Shifting Baseline Syndrome Prevention in North Central Texas Streams – A Scientific Collections Study in the Upper Trinity Basin

Professional Paper
April 20, 2022

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Abstract

Shifting baseline syndrome (SBS) can be defined by two criteria: (1) biological change must be present in the system and (2) any perceived changes must be consistent with the biological data. Within the Upper Trinity basin (6-digit Hydrologic Unit Code (HUC) – 120301), studies indicate biological change has been occurring within north central Texas stream systems for many years due to historical agricultural landuses and subsequent urbanization; however, consistent biological data is absent in many of these waterbodies (as identified in two well-developed, statewide aquatic life databases) to definitively support perceived changes on a basin-wide scale. Fish and mussel assemblages are variable between streams; therefore, true SBS status must be evaluated on a stream by stream basis to draw conclusions on the status of SBS in the overall Upper Trinity basin. In an effort to close these "data gaps" (incomplete or absent biological data) in the Fishes of Texas (FoTX) and Mussels of Texas (MoTX) databases with the overall goal of preventing SBS in the future within the Upper Trinity basin, this scientific collection study intends to provide well-documented accounts of fish and mussels species at several mid-sized streams in north central Texas. Results indicate that collected fish and mussel occurrence data (in the form of color photographs (mussels) and donated voucher specimens (fishes)) may provide new baseline conditions for sampled streams. Additionally, all collected data assisted in the development of the FoTX and MoTX databases and can be used by a variety of aquatic biologists from academia, agencies, and commercial firms.

Introduction

Shifting baselines are a familiar concept to fisheries and aquatic biologists. In 1995, marine biologist Daniel Pauly described the concept of "shifting baseline syndrome" in fisheries management in a publication which identified a fundamental problem in the way fisheries biologists assessed existing populations. Essentially, Pauly (1995) states that shifting baseline syndrome (SBS) influences the way fisheries biologists assess and manage stocks. Pauly (1995) further argues that each subsequent generation of fisheries scientists "accepts the "baseline" of stock size and composition that occurred at the beginning of their careers and uses [these] to evaluate changes". Due to this trend, Pauly (1995) concludes that as each generation starts their careers, stocks have declined; yet are incorrectly used to ultimately make management decisions. This results in the identified SBS, which is stated to cause the "gradual shift of the baseline, a gradual accommodation of the creeping disappearance of resource species, and inappropriate reference points for evaluating economic losses resulting from overfishing, or for identifying targets for rehabilitation measures" (Pauly (1995)).

The concept of SBS (an incorrect acceptance of the existing environmental state as a baseline for historic conditions) is further supported by unrelated psychological studies, such as those referenced in Kahn (2002), which describes the concept under a different term coined "environmental generational amnesia" (EGA). EGA is used to describe a phenomenon observed in children which can be summarized as a generational failure to observe or recognize

environmental degradation in a system experiencing progressive impoverishment due to a lack of consideration of how the given system was observed by previous generations (Kahn (2002)).

Summarily, as demonstrated by Pauly (1995) and Kahn (2002), the concepts of SBS and EGA provide clear evidence that there is a fundamental problem in the modern evaluation of environmental baselines which unfortunately does not discriminate between the average person and experienced natural resource managers.

A viable preventative against the detrimental effects of SBS/EGA in wildlife and fisheries management are natural history collections (biocollections). Historically, faunal and floral biocollections were limited to physical repositories of formal species records documented in the form of voucher specimens, hardcopy or digital photographs, and written word maintained by various organizations including academic institutions and state/federal agencies that provided verifiable accounts of species collected from various locations throughout recent history; however, in the modern era many biocollections now maintain digital databases of these species records that can be readily accessed online. By increasing ease of access, biocollections that have created and maintained digital repositories of existing species records allow researchers, consultants, and natural resource managers instant access to a wealth of species distribution and occurrence data which can assist in making informed management decisions. In providing both recent and historic reference points, digitized biocollections provide an invaluable resource in the form of searchable species records which can be used to not only understand baseline species assemblages, but also aid in recognizing population trends, if used alongside new data from directed survey efforts (i.e. live-capture sampling, acoustic monitoring, point-count surveys, etc.). Two such biocollections, which maintain state-of-the-art, publicly available, digital databases, are the Fishes of Texas and Mussels of Texas projects. These Texas-based databases provide instant online access to millions of freshwater fish and mussel occurrence records collected from hundreds of reputable sources to include federal/state/local agencies, academic institutions, and consultants.

The Fishes of Texas project (FoTX) is a collection of ichthyological records from over 40 institutions maintained by The University of Texas (UT) at Austin Biodiversity Center. The fish collection holds more than 1.5 million specimens across 70,000 lots, which represent 216 Texas counties. FoTX has its origins in the extensive statewide fish collection activities of Dr. Clark Hubbs which began in the late 1940s as part of his diverse research projects (Hendrickson and Cohen, 2015). Dr. Hubbs' growing collection of voucher specimens eventually became the fish collection of UT's Texas Natural Science Center's Texas Natural History Collection (TNHC) (Hendrickson and Cohen, 2015). In the late 1990's, Dr. Dean Hendrickson began compiling and standardizing museum specimen-based collections data on the state's fish fauna (Hendrickson and Cohen, 2015). In subsequent years, Dr. Hendrickson and his team have focused on developing a web interface to showcase the FoTX database. To supplement the development of the database, Dr. Timothy Bonner of Texas State at San Marcos provided his group's species accounts to FoTX in 2009. Digitization of the online database was further improved by the inclusion of UT's Texas Advanced Computing Center (TACC). Today, the online FoTX database provides an easily accessible account of thousands of fish occurrence records which include collectors' original field

notes, specimen photographs, images of ancillary documentation, a large collection of images of both preserved and live specimens, along with full color illustrations of many species and taxonomic identification keys. The most recent version of the FoTX database is maintained within the greater Global Biodiversity Information Facility (GBIF) database.

The Mussels of Texas project (MoTX) is a comprehensive, high-quality biodiversity database of freshwater mussel occurrences covering the entire state of Texas which is maintained by Texas A&M's Natural Resource Institute (NRI). Utilizing partial funding from the Texas Department of Transportation (TxDOT) over a 10-year period, freshwater mussel occurrence data was collected from museums, state agencies, academia, and private companies (Randklev et al., 2020). This occurrence data was checked for correctness, georeferenced (if applicable), and uploaded into the online database. This database provides a comprehensive resource for those working with freshwater mussels and is used for a variety of purposes from scholarly research to developing avoidance and minimization procedures for commercial development projects.

Both the FoTX and MoTX online databases provide aquatic biologists with thousands of readily available, verifiable species occurrence records to assist in making management decisions. Real world applications for these databases include: graduate and doctoral research, Aquatic Resource Relocation Plans (ARRP), and threatened/endangered species studies. By querying these high-quality databases, aquatic biologists gain access to both recent and historic accounts of species occurrences which can be used to effectively assess baseline assemblage conditions for riverine resources, provided occurrence data exists proximal to a given study area.

As stated above, data used to develop these databases comes from many sources. These sources ranging from well-documented agency occurrence accounts to handwritten field notes from the 1800s. Based on this variability in sources, occurrence data can be occasionally limited or incomplete. Despite a rapidly growing and ecologically degrative context, the Dallas-Fort Worth area (DFW) located in north central Texas contains many reaches of stream with either poorly documented, incomplete, or otherwise absent freshwater fish or mussel occurrence records. This presents a problem for biologists which are required to relocate or manage common, rare, or state/federally protected aquatic resources, as baseline conditions (e.g. fish and/or mussel records) are sometimes not available. The result of this encountered absence of species records normally results in the documentation of fish or mussel species which are either relocated or handled in the FoTX and MoTX databases; however, thus begins the progression of SBS for these stream reaches; as the submitted records provide only a snapshot of existing conditions with no prior records of historic populations for reference ("baseline" conditions). Unfortunately, many comprehensive fish and mussel occurrence accounts come from "fish kill" events documented by agency staff, which occur due to ecologically destructive accidents ranging from chemical releases to unauthorized dewaterings. These accidents can result in extremely high mortality in fish and mussels. Without established baselines (e.g. species occurrence records), rehabilitation of stream resources to prior ecological condition can be problematic or all together impossible.

Based on the above discussion, online biocollection databases, such as FoTX and MoTX provide an invaluable resource that should be built upon whenever possible to prevent the progression of

SBS as it pertains to Texan freshwater fish and mussel populations. These databases rely on the collaborative effort of many individuals and institutions. In an effort to close data gaps within these databases and to assist in the preventing SBS in the DFW area, the purpose of this scientific collections study was to live-capture, formally document, and submit species occurrence records of freshwater fish and mussels to the FoTX and MoTX databases.

Methodology

Database Coordination

The initial step in this study was coordinating with the curators of the FoTX and MoTX databases. Correspondence with Dr. Charles Randklev (MoTX) and Mr. Adam Cohen (FoTX) took place early in the planning phase of this study to ensure data was collected and delivered to each database in preferred formatting. Sampling for FoTX entailed the live-capture, enumeration, and documentation of freshwater fishes through the collection of voucher specimens and representative photographs for submittal to the database. At each sampling location, a representative subset of each collected species was vouchered and physically submitted to the FoTX curators, along with an electronic manifest of all live-captured fishes. Sampling for MoTX entailed the live-capture, enumeration, and documentation of freshwater mussels through the collection of voucher photographs for submittal to the database. In addition to live mussels, observations of valves were also documented with photographs and submitted to the MoTX database.

Sampling Location Selection

Prior to the determination of sampling methodology, sampling locations were selected based on the following criteria:

1. Data gap present in FoTX and/or MoTX database(s).
2. Sampling location is legally accessible (e.g. surrounding lands are public, stream is navigable under Texas state law, etc.).
3. Sampling location can be traversed safely to achieve study objectives.

Based on these criteria, it was determined that there were numerous potential sampling locations in the DFW area that have poor, limited, or absent freshwater fish and/or mussel occurrence records in the FoTX or MoTX databases. Utilizing the online databases in combination with a spatial data review conducted with the Environmental Systems Research Institute (ESRI) geographic information systems (GIS) software ArcGIS Pro, sampling sites were further narrowed down to include streams surrounded by public lands (e.g. city parks, United States Army Corps of Engineers (USACE) project lands, etc.) that could be accessed from the shoreline. Reviewed GIS spatial data included: the National Hydrography Dataset (NHD), the Watershed Boundary Dataset

(WBD), the LWRCRP Statewide Inventory Data Set (2016), municipal parcel data, United States Geological Survey (USGS) topographic maps, recent/historical aerial imagery from various public sources, and the recently released Texas stream groupings mentioned in the collaborative "Texas Freshwater Mussel Survey Protocol" created by the United States Fish and Wildlife Service (USFWS) and TPWD. Additionally, other species databases such as GBIF and the USGS Nonindigenous Aquatic Species (NAS) database were queried to determine if species records may have existed for prospective sampling locations in sources other than the FoTX or MoTX databases. Final sampling locations (by coincidence) generally consisted of lower order, wadeable streams, as most larger streams (such as the West Fork Trinity River or streams of similar size) had previous fish and mussel records. Additionally, the Preservation Society for Spring Creek Forest Preserve expressed interest in a fish survey of Spring Creek within Spring Creek Forest Preserve located in Garland, Texas. This fish survey was conducted as part of this larger study; however, will only be discussed in limited detail in this document. A copy has been furnished at the end of this document in "**Attachments**".

TPWD Scientific Permit for Research

A Scientific Permit for Research (SPR) is required to collect, salvage, band, or hold native Texas wildlife for scientific purposes. Scientific purposes include activities aimed at enhancing, protecting, conserving, or managing protected wildlife, or furthering scientific understanding of a resource or the environment (TPWD, 2022). Based on these legal requirements, an SPR was acquired from the Texas Parks and Wildlife Department (TPWD) to conduct freshwater fish and mussel surveys for this study. All collection, holding, and/or live-capture of freshwater fishes and mussels conducted for this study was authorized under the authority of TPWD-issued Scientific Permit Number SPR-0421-054. Authority to live-capture common, rare, and state-listed threatened/endangered species was granted by TPWD under the requested SPR. Taxa-specific methodology utilized in this study, as authorized under the acquired SPR, is described below.

Freshwater Fish – Field Sampling Protocol

Based on study objectives, it was determined that the live-capture of freshwater fishes could be accomplished via seining. Sampling methodology was derived from Chapter 3 of the TCEQ document "*Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Assemblage and Habitat Data*". Seining is a live-capture method which can generally be described as the manual capture of fishes utilizing mesh seines. The size of seines deployed depended on habitat type and included a 30 ft × 6 ft × ¼ in delta-weave mesh seine with double lead weights on the bottom line for pools and a 15 ft or 6 ft × 6 ft × 3/16 in delta-weave mesh seine with double lead weights on the bottom line for riffles, runs, and smaller pools. At each location, survey effort consisted of at least six effective seine hauls covering at least 60 meters in accordance with the TCEQ guidance document; however, based on previous TPWD studies that utilized seining to achieve high efficacy sampling in two mid-sized DFW streams (Wilson Creek

and Clear Creek) it was estimated that 10-12 effective seine hauls would be required to effectively characterize fishes at each location (Linam, Kleinsasser, & Mayes, 2002). Seining was continued until no new species were collected and all available habitats were adequately sampled. All seining activities took place during daylight hours and inspected for any holes and repaired or replaced prior to each use to ensure sampling efficacy. Seines were operated with the assistance of 2 to 3 unpermitted assistants (volunteers). Prior to each sampling event, a TPWD Game Warden was notified as specified in SPR guidance, since the live-capture of game species with a seine would not normally be legal. Live-captured fishes were held in 5-gallon buckets with aerators until the completion of seining activities. Care was taken to reduce stress on the collected fishes whenever possible. Stress minimization techniques included: placing fish containers in the shade, utilizing multiple containers to prevent crowding stress, and handling to the minimal extent possible. At each location, a GPS point was taken at the mid-point of each survey reach. Upon completion of seining, fishes were enumerated, identified to the species level, and either released or vouchered. Preservation methodology is provided in the next subsection.

Freshwater Fish – Voucher Specimen Collection

At each location, a representative subset of collected fish species were vouchered for donation to the UT fish collection (physical specimen repository for FoTX). Preservation methodology followed guidelines in the previously mentioned TCEQ document. Fishes to be preserved were placed in 10% formalin (one part full-strength formalin and nine parts water). Larger specimens were slit with a sterile blade on the right side of the abdominal cavity to allow proper preservation. Specimens were then left for one week in the preservative (formalin). After one week, specimens were thoroughly rinsed with water and placed into individual glass jars (by species) which contained 70% ethanol. Voucher specimens were then handed over to FoTX curators for accessioning.

Freshwater Mussels – Field Sampling Protocol

Based on study objectives, it was determined that the documentation of freshwater mussel occurrences could be accomplished via timed tactile (by-hand) searches (live mussels) and/or shoreline reconnaissance (valves, recently deceased). Sampling methodology was derived from the TPWD document "*Guidelines for Aquatic Resource Relocation Plans for Fish and Shellfish, Including Freshwater Mussels*" which includes the recently mandated "*Texas Freshwater Mussel Survey Protocol*". At each selected location, a survey area which consisted of all available habitat types with respect to substrate composition was delineated utilizing floating buoys and nylon rope. Within each delineated mussel survey area, a qualitative timed tactile survey of five person-hours was conducted to live-capture mussels. Collected mussels were held submerged in the stream in a mesh diving bag until the completion of the five person-hours. Mussels were then enumerated, identified to the species level, photographed, and then placed back into the substrate in a proper, filtering position. Care was taken to reduce stress on the collected mussels whenever possible.

