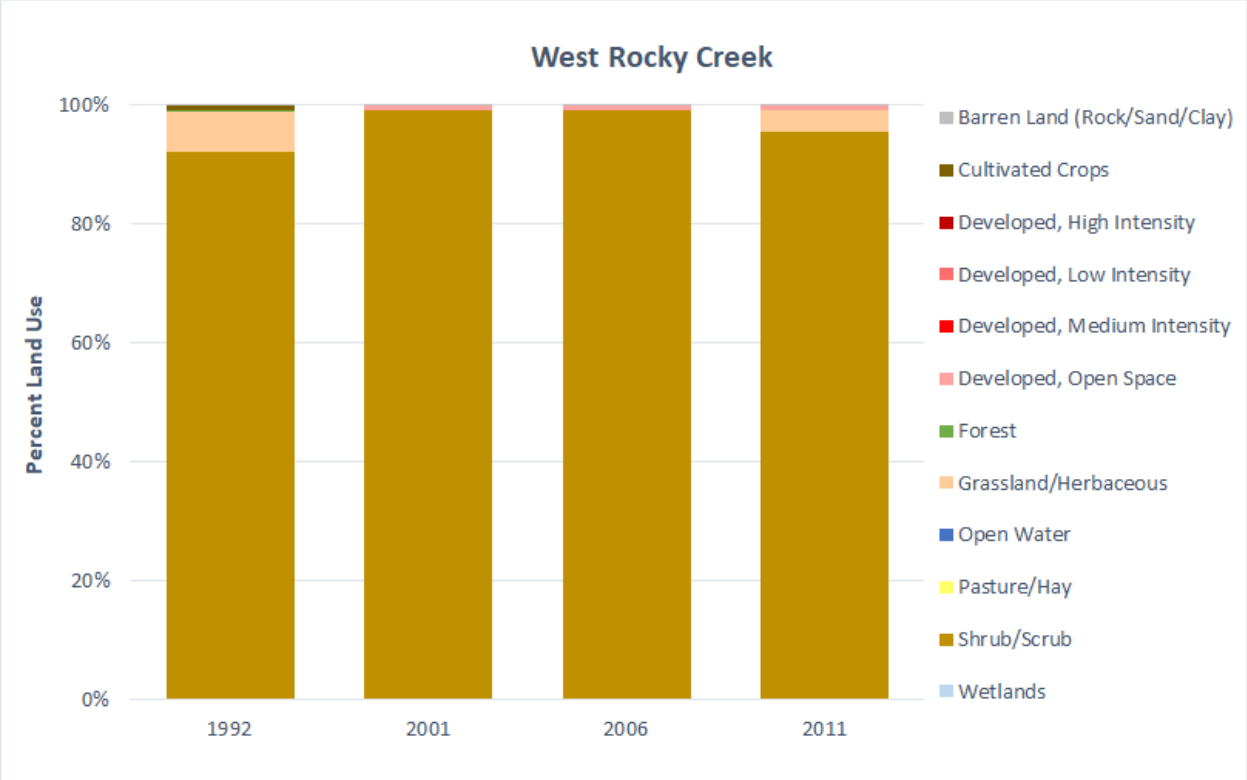

Figure 238. Percent land use in the West Rocky Creek watershed from 1992-2011.

