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 2016 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 were also collected on aquatic vegetation, 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 2016.

Results from 2016 provided unique insight into the continued transition from a prolonged drought to subsequent average to 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 and total system discharge in the San Marcos system. In fact, total system discharge remained at or above historical averages for the entirety of 2016. This increased total system discharge, which climbed to mean monthly levels not witnessed over the 15 years of biological monitoring, shaped (both positive and negative) the ecological landscape of the San Marcos system in 2016.

Similar to 2015, standard water quality parameters remained constant throughout 2016 and no recorded water temperatures exceeded the 26.7 ºC TCEQ water quality standard. Aquatic vegetation rebounded in total coverage in all monitoring reaches relative to the flooding impacts observed in late 2015. However, the recovery did not result in a return to long-term average aquatic vegetation conditions over the course of 2016 as expected. Higher flows in the river created more root wad scour and limited both the settling out and reestablishment of floating vegetative fragments as well as aquatic vegetation expansion from base plants. Although the aquatic vegetation in the Spring Lake Dam reach was below the fall long-term study average, the spring to fall decrease (-8%) in aquatic vegetation was approximately half the typical spring to fall decrease in this reach observed in previous years (-16%). This is likely a result of less recreation pressure directly associated with the fencing installed around the Spring Lake dam reach after the fall 2015 flood. Highlighting the on-going HCP restoration success, Texas wild rice was reported at the highest levels since Edwards Aquifer Authority biological monitoring was initiated over 15 years ago. Over 7,700 m^2 of Texas wild rice was mapped in August 2016.

Normalized fountain darter population estimates remained below the long-term averages in 2016. This result for the spring sampling likely reflects a delayed result of the November 2015 flood as that high-flow event scoured a considerable amount of aquatic vegetation. A driving factor for 2016 overall is likely the higher than average flows experienced that appear to have impeded aquatic vegetation recovery at levels typically experienced. Sampling of the overall fish community in the San Marcos River continued to reflect a diverse community of fishes resilient to the varying hydrology. Four years of fish community sampling since 2013 in the San Marcos River has resulted in collection of over 29,000 fishes representing 37 different species. In comparison, the San Marcos River dropnet database (2000-2016) contains over 58,000 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 sunfish and minnows. Additionally, fish community sampling is conducted much lower in the system than dropnet sampling, which does not extend below I-35. As a result, riverine fish characteristic of downstream areas are more abundant within fish community data than dropnet data. San Marcos salamander densities remained consistent with previous year's results, and similar to the fish community data, sampling of the macroinvertebrate community reflected a taxonomically rich and diverse population.

Following the prolonged drought in Texas, total system discharge in the San Marcos system increased considerably over the course of 2015 and extended throughout 2016. Unlike the Comal system, this dramatic increase in total system discharge did not necessarily translate to improved ecological conditions for all HCP species in the San Marcos system. The most notable impacts were to fountain darter habitat in the river proper. Yet, in spite of this impediment, Texas wild rice coverage was the highest it's been since this study began in 2000. This milestone is the result of a comprehensive HCP restoration plan with concentrated efforts to protect this endangered species. Future biological monitoring to assess conditions as well as quantify effects (both positive and negative) from mitigation and restoration activities is imperative to better understanding this dynamic system.

INTRODUCTION

Section 6.3.1 of the Edwards Aquifer Habitat Conservation Plan (HCP) lays out the path for continuation of biological monitoring. Formerly known as the Edwards Aquifer Authority (EAA) Variable Flow Study, the program initially included comprehensive sampling during "normal," set temporal periods, as well as specific, triggered sampling for low-flow events (i.e., Critical Period sampling) to gather baseline and Critical Period data for use in assessing ecological conditions and filling important data gaps relative to threatened and endangered species and their habitats. The importance of documenting effects of high-flow events was recognized and added to the Critical Period component. This foundational objective is still valid today, as continued monitoring of system conditions over time and filling in important data gaps where appropriate and practical remain imperative to the success of the HCP. However, the utility of the HCP biological monitoring program has surpassed this original goal and objective, with biological monitoring data collected through this original program (BIO-WEST 2001a–2014a, b) serving as the cornerstone for:

1. Development of the HCP long-term biological goals and objectives (HCP Section 4.1),

2. Development of HCP flow management objectives (flow regimes) embedded within the long-term biological goals (HCP Section 4.1),

3. Determining potential impacts to and incidental take assessment relative to the HCP and Environmental Impact Statement alternatives (HCP Section 4.2), and

4. Establishing 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 progresses, successful execution of the biological monitoring program is mandatory to adequately assess items 1–3 relative to HCP Phase II decisions. Item 4 is essential for the protection of the species should low-flow conditions occur.

Additionally, the HCP biological monitoring program data, in conjunction with other available information, are essential for the following tasks:

5. Assessing the effectiveness and efficiency of HCP mitigation/restoration activities being conducted in both the Comal and San Marcos springs systems.

6. Providing data to inform the ongoing HCP ecological model development either through parameterization and/or validation.

7. Calculating the HCP habitat baseline and net disturbance determination.

8. Calculating the HCP annual "take" estimate.

Items 5 and 6 again relate to providing guidance to assist with HCP Phase II decisions regarding achieving long-term biological goals and the level of protection afforded by the HCP flow-management objectives. Items 7 and 8 focus on addressing annual report requirements for the U.S. Fish and Wildlife Service (USFWS) Incidental Take Permit (ITP).

Needless to say, the current HCP biological monitoring program has expanded from monitoring with the sole objective to assess endangered species and habitat over time. In addition to the comprehensive and Critical Period monitoring already established and ongoing, a new sampling directive entitled "HCP species-specific sampling" was added to the program in 2013. The HCP species-specific sampling is triggered by low-flow conditions (similar to Critical Period sampling) but directly supports HCP adaptive management decisions (HCP Section 6.4.4).

It is important to recognize 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:

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*) dropnet
    - Fountain darter presence/absence dipnet sampling
    - Macroinvertebrate community sampling

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

5. River Section/Segment Sampling
    - Fountain darter timed dipnet surveys
    - Fish community sampling

The following sections provide a description of methods for all 2016 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 2016a).

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 (*Zizania texana*), San Marcos salamander (*Eurycea nana*), San Marcos gambusia (*Gambusia georgei*), Comal Springs riffle beetle (*Heterelmis comalensis*), Texas blind salamander (*Eurycea rathbuni*), and fountain darter (*Etheostoma fonticola*). 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 2016, two comprehensive sampling efforts (spring and fall) and several annual activities were conducted in the San Marcos River system. The 2016 sampling schedule included the following components:

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

Water Quality
Thermistor placement and retrieval
Fixed-station photography
Point water quality measurements
Grab samples (Critical Period only)

San Marcos Salamander Observations
Snorkel/SCUBA surveys

Texas Wild rice Physical Observations
Cross-section data
Physical measurements

Fountain Darter Sampling
Dropnets, dipnets
Visual observations

Fish Community Sampling
SCUBA surveys
Seining

Macroinvertebrate Community Sampling

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 conducted in the 2016 monitoring and so these will not be discussed any further in this report. See previous annual reports for a synopsis and examples.

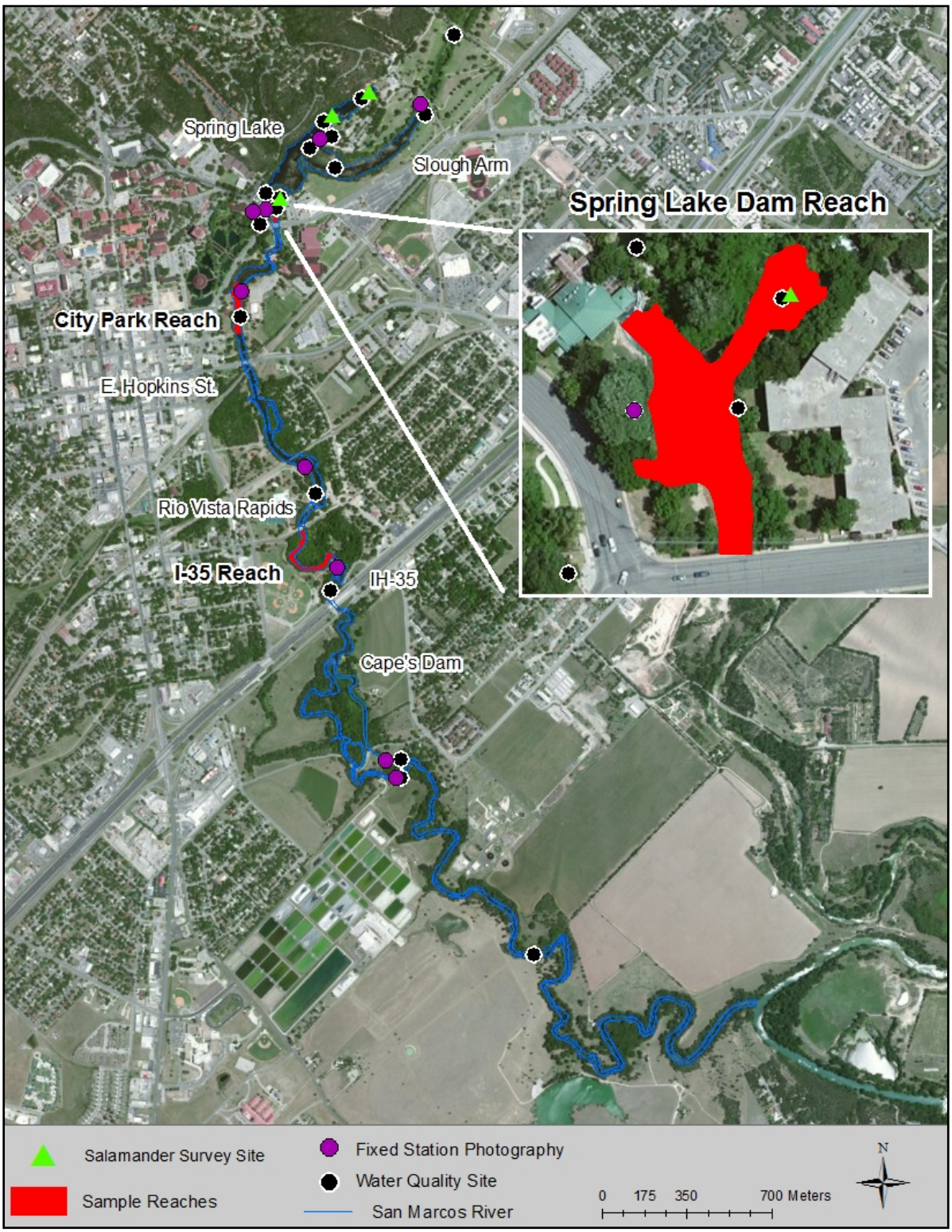

Figure 1. Upper San Marcos River sample reaches, San Marcos salamander count sites, water quality sampling sites, and fixed-station photography sites.

San Marcos Springflow

Total San Marcos River discharge data was acquired from the 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 2016). 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

Standard physio-chemical parameters, including water temperature, conductivity, pH, dissolved oxygen (DO), water depth at sampling point, and observations of local conditions, were recorded at all dropnet sampling sites and fish community sampling locations using a multiprobe water quality sonde. In addition, fixed-station photography continues to provide visual proof of changes in the system. It is important to note that comprehensive water, sediment 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 2016, 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 converted into 4-hour averages for analysis. 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). During these events two 500-milliliter (mL) surface-water samples are collected at each site. One of the two samples are left unpreserved for nitrate, soluble reactive phosphorus (SRP), alkalinity and total suspended solid (TSS) analyses, and the other sample is acidified with sulfuric acid for ammonia, total nitrogen, and total phosphorus analyses. Chemical analyses of surface water samples are conducted at an accredited laboratory, where water chemistry parameters are determined utilizing U.S. Environmental Protection Agency standard methods. No critical period sampling events were triggered in 2016 and thus, no water quality grab sampling was performed.

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 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

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 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 2016. 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.

Kayak-mounted GPS equipment used during aquatic vegetation mapping.

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 2016 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 the imaginary rectangle created from the maximum length and maximum width measurements.

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

Dropnet Sampling

A dropnet 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 dipnet (1 m^2) is used within the dropnet 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 dropnet was placed in randomly selected sites within specific aquatic vegetation types. The vegetation types sampled in each reach were those defined at the beginning of the study as dominant species found in that reach. Sampling sites were randomly selected per dominant vegetation type from a grid overlain on the most recent map (created using GPS-collected data 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 dropnets. However, in 2013, the Spring Lake Dam Reach was added to dropnet sampling efforts.

Dropnet 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 measurements were taken for all other fish species, except for 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 dipnet sweep.

Dipnet Sampling

In addition to dropnet sampling for fountain darters, a dipnet of approximately 40 cm x 40 cm (1.6-millimeter [mm] mesh) was used to conduct three separate types of fountain darter sampling (timed, random, and fixed-station surveys).

Dipnet Timed Surveys

For timed dipnet 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 dipnet 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.

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. Though information relating the number of fountain darters by vegetation type was not gathered using this method (as in the dropnet sampling), it did permit a more thorough exploration of various habitats within the reach. Also, 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. Dipnet data were used to identify periods of fountain darter reproductive activity because this method was efficient for collecting small fountain darters (<15 mm).

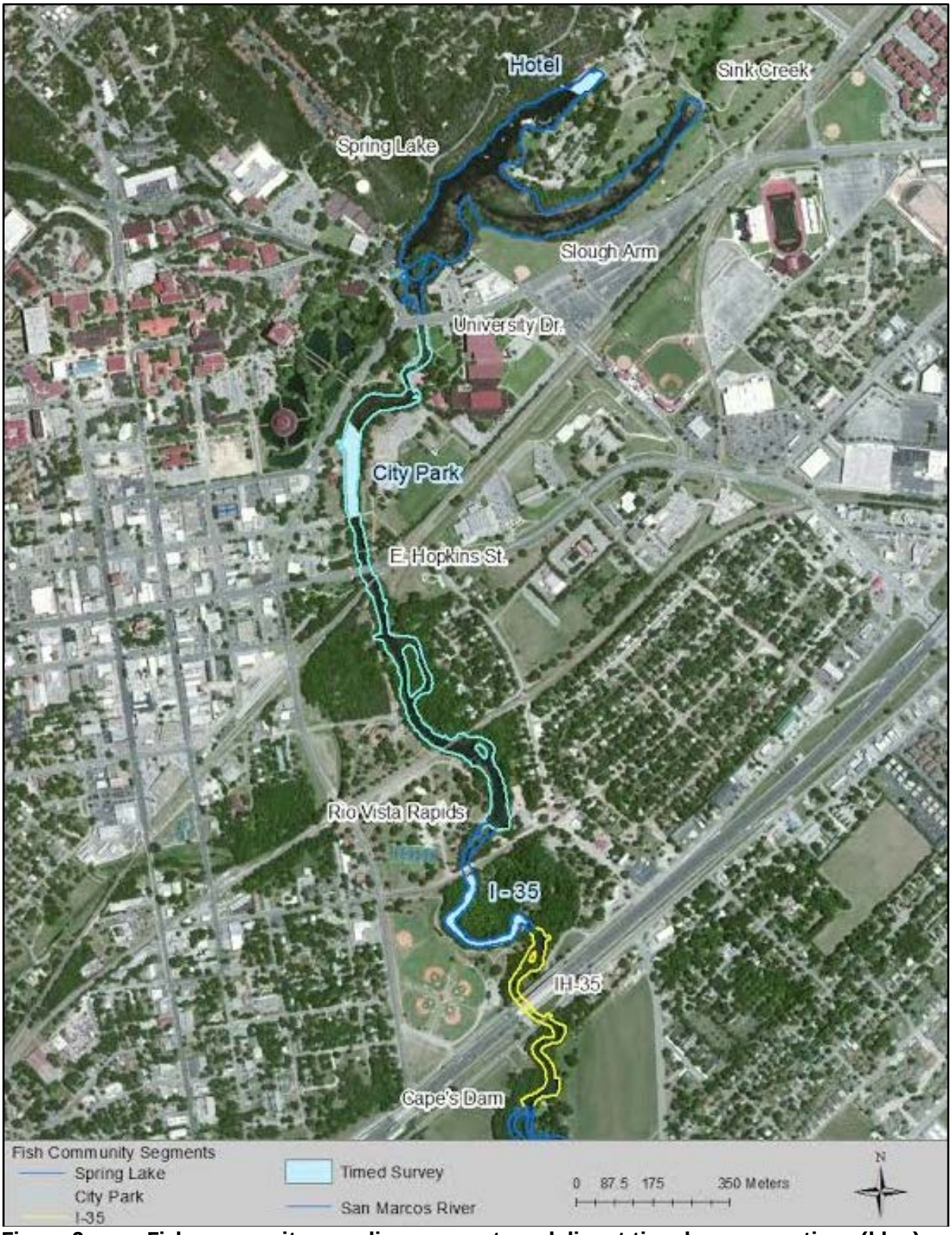

Figure 2. Fish community sampling segments and dipnet timed survey sections (blue) for the upper San Marcos River.

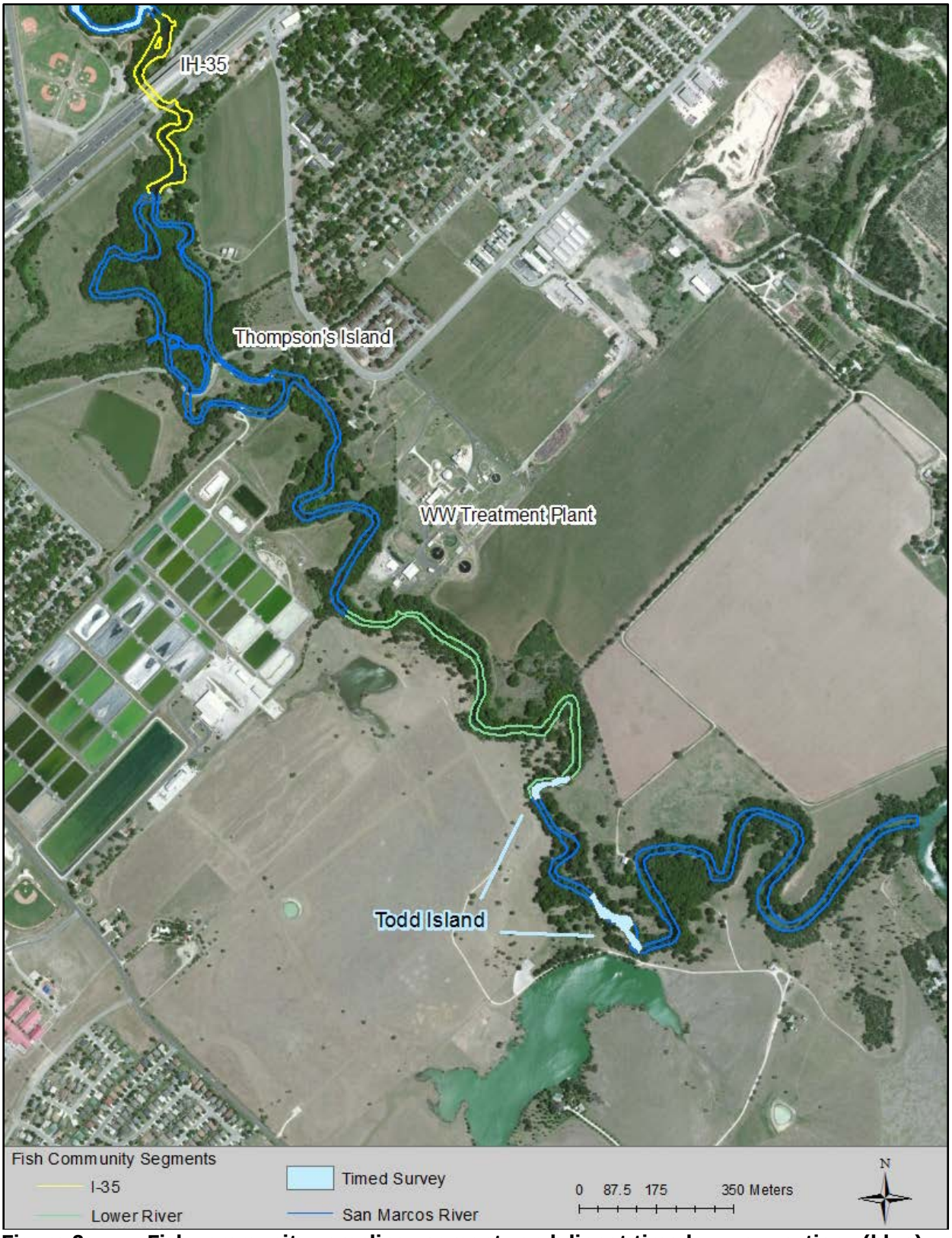

Figure 3. Fish community sampling segments and dipnet timed survey sections (blue) for the San Marcos River.

Random Dipnet Surveys

Random presence/absence dipnet sampling was initiated on the San Marcos River during spring 2006. This method is designed to be a quick, efficient, and repetitive means of monitoring the fountain darter population. Also, because it is less destructive than using a dropnet, it can be conducted during extremely low-flow periods with fewer disturbances to critical habitat. During each sample, 50 sites were distributed among three sample reaches (Figure 1) based on total area, diversity of vegetation, previous fountain darter abundance estimates, and overall biological importance of each sample reach. Fifteen sites were chosen in the Spring Lake Dam Reach, 20 sites were chosen in the City Park Reach, and 15 sites were chosen in the I-35 Reach. Several sites were chosen in each of the dominant vegetation types in each reach. However, because vegetation coverage changed often, the number of sites within each vegetation type fluctuated slightly between samples. Four dips were conducted at each site 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 dipnet area. After all dips were completed at a site, all organisms were released near the site of capture.

Fixed-station Dipnet Sampling

In addition to random presence/absence dipnet sampling, 50 fixed sampling locations for the collection of presence/absence data to be used in occupancy analysis were established in the San Marcos River in 2014 and continued through 2016. The overall number of fixed stations remained the same (50) as in the random site sampling scheme, as did their distribution among sample reaches. However, locations were fixed over time. The rationale for continuing both methods is that there is an established baseline for the random approach in place and, if drought conditions continue, there will be a need to confidently evaluate trigger mechanisms designated in the HCP. Additionally, because of the importance associated with this sampling component by the HCP adaptive management decision-making process, a period of overlapping data has been collected to observe and test differences between techniques and establish a baseline with the fixed-station approach.

Sampling methods were identical to those described for the presence/absence survey above, although additional data regarding habitat conditions were noted. At each fixed station, four dips were conducted with a 40-cm x 40-cm dipnet with 1.6-mm mesh. Presence or absence of fountain darters was noted on each dip. To avoid recapture, fountain darters were placed in a tub or moved a sufficient distance away from the dipnet area until sampling was complete. At each location, the dominant surficial substrate (clay, silt, sand, gravel, cobble, boulder, bedrock) was categorized based on the modified Wentworth scale (Cummins 1962), and the dominant type of aquatic vegetation was noted (e.g., *Sagittaria*, bryophytes, open). Also, since bryophytes are a key fountain darter habitat component and can grow within or attached to other vegetation types, presence/absence of bryophytes at each site was also noted. After four dips were completed and all necessary data were recorded, all organisms were released near the site of capture.

Fish Community Sampling

A multifaceted sampling methodology was again employed in 2016 to efficiently monitor fish community composition and abundance 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 San Marcos River in 2016.

Seining in the San Marcos River.

For fish community monitoring, the San Marcos system was split into the following four segments: Spring Lake, City Park, I-35, and 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 equally spaced along the stream bottom 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 millimeter total length, enumerated, and placed in a bucket containing river water to prevent recapture in subsequent seine hauls. 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 number of fishes or species caught 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.

San Marcos Salamander Visual Observations

San Marcos salamander sampling in Spring Lake.

In 2016 visual salamander surveys were conducted 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.

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.

Macroinvertebrate Community Sampling

In 2016, BIO-WEST conducted macroinvertebrate community sampling to determine species composition, relative number, and vegetation associations of macroinvertebrates in the City Park, I-35, and Spring Lake Dam reaches within the San Marcos system (Figure 1). As part of twice-annual comprehensive sampling efforts, macroinvertebrate community samples were collected from dominant vegetation types at each of the three reaches in the San Marcos system during spring (May 6, 2016) and fall (October 11, 2016).

Macroinvertebrate sampling using the Custom-built Triple-H sampler.

For each dominant vegetation type at each site, crews made three grab samples in areas with 100% cover of that vegetation type. Vegetation types sampled at each reach depended on the types of vegetation present at each site at the time of the sampling event. Samples were collected using a custom-built Triple-H sampler (pictured above), which allows collection of consistent volumes of sediment and vegetation at different sites and is similar to an Ekman sampler in function. Upon collection, the three grab samples taken per vegetation type were composited in a 541 micrometer (µm) sieve bucket, washed, and picked through to remove large objects and debris (e.g., sticks, rocks, and vegetation). Washed samples were placed into plastic containers, preserved in 95% ethanol, and transported to the laboratory, where the collected macroinvertebrates were picked out and placed into sample vials containing 95% ethanol. These samples were sent to a taxonomist who identified organisms to the lowest level practical, results of which are presented in Appendix C.

Please note that in 2016 analyses of macroinvertebrate abundance and taxonomic richness were restricted to those taxa that were identified to at least family or, in the case of chironomids, subclass. For this reason, Cladocera, Euhirundea, Gastropoda, Oligochaeta, and Ostracoda were excluded from the analyses presented in this report unless otherwise stated in the text. However, unaltered count data for all taxa collected in 2016 are presented in Appendix C.

OBSERVATIONS

The project team conducted 2016 comprehensive sampling during three different periods: Spring full event (April 8 – May 11), Summer fountain darter dipnet sampling and Texas wild rice annual mapping (July 14 – August 15), and Fall full event (October 12 – October 28).

San Marcos Springflow

Total system mean monthly discharge in the San Marcos River during 2016 exceeded the long-term average in the system for the entirety of the year (Figure 4). A minimum average daily flow of 227 cfs occurred on March 29th and the maximum average daily flow of 737 cfs occurred on September 26th (Table 1). The 2016 minimum average daily flow was the highest recorded during EAA's long-term biological monitoring (2000-2016).

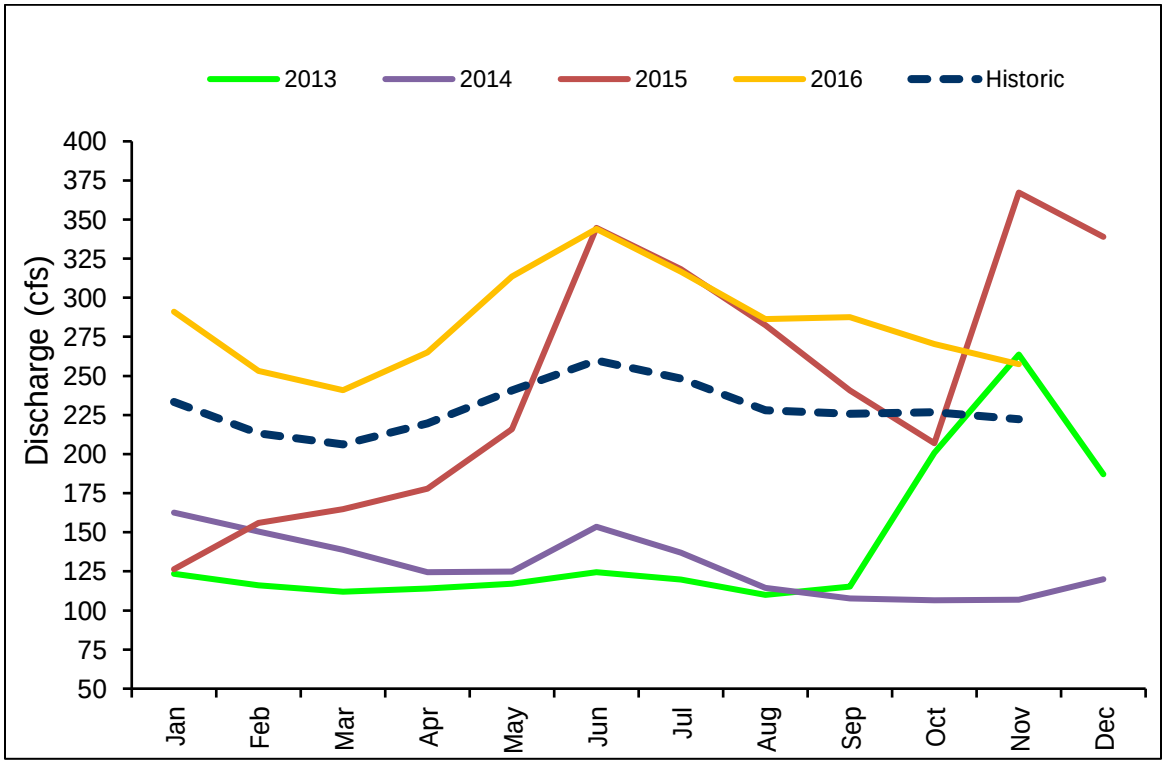

Figure 4. Mean monthly discharge (cubic feet per second) in the San Marcos River during recent years and the 1956–2016 period of record.

Table 1. Minimum and maximum daily average discharge (cubic feet per second) 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	550[a]
2016	227	737

[a] Flows for the May/June and October flood events have not been estimated by USGS.

Central Texas experienced considerable rainfall for the second consecutive year as evident in the discharge measurements from the San Marcos River (Figure 4). Spring discharge levels were quite high paralleling discharge levels observed in spring 2015. Figure 5 reflects the long-term daily discharge for the San Marcos River and how each daily high flow event (spikes) compare over time. Although estimates are not available for the two large floods in 2015 due to gage malfunctions, it is likely that these were the largest events since biological monitoring began.

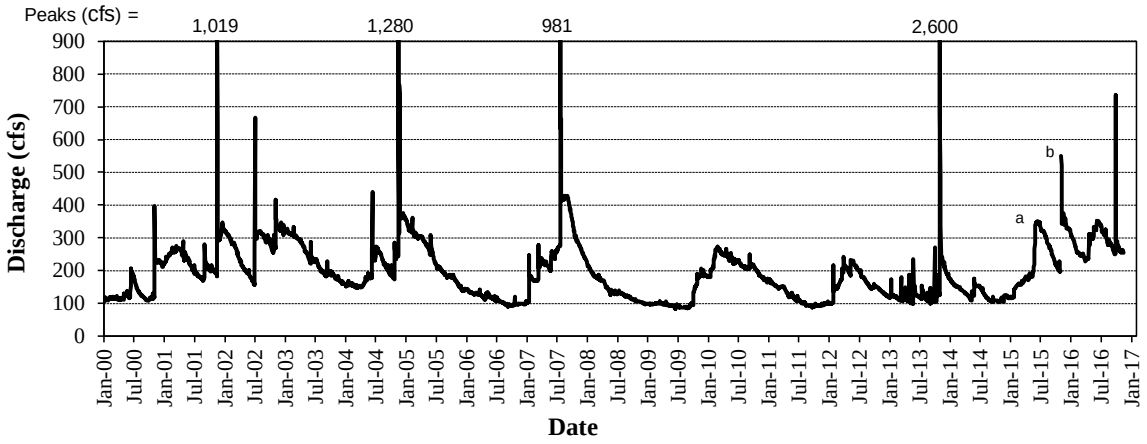

Figure 5. Daily average discharge (cubic feet per second) for the San Marcos River since the beginning of monitoring in 2000. [a] Memorial Day weekend flood 2015, USGS estimate not available. [b] Late-October flood 2015, USGS estimate not available.

Water Quality Results

Water Temperature Thermistors

The continuously sampled water temperature data provide information regarding fluctuations due to atmospheric conditions and springflow influences in the San Marcos River from 2000 to 2016. 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. 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 I35 sites recorded during the higher discharge years of 2015 and 2016 versus the fluctuating water temperatures at these sites during the previous drought (Figure 6).