Stress minimization techniques included: keeping live mussels submerged and in shaded waters, handling to the minimal extent possible, and not removing live mussels from the water for more than five minutes. At each location, a GPS point was taken at the mid-point of each survey reach. Mussel occurrence data (including negative survey results) were then provided to MoTX project curators along with color photographs of surveyed habitat and collected organisms, if applicable.

Freshwater Mussels – Photo Voucher Collection

Whenever possible, live freshwater mussels and valves were photographed utilizing methodology outlined in the TPWD document "*Guide to Photographing Freshwater Mussels*" authored by Robert G. Howells.

Taxonomic Identification Resources

In addition to the FoTX website, primary sources for the identification of freshwater fishes included the following database and publications:

- *Bonner, T. H., Craig, C. A., & Edwards, C. R. (2020). The Inland Fishes of Texas Pictorial Key. San Marcos: Texas State Department of Biology.*
- *Bonner, T. H., Whiteside, B. G., Thomas, C. (2007). Freshwater Fishes of Texas: A Field Guide. United States: Texas A&M University Press.*
- *GBIF.org (2022), GBIF Home Page. Available from: https://www.gbif.org [11 April 2022].*
- *Hubbs, C., R.J. Edwards, and G.P. Garrett. 2008. An Annotated Checklist of the Freshwater Fishes of Texas, with Keys to Identification of Species, 2nd Edition. Texas Academy of Science.*
- *Page, L. M., & Burr, B. M. (2011). Peterson field guide to freshwater fishes of North America north of Mexico. 2nd ed. Boston: Houghton Mifflin Harcourt.*

In addition to the MoTX website, primary sources for the identification of freshwater mussels included the following database, mobile phone application, and publications:

- *GBIF.org (2022), GBIF Home Page. Available from: https://www.gbif.org [11 April 2022].*
- *Howells, R. G., Neck, R. W., Murray, H. D., & Texas. (1996). Freshwater mussels of Texas. Austin, Texas: Texas Parks and Wildlife Dept., Inland Fisheries Division.*
- *Howells, R.G. 2014. Field Guide to Texas Freshwater Mussels. 2nd Edition. Biostudies, Kerrville, Texas. 141 pp.*
- *ScienceApps, L3C (2019). MusselID (Version 1.0.1) [Mobile app]. App Store. https://apps.apple.com/fi/app/musselid/id1478539883?platform=iphone*

Supplemental to the above-mentioned sources for freshwater fishes and mussels, subject matter experts from Texas A&M University, the University of Texas at Austin, and Texas State University were consulted to confirm identifications when necessary.

Results

Sampling Site Selection

All sampling sites for freshwater fishes and mussels were located in the Upper Trinity basin (HUC 6 – 120301). Seven streams were selected as sampling sites for freshwater fishes and eight waterbodies were selected as sampling sites for freshwater mussels. Some waterbodies were sampled at more than one location to improve per-stream sampling efficacy. See **Figure 1** for a visual representation of sampling locations with respect to the greater DFW area.

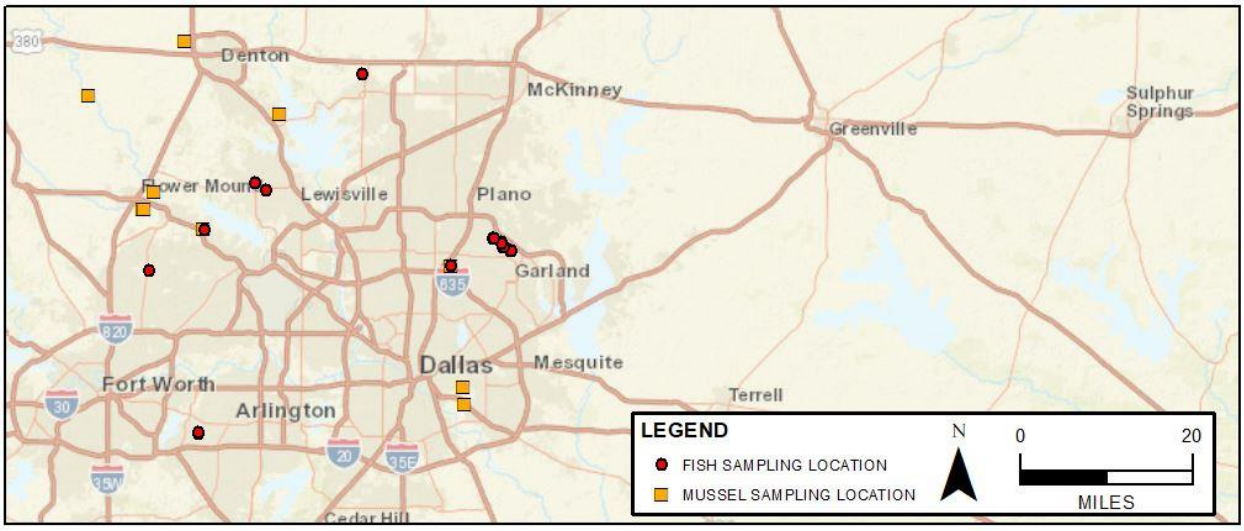


Figure 1. Sampling Site Location Map

Each location was assigned a name for referencing purposes. Naming consisted of the following:

Fish sampling site naming convention:
SurveyorInitals,YearMonthDay,WaterbodyInitialsLocationNumber,EffortNumber

Mussel sampling site naming convention:
SurveyorInitals,WaterbodyInitials,LocationNumber,YearMonthDay

Sampling Efficacy Determination

Fish sampling efficacy was determined for each sampling event. In the context of this study, sampling efficacy is an estimated metric, based on all available information and field observations, which provides an assessment of how effective each sampling event was at collecting a representative sample of the species present in their relative abundances at each location. A table summarizing efficacy classification used in this study (low, moderate, high) is provided below.

Sampling Efficacy Classification	Description
Low	Species collected (n) likely not representative sample of all species at that location (<50%). Only noted on sampling events in which effective seining was nearly precluded due to in-channel debris, jagged substrate, or deep (5ft<) pools which prevented effective seine hauls in some portions of the sampled reach.
Moderate	Species collected (n) likely representative sample of some species at that location; however, it is believed that other species may be present (50% - 75%). Noted on sampling events where thorough seining was possible, but few species were collected.
High	Species collected likely representative sample of all species at that location (75% - 100%). Few other species may be present; however, based on previous studies, collected sample likely suitable for use as a baseline for that location (Linam, Kleinsasser, & Mayes, 2002).

Since mussel sampling included both shoreline reconnaissance and tactile timed searches, sampling efficacy was not estimated for mussel sampling efforts. Rather than an estimate of sampling efficacy, mussel sampling was considered successful if live or the remains of freshwater mussels where found and documented, as across 25 person-hours of effort, only two live mussels were observed.

Fish and Mussel Sampling Results

Per-location sampling results are provided on subsequent pages. All coordinates are reported in decimal degrees in World Geodetic System (WGS) 1984.

Location Name: JJGD,20210619,TC1,1

Date of Collection: 6/19/2021

County/Location Collected: Denton County (33.050634, -97.071826)

Description: Data gap was identified in the FoTX project within this reach of Timber Creek in Flower Mound, TX. Access was achieved through Gaston Park to the north. Seining was difficult due to in channel debris and jagged bedrock substrate (not pictured below). 6 effective seine hauls across 70 meters.

Representative Site Photograph and Vicinity Map:

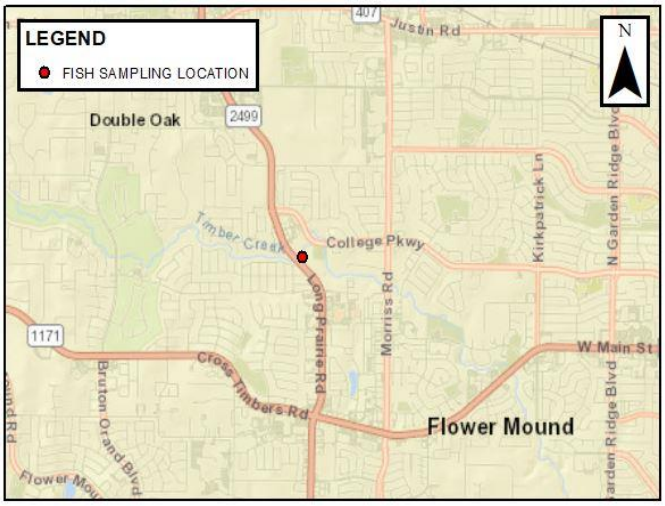


Table of Collected Fishes:

Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Lepomis cyanellus	0	1	0	0	Voucher Specimen, Donated
Lepomis macrochirus	0	3	0	0	Voucher Specimen, Donated

Catch Per Unit Effort (CPUE): 4 fish collected / 2 hours seining effort = 2 fish per hour.

Efficacy Comments: Visually observed other fishes here. Seining ineffective due to jagged substrate and boulder-sized particulate. Efficacy is believed to be low.

Location Name: JJ,20210615,KB1,1

Date of Collection: 6/15/2021

County/Location Collected: Tarrant/Denton County (32.984493, -97.156538)

Description: Data gap was identified in the FoTX project within this reach of Kirkwood Branch in Southlake, TX. Access was achieved through surrounding USACE lands. Seining conducted in riffle only habitat due to depth of pool (pictured, >5' in some areas). 6 effective hauls across 60 meters.

Representative Site Photograph and Vicinity Map: Representative image from Google Street View. Red circle indicates sampled riffles.

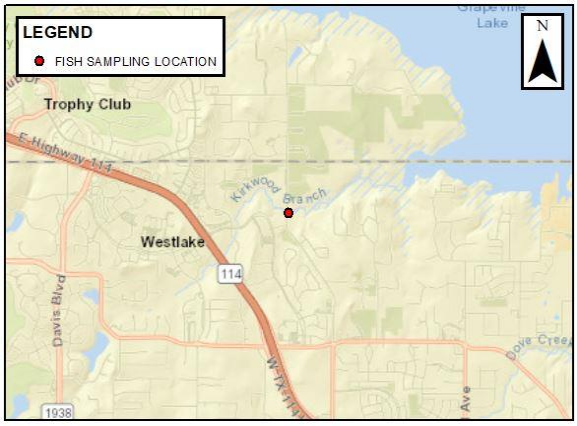


Table of Collected Fishes:

Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Gambusia affinis	0	5	0	0	Voucher Specimen, Donated
Cyprinella venusta	0	3	0	0	Voucher Specimen, Donated

Catch Per Unit Effort (CPUE): 8 fish collected / 1 hours seining effort = 8 fish per hour.

Efficacy Comments: Visually observed other fish species here (*Fundulus* spp., *Lepomis* spp.). Efficacy was low due to depth of pool habitats near roadway.

Location Name: JJRTHT,20210724,TC2,1

Date of Collection: 7/24/2021

County/Location Collected: Denton County (33.040740, -97.052232)

Description: Data gap was identified in the FoTX project within this reach of Timber Creek in Flower Mound, TX. Access was achieved through surrounding city-owned property. 10 effective hauls across 65 meters.

Representative Site Photograph and Vicinity Map:

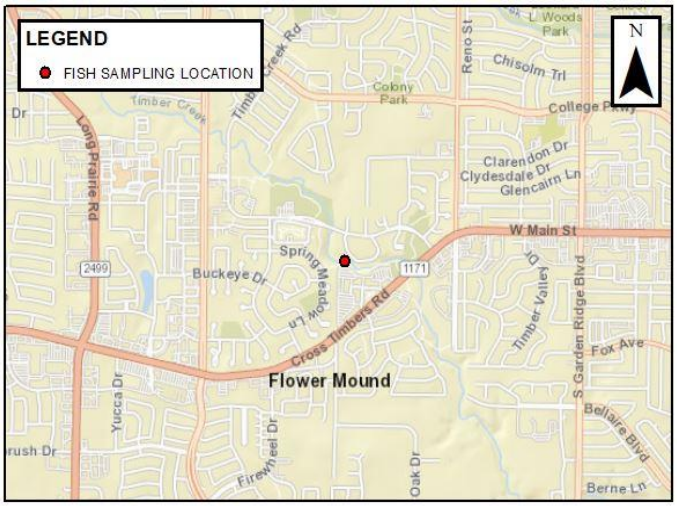


Table of Collected Fishes:

Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Ameiurus natalis	0	4	0	0	Voucher Specimen, Donated
Cyprinella venusta	0	13	0	0	Voucher Specimen, Donated
Gambusia affinis	0	8	0	0	Voucher Specimen, Donated
Lepomis gulosus	0	1	0	0	Voucher Specimen, Donated
Lepomis macrochirus	0	25	0	0	Voucher Specimen, Donated
Lepomis megalotis	0	12	0	0	Voucher Specimen, Donated
Lepomis spp. *(Juveniles)*	0	2	0	0	Voucher Specimen, Donated
Micropterus salmoides	0	1	0	0	Voucher Specimen, Donated

Catch Per Unit Effort (CPUE): 66 fish collected / 3 hours seining effort = 22 fish per hour.

Efficacy Comments: Some species may have not been sampled that are either not active during daylight hours or do not move far from structure. Wet conditions made site photography difficult (fogging up equipment). Efficacy is believed to be high.

Location Name: JJKP,20210807,RC1,1

Date of Collection: 8/7/2021

County/Location Collected: Tarrant County (32.696282, -97.167706)

Description: Data gap was identified in the FoTX project within this reach of Rush Creek in Arlington, TX. Access was achieved through surrounding city-owned property. Location 1 of 2. 12 effective seine hauls across 120 meters.

Representative Site Photograph and Vicinity Map:

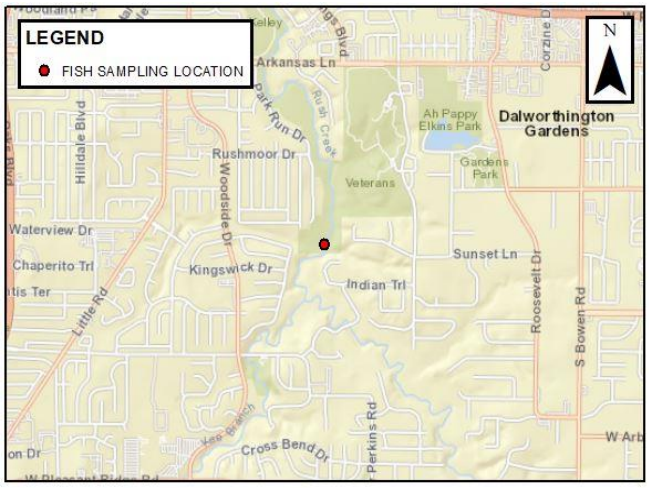


Table of Collected Fishes:

Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Campostoma anomalum	0	1	0	0	Voucher Specimen, Donated
Cyprinella lutrensis	208	12	0	32	Voucher Specimen, Donated
Fundulus olivaceus	13	6	0	0	Voucher Specimen, Donated
Gambusia affinis	0	4	0	0	Voucher Specimen, Donated
Lepomis cyanellus	0	1	0	0	Voucher Specimen, Donated
Lepomis megalotis	0	2	0	0	Voucher Specimen, Donated
Pimephales vigilax	0	2	0	0	Voucher Specimen, Donated

Catch Per Unit Effort (CPUE): 281 fish collected / 2 hours seining effort = 140.5 fish per hour.

Additional Comments: Some species may have not been sampled that are either not active during daylight hours or do not move far from structure. In-stream habitat complexity good for highly urbanized system. Two sampling events were necessary to accurately characterize fishes in this stream due to habitat complexity. Efficacy is believed to be high.

