HABITAT CONSERVATION PLAN BIOLOGICAL MONITORING PROGRAM San Marcos Springs/River Ecosystem

ANNUAL REPORT

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EXECUTIVE SUMMARY

The Edwards Aquifer Habitat Conservation Plan (HCP) Biological Monitoring program activities conducted in 2017 continued to track biota and habitat conditions of the San Marcos Springs/River ecosystem. Sampling efforts specifically targeting HCP species in the San Marcos system were conducted for the Fountain Darter *Etheostoma fonticola*, Texas wild-rice *Zizania texana*, and the San Marcos salamander *Eurycea nana*. Additional community level monitoring data was also collected on aquatic vegetation, benthic macroinvertebrate, and fish communities. This annual summary report presents a synopsis of methodologies used and observations made during comprehensive sampling activities conducted in the San Marcos system during 2017.

Results from 2017 provided insight into the continued transition from a prolonged drought to subsequent wet years in central Texas. The drought was broken in spectacular fashion with two major flooding events occurring in 2015 and continued rainfall in 2016 resulting in a resurgence of recharge. Total system discharge in the San Marcos system has remained at or above historical monthly averages since early summer 2015. Similar to 2016, water temperature and dissolved oxygen measurements throughout the system presented no cause for concern.

For the second year in a row Texas wild- rice was recorded at the highest levels since Edwards Aquifer Authority (EAA) biological monitoring was initiated over 17 years ago. Over 9,200 m^2 of Texas wild-rice was mapped in August 2017. Total coverage of aquatic vegetation in the biological monitoring study reaches remained consistent with long-term study averages at the conclusion of 2017. However, the rapid expansion of Texas wild-rice in the system has led to this plant species now representing the dominant aquatic vegetation in both the Spring Lake Dam and City Park study reaches, at approximately 75% and 60 percent of the aquatic plant community, respectively. In the I-35 biological monitoring reach, Texas wild-rice nearly doubled from spring to fall 2017, and presently makes up approximately 30% of the aquatic plant community. Overall, native aquatic vegetation restoration activities sponsored by the HCP continue to provide a boost to the native aquatic plant community of the San Marcos River.

Normalized Fountain Darter population estimates were well below the long-term averages again in 2017. This decrease was noted in 2016 with the hypothesis that the decrease may be attributed to above average flows impeding the expansion of key aquatic vegetation used by Fountain Darters. The rapid expansion and dominance of Texas wild-rice within the biological monitoring study reaches is also likely a contributing factor. Although Texas wild-rice is not sampled with drop-net sampling to avoid disturbance of a federally listed plant species, dip-net sampling in Texas wild-rice has resulted in approximately 10% of sites containing Fountain Darters compared to over 50% of sites containing Fountain Darters when examining all other vegetation types sampled in the San Marcos River. Timed and Random-station dip netting of Fountain Darters continue to provide an on-going “snapshot” of size-class distributions and an efficient way to assess on-going population and habitat conditions. Similar to drop net results, dip-net survey results for 2017 exhibited declines in abundance and detection in 2017.

Sampling of the overall fish community in the San Marcos River continued to reflect a diverse community of fishes although total numbers collected declined in 2017. Five years of fish community sampling since 2013 in the San Marcos River has resulted in collection of over

31,000 fishes representing 37 different fish species. In comparison, the San Marcos River drop-net database (2000–2017) contains over 59,000 fishes representing 25 species. Higher species richness within the fish community dataset is likely a result of both sampling technique and location. Seining and visual observation are more effective at enumerating large or highly mobile species such as sunfish and minnows. Conversely, drop netting is more successful for Fountain Darters compared to these other techniques as it was designed specifically to capture this species. Per direction of the HCP biological working group, limited fish tissue analysis was added to the HCP biological monitoring program specific to 2017. The objective was to explore if any toxicity concerns exist for different fish trophic levels in the San Marcos system. Although detections of several constituents were recorded ranging from caffeine to mercury, no results stood out as a cause for concern at this time. The acquisition of this type of fish tissue data serves well in the establishment of baseline conditions for future comparisons on a local or regional level.

San Marcos salamander densities observed were consistent with long term averages at all sampling locations in 2017. Per direction of the HCP biological working group, Benthic Macroinvertebrate Rapid Bioassessment sampling was added to the HCP biological monitoring program in 2017. The goal of this assessment is to track the “condition” of specific reaches over time as an indicator of trends, not necessarily as a comparison between reaches. Overall, areas of more lentic-type habitat (Spring Lake) near spring sources scored lower, as communities there are different when compared to swifter flowing “least disturbed reference streams.” Downstream areas with more lotic conditions generally scored higher, as habitat is more similar to reference streams. Continued monitoring may allow development of a reference dataset specific to this unique ecosystem, and potentially development of a specific scoring system for unique large spring environments such as the San Marcos and Comal rivers.

Overall, habitat and species conditions in Spring Lake remain excellent while conditions in the river have been more variable in these recent higher than average flow years. For certain species, particularly Texas wild-rice, vast improvements in establishment and expansion are being accomplished the past few years through HCP restoration and mitigation activities. For the Fountain Darter, declines in numbers and detection in the riverine study reaches coupled with a decrease in overall fish community results highlights the importance of future biological monitoring to assess conditions as well as quantify effects (both positive and negative) in continuing to better understand and track trends in the dynamic San Marcos river system.

INTRODUCTION

Section 6.3.1 of the Edwards Aquifer Habitat Conservation Plan (HCP) laid out the path forward for continuation of biological monitoring. Originally, the biological monitoring program's (formerly known as the Edwards Aquifer Authority [EAA] Variable Flow Study) main objective was to evaluate the effects of variable flow on the biological resources (particularly threatened/endangered species) within the Comal and San Marcos spring systems. This fundamental objective is still imperative to the success of the HCP, as is continued monitoring of system conditions over time and filling in important data gaps where appropriate and practical. However, the utility of the HCP biological monitoring program has surpassed this original goal and objective. The biological monitoring data collected through this original program (BIO-WEST 2001a–2014a, b) now also serves as (1) the cornerstone for several underlying sections in the HCP including long-term biological goals and management objectives (HCP Section 4.1); (2) determination of potential impacts to and incidental take assessment relative to the HCP and Environmental Impact Statement alternatives (HCP Section 4.2); and (3) establishment of core adaptive management activities for triggered monitoring and adaptive management response actions (HCP Sections 6.4.3 [Comal] and 6.4.4 [San Marcos]).

As the HCP proceeds, successful execution of the biological monitoring program is mandatory to adequately assess these topics relative to HCP Phase II decisions and guide management decisions aimed at protection of the species during low-flow conditions. Additionally, the HCP biological monitoring program data, in conjunction with other available information, is essential to assess the effectiveness and efficiency of certain HCP mitigation/restoration activities conducted in both the Comal and San Marcos springs systems and calculate the HCP habitat baseline and net disturbance determination and annual incidental "take" estimate.

Over the years, the EAA Variable Flow Study (now HCP biological monitoring program) has undergone numerous reviews and critiques. Adjustments have been made as appropriate. Most recently the National Academy of Science conducted a thorough review (NRC 2015), which led to the formation of a HCP Biological Working Group (BWG). The BWG recommended specific modifications to the monitoring program be implemented in 2017. The first was the addition of a preliminary investigation of fish tissue in both the Comal and San Marcos systems to explore the potential for contaminants and impacts to fish health. The second was a modification of the benthic macroinvertebrate community sampling initiated in 2013. The macroinvertebrate sampling effort was adjusted to a rapid bioassessment approach to track invertebrate health within reaches per existing Texas Commission on Environmental Quality (TCEQ) protocols (TCEQ 2014).

It is important to understand that many different sampling components are included in the HCP biological monitoring program and several sampling location strategies are employed. The sampling locations selected are designed to cover the entire extent of endangered species habitats in both systems, but they also allow for holistic ecological interpretation while maximizing resources. The current design employs five basic sampling location strategies for the San Marcos system as follows, with associated sampling components.

The five sampling location strategies are as follows:

1. System-wide sampling
   - Texas wild-rice full-system mapping—annually
   - Full-system aquatic vegetation mapping—once every 5 years (next scheduled for 2018)

2. Select Longitudinal Locations
   - Temperature monitoring—thermistors
   - Water quality sampling—during low-flow sampling
   - Fixed-station photography

3. Reach Sampling (three reaches)
   - Aquatic vegetation mapping
   - Fountain Darter *Etheostoma fonticola* drop netting
   - Fountain Darter random-station dip netting
   - Macroinvertebrate community sampling

4. Springs Sampling
   - San Marcos salamander (*Eurycea nana*) sampling

5. River Section/Segment Sampling
   - Fountain Darter timed dip-netting surveys
   - Fish community sampling
   - Benthic macroinvertebrate sampling
   - Fish tissue sampling

The following sections provide a description of methods for 2017 activities, followed by a presentation of observations and results. A more detailed description of the gear types used, methodologies employed, and specific GPS coordinates can be found in the Standard Operating Procedures Manual for the HCP biological monitoring program for the San Marcos Springs/River ecosystem (EAA 2017a).

METHODS

Study Location

The upper San Marcos River, which is part of the Edwards Aquifer system, extends from its origin as a series of spring upwellings in Spring Lake to the confluence with the Blanco River in Hays County. The upper portion of the river is characterized by near-constant water temperatures and relatively constant flow. This portion of the river also includes several endemic organisms that are federally listed as threatened or endangered, including: Texas wild-rice, San Marcos salamander, San Marcos gambusia *Gambusia georgei*, Comal Springs riffle beetle *Heterelmis comalensis*, Texas blind salamander *Eurycea rathbuni*, and Fountain Darter. This section of the river is located within an urban area and is subjected to a substantial amount of recreational use. Sites were chosen in this section of the river to better understand the interactions between the biota, the surrounding environment, and recreational users of this unique ecosystem (Figure 1).

During 2017 two comprehensive sampling efforts (spring and fall) and several annual activities were conducted in the San Marcos River system. The 2017 sampling schedule included the following components:

Aquatic Vegetation
Texas wild-rice full-system survey
Sample reach GPS mapping

Water Quality and Fixed Station Photos
Thermistor placement and retrieval
Fixed-station photography
Point water quality measurements

San Marcos Salamander Observations
Snorkel/SCUBA surveys

Texas Wild-Rice Physical Observations
Physical measurements

Fountain Darter Sampling
Drop nets, dip nets
Visual observations

Fish Community Sampling
SCUBA surveys
Seining

Macroinvertebrate Community Sampling
Benthic Macroinvertebrate Rapid Bioassessment

As discussed in previous annual reports, two types of low-flow sampling were incorporated into the HCP biological monitoring program in 2013. Respective sampling triggers and data collection activities are outlined in Appendix A. The first was the historically conducted Critical Period low-flow sampling, which is for the most part a repetition of sampling components and activities performed for a comprehensive sampling event. The second type of sampling that was incorporated in 2013 is species-specific triggered sampling, which was designed specifically to inform HCP adaptive management decisions. Neither of these two types of low-flow sampling were triggered in 2017 and thus will not be discussed further in this report. See previous annual reports for a synopsis and examples.

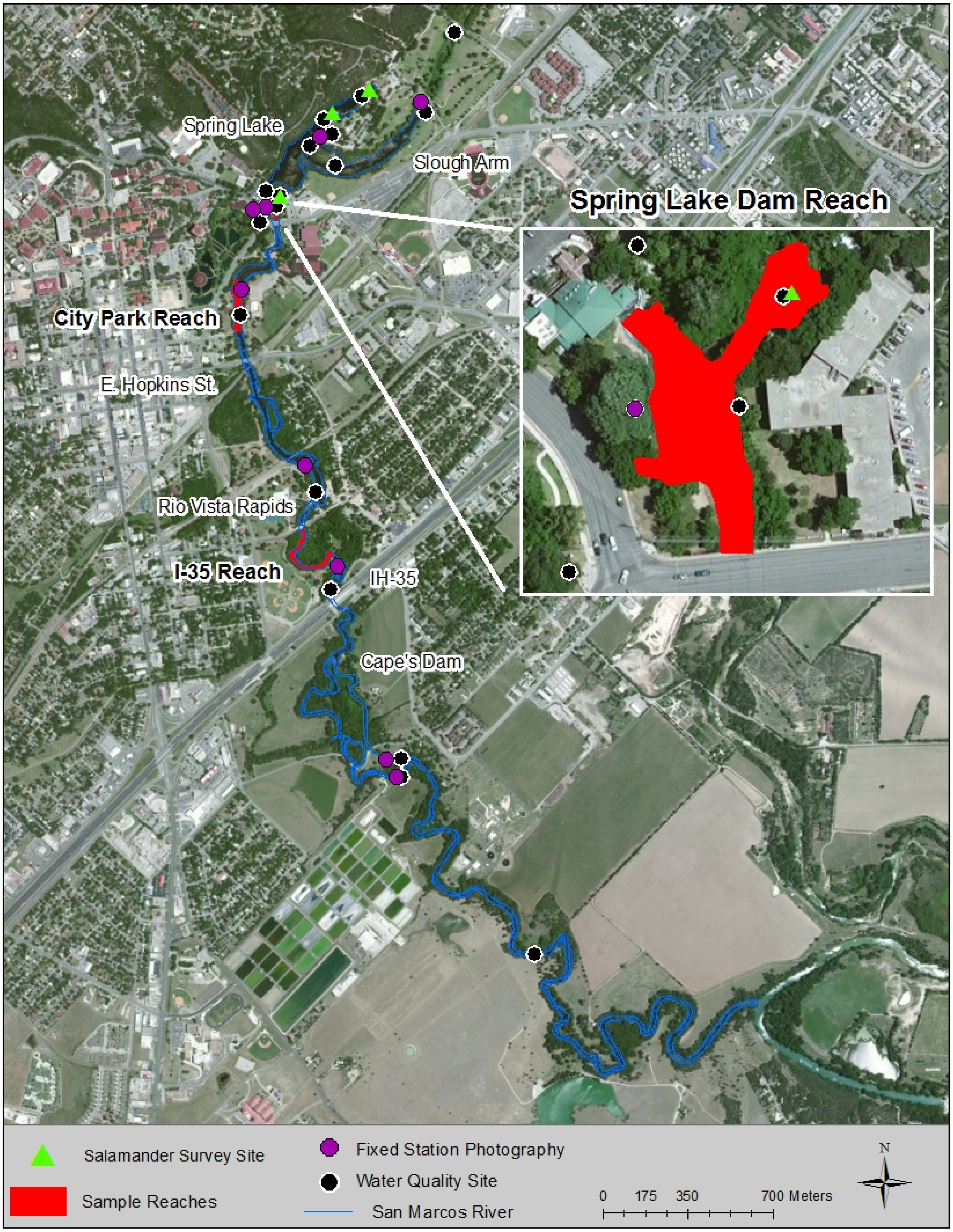


Figure 1. Upper San Marcos River sample reaches, San Marcos salamander count sites, water quality sampling sites, and fixed-station photography sites.

San Marcos Springflow

All San Marcos River discharge data were acquired from the US Geological Survey (USGS) Water Resources Division. Some of these data are provisional (as indicated in the disclaimer on the USGS website) and, as such, may be subject to revision at a later date. According to the disclaimer, "recent data provided by the USGS in Texas—including stream discharge, water levels, precipitation, and components from water-quality monitors—are preliminary and have not received final approval" (USGS 2017). The discharge data for the San Marcos River were taken from USGS gage 08170500 at the University Drive Bridge. This site represents the cumulative discharge of the springs that form the San Marcos River system, and also includes local runoff coming from the Sink Creek drainage.

San Marcos Water Quality and Fixed Station Photography

Standard parameters, including water temperature, conductivity, pH, dissolved oxygen, water depth at sampling point, and observations of local conditions, were recorded at all drop-net sampling sites and fish community sampling locations using a multiprobe water quality sonde. In addition, fixed-station photography continues to provide visual documentation of changes in the system. It is important to note that comprehensive water and stormwater monitoring is being conducted as part of the HCP with study locations, methods, sampling schedule, and results being presented as a stand-alone report (SWCA 2017, Draft).

Water Temperature Thermistors

One important component for maintenance of long-term baseline data is temperature loggers (thermistors), which are placed throughout the river. Thermistors (HOBO Tidbit v2 Temp Loggers) set to record water temperature every 10 minutes were placed at select water quality stations along the San Marcos River, and they continue to be downloaded at regular intervals to provide continuous monitoring of water temperatures in these areas. To provide a more manageable dataset, 10-minute readings are summarized as 4-hour averages. Thermistors were also placed in two deeper locations within Spring Lake using SCUBA. Thermistor locations will not be described in detail here to minimize the potential for tampering.

Water Quality Grab Samples

During Critical Period sampling events, surface-water grab samples are scheduled to be collected in Spring Lake and along the San Marcos River to evaluate conventional water chemistry parameters (Figure 1). There were no Critical Period sampling events, and thus no water quality grab sampling events, in 2017.

Fixed Station Photography

In addition to the water quality data collection effort, a long-term record of habitat conditions has been maintained with fixed-station photography. Fixed-station photographs allow qualitative temporal habitat evaluations. The record includes upstream, cross-stream, and downstream photographs; these were taken in proximity to several water quality sites as noted in Figure 1.

Aquatic Vegetation Mapping


Kayak-mounted GPS equipment used during aquatic vegetation mapping.

Aquatic vegetation mapping was conducted using a Trimble Pro-XT GPS and a Trimble Tempest external antenna capable of submeter accuracy. The antenna and GPS unit were attached, with the antenna on the bow, to a sit-in kayak with a plexiglass window in the bottom. The aquatic vegetation was identified and mapped by gathering coordinates (creating polygons) while maneuvering the kayak around the perimeter of each vegetation type at the water's surface. In 2013 a new protocol assessing all aquatic vegetation species was introduced following discussions with the HCP Science Committee; this protocol was continued in 2017. All vegetation species in mixed stands were assigned a percentage of cover, which was multiplied by the total area of the stand to calculate the surface area of that species. For maps (Appendix B), only the dominant vegetation type is presented for each polygon. Vegetation stands that measured between 0.5 and 1.0 meter (m) in diameter were mapped by recording a single point. Vegetation stands less than 0.5 m in diameter were not mapped.

Texas Wild-rice Physical Observations

At the beginning of the initial sampling activities for this project in 2000, Texas wild-rice stands throughout the San Marcos River were assessed and documented as being in "vulnerable" areas if they possessed one or more of the following characteristics: (1) occurred in shallow water (<0.5 feet), (2) revealed extreme root exposure because of substrate scouring, or (3) generally appeared to be in poor condition. Monitoring activities associated with vulnerable stands were designed following discussions with Dr. Robert Doyle, currently with Baylor University, and Ms. Paula Power, formerly with the USFWS San Marcos Aquatic Resource Center. The areal coverage of Texas wild-rice stands in vulnerable locations was determined in 2017 by GPS mapping (described above) in most instances, with some smaller stands measured using maximum length and maximum width. The length measurement was taken at the water surface parallel to streamflow and included the distance between the bases of the roots to the tip of the longest leaf. The width was measured at the widest point perpendicular to the stream current (this usually did not include roots). The length and width measurements were used to calculate the area of each stand according to a method used by the Texas Parks and Wildlife Department (J. Poole, TPWD, pers. comm.) in which percent cover was estimated for a rectangle formed from the maximum length and maximum width measurements.

HCP Information kiosk along the San Marcos River

Qualitative observations were also made on the condition of each vulnerable Texas wild-rice stand. These qualitative measurements included the following categories: the percent of the stand that was emergent (and the percent of that seeding), the percent covered with vegetation mats or algae buildup, any evidence of foliage predation, and a categorical estimation of root exposure. Flow measurements were taken at the upstream edge of each Texas wild-rice stand and depth was measured at the shallowest point in the stand. Data on velocity, depth, and substrate composition were collected at 1-m intervals along cross sections in the river in each area where Texas wild-rice plants were monitored.

Fountain Darter Sampling

Drop-net Sampling

A drop-net is a sampling device originally designed by the USFWS to sample Fountain Darters and other benthic fish species specific to the Comal and San Marcos springs/river ecosystems. The net encloses a known area (2 square meters [m^2]) and allows thorough sampling by preventing escape of fish occupying that area. A large dip net (1 m^2) is used within the drop net and is swept along the length of the river substrate 15 times to ensure complete enumeration of all fish trapped within the net. For sampling during this study, a stratified random design was used, placing samples in randomly selected sites within specific aquatic vegetation types (strata).

The vegetation types sampled in each reach were those defined as dominant species found in that reach. Sampling sites were randomly selected per dominant vegetation type with a random point generator in ArcGIS on the most recent map (created using GPS data collected during the previous week) of that reach. Prior to 2013, only the I-35 and City Park reaches in the San Marcos River were sampled using drop-nets. However, in 2013, the Spring Lake Dam Reach was added to drop-net sampling efforts.


Drop-net sampling.

At each location, the vegetation type, height, and areal coverage were recorded, along with substrate type, mean column velocity, velocity at 15 centimeters (cm) above the bottom, water temperature, conductivity, pH, and DO. In addition, vegetation type, height, and areal coverage, along with substrate type, were noted for the adjacent area within 3 m of the net. Fountain Darters were identified, enumerated, measured for total length, and returned to the river at the point of collection. The same data were collected for all other fish species, except for very abundant species, in which case only the first 25 individuals were measured. Fish not readily identifiable in the field were preserved for identification in the laboratory. All live giant ramshorn snails *Marisa cornuarietis*, were counted, measured, and destroyed, while a categorical abundance was recorded (i.e., none, slight, moderate, or heavy) for the exotic Asian snails *Melanoides tuberculatus,* and *Tarebia granifera* and the Asian clam *Corbicula* sp. A total count of crayfish *Procambarus* sp. and grass shrimp *Palaemonetes* sp. was also recorded for each dip-net sweep.

Dip-net Sampling

In addition to drop-net sampling for Fountain Darters, a dip net of approximately 40 cm x 40 cm (1.6-millimeter [mm] mesh) was used to conduct three separate types of Fountain Darter sampling (timed surveys, presence/absence surveys, and fixed-station surveys).

Dip-net Timed Surveys

For timed dip-net surveys, and attempt was made to sample various habitat types within each river section (Figures 2 and 3). Collection was generally performed by personnel moving upstream through a section. Habitats thought to contain Fountain Darters, such as along or in clumps of certain types of aquatic vegetation, were targeted and received the most effort. Areas deeper than 1.4 m were not sampled. Fountain Darters collected by this method were identified, measured, recorded as number per dip-net sweep, and returned to the river at the point of collection. The numbers of native and exotic snails were also quantified and recorded for each dip.

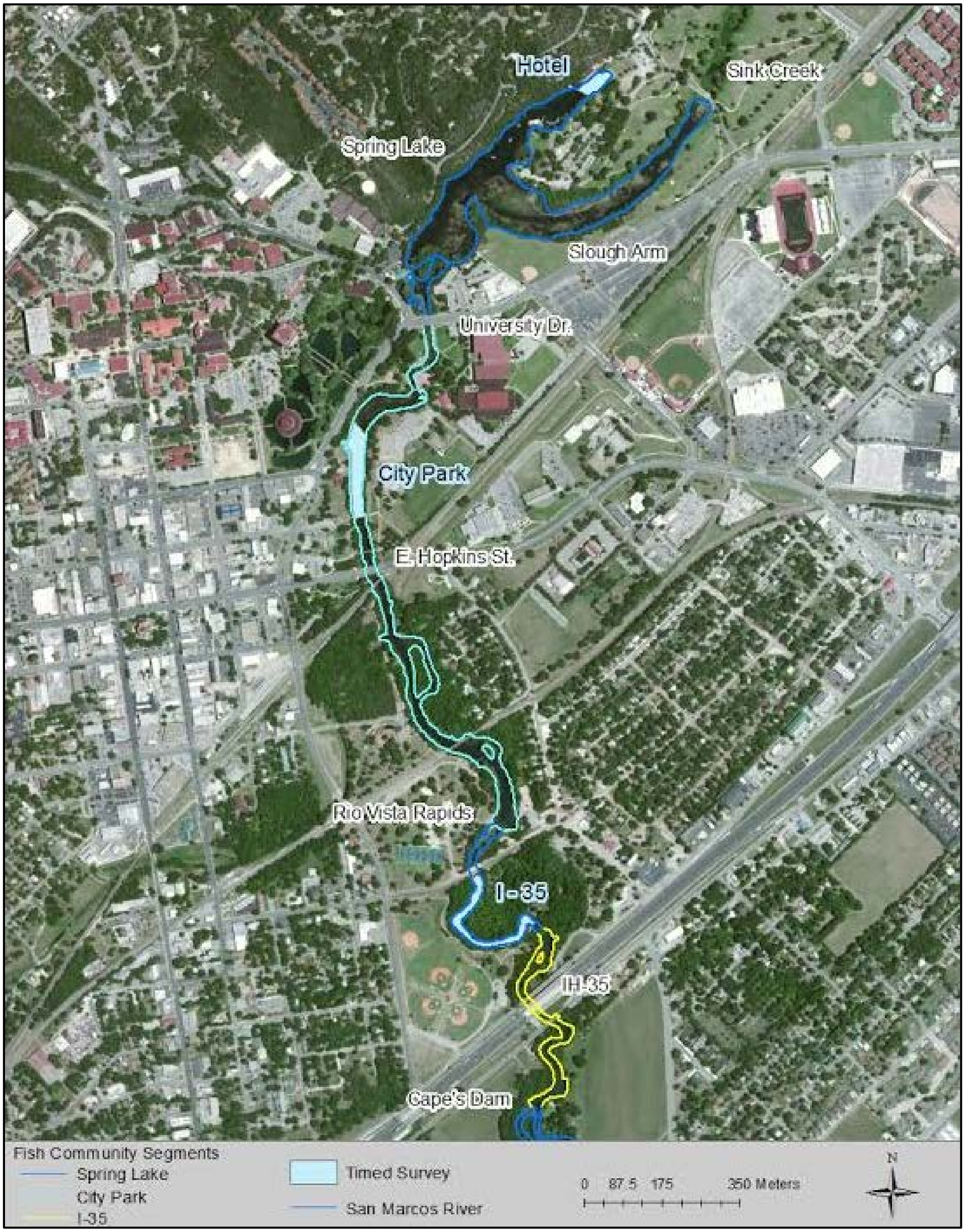


Figure 2. **Fish community sampling segments and dip-net timed survey sections (blue) for the upper San Marcos River.**

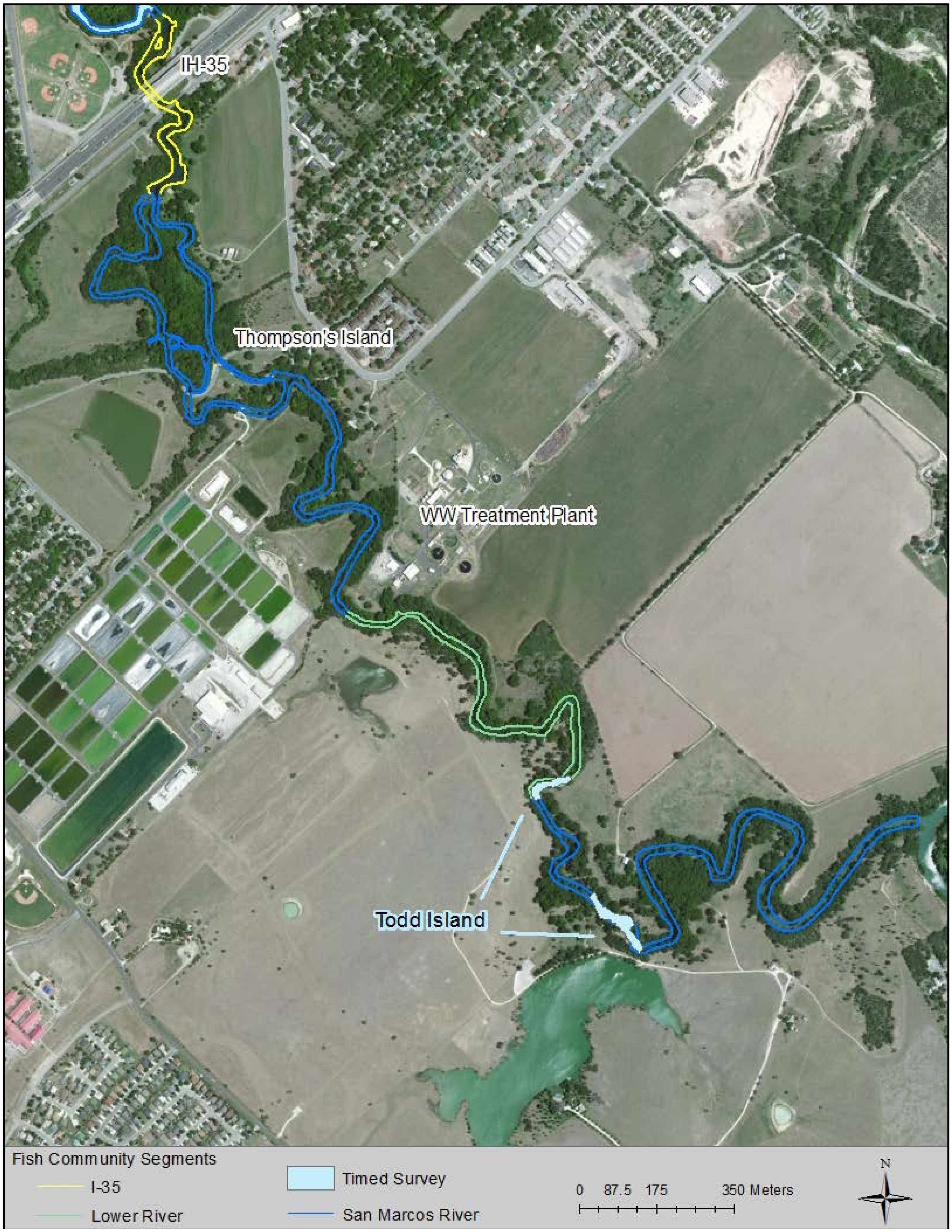


Figure 3. Fish community sampling segments and dip-net timed survey sections (blue) for the lower San Marcos River.

To balance the effort expended across sampling events, a predetermined time constraint was used for each section (Hotel: 0.5 hour, City Park: 1.0 hour, I-35: 1.0 hour, Todd Island: 1.0 hour). The areas of Fountain Darter collection were marked on a base map of the section, and these same areas were revisited in subsequent surveys. Spending a comparable length of time sampling the entirety of each reach allowed comparisons to be made between the data gathered during each sampling event. Dip-net data were used to identify periods of Fountain Darter reproductive activity because this method was efficient for collecting small Fountain Darters (<15 mm).

Random-station Dip Netting

Random-station presence/absence dip netting was initiated on the San Marcos River during spring 2006. It was designed to be a quick, efficient, and repetitive means of monitoring the Fountain Darter population. Also, because the footprint of impact is smaller than drop netting, it can be conducted during extremely low-flow periods with fewer disturbances to critical habitat.

During each sample event, 50 random locations were selected within vegetated areas across the three study reaches (Figure 1) using a random-point generator in ArcGIS and the most recent vegetation map of that reach. Sample stations in each study reach were distributed based on total area, diversity of vegetation, and previous Fountain Darter abundance estimates of each sample reach. Fifteen stations were chosen in the Spring Lake Dam Reach, 20 stations were chosen in the City Park Reach, and 15 stations were chosen in the I-35 Reach. At each random station, four dips were conducted for a total 200 dips per sample period. After each dip, presence or absence of Fountain Darters was recorded. To avoid recapture, Fountain Darters were placed into a plastic tub filled with river water or moved a sufficient distance away from the dip netter. At each station, the dominant surficial substrate (clay, silt, sand, gravel, cobble, boulder, bedrock) was recorded, along with the dominant type of aquatic vegetation (e.g., *Sagittaria*, bryophytes, open). Also, because bryophytes and algae are key Fountain Darter habitat components and can grow within or attach to other vegetation types, presence/absence of bryophytes and algae at each station was also noted. After four dips were completed and all necessary data were recorded, all organisms were released near the station of capture.

Fish Community Sampling

A multifaceted sampling methodology to efficiently monitor fish community composition and abundance was employed by using seines in shallower areas as well as conducting visual underwater surveys in deeper habitats. This methodology was originally developed by Dr. Timothy H. Bonner and his students at Texas State University during previous fish community work on the San Marcos River (Behen 2013). Dr. Bonner and crew performed all HCP fish community sampling in the San Marcos system in 2017.

Seining in the San Marcos River.

For fish community monitoring, the San Marcos system was split into the following four segments: (1) Spring Lake, (2) City Park, (3) I-35, and (4) Lower River (Figures 2 and 3). Within the deeper parts of each segment, at least three visual transect surveys were conducted by SCUBA and/or Hookah divers during each sampling event. At each transect, two divers swam across the river perpendicular to the flow at approximately midcolumn depth. Divers identified and enumerated all fish observed and relayed the information to a third biologist at the surface, who recorded the data. After the divers completed this initial transect, four 5-meter-long PVC pipe segments (micro-transect pipes) were placed on the stream bottom, spaced evenly along the original transect and oriented parallel to the river's current. The two divers then swam to the bottom and surveyed each of the micro-transect pipes. Divers started at the downstream end and swam up the pipe with one diver on each side searching through the vegetation (if present) and substrate within approximately 1 meter of the pipe to dislodge small benthic-oriented fishes such as darters. Again, all fish observed were identified, counted, and relayed to the data recorder on the surface. Notes on the percent coverage of various substrate and vegetation types were also recorded. After fish surveys were complete, depth and velocity data were collected near the middle of each micro-transect pipe using a Marsh McBirney Model 2000 portable flowmeter and adjustable wading rod. At each micro-transect pipe, velocity measurements were taken 15 cm from the bottom, midcolumn, and near the surface. Standard water quality parameters were also recorded once at each transect using a handheld water quality sonde.

In addition to visual surveys, seining was used to sample the fish community in shallow areas. At least three seining transects were conducted within each segment (except Spring Lake, which was too deep for seining) during each sampling event. At each transect, multiple seine hauls were pulled until the entire wadeable area at that transect had been covered. For example, seines were pulled along the bank on one side of the river and then the biologists moved closer to midchannel, taking caution not to sample the same area. They continued to move toward the opposite bank with subsequent seine hauls until the other bank was reached or water became too deep to seine effectively. Randomly selecting seining transects within the wadeable portion of each reach and using the protocol above ensured that habitats were sampled in similar proportions to their availability. After each seine haul, fish were identified, measured to the nearest mm of total length, and enumerated. Then, to prevent recapture on subsequent seine hauls, captured fish were placed in a bucket containing river water. At each seine haul location, notes on percent coverage of substrate, vegetation, and other cover types were recorded, and water depth and velocity were measured with a portable flowmeter and adjustable wading rod. Velocity measurements were taken at 15 cm, midcolumn, and near the surface. After completion of seine hauls at each transect, fish were released from holding buckets.

Data from underwater observations were combined with seine hauls to examine overall fish community composition during each event. Densities were calculated by dividing the abundance of each species captured by area sampled (m^2). Individual densities were averaged across each site per season to determine average densities of each species. Data were also collected to allow calculation of catch-per-unit-effort (CPUE) by gear type and taxa. Initial analysis focused on elucidating spatial and temporal trends in fish community structure.

Fish Tissue Sampling

In 2017 an exploratory effort to test fish tissue for contaminants was undertaken in the San Marcos system. Western Mosquitofish *Gambusia affinis* and Largemouth Bass *Micropterus salmoides* were collected from Spring Lake in the upstream portion of the system near spring orifices and from I-35 reach, which is the most downstream biomonitoring reach in the San Marcos River. Fish were collected with 40x40 cm dip nets, common sense seines, and by hook and line. Samples were frozen and shipped overnight to the ALS laboratory in Kelso Washington for analysis. Tissues analysis was conducted for the parameters described in Table 1.

Table 1. Parameters for fish tissue analysis.

PARAMETER	METHOD	METHOD DESCRIPTION	DETECTION LIMIT	REPORTING LIMIT	UNIT[a]
PCBs	8082A	GC	2.8	10	µg/Kg
PAHs	8270D	GC-MS SIM	.01–.1[b]	.1–1[b]	µg/Kg
PPBDEs	8270D	GC-MS	.01–.05[b]	.1–1[b]	µg/Kg
SVOCs	8270D	GC-MS SIM	10–200[b]	40–400	µg/Kg
Metals	1631, 6010C, 6020A, 7742	CVAA, ICPMS, AA	0.1	1	µg/Kg

[a] µg/Kg=micrograms per kilogram.
[b] detection and reporting limits vary by congener or analyte.

Additional fish samples were collected from the locations above and sent to Baylor University for testing of fish tissue, plasma, and water for pharmaceutical chemicals (Table 2).

San Marcos Salamander Visual Observations

San Marcos salamander sampling in Spring Lake.

Visual salamander surveys were conducted in 2017 at three sites within Spring Lake and the San Marcos River for each routine sampling effort. Visual observations were made in areas previously described as habitat for San Marcos salamanders (Nelson 1993) (Figure 1). Two of the sites—the Hotel and Riverbed sites—were located within Spring Lake: the Hotel Site is adjacent to the old hotel and was identified as Site 2 in Nelson (1993), and the Riverbed Site was located across from the former Aquarena Springs boat dock and was identified as Site 14 in Nelson (1993). The third survey area, called the Spring Lake Dam Site, was not located in Spring Lake but was instead in the main river channel immediately downstream of Spring Lake Dam in the eastern spillway. This was identified as Site 21 in Nelson (1993). The Spring Lake Dam Site was subdivided into three smaller areas to allow greater coverage of suitable salamander habitat; calculated salamander densities from these three subdivisions were averaged together as one.

Table 2. Pharmaceutical chemicals tested for in fish tissues and plasma at Baylor University.

ANALYTE	COMPOUND CLASS	METHOD DETECTION LIMIT (MDL)[a]		
		Water (ng/L)	Tissue (µg/Kg)	Plasma (ng/ml)
Acetaminophen	Analgesic	0.47	0.49	1.1
Amitriptyline	Antidepressant	0.46	0.47	0.3
Amlodipine	Anti-hypertensive	12.03	1.3	1.98
Aripiprazole	Anti-psychotic	2.21	2.28	1.1
Benzoylecgonine	Cocaine metabolite	0.26	0.10	0.08
Buprenorphine	Narcotic	0.26	0.5	2.16
Caffeine	Stimulant	0.7	0.51	0.88
Carbamazepine	Anti-seizure	0.17	0.16	0.20
Desmethylsertraline	Sertraline metabolite	7.16	2.19	1.11
Diclofenac	Anti-inflammatory	4.74	2.31	2.10
Diltiazem	Anti-hypertensive	0.24	0.06	0.06
Diphenhydramine	Antihistamine	0.08	0.11	0.03
Duloxetine	Antidepressant	0.32	0.32	0.15
Erythromycin	Antibiotic	0.16	0.9	1.03
Fluoxetine	Antidepressant	0.74	0.36	0.14
Ketamine	Anesthetic	0.07	0.32	0.26
Methylphenidate	Psychostimulant	0.17	0.06	0.11
Norfluoxetine	Fluoxetine metabolite	1.77	0.71	0.3
Promethazine	Antihistamine	3.45	0.39	2.33
Propranolol	Anti-hypertensive	0.11	0.19	0.18
Sertraline	Antidepressant	1.1	0.99	0.20
Sucralose	Sweetener	2.62	2.91	0.64
Sulfamethoxazole	Antibiotic	0.06	1.87	0.51
Trimethoprim	Antibiotic	0.07	0.45	0.36

[a] ng/L=nanograms per liter, µg/Kg=micrograms per kilogram, ng/ml=nanograms per milliliter.

SCUBA gear was used to sample habitats in Spring Lake, while a mask and snorkel were used in the site below Spring Lake Dam. For each sample, an area of macrophyte-free rock was outlined using flagging tape, and three timed surveys (5 minutes each) were conducted by overturning rocks >5 cm wide and noting the number of San Marcos salamanders observed underneath. Following each timed search, the total number of rocks surveyed was noted to estimate the number of San Marcos salamanders per rock in the area searched. The three surveys were averaged to yield the number of San Marcos salamanders per rock. The density of suitably sized rocks at each sampling site was determined by using a square frame constructed out of steel rod to take random samples within the area. Three random samples were taken in each area by blindly throwing the 0.25-m^2 frame into the sampling area and counting the number of appropriately sized rocks. The three samples were then averaged to yield a density estimate of the rocks in the sampling area. The area of each site was determined by physically measuring each sampling area with a tape measure.

An important note about these San Marcos salamander density estimates is that extrapolating beyond the area sampled into surrounding habitats would not necessarily yield accurate values, particularly in the Hotel Site. This is because the area sampled was selected based on the presence of silt-free rocks and relatively low algal coverage (compared to adjacent areas) during each survey. Much of the habitat surrounding the sampling areas is usually densely covered with aquatic macrophytes and algae, and provides a three-dimensional habitat structure that supports different densities of San Marcos salamanders. The estimates created from this work are valuable for comparing between trips, but any estimates of a total population size derived from this work should be viewed with caution.

Benthic Macroinvertebrate Rapid Bioassessment Protocol

Rapid Bioassessment Protocols (RBPs) are tools for evaluating biotic integrity and overall habitat health, based on the community of organisms residing in them (Barbour et al. 1999). Macroinvertebrates are the most frequently used biological units for RBPs because they are ubiquitous, diverse, and there is an acceptable working knowledge of their taxonomy and life histories (Poff et al. 2006, Merritt et al. 2008).

BIO-WEST performed sampling and processing of freshwater benthic macroinvertebrates, following Texas RBP standards (TCEQ 2014). Macroinvertebrates were sampled with a D-frame kick net (500 µm mesh) by disturbing riffle habitat consisting primarily of cobble-gravel substrate, when available, for 5 minutes while moving in a zig-zag fashion up-stream. When suitable cobble-gravel substrate was not available, the riffle sample was supplemented with a snag sample. Snag sampling entailed collecting submerged wood “snags” 0.5 – 2.5 cm in diameter and placing them in a sieve bucket. Snag materials were washed thoroughly in the bucket to remove attached organisms. Invertebrates from riffle and snag samples were then combined in a sorting tray and randomly distributed. Subsamples for riffle or riffle + snag were taken by scooping out random portions of material and placing them into a separate sorting tray. All macroinvertebrates were picked from the tray before another subsample was taken. This process was continued until a minimum of 140 individuals were picked to represent a sample. If the entire sample did not contain 140 individuals, the process was repeated again until this minimum count was reached. Macroinvertebrates were collected in this fashion from Spring Lake, Spring Lake Dam, City Park and I-35 reaches (Figure 1).

Rapid Bioassessment Protocol sampling and processing

Picked samples were preserved in 70% isopropyl, returned to the laboratory, and identified to the TCEQ taxonomic effort levels (TCEQ 2014), usually genus, though members of the family Chironomidae (non-biting midges) and class Oligochaeta (worms) were retained at those taxonomic levels. The 12 ecological measures or metrics of the Texas RBP benthic index of biotic integrity (B-IBI) were calculated for each sample. Each metric represents a functional aspect of the macroinvertebrate community, related to ecosystem health and sample values are scored 1 – 4 based on benchmarks set by reference condition streams for the state of Texas. The aggregate of all 12 metric scores for a sample represent the B-IBI score for the reach that sample was taken from. B-IBI point-scores for each sample are compared to benchmark ranges and are described as having aquatic-life-uses as “Exceptional”, “High”, “Intermediate”, or “Limited.” In this way, point-scores were calculated and the aquatic-life-use for each sample reach was evaluated.

OBSERVATIONS

The project team conducted 2017 comprehensive sampling during three different periods: spring full event (April 14 – May 11th), summer Fountain Darter dip netting and Texas wild-rice annual mapping (July 25 – August 18), and fall full event (October 16 – November 17).