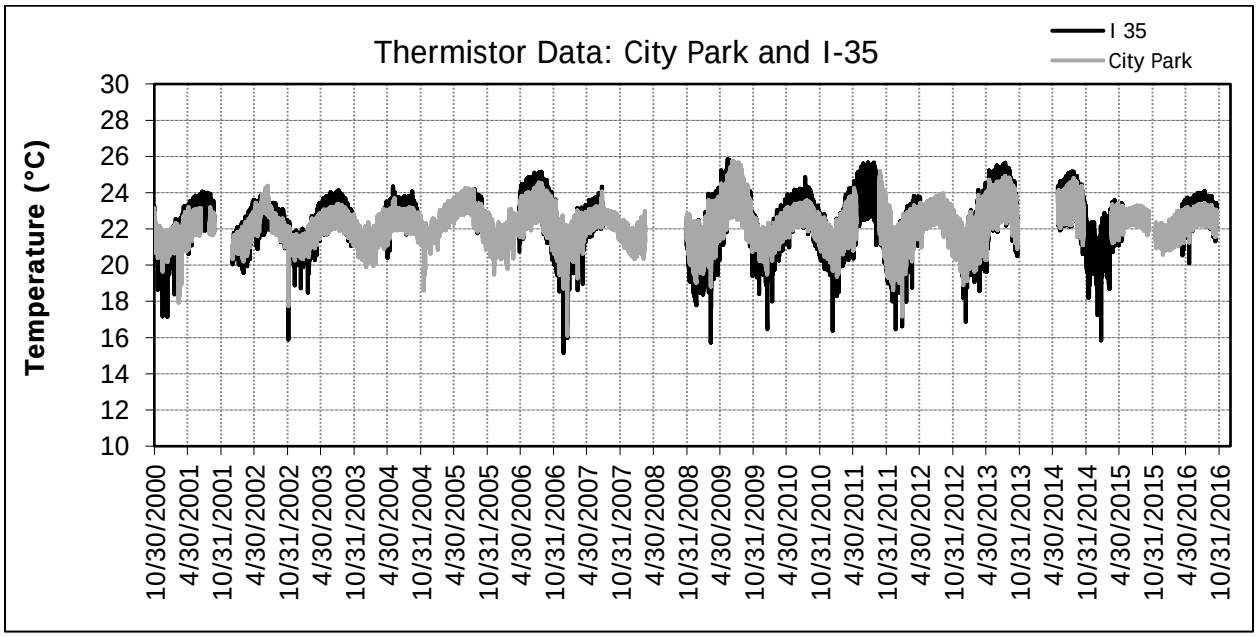

Figure 6. Thermistor data from the City Park and I-35 reaches.

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 in closer proximity to spring inputs (I-35, City Park). It is interesting to note that although the Animal Shelter thermistor is well downstream of spring inputs, water temperatures there still exhibited minimal variation compared to other rivers in the region. No thermistors collected readings that exceeded the Texas Commission on Environmental Quality's (TCEQ) water quality standard of 26.67 ºC for the San Marcos River in 2016 (Appendix C).

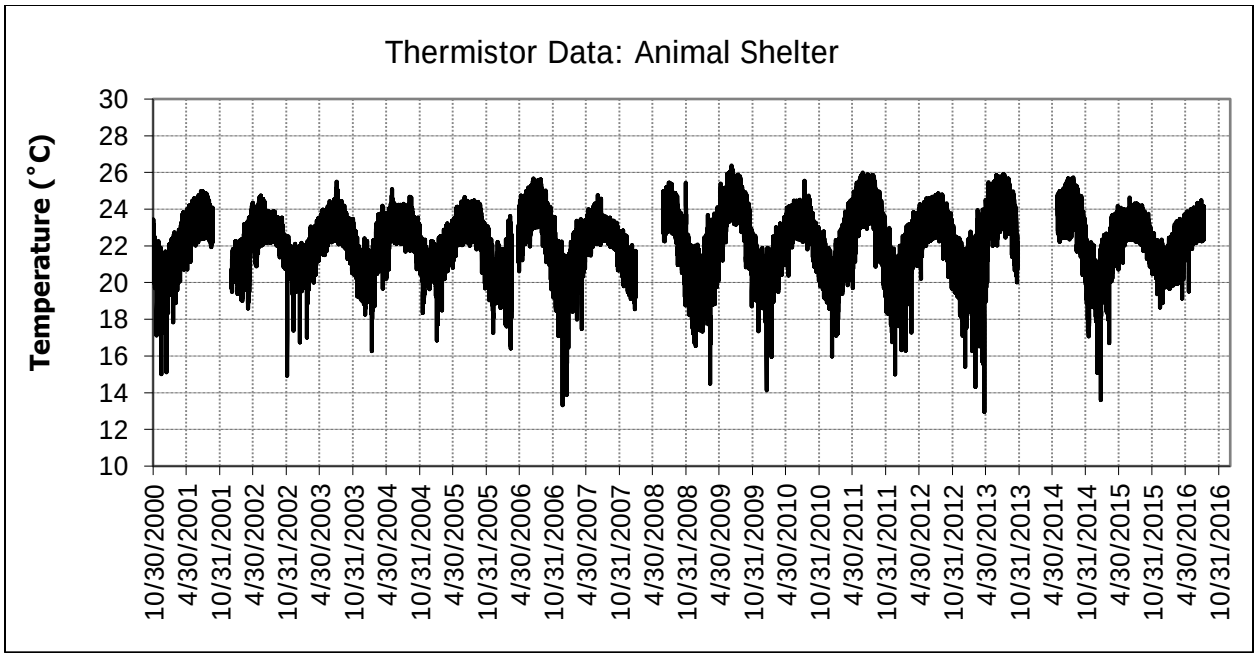

Figure 7. Thermistor data from the Animal Shelter reach.

Edwards Aquifer Authority Manta 2 Sonde Data

In 2012 the 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 2016 are summarized below. These data were taken directly from the EAA Environet web-based water quality data service (Edwards Aquifer Authority 2016b, provisional data).

Similar to the thermistor data collected in City Park previously referenced, the EAA sonde data showed little variation throughout the year. Temperature data for Aquarena Drive and Rio Vista Park are shown in Figure 8 and the data from near the fish hatchery in Figure 9. In 2016, no site had temperatures that exceeded the 26.7 ºC TCEQ water quality standard for the San Marcos River. Stable temperatures in 2016 mirror the long-term water temperatures collected over the course of HCP biological monitoring at City Park (Figure 6) and Rio Vista Dam (Appendix C).

Dissolved oxygen (DO) at Rio Vista Park averaged 7.37 mg/l with a max of 11.11 mg/l in 2016, while DO at Aquarena Drive averaged 7.92 with a max of 9.24 mg/l (Figure 10). Dissolved oxygen at the fish hatchery site ranged from 6.41 mg/l to 10.16 mg/l with an average of 8.40 mg/l in 2016. All three sites display relatively similar averages of DO; however, the Rio Vista site exhibited the largest variation around the DO average. Aquarena Drive is just downstream of Spring Lake where there is more mixing of water from the pour-off of the dam, and this results in less variation in DO observations. The sonde at the fish hatchery location is in an area of the Thomson Island natural channel that is fairly shallow with fast moving turbulent water similar to the Aquarena Drive site. This results in more mixing of the water column and less DO variation overall (Figure 11). Short-term drops in conductivity could be a result of low-conductivity rainwater entering the system after precipitation events (Figure 12). pH values were generally

higher at Thompson's Island than at Aquarena Drive. Lower pH at Aquarena Drive is a result of proximity to springs and higher carbonic acid levels in springwater (Figure 13).

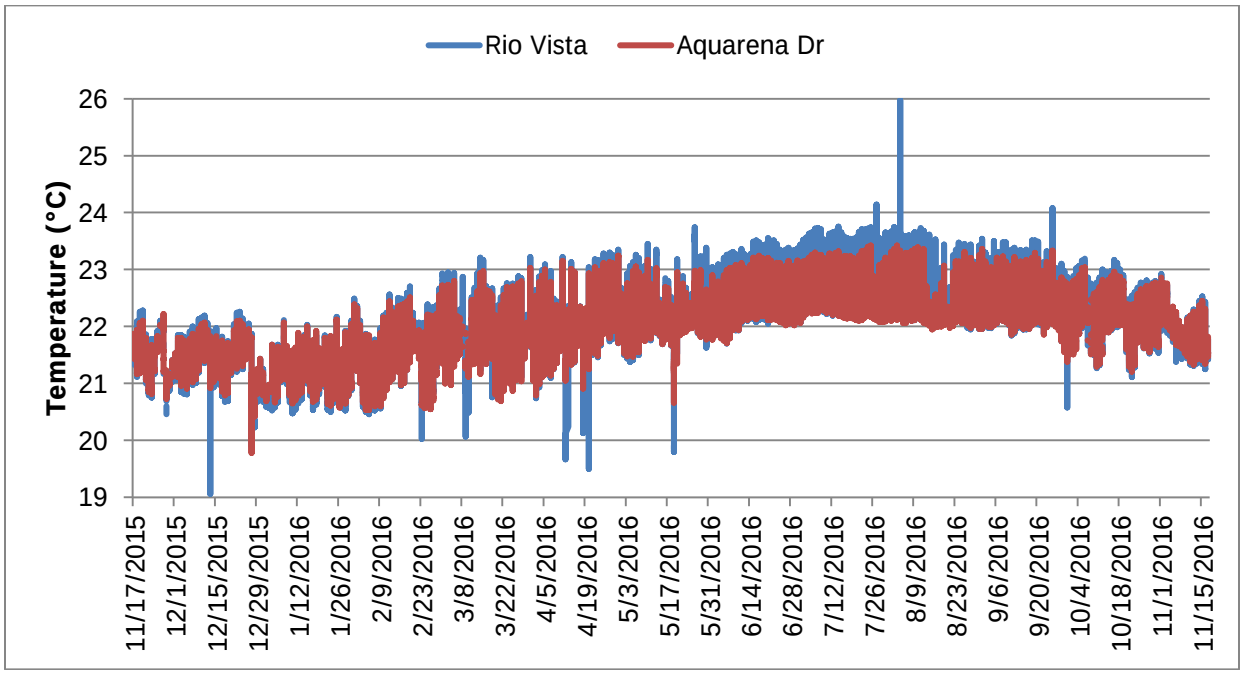

Figure 8. Edwards Aquifer Authority Manta 2 multiprobe temperature data from Rio Vista Park and Aquarena Drive.

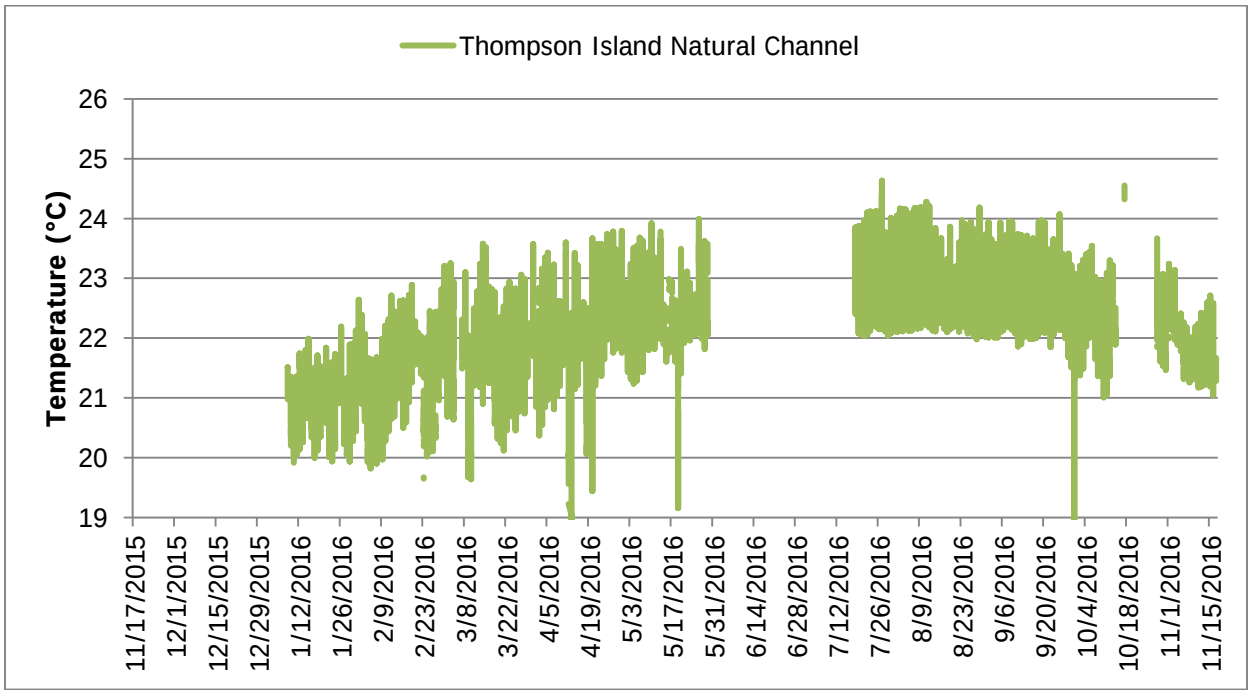

Figure 9. Edwards Aquifer Authority Manta 2 multiprobe temperature data from the Thompson Island Natural Channel.

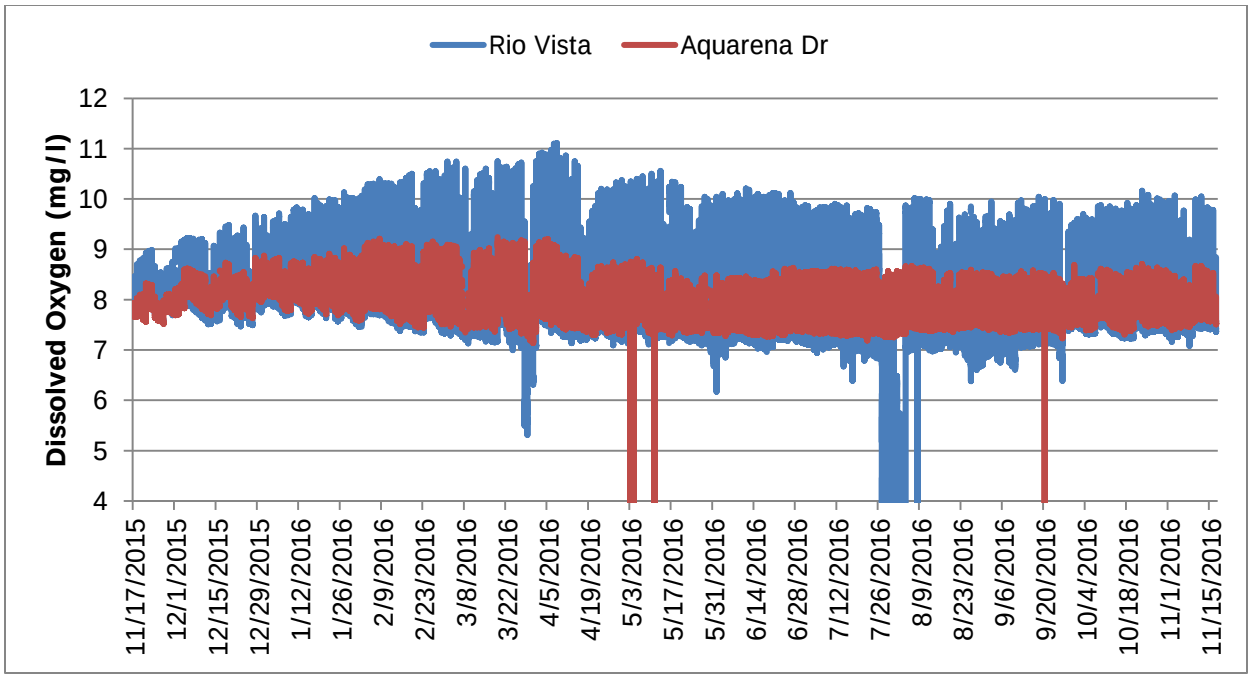

Figure 10. Edwards Aquifer Authority Manta 2 multiprobe dissolved oxygen (DO) data from Rio Vista Park and Aquarena Drive.

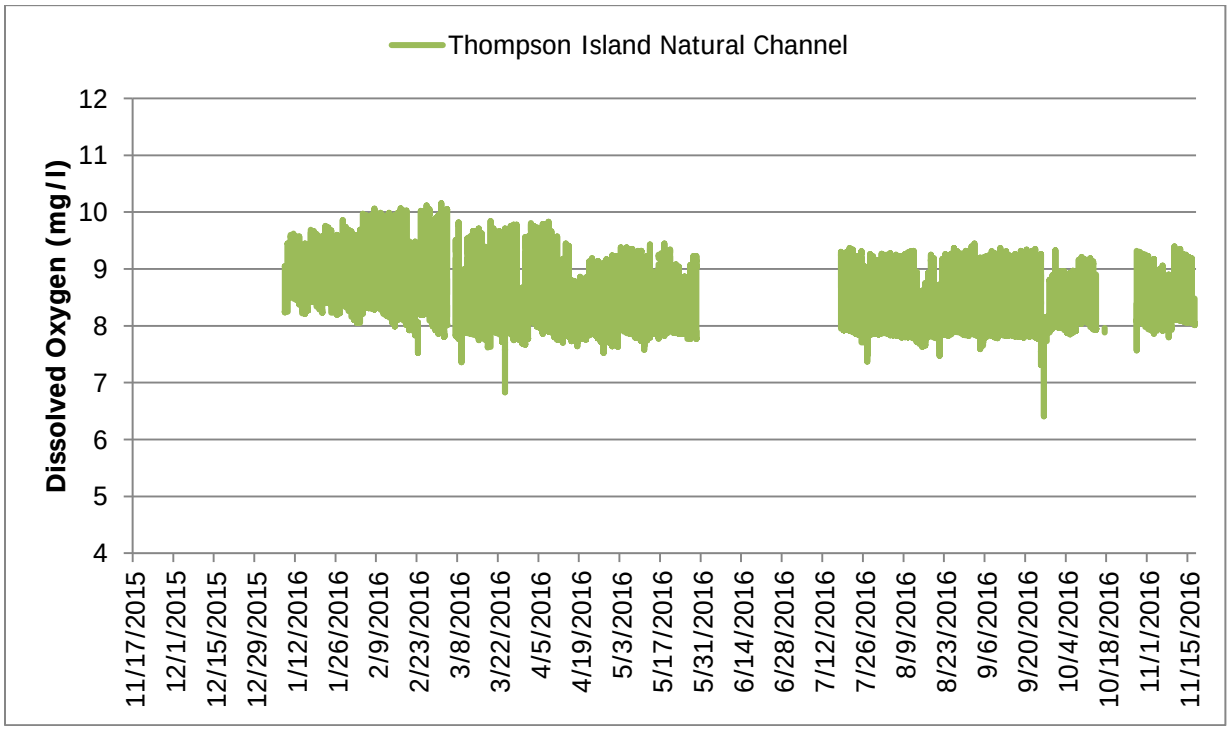

Figure 11. Edwards Aquifer Authority Manta 2 multiprobe dissolved oxygen (DO) data from Thompson Island Natural Channel.

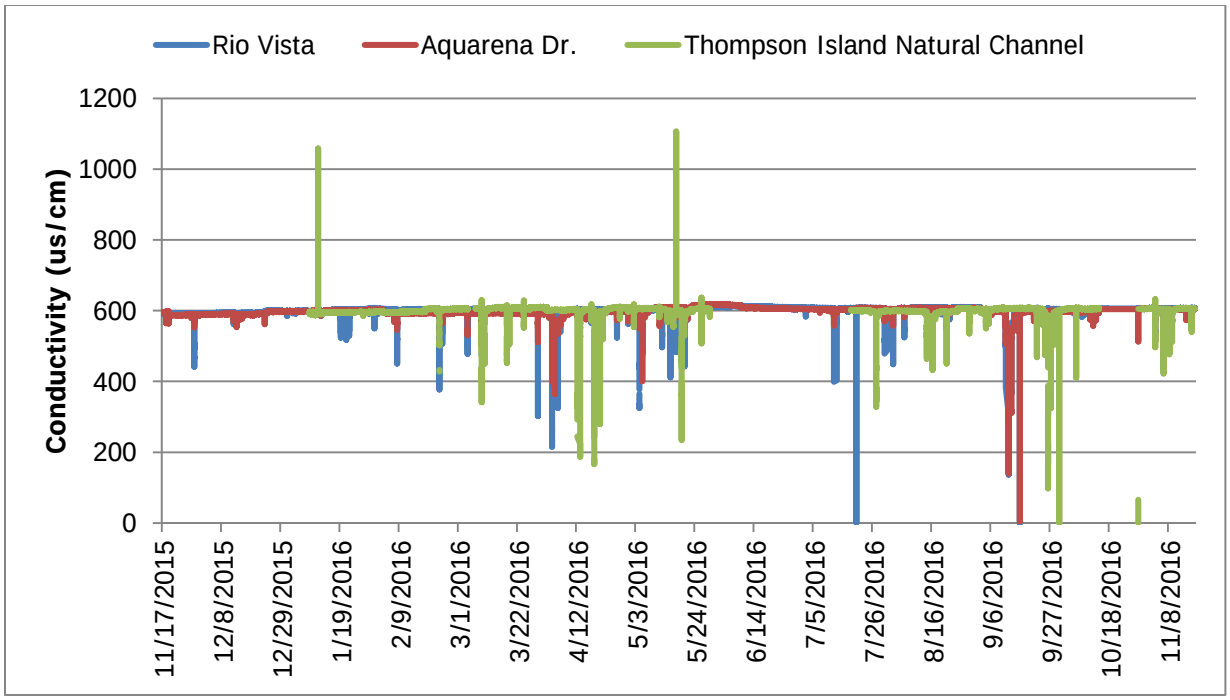

Figure 12. Edwards Aquifer Authority Manta 2 multiprobe conductivity data from Rio Vista Park, Aquarena Drive and Thompson Island Natural Channel locations.

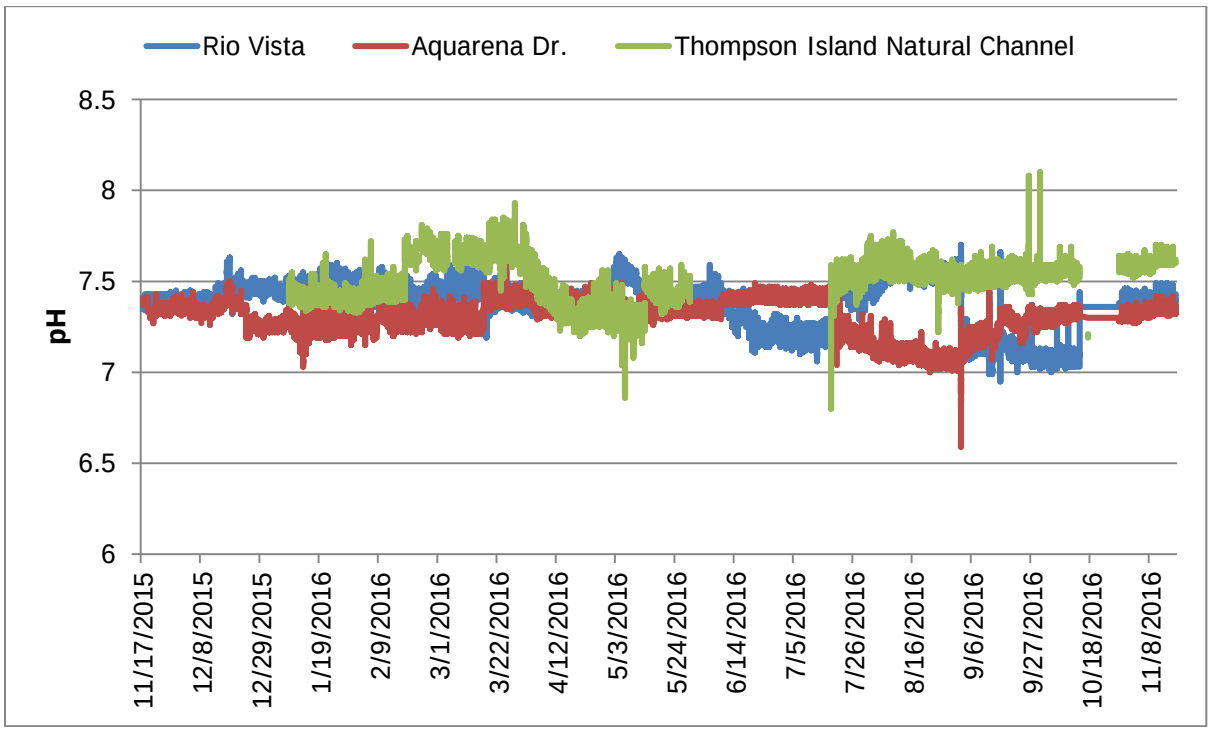

Figure 13. Edwards Aquifer Authority Manta 2 multiprobe pH data from Rio Vista Park, Aquarena Drive and Thompson Island Natural Channel locations.

Water Quality Grab Samples

No critical period water quality grab samples were collected in the San Marcos River in 2016. A more in-depth look at water and sediment quality can be found in the 2016 EAA HCP Expanded Water Quality Report (SWCA 2016, Draft). A review of the water quality results provided thus far for 2016 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

Maps of aquatic vegetation observed during each sampling effort are presented in Appendix B. The maps are organized by individual reach with successive sampling trips ordered chronologically. It is difficult to make generalizations about seasonal and other trip-to-trip characteristics because most changes occurred in fine detail; however, some of the more interesting observations are described below.

Spring Lake Dam Reach

The Spring Lake Dam Reach is the most upstream reach of the San Marcos River in this study. Total surface area of aquatic vegetation in the Spring Lake Dam Reach is highly variable due to heavy recreation pressure in the area. Recreational use by college students impacts the aquatic vegetation of this reach. Although total surface area increased after the November 2015 high-flow event (660 m^2) to 1,108 m^2 in spring 2016 this was below the long-term study average and slightly below one standard deviation (Figure 14). By fall 2016 total surface area had decreased slightly to 1,018 m^2. This total was below the fall long-term study average, but within one standard deviation (Figure 14). It should be noted that this decrease (-8%) is approximately half the typical spring to fall decrease in this reach observed in previous years (-16%). This is likely a result of less recreation pressure directly associated with the fencing installed around the Spring Lake dam reach after the fall 2015 flood. The fencing was installed to restrict access by the public while an evaluation of Spring Lake dam was performed.

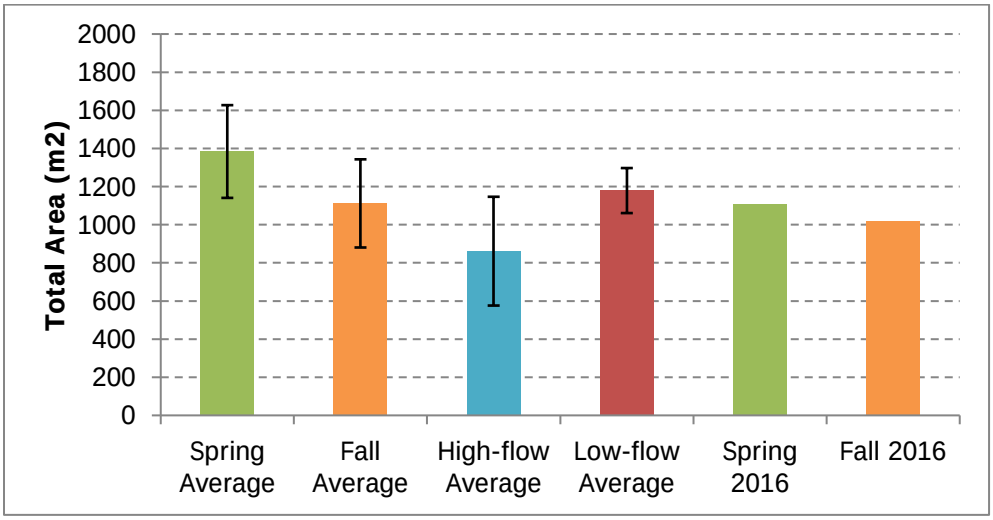

Figure 14. Total surface area (m^2) of aquatic vegetation at the Spring Lake Dam Reach. Long-term study averages are provided with bars representing one standard deviation from the mean.

City Park Reach

Total vegetation coverage after the November 2015 high-flow event (1,938 m^2) was the lowest observed in the City Park reach since the initiation of the project in 2000. Although total surface area of aquatic vegetation increased considerably from the November 2015 high-flow event to spring 2016 (3,246 m^2), it remained below the long-term spring study average and below one standard deviation from the mean (Figure 15). Total surface area of aquatic vegetation decreased further by fall 2016 (2,579 m^2) to the second lowest total vegetation coverage observed since initiation of the project. This is lower than the fall long-term study average, and again below one standard deviation from the mean. This decrease is likely a result of increasing recreation pressure during the summer months coupled with higher than average flows that impacts the ability of plants to reestablish in this reach.

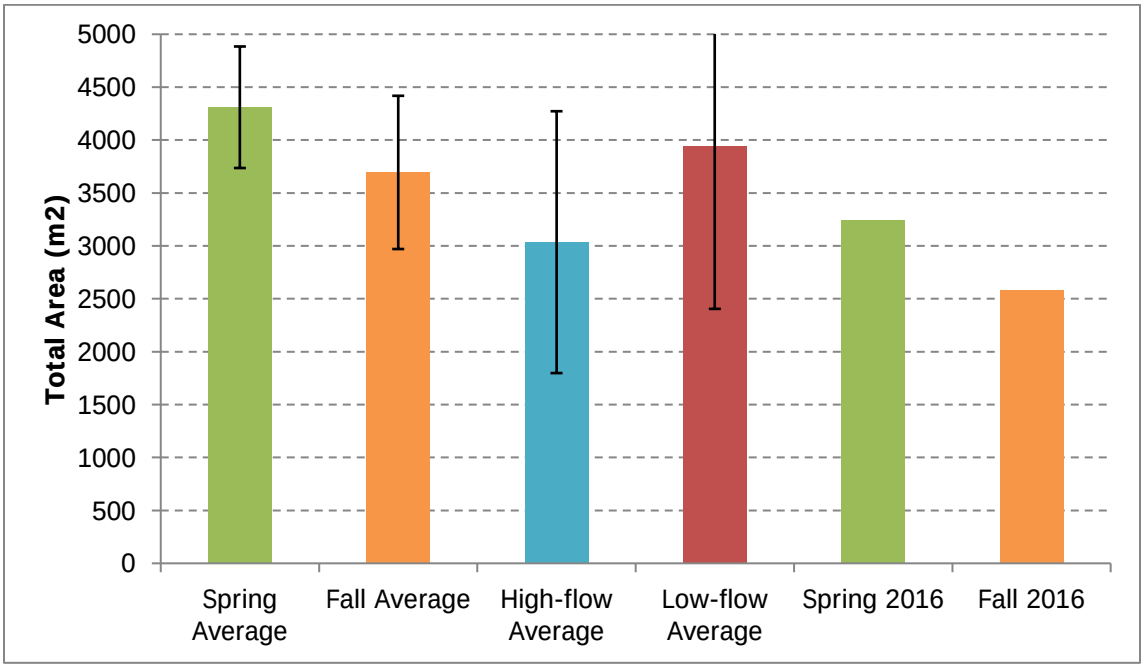

Figure 15. Total surface area (m^2) of aquatic vegetation at the City Park Reach. Long-term study averages are provided with bars representing one standard deviation from the mean.

I-35 Reach

Since the reconstruction of Rio Vista Dam in 2006, aquatic vegetation has been impacted in the I-35 Reach, likely due to increased sedimentation, which results in shallower water and increased velocities, and subsequent loss of aquatic vegetation as documented in previous annual reports (BIO-WEST 2013b). In 2014, the I-35 Reach was modified to include the San Marcos River from Cheatham Street downstream to the I-35 Highway Bridge (Figure 16). This increased the reach area by 54% and, more importantly, it included large stands of *Hygrophila*, *Sagittaria*, *Cabomba*, and *Hydrilla* that provide fountain darter habitat. In addition, this allowed continued monitoring of fountain darter populations using dropnets. Figure 17 displays the total aquatic vegetation from 2016 and the long-term study averages. However, it must be noted that these averages include all years prior to the expansion of the reach, which must be considered when

making comparisons. As a result, total areas during all 2016 events are above the respective study averages, but some observations can still be made.

Figure 16. I-35 Reach expansion in 2014 (bottom) and continued in 2016 due to relative scarcity of aquatic vegetation in the original reach (top).

Total aquatic vegetation coverage increased from the November 2015 high-flow event from 775 m^2 which was the lowest coverage observed since the I-35 reach expansion, to 1,172 m^2 in spring 2016 (Figure 17). In fall, 2016 total vegetation coverage decreased to 893.4 m^2. This decline appears to be a direct result of removing large areas of nonnative aquatic vegetation (*Hygrophila*) associated with ongoing HCP restoration activities. Further monitoring of this reach will allow for a better understanding of how these restoration efforts have contributed to the overall health of the system.