Location Name: JJKP,20210807,RC2,1

Date of Collection: 8/7/2021

County/Location Collected: Tarrant County (32.697756, -97.167176)

Description: Data gap was identified in the FoTX project within this reach of Rush Creek in Arlington, TX. Access was achieved through surrounding city-owned property. Location 2 of 2. 12 effective seine hauls across 120 meters.

Representative Site Photograph and Vicinity Map:

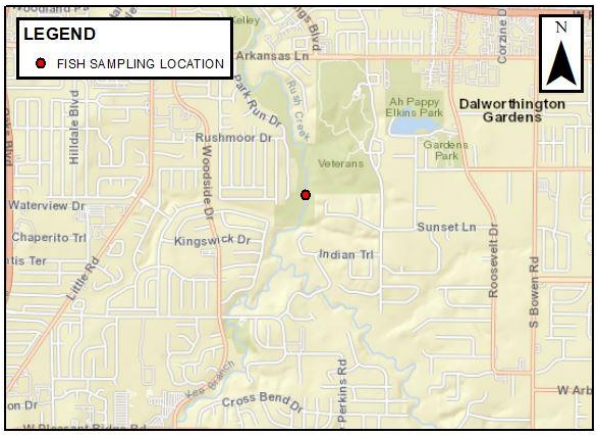


Table of Collected Fishes:

Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Ameiurus natalis	0	1	0	0	Voucher Specimen, Donated
Campostoma anomalum	0	9	0	0	Voucher Specimen, Donated
Cyprinella lutrensis	184	362	0	124	Voucher Specimen, Donated
Fundulus olivaceus	15	60	0	0	Voucher Specimen, Donated
Gambusia affinis	0	17	0	0	Voucher Specimen, Donated
Lepomis macrochirus	0	2	0	0	Voucher Specimen, Donated
Lepomis megalotis	0	15	0	0	Voucher Specimen, Donated
Lepomis spp. (Juveniles)	10	24	0	0	Voucher Specimen, Donated
Micropterus salmoides	0	3	0	0	Voucher Specimen, Donated
Pimephales vigilax	0	30	0	0	Voucher Specimen, Donated

Catch Per Unit Effort (CPUE): 865 fish collected / 2 hours seining effort = 432.5 fish per hour.

Additional Comments: Some species may have not been sampled that are either not active during daylight hours or do not move far from structure. In-stream habitat complexity decent for highly urbanized system. Two sampling events were necessary to accurately characterize fishes in this stream segment due to habitat complexity. Efficacy is believed to be high.

Location Name: JJRT,20210828,PC1,1

Date of Collection: 8/28/2021

County/Location Collected: Denton County (33.204295, -96.889422)

Description: Data gap was identified in the FoTX project within this reach of Panther Creek in Little Elm, TX. Access was achieved through surrounding USACE-owned property. 10 effective seine hauls across 105 meters.

Representative Site Photograph and Vicinity Map:

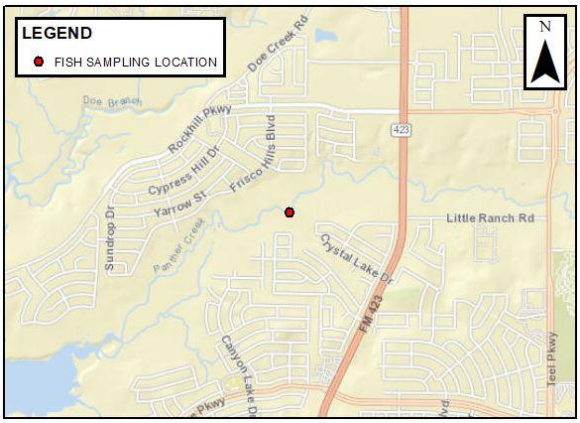


Table of Collected Fishes:

Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Cyprinella lutrensis	160	47	0	14	Voucher Specimen, Donated
Fundulus notatus	0	2	0	0	Voucher Specimen, Donated
Gambusia affinis	0	5	0	0	Voucher Specimen, Donated
Lepomis macrochirus	0	2	0	0	Voucher Specimen, Donated
Lepomis megalotis	0	1	0	0	Voucher Specimen, Donated
Pimephales vigilax	0	1	0	0	Voucher Specimen, Donated

Catch Per Unit Effort (CPUE): 232 fish collected / 2 hours seining effort = 116 fish per hour.

Efficacy Comments: Some species may have not been sampled that are either not active during daylight hours or do not move far from structure. Sedimentation was high in this area and soft substrate made seining difficult. Habitat complexity increased upstream and species diversity is likely to be higher than what is shown above. Efficacy is believed to be moderate.

Location Name: JJMH,20211210,FB1,1

Date of Collection: 12/10/2021

County/Location Collected: Dallas County (32.934224, -96.740891)

Description: TPWD indicated a fish kill due to an effluent release occurred in this reach. Fishes were sampled to see how everything was bouncing back. In the interest of allowing the area to repopulate naturally, no voucher specimens were taken. 10 effective seine hauls across 100 meters.

Representative Site Photograph and Vicinity Map:

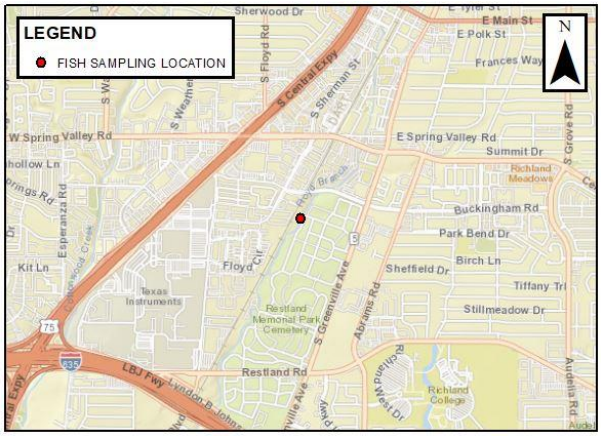


Table of Collected Fishes:

Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Lepomis cyanellus	8	0	0	0	n/a
Gambusia affinis	16	0	0	0	n/a

Catch Per Unit Effort (CPUE): 24 fish collected / 1.25 hours seining effort = 19.2 fish per hour.

Additional Comments: Habitat physically and chemically disturbed by effluent discharge from nearby wastewater facility and evidence of prior channel manipulation. Efficacy believed to be moderate, given the circumstances.

Location Name: JJKP,20210912,BBC1,1

Date of Collection: 9/12/2021

County/Location Collected: Tarrant County (32.927527, -97.249773)

Description: Data gap was identified in the FoTX project within this reach of Big Bear Creek in Keller, TX. Access was achieved through surrounding city-owned property. 12 effective seine hauls across 240 meters.

Representative Site Photograph and Vicinity Map:

Table of Collected Fishes:

Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Fundulus notatus	9	27	0	0	Voucher Specimen, Donated
Gambusia affinis	9	27	0	4	Voucher Specimen, Donated
Lepomis cyanellus	5	5	0	0	Voucher Specimen, Donated
Lepomis sp. (hybrid)	2	1	0	0	Voucher Specimen, Donated
Lepomis macrochirus	37	4	0	0	Voucher Specimen, Donated
Lepomis megalotis	27	4	0	0	Voucher Specimen, Donated
Lepomis microlophus	7	9	0	0	Voucher Specimen, Donated
Lepomis spp. (Juveniles)	8	0	0	4	Voucher Specimen, Donated
Micropterus salmoides	4	11	0	0	Voucher Specimen, Donated

Catch Per Unit Effort (CPUE): 204 fish collected / 2 hours seining effort = 102 fish per hour.

Additional Comments: Juveniles that were too small (<0.5 inch) to be accurately identified in the field are reported as "*Lepomis* spp. (Juveniles)". Habitat consisted of a modified, but somewhat natural channel followed by a trapezoidal canal. All habitat is significantly disturbed. Efficacy is believed to be high.

Location Name: JJLPJA,20211009,SC1,1

Date of Collection: 10/09/2021

County/Location Collected: Dallas County (Upstream Extent (32.954749, -96.640852); Downstream Extent (32.954218, -96.638364))

Description: Preservation Society for Spring Creek Forest Preserve needed updated fish survey (attached at the end of this document). Location 1 of 4 at Spring Creek within Spring Creek Forest Preserve. 12 effective seine hauls across 376 meters.

Representative Site Photograph and Vicinity Map:

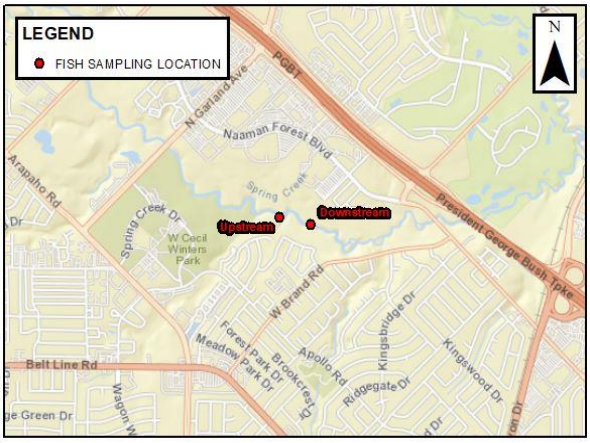


Table of Collected Fishes:

Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Campostoma anomalum	0	1	0	0	Voucher Specimen, Donated
Cyprinella lutrensis	129	39	0	19	Voucher Specimen, Donated
Fundulus spp.	57	45	0	0	Voucher Specimen, Donated
Gambusia affinis	23	26	0	6	Voucher Specimen, Donated
Lepomis macrochirus	4	2	0	0	Voucher Specimen, Donated
Lepomis megalotis	10	5	0	0	Voucher Specimen, Donated
Lepomis microlophus	0	1	0	0	Voucher Specimen, Donated
Lepomis spp. (Juveniles)	5	0	0	4	Voucher Specimen, Donated
Micropterus salmoides	0	1	0	0	Voucher Specimen, Donated
Notropis stramineus	0	15	0	3	Voucher Specimen, Donated
Pimephales vigilax	2	15	0	2	Voucher Specimen, Donated

Catch Per Unit Effort (CPUE): 414 fish collected / 3 hours seining effort = 138 fish per hour.

Efficacy Comments: Efficacy for all Spring Creek effort is high.

Location Name: JJAM,20211010,SC1,2

Date of Collection: 10/10/2021

County/Location Collected: Dallas County (Upstream Extent (32.967627, -96.656456); Downstream Extent (32.964368, -96.655905))

Description: Preservation Society for Spring Creek Forest Preserve needed updated fish survey (attached at the end of this document). A note on all Spring Creek locations – based on several expert opinions, distinguishing *F. notatus* and *F. olivaceus* was likely not 100% possible at this location without genetic verification as field characters were somewhat masked due to turbidity in some areas. All collected *Fundulus* are listed as "*Fundulus* spp.". 12 effective seine hauls across 319 meters.

Representative Site Photograph and Vicinity Map:

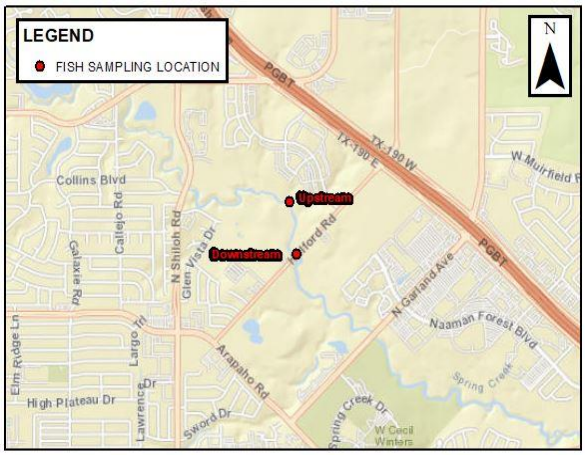


Table of Collected Fishes:

Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Campostoma anomalum	0	23	0	0	Voucher Specimen, Donated
Carpiodes carpio	0	1	0	0	Voucher Specimen, Donated
Cyprinella lutrensis	83	44	0	92	Voucher Specimen, Donated
Fundulus spp.	9	20	0	0	Voucher Specimen, Donated
Gambusia affinis	18	13	0	9	Voucher Specimen, Donated
Lepomis macrochirus	3	2	0	2	Voucher Specimen, Donated
Lepomis megalotis	11	1	0	2	Voucher Specimen, Donated
Lepomis spp. (Juvenile)	5	0	0	12	Voucher Specimen, Donated
Micropterus salmoides	0	2	0	0	Voucher Specimen, Donated
Pimephales vigilax	22	32	0	43	Voucher Specimen, Donated

Catch Per Unit Effort (CPUE): 449 fish collected / 2.5 hours seining effort = 179.6 fish per hour.

Location Name: JJRT,20211016,SC1,3

Date of Collection: 10/16/2021

County/Location Collected: Dallas County (Upstream Extent (32.960513, -96.653196); Downstream Extent (32.959602, -96.651345))

Description: Preservation Society for Spring Creek Forest Preserve needed updated fish survey (attached at the end of this document). 12 effective seine hauls across 494 meters.

Representative Site Photograph and Vicinity Map:

Table of Collected Fishes:

Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Campostoma anomalum	0	1	0	0	Voucher Specimen, Donated
Cyprinella lutrensis	304	9	0	8	Voucher Specimen, Donated
Dorosoma cepedianum	0	1	0	0	Voucher Specimen, Donated
Fundulus spp.	1	1	0	0	Voucher Specimen, Donated
Gambusia affinis	8	7	0	0	Voucher Specimen, Donated
Lepomis megalotis	0	2	0	0	Voucher Specimen, Donated
Lepomis spp. (Juvenile)	5	0	0	2	Voucher Specimen, Donated
Micropterus salmoides	1	3	0	0	Voucher Specimen, Donated
Notropis stramineus	0	5	0	0	Voucher Specimen, Donated
Pimephales vigilax	37	7	0	3	Voucher Specimen, Donated

Catch Per Unit Effort (CPUE): 405 fish collected / 3 hours seining effort = 135 fish per hour.

Location Name: JJAMFM,20211017,SC1,4

Date of Collection: 10/17/2021

County/Location Collected: Dallas County (Upstream Extent (32.972361, -96.669689); Downstream Extent (32.972117, -96.667755))

Description: Preservation Society for Spring Creek Forest Preserve needed updated fish survey (attached at the end of this document). High percentage of riffle habitat. 11 effective seine hauls across 236 meters.

Representative Site Photograph and Vicinity Map:

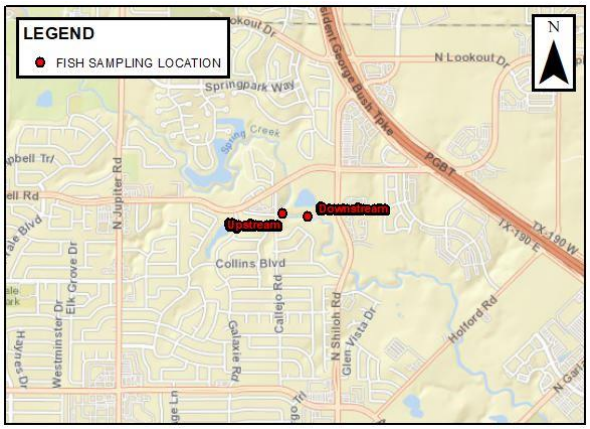


Table of Collected Fishes:

Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Campostoma anomalum	11	2	0	0	Voucher Specimen, Donated
Cyprinella lutrensis	469	12	0	22	Voucher Specimen, Donated
Fundulus spp.	0	1	0	0	Voucher Specimen, Donated
Gambusia affinis	0	1	0	0	Voucher Specimen, Donated
Lepomis macrochirus	5	0	0	0	Voucher Specimen, Donated
Lepomis megalotis	2	1	0	0	Voucher Specimen, Donated
Lepomis microlophus	1	2	0	0	Voucher Specimen, Donated
Lepomis spp. (Juvenile)	1	0	0	3	Voucher Specimen, Donated
Micropterus salmoides	0	1	0	0	Voucher Specimen, Donated
Notropis stramineus	4	56	0	36	Voucher Specimen, Donated
Pimephales vigilax	119	3	0	29	Voucher Specimen, Donated

Catch Per Unit Effort (CPUE): 781 fish collected / 1.8 hours seining effort = 433.8 fish per hour.