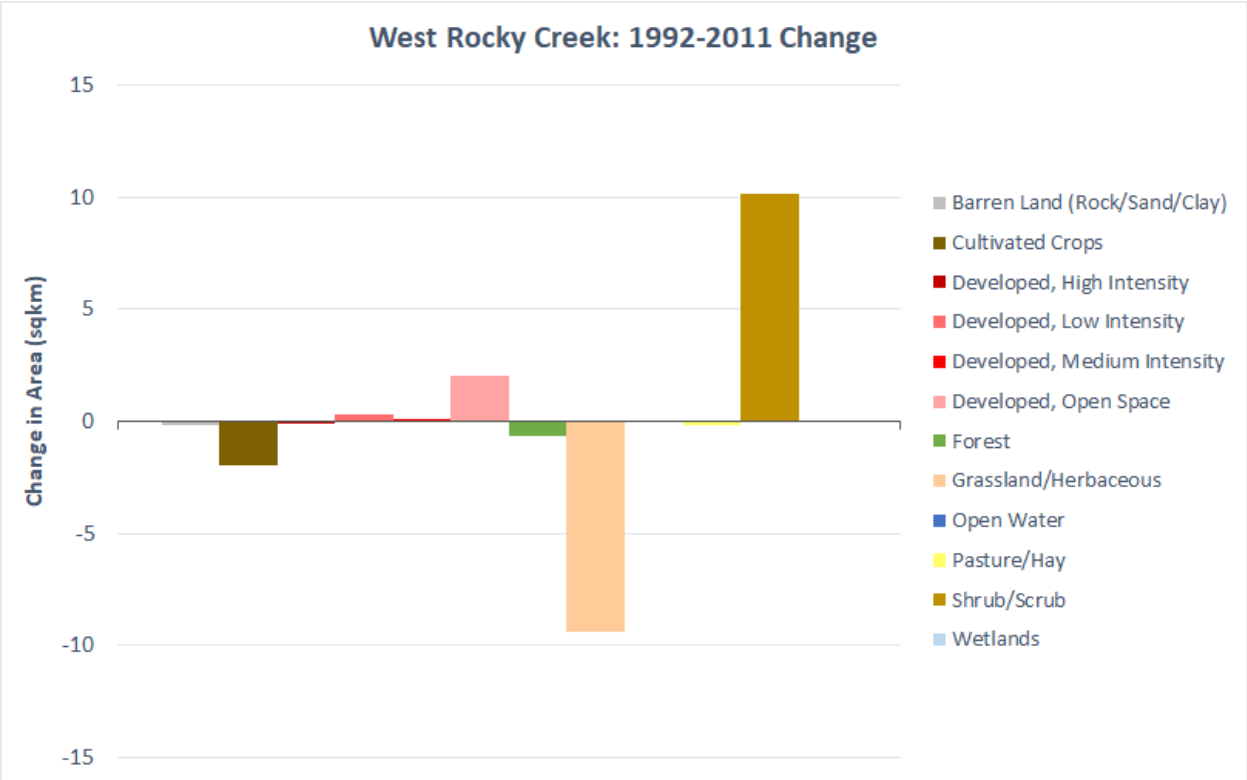

Figure 239. Land use change in area (sq km) from 1992-2011 for the West Rocky Creek watershed.

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).

