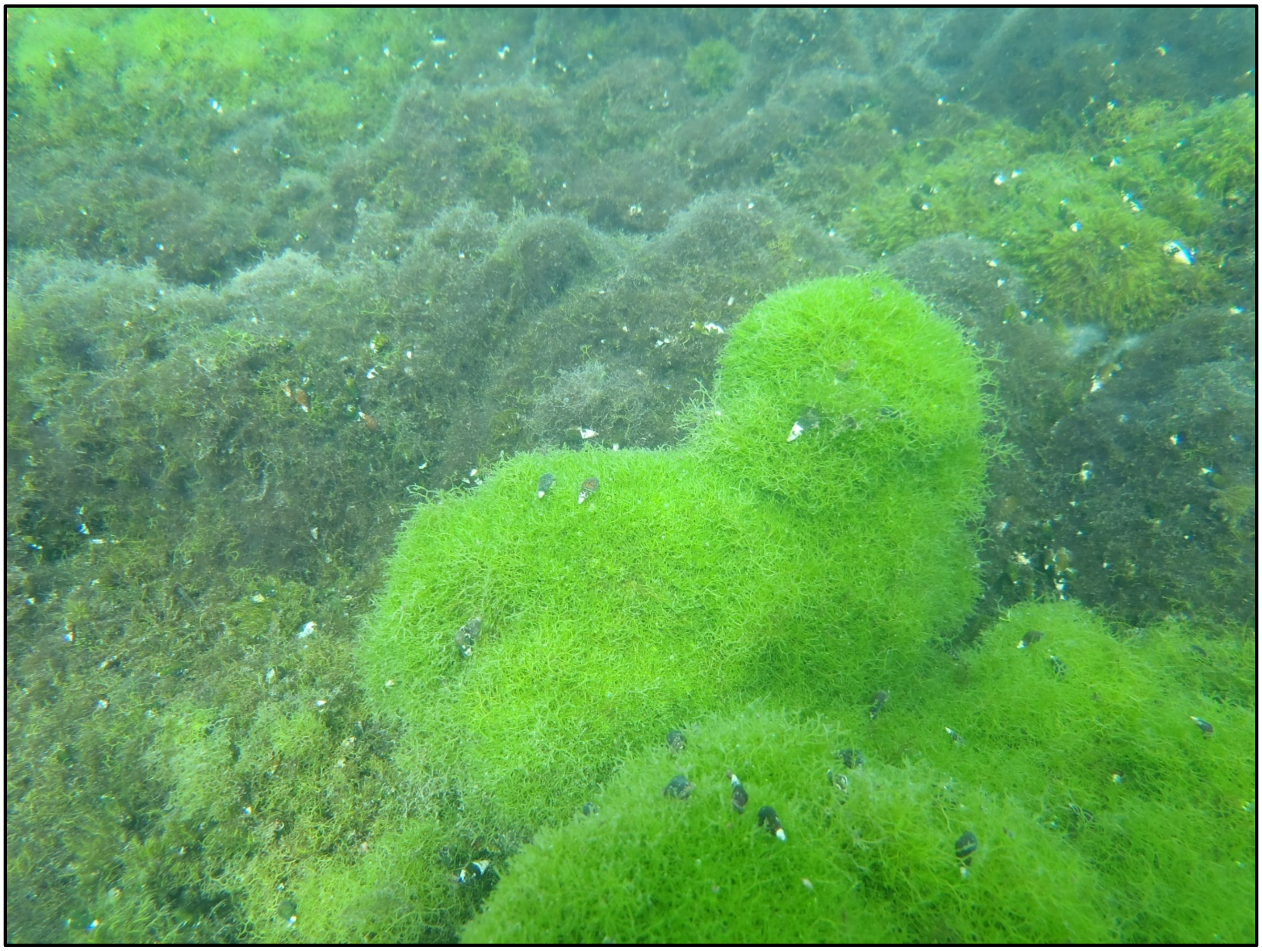
HABITAT CONSERVATION PLAN

BIOLOGICAL MONITORING PROGRAM

Comal Springs/River Aquatic Ecosystem

ANNUAL REPORT

December 2016



Prepared for:

Edwards Aquifer Authority
900 East Quincy
San Antonio, Texas 78215

Prepared by:

BIO-WEST, Inc.
Austin Office
1812 Central Commerce Court
Round Rock, TX 78664

TABLE OF CONTENTS

List of Figures

List of Tables

EXECUTIVE SUMMARY

The Edwards Aquifer Habitat Conservation Plan (HCP) Biological Monitoring program activities conducted in 2016 provided insight into the continued transition from a prolonged drought into subsequent average/wet conditions in the Comal River/Springs ecosystem. After the extremely low discharge of 2014, precipitation events (some severe) during 2015 resulted in a resurgence of aquifer recharge, and thus, total system discharge in the Comal system. In fact, total system discharge remained at or above historical averages for the entirety of 2016. As typical with a shift from drought to above average discharge conditions, the transition was not exactly smooth. A high-flow Critical Period sampling effort was triggered in November 2015, when a major precipitation event caused flooding throughout central Texas. During that event, total system discharge in the Comal River reached 4,070 cubic feet per second (cfs) on a daily average, with the majority of that water (2,530 cfs) coming in from Dry Comal Creek. The impacts from that flooding event were characterized in the 2015 annual report addendum, but are referenced herein because they shaped the ecological landscape heading into 2016.

Similar to 2015, water temperatures remained constant throughout 2016 without exceeding the 26.7 ºC TCEQ water quality standard. As typical, dissolved oxygen (DO) readings in Landa Lake varied, with the lowest concentrations occurring in late summer. Recreation pressure as recorded by Texas Master Naturalists remained highest in the New Channel during the summer months, which is when swimmers, kayakers, picnickers, and tubers descend on this beautiful spring-fed river to spend time with families and seek relief from summer-time Texas heat.

Aquatic vegetation rebounded in total coverage in three of the four monitoring reaches relative to the flooding impacts observed in late 2015. A comparison to long-term averages in the Old Channel study reach is skewed by on-going HCP native aquatic vegetation restoration activities in the Old Channel. Typical spring-to-fall responses in aquatic vegetation coverage were experienced in 2016, except in the New Channel. A moderately elevated flow occurred along the Dry Comal Creek in September scouring aquatic vegetation within the New Channel study reach which resulted in decreased coverage beyond typical summer disturbance. Habitat Conservation Plan aquatic vegetation restoration activities continue to provide a boost to the native aquatic plant community of the Comal system. Nonnative aquatic plants have essentially been eliminated from the Upper Spring Run and Landa Lake reaches and replaced with native aquatic vegetation through restoration efforts. These restoration activities also continued in earnest in the Old Channel with the major activity in 2016 being the completion of the Old Channel bank stabilization project. This restoration effort was designed and implemented to benefit the fountain darter (*Etheostoma fonticola*) and will be tracked through continued HCP biological monitoring.

Fountain darter populations continue to reflect the benefits of a thriving aquatic vegetation community, with the highest densities continuing to be collected in native aquatic vegetation. Normalized population estimates of fountain darters hovered at the lower range of the long-term study average in the spring which was likely a lingering response to the late 2015 flooding. However, by fall 2016, this normalized population estimate of fountain darters exceeded the long-term study average. Random and fixed-station presence/absence sampling of fountain

darters continue to provide an on-going "snapshot" of size-class distributions and an efficient way to assess on-going population and habitat conditions.

Four years of fish community sampling since 2013 has resulted in enumeration of over 55,000 fishes representing 26 distinct species. Species richness is similar to the long-term dropnet database (2000-2016) which has identified nearly 160,000 fishes representing 25 species. However, species composition and relative abundance differs between the two methods. Although *Gambusia* sp. and fountain darters are the dominant taxa within each dataset, the fish community sampling data has a much higher relative abundance of minnows and sunfish than the dropnet dataset. Seining and visual observation are more effective at enumerating these groups of fishes which are highly mobile and less susceptible to dropnet capture.

One of the most notable changes in 2016 was the resurgence of Comal salamander (*Eurycea* sp.) populations which had rebounded above long-term study averages at all study locations by fall 2016. Comal Springs dryopid beetles (*Stygoparnus comalensis*) were collected via drift net sampling for the first time since 2011. Additionally, Peck's cave amphipods (*Stygobromus pecki*) were collected via drift net sampling in all three study reaches. Comal Springs riffle beetles (*Heterelmis comalensis*) continue to be infrequently encountered in drift net data relative to lure sampling. Lure data indicated that adult Comal Springs riffle beetles were abundant throughout the documented habitats and consistent with or above the long-term study averages at each site. The macroinvertebrate community in 2016 remained diverse across vegetation types with taxa considered fountain darter prey making up the bulk of the samples at all sites.

Following the prolonged drought in Texas, hydrological and habitat conditions in the Comal system improved over the course of 2015 and this trend extended into 2016. The late 2015 flood event temporarily impeded habitat recovery, which was noted during spring 2016 sampling. However, by the fall 2016 sampling event, habitat and species conditions were near or at all-time highs. Future biological monitoring to assess conditions as well as quantify effects (both positive and negative) from mitigation and restoration activities is imperative in continuing to tell the HCP story.

INTRODUCTION

Section 6.3.1 of the Edwards Aquifer Habitat Conservation Plan (HCP) lays out the path forward for continuation of biological monitoring. Originally, the biological monitoring program (formerly known as the Edwards Aquifer Authority (EAA) Variable Flow Study) included comprehensive sampling during “normal” set temporal periods, as well as specific, triggered sampling for low-flow events (i.e., Critical Period sampling). Additionally, the importance of documenting effects of high-flow events was recognized and added to the Critical Period component. This fundamental objective is still valid today, just as continued monitoring of system conditions over time and filling in important data gaps where appropriate and practical remains 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. Developing HCP long-term biological goals and objectives (HCP Section 4.1),

2. Developing 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 proceeds, successful execution of the biological monitoring program is mandatory to adequately assess items 1 through 3 relative to HCP Phase II decisions. Item 4 is essential for the protection of the species during low-flow conditions. Additionally, the HCP biological monitoring program data, in conjunction with other available information, is essential to the following tasks:

5. Assessing the effectiveness and efficiency of HCP mitigation/restoration activities 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 incidental “take” estimate.

Items 5 and 6 again relate to providing guidance to assist with HCP Phase II decisions regarding the achievement of 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). The scope of the HCP biological monitoring program has expanded beyond only monitoring 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 6.4.3).

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 where practical and when applicable. As such, the current design employs the following five basic sampling location strategies for the Comal system, with associated sampling components:

1. System-wide Sampling
    - Full system aquatic vegetation mapping–once every 5 years (next scheduled for 2018)

2. Select longitudinal locations
    - Temperature monitoring—thermistors
    - Water quality sampling—during Critical Period sampling
    - Fixed-station photography
    - Discharge measurements

3. Reach Sampling (5 reaches)
    - Aquatic vegetation mapping
    - Fountain darter dropnet sampling
    - Fountain darter presence/absence dipnet sampling

4. Springs Sampling
    - Endangered Comal invertebrate sampling
    - Comal Springs salamander sampling

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

The following section provides a brief 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 Comal Springs / River ecosystem (EAA 2016a).

METHODS

Study Location

Comal Springs, which consists of numerous spring openings, is the largest spring system in Texas. The clear, thermally constant water issues from the downthrown side of the Comal Springs Fault Block. The Comal River extends approximately 5 kilometers to its confluence with the Guadalupe River. Although Comal Springs reportedly has the greatest discharge of any springs in the Southwest, the flows can diminish rapidly during drought conditions, and the springs completely ceased to flow for several months in the summer and fall of 1956 during the drought of record. Despite the cessation of flows, Comal Springs is home to several extremely rare, federally listed animal species. This study includes monitoring and applied research efforts directed toward federally listed species and those covered by the HCP. These include one fish, the fountain darter (*Etheostoma fonticola*), and the following three invertebrates: Comal Springs dryopid beetle (*Stygoparnus comalensis*), Comal Springs riffle beetle (*Heterelmis comalensis*), and Peck's cave amphipod (*Stygobromus pecki*). Three additional HCP-covered species monitored in this study include the Comal Springs salamander (*Eurycea* sp.), Edwards Aquifer diving beetle (*Haideoporus texanus*), and Texas troglobitic water slater (*Lirceolus smithii*).

Two full comprehensive sampling efforts (spring and fall) were conducted in 2016. Because the 2015 high-flow Critical Period event did not occur until late November, these data are often referenced in the data analyses for 2016 presented here. Additionally, Texas Master Naturalist volunteers assisted with weekly water quality measurements and recreational counts on the Comal system. A comprehensive sampling event includes the following sampling components and volunteer activities:

Water Quality/Thermistor Placement
Thermistor Retrieval
Fixed-station Photographs
Weekly Standard Parameters (Volunteer)
Point Water Quality Measurements
Discharge measurements

Aquatic Vegetation
GPS Mapping

Fountain Darter Sampling
Dropnet
Dipnet
Visual Observations

Comal Springs Salamander Observations
SCUBA/Snorkel Surveys

Macroinvertebrate Sampling
Drift Nets
Comal Springs Riffle Beetle Surveys
Community Sampling

Recreation Observations
Weekly Recreation Counts (Volunteer)

Fish Community Sampling
SCUBA/Seine Surveys

Comal Springflow

Total system discharge data for the Comal River was acquired from United States Geological Survey (USGS) water resources division. Some of the 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 Comal system were taken from USGS gage 08169000 on the Comal River in New Braunfels. This site represents the cumulative discharge of the springs that form the Comal River.

In addition to the cumulative discharge measurement, USGS maintains gages on the Old Channel and New Channel of the Comal River (gages 08168913 and 08168932, respectively). Specific to each comprehensive sampling effort, discharge was also measured at five specific locations: Upper Spring Run, Spring Run 1, Spring Run 2, Spring Run 3, and Old Channel. These data were used to estimate the contribution of each major Spring Run to total discharge in the river, and to evaluate the relative proportion of water flowing in the Old Channel and New Channel. All biological monitoring program discharge measurements at these locations were taken using a HACH FH950 portable flow meter.

In addition to the five wadable discharge measurement locations noted above, flow partitioning in Landa Lake was initiated in 2013 and was expanded to five locations the following year. This included adding discharge measurements above and below the Spring Island area and an upstream area of Landa Lake with a SonTek® RiverSurveyor M9 Acoustic Doppler Current Profiler. The objective was to track the contribution of a major upwelling area to the total system discharge in the Comal River.

Low-flow Sampling

Low-flow Critical Period events can prompt an intensive data collection effort that includes triggers and associated activities as outlined in Appendix A. No low-flow critical period events were conducted in 2016.

HCP Species-specific Triggered Sampling

Appendix A provides a detailed list of sampling requirements for HCP species-specific triggered sampling in the Comal system. No species-specific low-flow sampling occurred in the Comal River in 2016.

Critical Period High-Flow Sampling

Similar to low-flow critical period events, high-flows can trigger an intensive data collection effort with triggers and associated activities outlined in Appendix A. No high-flow critical period events were conducted in 2016, however, a large flood event in November 2015 resulted in a high-flow sampling event and greatly influenced conditions in spring 2016.

Water Quality Sampling

Conventional physio-chemical parameters (water temperature, conductivity, pH, dissolved oxygen, water depth at sampling point, and observations of local conditions) were taken at all dropnet sampling sites and fish community sampling locations using a calibrated, handheld water quality sonde. Study locations, methods, sampling schedule, and results of the comprehensive water, sediment and stormwater monitoring conducted under the HCP are presented in a standalone report (SWCA 2016a, Draft).

Water Temperature Thermistors

Thermistors (HOBO Tidbit v2 Temp Loggers) set to record water temperature every 10 minutes have been placed at select water quality stations along the Comal River, and are 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 in this report. Thermistors were also placed in two deeper locations within Landa Lake using SCUBA. The 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 collected at 12 locations along the Comal River to evaluate conventional water chemistry parameters (Figure 1). There were no water quality grab sampling events in 2016.

In addition to the water quality data collection effort, a long-term record of habitat conditions has been maintained via fixed-station photography. Fixed-station photographs allow temporal habitat evaluations. Photographs included upstream, cross-stream, and downstream photographs and were taken at each water quality site shown in Figure 1.

Master Naturalist Monitoring

Volunteers with the Texas Master Naturalist program continued their monitoring efforts in 2016 at select locations along the Comal system. Volunteers collected water quality and site-use data at five sites: the Houston Street Site within the Upper Spring Run Reach, the Gazebo site within the Landa Lake Reach, the Elizabeth Avenue site upstream of the Old Channel Reach, the New Channel site within the New Channel Reach, and the downstream-most Union Avenue site (Figure 2). Volunteer monitoring was performed on a weekly basis, with surveys conducted primarily on Friday afternoons, varying between 1200hrs and 1500hrs. At each site, an Oakton Waterproof EcoTestr pH 2 was used to measure pH, and a LaMotte Carbon Dioxide Test Kit was used to measure carbon dioxide (CO_2) concentrations in the water column. In addition to water quality measurements, recreational-use data were collected at each site by counting the number of tubers, kayakers, anglers, etc., within the survey site at the time of sampling. Volunteers also took photographs at each site during each sampling event and occasionally made additional notes on recreational use or condition of the river.

Figure 1. Fish community, water quality, and fountain darter timed dipnet surveys within the Comal River study area.

Texas master naturalist performing water quality sampling in the Comal River.

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, following discussions with the HCP Science Committee, a new protocol assessing all aquatic vegetation species was introduced: 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 each 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.

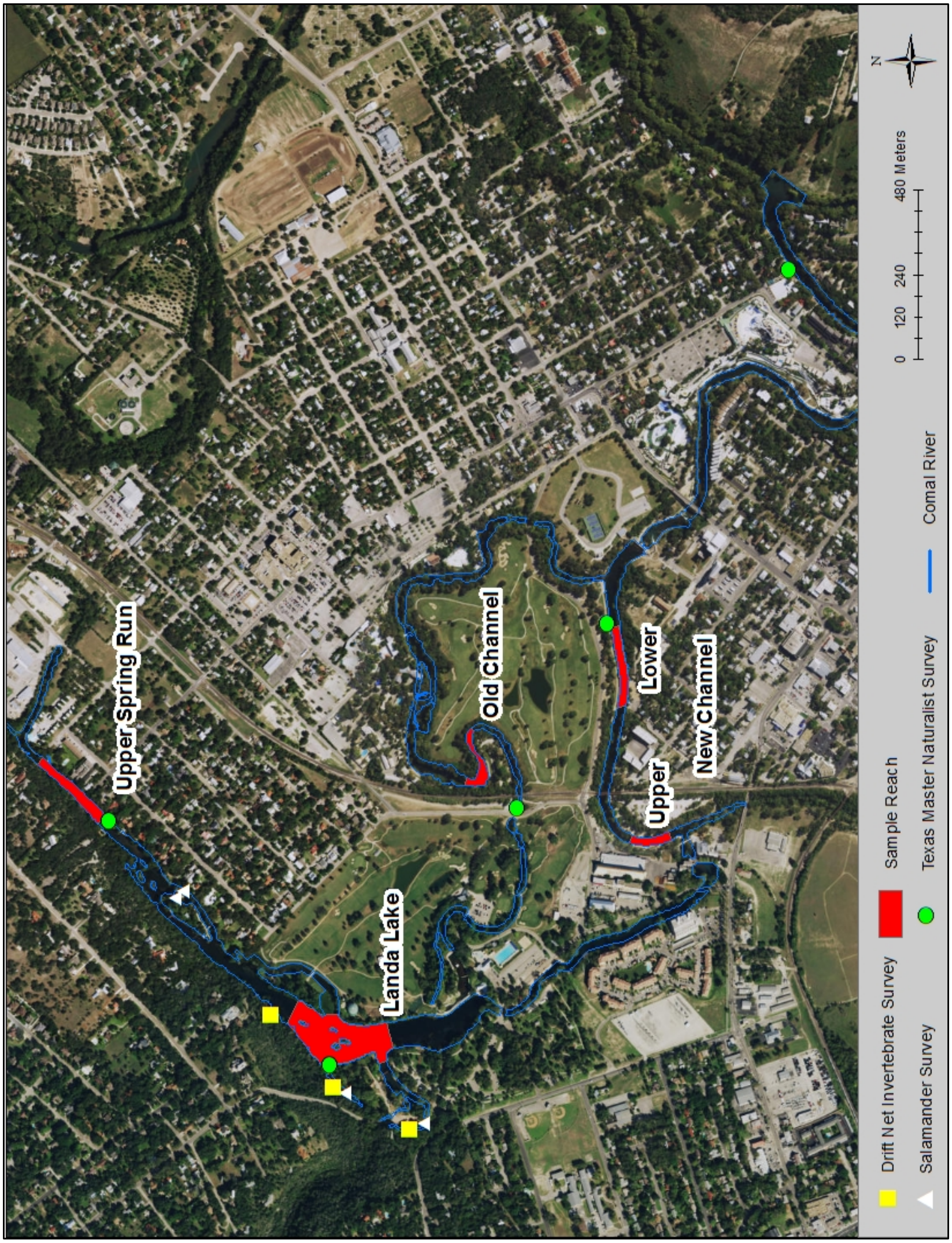


Figure 2. Invertebrate, Comal Springs salamander, Texas Master Naturalist, and biomonitoring sample reaches (includes aquatic vegetation mapping, dropnet sampling, presence/absence dipnet sampling, and macroinvertebrate community sampling) surveys within the Comal River study area.

Fountain Darter Sampling

Dropnet Sampling

A dropnet is a sampling device originally designed by the USFWS to sample fountain darters and additional benthic fish species. The net encloses a known area (2 square meters [m^2]), preventing the escape of fish occupying that area and allowing for thorough sample collection. A large dipnet (1 m^2) is used within the dropnet and is swept along the length of the river substrate 15 times in order to ensure complete enumeration of all fish trapped within the dropnet. 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 (Figure 2) were those that were defined at the beginning of the study as the dominant species found in that reach. Sampling sites were randomly selected per dominant vegetation type for each sampling event from a grid overlain on the most recent vegetation map (created with GPS-collected data during the previous week) of that reach.

Dropnet sampling in the Landa Lake study reach.

At each location, the vegetation type, height, and areal coverage were recorded, as were substrate type, mean column velocity, velocity at 15 centimeters (cm) above the bottom, water temperature, conductivity, pH, and dissolved oxygen. In addition, vegetation type, height, areal coverage, and substrate type were noted for the adjacent area within 3 m of the dropnet. 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 species not readily identifiable in the field were preserved for identification in the laboratory. When collected, all live giant ramshorn snails (*Marisa cornuarietis*) were counted, measured, and destroyed, while a categorical abundance level 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 centimeter (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

A dipnet was used to sample all habitat types within each river section (Figure 1). Collection was generally conducted by personnel moving upstream through a section. Attempts were made to sample all habitat types within each section. Habitats thought to contain fountain darters, such as along the edges or within clumps of certain aquatic vegetation, were targeted and received the most effort. Areas deeper than 1.4 m were not sampled. Fountain darters collected were identified, measured, recorded as number per dipnet sweep, and returned to the river at the point of collection. Occurrence and categorical abundance of native and exotic snails were also recorded per sweep.

To balance the effort expended across samples, a predetermined time constraint was used for each section (Upper Spring Run: 0.5 hour, Spring Island area: 0.5 hour, Landa Lake: 1.0 hour, New Channel: 1.0 hour, Old Channel: 1.0 hour, Garden Street: 1.0 hour). The areas of fountain darter collection were marked on a base map of the section, and the same general areas are sampled during each survey (Figure 1). Although information regarding the density of fountain darters per vegetation type was not gathered with this method (as in dropnet sampling), it did permit a more thorough exploration of various habitats within each reach. Also, spending a comparable length of time in each reach allowed comparisons between data gathered during each sampling event. Dipnet data were used to identify periods of fountain darter reproductive activity because this method was more likely to sample small fountain darters (<15 mm).

Random Dipnet Surveys

Random presence/absence dipnet sampling is designed to be a quick, efficient, and repetitive means of monitoring the fountain darter population. Also, because it is less destructive than dropnet sampling, it can be conducted during extreme low-flow periods with less harm to important habitat. During each sample, 50 sites were distributed among the five reaches based on total area, diversity of vegetation, previous fountain darter abundance estimates, and overall biological importance of each reach. Sites were randomly selected within the dominant vegetation types within each reach. Up to four dips were conducted at each site. After each dip, presence or absence of fountain darters was recorded. To avoid recapture, the entire contents of the net were placed into a plastic tub filled with river water. After all dips were completed at a site, all organisms were released near the site of capture.

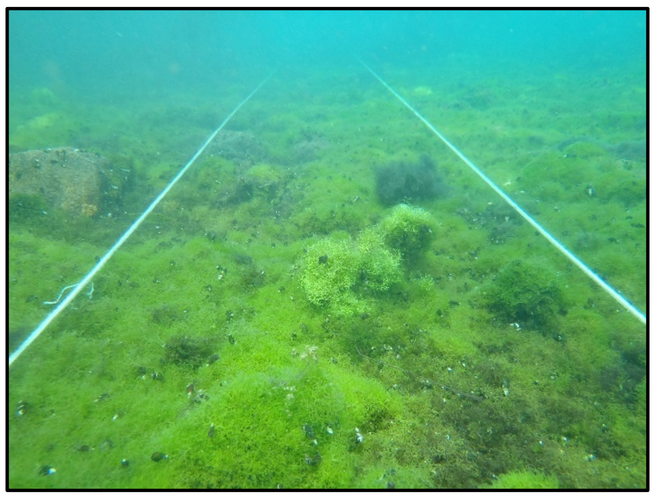
Fixed-station Dipnet Sampling

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 Comal 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 reaches. However, sample 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 become consistent, 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 the techniques and to establish a baseline with the fixed-station approach.

Sampling methods were identical to those described for the presence/absence survey above, although additional data on habitat conditions were noted. At each fixed site, 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. If fountain darters were present, they were placed in a tub or moved a sufficient distance away from the dipnetter to prevent recapture. 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, because 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.

Visual Observations

Visual surveys were conducted in Landa Lake using SCUBA gear to verify continued habitat use in deeper portions of the lake by fountain darters and Comal Springs salamanders. Observations were conducted in early afternoon during each sampling event. Since summer 2001, a specially designed grid (0.6 m x 13.0 m) has been used to quantify the number of fountain darters using these deeper habitats. During each survey, all fountain darters within the grid were counted and the percentage of bryophyte coverage within the grid was recorded.



Fountain darter visual SCUBA grid in Landa Lake.

Fish Community Sampling

A multifaceted sampling methodology was again employed in 2016 to monitor fish community composition and abundance by using seines in wadeable areas and by 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 Comal River in 2016.

Seining for fish community sampling in Blieder's Creek.

For fish community monitoring, the Comal system was split into six segments—Blieder's Creek, Upper Spring Run, Landa Lake, New Channel, Old Channel, and Lower River (Figure 1). Within the deeper sections of each reach, 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 mid-column depth. Divers identified and enumerated all fish observed, and relayed the information to a third biologist at the surface who recorded data. After the divers completed this initial transect, four 5-m-long PVC pipe segments (micro-transect pipes) were equally spaced on 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 m 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 at 15 cm from the bottom, mid-column, and near the surface. Standard water quality parameters were also recorded once at each transect using a HydroTech water quality sonde.

In addition to visual surveys, seining was used to sample the fish community in wadeable areas. At least three seining transects were conducted within each reach during each sampling event, with the exception of Landa Lake, which was too deep for seining. 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, after which point the seining crew moved closer to midchannel, taking caution not to sample the same area. The crew continued to move toward the opposite bank with each successive seine haul until either 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 in order to prevent recapture on 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 all 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 and densities during each event. Densities were calculated by dividing fishes/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 in a way that allowed calculation of catch-per-unit-effort (CPUE) by gear type and taxa.

Comal Springs Salamander Visual Observations

Timed surveys for the Comal Springs salamanders were conducted by two-person crews in Spring Run 1, Spring Run 3, and near Spring Island during both 2016 sampling events (Figure 2). Each survey began at the downstream-most edge of the sampling area. Crews turned over rocks located on the substrate surface while moving upstream toward the main spring orifice. A dive mask and snorkel or viewing box were utilized when depth permitted. Comal Springs salamander locations were noted, along with time, water depth, and presence/absence of vegetation. To maintain consistency between samples, all surveys were timed and initiated in the morning and terminated by early afternoon.

Biologists conducting salamander presence/absence survey in Spring Run 3.

Comal Springs salamander observed during visual survey of Landa Lake.

Within Spring Run 1, a 1-hour survey was conducted from the Landa Park Drive Bridge upstream to just below the head spring orifice. Spring Run 3 was surveyed for 1 hour from the pedestrian bridge closest to Landa Lake upstream to just below the head spring orifice. Surveys in the Spring Island area were divided into the following two sections: (1) one 30-minute survey of Spring Run 6 and, (2) one 30-minute survey of the east outfall upwelling area on the east side of Spring Island near Edgewater Drive.

Additionally, Comal Springs salamander visual observations were made during SCUBA surveys of deeper locations within Landa Lake. These visual surveys have been conducted along a deep water transect in Landa Lake since 2001 in an effort to verify continued habitat use by the fountain darter and Comal Springs salamander.

Macroinvertebrate Sampling

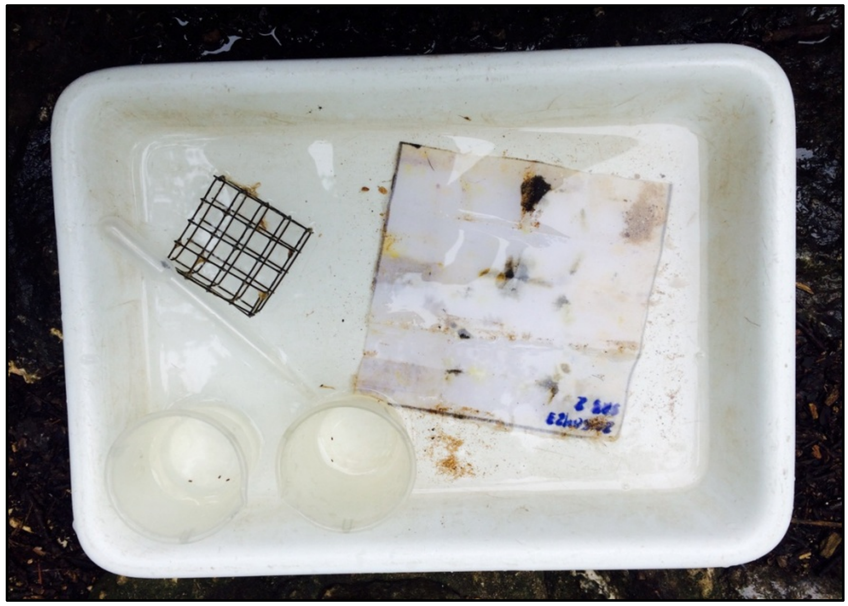
Drift Net Sampling

Macroinvertebrate samples were collected via drift net at three sites in the Comal system. During each comprehensive sampling event, drift nets were placed over the major spring openings of Comal Spring Runs 1 and 3 and a moderate-sized spring upwelling (Spring 7) along the western shoreline of Landa Lake (Figure 2). Drift nets were anchored into the substrate directly over each spring opening, with the net faced perpendicular to the direction of the flow. Net openings were rectangular with dimensions of 0.45 m by 0.30 m, and the mesh size was 150 micrometers (µm). The tail of the drift net was connected to a detachable, 0.28-m-long cylindrical bucket (200-µm mesh), which were removed at 6-hour intervals during sampling, after which cup contents were sorted and invertebrates removed in the field. The remaining bulk samples were preserved in ethanol and sorted later in the laboratory removing minute organisms overlooked in the field. All Comal Springs riffle beetles, Peck's cave amphipods, and Comal Springs dryopid beetles captured via drift net were returned to their spring of origin, with the exception of voucher organisms (fewer than 20 living specimens of each species identifiable in the field).

Drift net over Spring Run 1 orifice showing net placement and orientation to the spring.

All non-endangered invertebrates were preserved in 70% ethanol. Additionally, water quality measurements (temperature, pH, conductivity, dissolved oxygen, and current velocity) were taken at each drift-net site using a Hydrotech multiprobe (MS5) water quality meter and Hach (FH950) handheld flow meter.

Comal Springs Riffle Beetle



In 2016, Comal Springs riffle beetles were collected from three reaches in the Comal system during two routine sampling events, spring and fall. During the routine spring sampling, the cotton lure methodology of previous years was used, and in the fall season sampling followed the methods of the Cotton Lure SOP developed in the summer of 2016 (datasheets including metadata is available to the EAA for archive). Both methodologies consisted of placing lures of 15-cm x 15-cm pieces of 60% cotton/40% polyester cloth into spring openings/upwellings in the Comal system and leaving them in situ for approximately 30 days, during which time they would become inoculated with local organic and inorganic matter, biofilms, and invertebrates, including Comal Springs riffle beetles. Lures were placed in sets of 10 in 3 areas: (1) Spring Run 3, (2) along the western shoreline of Landa Lake ("Western Shoreline"), and (3) near Spring Island in locations that were previously found to have high densities of Comal Springs riffle beetles (BIO-WEST 2002a). Lures were deployed and collected at all sites in April/May and October/November; length of time lures were deployed ranged from 30 to 33 days. Lures lost, disturbed, or buried by sedimentation were not included in subsequent analyses.

With the exception of some permitted removal for laboratory studies, all Comal Springs riffle beetles collected with cotton lures were identified, counted, and returned to their spring of origin. Sampling crews also recorded lure counts of any *Microcylloepus pusillus* and Peck's cave amphipods collected. These and any other spring invertebrates collected on the lures were placed back into their spring of origin as well. Crews utilized a mask and snorkel to place and remove lures in somewhat deeper areas of the Spring Island site (pictured below).

Photograph of a biologist collecting a cotton lure at the Spring Island reach.

Macroinvertebrate Community Sampling

In 2016 BIO-WEST conducted macroinvertebrate community sampling to determine species composition, relative number, and vegetation associations of macroinvertebrates at four study reaches (Figure 2). Macroinvertebrates were collected from four reaches (Landa Lake, Upper New Channel, Old Channel, and Upper Spring Run) as part of each spring (May 16) and fall (October 12) comprehensive sampling event. The Lower New Channel Reach was not included because depths are too great to effectively sample. Macroinvertebrate samples were taken for dominant vegetation types at each reach.

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 at right), 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-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 practicable (Appendix C).

Please note that in 2016 we restricted analyses of macroinvertebrate abundance and taxonomic richness 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 16), Summer fountain darter dipnet sampling (July 21-22), and Fall full event (October 12 – November 16).

Comal Springflow

Consistent rainfall throughout 2016 resulted in Comal River total system discharge remaining at or above the long-term average for the entirety of 2016 (Figure 3). This is especially apparent in the peaks during the spring and fall where average monthly discharge was considerably higher than the three previous years (Figure 3). The lowest total springflow (daily average) occurred early in the year at 278 cfs which was more than double the 2015 minimum daily average of 131 cfs (Table 1). A peak daily average discharge of 4,070 cfs on October 30th, 2015 was almost double the peak daily average in 2016 of 2,510 cfs on May 18th (USGS gage 08169000). In addition, the overall 2016 average daily discharge was 370 cfs and only on three separate days did the discharge exceed 1,000 cfs. These represent consistent high flows compared to the previous three years, and the lack of large flood events (peak flows over 3,000 cfs) prevented extensive scouring of vegetation in the Upper Spring run and New Channel sections.

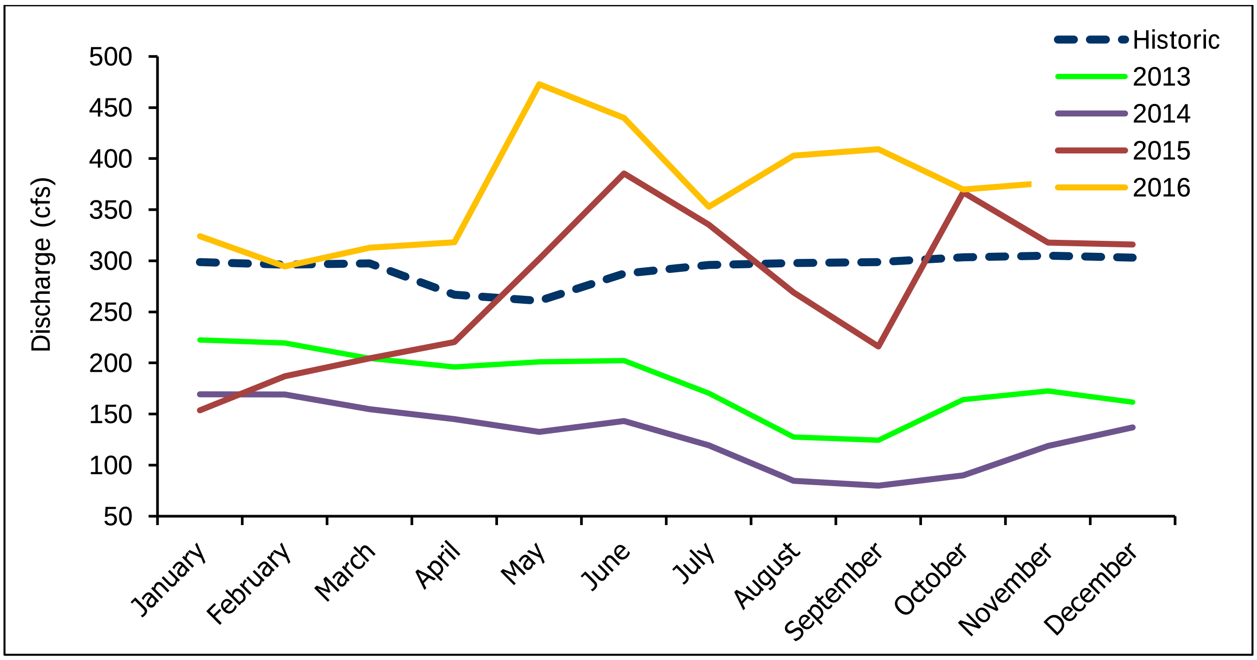


Figure 3. Mean monthly discharge in the Comal River 2013-2016, with historical period of 1934–2016 as dashed line.

Table 1. Lowest daily average discharge during each year of the study (2000–2016), and the date it occurred.

YEAR	DISCHARGE (cfs)	DATE
2000	138	September 7
2001	243	August 25
2002	247	June 27
2003	351	August 29
2004	335	May 28
2005	339	July 14
2006	202	August 25
2007	251	March 8–10
2008	260	June 30
2009	158	July 2
2010	305	August 26, 30
2011	159	September 14
2012	155	September 13
2013	111	September 4
2014	65	August 29, 30
2015	131	January 1–2,5–6
2016	278	February 22

During spring and fall 2016, discharges were measured at nine sites in the Comal River (Figure 4). Measured discharge in Spring Run 1 greatly increased from spring 2015 (12 cfs) to spring 2016 (30 cfs) and almost tripled from fall 2015 (14 cfs) to fall 2016 (42 cfs). This is largely due to the consistent rainfall in the recharge zone influencing the Comal River. Discharge at Spring Run 2 was around 6 cfs for both seasons in 2016 and above the long-term average (Figure 5). Spring Run 2 discharge was the highest it's been since 2010. Additionally, these seasonal averages were above the long-term average (Figure 5). Similar to 2015, discharge in Spring Run 3 was higher in the spring than fall (44 cfs vs. 32 cfs, respectively); however, 2016 discharge was higher overall than in 2015 and the long-term average (Figure 5).

Measured discharge in the Old Channel largely reflects the amount of water flowing through the culvert at the downstream end of Landa Lake. As this is a regulated culvert, flows are expected to be more consistent here. In 2016, discharge for the Old Channel was higher in the fall than in the spring (54 cfs vs. 41 cfs). Additionally, the 2016 spring and fall discharge in the Old Channel was lower than the 2015 discharge during each time period. At first glance, both observations appear odd, until one considers the entire HCP picture. The Old Channel bank stabilization project was initiated in May 2016 and completed in early October. During the setup and construction phase of this project, discharge in the Old Channel was purposely regulated to slightly lower flows than what is directed by the HCP flow split guidelines. This was purposely done to allow for ease of construction and ultimately less impact to immediate fountain darter habitat via scour when water flow was diverted into smaller sections of the channel via bladder dams. This deviation in discharge was requested and granted by the USFWS in advance of any modifications, and monitored closely by project team biologist over the course of the project. This highlights the importance of understanding the HCP big picture by providing a great example of an outlying circumstance which directly resulted in conditions that otherwise would be considered atypical.

In 2011, the study team began measuring discharge at Upper Spring Run (Liberty St.). Figure 6 reveals that discharge was higher in spring than fall (33 cfs and 29 cfs, respectively), with both seasons being higher than the long-term average (2011–2016). In fact, the 2016 Upper Spring Run discharge was the highest observed since implementation of these measurements in 2011.