Location Name: JJ,KB,1,20210530

Date of Collection: 5/30/2021

County/Location Collected: Tarrant/Denton County. Kirkwood Branch approximately 240 meters west of the North Whites Chapel Road crossing of Kirkwood Branch to a location upstream (32.986644, -97.159397)

Description: Data gap was identified in the MoTX project within this reach of Kirkwood Branch in Southlake, TX. Access was achieved through surrounding USACE-owned property.

Mussel Survey Type: Timed Tactile Search (5 person-hours)

Mussel Survey Results (Positive/Negative for Live Mussels): Positive

Mussel Survey Note: 5 person-hours across 200 meters; soft sandy substrate allowed for thorough grubbing; however, live mussels were only found beneath deep undercut banks at two locations.

Representative Site Photograph and Vicinity Map:

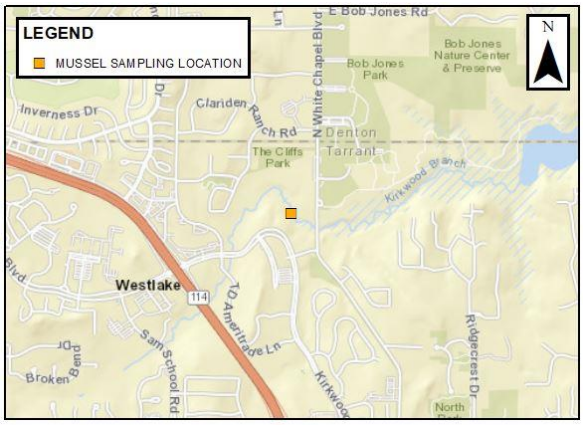


Table of Collected Mussels:

Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Uniomerus tetralasmus	2	0	0	0	Photo voucher-only

Location Name: JJHTBR,DC2,20210825

Date of Collection: 8/25/2021

County/Location Collected: Denton County. Denton Creek approximately 350 feet south of the FM2449 crossing (33.173412, -97.351943)

Description: Data gap was identified in the MoTX project within this reach of Denton Creek. Access was achieved by walking in from road crossing (state stream access laws).

Mussel Survey Type: Timed Tactile Search (5 person-hours)

Mussel Survey Results (Positive/Negative for Live Mussels): Positive

Mussel Survey Note: 5 person-hours across 70 meters. Substrate soft (sand) and suitable for mussels; however, no live native mussels or valves were found. Live Asian clam and a valve shown below. Disposed of in accordance with SPR.

Representative Site Photograph and Vicinity Map:

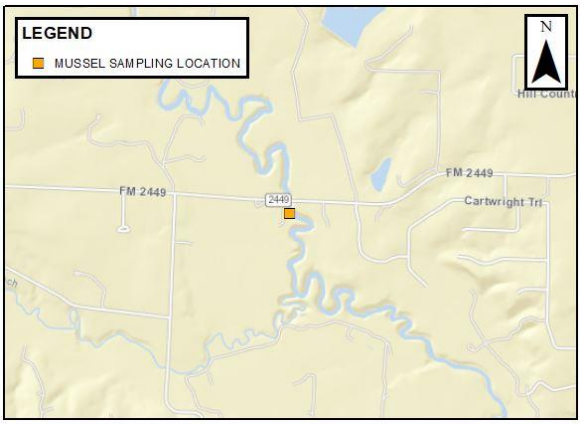


Table of Collected Organisms:

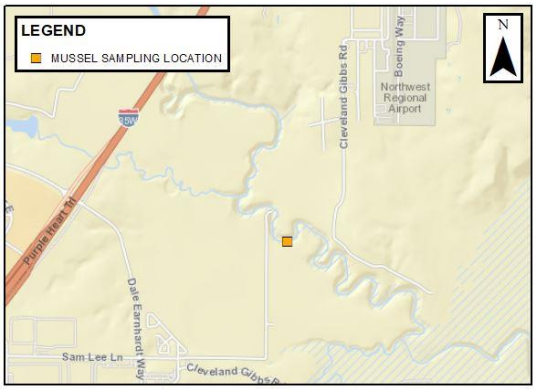
Common Name/Scientific Name	# Caught & Released	# Collected (live take)	# Salvaged	# Incidental Mortalities	Disposition of Specimens
Corbicula fluminea	0	1	0	0	Photo voucher-only

The following observations are valve-only observations of freshwater mussel remains observed during shoreline reconnaissance. One photo per species is provided for each location.

Location: JJ,DC,1,20210829 - Denton Creek approximately 1 mile east of the IH-35W crossing of Catherine Branch.

Mussel Valves Observed (Species (number)): *Potamilus* sp.* (1); *Quadrula apiculata* (1)

Representative Photos and Vicinity Map:



Comments: *appeared to be *P. ohiensis*, but that species is not confirmed from this stream. Based on this information, this valve was identified as *P. amphichaenus* which is known from the western extent of Grapevine Lake.

Location: JJ,175UT,1,20210919 - Unnamed Tributary to White Rock Creek beneath US-175.

Mussel Valves Observed (Species (Number)): *Lampsilis teres* (2); *Uniomerus tetralasmus* (3)

Representative Photos and Vicinity Map:

Comments: None

Location: JJ,HRP,1,20210915 - Stocked pond on private ranch northwest of Denton, TX (33.249824, -97.189312)

Mussel Valves Observed (Species (number)): *Uniomerus tetralasmus* (1)

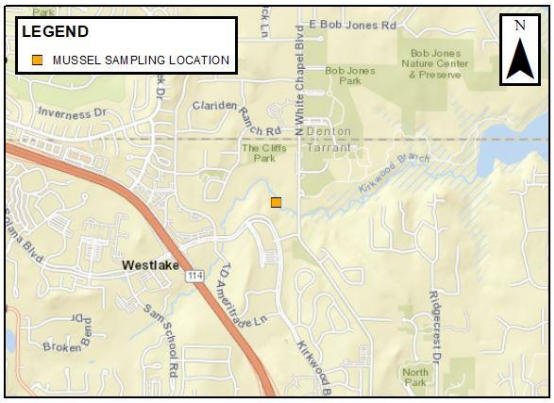
Representative Photo and Vicinity Map:

Comments: None

Location: JJ,KB,1,20210530 - Kirkwood Branch approximately 240 meters west of the North Whites Chapel Road crossing of Kirkwood Branch to a location upstream.

Mussel Valves Observed (Species (Number)): *Pyganodon grandis* (1); *Uniomerus tetralasmus* (4)

Representative Photos and Vicinity Map:



Comments: None

Location: JJ,LL,1,20220111 - Approximately 575 feet south of the intersection of Shady Shores Road and Oakwood Circle within the town limits of Shady Shores, TX along the shoreline of Graveyard Slough.

Mussel Valves Observed (Species (number)): *Pyganodon grandis* (1); *Utterbackiana suborbiculata* (1)

Representative Photos and Vicinity Map:

Comments: None

Location: JJ,PADP,1,20210928 - Small pond approximately 465 feet south of the Lawnview DART station.

Mussel Valves Observed (Species (Number)): *Pyganodon grandis* (1)

Representative Photo and Vicinity Map:

Comments: None

The following records indicate mussel surveys conducted during 2021 under this permit which resulted in negative findings (e.g. no live mussels) and no valves were found or observed during shoreline reconnaissance. All mussel surveys consisted 5 person-hour tactile surveys. Location data (mid-point) and general descriptions of surveys below:

Location: JJHTBR,EC,1,20210825

Elizabeth Creek – Location 1 (33.014464, -97.260951)

Length of Survey Reach: 65 meters

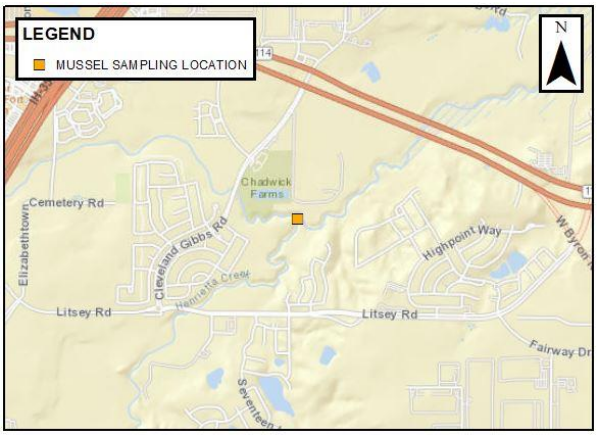
Notes: None

Location: JJHTBR,EC,2,20210825

Elizabeth Creek – Location 2 (33.014483, -97.257709)

Length of Survey Reach: 65 meters

Notes: None



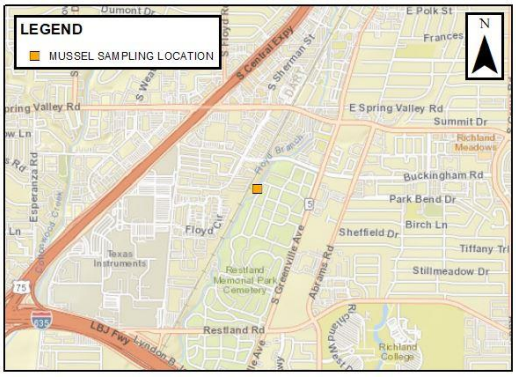
Location: JJMH,FB,1,20211210

Floyd Branch (32.934192, -96.740972)

Length of Survey Reach: 480 meters in suitable habitat only

Notes: Suitable habitat limited within this reach

(e.g. large expanses of Austin Chalk limestone substrate).



Discussion

Freshwater Fish Sampling – Statistics

A total of 3724 fish representing 17 species (n = 17), two hybridizations (possibly *Fundulus notatus* x *F. olivaceus* and an identified *Lepomis* sp. hybrid), and unidentifiable *Lepomis* juveniles (0.5 inch >) were collected during seine sampling yielding a mean catch per unit effort (CPUE) of 171.86 fish per hour (**Figure 2**; Sampling events JJGD,20210619,TC1,1 and JJ,20210615,KB1,1 were omitted in CPUE calculation, as sampling efficacy at these locations was believed to be low and were considered outliers.). Of the 3724 collected fishes, 1178 were vouchered and submitted directly to the UT ichthyological collection.

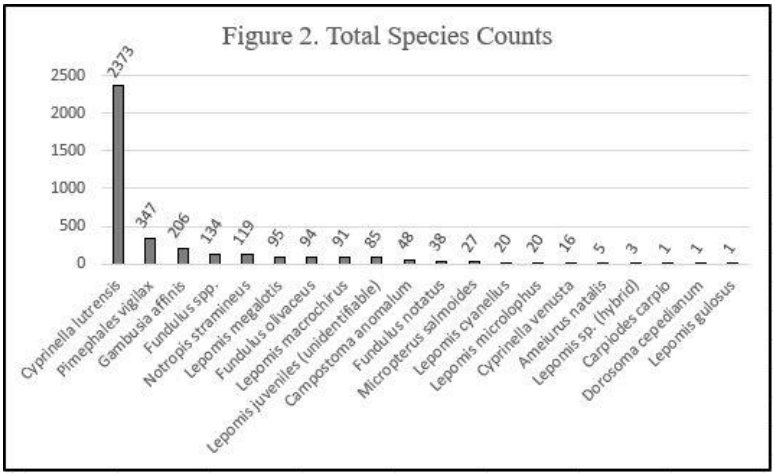


Figure 2. Fish species composition and number collected for all sampling locations.

Figure 3, below, depicts the number of locations at which each fish species was collected. This figure considers sites with multiple sampling events as a single location. No sites were omitted in this figure.

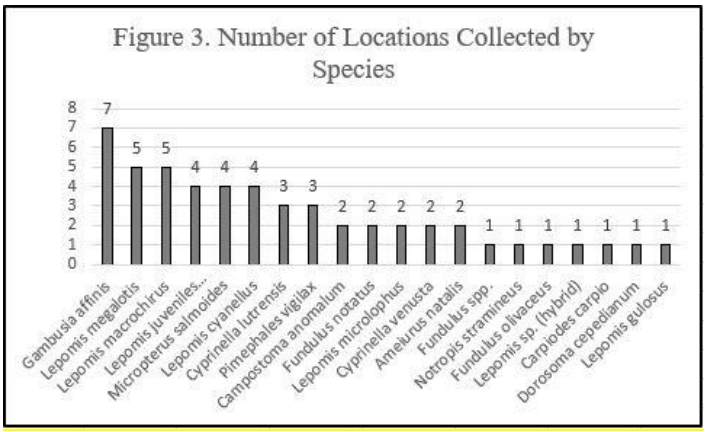


Figure 3. Number of locations at which each species was collected.

Figure 4, below, depicts number of species collected by sampling location (with sampling events JJGD,20210619,TC1,1 and JJ,20210615,KB1,1 omitted due to low efficacy and the sampling event at Floyd Branch (JJMH,20211210,FB1,1) was omitted due to a recent fish kill). Locations with multiple sampling events were considered a single sampling location. Species counts per location do not include juveniles that could not be identified to the species level (only very small *Lepomis*). For context, the *Fundulus* spp. noted at Spring Creek were considered both *F. notatus* and *F. olivaceus* (two separate species) for **Figure 4**). Figure only includes locations with moderate and high sampling efficacy, as sampling events with determined low efficacy or unusual circumstances (e.g. fish kill at Floyd Branch) likely do not provide an accurate account of species assemblages at those locations.

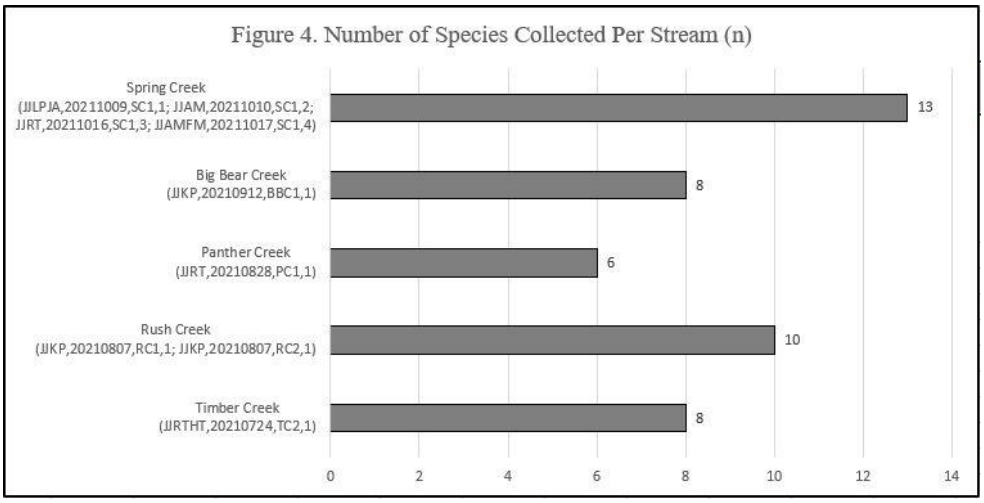


Figure 4. Number of species collected per stream, at sampling locations with determined high sampling efficacy.