San Marcos Springflow

Total system mean monthly discharge in the San Marcos River during 2017 exceeded the long-term average in the system for the entirety of the year (Figure 4). A minimum average daily flow of 172 cubic feet per second (cfs) occurred on August 2 and the maximum average daily flow of 489 cfs occurred on April 11 (Table 3). The 2017 minimum average daily flow (172 cfs) was the second highest recorded during EAA’s long-term biological monitoring (2000–2017). The highest minimum average daily flow of 227 was recorded in 2016 (Table 3).

Central Texas experienced rainfall totals in 2017 that were more consistent with long term averages than what was experienced in both 2015 and 2016 and this was evident in the discharge measurements from the San Marcos River (Figure 4). Spring and fall discharge levels were stable with no flood events observed in 2017. Figure 5 reflects the long-term daily discharge for the San Marcos River and how each daily high flow event (spikes) compare over time. The large flood in October 2015 was the highest discharge observed in the San Marcos system since biological monitoring began at 5,400 cfs (estimated by USGS).

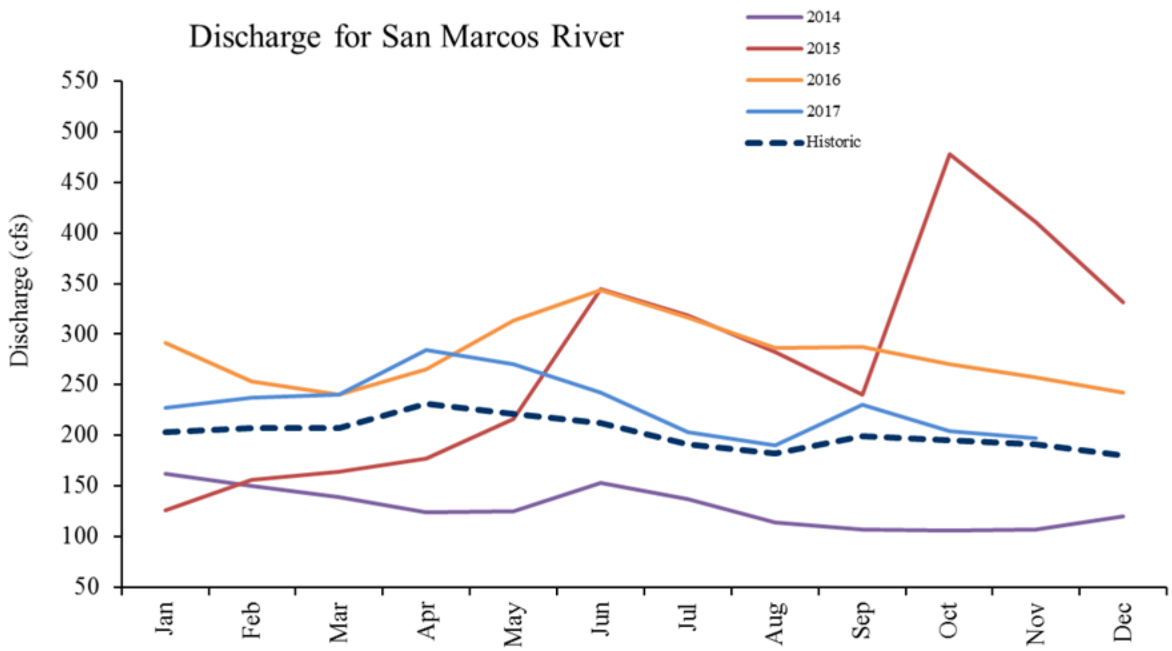


Figure 4. **Mean monthly discharge (cubic feet per second) in the San Marcos River during recent years and averaged over the 1956–2017 period of record (Historic).**

Table 3. **Minimum and maximum daily average discharge in cubic feet per second (cfs) in the San Marcos River since the beginning of the study in 2000.**

YEAR	MINIMUM DISCHARGE (cfs)	MAXIMUM DISCHARGE (cfs)
2000	108	397
2001	167	1,019
2002	157	668
2003	156	332
2004	146	1,280
2005	136	361
2006	90	145
2007	101	971
2008	97	217
2009	83	206
2010	163	273
2011	88	173
2012	100	241
2013	99	2,600
2014	104	176
2015	116	5,400
2016	227	737
2017	172	489

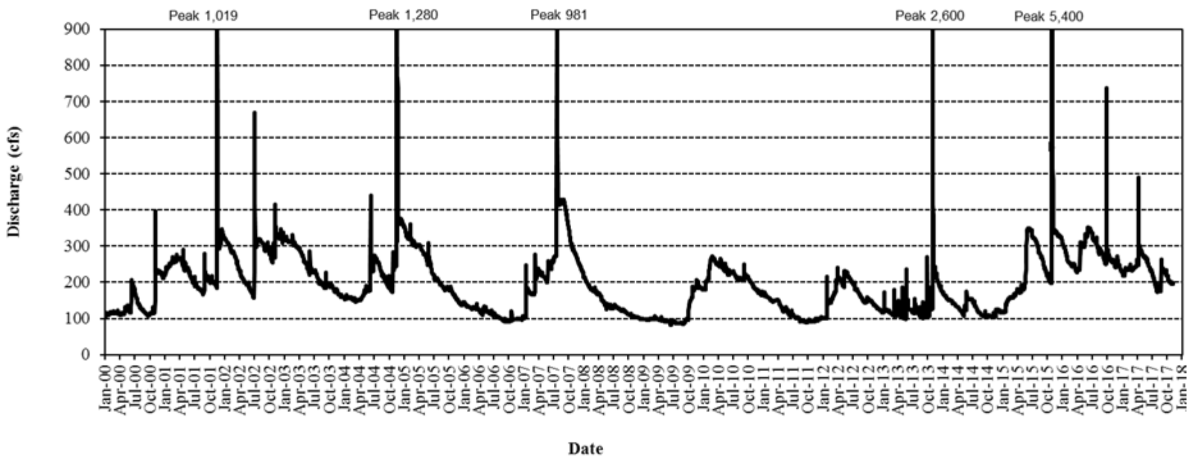


Figure 5. **Daily average discharge (cubic feet per second) for the San Marcos River since the beginning of monitoring in 2000.**

Water Quality Results

Water Temperature Thermistors

Water temperature data for the City Park and I-35 reaches are presented in Figure 6, and additional graphs for all reaches can be found in Appendix C.1. Thermistors collect data every 10 minutes; however, to condense this into a more manageable dataset, graphs and analysis in this report are based on 4-hour averages of these data. Data gaps are a result of lost, stolen, or malfunctioning thermistors. As expected, thermistors closest to spring inputs (farthest upstream) display relatively constant water temperatures, with periodic spikes of low temperatures signaling rainfall events. Also, quite evident is the difference that higher system discharge makes with the more consistent temperatures at the City Park and I-35 sites recorded during the higher discharge years of 2015 through 2017 vs. the fluctuating water temperatures at these sites during the previous drought (Figure 6).

Further downstream, ambient conditions exert a greater influence on water temperature due to increased exposure time and runoff from rain events. Figures 6 and 7 display this relationship; higher temperature fluctuations occur at the downstream thermistor (Animal Shelter) compared to thermistors that are closer to spring inputs (I-35, City Park). No thermistors collected readings that exceeded TCEQ water quality standard of 26.7 ºC for the San Marcos River in 2017 (Appendix C.1).

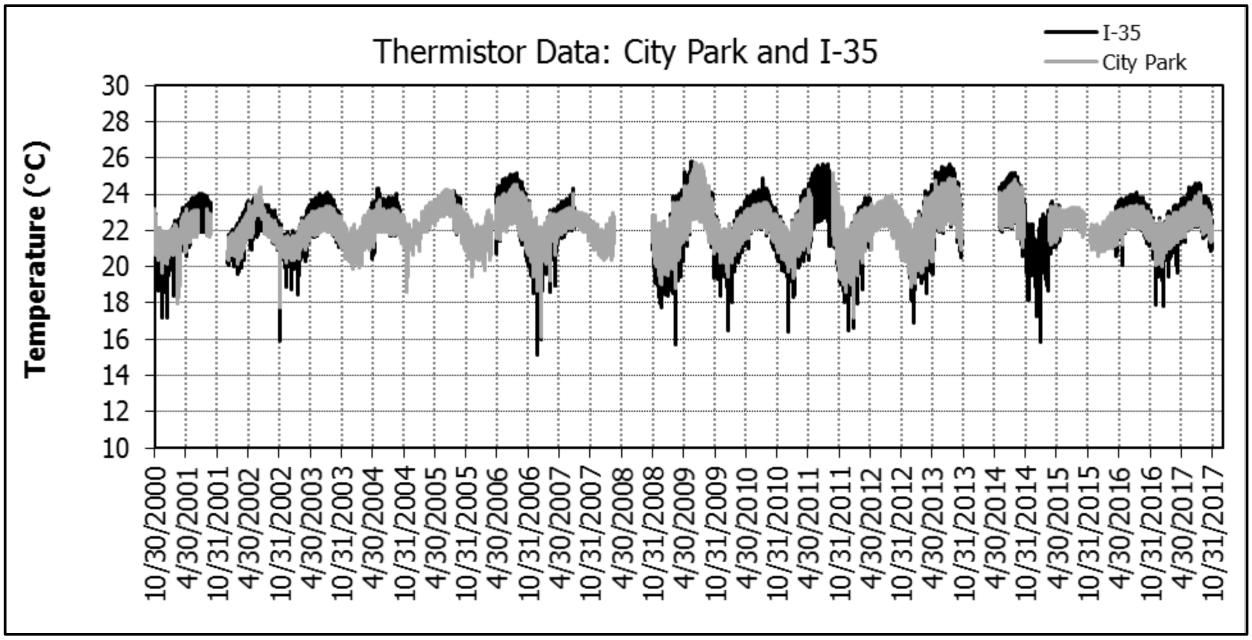


Figure 6. **Thermistor data from the City Park and I-35 reaches.**

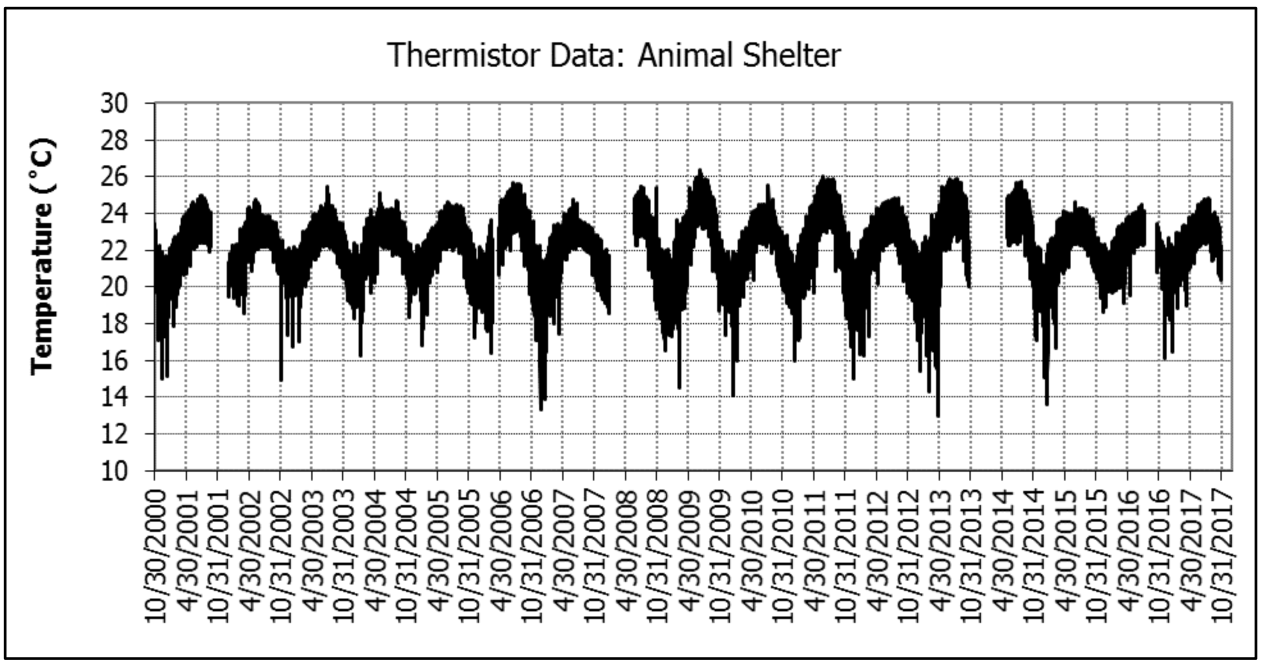


Figure 7. **Thermistor data from the Animal Shelter Reach.**

Edwards Aquifer Authority Manta 2 Sonde Data

In 2012 EAA installed Eureka Manta 2 multiprobes at two locations in the San Marcos River (Rio Vista Park and Aquarena Drive). A third sonde was installed in 2016 near the San Marcos fish hatchery in the Thompson Island natural channel. The multiprobes monitor standard parameters (temperature, pH, conductivity, DO, and turbidity) every 15 minutes, and the data from 2017 are summarized below. These data were taken directly from the EAA Environet web-based water quality data service (Edwards Aquifer Authority 2017b).

The EAA sonde data showed little variation throughout the year as would be expected in a spring fed system. Temperature recordings for Aquarena Drive and Rio Vista Park are shown in Figure 8 and Thomson Island Natural Channel are shown in Figure 9. No site had temperatures that exceeded the 26.7 ºC TCEQ water quality standard for the San Marcos River. Patterns were consistent with the long-term water temperatures collected over the course of HCP biological monitoring at the City Park (Figure 6) and Rio Vista Dam reaches (Appendix C.1). Temperatures were lower in the spring and fall in 2017, correlated with spring and fall rains. Average temperatures for all three sites were approximately 22 ºC.

Dissolved oxygen at Rio Vista Park averaged 7.35 mg/l, while dissolved oxygen at Aquarena Drive averaged 7.90 mg/l (Figure 10). Dissolved oxygen at Thompson Island Natural Channel ranged from 5.37 mg/l to 10.2 mg/l with an average of 8.37 mg/l in 2017 (Figure 11). Conductivity observations usually show short-term drops that could be a result of low-conductivity rainwater entering the system after precipitation events (Figure 12). pH values were generally higher at Thompsons Island Natural Channel than Aquarena Drive and slightly higher than Rio Vista Drive. Lower pH at Aquarena Drive is a result of proximity to springs and higher carbonic acid levels in spring water (Figure 13).

Water Quality Grab Samples

No Critical Period water quality grab samples were collected in the San Marcos River in 2017. A more in-depth look at water quality can be found in the 2017 EAA HCP Expanded Water Quality Report (SWCA 2017, Draft). A review of the water quality results provided thus far for 2017 show few incidences where pollutants were detected, and conventional parameters were generally within the ranges historically reported in the San Marcos River.

Aquatic Vegetation Mapping

Aquatic vegetation maps for all study reaches and for both sampling periods are presented in Appendix B. The maps are organized by individual reach with successive mapping events ordered chronologically. It is important to note that maps highlight only the single dominant plant species. While less dominant species may not be represented on the maps, the San Marcos vegetation community is a natural mosaic with intermixed stands containing multiple aquatic plant species, thus their coverage is estimated and included into the total vegetation calculations.

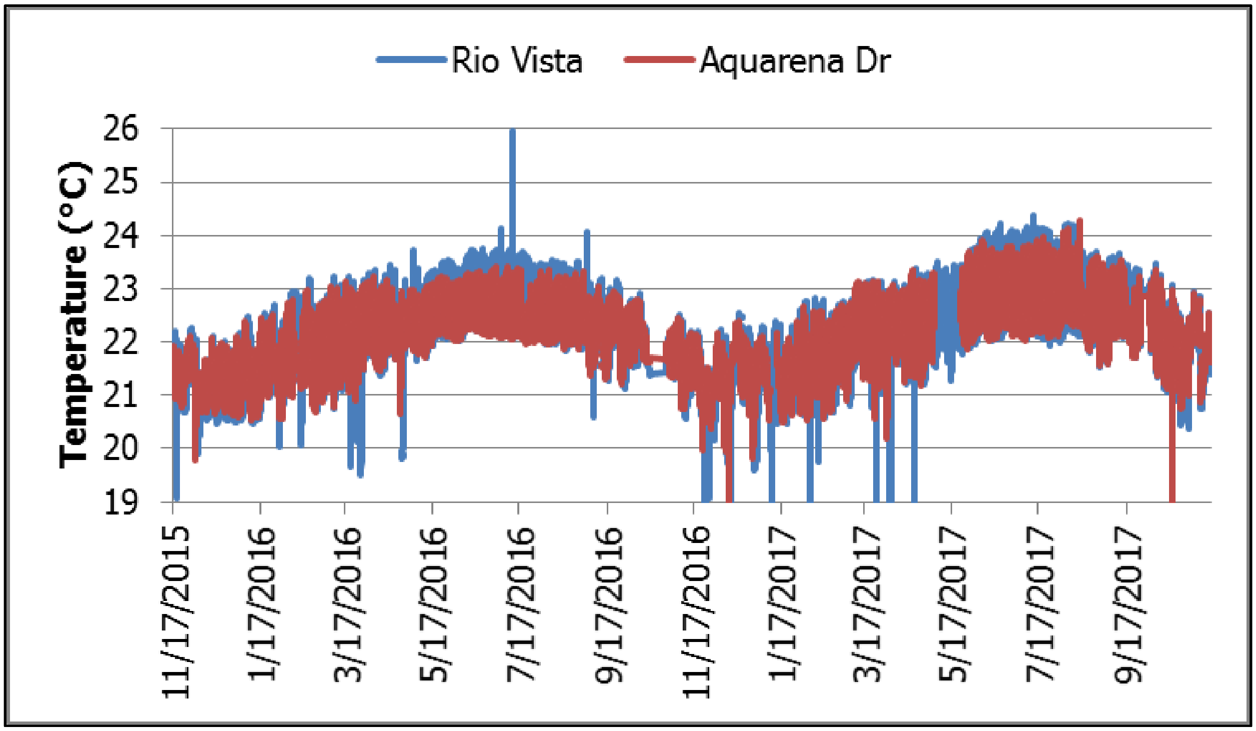


Figure 8. **Edwards Aquifer Authority Manta 2 multiprobe temperature data from Rio Vista Park and Aquarena Drive.**

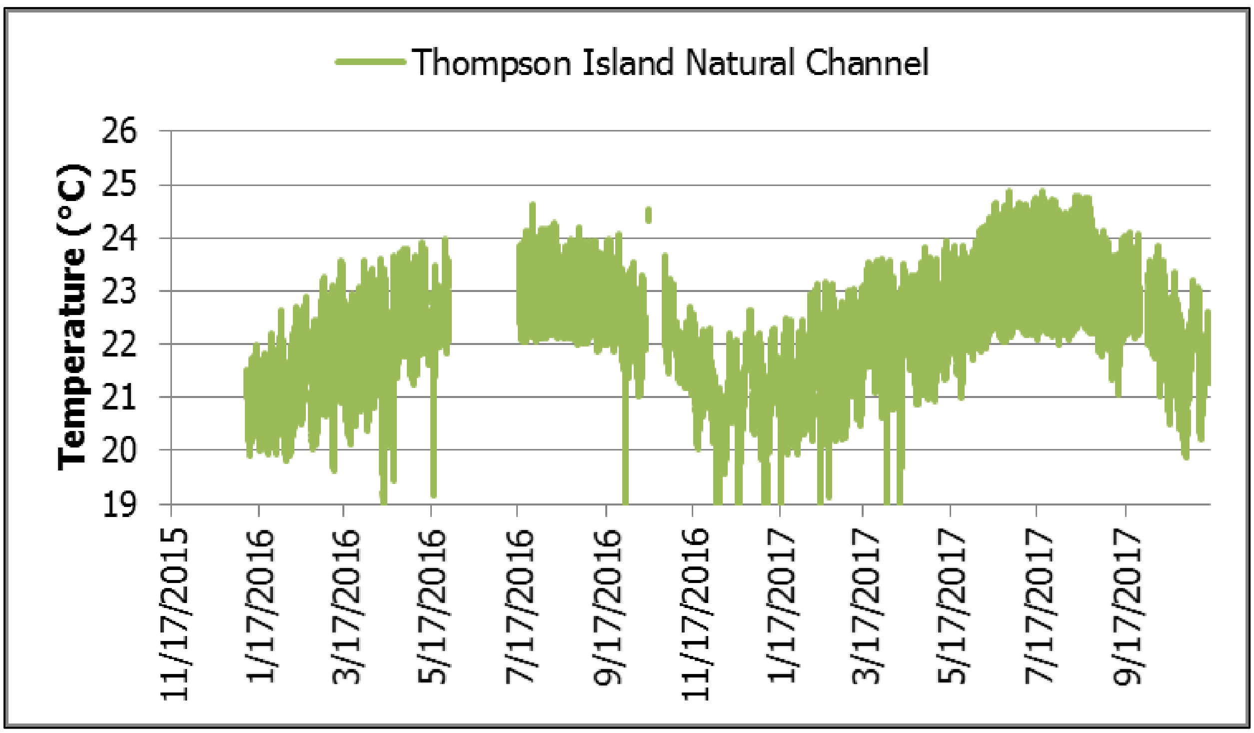


Figure 9. **Edwards Aquifer Authority Manta 2 multiprobe temperature data from the Thompson Island Natural Channel.**

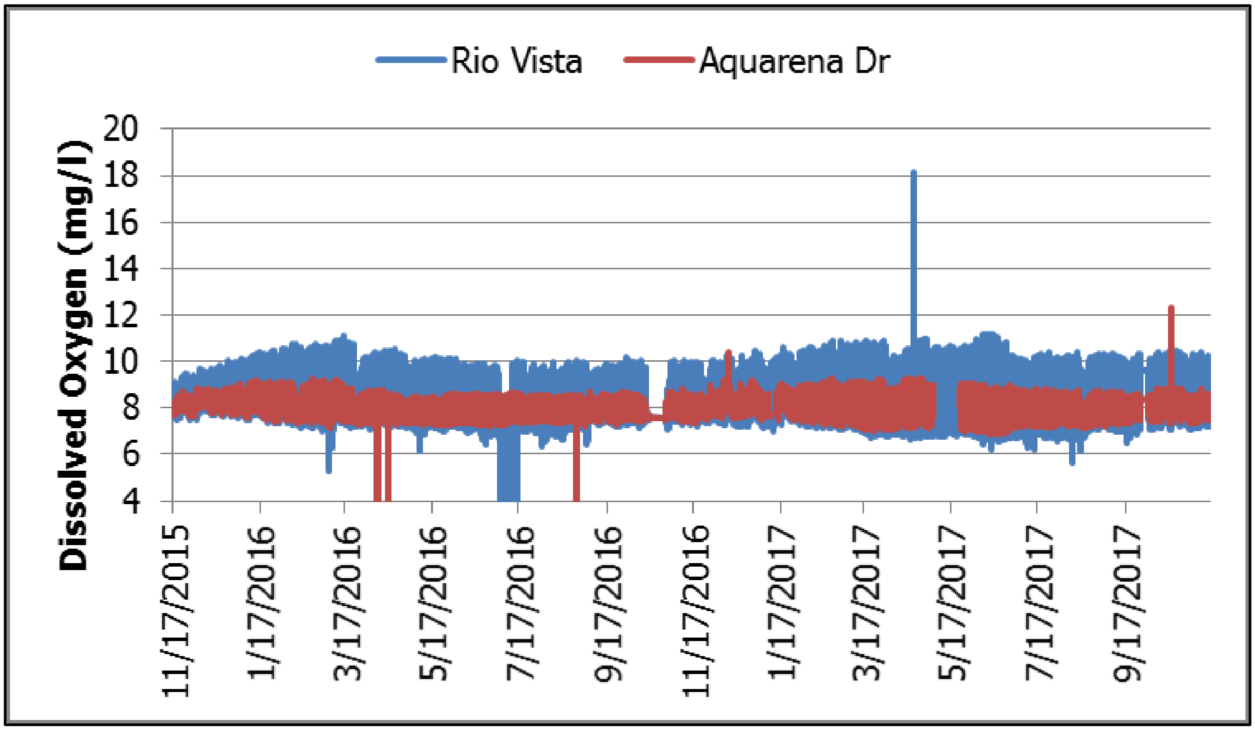


Figure 10. Edwards Aquifer Authority Manta 2 multiprobe dissolved oxygen (DO) data from Rio Vista Park and Aquarena Drive.

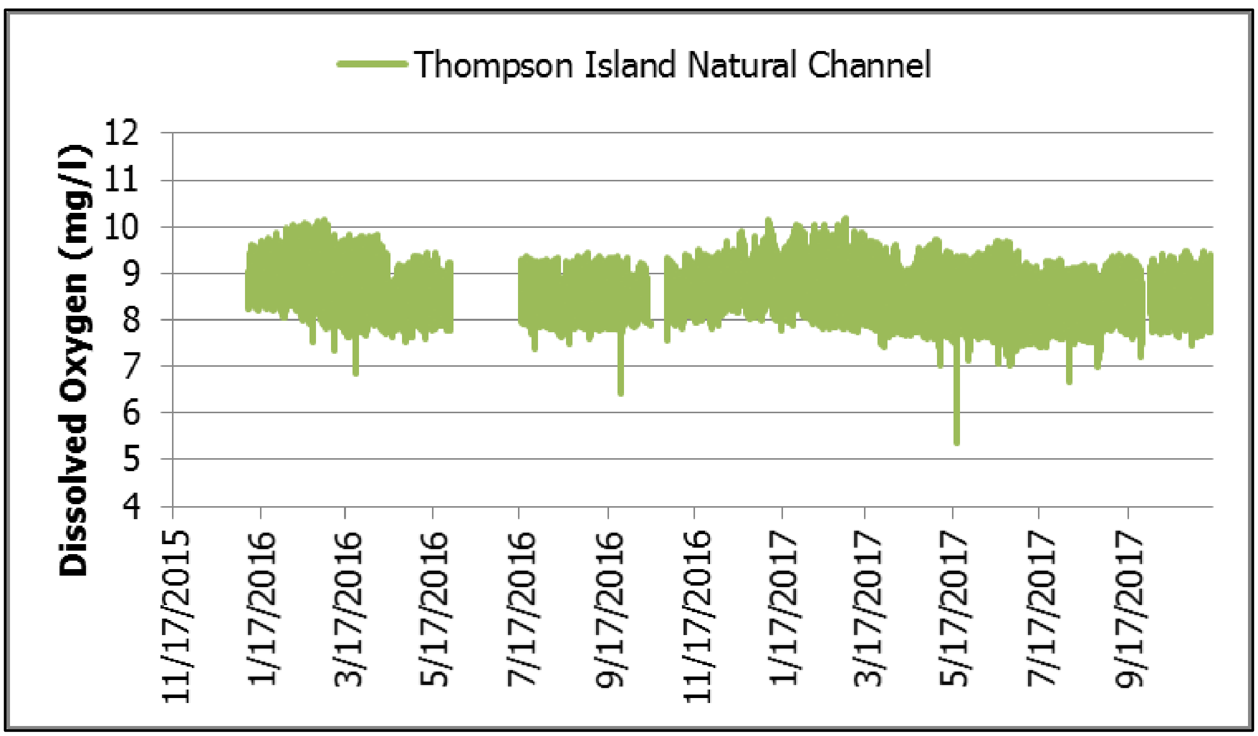


Figure 11. Edwards Aquifer Authority Manta 2 multiprobe dissolved oxygen (DO) data from Thompson Island Natural Channel.

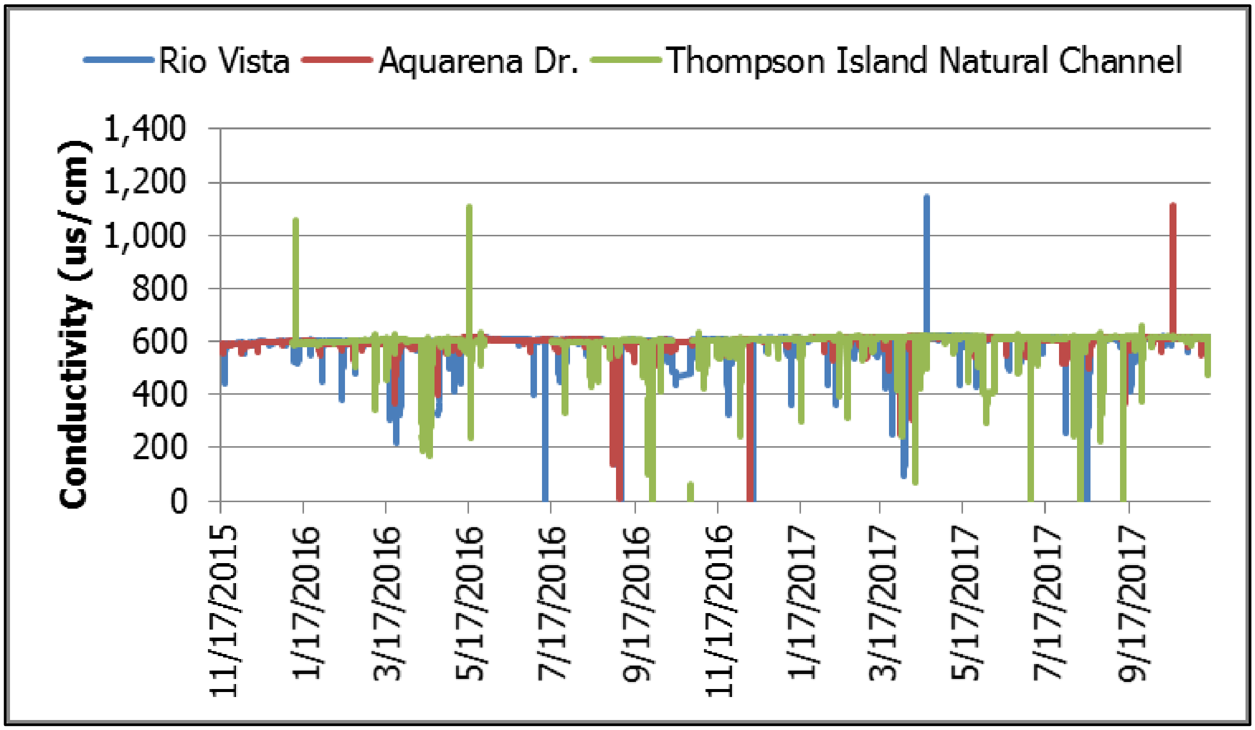


Figure 12. **Edwards Aquifer Authority Manta 2 multiprobe conductivity data from Rio Vista Park, Aquarena Drive and Thompson Island Natural Channel locations.**

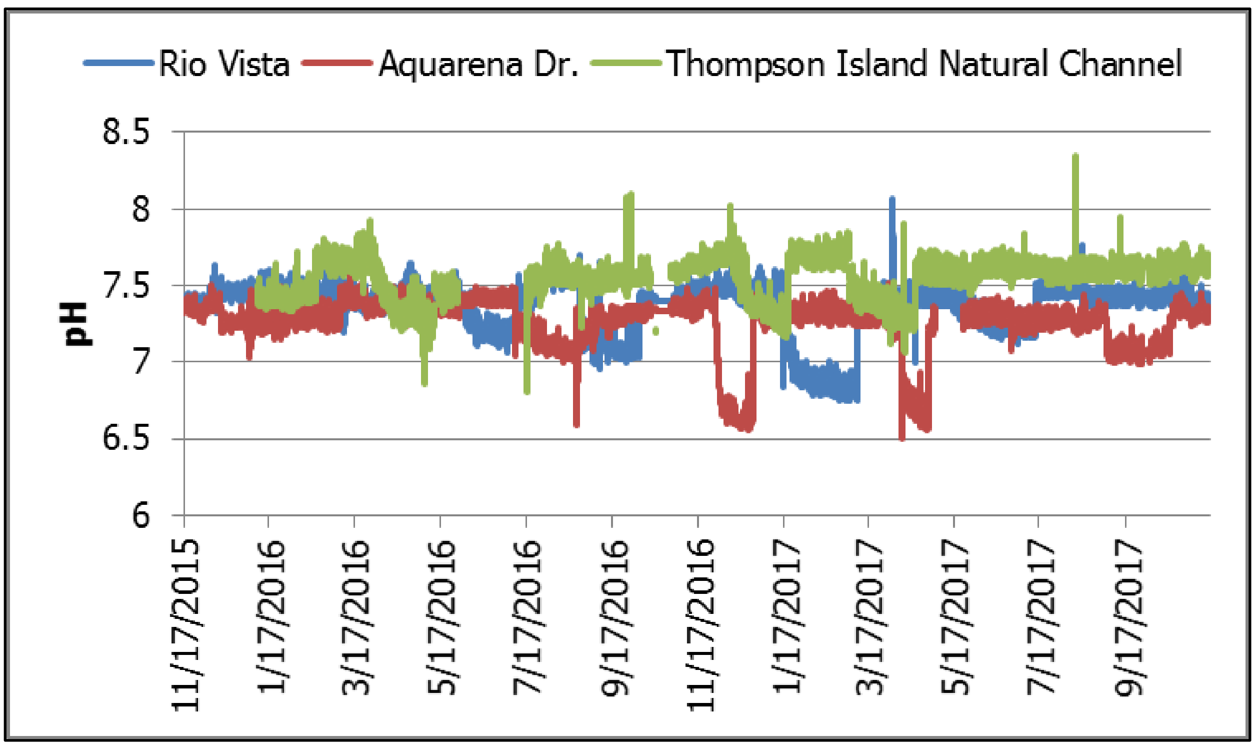


Figure 13. **Edwards Aquifer Authority Manta 2 multiprobe pH data from Rio Vista Park, Aquarena Drive and Thompson Island Natural Channel locations.**

Spring Lake Dam Reach

The Spring Lake Dam Reach is the most upstream reach of the San Marcos River. Coverage area of aquatic vegetation in the Spring Lake Dam Reach has been highly variable in past years due to heavy recreation pressure in the area. Flooding in 2015 and 2016 also decreased coverage of vegetation in this reach through scouring. Fencing installed in the summer of 2016 and recent HCP restorative efforts have allowed vegetation to expand in this reach. The aquatic plant community is now dominated by Texas wild-rice that expanded from existing stands as well as established new plants. Texas wild-rice accounts for a significant portion, approximately 70% of the total vegetation cover with smaller amounts of *Hygrophila*, *Hydrocotyle*, and *Potamogeton* (among others) making up the rest of the community. For 2017 the total vegetation cover changed little between spring and fall. Spring total vegetation coverage was 1,363 m^2, which is near average for the season, while fall coverage was above average at 1,373 m^2 (Figure 14).

City Park Reach

Total vegetation coverage in this reach has ranged from 1,900 to 4,500 m^2 since the initiation of biomonitoring in 2000. Both spring and fall 2017 values, 3,681 m^2 and 2,840 m^2 respectively, increased slightly from 2016 values yet remained significantly below the long-term seasonal average for the study reach (Figure 15). Loss of vegetation here tends to be a common trend due to a variety of disturbances including swimming and wading. Above-average flows have also contributed to scouring and loss of vegetation cover since 2015. In contrast, the amount of Texas wild-rice has increased significantly over the past 2 years as a direct result of HCP restoration efforts. In fall Texas wild-rice (1,793 m^2) made up the majority (> 60%) of the vegetation in this reach.

Texas wild-rice dominates the Spring Lake Dam Study Reach.

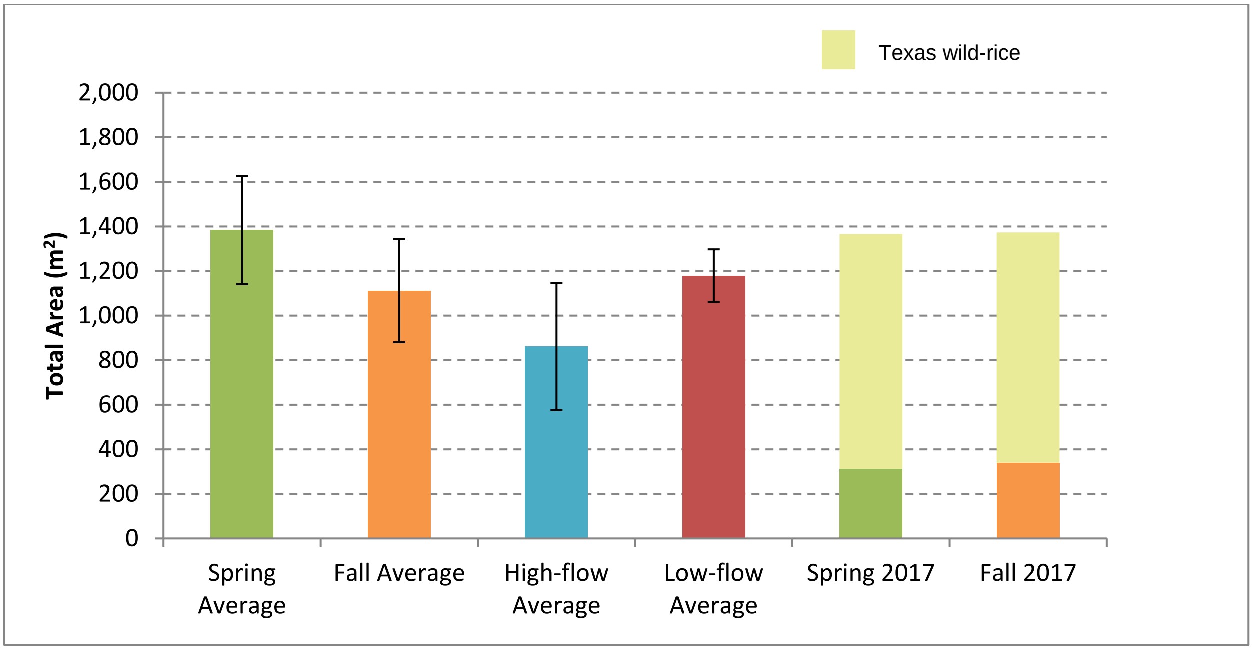


Figure 14. **Total surface area (m^2) of aquatic vegetation at the Spring Lake Dam Reach. Long-term study averages are provided with bars representing one standard deviation from the mean.**

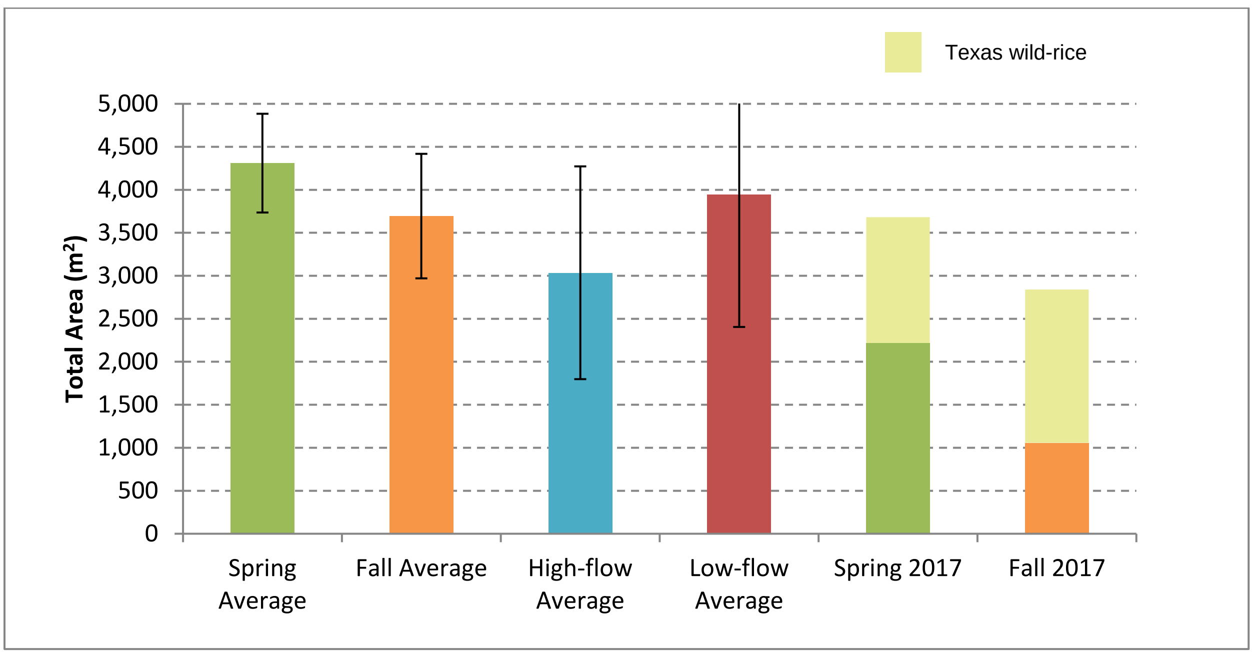


Figure 15. **Total surface area (m^2) of aquatic vegetation at the City Park Reach. Long-term study averages are provided with bars representing one standard deviation from the mean.**


Texas wild-rice mixed with Ludwigia repens in I-35 Study Reach.

I-35 Reach

The I-35 Study Reach has changed considerably over the past few years. The total vegetation cover ranged from 287 m^2 to 2,116 m^2 over the course of the biomonitoring program. Documented in past biomonitoring reports, a trend of decreasing aquatic vegetation cover has previously been observed in this reach, attributed to riverbed scour from changing flows. Recreation has also become more popular in this area in recent years and can contribute to reductions of vegetative cover. Total vegetation in 2017 increased from spring (1,404 m^2) to fall (1,417 m^2), which did not occur in any other study reach. Spring and fall total vegetation coverages were also higher than the seasonal averages (Figure 16). Typically, this reach is dominated by *Hygrophila* and *Sagittaria*, but *Ludwigia* and Texas wild-rice have increased in coverage over the course of 2017.

Texas Wild-rice Annual Mapping

The Texas wild-rice full system map set for the entire San Marcos River, broken out by river segment, can be found in Appendix B. In 2017, only the routine annual mapping event occurred with no other Critical Period events triggering additional mapping. On April 11 peak flows reached 1,800 cfs. Shortly after this event, routine spring vegetation mapping occurred, which showed little alteration to the Texas wild-rice distribution and no further full system mapping event was deemed necessary.

The 2017 routine annual mapping event showed an aerial cover of over 9,000 m^2, an increase from approximately 7,700 m^2 (Figure 17) in August 2016. This represents the highest coverage of Texas wild-rice recorded via this monitoring program.