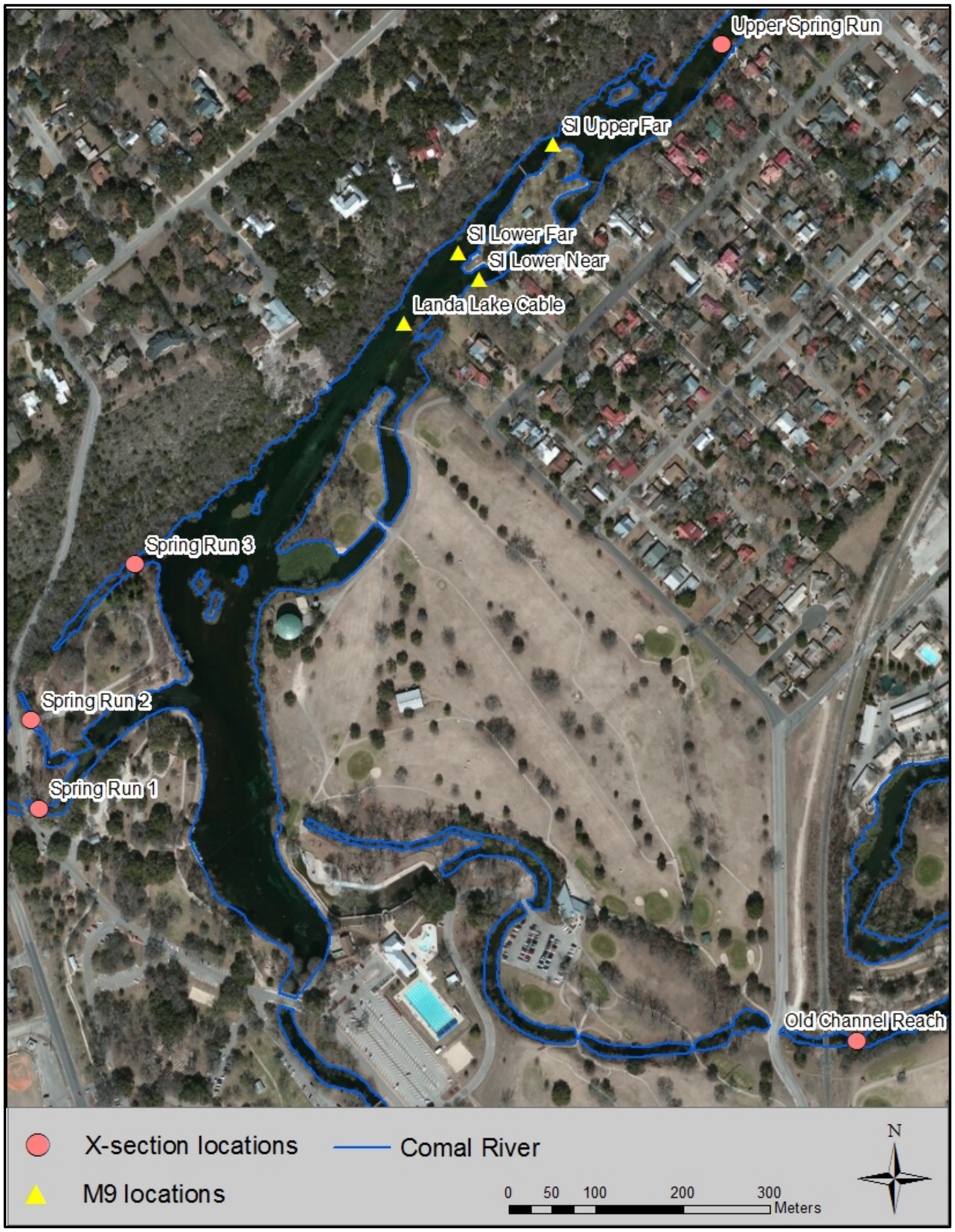


Figure 4. **Cross-section and flow partitioning (M9) discharge collection locations in the Comal River.**

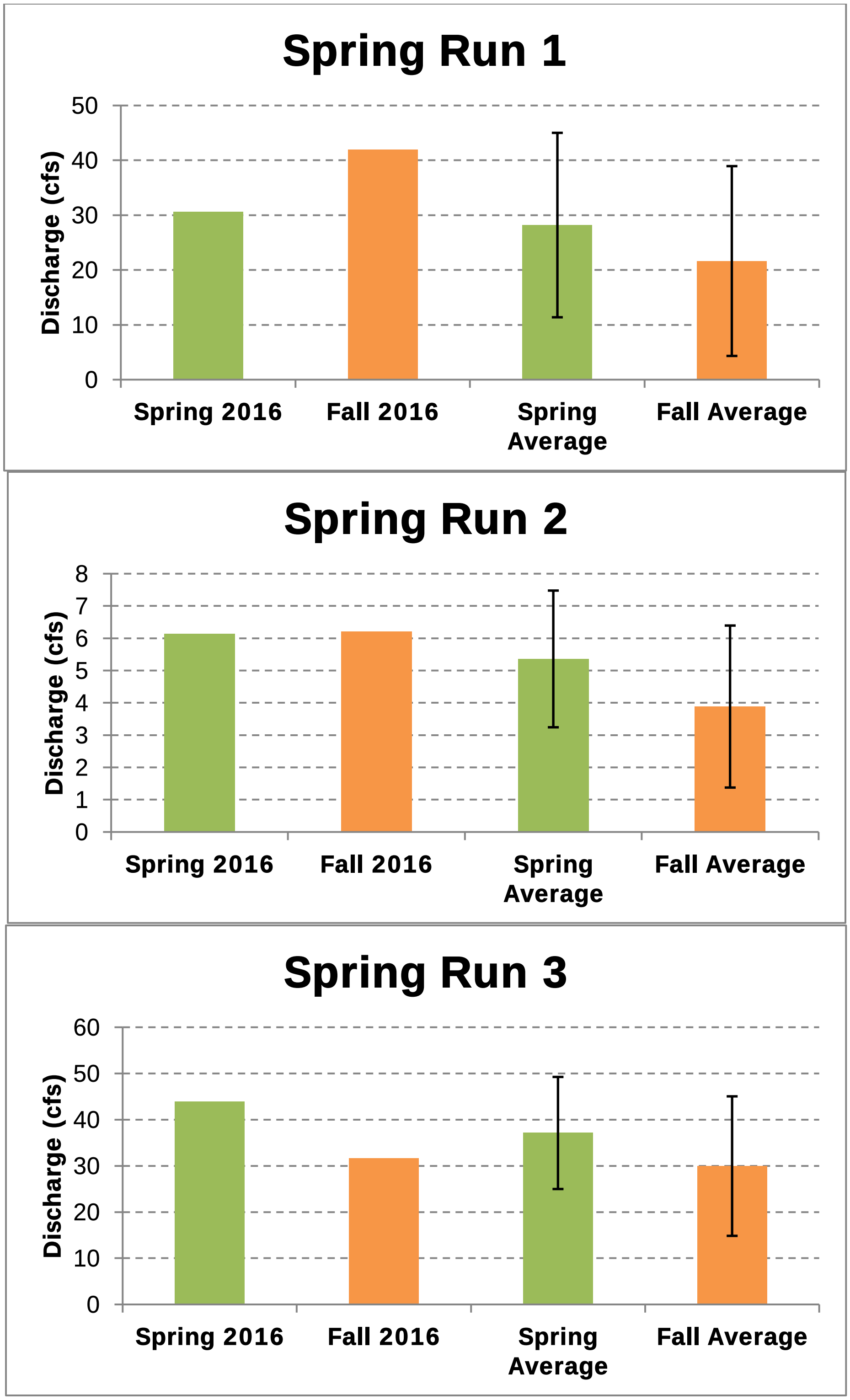


Figure 5. **Measured discharge for Spring runs 1, 2, and 3. Averages represent April/May values (spring) and October/November values (fall) from 2003 to 2016. Long-term study averages are provided with bars representing one standard deviation from the mean. *Note y-axis differences for discharge.**

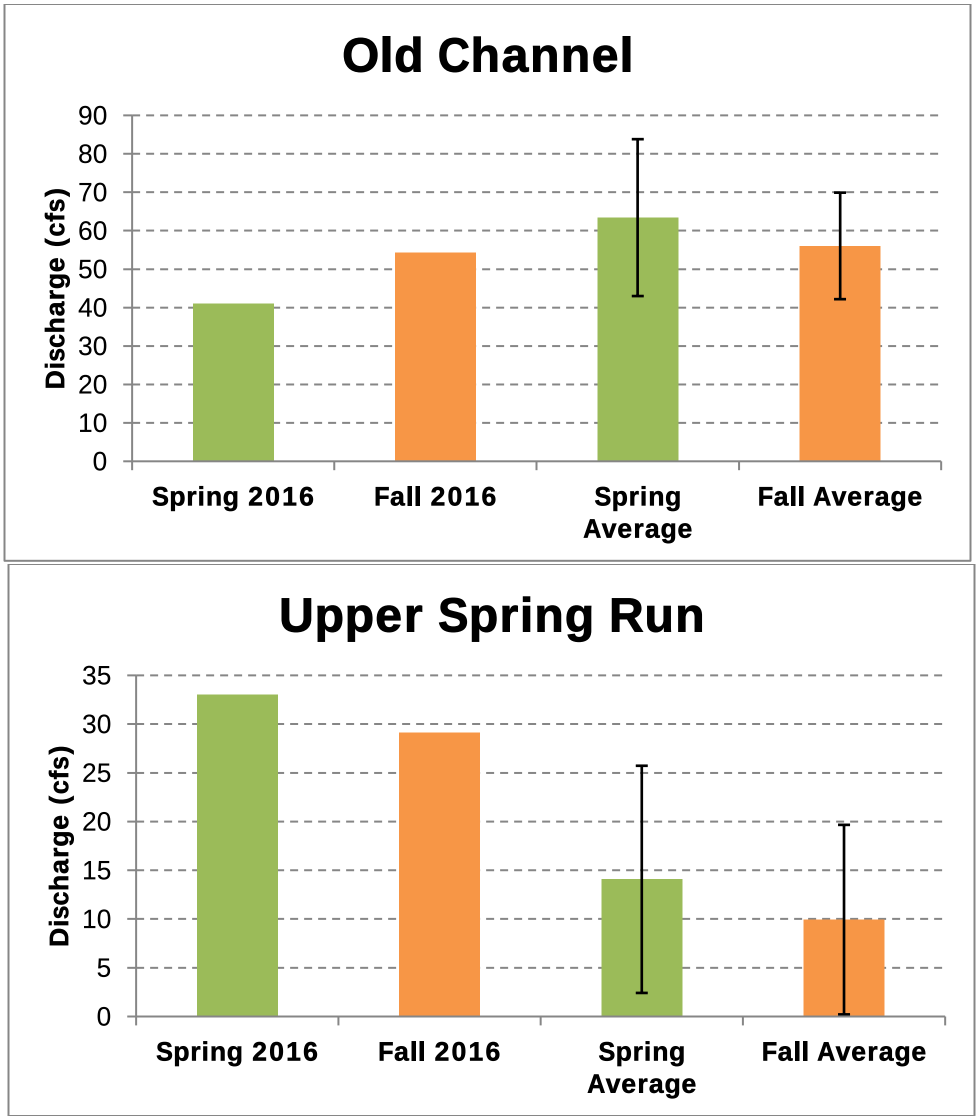


Figure 6. **Measured discharge for the Old Channel and Upper Spring Run reaches. Averages represent April/May (spring) and October/November values (fall) from 2003–2016 for the Old Channel, and 2011–2016 for Upper Spring Run. Long-term study averages are provided with bars representing one standard deviation from the mean. *Note differences in y-axis for discharge.**

The flow-partitioning effort that began in 2013 continued in 2016, above and below Spring Island and the upstream end of Landa Lake (Figure 4). Unlike 2014, when 8 flow-partitioning efforts were completed in association with low-flows, consistent flows in the Comal River led to only two efforts (spring and fall) in 2016 (Table 2). As expected with higher total discharge in the Comal River, higher flows were observed at all transects compared to those of previous years (2014 and 2015). Of the transects measured, Upper Spring Run contributed the least to overall discharge in spring and fall (9.6% and 8.0%, respectively) as it did in 2014 and 2015 (Table 3). However, areas on either side of Spring Island contribute substantial springflow. Overall, the area around and upstream of Spring Island contributes approximately 36-54% of the total system discharge, with the majority of that coming down the western channel. Continued data collection under various hydrologic scenarios will be useful in understanding the spatial distribution of springflow in this area and can contribute to more detailed modeling in the future.

Table 2. Flow partitioning data from five transects in 2014–2016.

DATE	DAILY MEAN DISCHARGE (USGS)	DISCHARGE (CUBIC FEET PER SECOND)				
		Transect 1 Upper Spring Run	Transect 2 SI Upper Far	Transect 3 SI Lower Far	Transect 4 SI Lower Near	Transect 5 Landa lake Cable
15 August 2014	86	1.1	11.9	22.2	9.3	46.5
5 September 2014	67	0.8	11.3	17.3	6.9	29.4
10 September 2014	73	1.1	10.0	21.0	7.5	33.7
17 September 2014	83	1.8	13.0	23.1	7.1	35.3
24 September 2014	85	0.6	12.5	18.9	7.6	32.7
2 October 2014	87	2.0	15.6	25.9	9.3	41.2
8 October 2014	85	1.6	17.3	26.1	8.5	40.1
23 October 2014	91	0.6	12.8	23.8	7.6	39.3
24 April 2015	256	18.9	38.1	54.0	22.0	92.2
3 September 2015	221	18.9	32.0	51.2	29.2	99.1
17 May 2016	343	33.0	51.2	76.7	48.9	141.0
25 October 2016	362	29.1	52.2	79.4	48.8	146.2

Table 3. Percentage of total discharge in the Comal River (USGS gage 08169000) from each flow partitioning transect in 2014–2016.

DATE	DAILY MEAN DISCHARGE (USGS)	PERCENTAGE OF TOTAL DISCHARGE				
		Transect 1 Upper Spring Run	Transect 2 SI Upper Far	Transect 3 SI Lower Far	Transect 4 SI Lower Near	Transect 5 Landa Lake Cable
15 August 2014	86	1.3	13.8	25.8	10.8	54.1
5 September 2014	67	1.2	16.9	25.8	10.3	43.9
10 September 2014	73	1.5	13.7	28.8	10.3	46.2
17 September 2014	83	2.2	15.7	27.8	8.6	42.5
24 September 2014	85	0.7	14.7	22.2	8.9	38.5
2 October 2014	87	2.3	17.9	29.8	10.7	47.4
8 October 2014	85	1.9	20.4	30.7	10.0	47.2
23 October 2014	91	0.7	14.1	26.2	8.4	43.2
24 April 2015	256	4.6	14.9	21.1	8.6	36.0
3 September 2015	221	8.6	14.5	23.2	13.2	44.8
17 May 2016	343	9.6	14.9	22.4	14.3	41.1
25 October 2016	362	8.0	14.4	21.9	13.5	40.4

Water Quality Results

Temperature Thermistors

Long-term water temperature data from thermistors (Appendix C) provides an overview of the thermal conditions throughout the Comal system from 2000 to 2016. Gaps in readings on some graphs indicate data-quality events (e.g., theft, thermistor failure); therefore, data were excluded from analysis. As expected, water temperatures are most constant at or near the spring inputs and become more variable downstream as other factors (e.g., runoff, precipitation, and ambient temperature) become more influential.

Four-hour average water temperature data for the Comal headwaters (Blieder's Creek and Heidelberg) are presented in Figure 7. These data exhibit the disparity between an area near a spring input (Heidelberg) and a non-spring area (Blieder's Creek). Blieder's Creek is fed by runoff from the surrounding area, and backup from the springs near the upstream end of the Upper Spring Run Reach. As a result, ambient air temperatures and precipitation events are typically more influential on water temperature causing fluctuations at Blieder's Creek, whereas water temperatures at Heidelberg are relatively constant due to the constant temperature of the spring inputs. Also quite evident is the difference that higher system discharge makes with the consistent temperatures at Heidelberg recorded during the higher discharge years of 2015 and 2016 versus the fluctuating water temperatures at this site during the previous drought.

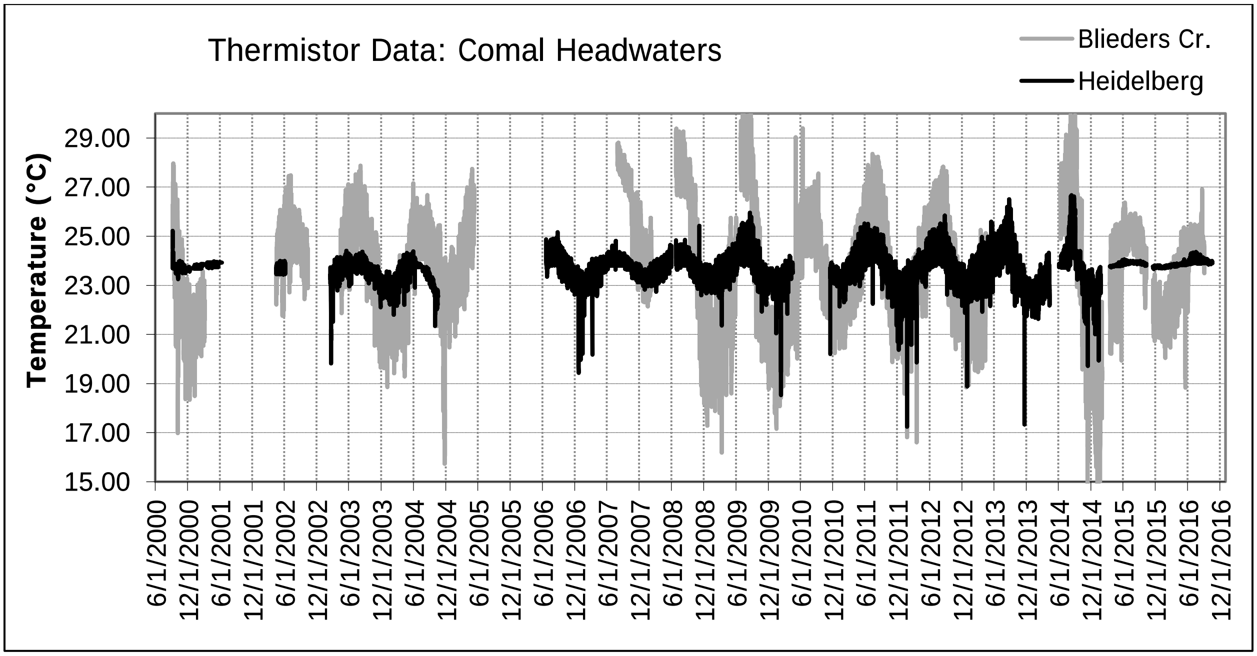


Figure 7. Water temperature (°C) data at Comal headwaters from 2000 to 2016.

Sites like the Other Place, New Channel, and Old Channel had wider temperature fluctuations than sites closer to spring inputs in 2016, but did not exceed the TCEQ water quality standard of 26.7 ºC (Appendix C). Temperatures in the spring runs and Landa Lake vary little (<1 ºC), because most of the water comes from the nearly constant temperatures of the Edward's Aquifer upwellings throughout the lake. Detailed graphs for each site can be found in Appendix C.

Water Quality Grab Samples

No water quality grab samples were collected during critical period events 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 2016a, Draft). A review of the water quality results provided thus far for 2016 show very few incidences where pollutants were detected, and conventional parameters (nutrients, etc.) were generally within the ranges historically reported in the Comal River.

EAA Manta 2 Sonde Data

In 2012 the EAA installed Eureka Manta 2 multiprobes at three locations in the Comal River (Spring Run 3, Spring 7, and downstream of Dry Comal Creek) (Figure 8). These multiprobes monitor standard parameters (temperature, pH, conductivity, dissolved oxygen, and turbidity) every 15 minutes and the data from 2016 is summarized below. These data were taken directly from the EAA Environet website (EAA 2016b, provisional data).

Much like the temperature data collected via HCP biological monitoring, the EAA water temperature data showed very little variation throughout the year in Spring Run 3 (Figure 9). There were two notable declines in temperature at Spring Run 3 which may represent downloading events or potentially be due to rainfall events. The temperatures at Spring Run 3 and Spring 7 are typical for areas near spring orifices like those recorded by the thermistors in the spring runs (Appendix C). The temperature probe downstream of Dry Comal Creek in the New Channel showed greater fluctuation in temperature as it is influenced more by runoff and ambient air temperatures (Figure 9). No sonde collected readings that exceeded the Texas Commission on Environmental Quality's (TCEQ) water quality standard of 26.67 ºC for the Comal River in 2016.

Dissolved oxygen (DO) in both Spring Run 3 and Spring 7 varied from 4.55 mg/l to 10.07 mg/l in 2016, whereas DO downstream of Dry Comal Creek showed greater fluctuation throughout the year from 2.52 mg/l to 12.83 mg/l (Figure 10). Short-term drops in DO below Dry Comal Creek likely result from an influx of nutrients and organic matter in runoff during rainfall events that temporarily increases oxygen demand. The pH and conductivity observations at all three locations also showed little variation throughout the year. The pH values ranged from 6.56 to 8.30 (Figure 11) while conductivity averaged from 567 uS/cm to 576 uS/cm at all three locations (Figure 12). Short-term drops in conductivity downstream of Dry Comal Creek likely result from an influx of low-conductivity rainwater during precipitation events.

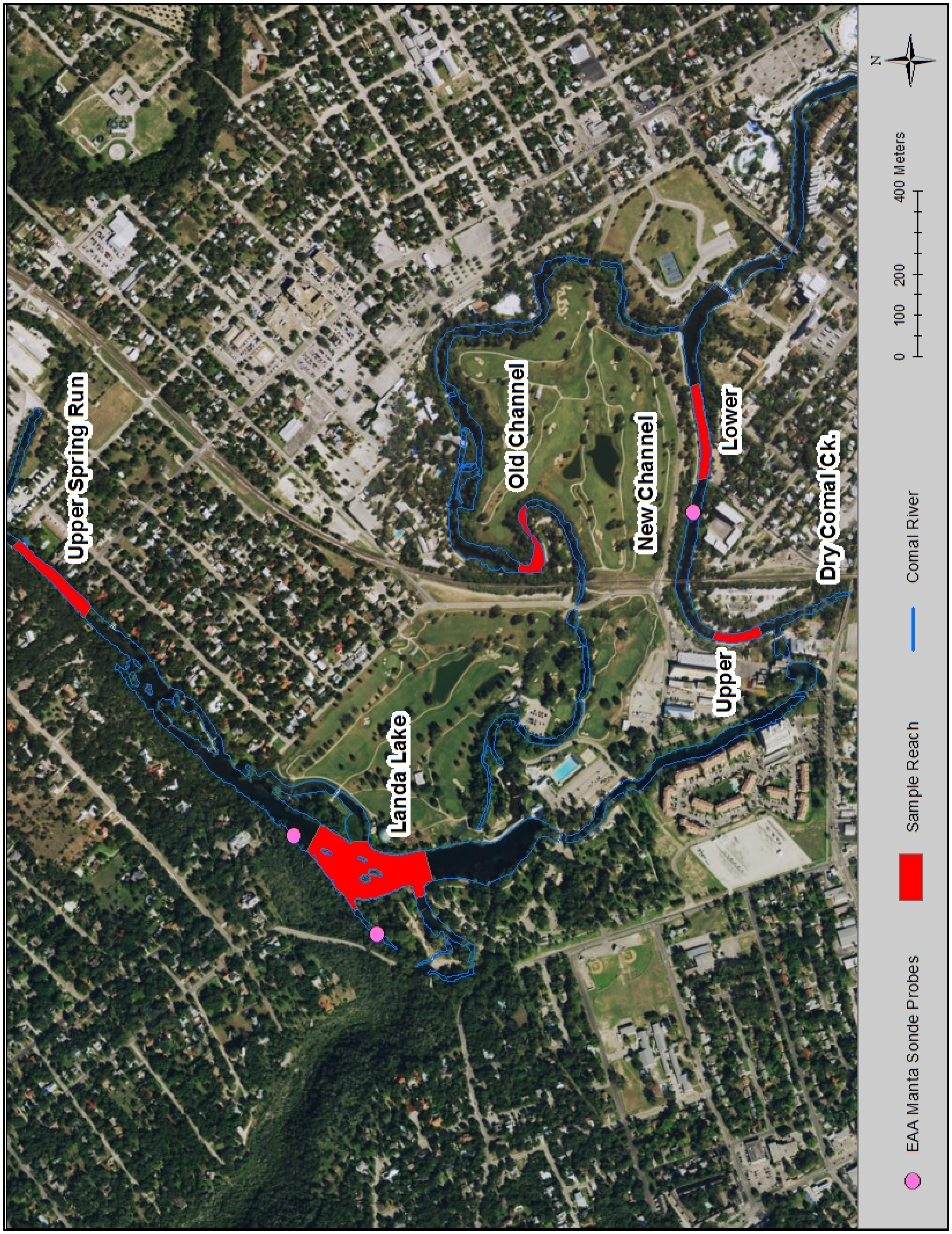


Figure 8. Edwards Aquifer Authority Manta Sonde probe locations in 2016.

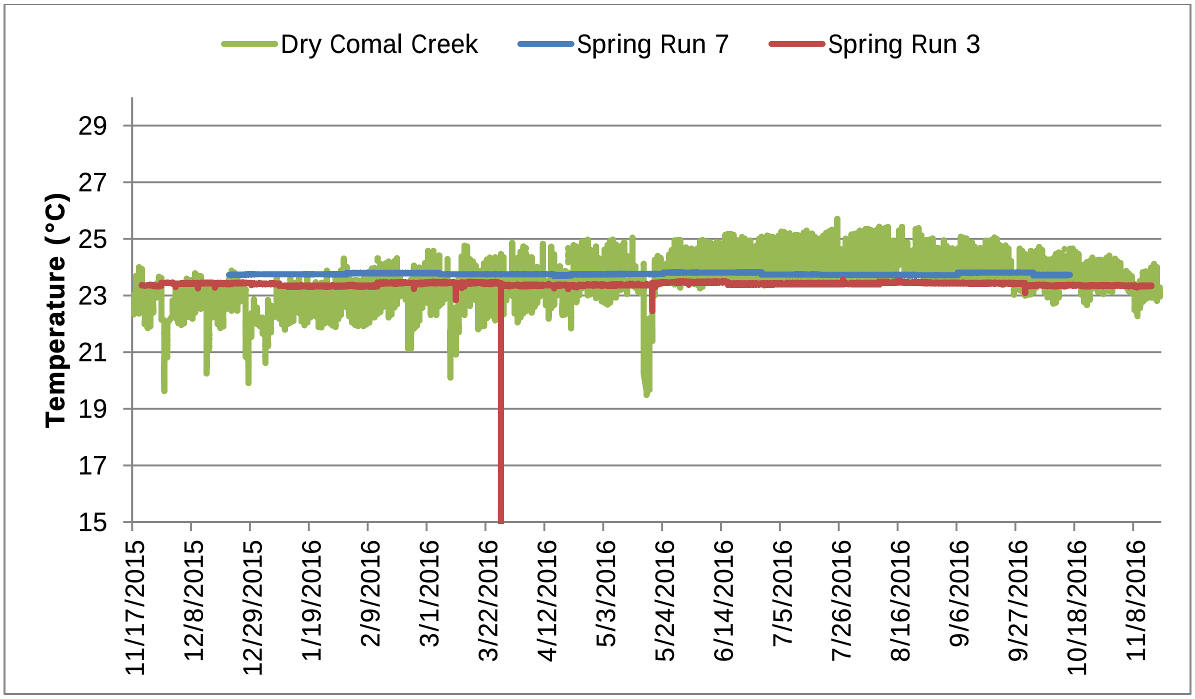


Figure 9. **Edwards Aquifer Authority Manta 2 multiprobe temperature data in Spring Run 3 and Spring 7.**

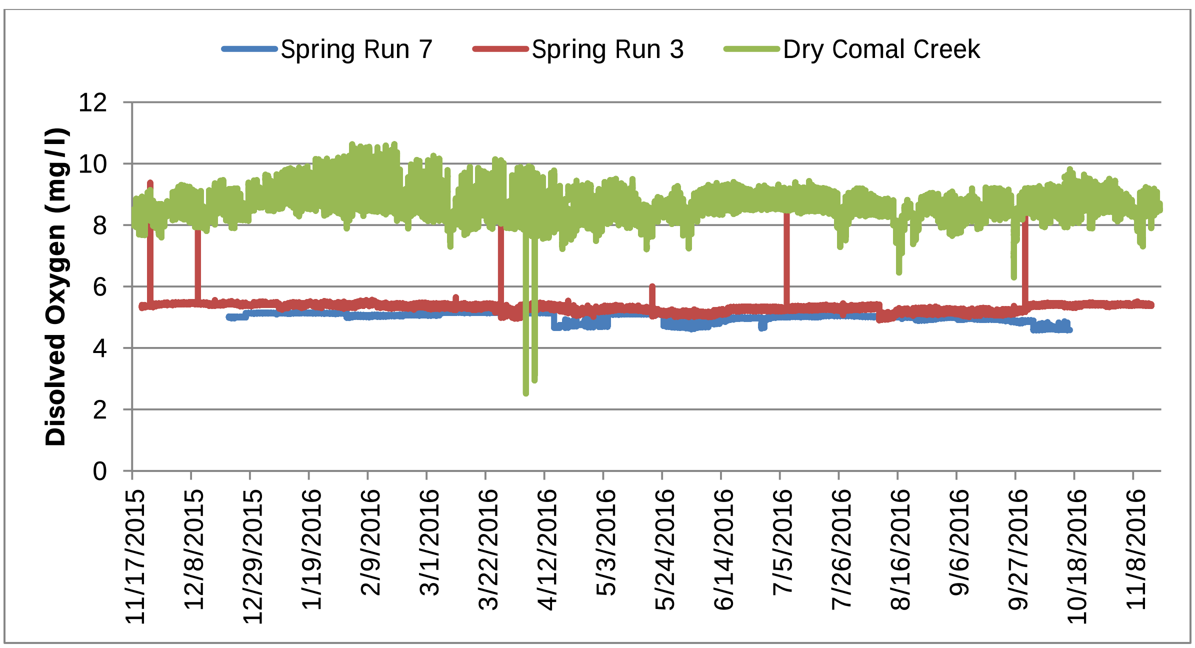


Figure 10. **Edwards Aquifer Authority Manta 2 multiprobe dissolved oxygen data in Spring Run 3, Spring 7, and downstream of Dry Comal Creek in 2016.**

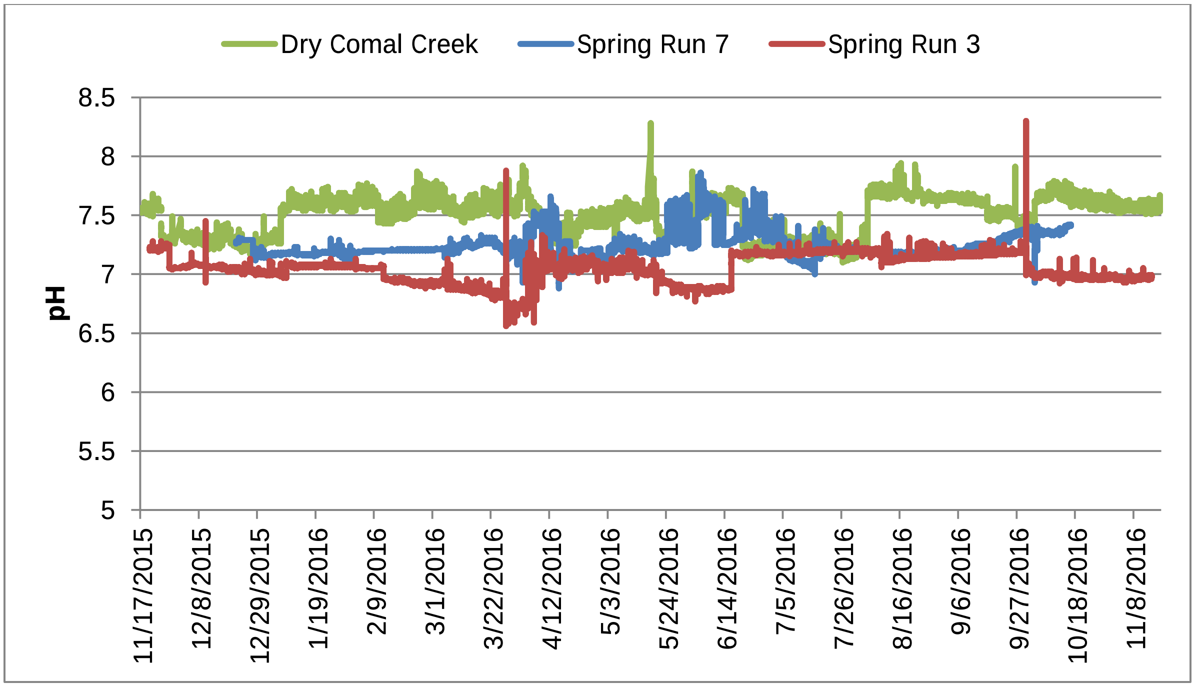


Figure 11. Edwards Aquifer Authority Manta 2 multiprobe pH data in Spring Run 3, Spring 7, and downstream of Dry Comal Creek in 2016.

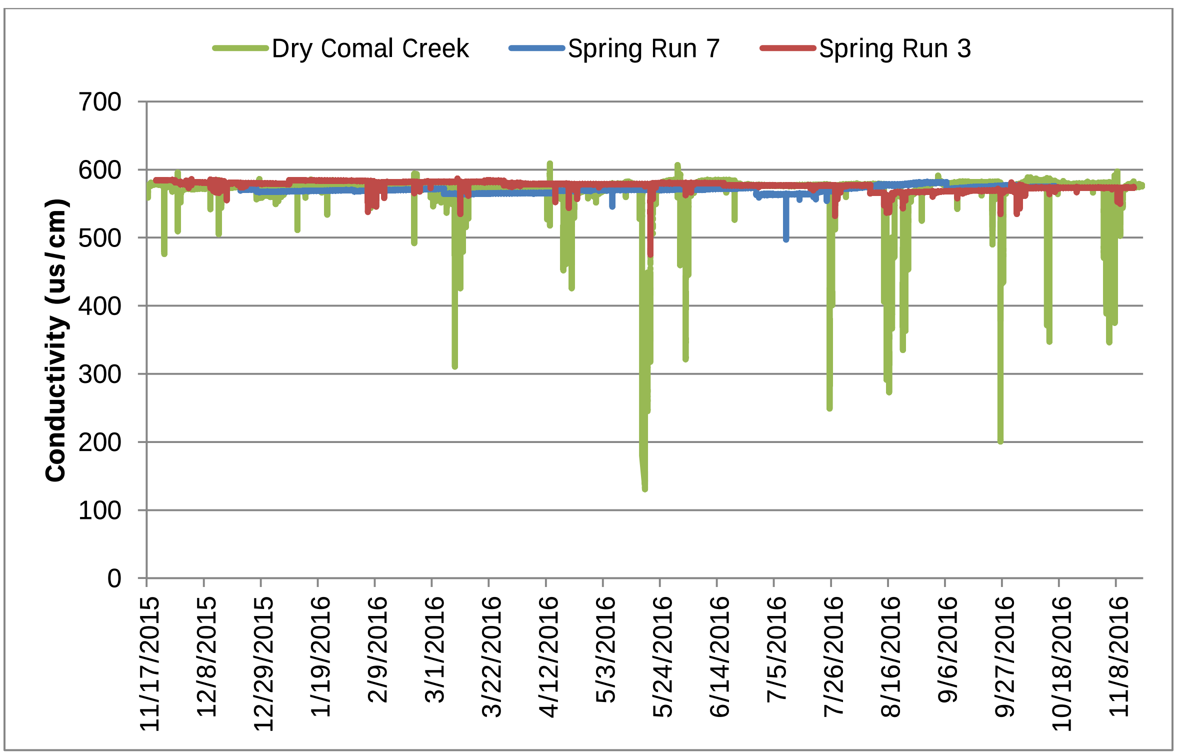


Figure 12. Edwards Aquifer Authority Manta 2 multiprobe conductivity data in Spring Run 3, Spring 7, and downstream of Dry Comal Creek in 2016.

City of New Braunfels Landa Lake Dissolved Oxygen Monitoring

In addition, to point water-quality measurements directly associated with biological sampling, and EAA Manta probes discussed above, the City of New Braunfels installed continuous water quality monitoring equipment in Landa Lake in 2013 as part of their HCP DO mitigation project. In summary, the mean water temperature in 2016 at the Landa Lake sonde was 23.4 °C with a standard deviation of 0.40 °C (95% of temperatures ranged from 22.56 °C to 24.16 °C) (SWCA 2016b). In 2016, DO ranged from 0 to 15.53 mg/L, with values <2.0 mg/L reported approximately 9% of the time (SWCA 2016b). SWCA (2016b) states, "Many of these were likely associated with communications errors, however, this is difficult to determine in consideration of the paucity of data". A full account of 2016 activities and results can be found in SWCA (2016b).

Texas Master Naturalist Monitoring

Water quality data collected by Master Naturalist volunteers in 2016 showed that CO_2 concentrations continue to be highest at sites near springs, such as the Houston Street (Upper Spring Run Reach) and Gazebo (Landa Lake/ Spring Run 3) sample sites (Figure 13), whereas pH increased with distance from the springs (Figure 14). Site locations are shown in Figure 2 and listed from upstream (Houston St.) to downstream (Union Ave.). The inverse relationship between these two variables is due to the presence of carbonic acid in spring waters, so as CO_2 concentrations (and thus, carbonic acid concentrations) decline going downstream, pH rises in the system. Within sites, year-to-year variation was relatively small in both CO_2 concentrations and pH.

To compare recreational use at the various sites, weekly counts of recreation users collected by the Texas Master Naturalist volunteers were converted to monthly averages and plotted over a long-term survey period (Figures 15–19). In 2016 (as in all years), the New Channel received the most recreation pressure, followed by Union Avenue and the Gazebo (Landa Lake). Please note that the y-axis varies for each site for better presentation. As in previous years, recreation use at Elizabeth Street (Old Channel) was low (Figure 15) likely because this site is not located within a city park or advertised for recreational use. Each site, with the exception of Elizabeth Street, saw peaks in recreation use during the summer months or warmer months.