Freshwater Fish Sampling – Data Analysis

Due to estimated low sampling efficacy at two sampling locations, these were omitted from calculations as to preclude data that may not be representative of the true species richness at those locations (e.g. species diversity is likely much higher than what was collected). Across all locations with viable results (moderate to high efficacy as shown in **Figure 4**), mean species richness was n = 9. Based on the calculated sample standard deviation (s = 2.65) and sample mean ($\bar{x}$ = 9), the coefficient of variation for this dataset is 0.294 (CV = 29.4%). This calculated CV implies that despite estimated moderate to high sample efficacy, there is still significant variation between species richness at the five referenced sample locations.

As shown in **Figure 2**, *Cyprinella lutrensis* was the most collected species overall across all locations (n = 2373; 63.7% of total collected); however, was only collected at three locations (**Figure 3**). This was to be expected, as *C. lutrensis* is one of the most widespread and environmentally tolerant species in North America (Nico, Fuller, Neilson, & Daniel, 2021). The same could be said for the other two most numerously collected species (*Pimephales vigilax* (n =

347; 9.3% of total collected) and *Gambusia affinis* (n = 206; 5.5% of total collected) which are both tolerant of degraded stream habitats ("disturbance"), such as those sampled in this study and have been well documented in many streams in the DFW area (Linam, Kleinsasser, & Mayes, 2002). Representatives of *Fundulus* (*F. notatus* (n = 38; 1% of total collected) and *F. olivaceus* (n = 94; 2.5% of total collected)) captured across all locations expressed considerable variability in external pigmentation, such that a positive identification with field characters was only possible at some locations (such as Spring Creek, where fish displayed field characters of both species (all marked *Fundulus* spp. (n = 134; 3.6% of total collected) at this location)). This is not unheard of in urban streams with high turbidity, as these conditions can mask pigmentation-based identification characters (e.g. lessen the prominence of distinct markings). Given that the ranges of *F. notatus* and *F. olivaceus* overlap in the DFW area, it is also possible that both species may have been present at sample locations or some hybridizations of this species were collected (either *F. notatus* x *olivaceus* or *F. olivaceus* x *notatus*) (Schaefer et al., 2016). Collectively, *Fundulus* spp. (*F. notatus*, *F. olivaceus*, and *Fundulus* documented at Spring Creek) made up approximately 7% of total collected fishes (n = 266). These species were also found at four out of the seven sample locations (**Figure 3**). When compared to previous fish collections reported from other studies, fishes from genus *Fundulus* are found throughout north central Texas and are important components of stream fish assemblages within the region; however, the results of this study indicate that more collections are required to determine the true distribution of each species individually in the DFW area (Linam, Kleinsasser, & Mayes, 2002).

Representatives from genus *Lepomis* (n = 315) collectively made up 8.5% of total collected fishes. *Lepomis megalotis* (n = 95; 2.6% of total collected) and *Lepomis macrochirus* (n = 91; 2.4% of total collected) were collected at five out of seven sampling locations. Additionally, existing records indicate these two species are found throughout the DFW area and are normally found in abundance relative to other sunfishes (Linam, Kleinsasser, & Mayes, 2002; Hendrickson and Cohen, 2015). *Lepomis cyanellus* (n = 20; <1% of total collected) was collected at four of seven sampling locations and *Lepomis microlophus* (n = 20; <1% of total collected) was collected at two of seven sampling sites. *Lepomis gulosus* (n = 1; <1% of total collected) was collected at only one location. Small (<0.5 inch) *Lepomis* juveniles (n = 85; 2.3% of total collected) that were unidentifiable with field characters alone were collected at four out of seven locations indicating active recruitment where captured. To that note, three hybrid sunfish of unverifiable lineage (noted *Lepomis* sp.) were collected at Big Bear Creek. These hybrids displayed field characters of several species. At 8.8% of total collected species, genus *Lepomis* (to include juveniles and hybridizations) are important components of north central Texas fish assemblages.

Prior to beginning the field effort for this study, FoTX staff expressed an interest in gathering verifiable observations of *Notropis stramineus*. This species has very few records in the Upper Trinity basin, having only 7 occurrences documented since 1957 (GBIF.org, 2022). Within Spring Creek, 119 individuals were collected and preserved (n = 119; 3.2% of total collected). Of note,

this species was only collected at one location in this study; however, sources indicate that this species may have other undocumented populations within the DFW area (GBIF.org, 2022; Hendrickson and Cohen, 2015). These new records will assist the FoTX staff in determining the distribution and abundance of this species within the Upper Trinity basin. No other representatives of genus *Notropis* were collected and the results of this study indicate that further collections will be needed to assess the status of *Notropis* (including *N. stramineus*) in the Upper Trinity basin.

Campostoma anomalum (n = 48; 1.3% of total collected) was collected at two out of seven sampling locations. *Micropterus salmoides*, a popular sportfish, was found at four of seven sampling locations. While other black basses (*Micropterus* spp.) are found in the Upper Trinity, this species is generally the dominant in most waterbodies (GBIF.org, 2022; Hendrickson and Cohen, 2015). *Cyprinella venusta* (n = 16; <1% of total collected) and *Ameiurus natalis* (n = 5; <1% of total collected) were each collected at two out of seven locations. *Dorosoma cepedianum* (n = 1; <1% of total collected) and *Carpiodes carpio* (n = 1; <1% of total collected) were collected at only one location (Spring Creek).

Other fish surveys conducted within the DFW area generally included a backpack electrofishing component in addition to seining; however, it was determined early on in this study that electrofishing would not be necessary to achieve intended objectives (formally document fishes at locations in the Upper Trinity basin to both provide data gap assistance to the FoTX project and establish new assemblage baselines for reaches of stream with either poor or absent species observations). Based on a TPWD study conducted in 2002 in which fishes were sampled statewide utilizing seining and backpack electrofishing, the majority of collected fishes and fish species were collected via seining (Linam, Kleinsasser, & Mayes, 2002). Linam, Kleinsasser, & Mayes (2002) cited two sampling events in the DFW area at Clear Creek in Denton County and Wilson Creek in Collin County in which 76% to 100% of all collected species were collected with seining alone. As most streams sampled in this study were of similar size and character to these two streams (e.g. mid-sized tributaries to larger branches of the greater Trinity River system (West Fork, East Fork, Elm Fork, etc.), it was determine that were sampling efficacy is believed to be moderate to high. Linam, Kleinsasser, & Mayes (2002) also cites several instances at locations outside of the Upper Trinity basin were between 7 and 13 species were normally collected with as little as 6 seine hauls. Based on this information and fish sampling results, it was determined that while the overlying goal of this study was to collect species records at previous poorly/unsampled reaches of stream, the provided species data for Spring Creek, Big Bear Creek, Panther Creek, Rush Creek, and Timber Creek should be considered new baseline fish lists for these streams.

Freshwater Mussel Sampling Results

The intention of this study was to gather as many observations of freshwater mussels as possible to assist the MoTX database in gaining new species distribution data. While few live mussels were collected, there were many observations of mussel remains (valves). Mussel valves can be a strong indicator of the presence of live mussels (TPWD, 2021). The only live mussel observations

collected were of *Uniomerus tetralasmus* (n = 2). In addition to these live mussels, the remains of the following species were observed at locations listed in **Figure 5** on the next page. Additionally, please reference **Figure 6** for all negative survey results.

Figure 5. Table of Freshwater Mussel Observations

Species	General Locality
*Potamilus amphichaenus**	Denton Creek
Quadrula apiculata	Denton Creek
Lampsilis teres	Semi-impounded tributary to White Rock Creek
Uniomerus tetralasmus	Stock Pond on private land in western Denton County, Semi-impounded tributary to White Rock Creek, Kirkwood Branch
Pyganodon grandis	Lake Lewisville (Graveyard Slough), Excavated pond near White Rock Creek, Kirkwood Branch
Utterbackiana suborbiculata	Lake Lewisville (Graveyard Slough)
Corbicula fluminea	Denton Creek

**Potamilus* sp. determined to likely to be *P. amphichaenus* based on locality.

Figure 6. Table of Negative Survey Results for Freshwater Mussels

Survey Effort	General Locality
Two locations, five person-hours each, total of 130 meters. Three surveyors.	Elizabeth Creek
Five person-hours in suitable habitat only across 480 meters. Two surveyors.	Floyd Branch

The observation of few live mussels is likely due to the current locations of data gaps in the MoTX database mostly occurring in small to mid-sized tributaries (in the Upper Trinity basin). Based on the recently released Texas freshwater mussel survey protocol guidelines produced by a joint effort between TPWD and USFWS, nearly all observed streams where either valves or live mussels were

collected are either listed Group 5 streams or tributaries to listed Group 5 streams (TPWD, 2021). Group 5 streams are defined as "*streams where no federally- or state-listed freshwater mussels occur, but mussels are known to occur; or, perennial streams where it is anticipated that live freshwater mussels may occur, but presence or diversity have not been confirmed*" (TPWD, 2021)

It should also be noted that Lake Lewisville is considered a Group 4 stream. Group 4 waterbodies are defined as "*large stream reaches that are known to or may be inhabited by state-listed freshwater mussel species, but presence of federally-listed freshwater mussel species is not anticipated*" (TPWD, 2021). Lake Lewisville is not stream; however, guidance further states that "*reservoirs will be included using the [stream groupings] as appropriate, based upon expected freshwater mussel occupancy and diversity*" (TPWD, 2021). Lake Lewisville has historic occurrences of state-listed species (*P. amphichaenus*; potentially others); therefore, was listed as a Group 4 stream (Randklev et al., 2020). Of note, a valve of *Utterbackiana suborbiculata* was recovered along the shoreline of Lake Lewisville during this study. The MoTX database has few records for this species in the Upper Trinity basin and nearly all of them are associated with Lake Lewisville (Randklev et al., 2020). While a valve-only occurrence, the observation presented in this study provides photograph evidence of this species which can provide additional context that can be used in unraveling the status of this species in the Upper Trinity.

While there is an obvious need for occurrence data regarding federally and state-listed freshwater mussels, there is also an apparent need for presence/absence surveys in many perennial streams throughout the state of Texas to documented mussel occurrences in general (to include common, rare, and list species). As stationary, benthic organisms with specific habitat requirements (e.g. suitable flow conditions, presence of host species, substrates that allow for burying) there are few other ways to document mussel occurrence other than physically visiting streams with suitable conditions and performing either shoreline reconnaissance or tactile survey efforts to assess the presence of absence of freshwater mussels. Probability-based modeling is effective to assist in determining the likelihood of mussel occurrence; however, there will likely not be a substitute for field efforts to understand the true distribution and occurrence of freshwater mussels.

The results of the mussel sampling associated with this study were mostly negative; however, this does not come without findings which otherwise support the recently released Texas Freshwater Mussel Survey Protocol. Based on mussel sampling results, this study supports that current stream groupings listed in recently released Texas mussel survey protocol are effective for determining the presence or absence of freshwater mussels; however, do not eliminate the need for land-based assessment, as even unlisted streams may contain mussels. The sampled reach of Kirkwood Branch had two live mussels documented after a five person-hour tactile survey effort. While a common species which can tolerate disturbed conditions, the occurrence of *U. tetralasmus* in an ungrouped stream provides support for the fact that each stream is different and must be evaluated on a case-by-case basis as it pertains to the presence or absence of freshwater mussels. Freshwater mussels provide beneficial ecological functions such as improved water quality and a food source for higher trophic levels. By providing the mussel observations documented herein to the MoTX database, the results of this study intend to assist in providing additional documentation of live or deceased

freshwater mussels that can be used by malacologists from agencies, academia, and consultancies in studies related to the conservation of freshwater mussels in the Upper Trinity basin.

Conclusion

North American streams and rivers are experiencing a rapid and progressive rate of degradation that is unfortunately not likely to cease in the near future. "Urban Stream Syndrome" (USS) is affecting streams throughout many growing areas of the United States, such as the DFW area. USS can simply be described as "*the consistently observed ecological degradation of streams draining urban land*" (Walsh, et al., 2005). Part of this ecological degradation is a gradual shift from native aquatic life assemblages to those which can tolerate increasingly disturbed conditions such as lower dissolved oxygen levels, increased water temperatures, higher turbidity, and modified flow regimes (Bell, Coles, & McMahon, 2012). This ecological shift can easily go unnoticed if faunal occurrence records, to include both common and rare species, are not effectively documented. The result of poor or absent species documentation is unfortunately that of the shifting baseline (SBS).

Papworth et al., (2009) indicates for SBS to be truly present, two distinguishing characteristics must be identifiable: (1) biological change must be present in the system and (2) any perceived changes must be consistent with the biological data (Papworth et al., 2009). This information supports that in determining if SBS truly exists in a given system, comprehensive data must exist that provides sufficient evidence (e.g. biological data) that perceived changes are occurring. While it has been identified that biological change has already occurred within some riverine aquatic life habitats subject to the effects of historical agricultural activity within the Upper Trinity basin, agency studies indicate fish populations and distributions can be affected by a broader range of geographical factors, even within a single region (Coles, et al., 2012). Additionally, while freshwater mussel distribution is documented in recent years more than ever (in formats to include MoTX), there are still many poorly sampled streams and rivers in Texas (Randklev et al., 2020). Based on the above discussion, biological change has either occurred or is actively occurring due to urbanization in many streams within the Upper Trinity basin; however, due to identified data gaps in species occurrence data in the MoTX and FoTX databases (as well as other sources), it would be erroneous to conclude that true SBS is actively occurring throughout the basin as a whole. While the "by definition" occurrence of SBS within the entire Upper Trinity basin (as an single unit) cannot be definitively justified with existing data, sufficient predicators for the condition of SBS are present such as incomplete species occurrence datasets and documented biological changes within the system. A strong preventative against SBS are easily accessible, biodiversity databases such as the FoTX and the MoTX projects which can be used to assess changes in species distribution and abundance over time. By providing several new datasets to the FoTX and MoTX projects, this study provides biological data which can be used to determine baseline conditions at several streams within the DFW area. By providing new or updated assemblage data (be that partial or comprehensive), this study in of itself provides a preventative measure for SBS in several mid-sized streams within the Upper Trinity basin as these new baselines may now be used to assess and gauge biological change – the overall determining factor of true SBS.

Acknowledgements

This study would not have been possible if not for a strong support network of close friends, family, and other natural resource professionals. First and foremost, I would to thank my graduate committee for their support in planning this effort. Next, I would like to thank the curators of the Fishes of Texas and Mussels of Texas projects for supporting my collection efforts and providing excellent guidance whenever requested. I would also like to thank the subject matter experts which assisted in species identification as well as general advice for this study including Dr. Charles Randklev, Dr. Timothy Bonner, Mr. Clint Robertson, Mr. Kevin Mayes, Dr. Todd Sink, Mr. Jeremy Maikoetter, and Ms. Christa Edwards. Additionally, the following volunteers deserve the utmost praise from assistance in this study: Mr. Greg DeMars, Mr. Ryan Triebel, Mr. Hunter Triebel, Mr. Kevin Philips, Mrs. Judy Aschner, Ms. Ashleigh Miller, Mr. Landry Pogue, Mr. Finley Miller, Ms. Margaret Harpe, and Mr. Bennett Rocco. Lastly, I would like to thank my darling wife for supporting me throughout graduate school, including this study.

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ATTACHMENTS

SPRING CREEK FOREST PRESERVE FISH SURVEY

Prepared for

The Preservation Society for Spring Creek Forest

Garland, Texas 75045-0176

By

Jeremy V. Jordan

December 13, 2021

Table of Contents

1.0 Introduction

1.1 Project Purpose

The Preservation Society for Spring Creek Forest (Society) identified the need for an updated list of fish species found within the reach of Spring Creek in Spring Creek Forest Preserve (Preserve) located in Garland, Dallas County, Texas (**Figure 1 – Location Map** in **Attachment A - Figures**; 32.964233, -96.655939 (WGS84)). The purpose of this project was to provide the Society with an updated fish list while also supporting an on-going larger scale survey located within the Upper Trinity basin. This technical report was drafted to report findings and the information will be presented in a formal event sponsored by the Society.