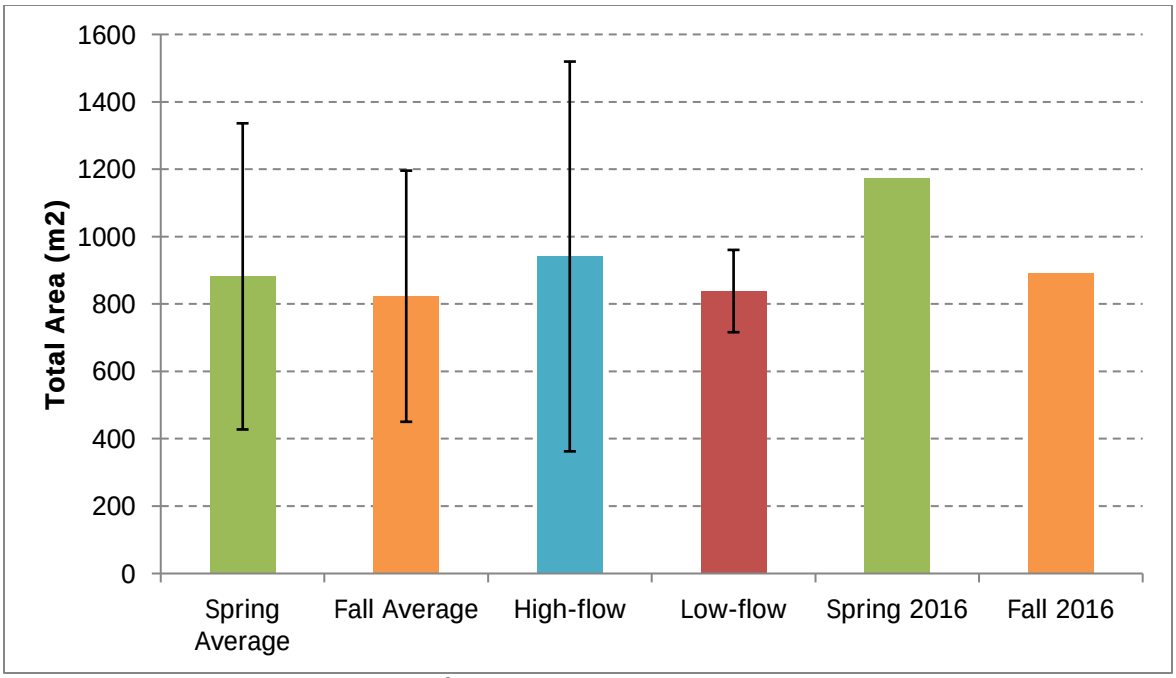

Figure 17. Total surface area (m^2) of aquatic vegetation at the I-35 Reach. Long-term study averages are provided with bars representing one standard deviation from the mean. Note that the reach was expanded in 2014 resulting in greater surface area of aquatic vegetation.

Texas Wild Rice Annual Mapping

A 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 2016, only one annual mapping event occurred with no critical period events triggering additional mapping. Over the course of 2016, flow rates remained above historical average with only one major flood event occurring on September 20th, in which peak flows reached above 2,000 cfs. Shortly after this event, routine fall vegetation mapping occurred, which showed little alteration to the Texas wild rice distribution and no further full system mapping event was deemed necessary.

The 2016 routine mapping event showed an aerial cover of 7,704 m^2 (Figure 18). This is an increase of 351 m^2 over August 2015 and the highest coverage of Texas wild rice recorded by EAA biological monitoring, since Texas wild rice mapping via this program was initiated in 2001. The present coverage also shows that Texas wild rice has rebounded since November 2015, when a critical period mapping event was conducted that detected a substantial loss in Texas wild rice (BIO-WEST 2016b). The flood that triggered the critical period mapping affected the area below the I-35 bridge, which had been completely scoured of Texas wild rice after several historical flood events. As of August 2016, this area contained almost 30 m^2 of Texas wild rice with multiple individual Texas wild rice plants. However, that is still considerably less than the 100+ m^2 of Texas wild rice that was present in this stretch in 2013.

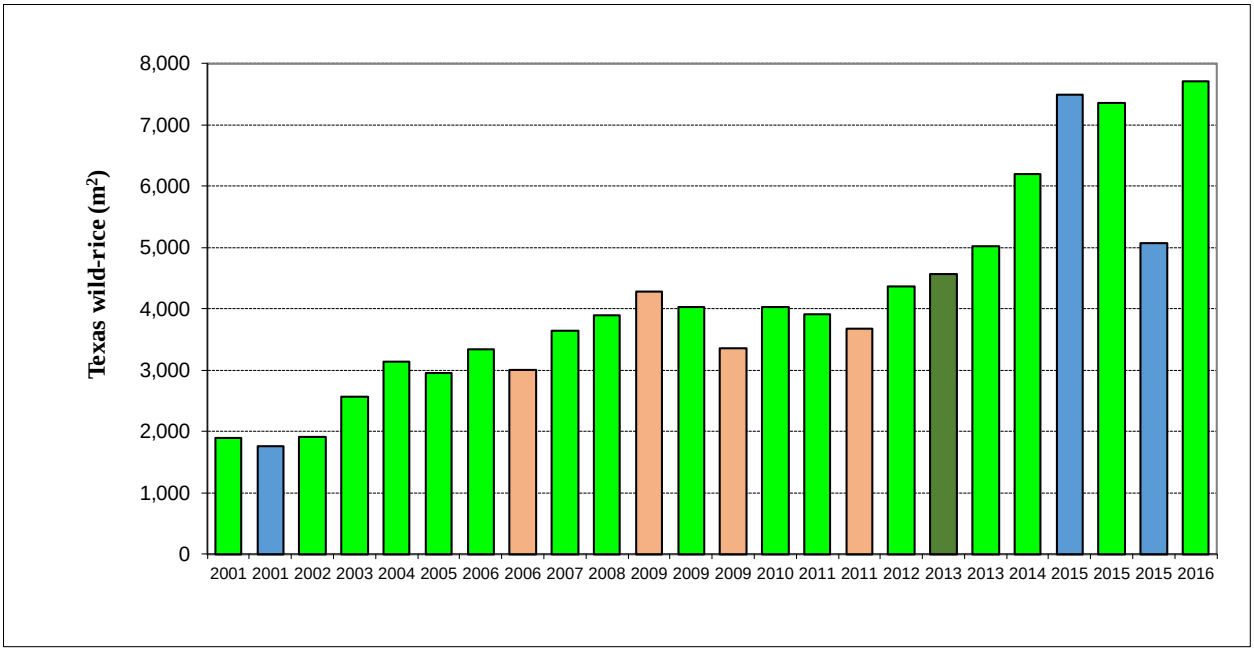

Figure 18. Coverage of Texas wild rice since inception of EAA monitoring program. Bright green = routine annual Texas wild rice mapping; Blue = post-high flow monitoring; Tan = low-flow monitoring; Dark green = 2013 full system aquatic vegetation mapping.

Figure 19 displays the Texas Parks and Wildlife department (TPWD) designated Texas wild rice river segments with Table 2 describing changes per segment from 2015 to 2016. The Spring Lake Dam study reach experienced the most significant gains (60%) in Texas wild rice coverage from August 2015 to August 2016. Typically, this area is highly recreated and Texas wild rice is disturbed by wading and swimming. However, since October of 2015, the area has been fenced off from the public and as a result, minimal recreation occurred this year.

Areas where Texas wild rice experienced a decline in cover between August 2015 and August 2016 include Sewell Park and the I-35 Study Reach (Table 2). In the recent past, Texas wild rice has been expanding in Sewell Park and this area typically accounts for 15 percent or more of the total area. However, this year Texas wild rice in Sewell Park experienced heavier losses than usual which may be related to the swift water flows from greater than average total system discharge over the entire year

Texas wild rice in the I-35 Reach continued to decline for the third consecutive year. Extreme scouring from flooding as well as continuous above average flows have contributed to loss of Texas wild rice stands in vulnerable areas. The few large stands which have persisted here have mostly fragmented into smaller patches allowing velocities to further erode river bed material from around Texas wild rice roots.

Figure 19. Texas wild rice river segments as designated by Texas Parks and Wildlife Department.

Table 2. Change in cover of Texas wild rice in corresponding river segments to Figure 19 between August 2015 and August 2016 mapping.

River Segment	August 2015 Cover (m^2)	August 2016 Cover (m^2)	Status	Difference (m^2)	Percent Change
A Spring Lake Dam Study Reach	455	739	⬆	284	62%
B Sewell Park	1,439	992	⬇	447	31%
C Sewell Park to City Park Study Reach	2,377	2,333	⬇	44	2%
D City Park Study Reach	1,380	1,599	⬆	219	14%
E City Park Study Reach to Hopkins Street Bridge	274	373	⬆	93	36%
F Hopkins Street Bridge to Rio Vista Dam	1,105	1,383	⬆	281	25%
G I-35 Study Reach	386	235	⬇	151	39%
H I-35 to WWTP	28	29	⬆	1	4%

A total of 565 Texas wild rice polygons were mapped along with 161 Texas wild rice points in August of 2016, compared to 499 wild rice stands mapped along with 120 points the previous year. As of August 2016, distribution of Texas wild rice stretches from Spring Lake to approximately 170 meters below Cape's Dam. Of the 565 Texas wild rice stands mapped in August of 2016, 390 of them were found to be in water deeper than 3 feet and 175 stands were found to be in water less than 3 feet in depth (Table 3). Nearly 50% of Texas wild rice stands were found to be associated with another aquatic plant species (Table 4). This is an increase from post flood results collected in November 2015, which showed 28% of Texas wild rice stands (n=97) were found to be associated with another species of aquatic plant, but about even with August 2015 results. Typically, *Hydrilla* is more commonly associated with Texas wild rice than any other aquatic plant species. Multiple Texas wild rice stands were observed blooming during August mapping. Forty-two individual stands were observed in some degree of flower. Three stands were noted with 100% of the culms emergent and in bloom.

Table 3. Distribution of Texas wild rice based on water depth (n=565).

Depth (ft)	# of Texas wild rice stands	Frequency (%)
0 to 1	0	0
1-2	48	9
2-3	127	22
3 +	390	69

Table 4. Associated species found with Texas wild rice (n=268).

Species	# of Texas wild rice stands	Frequency (%)
Hydrilla verticillata	132	49
Hygrophila polysperma	63	23
Potamogeton illinoensis	42	16
Sagittaria platyphylla	28	10
Hydrocotyle verticillata	3	1
Ludwigia repens	1	1

Texas Wild Rice Physical Observations

Observations for vulnerable Texas wild rice stands were conducted two times during 2016. These qualitative measurements included the following categories: the percent of the stand that was emergent (including the percent with seed), the percent covered with vegetation mats or algae buildup, any evidence of foliage herbivory, and a categorical estimation of root exposure. Velocity measurements were taken at the upstream edge of each Texas wild rice stand and depth was measured at the shallowest point in the stand. Physical observations were made for vulnerable wild rice stands within three general study areas, the Spring Lake Dam / Sewell Park location and the I-35 location. A third study area, Veramendi Park, was added for 2016 to include stands between the Hopkins Street bridge and the Union Pacific train trestle. To help better asses the cover of designated vulnerable Texas wild rice stands and better locate stands; rectangular plots encompassing each stand were mapped in ArcGIS to provide a reference area and Texas wild rice stand cover measured within the plot can then be used to better document the expansion and retraction of Texas wild rice. In 2016, three additional stands were included in the Hopkins Street bridge study area while all other stands were relocated from previous years. The coverage of each vulnerable stand in the San Marcos River is presented in Appendix C. Maps showing the cover of wild rice in these areas during 2016 are found in Appendix B.

Spring Lake Dam / Sewell Park Reach

Starting in 2015, eight stands were monitored in this area providing insight on the effects of recreation and high flows on Texas wild rice. Two stands were lost in 2015 while all other stands were able to be revisited for both 2016 sampling events. Vulnerable stands here have been moderately impacted by flooding events. Stand # 1 located above Aquarena Drive Bridge maintained its density and size over the course of 2016, expanding and merging with surrounding Texas wild rice stands into essentially one large stand. Stands occurring below Aquarena Springs Drive were not as vigorous. Stand #4/5 typically maintains its size, but lost significant amounts of cover between spring and fall 2016, becoming fragmented and shrinking in length and width (Figure 20). During spring sampling, velocity at individual stands ranged from 0.14 ft/sec. to 3.02 ft/sec and depths at all stands were deeper than 0.5ft. Root exposure

from scouring was noted in this section, but only moderate at stand # 4/5. Two stands, #1 and #6, were noted in bloom. For the fall sampling event, velocities were lower ranging from 0.00 ft/sec to 1.63 ft/sec. Root exposure was minimal and all stands were observed in some degree of flowering.

Figure 20. Stand #4/5 typically stretches to the concrete bulkhead but was significanlty narrowed between Spring 2016 and Fall 2016.

Veramendi Park

Veramendi Park is a new location for physical observations in 2016 and added in part because of heavy recreation in the area and because some planting of Texas wild rice and other restoration activities have occurred in the vicinity. However, the stands monitored here are persistent and

not recently restored. Three Texas wild rice stands were monitored and mapped in the spring and fall sampling events (Figure 21). Two of these stands were reduced between spring and fall, while one increased in length and width. Stand flow velocities ranged from 0.30 ft/sec. to 1.53 ft/sec, with depths at all stands deeper than 0.5ft. Associated species growing with Texas wild rice included *Sagittaria*, *Potamogeton*, and *Hydrilla*. No flowering was observed and root exposure was minimal.

Figure 21. Location of monitored Texas wild rice stands at Veramendi Park.

I-35 Reach

Vulnerable Texas wild rice in this location continues to decline. In 2014, ten vulnerable wild rice stands were located in this reach; three disappearing by 2015. Three new stands were added for

2015. In spring of 2016, nine Texas wild rice stands were measured, and by fall of 2016, only five of these Texas wild rice stands remained. Two of these stands, # 7 and # 8, expanded substantially from spring to fall, while all others maintained size or lost cover. Stand #4 fragmented considerably over the course of 2016 and stand # 10 has all but disappeared completely. Although stand #8 expanded between spring and fall, its location is precarious and under constant barrage of high velocities, and scouring effects. In April of 2015, this stand covered 23 m^2. Beginning with the floods of 2015, a steep gouge was cut through stand # 8 leading to its decline (Figure 22). Although remnant plants have regrown over the course of 2016, it is uncertain if the plants within this patch can withstand further degradation of the stream bed. On the opposite end of the spectrum, stand #7 has flourished over the course of 2016, expanding both upstream and downstream as well as becoming denser. Point water velocities measured in the Spring at Texas wild rice stands in this reach ranged from 0.07 ft/sec. to 2.75 ft/sec. and water depths at all stands were well above 0.5ft. Point water velocities measured in the Fall ranged from 0.04 to 2.7 ft/sec. with all stands being in water deeper than 0.5ft. For spring 2016, one stand (#7) was observed in heavy bloom with no other stands blooming and no stands were observed in bloom during the fall monitoring period. Root exposure was severe in one stand (#4) for both spring and fall and minimal to moderate in all other stands.

Figure 22. Location of stand #8 showing the steep cut formed from flooding and above average flows.

Fountain Darter Sampling Results

Dropnet Sampling

In 2016, dropnet sampling was conducted on the San Marcos River during the spring (May), and fall (October) routine sampling efforts. The number of dropnet sites and vegetation types sampled in each sample reach per event is presented in Table 5. City Park and I-35 reaches have been sampled continuously since the beginning of the study, while dropnet sampling 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 5. Dropnet sites and vegetation types sampled in each reach in the San Marcos River in 2016.

VEGETATION TYPE	SPRING (May 3-4)			FALL (October 19–20)			TOTAL
	Spring Lake Dam	City Park	I-35	Spring Lake Dam	City Park	I-35	
Potamogeton	2			2			4
Hydrilla		2	2		2	2	8
Hygrophila	2	2	2	2	2	2	12
Potamogeton/ Hygrophila		2			2		4
Hydrocotyle	2						2
Sagittaria		2	2	2	2	2	10
Cabomba			2			2	4
Open	2	2	2	2	2	2	12
TOTAL	**8[a]**	**10**	**10**	**8[a]**	**10**	**10**	**56**

[a] *Vallisneria* and Hygrophila no longer present in sufficient coverage in the reach, therefore it was not sampled.

Using dropnets, biologists captured 291 fountain darters in the San Marcos River in 2016, with 205 captured during spring, and 86 in fall. This is a decrease from the number of fountain darters observed in 2015 (509 in spring and fall). 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 versus vegetated habitats (2.3–11.6/m^2) (Figure 23). However, fountain darter density varies considerably both within and between various vegetation types. *Cabomba* (7.9 /m^2) exhibited the highest densities of fountain darters of native vegetation types, while *Hydrilla* (6.6 /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.

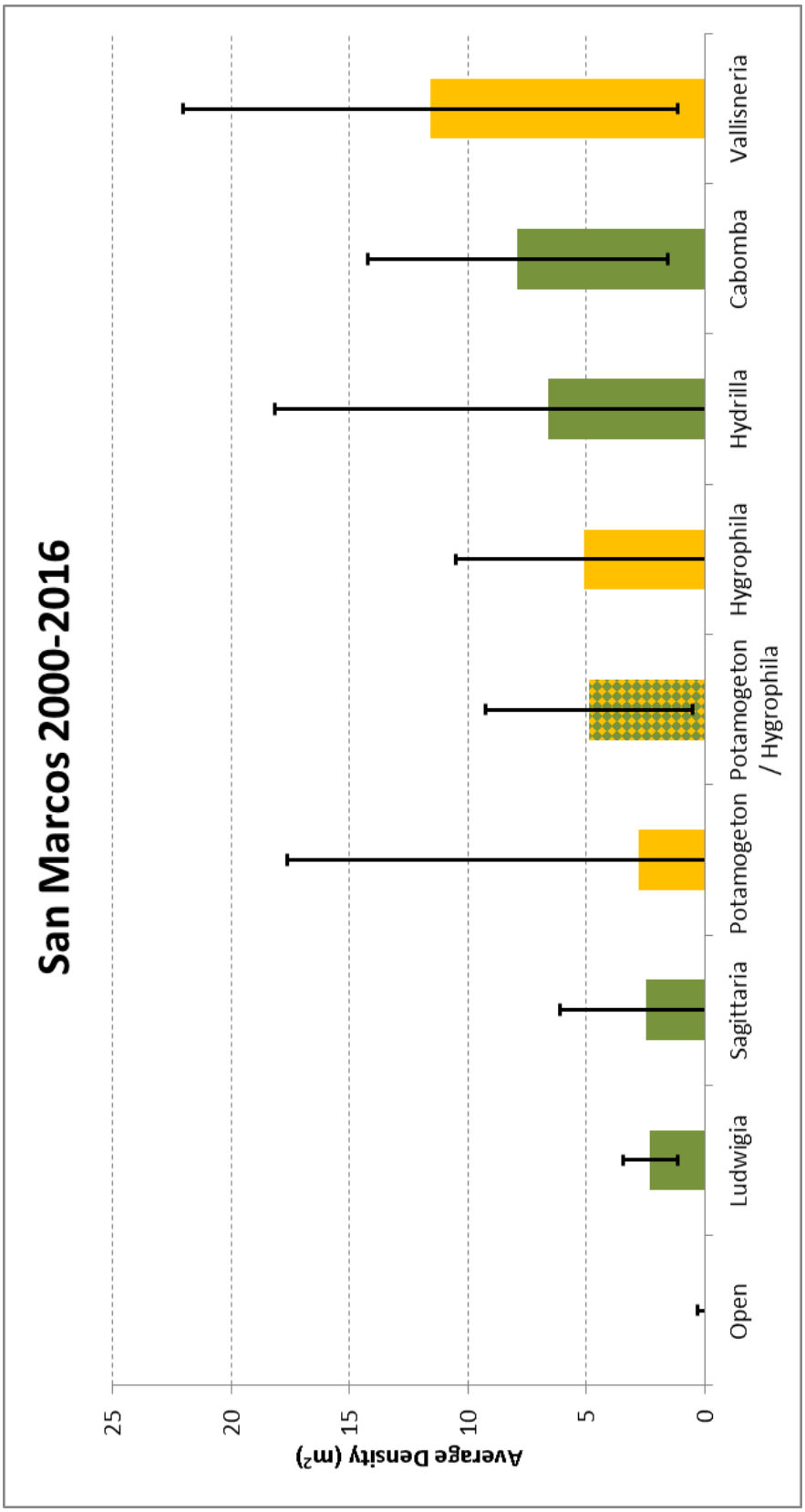

Figure 23. Average fountain darter density for each sampled vegetation type in the San Marcos River from 2000–2016. Green represents native vegetation, while yellow reflect nonnative types.

The macroinvertebrate assessment of the HCP biological monitoring program (discussed later in this report) 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).

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 (27 fountain darters/m^2) and an overall greater number of fountain darters (BIO-WEST 2017a). 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 dropnet, dipnet data confirm a high abundance of fountain darters in this vegetation type within the lake.

The length-frequency distributions for fountain darters collected by dropnet in the San Marcos system during spring and fall sampling events are presented in Figure 24. 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 suggest 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 24). In contrast, fall samples are usually dominated by larger individuals due to less recent reproductive activity (Figure 24).

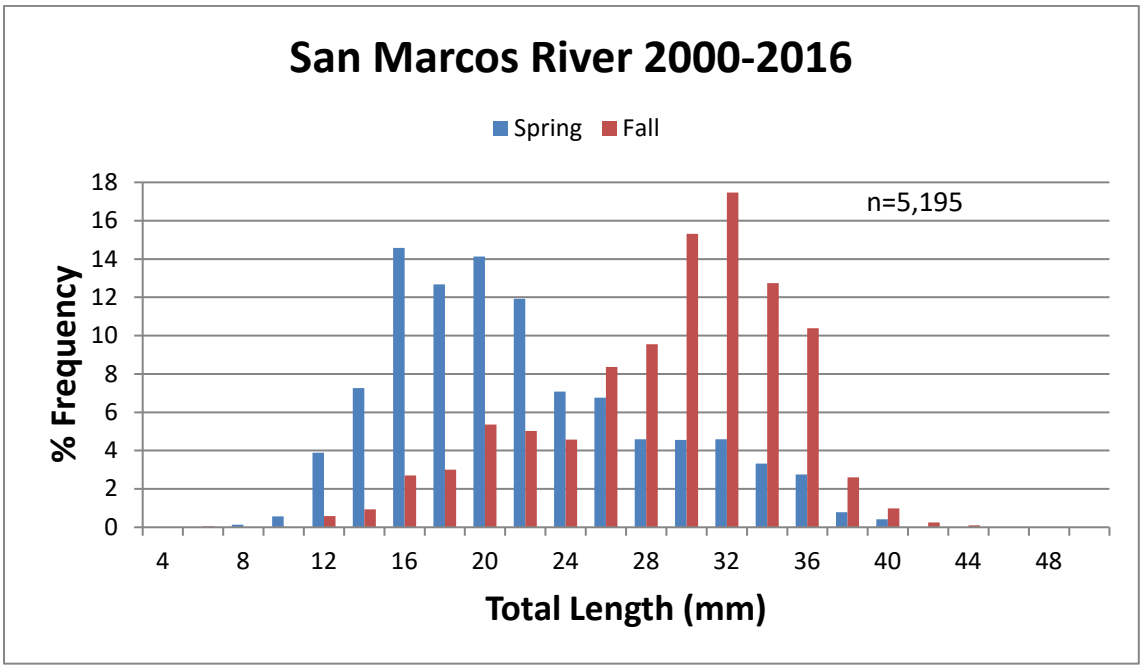

Figure 24. Length frequency distribution of fountain darters collected from the San Marcos system during all routine fall and spring events (2000–2016).

Estimates of fountain darter population abundance (Figure 25) 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. The spring and fall 2016 population estimates were lower than the long-term average and outside of one standard deviation. This could be a delayed result of the November 2015 flood as that high-flow event scoured a considerable amount aquatic vegetation and/or the higher than average flows experienced during 2016 that appear to have impeded aquatic vegetation recovery.

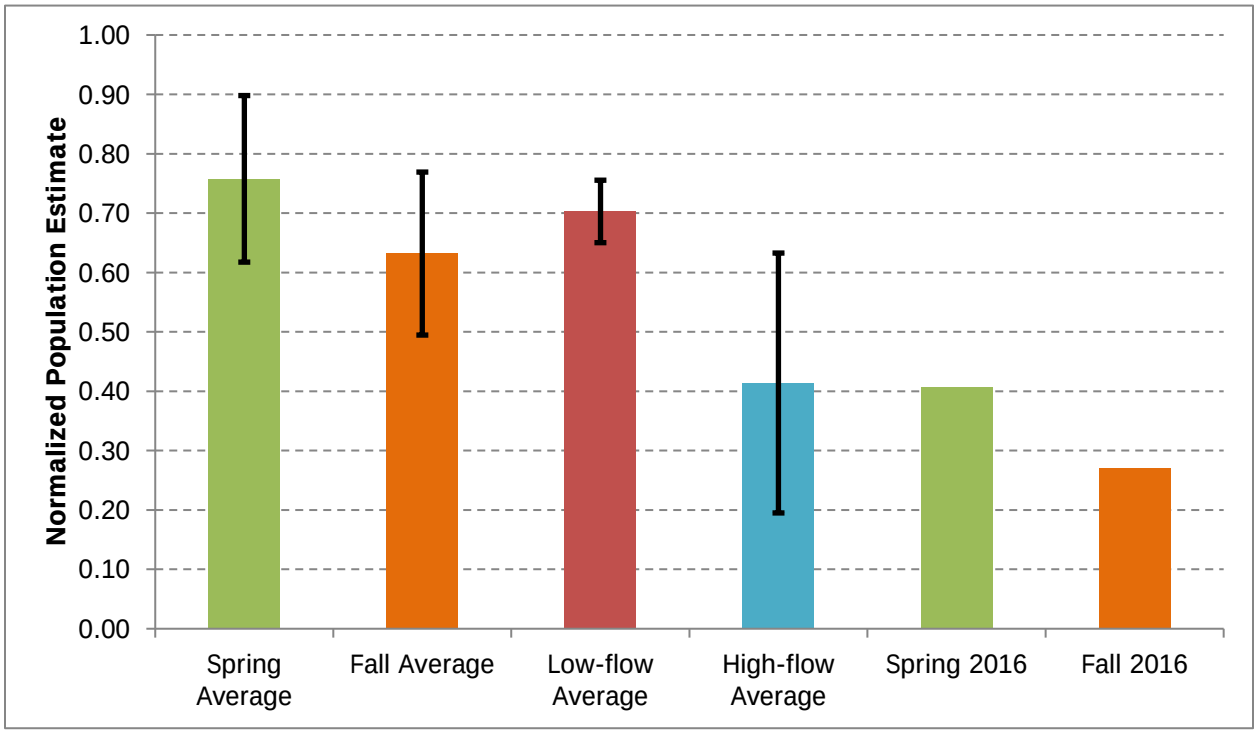

Figure 25. Normalized population estimate for all events 2000–2016. Long-term study averages are provided with error bars representing one standard deviation from the mean.

In addition to fountain darters, 50,823 fishes representing 27 other taxa have been collected by dropnet since 2000 (Table 6). 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. However, one exotic fish of particular concern is the armadillo del rio (*Hypostomus* spp.). This detritivorous species (Pound et al. 2011) feeds by scraping algae and detritus from the river substrate and, therefore, has the potential to alter the food chain and impact fountain darter habitat and food supplies. Five of these fish were captured in 2016 (Table 6) and continued monitoring and management of the armadillo del rio population in the San Marcos River is important.

Table 6. All fish collected in dropnets from 2000 to 2016.

Family	Scientific Name	Common Name	Status	Number Collected	
				2016	2000-2016
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	42	99
	Notropis amabilis	Texas shiner	N	1	90
	Notropis chalybaeus	Ironcolor shiner	N		131
	Notropis sp.	Unknown shiner	N	1	5
Catostomidae	*Moxostoma congestum*	Gray redhorse	N		2
Characidae	*Astyanax mexicanus*	Mexican tetra	I	2	61
Ictaluridae	*Ameiurus melas*	Black bullhead	N		1
	Ameiurus natalis	Yellow bullhead	N	3	161
	Noturus gyrinus	Tadpole madtom	N		4
Loricariidae	*Hypostomus plecostomus*	Suckermouth catfish	I	5	63
Poeciliidae	*Gambusia* sp.	Mosquitofish	N	307	47,004
	Poecilia latipinna	Sailfin molly	I	4	162
Centrarchidae	*Ambloplites rupestris*	Rock bass	I	50	815
	Lepomis auritus	Redbreast sunfish	I		100
	Lepomis cyanellus	Green sunfish	N		11
	Lepomis gulosus	Warmouth	N	9	63
	Lepomis macrochirus	Bluegill	N	8	86
	Lepomis megalotis	Longear sunfish	N		19
	Lepomis microlophus	Redear sunfish	N	2	4
	Lepomis miniatus	Redspotted sunfish	N	75	1,598
	Lepomis sp.	Sunfish	N/I	9	307
Percidae	*Micropterus salmoides*	Largemouth bass	N	10	94
	Etheostoma fonticola	Fountain darter	N	291	7,234
	Percina apristis	Guadalupe darter	N		27
Cichlidae	*Percina carbonaria*	Texas logperch	N		1
	Herichthys cyanoguttatus	Rio Grande cichlid	I	34	201
	Oreochromis aureus	Blue tilapia	I		16
Total				853	58,369

N= Native, I=Introduced

Dipnet Timed Surveys

Timed dipnet collections were conducted three times in the San Marcos River during 2016: May (spring), July (summer), and October (fall). Each section where dipnet collections were conducted is depicted in Figures 2 and 3. Data gathered from all reaches are graphically represented in Appendix C. Although only half the sampling effort is exerted in the Hotel Section (Spring Lake) compared with other sections, the overall number of fountain darters collected by dipnet sampling 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 contained individuals in the smallest size class (5–15 mm, Appendix C). 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.

The spring 2016 sampling effort in the City Park Section was similar to recent years (n = 27) while summer 2016 had the 3rd highest abundance (n = 65) and fall declined below average with only 17 darters collected (Appendix C). Reductions in available habitat in the I-35 section after modification of Rio Vista Dam led to this reach being extended to the I-35 Highway Bridge in 2014. The recent reach modification makes it premature to use these data for sweeping long-term year-to-year comparisons at this time.

Observed abundance of fountain darters was lower and more variable in the lower portion of the river near Todd Island (Appendix C). 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 darters 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 Dipnet Surveys

Random presence/absence dipnet sampling was conducted on the San Marcos River during the spring (May), summer (July), and fall (October) sampling events in 2016. Fountain darters were present at 54% of sites in spring (Figure 26). This number increased to 72% during the July summer event, and decreased slightly to 60% in the fall. Figure 25 shows the variation observed in this metric since 2006. The average percent of sites occupied by fountain darters during comprehensive sampling is 57%, and the blue lines show the 5th and 95th percentiles of the comprehensive sampling data. It is interesting to note that only two samples have occurred outside this range. For the 2006 to 2014-time period, the percent detected was lowest in fall 2009 (36%), after flows increased following a period of sustained low flows in summer 2009, and was highest in summer 2014 (78%), during a period of sustained lower-than-average flows.