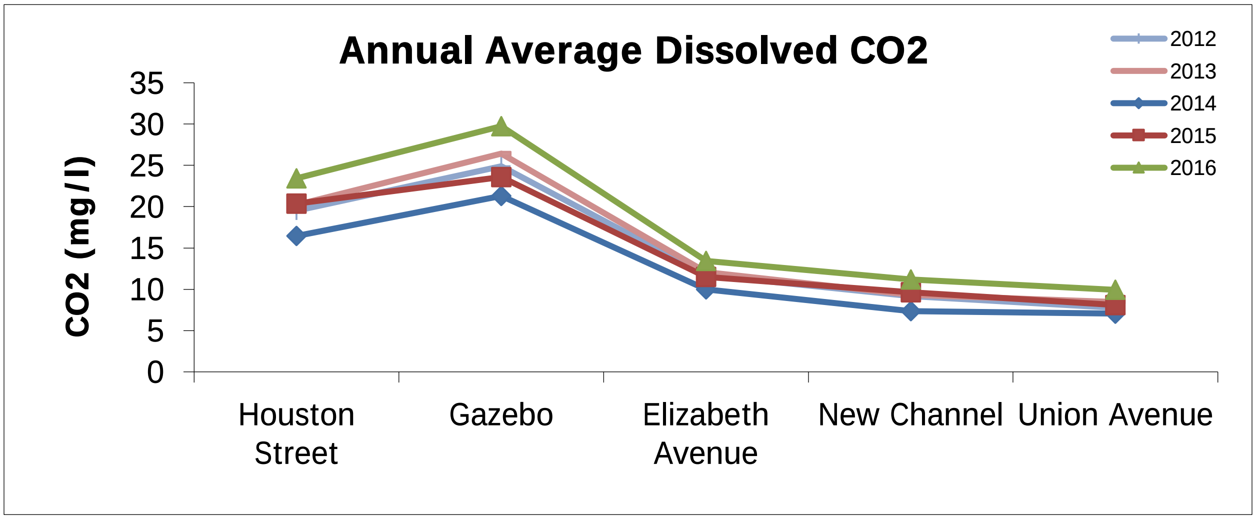


Figure 13. **Annual average dissolved carbon dioxide (CO_2) concentrations at five sites on the Comal River system (2012–2016).**

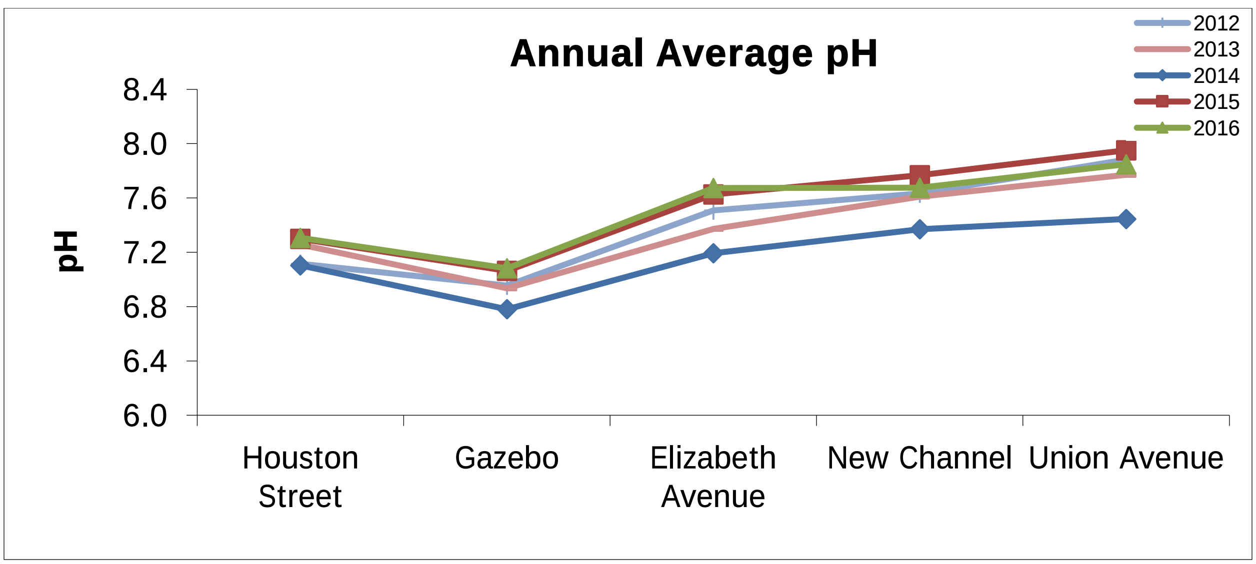


Figure 14. **Annual average pH values at five sites on the Comal River system (2012–2016).**

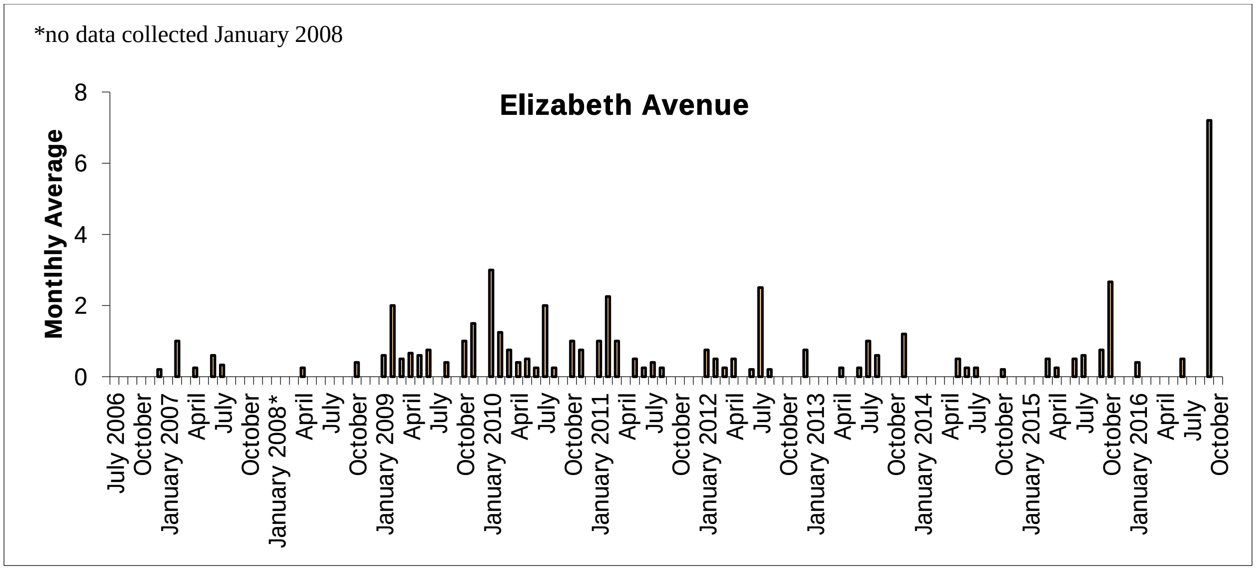


Figure 15. Average recreational use counts at the Elizabeth Avenue site (2006–2016).

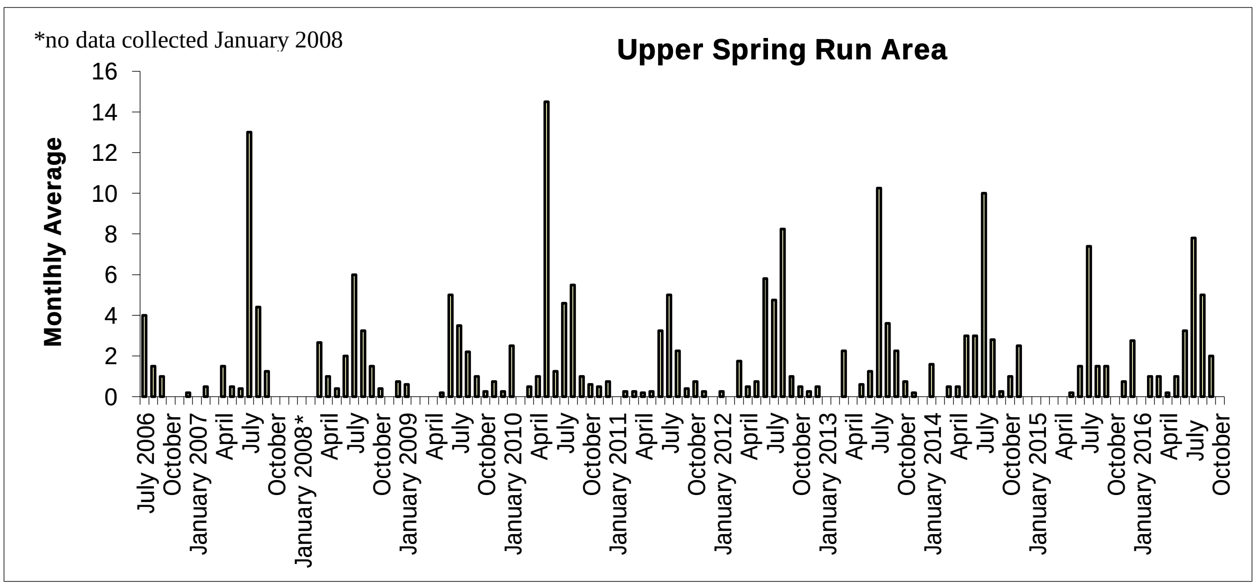


Figure 16. Average recreational use counts at the Upper Spring Run area (2006–2016).

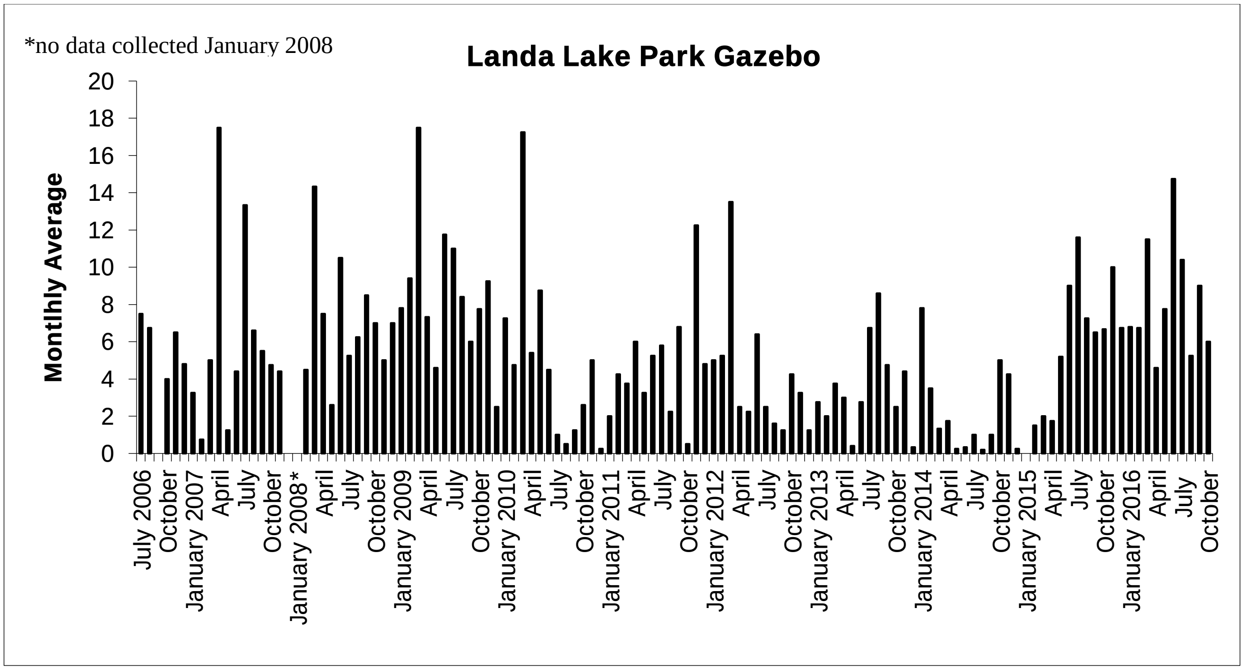


Figure 17. **Average recreational use counts at the Landa Lake Park Gazebo site (2006–2016).**

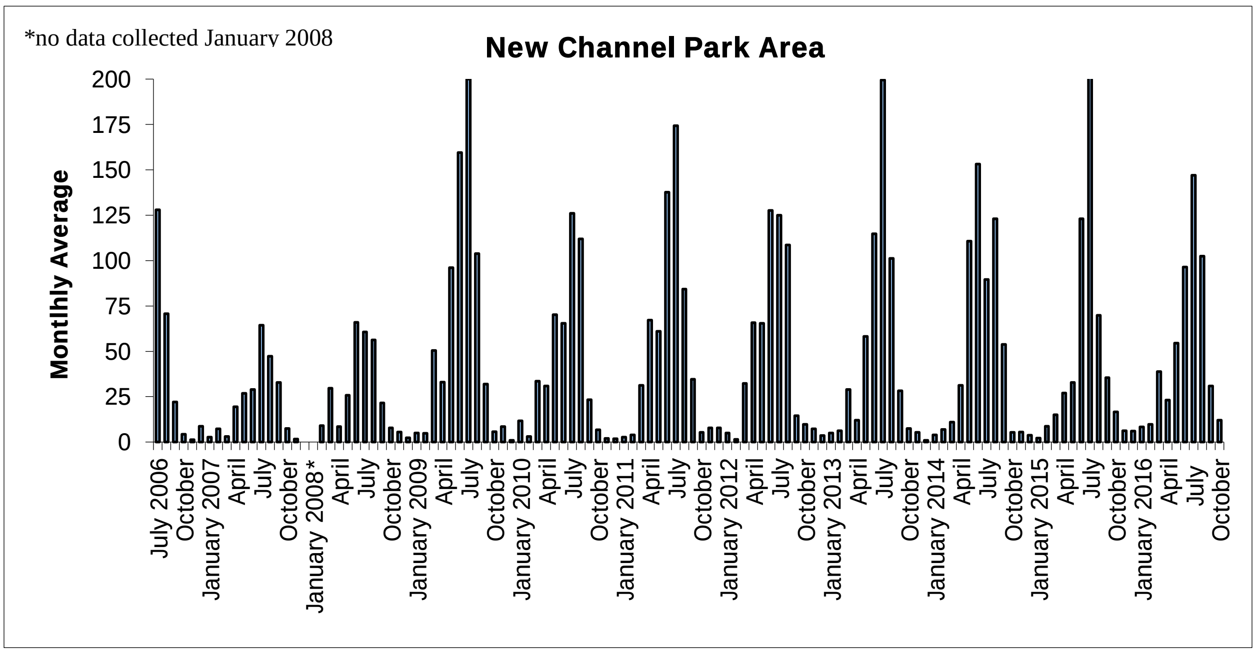


Figure 18. **Average recreational use counts at the New Channel site (2006–2016).**

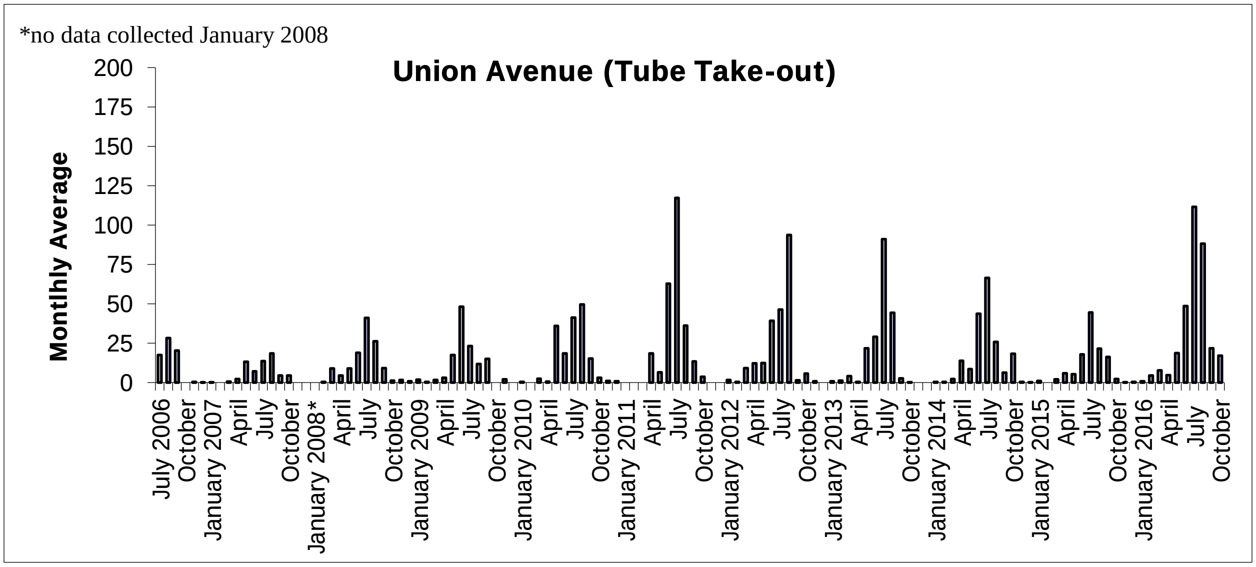


Figure 19. Average recreational use counts at the Union Avenue site (2006–2016).

From 2010 to 2014, the road to the Landa Park Gazebo was closed due to reconstruction of the walls throughout Landa Park. Figure 17 reflects this drop in recreation pressure and its subsequent increase in 2016. This increase in recreation traffic was expected and predicted in earlier reports. The New Channel site has received the most recreation pressure throughout the Texas Master Naturalist monitoring (2006-2016) and is expected to continue. The peak of recreational use is during the summer months of June-September (Figure 18). During the warmer months, the New Channel site becomes a popular destination for tubers and others seeking relief from the heat in the cooler spring-fed water. Much like the New Channel site, recreation pressure at the Union Avenue site can also be substantial during summer because this is a take-out site for many tubers floating the river (Figure 19). However, unlike the New Channel site, this location does not offer long-term attraction such as picnic tables, resulting in fewer alternative or additional recreational activities.

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.

Upper Spring Run Reach

The Upper Spring Run Reach is the most upstream study reach of the Comal River (Figure 2), and the springs creating much of the flow in this reach are higher in elevation than their downstream counterparts (e.g., Spring Island, the Landa Lake complex). For these reasons, the Upper Spring Run Reach is a unique reach where vegetation often responds differently than that in other reaches, especially during periods of lower-than-average discharge. During 2016, the Comal River discharge was at or higher than the historical average and higher than has been observed over the last several years. Spring saw a large increase in the total amount of aquatic vegetation (1,964 m^2) in the Upper Spring Run Reach compared to the November 2015 high-flow (974 m^2) event that scoured much of the vegetation in the reach. This is due mostly to the regrowth of Bryophytes in early spring. This total area is below the long-term study average, but within one standard deviation from the mean (Figure 20). By fall 2016 due to slight decreases in Bryophytes and *Sagittaria* within the reach the amount of aquatic vegetation decreased to (1,610 m^2), which again is lower than the long-term study average (but within one standard deviation) (Figure 20).

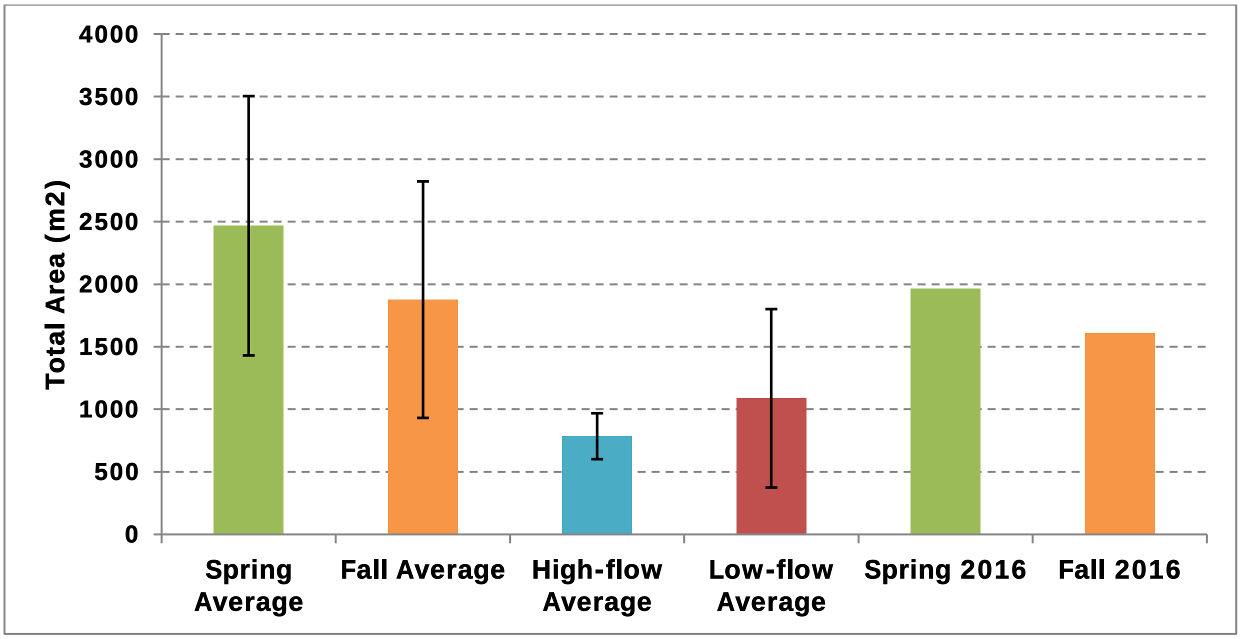


Figure 20. Total surface area (m^2) of aquatic vegetation in the Upper Spring Run Reach. Long-term study averages are provided with bars representing one standard deviation from the mean.

Landa Lake Reach

Total surface area of aquatic vegetation in the Landa Lake reach in spring 2016 (17,566 m^2) was slightly lower than the long-term study average (within one standard deviation), but did show an increase from the November 2015 high-flow event (16,383 m^2). Total vegetated area in fall 2016 (18,945 m^2) was higher than both spring 2016 and the long-term fall average (but within one standard deviation) (Figure 21). However, it should be noted the total reach area for Landa Lake was expanded slightly in fall 2016 (507 m^2) to encompass all of the aquatic vegetation restoration activities near the confluence of Spring Run 1 (See Appendix B).

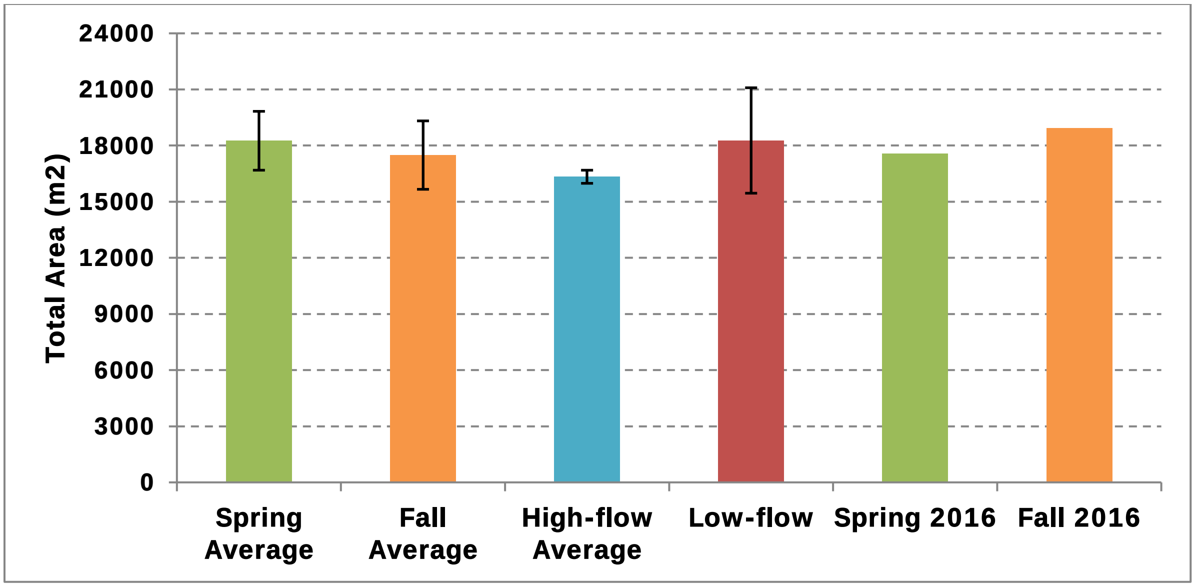


Figure 21. **Total surface area (m^2) of aquatic vegetation in the Landa Lake Reach. Long-term study averages are provided with bars representing one standard deviation from the mean.**

Overall total vegetation coverage in Landa Lake was stable and consistent to what has been seen in the past. Further monitoring of this important reach will allow for a better understanding of how restoration efforts (see picture below) have contributed to the overall health of the reach.

Landa Lake Native Vegetation Restoration

Old Channel Reach

Throughout the years of aquatic vegetation monitoring in the Old Channel Reach, many changes have occurred in the vegetative community. Until 2004, filamentous algae was one of the dominant plants, which contributed to a large fountain darter population. After 2004, *Hygrophila* came to dominate, with *Ludwigia* present in the upstream portion of the reach. By 2013, *Ludwigia* was no longer present and *Hygrophila* dominated nearly the entire reach. Habitat Conservation Plan restoration efforts are being implemented to reverse this trend by removing *Hygrophila* and introducing native plants back into the reach. However, the aforementioned Old Channel bank stabilization project completed upstream of the study reach during 2016 delayed some of the restoration efforts downstream, and *Hygrophila* remains the dominant aquatic plant species in this reach. Although both spring and fall 2016 values were below the long-term averages for this reach, those comparisons need to be interpreted with an understanding of the big picture HCP plans for this reach. Continued restoration efforts will result in greater total vegetation in years to come focused on re-establishment of native plants within the Old Channel Reach (see picture below).

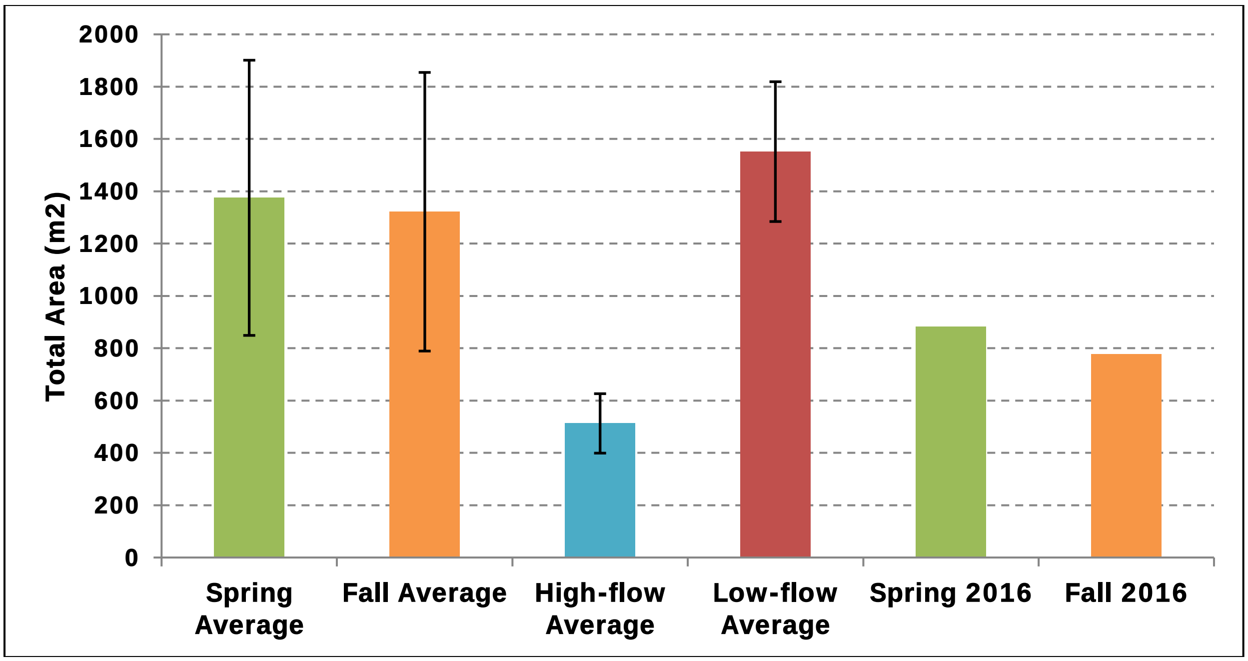


Figure 22. Total surface area (m^2) of aquatic vegetation in the Old Channel Reach. Long-term study averages are provided with error bars representing one standard deviation from the mean.

Old Channel Reach Aquatic Vegetation Restoration

Lower New Channel Reach

The Lower New Channel Reach is entirely channelized and characterized by greater water depths and, because of the influence of Dry Comal Creek, it has vegetation that is highly affected by pulse flow events. As a result of the lower-than-average flows during the prolonged drought of 2013 through early 2015 aquatic vegetation flourished in this reach. *Cabomba* and *Hygrophila* dominated this reach because there had been no flushing flows to scour them out in recent years. Because of this, in fall 2015 the total vegetation coverage was one of the highest since the start of the project in 2000. Due to scouring during the November 2015 high-flow event the total vegetation coverage in the reach declined to levels not observed since spring 2012 (2,288 m^2). The total surface area in spring 2016 (2,377 m^2) was an increase from after the November high-flow event and exceeded the long-term average for the project (Figure 23). In fall 2016, total vegetated area dropped slightly to 2,046 m^2 in response to a moderate flow pulse in September, resulting in conditions just below the long-term fall average but within one standard deviation.

Upper New Channel Reach

An extension to the New Channel Reach was added in 2014 upstream of the (now) Lower New Channel Reach (Figure 2). The Upper New Channel Reach is located upstream of the railroad bridge, and downstream of the outflow from the power plant adjacent to the Wurstfest grounds. Like the rest of the original New Channel Reach, the upper reach is channelized, although it is also characterized by shallower depths and a concrete wall on river-left only. Substrates vary, but are dominated by gravel and silt. Due to its proximity to Dry Comal Creek, this reach can be highly affected by the flashy flows coming down Dry Comal Creek during precipitation events.

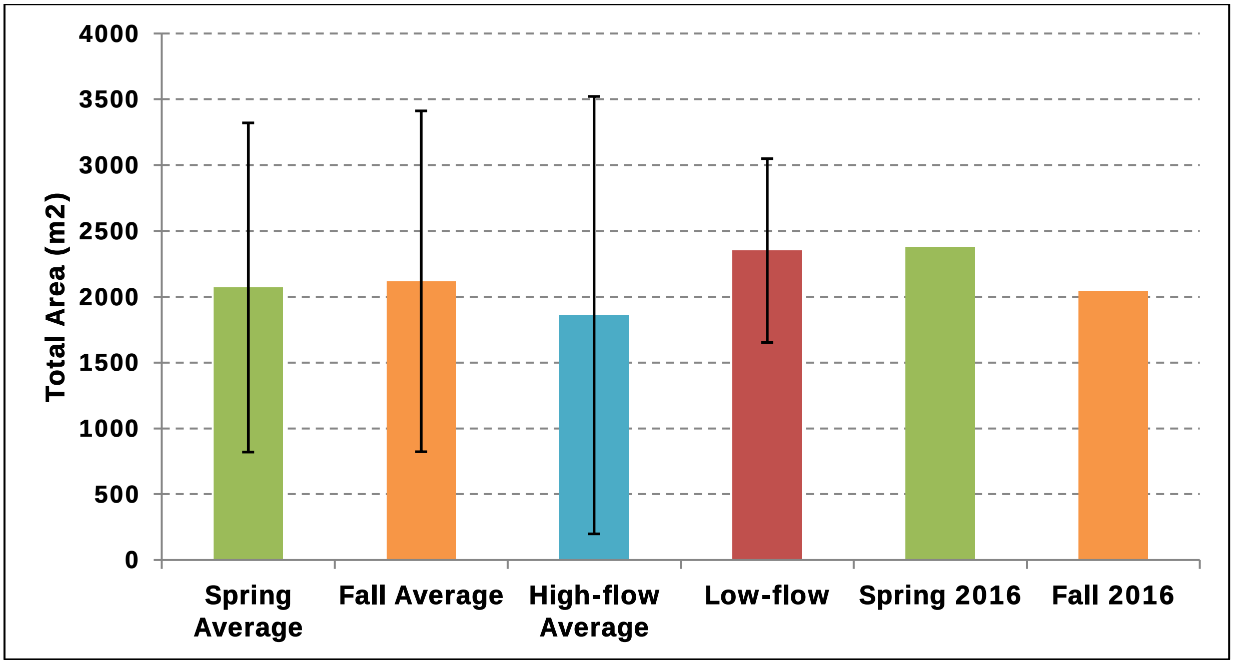


Figure 23. **Total surface area (m^2) of aquatic vegetation in the Lower New Channel Reach. Long-term study averages are provided with error bars representing one standard deviation from the mean.**

Please note data presented in Figure 24 only includes data from spring 2014 to present thus; more sampling is needed to establish long-term averages. Total surface area of aquatic vegetation increased from the November high-flow 2015 event (381 m^2) to spring 2016 (511 m^2) with much of this increase attributed to increases in *Cabomba* and *Hygrophila* coverage (Figure 24). The amount of aquatic vegetation decreased to 216 m^2 by fall 2016, mostly attributed to a flow pulse coming down Dry Comal Creek in late September. This reach is even more susceptible to scouring flows than the Lower New Channel Reach due to its channelized nature and its close proximity to Dry Comal Creek which enters the system ~20 m upstream of this reach.

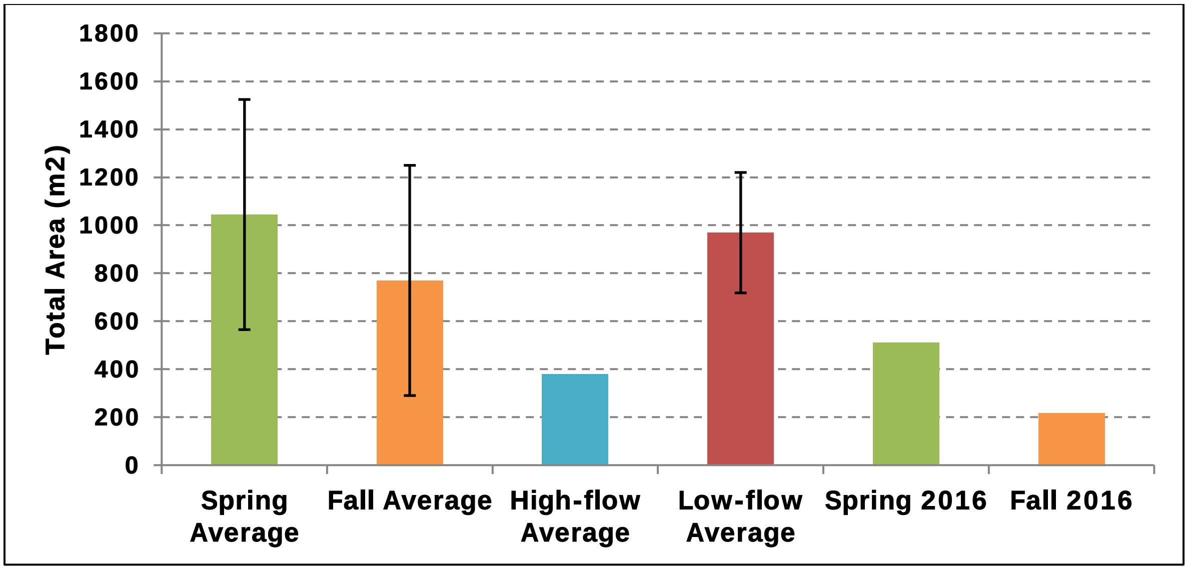


Figure 24. **Total surface area (m^2) of aquatic vegetation in the Upper New Channel Reach. Long-term study averages are provided with bars representing one standard deviation from the mean.**

Fountain Darter Sampling Results

Dropnet Sampling

A total of 66 dropnet samples were conducted during 2016 comprehensive sampling in the Comal River system. Table 4 shows the number of dropnet samples taken from each vegetation type in each reach during the two sampling efforts.

Table 4. **Number of dropnet samples collected in each vegetation type per reach during 2016 sampling efforts.**

	SPRING (May 9–11)				FALL (OCTOBER 26–28)				
VEGETATION	**Upper Spring Run**	**Landa Lake**	**Old Channel**	**Upper New Channel**	**Upper Spring Run**	**Landa Lake**	**Old Channel**	**Upper New Channel**	**TOTAL**
Bryophytes	3	2	2		2	2	2		13
Ludwigia		2	2		2	2	2		10
Hygrophila			2	2			2	2	8
Sagittaria	3	2			2	2			9
Vallisneria		2				2			4
Cabomba		2		2		2		2	8
Open	2	2	2	2	2		2	2	14
TOTAL	8	12	8	6	8	10	8	6	66

Changing conditions in the Upper New Channel Reach associated with an increase in flows usually allows for only four dropnet samples to be completed as water at the site is generally too deep for effective sampling; however, biologists were able to complete 6 dropnet samples during both routine sampling efforts in 2016. Dropnet data sheets for 2016 are included in Appendix D. From these dropnet samples, a total of 1,237 fountain darters were collected in 2016, with 825 darters collected during spring sampling, and 412 collected during fall sampling. Although effort has varied slightly between events, the number of fountain darters captured per sampling event has ranged from 103 to 1,058 (mean=505) in 47 separate sampling events since the beginning of the comprehensive monitoring study in 2000.

Dropnet data collected from 2000 to 2016 show that average densities of fountain darters in the various vegetation types ranged from 0.9/m^2 in open sites to 27.3/m^2 in bryophyte-dominated sites (Figure 25). Although variation is high, native vegetation types that provide thick cover at or near the substrate such as bryophytes and filamentous algae (26.1/m^2) tend to have the highest fountain darter densities, whereas open substrate with no vegetation has relatively low densities. Filamentous algae and bryophytes, which have provided the highest fountain darter density, are also most susceptible to scouring during high-flow events and have shown considerable fluctuation in coverage over the long-term study period. These plants do not firmly root to the substrate, and can be easily uprooted by high water velocities. Bryophytes are a key habitat component because they occupy large areas of the Upper Spring Run and Landa Lake reaches, and thus make up a significant portion of the available habitat. *Cabomba*, *Ludwigia*, *Sagittaria, and Vallisneria* are also relatively common and, therefore, provide substantial amounts of fountain darter habitat. Although nonnative *Hygrophila* was once a dominant vegetation type in many reaches, recent vegetation restoration activities have substantially reduced *Hygrophila* coverage within the study reaches. In particular, this nonnative plant is no longer present in the Upper Spring Run and Landa Lake reaches. Unlike the San Marcos River, the Comal River is dominated by native vegetation, which has become even more prevalent following restoration activities (BIOWEST 2016c).

Estimates of fountain darter population abundance in all reaches (Figure 26) were based on the changes in vegetation composition and abundance, and the average density of fountain darters found in all vegetation types from 2000–2016. Population abundance estimates are similar for spring, fall, and low-flow events from 2000–2016. The spring 2016 population estimate was lower than the long-term study average, but within one standard deviation, while the fall 2016 estimate was above the long-term average, and also within one standard deviation of the mean (Figure 26). It is likely the spring estimate was lower than the long-term average because of some lingering effects of the November 2015 flooding.

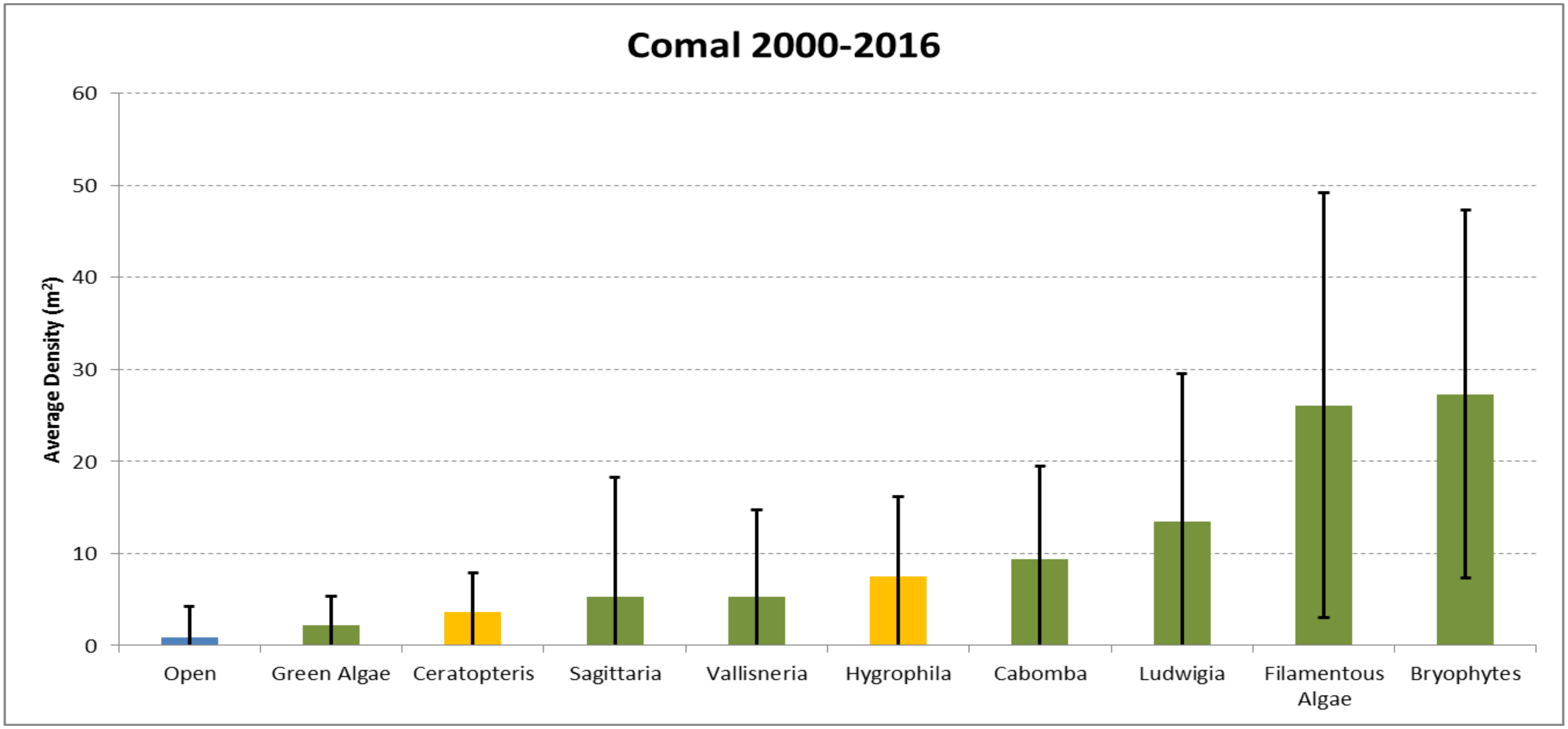


Figure 25. **Average density of fountain darters collected by vegetation type in the Comal system from 2000 to 2016. Bars provided represent one standard deviation from the mean.**

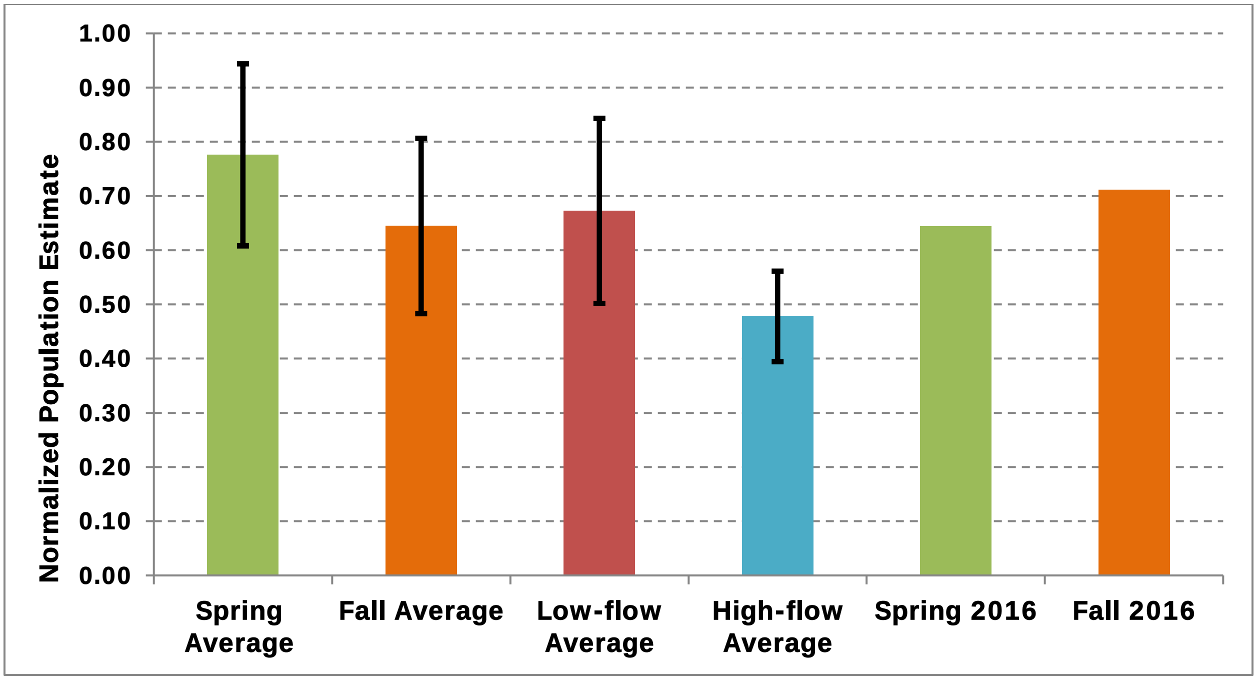


Figure 26. Normalized fountain darter population estimates in the Comal River based on coverage of various vegetation types in the study reaches and average density of fountain darters in each type. Long-term study averages are provided with bars representing one standard deviation from the mean.