1.2 Project Objectives

- Capture and enumerate fishes within Spring Creek within Spring Creek Forest Preserve via seining to create a species list for the Society.
- Collect a representative subset of voucher specimens for all species collected are to be deposited in the University of Texas', Biodiversity Collections where they will be permanently housed for future research and their data will be provided on the Fishes of Texas (FoTX) project (www.fishesoftexas.org) and other online databases.
- Document species with color photographs (included) and post on the Preserve's iNaturalist project for the public.
- Present on the fish species found within Spring Creek Forest Preserve collected during the survey at a Society-sponsored public education event.
- Support on-going scientific collections within the Upper Trinity basin.
- Provide volunteer opportunity for Master Naturalists and other interested individuals.
- Provide hands-on opportunity to educate others on fish species found within Spring Creek.

1.3 Personnel

- Jeremy V. Jordan (Project Lead; TPWD-Permitted Biologist)
- Volunteers (Society members, Master Naturalists, City of Garland staff, etc.)

1.4 Usage and Citation of this Report

All information collected or produced during this project will be utilized to create or support additional studies that may be published elsewhere. This technical report will supplement a larger study, which will be archived with the Texas A&M OAKTrust Digital Repository (coming 2022). Content has been peer-reviewed by subject matter experts affiliated with academic institutions. For citing this report specifically, please use the following citation:

Jordan, J. (2021). Spring Creek Forest Preserve Fish Survey, 35p. https://springcreekforest.org/fishes/

1.5 Project Timeline

- September 2021
  - Attend Society executive meeting on 9/16/2021 to discuss project.
  - Draft and submit proposal to Society.
  - Preliminary site visits.
  - Promulgate volunteer opportunity and gather list of interested individuals.
- October 2021
  - Execute fish survey.
  - Draft report.
- November 2021
  - Finish and submit report to Society.
  - Present findings at Society-sponsored event.

2.0 Methodology

2.1 Preliminary Habitat Description

A brief review of background information was conducted to determine habitat quality within the reach of Spring Creek in Spring Creek Forest Preserve. A review of recent and historic aerial imagery indicated the area surrounding the land that would eventually become the Preserve was primarily dominated by agricultural land in the early 1940s; however, by the late 1970s residential and commercial developments began increasing. By the early 2000s, most of the area surrounding the Preserve had been urbanized. In the present day, the Preserve exists as a localized greenspace amongst urban sprawl. Across all years of

recent and historic aerial imagery, Spring Creek and the associated riparian corridor have persisted, indicating habitat within this area is likely reminiscent of what is considered "natural" for the Blackland Prairie ecoregion of Texas. A preliminary reconnaissance of the Preserve indicated that the majority of the Preserve consists of a relic Blackland Prairie bottomland forest dominated by species such as bur oak (*Quercus macrocarpa*), Shumard oak (*Quercus shumardii*), and Chinquapin oak (*Quercus muehlenbergii*) with species such as deciduous holly (*Ilex decidua*), eastern redbud (*Cercis canadensis*), Virginia wildrye (*Elymus virginicus*), and greenbrier (*Smilax* spp.) dominating the understory. Some areas have been encroached by oriental privets (*Ligustrum quihoui* and/or *Ligustrum sinense*) and eastern red cedar (*Juniperus virginiana*). Additionally, some areas of the Preserve that were not forested in older aerial imagery now contain successional forest stands dominated by species such as eastern cottonwood (*Populus deltoides*), sugar hackberry (*Celtis laevigata*), American elm (*Ulmus americana*) or expanses of prairie/prairie-like vegetation communities. Soils within the Preserve are of orders Inceptisol, Entisol, Vertisol, and Mollisol mostly derived from calcareous claystone, limestone, and mudstone (USDA NRCS, 2021). Based on field observations of nearby streams, most of the channel substrate of Spring Creek within the Preserve is likely to consist mostly of variably sized gravel fragments with intermixed anthropogenic material (i.e. asphalt, refuse, metal fragments, etc.) and only minor areas of fines underlain by calcareous bedrock (e.g. limestone) or hardpacked clay. No United States Geological Survey (USGS) or National Oceanic and Atmospheric Administration (NOAA) stream gages were found on online sources to exist on Spring Creek; however, flow within the channel is likely heavily influenced by impervious surface runoff and stormwater outfalls both within and upstream of the Preserve. This is supported by data from the nearby USGS stream gage (08061540) on Rowlett Creek (a similar, larger stream to which Spring Creek is a tributary) which shows gage height and discharge increasing and decreasing rapidly in relatively short intervals (USGS, 2021). Rapid fluctuations in streamflow cause downcutting in urban streams (Bell, Coles, & McMahon, 2012); therefore, it is also very likely that while the riparian corridor of Spring Creek within the Preserve has persisted over time, the stream itself has likely experienced loss of floodplain connectivity due to downcutting from flow modification. Summarily, this loss of ecohydrological functionality between Spring Creek and its floodplain has likely caused at least some degree of habitat degradation for aquatic life within Spring Creek; however, due to being surrounded by the Preserve which contains an unbroken expanse of intact riparian corridor, the reach of Spring Creek within the Preserve is very likely to be the least degraded area of the overall watershed in the present day.

2.2 Review of Available Fish Data

A review of publicly available fish occurrence data resulted in a list of species that may be present in the reach of Spring Creek within Spring Creek Forest Preserve. Please reference **Table 1** and **Table 2** below which were generated from the FoTX and USGS Nonindigenous Aquatic Species (NAS) databases:

TABLE 1. FISH SPECIES LISTED TO EXIST WITHIN THE EAST FORK TRINITY RIVER BASIN WITHIN THE FOTX DATABASE.

Scientific Name	Common Name
Menidia beryllina	Inland Silverside
Carpiodes carpio	River Carpsucker
Minytrema melanops	Spotted Sucker
Lepomis cyanellus	Green Sunfish
Lepomis gulosus	Warmouth
Lepomis humilis	Orangespotted Sunfish
Lepomis macrochirus	Bluegill
Lepomis megalotis	Longear Sunfish
Lepomis microlophus	Redear Sunfish
Micropterus salmoides	Largemouth Bass
Pomoxis annularis	White Crappie
Pomoxis nigromaculatus	Black Crappie
Dorosoma cepedianum	Gizzard Shad
Dorosoma petenense	Threadfin Shad
Campostoma anomalum	Central Stoneroller
Cyprinella lutrensis	Red Shiner
Cyprinus carpio	Common Carp
Notemigonus crysoleucas	Golden Shiner
Notropis buchanani	Ghost Shiner
Notropis stramineus	Sand Shiner
Notropis volucellus	Mimic Shiner
Opsopoeodus emiliae	Pugnose Minnow
Pimephales promelas	Fathead Minnow
Pimephales vigilax	Bullhead Minnow
Fundulus notatus	Blackstripe Topminnow
Ameiurus melas	Black Bullhead
Ameiurus natalis	Yellow Bullhead
Ictalurus punctatus	Channel Catfish
Noturus gyrinus	Tadpole Madtom
Noturus nocturnus	Freckled Madtom
Lepisosteus oculatus	Spotted Gar
Lepisosteus osseus	Longnose Gar
Morone chrysops	White Bass
Morone mississippiensis	Yellow Bass
Morone saxatilis	Striped Bass

Etheostoma chlorosoma	Bluntnose Darter
Etheostoma gracile	Slough Darter
Percina macrolepida	Bigscale Logperch
Percina sciera	Dusky Darter
Gambusia affinis	Western Mosquitofish
Aplodinotus grunniens	Freshwater Drum

TABLE 2. FISH SPECIES IDENTIFIED TO EXIST[1] WITHIN THE EAST FORK TRINITY RIVER BASIN WITHIN THE USGS NAS DATABASE.

Scientific Name	**Common Name**
Micropterus salmoides floridanus	Florida Largemouth Bass
Pomoxis nigromaculatus	Black Crappie
Colossoma or *Piaractus* sp.	Unidentified Pacu
Dorosoma petenense	Threadfin Shad
Ictalurus furcatus	Blue Catfish
Morone chrysops	White Bass
Morone chrysops x *mississippiensis*	White Bass x Yellow Bass
Morone chrysops x *saxatilis*	Wiper
Morone mississippiensis	Yellow Bass
Morone saxatilis	Striped Bass
Sander vitreus	Walleye
Oncorhynchus mykiss	Rainbow Trout

[1]Some species are listed due to historic introductions and are unlikely to be encountered in the present day.

Furthermore, a query of the FoTX database indicates that fishes were historically sampled at the Holford Road crossing of Spring Creek and further up in the watershed at a location stated to be Spring Creek at Richardson Rd 1 mile north of the Dallas County line in 1948 (Hendrickson, Dean A., and Adam E. Cohen, 2015). Species collected during these events included *Lepomis megalotis*, *Campostoma anomalum*, *Lepomis cyanellus*, and *Cyprinella lutrensis* (Hendrickson, Dean A., and Adam E. Cohen, 2015). Other species collected upstream of the Preserve in the Pittman Creek-Spring Creek drainage (HUC 12 – 120301060407) included *Ameiurus melas*, *Ameiurus natalis*, *Cyprinus carpio*, *Fundulus notatus*, *Lepomis macrochirus*, *Lepomis microlophus*, *Micropterus salmoides*, and *Notropis stramineus*. Based on all reviewed sources of species distribution data, fish assemblage in Spring Creek within the Preserve is likely to be a combination of any of the above-mentioned species; however, is most likely to consist of those that are able to tolerate the previously discussed altered flow regime.

2.3 Fish Survey

The reach of Spring Creek within the boundaries of the Preserve is approximately 6828 meters (4.24 miles) in length along the centerline. We selected one reach per mile within the confines of Preserve to be surveyed, resulting in the selection of four survey reaches of similar extents (please reference **Table 3** found later on in this document). All of these segments were walked during a preliminary reconnaissance. These locations were selected based on habitat complexity (i.e. the amount of riffle-pool-run-glide sequences) that best represented the entire reach of Spring Creek within the Preserve. Based on observations made during the preliminary reconnaissance and in consideration of project constraints (i.e. safety of survey crews, ease of operation by volunteers, budget, etc.), we sampled using a seine. Seines were deployed by 2-3 person crews under the supervision of a TPWD-permitted biologist. The size of seines to be deployed depended on habitat type and included a 30 ft × 6 ft × ¼ in mesh seine for pools and a 15 ft or 6 ft × 6 ft × 3/16 in mesh seine for riffles, runs, and smaller pools. At each location, survey effort consisted of at least six effective seine hauls covering at least 60m. Seining was continued until no new species were collected and all available habitats were adequately sampled. All seining activities took place during daylight hours on 10/9/2021, 10/10/2021, 10/16/2021, 10/17/2021. Live-captured fishes were held in 5-gallon buckets with aerators until the completion of seining activities. Upon completion of seining, fishes were enumerated and recorded by the permitted biologist to the species level. To assist in updating species biodiversity information for this drainage, a representative subset of specimens of each species was preserved and will be deposited in the University of Texas' Biodiversity Collections. All other fishes were released alive immediately after being recorded. Representative photographs of each species were added to the Preserve's iNaturalist project. Only adult fishes were identified to the species level. Between survey dates, all equipment was decontaminated following methodology outlined by TPWD Best Management Practices (BMPs) described in guidance documentation for Aquatic Resource Relocation Plans (ARRPs). These BMPs are generally described as cleaning all mud, plant fragments, and other debris from all equipment before leaving the site; draining all water from boats, fish hauling units, buckets, or other receptacles at a location where the water will not drain into any water body; and allowing all equipment to dry completely before use at another survey site. These BMPs assist in preventing the spread of exotic/introduced aquatic species in Texas waterways. Consistent with guidance outlined in the American Fisheries Society publication *Guidelines for the Use of Fishes in Research* (American Fisheries Society, 2014), representatives of non-native species collected during sampling events were also preserved as voucher specimens; however, the remainder were euthanized and disposed of at a local landfill. In addition to the fish survey, several anglers were interviewed to determine other species that

may exist within the Preserve. This creel survey will only be considered valid if photos can be produced that allow for a positive identification by the permitted biologist or other consulted subject matter experts.

2.4 Fish Identification

The primary identification resource for this fish survey was the latest edition of *The Inland Fishes of Texas Pictorial Key* (Bonner, Craig, & Edwards, 2020). Supplementary identification materials were the FoTX website, the publication *Drainage Basin Checklists and Dichotomous Keys for Inland Fishes of Texas* (Bonner & Craig, 2019), and the *Peterson Field Guide to Freshwater Fishes, Second Edition* (Burr & Page, 2011). Additionally, online resources such as GBIF.org were utilized to supplement the above-mentioned sources of identification. The identification of fishes was based on field characters supported by verification of submitted voucher specimens by FoTX staff or other subject matter experts. This report is designed to serve as a general guide for fish species collected during the survey and a pictorial guide will be provided in **Attachment B – Fish Photographs**.

3.0 Results

3.1 Surveyed Habitats

For simplification, habitat was broken down into riffles, pools, and runs. Glides were included in the run category. A summary of surveyed habitat types at each of the four locations has been provided below in **Table 3**. For the approximate locations of each survey reach, please reference **Figure 2** in **Attachment A - Figures**.

TABLE 3. SURVEYED HABITAT INFORMATION.

Survey Reach	Upstream Extent[1]	Downstream Extent[1]	Distance within Reach (m)	Riffle[2]	Pool[2]	Run[2]	Total[2]	Time at Location (hr)	Air Temperature (°F)
1	32.954749 -96.640852	32.954218 -96.638364	376	3	5	4	12	3.0	86°F
2	32.960513 -96.653196	32.959602 -96.651345	319	3	3	2	8	2.5	72°F
3	32.967627 -96.656456	32.964368 -96.655905	494	2	4	2	8	3.0	90°F
4	32.972361 -96.669689	32.972117 -96.667755	236	5	2	0	7	1.8	73°F
Total			**1425**	**13**	**14**	**8**	**35**	**10.3**	**---**
Percentage of Total Sampled Areas				**37%**	**40%**	**23%**	**100%**	---	---

[1]Reported in decimal degrees (WGS84).
[2]Represents the number of each habitat type surveyed within each survey reach across the distance listed in the "Distance (m)" column.