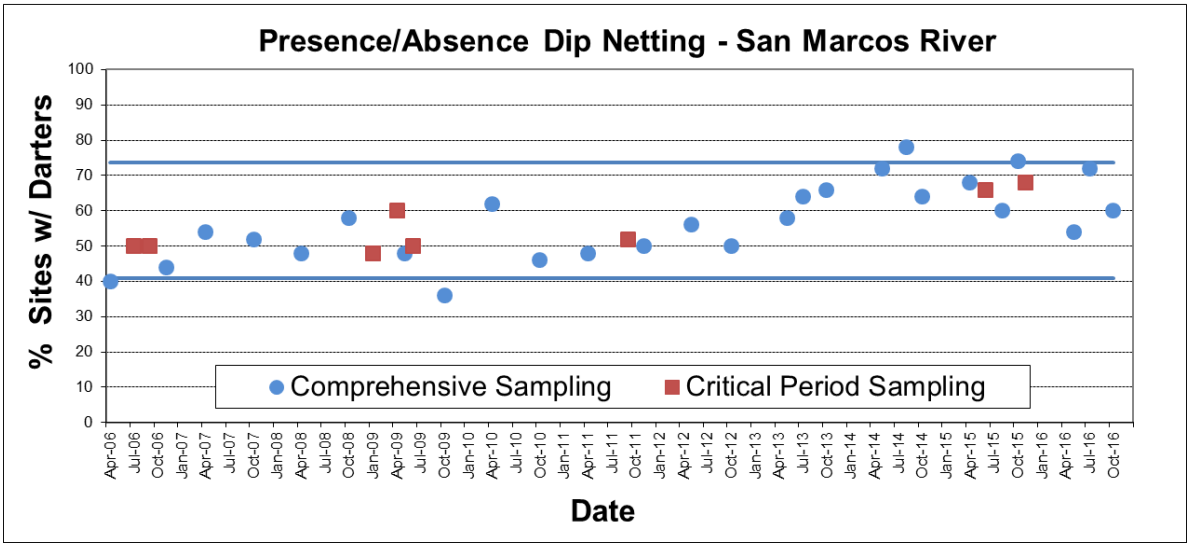

Figure 26. Percentage of sites (n=50) in which fountain darters were present. Solid blue lines mark 5th and 95th percentiles of comprehensive sampling data.

Fixed-station Dipnet Sampling

Fifty fixed sampling locations for the collection of presence/absence data for occupancy analysis were established in 2014. Three presence/absence samples (spring, summer and fall) from the San Marcos River system each year (2014, 2015, and 2016) were analyzed using the multiple season occupancy model methods (MacKenzie, Nichols, Hines, Knutsin, & Franklin, 2003) implemented in PRESENCE v11.6 (Hines, 2006). These models avoid underestimation of occupancy in cases of imperfect detection by modeling detection probabilities and other nuisance parameters. A primary assumption of these season models is that of "closure" within a season, in other words occupancy of a site does not change permanently over the "season," an assumption likely to be met by these presence/absence data as (1) fountain darters are unlikely to move appreciably, even given drastic changes in habitat conditions (BIO-WEST, 2014c), and (2) repeat samples within each season consisted of four adjacent dipnet samples taken in immediate succession, thereby occurring in such a short temporal window that no changes in occupancy would be expected. Thus, the data consist of three primary sampling periods (years) each composed of three secondary samples (seasonal samples).

The best candidate model for the San Marcos River data was chosen the previous season and shows detection as a function of vegetation. This model for 2016 has an initial ψ=1.00 and p varied from 0.38 to 1.00. Detection (the probability that the species would be detected in a single secondary sample given that the site was occupied) was highest for sites whose habitat consisted of *Ludwigia* (p=1.00) (Table 7). The naïve (#sites occupied / #sites) and informed (modeled) estimates of occupancy for these data have fluctuated over the three primary periods, but overall have remained high (Table 8). It is likely that this was due to changes in vegetative cover at sample sites that has occurred over time due to numerous factors, including recreation, high and low-flow periods, and sampling impacts.

Table 7. Detection probabilities for different habitat types estimated by multiple season occupancy modeling of San Marcos River fountain darter presence/absence data.

Habitat	p
Ludwigia	1.00
Hydrilla	0.63
Hygrophila	0.58
Vallisneria	0.56
Sagittaria	0.56
Potamogeton	0.56
Hydrocotyle	0.38

Table 8. Estimates of site occupancy in 2014, 2015, and 2016 by fountain darters in the San Marcos River from multiple season occupancy modeling, as well as naïve occupancy (proportion of sites observed occupied) for comparison.

Sample	MODEL Ψ	NAÏVE Ψ
2014	0.66	0.65
2015	0.80	0.48
2016	1.00	0.50

Changes in habitat characteristics of sites (i.e. vegetation type over time changing to a bare site) among sampling periods not only are likely to cause some changes in detection estimates, they prevent the modeling of occupancy by habitat type, which is of more interest and a useful way to stratify the results. Future sampling needs revision to ensure that some of these issues are overcome to the greatest possible degree, and that inferences made from this data are appropriate. In the current case, the appropriate and most confident inference is that fountain darter occupancy remains high in the San Marcos River system at the present time. Continued monitoring will allow more confident inferences to be made from these data in the future.

Fish Community Sampling

Twenty-eight species of fishes and 7,019 individuals were identified and enumerated among four locations in the San Marcos River during spring and fall 2016 (Table 9). The Guadalupe roundnose minnow *Dionda nigrotaeniata* was the most abundant species, representing 38% of all individuals in 2016. Other abundant species included the Mexican tetra *Astyanax mexicanus* (17% relative abundance), largespring gambusia *Gambusia geiseri* (13%), and fountain darter (8%). Uncommon species in 2016 collections included gray redhorse *Moxostoma congestum*, yellow bullhead *Ameiurus natalis*, and central stoneroller *Campostoma anomalum*, which were all represented by only two individuals. Central stoneroller had not been previously collected during fish community sampling in the San Marcos River.

Fish community sampling from 2013-2016 in the San Marcos River has resulted in collection of 29,468 fishes representing 37 different species. In contrast, the San Marcos River dropnet database (2000-2016) contains 58,369 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 dropnet sampling, which does not extend below I-35. As a result, riverine fish, characteristic of downstream areas, are more abundant within fish community data than dropnet data. Species identified in fish community sampling that are not present within the dropnet 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 dropnet dataset but not in the fish community dataset.

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 four 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 9. Number (#) and percent relative abundance (%) of fish species captured in fish community sampling during 2013-2016 compared to dropnet data from 2000-2016. N=native and I=Introduced.

Family	Scientific Name	Common Name	Status	Drop Net (2000-2016)		Fish Community (2013-2016)					
				Total #	Total %	2013 #	2014 #	2015 #	2016 #	Total #	Total %
Lepisosteidae	*Lepisosteus oculatus*	Spotted Gar	N	1	0.00	8	3	9	3	23	0.08
Cyprinidae	*Campostoma anomalum*	Central Stoneroller	N	3	0.01	0	0	0	2	2	0.01
	Cyprinella venusta	Blacktail Shiner	N	6	0.01	456	159	286	116	1017	3.45
	Cyprinus carpio	Common Carp	I	0	0.00	0	1	0	0	1	0.00
	Dionda nigrotaeniata	Guadalupe Roundnose Minnow	N	99	0.17	237	954	2394	2690	6275	21.29
	Macrhybopsis marconis	Burrhead Chub	N	0	0.00	1	0	1	0	2	0.01
	Notropis amabilis	Texas Shiner	N	90	0.15	222	143	23	14	402	1.36
	Notropis chalybaeus	Ironcolor Shiner	N	131	0.22	4	22	10	54	90	0.31
	Notropis volucellus	Mimic Shiner	N	0	0.00	6	2	0	0	8	0.03
	Notropis sp.	Unknown shiner	N	5	0.01	0	0	0	0	0	0.00
	Pimephales vigilax	Bullhead Minnow	N	0	0.00	4	0	5	0	9	0.03
Catostomidae	*Moxostoma congestum*	Gray Redhorse	N	2	0.00	1	4	40	2	47	0.16
Characidae	*Astyanax mexicanus*	Mexican Tetra	I	61	0.10	575	1308	2757	1177	5817	19.74
Ictaluridae	*Ameiurus melas*	Black Bullhead	N	1	0.00	0	0	0	0	0	0.00
	Ameiurus natalis	Yellow Bullhead	N	161	0.28	5	11	13	2	31	0.11
	Ictalurus punctatus	Channel Catfish	N	0	0.00	1	0	6	3	10	0.03
	Noturus gyrinus	Tadpole Madtom	N	4	0.01	0	0	0	0	0	0.00
Loricariidae	*Hypostomus plecostomus*	Suckermouth Catfish	I	63	0.11	177	155	179	68	579	1.96
	Pterygoplichthys sp.	Sailfin Catfish	I	0	0.00	2	0	0	0	2	0.01
Atherinopsidae	*Menidia beryllina*	Inland Silverside	N	0	0.00	1	0	0	0	1	0.00
Poeciliidae	*Gambusia affinis*	Western Mosquitofish	N	0	0.00	33	155	13	13	214	0.73
	Gambusia geiseri	Largespring Gambusia	N	0	0.00	728	1418	640	943	3729	12.65
	Gambusia sp.	Mosquitofish	N	47,004	80.53	2471	918	349	369	4107	13.94
	Poecilia latipinna	Sailfin Molly	I	162	0.28	38	24	26	39	127	0.43
	Poecilia formosa	Amazon Molly	I	0	0.00	1	0	0	3	4	0.01
Centrarchidae	*Ambloplites rupestris*	Rock Bass	I	815	1.40	47	25	4	12	88	0.30
	Lepomis auritus	Redbreast Sunfish	I	100	0.17	218	246	450	264	1178	4.00
	Lepomis cyanellus	Green Sunfish	N	11	0.02	0	0	0	4	4	0.01
	Lepomis gulosus	Warmouth	N	63	0.11	8	10	4	9	31	0.11
	Lepomis macrochirus	Bluegill	N	86	0.15	94	188	263	81	626	2.12
	Lepomis megalotis	Longear Sunfish	N	19	0.03	3	27	56	38	124	0.42
	Lepomis microlophus	Redear Sunfish	N	4	0.01	26	41	338	39	444	1.51
	Lepomis miniatus	Redspotted Sunfish	N	1,598	2.74	59	28	40	44	171	0.58
	Lepomis sp.	Sunfish	N/I	307	0.53	374	362	287	248	1271	4.31
	Micropterus salmoides	Largemouth Bass	N	94	0.16	168	301	290	144	903	3.06
	Micropterus treculii	Guadalupe Bass	N	0	0.00	1	0	0	0	1	0.00
Percidae	*Etheostoma fonticola*	Fountain Darter	N	7,234	12.39	200	351	481	541	1573	5.34
	Etheostoma spectabile	Orangethroat Darter	N	0	0.00	5	18	62	15	100	0.34
	Percina apristis	Guadalupe Darter	N	27	0.05	31	34	75	57	197	0.67
	Percina carbonaria	Texas Logperch	N	1	0.00	4	6	50	5	65	0.22
	Percina sp.	Unidentified Percina	N	0	0.00	0	0	1	3	4	0.01
Cichlidae	*Herichthys cyanoguttatus*	Rio Grande Cichlid	I	201	0.34	41	75	51	17	184	0.62
	Oreochromis aureus	Blue Tilapia	I	16	0.03	1	2	4	0	7	0.02
Total				58,369		6,251	6,991	9,207	7,019	29,468	

San Marcos Salamander Visual Observations

In 2016, only routine sampling events (Spring and Fall) were conducted. There were 234 San Marcos salamander observations in spring sampling and 207 salamander observations in fall sampling for a total of 441 observations in 2016. Densities of San Marcos salamanders observed during the spring and fall sampling events in 2016 were below the long-term averages for salamander monitoring at the Hotel Site (Site 2; Figure 27). Conversely, at the Riverbed Site (Site 14), salamander observations were above the long-term average (Figure 28). Salamander observations decreased in fall 2016 compared to spring 2016 at both lake locations, which is the common seasonal observation.

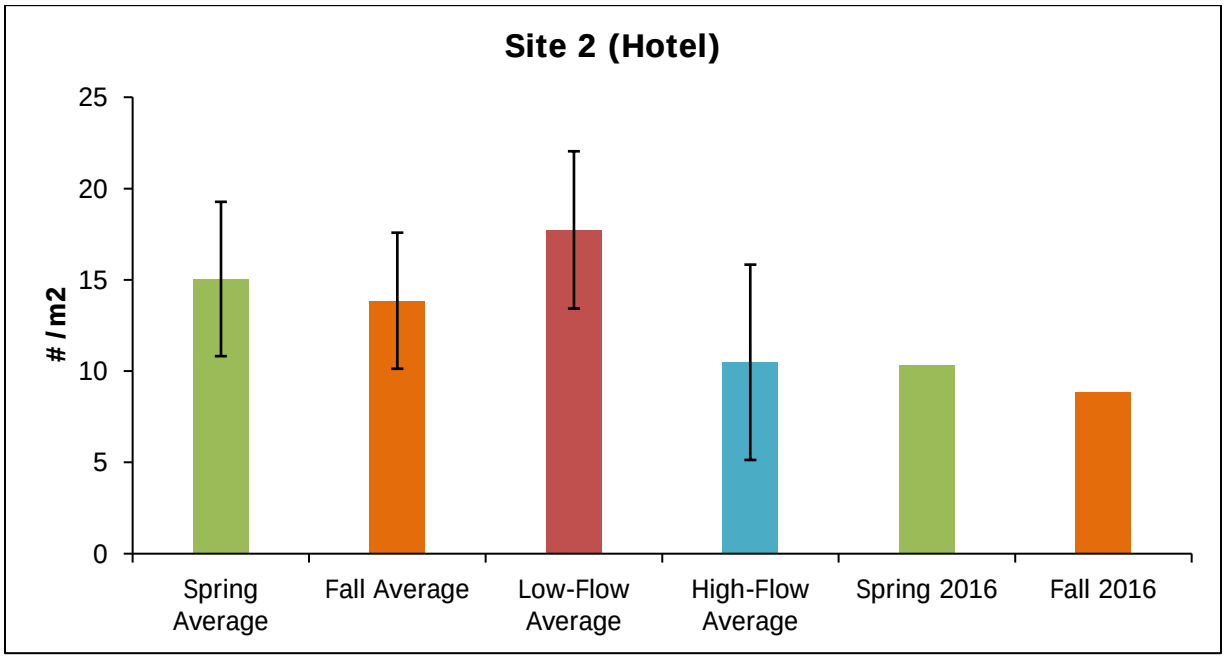

Figure 27. San Marcos salamander observations at Site 2 (Hotel Site) in 2016. Long-term monitoring averages are provided with standard deviation bars.

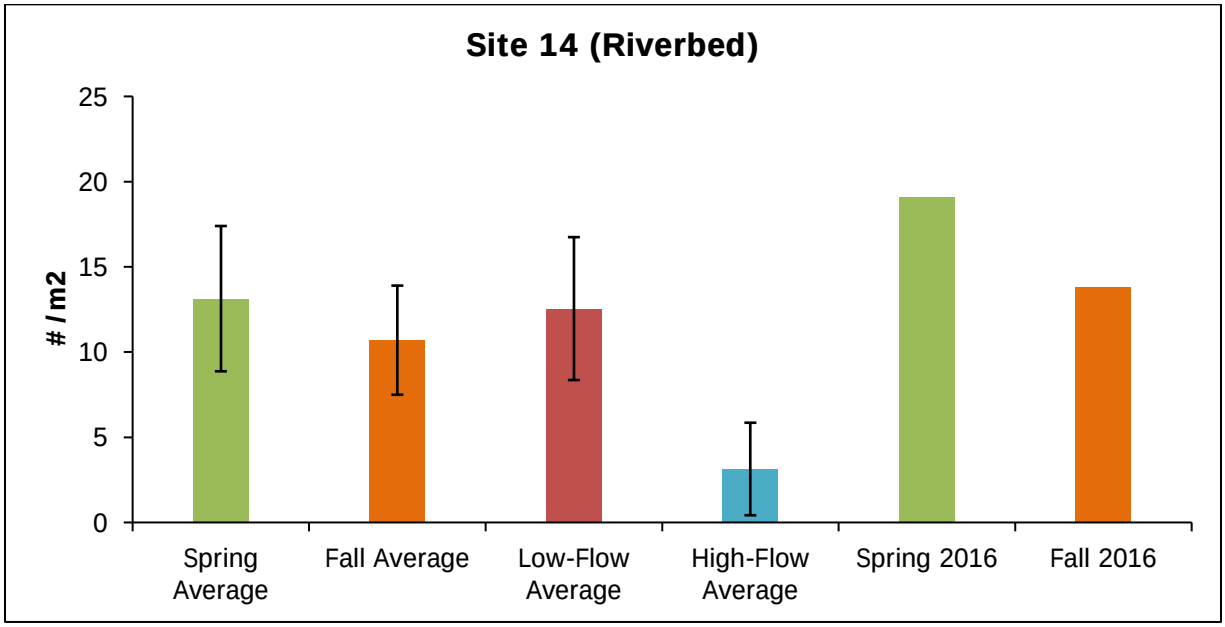

Figure 28. San Marcos salamander observations at Site 14 (Riverbed Site) in 2016. Long-term monitoring averages are provided with standard deviation bars.

San Marcos salamander densities at the Spring Lake Dam Site (Site 21) were more consistent in both spring and fall 2016 compared to the Spring Lake sites (Figure 29). Of the three sampling areas surveyed for salamanders, this site is the only one located within the San Marcos River. As previously mentioned, the Spring Lake Dam reach was fenced off for all of 2016, limiting recreational pressure. This decrease in recreational pressure did not appear to have a large effect on salamander densities with near average densities recorded at this site in 2016.

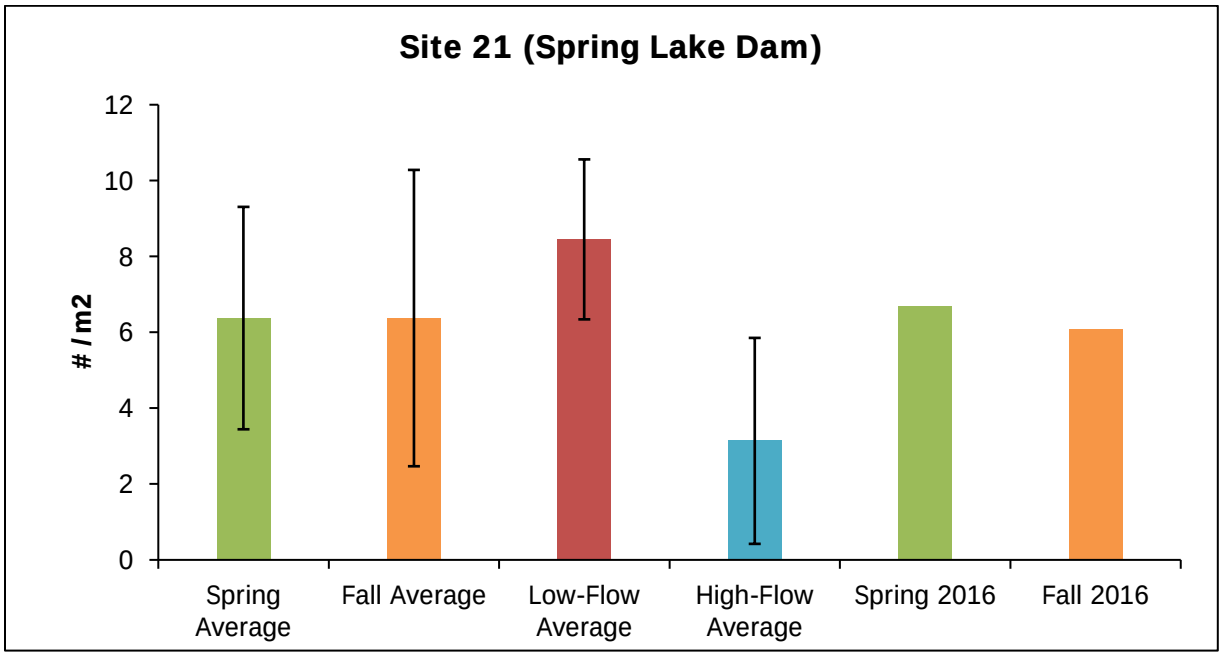

Figure 29. San Marcos salamander observations at Site 21 (Spring Lake Dam Site) in 2016. Long-term monitoring averages are provided with standard deviation bars.

Macroinvertebrate Community

Macroinvertebrate community samples were collected from dominant vegetation types at each of the three reaches in the San Marcos system during spring and fall (Table 10). Over the course of 2016 macroinvertebrate community sampling efforts in the San Marcos system, 2,734 organisms were collected during the spring comprehensive sampling event and 1,897 organisms were collected during the fall comprehensive sampling event (counts include Cladocera, Euhirundea, Gastropoda, Oligochaeta, and Ostracoda).

Table 10. Dominant vegetation types sampled by reach during spring and fall 2016 macroinvertebrate sampling efforts in the San Marcos system.

VEGETATION	CITY PARK REACH	I-35 REACH	SPRING LAKE DAM REACH
Cabomba	not sampled [a]	spring and fall	not sampled [a]
Hydrilla	spring and fall	spring and fall	not sampled [a]
Hygrophila	spring and fall	spring and fall	spring and fall
Potamogeton	spring and fall	not sampled [a]	spring and fall
Sagittaria	spring and fall	spring and fall	spring and fall
Ludwigia	not sampled [a]	not sampled [a]	not sampled [a]
Vallisneria	not sampled [a]	not sampled [a]	not sampled [a]

[a] not sampled = Vegetation type not dominant at reach; reach not sampled for this vegetation type.

Of the three study reaches sampled in spring and fall 2016, the City Park Reach had the highest total count of organisms collected (*n*=1,665, 36%), followed closely by Spring Lake Dam (*n*=1,593, 34%) and the City Park reaches (*n*=1373, 30%) (Table 11). In addition, snails contribute to a large portion of the macroinvertebrate community, with the I-35 Reach exhibiting the highest number and greatest relative proportion (*n*=1,103, 80%), followed by City Park (*n*=447, 27%), and Spring Lake Dam reaches (*n*=320, 20%). Indeed, when comparing reaches for relative abundance of all macroinvertebrates collected *excluding* snails, the reach with the highest macroinvertebrate abundance was Spring Lake Dam (*n*=1,273, 46%), followed by City Park (*n*=1,218, 44%), and the I-35 Reach (*n*=270, 10%). Between 2016 spring and fall sampling efforts, organisms were collected from 13 distinct taxonomic orders/classes, 32 distinct families, and 40 taxonomic genera/species from the San Marcos system (Table 12).

Amphipoda and Gastropoda comprised 84% of all organisms sampled during spring and fall 2016 (44% [*n*=2,029] and 40% [*n*=1,861], respectively) (Figure 30). Mayflies (Ephemeroptera) were abundant in spring samples (*n*=405), making up 15% of the total organisms observed and 22% of macroinvertebrates excluding snails. Mayflies are considered an important species because they make up a portion of the preferred diet of fountain darters (Schenck and Whiteside 1977).

Table 11. Summary of count and fountain darter data per reach from spring and fall 2016 in the San Marcos River.

REACH	NUMBER ORGANISMS COLLECTED	NUMBER ORGANISMS COLLECTED (ALL MACROINVERTEBRATES EXCEPT SNAILS)	FOUNTAIN DARTER PREY ORGANISMS
Spring Lake Dam	1,593	1,273	1,257
City Park	1,665	1,218	1,130
I-35	1,373	270	240
All sites	4,631	2,761	2,627

Table 12. Number of distinct macroinvertebrate taxa and taxonomic orders/classes, families, and genera identified from each reach during 2016 spring, and fall sampling events. [a, b]

2016 SAMPLING EVENT	NUMBER OF TAXONOMIC ORDERS/CLASSES COLLECTED [a]	NUMBER OF TAXONOMIC FAMILIES COLLECTED [b]	NUMBER OF TAXONOMIC GENERA/SPECIES COLLECTED [b]
Spring	12	28	34
Fall	11	21	27
Total	13	32	40

[a] Includes orders/classes Cladocera, Euhirundea, Gastropoda, Oligochaeta, and Ostracoda. [b] Some organisms were only identified to order/class or family; such taxa therefore not accounted for in the tallies of taxonomic categories lower than the level of identification achieved.

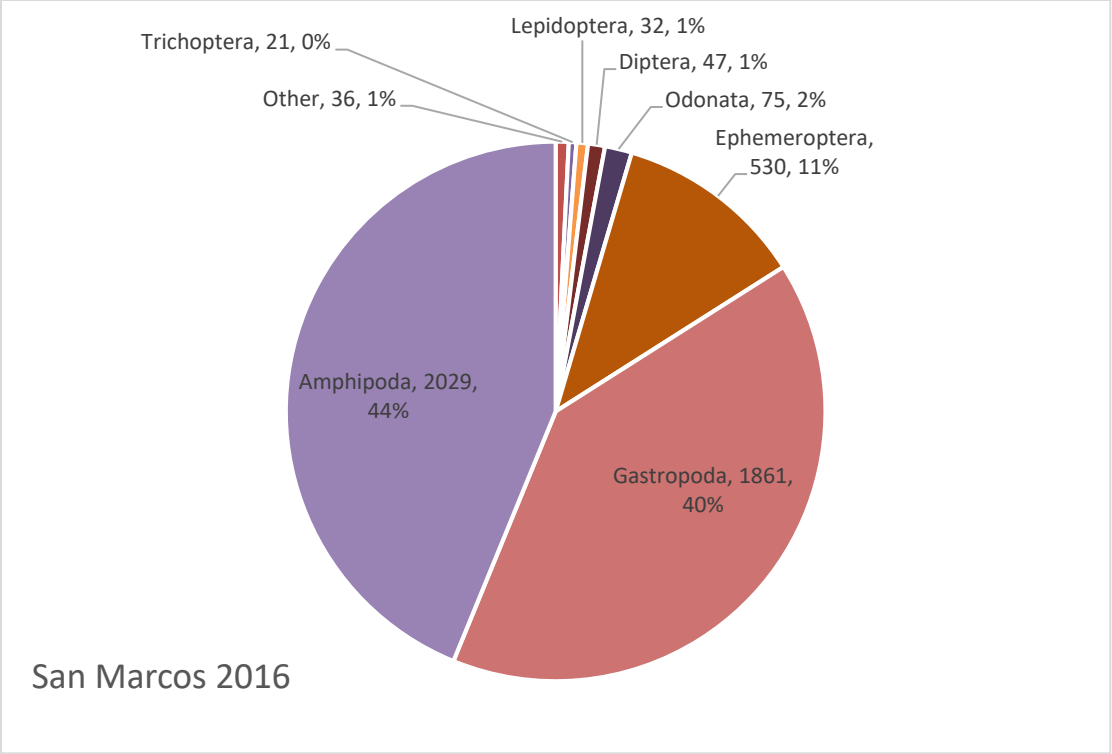

Figure 30. Relative percentage of macroinvertebrate abundance by order/class from combined 2016 spring and fall comprehensive sampling events in the San Marcos system. Data labels show frequency and relative percent abundance of each order/class collected.

The abundance of four macroinvertebrate orders/classes (Amphipoda, Diptera, Ephemeroptera, and Trichoptera) representative of fountain darter food sources (Schenk and Whiteside 1977) were examined in order to better understand factors affecting fountain darter prey availability. Between the three San Marcos River sample reaches, Spring Lake Dam Reach had the highest abundance of fountain darter prey taxa (*n*=1,257, 79%), followed by the City Park Reach (*n*=1,130, 68%) and I-35 Reach (*n*=240, 17%) (Table 13). Abundance of all fountain darter prey taxa was higher in spring (*n*=1,716) than in fall (*n*=911), most likely due to larval-to-adult ecdysis and emergence of many species grouped within the fountain darter prey taxa.

In terms of prey availability to fountain darters, amphipods and mayflies were the most commonly collected. Amphipods made up the largest proportion of prey at the Spring Lake Dam Reach (67%), followed by City Park (47%) and I-35 reaches (14%). While mayflies were common prey items at all reaches, only the City Park Reach had a noticeable proportion of true flies (Diptera, 2%).

Table 13. Average abundance of fountain darter prey taxa collected per sampling event by reach and vegetation type; values are from 2016 spring, fall, and combined macroinvertebrate collection efforts in the San Marcos system.

Reach	Vegetation	NO. of Food Source Organisms Spring 2016[a]	NO. of Food Source Organisms Fall 2016[a]	Average NO. of Food Source Organisms 2016[b]
Spring Lake Dam	*Hygrophila*	57	40	48.5±12.02, *n*=2
Spring Lake Dam	*Potamogeton*	154	463	308.5±218.50, *n=2*
Spring Lake Dam	*Sagittaria*	435	108	271.5±231.22, *n*=2
City Park	*Hygrophila*	454	16	235±309.71, *n*=2
City Park	*Potamogeton*	201	19	110±128.69, *n*=2
City Park	*Hydrilla*	280	118	199±114.55, *n*=2
City Park	*Sagittaria*	8	34	21±18.38, *n*=2
I-35 Reach	*Cabomba*	25	9	17±11.31, *n*=2
I-35 Reach	*Hygrophila*	13	27	20±9.90, *n*=2
I-35 Reach	*Hydrilla*	70	69	69.5±.71, *n*=2
I-35 Reach	*Sagittaria*	19	8	13.5±7.78, *n*=2

[a] Includes only Amphipoda, Diptera, Ephemeroptera, and Trichoptera (Schenk and Whiteside, 1977).
[b] Average and standard deviation of number of fountain darter food source organisms collected from each vegetation type during each sampling event in 2016 (spring and fall combined).

CONCLUSIONS

Following the prolonged drought in Texas, total system discharge in the San Marcos system increased considerably over the course of 2015 which extended throughout 2016. In fact, total system mean monthly discharge conditions in the San Marcos system (excluding flood influenced months) were at levels unseen in over a decade. Unlike the Comal system, this dramatic increase in total system discharge did not necessarily translate to improved ecological conditions for the HCP species in the San Marcos system. The late 2015 flooding event temporarily impeded habitat recovery, which was noted during spring 2016 sampling. Somewhat unexpectedly, the extended high flow conditions continued to impede recovery of aquatic vegetation in this spring-fed system. The most notable impacts were to fountain darter habitat in the river proper. In spite of this impediment, mapping in summer 2016 revealed that Texas wild rice coverage (7,703.8m^2) was the highest it's been since this study began in 2000. This milestone is the result of a comprehensive HCP restoration plan with concentrated efforts to protect this endangered species. Future biological monitoring to assess conditions as well as quantify effects (both positive and negative) from mitigation and restoration activities is imperative to better understanding this dynamic system.

REFERENCES

Akaike, H. 1974. A new look at the statistical model identification. IEEE Transactions on Automatic Control 19 (6): 716–723.

Behen, K. P. K. 2013. Influence of connectivity and habitat on fishes of the upper San Marcos River. M.S. Thesis, Texas State University.

BIO-WEST 2001a. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the San Marcos Springs / River aquatic ecosystem. 2000 Draft Report. Edwards Aquifer Authority, San Antonio, TX. 33 p.

BIO-WEST 2001b. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the Comal Springs/River aquatic ecosystem. 2000 Draft Report. Edwards Aquifer Authority, San Antonio, TX. 35 p.

BIO-WEST 2002a. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the San Marcos River Aquatic Ecosystem. 2001 Annual Report. Edwards Aquifer Authority. 26 p. plus Appendices.

BIO-WEST 2002b. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the Comal Springs/River aquatic ecosystem. 2001 Annual Report. Edwards Aquifer Authority. 24 p. plus Appendices.

BIO-WEST 2003a. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the San Marcos River aquatic ecosystem. 2002 Annual Report. Edwards Aquifer Authority. 42 p. plus Appendices.

BIO-WEST 2003b. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the Comal Springs/River aquatic ecosystem. 2002 Annual Report. Edwards Aquifer Authority. 45 p. plus Appendices.

BIO-WEST 2004a. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the San Marcos River aquatic ecosystem. 2003 Annual Report. Edwards Aquifer Authority. 30 p. plus Appendices.

BIO-WEST 2004b. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the Comal Springs/River aquatic ecosystem. 2003 Annual Report. Edwards Aquifer Authority. 42 p. plus Appendices.

BIO-WEST 2005a. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the San Marcos River aquatic ecosystem. 2004 Annual Report. Edwards Aquifer Authority. 57 p. plus Appendices.

BIO-WEST 2005b. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the Comal Springs/River aquatic ecosystem. 2004 Annual Report. Edwards Aquifer Authority. 70 p. plus Appendices.

BIO-WEST 2006a. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the San Marcos River aquatic ecosystem. 2005 Annual Report. Edwards Aquifer Authority. 33 p. plus Appendices.

BIO-WEST 2006b. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the Comal River aquatic ecosystem. 2005 Annual Report. Edwards Aquifer Authority. 43 p. plus Appendices.

BIO-WEST 2007a. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the San Marcos River aquatic ecosystem. 2006 Annual Report. Edwards Aquifer Authority. 54 p. plus Appendices.

BIO-WEST 2007b. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the Comal River aquatic ecosystem. 2006 Annual Report. Edwards Aquifer Authority. 42 p. plus Appendices.