The length frequency distribution for fountain darters collected by dropnets from the Comal system during spring (n = 9,138) and fall (n = 7,836) sampling events from 2000–2016 is presented in Figure 27. Small fountain darters (from 12 to 22 mm total length) are more abundant in spring samples, whereas fall is dominated by larger fountain darters, from 24 to 38 mm total length. This suggests a strong late winter/early spring reproductive event with ongoing but limited reproduction occurring during other parts of the year. This corresponds well with results of studies on fountain darter reproduction completed in 2014 (BIO-WEST 2014d).

In addition to fountain darters, 140,932 other specimens representing 24 other fish taxa have been collected by dropnet sampling from the Comal system during the study period (2000–2016). Of these, seven are considered exotic or introduced (Table 5). Although several of these species are potential predators of fountain darters, previous data collected during this study suggests that predation by both native and introduced predators is minimal during average discharge conditions. Other than fountain darters, mosquitofish (*Gambusia spp*.) and redspotted sunfish were the most common fish collected in 2016 with 3,072 and 156 respectively.

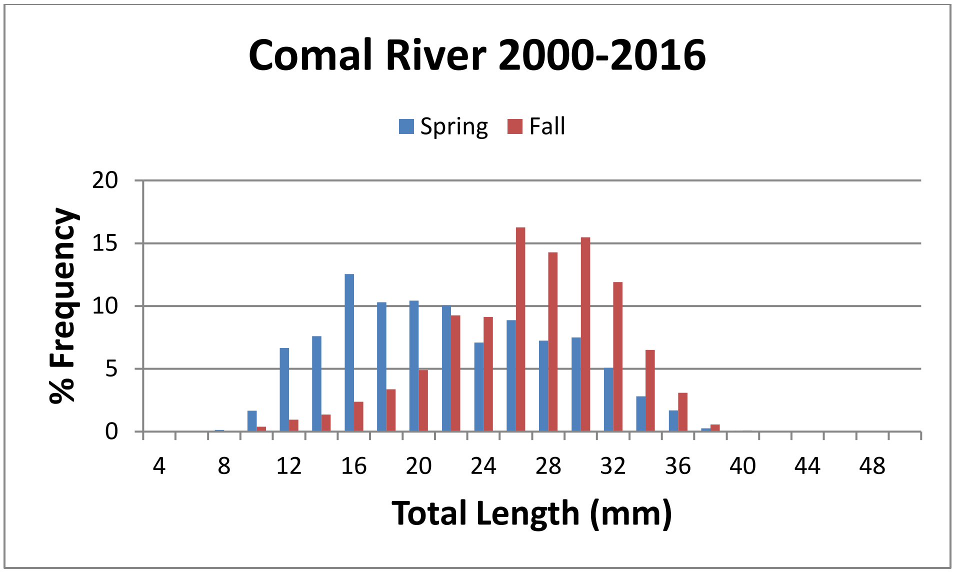


Figure 27. **Length frequency distribution of fountain darters collected from the Comal system during all events (2000–2016).**

Table 5. **Fish taxa and the number of each collected during dropnet sampling.**

Family	Scientific Name	Common Name	Status	2016	2000-2016
Cyprinidae	*Campostoma anomalum*	Central stoneroller	N		1
	Dionda nigrotaeniata	Guadalupe roundnose minnow	N	20	1,074
	Notropis amabilis	Texas shiner	N	11	331
	Notropis volucellus	Mimic shiner	N		34
	Pimephales vigilax	Bullhead minnow	N		4
Characidae	*Astyanax mexicanus*	Mexican tetra	I		440
Ictaluridae	*Ameiurus melas*	Black bullhead	N		1
	Ameiurus natalis	Yellow bullhead	N	2	115
Loricariidae	*Pterygoplichthys sp.*	Sailfin catfish	I	13	89
Poeciliidae	*Gambusia* sp.	Mosquitofish	N	3,072	128,988
	Poecilia latipinna	Sailfin molly	I	3	4,709
Centrarchidae	*Ambloplites rupestris*	Rock bass	I		24
	Lepomis auritus	Redbreast sunfish	I		146
	Lepomis cyanellus	Green sunfish	N	18	45
	Lepomis gulosus	Warmouth	N	2	35
	Lepomis macrochirus	Bluegill	N	25	253
	Lepomis megalotis	Longear sunfish	N		261
	Lepomis microlophus	Redear sunfish	N		2
	Lepomis miniatus	Redspotted sunfish	N	156	2,250
	Lepomis sp.	Sunfish	N/I	16	836
	Micropterus punctulatus	Spotted bass	N		3
	Micropterus salmoides	Largemouth bass	N	5	450
Percidae	*Etheostoma fonticola*	Fountain darter	N	1,237	24,809
	Etheostoma lepidum	Greenthroat darter	N	9	61
Cichlidae	*Herichthys cyanoguttatus*	Rio Grande cichlid	I	29	713
	Oreochromis aureus	Blue tilapia	I		67
Total				4,618	165,741

*N= Native, I=Introduced

Seven species collected during dropnet sampling from 2000-2016 are considered nonnative or introduced to the system. Most of these pose little threat to fountain darters. However, impacts of exotic sailfin catfish (Siluriformes: Loricariidae) on algae and vegetation communities that serve as fountain darter habitat are possible. Although these fish are rarely captured in dropnets, based on data from fish community sampling (see fish community section) they are common in the system. These species have the potential to affect the vegetation community and thus impact important fountain darter habitats and food supplies. A total of 13 individuals were collected in dropnets during 2016 and ongoing population monitoring and management of this species is important.

Dipnet Surveys

Dipnet Timed Surveys

The locations for each section of the dipnet timed surveys are shown in Figure 1. Timed dipnet collections were conducted three times during routine sampling events in the Comal River during 2016: May (spring), July (summer), and October (fall). Overall, the average number of darters collected from timed dipnet surveys in 2016 was higher than the long-term average for all three sampling occasions. Detailed tables of all data collected for each site are available in Appendix C. Size class distributions of fountain darters from dipnet sampling correlate well with those of the dropnet method: small fountain darters were most abundant in the spring, and larger fountain darters dominated fall samples (Appendix C). However, small fountain darters are occasionally captured in summer, winter, and fall sampling periods as well. This indicates that there is some reproduction occurring in all seasons, although perhaps on a limited basis and only in certain areas. Areas that exhibit more continuous reproduction/recruitment based on length frequency data are relatively close to spring upwellings and contain large amounts of bryophytes.

Random Dipnet Surveys

In 2016, presence/absence dipnet sampling was conducted within reaches on the Comal River during the typical spring (May), summer (July), and fall (October) sampling efforts (Figure 28).

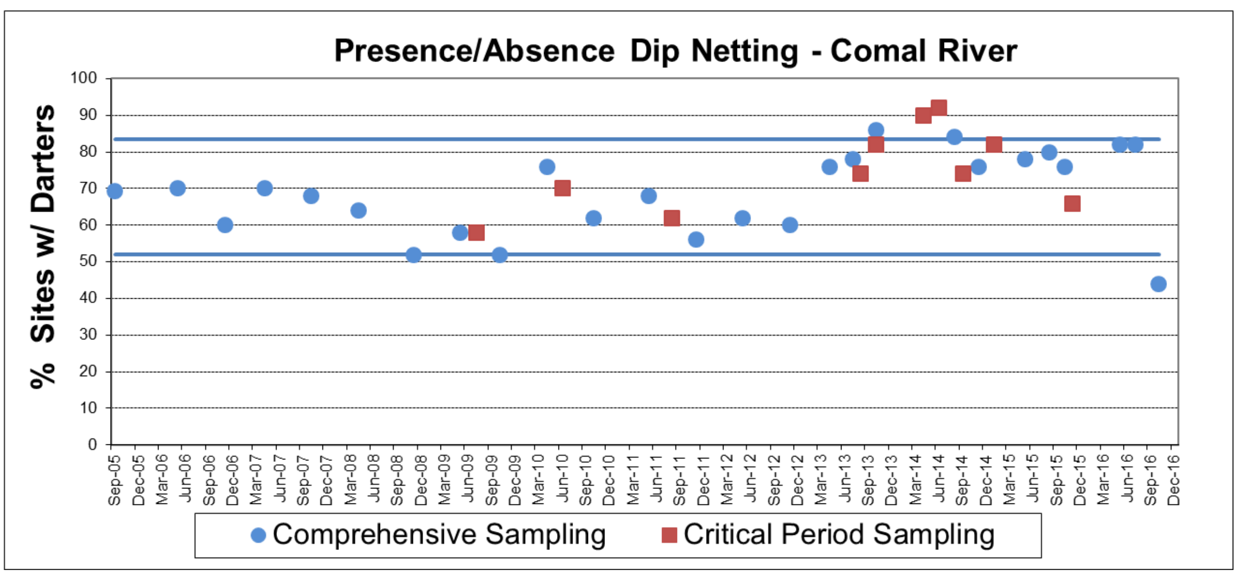


Figure 28. Percentage of sites (*n*=50) in which fountain darters were present. Solid blue lines mark 5th and 95th percentiles for comprehensive sampling.

Although this technique does not provide detailed data on habitat use, and does not allow for quantification of population estimates, it does provide a quick and less-intrusive method of examining large-scale trends in the fountain darter population. Therefore, data collected thus far provide a good baseline for comparison with other sampling events. The percentage of sites with fountain darters was 82% during the spring and summer sampling efforts, and decreased to 44% by fall (Figure 28). While the spring and summer percentages were within the 5^{th} and 95^{th} percentiles for the study, fall was below the 5^{th} percentile for the first time since the initiation of dipnet sampling in 2005. This deviation highlights the inherent variability in biological data collection. It is important to continue to closely monitor fountain darter presence/absence information to assess potential trends over time as results from this analysis can directly influence adaptive management decisions.

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 Comal 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, chosen from previous season, for the Comal River data shows detection as a function of vegetation. This model has an initial ψ=1.00 and p varied from 0.45 to 0.82. 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 bryophytes (p=0.89) and *Hygrophila* (p=0.81) (Table 6). The naïve (#sites occupied / #sites) annual estimates of occupancy have fluctuated over the three years, while the model estimated annual estimates of occupancy for all three years (Table 7) have remained high and more or less stable (consistent with the results of the previous section). This illustrates the tendency of naïve estimates of occupancy to under-estimate the proportion of habitat likely to be occupied.

Table 6. Detection probabilities for different habitat types estimated by multiple season occupancy modeling of Comal River fountain darter presence/absence data.

Habitat	p
Bryophytes	0.89
Hygrophila	0.81
Cabomba	0.63
Vallisneria	0.52
Ludwigia	0.52
Sagittaria	0.49

Table 7. Estimates of site occupancy in 2014, 2015, and 2016 by fountain darters in the Comal River from multiple season occupancy modeling, as well as naïve occupancy (proportion of sites observed occupied) for comparison.

Sample	MODEL Ψ	NAÏVE Ψ
2014	0.93	0.70
2015	0.92	0.52
2016	1.00	0.58

Changes in habitat characteristics of sites (i.e. vegetation type over the years 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. 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 is high and does not appear to be changing in the Comal system at the present time. Continued monitoring will allow more confident inferences to be made from these data in the future.

Visual Observations

Fountain darters were again observed in the deepest portions of Landa Lake (depths greater than 2 m) during both 2016 sampling events. Such utilization of deeper habitats within Landa Lake by fountain darters has been well documented in all flow conditions observed to date. Specifically, fountain darters have been observed in the deepest portions of Landa Lake during every SCUBA survey conducted since the adoption of this methodology in summer 2001. Bryophyte coverage and fountain darter visual observations rebounded well in spring 2016 after the late 2015 flood event that scoured out 90% of the bryophyte coverage. In spring 2016 bryophyte coverage jumped to 100% with 73 darters being observed. This is up substantially from the 15 fountain darters observed in late 2015. During the fall 2016 survey event bryophyte coverage remained at 100% and 65 darters were observed.

Fish Community Sampling

Twenty species of fishes and 4,241 individuals were identified and enumerated among four locations on the Comal River observed in November (Fall) and May (Spring) 2016 (Table 8). Some individuals are only reported to the genus level, since species-level identification is often uncertain based on underwater observations. Texas shiner *Notropis amabilis* was the most abundant species, representing approximately 26% of all fishes encountered. *Gambusia* sp. ranked second in abundance, comprising 22% of all individuals. Fountain darter ranked third with 634 individuals encountered (15% relative abundance). Other abundant taxa included Mexican tetra *Astyanax mexicanus* (6%), *Lepomis* sp. (4%), and Guadalupe roundnose minnow *Dionda nigrotaeniata* (4%). Uncommon species included western mosquitofish *Gambusia affinis* (2 individuals), rock bass *Ambloplites rupestris* (2 individuals), and warmouth *Lepomis gulosus* (5 individuals).

Four years of fish community sampling since 2013 has resulted in enumeration of 56,490 fishes representing 26 distinct species (Table 8). Species richness is similar to the long-term dropnet database (2000-2016) which has identified 165,741 fishes representing 25 species. However, species composition and relative abundance differs between the two methods. Although *Gambusia* sp. and fountain darters are the dominant taxa within each dataset, the fish community sampling data has a much higher relative abundance of Cyprinidae (11% vs. 1%), Centrarchidae (7% vs. 3%), and Characidae (3% vs. <0.5%) than the dropnet dataset. Seining and visual observation are more effective at enumerating these groups of fishes which are highly mobile and less susceptible to dropnet capture.

Eight introduced species have been identified based on four years of fish community sampling. Active removal of nonnative blue tilapia and sailfin catfish is occurring as part of ongoing HCP-sponsored activities (SWCA 2016c). However, 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 8. Fishes captured from the Comal River/Springs Ecosystems during dropnet sampling from 2000-2016 and fish community sampling from 2013-2016. Total percent relative abundance (Total %) is reported for the dropnet dataset and the fish community dataset. N= native, I = Introduced.

Family	Scientific Name	Common Name	Status	Drop Net (2000-2016)		Fish Community (2013-2016)					
				Total #	Total %	2013 #	2014 #	2015 #	2016 #	Total #	Total %
Cyprinidae	*Campostoma anomalum*	Central Stoneroller	N	1	0.00	0	0	0	0	0	0.00
	Cyprinella lutrensis	Red Shiner	N	0	0.00	1	0	0	0	1	0.00
	Cyprinella venusta	Blacktail Shiner	N	0	0.00	7	3	0	21	31	0.05
	Dionda nigrotaeniata	Guadalupe Roundnose Minnow	N	1,074	0.65	1298	372	257	181	2108	3.73
	Notropis amabilis	Texas Shiner	N	331	0.20	1357	544	416	1101	3418	6.05
	Notropis volucellus	Mimic Shiner	N	34	0.02	34	273	13	71	391	0.69
	Pimephales vigilax	Bullhead Minnow	N	4	0.00	0	0	0	0	0	0.00
Characidae	*Astyanax mexicanus*	Mexican Tetra	I	440	0.27	382	766	249	248	1645	2.91
Ictaluridae	*Ameiurus melas*	Black Bullhead	N	1	0.00	0	0	0	0	0	0.00
	Ameiurus natalis	Yellow Bullhead	N	115	0.07	0	0	7	0	7	0.01
	Ictalurus punctatus	Channel Catfish	N	0	0.00	1	6	5	0	12	0.02
Loricariidae	*Pterygoplichthys* sp.	Sailfin Catfish	I	89	0.05	6	8	11	8	33	0.06
Poeciliidae	*Gambusia affinis*	Western Mosquitofish	N	0	0.00	14	376	168	2	560	0.99
	Gambusia geiseri	Largespring Gambusia	N	0	0.00	514	249	122	137	1022	1.81
	Gambusia sp.	Mosquitofish	N	128,988	77.83	18266	11087	5549	942	35844	63.45
	Poecilia latipinna	Sailfin Molly	I	4,709	2.84	144	31	27	0	202	0.36
Centrarchidae	*Ambloplites rupestris*	Rock Bass	I	24	0.01	3	3	4	2	12	0.02
	Lepomis auritus	Redbreast Sunfish	I	146	0.09	179	268	290	114	851	1.51
	Lepomis cyanellus	Green Sunfish	N	45	0.03	4	0	6	24	34	0.06
	Lepomis gulosus	Warmouth	N	35	0.02	1	17	5	5	28	0.05
	Lepomis macrochirus	Bluegill	N	253	0.15	44	194	106	14	358	0.63
	Lepomis megalotis	Longear Sunfish	N	261	0.16	37	33	38	40	148	0.26
	Lepomis microlophus	Redear Sunfish	N	2	0.00	0	2	0	0	2	0.00
	Lepomis miniatus	Redspotted Sunfish	N	2,250	1.36	131	84	100	50	365	0.65
	Lepomis sp.	Sunfish	N/I	836	0.50	296	356	369	185	1206	2.13
	Micropterus dolomieu	Smallmouth Bass	I	0	0.00	0	1	0	0	1	0.00
	Micropterus punctulatus	Spotted Bass	N	3	0.00	0	0	0	0	0	0.00
	Micropterus salmoides	Largemouth Bass	N	450	0.27	359	266	146	137	908	1.61
Percidae	*Etheostoma fonticola*	Fountain Darter	N	24,809	14.97	1474	1808	1177	634	5093	9.02
	Etheostoma lepidum	Greenthroat Darter	N	61	0.04	23	277	128	135	563	1.00
	Etheostoma sp.	Unidentified darter	N	0	0.00	0	504	232	100	836	1.48
Cichlidae	*Herichthys cyanoguttatus*	Rio Grande Cichlid	I	713	0.43	296	217	69	31	613	1.09
	Oreochromis aureus	Blue Tilapia	I	67	0.04	117	19	3	59	198	0.35
Total				165,741		24,988	17,764	9,497	4,241	56,490	

Comal Springs Salamander Visual Observations

Biologists conducted spring and fall presence/absence surveys for the Comal Springs salamander in the Comal system in 2016. Unlike previous years, there were no critical period surveys for the Comal Springs salamander. However, in late 2015 there was a high-flow critical period event that triggered a survey. Much like 2015, the Comal River had increased total system discharge in 2016 resulting in more available surface habitat for the salamanders. High flow also increases interstitial spaces between rock substrate (e.g. gravel and cobble) by scouring excess silt and allowing salamanders to forage for prey as well as use the spaces for refuge (Chippindale et al. 1993). All three sampling locations had continual water flow throughout the year, resulting in a high number of observations. In fact, 2016 had the most Comal Springs salamander observations to date (2001-2016) and the fall sampling event had the highest observations of salamanders in a single sampling event (Table 9). This represents more than double the observations seen in 2013 and 2014 and triple the observations in 2015 (BIO-WEST 2016a). Even though 2015 had relatively high flows, the data suggests that recruitment was still lacking or potentially the salamanders were utilizing the subsurface spaces of the aquifer.

Table 9. Total salamander observations for spring and fall routine sampling 2016.

2016 Sampling Event	Spring Run 1	Spring Run 3	Spring Island Run	Spring Island Outfall	**Total**
Spring	10	24	6	8	**48**
Fall	28	38	18	28	**112**
Total	**38**	**62**	**24**	**36**	**160**

In fall 2016, the number of salamanders observed exceeded the long-term sampling average (2001-2016) in all of the sampling locations (Figure 29). Salamanders were observed below the average during the spring sampling event in Spring Run 1 and Spring Island Outfall reaches. Spring Run 3 had the highest number of salamander observations (Figure 29) in 2016, which is similar to previous years when compared to the other reaches. Spring Run 3 has continually maintained higher flows relative to the other sampling locations and this may be due to several spring heads and fissures along the reach adding additional water flow. Spring Island Spring Run (Spring Run 6) was above the long-term average and higher than previous years (Figure 29 and 33). In fact, the fall sampling event yielded the most salamanders observed in the reach during long-term monitoring.

Spring Island East Outfall was below the long-term average during the spring 2016 sampling, although observations tripled in the fall (Figure 34). Historically, this reach is relatively covered in a high abundance of bryophytes and had high human traffic (i.e., swimmers and waders). Spring Run 1 salamander observations were below the average during spring but rebounded in fall (Figure 31). Low observations during the spring sampling could likely be attributed to habitat alterations (see BIO-WEST 2015a) and severe drought effects during the previous monitoring years. High flows and sufficient time to restore suitable habitat have likely led to salamanders repopulating these locations as indicated by the 2016 data (Figure 29).

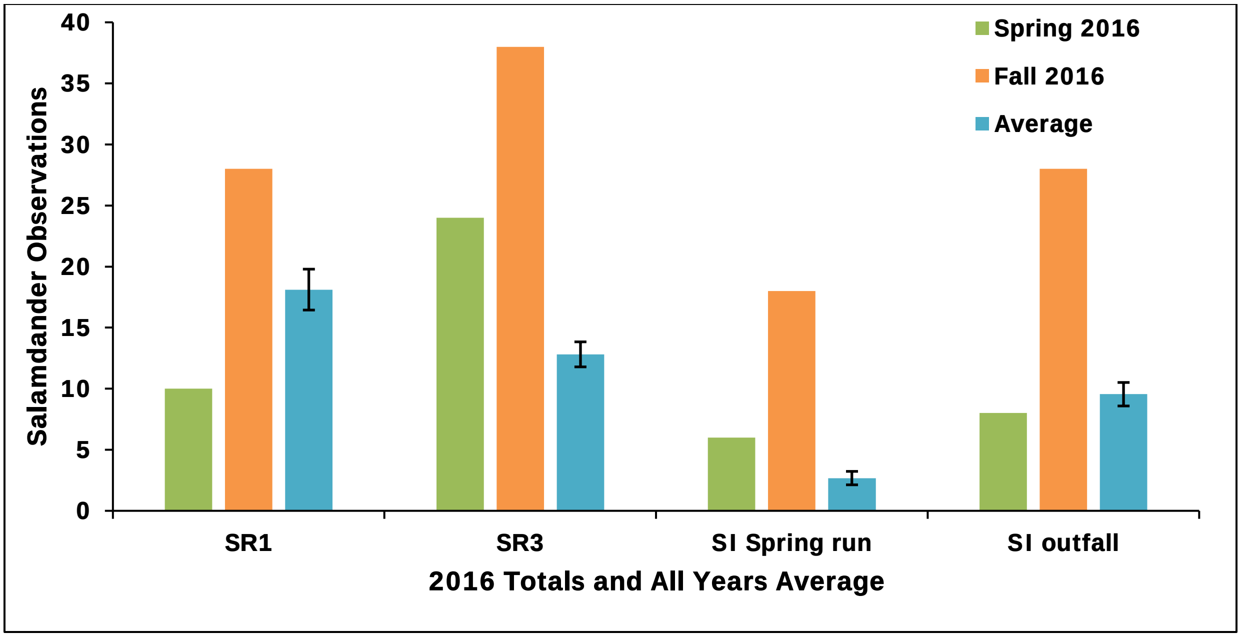


Figure 29. **Total salamander observations for spring and fall 2016 in each reach with the long-term average in blue. Long-term study averages are provided with bars representing one standard deviation from the mean.**

Figure 30. **Photographs showing flow cessation of Spring Run 6 at Spring Island; left photograph was taken September 17, 2014, and resurgent springflow; right photograph on October 19, 2016. Photographs are of the lower portion of Spring Run 6 with view towards the southeast.**

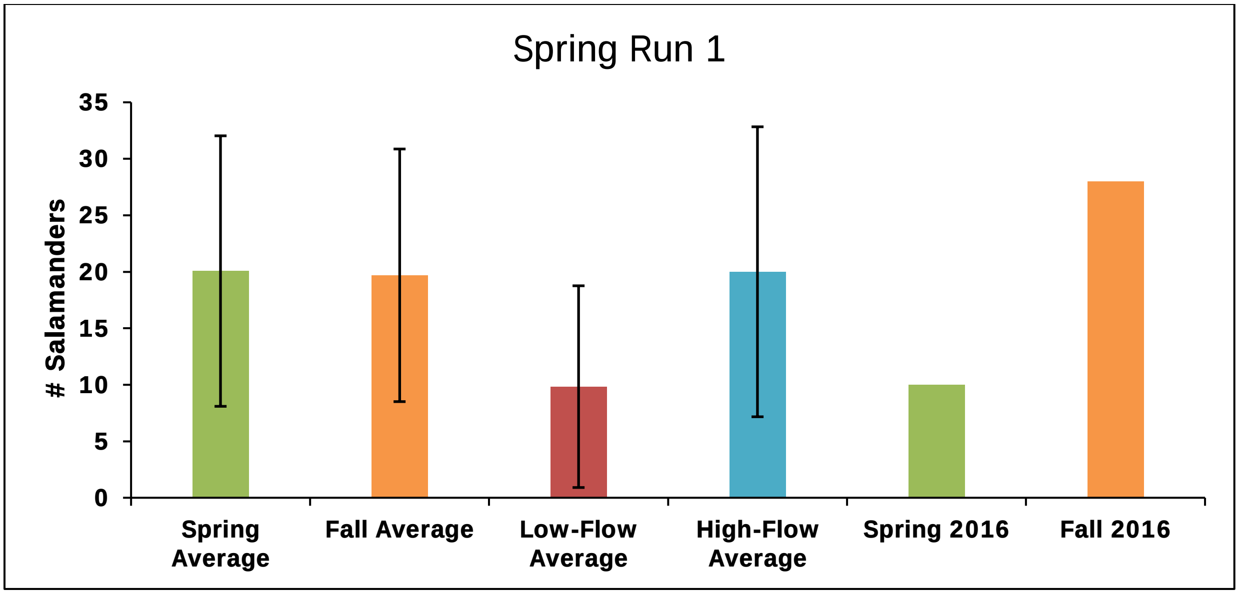


Figure 31. **Salamander observations at Spring Run 1 in 2016, with the long-term average for each sampling event. Long-term study averages are provided with bars representing one standard deviation from the mean.**

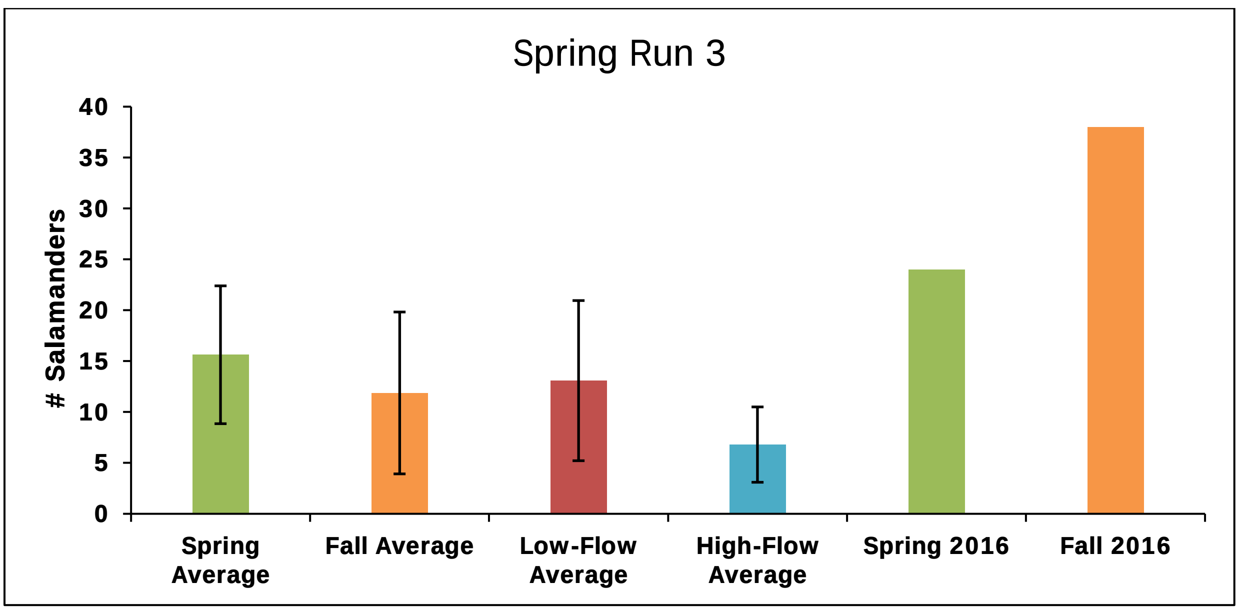


Figure 32. **Salamander observations at the Spring Run 3 in 2016, with the long-term average for each sampling event. Long-term study averages are provided with bars representing one standard deviation from the mean.**

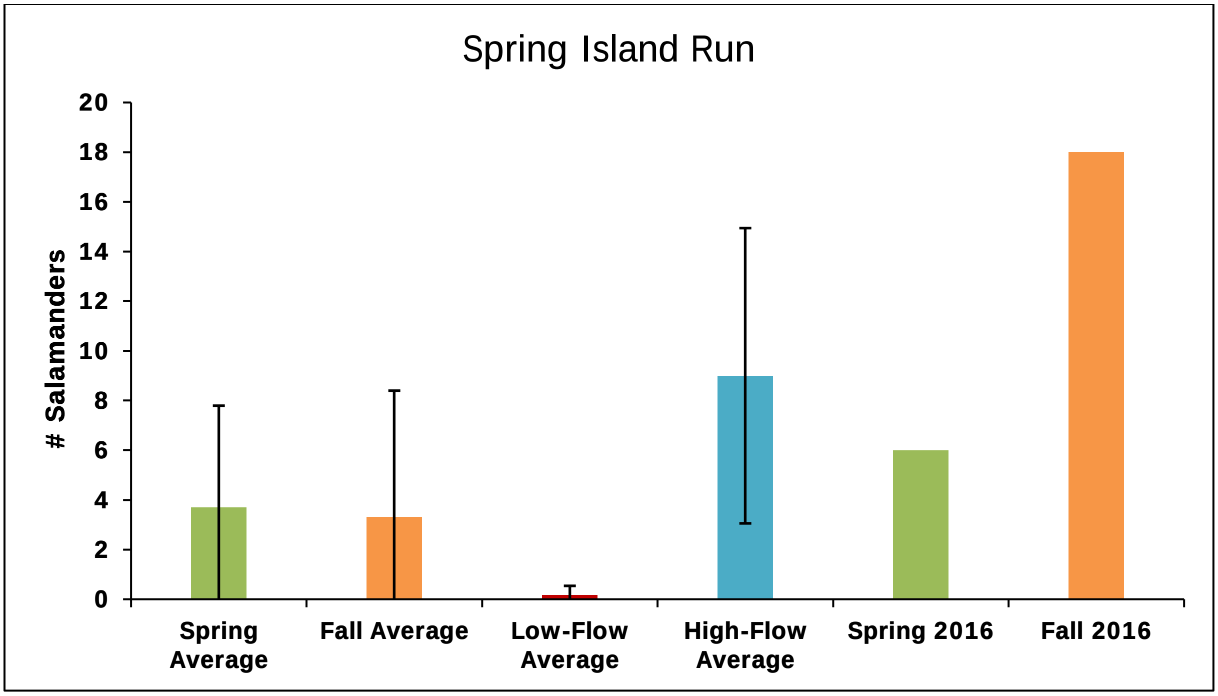


Figure 33. Salamander observations at the Spring Island Spring Run (Spring Run 6) in 2016, with the long-term average for each sampling event. Long-term study averages are provided with bars representing one standard deviation from the mean.

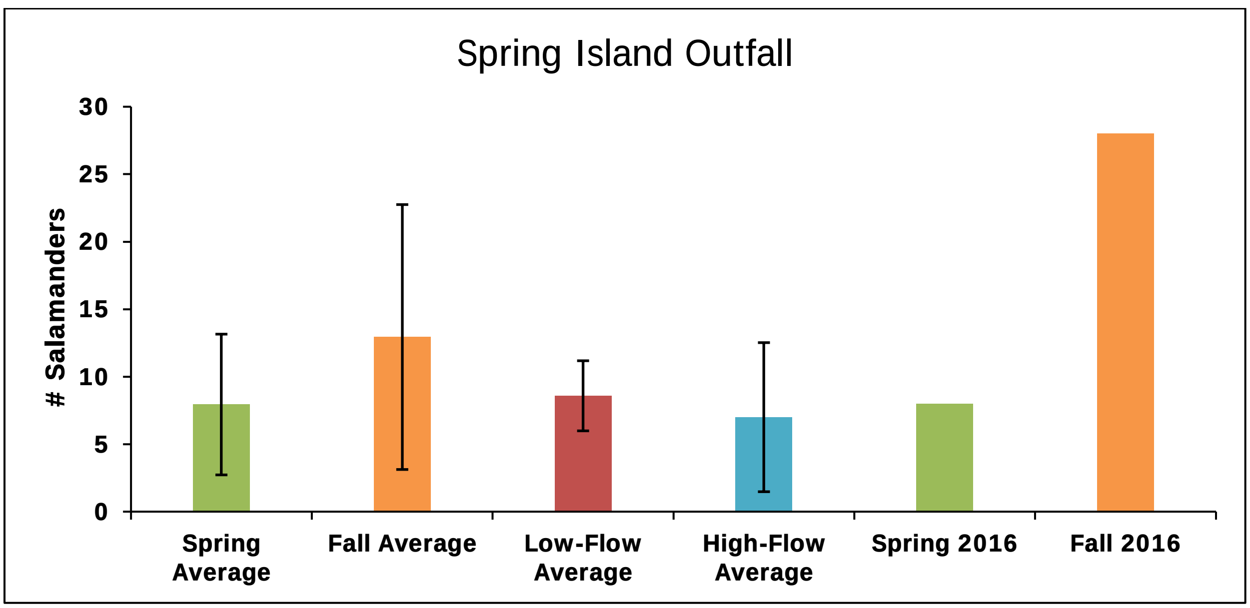


Figure 34. Salamander observations at the Spring Island East Outfall in 2016, with the long-term average for each sampling event. Long-term study averages are provided with bars representing one standard deviation from the mean.

Comal Invertebrate Sampling

Both drift net and cotton lure sampling were used to assess population dynamics and habitat requirements of federally listed Comal invertebrate species in 2016. Drift net sampling was conducted around spring openings at three sites (Figure 2) in the fall and spring, and cotton lures were deployed and collected three times within the three study reaches.

Drift Net Sampling

Water quality and current velocity data associated with each 2016 drift net sampling event are presented in Table 10. Water quality conditions show little variation among springs and sampling events.

In 2016, groundwater invertebrates collected during drift net sampling efforts were of relatively high abundance (total n = 1,999) in Spring Run 1 (total n = 486), Spring Run 3 (total n = 483), and an upwelling along the Western Shoreline of Landa Lake (Spring 7, total n = 1,030) (Table 11). Across all sites, *Stygobromus* species were the most commonly captured organisms with *Lirceolus* (isopods) having the second most observations in drift net collections. No adult Comal Springs riffle beetles, and only 10 early-instar larvae were collected in drift net sampling (Table 11). Six Comal Springs dryopid beetles were collected in drift net sampling in 2016 with four being collected from Spring Run 1 and two individuals from Spring Run 3. This represents the first collection of Comal Springs dryopid beetles via drift net in the biological monitoring program since 2011.

No Comal Springs riffle beetles or Comal Springs dryopid beetles were collected at the Western Shoreline site (Spring 7). However, this site did have the greatest number of Peck's Cave amphipods (n=66) and overall organisms captured (n = 1,030) of any of the sites with the majority being *Stygobromus* species.

Table 10. Water quality measurements taken in conjunction with drift net sampling in 2016 at Comal Springs. Values with the exception of current velocity represent the mean of two readings (before and after drift sampling).

PARAMETER [a]	SPRING RUN 1		SPRING RUN 3		SPRING 7	
	May	Oct	May	Oct	May	Oct
Temperature (°C)	23.0	23.0	23.2	23.1	23.7	23.6
Conductivity (µS/cm)	581.1	587.5	574.3	581.5	561.9	576.0
pH	6.8	6.7	6.8	6.7	6.8	6.7
Dissolved Oxygen (mg/L)	5.7	5.8	5.6	5.6	5.3	5.2
Current Velocity (m/s)	0.4	0.5	0.6	0.5	0.1	0.4

[a] C=Celsius, µS/cm=microsiemens per centimeter, mg/L=milligrams per liter, m/s=meters per second.

Table 11. Total numbers of subterranean and endangered species collected at each site during May and October, 2016. Federally endangered species are designated with (E).

	RUN 1	RUN 3	SPRING 7	TOTAL
Total Drift Net Time (hours)	48	48	48	144
TAXA				
Crustaceans				
Amphipoda				
Crangonyctidae				
Stygobromus pecki (E)	15	22	66	103
Stygobromus russelli	3		1	4
Stygobromus spp.	121	115	423	659
All *Stygobromus*	139	137	490	766
Hadziidae				
Mexiweckelia hardeni	36	30	3	69
Sebidae				
Seborgia relicta	11	24	11	46
Bogidiellidae				
Artesia subterranea	1	1		2
Parabogidiella americana				
Ingolfiellidae				
Ingolfiella n. sp	1	5		6
Isopoda				
Asellidae				
Lirceolus spp.	125	126	34	285
Cirolanidae				
Cirolanides texensis	2	3	2	7
Arachnids				
Hydrachnoidea				
Almuerzothyas comalensis	24			24
Insects				
Coleoptera				
Dytiscidae				
Comaldessus stygius	2	10		12
Dryopidae				
Stygoparnus comalensis (E)	4	2		6
Elmidae				
Heterelmis comalensis (E)	2	8		10

Comal Springs Riffle Beetle

There were two sampling efforts in 2016 for Comal Springs riffle beetles. Data presented below summarizes densities of adult Comal Springs riffle beetles from 2016 in the context of the long-term study. Densities on lures in all sampling locations was highly variable in 2016 (Figure 35-37) but exceeded long-term averages for all sampling events at all locations except at Western Shoreline (Figure 36). This was due to the extremely high abundance of riffle beetles along the Western Shoreline in spring 2016 followed by low abundance in the fall 2016 sample. The exact cause of this extreme change is unknown but it is possible that it is correlated with siltation associated with run-off from the adjacent hillside. However, the fall mean was not exceptionally low compared to long-term averages. It is possible that abundance of beetles along the Western Shoreline were exceptionally high in the spring because of higher flows throughout the fall/winter of 2015 into the spring of 2016 or possibly direct results of the ongoing HCP riffle beetle habitat restoration along Spring Run 3 and, the Western shoreline (RPS Final Report, 2016).