A total of 13 riffles, 14 pools, and 8 runs were sampled across all four survey segments for a total of 1425 meters across 10.3 total survey hours. The mean reach distance surveyed was approximately 356 meters and the mean time spent at each location was approximately 2.6 hours. Time at location has been provided for a catch per unit effort (CPUE) calculation (provided later in this document). The average air temperature during survey activities was 80.8°F. Water temperature was not measured; however, was estimated to be between 70°F and 80°F. The most common habitat type surveyed were pools (40%) followed by riffles (37%) and lastly runs (23%). This distribution of habitats is representative of the overall available habitat within Spring Creek within the Preserve. Based on field observations, channel substrate was consistent with what was described in **Section 2.1** of this document. Of note, an abandoned sanitary sewer line was observed within the channel throughout several reaches. Flow velocity across habitat types was consistent among each type (pool, riffle, run) throughout the entire reach. Field indicators of bankfull and the ordinary high water mark indicate at the time of fish sampling, the stream was observed under

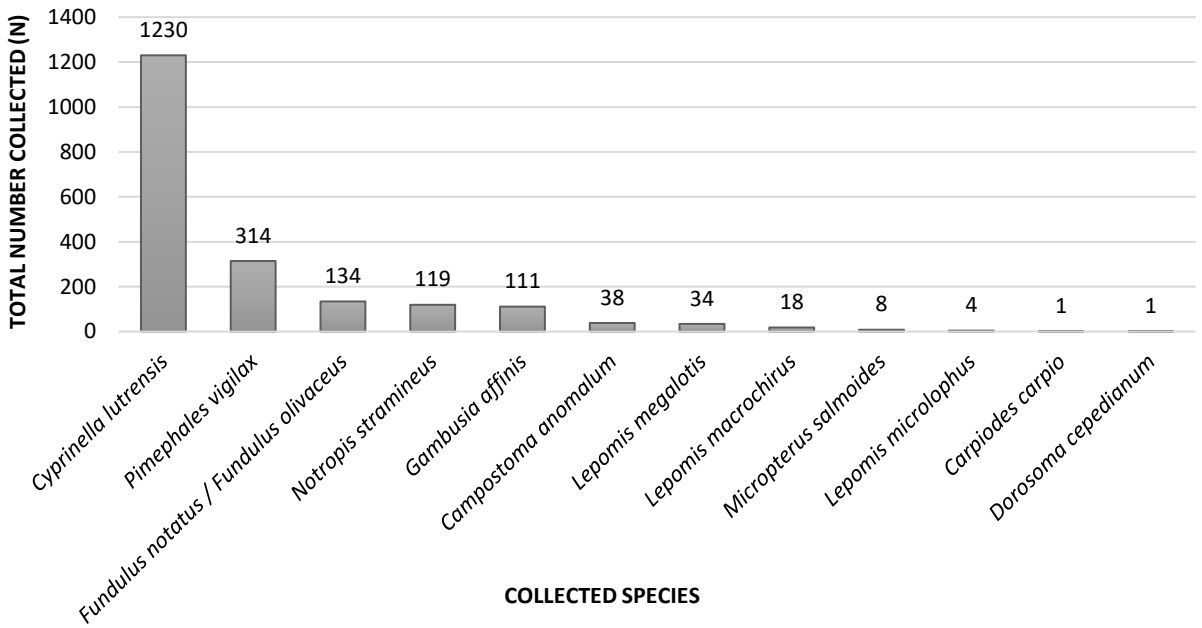
conditions that could be best described as “low flow” for the reach of stream within the Preserve for the given time of year (late summer/early fall).

3.2 Species Collected

Across all survey segments, a total of 2049 fish were collected and enumerated. CPUE was calculated to be approximately 200 fish/hour for all seining efforts. Sunfishes collected that were too small to be accurately identified in the field (<25mm) were documented as “juvenile sunfish”. These represented only 2% of live-captured fishes (37 individuals out of 2049) and will not be included in this discussion as these records may consist of multiple *Lepomi*s sp.; therefore, all statistics are based on collected fishes minus juvenile sunfish (n = 2012). Additionally, conversations with subject matter experts indicate two species of topminnow (*Fundulus notatus* and *Fundulus olivaceus*) were likely collected that are morphologically similar to the point where field characters are insufficient to differentiate. Turbid waters such as those found in slower moving portions of Spring Creek within the Preserve can also cause these species to mask certain characters (e.g. lessen the prominence of distinct markings) making determination without genetic verification difficult or even impossible. For the purposes of statistical analysis, both of these species were enumerated together; however, all vouchers were submitted to FoTX for ID confirmation. In the context of this report, the presence of both species was assumed as they are known to exhibit hybridization and have ranges that overlap in the DFW area (Schaefer et al., 2016). A table (**Table 4**) and graph (**Figure 3**) depicting totals of collected fish species without juvenile sunfish across all survey segments has been provided below. Please reference **Attachment B – Fish Photographs** for representative photos of all collected species.

TABLE 4. COLLECTED SPECIES TOTALS.		
Scientific Name	**n**	**Percent**
Cyprinella lutrensis	1230	61.13%
Pimephales vigilax	314	15.61%
Fundulus notatus / Fundulus olivaceus	134	6.66%
Notropis stramineus	119	5.91%
Gambusia affinis	111	5.52%
Campostoma anomalum	38	1.89%
Lepomis megalotis	34	1.69%
Lepomis macrochirus	18	0.89%
Lepomis spp. (Juvenile)	37	---
Micropterus salmoides	8	0.40%
Lepomis microlophus	4	0.20%
Carpiodes carpio	1	0.05%
Dorosoma cepedianum	1	0.05%
Total w/o Juvenile *Lepomis*	**(2012)**	**100%**

FIGURE 3. SPECIES TOTALS FOR ALL SURVEY SEGMENTS.



3.3 Creel Survey

Anglers indicated that there were several species other than those listed above present within Spring Creek including the common carp (*Cyprinus carpio*), green sunfish (*Lepomis cyanellus*), channel catfish (*Ictalurus punctatus*), spotted gar (*Lepisosteus oculatus*), and sunfish hybrids (*Lepomis* sp. X *Lepomis* sp.).

A few of the anglers were able to produce photographs which were sufficient enough to make a positive identification of the above-mentioned species. Furthermore, all of the species listed by anglers were visually observed during the fish survey efforts; however, none were collected. These species were not included in the statistics above and will not be included in the fish guide found in **Attachment B – Fish Photographs**.

3.4 Discussion

In addition to the 13 species collected during seining efforts, an additional 4 species were confirmed to exist in the segment of Spring Creek within the Preserve based on the creel survey and visual observations (minus unidentifiable sunfish hybrids). An additional consideration is that Spring Creek within the Preserve is a larger tributary upstream of Lake Ray Hubbard, an impoundment of the East Fork Trinity River, which supports a popular white bass (*Morone chrysops*) fishery. Between Lake Ray Hubbard and Spring Creek lies Rowlett Creek, a locally well-known destination among anglers for the seasonal spring white bass spawning run. Based on field observations, the lower extent of Spring Creek within the Preserve may be used by introduced *M*. *chrysops* for a short period during the spawning run, as these fish are known to run upstream of their resident pelagic waters >15 miles in some instances in the DFW area. Of note, 119 individuals of sand shiner (*Notropis stramineus*) were also collected during seine survey efforts. This species is considered rare within the Upper Trinity basin, having only 7 recorded observations since 1957 (GBIF.org, 2021). Only one these records was within Spring Creek and was a photo-only, "Research-grade" iNaturalist observation posted by a TPWD biologist in 2017. Individuals collected were of various life stages (juveniles and adults) indicating recruitment is actively occurring in the reach of Spring Creek within the Preserve. Based on the reproductive biology of this species (e.g. broadcast spawner, laying demersal-adhesive eggs) and known habitat requirements (e.g. shallow streams with sufficient flow for broadcast spawning), the existence of this species within Spring Creek is very likely due to the higher percentage of riffle and run (combined 60%) habitats present and its continued existence within this reach will likely be determined by the persistence of these habitat types over time (Hendrickson, Dean A., and Adam E. Cohen, 2015). *N*. *stramineus* was also the third most abundant species collected during this fish survey (n = 119; 5.91%) which may indicate that while this species is considered rare, it is likely abundant wherever it is found; be that only in limited locations in the Upper Trinity basin. Another notable finding was the possible collection of two species of topminnow (*Fundulus notatus* and *Fundulus olivaceus*) or hybrids between the two species (*F. notatus* x *olivaceus*/*F*. *olivaceus* x *notatus*). The distinction of these two

species is primarily based on the distinction of black spots[1] on the anterior dorso-lateral region and throughout the dorsal and caudal fins (Bonner, Craig, & Edwards, 2020); however, this is known to be masked in turbid waters such as those found in some of the expansive, slow moving pools observed in Spring Creek within the Preserve. The voucher specimens collected of *Fundulus* spp. from this fish survey will assist in determining the distribution of these species within the Upper Trinity basin. To account for uncertainty regarding the verified identification of these two species, representative photos of individuals displaying physical characters of both species have been provided in **Attachment B – Fish Photographs** and the existence of both species (and a hybridization) within the Preserve should be assumed until proven otherwise. The red shiner (*Cyprinella lutrensis*) accounted for approximately 60% (n = 1230) of all collected species. None of the other collected species were close to this abundance and this drastically altered the standard deviation of species totals (346.619 with *C. lutrensis* included versus 95.104 without). While considered native to the East Fork Trinity River basin, this species thrives under harsh conditions such as low flows, high turbidity, and poor water quality (Nico, Fuller, Neilson, & Daniel, 2021). Additionally, the breeding season for this species in Texas is known to be mid-April to September (Hendrickson, Dean A., and Adam E. Cohen, 2015). Seining occurred in mid-October and very few individuals were collected with strong nuptial tuberculation indicating the species had already spawned for the year. Based on this information, the high abundance of this species is very likely due to a high percentage of riffle habitat (37%) within the segment of Spring Creek in the Preserve that created ideal reproductive habitat for this species such as shallow expanses of limestone particulate and bedrock with crevices in moving water (Hendrickson, Dean A., and Adam E. Cohen, 2015). It should also be considered that the only live-capture method deployed during this fish survey was seining. While this method is very effective for collecting freshwater fishes in wadeable streams, it should be noted that combining this technique with electrofishing may produce more unbiased results as species that evade capture can be more readily collected from around structure (i.e. debris, boulders, larger cobbles, etc.) that would cause seine hauls to be ineffective. A future direction for additional fish survey efforts may be to employ electrofishing as a supplement to seining to better sample more complex habitat types (i.e. large boulder complexes and organic/anthropogenic debris piles) in Spring Creek within the Preserve. Additionally, there is a demonstrated need for future fish surveys within this reach of Spring Creek due to the altered flow regime identified within the background review. The Preserve exists as a buffer from the immediate effects of surrounding urbanization; however, upstream flow modification and other unforeseeable

[1] Faint in *F. notatus*, distinct in *F. olivaceus*. Hybrid is not distinguishable by this character alone.

events such as water line ruptures can produce immense stress on fish assemblages within the referenced reach of Spring Creek and possibly cause permanent species composition shifts. It is recommended that fish assemblage be sampled every few years within the Preserve to monitor species composition; especially due to the presence of a locally rare species (*N. stramineus*) and a species richness that is relatively high for a highly urbanized stream system (comparable to Wilson Creek, a less urbanized stream within the same larger East Fork Trinity River drainage basin (Hendrickson, Dean A., and Adam E. Cohen, 2015)).

3.5 Final Species List

Based on the results of the fish survey and historic fish data, a final species list for Spring Creek within the Preserve has been provided on the next page in **Table 5**.

TABLE 5. SPRING CREEK FOREST PRESERVE FISH LIST.		
Scientific Name	**Common Name**	**Justification**
Ameiurus melas	Black bullhead	H
Ameiurus natalis	Yellow bullhead	H
Campostoma anomalum	Central stoneroller	H,C
Carpiodes carpio	River carpsucker	C
Cyprinella lutrensis	Red shiner	H,C
Cyprinus carpio	Common carp	H,CR,VO
Dorosoma cepedianum	Gizzard shad	C
Fundulus notatus	Blackstripe topminnow	H,C
Fundulus olivaceus	Blackspotted topminnow	C (possible)
Fundulus sp. (hybrid)	*F. notatus/olivaceus* hybrids	C (possible)
Gambusia affinis	Western mosquitofish	C
Ictalurus punctatus	Channel catfish	CR,VO
Lepisosteus oculatus	Spotted gar	VO
Lepomis cyanellus	Green sunfish	H,CR,VO
Lepomis macrochirus	Bluegill	H,C
Lepomis megalotis	Longear sunfish	H,C
Lepomis microlophus	Redear sunfish	H,C
Lepomis sp. *(*hybrid)	Various *Lepomis* hybrids	CR
Micropterus salmoides	Largemouth bass	H,C,CR,VO
Morone chrysops	White bass	CR (seasonally only)
Notropis stramineus	Sand shiner	H,C
Pimephales vigilax	Bullhead minnow	H,C
*H – Historic Record; C – Collected during Seine Surveys; CR- Creel Survey; VO – Visual Observation		

3.6 Conclusion

A total of 22 fish species (including hybridizations) were determined to occur within the reach of Spring Creek within the Preserve. Of these 22 species, 19 are likely to be permanent residents. 1 species is likely to occur within the Preserve during the spring (*Morone chrysops*); however, is likely absent throughout the remainder of the year. The remaining 2 taxa represent hybrids of species listed above in the genera *Fundulus* and *Lepomis*. This list should not be considered completely exhaustive, as the composition of stream fish assemblages is dynamic and can fluctuate in time. Based on the results of the seine survey efforts, species richness of collected fishes was n = 12; however, the actual species richness is likely n = 22 according to the supplemental creel survey, visual observations, and historic data review. If all possible *Lepomis* hybrids are to be considered separate and distinct species, species richness would be even higher.

This species richness can also be affected by the accidental or intentional release of non-native species; therefore, this should be considered as well. Please refer to **Attachment B – Fish Photographs** for a visual guide created from field photos taken during the fish survey (non-collected species not included).

3.7 Acknowledgements

This fish survey would not have been possible without the unwavering support of several highly motivated, hard-working volunteers, the support of the Preservation Society for Spring Creek Forest, and Fishes of Texas staff. The following individuals deserve the highest of praises for assisting in the completion of this fish survey:

Ms. Ashleigh Miller

Mr. Finley Miller

Mrs. Judy Aschner

Mr. Landry Pogue

Mr. Ryan Triebel

"A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise."