BIO-WEST 2008a. Comprehensive and Critical Period Monitoring Program to Evaluate the Effects of Variable Flow on Biological Resources in the San Marcos River Aquatic Ecosystem. 2007 Annual Report. Edwards Aquifer Authority. 33 p. plus Appendices.

BIO-WEST 2008b. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the Comal River aquatic ecosystem. 2007 Annual Report. Edwards Aquifer Authority. 41 p. plus Appendices.

BIO-WEST 2009a. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the San Marcos River aquatic ecosystem. 2008 Annual Report. Edwards Aquifer Authority. 36 p. plus Appendices.

BIO-WEST 2009b. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the Comal River aquatic ecosystem. 2008 Annual Report. Edwards Aquifer Authority. 41 p. plus Appendices.

BIO-WEST 2010a. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the Comal River aquatic ecosystem. 2009 Annual Report. Edwards Aquifer Authority. 45 p. plus Appendices.

BIO-WEST 2010b. Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the San Marcos River aquatic ecosystem. 2009 Annual Report. Edwards Aquifer Authority. 60 p. plus Appendices.

BIO-WEST 2011a. Comprehensive and Critical Period Monitoring Program to Evaluate the Effects of Variable Flow on Biological Resources in the Comal River Aquatic Ecosystem. 2010 Annual Report. Edwards Aquifer Authority. 51 p. plus Appendices.

BIO-WEST 2011b. Comprehensive and Critical Period Monitoring Program to Evaluate the Effects of Variable Flow on Biological Resources in the San Marcos River Aquatic Ecosystem. 2010 Annual Report. Edwards Aquifer Authority. 44 p. plus Appendices.

BIO-WEST 2012a. Comprehensive and Critical Period Monitoring Program to Evaluate the Effects of Variable Flow on Biological Resources in the Comal River Aquatic Ecosystem. 2011 Annual Report. Edwards Aquifer Authority. 50 p. plus Appendices.

BIO-WEST 2012b. Comprehensive and Critical Period Monitoring Program to Evaluate the Effects of Variable Flow on Biological Resources in the San Marcos River Aquatic Ecosystem. 2011 Annual Report. Edwards Aquifer Authority. 51 p. plus Appendices.

BIO-WEST 2013a. Comprehensive and Critical Period Monitoring Program to Evaluate the Effects of Variable Flow on Biological Resources in the Comal River Aquatic Ecosystem. 2012 Annual Report. Edwards Aquifer Authority. 41 p. plus Appendices.

BIO-WEST 2013b. Comprehensive and Critical Period Monitoring Program to Evaluate the Effects of Variable Flow on Biological Resources in the San Marcos River Aquatic Ecosystem. 2012 Annual Report. Edwards Aquifer Authority. 44 p. plus Appendices.

BIO-WEST 2014a. Habitat Conservation Plan Biological Monitoring Program. Comal Springs/River Aquatic Ecosystem 2013 Annual Report. Edwards Aquifer Authority. 92 p. plus Appendices.

BIO-WEST 2014b. Habitat Conservation Plan Biological Monitoring Program. San Marcos Springs/River Aquatic Ecosystem. 2013 Annual Report. Edwards Aquifer Authority. 80 p. plus Appendices.

BIO-WEST 2014c. Effects of low flow on fountain darter reproductive effort. Prepared for the Edward's Aquifer Authority, October 2014. 28 p.

BIO-WEST 2015a. Habitat Conservation Plan Biological Monitoring Program. Comal Springs/River Aquatic Ecosystem 2014 Annual Report. Edwards Aquifer Authority. 98 p. plus Appendices.

BIO-WEST 2015b. Habitat Conservation Plan Biological Monitoring Program. San Marcos Springs/River Aquatic Ecosystem. 2014 Annual Report. Edwards Aquifer Authority. 67 p. plus Appendices.

BIO-WEST 2016a. Habitat Conservation Plan Biological Monitoring Program. Comal Springs/River Aquatic Ecosystem 2015 Annual Report. Edwards Aquifer Authority. 75 p. plus Appendices.

BIO-WEST 2016b. Habitat Conservation Plan Biological Monitoring Program. San Marcos Springs/River Aquatic Ecosystem. 2015 Annual Report. Edwards Aquifer Authority. 68 p. plus Appendices.

BIO-WEST 2017a. Habitat Conservation Plan Biological Monitoring Program. Comal Springs/River Aquatic Ecosystem 2016 Annual Report. Edwards Aquifer Authority. Draft under review.

Brandt, T. M., K. G. Graves, C. S. Berkhouse, T. P. Simon, and B. G. Whiteside. 1993. Laboratory spawning and rearing of the endangered fountain darter. Progressive Fish-Culturist 55:149–156.

Burnham, K. P., and D. R. Anderson. 1998. Model selection and inference. New York: Springer-Verlag. 353 p.

Bush, P.W., A.F. Ardis, L. Fahlquist, P.B. Ging, C.E. Hornig, and J.L. Lanning-Rush. 1998. Water Quality in South Central Texas, Texas 1996-98. U. S. Geological Survey, Circular 1212.

Cummins, K.W. 1962. An evaluation of some techniques for the collection and analysis of benthic samples with special emphasis on lotic waters. The American Midland Naturalist 67 (2) 477-504.

Edwards Aquifer Authority. San Antonio (TX): Edwards Aquifer Authority; c2013. Aquifer Data and Maps; 2013, [accessed 2014 Dec 26]. http://www.edwardsaquifer.org/aquifer-data-and-maps.

Edwards Aquifer Authority (EAA). 2016a. Standard Operating Procedures for the Habitat Conservation Plan (HCP) Biological Monitoring Program for the San Marcos Springs/River Ecosystem. Revised September 2016. 28pp. + Appendices.

Edwards Aquifer Authority (EAA). 2016b. San Antonio (TX): Edwards Aquifer Authority. 11/2016. Provisional Environet water quality data. Location: https://ienvironet.com.

Hines, J. E. 2006. PRESENCE-software to estimate patch occupancy and related parameters. Retrieved from USGS-PWRC: www.mbr-pwrc.usgs.gov/software/presence/html.

Horne, F. R., T. L. Arsuffi, and R. W. Neck. 1992. Recent introduction and potential botanical impact of the giant rams-horn snail, *Marisa cornuarietis* (Pilidae), in the Comal Springs Ecosystem of central Texas. The Southwestern Naturalist 37(2):194–214.

MacKenzie, D. I., and L. L. Bailey. 2004. Assessing the fit of site occupancy models. Journal of Agricultural, Biological, and Environmental Statistics, (3), 300–318.

MacKenzie, D. I., J. D. Nichols, G. B. Lachman, S. Droege, J. A. Royle, and C. A. Langtim. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology, 83(8), 2248–2255.

MacKenzie, D. I., Nichols, J. D., Hines, J. E., Knutson, M. G., & Franklin, A. B. 2003. Estimating site occupancy, colonization and local extinction probabilities when a species is detected imperfectly. *Ecology, 84*, 2200-2207.

Nelson, J. 1993. Population size, distribution, and life history of *Eurycea nana* in the San Marcos River. M.S. Thesis, Southwest Texas State University. 43 p.

Poole, J. 2000. Botanist, Texas Parks and Wildlife Department. Personal communication with Marty Heaney, PBS&J, Inc., Houston, Texas, regarding Texas wild rice physical observations–San Marcos system. 09/2000.

Pound, K. L., W. H. Nowlin, D. G. Huffman, and T. H. Bonner. 2011. Trophic ecology of a nonnative population of suckermouth catfishes (*Hypostomus plecostomus*) in a central Texas spring-fed stream. Environmental Biology of Fishes 90:277–285.

Schenck, J. R. and B. G. Whiteside. 1977. Reproduction, fecundity, sexual dimorphism and sex ratio of *Etheostoma fonticola* (Osteichthyes: Percidae). The American Midland Naturalist 98 (2): 365-375.

SWCA. 2016. Edwards Aquifer Habitat Conservation Plan Draft Expanded Water Quality Monitoring 2016 Annual Report. Edwards Aquifer Authority. In Press.

U.S. Geological Survey (USGS). 01/2015. Provisional data for Texas. Location: http://tx.waterdata.usgs.gov/niwis/help/provisional.

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 2016

Surveyed: April 5, 2016

SPRING LAKE DAM

Study Reach	4,381.9 m^2

Vegetation Types

Zizania	924.0 m^2
Bacopa	0.7 m^2
Heteranthera	0.6 m^2
Hydrilla	14.0 m^2
Hydrocotyle	60.0 m^2
Hygrophila	54.1 m^2
Potamogeton	44.6 m^2
Sagittaria	9.6 m^2
Vallisneria	0.7 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: December 7, 2016

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study Reach
October 2016

Surveyed: October 17, 2016

SPRING LAKE DAM

Study Reach	4,381.9 m²

Vegetation Types

Zizania	816.9 m²
Hydrocotyle	21.8 m²
Hygrophila	47.4 m²
Pistia	7.5 m²
Potamogeton	109.7 m²
Sagittaria	7.8 m²
Vallisneria	2.5 m²

0 25 50 100 Feet

0 10 20 Meters

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Projection: UTM, NAD 83, 14 North
Map Revised: November 21, 2016

City Park Reach

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study Reach
April 2016

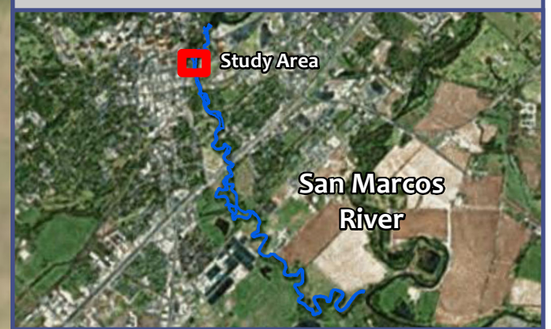
Surveyed: April 1, 2016

City Park

Study Reach	6,389.0 m^2

Vegetation Types

Zizania	1,605.5 m^2
Heteranthera	3.7 m^2
Hydrilla	748.4 m^2
Hydrocotyle	13.5 m^2
Hygrophila	553.2 m^2
Ludwigia	4.8 m^2
Nasturtium	7.3 m^2
Potamogeton	172.0 m^2
Sagittaria	135.9 m^2



0 37.5 75 150 Feet

0 20 40 Meters

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Projection: UTM, NAD 83, 14 North
Map Revised: December 7, 2016

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study Reach
October 2016

Surveyed: October 15, 2016

City Park

Study Reach	6,389.0 m^2

Vegetation Types

Zizania	1,561.6 m^2
Hydrilla	503.2 m^2
Hygrophila	264.2 m^2
Ludwigia	1.3 m^2
Potamogeton	133.0 m^2
Sagittaria	112.7 m^2

0 37.5 75 150 Feet

0 20 40 Meters

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BIO-WEST
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Projection: UTM, NAD 83, 14 North
Map Revised: November 21, 2016

I-35 Reach

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study Reach
April 2016

Surveyed: April 7, 2016

I - 35

Study Reach	10,969.7 m^2

Vegetation Types

Zizania	177.6 m^2
Alternanthera	7.8 m^2
Cabomba	105.2 m^2
Heteranthera	1.4 m^2
Hydrilla	35.3 m^2
Hydrocotyle	1.2 m^2
Hygrophila	418.6 m^2
Ludwigia	56.8 m^2
Nuphar	40.7 m^2
Sagittaria	327.8 m^2

0 50 100 200 Feet

0 20 40 Meters

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BIO-WEST
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512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: December 7, 2016

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study Reach
October 2016

Surveyed: October 14, 2016

I - 35

Study Reach	10,969.7 m^2

Vegetation Types

Zizania	216.9 m^2
Cabomba	27.9 m^2
Heteranthera	7.8 m^2
Hydrilla	28.3 m^2
Hydrocotyle	14.4 m^2
Hygrophila	252.9 m^2
Ludwigia	103.2 m^2
Nuphar	29.0 m^2
Sagittaria	429.7 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: November 21, 2016

Texas Wild Rice

SAN MARCOS RIVER

San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2016

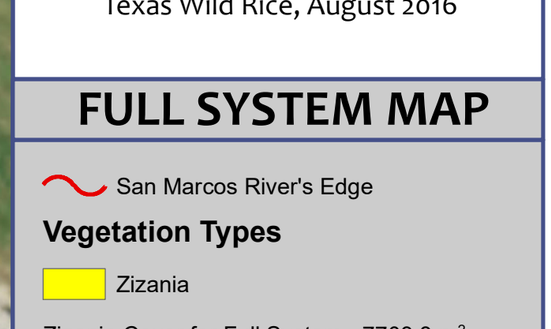
FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania

Zizania Cover for Full System =7703.8 m^2



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0 20 40 Meters

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Projection: UTM, NAD 83, 14 North
Map Revised: November 8, 2016

SAN MARCOS RIVER
San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2016

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania

Zizania Cover for Full System =7703.8 m^2

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SAN MARCOS RIVER
San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2016

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San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2016

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San Marcos River's Edge

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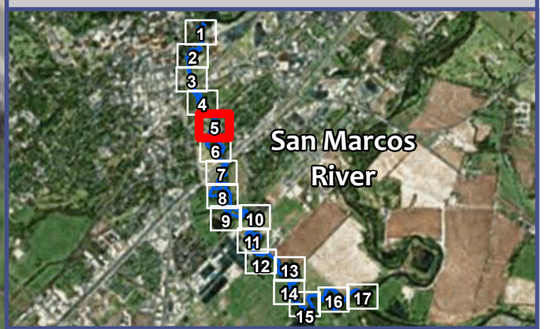

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San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2016

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Texas Wild Rice, August 2016

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San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2016

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Texas Wild Rice, August 2016

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San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2016

FULL SYSTEM MAP

San Marcos River's Edge

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0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: November 8, 2016

SAN MARCOS RIVER
San Marcos, Texas

Aquatic Vegetation Study
Texas Wild Rice, August 2016

FULL SYSTEM MAP

San Marcos River's Edge

Vegetation Types

Zizania

Zizania Cover for Full System =7703.8 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: November 8, 2016

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N

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0 50 100 200 Feet

0 20 40 Meters

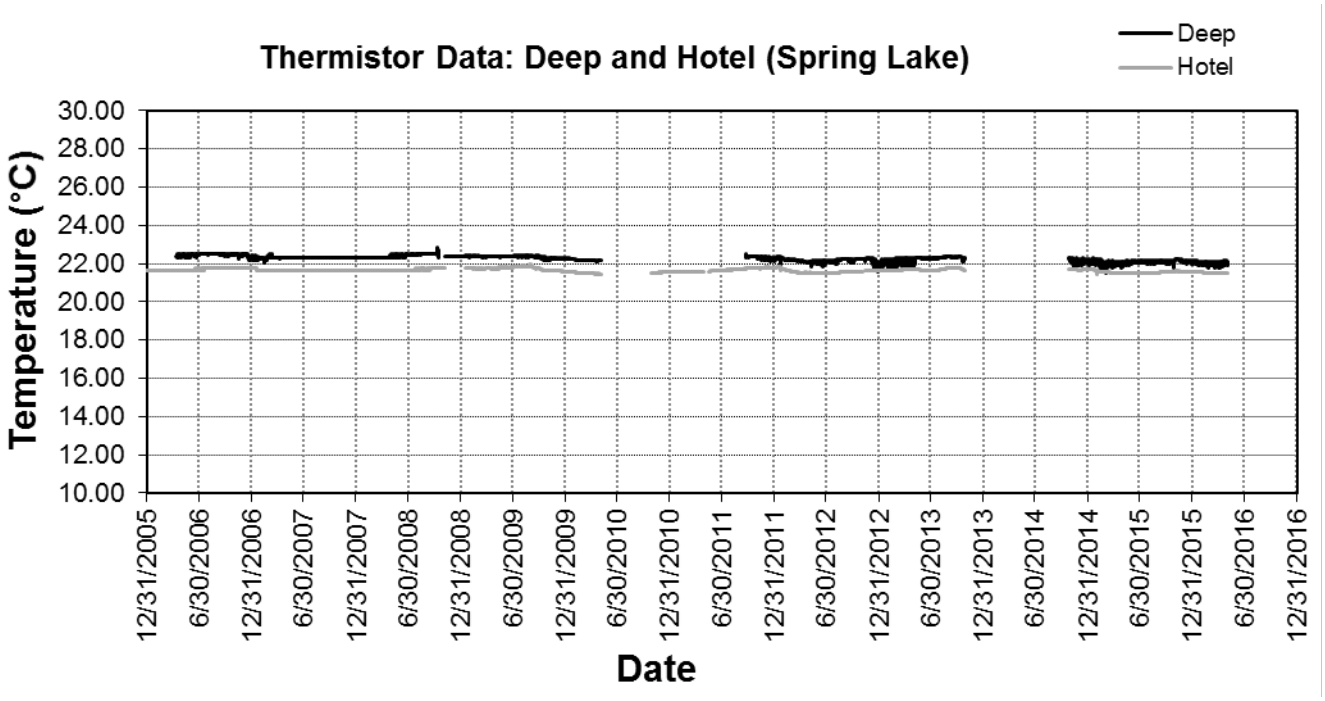
N

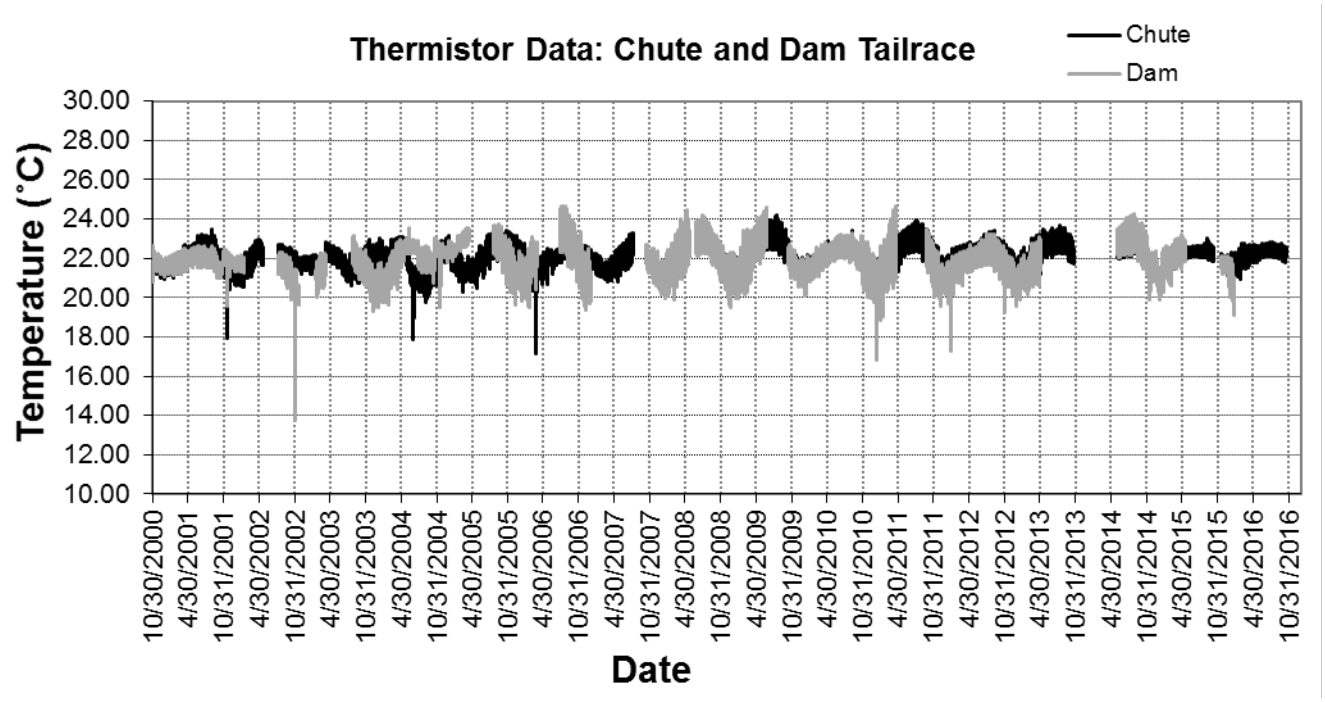
BIO-WEST
www.bio-west.com
512.990.3954

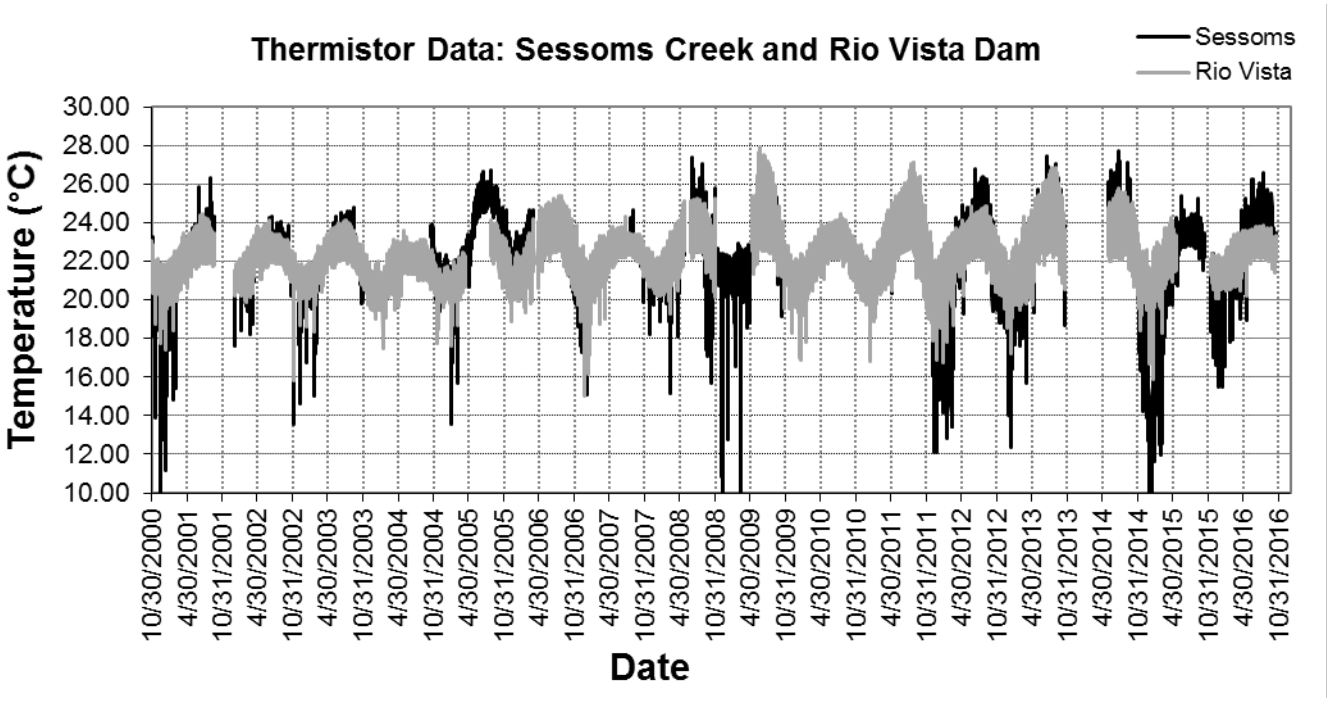
Projection: UTM, NAD 83, 14 North
Map Revised: November 8, 2016

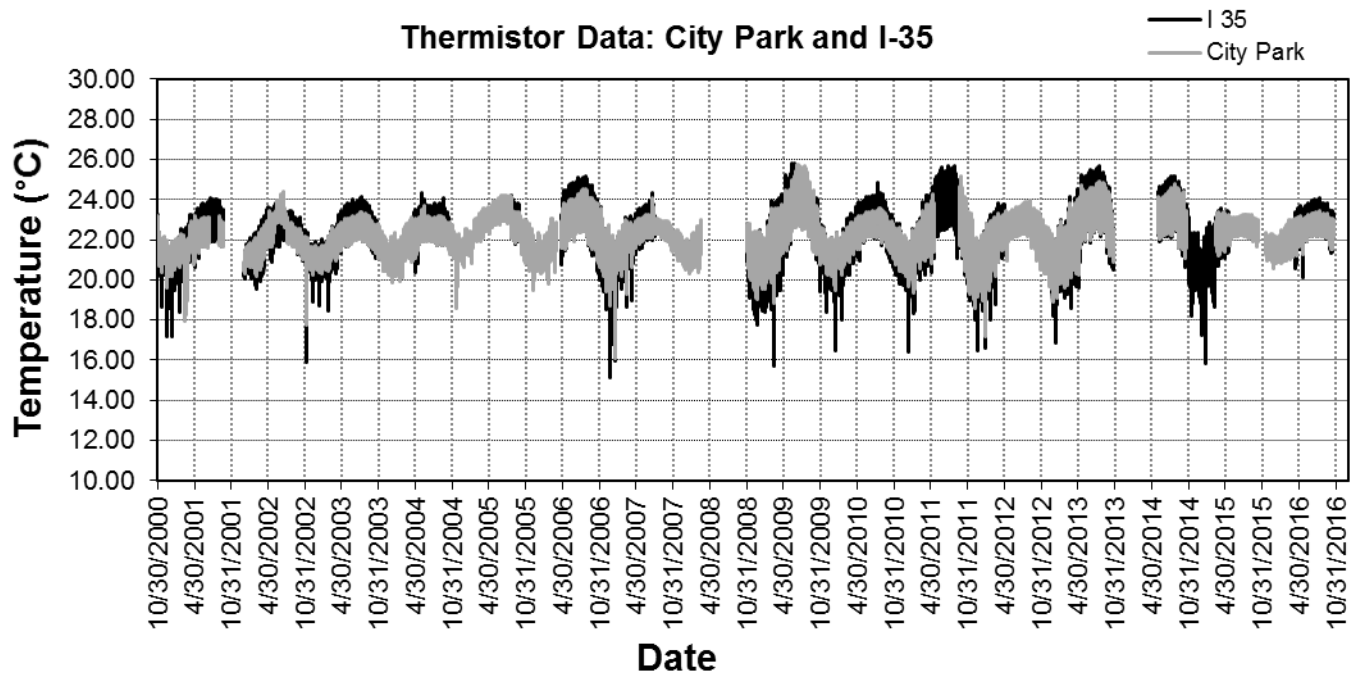
APPENDIX C: DATA AND GRAPHS

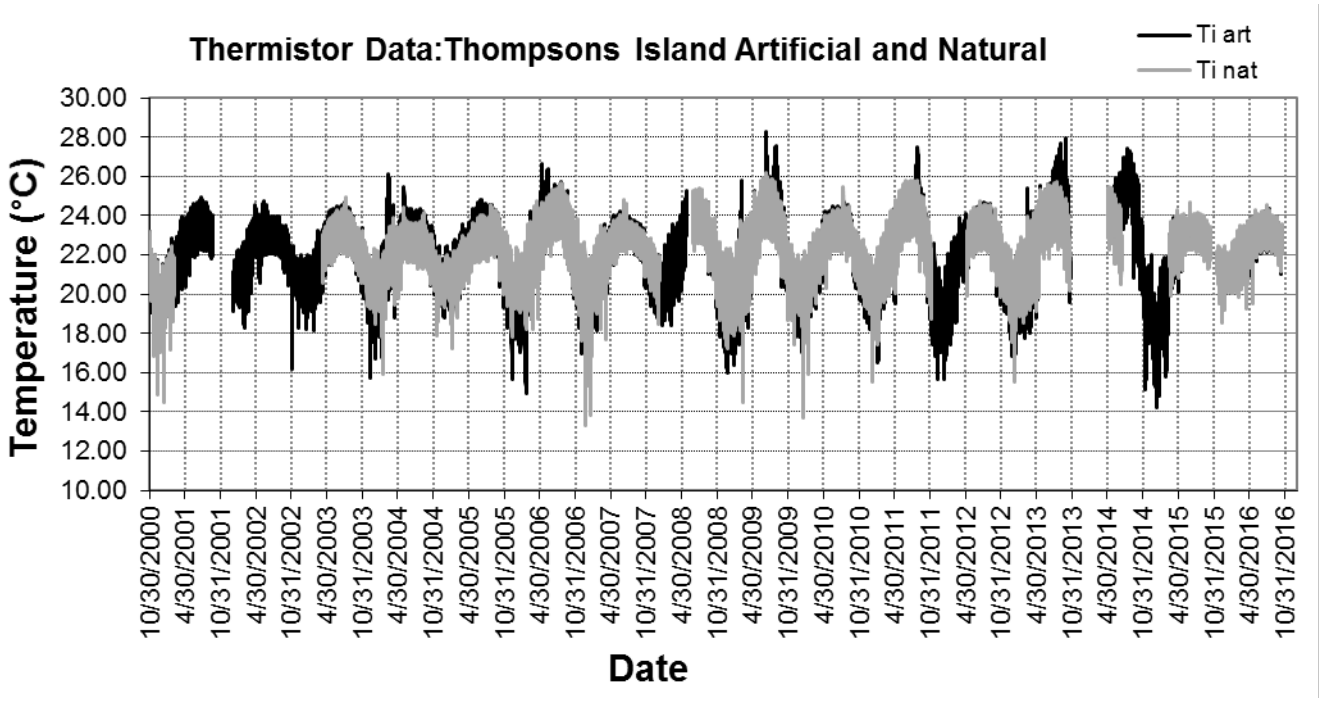
Thermistor Graphs

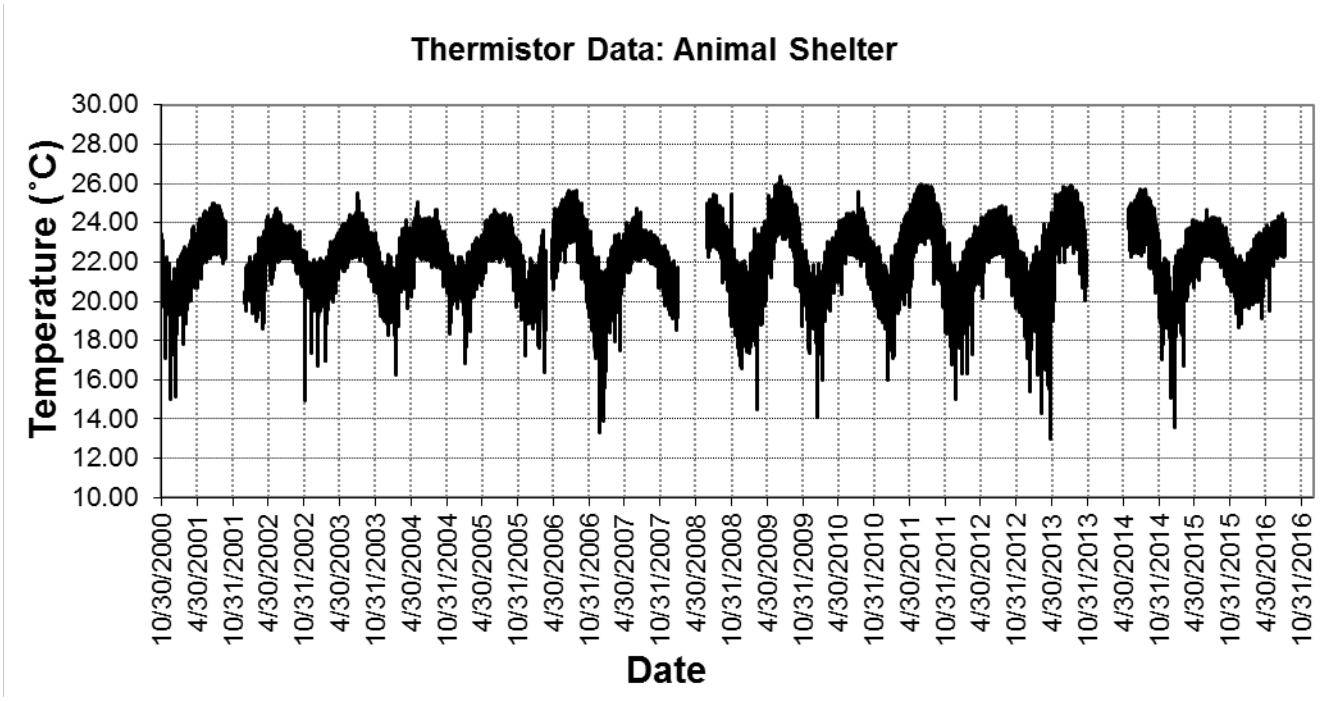

Thermistor Data: Deep and Hotel (Spring Lake)
Deep
Hotel
Temperature (°C)
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
12/31/2005
6/30/2006
12/31/2006
6/30/2007
12/31/2007
6/30/2008
12/31/2008
6/30/2009
12/31/2009
6/30/2010
12/31/2010
6/30/2011
12/31/2011
6/30/2012
12/31/2012
6/30/2013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