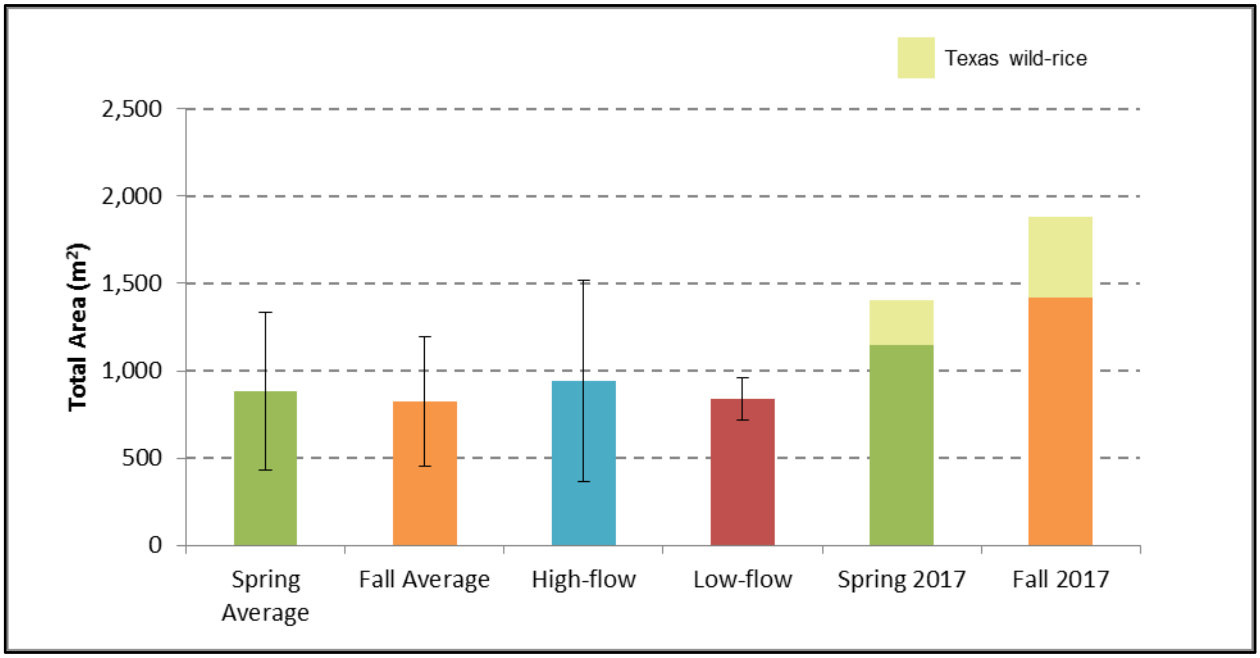


Figure 16. **Total surface area (m^2) of aquatic vegetation at the I-35 Reach. Long-term study averages are provided with bars representing one standard deviation from the mean. Note that the reach was expanded in 2014 resulting in greater surface area of aquatic vegetation.**

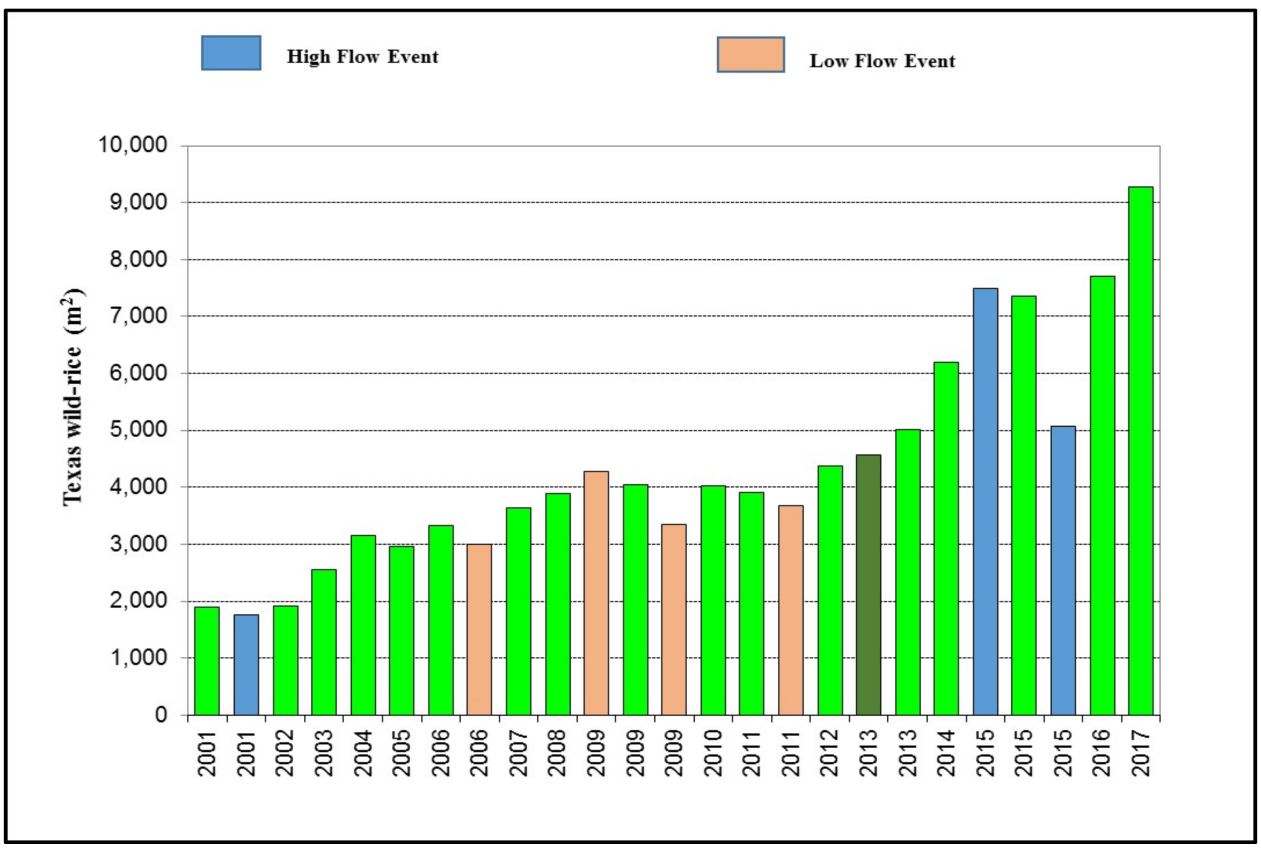


Figure 17. **Coverage of Texas wild-rice across selected years.**

Figure 18 displays BIO-WEST designated river segments to further compare localized changes in Texas wild-rice per segment between the 2016 and 2017 mapping events. All segments saw an increase in Texas wild-rice cover compared to 2015–2016 when three segments experienced losses (Table 4). This is a good indicator that Texas wild-rice has recovered from past disturbances and that HCP restoration activities are benefiting this species. Segment H has the smallest overall amount of Texas wild-rice, but it experienced the largest percent gain, a 79% increase over the previous year. Prior to the 2015 flooding events, this segment contained more than 100 m^2 of Texas wild-rice, which dropped to 0 m^2 after the flood events. The I-35 segment G has seen remarkable recovery in overall Texas wild-rice coverage this year after three consecutive years of loss. This reach increased 70% to 400 m^2 in 2017. Spring Lake Dam Reach, which saw the most significant gains from August 2015 to August 2016, had a 48% increase for 2017 to 1,096 m^2. Typically, this area is heavily used for recreation, and Texas wild-rice is usually disturbed by wading and swimming. However, since 2016, the area has been fenced off from the public and recreation in this area has since been limited.

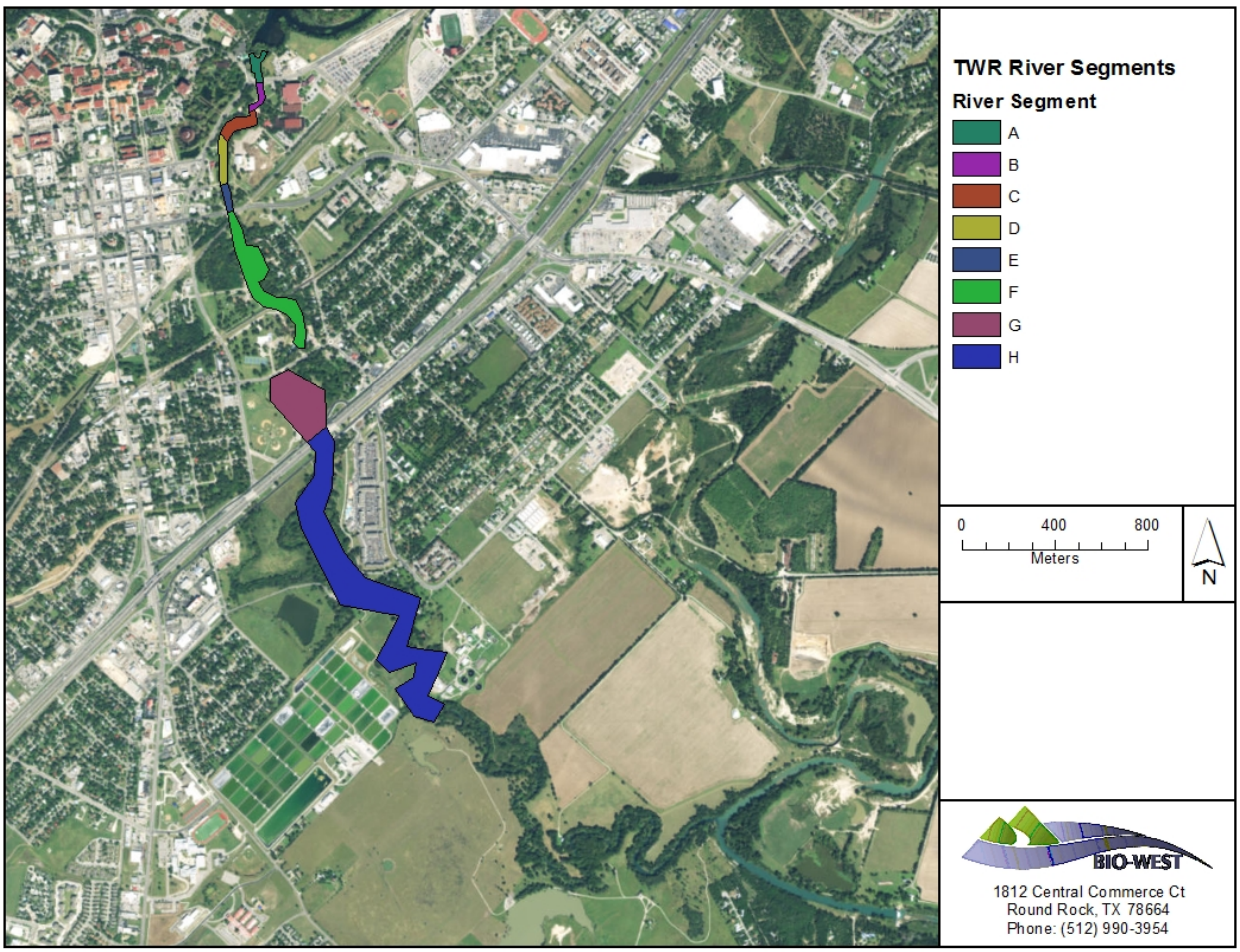


Figure 18. BIO-WEST designated Texas wild-rice river segments.

Table 4. **Change in cover of Texas wild-rice in river segments (Figure 18) between August 2016 and August 2017 mapping.**

RIVER SEGMENT	AUG 2015 COVER (m²)	AUG 2016 COVER (m²)	AUG 2017 COVER (m²)	STATUS 2016–2017	DIFFERENCE 2016–2017	CHANGE 2016–2017
A Spring Lake Dam Reach	455	739	1,096	↑	357	48%
B Sewell Park	1,439	992	1,181	↑	189	19%
C Sewell Park to City Park Reach	2,377	2,333	2,815	↑	482	21%
D City Park Reach	1,380	1,599	1,652	↑	53	3%
E City Park Reach to Hopkins Street Bridge	274	373	502	↑	129	35%
F Hopkins Street Bridge to Rio Vista Dam	1,105	1,383	1,519	↑	136	10%
G I-35 Reach	386	235	400	↑	165	70%
H I-35 to below WWTP	28	29	52	↑	23	79%

A total of 571 Texas wild-rice polygons were mapped, along with 186 Texas wild-rice points in August 2017, compared to 565 wild-rice polygons mapped, along with 161 points the previous year. As of August 2017, distribution of Texas wild-rice includes the Mill Race and spillway areas of Spring Lake to approximately 170 m below Capes Road in the Thompson's Island stretch of river. Of the 571 Texas wild-rice stands mapped, 302 of them were found to be in water deeper than 3 feet and 269 stands were found to be in water less than 3 feet in depth (Table 5). Nearly 40% of Texas wild-rice stands were found to be associated with another aquatic plant species. Typically, *Hydrilla verticillata* is more commonly associated with Texas wild-rice than any other aquatic plant species and this year was no different. For the last 4 years, nonnative *Hygrophila polysperma* has been the second-most dominant species associated with Texas wild-rice. However, one notable change this year is the shift from *Hygrophila polyspema* to *Potamogeton illinoensis* as the second most common associated species (Table 6). The observed number of blooming stands was greatly decreased this year from previous years. Only four Texas wild-rice stands were observed blooming during August mapping compared to the previous year when 42 individual stands were observed in some degree of flower.

Table 5. **Distribution of Texas wild-rice based on water depth (n=571).**

DEPTH (FEET)	NUMBER OF TEXAS WILD-RICE STANDS	FREQUENCY (%)
0–0.9	4	<1
1–1.9	100	18
2–2.9	165	29
3+	302	53

Table 6. Associated species found with Texas wild-rice (n=229).

SPECIES	NUMBER OF TEXAS WILD-RICE STANDS	FREQUENCY (%)
Hydrilla verticillata	100	44
Potamogeton illinoensis	52	23
Hygrophila polysperma	50	22
Sagittaria platyphylla	18	8
Hydrocotyle verticillata	5	2
Ludwigia repens	4	1

Texas Wild-rice Physical Observations

Observations for vulnerable Texas wild-rice stands were conducted during both spring (May 22) and fall (November 17) routine biomonitoring events in 2017. These qualitative measurements included the following categories: the percent of the stand that was emergent (including the percent with seed or flower), the percent covered with vegetation mats or algae buildup, any evidence of foliage herbivory, and a categorical estimation of root exposure (Appendix C.2). Water depth and flow measurements were also taken at the upstream edge of each Texas wild-rice stand. Rectangular study plots, established around existing vulnerable stands in spring 2016, were used to re-locate vulnerable wild-rice stands for 2017 sampling. Individual stands are mapped in GIS to provide length, width and cover estimates. The resulting maps of vulnerable stands can be found in Appendix B.

As in the previous year, physical observations were made for vulnerable wild-rice stands within three general study areas, the Spring Lake Dam/Sewell Park location, Veramendi Park, and the I-35 location. These locations are heavily trafficked with river recreation and are also located near river access points where river recreationists enter, exit or linger for the duration of the day. Therefore, during peak recreation season, Texas wild-rice patches at these locations are subjected to harsher disturbances compared to Texas wild-rice located in any other part of the river. The coverage of each vulnerable stand in the San Marcos River is presented at the end of this section (Table 7).

Spring Lake Dam/Sewell Park Reach

The overall health of vulnerable stands here improved after being impacted by flooding events and high recreation pressure in 2016. Stand #1 located above Aquarena Drive Bridge accounts for the largest amount of cover for vulnerable stands in this sample reach. Although it slightly decreased in total coverage in 2017, from 143 m^2 to 113 m^2, it has recovered well from 2016 when it was highly fragmented and covered less than 100 m^2. This stand has now merged with several surrounding stands creating one continuous Texas wild-rice stand that now takes up a large portion of this reach.

Since 2016 stand #4/5 has begun to fragment and shrink considerably most likely as a result of recreation since it is located very near entrance stairs to the river. In 2016 this stand, originally one continuous stand, fragmented into several smaller patches and has continued to do so between spring and fall 2017. This stand was the most degraded of all vulnerable stands in this area with a highly eroded root zone and thin growth. Stands #2 and #7 expanded quite

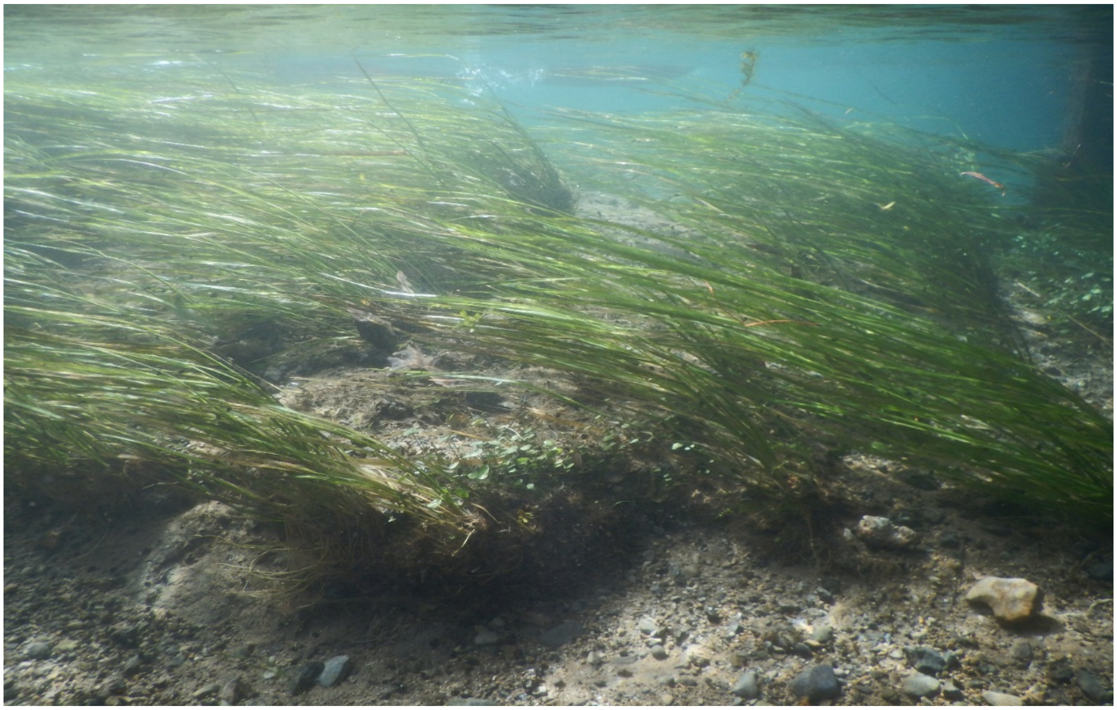
Table 7. Cover of individual vulnerable Texas wild-rice stands from fall 2016 to fall 2017.

REACH STAND NUMBER	FALL 2016	SPRING 2017	FALL 2017
Sewell Park 1	96.93	143.31	113.50
Sewell Park 2	3.15	2.20	8.54
Sewell Park 3	Gone	Gone	Gone
Sewell Park 4/5	18.00	27.30	20.34
Sewell Park 6	1.79	8.22	3.46
Sewell Park 7	43.60	86.53	91.05
Sewell Park 8	Gone	Gone	Gone
Sum of Cover	163.47	267.56	236.89
Veramendi 1	7.26	9.02	17.97
Veramendi 2	19.31	22.89	31.44
Veramendi 3	35.10	39.89	35.10
Sum of Cover	61.67	71.80	84.51
I-35-1	Gone	Gone	Gone
I-35-2	Gone	Gone	Gone
I-35-3	Gone	2.88	3.24
I-35-4	28.59	17.20	35.60
I-35-5	Gone	Gone	Gone
I-35-6	Gone	Gone	Gone
I-35-7	26.31	57.44	57.49
I-35-8	12.34	3.80	8.25
I-35-9	1.69	3.00	0.08
I-35-10	0.84	Gone	4.36
Sum of Cover	69.77	84.32	109.02

considerably in 2017 providing a boost to the overall coverage in this reach. During spring sampling, velocity at individual stands ranged from 0.2 ft/sec. to 3 ft/sec and depths at all stands were deeper than 0.5 ft. Root exposure from scouring was noted in this section, but only excessive at stand #4 and #5. Two stands, #1 and #6, were noted in bloom. For the fall sampling event, velocities were lower ranging from 0.1 ft/sec to 0.7 ft/sec. Root exposure was minimal for all stands except stands #4 and #5, which had a highly exposed root zone. Thick vegetation mats were observed covering a small portion of stand #1 but were not present on any other stand.

Veramendi Park

Although located adjacent to a very popular recreational area all three vulnerable stands here maintained size or expanded from spring to fall. For spring sampling, the velocity at individual stands ranged from 0.3 to 1.5 ft/sec. with depths at all stands greater than 1 ft. Fall velocities ranged from 0.4 to 1.3 ft/sec. with stand depths deeper than 1.5 ft. Only one stand (#2) was noted as flowering. Vegetation mats were minimal in the fall covering only small portions of stand #3.

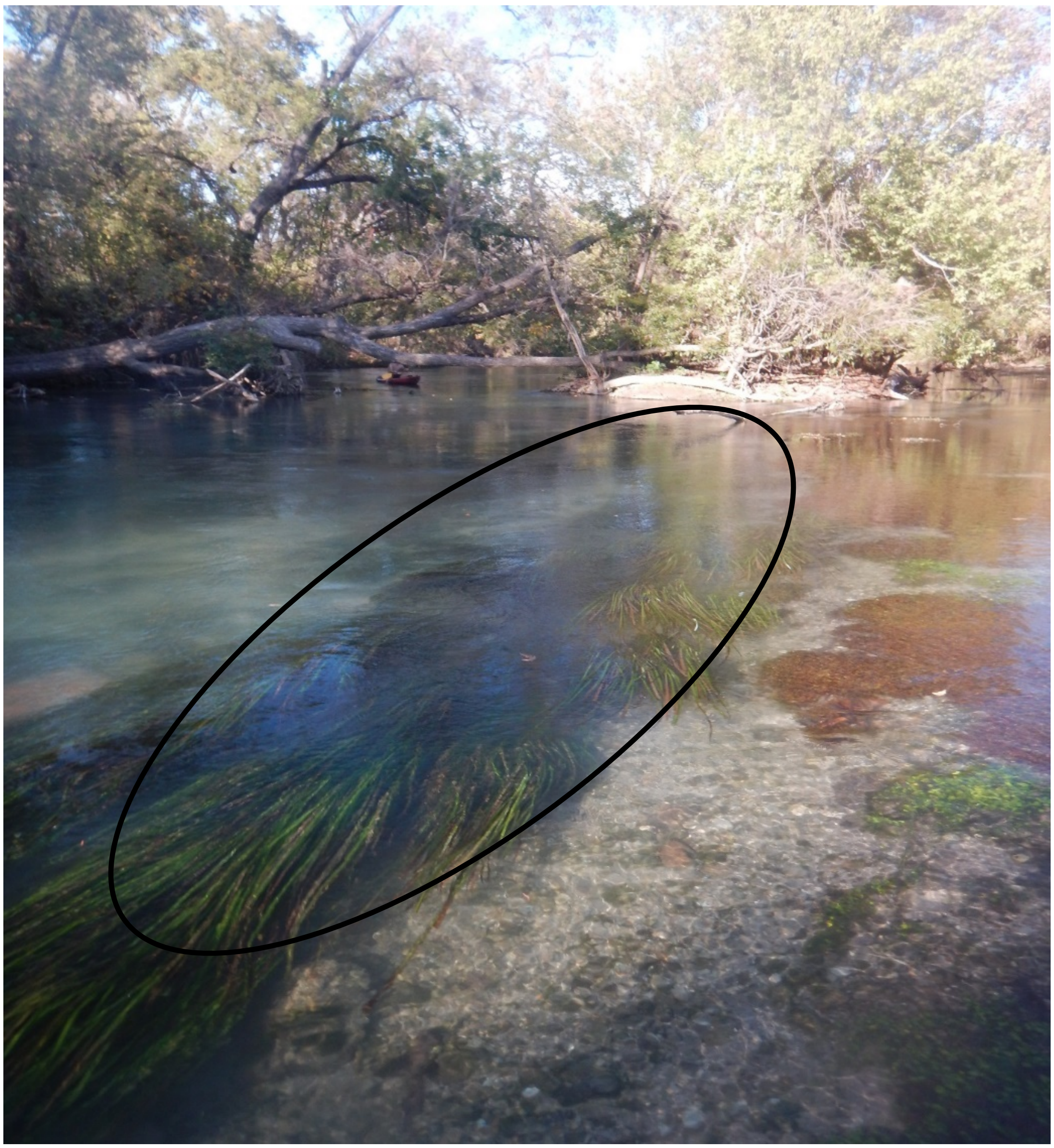


Stand #4/5 had highly eroded root zones.

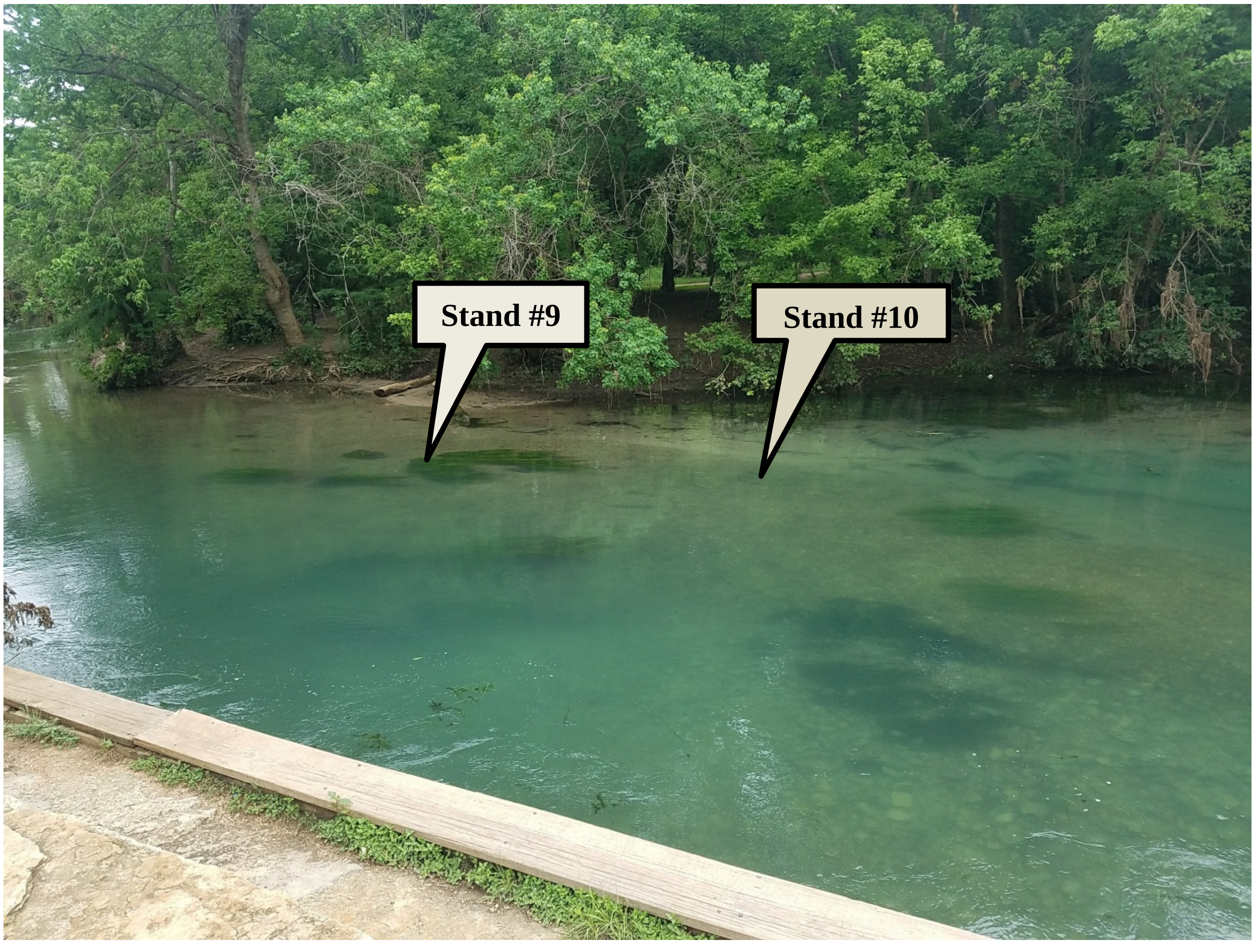
Condition of vulnerable Texas wild-rice stands at Veramendi Park with minimal vegetation matting in fall 2017.

I-35 Reach

The overall cover of vulnerable Texas wild-rice in this location has increased since 2016 and continued to increase between spring and fall 2017, although a majority of this increase can be attributed to an increase of coverage in one stand (#4). In previous years Texas wild-rice here has declined drastically with five stands disappearing over the course of 2016 leading to a low coverage amount by fall of 2016. In 2017 all stands measured in the spring were able to be relocated and measured in the fall with the reappearance of one stand (#10) but stand #9 almost disappeared. For spring sampling velocity at individual stands ranged from 0.1 to 2.2 ft/sec. and minimal depths were greater than 1 ft. For fall sampling stand velocities ranged from 0.4 to 1.5 ft/sec. and all minimal depths greater than 1 ft. Root exposure was significant at stand #4 in the spring but moderate to low at all stands in the fall. No stands were observed blooming in the spring and only one stand was observed blooming in the fall.



The condition of stand #8 (fall 2017 physical observations).



Comparative condition of Texas wild-rice stand #9 and stand #10 in the I-35 Reach during the spring 2017 observation.

Fountain Darter Sampling Results

Drop-net Sampling

In 2017, drop netting was conducted on the San Marcos River during the spring (April), and fall (October) routine sampling efforts. Drop-net raw data for 2017 are included in Appendix D. The number of drop-net sites and vegetation types sampled in each sample reach per event is presented in Table 8. City Park and I-35 reaches have been sampled continuously since the beginning of the study, while drop netting in the Spring Lake Dam Reach was added to the HCP biological monitoring program in 2013. In addition, two *Sagittaria* sites were added to each of the City Park and I-35 reaches in 2013, and two open sites were added to each of the three reaches in fall 2014.

Table 8. Drop-net sites and vegetation types sampled in each reach in the San Marcos River in 2017.

VEGETATION TYPE	SPRING (April 24–25)			FALL (October 16–17)			TOTALS
	Spring Lake Dam	City Park	I-35	Spring Lake Dam	City Park	I-35	
Potamogeton	2			2			4
Hydrilla		2	2		2	1	7
Hygrophila	2	2	2	2	2	2	12
Potamogeton/ Hygrophila		2			2		4
Hydrocotyle				2			2
Sagittaria	2	2	2	1	2	2	11
Cabomba			2			2	4
Ludwigia						1	1
Open	2	2	2	2	2	2	12
TOTALS	8	10	10	9	10	10	57

Using drop nets, biologists captured 210 Fountain Darters in the San Marcos River in 2017, with 92 captured during spring and 118 in fall. This is a decrease from the number of Fountain Darters observed in both 2015 and 2016 (509 and 291, respectively). Effort has varied only slightly between events with the number of Fountain Darters captured per sampling event ranging from 24 to 616 (mean=144) in 50 separate sampling events since the beginning of the comprehensive monitoring study in 2000. Submerged aquatic vegetation is a critical component of Fountain Darter habitat in the San Marcos River, as demonstrated by the observed density of Fountain Darters in open habitats (near zero) vs. vegetated habitats (2.1–7.7/m^2) (Figure 19, Appendix C.3). However, Fountain Darter density varies considerably both within and between various vegetation types. From long-term vegetation types sampled *Cabomba* (7.7 /m^2) exhibited the highest densities of Fountain Darters of native vegetation types sampled, while *Hydrilla* (6.5 / m^2) showed the highest densities of Fountain Darters in nonnative vegetation types sampled in the San Marcos River. While these densities are similar, these aquatic plants are different in both structure and physical habitat requirements. *Cabomba* has a more complex leaf structure, and is typically found in low-velocity backwaters.

The macroinvertebrate assessment of the HCP biological monitoring program has also shown that *Cabomba* harbors the most Fountain Darter prey items (amphipods, true flies, mayflies, caddisflies) at both the City Park and I-35 reaches (this plant is not found at the Spring Lake Dam Reach); therefore, it is not surprising to find higher densities of Fountain Darters in this native species.

Fountain Darter densities are generally lower in the San Marcos system than in the Comal system, in which certain vegetation types, such as bryophytes, exhibit higher mean densities (26.7 Fountain Darters/m^2) and an overall greater number of Fountain Darters (BIO-WEST 2018a). Bryophytes provide dense cover at the substrate level and also harbor very large numbers of invertebrates on which Fountain Darters commonly feed. Spring Lake is the only reach in the San Marcos system that yields a relatively high abundance of bryophytes. Although Spring Lake is not sampled by drop netting, dip-net data confirm a high abundance of Fountain Darters in this vegetation type within the lake.

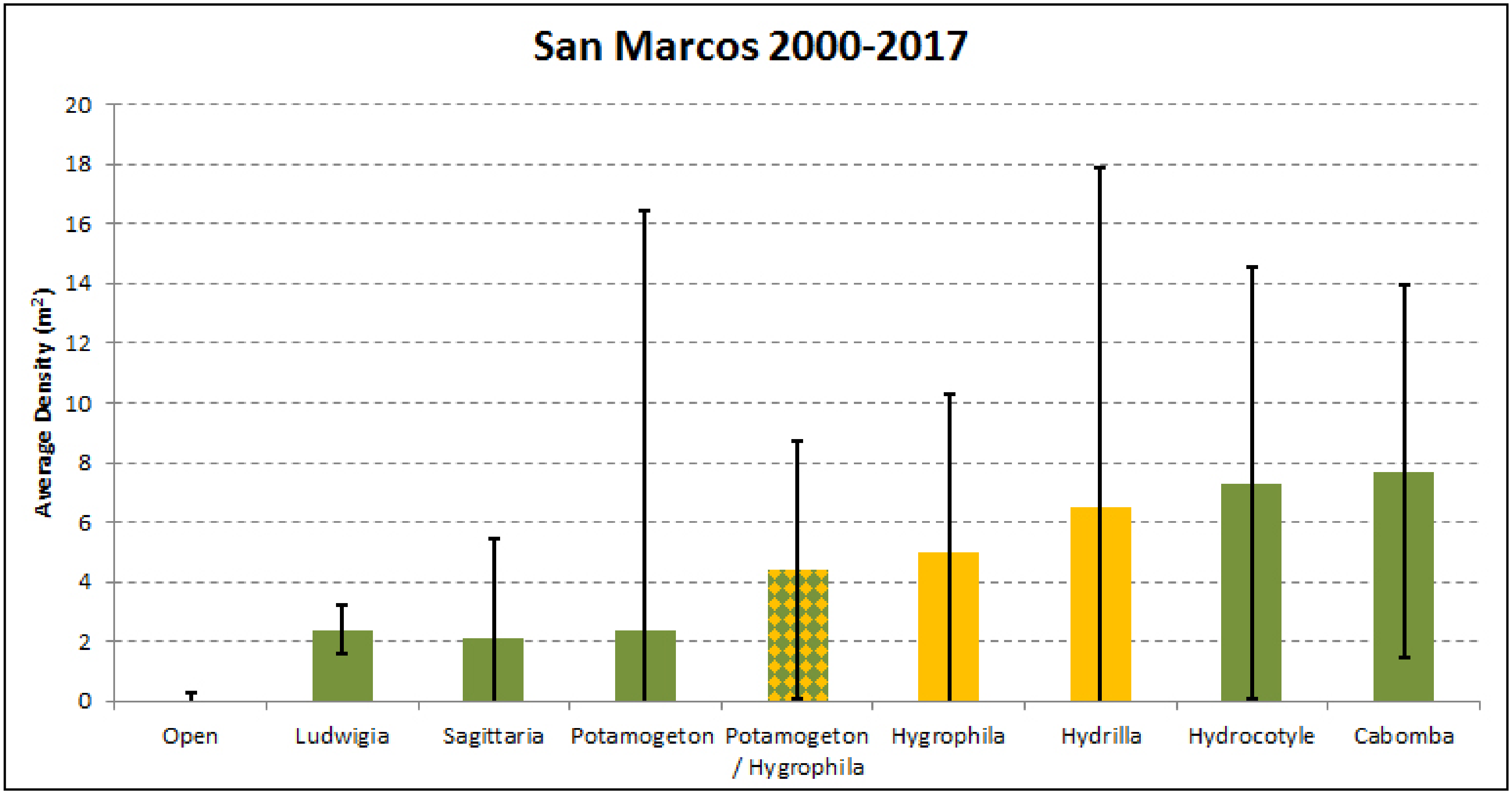


Figure 19. Average Fountain Darter density for each sampled vegetation type in the San Marcos River from 2000–2017. Green represents native vegetation, while yellow reflect nonnative types.

The length-frequency distributions for Fountain Darters collected by drop nets in the San Marcos system during spring and fall sampling events are presented in Figure 20 (all data presented in Appendix C.3). Laboratory studies have shown that Fountain Darters of 16 mm total length are approximately 63 days old (Brandt et al. 1993). Therefore, the presence of Fountain Darters at or below this size threshold suggests recent reproduction. Recent studies of Fountain Darter reproduction found that reproductive effort peaks in late winter/early spring and declines throughout the summer before beginning to increase in the fall (BIO-WEST 2014c). Indeed, spring collections from all reaches show a larger proportion of small Fountain Darters, confirming a peak in reproduction in late winter/early spring (Figure 20). In contrast, fall samples are usually dominated by larger individuals due to less recent reproductive activity (Figure 20).

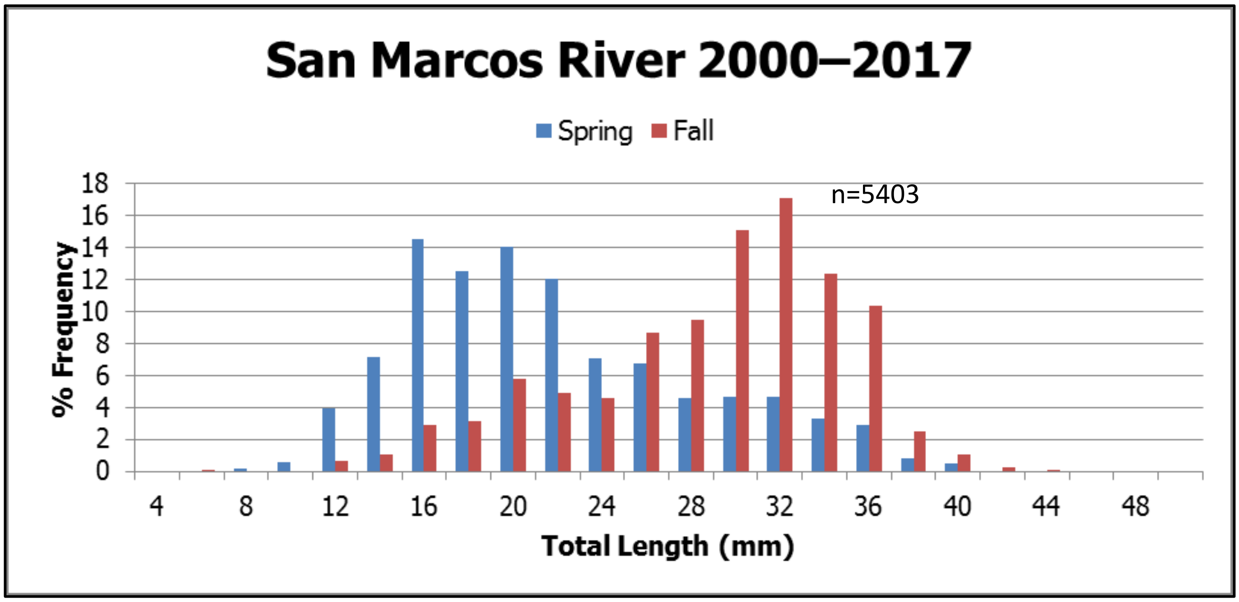


Figure 20. **Length frequency distribution of Fountain Darters collected from the San Marcos system during all routine fall and spring events (2000–2017).**

Estimates of Fountain Darter normalized population abundance (Figure 21) were made according to vegetation coverage within the study reaches and average density of Fountain Darters found in each vegetation type, as described in the Methods section. For the second year in a row, both the spring and fall 2017 population estimates were lower than the long-term average and outside of one standard deviation. It was hypothesized in last year's annual report that the higher flow conditions experienced the past several years has been a deterrent to establishment and expansion of native aquatic vegetation (e.g. *Cabomba*) that provides quality Fountain Darter habitat. An additional contributing factor could be the high increase in Texas wild-rice coverage in all sample reaches, which has more than doubled since fall 2014, coupled with not sampling Texas wild-rice with the drop net and not being able to generate densities. Further data collection may help understand why Fountain Darter densities have considerably decreased with the drop-net sampling.

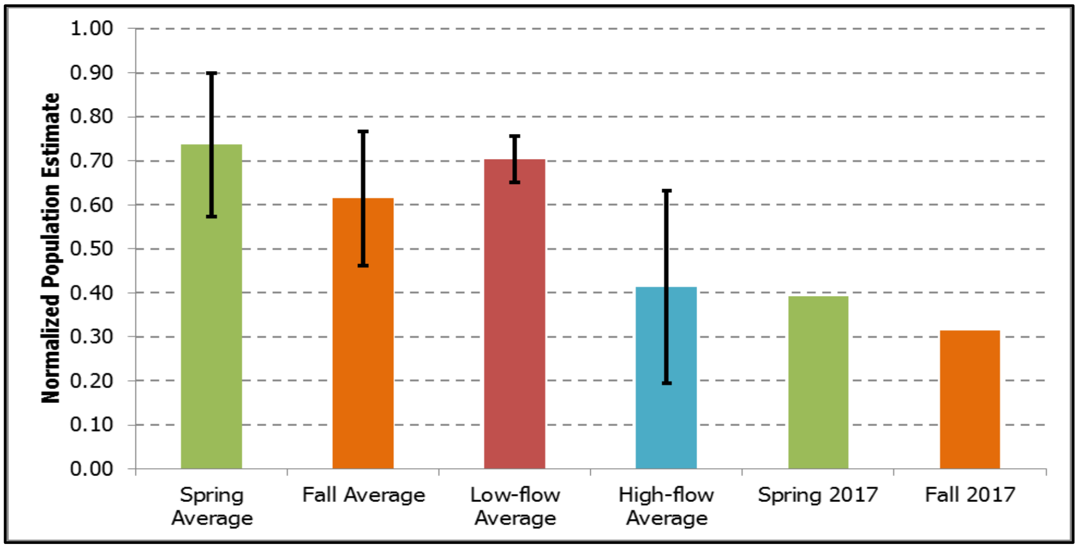


Figure 21. **Normalized population estimate for all events 2000–2017. Long-term study averages are provided with error bars representing one standard deviation from the mean.**

Table 9. **All fish collected in drop nets from 2000 to 2017.**

FAMILY	SCIENTIFIC NAME	COMMON NAME	STATUS	NUMBER COLLECTED 2017	NUMBER COLLECTED 2000–2017
Lepisosteidae	*Lepisosteus oculatus*	Spotted Gar	N		1
Cyprinidae	*Campostoma anomalum*	Central Stoneroller	N		3
	Cyprinella venusta	Blacktail Shiner	N		6
	Dionda nigrotaeniata	Guadalupe Roundnose Minnow	N	25	124
	Notropis amabilis	Texas Shiner	N		90
	Notropis chalybaeus	Ironcolor Shiner	N		131
	Notropis sp.	Unknown Shiner	N		5
Catostomidae	*Moxostoma congestum*	Gray Redhorse	N		2
Characidae	*Astyanax mexicanus*	Mexican Tetra	I	11	72
Ictaluridae	*Ameiurus melas*	Black Bullhead	N	3	4
	Ameiurus natalis	Yellow Bullhead	N	1	162
	Noturus gyrinus	Tadpole Madtom	N		4
Loricariidae	*Hypostomus plecostomus*	Suckermouth Catfish	I	1	64
Poeciliidae	*Gambusia* sp.	Mosquitofish	N	400	47,404
	Poecilia latipinna	Sailfin Molly	I	1	163
Centrarchidae	*Ambloplites rupestris*	Rock Bass	I	43	858
	Lepomis auritus	Redbreast Sunfish	I		100
	Lepomis cyanellus	Green Sunfish	N	2	13
	Lepomis gulosus	Warmouth	N	3	66
	Lepomis macrochirus	Bluegill	N	8	94
	Lepomis megalotis	Longear Sunfish	N		19
	Lepomis microlophus	Redear Sunfish	N		4
	Lepomis miniatus	Redspotted Sunfish	N	68	1,666
	Lepomis sp.	Sunfish	N/I	18	325
	Micropterus salmoides	Largemouth Bass	N	6	100
Percidae	*Etheostoma fonticola*	Fountain Darter	N	210	7,444
	Percina apristis	Guadalupe Darter	N		27
	Percina carbonaria	Texas Logperch	N		1
Cichlidae	*Herichthys cyanoguttatus*	Rio Grande Chichlid	I	22	223
	Oreochromis aureus	Blue Tilapia	I		16
[b]**Totals**				822	59,191

a N=Native, I=Introduced.
b Includes Fountain Darters and unidentified fishes.