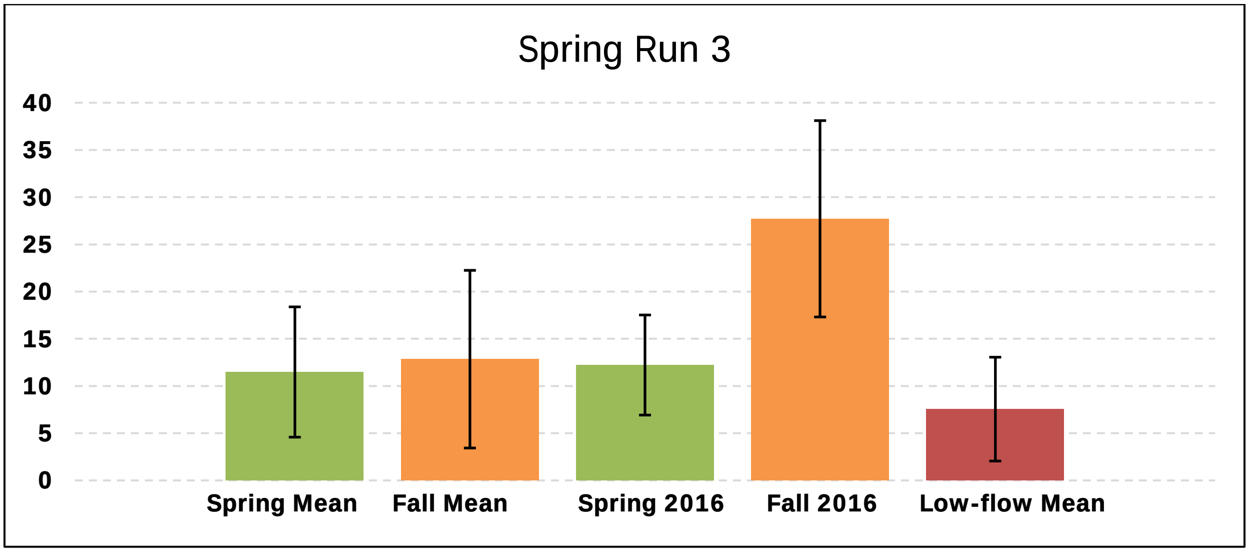


Figure 35. Densities of adult Comal Springs riffle beetles at the Spring Run 3 site during 2016 in the Comal River. Long-term study averages are provided with error bars representing one standard deviation from the mean.

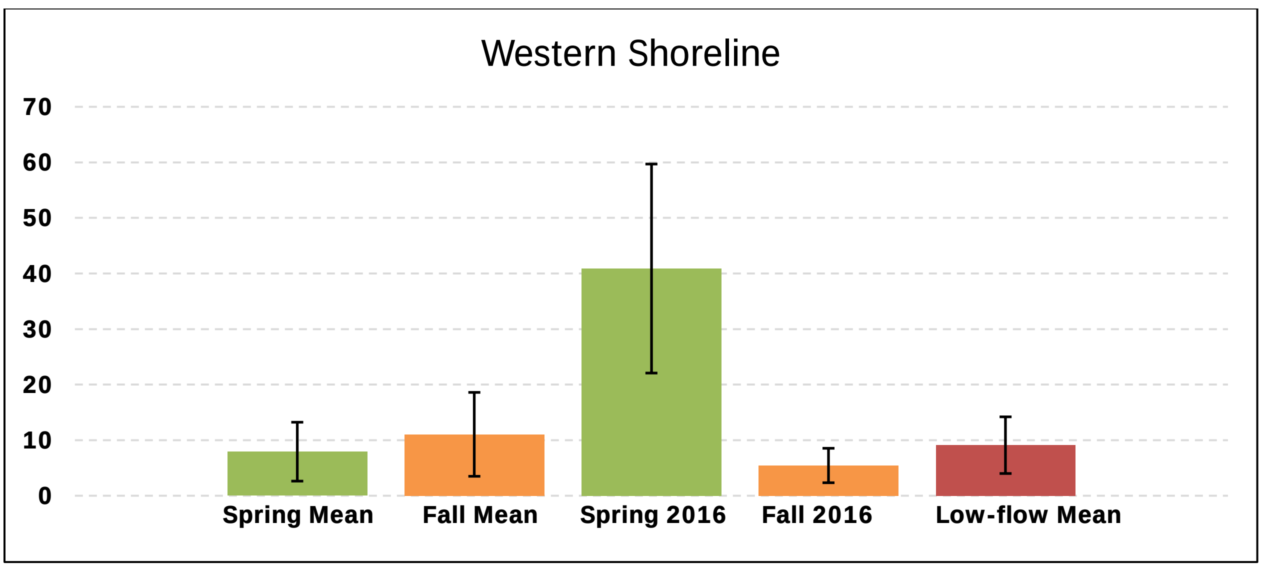


Figure 36. Densities of adult Comal Springs riffle beetles at the Western Shoreline site during 2016 in the Comal River. Long-term study averages are provided with error bars representing one standard deviation from the mean.

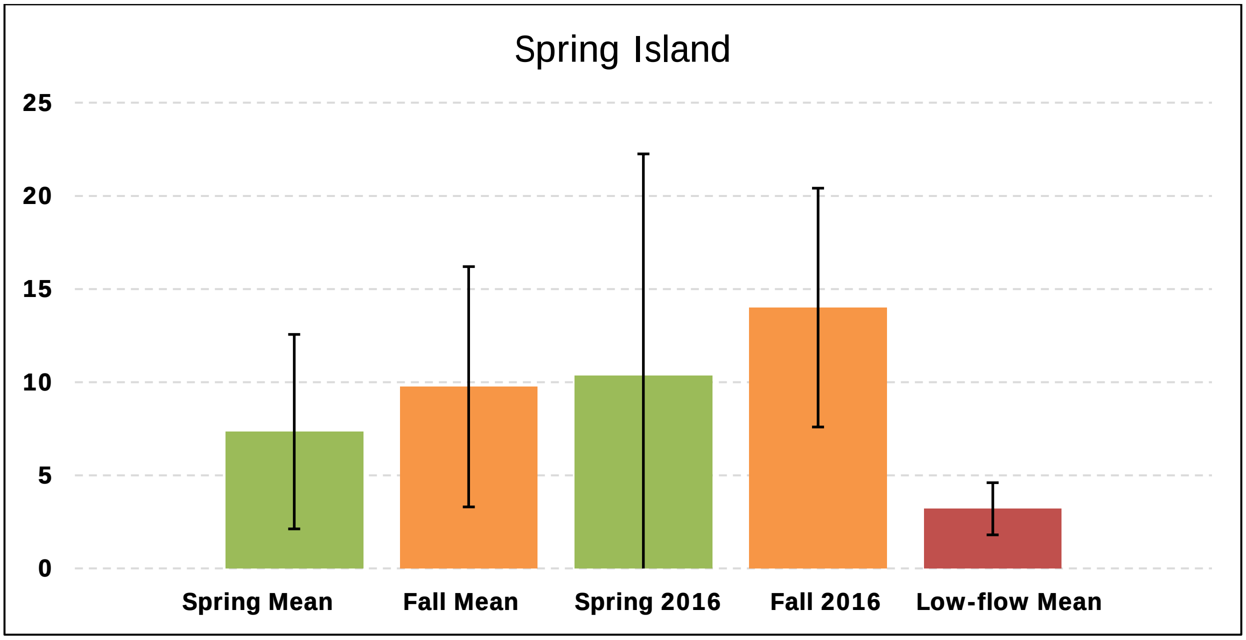


Figure 37. **Densities of adult Comal Springs riffle beetles at the Spring Island site during 2016 in the Comal River. Long-term study averages are provided with error bars representing one standard deviation from the mean.**

Macroinvertebrate Community Sampling

Macroinvertebrate samples collected in 2016 were taken for each dominant vegetation type at each reach (Table 12). In 2016, macroinvertebrate community sampling efforts in the Comal system collected 2,117 organisms during spring, and 1,784 organisms during fall. Total counts include *Cladocera, Euhirundea, Gastropoda, Oligochaeta, Ostracoda*. For spring and fall sampling efforts, the Old Channel Reach had the highest total organism abundance (*n*=1,804, 46%), followed by the Landa Lake Reach (*n*=1,586, 41%), Upper Spring Run Reach (*n*=406, 10%), and the Upper New Channel Reach (*n*=105, 3%) (Table 13).

Table 12. **Dominant vegetation types sampled by reach during 2016 spring and fall comprehensive macroinvertebrate sampling efforts in the Comal system.**

VEGETATION TYPE	LANDA LAKE	UPPER NEW CHANNEL	OLD CHANNEL	UPPER SPRING RUN
Bryophytes	Spring and Fall	not sampled [a]	Spring and Fall	Spring and Fall
Cabomba	Spring and Fall	Spring and Fall	Spring and Fall	not sampled [a]
Hygrophila	not sampled [a]	Fall	not sampled [a]	not sampled [a]
Ludwigia	Spring and Fall	Spring	Spring and Fall	not sampled [a]
Sagittaria	Spring and Fall	not sampled [a]	Spring and Fall	Spring and Fall
Vallisneria	Spring and Fall	not sampled [a]	not sampled [a]	not sampled [a]
Green algae	not sampled [a]	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.

The high relative abundance of macroinvertebrates at the Old Channel Reach is largely due to the large number of snails collected at the site. For combined fall and spring sampling efforts, the Old Channel featured the highest number and second highest relative proportion of snails collected within an individual reach (*n*=1,529, 85%), followed by the Upper New Channel (*n*=74, 71%), Landa Lake (*n*=734, 46%), and the Upper Spring Run reaches (*n*=24, 6%). Indeed, when comparing within reaches for relative abundance of all macroinvertebrates collected *except* for snails, the reach with the highest macroinvertebrate abundance was the Upper Spring Run Reach (*n*=382, 94%), followed by Landa Lake (*n*=852, 54%), Upper New Channel (*n*=31, 30%), and Old Channel reaches (*n*=275, 15%).

Between 2016 spring and fall sampling efforts, organisms were collected from 9 distinct taxonomic orders/classes, 17 distinct families, and 33 taxonomic subfamilies/genera/species from the Comal system (Table 14). *Amphipoda* and *Gastropoda* comprised over 93% of all organisms sampled during spring and fall 2016 (32% [*n*=1,253] and 61% [*n*=2,361], respectively) (Figure 35).

Table 13. Summarized total macroinvertebrate counts and fountain darter prey per reach data from 2016 spring and fall macroinvertebrate collection events in the Comal system.

REACH	NUMBER ORGANISMS COLLECTED	NUMBER ORGANISMS COLLECTED (ALL MACROINVERTEBRATES EXCEPT SNAILS)	Number of FOUNTAIN DARTER PREY ORGANISMS*
Landa Lake	1,586	852	233
Upper New Channel	105	31	837
Old Channel	1,804	275	24
Upper Spring Run	406	382	289
All Sites	3,901	1,540	1,383

* Fountain darter prey organisms include Amphipoda, Diptera, Ephemeroptera, and Trichoptera) (Schenck and Whiteside 1977)

Table 14. 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 SUBFAMILIES/GENERA /SPECIES COLLECTED [b]
Spring	10	18	22
Fall	10	15	25
Total	20	33	33

[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.

The macroinvertebrate data were analyzed for trends in relative abundance of organisms that are representative of fountain darter food sources (e.g., Amphipoda, Diptera, Ephemeroptera, and Trichoptera) (Schenck and Whiteside 1977) (Table 15). The reach with the highest relative abundance of macroinvertebrate prey taxa collected during 2016 spring and fall sampling efforts was the Upper Spring Run (*n*=289, 71%), followed by Landa Lake (*n*=837, 53%), Upper New Channel (*n*=24, 23%), and Old Channel (*n*=233, 13%). It should be noted that because of low water visibility associated with a considerable rain event which caused lingering contributions from Dry Comal creek, no macroinvertebrate sampling was collected in the spring 2016 at the Upper New Channel reach. Taxonomic makeup of organisms in fountain darter prey taxa was fairly consistent between reaches, with Amphipoda comprising a higher proportion of the food source group at all reaches (11 to 69%).

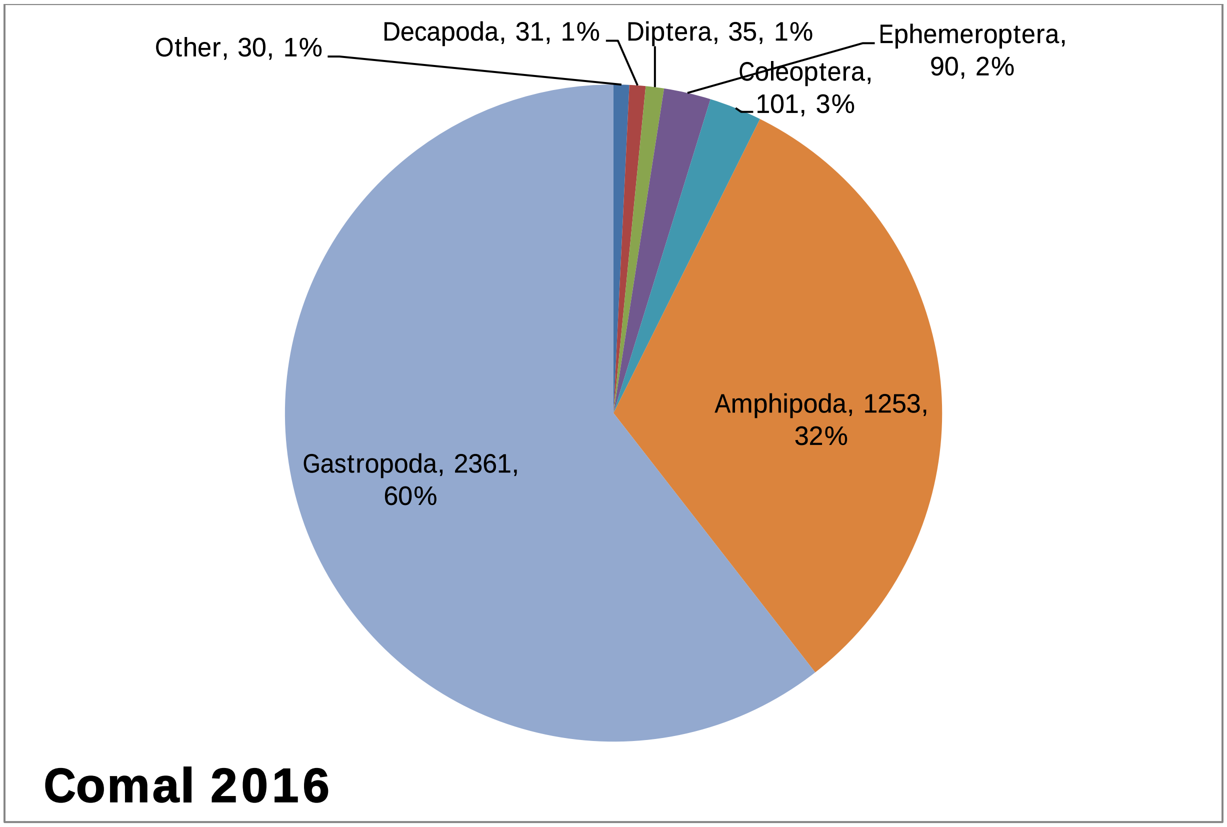


Figure 38. Relative percentage of macroinvertebrate abundance by order/class from combined 2016 spring and fall sampling efforts in the Comal system; data labels show frequency and relative percent abundance of each order/class collected. Includes orders/classes Cladocera, Hirundea, Gastropoda, Oligochaeta, and Ostracoda.

Table 15. 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 Comal system.

Reach	Vegetation	Number of Food Source Organisms Spring 2016[a]	Number of Food Source Organisms Fall 2016[a]	Average Number of Food Source Organisms 2016[c]
Old Channel	*Ludwigia*	46	12	29±24.04, *n*=2
Old Channel	Bryophytes	82	29	55.5±37.48, *n*=2
Old Channel	*Cabomba*	18	13	15.5±3.54, *n*=2
Old Channel	*Sagittaria*	20	13	16.5±4.95, *n*=2
Landa Lake	*Ludwigia*	108	404	256±209.30, *n*=2
Landa Lake	Bryophytes	8	36	22±19.80, *n*=2
Landa Lake	*Cabomba*	47	64	55.5±12.02, *n*=2
Landa Lake	*Sagittaria*	50	13	31.5±26.16, *n*=2
Landa Lake	*Vallisneria*	2	5	3.5±2.12, *n*=2
Upper Spring Run	*Sagittaria*	35	12	23.5±16.26, *n*=2
Upper Spring Run	Bryophytes	Not Sampled[b]	242	N/A, *n*=1
Upper new Channel	*Hygrophila*	Not Sampled[b]	17	N/A, *n*=1
Upper new Channel	*Cabomba*	Not Sampled[b]	7	N/A, *n*=1

[a] Includes only Amphipoda, Diptera, Ephemeroptera, and Trichoptera (Schenk and Whiteside, 1977).
[b] Reach not sampled for this vegetation type during this event.
[c] 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).

CONCLUSION

The HCP Biological Monitoring program activities conducted in 2016 provided insight into the continued transition from a prolonged drought to subsequent average to wet years in the Comal River/Springs ecosystem. In fact, total system discharge remained at or above historical averages for the entirety of 2016. The late 2015 flooding event temporarily impeded habitat recovery, which was noted during spring 2016 sampling. However, by the fall 2016 sampling event, habitat and species conditions were near or at all-time highs. Continued biological monitoring to assess conditions as well as quantify effects (both positive and negative) from mitigation and restoration activities is imperative in telling the dynamic HCP story.

REFERENCES

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. 33p.

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. 35p.

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 River Aquatic Ecosystem 2013 Annual Report. Edwards Aquifer Authority. 92 p. plus Appendices.

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

BIO-WEST 2014c. Fountain darter movement under low-flow conditions in the Comal Springs/River Ecosystem. Edwards Aquifer Authority.

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

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

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

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

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

BIO-WEST 2016c. 2015 Native Aquatic Vegetation Restoration in Landa Lake and Old Channel of the Comal River. November 9, 2016. Prepared for City of New Braunfels, TX, 44pp.

BIO-WEST 2017. Habitat Conservation Plan Biological Monitoring Program. San Marcos River Aquatic Ecosystem 2016 Annual Report. Edwards Aquifer Authority. In Press.

Chippindale, P.T., A.H. Price and D.M. Hillis. 1993. A new species of perennibranchiate salamander (*Eurycea*: Plethodontidae) from Austin, Texas. Herpetologica 49:248–259.

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 (EAA). 2016a. Standard Operating Procedures for the Habitat Conservation Plan (HCP) Biological Monitoring Program for the Comal Springs/River Ecosystem. Revised September 2016. 29pp. + Appendices.

Edwards Aquifer Authority (EAA). 2016b. Water quality monitors. Provisional data retrieved from: http://www.edwardsaquifer.org/aquifer-data-and-maps/water-quality-monitors.

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

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.

RPS. 2016. Final report for riffle beetle habitat restoration Spring Run 3 and Landa Lake shoreline. Prepared for City of New Braunfels, TX, 25pp. plus Appendices.

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. 2016a. Edwards Aquifer Habitat Conservation Plan Draft Expanded Water Quality Monitoring 2016 Annual Report. Edwards Aquifer Authority. DRAFT.

SWCA. 2016b. Landa Lake Dissolved Oxygen Mitigation: 2016 Report. City of New Braunfels, TX. 32 pp. including Appendices

SWCA. 2016c. Final Report For The Invasive Species Removal Project For The City of New Braunfels. City of New Braunfels, TX. 26 pp. plus Appendices

U.S. Geological Survey (USGS). 12/2015. Provisional data for Texas. Location: http://tx.waterdata.usgs.gov/niwis/help/provisional.

APPENDIX A: CRITICAL PERIOD MONITORING SCHEDULES

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

FLOW TRIGGER (+ or - 10 cfs)	**PARAMETER**
200 cfs	Full Sampling Event
150 cfs	Full Sampling Event
120 cfs - 80 cfs	Riffle Beetles and spring discharge - Every 10 cfs decline (maximum weekly)
100 cfs	Full Sampling Event
100 cfs - 50 cfs	Habitat Evaluations - Every 10 cfs decline (maximum weekly)
50 cfs	Full Sampling Event
50 cfs - 0 cfs	Habitat Evaluations - Every 10 cfs decline (maximum weekly)
10 - 0 cfs	Full Sampling Event
RECOVERY	
25 cfs - 100 cfs	Full Sampling Event (dependant on flow stabilization)
100 cfs - 200 cfs	Full Sampling Event (dependant on flow stabilization)

PARAMETER DESCRIPTION

Full Sampling Event	Aquatic Vegetation Mapping Fountain Darter Sampling Drop Net, Dip net (Presence/Absence), and Visual Parasite evaluations Fish Community Sampling Salamander Sampling - Visual Riffle beetle - Cotton lure sampling Fish sampling - Exotics / Predation (100 cfs and below) Water Quality - Suite I and Suite II Flow partitioning - Landa Lake
Riffle Beetle Monitoring	Spring Discharge and wetted perimeter measurements
Habitat Evaluations	Photographs

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

Flow Rate (+ or - 5 cfs)	**Species**	**Frequency**	**Parameter**
≤150 or ≥80 cfs	fountain darter	every other month	Aquatic vegetation mapping to include Upper Spring Run reach, Landa Lake, Old Channel reach, and New Channel reach
≤150 or ≥80 cfs	fountain darter	every other month	Conduct Dip net sampling/visual parasite evaluations at five (5) sites in the Upper Spring Reach; twenty (20) sites in Landa Lake; twenty (20) sites in the Old Channel reach and; at five (5) sites in the New Channel reach.
≤60 cfs	fountain darter	weekly	Conduct Dip net sampling/visual parasite evaluations at five (5) sites in the Upper Spring Reach; twenty (20) sites in Landa Lake; twenty (20) sites in the Old Channel reach and; at five (5) sites in the New Channel reach.
≤60 cfs	fountain darter	monthly	Aquatic vegetation mapping at Upper Spring Run reach, Landa Lake, Old Channel reach, and New Channel reach
≤120 cfs	riffle beetle	every 2 weeks	Monitoring via cotton lures at Spring Run 3, western shore of Landa Lake, and Spring Island upwelling
≤120 cfs or ≥80 cfs	salamander	every other week	Salamander snorkel surveys will be conducted at three sites (Spring Runs 1 and 3 and the Spring Island area)
≤80 cfs	salamander	weekly	Salamander snorkel surveys will be conducted at three sites (Spring Runs 1 and 3 and the Spring Island area)

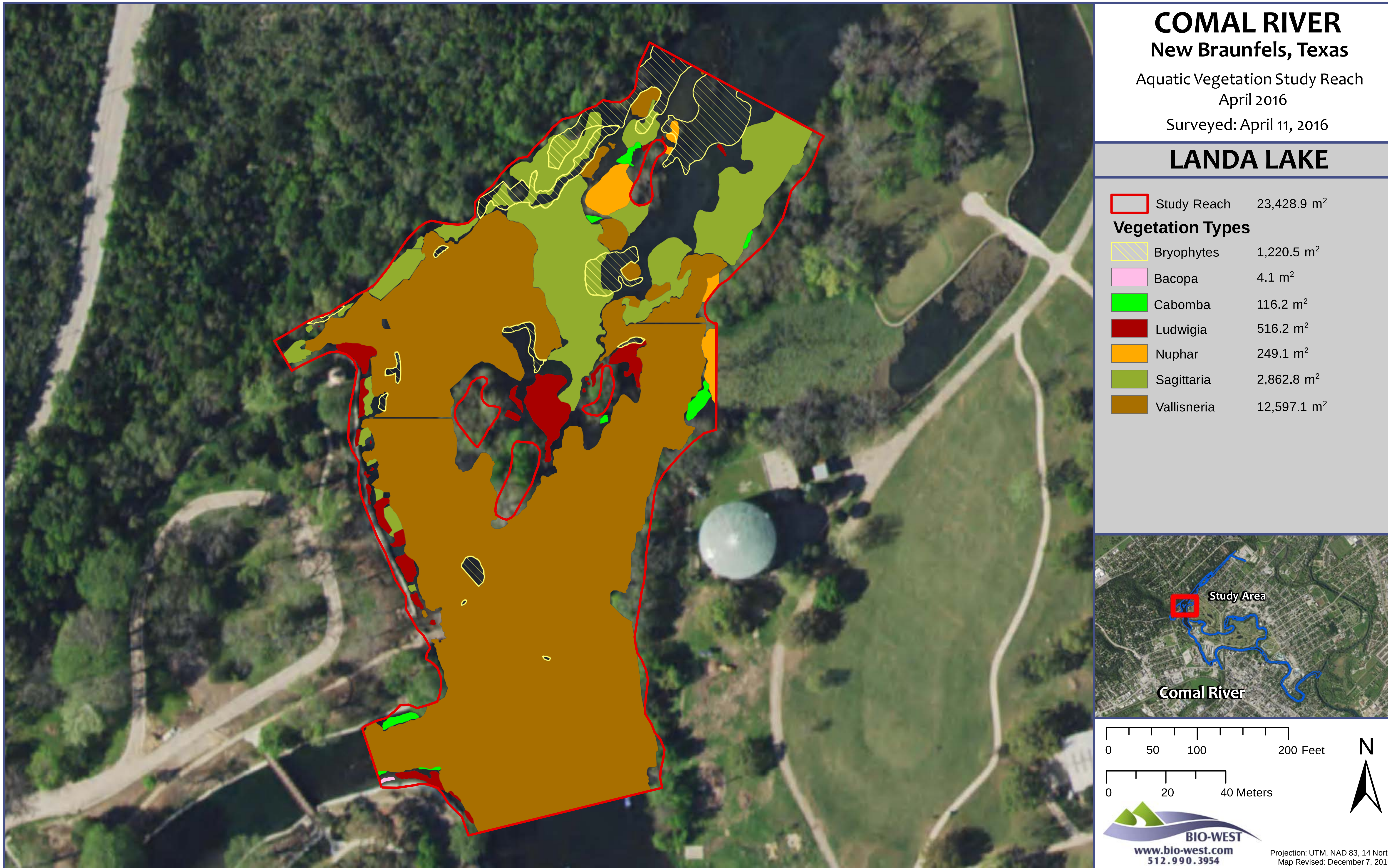
APPENDIX B: AQUATIC VEGETATION MAPS

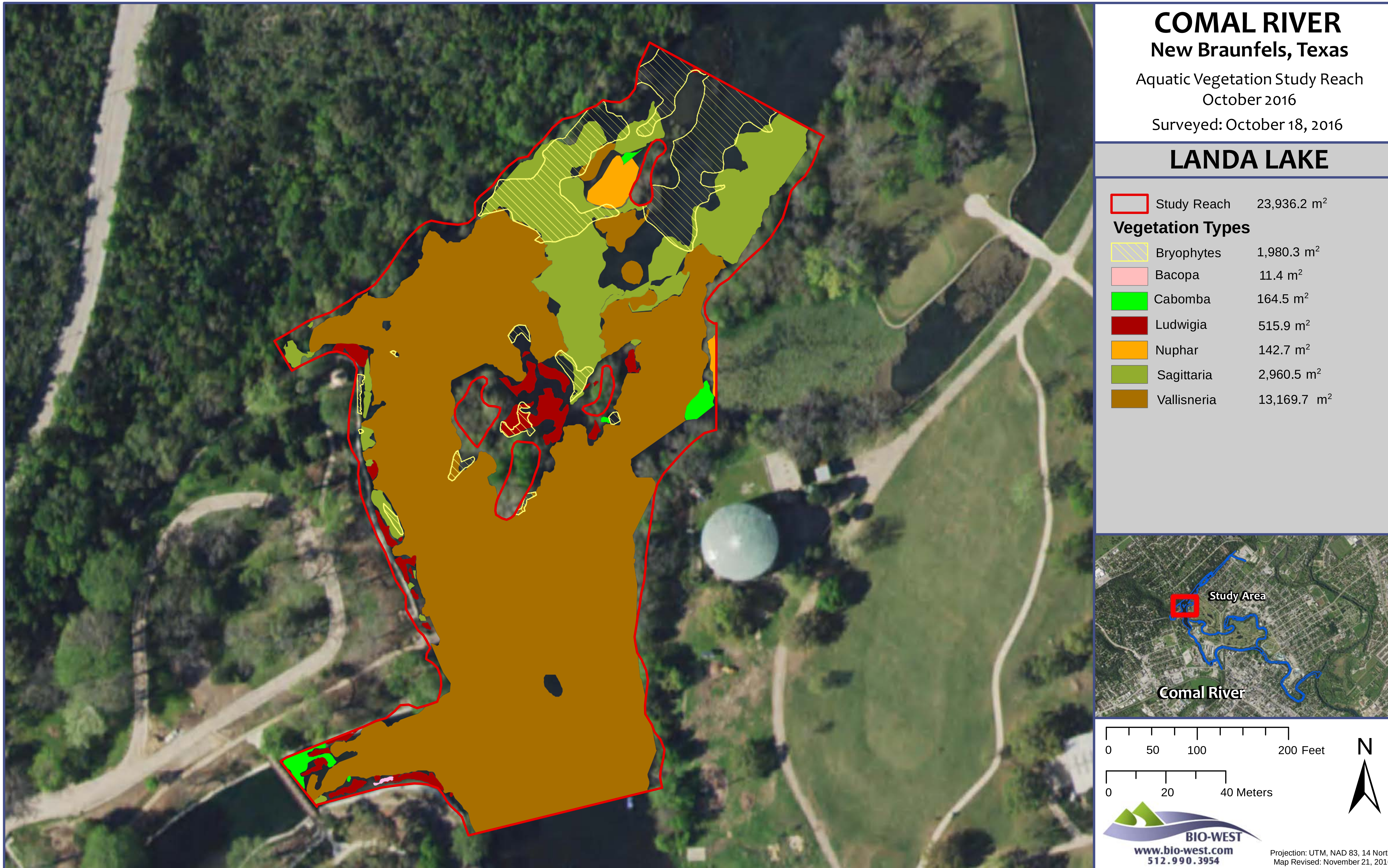
Upper Spring Run Reach


COMAL RIVER
New Braunfels, Texas
Aquatic Vegetation Study Reach
April 2016
Surveyed: April 14, 2016
UPPER SPRING RUN
Study Reach 4,835.4 m²
Vegetation Types
Bryophytes 749.5 m²
Green Algae 20.2 m²
Cabomba 2.5 m²
Chara 105.8 m²
Ludwigia 10.1 m²
Sagittaria 1,075.2 m²
Study Area
Comal River
0 25 50 100 Feet
0 10 20 Meters
N
BIO-WEST
www.bio-west.com
512.990.3954
Projection: UTM, NAD 83, 14 North
Map Revised: December 7, 2016

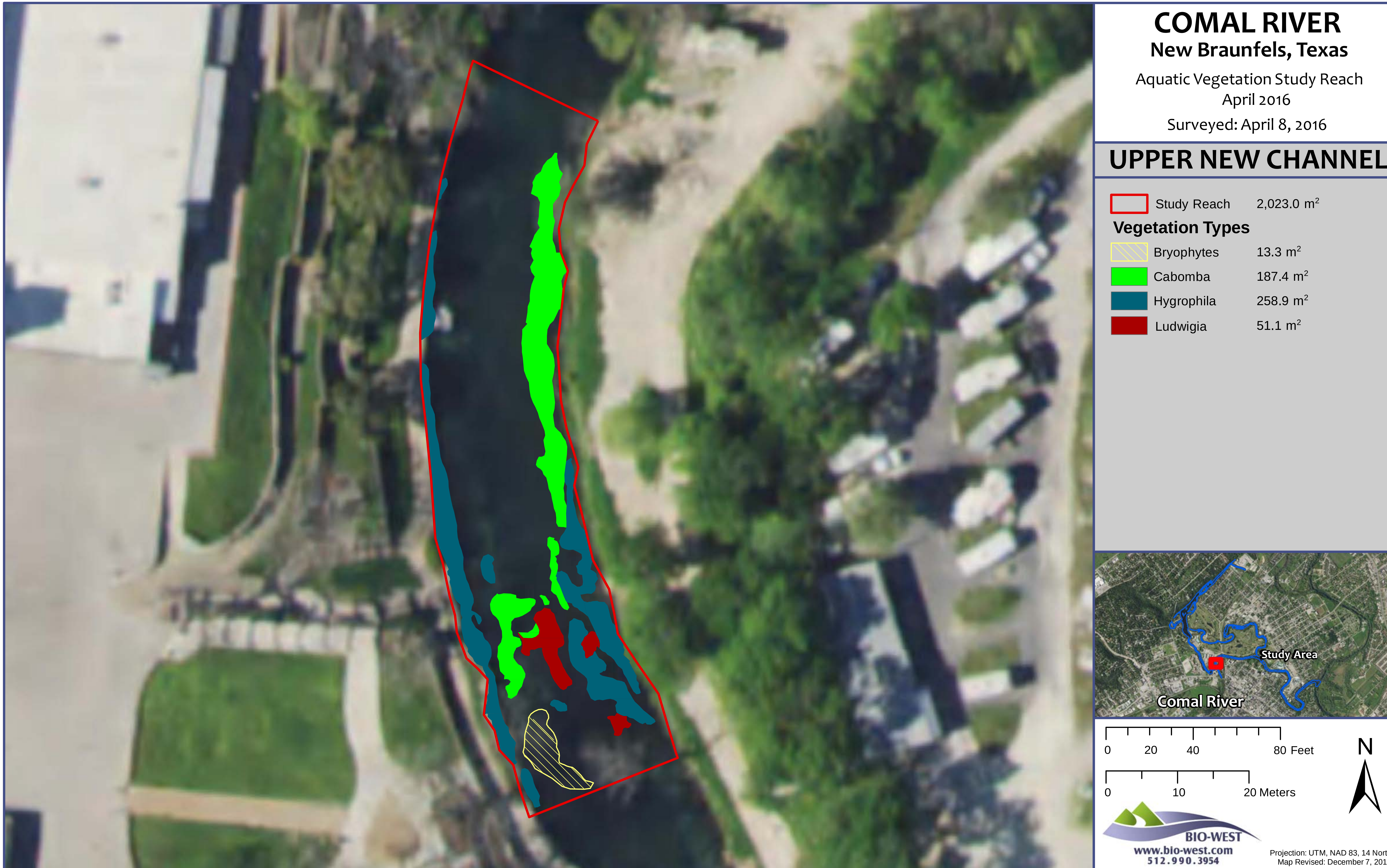

COMAL RIVER
New Braunfels, Texas
Aquatic Vegetation Study Reach
October 2016
Surveyed: October 19, 2016
UPPER SPRING RUN
Study Reach 4,835.4 m2
Vegetation Types
Bryophytes 681.4 m2
Green Algae 16.2 m2
Sagittaria 850.1 m2
Cabomba 8.6 m2
Ludwigia 53.8 m2
Study Area
Comal River
0 25 50 100 Feet
0 10 20 Meters
N
BIO-WEST
www.bio-west.com
512.990.3954
Projection: UTM, NAD 83, 14 North
Map Revised: November 21, 2016

Landa Lake Reach


COMAL RIVER
New Braunfels, Texas
Aquatic Vegetation Study Reach
April 2016
Surveyed: April 11, 2016
LANDA LAKE
Study Reach 23,428.9 m^2
Vegetation Types
Bryophytes 1,220.5 m^2
Bacopa 4.1 m^2
Cabomba 116.2 m^2
Ludwigia 516.2 m^2
Nuphar 249.1 m^2
Sagittaria 2,862.8 m^2
Vallisneria 12,597.1 m^2
Study Area
Comal River
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: December 7, 2016


COMAL RIVER
New Braunfels, Texas
Aquatic Vegetation Study Reach
October 2016
Surveyed: October 18, 2016
LANDA LAKE
Study Reach 23,936.2 m²
Vegetation Types
Bryophytes 1,980.3 m²
Bacopa 11.4 m²
Cabomba 164.5 m²
Ludwigia 515.9 m²
Nuphar 142.7 m²
Sagittaria 2,960.5 m²
Vallisneria 13,169.7 m²
Study Area
Comal River
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

Upper New Channel Reach


COMAL RIVER
New Braunfels, Texas
Aquatic Vegetation Study Reach
April 2016
Surveyed: April 8, 2016
UPPER NEW CHANNEL
Study Reach 2,023.0 m2
Vegetation Types
Bryophytes 13.3 m2
Cabomba 187.4 m2
Hygrophila 258.9 m2
Ludwigia 51.1 m2
Study Area
Comal River
0 20 40 80 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

COMAL RIVER

New Braunfels, Texas

Aquatic Vegetation Study Reach
October 2016

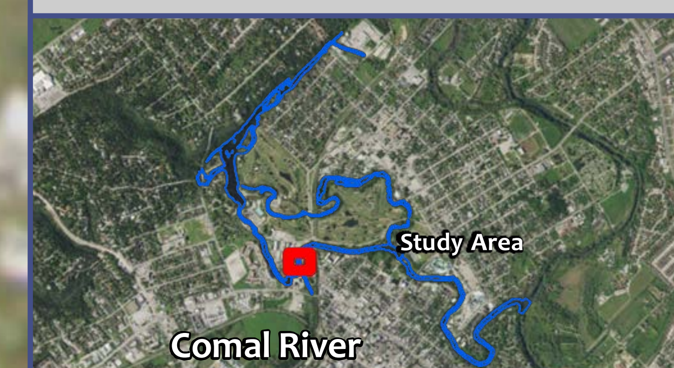
Surveyed: October 25, 2016

UPPER NEW CHANNEL

Study Reach	2,023.0 m²

Vegetation Types

Bryophytes	3.1 m²
Cabomba	33.0 m²
Hygrophila	155.6 m²
Ludwigia	24.5 m²



0 20 40 80 Feet

0 10 20 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

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

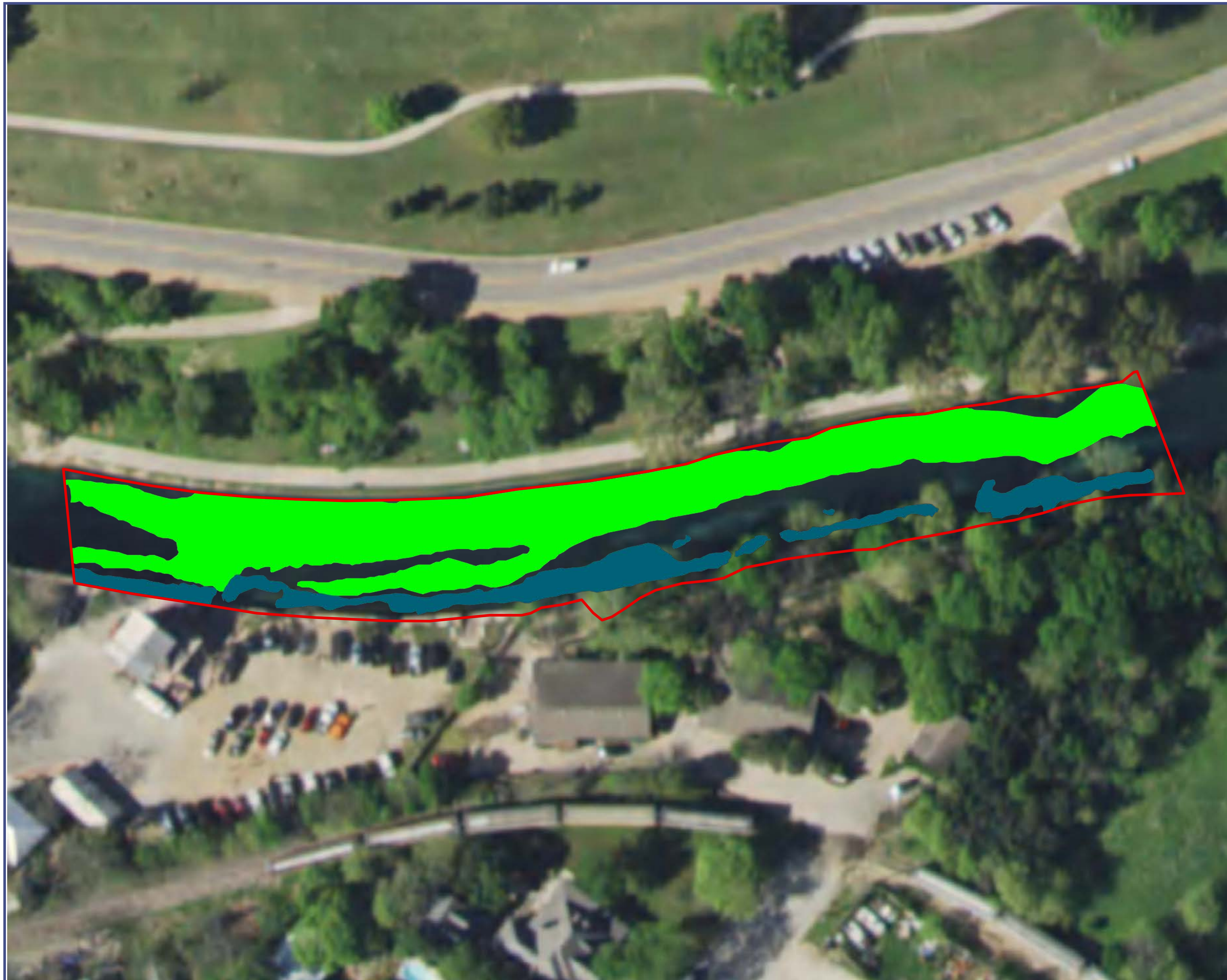
Lower New Channel Reach

COMAL RIVER
New Braunfels, Texas

Aquatic Vegetation Study Reach
April 2016

Surveyed: April 8, 2016

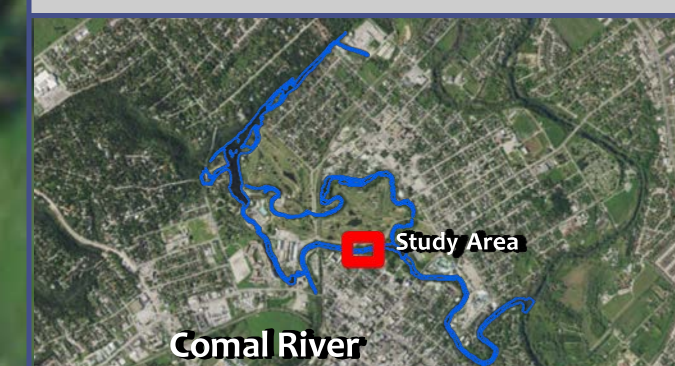
LOWER NEW CHANNEL



Study Reach	4,258.8 m^2

Vegetation Types

Cabomba	1,888.9 m^2
Hygrophila	488.6 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