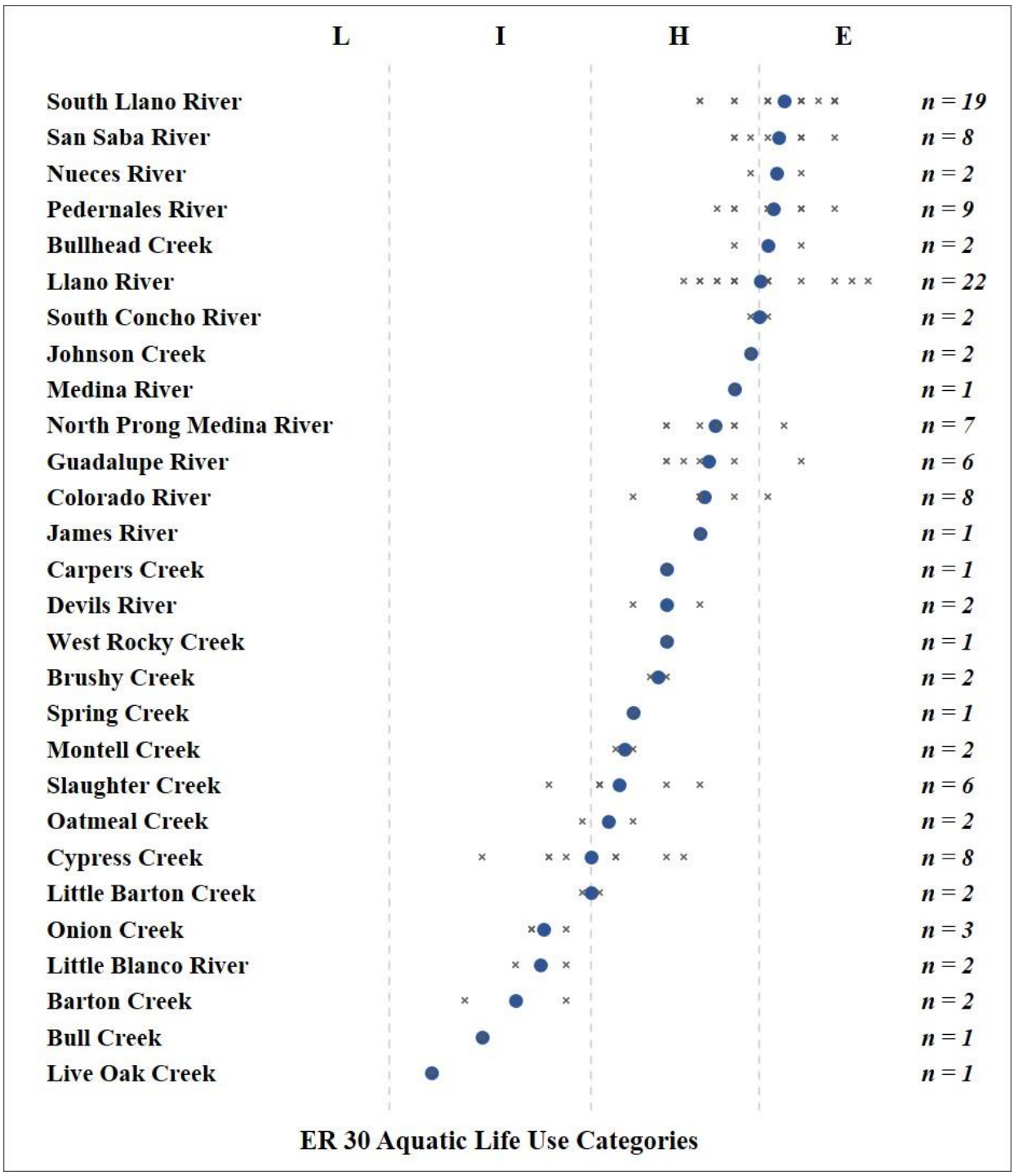

Figure 240. Aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all fish sampling events in Ecoregion 30 grouped by site and ranked by mean ALU score (blue dot); number of sampling events per site noted on right.