In addition to Fountain Darters, 51,747 fishes representing 27 other taxa have been collected by drop netting since 2000 (Table 9). Commonly captured exotic or introduced species include the Rock Bass *Ambloplites rupestris*, Rio Grande Cichlid *Herichthys cyanoguttatus*, Redbreast Sunfish *Lepomis auritus*, and the Sailfin Molly *Poecilia latipinna*. Although these species are not native to the system, most have been established for decades and negative impacts to the Fountain Darter have not been noted. The most common native fishes other than Fountain Darters collected include Mosquito Fish *Gambusia* spp., and Redspotted Sunfish *Lepomis miniatus*.

Dip-net Sampling

Dip-net Timed Surveys

Timed dip-net collections were conducted three times in the San Marcos River during 2017: May (spring), August (summer), and October (fall). Each section where dip-net collections were conducted is depicted in Figures 2 and 3. Data gathered from all reaches are graphically represented in Appendix C.4. Although only half the sampling effort was exerted in the Hotel Section (Spring Lake) compared with other sections, the overall number of Fountain Darters collected by dip netting there is typically greater than found in the other three sections. Filamentous algae and bryophytes present in this area provided the highest-quality habitat found in the San Marcos system via dense cover at the substrate level and also harboring very large numbers of invertebrates on which Fountain Darters commonly feed.

Almost all samples collected from the Hotel Section during the study period including all samples in 2017 contained individuals in the smallest size class (5–15 mm, Appendix C.4). The presence of this size class suggests some reproduction is occurring during all seasons. Spring Lake has an influx of spring fissures and upwellings and heterogeneous vegetation. These habitat characteristics are thought to provide quality habitat for darters in the system and may explain the year-round reproduction. Fountain Darters within this size class are more sporadically observed in the other sections within the San Marcos River and are often found only in spring collections. This may suggest lower recruitment in these downstream sections highlighting the importance of habitats in Spring Lake to the overall health of the Fountain Darter population. Fountain Darter abundances collected in 2017 timed dip-net samples in Spring Lake were consistent to what has been observed in the past with 64 Fountain Darters collected in spring, 54 in summer, and 42 in the fall (the average of 2000–2017 is 62).

Within the City Park Section, abundances observed during timed dip-net surveys were low in 2017 (9–16, Appendix C.4). The spring 2017 sampling effort was the second lowest since timed dip-net surveys began in 2001 (n=11, Avg=35) while summer 2017 had the lowest abundance observed (n=9, Avg=35). In fall, although below average with only 16 darters collected, this was higher than what was observed in both spring and summer. This decrease in Fountain Darters may be a due to the large increase in Texas wild-rice coverage observed in this reach over the last several years. In the I-35 reach abundances observed were similar to recent years. In spring 32 Fountain Darters were collected (Avg = 37), summer saw slightly above average abundance (n = 47) and fall the Fountain Darter abundances dropped below average again with 29 collected.

Observed abundance of Fountain Darters was lower and more variable in the lower portion of the river near Todd Island (Appendix C.4). Habitat (sparse patches of submerged *Hygrophila* and filamentous algae) within this reach fluctuates drastically based on flow conditions and land use in the area. High flows result in excessive scouring, whereas low flows often result in portions of the sampling area being trampled by cattle entering the river for water. Occurrence of Fountain Darter in this lower section is essentially dependent on availability of submerged aquatic vegetation, which fluctuates based on the above-mentioned factors. When such habitat is present within the sampled areas, Fountain Darters are typically present, though never abundant. Additionally, competitive interactions with the Orangethroat Darter *Etheostoma spectabile*, a congener of the Fountain Darter, which also occurs in this segment of the San Marcos River, may influence Fountain Darter populations in this area.

Random-station Dip-net Surveys

Random-station presence/absence dip netting was conducted on the San Marcos River during the spring (May), summer (August), and fall (November) sampling events in 2017. Fountain Darters were present at 40% of sites in spring (Figure 22). This number increased slightly to 48% during the July summer event, and decreased to 34% in the fall, which is the lowest observed over the course of presence/absence dip netting. Figure 22 shows the variation observed in this metric since 2006. The average percent of sites occupied by Fountain Darters during comprehensive sampling is 55%, and the blue lines show the 5th and 95th percentiles of the comprehensive sampling data. To date only three samples have occurred outside of this range. For the 2006 to 2014 time-period, the percent occupied was 36% in fall 2009 after total flows increased following a period of sustained low flows in 2008–2009, and was highest in summer 2014 (78%), during a period of sustained lower-than-average flows. The fall 2017 sample was taken after a long period of above-average flows in 2016 and most of 2017 that has not been seen since presence/absence dip netting began in 2006 (Figure 5).

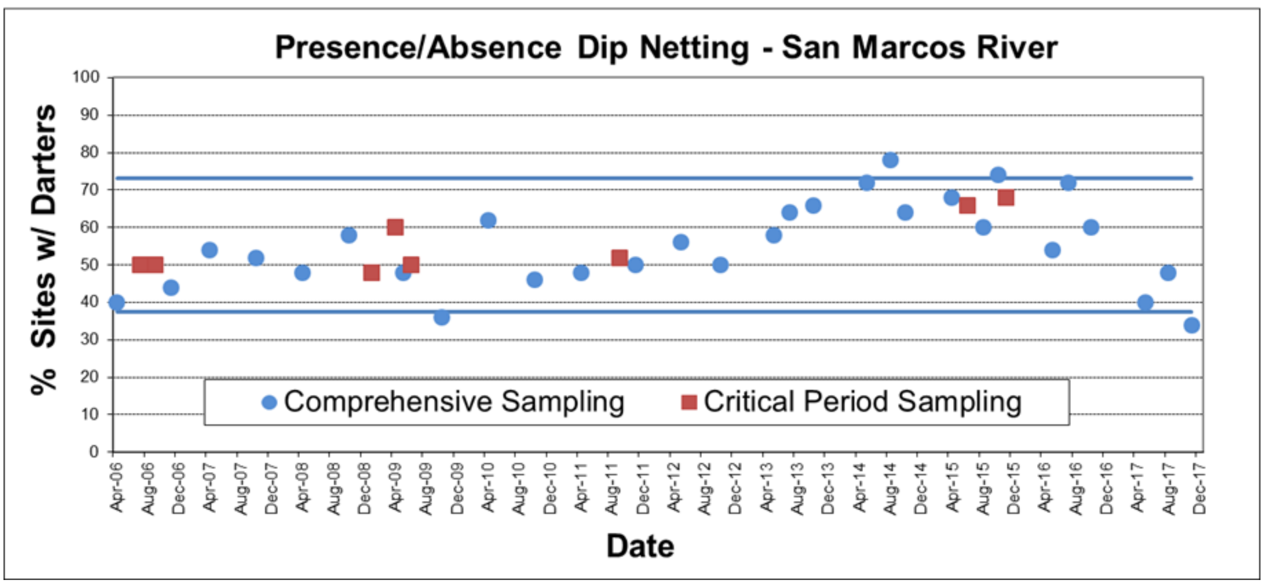


Figure 22. **Percentage of sites (n=50) in which Fountain Darters were present. Solid blue lines mark 5th and 95th percentiles of comprehensive sampling data.**

Fish Community Sampling

Twenty-five species of fishes and 2,279 individuals were identified and enumerated among four locations in the San Marcos River during spring and fall 2017 (Table 10). The Largespring Gambusia *geiseri* was the most abundant species, representing 20% of all individuals in 2017. Other abundant species included the Mexican Tetra *Astyanax mexicanus* (17% relative abundance), Guadalupe Roundnose Minnow *Dionda nigrotaeniata* (15%), and Redbreast Sunfish *Lepomis auratus* (8%). Uncommon species in 2017 collections included Lepisosteidae (1 individual), Gray Redhorse *Moxostoma congestum* (6 individuals), and Ironclad Shiner *Notropis chalybaeus* (2 individuals).

Fish community sampling from 2013 to 2017 in the San Marcos River has resulted in collection of 31,747 fishes representing 37 different species. In contrast, the San Marcos River drop-net database (2000–2017) contains 59,189 fishes representing 28 species. Higher species richness within the fish community dataset is likely a result of both sampling technique and location. Seining and visual observation are more effective at enumerating large or highly mobile species such as Centrarchids, Cyprinids, or Characids. Additionally, fish community sampling is conducted much lower in the system than drop netting, which does not extend below I-35. As a result, riverine fish characteristic of downstream areas are more abundant within fish community data than drop-net data. Species identified in fish community sampling that are not present within the drop-net database include Common Carp *Cyprinus carpio*, Burrhead Chub *Macrhybopsis marconis*, Mimic Shiner *Notropis volucellus*, Bullhead Minnow *Pimephales vigilax*, Channel Catfish *Ictalurus punctatus*, Suckermouth Armored Catfish *Pterygoplichthys* sp., Inland Silverside *Menidia beryllina*, Amazon Molly *Poecilia latipinna*, Guadalupe Bass *Micropterus treculii*, and Orangethroat Darter *Etheostoma spectabile*. Two species, Black Bullhead *Ameiurus natalis* and Tadpole Madtom *Noturus gyrinus*, are present in the drop-net dataset but not in the fish community dataset. Conversely, it is not surprising that drop netting is more successful (13% abundance relative to all species) for Fountain Darters compared to these other techniques (5%) as it was designed specifically to capture this species.

Ten nonnative species are present within the long-term fish community dataset. Of these, Blue Tilapia *Oreochromis aurea* and two taxa of exotic Loricariid Catfishes (*Hypostomus* and *Pterygoplichthys*) are considered the most invasive. An ongoing HCP-sponsored nonnative removal program is focusing on removing these species from the system. Relative abundance and catch-per-unit-effort (CPUE) for both of these species has been variable over the past five years, and no distinct trends in abundance are apparent. Continued monitoring will be important to assess the long-term effectiveness of nonnative removal programs.

Table 10. Number (#) and percent relative abundance (%) of fish species captured in fish community sampling during 2013–2017 compared to drop-net data from 2000–2017. N=native and I=Introduced.

FAMILY	SCIENTIFIC NAME	COMMON NAME	STATUS	DROP NET (2000–2017)		FISH COMMUNITY (2013–2017)						
				Total #	Total %	2013 #	2014 #	2015 #	2016 #	2017#	Total #	Total %
Lepisosteidae	*Lepisosteus oculatus*	Spotted Gar	N	1	0.00	8	3	9	3	1	24	0.08
Cyprinidae	*Campostoma anomalum*	Central Stoneroller	N	3	0.01	0	0	0	2	0	2	0.01
	Cyprinella venusta	Blacktail Shiner	N	6	0.01	456	159	286	116	123	1140	3.59
	Cyprinus carpio	Common Carp	I	0	0.00	0	1	0	0	0	1	0.00
	Dionda nigrotaeniata	Guadalupe Roundnose Minnow	N	124	0.21	237	954	2394	2690	336	6611	20.82
	Macrhybopsis marconis	Burrhead Chub	N	0	0.00	1	0	1	0	0	2	0.01
	Notropis amabilis	Texas Shiner	N	90	0.15	222	143	23	14	42	444	1.40
	Notropis chalybaeus	Ironcolor Shiner	N	131	0.22	4	22	10	54	2	92	0.29
	Notropis volucellus	Mimic Shiner	N	0	0.00	6	2	0	0	0	8	0.03
	Notropis sp.	Unknown shiner	N	5	0.01	0	0	0	0	0	0	0.00
	Pimephales vigilax	Bullhead Minnow	N	0	0.00	4	0	5	0	3	12	0.04
Catostomidae	*Moxostoma congestum*	Gray Redhorse	N	2	0.00	1	4	40	2	6	53	0.17
Characidae	*Astyanax mexicanus*	Mexican Tetra	I	72	0.12	575	1308	2757	1177	380	6197	19.52
Ictaluridae	*Ameiurus melas*	Black Bullhead	N	4	0.01	0	0	0	0	0	0	0.00
	Ameiurus natalis	Yellow Bullhead	N	162	0.27	5	11	13	2	0	31	0.10
	Ictalurus punctatus	Channel Catfish	N	0	0.00	1	0	6	3	0	10	0.03
	Noturus gyrinus	Tadpole Madtom	N	4	0.01	0	0	0	0	0	0	0.00
Loricariidae	*Hypostomus plecostomus*	Armadillo Del Rio	I	0	0.00	177	155	179	68	111	690	2.17
	Pterygoplichthys sp.	Suckermouth Armored Catfish	I	64	0.11	2	0	0	0	0	2	0.01
Atherinopsidae	*Menidia beryllina*	Inland Silverside	N	0	0.00	1	0	0	0	0	1	0.00
Poeciliidae	*Gambusia affinis*	Western Mosquitofish	N	0	0.00	33	155	13	13	3	217	0.68
	Gambusia geiseri	Largespring Gambusia	N	0	0.00	728	1418	640	943	465	4194	13.21
	Gambusia sp.	Mosquitofish	N	47,404	80.09	2471	918	349	369	27	4134	13.02
	Poecilia latipinna	Sailfin Molly	I	163	0.28	38	24	26	39	8	135	0.43
	Poecilia formosa	Amazon Molly	I	0	0.00	1	0	0	3	0	4	0.01
Centrarchidae	*Ambloplites rupestris*	Rock Bass	I	858	1.45	47	25	4	12	7	95	0.30
	Lepomis auritus	Redbreast Sunfish	I	100	0.17	218	246	450	264	174	1352	4.26
	Lepomis cyanellus	Green Sunfish	N	13	0.02	0	0	0	4	2	6	0.02
	Lepomis gulosus	Warmouth	N	66	0.11	8	10	4	9	0	31	0.10
	Lepomis macrochirus	Bluegill	N	94	0.16	94	188	263	81	67	693	2.18
	Lepomis megalotis	Longear Sunfish	N	19	0.03	3	27	56	38	4	128	0.40
	Lepomis microlophus	Redear Sunfish	N	4	0.01	26	41	338	39	19	463	1.46
	Lepomis miniatus	Redspotted Sunfish	N	1,666	2.81	59	28	40	44	13	184	0.58
	Lepomis sp.	Sunfish	N/I	325	0.55	374	362	287	248	143	1414	4.45
	Micropterus salmoides	Largemouth Bass	N	100	0.17	168	301	290	144	103	1006	3.17
	Micropterus treculii	Guadalupe Bass	N	0	0.00	1	0	0	0	0	1	0.00
Percidae	*Etheostoma fonticola*	Fountain Darter	N	7,444	12.58	200	351	481	541	145	1718	5.41
	Etheostoma spectabile	Orangethroat Darter	N	0	0.00	5	18	62	15	16	116	0.37
	Percina apristis	Guadalupe Darter	N	27	0.05	31	34	75	57	54	251	0.79
	Percina carbonaria	Texas Logperch	N	1	0.00	4	6	50	5	7	72	0.23
	Percina sp.	Unidentified Percina	N	0	0.00	0	0	1	3	0	4	0.01
Cichlidae	*Herichthys cyanoguttatus*	Rio Grande Cichlid	I	223	0.38	41	75	51	17	18	202	0.64
	Oreochromis aureus	Blue Tilapia	I	16	0.03	1	2	4	0	0	7	0.02
Totals				59,191		6,251	6,991	9,207	7,019	2,279	31,747	

Fish Tissue Sampling

As described in the methods, exploratory fish tissue sampling and analysis was conducted in 2017 for a wide range of constituents. In the San Marcos system, samples were collected from Spring Lake and just upstream of Interstate 35 on May 30th and sent to the ALS Kelso laboratory for evaluation of PCBs, PAHs, PPBDEs, SVOCs and metals. Table 11 shows the constituents that were detected in either Western Mosquitofish or Largemouth Bass fish tissue from each location. In the San Marcos system, a total of 17 metals, 1 PAH (Perylene), 1 PCB (Aroclor 1260), and 2 semi-volatiles (Benzoic acid and 4-methylphenol) were detected (Table 11, first page) at most locations and for both species which was consistent with fish tissue results from the Comal system (BIO-WEST 2018a). However, unlike the Comal system where overall detections were consistent among locations, an additional 41 chemicals encompassing a variety of organic compounds were detected in Spring Lake Largemouth Bass tissue samples (Table 11, second page). The cause for this result is unknown at this time. Interestingly, the aforementioned results from Spring Lake (metals, etc.) were not dissimilar from the other locations or species tested. Similar to the Comal system, Aluminum, Iron and Zinc were detected in all samples but were consistently higher in Western Mosquitofish than Largemouth Bass. Additionally, benzoic acid was only detected at the downstream most location sampled in the San Marcos River.

Table 11. Fish Tissue Constituent Detections from ALS Kelso Laboratory.

Analyte (units)	Spring Lake		I-35	
	Largemouth Bass	Western Mosquitofish	Largemouth Bass	Western Mosquitofish
Aluminum, Total (mg/kg)	3.1	28.3	2.3	71.6
Arsenic, Total (mg/kg)	0.22	0.19	--	0.24
Barium, Total (mg/kg)	0.71	2.39	0.30	1.88
Boron, Total (mg/kg)	--	0.29	--	0.24
Cadmium, Total (mg/kg)	--	0.008	--	0.005
Chromium, Total (mg/kg)	2.20	0.49	0.31	0.81
Copper, Total (mg/kg)	0.62	0.94	0.39	1.29
Iron, Total (mg/kg)	19.3	30.7	9.6	65.8
Lead, Total (mg/kg)	0.005	0.040	0.013	0.348
Manganese, Total (mg/kg)	1.22	4.49	0.70	6.77
Molybdenum, Total (mg/kg)	0.04	0.02	0.02	0.03
Nickel, Total (mg/kg)	0.95	0.22	0.12	0.38
Selenium (mg/kg)	0.40	0.43	0.57	0.55
Vanadium, Total (mg/kg)	--	0.10	--	0.22
Zinc, Total (mg/kg)	15.3	42.1	14.8	41.5
Magnesium, Total (mg/kg)	475	378	460	379
Mercury, Total (ng/g)	41	13	43	15
Perylene (ug/kg)	--	14	--	30
4-Methylphenol (ug/kg)	--	130	--	76
Aroclor 1260 (ug/kg)	--	--	--	42
Benzoic Acid (ug/kg)	--	--	--	3,300

Table 11 (concluded). Fish Tissue Constituent Detections from ALS Kelso Laboratory.

Analyte (units)	Spring Lake		I-35	
	Largemouth Bass	Western Mosquitofish	Largemouth Bass	Western Mosquitofish
2-Methylnaphthalene (ug/kg)	361	--	--	--
1-Methylnaphthalene (ug/kg)	380	--	--	--
2,6-Dimethylnaphthalene (ug/kg)	368	--	--	--
Biphenyl (ug/kg)	367	--	--	--
Acenaphthylene (ug/kg)	361	--	--	--
Acenaphthene (ug/kg)	376	--	--	--
Dibenzofuran (ug/kg)	375	--	--	--
2,3,5-Trimethylnaphthalene (ug/kg)	388	--	--	--
Fluorene (ug/kg)	388	--	--	--
Dibenzothiophene (ug/kg)	371	--	--	--
Phenanthrene (ug/kg)	395	--	--	--
Anthracene (ug/kg)	393	--	--	--
Carbazole (ug/kg)	389	--	--	--
1-Methylphenanthrene (ug/kg)	404	--	--	--
Fluoranthene (ug/kg)	405	--	--	--
Pyrene (ug/kg)	396	--	--	--
Benz(a)anthracene (ug/kg)	403	--	--	--
Chrysene (ug/kg)	414	--	--	--
Benzo(b)fluoranthene (ug/kg)	390	--	--	--
Benzo(k)fluoranthene (ug/kg)	392	--	--	--
Benzo(e)pyrene (ug/kg)	394	--	--	--
Benzo(a)pyrene (ug/kg)	379	--	--	--
Perylene (ug/kg)	387	--	--	--
Indeno(1,2,3-cd)pyrene (ug/kg)	378	--	--	--
Dibenz(a,h)anthracene (ug/kg)	394	--	--	--
Benzo(g,h,i)perylene (ug/kg)	389	--	--	--
Aroclor 1260 (ug/kg)	103	--	--	--
Phenol (ug/kg)	2,300	--	--	--
2,4-Dichlorophenol (ug/kg)	43	--	--	--
2-Chlorophenol (ug/kg)	2,220	--	--	--
1,4-Dichlorobenzene (ug/kg)	1,980	--	--	--
Hexachloroethane (ug/kg)	1,520	--	--	--
N-Nitrosodi-n-propylamine (ug/kg)	2,030	--	--	--
1,2,4-Trichlorobenzene (ug/kg)	2,060	--	--	--
4-Chloro-3-methylphenol (ug/kg)	2,310	--	--	--
2-Chloronaphthalene (ug/kg)	2,490	--	--	--
4-Nitrophenol (ug/kg)	2,410	--	--	--
2,4-Dinitrotoluene (ug/kg)	2,360	--	--	--
Diethyl Phthalate (ug/kg)	2,540	--	--	--
4-Bromophenyl Phenyl Ether (ug/kg)	2,560	--	--	--
Pentachlorophenol (ug/kg)	2,120	--	--	--

Mercury was detected in all samples from the San Marcos River, but was not present in alarming concentrations. A nationwide study of 500 lakes and reservoirs throughout the continental United States published by the EPA in 2009 found mercury present in all fish tissue samples examined, and found concentrations higher than the EPA human health screening value of 0.3 mg/kg in 49% of the lakes examined (U. S. EPA 2009). In the San Marcos River, the maximum concentration observed was 43 ng/g, or 0.043 mg/kg. This is well below both the EPA human health screening value of 0.3 mg/kg and the Texas Department of State Health Services (TDSHS) screening value of 0.7 mg/kg (TDSHS 2004). Mercury levels were higher in Largemouth Bass (41 - 43 ng/g) than in Western Mosquitofish (13 - 15 ng/g), which is not unexpected being that it is known to bioaccumulate and is typically most concentrated in top predators within aquatic systems. Although a snapshot in time, this exploratory fish tissue sampling and analysis does provide a starting point for baseline condition establishment for future comparisons.

In conjunction with the samples collected and sent to ALS Kelso Labs, Dr. Bryan Brooks of Baylor University collected and analyzed fish tissue, plasma and water samples from the San Marcos system for pharmaceutical agents. In the San Marcos system, Caffeine (stimulant), diphenhydramine (antihistamine), sucralose (artificial sweetener) and sulfamethoxazole (antibiotic) were consistently detected in the water samples at all stations (Appendix C.5). Caffeine, and diltiazem (anti-hypertension) were the only parameters consistently detected in fish plasma while caffeine and trimethoprim (antibiotic) were the only constituent consistently detected in fish tissue. (Appendix C.5). As pharmaceutical effects on aquatic organisms is a developing science it is difficult to surmise too much from this exploratory dataset. However, as mentioned above, the acquisition of this type of fish tissue data serves well in the establishment of baseline conditions for future comparisons on a local or regional level.

San Marcos Salamander Visual Observations

In 2017, routine sampling events (spring and fall) were conducted and no Critical Periods were triggered. Biologists observed 189 San Marcos salamanders for the spring sampling and 219 salamander observations in the fall sampling for a total of 408 salamander observations for 2017. San Marcos salamander densities observed during the spring and fall sampling events in 2017 were similar to the long-term averages for salamander monitoring at the Hotel Site (Site 2) (Figure 23) and Spring Lake Dam (Site 21) (Figure 24). Conversely, at the Riverbed Site (Site 14), salamander observations were above the long-term average (Figure 25), much like the previous year in 2016. Consistent with 2016, San Marcos salamander densities at the Spring Lake Dam Site (Site 21) did not vary among spring and fall 2017 compared to other sites (Figure 3). This site has been fenced off to prevent recreational pressure since 2016.

Benthic Macroinvertebrate Rapid Bioassessment

Benthic macroinvertebrate rapid bioassessment data was collected during both the spring and fall sampling events in 2017 (raw data presented in Appendix C.6). A total of 708 and 842 macroinvertebrate individuals, representing 41 and 34 unique taxa were sampled in spring and fall, respectively. Altogether, 52 unique taxa were represented among all samples from 2017. Metric values for each metric are reported, and metric scores for calculating the B-IBI can be found in Table 12. Figures for each metric can be found in Appendix C.7.

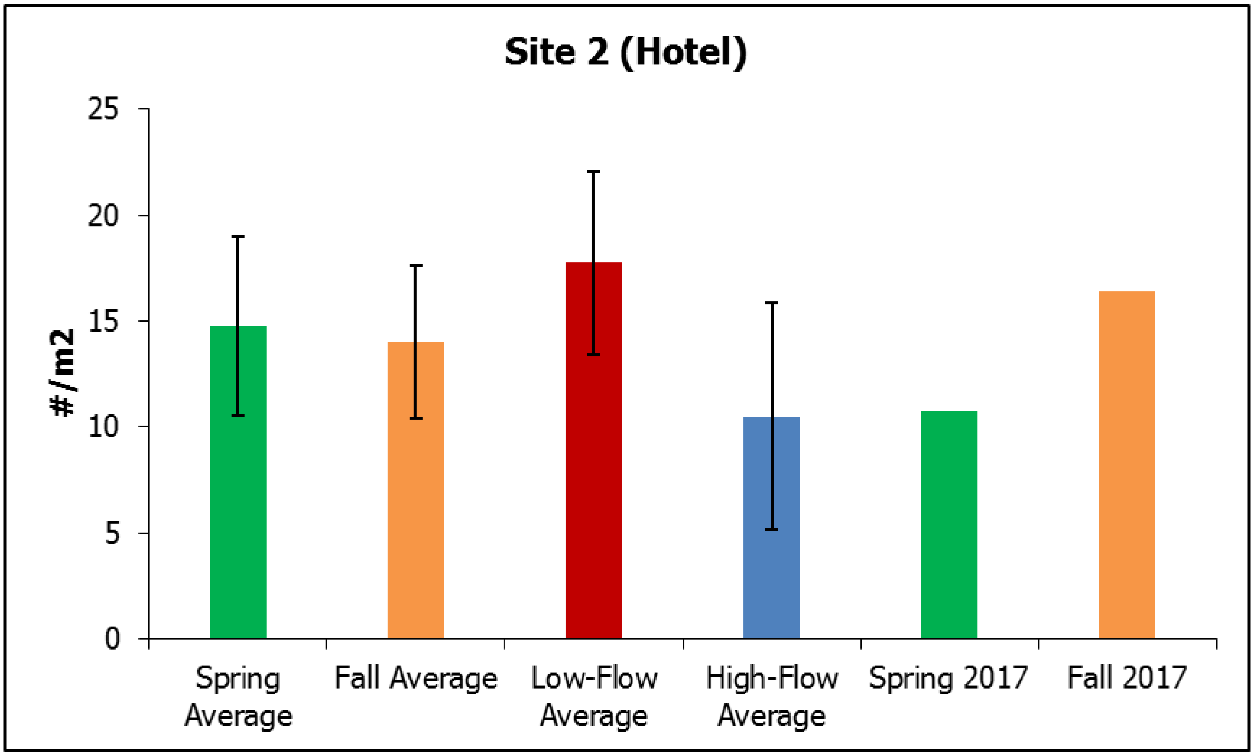


Figure 23. San Marcos salamander observations at Site 2 (Hotel Site) in 2017. Long-term monitoring averages are provided with error bars representing one standard deviation of the mean.

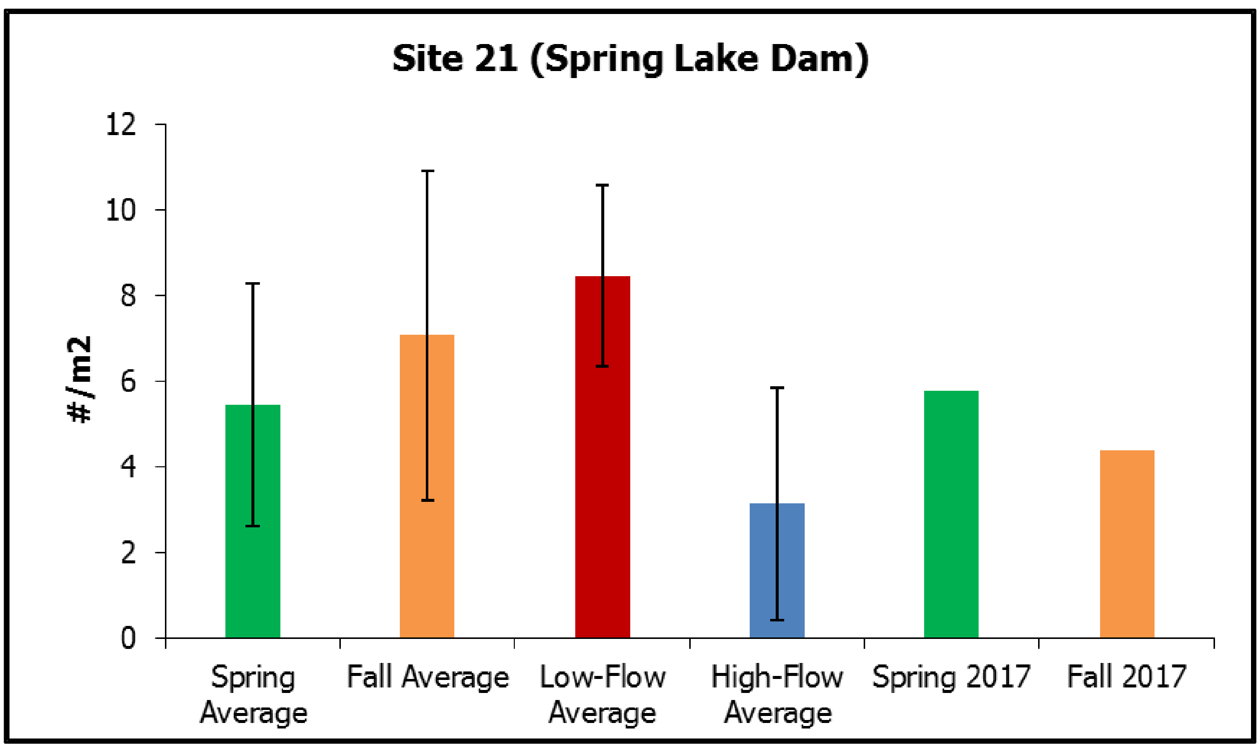


Figure 24. San Marcos salamander observations at Site 21 (Spring Lake Dam Site) in 2017. Long-term monitoring averages are provided with error bars representing one standard deviation of the mean.

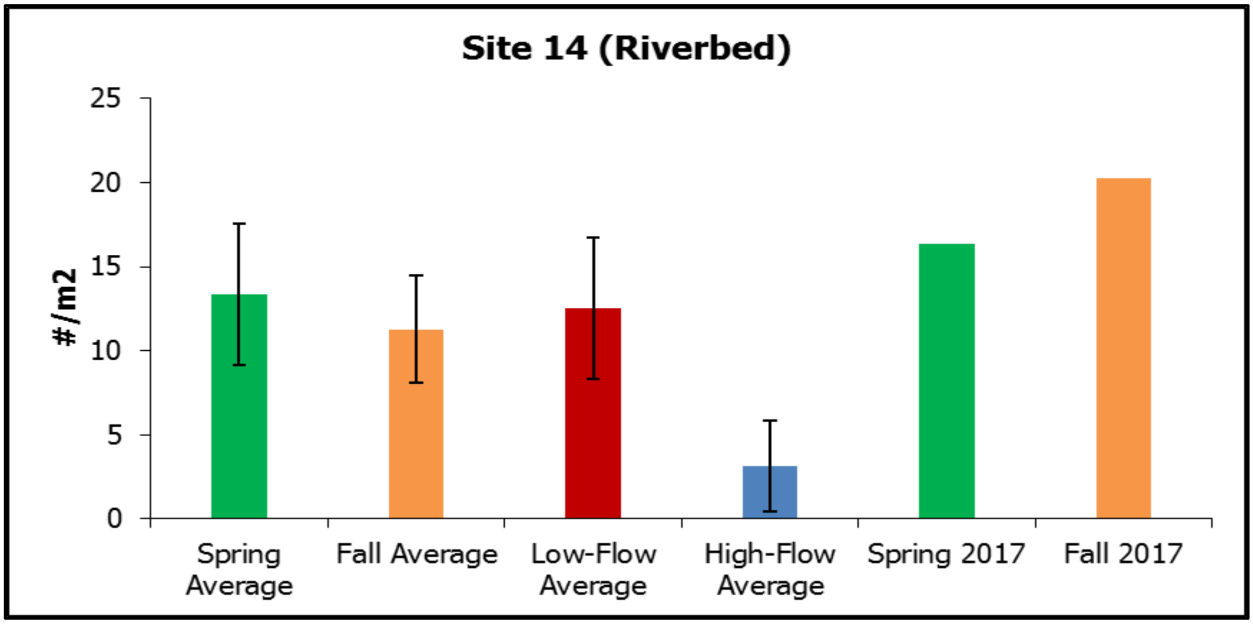


Figure 25. San Marcos salamander observations at Site 14 (Riverbed Site) in 2017. Long-term monitoring averages are provided with error bars representing one standard deviation of the mean.

Table 12. Metric value scoring ranges for calculating the Texas RBP B-IBI (TCEQ 2014).

METRIC	SCORING CRITERIA			
	4	3	2	1
Taxa richness	>21	15–21	8–14	<8
EPT taxa abundance	>9	7–9	4–6	<4
Biotic index (HBI)	<3.77	3.77–4.52	4.56–5.27	>5.27
% Chironomidae	0.79–4.10	4.11–9.48	9.49–16.19	<0.79 or >16.19
% Dominant taxon	<22.15	22.15–31.01	31.02–39.88	>39.88
% Dominant FFG	<36.50	36.50–45.30	45.31–54.12	>54.12
% Predators	4.73–15.20	15.21–25.67	25.68–36.14	<4.73 or >36.14
Ratio of intolerant: tolerant taxa	>4.79	3.21–4.79	1.63–3.20	<1.63
% of total Trichoptera as Hydropsychidae	<25.50	25.51–50.50	50.51–75.50	>75.50 or no Trichoptera
# of non–insect taxa	>5	4–5	2–3	<2
% Collector–gatherers	8.00–19.23	19.24–30.46	30.47–41.68	<8.00 or >41.68
% of total number as Elmidae	0.88–10.04	10.05–20.08	20.09–30.12	<0.88 or >30.12

The overall results of this metric analysis contribute to the B-IBI scores and assessment of the aquatic-life-use (Figure 25). Spring Lake is described from these assessments as being “Limited” in supporting a balanced, integrated, adaptive community of organisms. City Park showed “Intermediate” support of a healthy community. Spring Lake Dam showed “High” and “Exceptional” support for aquatic life in spring and fall, respectively. The I-35 Site was found to have a “High” support for aquatic life in both seasons. It is also important to note that although it is easy to focus on the differences between reaches, the goal of this assessment is to track the “condition” of specific reaches over time as an indicator of trends.

In summary, areas of more lentic-type habitat (Spring Lake) near spring sources scored lower, as communities there are different when compared to swift flowing “least disturbed reference streams.” Downstream and tailwater areas with more lotic conditions generally scored higher, as habitat is more similar to reference streams. It should also be noted that most reference streams do not exhibit the stenothermal conditions present within the upper San Marcos River, and this may result in differing community composition. Additional monitoring will allow development of a reference dataset specific to this unique ecosystem, and potentially development of a specific IBI scoring system for unique large spring environments such as the San Marcos and Comal rivers.

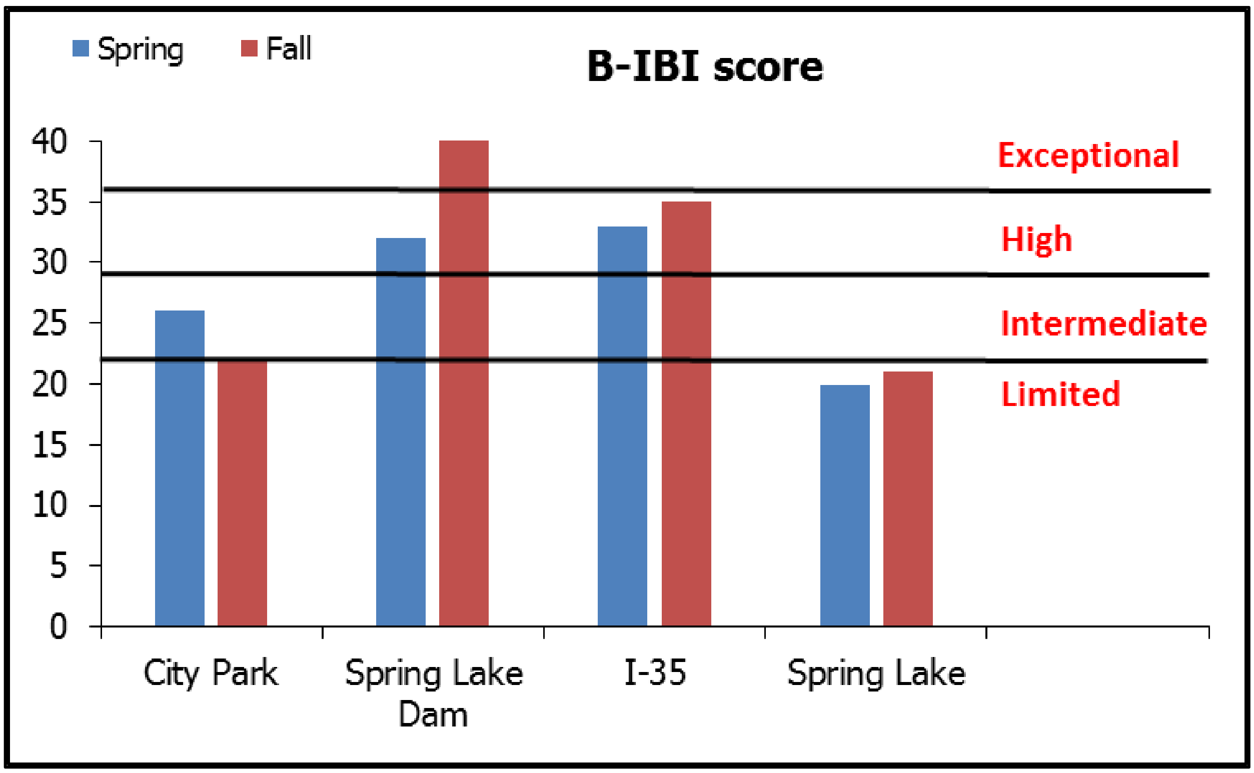


Figure 26. **Benthic macroinvertebrate Index of Biotic Integrity (B-IBI) scores and aquatic-life-use point-score ranges for San Marcos River sample sites. “Exceptional” indicates highest quality habitats.**

CONCLUSION

The HCP Biological Monitoring program activities conducted in 2017 provided insight into the continued transition from a prolonged drought to subsequent wet years in the San Marcos River/Springs ecosystem. Total system discharge in the San Marcos system has remained at or above historical monthly averages since early summer 2015. Similar to 2016, water temperature and dissolved oxygen measurements throughout the system presented no cause for concern. Texas wild- rice eclipsed 9,000 m^2 in 2017 representing the highest coverage recorded since EAA biological monitoring was initiated in 2000. The rapid expansion of Texas wild-rice in the system has led to this plant species now representing the dominant aquatic vegetation in both the Spring Lake Dam and City Park study reaches.

Normalized Fountain Darter population estimates were well below the long-term averages again in 2017. This decrease was noted in 2016 with the hypothesis that the decrease may be attributed to above average flows impeding the expansion of key aquatic vegetation used by Fountain Darters. The rapid expansion and dominance of Texas wild-rice within the biological monitoring study reaches is also likely a contributing factor. Similar to drop net results, dip-net survey results for 2017 exhibited declines in abundance and detection in river reaches. Sampling of the overall fish community in the San Marcos River continued to reflect a diverse community of fishes although total numbers collected declined in 2017. Although detections of several parameters were recorded in the preliminary fish tissue analysis, no results stood out as a cause for concern at this time. San Marcos salamander densities observed were consistent with recent years and historical information. The benthic macroinvertebrate RBA sampling initiated the development of a baseline to track the “condition” of specific reaches over time.

Overall, habitat and species conditions in Spring Lake remain excellent while conditions in the river have been more variable in these recent higher than average flow years. For certain species, particularly Texas wild-rice, vast improvements in establishment and expansion are being accomplished the past few years through HCP restoration and mitigation activities. In contrast, declines in Fountain Darter numbers and detection in the riverine study reaches coupled with a decrease in overall fish community results highlights the importance of future biological monitoring to assess conditions as well as quantify effects (both positive and negative) in continuing to better understand and track trends in the San Marcos river system.