COMAL RIVER
New Braunfels, Texas

Aquatic Vegetation Study Reach
October 2016

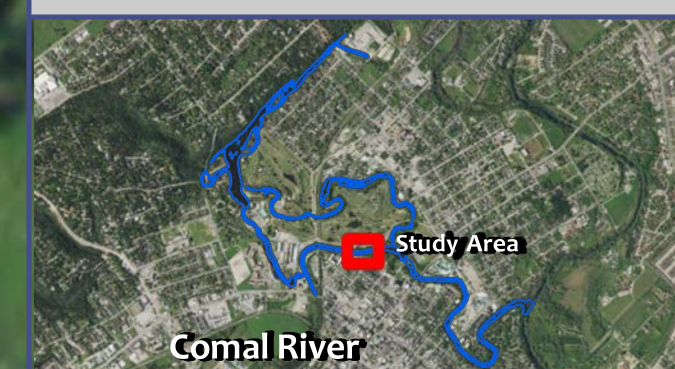
Surveyed: October 25, 2016

LOWER NEW CHANNEL

Study Reach	4,258.8 m^2

Vegetation Types

Cabomba	1,650.4 m^2
Hygrophila	395.1 m^2



0 25 50 100 Feet

0 10 20 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

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

Old Channel Reach

COMAL RIVER

New Braunfels, Texas

Aquatic Vegetation Study Reach
April 2016

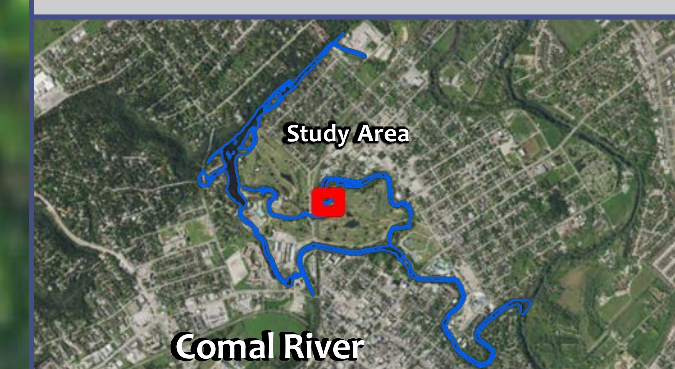
Surveyed: April 8, 2016

OLD CHANNEL

Study Reach	2,797.4 m^2

Vegetation Types

Bryophytes	88.0 m^2
Hygrophila	722.0 m^2
Ludwigia	31.5 m^2
Nuphar	32.6 m^2
Sagittaria	7.3 m^2



0 25 50 100 Feet

0 10 20 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

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

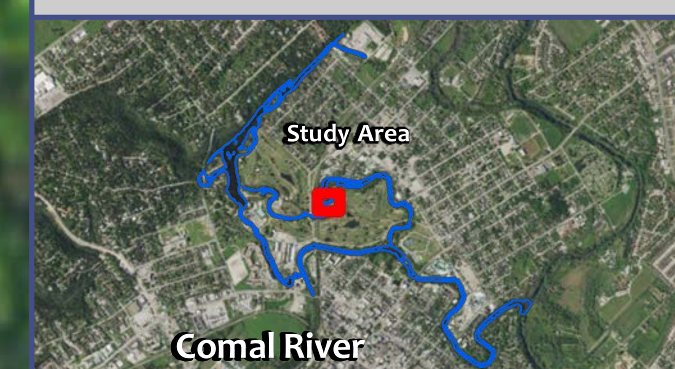
COMAL RIVER
New Braunfels, Texas

Aquatic Vegetation Study Reach
October 2016

Surveyed: October 20, 2016

OLD CHANNEL

Study Reach	2,797.4 m^2
Vegetation Types	
Bryophytes	235.2 m^2
Hygrophila	478.1 m^2
Ludwigia	34.6 m^2
Nuphar	29.8 m^2



0 25 50 100 Feet

0 10 20 Meters

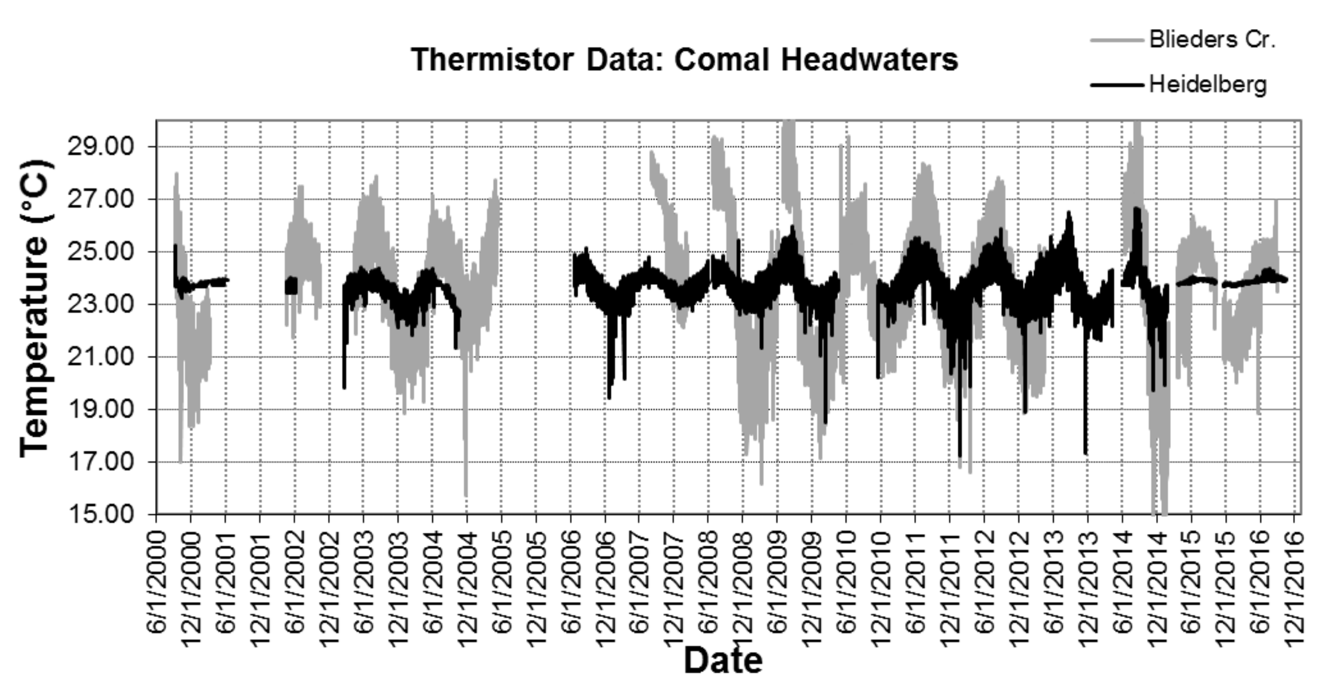
N

BIO-WEST
www.bio-west.com
512.990.3954

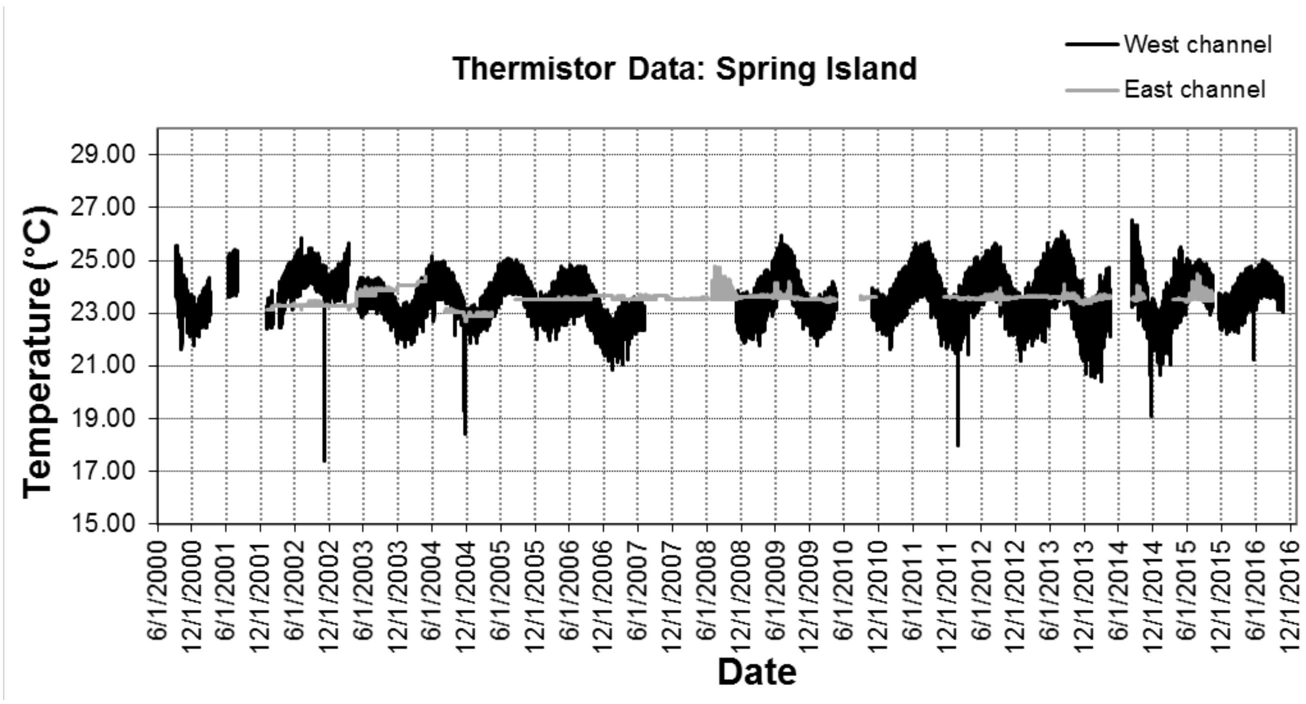
Projection: UTM, NAD 83, 14 North
Map Revised: November 21, 2016

APPENDIX C: DATA AND GRAPHS

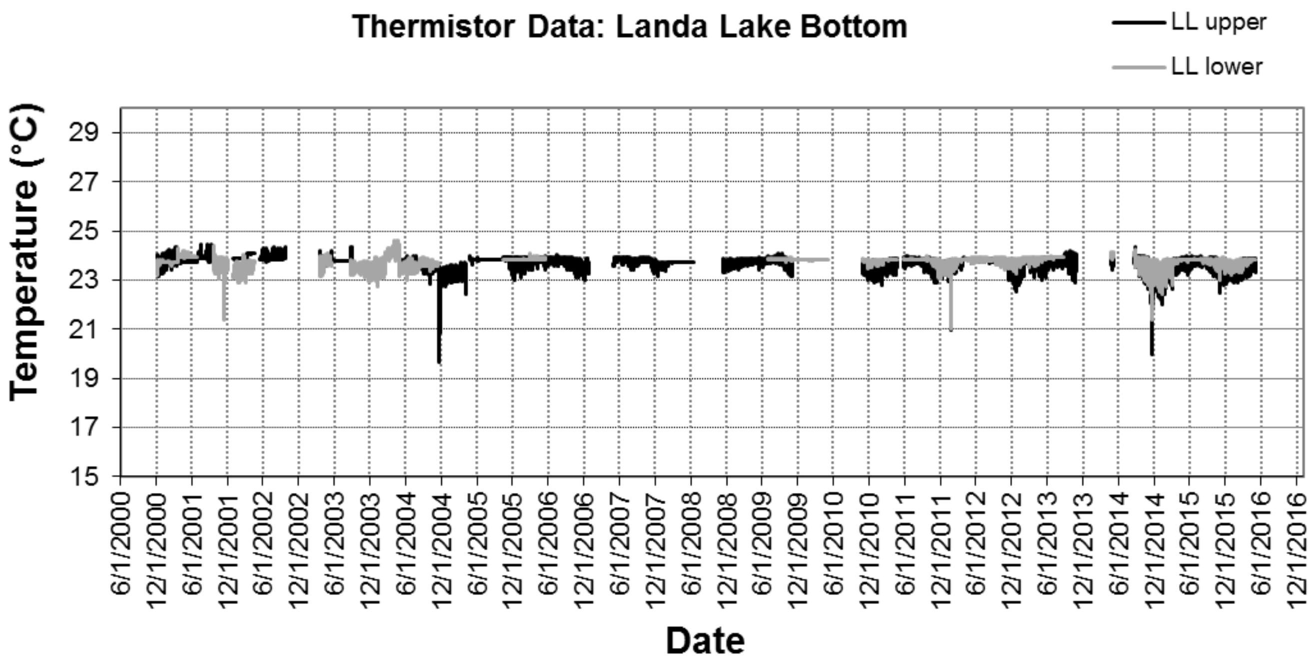
Thermistor Graphs

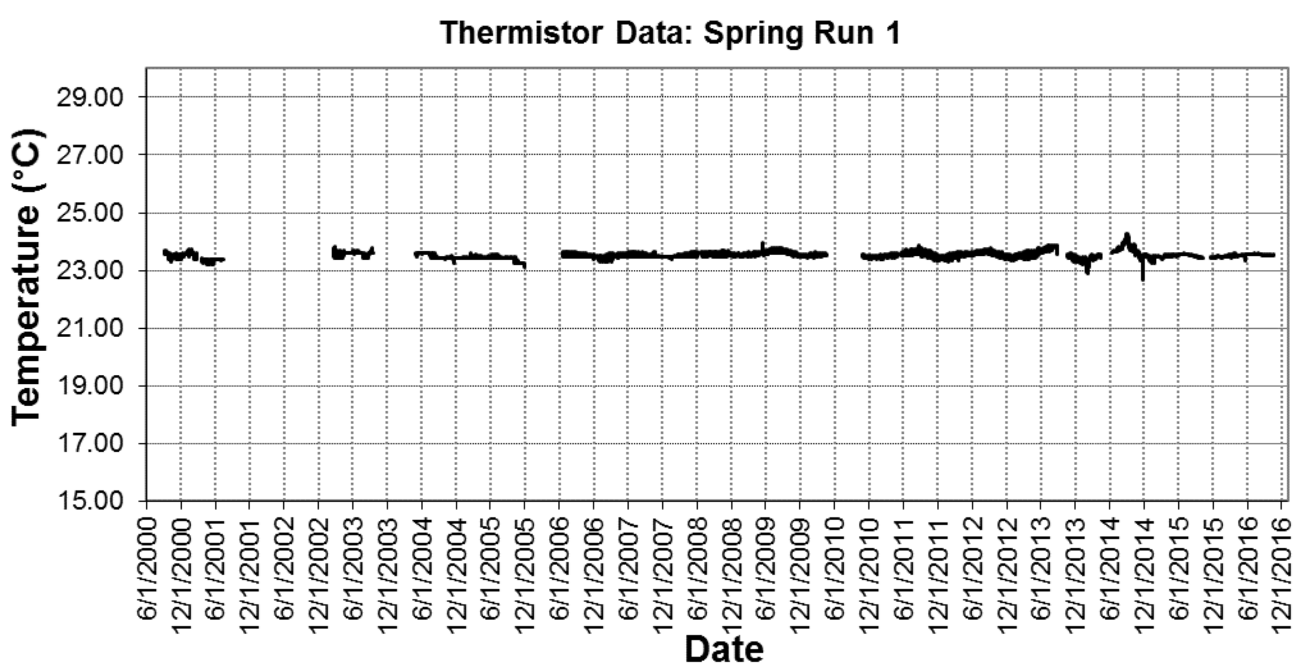


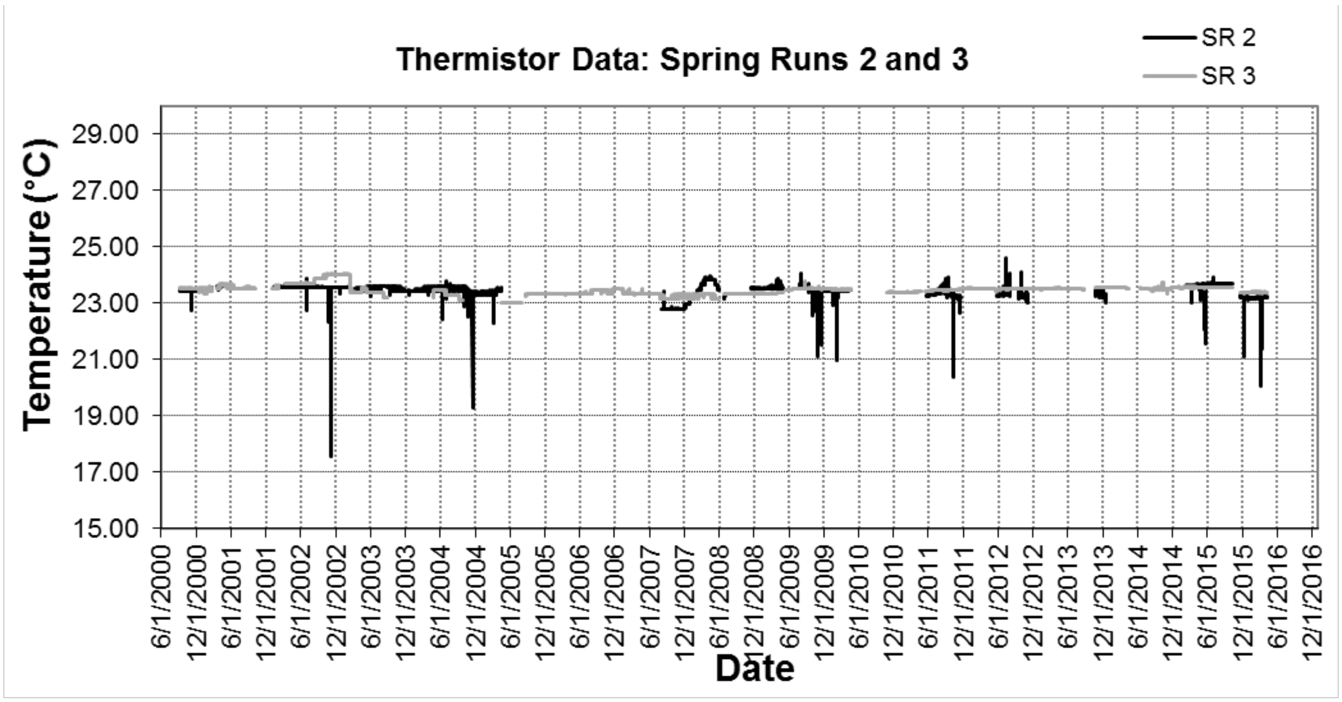
Thermistor Data: Comal Headwaters
Blieders Cr.
Heidelberg
Temperature (°C)
29.00
27.00
25.00
23.00
21.00
19.00
17.00
15.00
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
6/1/2006
12/1/2006
6/1/2007
12/1/2007
6/1/2008
12/1/2008
6/1/2009
12/1/2009
6/1/2010
12/1/2010
6/1/2011
12/1/2011
6/1/2012
12/1/2012
6/1/2013
12/1/2013
6/1/2014
12/1/2014
6/1/2015
12/1/2015
6/1/2016
12/1/2016
Date

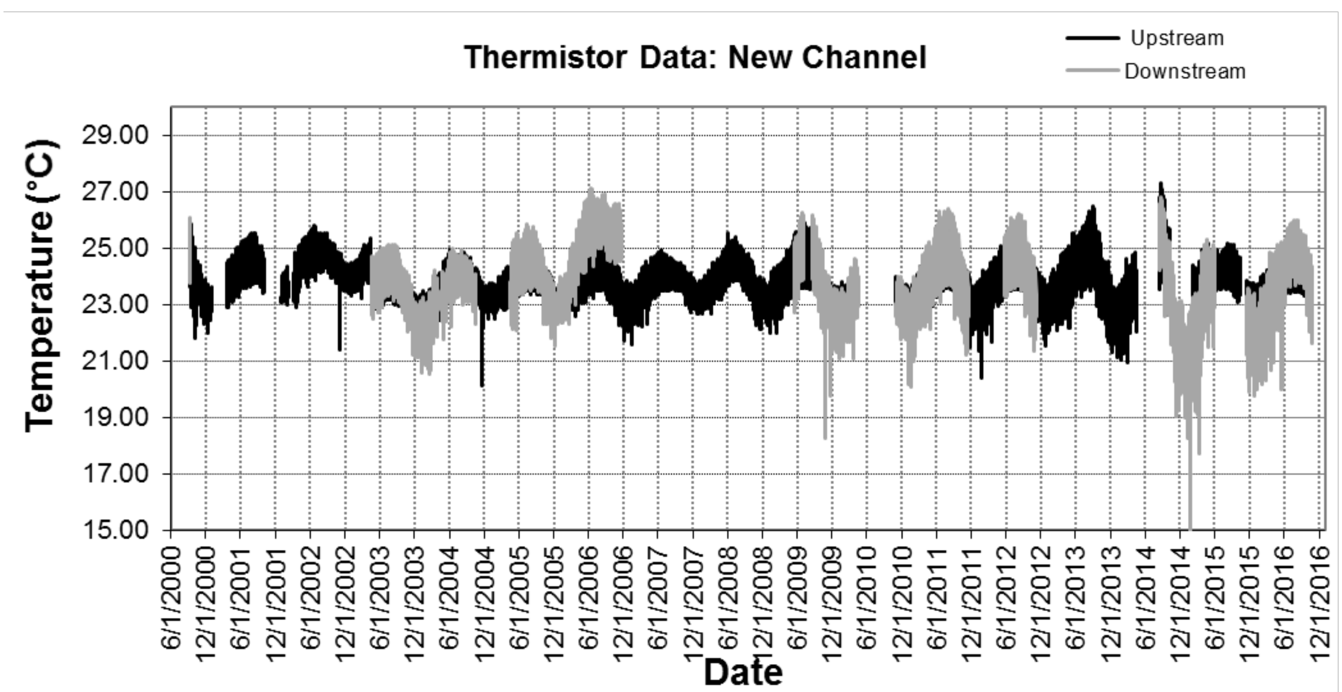


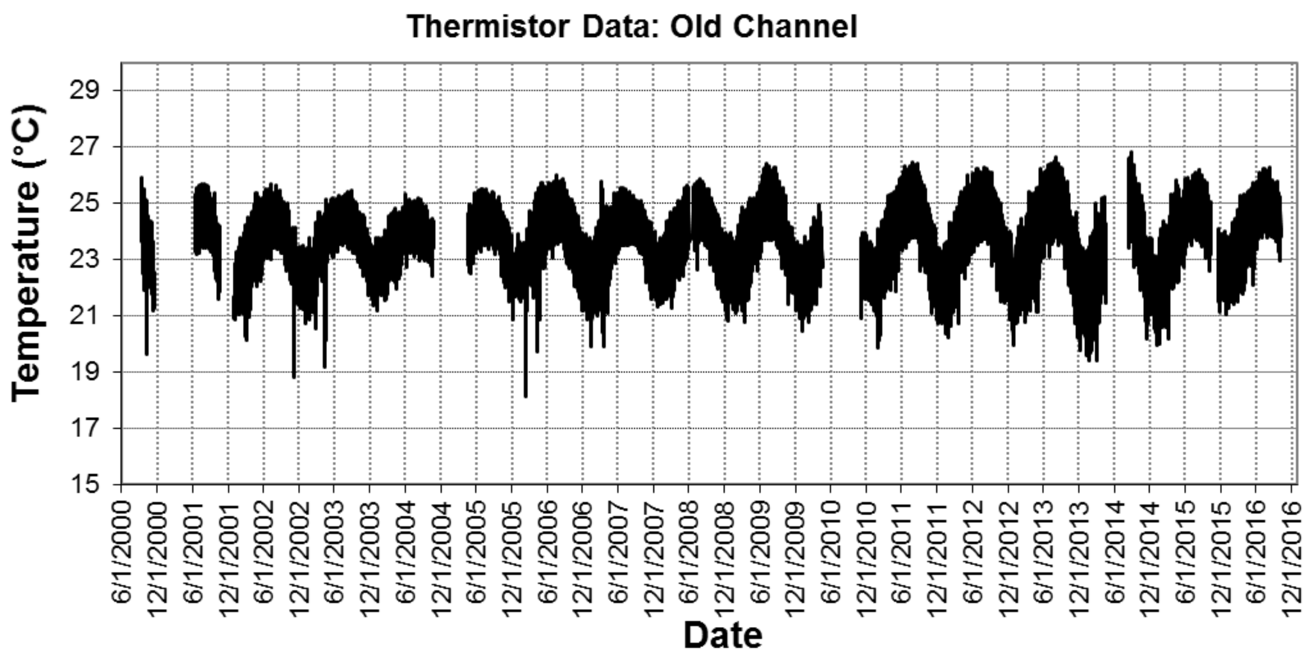
Thermistor Data: Spring Island
West channel
East channel
Temperature (°C)
29.00
27.00
25.00
23.00
21.00
19.00
17.00
15.00
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
6/1/2006
12/1/2006
6/1/2007
12/1/2007
6/1/2008
12/1/2008
6/1/2009
12/1/2009
6/1/2010
12/1/2010
6/1/2011
12/1/2011
6/1/2012
12/1/2012
6/1/2013
12/1/2013
6/1/2014
12/1/2014
6/1/2015
12/1/2015
6/1/2016
12/1/2016
Date


Thermistor Data: Landa Lake Bottom
LL upper
LL lower
Temperature (°C)
29
27
25
23
21
19
17
15
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
6/1/2006
12/1/2006
6/1/2007
12/1/2007
6/1/2008
12/1/2008
6/1/2009
12/1/2009
6/1/2010
12/1/2010
6/1/2011
12/1/2011
6/1/2012
12/1/2012
6/1/2013
12/1/2013
6/1/2014
12/1/2014
6/1/2015
12/1/2015
6/1/2016
12/1/2016
Date

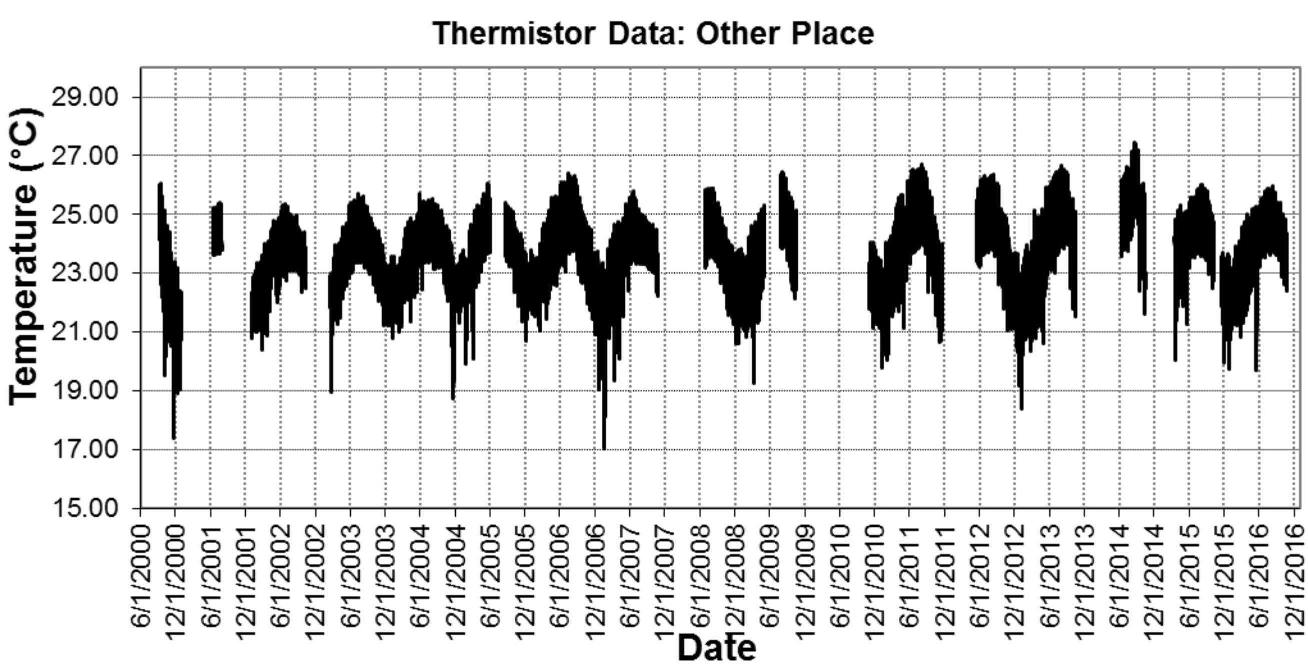

Thermistor Data: Spring Run 1
Temperature (°C)
29.00
27.00
25.00
23.00
21.00
19.00
17.00
15.00
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
6/1/2006
12/1/2006
6/1/2007
12/1/2007
6/1/2008
12/1/2008
6/1/2009
12/1/2009
6/1/2010
12/1/2010
6/1/2011
12/1/2011
6/1/2012
12/1/2012
6/1/2013
12/1/2013
6/1/2014
12/1/2014
6/1/2015
12/1/2015
6/1/2016
12/1/2016
Date


Thermistor Data: Spring Runs 2 and 3
SR 2
SR 3
Temperature (°C)
29.00
27.00
25.00
23.00
21.00
19.00
17.00
15.00
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
6/1/2006
12/1/2006
6/1/2007
12/1/2007
6/1/2008
12/1/2008
6/1/2009
12/1/2009
6/1/2010
12/1/2010
6/1/2011
12/1/2011
6/1/2012
12/1/2012
6/1/2013
12/1/2013
6/1/2014
12/1/2014
6/1/2015
12/1/2015
6/1/2016
12/1/2016
Date


Thermistor Data: New Channel
Upstream
Downstream
Temperature (°C)
29.00
27.00
25.00
23.00
21.00
19.00
17.00
15.00
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
6/1/2006
12/1/2006
6/1/2007
12/1/2007
6/1/2008
12/1/2008
6/1/2009
12/1/2009
6/1/2010
12/1/2010
6/1/2011
12/1/2011
6/1/2012
12/1/2012
6/1/2013
12/1/2013
6/1/2014
12/1/2014
6/1/2015
12/1/2015
6/1/2016
12/1/2016
Date

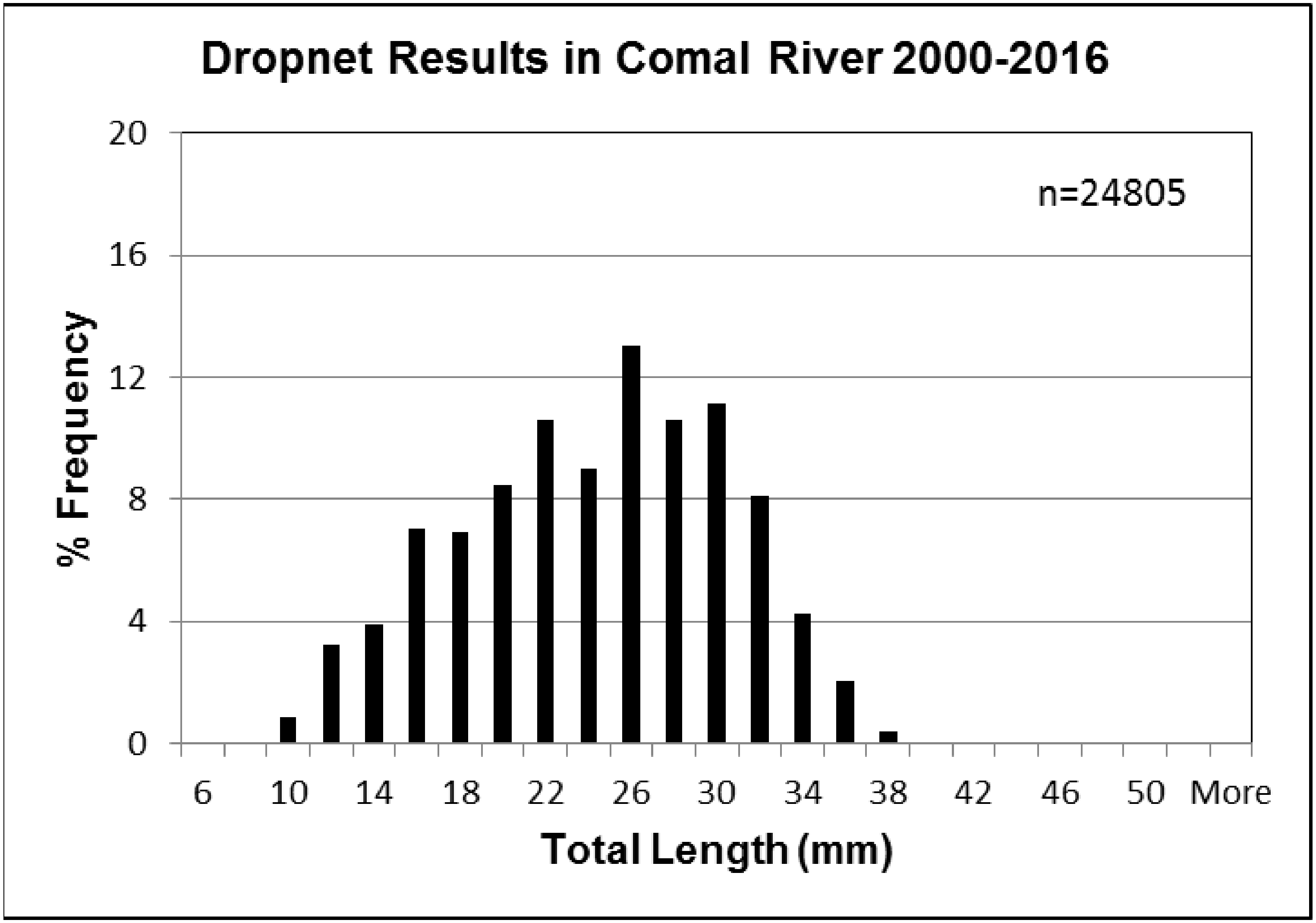


Thermistor Data: Old Channel
Temperature (°C)
29
27
25
23
21
19
17
15
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
6/1/2006
12/1/2006
6/1/2007
12/1/2007
6/1/2008
12/1/2008
6/1/2009
12/1/2009
6/1/2010
12/1/2010
6/1/2011
12/1/2011
6/1/2012
12/1/2012
6/1/2013
12/1/2013
6/1/2014
12/1/2014
6/1/2015
12/1/2015
6/1/2016
12/1/2016
Date

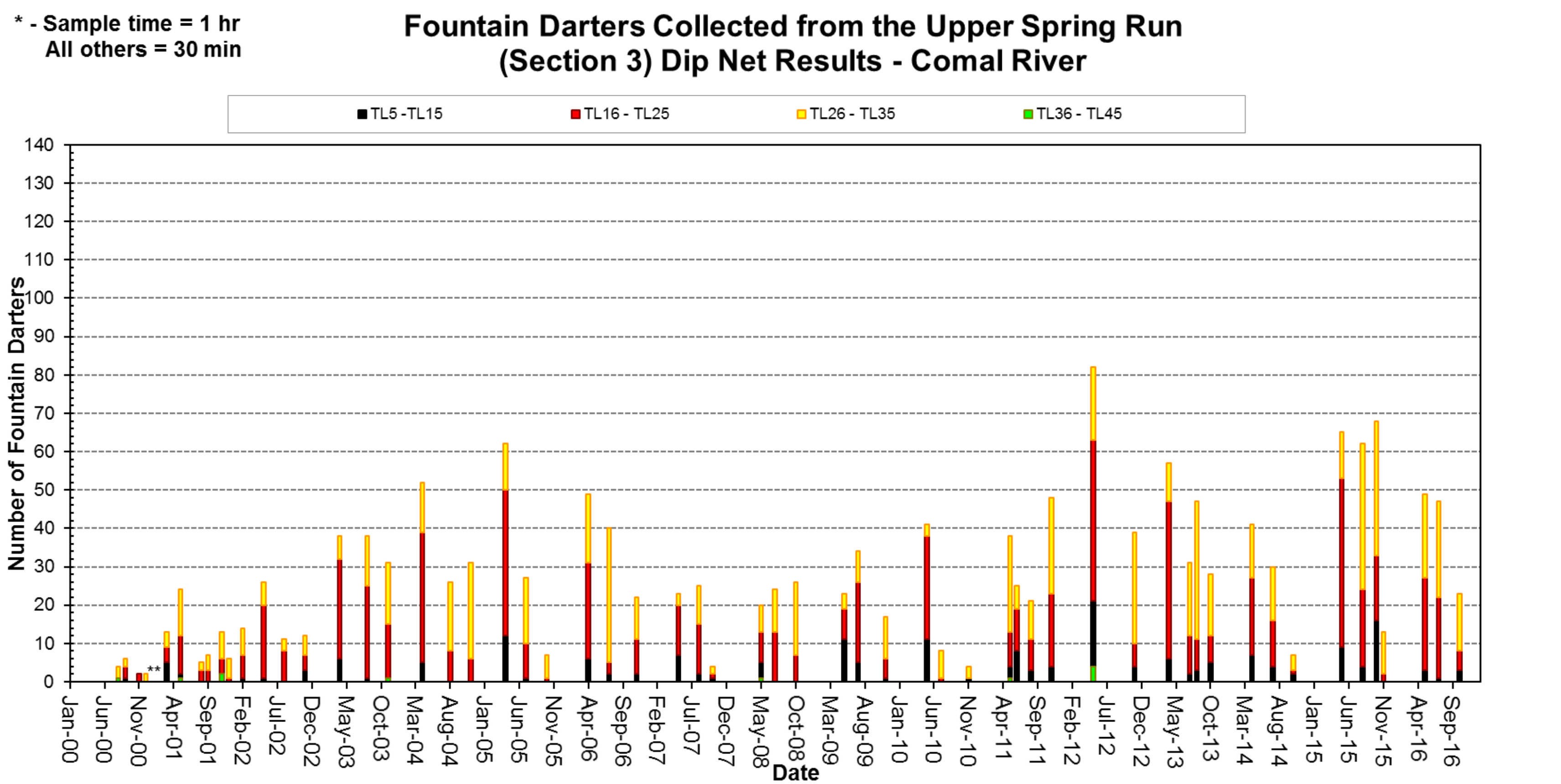


Thermistor Data: Other Place
Temperature (°C)
29.00
27.00
25.00
23.00
21.00
19.00
17.00
15.00
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
6/1/2006
12/1/2006
6/1/2007
12/1/2007
6/1/2008
12/1/2008
6/1/2009
12/1/2009
6/1/2010
12/1/2010
6/1/2011
12/1/2011
6/1/2012
12/1/2012
6/1/2013
12/1/2013
6/1/2014
12/1/2014
6/1/2015
12/1/2015
6/1/2016
12/1/2016
Date