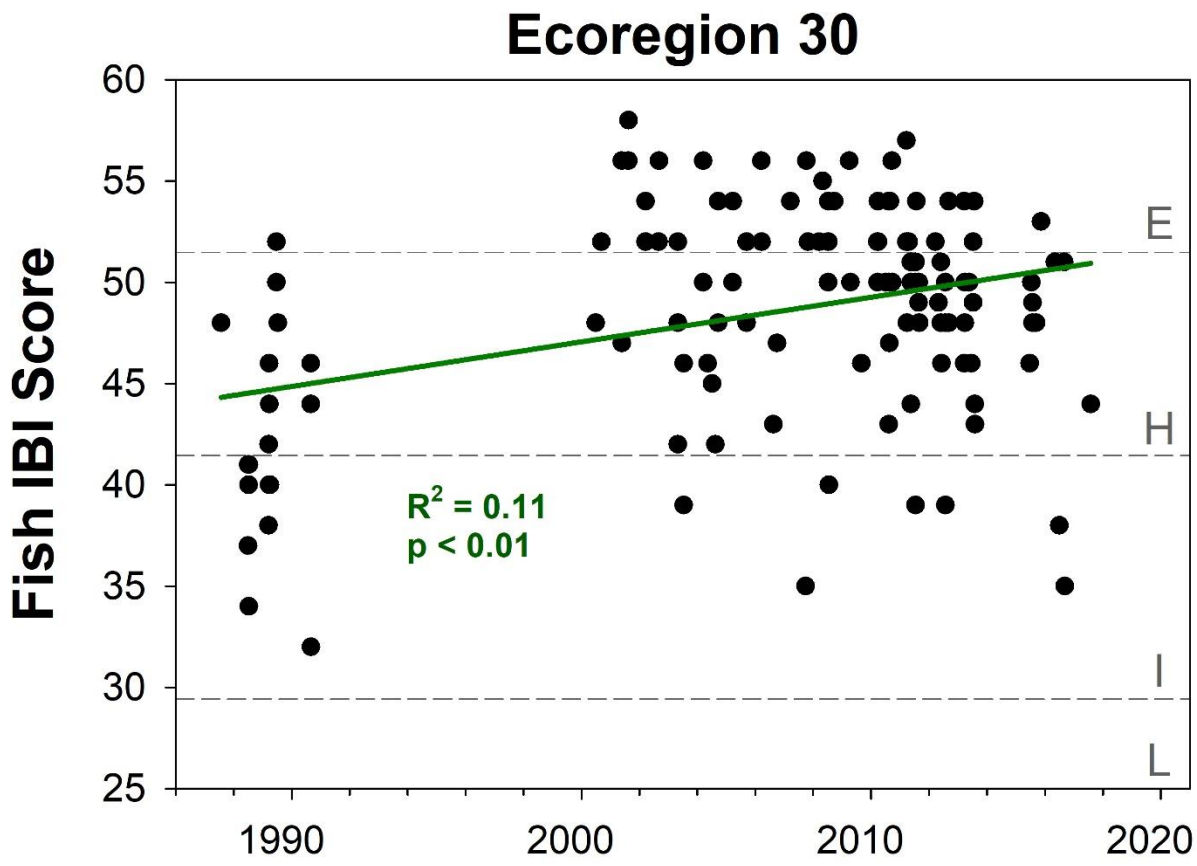

Figure 241. Fish index of biotic integrity scores through time for all sampling events in Ecoregion 30; break lines for aquatic life use categories (i.e., limited, intermediate, high, and exceptional) shown on each graph for reference (see Linam et al. 2002).