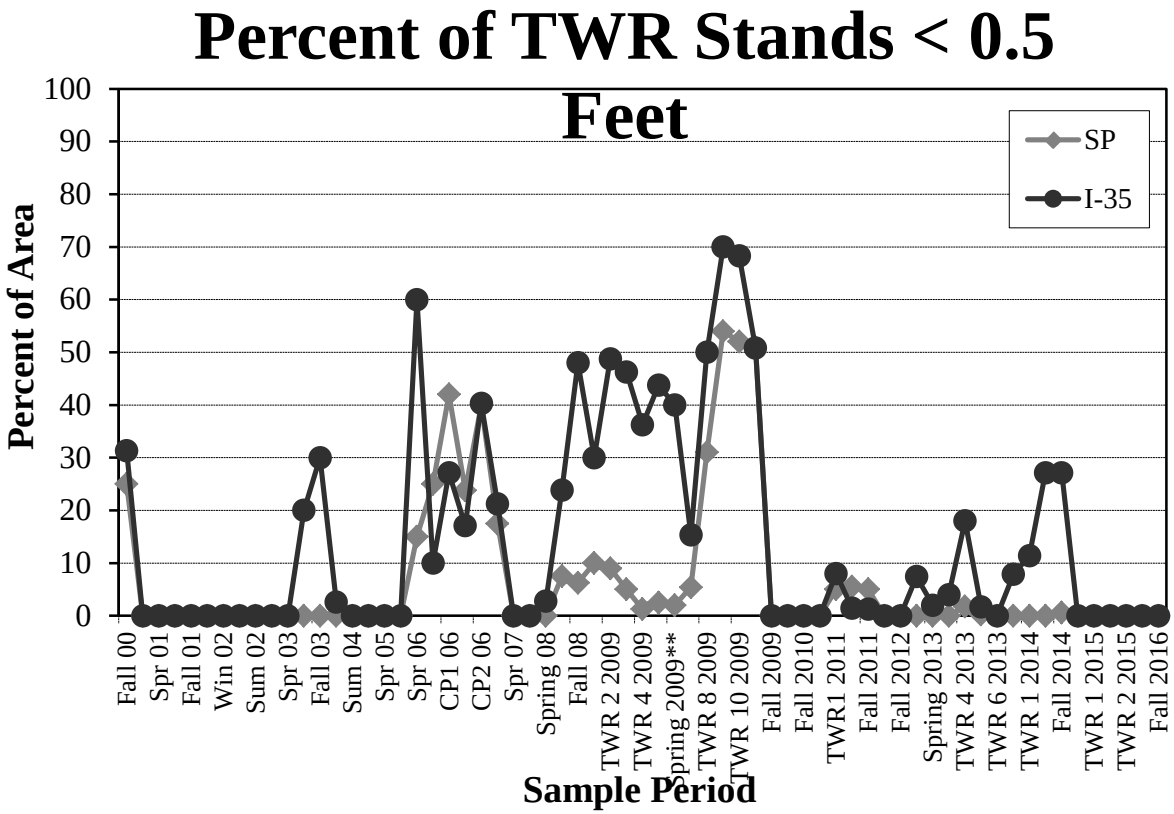

Thermistor Data: Sessoms Creek and Rio Vista Dam
Sessoms
Rio Vista
Temperature (°C)
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
10/30/2000
4/30/2001
10/31/2001
4/30/2002
10/31/2002
4/30/2003
10/31/2003
4/30/2004
10/31/2004
4/30/2005
10/31/2005
4/30/2006
10/31/2006
4/30/2007
10/31/2007
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
Date

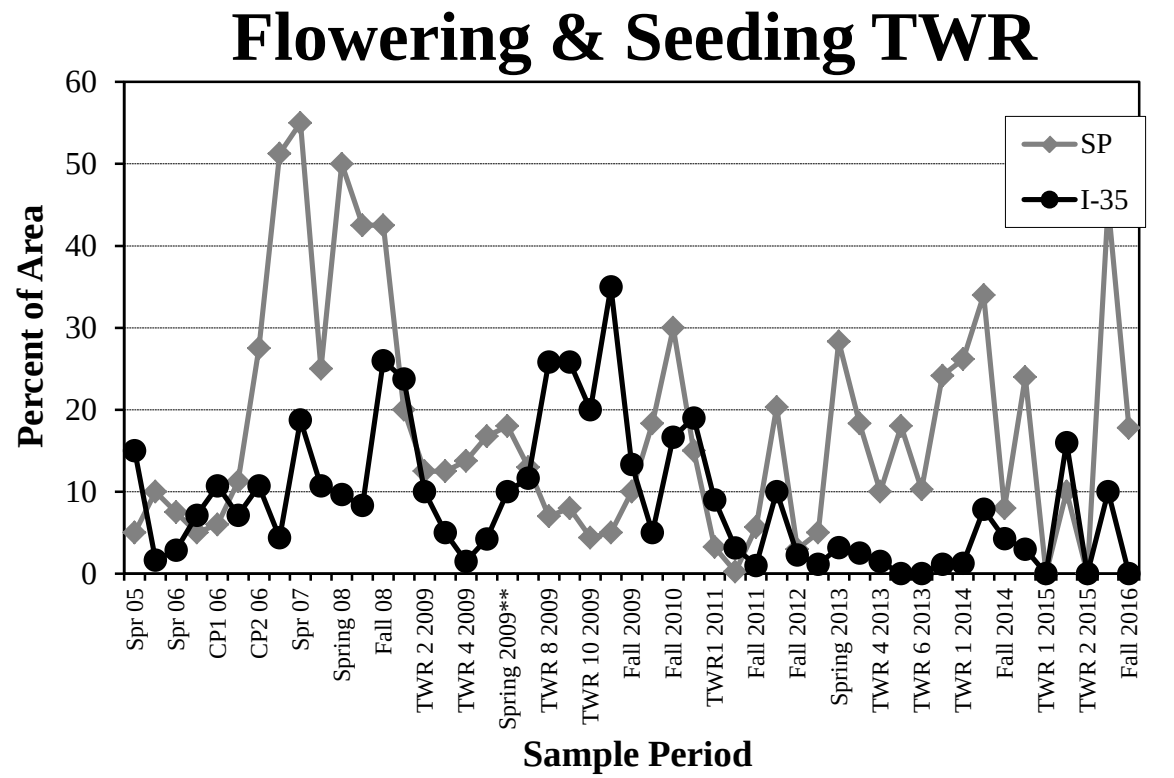

Thermistor Data: City Park and I-35
I 35
City Park
Temperature (°C)
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
10/30/2000
4/30/2001
10/31/2001
4/30/2002
10/31/2002
4/30/2003
10/31/2003
4/30/2004
10/31/2004
4/30/2005
10/31/2005
4/30/2006
10/31/2006
4/30/2007
10/31/2007
4/30/2008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

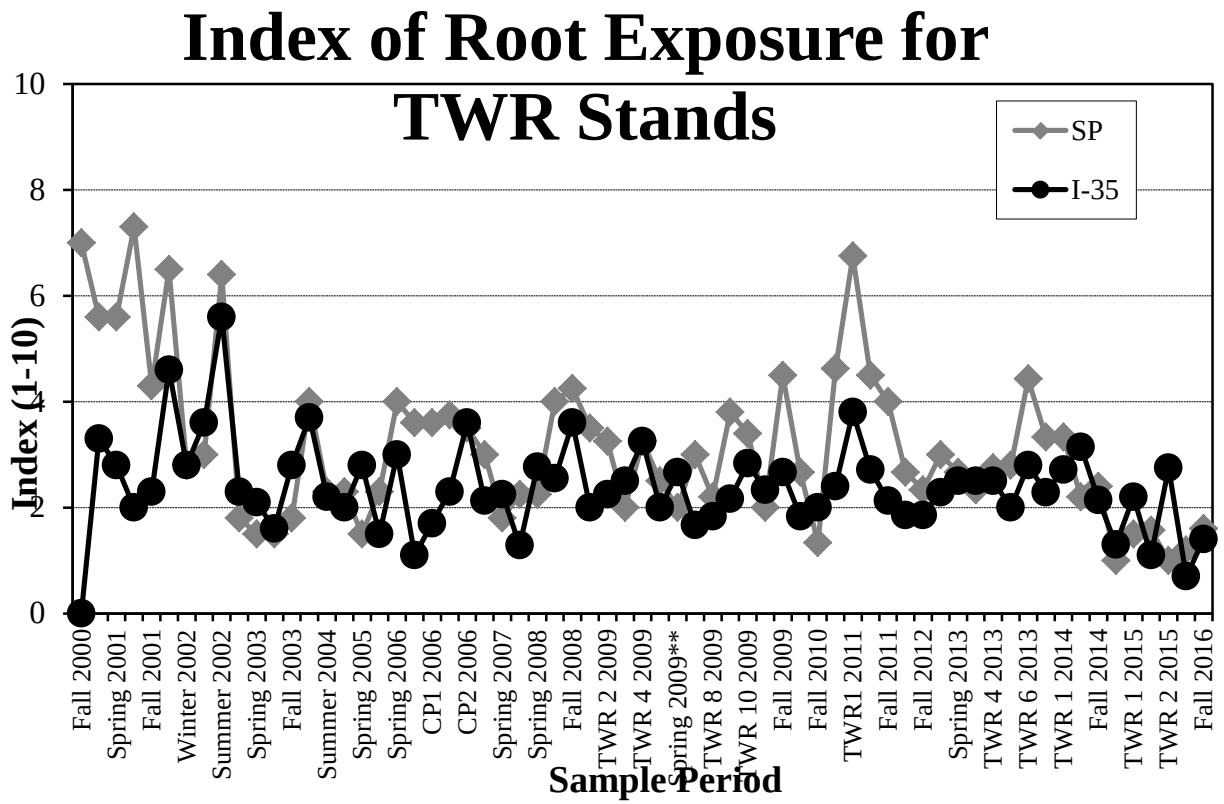

Thermistor Data:Thompsons Island Artificial and Natural
Ti art
Ti nat
Temperature (°C)
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
10/30/2000
4/30/2001
10/31/2001
4/30/2002
10/31/2002
4/30/2003
10/31/2003
4/30/2004
10/31/2004
4/30/2005
10/31/2005
4/30/2006
10/31/2006
4/30/2007
10/31/2007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

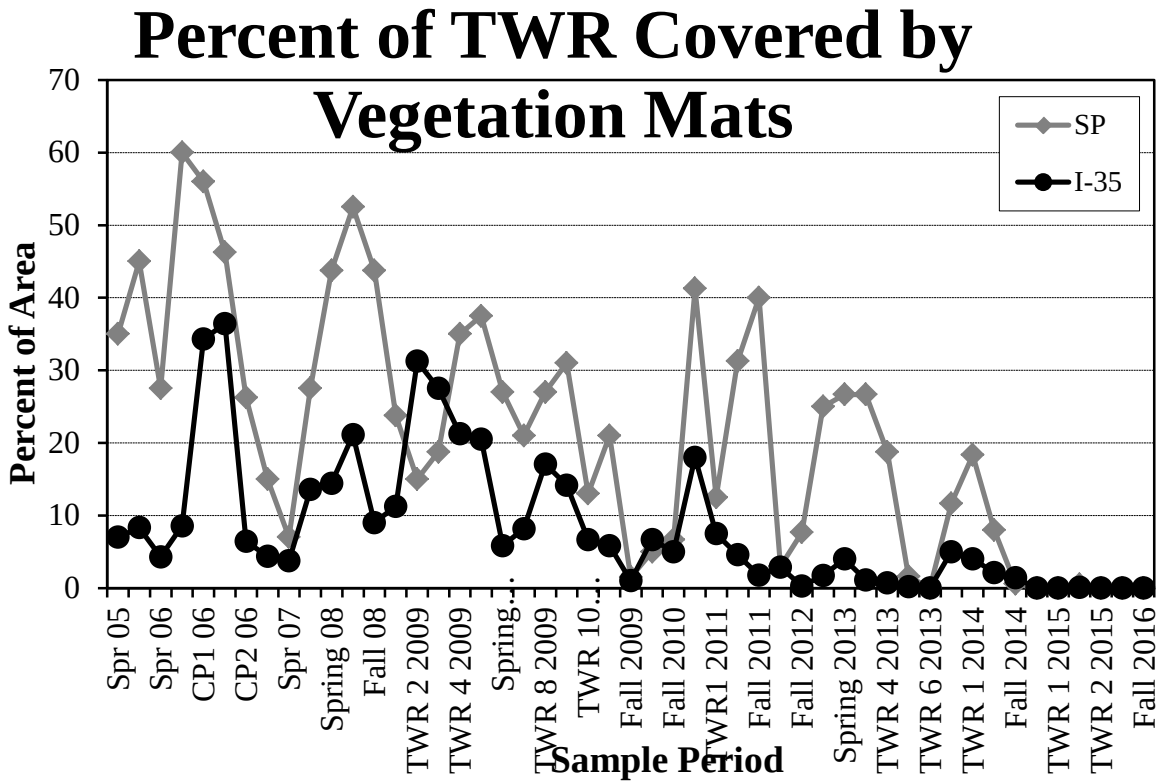

Thermistor Data: Animal Shelter
Temperature (°C)
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
10/30/2000
4/30/2001
10/31/2001
4/30/2002
10/31/2002
4/30/2003
10/31/2003
4/30/2004
10/31/2004
4/30/2005
10/31/2005
4/30/2006
10/31/2006
4/30/2007
10/31/2007
4/30/2008
10/31/2008
4/30/2009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

Texas Wild Rice Observation Data

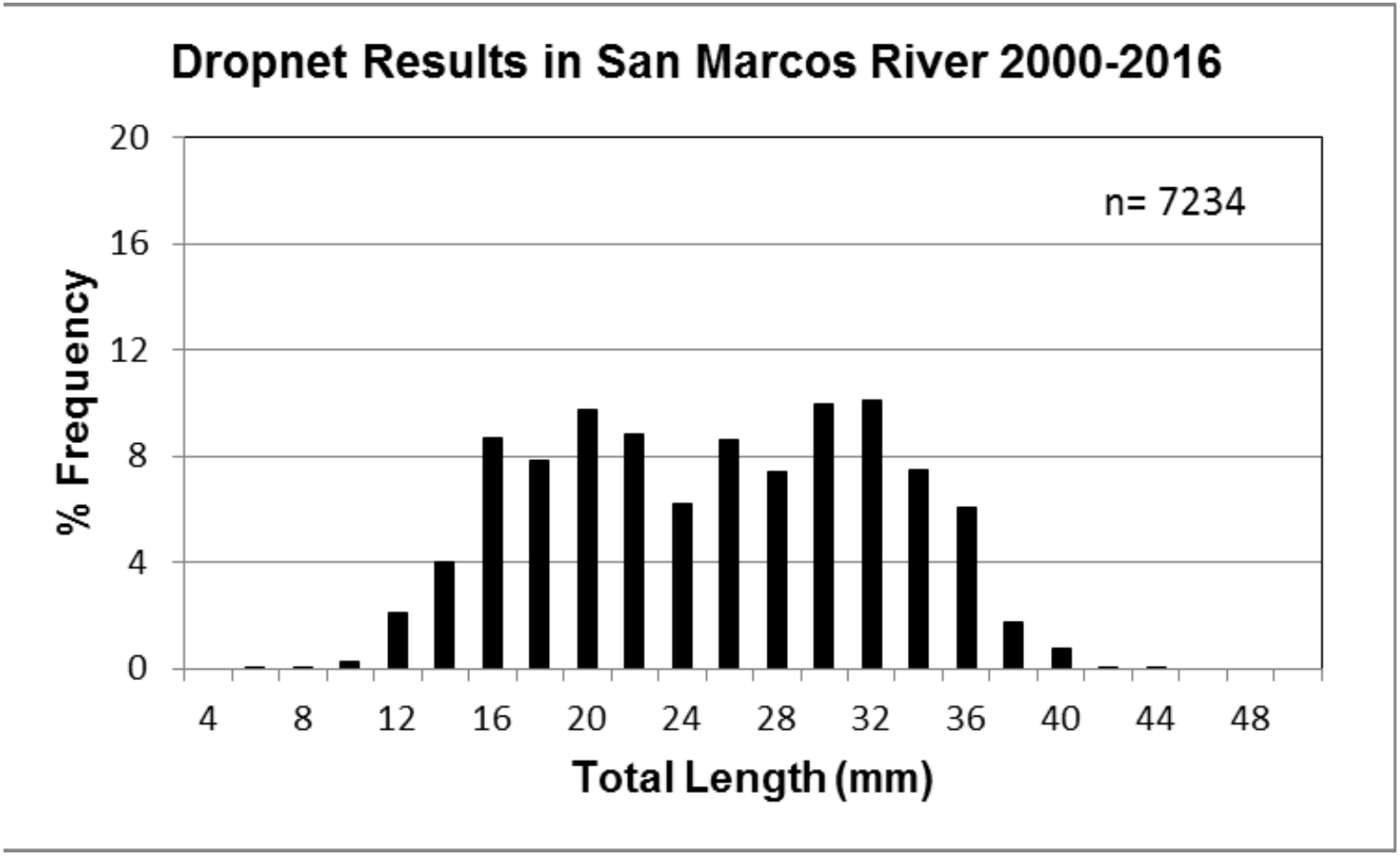

Percent of TWR Stands < 0.5 Feet
Percent of Area
100
90
80
70
60
50
40
30
20
10
0
SP
I-35
Fall 00
Spr 01
Fall 01
Win 02
Sum 02
Spr 03
Fall 03
Sum 04
Spr 05
Spr 06
CP1 06
CP2 06
Spr 07
Spring 08
Fall 08
TWR 2 2009
TWR 4 2009
Spring 2009**
TWR 8 2009
TWR 10 2009
Fall 2009
Fall 2010
TWR1 2011
Fall 2011
Fall 2012
Spring 2013
TWR 4 2013
TWR 6 2013
TWR 1 2014
Fall 2014
TWR 1 2015
TWR 2 2015
Fall 2016
Sample Period


Flowering & Seeding TWR
Percent of Area
60
50
40
30
20
10
0
SP
I-35
Spr 05
Spr 06
CP1 06
CP2 06
Spr 07
Spring 08
Fall 08
TWR 2 2009
TWR 4 2009
Spring 2009**
TWR 8 2009
TWR 10 2009
Fall 2009
Fall 2010
TWR1 2011
Fall 2011
Fall 2012
Spring 2013
TWR 4 2013
TWR 6 2013
TWR 1 2014
Fall 2014
TWR 1 2015
TWR 2 2015
Fall 2016
Sample Period

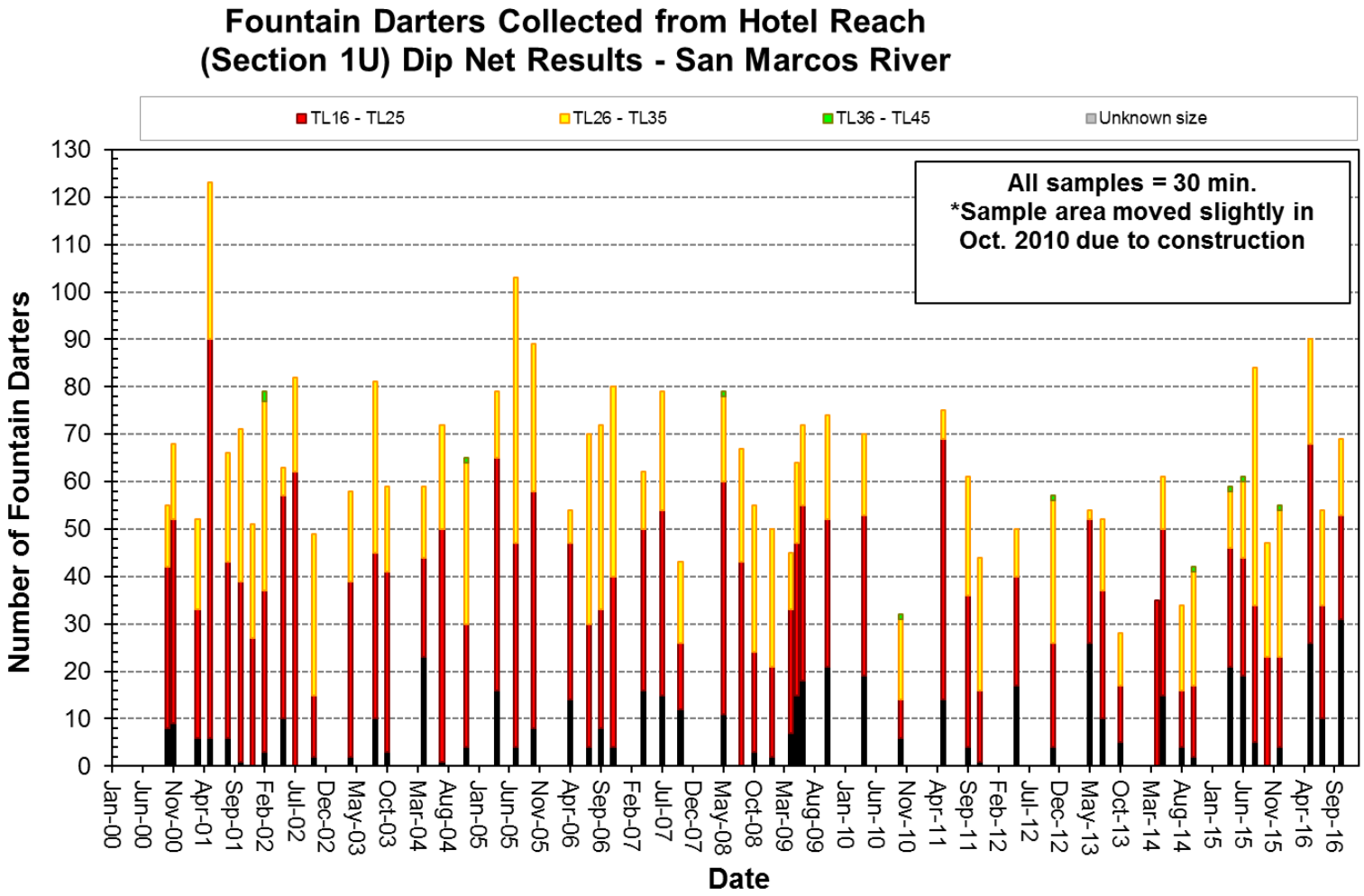

Index of Root Exposure for TWR Stands
SP
I-35
Index (1-10)
Sample Period
0
2
4
6
8
10
Fall 2000
Spring 2001
Fall 2001
Winter 2002
Summer 2002
Spring 2003
Fall 2003
Summer 2004
Spring 2005
Spring 2006
CP1 2006
CP2 2006
Spring 2007
Spring 2008
Fall 2008
TWR 2 2009
TWR 4 2009
Spring 2009**
TWR 8 2009
TWR 10 2009
Fall 2009
Fall 2010
TWR1 2011
Fall 2011
Fall 2012
Spring 2013
TWR 4 2013
TWR 6 2013
TWR 1 2014
Fall 2014
TWR 1 2015
TWR 2 2015
Fall 2016

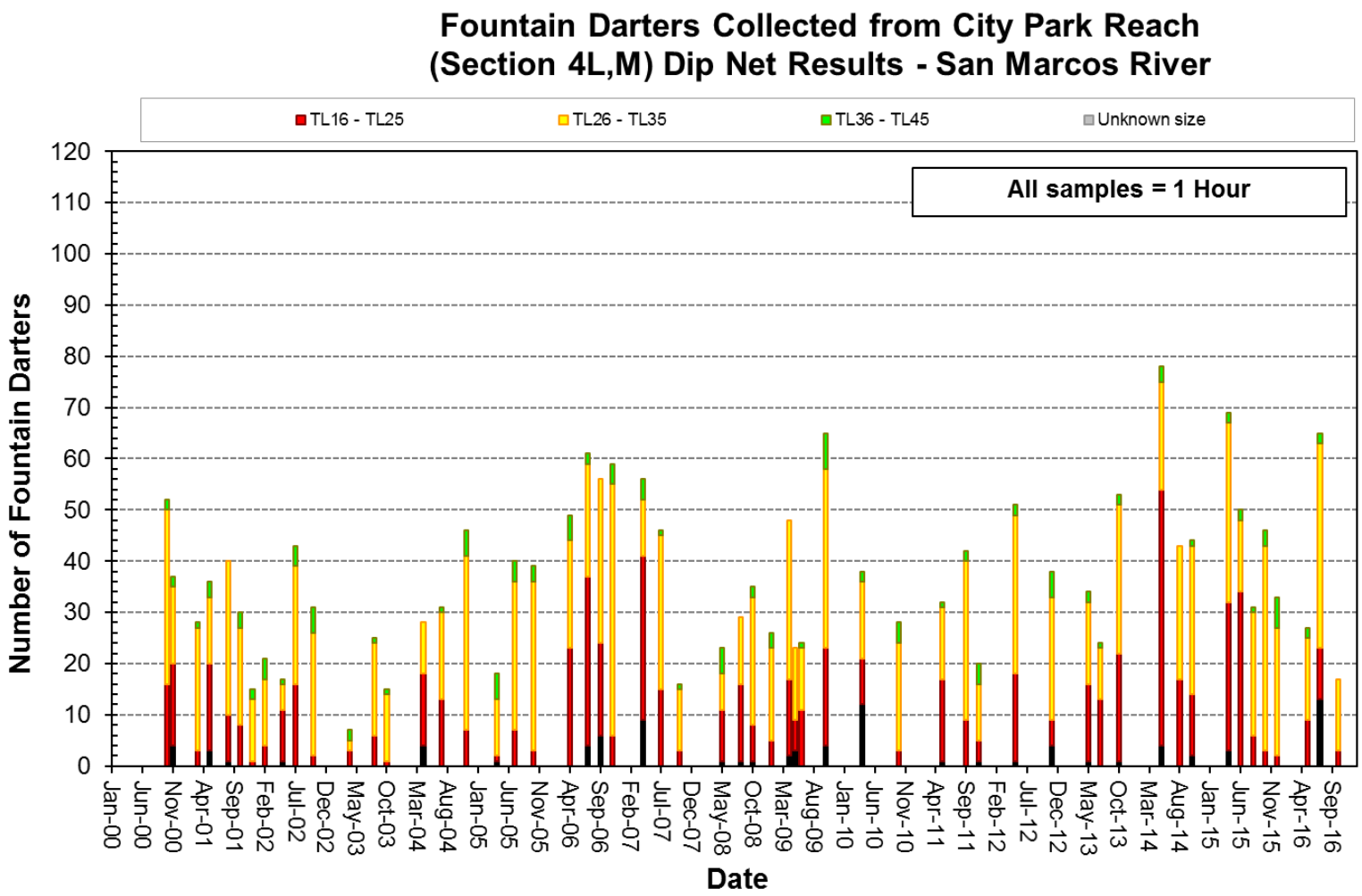

Percent of TWR Covered by Vegetation Mats
SP
I-35
Percent of Area
Sample Period
0
10
20
30
40
50
60
70
Spr 05
Spr 06
CP1 06
CP2 06
Spr 07
Spring 08
Fall 08
TWR 2 2009
TWR 4 2009
Spring...
TWR 8 2009
TWR 10...
Fall 2009
Fall 2010
TWR1 2011
Fall 2011
Fall 2012
Spring 2013
TWR 4 2013
TWR 6 2013
TWR 1 2014
Fall 2014
TWR 1 2015
TWR 2 2015
Fall 2016

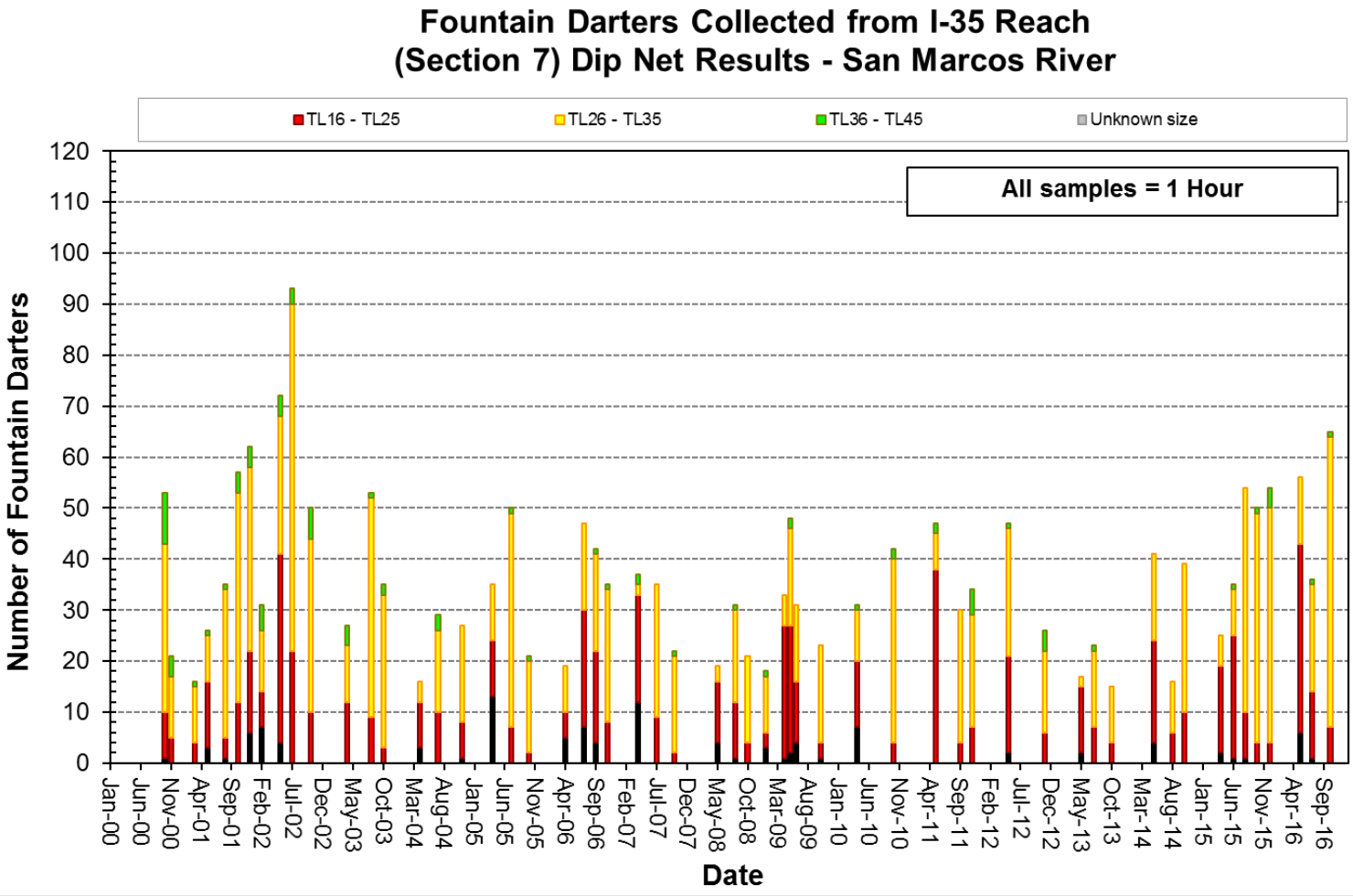
Drop net Graph

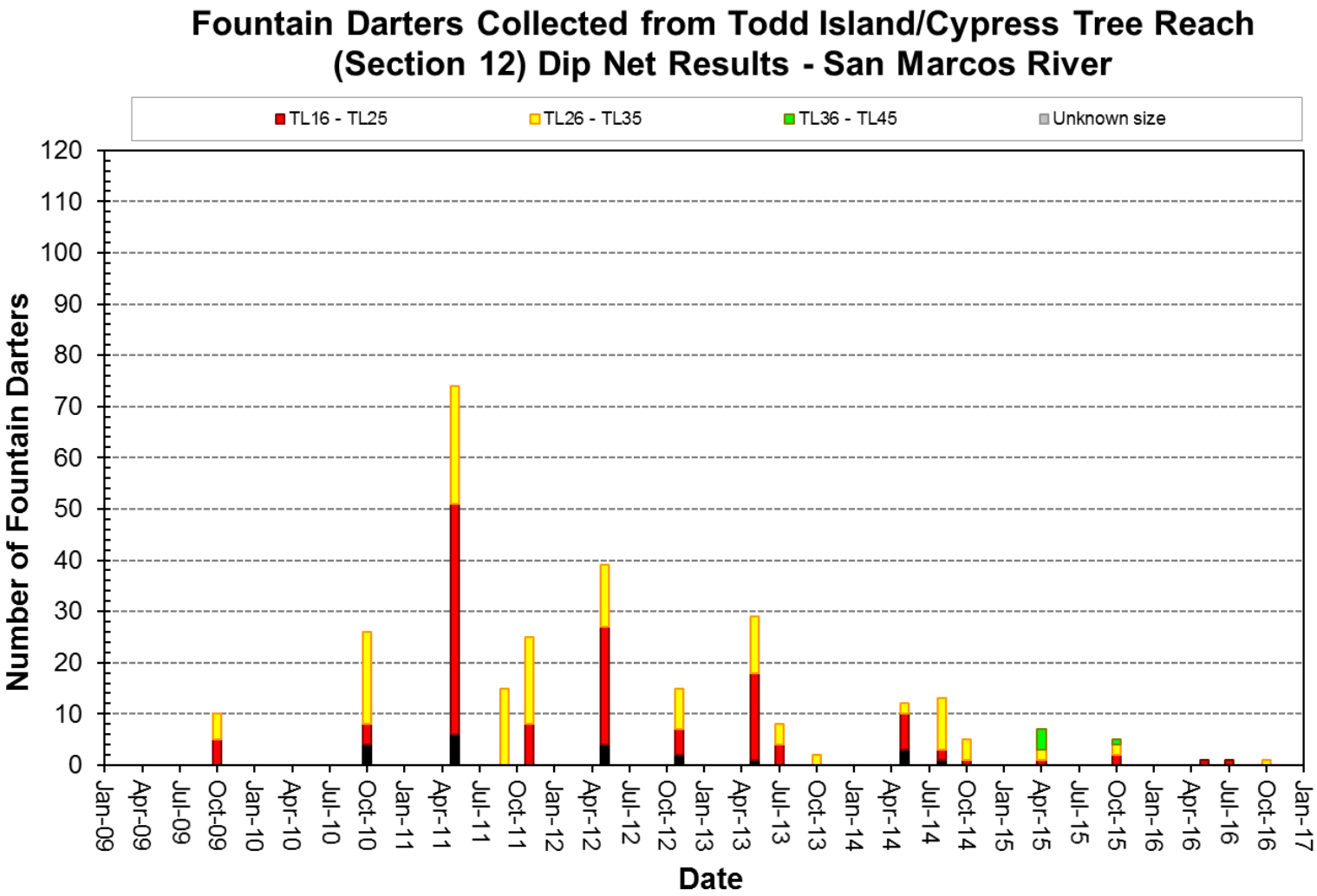

Dropnet Results in San Marcos River 2000-2016
n= 7234
% Frequency
0
4
8
12
16
20
4
8
12
16
20
24
28
32
36
40
44
48
Total Length (mm)