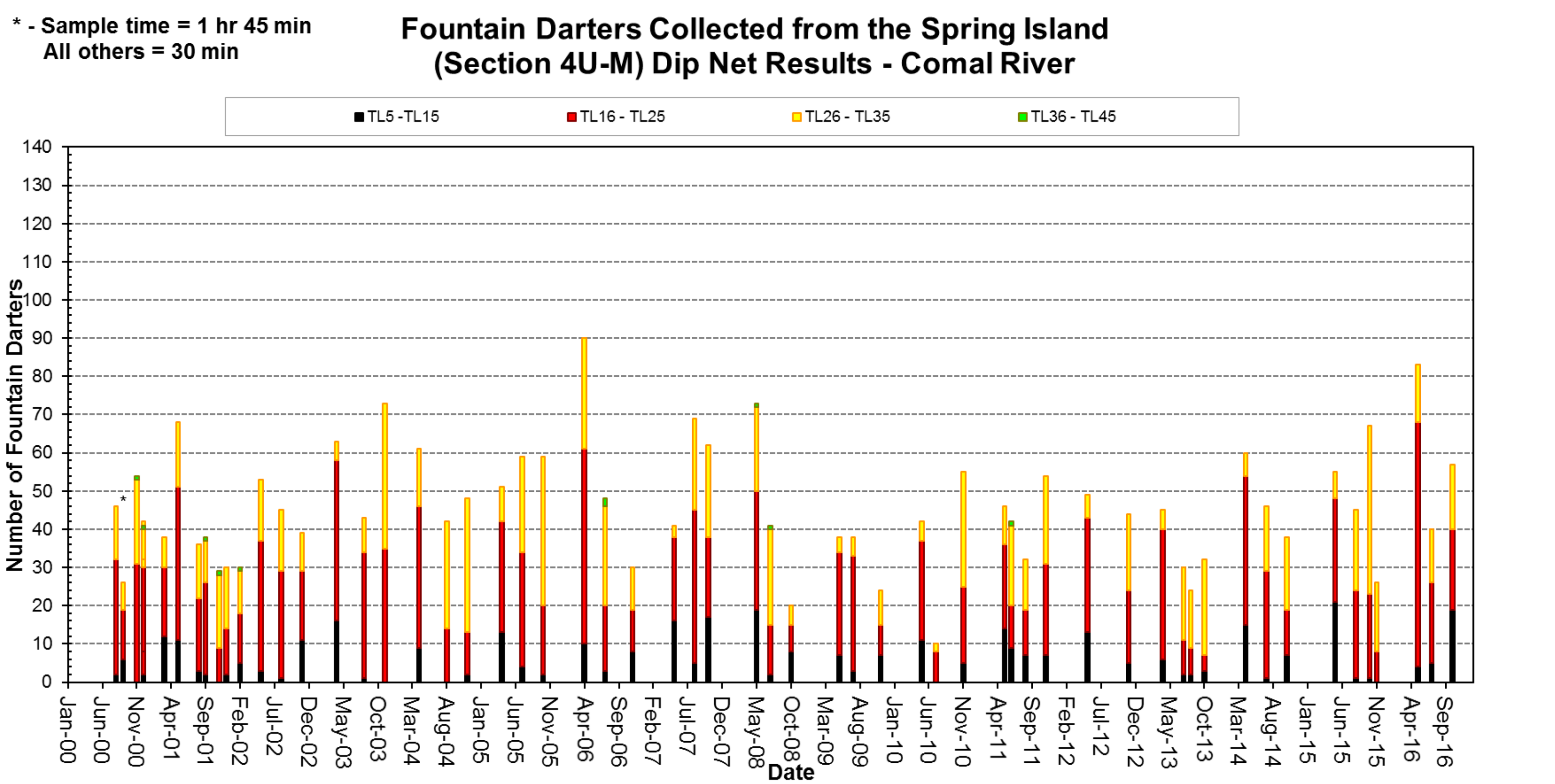
Drop Net Graph


Dropnet Results in Comal River 2000-2016
n=24805
% Frequency
20
16
12
8
4
0
6
10
14
18
22
26
30
34
38
42
46
50
More
Total Length (mm)

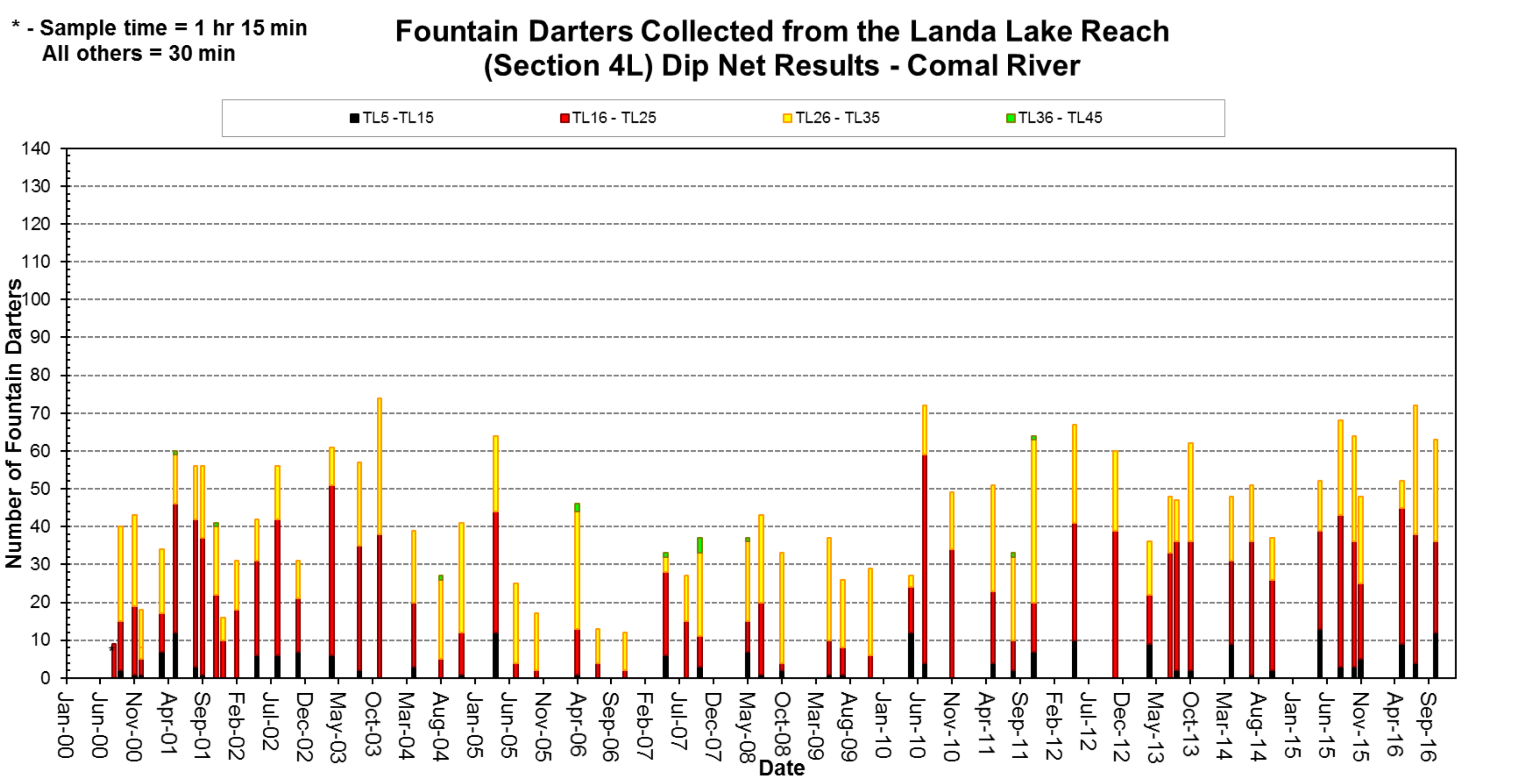
Dip Net Graphs



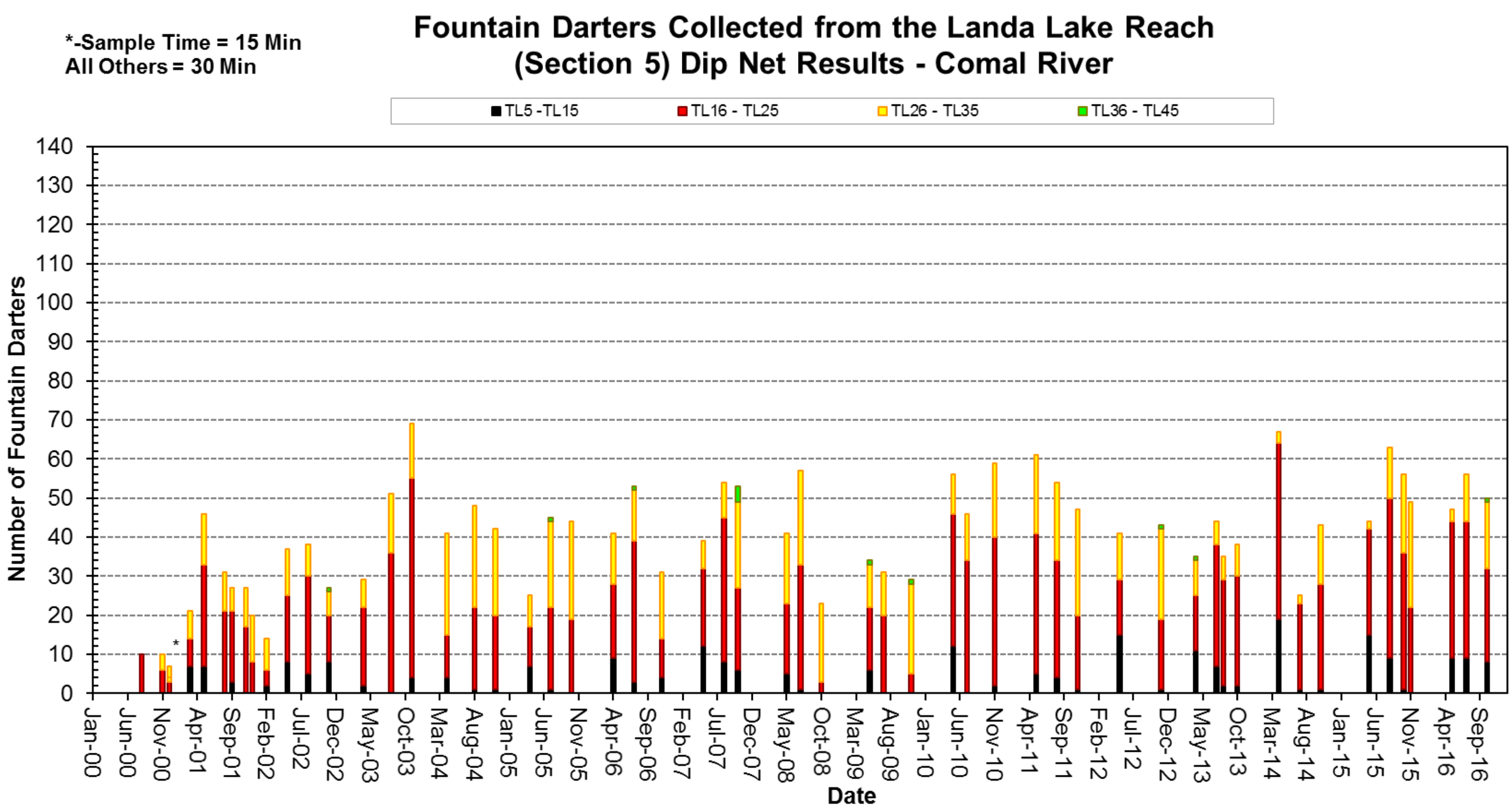
* - Sample time = 1 hr
All others = 30 min
Fountain Darters Collected from the Upper Spring Run
(Section 3) Dip Net Results - Comal River
TL5 -TL15
TL16 - TL25
TL26 - TL35
TL36 - TL45
Number of Fountain Darters
Date



* - Sample time = 1 hr 45 min
All others = 30 min
Fountain Darters Collected from the Spring Island
(Section 4U-M) Dip Net Results - Comal River
TL5 -TL15
TL16 - TL25
TL26 - TL35
TL36 - TL45
Number of Fountain Darters
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
*
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

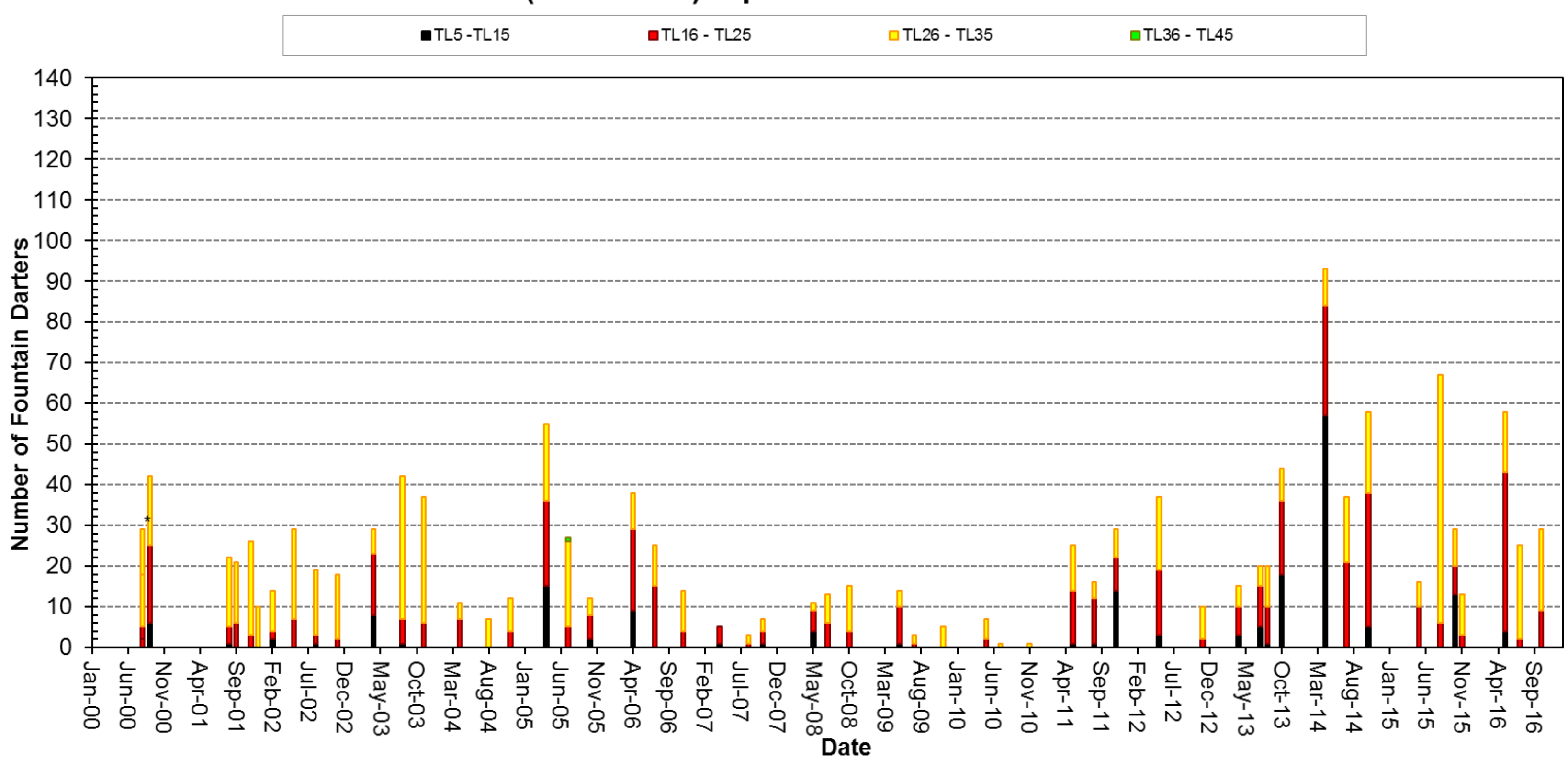

* - Sample time = 1 hr 15 min
All others = 30 min
Fountain Darters Collected from the Landa Lake Reach
(Section 4L) Dip Net Results - Comal River
TL5 -TL15
TL16 - TL25
TL26 - TL35
TL36 - TL45
Number of Fountain Darters
Date
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Jan-00
Jun-00
Nov-00
Apr-01
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

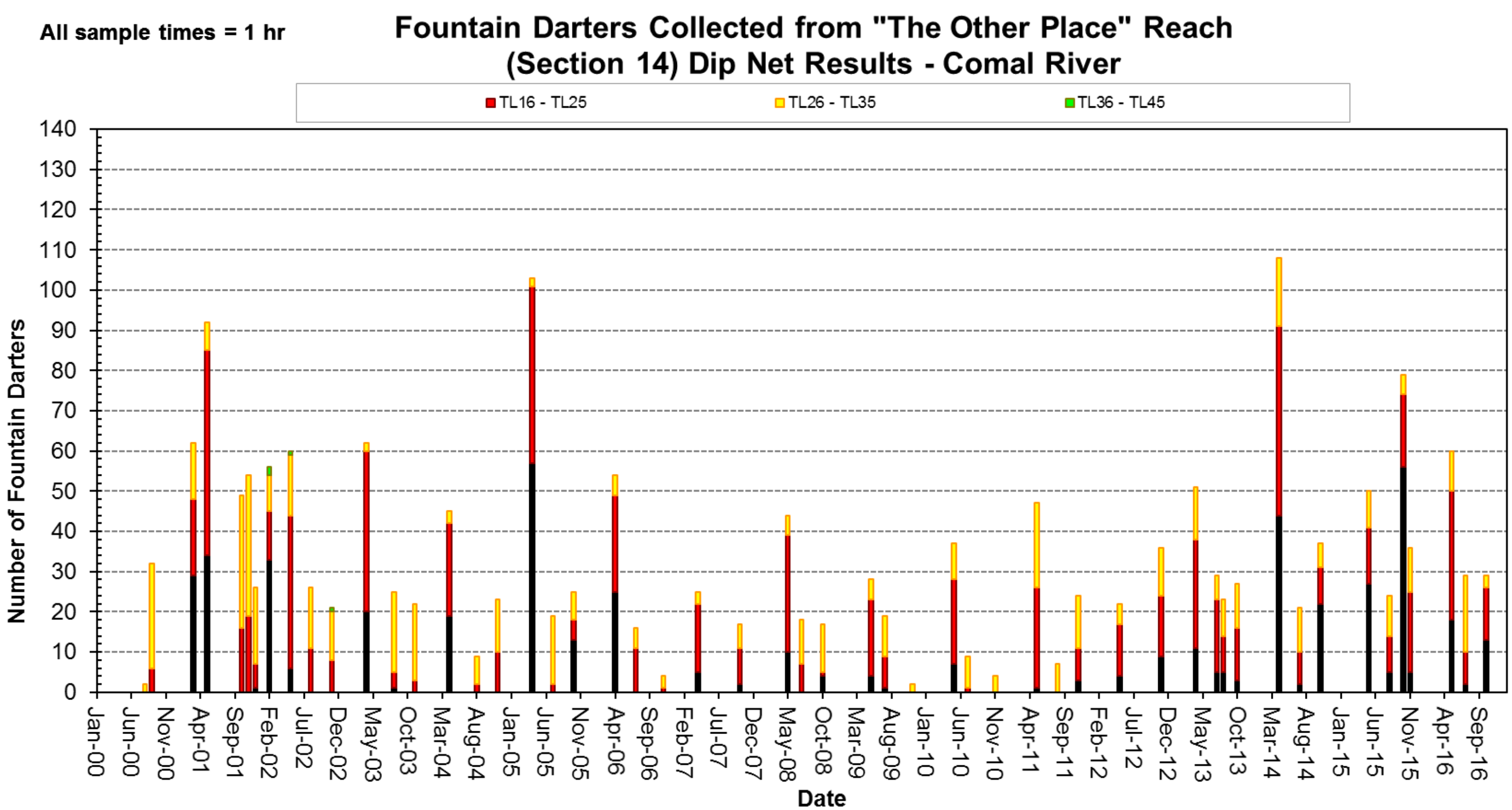
*-Sample Time = 15 Min
All Others = 30 Min



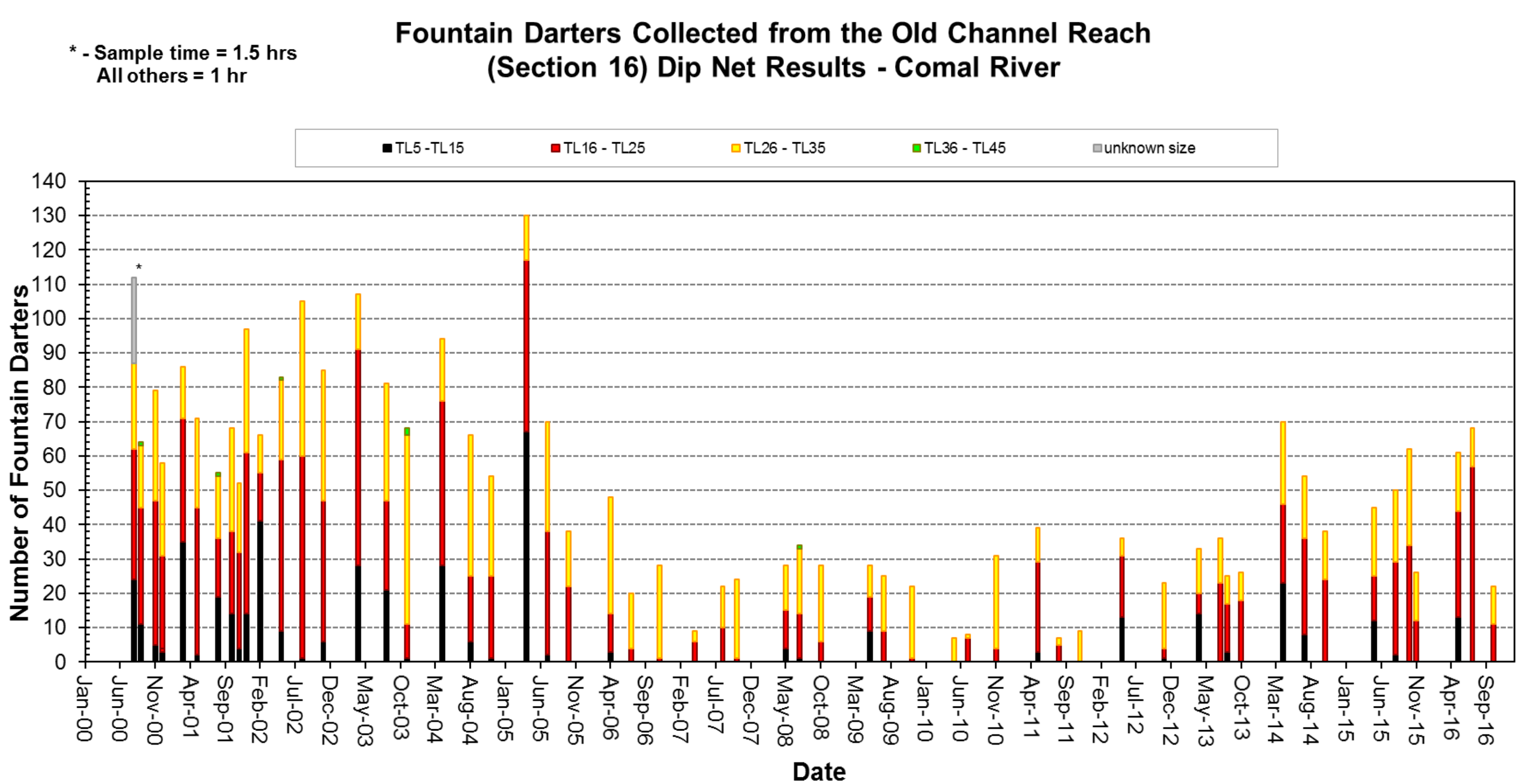
* - Unknown time interval
All others = 1 hr

Fountain Darters Collected from the New Channel Reach (Section 10) Dip Net Results - Comal River





All sample times = 1 hr
Fountain Darters Collected from "The Other Place" Reach
(Section 14) Dip Net Results - Comal River
TL16 - TL25
TL26 - TL35
TL36 - TL45
Number of Fountain Darters
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
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


* - Sample time = 1.5 hrs
All others = 1 hr
Fountain Darters Collected from the Old Channel Reach
(Section 16) Dip Net Results - Comal River
TL5 -TL15
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
130
140
*
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

Macroinvertebrate Data

Spring

Order / Class	**Family**	**Genus**	**OCR-LUD**	**OCR-BRY**	**OCR-CAB**	**OCR-SAG**	**LL-LUD**	**LL-BRY**	**LL-CAB**	**LL-SAG**	**LL-VAL**	**USR-SAG**
Ephemeroptera	Baetidae	*Callibaetis*							1			
Ephemeroptera	Baetidae	*Fallceon quilleri*	1							1		
Ephemeroptera	Ephmeridae	*Hexagenia*	1		2							
Ephemeroptera	Leptohyphidae	*Tricorythodes*		3	1		2	1	16	6		
Odonata	Ceonagrionidae	Early Instar		7								
Odonata	Ceonagrionidae	*Enallagma*			1					1		
Odonata	Gomphidae	*Erpetogomphus*	1									
Trichoptera	Leptoceridae	*Nectopsyche*		1								
Trichoptera	Hydroptilldae	*Oxytheria*					1			2		
Trichoptera	Glossosomatidae	*Protoptila*		1								
Lepidoptera	Crambidae	*Paraponyx*	3	1								
Coleoptera	Elmidae	*Hexacylloepus ferrugineus*		1								
Coleoptera	Psephinidae	*Psephenus*					4					
Diptera	Chironomidae	*Chironomid* Pupae								1		
Diptera	Chironomidae	*Chironomini*							14	2		3
Diptera	Chironomidae	*Tanytarsini*				1					1	
Diptera	Chironomidae	*Tanypodinae*										1
Amphipoda	Hyalellidae	*Hyalella*	44	77	15	19	105	7	16	38	1	31
Decapoda	Cambaridae		9	7	3			2				
Decapoda	Palaemonidae	*Palaemonetes*			2							
Gastropoda	Thiaridae	*M. tuberculata*	1				1		2		1	
Gastropoda	Thiaridae	*Terabia*	610	273	157	203	2	227		54	57	16
Gastropoda	Planorbidae	*Helisoma*					1				1	
Gastropoda	Pleuroceridae	*Elimia*	7		1		8			9		1
Gastropoda	Hydrobiidae		1		7				9			7
Gastropoda	Physidae	*Physa*							1			
Oligochaeta						1				1		

Fall

Order / Class	Family	Genus	OCR-LUD	OCR-BRY	OCR-CAB	OCR-SAG	LL-LUD	LL-BRY	LL-CAB	LL-SAG	LL-VAL	NC-HYG	NC-CAB	USR-SAG	USR-BRY
Ephemeroptera	Baetidae	*Callibaetis*					8		3						
Ephemeroptera	Baetidae	*Fallceon quilleri*										1			
Ephemeroptera	Ephmeridae	*Hexagenia*	2		6				3						
Ephemeroptera	Leptohyphidae	*Tricorythodes*	2	14	1	2	1		8			2			2
Odonata	Ceonagrionidae	*Argia*				1									
Odonata	Ceonagrionidae	*Enallagma*							3			1	1		
Lepidoptera	Crambidae	*Paraponyx*							1						
Coleoptera	Elmidae	*Microcylloepus pusillus*					1								18
Coleoptera	Elmidae	*Phanocerus clavicornis*		1											
Coleoptera	Elmidae	*Dubiraphia*											1		
Coleoptera	Elmidae	*Heterelmis*													3
Coleoptera	Psephinidae	*Psephenus*	2												70
Diptera	Ceratopogonidae	*Bezzia*													1
Diptera	Chironomidae	*Chironomini*		1	2		1								
Diptera	Chironomidae	*Tanytarsini*									1				
Diptera	Chironomidae	*Tanypodinae*				1			1						
Diptera	Chironomidae	*Orthocladinae*					2				2				
Amphipoda	Hyalellidae	*Hyalella*	7	14	4	10	392	36	149	13	2	14	7	12	221
Amphipoda	Crangonyictidae	*Stygobromus*	1												18
Isopoda	Crangonyictidae	*Lirceolus*													1
Decapoda	Cambaridae		1		1		2					3			1
Gastropoda	Thiaridae	*M. tuberculata*				3					1				
Gastropoda	Thiaridae	*Terabia*	4	93	33	130	2	149		63	82	29	37		
Gastropoda	Pleuroceridae	*Elimia*	1				2	15		28	15				
Gastropoda	Hydrobiidae		2			3	1		2			4	4		
Gastropoda	Physidae	*Physa*					1								
Euhirundea												1			

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**	**Site on Map:**
Upper Spring Run		R1-Site 1	
Date:	**Time:**	**Observer(s):**	
5/9/2016	915-956	JG,JW,NP,JO	

Overall	**Species**	**Number**	**Avg. Length (mm)**
62	*Etheostoma fonticola*		
105	*Procambarus* sp.		
2	*Etheostoma lepidum*		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Etheostoma fonticola*	13	24,22,27,28,27,22,17,15,21,14,18,18,15
	Procambarus sp.	46	
	Etheostoma lepidum	1	38
2	*Procambarus* sp.	32	
	Etheostoma fonticola	16	30,35,16,19,24,26,21,16,20,22,11,14,15,29,23,22
3	*Etheostoma fonticola*	15	22,15,15,20,22,22,26,16,20,22,25,24,22,16,21
	Procambarus sp.	10	
	Etheostoma lepidum	1	41
4	*Etheostoma fonticola*	9	25,25,17,20,16,18,24,14,15
	Procambarus sp.	2	
5	*Etheostoma fonticola*	4	38,26,18,16
	Procambarus sp.	7	
6	*Etheostoma fonticola*	2	28,15
	Procambarus sp.	1	
7	*Procambarus* sp.	1	
8	*Procambarus* sp.	2	
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	*Etheostoma fonticola*	1	13
12	*Etheostoma fonticola*	1	23
	Procambarus sp.	1	
13	*Etheostoma fonticola*	1	12
	Procambarus sp.	2	
14	*Procambarus* sp.	1	
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		
Upper Spring Run		O1- Site 2		
Date: 5/9/2016	**Time:** 958-1011	**Observer(s):** JG,JW,NP,JO		
Overall	**Species**		**Number**	**Avg. Length (mm)**
3	*Etheostoma fonticola*			
4	*Procambarus* sp.			

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	*Etheostoma fonticola*	1	16
4	*Procambarus* sp.	1	
5	*Procambarus* sp.	1	
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	*Etheostoma fonticola*	1	14
	Procambarus sp.	1	
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	*Etheostoma fonticola*	1	21
	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		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**	**Site on Map:**
Upper Spring Run		S1 -Site 3	S3
Date: 5/9/2016	**Time:** 1013-1028	**Observer(s):** JG,JW,NP,JO	

Overall	**Species**	**Number**	**Avg. Length (mm)**
6	*Lepomis miniatus*		
1	*Herichthys cyanoguttatus*		
17	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Procambarus* sp.	1	
2	*Lepomis miniatus*	2	95,40
	Herichthys cyanoguttatus	1	76
3	*Lepomis miniatus*	1	78
	Procambarus sp.	2	
4	*Lepomis miniatus*	1	72
	Procambarus sp.	4	
5	*Lepomis miniatus*	1	44
	Procambarus sp.	2	
6	*Procambarus* sp.	1	
7	*Lepomis miniatus*	1	33
	Procambarus sp.	1	
8	No fish or crustaceans collected		
9	*Procambarus* sp.	2	
10	No fish or crustaceans collected		
11	*Procambarus* sp.	2	
12	*Procambarus* sp.	1	
13	No fish or crustaceans collected		
14	*Procambarus* sp.	1	
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	
Upper Spring Run		S2- Site 4	
Date:	**Time:**	**Observer(s):**	
5/9/2016	1032-1049	JG,JW,NP,JO	

Overall	Species	Number	Avg. Length (mm)
13	*Lepomis miniatus*		
5	*Herichthys cyanoguttatus*		
2	*Dionda nigrotaeniata*		
27	*Procambarus* sp.		
1	*Lepomis sp.*		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	4	53,79,86,70
	Herichthys cyanoguttatus	3	95,89,121
	Dionda nigrotaeniata	1	38
	Procambarus sp.	3	
	Lepomis sp.	1	18
2	*Lepomis miniatus*	1	68
	Herichthys cyanoguttatus	1	69
	Procambarus sp.	3	
3	*Procambarus* sp.	7	
	Lepomis miniatus	1	128
	Herichthys cyanoguttatus	1	108
4	*Procambarus* sp.	2	
5	*Procambarus* sp.	2	
	Lepomis miniatus	1	79
6	*Procambarus* sp.	2	
7	*Procambarus* sp.	1	
8	*Procambarus* sp.	2	
	Lepomis miniatus	1	90
9	*Lepomis miniatus*	2	55,135
	Dionda nigrotaeniata	1	27
	Procambarus sp.	1	
10	*Procambarus* sp.	1	
	Lepomis miniatus	1	61
11	*Procambarus* sp.	1	
12	*Lepomis miniatus*	2	72,79
13	No fish or crustaceans collected		
14	*Procambarus* sp.	2	
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
Upper Spring Run		S3- Site 5	
Date: 5/9/2016	Time: 1059-1110	Observer(s): JG,JW,NP,JO	

Overall	Species	Number	Avg. Length (mm)
7	*Lepomis miniatus*		
16	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	2	68,79
	Procambarus sp.	2	
2	*Lepomis miniatus*	1	83
	Procambarus sp.	4	
3	*Procambarus* sp.	2	
4	*Procambarus* sp.	2	
5	*Procambarus* sp.	1	
	Lepomis miniatus	1	64
6	*Procambarus* sp.	2	
7	*Lepomis miniatus*	1	86
	Procambarus sp.	1	
8	*Procambarus* sp.	1	
9	No fish or crustaceans collected		
10	*Procambarus* sp.	1	
11	No fish or crustaceans collected		
12	*Lepomis miniatus*	1	46
13	No fish or crustaceans collected		
14	*Lepomis miniatus*	1	82
15	No fish or crustaceans collected		
	**Melanoides - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		
Upper Spring Run		R3- Site 6		
Date: 5/9/2016	**Time:** 1117-1156	**Observer(s):** JG,JW,NP,JO		
Overall	**Species**		**Number**	**Avg. Length (mm)**
115	*Etheostoma fonticola*			
2	*Etheostoma lepidum*			
152	*Procambarus* sp.			
1	*Gambusia sp.*			

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	15	25,25,21,25,24,21,24,21,22,21,18,16,21,15,20
	Gambusia sp.	1	16
	Procambarus sp.	11	
2	*Etheostoma fonticola*	22	22,20,29,23,24,26,21,18,23,20,24,26,21,27,26,16,24,21,25,21,25,16
	Procambarus sp.	32	
3	*Etheostoma fonticola*	11	31,20,26,31,28,23,30,23,20,25,15
	Procambarus sp.	9	
4	*Etheostoma fonticola*	17	12,24,12,25,22,25,23,21,24,27,25,19,20,24,25,26,10
	Etheostoma lepidum	2	34,34
	Procambarus sp.	20	
5	*Etheostoma fonticola*	7	18,28,25,24,26,21,24
	Procambarus sp.	19	
6	*Etheostoma fonticola*	16	22,29,24,22,24,22,25,24,28,28,21,27,18,20,20,21
	Procambarus sp.	18	
7	*Etheostoma fonticola*	4	25,24,25,28
	Procambarus sp.	9	
8	*Etheostoma fonticola*	13	25,23,21,23,22,27,11,17,24,26,23,25,22
	Procambarus sp.	20	
9	*Etheostoma fonticola*	3	26,22,28
	Procambarus sp.	3	
10	*Etheostoma fonticola*	5	23,26,32,20,22
	Procambarus sp.	1	
11	No fish or crustaceans collected		
12	*Etheostoma fonticola*	1	29
	Procambarus sp.	5	
13	*Etheostoma fonticola*	1	22
	Procambarus sp.	1	
14	No fish or crustaceans collected		
15	*Procambarus* sp.	4	
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	
Upper Spring Run		R2- Site 7	
Date: 5/9/2016	**Time:** 1200-1223	**Observer(s):** JG,JW,NP,JO	

Overall	Species	Number	Avg. Length (mm)
31	*Etheostoma fonticola*		
3	*Lepomis miniatus*		
1	*Micropterus salmoides*		
2	*Herichthys cyanoguttatus*		
1	*Palaemonetes* sp.		
21	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	8	30,18,24,26,22,32,22,31
	Procambarus sp.	2	
2	*Micropterus salmoides*	1	88
	Etheostoma fonticola	6	20,21,25,23,20,30
	Palaemonetes sp.	1	
	Procambarus sp.	1	
3	*Etheostoma fonticola*	3	22,28,25
	Procambarus sp.	6	
4	*Herichthys cyanoguttatus*	2	70,58
	Etheostoma fonticola	2	17,20
	Procambarus sp.	3	
5	*Etheostoma fonticola*	1	17
	Procambarus sp.	3	
6	*Etheostoma fonticola*	2	28,35
	Lepomis miniatus	2	30,28
	Procambarus sp.	1	
7	*Etheostoma fonticola*	7	22,25,25,28,19,27,34
	Procambarus sp.	3	
8	No fish or crustaceans collected		
9	*Etheostoma fonticola*	1	31
10	*Procambarus* sp.	1	
11	*Etheostoma fonticola*	1	27
	Procambarus sp.	1	
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	*Lepomis miniatus*	1	30
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
Upper Spring Run		O2- Site 8	
Date: 5/9/2016	**Time:** 1229-1235	**Observer(s):** JG,JW,NP,JO	

Overall	Species	Number	Avg. Length (mm)
1	*Notropis amabilis*		

COMAL 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	*Notropis amabilis*	1	21
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
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach): Upper Spring Run		**Site:** L1- Site 1	**Site on Map:** L4
Date: 10/26/2016	**Time:** 907-927	**Observer(s):** JG,DS,JH,JO	

Overall	**Species**	**Number**	**Avg. Length (mm)**
1	*Ameiurus melas*		
1	*Ameiurus natalis*		
5	*Dionda nigrotaeniata*		
4	*Etheostoma fonticola*		
1	*Etheostoma lepidum*		
7	*Herichthys cyanoguttatus*		
8	*Lepomis miniatus*		
5	*Palaemonetes* sp.		
11	*Procambarus* sp.		

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Herichthys cyanoguttatus*	2	16,21
2	*Lepomis miniatus*	3	32,28,39
	Herichthys cyanoguttatus	1	15
	Palaemonetes sp.	2	
	Procambarus sp.	4	
3	*Dionda nigrotaeniata*	1	66
	Lepomis miniatus	1	81
	Herichthys cyanoguttatus	1	20
	Procambarus sp.	2	
	Palaemonetes sp.	1	
4	*Lepomis miniatus*	1	54
	Ameiurus melas	1	12
	Procambarus sp.	1	
5	*Dionda nigrotaeniata*	1	46
	Lepomis miniatus	1	52
6	*Dionda nigrotaeniata*	1	75
	Etheostoma fonticola	1	25
	Procambarus sp.	1	
	Herichthys cyanoguttatus	1	25
7	*Procambarus* sp.	1	
	Dionda nigrotaeniata	1	43
8	No fish or crustaceans collected		
9	*Etheostoma fonticola*	1	33
10	*Palaemonetes* sp.	1	
	Procambarus sp.	1	
	Etheostoma lepidum	1	46
11	No fish or crustaceans collected		
12	*Etheostoma fonticola*	1	28
	Dionda nigrotaeniata	1	49

COMAL RIVER -FALL 2016 SAMPLING			
Dip net sweep	**Species**	**Number**	**Length (mm)**
13	*Lepomis miniatus*	1	67
	Procambarus sp.	1	
	Ameiurus natalis	1	20
14	*Herichthys cyanoguttatus*	2	90,19
	Palaemonetes sp.	1	
	Etheostoma fonticola	1	34
15	*Lepomis miniatus*	1	66

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	
Upper Spring Run		S2- Site 2	
Date: 10/26/2016	**Time:** 933-950	**Observer(s):** JG,DS,JH,JO	
Overall	**Species**	**Number**	**Avg. Length (mm)**
6	*Herichthys cyanoguttatus*		
16	*Lepomis miniatus*		
2	*Marisa cornuarietis*		
18	*Procambarus* sp.		

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Herichthys cyanoguttatus*	3	81,16,111
	Lepomis miniatus	1	52
2	*Lepomis miniatus*	6	55,105,95,82,71,68
	Herichthys cyanoguttatus	1	72
	Procambarus sp.	2	
3	*Lepomis miniatus*	1	55
	Procambarus sp.	2	
	Herichthys cyanoguttatus	1	90
4	*Procambarus* sp.	9	
	Lepomis miniatus	1	46
5	*Procambarus* sp.	2	
6	*Lepomis miniatus*	2	65,63
7	*Lepomis miniatus*	2	52,60
8	*Lepomis miniatus*	1	
	Herichthys cyanoguttatus	1	90
9	*Lepomis miniatus*	1	55,135
10	*Procambarus* sp.	2	
11	*Lepomis miniatus*	1	
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	*Procambarus* sp.	1	
15	No fish or crustaceans collected		
	Marisa cornuarietis	2	40,35

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:		Site on Map:
Upper Spring Run		L2- Site 3		L3
Date:	**Time:**	**Observer(s):**		
10/26/2016	953-1008	JG,DS,JH,JO		

Overall	Species	Number	Avg. Length (mm)
5	*Dionda nigrotaeniata*		
1	*Etheostoma fonticola*		
9	*Lepomis miniatus*		
1	*Lepomis sp.*		
1	*Micropterus salmoides*		
1	*Notropis amabilis*		
1	*Palaemonetes* sp.		
2	*Procambarus* sp.		