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APPENDIX A: CRITICAL PERIOD MONITORING SCHEDULES

SAN MARCOS RIVER/SPRINGS
Critical Period Low-Flow Sampling – Schedule and Parameters

FLOW TRIGGER (+ or - 5 cfs)	PARAMETERS
120 cfs	Wild Rice vulnerable stands - Every 5 cfs decline (maximum weekly)
100 cfs	Full Sampling Event
100 cfs - 85 cfs	Habitat Evaluations - Every 5 cfs decline (maximum weekly)
85 cfs	Full Sampling Event
85 cfs - 60 cfs	Habitat Evaluations - Every 5 cfs decline (maximum weekly)
60 cfs	Full Sampling Event
60 cfs - 25 cfs	Habitat Evaluations - Every 5 cfs decline (maximum weekly)
25 cfs	Full Sampling Event
25 cfs - 0 cfs	Habitat Evaluations - Every 5 cfs decline (maximum weekly)
10 - 0 cfs	Full Sampling Event
RECOVERY	
25 cfs - 85 cfs	Full Sampling Event (dependant on flow stabilization)
85 cfs - 125 cfs	Full Sampling Event (dependant on flow stabilization)

PARAMETER DESCRIPTION

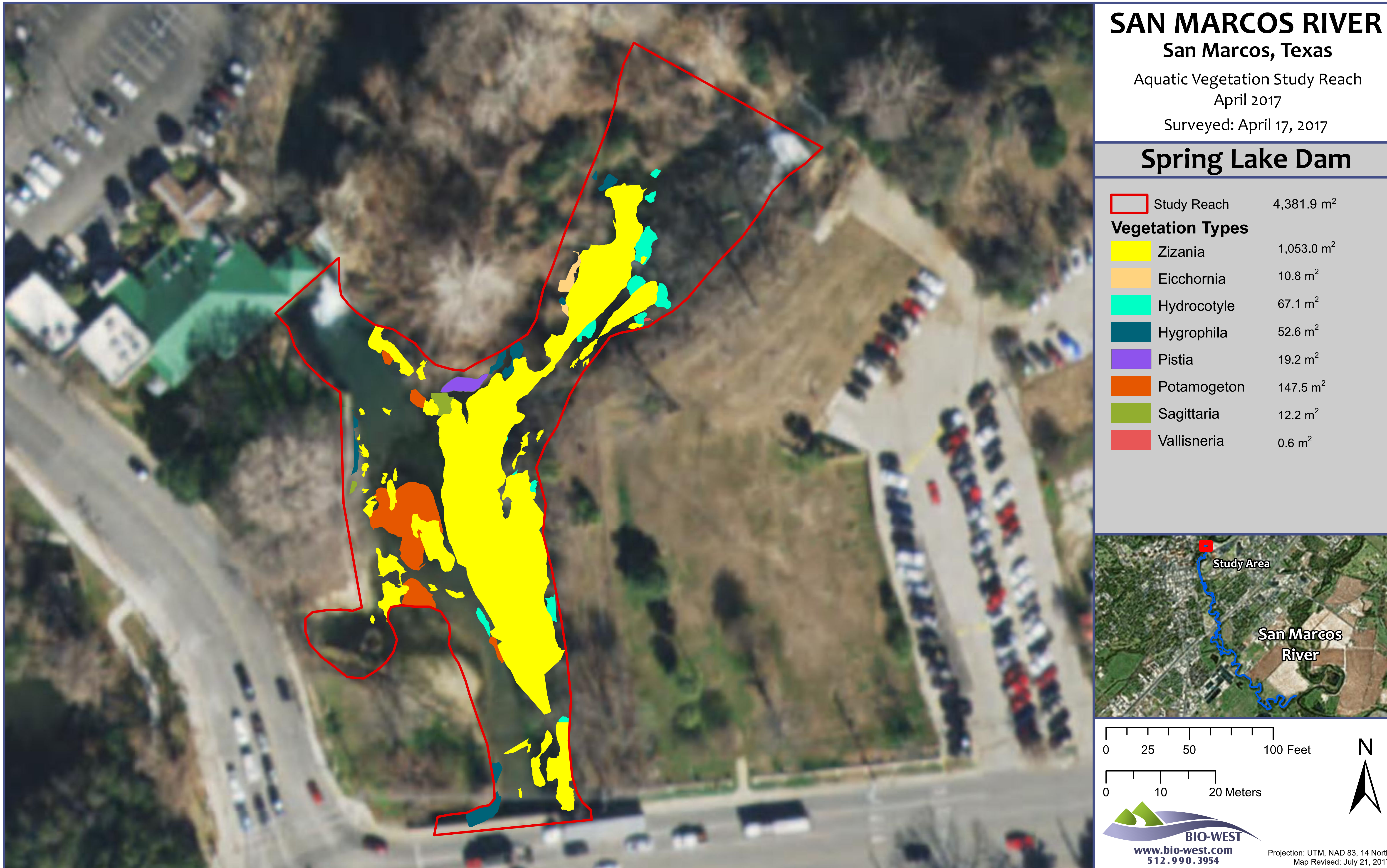
Wild Rice Monitoring	Physical changes vulnerable stands
Full Sampling Event	Aquatic Vegetation Mapping - including Texas Wild-Rice Fountain Darter Sampling Drop Net, Dip net (Presence/Absence), and Visual Parasite evaluations Fish Community Sampling Salamander Sampling - Visual Fish sampling - Exotics / Predation (85 cfs and below) Water Quality - Suite I and Suite II
Habitat Evaluations	Photographs

SAN MARCOS RIVER/SPRINGS
Species-Specific Triggered Sampling (New HCP component 2013)

Flow Rate (+ or - 10 cfs)	**Species**	**Frequency**	**Parameter**
≤80 cfs or ≥ 50 cfs continuing until flow rate restores to ≥100 cfs	fountain darter	every other month	Aquatic vegetation mapping at Spring Lake Dam reach, City Park reach, and IH-35 reach
≤80 cfs or ≥ 50 cfs continuing until flow rate restores to ≥100 cfs	fountain darter	every other month	Conduct dip net sampling/visual parasite evaluations at 50 sites in high quality habitat to include fifteen (15) sites in Spring Lake Dam reach; twenty (20) sites in City Park reach, and fifteen (15) sites in IH-35 reach.
≤50 cfs	fountain darter	monthly	Aquatic vegetation mapping at Spring Lake Dam reach, City Park reach, and IH-35 reach
≤50 cfs	fountain darter	weekly	Conduct dip net sampling/visual parasite evaluations at 50 sites in high quality habitat to include fifteen (15) sites in Spring Lake Dam reach; twenty (20) sites in City Park reach, and fifteen (15) sites in IH-35 reach.
≤80 cfs or ≥ 50 cfs	San Marcos salamander	every other week	Salamander surveys (SCUBA and snorkel) will be conducted at the Hotel Area, Riverbed area, and eastern spillway of Spring Lake Dam
<50 cfs	San Marcos salamander	weekly	Salamander surveys (SCUBA and snorkel) will be conducted at the Hotel Area, Riverbed area, and eastern spillway of Spring Lake Dam
100 cfs	Texas wild-rice	once	Mapping of Texas wild-rice coverage for the entire San Marcos River will be conducted
≤100 cfs or ≥60 cfs	Texas wild-rice	every other week	Physical parameters of Texas wild-rice will be monitored in designated "vulnerable" areas
<80 cfs	Texas wild-rice	monthly	Mapping of Texas wild-rice coverage for the entire San Marcos River will be conducted
<80 cfs	Texas wild-rice	weekly	Physical visual observations of Texas wild-rice will occur

APPENDIX B: AQUATIC VEGETATION MAPS

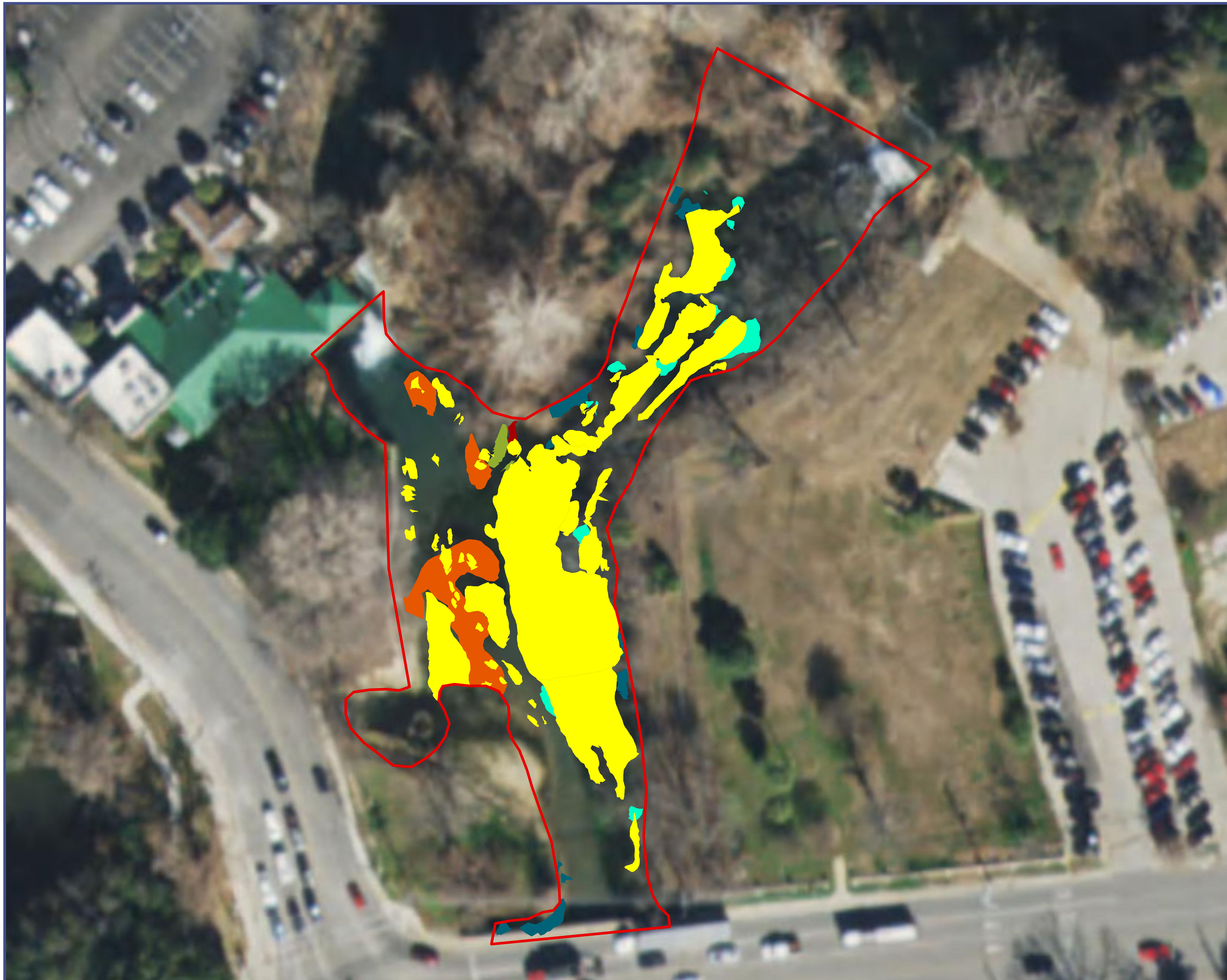
Spring Lake Dam Reach


SAN MARCOS RIVER
San Marcos, Texas
Aquatic Vegetation Study Reach
April 2017
Surveyed: April 17, 2017
Spring Lake Dam
Study Reach 4,381.9 m^2
Vegetation Types
Zizania 1,053.0 m^2
Eicchornia 10.8 m^2
Hydrocotyle 67.1 m^2
Hygrophila 52.6 m^2
Pistia 19.2 m^2
Potamogeton 147.5 m^2
Sagittaria 12.2 m^2
Vallisneria 0.6 m^2
Study Area
San Marcos River
0 25 50 100 Feet
0 10 20 Meters
N
BIO-WEST
www.bio-west.com
512.990.3954
Projection: UTM, NAD 83, 14 North
Map Revised: July 21, 2017

SAN MARCOS RIVER
San Marcos, Texas

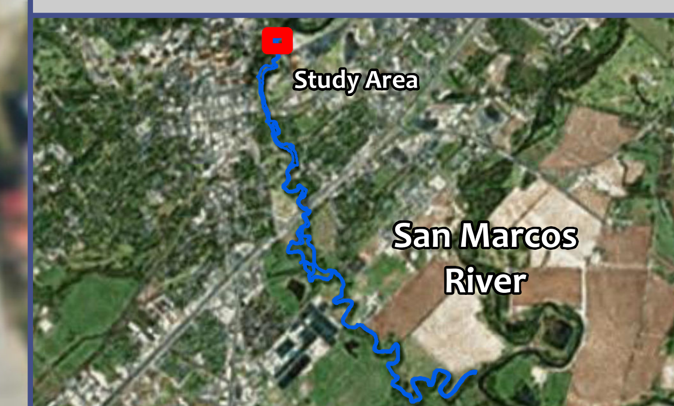
Aquatic Vegetation Study Reach
October 2017

Surveyed: October 11, 2017



Spring Lake Dam

Study Reach	4,381.9 m^2
Vegetation Types	
Zizania	1,032.7 m^2
Hydrilla	3.7 m^2
Hydrocotyle	53.4 m^2
Hygrophila	57.8 m^2
Ludwigia repens	5.8 m^2
Potamogeton	208.1 m^2
Sagittaria	11.3 m^2



0 25 50 100 Feet

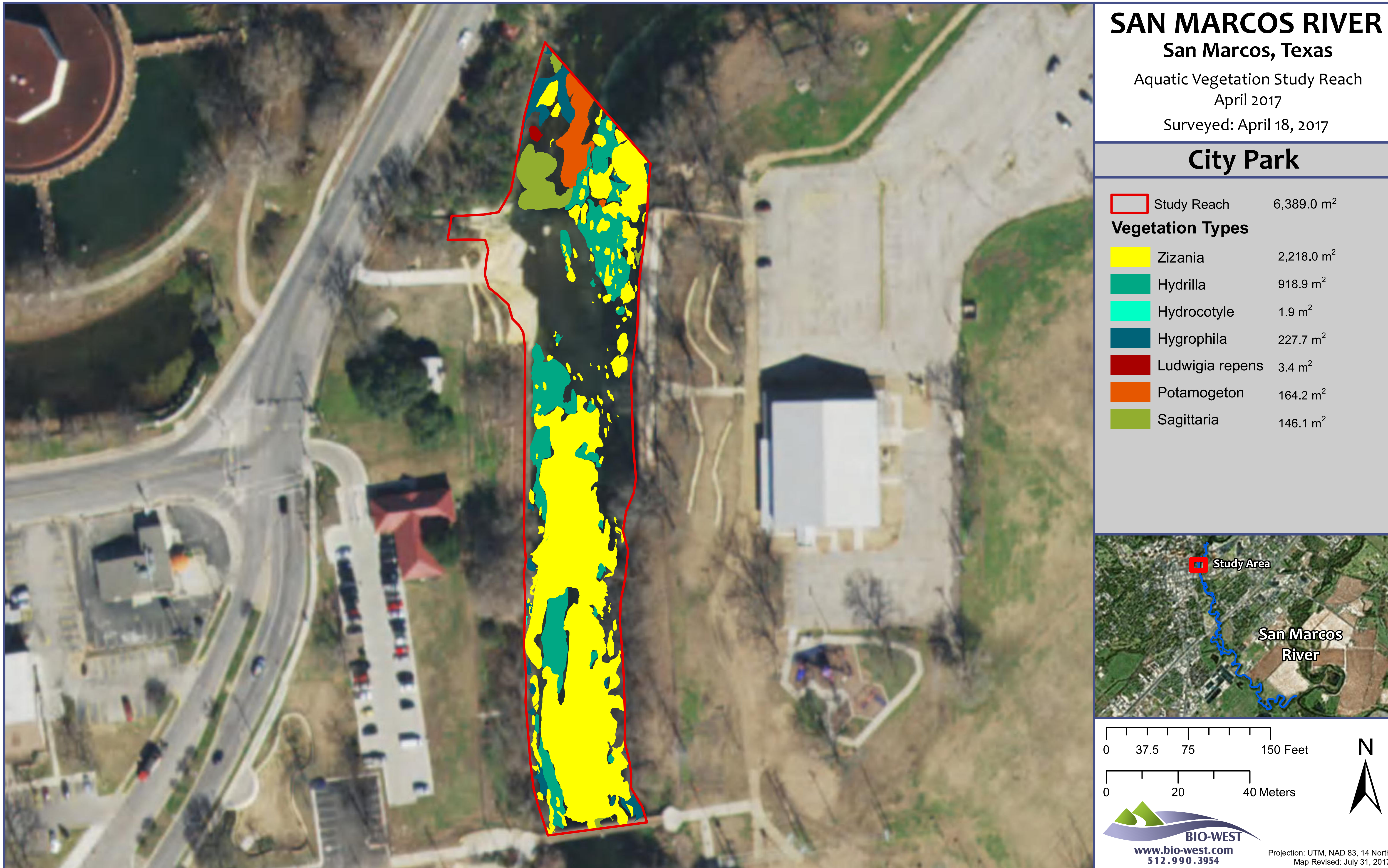
0 10 20 Meters

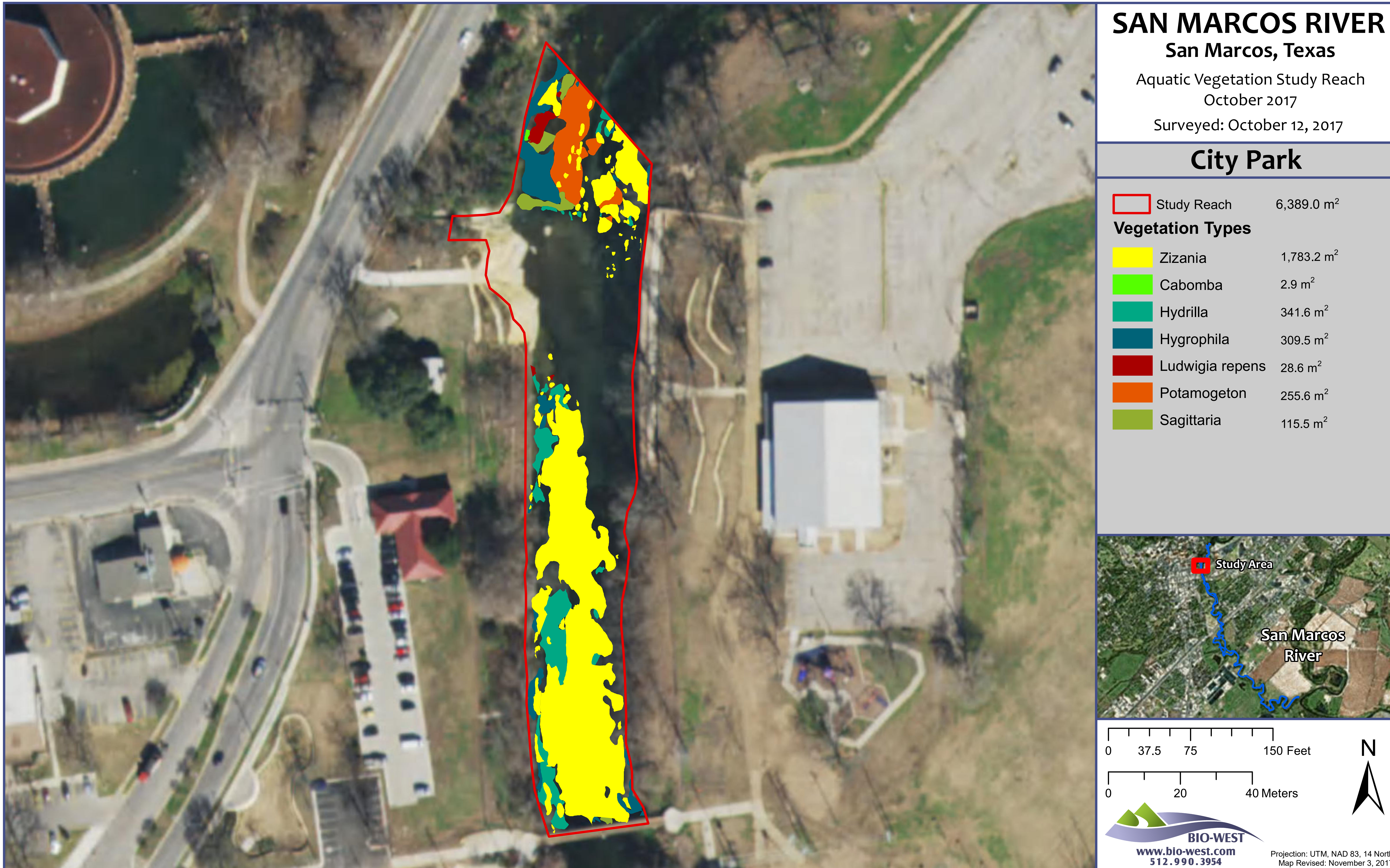
N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: November 3, 2017

City Park Reach


SAN MARCOS RIVER
San Marcos, Texas
Aquatic Vegetation Study Reach
April 2017
Surveyed: April 18, 2017
City Park
Study Reach 6,389.0 m²
Vegetation Types
Zizania 2,218.0 m²
Hydrilla 918.9 m²
Hydrocotyle 1.9 m²
Hygrophila 227.7 m²
Ludwigia repens 3.4 m²
Potamogeton 164.2 m²
Sagittaria 146.1 m²
Study Area
San Marcos
River
0 37.5 75 150 Feet
0 20 40 Meters
N
BIO-WEST
www.bio-west.com
512.990.3954
Projection: UTM, NAD 83, 14 North
Map Revised: July 31, 2017


SAN MARCOS RIVER
San Marcos, Texas
Aquatic Vegetation Study Reach
October 2017
Surveyed: October 12, 2017
City Park
Study Reach 6,389.0 m2
Vegetation Types
Zizania 1,783.2 m2
Cabomba 2.9 m2
Hydrilla 341.6 m2
Hygrophila 309.5 m2
Ludwigia repens 28.6 m2
Potamogeton 255.6 m2
Sagittaria 115.5 m2
Study Area
San Marcos River
0 37.5 75 150 Feet
0 20 40 Meters
N
BIO-WEST
www.bio-west.com
512.990.3954
Projection: UTM, NAD 83, 14 North
Map Revised: November 3, 2017

I-35 Reach

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study Reach
April 2017

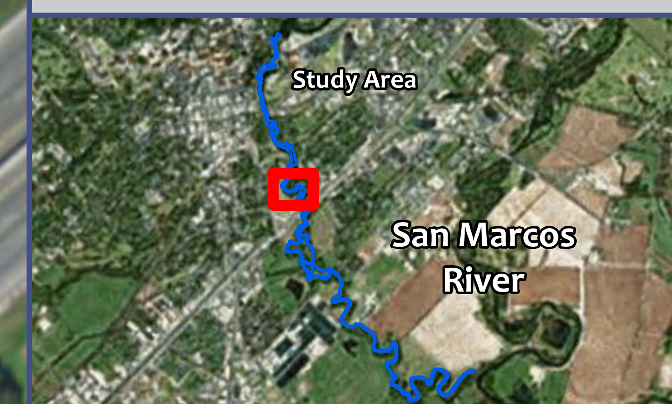
Surveyed: April 20, 2017

I-35

Study Reach	10,969.7 m^2

Vegetation Types

Zizania	255.8 m^2
Cabomba	49.9 m^2
Heteranthera	1.4 m^2
Hydrilla	57.9 m^2
Hydrocotyle	22.1 m^2
Hygrophila	397.8 m^2
Ludwigia repens	151.7 m^2
Nuphar	17.7 m^2
Potamogeton	17.2 m^2
Sagittaria	432.6 m^2



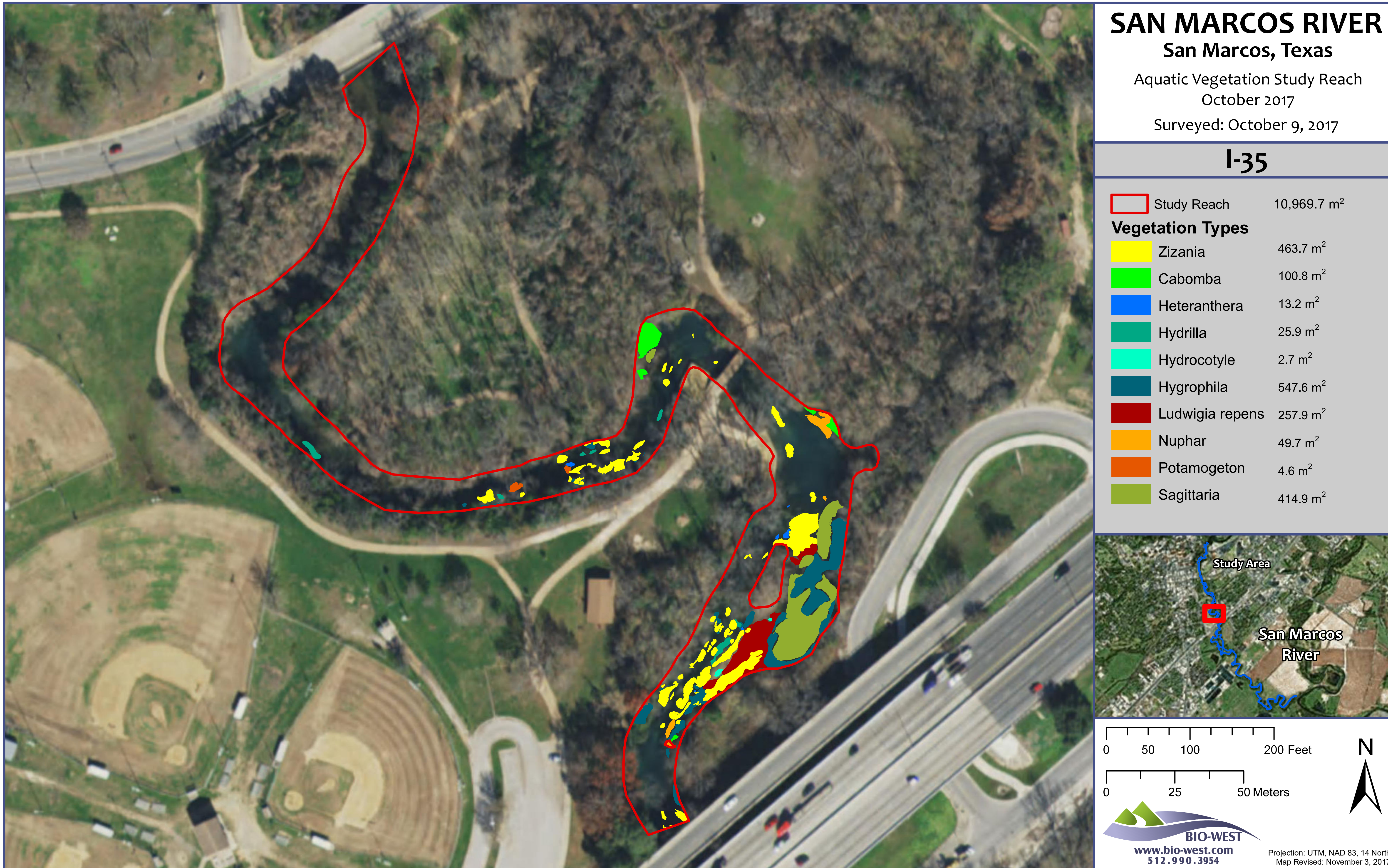
0 50 100 200 Feet

0 25 50 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: July 31, 2017


SAN MARCOS RIVER
San Marcos, Texas
Aquatic Vegetation Study Reach
October 2017
Surveyed: October 9, 2017
I-35
Study Reach 10,969.7 m2
Vegetation Types
Zizania 463.7 m2
Cabomba 100.8 m2
Heteranthera 13.2 m2
Hydrilla 25.9 m2
Hydrocotyle 2.7 m2
Hygrophila 547.6 m2
Ludwigia repens 257.9 m2
Nuphar 49.7 m2
Potamogeton 4.6 m2
Sagittaria 414.9 m2
Study Area
San Marcos River
0 50 100 200 Feet
0 25 50 Meters
N
BIO-WEST
www.bio-west.com
512.990.3954
Projection: UTM, NAD 83, 14 North
Map Revised: November 3, 2017

Texas Wild Rice

SAN MARCOS RIVER
San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Page 1 of 17

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

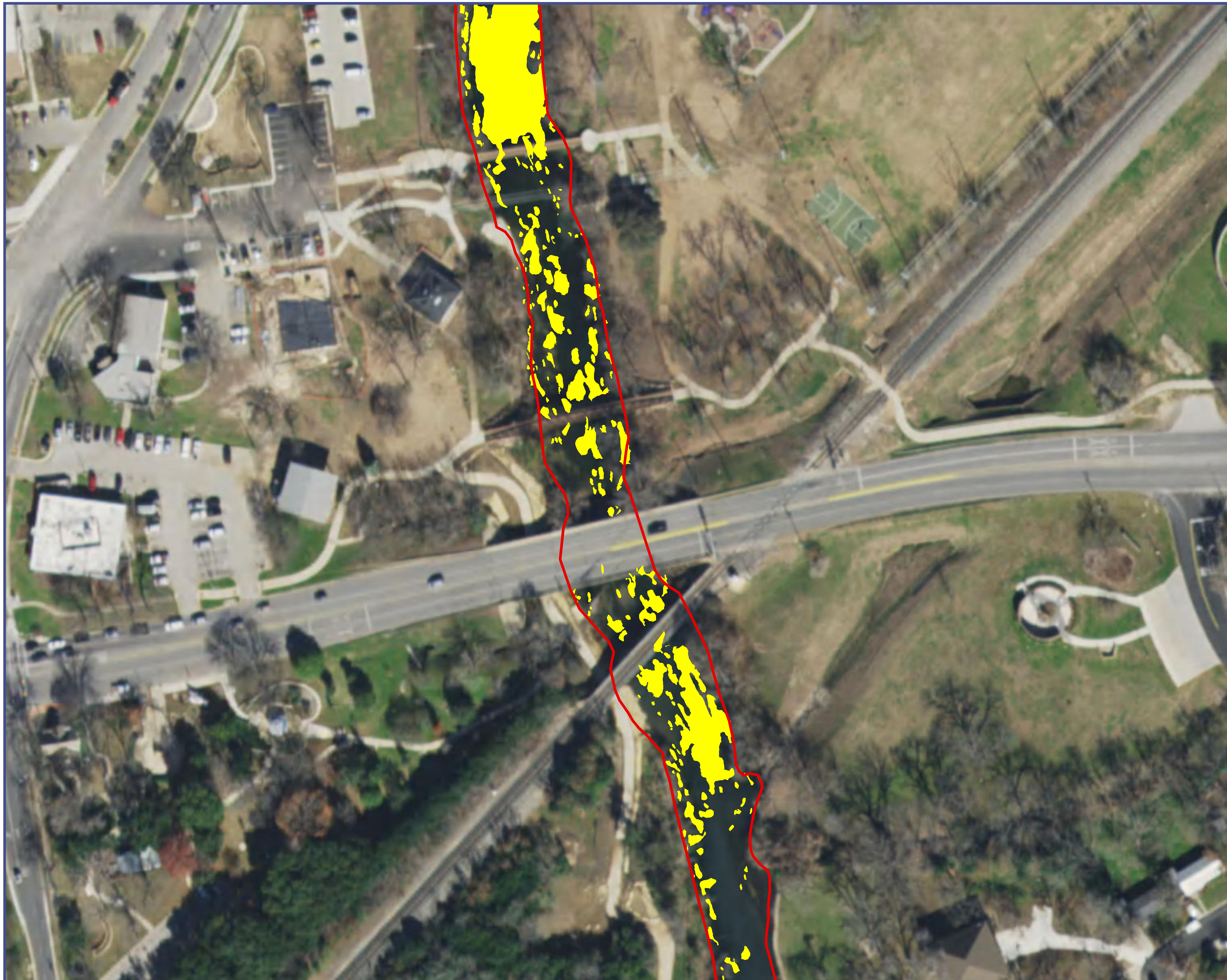
0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017



SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER
San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Page 5 of 17

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER
San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

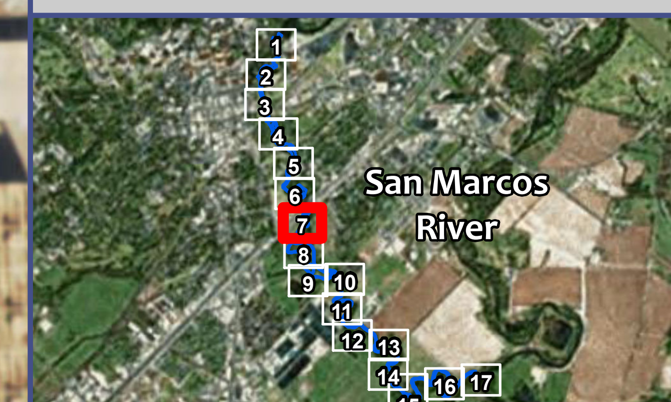
FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2



0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017


SAN MARCOS RIVER
San Marcos, Texas
Aquatic Vegetation Study
Texas Wild Rice, August 2017
FULL SYSTEM MAP
San Marcos River's Edge
Vegetation Types
Zizania texana
Zizania Cover for Full System = 9,266.4 m²
San Marcos River
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
0
50
100
200 Feet
0
20
40 Meters
N
BIO-WEST
www.bio-west.com
512.990.3954
Page 8 of 17
Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

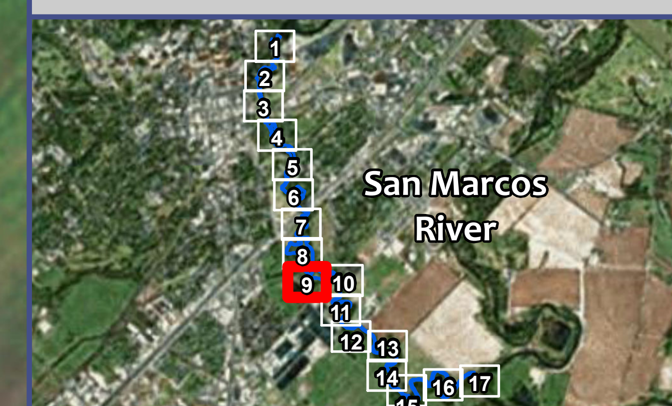
FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2



0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER
San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
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512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER
San Marcos, Texas
Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

0 50 100 200 Feet
0 20 40 Meters
N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER
San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

SAN MARCOS RIVER
San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2017

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania texana

Zizania Cover for Full System = 9,266.4 m^2

0 50 100 200 Feet
0 20 40 Meters

N

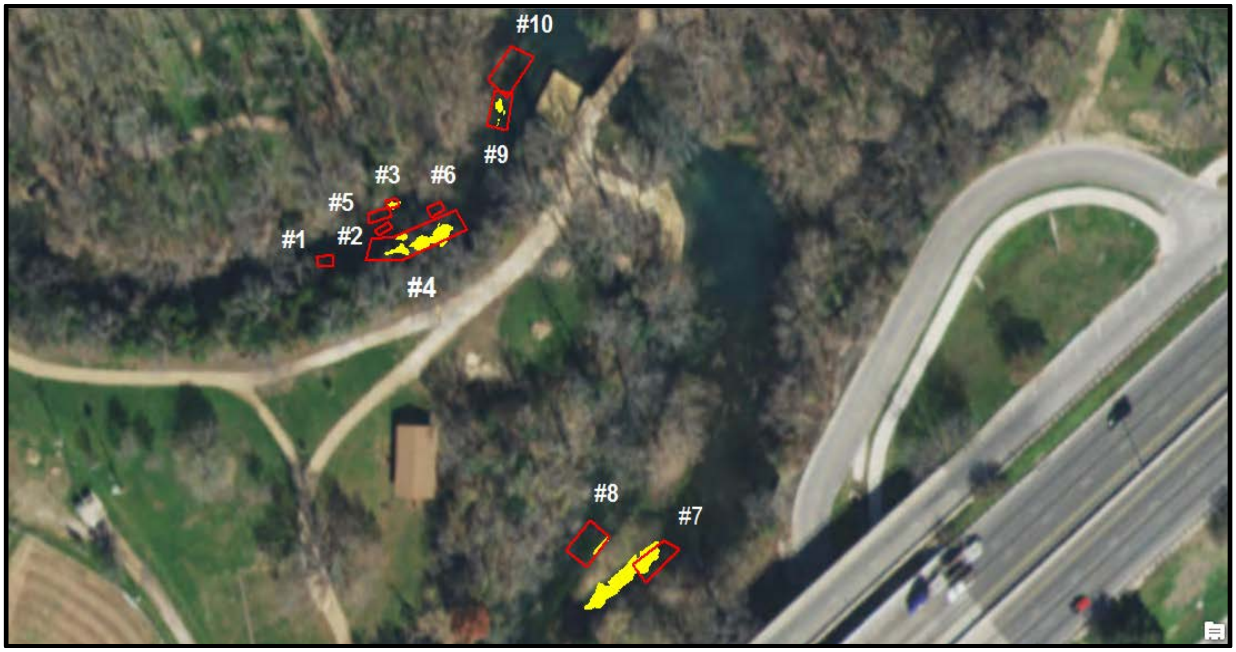
BIO-WEST
www.bio-west.com
512.990.3954

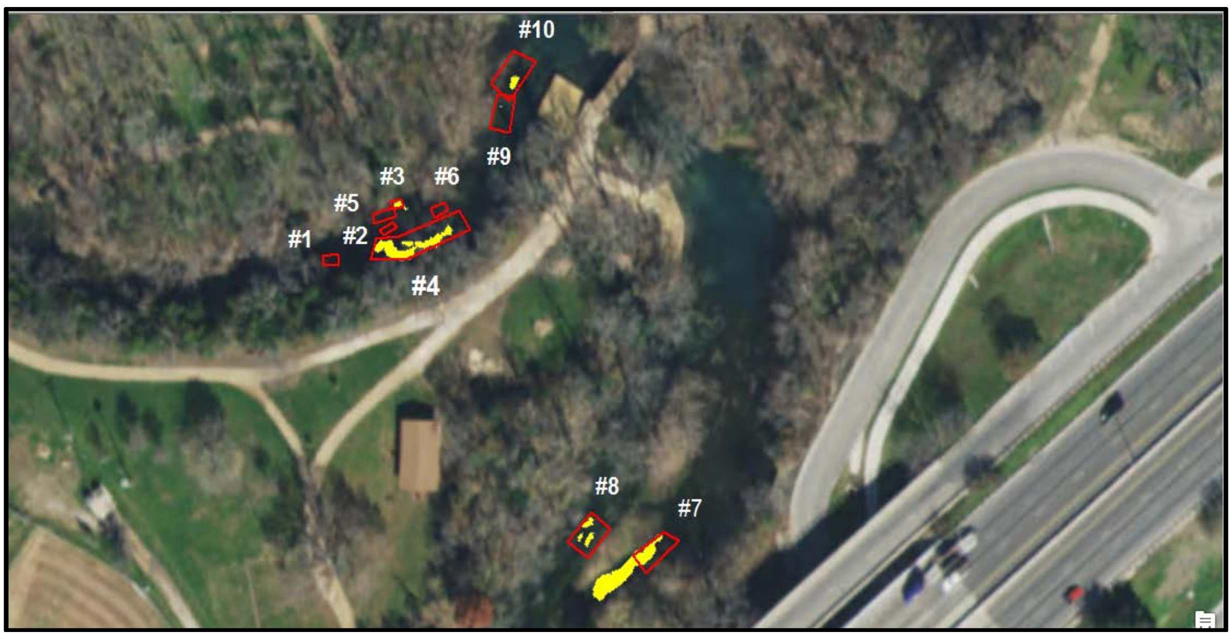
Projection: UTM, NAD 83, 14 North
Map Revised: September 18, 2017

Texas Wild Rice Physical Observations Of Individual Stands

Spring 2017 (top) and fall 2017 (bottom) vulnerable Texas wild-rice plots in the Spring Lake dam / Sewell Park location. Yellow polygons indicated Texas wild rice stands. Red rectangles indicate the stand plots.

Spring 2017 (top) and Fall 2017 (bottom) vulnerable Texas wild-rice in the Veramendi Park location.

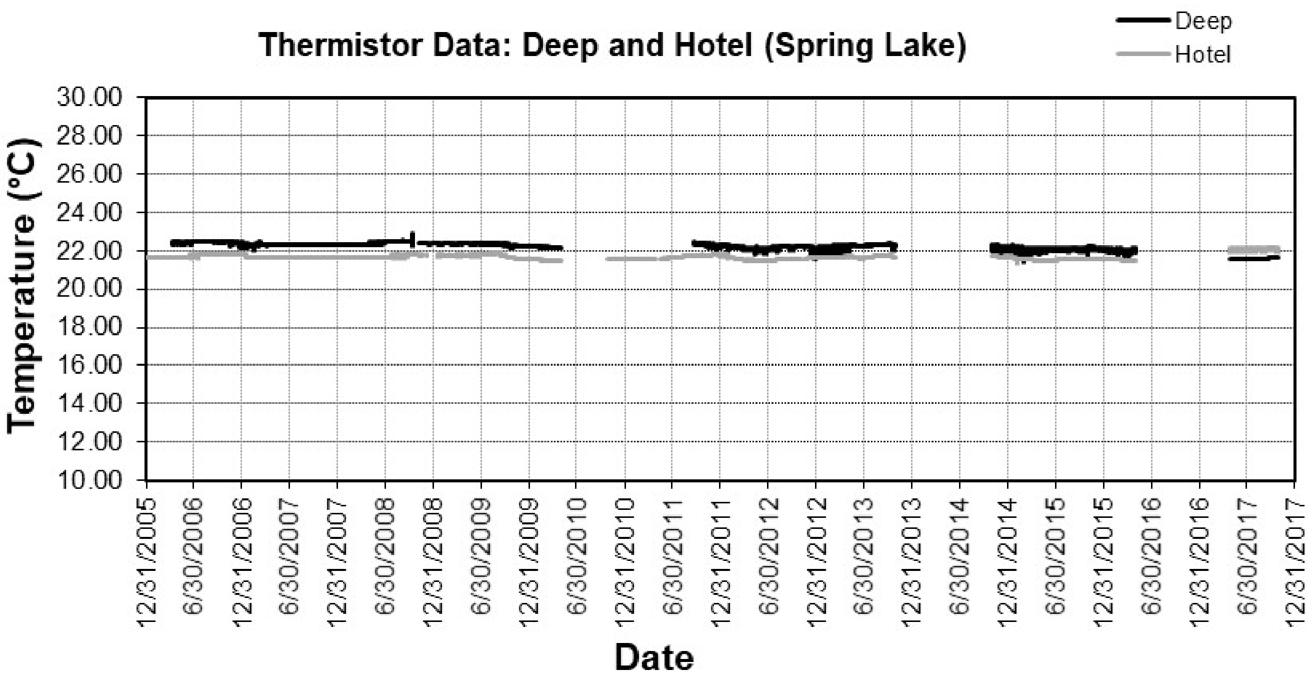


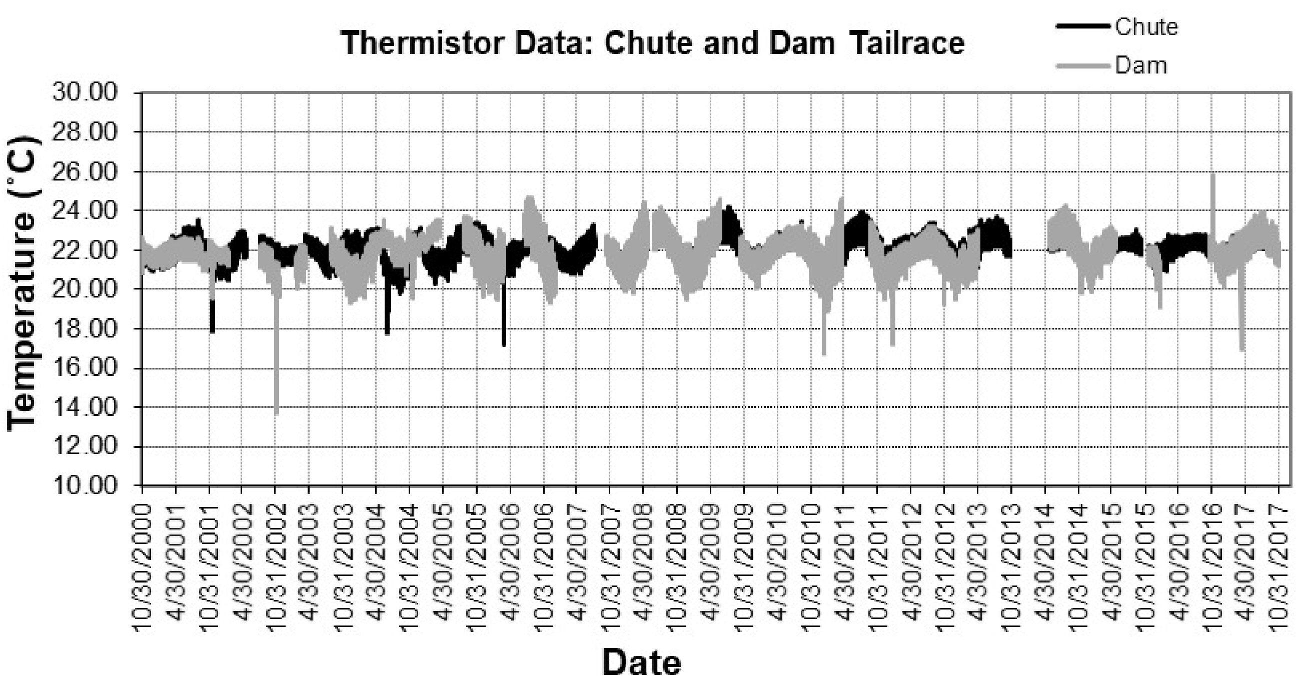


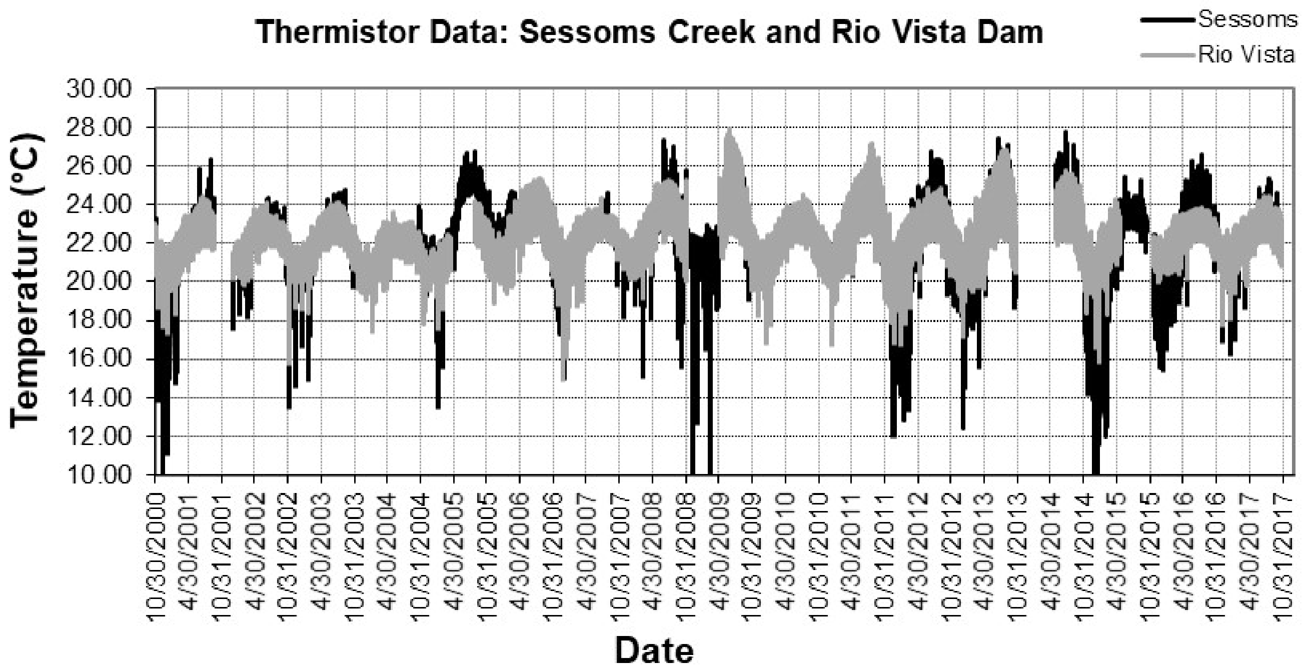
Spring 2017 (top) and Fall 2017 (bottom) vulnerable Texas wild-rice in the I-35 location.