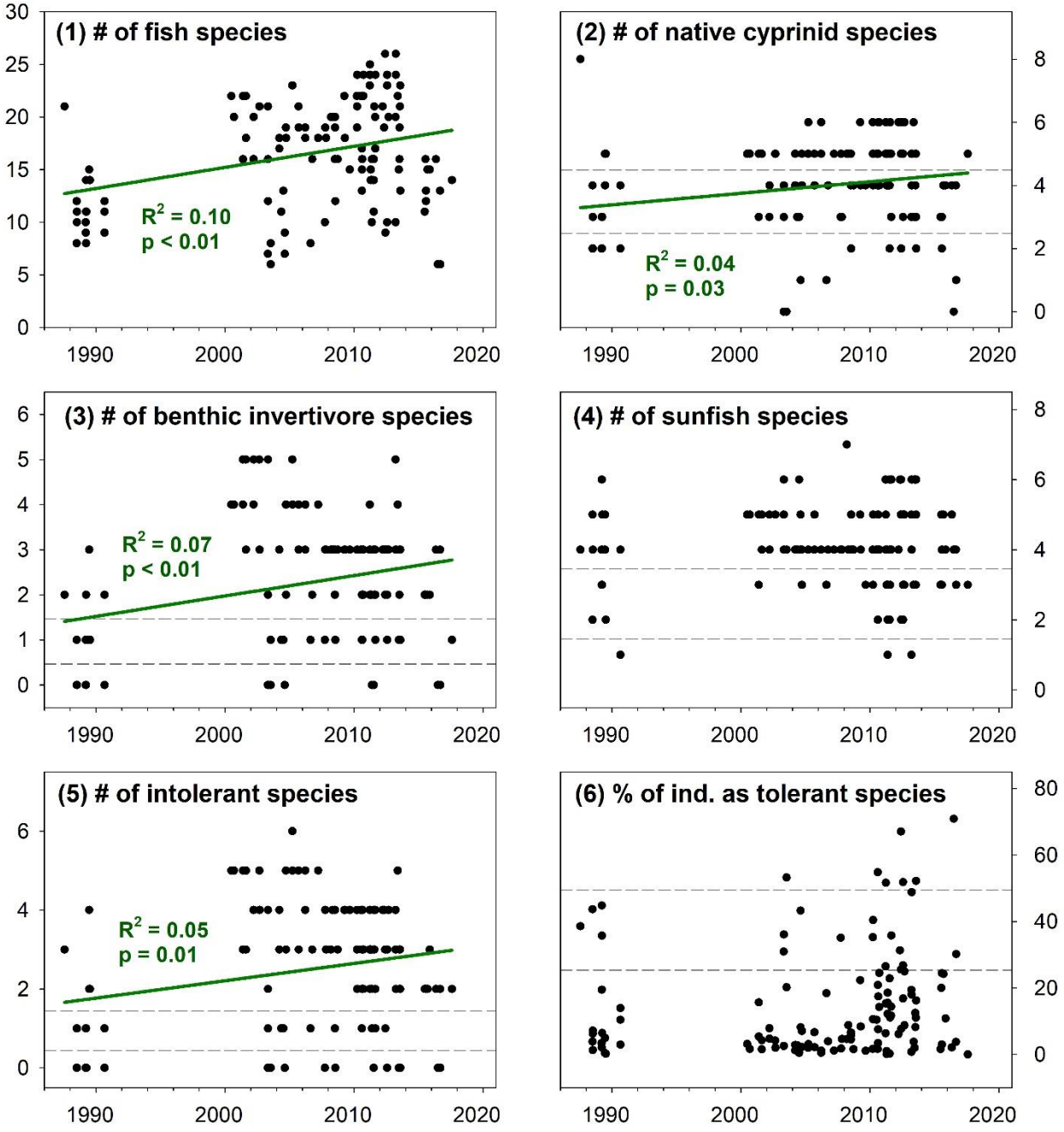

Figure 242. Raw values for fish index of biotic integrity metrics 1-6 through time for all sampling events in Ecoregions 30; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002).