Dip Net Graphs


Fountain Darters Collected from Hotel Reach
(Section 1U) Dip Net Results - San Marcos River
TL16 - TL25
TL26 - TL35
TL36 - TL45
Unknown size
All samples = 30 min.
*Sample area moved slightly in
Oct. 2010 due to construction
Number of Fountain Darters
0
10
20
30
40
50
60
70
80
90
100
110
120
130
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
Date


Fountain Darters Collected from City Park Reach
(Section 4L,M) Dip Net Results - San Marcos River
TL16 - TL25
TL26 - TL35
TL36 - TL45
Unknown size
All samples = 1 Hour
Number of Fountain Darters
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
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
Date


Fountain Darters Collected from I-35 Reach
(Section 7) Dip Net Results - San Marcos River
TL16 - TL25
TL26 - TL35
TL36 - TL45
Unknown size
All samples = 1 Hour
Number of Fountain Darters
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
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
Date


Fountain Darters Collected from Todd Island/Cypress Tree Reach
(Section 12) Dip Net Results - San Marcos River
TL16 - TL25
TL26 - TL35
TL36 - TL45
Unknown size
Number of Fountain Darters
0
10
20
30
40
50
60
70
80
90
100
110
120
Jan-09
Apr-09
Jul-09
Oct-09
Jan-10
Apr-10
Jul-10
Oct-10
Jan-11
Apr-11
Jul-11
Oct-11
Jan-12
Apr-12
Jul-12
Oct-12
Jan-13
Apr-13
Jul-13
Oct-13
Jan-14
Apr-14
Jul-14
Oct-14
Jan-15
Apr-15
Jul-15
Oct-15
Jan-16
Apr-16
Jul-16
Oct-16
Jan-17
Date

Macroinvertebrate Data

Spring

Order/Class	Family	Genus	SLD-HYG	SLD-POT	SLD-SAG	CP-HYG	CP-POT	CP-HYD	CP-SAG	I35-CAB	I35-HYG	I35-HYD	I35-SAG
Ephemeroptera	Baetidae	*Fallceon quilleri*		11		6		8					
Ephemeroptera	Baetidae	*Baetis*		5									
Ephemeroptera	Ephmeridae	*Hexagenia*	4			5	3	1	2	4	1		
Ephemeroptera	Leptohyphidae	*Tricorythodes*	9	59	51	66	113	78	2	3	2	19	3
Ephemeroptera	Leptohyphidae	*Leptohyphes*		3		1							
Ephemeroptera	Heptagenidae	*Stenacron*				5							
Odonata	Ceonagrionidae	Early Instar				1							
Odonata	Ceonagrionidae	*Argia*										4	
Odonata	Ceonagrionidae	*Enallagma*			3	44	1			6	3	1	1
Odonata	Aeshnidae	*Anax*				1							
Hemiptera	Naucoridae	*Limnocoris*										1	
Megaloptera	Corydalidae	*Corydalus*				1							
Trichoptera	Leptoceridae	*Nectopsyche*		1			11	1			1		
Trichoptera	Hydroptilldae	*Oxytheria*						1					
Trichoptera	Hydropsychidae	*Smicridea*		1									
Trichoptera	Hydrobiosidae	*Atopsyche*		1									
Lepidoptera	Crambidae	Early Instar/Pupa					1						
Lepidoptera	Crambidae	*Paraponyx*		3	1	2	1	5		1			
Lepidoptera	Crambidae	*Oxyelophila c.f.*		1									
Coleoptera	Elmidae	*Microcylloepus pusillus*	1	1	5								
Coleoptera	Elmidae	*Hexacylloepus ferrugineus*				1	3			1			1
Coleoptera	Elmidae	*Phanocerus clavicornis*	1			2	2						
Coleoptera	Psephinidae	*Psephenus*			2								
Diptera	Empididae	*Hemerodromia*					1						
Diptera	Simuliidae	*Simulium*		2									
Diptera	Chironomidae	*Chironomini*			1			1					

Diptera	Chironomidae	*Tanytarsini*		6		1					1		
Diptera	Chironomidae	*Tanypodinae*				2							
Diptera	Chironomidae	*Orthocladinae*		12			1						
Diptera	Chironomidae	*Pseudochironomini*		3									
Diptera	Muscidae						1						
Amphipoda	Hyalellidae	*Hyalella*	44	48	383	324	71	190	4	18	8	47	16
Amphipoda	Crangonyictidae	*Crangonyx*		2		44						4	
Decapoda	Cambaridae				1	2						2	
Gastropoda	Thiaridae	*M. tuberculata*						1		20	21	11	
Gastropoda	Thiaridae	*Terabia*	34		13	8	8	6		13	446	48	2
Gastropoda	Pleuroceridae	*Elimia*	14	5	6	15	11	54	4		29	99	5
Gastropoda	Ancylidae				1								
Gastropoda	Hydrobiidae				2					13	2		
Gastropoda	Physidae	*Physa*			2	1		2		1		13	
Acari	Hydracarina							1					

Fall

Order/Class	Family	Genus	SLD-HYG	SLD-POT	SLD-SAG	CP-HYG	CP-POT	CP-HYD	CP-SAG	I35-CAB	I35-HYG	I35-HYD	I35-SAG
Ephemeroptera	Baetidae	*Fallceon quilleri*		2								3	1
Ephemeroptera	Baetidae	*Baetis*										1	
Ephemeroptera	Ephmeridae	*Hexagenia*				10				1			
Ephemeroptera	Leptohyphidae	*Tricorythodes*	5	7	1	1	1	22	1	1		6	1
Ephemeroptera	Leptohyphidae	*Leptohyphes*										1	
Ephemeroptera	Caenidae	*Caenis*				1							
Odonata	Calopterygidae	*Hetaerina*										1	
Odonata	Ceonagrionidae	*Enallagma*				3		4				2	
Hemiptera	Naucoridae	*Limnocoris*										1	
Hemiptera	Naucoridae	*Ambrysus*										1	
Trichoptera	Leptoceridae	*Nectopsyche*		1									
Trichoptera	Hydropsychidae	*Smicridea*		1			1	1					
Lepidoptera	Crambidae	*Paraponyx*		4		3	1	5	1		1		
Lepidoptera	Crambidae	*Oxyelophila c.f.*	1						1				
Coleoptera	Elmidae	*Phanocerus clavicornis*					1						
Diptera	Empididae	*Hemerodromia*						1					
Diptera	Ceratopogonidae	*Ceratopogon*									1		
Diptera	Chironomidae	*Tanytarsini*		5		1	1					2	
Diptera	Chironomidae	*Tanypodinae*				1							
Diptera	Chironomidae	*Orthocladinae*		1	1		1						
Amphipoda	Hyalellidae	*Hyalella*	35	446	105	2	15	94	32	7	19	56	6
Amphipoda	Crangonyictidae	*Crangonyx*			1				1		7		
Decapoda	Cambaridae									1	1	1	
Decapoda	Palaemonidae	*Palaemonetes*	1										
Gastropoda	Thiaridae	*M. tuberculata*				1		2		25	2	2	
Gastropoda	Thiaridae	*Terabia*	3		5	4	104	12	138	14	122	63	40
Gastropoda	Pleuroceridae	*Elimia*	102	11	103	3	9	53	8	3	4	85	20

Gastropoda	Hydrobiidae		1	9		2		1					
Veneroida	Spheriidae							1					

APPENDIX D: DROP NET RAW DATA

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Map site:
Spring Lake Dam		P1- Site 1	
Date:	**Time:**	**Observer(s):**	
5/3/2016	902-921	JO,JH,JW,JG	

Overall	Species	Number	Avg. Length (mm)
8	*Etheostoma fonticola*		
6	*Palaemonetes* sp.		
2	*Gambusia sp.*		
2	*Procambarus* sp.		
1	*Lepomis miniatus*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	1	29
	Palaemonetes sp.	1	
2	*Gambusia sp.*	2	16,16
	Etheostoma fonticola	1	28
	Palaemonetes sp.	4	
3	*Etheostoma fonticola*	2	21,23
4	No fish or crustaceans collected		
5	*Procambarus* sp.	1	
6	No fish or crustaceans collected		
7	*Palaemonetes* sp.	1	
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	*Lepomis miniatus*	1	34
	Etheostoma fonticola	1	15
11	*Etheostoma fonticola*	1	22
12	*Etheostoma fonticola*	1	16
13	*Etheostoma fonticola*	1	20
14	*Procambarus* sp.	1	
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Map site:
Spring Lake Dam		P2- Site 2	
Date:	**Time:**	**Observer(s):**	
5/3/2016	925-936	JO,JH,JW,JG	

Overall	Species	Number	Avg. Length (mm)
1	*Micropterus salmoides*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Micropterus salmoides*	1	159
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Map site:
Spring Lake Dam		O1 - Site 3	
Date:	**Time:**	**Observer(s):**	
5/3/2016	935-942	JO,JH,JW,JG	

Overall	Species	Number	Avg. Length (mm)

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**	**Map site:**
Spring Lake Dam		O2 - Site 4	
Date:	**Time:**	**Observer(s):**	
5/3/2016	944-948	JO,JH,JW,JG	

Overall	**Species**	**Number**	**Avg. Length (mm)**

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Map site:
Spring Lake Dam		H2 - Site 5	
Date:	**Time:**	**Observer(s):**	
5/3/2016	950-1030	JO,JH,JW,JG	

Overall	Species	Number	Avg. Length (mm)
2	*Lepomis gulosus*		
6	*Lepomis miniatus*		
38	*Etheostoma fonticola*		
9	*Gambusia sp.*		
3	*Dionda nigrotaeniata*		
1	*Lepomis sp.*		
11	*Procambarus* sp.		
5	*Palaemonetes* sp.		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis gulosus*	1	115
	Lepomis miniatus	2	91,28
	Etheostoma fonticola	10	15,19,18,21,22,22,17,19,16,16
	Gambusia sp.	6	18,16,12,13,15,16
	Palaemonetes sp.	3	
2	*Lepomis gulosus*	1	150
	Dionda nigrotaeniata	3	31,27,28
	Etheostoma fonticola	10	26,31,21,24,21,17,24,22,24,18
3	*Etheostoma fonticola*	3	26,21,22
	Lepomis sp.	1	20
	Gambusia sp.	1	11
	Procambarus sp.	1	
4	*Lepomis miniatus*	2	101,145
	Procambarus sp.	1	
	Etheostoma fonticola	4	27,21,26,18
5	*Lepomis miniatus*	1	43
	Gambusia sp.	1	23
	Etheostoma fonticola	2	30,22
	Palaemonetes sp.	1	
	Procambarus sp.	3	
6	*Etheostoma fonticola*	4	25,29,19,31
	Procambarus sp.	1	
	Palaemonetes sp.	1	
	Gambusia sp.	1	16
7	*Lepomis miniatus*	1	139
	Etheostoma fonticola	1	23
8	*Etheostoma fonticola*	1	30
9	*Etheostoma fonticola*	1	25
10	*Procambarus* sp.	1	
	Etheostoma fonticola	2	21,22
11	*Procambarus* sp.	2	
12	*Procambarus* sp.	1	
13	No fish or crustaceans collected		
14	*Procambarus* sp.	1	
15	No fish or crustaceans collected		

**Tarebia granifera - slight*

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Map site:
Spring Lake Dam		H1 - Site 6	
Date:	**Time:**	**Observer(s):**	
5/3/2016	1036-1053	JO,JH,JW,JG	

Overall	Species	Number	Avg. Length (mm)
1	*Notropis amabilis*		
8	*Etheostoma fonticola*		
12	*Procambarus* sp.		
3	*Palaemonetes* sp.		
2	*Ameiurus natalis*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	2	17,35
	Procambarus sp.	1	
	Palaemonetes sp.	1	
2	*Notropis amabilis*	1	75
	Etheostoma fonticola	1	25
	Palaemonetes sp.	1	
3	*Procambarus* sp.	3	
	Palaemonetes sp.	1	
	Etheostoma fonticola	1	16
4	*Procambarus* sp.	1	
	Ameiurus natalis	2	50,22
	Etheostoma fonticola	1	23
5	No fish or crustaceans collected		
6	*Procambarus* sp.	4	
	Etheostoma fonticola	2	36,26
7	No fish or crustaceans collected		
8	*Procambarus* sp.	1	
9	*Procambarus* sp.	1	
10	*Procambarus* sp.	1	
11	No fish or crustaceans collected		
12	*Etheostoma fonticola*	1	31
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

**Tarebia granifera - slight*

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):	Site:	Map site:
Spring Lake Dam	HDRO2 - Site 7	

Date:	Time:	Observer(s):
5/3/2016	1054-1110	JO,JH,JW,JG

Overall	Species	Number	Avg. Length (mm)
3	*Etheostoma fonticola*		
2	*Gambusia sp.*		
4	*Procambarus* sp.		
1	*Herichthys cyanoguttatus*		
1	*Hypostomus plecostomus*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	2	21,18
	Gambusia sp.	1	
2	*Procambarus* sp.	1	
3	No fish or crustaceans collected		
4	*Gambusia sp.*	1	15
5	*Procambarus* sp.	2	
6	*Herichthys cyanoguttatus*	1	43
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	*Procambarus* sp.	1	
11	No fish or crustaceans collected		
12	*Etheostoma fonticola*	1	32
	Hypostomus plecostomus	1	66
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Map site:
Spring Lake Dam		HDRO1 - Site 8	HDRO3
Date:	**Time:**	**Observer(s):**	
5/3/2016	1115-1130	JO,JH,JW,JG	

Overall	Species	Number	Avg. Length (mm)
1	*Etheostoma fonticola*		
2	*Procambarus* sp.		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	*Etheostoma fonticola*	1	22
3	*Procambarus* sp.	1	
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	*Procambarus* sp.	1	
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Map site:
Spring Lake Dam		P1- Site 1	
Date:	**Time:**	**Observer(s):**	
10/19/2016	834-902	JO,JH,DS,JG	

Overall	Species	Number	Avg. Length (mm)

SAN MARCOS RIVER -FALL SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Map site:
Spring Lake Dam		P2- Site 2	
Date:	**Time:**	**Observer(s):**	
10/19/2016	904-918	JO,JH,DS,JG	

Overall	Species	Number	Avg. Length (mm)
4	*Dionda nigrotaeniata*		

SAN MARCOS RIVER -FALL SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	*Dionda nigrotaeniata*	1	58
8	*Dionda nigrotaeniata*	3	61,67,64
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS
SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):	Site:	Map site:
Spring Lake Dam	S1 - Site 3	
Date:	**Time:**	**Observer(s):**
10/19/2016	921-942	JO,JH,DS,JG

Overall	Species	Number	Avg. Length (mm)
32	*Procambarus* sp.		
6	*Dionda nigrotaeniata*		
4	*Lepomis miniatus*		
12	*Etheostoma fonticola*		
12	*Herichthys cyanoguttatus*		
11	*Palaemonetes* sp.		

SAN MARCOS RIVER -FALL SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	9	
	Lepomis miniatus	1	53
	Etheostoma fonticola	3	26,32,34
	Herichthys cyanoguttatus	1	33
	Palaemonetes sp.	3	
2	*Herichthys cyanoguttatus*	3	35,34,35
	Dionda nigrotaeniata	1	37
	Palaemonetes sp.	5	
	Procambarus sp.	1	
	Etheostoma fonticola	3	35,36,35
3	*Dionda nigrotaeniata*	1	65
	Procambarus sp.	6	
	Herichthys cyanoguttatus	2	30,40
	Lepomis miniatus	2	38,41
	Palaemonetes sp.	2	
4	*Herichthys cyanoguttatus*	3	44,36,30
	Dionda nigrotaeniata	1	55
	Etheostoma fonticola	2	30,41
	Procambarus sp.	1	
5	*Palaemonetes* sp.	1	
6	*Procambarus* sp.	6	
	Herichthys cyanoguttatus	1	44
	Etheostoma fonticola	1	37
7	*Herichthys cyanoguttatus*	1	44
	Dionda nigrotaeniata	1	60
	Procambarus sp.	3	
8	*Procambarus* sp.	1	
	Etheostoma fonticola	1	33
9	*Procambarus* sp.	2	
10	*Dionda nigrotaeniata*	1	60
11	*Procambarus* sp.	1	
	Lepomis miniatus	1	39
12	*Herichthys cyanoguttatus*	1	31
	Dionda nigrotaeniata	1	61
13	*Procambarus* sp.	1	
	Etheostoma fonticola	2	33,35
14	*Procambarus* sp.	1	
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):	Site:	Map site:
Spring Lake Dam	S2 - Site 4	

Date:	Time:	Observer(s):
10/19/2016	942-1003	JO,JH,DS,JG

Overall	Species	Number	Avg. Length (mm)
22	*Dionda nigrotaeniata*		
1	*Etheostoma fonticola*		
3	*Gambusia sp.*		
11	*Herichthys cyanoguttatus*		
5	*Lepomis miniatus*		
12	*Palaemonetes* sp.		
13	*Procambarus* sp.		

SAN MARCOS RIVER -FALL SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	2	
	Palaemonetes sp.	5	
	Dionda nigrotaeniata	3	51,56,52
	Herichthys cyanoguttatus	1	49
	Gambusia sp.	1	13
2	*Procambarus* sp.	1	
3	*Procambarus* sp.	3	
	Dionda nigrotaeniata	7	52,56,63,31,31,52,62
	Etheostoma fonticola	1	29
	Gambusia sp.	1	31
	Palaemonetes sp.	1	
4	*Lepomis miniatus*	1	30
	Dionda nigrotaeniata	2	59,58
	Procambarus sp.	1	
	Palaemonetes sp.	2	
5	*Herichthys cyanoguttatus*	1	44
	Dionda nigrotaeniata	2	60,60
	Gambusia sp.	1	36
	Palaemonetes sp.	2	
6	*Herichthys cyanoguttatus*	2	40,31
7	*Dionda nigrotaeniata*	3	62,56,52
	Lepomis miniatus	1	54
	Herichthys cyanoguttatus	3	44,47,42
	Palaemonetes sp.	1	
8	*Dionda nigrotaeniata*	3	53,55,60
9	*Procambarus* sp.	2	
	Herichthys cyanoguttatus	2	33,36
	Lepomis miniatus	1	38
10	*Procambarus* sp.	1	
	Palaemonetes sp.	1	
11	*Dionda nigrotaeniata*	1	58
	Herichthys cyanoguttatus	1	49
	Lepomis miniatus	1	49
12	*Lepomis miniatus*	1	36
	Procambarus sp.	1	
13	*Herichthys cyanoguttatus*	1	45
14	*Procambarus* sp.	1	
15	*Procambarus* sp.	1	
	Dionda nigrotaeniata	1	66
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):	Site:	Map site:
Spring Lake Dam	H1 - Site 5	

Date:	Time:	Observer(s):
10/19/2016	1008-1037	JO,JH,DS,JG

Overall	Species	Number	Avg. Length (mm)
1	*Dionda nigrotaeniata*		
2	*Herichthys cyanoguttatus*		
5	*Etheostoma fonticola*		
12	*Gambusia sp.*		
1	*Lepomis macrochirus*		
11	*Lepomis miniatus*		
24	*Palaemonetes* sp.		
11	*Procambarus* sp.		

SAN MARCOS RIVER -FALL SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Dionda nigrotaeniata*	1	46
	Lepomis miniatus	8	101,43,47,50,44,45,52,29
	Procambarus sp.	1	
	Etheostoma fonticola	2	31,19
	Gambusia sp.	2	29,20
	Palaemonetes sp.	13	
2	*Gambusia sp.*	4	24,26,40,13
	Lepomis miniatus	1	65
	Palaemonetes sp.	3	
	Procambarus sp.	1	
3	*Gambusia sp.*	1	18
	Procambarus sp.	2	
	Palaemonetes sp.	3	
4	*Procambarus* sp.	4	
	Gambusia sp.	2	15,15
	Palaemonetes sp.	1	
5	*Procambarus* sp.	2	
	Herichthys cyanoguttatus	1	40
	Palaemonetes sp.	2	
	Etheostoma fonticola	1	22
	Gambusia sp.	2	
6	*Herichthys cyanoguttatus*	1	120
	Gambusia sp.	1	26
	Lepomis miniatus	1	55
7	*Etheostoma fonticola*	1	30
	Lepomis miniatus	1	62
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	*Lepomis macrochirus*	1	55
11	*Procambarus* sp.	1	
	Etheostoma fonticola	1	35
12	*Palaemonetes* sp.	2	
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Map site:
Spring Lake Dam		H2 - Site 6	H4
Date:	**Time:**	**Observer(s):**	
10/19/2016	1047-1107	JO,JH,DS,JG	

Overall	Species	Number	Avg. Length (mm)
3	*Lepomis macrochirus*		
2	*Procambarus* sp.		
2	*Lepomis miniatus*		
22	*Gambusia sp.*		
1	*Poecilia latipinna*		
1	*Herichthys cyanoguttatus*		
2	*Etheostoma fonticola*		
1	*Lepomis microlophus*		

SAN MARCOS RIVER -FALL SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis macrochirus*	3	54,55,41
	Procambarus sp.	2	
	Lepomis miniatus	1	42
	Gambusia sp.	5	15,20,21,15,35
	Poecilia latipinna	1	37
2	*Gambusia sp.*	4	17,12,20,26
3	*Gambusia sp.*	4	15,25,12,25
4	*Herichthys cyanoguttatus*	1	40
	Gambusia sp.	5	15,20,15,20,15
5	*Lepomis miniatus*	1	48
	Gambusia sp.	1	20
6	No fish or crustaceans collected		
7	*Etheostoma fonticola*	2	30,15
8	*Lepomis microlophus*	1	54
9	No fish or crustaceans collected		
10	*Gambusia sp.*	2	25,28
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	*Gambusia sp.*	1	20

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Map site:
Spring Lake Dam		O1 - Site 7	
Date:	**Time:**	**Observer(s):**	
10/19/2016	1110-1112	JO,JH,DS,JG	

Overall	Species	Number	Avg. Length (mm)

SAN MARCOS RIVER -FALL SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Map site:
Spring Lake Dam		O2 - Site 8	
Date:	**Time:**	**Observer(s):**	
10/19/2016	1114-1117	JO,JH,DS,JG	

Overall	Species	Number	Avg. Length (mm)

SAN MARCOS RIVER -FALL SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:
City Park		H1 - Site 1
Date:	**Time:**	**Observer(s):**
5/4/2016	845-910	JG,JW,JH,NP

Overall	Species	Number	Avg. Length (mm)
3	*Ambloplites rupestris*		
3	*Herichthys cyanoguttatus*		
3	*Lepomis gulosus*		
14	*Gambusia* sp.		
8	*Etheostoma fonticola*		
33	*Procambarus* sp.		
2	*Lepomis miniatus*		
1	*Hypostomus plecostomus*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Ambloplites rupestris*	2	85,117
	Herichthys cyanoguttatus	1	66
	Lepomis gulosus	1	63
	Gambusia sp.	5	45,15,17,37,19
	Etheostoma fonticola	1	28
	Procambarus sp.	2	
2	*Herichthys cyanoguttatus*	1	65
	Lepomis miniatus	1	65
	Gambusia sp.	1	24
	Procambarus sp.	6	
3	*Lepomis miniatus*	1	80
	Gambusia sp.	5	43,28,20,24,20
	Etheostoma fonticola	1	16
	Procambarus sp.	2	
4	*Etheostoma fonticola*	6	32,18,22,22,16,13
	Lepomis gulosus	1	40
	Hypostomus plecostomus	1	35
	Gambusia sp.	1	27
	Procambarus sp.	4	
5	*Ambloplites rupestris*	1	43
	Procambarus sp.	2	
6	*Lepomis gulosus*	1	72
	Herichthys cyanoguttatus	1	70
	Procambarus sp.	5	
7	*Procambarus* sp.	2	
	Gambusia sp.	2	45,34
8	*Procambarus* sp.	1	
9	*Procambarus* sp.	1	
10	No fish or crustaceans collected		
11	*Procambarus* sp.	5	
12	*Procambarus* sp.	1	
13	No fish or crustaceans collected		
14	*Procambarus* sp.	1	
15	*Procambarus* sp.	1	
	***Tarebia granifera-slight*		
	**Corbicula - slight*		

DROP NET - FIELD DATA SHEETS
SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):	Site:	Site on Map:
City Park	HD2 - Site 2	

Date:	Time:	Observer(s):
5/4/2016	915-940	JG,JW,JH,NP

Overall	Species	Number	Avg. Length (mm)
10	*Ambloplites rupestris*		
3	*Micropterus salmoides*		
2	*Lepomis gulosus*		
36	*Gambusia* sp.		
15	*Etheostoma fonticola*		
13	*Procambarus* sp.		
5	*Palaemonetes* sp.		
1	*Lepomis sp.*		
1	*Lepomis miniatus*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Ambloplites rupestris*	5	118,18,41,16,18
	Micropterus salmoides	1	146
	Lepomis gulosus	1	32
	Gambusia sp.	8	27,19,21,18,19,19,14,22
	Etheostoma fonticola	5	33,20,14,21,17
	Procambarus sp.	7	
	Palaemonetes sp.	2	
2	*Ambloplites rupestris*	2	47,40
	Etheostoma fonticola	2	17,20
	Gambusia sp.	9	30,22,25,21,25,21,21,12,22
	Lepomis sp.	1	7
	Palaemonetes sp.	2	
	Procambarus sp.	1	
3	*Gambusia* sp.	3	30,25,20
	Ambloplites rupestris	1	42
	Etheostoma fonticola	1	23
	Palaemonetes sp.	1	
	Procambarus sp.	1	
4	*Micropterus salmoides*	1	38
	Gambusia sp.	7	37,31,16,19,21
5	*Lepomis miniatus*	1	81
	Etheostoma fonticola	3	20,23,19
	Gambusia sp.	3	
6	*Lepomis gulosus*	1	114
	Gambusia sp.	1	
	Procambarus sp.	1	
7	*Gambusia* sp.	1	
8	*Procambarus* sp.	1	
	Ambloplites rupestris	1	13
9	*Gambusia* sp.	2	
10	*Etheostoma fonticola*	2	35,11
	Gambusia sp.	1	
11	*Ambloplites rupestris*	1	18
	Etheostoma fonticola	1	21
12	No fish or crustaceans collected		
13	*Etheostoma fonticola*	1	17
14	*Micropterus salmoides*	1	43
	Gambusia sp.	1	
15	*Procambarus* sp.	2	
	***Tarebia granifera-slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:
City Park		O2-Site 3
Date:	**Time:**	**Observer(s):**
5/4/2016	945-950	JG,JW,JH,NP

Overall	Species	Number	Avg. Length (mm)

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
	***Tarebia granifera-slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**	
City Park		O1 - Site 4	
Date:	**Time:**	**Observer(s):**	
5/4/2016	952-956	JG,JW,JH,NP	
Overall	**Species**	**Number**	**Avg. Length (mm)**

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
	***Tarebia granifera-slight*		

DROP NET - FIELD DATA SHEETS
SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**	
City Park		S2- Site 5	
Date:	**Time:**	**Observer(s):**	
5/4/2016	958-1009	JG,JW,JH,NP	
Overall	**Species**	**Number**	**Avg. Length (mm)**
1	*Procambarus* sp.		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Procambarus* sp.	1	
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:
City Park		H2 - Site 6
Date:	**Time:**	**Observer(s):**
5/4/2016	1010-1029	JG,JW,JH,NP

Overall	Species	Number	Avg. Length (mm)
5	*Ambloplites rupestris*		
1	*Etheostoma fonticola*		
1	*Lepomis microlophus*		
4	*Lepomis miniatus*		
5	*Procambarus* sp.		
3	*Palaemonetes* sp.		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	1	12
	Procambarus sp.	1	
2	*Ambloplites rupestris*	1	40
3	*Procambarus* sp.	3	
	Ambloplites rupestris	2	34,25
	Palaemonetes sp.	2	
4	*Lepomis miniatus*	2	68,67
5	*Lepomis microlophus*	1	90
	Ambloplites rupestris	1	97
6	*Procambarus* sp.	1	
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	*Lepomis miniatus*	2	61,72
	Palaemonetes sp.	1	
13	*Ambloplites rupestris*	1	29
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

***Tarebia granifera-slight*
**Melanoides - slight*

DROP NET - FIELD DATA SHEETS
SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**
City Park		S1 - Site 7
Date:	**Time:**	**Observer(s):**
5/4/2016	1033-1049	JG,JW,JH,NP

Overall	**Species**	**Number**	**Avg. Length (mm)**
1	*Dionda nigrotaeniata*		
7	*Procambarus* sp.		
1	*Micropterus salmoides*		
1	*Etheostoma fonticola*		
1	*Lepomis miniatus*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Dionda nigrotaeniata*	1	62
	Procambarus sp.	1	
2	*Micropterus salmoides*	1	46
3	*Etheostoma fonticola*	1	27
	Procambarus sp.	1	
4	No fish or crustaceans collected		
5	*Lepomis miniatus*	1	76
6	No fish or crustaceans collected		
7	*Procambarus* sp.	1	
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	*Procambarus* sp.	1	
11	*Procambarus* sp.	1	
12	No fish or crustaceans collected		
13	*Procambarus* sp.	1	
14	No fish or crustaceans collected		
15	*Procambarus* sp.	1	
	***Tarebia granifera-slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**
City Park		PH1- Site 8
Date:	**Time:**	**Observer(s):**
5/4/2016	1055-1145	JG,JW,JH,NP