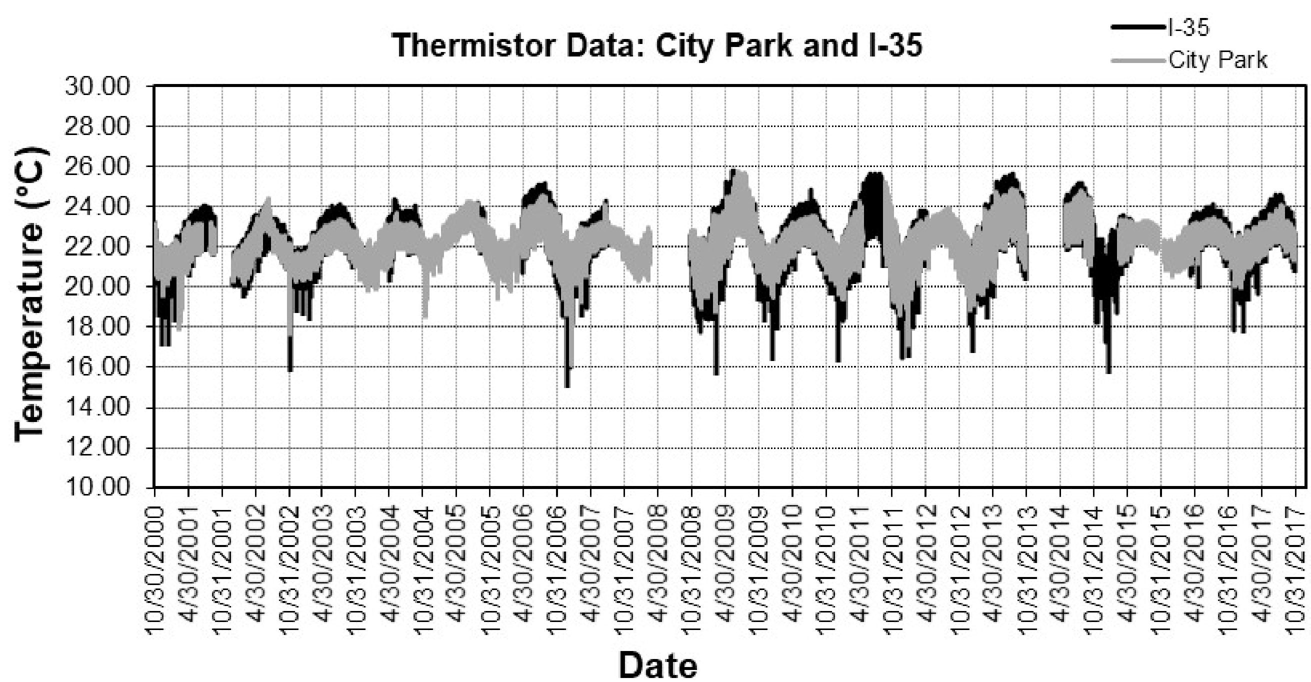
APPENDIX C: DATA AND GRAPHS

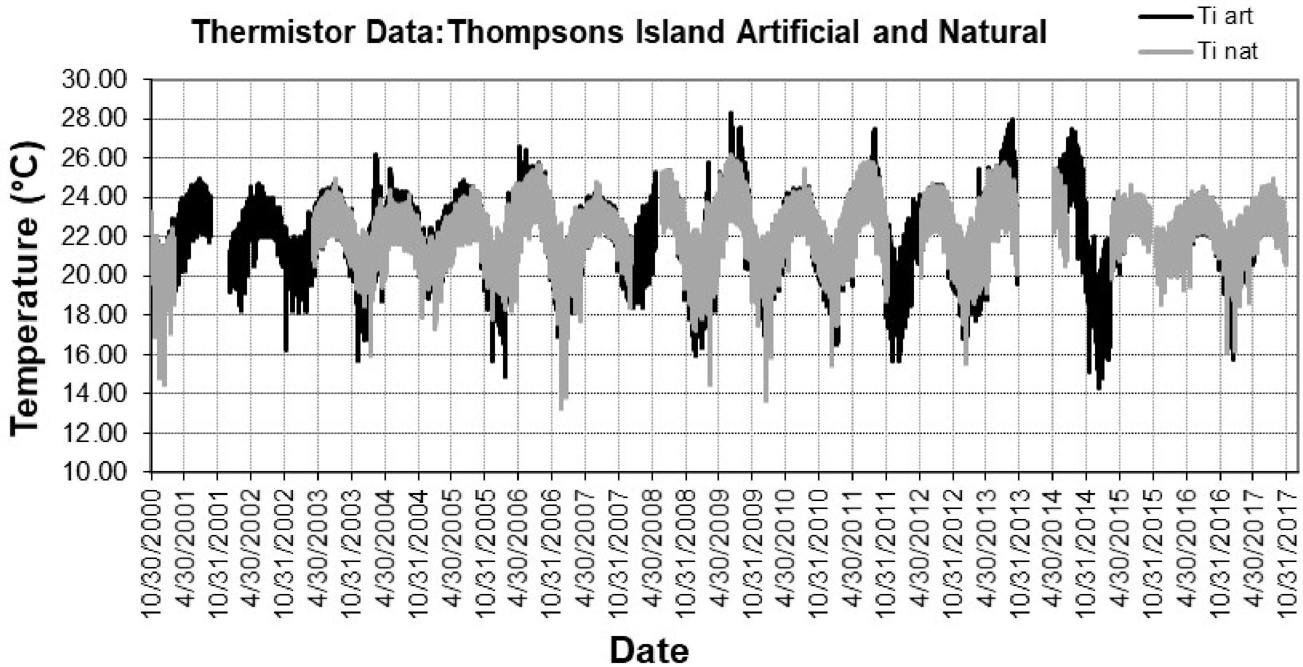
C.1: Thermistor Graphs


Thermistor Data: Deep and Hotel (Spring Lake)
Deep
Hotel
Temperature (°C)
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
12/31/2005
6/30/2006
12/31/2006
6/30/2007
12/31/2007
6/30/2008
12/31/2008
6/30/2009
12/31/2009
6/30/2010
12/31/2010
6/30/2011
12/31/2011
6/30/2012
12/31/2012
6/30/2013
12/31/2013
6/30/2014
12/31/2014
6/30/2015
12/31/2015
6/30/2016
12/31/2016
6/30/2017
12/31/2017
Date

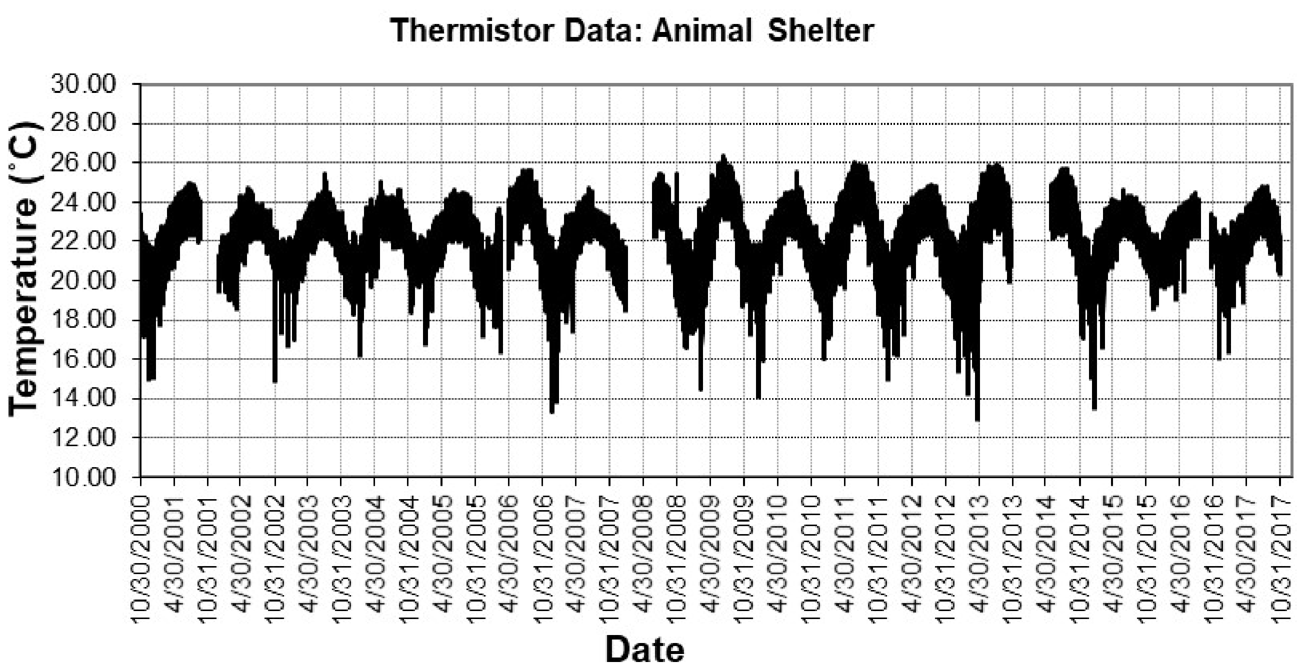

Thermistor Data: Chute and Dam Tailrace
Chute
Dam
Temperature (˚C)
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
10/30/2000
4/30/2001
10/31/2001
4/30/2002
10/31/2002
4/30/2003
10/31/2003
4/30/2004
10/31/2004
4/30/2005
10/31/2005
4/30/2006
10/31/2006
4/30/2007
10/31/2007
4/30/2008
10/31/2008
4/30/2009
10/31/2009
4/30/2010
10/31/2010
4/30/2011
10/31/2011
4/30/2012
10/31/2012
4/30/2013
10/31/2013
4/30/2014
10/31/2014
4/30/2015
10/31/2015
4/30/2016
10/31/2016
4/30/2017
10/31/2017
Date


Thermistor Data: Sessoms Creek and Rio Vista Dam
Sessoms
Rio Vista
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
Temperature (°C)
10/30/2000
4/30/2001
10/31/2001
4/30/2002
10/31/2002
4/30/2003
10/31/2003
4/30/2004
10/31/2004
4/30/2005
10/31/2005
4/30/2006
10/31/2006
4/30/2007
10/31/2007
4/30/2008
10/31/2008
4/30/2009
10/31/2009
4/30/2010
10/31/2010
4/30/2011
10/31/2011
4/30/2012
10/31/2012
4/30/2013
10/31/2013
4/30/2014
10/31/2014
4/30/2015
10/31/2015
4/30/2016
10/31/2016
4/30/2017
10/31/2017
Date


Thermistor Data: City Park and I-35
I-35
City Park
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
Temperature (°C)
10/30/2000
4/30/2001
10/31/2001
4/30/2002
10/31/2002
4/30/2003
10/31/2003
4/30/2004
10/31/2004
4/30/2005
10/31/2005
4/30/2006
10/31/2006
4/30/2007
10/31/2007
4/30/2008
10/31/2008
4/30/2009
10/31/2009
4/30/2010
10/31/2010
4/30/2011
10/31/2011
4/30/2012
10/31/2012
4/30/2013
10/31/2013
4/30/2014
10/31/2014
4/30/2015
10/31/2015
4/30/2016
10/31/2016
4/30/2017
10/31/2017
Date



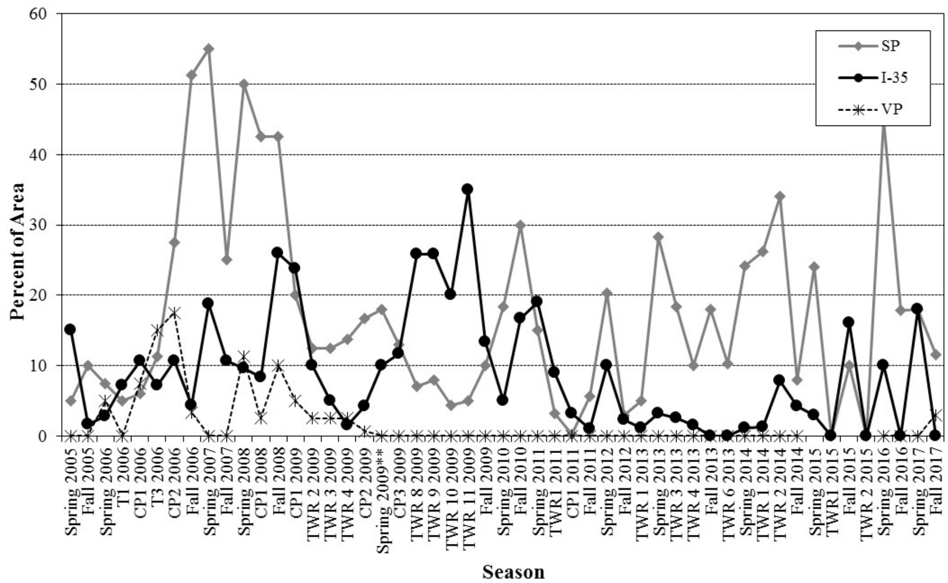
Thermistor Data: Thompsons Island Artificial and Natural
Ti art
Ti nat
Temperature (°C)
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
10/30/2000
4/30/2001
10/31/2001
4/30/2002
10/31/2002
4/30/2003
10/31/2003
4/30/2004
10/31/2004
4/30/2005
10/31/2005
4/30/2006
10/31/2006
4/30/2007
10/31/2007
4/30/2008
10/31/2008
4/30/2009
10/31/2009
4/30/2010
10/31/2010
4/30/2011
10/31/2011
4/30/2012
10/31/2012
4/30/2013
10/31/2013
4/30/2014
10/31/2014
4/30/2015
10/31/2015
4/30/2016
10/31/2016
4/30/2017
10/31/2017
Date



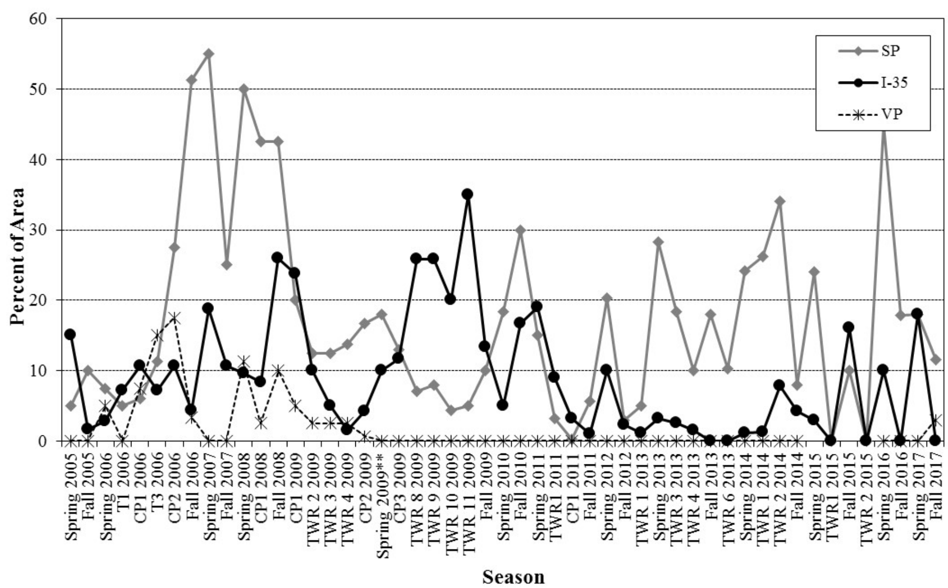
Thermistor Data: Animal Shelter
Temperature (°C)
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
10/30/2000
4/30/2001
10/31/2001
4/30/2002
10/31/2002
4/30/2003
10/31/2003
4/30/2004
10/31/2004
4/30/2005
10/31/2005
4/30/2006
10/31/2006
4/30/2007
10/31/2007
4/30/2008
10/31/2008
4/30/2009
10/31/2009
4/30/2010
10/31/2010
4/30/2011
10/31/2011
4/30/2012
10/31/2012
4/30/2013
10/31/2013
4/30/2014
10/31/2014
4/30/2015
10/31/2015
4/30/2016
10/31/2016
4/30/2017
10/31/2017
Date

C.2: Texas Wild Rice Observation Data

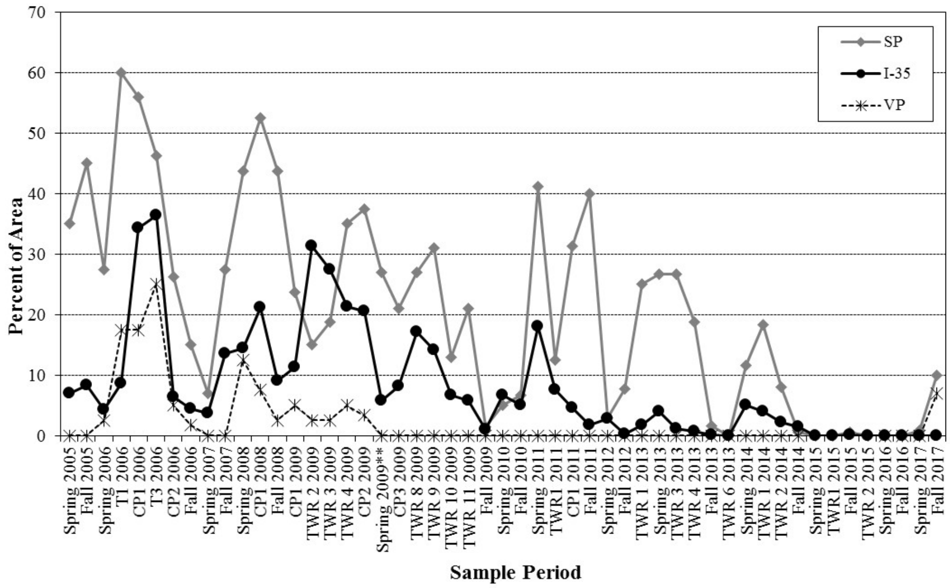
Flowering & Seeding TWR



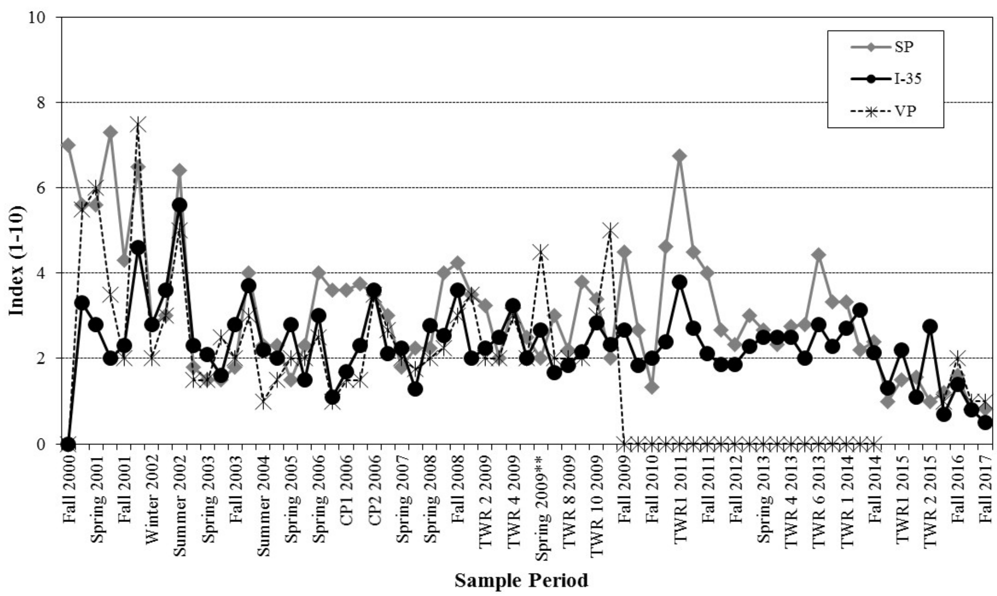
Flowering & Seeding TWR



Percent of TWR Covered by Vegetation Mats



Index of Root Exposure for TWR Stands

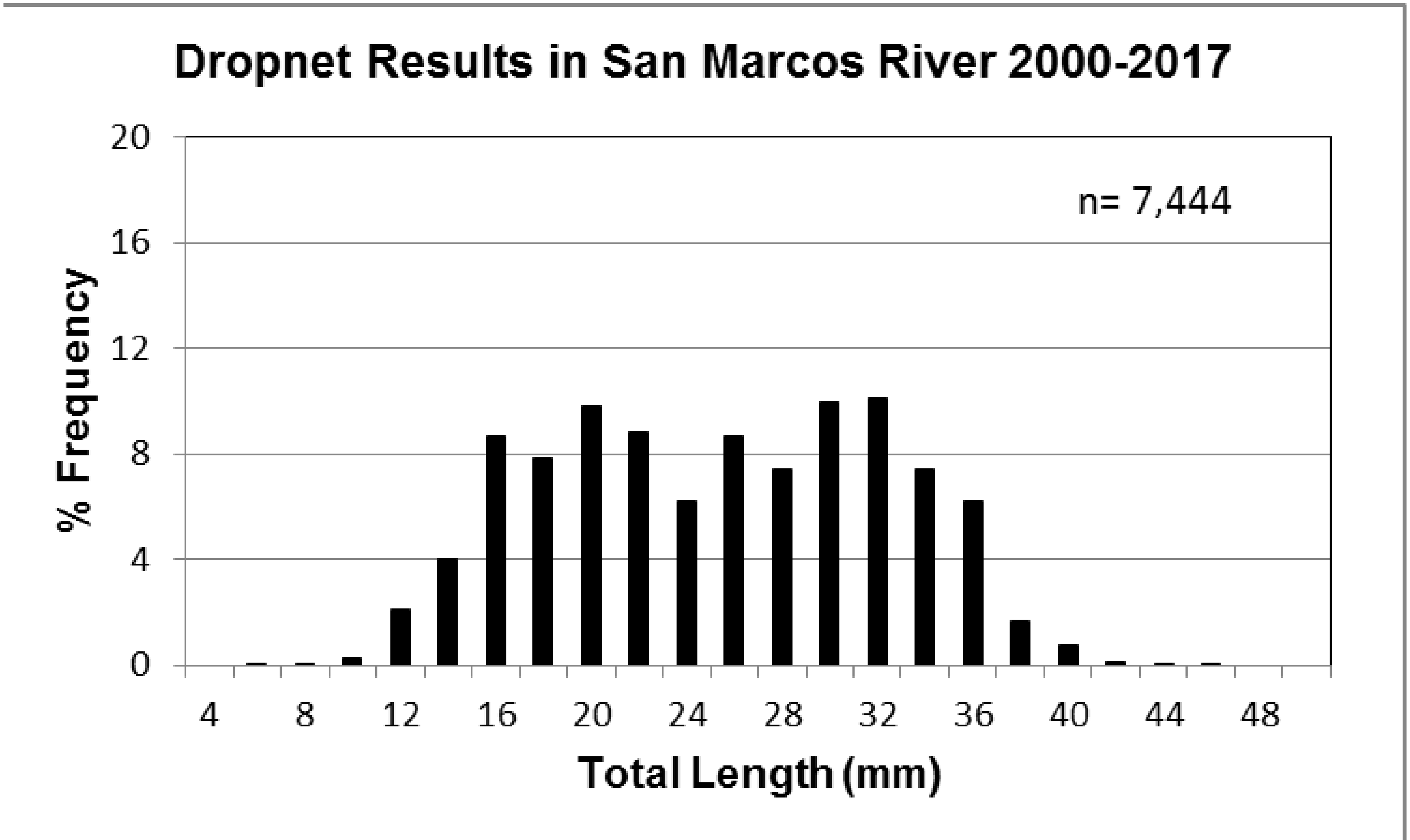


C.3: Drop net Table and Graph

Fountain Darter mean densities and one standard deviation from the mean per aquatic vegetation per meter squared (m^2) for all drop net samples collected in the San Marcos Springs / River system from 2000 through 2017*.

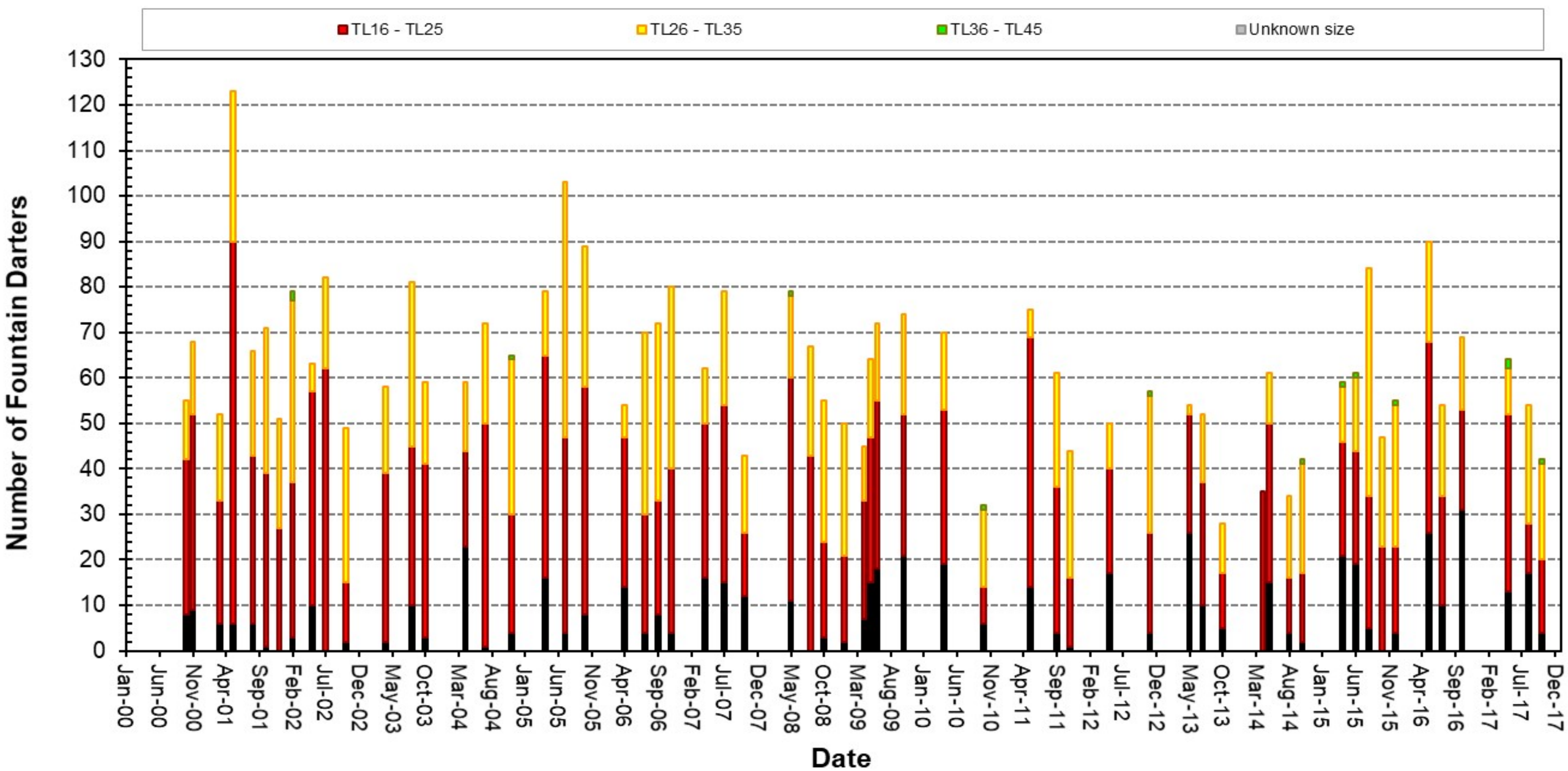
Sample Type	Mean Density (m^2)	Standard Deviation
Open	0.0	0.28
Ludwigia	2.4	0.83
Sagittaria	2.1	3.33
Potamogeton	2.4	14.06
Potamogeton / Hygrophila	4.4	4.30
Hygrophila	5.0	5.32
Hydrilla	6.5	11.41
Hydrocotyle	7.3	7.21
Cabomba	7.7	6.25

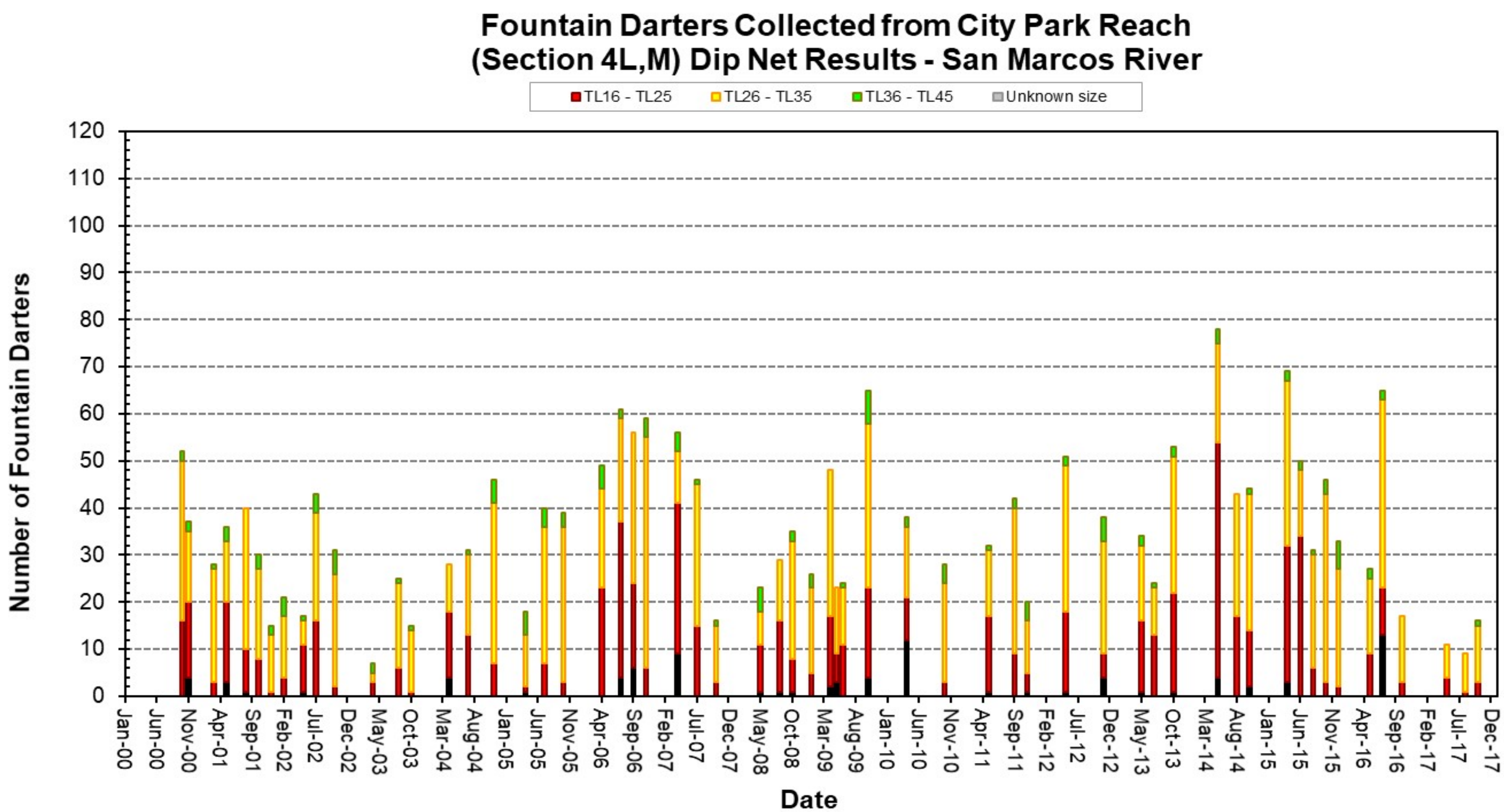
* Corresponds with Figure 19 in main body of the report.


Dropnet Results in San Marcos River 2000-2017
n= 7,444
% Frequency
0
4
8
12
16
20
4
8
12
16
20
24
28
32
36
40
44
48
Total Length (mm)

C.4: Dip Net Graphs

Fountain Darters Collected from Hotel Reach (Section 1U) Dip Net Results - San Marcos River





Fountain Darters Collected from City Park Reach
(Section 4L,M) Dip Net Results - San Marcos River
TL16 - TL25
TL26 - TL35
TL36 - TL45
Unknown size
Number of Fountain Darters
Date
0
10
20
30
40
50
60
70
80
90
100
110
120
Jan-00
Jun-00
Nov-00
Apr-01
Sep-01
Feb-02
Jul-02
Dec-02
May-03
Oct-03
Mar-04
Aug-04
Jan-05
Jun-05
Nov-05
Apr-06
Sep-06
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Jul-07
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May-08
Oct-08
Mar-09
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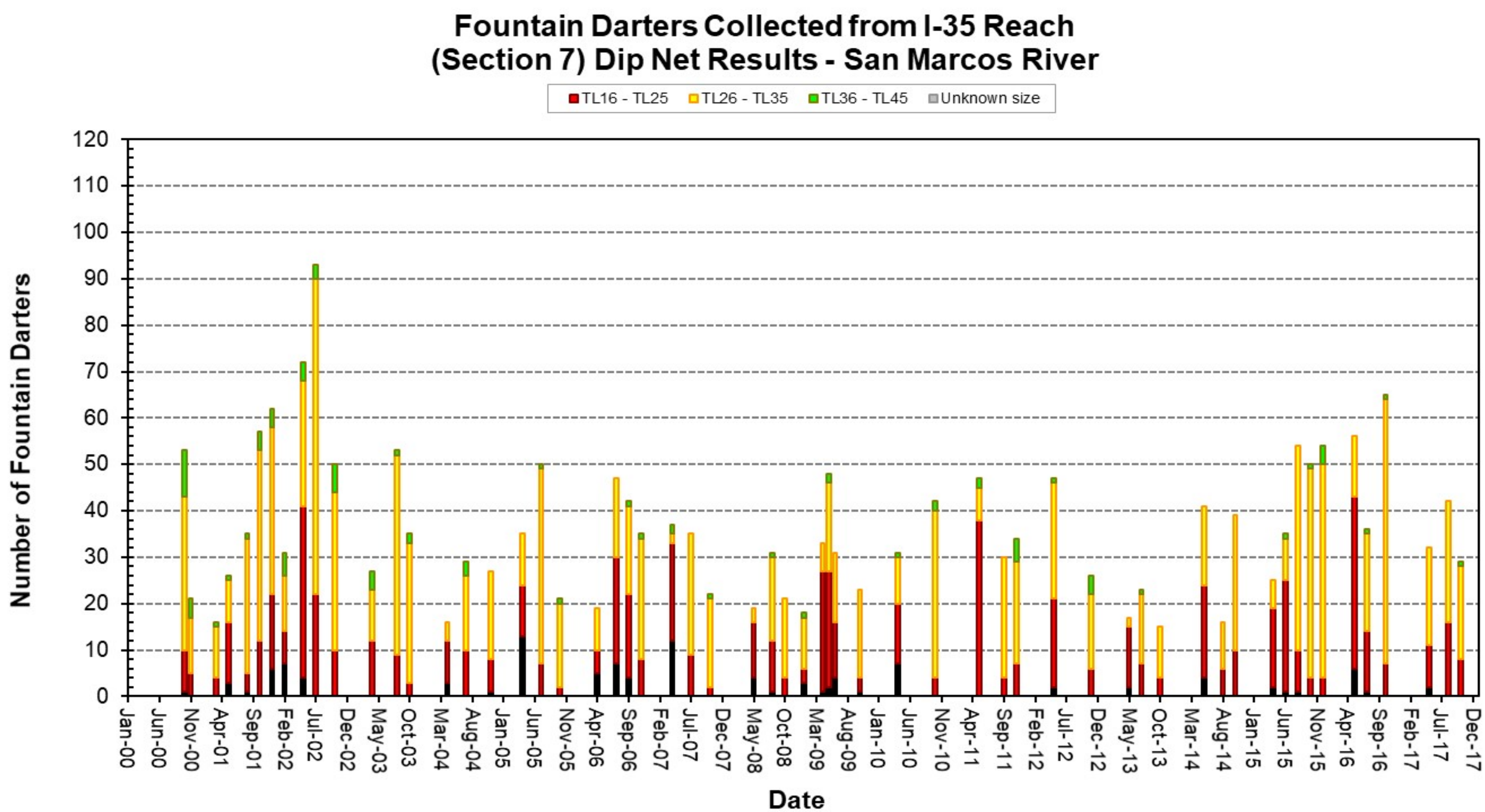
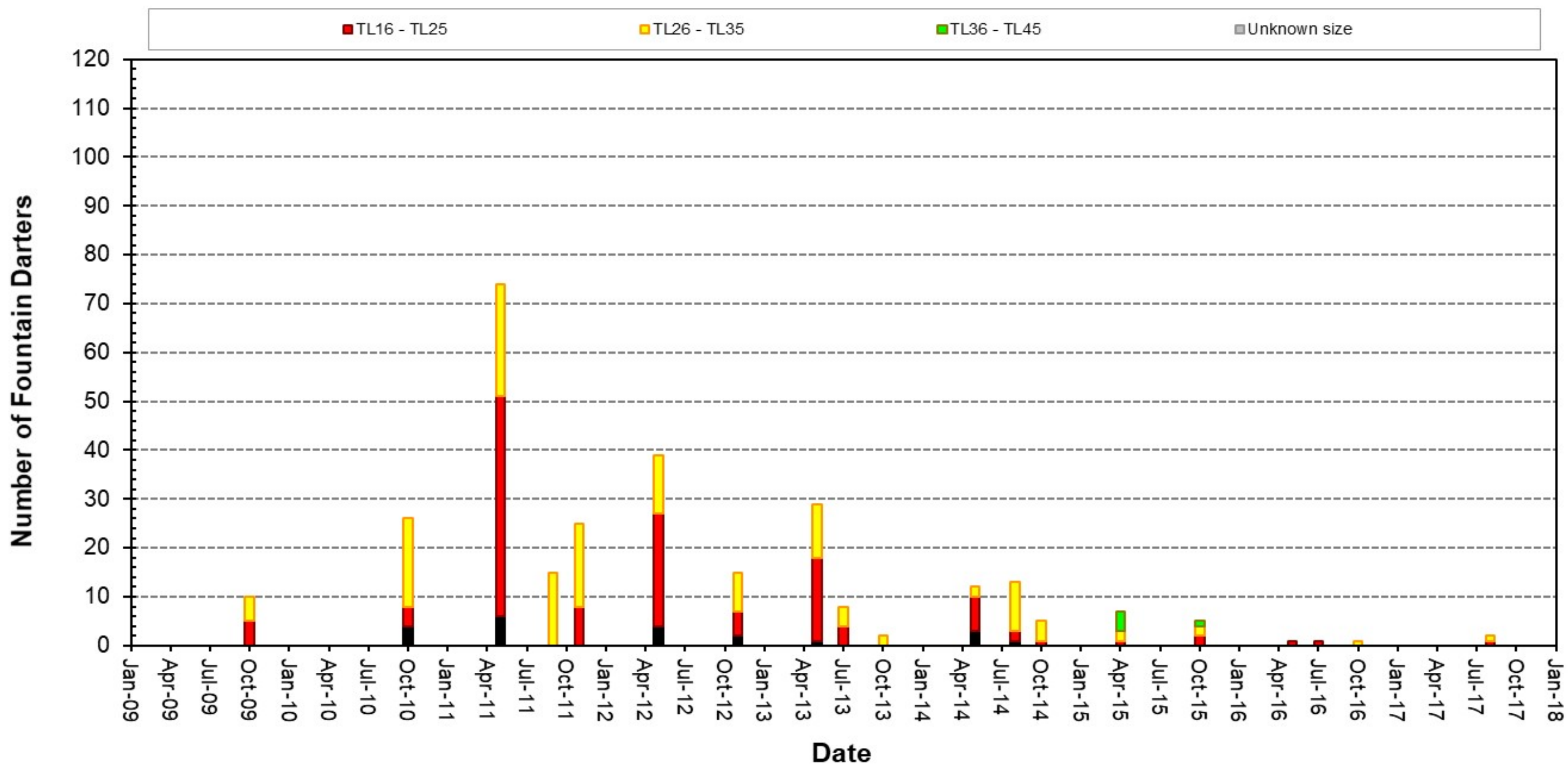
Feb-17
Jul-17
Dec-17



Fountain Darters Collected from I-35 Reach
(Section 7) Dip Net Results - San Marcos River
TL16 - TL25
TL26 - TL35
TL36 - TL45
Unknown size
Number of Fountain Darters
120
110
100
90
80
70
60
50
40
30
20
10
0
Jan-00
Jun-00
Nov-00
Apr-01
Sep-01
Feb-02
Jul-02
Dec-02
May-03
Oct-03
Mar-04
Aug-04
Jan-05
Jun-05
Nov-05
Apr-06
Sep-06
Feb-07
Jul-07
Dec-07
May-08
Oct-08
Mar-09
Aug-09
Jan-10
Jun-10
Nov-10
Apr-11
Sep-11
Feb-12
Jul-12
Dec-12
May-13
Oct-13
Mar-14
Aug-14
Jan-15
Jun-15
Nov-15
Apr-16
Sep-16
Feb-17
Jul-17
Dec-17
Date

Fountain Darters Collected from Todd Island/Cypress Tree Reach (Section 12) Dip Net Results - San Marcos River



C.5: Fish Tissue Sampling for Pharmaceutical Chemicals

Water Sample Detections								
System	Sample Location	Sample Type (n=2)	Acetaminophen (ng/L)	Benzoylecgonine (ng/L)	Caffeine (ng/L)	Diphenhydramine (ng/L)	Sucralose (ng/L)	Sulfamethoxazole (ng/L)
San Marcos	Hotel Spring Lake	water			*0.35**	0.34	114.50	0.25
San Marcos	I-35	water	2.53	*0.13*	4.36	0.75	124.90	0.31

Notes: *Values indicate samples with detections below the method detection limit (MDL). In these cells, 1/2 MDL value has been inserted.