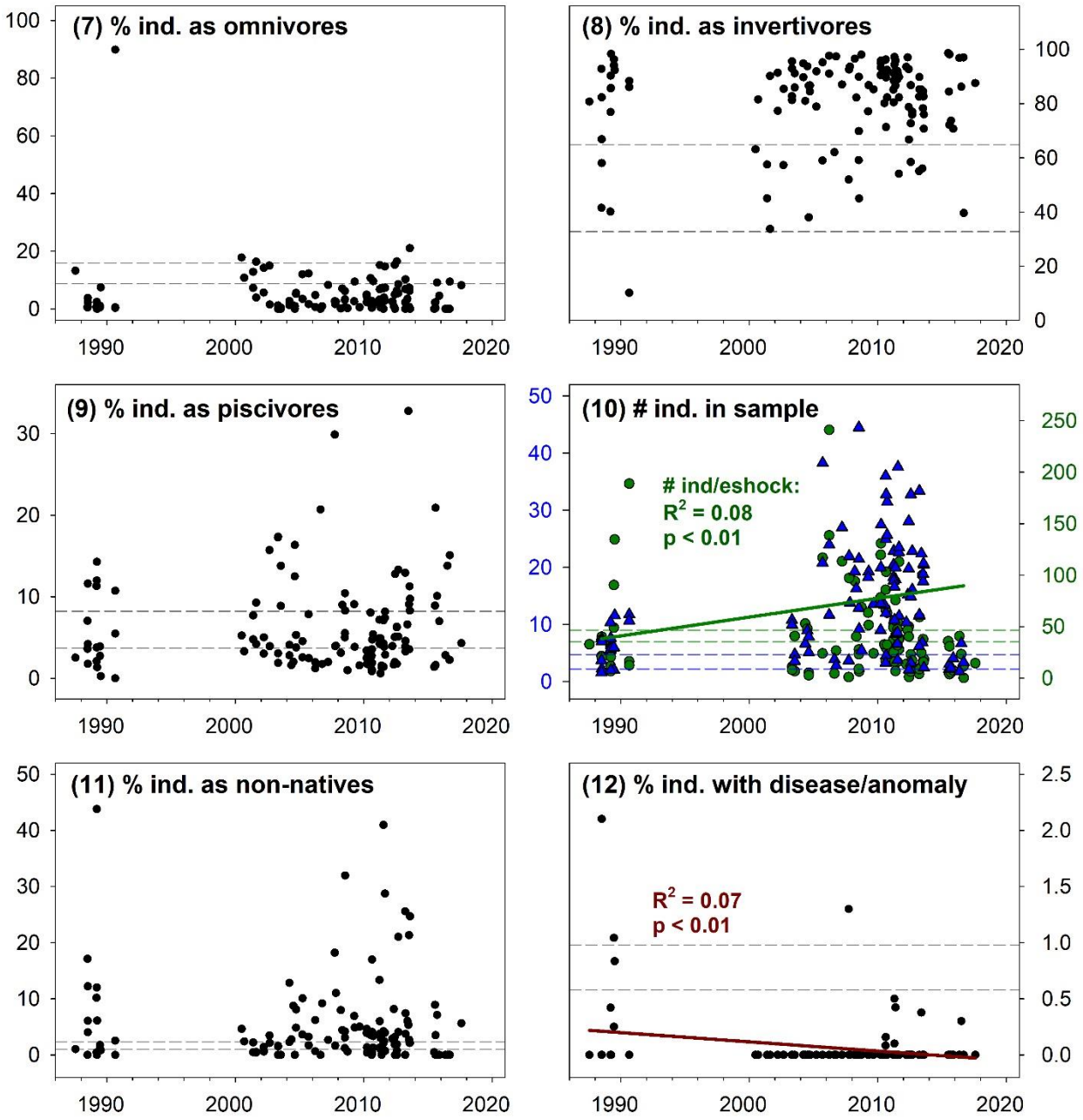

Figure 243. Raw values for fish index of biotic integrity metrics 7-12 through time for all sampling events in Ecoregions 30; break lines for scoring criteria (i.e., 1, 3, and 5) shown on each graph for reference (see Linam et al. 2002); number of ind./seine haul represented by green circles and number of ind./min electrofishing represented by blue triangles for metric number 10.