Overall	**Species**	**Number**	**Avg. Length (mm)**
1	*Gambusia* sp.		
3	*Procambarus* sp.		
4	*Etheostoma fonticola*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Gambusia* sp.	1	21
2	*Etheostoma fonticola*	2	22,14
3	No fish or crustaceans collected		
4	*Procambarus* sp.	1	
5	*Procambarus* sp.	1	
6	*Etheostoma fonticola*	1	15
	Procambarus sp.	1	
7	*Etheostoma fonticola*	1	12
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:
City Park		HD1 - Site 9
Date:	**Time:**	**Observer(s):**
5/4/2016	1150-1210	JG,JW,JH,NP

Overall	Species	Number	Avg. Length (mm)
2	*Micropterus salmoides*		
1	*Ambloplites rupestris*		
26	*Procambarus* sp.		
3	*Etheostoma fonticola*		
1	*Gambusia* sp.		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Micropterus salmoides*	1	43
	Ambloplites rupestris	1	39
	Procambarus sp.	6	
	Etheostoma fonticola	1	27
2	*Micropterus salmoides*	1	32
	Etheostoma fonticola	1	33
	Procambarus sp.	7	
3	*Procambarus* sp.	1	
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	*Etheostoma fonticola*	1	32
	Procambarus sp.	3	
8	*Procambarus* sp.	2	
9	*Procambarus* sp.	3	
10	No fish or crustaceans collected		
11	*Procambarus* sp.	3	
12	*Procambarus* sp.	1	
13	*Gambusia* sp.	1	27
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	***Tarebia granifera-slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
City Park		PH2- Site 10	PH3
Date:	**Time:**	**Observer(s):**	
5/4/2016	1220-1245	JG,JW,JH,NP	

Overall	Species	Number	Avg. Length (mm)
2	*Lepomis miniatus*		
2	*Procambarus* sp.		
1	*Gambusia* sp.		
2	*Etheostoma fonticola*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	*Procambarus* sp.	1	
4	*Etheostoma fonticola*	1	22
	Gambusia sp.	1	28
5	No fish or crustaceans collected		
6	*Lepomis miniatus*	1	105
	Procambarus sp.	1	
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	*Etheostoma fonticola*	1	32
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	*Lepomis miniatus*	1	51
	***Tarebia granifera-slight*		

DROP NET - FIELD DATA SHEETS
SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
City Park		PH2- Site 1	
Date:	**Time:**	**Observer(s):**	
10/19/2016	1210-1225	JG,JO,JH,DS	

Overall	Species	Number	Avg. Length (mm)
8	*Ambloplites rupestris*		
1	*Lepomis miniatus*		
4	*Etheostoma fonticola*		
1	*Herichthys cyanoguttatus*		
6	*Procambarus* sp.		
1	*Gambusia* sp.		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Ambloplites rupestris*	2	70,71
2	*Ambloplites rupestris*	2	45,73
3	*Ambloplites rupestris*	1	74
	Lepomis miniatus	1	42
	Etheostoma fonticola	1	36
4	*Etheostoma fonticola*	1	36
	Procambarus sp.	2	
5	*Herichthys cyanoguttatus*	1	50
6	*Ambloplites rupestris*	1	71
	Etheostoma fonticola	1	38
7	*Ambloplites rupestris*	1	145
	Gambusia sp.	1	20
8	No fish or crustaceans collected		
9	*Procambarus* sp.	1	
10	*Procambarus* sp.	2	
	Ambloplites rupestris	1	61
11	*Procambarus* sp.	1	
12	No fish or crustaceans collected		
13	*Etheostoma fonticola*	1	36
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	***Tarebia granifera-slight*		
	**Melanoides - slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
City Park		PH1- Site 2	PH4
Date:	**Time:**	**Observer(s):**	
10/19/2016	1228-1238	JG,JO,JH,DS	

Overall	Species	Number	Avg. Length (mm)
1	*Gambusia* sp.		
1	*Hypostomus plecostomus*		
1	*Dionda nigrotaeniata*		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	*Gambusia* sp.	1	23
4	No fish or crustaceans collected		
5	*Hypostomus plecostomus*	1	25
6	*Dionda nigrotaeniata*	1	63
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:
City Park		H2 - Site 3
Date:	**Time:**	**Observer(s):**
10/19/2016	1244-1300	JG,JO,JH,DS

Overall	Species	Number	Avg. Length (mm)
1	*Micropterus salmoides*		
1	*Ambloplites rupestris*		
3	*Etheostoma fonticola*		
16	*Procambarus* sp.		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Micropterus salmoides*	1	78
	Ambloplites rupestris	1	70
	Etheostoma fonticola	1	36
	Procambarus sp.	2	
2	*Procambarus* sp.	1	
3	*Procambarus* sp.	3	
4	*Procambarus* sp.	2	
5	*Procambarus* sp.	1	
6	*Procambarus* sp.	1	
7	*Etheostoma fonticola*	1	36
8	*Procambarus* sp.	2	
9	*Procambarus* sp.	1	
10	*Procambarus* sp.	2	
11	*Procambarus* sp.	1	
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	*Etheostoma fonticola*	1	36
15	No fish or crustaceans collected		
	***Tarebia granifera-slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
City Park		HD1 - Site 4	HD3
Date:	**Time:**	**Observer(s):**	
10/19/2016	1307-1321	JG,JO,JH,DS	

Overall	Species	Number	Avg. Length (mm)
1	*Lepomis miniatus*		
1	*Procambarus* sp.		
1	*Dionda nigrotaeniata*		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	*Lepomis miniatus*	1	105
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	*Procambarus* sp.	1	
	Dionda nigrotaeniata	1	71
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	***Tarebia granifera-slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):	Site:	Site on Map:
City Park	HD2 - Site 5	

Date:	Time:	Observer(s):
10/19/2016	1326-1347	JG,JO,JH,DS

Overall	Species	Number	Avg. Length (mm)
3	*Ambloplites rupestris*		
12	*Etheostoma fonticola*		
6	*Gambusia* sp.		
3	*Lepomis miniatus*		
1	*Micropterus salmoides*		
6	*Procambarus* sp.		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	1	24
	Procambarus sp.	2	
2	*Gambusia* sp.	2	25,38
3	*Lepomis miniatus*	1	67
	Gambusia sp.	2	29,12
	Etheostoma fonticola	2	32,17
	Procambarus sp.	1	
4	*Lepomis miniatus*	1	98
	Etheostoma fonticola	1	36
5	*Procambarus* sp.	1	
	Lepomis miniatus	1	79
	Ambloplites rupestris	1	85
	Etheostoma fonticola	3	39,36,33
6	*Ambloplites rupestris*	1	56
7	*Gambusia* sp.	1	10
8	*Etheostoma fonticola*	1	32
	Micropterus salmoides	1	65
9	*Ambloplites rupestris*	1	66
10	No fish or crustaceans collected		
11	*Procambarus* sp.	1	
12	*Etheostoma fonticola*	2	31,22
13	*Etheostoma fonticola*	2	31,31
14	*Procambarus* sp.	1	
15	*Etheostoma fonticola*	1	32
16	No fish or crustaceans collected		
	***Tarebia granifera-slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:
City Park		O2-Site 6
Date:	**Time:**	**Observer(s):**
10/19/2016	1348-1351	JG,JO,JH,DS

Overall	Species	Number	Avg. Length (mm)

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:
City Park		O1 - Site 7
Date:	**Time:**	**Observer(s):**
10/19/2016	1352-1355	JG,JO,JH,DS

Overall	Species	Number	Avg. Length (mm)

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS
SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:
City Park		S1 - Site 8
Date:	**Time:**	**Observer(s):**
10/19/2016	1356-1411	JG,JO,JH,DS

Overall	Species	Number	Avg. Length (mm)
2	*Ambloplites rupestris*		
2	*Procambarus* sp.		
2	*Etheostoma fonticola*		
6	*Gambusia* sp.		
1	*Lepomis miniatus*		
2	*Herichthys cyanoguttatus*		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Ambloplites rupestris*	1	69
2	*Procambarus* sp.	1	
	Etheostoma fonticola	1	38
3	*Gambusia* sp.	2	16,18
4	*Herichthys cyanoguttatus*	1	95
	Gambusia sp.	1	26
5	*Gambusia* sp.	2	24,23
6	*Ambloplites rupestris*	1	62
7	*Etheostoma fonticola*	1	39
8	No fish or crustaceans collected		
9	*Gambusia* sp.	1	20
	Herichthys cyanoguttatus	1	55
10	No fish or crustaceans collected		
11	*Lepomis miniatus*	1	80
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	*Procambarus* sp.	1	

DROP NET - FIELD DATA SHEETS
SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:
City Park		H1 - Site 9
Date:	**Time:**	**Observer(s):**
10/19/2016	1414-1434	JG,JO,JH,DS

Overall	Species	Number	Avg. Length (mm)
4	*Ambloplites rupestris*		
8	*Etheostoma fonticola*		
5	*Gambusia* sp.		
1	*Herichthys cyanoguttatus*		
1	*Lepomis gulosus*		
1	*Lepomis macrochirus*		
1	*Lepomis sp.*		
2	*Palaemonetes* sp.		
2	*Poecilia latipinna*		
14	*Procambarus* sp.		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Ambloplites rupestris*	4	156,80,40,56
	Lepomis gulosus	1	155
	Etheostoma fonticola	2	31,16
	Procambarus sp.	6	
	Palaemonetes sp.	2	
2	*Etheostoma fonticola*	2	35,31
	Gambusia sp.	1	38
3	*Lepomis macrochirus*	1	34
4	*Gambusia* sp.	2	30,15
	Poecilia latipinna	1	35
5	*Lepomis sp.*	1	19
6	*Poecilia latipinna*	1	40
	Gambusia sp.	1	32
	Etheostoma fonticola	1	20
7	*Herichthys cyanoguttatus*	1	31
	Etheostoma fonticola	1	37
	Procambarus sp.	1	
8	No fish or crustaceans collected		
9	*Procambarus* sp.	3	
10	*Etheostoma fonticola*	1	24
11	No fish or crustaceans collected		
12	*Procambarus* sp.	1	
13	*Gambusia* sp.	1	15
	Procambarus sp.	1	
14	*Etheostoma fonticola*	1	31
15	*Procambarus* sp.	2	

***Tarebia granifera-slight*
**Melanoides - slight*

DROP NET - FIELD DATA SHEETS
SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:
City Park		S2- Site 10
Date:	**Time:**	**Observer(s):**
10/19/2016	1437-1456	JG,JO,JH,DS

Overall	Species	Number	Avg. Length (mm)
4	*Lepomis miniatus*		
13	*Procambarus* sp.		
2	*Lepomis sp.*		
1	*Gambusia* sp.		
1	*Etheostoma fonticola*		
1	*Lepomis macrochirus*		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	1	48
	Procambarus sp.	1	
	Lepomis sp.	1	24
	Gambusia sp.	1	
2	*Etheostoma fonticola*	1	35
	Lepomis miniatus	1	105
	Lepomis sp.	1	21
3	*Procambarus* sp.	2	
	Lepomis macrochirus	1	40
	Lepomis miniatus	1	30
4	*Procambarus* sp.	2	
5	*Procambarus* sp.	3	
6	*Procambarus* sp.	2	
7	*Procambarus* sp.	1	
8	No fish or crustaceans collected		
9	*Procambarus* sp.	1	
10	No fish or crustaceans collected		
11	*Lepomis miniatus*	1	80
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	*Procambarus* sp.	1	
	***Tarebia granifera-slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):	Site:	Site on Map:
IH-35	C2- Site 1	

Date:	Time:	Observer(s):
5/3/2016	1253-1335	JO,JW,JG,JH

Overall	Species	Number	Avg. Length (mm)
14	*Etheostoma fonticola*		
7	*Ambloplites rupestris*		
11	*Gambusia* sp.		
6	*Lepomis miniatus*		
1	*Lepomis gulosus*		
3	*Lepomis sp.*		
1	*Dionda nigrotaeniata*		
17	*Procambarus* sp.		
1	*Cyprinidae sp.*		
1	*Palaemonetes* sp.		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	5	35,16,28,17,16
	Ambloplites rupestris	5	26,27,31,23,21
	Gambusia sp.	3	15,20,22
	Lepomis miniatus	2	21,22
	Lepomis sp.	3	17,11,12
	Procambarus sp.	2	
	Cyprinidae sp.	1	9
2	*Procambarus* sp.	3	
	Ambloplites rupestris	1	110
	Gambusia sp.	3	18,40,44
	Etheostoma fonticola	1	26
	Lepomis miniatus	1	32
	Palaemonetes sp.	1	
3	*Gambusia* sp.	1	21
	Etheostoma fonticola	2	20,17
	Procambarus sp.	2	
4	*Lepomis miniatus*	1	57
	Etheostoma fonticola	1	14
	Procambarus sp.	3	
5	*Procambarus* sp.	4	
	Etheostoma fonticola	2	31,19
6	*Dionda nigrotaeniata*	1	38
	Procambarus sp.	1	
7	*Procambarus* sp.	1	
	Etheostoma fonticola	2	28,19
	Gambusia sp.	1	26
8	*Gambusia* sp.	2	26,21
	Procambarus sp.	1	
9	*Etheostoma fonticola*	1	13
10	*Lepomis gulosus*	1	68
11	*Gambusia* sp.	1	39
12	*Lepomis miniatus*	1	70
	Ambloplites rupestris	1	11
13	*Lepomis miniatus*	1	76
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	***Corbicula - slight*		
	***Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
IH-35		C1 - Site 2	
Date:	**Time:**	**Observer(s):**	
5/3/2016	1337-1423	JO,JW,JG,JH	

Overall	Species	Number	Avg. Length (mm)
4	*Lepomis miniatus*		
1	*Micropterus salmoides*		
59	*Gambusia* sp.		
1	*Poecilia formosa*		
1	*Ameiurus natalis*		
1	*Lepomis sp.*		
19	*Procambarus* sp.		
9	*Etheostoma fonticola*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	1	52
	Micropterus salmoides	1	90
	Gambusia sp.	43	21,11,11,11,10,11,11,19,11,10,10,10, 10,11,9,10,11,10,10,9,12,10,11,11,10
	Etheostoma fonticola	3	17,12,15
2	*Etheostoma fonticola*	2	15,12
	Gambusia sp.	10	
3	*Lepomis sp.*	1	11
	Gambusia sp.	2	
4	*Procambarus* sp.	7	
	Poecilia formosa	1	52
	Etheostoma fonticola	1	12
	Gambusia sp.	4	
5	*Procambarus* sp.	1	
6	*Procambarus* sp.	1	
7	No fish or crustaceans collected		
8	*Procambarus* sp.	1	
9	*Lepomis miniatus*	2	50,83
	Etheostoma fonticola	1	17
	Procambarus sp.	6	
	Ameiurus natalis	1	16
10	No fish or crustaceans collected		
11	*Etheostoma fonticola*	1	16
	Procambarus sp.	3	
12	*Etheostoma fonticola*	1	32
13	No fish or crustaceans collected		
14	*Lepomis miniatus*	1	30
15	No fish or crustaceans collected		

** *Melanoides - slight*
****Tarebia granifera - slight*

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
IH-35		H2 - Site 3	
Date:	**Time:**	**Observer(s):**	
5/3/2016	1425-1454	JO,JW,JG,JH	

Overall	Species	Number	Avg. Length (mm)
4	*Gambusia* sp.		
25	*Etheostoma fonticola*		
1	*Ambloplites rupestris*		
23	*Procambarus* sp.		
1	*Dionda nigrotaeniata*		
1	*Lepomis miniatus*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	1	32
	Etheostoma fonticola	5	26,18,26,24,26
	Ambloplites rupestris	1	25
	Procambarus sp.	8	
2	*Procambarus* sp.	3	
	Dionda nigrotaeniata	1	52
	Etheostoma fonticola	1	33
	Lepomis miniatus	1	62
3	*Etheostoma fonticola*	2	11,18
	Procambarus sp.	1	
4	*Etheostoma fonticola*	7	21,25,22,27,21,22,28
	Procambarus sp.	5	
5	*Etheostoma fonticola*	3	23,16,18
6	*Procambarus* sp.	3	
7	*Procambarus* sp.	2	
8	No fish or crustaceans collected		
9	*Gambusia* sp.	1	23
	Procambarus sp.	1	
10	*Gambusia* sp.	1	21
	Etheostoma fonticola	2	21,22
11	*Etheostoma fonticola*	1	18
12	*Etheostoma fonticola*	1	22
	Gambusia sp.	1	15
13	*Etheostoma fonticola*	2	21,27
14	No fish or crustaceans collected		
15	*Etheostoma fonticola*	1	19
16	No fish or crustaceans collected		
	***Corbicula - slight*		
	*** Melanoides - moderate*		
	***Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:
IH-35		H1 - Site 4
Date:	**Time:**	**Observer(s):**
5/3/2016	1456-1530	JO,JW,JG,JH

Overall	Species	Number	Avg. Length (mm)
9	*Gambusia* sp.		
4	*Lepomis miniatus*		
19	*Etheostoma fonticola*		
18	*Procambarus* sp.		
1	*Dionda nigrotaeniata*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	2	41,21
	Lepomis miniatus	2	83,31
	Etheostoma fonticola	4	24,16,16,27,22,16,16,13,19
	Procambarus sp.	8	
2	*Gambusia* sp.	4	20,26,15,15
	Etheostoma fonticola	1	25
	Procambarus sp.	1	
3	*Gambusia* sp.	2	16,13
	Etheostoma fonticola	4	20,22,26,20
	Procambarus sp.	1	
4	*Procambarus* sp.	4	
5	*Lepomis miniatus*	1	46
	Etheostoma fonticola	1	19
6	*Etheostoma fonticola*	1	30
7	*Lepomis miniatus*	1	64
	Etheostoma fonticola	1	19
	Dionda nigrotaeniata	1	50
8	*Etheostoma fonticola*	2	21,11
9	*Etheostoma fonticola*	2	20,29
10	*Procambarus* sp.	2	
	Gambusia sp.	1	22
	Etheostoma fonticola	1	9
11	No fish or crustaceans collected		
12	*Procambarus* sp.	1	
	Etheostoma fonticola	2	31,25
13	*Procambarus* sp.	1	
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	*** Melanoides - slight*		
	***Tarebia granifera - slight*		
	***Corbicula - slight*		

DROP NET - FIELD DATA SHEETS
SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**
IH-35		S1 - Site 5
Date:	**Time:**	**Observer(s):**
5/3/2016	1532-1546	JO,JW,JG,JH

Overall	**Species**	**Number**	**Avg. Length (mm)**
1	*Herichthys cyanoguttatus*		
5	*Lepomis miniatus*		
8	*Procambarus* sp.		
1	*Ambloplites rupestris*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Herichthys cyanoguttatus*	1	84
2	*Procambarus* sp.	2	
3	No fish or crustaceans collected		
4	*Procambarus* sp.	3	
	Lepomis miniatus	1	79
5	*Lepomis miniatus*	1	72
6	*Lepomis miniatus*	1	65
7	*Ambloplites rupestris*	1	39
	Procambarus sp.	1	
8	No fish or crustaceans collected		
9	*Lepomis miniatus*	1	95
10	No fish or crustaceans collected		
11	*Procambarus* sp.	1	
12	*Lepomis miniatus*	1	79
13	No fish or crustaceans collected		
14	*Procambarus* sp.	1	
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
IH-35		HD1 - Site 6	
Date:	**Time:**	**Observer(s):**	
5/3/2016	1558-1609	JO,JW,JG,JH	

Overall	Species	Number	Avg. Length (mm)
22	*Etheostoma fonticola*		
10	*Gambusia* sp.		
112	*Procambarus* sp.		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	12	33,21,27,25,22,32,17,22,28,21,20,24
	Gambusia sp.	5	23,18,16,14,15
	Procambarus sp.	16	
2	*Procambarus* sp.	30	
	Gambusia sp.	3	28,19,13
	Etheostoma fonticola	6	22,25,14,22,19,26
3	*Etheostoma fonticola*	1	25
	Procambarus sp.	11	
4	*Procambarus* sp.	15	
5	*Gambusia* sp.	1	30
	Procambarus sp.	3	
6	*Procambarus* sp.	3	
7	*Etheostoma fonticola*	3	26,25,17
	Procambarus sp.	3	
8	*Procambarus* sp.	5	
9	*Procambarus* sp.	5	
10	*Procambarus* sp.	9	
11	*Procambarus* sp.	2	
12	*Procambarus* sp.	5	
13	*Procambarus* sp.	1	
14	No fish or crustaceans collected		
15	*Gambusia* sp.	1	15
	Procambarus sp.	4	
	***Corbicula - slight*		
	***Tarebia granifera - slight*		
	*** Melanoides - slight*		

DROP NET - FIELD DATA SHEETS
SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:
IH-35		HD2 - Site 7
Date:	**Time:**	**Observer(s):**
5/3/2016	1610-1627	JO,JW,JG,JH

Overall	Species	Number	Avg. Length (mm)
12	*Gambusia* sp.		
17	*Etheostoma fonticola*		
1	*Astyanax mexicanus*		
20	*Procambarus* sp.		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	4	26,38,26,28
	Gambusia sp.	1	26
	Procambarus sp.	2	
2	*Gambusia* sp.	1	23
	Etheostoma fonticola	1	26
3	*Gambusia* sp.	4	44,25,20,30
	Etheostoma fonticola	6	17,20,22,27,20,26
	Astyanax mexicanus	1	38
	Procambarus sp.	7	
4	*Etheostoma fonticola*	4	22,24,26,21
	Gambusia sp.	2	25,34
	Procambarus sp.	4	
5	*Etheostoma fonticola*	1	18
	Procambarus sp.	1	
6	*Gambusia* sp.	2	54,16
	Procambarus sp.	2	
7	*Procambarus* sp.	1	
8	*Etheostoma fonticola*	1	22
	Procambarus sp.	1	
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	*Gambusia* sp.	1	46
12	No fish or crustaceans collected		
13	*Gambusia* sp.	1	38
	Procambarus sp.	1	
14	*Procambarus* sp.	1	
15	No fish or crustaceans collected		
	***Corbicula - slight*		
	***Tarebia granifera - slight*		
	*** Melanoides - slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**
IH-35		S2 - Site 8
Date:	**Time:**	**Observer(s):**
5/3/2016	1629-1645	JO,JW,JG,JH

Overall	**Species**	**Number**	**Avg. Length (mm)**
2	*Etheostoma fonticola*		
1	*Lepomis miniatus*		
26	*Procambarus* sp.		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Procambarus* sp.	3	
2	*Procambarus* sp.	4	
3	*Procambarus* sp.	5	
	Etheostoma fonticola	1	23
4	*Procambarus* sp.	2	
5	*Procambarus* sp.	3	
6	*Procambarus* sp.	1	
7	*Procambarus* sp.	3	
8	*Etheostoma fonticola*	1	32
	Procambarus sp.	2	
9	*Procambarus* sp.	1	
10	*Lepomis miniatus*	1	65
	Procambarus sp.	1	
11	*Procambarus* sp.	1	
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**
IH-35		O1 - Site 9
Date:	**Time:**	**Observer(s):**
5/3/2016	1647-1650	JO,JW,JG,JH

Overall	**Species**	**Number**	**Avg. Length (mm)**
1	*Gambusia sp.*		

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	*Gambusia sp.*	1	25
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**	**Site on Map:**
IH-35		O2 - Site 10	
Date:	**Time:**	**Observer(s):**	
5/3/2016	1651-1655	JO,JW,JG,JH	

Overall	**Species**	**Number**	**Avg. Length (mm)**

SAN MARCOS RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
IH-35		C1 - Site 1	
Date:	**Time:**	**Observer(s):**	
10/20/2016	810-842	JO,DS,JG,JH	

Overall	Species	Number	Avg. Length (mm)
8	*Etheostoma fonticola*		
24	*Gambusia* sp.		
1	*Herichthys cyanoguttatus*		
2	*Lepomis macrochirus*		
1	*Lepomis miniatus*		
2	*Palaemonetes* sp.		
85	*Procambarus* sp.		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	47	
	Etheostoma fonticola	5	29,27,27,28,34
	Lepomis macrochirus	2	27,24
	Gambusia sp.	17	20,21,16,18,24,9,11,18,22,10,9,10,9,9,10,10,12
	Palaemonetes sp.	2	
2	*Etheostoma fonticola*	1	30
	Gambusia sp.	2	27,11
	Procambarus sp.	8	
3	*Lepomis miniatus*	1	80
	Gambusia sp.	4	11,30,10,17
	Herichthys cyanoguttatus	1	25
	Procambarus sp.	13	
4	*Procambarus* sp.	2	
5	*Procambarus* sp.	4	
6	*Procambarus* sp.	1	
7	*Etheostoma fonticola*	1	32
	Gambusia sp.	1	12
	Procambarus sp.	5	
8	*Etheostoma fonticola*	1	32
	Procambarus sp.	1	
9	*Procambarus* sp.	2	
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	*Procambarus* sp.	2	

*** Melanoides - slight*

***Tarebia granifera - slight*

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):	Site:	Site on Map:
IH-35	C2- Site 2	

Date:	Time:	Observer(s):
10/20/2016	845-918	JO,DS,JG,JH

Overall	Species	Number	Avg. Length (mm)
9	*Etheostoma fonticola*		
4	*Gambusia* sp.		
25	*Procambarus* sp.		
2	*Palaemonetes* sp.		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	16	
	Gambusia sp.	2	30,15
	Etheostoma fonticola	1	30
	Palaemonetes sp.	2	
2	*Etheostoma fonticola*	1	32
	Procambarus sp.	3	
3	*Gambusia* sp.	1	14
	Etheostoma fonticola	2	19,29
	Procambarus sp.	1	
4	*Gambusia* sp.	1	11
	Procambarus sp.	5	
5	*Etheostoma fonticola*	1	30
6	No fish or crustaceans collected		
7	*Etheostoma fonticola*	2	25,21
8	*Etheostoma fonticola*	1	28
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	*Etheostoma fonticola*	1	33
16	No fish or crustaceans collected		

*** Melanoides - slight*
***Tarebia granifera - slight*

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
IH-35		H2 - Site 3	
Date:	**Time:**	**Observer(s):**	
10/20/2016	921-940	JO,DS,JG,JH	

Overall	Species	Number	Avg. Length (mm)
6	*Gambusia* sp.		
4	*Etheostoma fonticola*		
1	*Ambloplites rupestris*		
72	*Procambarus* sp.		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	1	22
	Procambarus sp.	27	
2	*Gambusia* sp.	2	15,12
	Procambarus sp.	20	
3	*Gambusia* sp.	2	17,25
	Etheostoma fonticola	3	27,32,31
4	*Procambarus* sp.	4	
	Ambloplites rupestris	1	61
5	*Gambusia* sp.	1	33
	Etheostoma fonticola	1	27
	Procambarus sp.	2	
6	No fish or crustaceans collected		
7	*Procambarus* sp.	8	
8	*Procambarus* sp.	1	
9	No fish or crustaceans collected		
10	*Procambarus* sp.	2	
11	*Procambarus* sp.	1	
12	*Procambarus* sp.	2	
13	*Procambarus* sp.	1	
14	*Procambarus* sp.	4	
15	No fish or crustaceans collected		

** *Melanoides - slight*
***Tarebia granifera - slight*

DROP NET - FIELD DATA SHEETS
SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:
IH-35		H1 - Site 4
Date:	**Time:**	**Observer(s):**
10/20/2016	945-1004	JO,DS,JG,JH

Overall	Species	Number	Avg. Length (mm)
2	*Gambusia* sp.		
1	*Herichthys cyanoguttatus*		
1	*Ambloplites rupestris*		
5	*Etheostoma fonticola*		
18	*Procambarus* sp.		
3	*Palaemonetes* sp.		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	1	35
	Palaemonetes sp.	1	
2	*Etheostoma fonticola*	2	31,34
	Procambarus sp.	4	
	Palaemonetes sp.	2	
3	*Ambloplites rupestris*	1	40
	Gambusia sp.	1	24
4	*Gambusia* sp.	1	22
5	*Procambarus* sp.	8	
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	*Procambarus* sp.	1	
9	*Etheostoma fonticola*	1	31
10	*Procambarus* sp.	1	
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	*Herichthys cyanoguttatus*	1	43
	Procambarus sp.	4	
14	No fish or crustaceans collected		
15	*Etheostoma fonticola*	1	31
16	No fish or crustaceans collected		
	***Corbicula - slight*		
	*** Melanoides - slight*		
	***Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:
IH-35		S2 - Site 5
Date:	**Time:**	**Observer(s):**
10/20/2016	1007-1025	JO,DS,JG,JH

Overall	Species	Number	Avg. Length (mm)
4	*Lepomis miniatus*		
4	*Etheostoma fonticola*		
9	*Gambusia* sp.		
38	*Procambarus* sp.		
1	*Ambloplites rupestris*		
3	*Palaemonetes* sp.		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	1	86
	Etheostoma fonticola	1	28
	Gambusia sp.	4	18,26,25,15
	Procambarus sp.	6	
	Palaemonetes sp.	2	
2	*Gambusia* sp.	3	34,28,19
	Procambarus sp.	2	
	Palaemonetes sp.	1	
3	*Procambarus* sp.	7	
	Lepomis miniatus	1	46
4	*Etheostoma fonticola*	1	29
	Gambusia sp.	1	18
5	*Gambusia* sp.	1	24
	Procambarus sp.	4	
6	*Ambloplites rupestris*	1	47
	Lepomis miniatus	1	75
	Etheostoma fonticola	1	32
7	*Etheostoma fonticola*	1	33
	Procambarus sp.	5	
8	*Lepomis miniatus*	1	80
	Procambarus sp.	5	
9	*Procambarus* sp.	2	
10	*Procambarus* sp.	5	
11	No fish or crustaceans collected		
12	*Procambarus* sp.	2	
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	***Tarebia granifera - slight*		
	*** Melanoides - slight*		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
IH-35		S1 - Site 6	S3
Date:	**Time:**	**Observer(s):**	
10/20/2016	1031-1042	JO,DS,JG,JH	

Overall	Species	Number	Avg. Length (mm)
14	*Gambusia* sp.		
6	*Procambarus* sp.		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	6	35,22,28,32,20,12
2	*Gambusia* sp.	6	15,15,15,18,32,21
3	*Gambusia* sp.	1	18
4	*Gambusia* sp.	1	25
	Procambarus sp.	1	
5	*Procambarus* sp.	5	
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:
IH-35		HD2 - Site 7
Date:	**Time:**	**Observer(s):**
10/20/2016	1045-1052	JO,DS,JG,JH

Overall	Species	Number	Avg. Length (mm)

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
IH-35		HD1 - Site 8	HD4
Date:	**Time:**	**Observer(s):**	
10/20/2016	1053-1107	JO,DS,JG,JH	

Overall	Species	Number	Avg. Length (mm)
20	*Gambusia* sp.		
6	*Etheostoma fonticola*		
31	*Procambarus* sp.		
2	*Palaemonetes* sp.		
1	*Astyanax mexicanus*		

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	7	25,32,16,17,12,10,18
	Etheostoma fonticola	2	35,35
	Procambarus sp.	15	
	Palaemonetes sp.	2	
2	*Etheostoma fonticola*	2	34,32
	Gambusia sp.	3	
3	*Astyanax mexicanus*	1	27
	Gambusia sp.	5	15,20,21,22,15
	Procambarus sp.	3	
4	*Gambusia* sp.	2	23,15
5	*Gambusia* sp.	2	20,22
	Procambarus sp.	2	
6	*Procambarus* sp.	3	
7	*Procambarus* sp.	2	
8	*Etheostoma fonticola*	2	35,37
	Gambusia sp.	1	19
	Procambarus sp.	3	
9	No fish or crustaceans collected		
10	*Procambarus* sp.	1	
11	*Procambarus* sp.	1	
12	*Procambarus* sp.	1	
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	****Tarebia granifera - slight**		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
IH-35		O1 - Site 9	O3
Date:	**Time:**	**Observer(s):**	
10/20/2016	1111-1113	JO,DS,JG,JH	

Overall	Species	Number	Avg. Length (mm)

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS

SAN MARCOS RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
IH-35		O2 - Site 10	O4
Date:	**Time:**	**Observer(s):**	
10/20/2016	1115-1118	JO,DS,JG,JH	

Overall	Species	Number	Avg. Length (mm)

SAN MARCOS RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		