Not detected:
Amitriptyline
Amlodipine
Aripiprazole
Buprenorphine
Carbamazepine
Desmethylsertraline
Diclofenac
Diltiazem
Duloxetine
Erythromycin
Fluoxetine
Ketamine
Methylphenidate
Norfluoxetine
Propranolol
Promethazine
Sertraline
Sucralose
Trimethoprim

Plasma Sample Detections										
System	Sample Location	Fish Type	Sample type	Volume (µL)	Caffeine (ng/mL)	Carbama-zepine (ng/mL)	Diltiazem (ng/mL)	Diphen-hydramine (ng/mL)	Propranolol (ng/mL)	Trimetho-prim (ng/mL)
San Marcos	I-35	Largemouth Bass	plasma	334	*0.44**		0.59	0.56		*0.18**
San Marcos	I-35	Largemouth Bass	plasma	186	1.29	6.59	1.07	1.34		
San Marcos	I-35	Largemouth Bass	plasma	123	0.92		1.51			
San Marcos	Hotel Spring Lake	Largemouth Bass	plasma	153	1.33		1.30			
San Marcos	Hotel Spring Lake	Largemouth Bass	plasma	400	*0.44*		0.50			
San Marcos	Hotel Spring Lake	Largemouth Bass	plasma	333	3.93		0.60			*0.18**
San Marcos	Hotel Spring Lake	Largemouth Bass	plasma	184	2.62	5.61	1.09	1.55	1.13	

Notes: *Values indicate samples with detections below the method detection limit (MDL). In these cells, 1/2 MDL value has been inserted.

Not detected:
Acetaminophen
Amitriptyline
Amlodipine
Aripiprazole
Benzoylecgonine
Buprenorphine
Desmethylsertraline
Diclofenac
Duloxetine
Erythromycin
Fluoxetine
Ketamine
Methylphenidate
Norfluoxetine
Promethazine
Sertraline
Sucralose
Sulfamethoxazole

Tissue Sample Detections												
System	Sample Location	Fish Type	Sample type	Length (cm)	Weight (g)	Benzoyl-ecgonine (µg/kg)	Caffeine (µg/kg)	Diltiazem (µg/kg)	Diphen-hydramine (µg/kg)	Fluoxetine (µg/kg)	Norfluox-etine (µg/kg)	Trimetho-prim (µg/kg)
San Marcos	Hotel Spring Lake	Largemouth Bass	tissue	16.40	46.30		0.64			_0.18*_		_0.225*_
San Marcos	Hotel Spring Lake	Largemouth Bass	tissue	21.20	83.50		_0.255*_					_0.225*_
San Marcos	Hotel Spring Lake	Largemouth Bass	tissue	18.60	59.90		3.03	0.26				
San Marcos	Hotel Spring Lake	Largemouth Bass	tissue			0.31	1.14					_0.225*_
San Marcos	Hotel Spring Lake	Largemouth Bass	tissue									0.61
San Marcos	Hotel Spring Lake	Gambusia sp.	tissue, pooled				7.70		0.45			
San Marcos	I-35	Largemouth Bass	tissue	13.30	25.20			0.32		_0.18*_	_0.355*_	3.43
San Marcos	I-35	Largemouth Bass	tissue									0.57
San Marcos	I-35	Largemouth Bass	tissue	18.50	81.40				0.18			1.07
San Marcos	I-35	Largemouth Bass	tissue	14.80	37.00				0.18			
San Marcos	I-35	Gambusia sp.	tissue, pooled				1.38		0.44			_0.225*_

Notes: *Values indicate samples with detections below the method detection limit (MDL). In these cells, 1/2 MDL value has been inserted.

Not detected:
Acetaminophen
Amitriptyline
Amlodipine
Aripiprazole
Buprenorphine
Carbamazepine
Desmethylsertraline
Diclofenac
Duloxetine
Erythromycin
Ketamine
Methylpł riddlen
Promethazine
Propranolol
Sertraline
Sucralose
Sulfamethoxazole

C.6: Macroinvertebrate Rapid Bioassessment Data

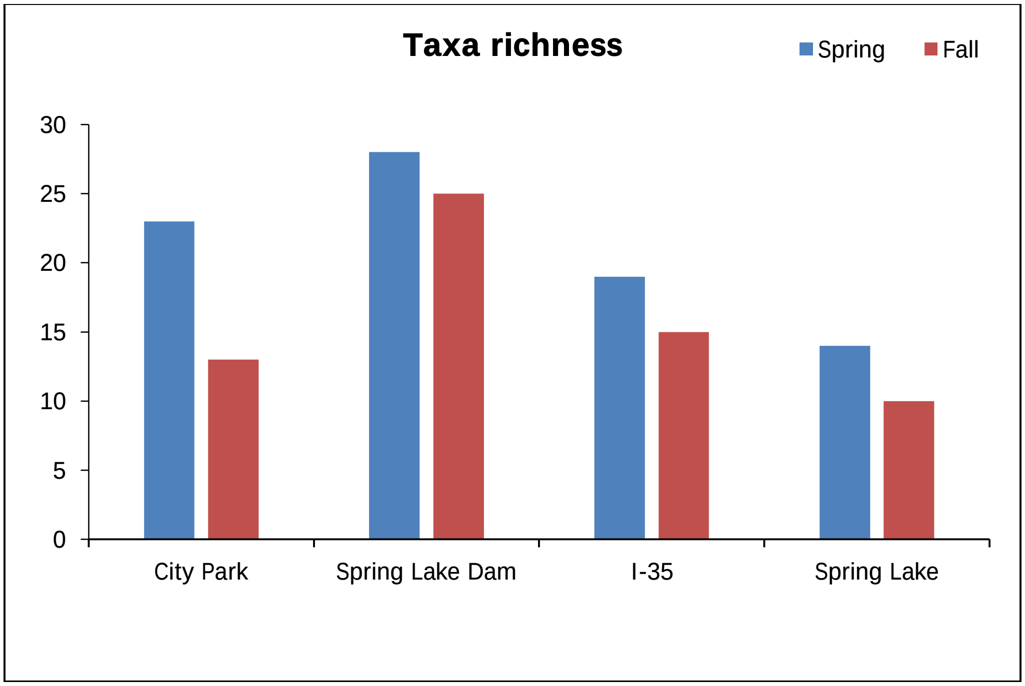
Spring

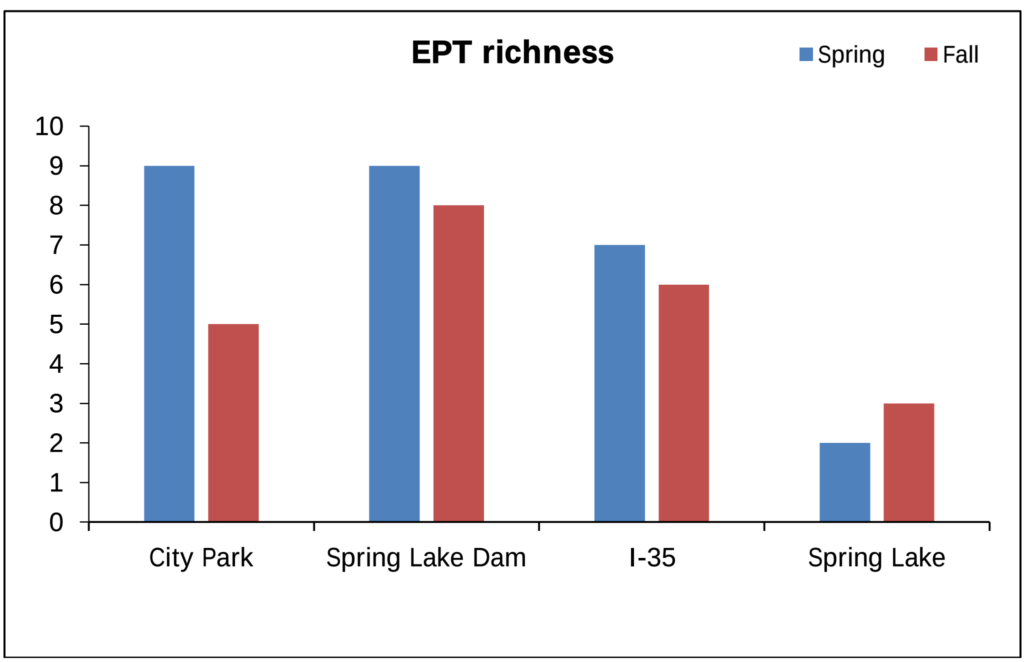
Date	Site	Class	Order	Family	FinalID	No.	Tolerance Value	Functional Feeding Guild 1	Functional Feeding Guild 2
5/18/2017	City Park	Insecta	Ephemeroptera	Baetidae	Callibaetis	1	4	Gather/Collector	
5/18/2017	City Park	Insecta	Trichoptera	Leptoceridae	Nectopsyche	1	3	Shredder	Gather/Collector
5/18/2017	City Park	Insecta	Trichoptera	Hydrobiosidae	Atopsyche	1	0	Predator	
5/18/2017	City Park	Insecta	Trichoptera	Heliocopyschidae	Helicopsyche	1	2	Scraper	
5/18/2017	City Park	Insecta	Trichoptera	Polycentropodidae	Polycentropus	1	3	Filterer/Collector	Predator
5/18/2017	City Park	Insecta	Trichoptera	Polycentropodidae	Polyplectropus	1	6	Filterer/Collector	Predator
5/18/2017	City Park	Insecta	Odonata	Aeshnidae	Boyeria	1	3	Predator	
5/18/2017	City Park	Insecta	Hemiptera	Gerridae	Metrobates	1			
5/18/2017	City Park	Insecta	Hemiptera	Naucoridae	Limnocoris	1	5	Predator	
5/18/2017	City Park		Decopoda	Cambaridae	Cambaridae	1	5	Gather/Collector	
5/18/2017	City Park	Gastropoda	Neotaenioglossa	Thiaridae	Terabia	1		Scraper	
5/18/2017	City Park	Arachnida	Trombidiformes		Acari	1	6	Predator	
5/18/2017	City Park	Insecta	Heteroptera	Gerridae	Trepobates	2		Predator	
5/18/2017	City Park	Insecta	Megaloptera	Sialidae	Sialis	2	5	Predator	
5/18/2017	City Park	Insecta	Lepidoptera	Pyralidae	Parapoynx	2	5	Shredder	
5/18/2017	City Park	Clitellata			Hirudinea	2	8	Predator	
5/18/2017	City Park	Clitellata			Oligochaeta	2	8	Gather/Collector	
5/18/2017	City Park	Gastropoda	Neotaenioglossa	Pleuroceridae	Elimia	3	2.5	Scraper	
5/18/2017	City Park	Insecta	Ephemeroptera	Baetidae	Fallceon	4	4	Gather/Collector	Scraper
5/18/2017	City Park	Insecta	Ephemeroptera	Ephemeridae	Hexagenia	9	6	Gather/Collector	
5/18/2017	City Park	Insecta	Odonata	Coenagrionidae	Enallagma	25	6	Predator	
5/18/2017	City Park	Malacostraca	Amphipoda	Talitridae	Hyalella	48	8	Gather/Collector	Shredder
5/18/2017	City Park	Insecta	Ephemeroptera	Tricorythidae	Tricorythodes	67	5	Gather/Collector	
5/18/2017	Headwaters	Insecta	Ephemeroptera	Baetidae	Baetodes	1	4	Scraper	
5/18/2017	Headwaters	Insecta	Trichoptera	Hydrobiosidae	Atopsyche	1	0	Predator	
5/18/2017	Headwaters	Insecta	Trichoptera	Heliocopyschidae	Helicopsyche	1	2	Scraper	
5/18/2017	Headwaters	Insecta	Heteroptera	Gerridae	Trepobates	1		Predator	
5/18/2017	Headwaters	Insecta	Lepidoptera	Pyralidae	Petrophila	1	5	Scraper	
5/18/2017	Headwaters	Gastropoda	Neotaenioglossa	Thiaridae	Terabia	1		Scraper	
5/18/2017	Headwaters	Gastropoda	Neotaenioglossa	Pleuroceridae	Elimia	1	2.5	Scraper	
5/18/2017	Headwaters	Turbellaria	Tricladida		Planariidae	1			
5/18/2017	Headwaters	Clitellata			Oligochaeta	1	8	Gather/Collector	
5/18/2017	Headwaters	Insecta	Ephemeroptera	Baetidae	Callibaetis	2	4	Gather/Collector	
5/18/2017	Headwaters	Insecta	Trichoptera	Philopotamidae	Chimarra	2	2	Filterer/Collector	
5/18/2017	Headwaters	Insecta	Odonata	Aeshnidae	Boyeria	2	3	Predator	
5/18/2017	Headwaters	Insecta	Coleoptera	Elmidae	Microcylloepus	2	2	Gather/Collector	Scraper
5/18/2017	Headwaters	Insecta	Coleoptera	Psephinidae	Psephenus	2	4	Scraper	
5/18/2017	Headwaters		Decopoda	Cambaridae	Cambaridae	2	5	Gather/Collector	
5/18/2017	Headwaters	Clitellata			Hirudinea	2	8	Predator	
5/18/2017	Headwaters	Insecta	Trichoptera	Hydropsychidae	Smicridea	3	4	Filterer/Collector	
5/18/2017	Headwaters	Insecta	Lepidoptera	Pyralidae	Parapoynx	3	5	Shredder	
5/18/2017	Headwaters	Insecta	Diptera	Chironomidae	Chironomidae	3	6	Gather/Collector	Filterer/Collector
5/18/2017	Headwaters	Malacostraca	Decapoda	Palaemonidae	Palaemonetes	3	4	Gather/Collector	
5/18/2017	Headwaters	Insecta	Coleoptera	Elmidae	Phanocerus clavicornis	4			
5/18/2017	Headwaters	Insecta	Ephemeroptera	Baetidae	Baetis	5	4	Gather/Collector	Scraper
5/18/2017	Headwaters	Insecta	Hemiptera	Naucoridae	Ambrysus	5	5	Predator	
5/18/2017	Headwaters	Insecta	Diptera	Simuliidae	Simulium	9	4	Filterer/Collector	
5/18/2017	Headwaters	Insecta	Ephemeroptera	Leptohyphidae	Leptohyphes	11	2	Gather/Collector	
5/18/2017	Headwaters	Insecta	Odonata	Coenagrionidae	Enallagma	31	6	Predator	
5/18/2017	Headwaters	Malacostraca	Amphipoda	Talitridae	Hyalella	35	8	Gather/Collector	Shredder
5/18/2017	Headwaters	Insecta	Ephemeroptera	Tricorythidae	Tricorythodes	48	5	Gather/Collector	
5/18/2017	I-35	Insecta	Trichoptera	Leptoceridae	Triaenodes	1	3	Predator	
5/18/2017	I-35	Insecta	Trichoptera	Hydrobiosidae	Atopsyche	1	0	Predator	
5/18/2017	I-35	Insecta	Trichoptera	Heliocopyschidae	Helicopsyche	1	2	Scraper	
5/18/2017	I-35	Insecta	Odonata	Coenagrionidae	Argia	1	6	Predator	
5/18/2017	I-35	Insecta	Hemiptera	Naucoridae	Ambrysus	1	5	Predator	
5/18/2017	I-35	Insecta	Lepidoptera	Pyralidae	Parapoynx	1	5	Shredder	
5/18/2017	I-35	Malacostraca	Amphipoda	Crangonyctidae	Crangonyx	2	8	Gather/Collector	Shredder
5/18/2017	I-35	Clitellata			Oligochaeta	2	8	Gather/Collector	
5/18/2017	I-35	Insecta	Ephemeroptera	Leptohyphidae	Leptohyphes	3	2	Gather/Collector	
5/18/2017	I-35	Insecta	Odonata	Coenagrionidae	Enallagma	3	6	Predator	
5/18/2017	I-35	Gastropoda	Neotaenioglossa	Thiaridae	Terabia	3		Scraper	
5/18/2017	I-35	Insecta	Diptera	Simuliidae	Simulium	5	4	Filterer/Collector	
5/18/2017	I-35	Insecta	Diptera	Chironomidae	Chironomidae	5	6	Gather/Collector	Filterer/Collector
5/18/2017	I-35	Insecta	Ephemeroptera	Baetidae	Fallceon	11	4	Gather/Collector	Scraper
5/18/2017	I-35	Gastropoda	Neotaenioglossa	Pleuroceridae	Elimia	11	2.5	Scraper	
5/18/2017	I-35	Insecta	Ephemeroptera	Tricorythidae	Tricorythodes	12	5	Gather/Collector	
5/18/2017	I-35	Malacostraca	Amphipoda	Talitridae	Hyalella	16	8	Gather/Collector	Shredder
5/18/2017	I-35	Insecta	Hemiptera	Naucoridae	Limnocoris	26	5	Predator	
5/18/2017	I-35	Insecta	Ephemeroptera	Baetidae	Baetis	74	4	Gather/Collector	Scraper
5/18/2017	Spring Lake	Insecta	Odonata	Coenagrionidae	Argia	1	6	Predator	
5/18/2017	Spring Lake	Insecta	Ephemeroptera	Baetidae	Callibaetis	1	4	Gather/Collector	
5/18/2017	Spring Lake	Insecta	Odonata	Coenagrionidae	Enallagma	1	6	Predator	
5/18/2017	Spring Lake	Insecta	Hemiptera	Gerridae	Metrobates	1			
5/18/2017	Spring Lake	Clitellata			Oligochaeta	1	8	Gather/Collector	
5/18/2017	Spring Lake	Gastropoda	Basommatophora	Physidae	Physa	1	9	Scraper	
5/18/2017	Spring Lake	Arachnida	Trombidiformes		Acari	2	6	Predator	
5/18/2017	Spring Lake	Insecta	Hemiptera	Naucoridae	Ambrysus	2	5	Predator	
5/18/2017	Spring Lake	Clitellata			Hirudinea	2	8	Predator	
5/18/2017	Spring Lake	Insecta	Heteroptera	Gerridae	Trepobates	3		Predator	
5/18/2017	Spring Lake	Insecta	Ephemeroptera	Tricorythidae	Tricorythodes	6	5	Gather/Collector	
5/18/2017	Spring Lake		Decopoda	Cambaridae	Cambaridae	7	5	Gather/Collector	
5/18/2017	Spring Lake	Malacostraca	Decapoda	Palaemonidae	Palaemonetes	9	4	Gather/Collector	
5/18/2017	Spring Lake	Malacostraca	Amphipoda	Talitridae	Hyalella	131	8	Gather/Collector	Shredder

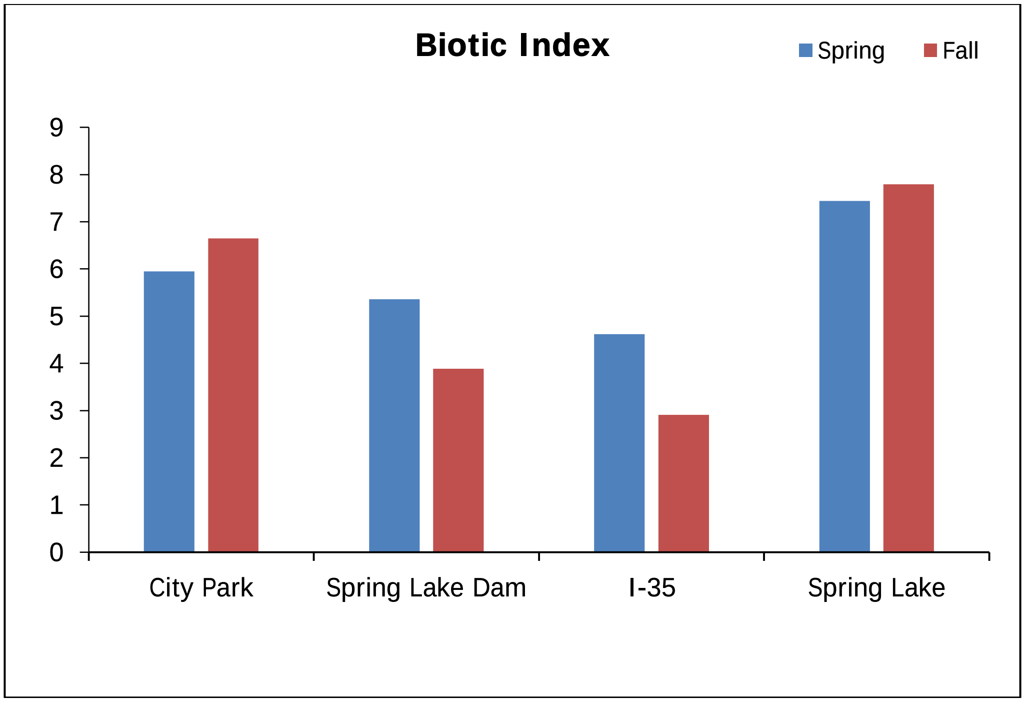
Fall

Date	Site	Class	Order	Family	FinalID	No.	Tolerance Value	Functional Feeding Guild 1	Functional Feeding Guild 2
10/18/2017	City Park	Malacostraca	Amphipoda	Talitridae	Hyalella	133	8	Gather/Collector	Shredder
10/18/2017	City Park	Gastropoda	Neotaenioglossa	Pleuroceridae	Elimia	29	2.5	Scraper	
10/18/2017	City Park	Gastropoda	Neotaenioglossa	Thiaridae	Terabia	8		Scraper	
10/18/2017	City Park	Insecta	Ephemeroptera	Baetidae	Fallceon	2	4	Gather/Collector	Scraper
10/18/2017	City Park	Clitellata			Hirudinea	1	8	Predator	
10/18/2017	City Park	Insecta	Coleoptera	Elmidae	Microcylloepus	1	2	Gather/Collector	Scraper
10/18/2017	City Park	Insecta	Ephemeroptera	Leptohyphidae	Allenhyphes	1			
10/18/2017	City Park	Insecta	Ephemeroptera	Tricorythidae	Tricorythodes	1	5	Gather/Collector	
10/18/2017	City Park	Insecta	Trichoptera	Heliocopyschidae	Helicopsyche	1	2	Scraper	
10/18/2017	City Park	Gastropoda	Neotaenioglossa	Hydrobiidae	Hydrobiidae	1	7	Scraper	
10/18/2017	City Park	Turbellaria	Tricladida		Planariidae	4			
10/18/2017	City Park	Clitellata			Oligochaeta	12	8	Gather/Collector	
10/18/2017	City Park	Insecta	Trichoptera	Leptoceridae	Nectopsyche	17	3	Shredder	Gather/Collector
10/18/2017	Headwaters	Gastropoda	Neotaenioglossa	Thiaridae	Terabia	3		Scraper	
10/18/2017	Headwaters	Gastropoda	Neotaenioglossa	Pleuroceridae	Elimia	11	2.5	Scraper	
10/18/2017	Headwaters	Malacostraca	Amphipoda	Talitridae	Hyalella	7	8	Gather/Collector	Shredder
10/18/2017	Headwaters	Insecta	Coleoptera	Psephinidae	Psephenus	5	4	Scraper	
10/18/2017	Headwaters	Insecta	Coleoptera	Elmidae	Microcylloepus	1	2	Gather/Collector	Scraper
10/18/2017	Headwaters	Insecta	Coleoptera	Elmidae	Neoelmis	1	2	Scraper	
10/18/2017	Headwaters	Insecta	Coleoptera	Elmidae	Hexacylloepus ferrugineus	2	2	Scraper	
10/18/2017	Headwaters	Gastropoda	Neotaenioglossa	Hydrobiidae	Hydrobiidae	2	7	Scraper	
10/18/2017	Headwaters	Insecta	Ephemeroptera	Tricorythidae	Tricorythodes	1	5	Gather/Collector	
10/18/2017	Headwaters	Insecta	Diptera	Ceratopogonidae	Bezzia/Palpomyia Complex	1	7	Predator	
10/18/2017	Headwaters	Insecta	Lepidoptera	Pyralidae	Petrophila	1	5	Scraper	
10/18/2017	Headwaters	Insecta	Trichoptera	Hydropsychidae	Smicridea	2	4	Filterer/Collector	
10/18/2017	Headwaters	Insecta	Coleoptera	Elmidae	Heterelmis	1	4	Scraper	
10/18/2017	Headwaters	Insecta	Trichoptera	Philopotamidae	Chimarra	34	2	Filterer/Collector	
10/18/2017	Headwaters	Insecta	Coleoptera	Elmidae	Macrelmis	2	4	Scraper	
10/18/2017	Headwaters	Insecta	Trichoptera	Heliocopyschidae	Helicopsyche	21	2	Scraper	
10/18/2017	Headwaters	Insecta	Diptera	Chironomidae	Chironomidae	19	6	Gather/Collector	Filterer/Collector
10/18/2017	Headwaters	Insecta	Ephemeroptera	Leptohyphidae	Leptohyphes	45	2	Gather/Collector	
10/18/2017	Headwaters	Insecta	Ephemeroptera	Baetidae	Fallceon	11	4	Gather/Collector	Scraper
10/18/2017	Headwaters	Insecta	Hemiptera	Naucoridae	Ambrysus	20	5	Predator	
10/18/2017	Headwaters	Insecta	Odonata	Libellulidae	Brechmorhoga	5	6	Predator	
10/18/2017	Headwaters	Turbellaria	Tricladida		Planariidae	17			
10/18/2017	Headwaters	Clitellata			Oligochaeta	23	8	Gather/Collector	
10/18/2017	Headwaters	Insecta	Ephemeroptera	Baetidae	Baetodes	6	4	Scraper	
10/18/2017	Headwaters	Insecta	Ephemeroptera	Leptohyphidae	Allenhyphes	25			
10/18/2017	I-35	Gastropoda	Neotaenioglossa	Thiaridae	Terabia	27		Scraper	
10/18/2017	I-35	Insecta	Coleoptera	Elmidae	Macrelmis	1	4	Scraper	
10/18/2017	I-35	Insecta	Ephemeroptera	Leptophlebiidae	Thraulodes	12	2	Gather/Collector	
10/18/2017	I-35	Insecta	Trichoptera	Heliocopyschidae	Helicopsyche	28	2	Scraper	
10/18/2017	I-35	Turbellaria	Tricladida		Planariidae	19			
10/18/2017	I-35	Clitellata			Oligochaeta	5	8	Gather/Collector	
10/18/2017	I-35	Malacostraca	Amphipoda	Talitridae	Hyalella	3	8	Gather/Collector	Shredder
10/18/2017	I-35	Insecta	Hemiptera	Naucoridae	Limnocoris	9	5	Predator	
10/18/2017	I-35	Insecta	Odonata	Libellulidae	Libellulidae	2		Predator	
10/18/2017	I-35	Insecta	Trichoptera	Glossosomatidae	Protoptila	10	1	Scraper	
10/18/2017	I-35	Insecta	Diptera	Chironomidae	Chironomidae	1	6	Gather/Collector	Filterer/Collector
10/18/2017	I-35	Insecta	Ephemeroptera	Leptohyphidae	Leptohyphes	1	2	Gather/Collector	
10/18/2017	I-35	Insecta	Ephemeroptera	Leptohyphidae	Allenhyphes	1			
10/18/2017	I-35	Gastropoda	Neotaenioglossa	Pleuroceridae	Elimia	19	2.5	Scraper	
10/18/2017	I-35	Insecta	Trichoptera	Leptoceridae	Nectopsyche	1	3	Shredder	Gather/Collector
10/18/2017	Spring Lake	Malacostraca	Amphipoda	Talitridae	Hyalella	212	8	Gather/Collector	Shredder
10/18/2017	Spring Lake	Insecta	Coleoptera	Elmidae	Microcylloepus	2	2	Gather/Collector	Scraper
10/18/2017	Spring Lake	Insecta	Hemiptera	Naucoridae	Ambrysus	1	5	Predator	
10/18/2017	Spring Lake	Insecta	Trichoptera	Heliocopyschidae	Helicopsyche	1	2	Scraper	
10/18/2017	Spring Lake	Insecta	Ephemeroptera	Tricorythidae	Tricorythodes	2	5	Gather/Collector	
10/18/2017	Spring Lake		Decopoda	Cambaridae	Cambaridae	3	5	Gather/Collector	
10/18/2017	Spring Lake	Clitellata			Hirudinea	1	8	Predator	
10/18/2017	Spring Lake	Insecta	Ephemeroptera	Baetidae	Callibaetis	2	4	Gather/Collector	
10/18/2017	Spring Lake	Insecta	Odonata	Coenagrionidae	Enallagma	1	6	Predator	
10/18/2017	Spring Lake	Insecta	Odonata	Libellulidae	Libellulidae	1		Predator	

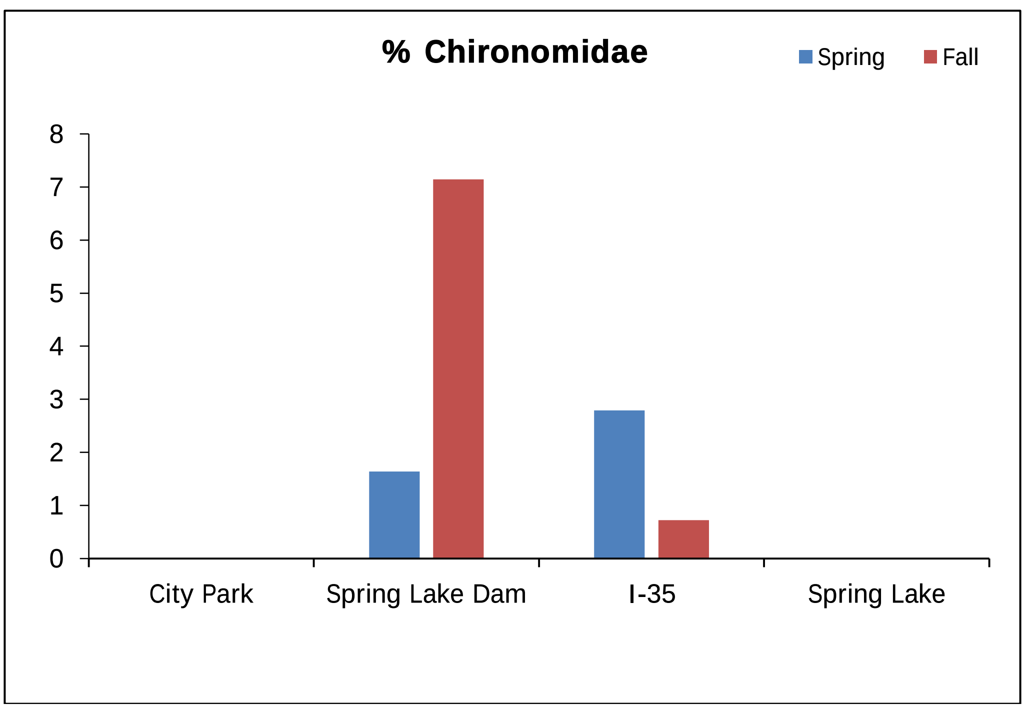
C.7: Benthic Macroinvertebrate Rapid Bioassessment Metrics


Taxa richness
Spring
Fall
30
25
20
15
10
5
0
City Park
Spring Lake Dam
I-35
Spring Lake

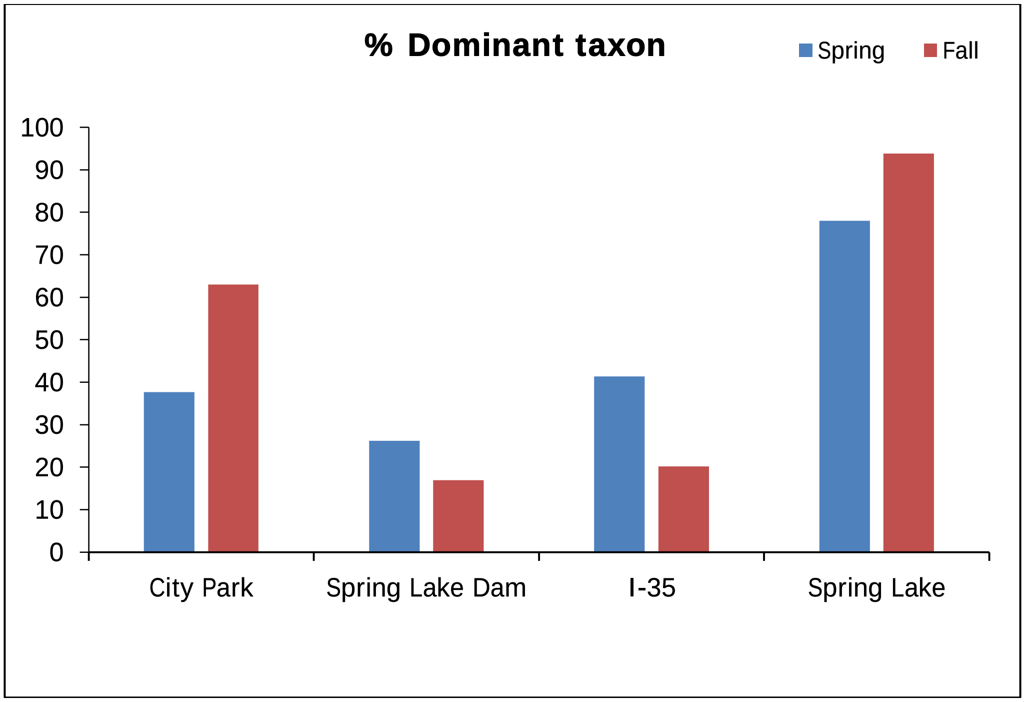

EPT richness
Spring
Fall
10
9
8
7
6
5
4
3
2
1
0
City Park
Spring Lake Dam
I-35
Spring Lake



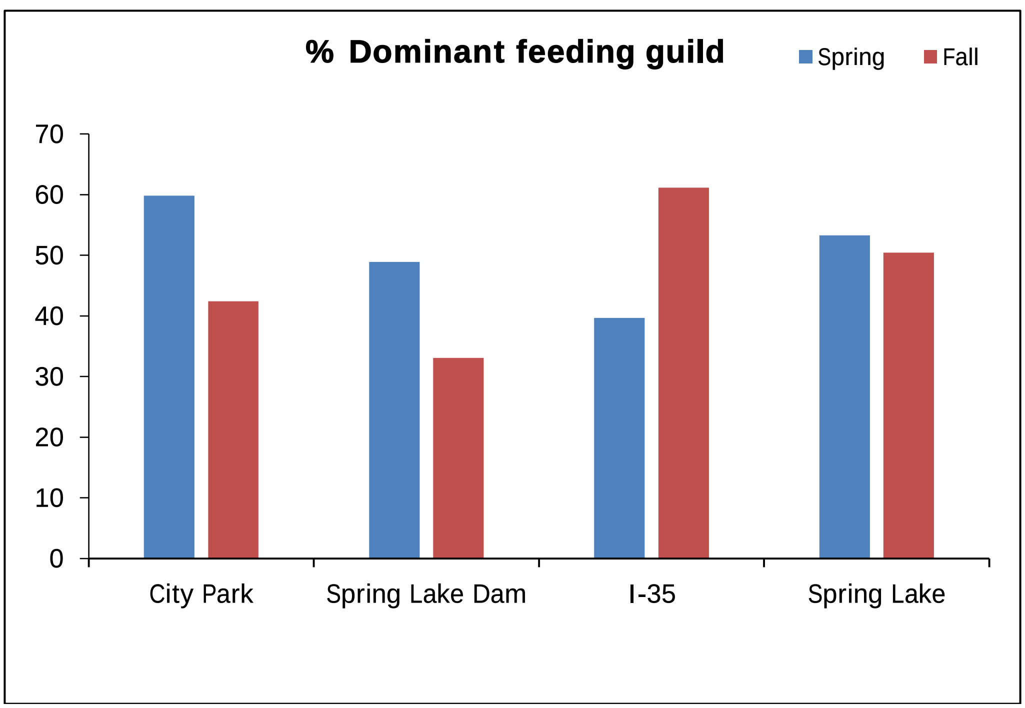
Biotic Index
Spring
Fall
9
8
7
6
5
4
3
2
1
0
City Park
Spring Lake Dam
I-35
Spring Lake



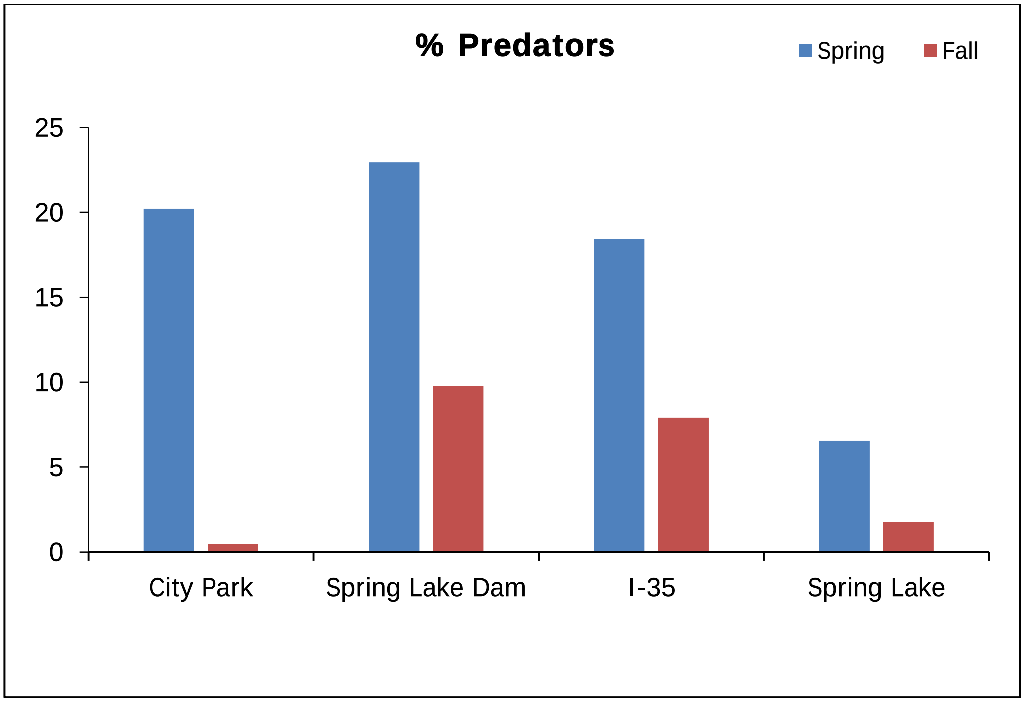
% Chironomidae
Spring
Fall
8
7
6
5
4
3
2
1
0
City Park
Spring Lake Dam
I-35
Spring Lake



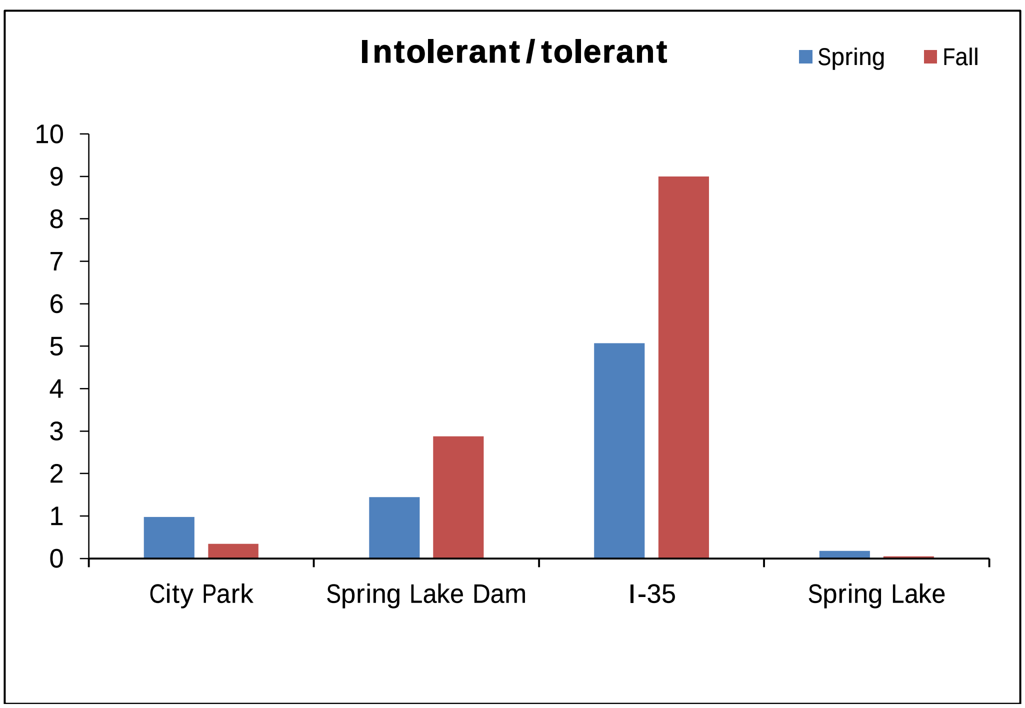
% Dominant taxon
Spring
Fall
100
90
80
70
60
50
40
30
20
10
0
City Park
Spring Lake Dam
I-35
Spring Lake



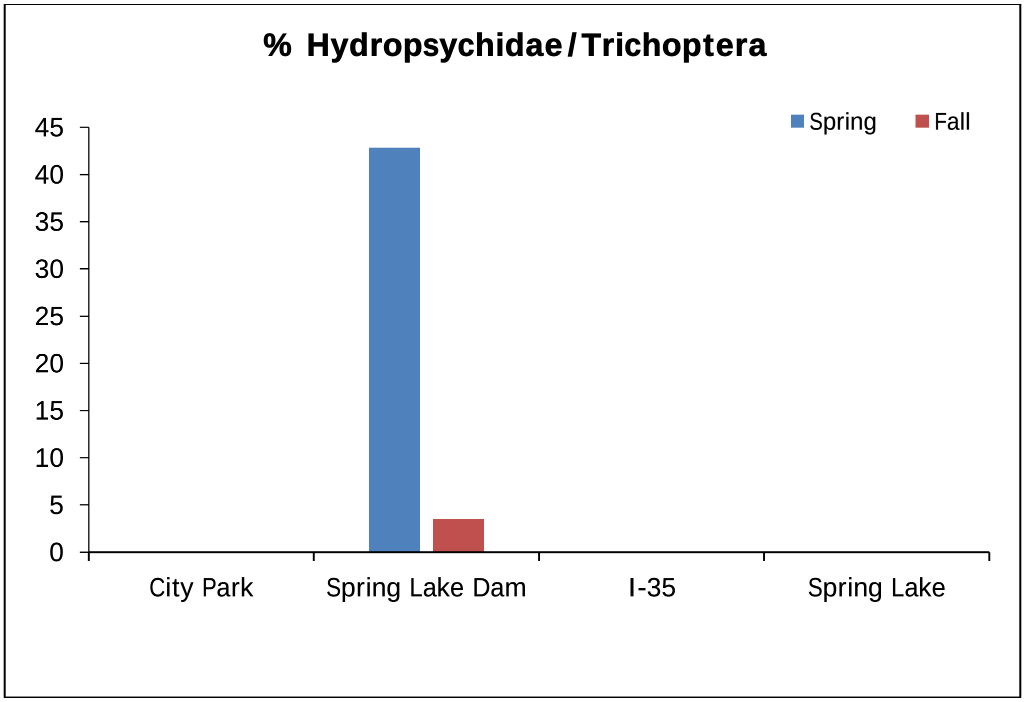
% Dominant feeding guild
Spring
Fall
70
60
50
40
30
20
10
0
City Park
Spring Lake Dam
I-35
Spring Lake