- Aldo Leopold

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ATTACHMENT A – FIGURES

FIGURE 1

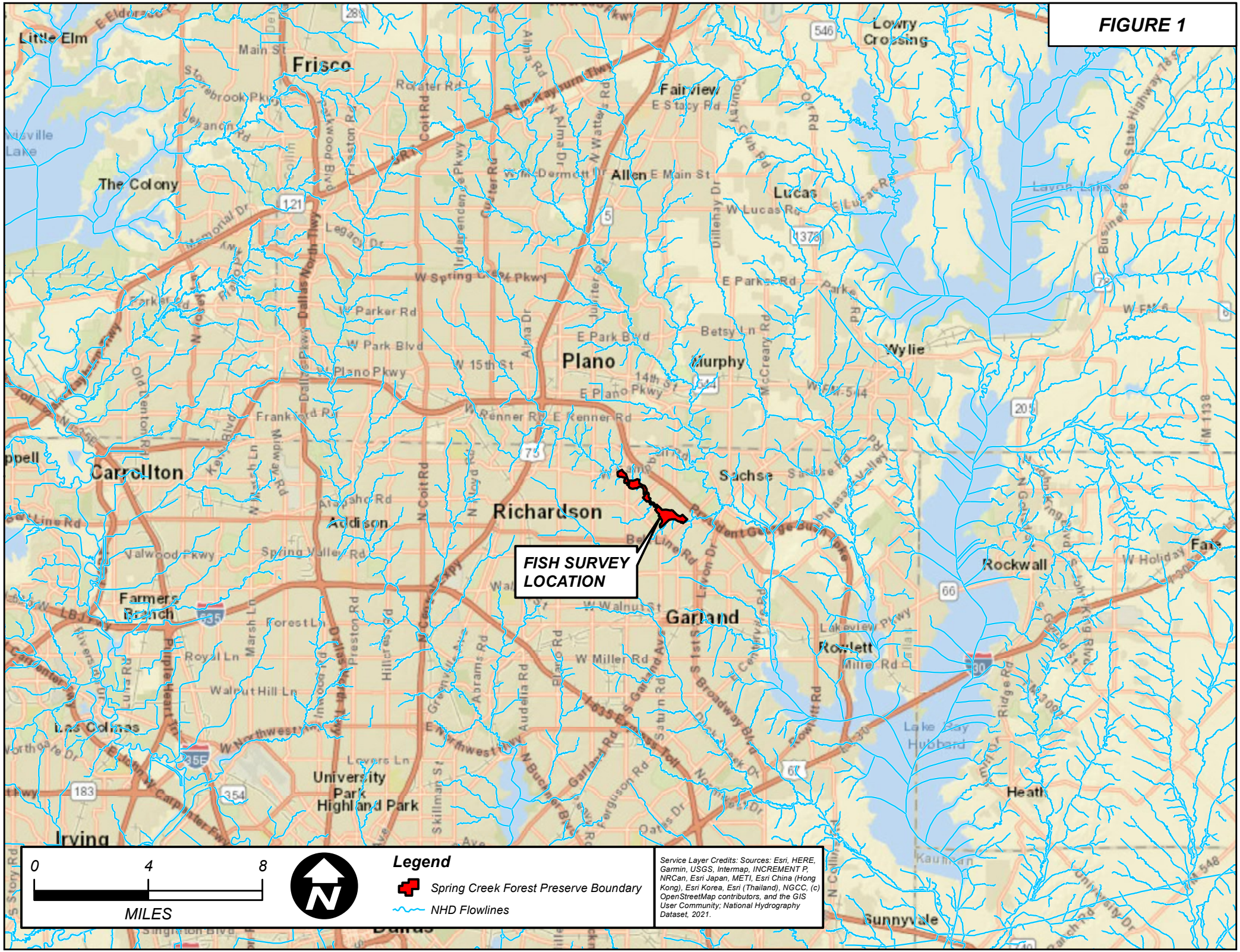
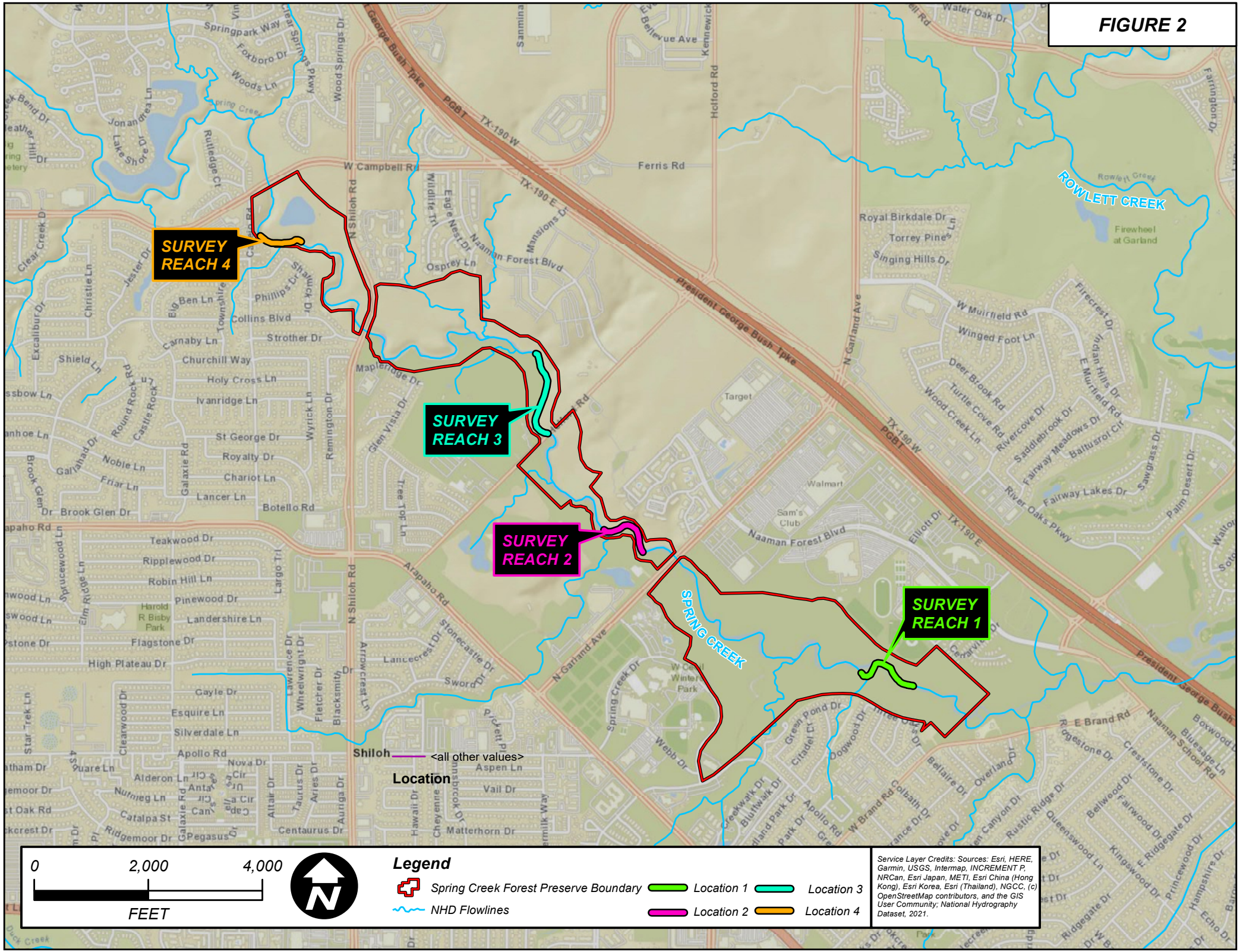

FISH SURVEY LOCATION
Little Elm
Frisco
The Colony
Lewisville Lake
Lowry Crossing
Fairview
Allen
Lucas
Plano
Murphy
Wylie
Carrollton
Addison
Richardson
Sachse
Garland
Rockwall
Rowlett
Farmers Branch
University Park
Highland Park
Irving
Heath
Sunnyvale
Lake Ray Hubbard
0
4
8
MILES
N
Legend
Spring Creek Forest Preserve Boundary
NHD Flowlines
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community; National Hydrography Dataset, 2021.

FIGURE 2


SURVEY REACH 4
SURVEY REACH 3
SURVEY REACH 2
SURVEY REACH 1
ROWLETT CREEK
SPRING CREEK
President George Bush Tpke
PGBT
TX-190 W
TX-190 E
W Campbell Rd
Ferris Rd
N Shiloh Rd
Naaman Forest Blvd
Arapaho Rd
N Garland Ave
Holford Rd
Kennewick
Springpark Way
Foxboro Dr
Woods Ln
Wood Springs Dr
Water Oak Dr
Royal Birkdale Dr
Torrey Pines Ln
Singing Hills Dr
W Muirfield Rd
Winged Foot Ln
Deer Brook Rd
Turtle Cove Rd
Wood Creek Ln
Rivercove Dr
Saddlebrook Dr
Fairway Meadows Dr
Baltusrol Cir
E Muirfield Rd
Indian Hills Dr
Firecrest Dr
Fairway Lakes Dr
River Oaks Pkwy
Sawgrass Dr
Palm Desert Dr
Elliott Dr
Target
Walmart
Sam's Club
Collins Blvd
Strother Dr
Churchill Way
Holy Cross Ln
Ivanridge Ln
St George Dr
Royalty Dr
Chariot Ln
Lancer Ln
Botello Rd
Teakwood Dr
Ripplewood Dr
Robin Hill Ln
Pinewood Dr
Landershire Ln
Flagstone Dr
High Plateau Dr
Gayle Dr
Esquire Ln
Silverdale Ln
Apollo Rd
Nova Dr
Alderon Ln
Nutmeg Ln
Catalpa St
Ridgemoor Dr
Pegasus Dr
Centaurus Dr
Aspen Ln
Vail Dr
Matterhorn Dr
Cheyenne Dr
Hawaii Dr
Lancecrest Dr
Stonecastle Dr
Sword Dr
Arrowcrest Ln
Blacksmith Dr
Fletcher Dr
Wheelwright Dr
Lawrence Dr
Largo Trl
Tree Top Ln
Glen Vista Dr
Mapleridge Dr
Osprey Ln
Eagle Nest Dr
Wildlife Trl
Mansions Dr
Naaman Forest Blvd
Phillips Dr
Shamrock Dr
Jester Dr
Clear Creek Dr
Excalibur Dr
Christie Ln
Shield Ln
Carnaby Ln
Ben Ln
Townshire
Round Rock Rd
Castle Rock
Wyrick Ln
Remington Dr
Galaxie Rd
Noble Ln
Friar Ln
Brook Glen Dr
Teakwood Dr
Spruce Wood Ln
Elm Ridge Ln
Harold R Bisby Park
Clearwood Dr
Star Trek Ln
Square Ln
Nutmeg Ln
Catalpa St
Ridgemoor Dr
Pegasus Dr
Centaurus Dr
Auriga Dr
Aries Dr
Taurus Dr
Altair Dr
Galaxie Rd
Alderon Ln
Nova Dr
Apollo Rd
Silverdale Ln
Esquire Ln
Gayle Dr
High Plateau Dr
Flagstone Dr
Landershire Ln
Pinewood Dr
Robin Hill Ln
Ripplewood Dr
Teakwood Dr
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Royalty Dr
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Churchill Way
Strother Dr
Collins Blvd
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2,000
4,000
FEET
N
Legend
Spring Creek Forest Preserve Boundary
NHD Flowlines
Location 1
Location 2
Location 3
Location 4
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community; National Hydrography Dataset, 2021.

ATTACHMENT B – FISH PHOTOGRAPHS

Blackspotted topminnow

(*Fundulus olivaceus*)

Spotting distinct and more frequent.

Blackstripe topminnow

(*Fundulus notatus*)

Spotting faint and less frequent.

Bluegill

(*Lepomis macrochirus*)

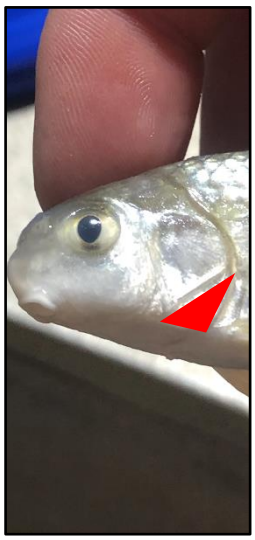
Bullhead minnow

(*Pimephales vigilax*)

River carpsucker

(*Carpiodes carpio*)

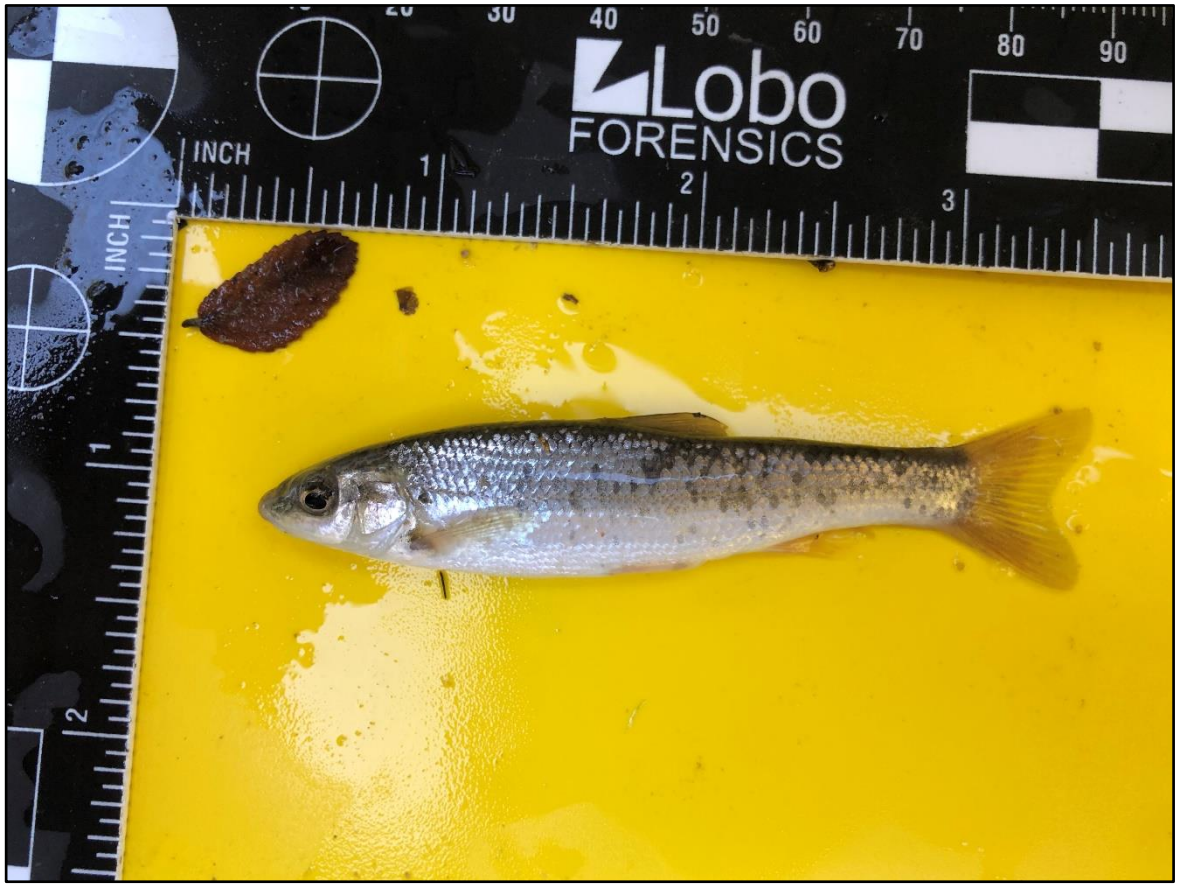
Protrusion on center of lower lip.



Triangular subopercle.

Central stoneroller

(*Campostoma anomalum*)



Gizzard shad

(*Dorosoma cepedianum*)

Largemouth bass

(*Micropterus salmoides*)

Longear sunfish

(*Lepomis megalotis*)

Redear sunfish

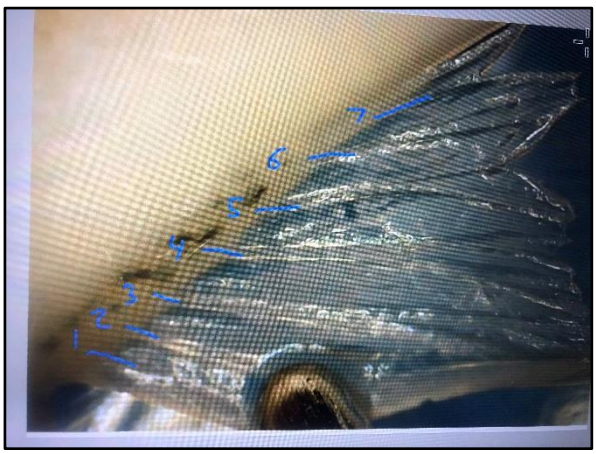
(*Lepomis microlophus*)

Red shiner

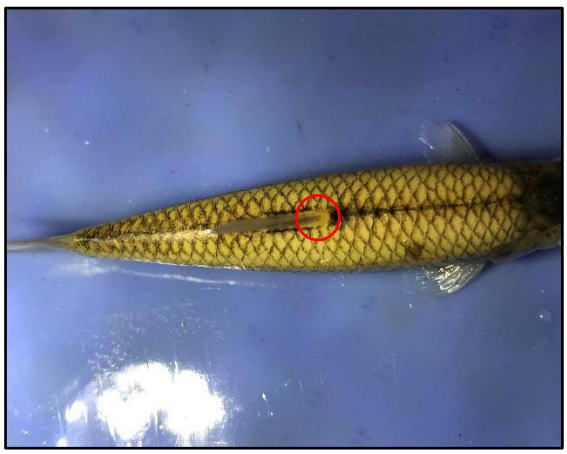
(*Cyprinella lutrensis*)

Sand shiner

(*Notropis stramineus*)



Seven rays on anal fin.



Distinct and separate black dash at base of dorsal fin.

Western mosquitofish

(*Gambusia affinis*)