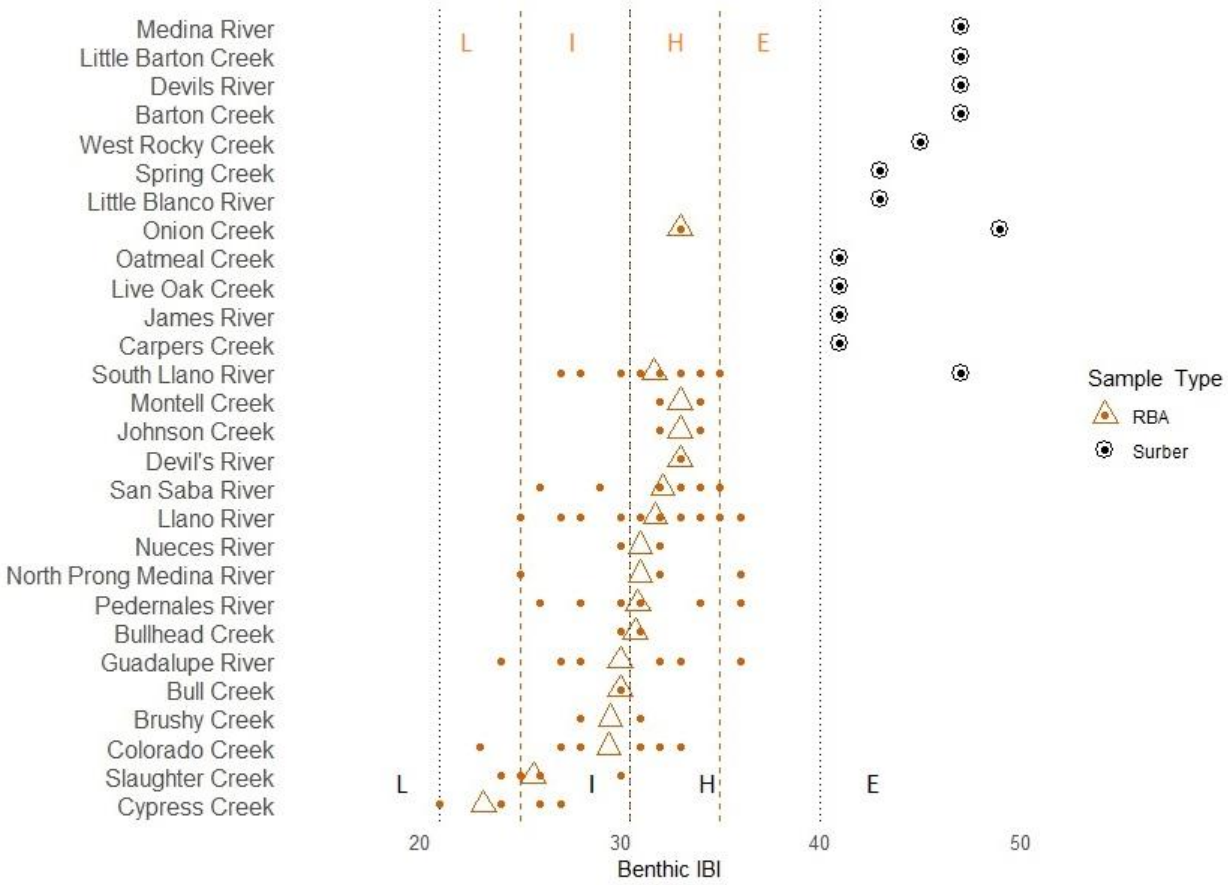

Figure 244. Benthic IBIs and aquatic life use categories (L – limited; I – intermediate; H – high; E – exceptional) for all benthic sampling events in Ecoregion 30 grouped by site and ranked by mean IBI score. Site scores are solid circles, and mean scores are hollow circles for Surber IBI samples and hollow triangles for RBP IBI samples. RBP IBI ALU cut offs are red dashed lines and Surber ALU cutoffs are in black dotted lines.

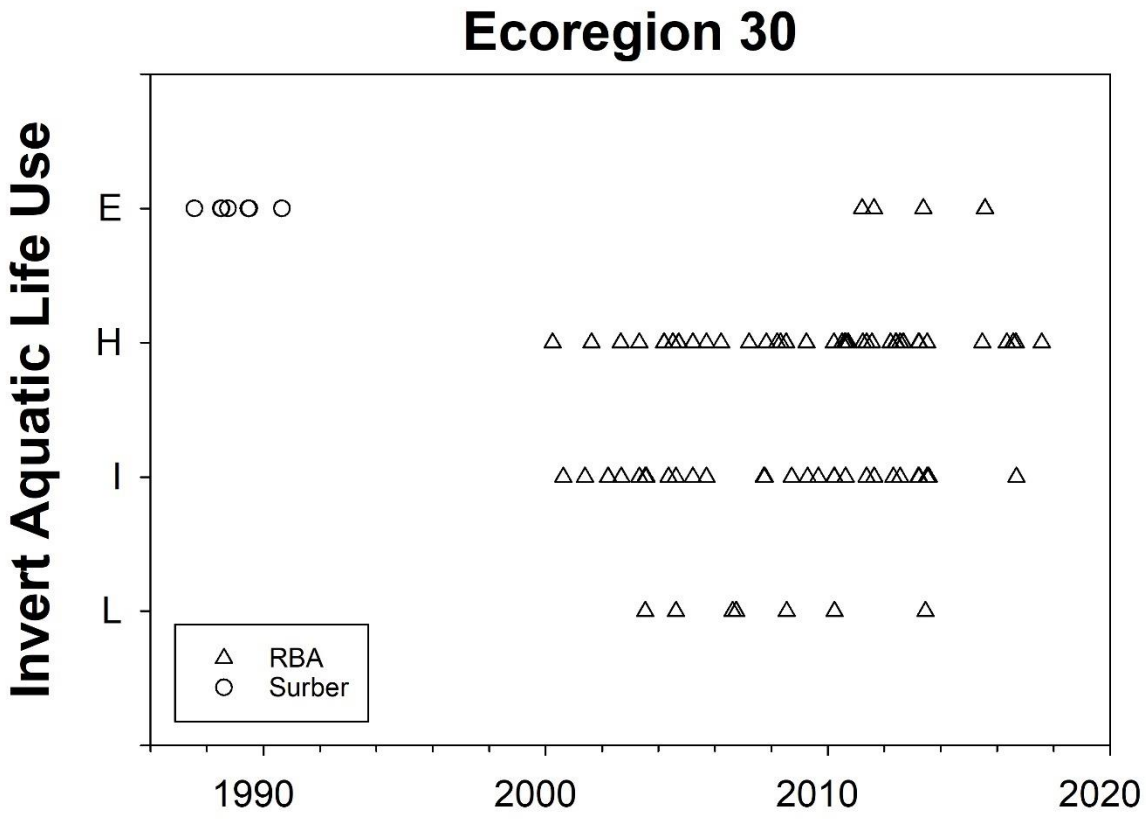

Figure 245. Benthic aquatic life use (ALU) categories through time for all sampling events in Ecoregion 30; Surber ALUs are noted by circles and RBP ALUs are noted by triangles.