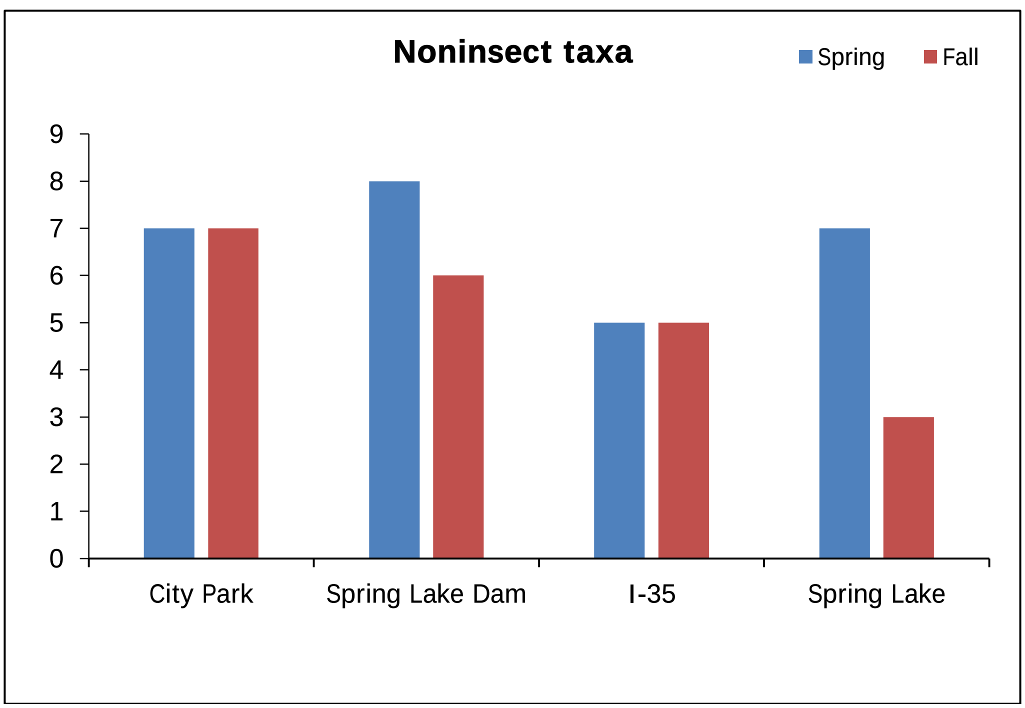


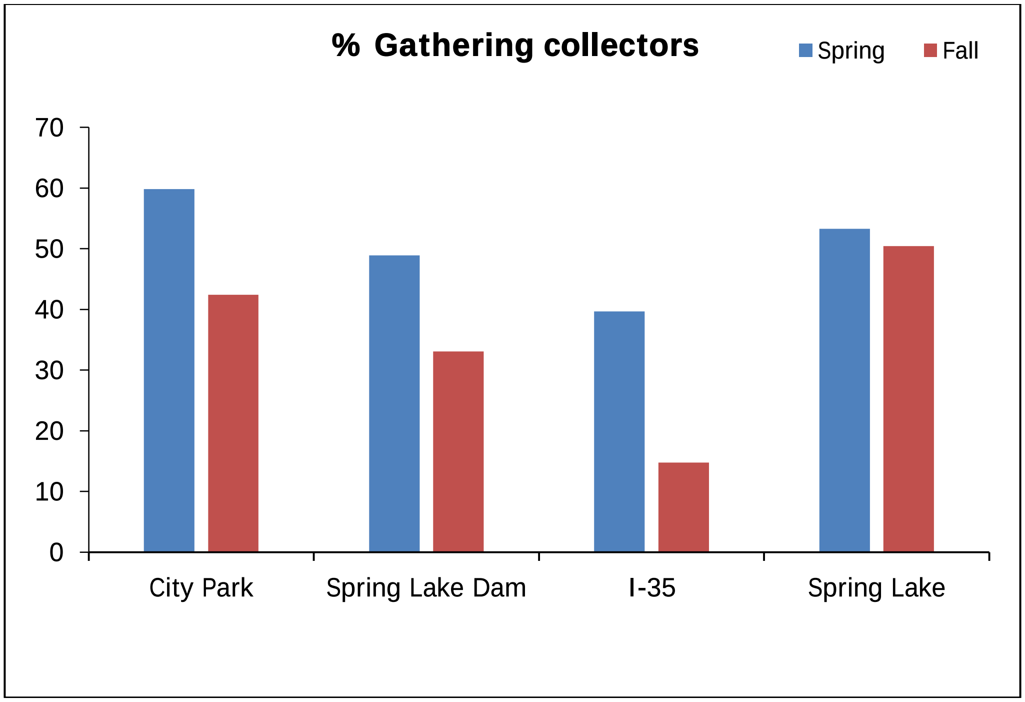
% Predators
Spring
Fall
25
20
15
10
5
0
City Park
Spring Lake Dam
I-35
Spring Lake

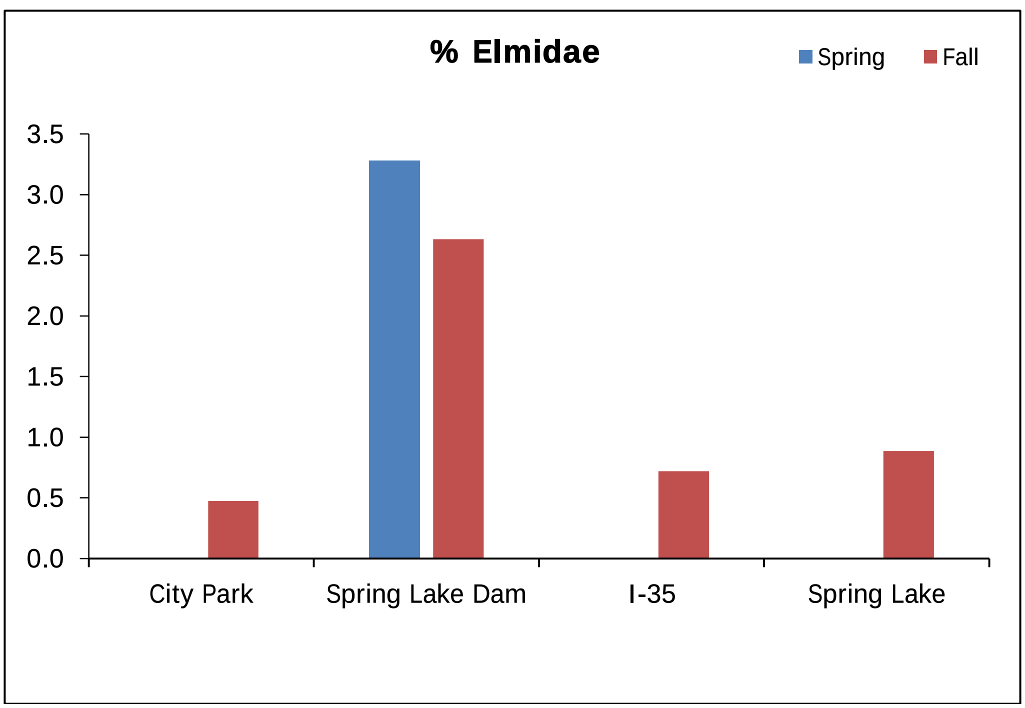


Intolerant/tolerant
Spring
Fall
10
9
8
7
6
5
4
3
2
1
0
City Park
Spring Lake Dam
I-35
Spring Lake


% Hydropsychidae/Trichoptera
Spring
Fall
45
40
35
30
25
20
15
10
5
0
City Park
Spring Lake Dam
I-35
Spring Lake


Noninsect taxa
Spring
Fall
9
8
7
6
5
4
3
2
1
0
City Park
Spring Lake Dam
I-35
Spring Lake


% Gathering collectors
Spring
Fall
70
60
50
40
30
20
10
0
City Park
Spring Lake Dam
I-35
Spring Lake


% Elmidae
Spring
Fall
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
City Park
Spring Lake Dam
I-35
Spring Lake

APPENDIX D: DROP NET RAW DATA

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2101	Spring Lake Dam	H1	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Gambusia sp.	5	20, 16, 15, 18, 16
	Palaemonetes sp.	17	-
2	Etheostoma fonticola	3	32, 22, 16
	Gambusia sp.	4	19, 18, 15, 15
	Lepomis miniatus	1	28
	Palaemonetes sp.	3	-
3	Etheostoma fonticola	1	21
	Gambusia sp.	2	18, 14
	Palaemonetes sp.	3	-
4	Etheostoma fonticola	1	17
	Palaemonetes sp.	5	-
5	Etheostoma fonticola	1	15
	Palaemonetes sp.	2	-
6	Palaemonetes sp.	5	-
7	Palaemonetes sp.	1	-
8	Palaemonetes sp.	1	-
9	Lepomis miniatus	1	78
	Palaemonetes sp.	1	-
10	Palaemonetes sp.	1	-
11	Etheostoma fonticola	1	15
	Palaemonetes sp.	3	-
12	Gambusia sp.	1	20
	Palaemonetes sp.	2	-
13	Gambusia sp.	1	12
14	Procambarus sp.	1	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2102	Spring Lake Dam	H2	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Etheostoma fonticola	1	30
	Lepomis cyanellus	2	130, 70
	Lepomis macrochirus	2	130, 110
	Lepomis miniatus	4	94, 101, 52, 58
	Micropterus salmoides	1	30
	Procambarus sp.	3	-
2	Dionda nigrotaeniata	2	62, 62
	Lepomis miniatus	2	88, 115
3	Etheostoma fonticola	2	21, 19
	Gambusia sp.	1	22
	Lepomis miniatus	1	70
4	Dionda nigrotaeniata	3	68, 65, 60
	Etheostoma fonticola	2	18, 20
	Gambusia sp.	2	42, 18
5	Dionda nigrotaeniata	6	49, 70, 52, 68, 62, 47
6	Dionda nigrotaeniata	4	60, 56, 65, 60
	Procambarus sp.	1	-
7	Gambusia sp.	2	18, 18
	Procambarus sp.	2	-
8	Dionda nigrotaeniata	1	62
9	No fish collected	-	-
10	Lepomis miniatus	1	89
11	No fish collected	-	-
12	No fish collected	-	-
13	Procambarus sp.	2	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2103	Spring Lake Dam	P1	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	Etheostoma fonticola	1	12
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-
11	No fish collected	-	-
12	No fish collected	-	-
13	No fish collected	-	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2104	Spring Lake Dam	P2	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2105	Spring Lake Dam	S1	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Ameiurus melas	1	22
	Etheostoma fonticola	1	30
	Palaemonetes sp.	8	-
2	Gambusia sp.	3	15, 13, 14
	Palaemonetes sp.	2	-
3	Ameiurus melas	1	19
	Etheostoma fonticola	1	14
	Gambusia sp.	1	11
	Herichthys cyanoguttatus	1	65
	Palaemonetes sp.	2	-
4	Gambusia sp.	1	10
	Micropterus salmoides	1	40
5	Lepomis miniatus	1	64
	Procambarus sp.	2	-
6	No fish collected	-	-
7	Procambarus sp.	2	-
8	Palaemonetes sp.	1	
	Procambarus sp.	2	
9	Lepomis miniatus	2	68, 71
	Procambarus sp.	1	-
10	No fish collected	-	-
11	Procambarus sp.	1	-
12	Procambarus sp.	2	-
13	Etheostoma fonticola	1	21
	Palaemonetes sp.	1	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2106	Spring Lake Dam	S2	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Gambusia sp.	8	15, 20, 10, 13, 10, 15, 12, 10
	Herichthys cyanoguttatus	1	58
	Procambarus sp.	1	-
2	Gambusia sp.	2	16, 15
	Palaemonetes sp.	1	-
	Procambarus sp.	2	-
3	Gambusia sp.	1	20
	Palaemonetes sp.	1	-
	Procambarus sp.	1	-
4	Etheostoma fonticola	1	18
	Herichthys cyanoguttatus	2	55, 62
5	Procambarus sp.	1	-
6	Etheostoma fonticola	1	30
	Gambusia sp.	1	13
	Palaemonetes sp.	2	-
	Procambarus sp.	2	-
7	No fish collected	-	-
8	Etheostoma fonticola	2	23, 32
9	No fish collected	-	-
10	No fish collected	-	-
11	Lepomis miniatus	1	64
	Procambarus sp.	2	-
12	No fish collected	-	-
13	No fish collected	-	-
14	No fish collected	-	-
15	Lepomis miniatus	1	50

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2107	Spring Lake Dam	O1	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2108	Spring Lake Dam	O2	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	Etheostoma fonticola	1	20
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-
11	No fish collected	-	-
12	No fish collected	-	-
13	No fish collected	-	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2109	City Park	H1	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Micropterus salmoides	1	125
2	Ambloplites rupestris	1	31
	Ameiurus natalis	1	55
	Gambusia sp.	2	13, 15
	Palaemonetes sp.	1	-
	Procambarus sp.	2	-
3	Etheostoma fonticola	1	23
	Palaemonetes sp.	2	-
	Procambarus sp.	1	-
4	Ambloplites rupestris	1	33
	Etheostoma fonticola	1	28
	Palaemonetes sp.	2	-
	Procambarus sp.	1	-
5	Ambloplites rupestris	1	102
	Lepomis miniatus	1	72
	Procambarus sp.	2	-
6	Ambloplites rupestris	2	25, 15
	Etheostoma fonticola	1	25
7	Gambusia sp.	1	46
8	Etheostoma fonticola	3	40, 20, 24
	Procambarus sp.	3	-
9	Palaemonetes sp.	1	-
10	Etheostoma fonticola	1	16
	Palaemonetes sp.	2	-
11	Ambloplites rupestris	1	30
	Procambarus sp.	2	-
12	No fish collected	-	-
13	Palaemonetes sp.	1	-
14	Procambarus sp.	1	-
15	Gambusia sp.	1	22
	Procambarus sp.	1	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2110	City Park	H2	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Gambusia sp.	1	15
	Herichthys cyanoguttatus	1	20
2	No fish collected	-	-
3	Etheostoma fonticola	1	40
	Gambusia sp.	1	12
	Lepomis miniatus	1	42
	Procambarus sp.	2	-
4	Procambarus sp.	1	-
5	Dionda nigrotaeniata	1	60
	Herichthys cyanoguttatus	1	20
6	No fish collected	-	-
7	Procambarus sp.	1	-
8	No fish collected	-	-
9	No fish collected	-	-
10	Ambloplites rupestris	1	12
	Etheostoma fonticola	1	20
	Gambusia sp.	1	18
	Procambarus sp.	1	-
11	No fish collected	-	-
12	No fish collected	-	-
13	No fish collected	-	-
14	No fish collected	-	-
15	Procambarus sp.	1	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2111	City Park	HD1	5/11/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Ambloplites rupestris	2	30, 35
	Etheostoma fonticola	2	30, 26
	Gambusia sp.	16	20, 17, 14, 25, 17, 15, 22, 24, 17, 15, 12, 11, 22, 16, 9, 16
	Lepomis miniatus	1	27
	Procambarus sp.	10	-
2	Etheostoma fonticola	1	15
	Gambusia sp.	22	25, 36, 30, 10, 11, 32, 31, 20, 25
	Poecilia latipinna	1	36
	Procambarus sp.	10	-
3	Procambarus sp.	9	-
4	Etheostoma fonticola	1	22
	Gambusia sp.	18	-
	Palaemonetes sp.	1	-
	Procambarus sp.	4	-
5	Etheostoma fonticola	1	30
	Gambusia sp.	16	-
	Procambarus sp.	7	-
6	Ambloplites rupestris	1	41
	Gambusia sp.	3	-
	Procambarus sp.	3	-
7	Procambarus sp.	1	-
8	Gambusia sp.	9	-
	Lepomis macrochirus	1	62
	Procambarus sp.	1	-
9	Ambloplites rupestris	1	31
	Etheostoma fonticola	3	20, 22, 14
	Gambusia sp.	3	-
10	Etheostoma fonticola	1	22
	Procambarus sp.	3	-
11	Etheostoma fonticola	1	32
	Procambarus sp.	3	-
12	Procambarus sp.	3	-
13	No fish collected	-	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2112	City Park	HD2	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Ambloplites rupestris	2	15, 22
	Etheostoma fonticola	1	30
	Palaemonetes sp.	1	-
2	Etheostoma fonticola	2	35, 33
	Palaemonetes sp.	1	-
	Procambarus sp.	3	-
3	Ambloplites rupestris	1	18
	Procambarus sp.	1	-
4	Ameiurus melas	1	26
	Etheostoma fonticola	2	36, 16
	Procambarus sp.	1	-
5	Ambloplites rupestris	1	22
	Herichthys cyanoguttatus	1	52
6	Procambarus sp.	2	-
7	Ambloplites rupestris	1	17
8	Gambusia sp.	1	10
9	Etheostoma fonticola	1	39
	Procambarus sp.	1	-
10	Gambusia sp.	1	22
	Procambarus sp.	1	-
11	Etheostoma fonticola	1	15
	Procambarus sp.	3	-
12	Procambarus sp.	1	-
13	Ambloplites rupestris	1	23
	Gambusia sp.	3	15, 12, 15
14	Gambusia sp.	1	12
15	Etheostoma fonticola	2	11, 10
	Procambarus sp.	1	-
16	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2113	City Park	O1	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	**Location (Reach):**	**Site:**	**Date:**
2114	City Park	O2	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	**Species**	**Number**	**Length (mm)**
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2115	City Park	S1	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	Lepomis miniatus	1	80
8	Ambloplites rupestris	1	150
9	No fish collected	-	-
10	No fish collected	-	-
11	No fish collected	-	- 0
12	No fish collected	-	-
13	No fish collected	-	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2116	City Park	S2	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Etheostoma fonticola	1	36
	Procambarus sp.	1	-
2	Procambarus sp.	1	-
3	No fish collected	-	-
4	No fish collected	-	-
5	Gambusia sp.	1	20
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-
11	No fish collected	-	-
12	No fish collected	-	-
13	Procambarus sp.	1	-
14	No fish collected	-	
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2117	City Park	PH1	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Lepomis miniatus	1	144
2	Etheostoma fonticola	3	28, 21, 19
3	No fish collected	-	-
4	No fish collected	-	-
5	Lepomis miniatus	1	98
6	Etheostoma fonticola	1	22
7	Etheostoma fonticola	2	35, 24
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-
11	Etheostoma fonticola	1	27
	Procambarus sp.	1	-
12	No fish collected	-	-
13	No fish collected	-	-
14	Etheostoma fonticola	1	33
15	Etheostoma fonticola	1	21
16	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2118	City Park	PH2	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	Ambloplites rupestris	1	31
	Procambarus sp.	4	-
3	No fish collected	-	-
4	No fish collected	-	-
5	Etheostoma fonticola	1	12
6	Etheostoma fonticola	1	15
	Gambusia sp.	1	12
	Procambarus sp.	2	-
7	Etheostoma fonticola	1	26
8	No fish collected	-	-
9	No fish collected	-	-
10	Etheostoma fonticola	1	37
11	Etheostoma fonticola	1	22
12	No fish collected	-	-
13	No fish collected	-	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2119	I-35	HD1	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2120	I-35	HD2	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	Procambarus sp.	1	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2121	I-35	O1	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2122	I-35	O2	4/25/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2123	I-35	C1	4/25/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Dionda nigrotaeniata	1	16
	Etheostoma fonticola	2	21, 46
	Lepomis miniatus	1	90
	Procambarus sp.	9	-
2	Dionda nigrotaeniata	1	33
	Etheostoma fonticola	2	16, 21
	Gambusia sp.	1	11
	Lepomis sp.	1	21
	Micropterus salmoides	1	48
	Procambarus sp.	21	-
3	Dionda nigrotaeniata	2	36, 24
	Etheostoma fonticola	1	29
	Lepomis gulosus	1	50
	Procambarus sp.	13	-
4	Dionda nigrotaeniata	1	27
	Etheostoma fonticola	1	32
	Lepomis miniatus	2	41, 28
	Procambarus sp.	11	-
5	Etheostoma fonticola	1	38
	Lepomis miniatus	2	27, 24
	Lepomis sp.	2	12, 15
	Procambarus sp.	7	-
6	Lepomis gulosus	1	79
	Lepomis macrochirus	1	52
	Procambarus sp.	6	-
7	Procambarus sp.	2	-
8	Procambarus sp.	3	-
9	Procambarus sp.	4	-
10	Dionda nigrotaeniata	1	25
	Lepomis gulosus	1	56
	Lepomis sp.	1	12
	Procambarus sp.	3	-
11	Etheostoma fonticola	1	20

	Lepomis macrochirus	1	45
	Lepomis sp.	1	18
12	No fish collected	-	-
13	Procambarus sp.	1	-
14	Procambarus sp.	3	-
15	Lepomis sp.	1	14

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2124	I-35	C2	4/24/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Ambloplites rupestris	1	30
	Etheostoma fonticola	6	18, 22, 26, 31, 18, 20
	Gambusia sp.	32	16, 40, 18, 21, 12, 10, 10, 12, 20, 7, 20, 10, 16, 22, 10, 11, 20, 16, 22, 12, 15, 18, 19, 10, 16, 15, 13, 10, 10, 10, 15, 13
	Lepomis sp.	1	15
	Procambarus sp.	72	-
2	Etheostoma fonticola	1	16
	Gambusia sp.	50	-
	Procambarus sp.	11	-
3	Etheostoma fonticola	1	16
	Gambusia sp.	11	-
	Procambarus sp.	5	-
4	Etheostoma fonticola	1	20
	Gambusia sp.	2	-
	Procambarus sp.	1	-
5	Etheostoma fonticola	1	24
	Gambusia sp.	8	-
	Procambarus sp.	12	-
6	Gambusia sp.	5	-
	Lepomis miniatus	1	26
	Procambarus sp.	5	-
7	Gambusia sp.	2	-
	Procambarus sp.	3	-
8	Lepomis sp.	1	19
	Procambarus sp.	1	-
9	Procambarus sp.	1	-
10	No fish collected	-	-
11	No fish collected	-	-
12	No fish collected	-	-
13	No fish collected	-	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2125	I-35	H1	4/25/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Ambloplites rupestris	3	81, 64, 34
	Etheostoma fonticola	1	21
	Gambusia sp.	7	26, 30, 26, 26, 26, 17, 22
	Procambarus sp.	15	-
2	Etheostoma fonticola	1	22
	Gambusia sp.	2	25, 27
	Procambarus sp.	5	-
3	Ambloplites rupestris	2	78, 25
	Etheostoma fonticola	2	31, 16
	Gambusia sp.	2	21, 20
	Palaemonetes sp.	1	-
	Procambarus sp.	12	-
4	Etheostoma fonticola	1	35
	Gambusia sp.	1	24
	Procambarus sp.	2	-
5	Ambloplites rupestris	1	88
	Gambusia sp.	1	18
	Procambarus sp.	1	-
6	Procambarus sp.	3	-
7	Etheostoma fonticola	3	26, 35, 27
	Lepomis sp.	1	14
	Procambarus sp.	6	-
8	No fish collected	-	-
9	Procambarus sp.	1	-
10	Procambarus sp.	3	-
11	Procambarus sp.	2	-
12	Procambarus sp.	3	-
13	Procambarus sp.	1	-
14	Gambusia sp.	1	28
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2126	I-35	H2	4/25/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Dionda nigrotaeniata	1	27
	Gambusia sp.	18	22, 24, 22, 15, 16, 13, 23, 20, 21, 18, 20, 15, 35, 14, 16, 17, 17, 15
	Procambarus sp.	19	-
2	Gambusia sp.	8	36, 19, 28, 20, 25, 17, 18
	Procambarus sp.	11	-
3	Etheostoma fonticola	1	12
	Gambusia sp.	4	-
	Procambarus sp.	1	-
4	Etheostoma fonticola	1	17
	Gambusia sp.	3	-
5	Astyanax mexicanus	1	65
	Procambarus sp.	1	-
6	Gambusia sp.	2	-
	Procambarus sp.	6	-
7	No fish collected	-	-
8	Procambarus sp.	1	-
9	No fish collected	-	-
10	Procambarus sp.	1	-
11	Procambarus sp.	2	-
12	Procambarus sp.	1	-
13	Ambloplites rupestris	1	20
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2127	I-35	S1	4/25/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Astyanax mexicanus	4	90, 60, 75, 70
	Gambusia sp.	4	15, 22, 27, 20
	Procambarus sp.	3	-
2	Astyanax mexicanus	2	70, 94
	Gambusia sp.	1	25
	Procambarus sp.	1	-
3	Astyanax mexicanus	1	82
4	Astyanax mexicanus	2	65, 80
	Gambusia sp.	1	25
5	Gambusia sp.	1	25
	Procambarus sp.	1	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-
11	Procambarus sp.	1	-
12	No fish collected	-	-
13	Gambusia sp.	1	12
14	Procambarus sp.	1	-
15	Procambarus sp.	1	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-SPRING 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2128	I-35	S2	4/25/2017

SAN MARCOS RIVER-SPRING 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Lepomis miniatus	1	69
	Procambarus sp.	5	-
2	Lepomis miniatus	1	75
	Procambarus sp.	6	-
3	Gambusia sp.	1	20
	Procambarus sp.	5	-
4	Gambusia sp.	1	21
	Procambarus sp.	5	-
5	Herichthys cyanoguttatus	1	101
6	No fish collected	-	-
7	Procambarus sp.	1	-
8	Procambarus sp.	4	-
9	No fish collected	-	-
10	Procambarus sp.	1	-
11	No fish collected	-	-
12	Procambarus sp.	4	-
13	No fish collected	-	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2163	Spring Lake Dam	P1	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2164	Spring Lake Dam	P2	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	Ambloplites rupestris	1	125
9	No fish collected	-	-
10	No fish collected	-	-
11	No fish collected	-	-
12	No fish collected	-	-
13	No fish collected	-	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2165	Spring Lake Dam	S1	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Lepomis miniatus	3	54, 45, 65
2	Etheostoma fonticola	1	40
	Herichthys cyanoguttatus	3	55, 47, 37
	Palaemonetes sp.	1	-
	Procambarus sp.	3	-
3	Palaemonetes sp.	4	-
	Procambarus sp.	2	-
4	Lepomis miniatus	1	47
	Palaemonetes sp.	3	-
	Procambarus sp.	2	-
5	Procambarus sp.	2	-
6	Herichthys cyanoguttatus	1	55
	Palaemonetes sp.	1	-
7	Lepomis miniatus	1	49
	Procambarus sp.	1	-
8	Lepomis miniatus	1	35
9	Herichthys cyanoguttatus	1	43
	Lepomis miniatus	1	55
	Procambarus sp.	1	-
10	No fish collected	-	-
11	Lepomis miniatus	1	76
12	No fish collected	-	-
13	Lepomis miniatus	2	55, 39
	Procambarus sp.	1	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2166	Spring Lake Dam	H1	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Etheostoma fonticola	1	29
	Gambusia sp.	38	15, 10, 22, 35, 43, 20, 25, 33, 23, 24, 15, 16, 14, 12, 29, 10, 9, 18, 18, 20, 20, 20, 18, 15, 15
	Lepomis miniatus	5	61, 15, 28, 45, 35
	Micropterus salmoides	1	90
	Palaemonetes sp.	5	-
	Procambarus sp.	3	-
2	Gambusia sp.	2	-
	Lepomis miniatus	1	57
	Palaemonetes sp.	1	-
	Procambarus sp.	1	-
3	Etheostoma fonticola	1	34
	Gambusia sp.	3	-
	Lepomis miniatus	3	85, 45, 47
	Palaemonetes sp.	4	-
	Procambarus sp.	1	-
4	Etheostoma fonticola	1	35
	Gambusia sp.	2	-
	Palaemonetes sp.	3	-
	Procambarus sp.	2	-
5	Gambusia sp.	2	-
	Palaemonetes sp.	1	-
6	Gambusia sp.	1	-
	Palaemonetes sp.	1	-
	Procambarus sp.	1	-
7	Etheostoma fonticola	1	24
	Palaemonetes sp.	1	-
	Procambarus sp.	1	-
8	Lepomis miniatus	1	45
9	Lepomis miniatus	1	40
	Marisa cornuarietis	1	35
	Procambarus sp.	1	-
10	Procambarus sp.	3	-
11	Etheostoma fonticola	1	32
	Gambusia sp.	1	-
	Palaemonetes sp.	1	
12	No fish collected	-	-

13	No fish collected	-	-
14	No fish collected	-	-
15	Lepomis miniatus	1	40
	Procambarus sp.	1	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2167	Spring Lake Dam	H2	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Etheostoma fonticola	4	32, 36, 33, 28
	Gambusia sp.	18	11, 15, 12, 11, 19, 19, 24, 11, 18, 19, 23, 20, 12, 22, 13, 15, 17, 18
	Lepomis miniatus	2	32, 46
	Palaemonetes sp.	4	-
	Procambarus sp.	4	-
2	Etheostoma fonticola	1	35
	Gambusia sp.	24	20, 21, 25, 16, 15, 18, 25
	Marisa cornuarietis	1	20
	Palaemonetes sp.	4	-
	Procambarus sp.	3	-
3	Gambusia sp.	5	-
	Lepomis miniatus	1	41
	Palaemonetes sp.	2	-
4	Gambusia sp.	2	-
	Palaemonetes sp.	1	-
5	Etheostoma fonticola	2	31, 30
6	Etheostoma fonticola	1	35
7	Etheostoma fonticola	1	33
	Gambusia sp.	1	-
	Herichthys cyanoguttatus	1	39
	Palaemonetes sp.	1	-
8	No fish collected	-	-
9	Etheostoma fonticola	1	32
10	Gambusia sp.	2	-
	Procambarus sp.	2	-
11	Lepomis miniatus	1	40
12	No fish collected	-	-
13	No fish collected	-	-
14	No fish collected	-	-
15	Procambarus sp.	2	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2168	Spring Lake Dam	Hydro1	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Gambusia sp.	1	10
	Palaemonetes sp.	12	-
2	Etheostoma fonticola	1	27
	Gambusia sp.	1	14
	Lepomis miniatus	1	45
	Palaemonetes sp.	3	-
3	Gambusia sp.	1	15
	Palaemonetes sp.	5	-
4	Gambusia sp.	3	21, 21, 20
	Palaemonetes sp.	10	-
5	Palaemonetes sp.	3	-
6	Etheostoma fonticola	2	29, 34
	Palaemonetes sp.	2	-
	Procambarus sp.	2	-
7	Etheostoma fonticola	1	32
	Palaemonetes sp.	2	-
8	Procambarus sp.	1	-
9	No fish collected	-	-
10	Etheostoma fonticola	1	35
	Procambarus sp.	2	-
11	No fish collected	-	-
12	Procambarus sp.	1	-
13	Gambusia sp.	2	18, 21
14	Procambarus sp.	1	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2169	Spring Lake Dam	Hydro2	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Etheostoma fonticola	5	31, 27, 26, 16, 23
	Gambusia sp.	3	22, 17, 17
	Palaemonetes sp.	12	-
	Procambarus sp.	2	-
2	Etheostoma fonticola	4	30, 31, 30, 20
	Palaemonetes sp.	7	-
3	Palaemonetes sp.	1	-
	Procambarus sp.	1	-
4	Etheostoma fonticola	2	28, 20
	Gambusia sp.	1	17
5	Etheostoma fonticola	2	31, 17
6	Etheostoma fonticola	9	31, 30, 20, 18, 16, 20, 25, 35, 27
	Gambusia sp.	1	22
	Palaemonetes sp.	7	-
	Procambarus sp.	1	-
7	Etheostoma fonticola	1	32
	Palaemonetes sp.	6	-
8	No fish collected	-	-
9	Palaemonetes sp.	2	-
	Procambarus sp.	1	-
10	Etheostoma fonticola	1	26
11	Etheostoma fonticola	3	28, 30, 28
12	Etheostoma fonticola	4	35, 30, 30, 22
13	Etheostoma fonticola	1	34
	Palaemonetes sp.	1	-
	Procambarus sp.	1	-
14	Etheostoma fonticola	1	28
15	Etheostoma fonticola	1	26
16	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2170	Spring Lake Dam	O1	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2171	Spring Lake Dam	O2	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2172	City Park	H1	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Etheostoma fonticola	1	20
	Gambusia sp.	11	50, 44, 20, 17, 15, 21, 25, 22, 13, 14, 22
	Procambarus sp.	3	-
2	Gambusia sp.	5	40, 15, 20, 12, 12
	Herichthys cyanoguttatus	1	36
	Procambarus sp.	5	-
3	Gambusia sp.	7	16, 20, 17, 18, 11, 21, 12
	Procambarus sp.	1	-
4	Ambloplites rupestris	1	72
	Gambusia sp.	2	28, 16
	Procambarus sp.	1	-
5	No fish collected	-	-
6	Gambusia sp.	2	-
	Procambarus sp.	1	-
7	Gambusia sp.	1	-
	Procambarus sp.	2	-
8	Procambarus sp.	1	-
9	No fish collected	-	-
10	Gambusia sp.	1	-
	Procambarus sp.	2	-
11	Gambusia sp.	1	-
12	Etheostoma fonticola	1	33
	Gambusia sp.	1	-
13	Gambusia sp.	1	-
14	Procambarus sp.	1	-
15	Procambarus sp.	2	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2173	City Park	H2	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Etheostoma fonticola	5	35, 14, 15, 18, 20
	Gambusia sp.	15	14, 29, 11, 30, 20, 15, 14, 15, 30, 20, 13, 13, 26, 10, 10
2	Etheostoma fonticola	2	35, 25
	Gambusia sp.	3	12, 42, 24
3	Etheostoma fonticola	1	14
	Gambusia sp.	11	16, 40, 10, 16, 32, 28, 22, 12
	Procambarus sp.	3	-
4	Gambusia sp.	7	-
	Procambarus sp.	2	-
5	Gambusia sp.	1	-
	Procambarus sp.	1	-
6	Gambusia sp.	8	-
7	Gambusia sp.	3	-
8	Etheostoma fonticola	4	19, 25, 17, 13
	Gambusia sp.	4	-
9	Gambusia sp.	3	-
10	No fish collected	-	-
11	No fish collected	-	-
12	No fish collected	-	-
13	Procambarus sp.	2	-
14	Procambarus sp.	3	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2174	City Park	HD1	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Etheostoma fonticola	2	26, 30
	Gambusia sp.	6	20, 25, 21, 30, 17, 26
	Herichthys cyanoguttatus	2	26, 40
	Lepomis miniatus	1	42
	Lepomis sp.	1	20
	Palaemonetes sp.	19	-
	Procambarus sp.	5	-
2	Etheostoma fonticola	2	19, 25
	Lepomis miniatus	1	38
	Palaemonetes sp.	5	-
3	Ambloplites rupestris	1	31
	Lepomis sp.	1	18
4	Gambusia sp.	3	15, 20, 25
	Procambarus sp.	5	-
5	Etheostoma fonticola	1	25
	Gambusia sp.	3	15, 20, 31
6	Gambusia sp.	3	20, 20, 17
7	No fish collected	-	-
8	Herichthys cyanoguttatus	2	25, 20
	Lepomis miniatus	1	27
9	No fish collected	-	-
10	Etheostoma fonticola	2	20, 23
11	No fish collected	-	-
12	No fish collected	-	-
13	Procambarus sp.	3	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2175	City Park	HD2	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Ambloplites rupestris	2	33, 12
	Etheostoma fonticola	1	15
	Gambusia sp.	4	13, 12, 15, 10
	Herichthys cyanoguttatus	1	20
2	Lepomis sp.	2	12, 9
3	Etheostoma fonticola	1	19
	Gambusia sp.	2	16, 10
	Lepomis sp.	1	15
	Procambarus sp.	3	-
4	Gambusia sp.	1	20
5	No fish collected	-	-
6	Etheostoma fonticola	1	20
	Gambusia sp.	1	5
	Lepomis miniatus	1	34
	Procambarus sp.	1	-
7	Gambusia sp.	1	14
8	Etheostoma fonticola	2	32, 38
	Gambusia sp.	1	14
	Lepomis sp.	2	13, 12
9	Etheostoma fonticola	1	16
10	No fish collected	-	-
11	No fish collected	-	-
12	Procambarus sp.	1	-
13	No fish collected	-	-
14	Procambarus sp.	2	-
15	Etheostoma fonticola	1	23
	Gambusia sp.	1	12
	Procambarus sp.	2	-
16	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2176	City Park	O1	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2177	City Park	O2	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	**Location (Reach):**	**Site:**	**Date:**
2178	City Park	S1	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	**Species**	**Number**	**Length (mm)**
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2179	City Park	S2	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	Gambusia sp.	1	20
2	Procambarus sp.	1	-
3	No fish collected	-	-
4	Palaemonetes sp.	1	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-
11	No fish collected	-	-
12	No fish collected	-	-
13	No fish collected	-	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2180	City Park	PH1	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Ambloplites rupestris	1	50
	Palaemonetes sp.	4	-
2	Etheostoma fonticola	1	28
	Herichthys cyanoguttatus	1	37
	Procambarus sp.	2	-
3	Ambloplites rupestris	1	77
	Etheostoma fonticola	1	33
	Palaemonetes sp.	1	-
	Procambarus sp.	4	-
4	Ambloplites rupestris	1	80
	Palaemonetes sp.	1	-
	Procambarus sp.	8	-
5	Ambloplites rupestris	1	60
	Procambarus sp.	1	-
6	Procambarus sp.	2	-
7	Etheostoma fonticola	1	26
	Gambusia sp.	1	10
8	Etheostoma fonticola	1	32
9	Procambarus sp.	1	-
10	Etheostoma fonticola	1	26
	Gambusia sp.	1	25
	Procambarus sp.	1	-
11	No fish collected	-	-
12	No fish collected	-	-
13	Procambarus sp.	1	-
14	No fish collected	-	-
15	Etheostoma fonticola	1	25
16	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2181	City Park	PH2	10/16/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	Procambarus sp.	2	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2182	I-35	HD1	10/17/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Etheostoma fonticola	1	30
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	Procambarus sp.	1	-
11	No fish collected	-	-
12	No fish collected	-	-
13	No fish collected	-	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	**Location (Reach):**	**Site:**	**Date:**
2183	I-35	O1	10/17/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	**Species**	**Number**	**Length (mm)**
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2184	I-35	O2	10/17/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	No fish collected	-	-
2	No fish collected	-	-
3	No fish collected	-	-
4	No fish collected	-	-
5	No fish collected	-	-
6	No fish collected	-	-
7	No fish collected	-	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2185	I-35	C1	10/17/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Procambarus sp.	3	-
2	Etheostoma fonticola	2	25, 24
	Procambarus sp.	5	-
3	Micropterus salmoides	1	54
	Procambarus sp.	3	-
4	Etheostoma fonticola	3	32, 25, 35
	Gambusia sp.	1	20
5	Etheostoma fonticola	1	23
6	No fish collected	-	-
7	Etheostoma fonticola	1	18
	Procambarus sp.	1	-
8	No fish collected	-	-
9	No fish collected	-	-
10	Etheostoma fonticola	1	21
11	Lepomis miniatus	1	120
12	Lepomis macrochirus	1	88
13	Etheostoma fonticola	1	21
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2186	I-35	C2	10/17/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Etheostoma fonticola	3	35, 19, 15
	Gambusia sp.	5	20, 16, 16, 15, 14
	Lepomis macrochirus	1	34
	Lepomis miniatus	1	38
	Lepomis sp.	1	22
	Palaemonetes sp.	1	-
	Procambarus sp.	5	-
2	Procambarus sp.	6	-
3	Lepomis miniatus	1	47
	Procambarus sp.	3	-
4	Procambarus sp.	2	-
5	Procambarus sp.	3	-
6	Procambarus sp.	1	-
7	Etheostoma fonticola	1	17
	Lepomis sp.	1	24
	Procambarus sp.	2	-
8	Procambarus sp.	1	-
9	No fish collected	-	-
10	No fish collected	-	-
11	Procambarus sp.	1	-
12	No fish collected	-	-
13	No fish collected	-	-
14	No fish collected	-	-
15	Etheostoma fonticola	1	20
16	Etheostoma fonticola	1	20
17	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2187	I-35	S1	10/17/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Ambloplites rupestris	1	54
	Etheostoma fonticola	2	17, 15
	Gambusia sp.	1	
	Procambarus sp.	4	-
2	Dionda nigrotaeniata	1	60
	Procambarus sp.	4	-
3	Procambarus sp.	2	-
4	Ambloplites rupestris	1	62
	Herichthys cyanoguttatus	1	40
	Procambarus sp.	8	-
5	Procambarus sp.	3	-
6	Etheostoma fonticola	2	35, 25
	Procambarus sp.	4	-
7	Gambusia sp.	1	23
8	Lepomis miniatus	2	93, 63
	Procambarus sp.	10	-
9	Procambarus sp.	5	-
10	Procambarus sp.	1	-
11	No fish collected	-	-
12	Procambarus sp.	1	-
13	Lepomis miniatus	1	80
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2188	I-35	S2	10/17/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Ambloplites rupestris	1	104
	Procambarus sp.	4	-
2	Lepomis miniatus	1	99
	Procambarus sp.	3	-
3	No fish collected	-	-
4	No fish collected	-	-
5	Procambarus sp.	2	-
6	Procambarus sp.	1	-
7	Procambarus sp.	1	-
8	No fish collected	-	-
9	No fish collected	-	-
10	No fish collected	-	-
11	No fish collected	-	-
12	No fish collected	-	-
13	Procambarus sp.	1	-
14	No fish collected	-	-
15	No fish collected	-	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2189	I-35	H1	10/17/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Ambloplites rupestris	1	65
	Etheostoma fonticola	1	12
	Gambusia sp.	4	26, 19, 20, 22
	Procambarus sp.	14	-
2	Astyanax mexicanus	1	30
	Gambusia sp.	3	23, 20, 21
	Lepomis macrochirus	1	70
	Procambarus sp.	9	-
3	Procambarus sp.	5	-
4	Procambarus sp.	5	-
5	Ambloplites rupestris	1	107
	Etheostoma fonticola	1	30
	Procambarus sp.	4	-
6	Palaemonetes sp.	1	-
	Procambarus sp.	2	-
7	Procambarus sp.	2	-
8	Etheostoma fonticola	1	14
	Procambarus sp.	3	-
9	No fish collected	-	-
10	No fish collected	-	-
11	Etheostoma fonticola	1	39
	Procambarus sp.	1	-
12	Procambarus sp.	2	-
13	Hypostomus plecostomus	1	20
14	No fish collected	-	-
15	Procambarus sp.	2	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2190	I-35	H2	10/17/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Ambloplites rupestris	2	40, 82
	Gambusia sp.	13	18, 15, 15, 12, 35, 2, 9, 21, 16, 15, 16, 20, 15
	Procambarus sp.	11	-
2	Gambusia sp.	2	16, 15
	Procambarus sp.	12	-
3	Gambusia sp.	1	20
	Procambarus sp.	6	-
4	Gambusia sp.	3	38, 20, 21
	Procambarus sp.	7	-
5	Gambusia sp.	1	18
	Procambarus sp.	3	-
6	No fish collected	-	-
7	Gambusia sp.	1	18
	Lepomis miniatus	1	70
8	No fish collected	-	-
9	Gambusia sp.	1	38
	Procambarus sp.	1	-
10	No fish collected	-	-
11	No fish collected	-	-
12	Gambusia sp.	2	25, 20
13	No fish collected	-	-
14	Procambarus sp.	1	-
15	Procambarus sp.	1	-

DROP NET-FIELD DATA SHEETS

SAN MARCOS RIVER-FALL 2017 SAMPLING

SiteCode	Location (Reach):	Site:	Date:
2191	I-35	L1	10/17/2017

SAN MARCOS RIVER-FALL 2017 SAMPLING

Dip Net Sweep	Species	Number	Length (mm)
1	Gambusia sp.	1	20
	Procambarus sp.	4	-
2	Etheostoma fonticola	1	30
	Gambusia sp.	5	15, 16, 19, 10, 8
	Procambarus sp.	31	-
3	Gambusia sp.	4	20, 27, 21, 11
	Procambarus sp.	17	-
4	Gambusia sp.	4	20, 20, 24, 17
	Procambarus sp.	18	-
5	Etheostoma fonticola	1	20
	Procambarus sp.	22	-
6	Gambusia sp.	1	22
	Procambarus sp.	19	-
7	Gambusia sp.	4	20, 19, 16, 13
	Procambarus sp.	16	-
8	Procambarus sp.	8	-
9	Etheostoma fonticola	1	42
	Procambarus sp.	28	-
10	Etheostoma fonticola	1	25
	Procambarus sp.	3	-
11	Procambarus sp.	7	-
12	Procambarus sp.	7	-
13	Etheostoma fonticola	1	26
	Procambarus sp.	6	-
14	Procambarus sp.	7	-
15	Procambarus sp.	2	-