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	2	52,56
	Dionda nigrotaeniata	3	50,37,44
	Micropterus salmoides	1	55
	Lepomis sp.	1	15
2	*Dionda nigrotaeniata*	1	42
	Notropis amabilis	1	47
	Lepomis miniatus	1	39
3	*Lepomis miniatus*	3	22,53,53
	Etheostoma fonticola	1	31
4	*Palaemonetes* sp.	1	
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	*Procambarus* sp.	1	
	Dionda nigrotaeniata	1	64
	Lepomis miniatus	2	42,24
8	No fish or crustaceans collected		
9	*Procambarus* sp.	1	
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	*Lepomis miniatus*	1	57
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

COMAL RIVER -FALL 2016 SAMPLING

Location (Reach): Upper Spring Run		**Site:** S1 -Site 4	**Site on Map:**
Date: 10/26/2016	**Time:** 1010-1025	**Observer(s):** JG,DS,JH,JO	

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

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Lepomis miniatus*	2	76,61
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	*Lepomis miniatus*	1	56
5	*Lepomis miniatus*	1	39
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	*Lepomis miniatus*	1	77
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	*Lepomis miniatus*	1	56
	Procambarus sp.	1	
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	***Melanoides-slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach):		**Site:**	
Upper Spring Run		R2- Site 5	
Date: 10/26/2016	**Time:** 1034-1055	**Observer(s):** JG,DS,JH,JO	

Overall	**Species**	**Number**	**Avg. Length (mm)**
4	*Etheostoma fonticola*		
2	*Etheostoma lepidum*		
2	*Lepomis miniatus*		
1	*Lepomis sp.*		
1	*Micropterus salmoides*		
6	*Palaemonetes* sp.		
12	*Procambarus* sp.		

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Etheostoma fonticola*	2	30,27
	Lepomis sp.	1	8
2	*Palaemonetes* sp.	4	
3	*Procambarus* sp.	4	
4	*Micropterus salmoides*	1	230
	Lepomis miniatus	1	75
	Procambarus sp.	4	
5	*Etheostoma lepidum*	1	47
6	No fish or crustaceans collected		
7	*Procambarus* sp.	4	
	Palaemonetes sp.	1	
8	*Lepomis miniatus*	1	42
	Etheostoma fonticola	1	25
9	*Etheostoma fonticola*	1	32
10	No fish or crustaceans collected		
11	*Etheostoma lepidum*	1	41
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	*Palaemonetes* sp.	1	
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		
	***Melanoides-slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach):		**Site:**	**Site on Map:**
Upper Spring Run		R1-Site 6	R3
Date: 10/26/2016	**Time:** 1102-1127	**Observer(s):** JG,DS,JH,JO	

Overall	**Species**	**Number**	**Avg. Length (mm)**
1	*Dionda nigrotaeniata*		
42	*Etheostoma fonticola*		
95	*Procambarus* sp.		

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Etheostoma fonticola*	21	25,28,22,28,28,26,27,22,27,26,22,28, 20,23,27,28,27,29,25,21,25
	Procambarus sp.	28	
	Dionda nigrotaeniata	1	15
2	*Etheostoma fonticola*	3	31,29,29
3	*Etheostoma fonticola*	3	29,31,27
	Procambarus sp.	32	
4	*Etheostoma fonticola*	1	30
	Procambarus sp.	5	
5	*Etheostoma fonticola*	4	25,26,25,29
	Procambarus sp.	8	
6	*Etheostoma fonticola*	3	27,32,25
	Procambarus sp.	8	
7	*Etheostoma fonticola*	4	23,26,26,30
	Procambarus sp.	3	
8	*Procambarus* sp.	3	
9	*Etheostoma fonticola*	1	27
	Procambarus sp.	4	
10	*Etheostoma fonticola*	2	29,29
	Procambarus sp.	2	
11	*Procambarus* sp.	2	
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
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:		
Upper Spring Run		O1- Site 7		
Date: 10/26/2016	**Time:** 1132-1137	**Observer(s):** JG,DS,JH,JO		
Overall	**Species**		**Number**	**Avg. Length (mm)**
COMAL 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
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach): Upper Spring Run		**Site:** O2- Site 8	**Site on Map:**
Date: 10/26/2016	**Time:** 1139-1141	**Observer(s):** JG,DS,JH,JO	

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

COMAL 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
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**		
Landa Lake		L2- Site 1		
Date:	**Time:**	**Observer(s):**		
5/9/2016	1335-1409	JW,JO,JG,NP		
Overall	**Species**		**Number**	**Avg. Length (mm)**
242	*Gambusia* sp.			
2	*Lepomis miniatus*			
11	*Etheostoma fonticola*			
15	*Procambarus* sp.			
2	*Marisa cornuarietis*			

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	60	15,22,11,15,18,18,14,17,20,7,34,36,25,20,16,12,19,32, 18,18,13,21,20,12,15,21,16,15,17
	Lepomis miniatus	1	76
	Etheostoma fonticola	3	22,13,12
	Procambarus sp.	5	
2	*Etheostoma fonticola*	1	17
	Gambusia sp.	114	
	Lepomis miniatus	1	115
3	*Procambarus* sp.	8	
	Gambusia sp.	18	
4	*Gambusia* sp.	37	
	Etheostoma fonticola	3	15,19,21
5	*Gambusia* sp.	2	
6	*Etheostoma fonticola*	1	17
7	*Etheostoma fonticola*	1	16
	Gambusia sp.	2	
8	*Etheostoma fonticola*	1	18
	Gambusia sp.	1	
	Procambarus sp.	1	
9	No fish or crustaceans collected		
10	*Gambusia* sp.	2	
	Procambarus sp.	1	
11	No fish or crustaceans collected		
12	*Gambusia* sp.	3	
13	*Gambusia* sp.	2	
14	*Etheostoma fonticola*	1	21
	Gambusia sp.	1	
15	No fish or crustaceans collected		
	Marisa cornuarietis	2	16,25
	***Melanoides-slight*		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	
Landa Lake		V1- Site 2	
Date:	**Time:**	**Observer(s):**	
5/9/2016	1415-1445	JW,JO,JG,NP	

Overall	Species	Number	Avg. Length (mm)
27	*Procambarus* sp.		
9	*Palaemonetes* sp.		
268	*Gambusia* sp.		
1	*Lepomis miniatus*		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	72	10,19,7,40,22,21,20,14,13,17,20,22,19,31,11,14,15, 40,15,10,31,14,14,16,13
	Palaemonetes sp.	2	
	Procambarus sp.	6	
2	*Lepomis miniatus*	1	84
	Palaemonetes sp.	4	
	Gambusia sp.	84	
	Procambarus sp.	3	
3	*Gambusia* sp.	29	
4	*Gambusia* sp.	5	
5	*Gambusia* sp.	8	
	Procambarus sp.	3	
6	*Gambusia* sp.	7	
	Procambarus sp.	4	
	Palaemonetes sp.	1	
7	*Palaemonetes* sp.	1	
	Gambusia sp.	8	
	Procambarus sp.	5	
8	*Gambusia* sp.	8	
9	*Procambarus* sp.	1	
10	*Gambusia* sp.	23	
	Palaemonetes sp.	1	
	Procambarus sp.	1	
11	*Gambusia* sp.	4	
12	*Gambusia* sp.	9	
	Procambarus sp.	1	
13	*Procambarus* sp.	2	
	Gambusia sp.	6	
14	*Procambarus* sp.	1	
15	*Gambusia* sp.	5	

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		
Landa Lake		C2 -Site 3		
Date:	**Time:**	**Observer(s):**		
5/9/2016	1453-1540	JW,JO,JG,NP		

Overall	Species	Number	Avg. Length (mm)
369	*Gambusia* sp.		
2	*Dionda nigrotaeniata*		
2	*Lepomis miniatus*		
15	*Etheostoma fonticola*		
17	*Palaemonetes* sp.		
15	*Procambarus* sp.		
6	*Marisa cornuarietis*		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	171	10,20,21,20,18,21,30,32,20,20,27,22,22,23,18,21, 15,17,20,10,19,20,18,15,9
	Lepomis miniatus	1	81
	Etheostoma fonticola	3	21,20,20
	Palaemonetes sp.	3	
	Procambarus sp.	7	
2	*Dionda nigrotaeniata*	1	14
	Etheostoma fonticola	5	24,17,27,17,20
	Lepomis miniatus	1	31
	Gambusia sp.	93	
	Palaemonetes sp.	2	
3	*Palaemonetes* sp.	4	
	Procambarus sp.	3	
	Gambusia sp.	18	
4	*Etheostoma fonticola*	3	17,21,20
	Gambusia sp.	20	
	Dionda nigrotaeniata	1	16
	Palaemonetes sp.	4	
5	*Etheostoma fonticola*	1	25
	Gambusia sp.	32	
	Procambarus sp.	1	
6	*Procambarus* sp.	1	
	Etheostoma fonticola	1	24
	Palaemonetes sp.	2	
	Gambusia sp.	7	
7	*Procambarus* sp.	2	
	Etheostoma fonticola	1	16
	Gambusia sp.	12	
8	*Palaemonetes* sp.	1	
	Gambusia sp.	2	
9	*Etheostoma fonticola*	1	25
	Gambusia sp.	3	
10	*Gambusia* sp.	2	
11	*Gambusia* sp.	6	
12	*Gambusia* sp.	3	
13	*Palaemonetes* sp.	1	
14	No fish or crustaceans collected		
15	*Procambarus* sp.	1	
	Marisa cornuarietis	6	42,37,39,39,39,38
	***Melanoides-slight*		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach): Landa Lake		**Site:** O1 - Site 4	
Date: 5/10/2016	**Time:** 936-919	**Observer(s):** JW,JO,JG,NP	
Overall	**Species**	**Number**	**Avg. Length (mm)**
1	*Etheostoma fonticola*		
COMAL 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	*Etheostoma fonticola*	1	21
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		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach): Landa Lake		**Site:** O2 - Site 5	
Date: 5/10/2016	**Time:** 954-1013	**Observer(s):** JW,IP,JG,NP	
Overall	**Species**	**Number**	**Avg. Length (mm)**
3	*Gambusia* sp.		
9	*Etheostoma fonticola*		
COMAL RIVER -SPRING 2016 SAMPLING			
Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Etheostoma fonticola*	1	24
2	*Gambusia* sp.	1	10
3	*Gambusia* sp.	1	10
4	*Etheostoma fonticola*	2	15,14
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	*Etheostoma fonticola*	2	10,11
	Gambusia sp.	1	12
9	*Etheostoma fonticola*	2	20,12
10	*Etheostoma fonticola*	1	18
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	*Etheostoma fonticola*	1	19
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		
Landa Lake		L1- Site 6		
Date:	**Time:**	**Observer(s):**		
5/10/2016	1017-1056	JW,IP,JG,NP		

Overall	Species	Number	Avg. Length (mm)
131	*Procambarus* sp.		
84	*Gambusia* sp.		
35	*Etheostoma fonticola*		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	10	
	Gambusia sp.	57	11,15,12,12,15,10,12,15,15,15,15,10,14,15,15,15,17, 15,12,10,10,10,10,10,15
	Etheostoma fonticola	15	18,26,9,18,16,22,22,20,23,12,27,22,20,12,23
2	*Gambusia* sp.	13	
	Procambarus sp.	13	
	Etheostoma fonticola	2	26,17
3	*Procambarus* sp.	16	
	Gambusia sp.	2	
	Etheostoma fonticola	4	26,12,25,11
4	*Etheostoma fonticola*	1	25
	Gambusia sp.	3	
	Procambarus sp.	6	
5	*Etheostoma fonticola*	1	23
	Gambusia sp.	5	
	Procambarus sp.	9	
6	*Etheostoma fonticola*	3	22,16,15
	Gambusia sp.	1	
	Procambarus sp.	10	
7	*Etheostoma fonticola*	3	30,17,28
	Procambarus sp.	11	
8	*Etheostoma fonticola*	1	18
	Procambarus sp.	4	
	Gambusia sp.	3	
9	*Etheostoma fonticola*	2	30,16
	Procambarus sp.	14	
10	*Procambarus* sp.	12	
11	*Procambarus* sp.	7	
12	*Procambarus* sp.	6	
13	*Etheostoma fonticola*	1	20
	Procambarus sp.	6	
14	*Etheostoma fonticola*	2	34,29
	Procambarus sp.	2	
15	*Procambarus* sp.	5	
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		
Landa Lake		C1- Site 7		
Date:	Time:	Observer(s):		
5/10/2016	1102-1133	JW,IP,JG,NP		

Overall	Species	Number	Avg. Length (mm)
172	*Gambusia* sp.		
9	*Etheostoma fonticola*		
1	*Dionda nigrotaeniata*		
12	*Procambarus* sp.		
26	*Palaemonetes* sp.		
1	*Lepomis sp.*		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	11	12,17,12,25,21,15,12,16,11,10,11
	Dionda nigrotaeniata	1	16
	Procambarus sp.	2	
	Palaemonetes sp.	4	
2	*Gambusia* sp.	36	15,28,16,18,20,21,19,21,26,18,20,27,24,15
	Palaemonetes sp.	3	
3	*Etheostoma fonticola*	1	22
	Gambusia sp.	30	
	Palaemonetes sp.	2	
	Procambarus sp.	7	
4	*Etheostoma fonticola*	2	26,10
	Gambusia sp.	9	
5	*Gambusia* sp.	3	
6	*Gambusia* sp.	25	
	Palaemonetes sp.	3	
7	*Etheostoma fonticola*	4	31,26,27,23
	Gambusia sp.	45	
	Palaemonetes sp.	11	
8	*Etheostoma fonticola*	2	28,23
	Gambusia sp.	3	
9	*Lepomis sp.*	1	12
	Gambusia sp.	5	
	Palaemonetes sp.	1	
10	*Procambarus* sp.	2	
11	*Gambusia* sp.	2	
	Palaemonetes sp.	2	
12	*Gambusia* sp.	2	
13	*Procambarus* sp.	1	
14	No fish or crustaceans collected		
15	*Gambusia* sp.	1	
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	
Landa Lake		S2 - Site 8	
Date:	**Time:**	**Observer(s):**	
5/10/2016	1141-1203	JW,IP,JG,NP	
Overall	**Species**	**Number**	**Avg. Length (mm)**
23	*Procambarus* sp.		
4	*Herichthys cyanoguttatus*		
9	*Etheostoma fonticola*		
27	*Gambusia* sp.		
3	*Palaemonetes* sp.		
1	*Lepomis miniatus*		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	1	32
	Gambusia sp.	8	34,19,20,24,12,13,10,9
	Procambarus sp.	3	
2	*Gambusia* sp.	10	26,29,19,32,22,11,16,10,9,10
	Palaemonetes sp.	2	
	Procambarus sp.	5	
3	*Procambarus* sp.	3	
	Herichthys cyanoguttatus	1	55
	Etheostoma fonticola	2	22,19
	Gambusia sp.	6	26,16,10,10,10,11
4	*Lepomis miniatus*	1	120
	Etheostoma fonticola	2	20,19
	Gambusia sp.	1	10
	Procambarus sp.	3	
5	*Gambusia* sp.	1	
6	*Herichthys cyanoguttatus*	1	71
	Palaemonetes sp.	1	
7	*Procambarus* sp.	2	
8	*Procambarus* sp.	1	
9	*Herichthys cyanoguttatus*	2	54,49
10	*Procambarus* sp.	1	
11	*Etheostoma fonticola*	2	18,19
	Procambarus sp.	1	
12	*Procambarus* sp.	2	
13	*Etheostoma fonticola*	1	21
	Gambusia sp.	1	
14	*Procambarus* sp.	1	
	Etheostoma fonticola	1	16
15	*Procambarus* sp.	1	
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
Landa Lake		S1 - Site 9	S3
Date:	**Time:**	**Observer(s):**	
5/10/2016	1209-1241	JW,IP,JG,NP	

Overall	Species	Number	Avg. Length (mm)
1	*Poecilia formosa*		
5	*Etheostoma fonticola*		
1	*Herichthys cyanoguttatus*		
74	*Procambarus* sp.		
2	*Palaemonetes* sp.		
72	*Gambusia* sp.		
2	*Lepomis miniatus*		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	45	15,20,24,14,11,12,9,12,22,10,11,12,11,13, 12,10,11,11,12,10,10,13,13,9,12
	Palaemonetes sp.	1	
	Procambarus sp.	3	
	Lepomis miniatus	1	29
2	*Poecilia formosa*	1	70
	Etheostoma fonticola	3	31,25,17
	Herichthys cyanoguttatus	1	80
	Procambarus sp.	15	
	Palaemonetes sp.	1	
	Gambusia sp.	11	
3	*Procambarus* sp.	13	
	Gambusia sp.	4	
4	*Procambarus* sp.	8	
	Etheostoma fonticola	1	32
	Gambusia sp.	1	
5	*Lepomis miniatus*	1	50
	Procambarus sp.	3	
	Gambusia sp.	3	
6	*Procambarus* sp.	5	
7	*Procambarus* sp.	4	
	Gambusia sp.	6	
8	*Procambarus* sp.	4	
9	*Procambarus* sp.	4	
10	*Etheostoma fonticola*	1	31
	Gambusia sp.	1	
	Procambarus sp.	3	
11	*Procambarus* sp.	3	
	Gambusia sp.	1	
12	No fish or crustaceans collected		
13	*Procambarus* sp.	5	
14	*Procambarus* sp.	4	
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		
Landa Lake		R1 - Site 10		
Date:	**Time:**	**Observer(s):**		
5/10/2016	1321-1405	JW,IP,JG,NP		
Overall	**Species**		**Number**	**Avg. Length (mm)**
86	*Etheostoma fonticola*			
64	*Procambarus* sp.			
23	*Gambusia* sp.			

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	44	29,36,24,27,23,19,18,21,27,13,27,26,25,28,26,17,30,28,22,27,20,21, 23,20,27,21,19,24,26,20,18,24,16,18,14,13,18,15,24,12,11,14,14,14
	Procambarus sp.	8	
	Gambusia sp.	5	18,16,16,18,13
2	*Etheostoma fonticola*	15	29,25,21,27,18,28,22,26,29,12,20,23,13,15,15
	Gambusia sp.	9	15,17,17,18,21,10,18,11,12
	Procambarus sp.	12	
3	*Etheostoma fonticola*	5	24,30,20,13,24
	Gambusia sp.	2	16,19
	Procambarus sp.	11	
4	*Etheostoma fonticola*	2	24,14
	Procambarus sp.	3	
5	*Etheostoma fonticola*	7	23,25,15,15,22,11,23
	Gambusia sp.	6	33,22,13,20,20,20
	Procambarus sp.	6	
6	*Etheostoma fonticola*	3	14,32,23
7	*Etheostoma fonticola*	5	23,28,28,21,18
	Gambusia sp.	1	12
	Procambarus sp.	5	
8	*Procambarus* sp.	4	
9	*Procambarus* sp.	3	
	Etheostoma fonticola	1	26
10	*Etheostoma fonticola*	3	18,25,9
	Procambarus sp.	2	
11	*Procambarus* sp.	5	
12	*Procambarus* sp.	1	
13	*Etheostoma fonticola*	1	20
	Procambarus sp.	4	
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	**Tarebia granifera - moderate*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
Landa Lake		R2- Site 11	R3
Date:	**Time:**	**Observer(s):**	
5/10/2016	1408-1452	JW,IP,JG,NP	

Overall	Species	Number	Avg. Length (mm)
103	*Etheostoma fonticola*		
30	*Gambusia* sp.		
79	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	31	17,15,20,22,21,22,17,30,17,15,17,15,13,22,19,25,16,11,28,16,25,19, 13,12,16,15,11,15,14,14,11
	Gambusia sp.	14	14,21,18,15,15,15,15,15,10,8,10,7,11,9
	Procambarus sp.	14	
2	*Etheostoma fonticola*	10	25,15,15,25,23,18,25,20,28,25
	Gambusia sp.	6	18,15,10,12,15,9
	Procambarus sp.	16	
3	*Etheostoma fonticola*	22	26,17,20,22,20,25,20,21,18,18,32,30,25,21,20,26,20,26,20,10,9,13
	Procambarus sp.	7	
4	*Gambusia* sp.	6	15,10,12,15,9,11
	Etheostoma fonticola	11	28,30,27,12,27,20,23,15,18,15,10
	Procambarus sp.	9	
5	*Procambarus* sp.	8	
	Etheostoma fonticola	10	10,15,15,30,12,20,15,16,14,22
	Gambusia sp.	1	20
6	*Etheostoma fonticola*	6	25,25,26,20,15,20
	Gambusia sp.	1	14
	Procambarus sp.	11	
7	*Etheostoma fonticola*	4	32,30,11,21
	Gambusia sp.	1	16
	Procambarus sp.	4	
8	*Etheostoma fonticola*	2	21,34
	Procambarus sp.	5	
9	*Etheostoma fonticola*	2	25,20
	Procambarus sp.	2	
10	*Etheostoma fonticola*	1	22
	Gambusia sp.	1	20
	Procambarus sp.	1	
11	*Etheostoma fonticola*	2	28,20
12	*Etheostoma fonticola*	1	20
	Procambarus sp.	2	
13	*Etheostoma fonticola*	1	23
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		
Landa Lake		V2 -Site 12		
Date:	**Time:**	**Observer(s):**		
5/10/2016	1455-1536	JW,IP,JG,NP		
Overall	**Species**		**Number**	**Avg. Length (mm)**
4	*Lepomis miniatus*			
13	*Etheostoma fonticola*			
2	*Lepomis sp.*			
10	*Palaemonetes* sp.			
139	*Procambarus* sp.			
493	*Gambusia* sp.			
1	*Marisa cornuarietis*			

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	166	20,20,20,22,20,20,22,27,25,21,20,24,20,31,20, 20,18,20,20,15,22,23,22,30,24
	Lepomis sp.	1	23
	Palaemonetes sp.	8	
	Procambarus sp.	5	
2	*Gambusia* sp.	107	
	Etheostoma fonticola	6	20,23,15,12,21,8
	Procambarus sp.	9	
3	*Lepomis miniatus*	1	40
	Etheostoma fonticola	1	32
	Palaemonetes sp.	1	
	Gambusia sp.	79	
	Procambarus sp.	14	
4	*Lepomis miniatus*	1	71
	Gambusia sp.	12	
	Etheostoma fonticola	1	31
	Procambarus sp.	16	
5	*Lepomis miniatus*	1	70
	Etheostoma fonticola	2	34,21
	Lepomis sp.	1	24
	Palaemonetes sp.	1	
	Procambarus sp.	10	
	Gambusia sp.	74	
6	*Procambarus* sp.	25	
	Etheostoma fonticola	2	34,23
	Gambusia sp.	1	
7	*Procambarus* sp.	20	
	Etheostoma fonticola	1	25
	Gambusia sp.	32	
8	*Gambusia* sp.	1	
	Procambarus sp.	1	
9	*Lepomis miniatus*	1	76
	Procambarus sp.	9	
	Gambusia sp.	5	
10	*Procambarus* sp.	5	
	Gambusia sp.	2	

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		
Landa Lake		L1- Site 1		
Date:	**Time:**	**Observer(s):**		
10/26/2016	1302-1325	JH,JO,JG,DS		
Overall	**Species**		**Number**	**Avg. Length (mm)**
27	*Procambarus* sp.			
1	*Etheostoma lepidum*			
141	*Gambusia* sp.			
6	*Etheostoma fonticola*			

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma lepidum*	1	47
	Gambusia sp.	68	26,29,31,22,26,28,23,23,27,24,21,28,12,22,20,19,29,26, 24,22,25,23,28,20,28,22,18,27,23,20,18,20,20,20,21
	Procambarus sp.	2	
2	*Etheostoma fonticola*	4	26,31,14,23
	Procambarus sp.	6	
	Gambusia sp.	25	
3	*Gambusia* sp.	5	
	Procambarus sp.	2	
4	*Gambusia* sp.	27	
5	*Gambusia* sp.	3	
6	*Procambarus* sp.	4	
	Etheostoma fonticola	1	33
	Gambusia sp.	4	
7	*Procambarus* sp.	1	
	Etheostoma fonticola	1	23
	Gambusia sp.	2	
8	*Procambarus* sp.	4	
9	*Procambarus* sp.	1	
	Gambusia sp.	1	
10	*Gambusia* sp.	1	
11	*Procambarus* sp.	1	
12	*Procambarus* sp.	4	
	Gambusia sp.	5	
13	*Procambarus* sp.	2	
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	
Landa Lake		V1- Site 2	
Date: 10/26/2016	**Time:** 1334-1349	**Observer(s):** JH,JO,JG,DS	

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

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	4	15,21,17,20
2	*Procambarus* sp.	2	
	Gambusia sp.	1	22
3	*Procambarus* sp.	1	
	Gambusia sp.	1	28
4	No fish or crustaceans collected		
5	*Etheostoma fonticola*	1	27
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	*Gambusia* sp.	1	12
11	No fish or crustaceans collected		
12	*Procambarus* sp.	1	
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach): Landa Lake		**Site:** C1- Site 3	
Date: 10/26/2016	**Time:** 1352-1420	**Observer(s):** JH,JO,JG,DS	
Overall	**Species**	**Number**	**Avg. Length (mm)**
352	*Gambusia* sp.		
6	*Etheostoma fonticola*		
9	*Procambarus* sp.		
1	*Palaemonetes* sp.		
1	*Marisa cornuarietis*		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Gambusia* sp.	220	11,10,10,10,10,12,16,15,12,12,11,11,13,12,13, 15,13,10,17,16,21,22,14,15,15,15,17,15,20
	Etheostoma fonticola	1	33
	Procambarus sp.	3	
2	*Palaemonetes* sp.	1	
	Gambusia sp.	55	
	Procambarus sp.	2	
3	*Etheostoma fonticola*	1	32
	Gambusia sp.	2	
	Procambarus sp.	1	
4	*Procambarus* sp.	2	
	Gambusia sp.	25	
5	*Etheostoma fonticola*	1	33
	Gambusia sp.	10	
6	*Gambusia* sp.	16	
7	*Etheostoma fonticola*	2	32,35
	Gambusia sp.	7	
8	*Gambusia* sp.	5	
9	*Procambarus* sp.	1	
	Gambusia sp.	2	
10	*Etheostoma fonticola*	1	32
	Gambusia sp.	8	
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	*Gambusia* sp.	1	
14	*Gambusia* sp.	1	
15	No fish or crustaceans collected		
	Marisa cornuarietis	1	35
	***Melanoides-slight*		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		Site on Map:
Landa Lake		C2 -Site 4		C3
Date: 10/26/2016	**Time:** 1436-1508	**Observer(s):** JH,JO,JG,DS		

Overall	Species	Number	Avg. Length (mm)
33	*Etheostoma fonticola*		
92	*Gambusia* sp.		
4	*Lepomis miniatus*		
2	*Palaemonetes* sp.		
49	*Procambarus* sp.		
1	*Marisa cornuarietis*		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Palaemonetes* sp.	2	
	Etheostoma fonticola	12	28,32,27,30,25,29,33,33,27,37,26,24
	Procambarus sp.	22	
	Lepomis miniatus	2	55,42
	Gambusia sp.	53	30,10,12,12,11,11,10,12,16,12,12,12,12,13,11,12, 11,12,12,15,12,13,13,15,12
2	*Etheostoma fonticola*	4	24,28,30,33
	Gambusia sp.	15	
3	*Etheostoma fonticola*	3	33,32,27
	Gambusia sp.	6	
4	*Lepomis miniatus*	1	35
	Procambarus sp.	4	
	Etheostoma fonticola	6	30,31,29,29,31,32
	Gambusia sp.	9	
5	*Procambarus* sp.	3	
	Gambusia sp.	1	
6	*Procambarus* sp.	1	
7	*Etheostoma fonticola*	1	28
	Procambarus sp.	3	
	Gambusia sp.	2	
8	*Etheostoma fonticola*	1	28
	Procambarus sp.	3	
	Gambusia sp.	2	
9	*Procambarus* sp.	1	
10	*Procambarus* sp.	4	
	Etheostoma fonticola	1	32
11	*Gambusia* sp.	3	
	Procambarus sp.	2	
12	*Procambarus* sp.	3	
13	No fish or crustaceans collected		
14	*Etheostoma fonticola*	5	33,29,31,30,30
	Procambarus sp.	1	
	Gambusia sp.	1	
15	*Lepomis miniatus*	1	43
	Procambarus sp.	2	
	Marisa cornuarietis	1	32
	***Melanoides-slight*		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		
Landa Lake		L2- Site 5		
Date:	**Time:**	**Observer(s):**		
10/26/2016	1514-1538	JH,JO,JG,DS		

Overall	Species	Number	Avg. Length (mm)
15	*Etheostoma fonticola*		
80	*Gambusia* sp.		
1	*Lepomis miniatus*		
5	*Palaemonetes* sp.		
18	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	25	26,27,25,21,19,10,31,30,30,28,27,22,15,15,20,12,29,32, 12,15,10,16,20,11,10
	Palaemonetes sp.	1	
	Etheostoma fonticola	4	28,29,30,14
2	*Procambarus* sp.	8	
	Palaemonetes sp.	2	
	Etheostoma fonticola	2	33,17
	Gambusia sp.	20	
3	*Etheostoma fonticola*	4	23,20,18,13
	Gambusia sp.	16	
4	*Lepomis miniatus*	1	60
	Etheostoma fonticola	1	17
	Palaemonetes sp.	1	
	Procambarus sp.	2	
	Gambusia sp.	8	
5	*Procambarus* sp.	3	
	Gambusia sp.	6	
6	*Etheostoma fonticola*	1	29
	Gambusia sp.	2	
	Palaemonetes sp.	1	
	Procambarus sp.	1	
7	No fish or crustaceans collected		
8	*Gambusia* sp.	2	
9	No fish or crustaceans collected		
10	*Procambarus* sp.	2	
11	*Procambarus* sp.	2	
12	*Etheostoma fonticola*	2	34,35
13	No fish or crustaceans collected		
14	*Etheostoma fonticola*	1	22
15	*Gambusia* sp.		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**	
Landa Lake		V2 -Site 6	
Date:	**Time:**	**Observer(s):**	
10/27/2016	848-920	JH,JO,JG,DS	

Overall	**Species**	**Number**	**Avg. Length (mm)**
20	*Etheostoma fonticola*		
319	*Gambusia* sp.		
8	*Lepomis miniatus*		
1	*Micropterus salmoides*		
11	*Palaemonetes* sp.		
2	*Poecilia latipinna*		
36	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Micropterus salmoides*	1	128
	Lepomis miniatus	1	93
	Etheostoma fonticola	4	31,29,21,32
	Procambarus sp.	5	
	Gambusia sp.	144	18,34,21,33,12,20,20,20,19,15,16,24,18,20,25, 16,30,16,26,27,15,20,24,22,19
	Poecilia latipinna	1	24
	Palaemonetes sp.	5	
2	*Lepomis miniatus*	1	88
	Etheostoma fonticola	6	29,32,32,31,27,32
	Palaemonetes sp.	1	
	Gambusia sp.	63	
3	*Lepomis miniatus*	1	146
	Gambusia sp.	16	
	Procambarus sp.	2	
4	*Etheostoma fonticola*	1	31
	Poecilia latipinna	1	24
	Palaemonetes sp.	3	
	Procambarus sp.	4	
	Gambusia sp.	30	
5	*Lepomis miniatus*	1	87
	Gambusia sp.	11	
	Procambarus sp.	4	
	Palaemonetes sp.	2	
6	*Gambusia* sp.	16	
7	*Lepomis miniatus*	2	146,35
	Etheostoma fonticola	3	26,32,21
	Gambusia sp.	7	
	Procambarus sp.	5	
8	*Etheostoma fonticola*	1	31
	Gambusia sp.	8	
	Procambarus sp.	1	
9	*Etheostoma fonticola*	2	30,28
	Procambarus sp.	3	
10	*Lepomis miniatus*	1	115
	Etheostoma fonticola	3	29,22,27
	Procambarus sp.	3	
	Gambusia sp.	9	

COMAL RIVER -SPRING 2016 SAMPLING			
Dip net sweep	**Species**	**Number**	**Length (mm)**
11	*Gambusia* sp.	3	
12	*Gambusia* sp.	7	
13	*Procambarus* sp.	4	
14	*Gambusia* sp.	5	
15	*Lepomis miniatus*	1	75
	Procambarus sp.	5	
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		Site on Map:
Landa Lake		S2 - Site 7		S3
Date:	**Time:**	**Observer(s):**		
10/27/2016	925-940	JH,JO,JG,DS		

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

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	3	25,20,23
	Procambarus sp.	2	
2	*Gambusia* sp.	4	29,22,21,18
3	*Procambarus* sp.	4	
	Gambusia sp.	2	20,26
4	*Procambarus* sp.	1	
	Gambusia sp.	4	21,20,35,27
5	*Procambarus* sp.	11	
6	*Gambusia* sp.	3	30,30,27
	Procambarus sp.	1	
7	*Procambarus* sp.	3	
8	*Procambarus* sp.	1	
	Gambusia sp.	1	18
9	*Procambarus* sp.	3	
10	*Procambarus* sp.	3	
	Etheostoma fonticola	1	31
	Gambusia sp.	2	15,20
11	*Procambarus* sp.	2	
12	No fish or crustaceans collected		
13	*Procambarus* sp.	3	
	Lepomis miniatus	1	66
14	*Procambarus* sp.	3	
15	*Procambarus* sp.	3	

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
Landa Lake		S1 - Site 8	S3
Date: 10/27/2016	**Time:** 945-1004	**Observer(s):** JH,JO,JG,DS	

Overall	Species	Number	Avg. Length (mm)
66	*Gambusia* sp.		
1	*Lepomis miniatus*		
1	*Micropterus salmoides*		
3	*Palaemonetes* sp.		
17	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	41	15,13,16,12,11,14,28,11,16,19,20,18,10,15,17,17,19,11,12,9,14,15,9,12
	Lepomis miniatus	1	95
	Procambarus sp.	3	
2	*Gambusia* sp.	6	
	Procambarus sp.	2	
	Palaemonetes sp.	1	
3	*Gambusia* sp.	1	
4	*Gambusia* sp.	5	
	Procambarus sp.	1	
5	*Procambarus* sp.	5	
6	*Procambarus* sp.	1	
	Gambusia sp.	1	
7	*Procambarus* sp.	1	
8	*Gambusia* sp.	2	
	Procambarus sp.	1	
9	*Palaemonetes* sp.	1	
	Procambarus sp.	1	
	Gambusia sp.	1	
10	*Micropterus salmoides*	1	95
	Gambusia sp.	1	
11	*Procambarus* sp.	1	
	Gambusia sp.	2	
	Palaemonetes sp.	1	
12	*Gambusia* sp.	4	
13	*Gambusia* sp.	1	
14	*Procambarus* sp.	1	
15	*Gambusia* sp.	1	
	***Melanoides-slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
Landa Lake		R1 - Site 9	R3
Date:	**Time:**	**Observer(s):**	
10/27/2016	1009-1101	JH,JO,JG,DS	

Overall	Species	Number	Avg. Length (mm)
107	*Etheostoma fonticola*		
97	*Procambarus* sp.		
2	*Palaemonetes* sp.		
20	*Gambusia* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	14	22,25,34,26,28,25,20,15,26,11,15,25,22,26
	Gambusia sp.	3	14,16,15
	Procambarus sp.	20	
2	*Etheostoma fonticola*	25	32,25,29,32,33,24,28,26,27,32,24,14,21,29, 29,29,24,23,29,31,23,27,20,17,25
	Procambarus sp.	41	
	Palaemonetes sp.	1	
	Gambusia sp.	4	15,16,16,18
3	*Etheostoma fonticola*	24	16,29,25,13,30,33,22,30,14,31,27,31,31,31,25, 24,30,30,31,26,30,28,22,26
	Gambusia sp.	3	15,11,17
4	*Etheostoma fonticola*	16	27,29,29,31,30,25,14,33,18,3128,27,15,34,27,22
	Gambusia sp.	1	13
	Palaemonetes sp.	1	
	Procambarus sp.	20	
5	*Etheostoma fonticola*	3	17,30,24
	Procambarus sp.	1	
6	*Etheostoma fonticola*	4	24,24,25,14
	Procambarus sp.	6	
7	*Etheostoma fonticola*	3	30,17,22
	Gambusia sp.	1	15
8	*Etheostoma fonticola*	5	28,14,24,26,27
	Gambusia sp.	7	
9	*Gambusia* sp.	1	21
	Etheostoma fonticola	1	14
	Procambarus sp.	3	
10	*Etheostoma fonticola*	3	29,31,22
	Procambarus sp.	2	
11	*Etheostoma fonticola*	1	31
	Procambarus sp.	3	
12	*Etheostoma fonticola*	4	25,27,21,25
	Procambarus sp.	1	
13	No fish or crustaceans collected		
14	*Etheostoma fonticola*	4	30,26,27,25
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on Map:
Landa Lake		R2- Site 10	
Date:	**Time:**	**Observer(s):**	
10/27/2016	1105-1140	JH,JO,JG,DS	

Overall	Species	Number	Avg. Length (mm)
67	*Etheostoma fonticola*		
29	*Gambusia* sp.		
6	*Palaemonetes* sp.		
99	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	8	27,30,30,34,23,32,28,25
	Gambusia sp.	4	16,21,15,17
	Procambarus sp.	32	
2	*Palaemonetes* sp.	2	
	Etheostoma fonticola	7	32,32,25,26,30,26,23,24
	Gambusia sp.	9	24,20,25,13,20,20,18,26,23,17
3	*Etheostoma fonticola*	12	26,27,27,15,22,30,29,17,31,26
	Procambarus sp.	27	
	Palaemonetes sp.	3	
4	*Etheostoma fonticola*	14	27,25,19,25,26,27,29,27,30,28
	Gambusia sp.	2	19,23
	Palaemonetes sp.	1	
	Procambarus sp.	13	
5	*Etheostoma fonticola*	12	25,30,32,25,31,32,22,24,26,24,25,14
	Gambusia sp.	5	17,22,21,20,19
	Procambarus sp.	7	
6	*Etheostoma fonticola*	6	26,24,29,22,25,29
	Gambusia sp.	3	17,12,12
7	*Etheostoma fonticola*	5	33,27,23,25,26
	Procambarus sp.	6	
8	*Procambarus* sp.	7	
9	*Gambusia* sp.	3	15,15
	Etheostoma fonticola	1	21
10	*Etheostoma fonticola*	1	33
	Gambusia sp.	1	
11	No fish or crustaceans collected		
12	*Procambarus* sp.	1	
	Etheostoma fonticola	1	26
13	No fish or crustaceans collected		
14	*Procambarus* sp.	6	
	Gambusia sp.	2	
15	No fish or crustaceans collected		
	**Tarebia granifera - moderate*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach): Landa Lake		Site: O1 - Site 11	
Date:	Time:	Observer(s):	

Overall	Species	Number	Avg. Length (mm)

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach): Landa Lake		**Site:** O2 - Site 12	
Date:	**Time:**	**Observer(s):**	

Overall	**Species**	**Number**	**Avg. Length (mm)**
COMAL RIVER -SPRING 2016 SAMPLING			
Dip net sweep	**Species**	**Number**	**Length (mm)**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on map:
New Channel		H1- Site 1	H4
Date:	**Time:**	**Observer(s):**	
5/11/2016	1400-1423	NP,JW,IP,JG	

Overall	Species	Number	Avg. Length (mm)
7	*Lepomis miniatus*		
2	*Lepomis gulosus*		
24	*Procambarus* sp.		
14	*Etheostoma fonticola*		
1	*Lepomis sp.*		
7	*Palaemonetes* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	4	55,70,23,32
	Lepomis gulosus	2	110,55
	Procambarus sp.	3	
	Etheostoma fonticola	5	26,28,20,16,16
	Lepomis sp.	1	15
	Palaemonetes sp.	4	
2	*Procambarus* sp.	4	
	Etheostoma fonticola	2	22,25
3	*Procambarus* sp.	1	
4	*Procambarus* sp.	6	
	Lepomis miniatus	1	62
	Etheostoma fonticola	1	16
5	*Lepomis miniatus*	2	72,63
	Etheostoma fonticola	4	18,32,22,16
	Procambarus sp.	3	
	Palaemonetes sp.	1	
6	*Palaemonetes* sp.	1	
7	*Etheostoma fonticola*	1	24
	Procambarus sp.	1	
8	*Palaemonetes* sp.	1	
9	No fish or crustaceans collected		
10	*Procambarus* sp.	2	
11	*Procambarus* sp.	2	
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	*Etheostoma fonticola*	1	22
	Procambarus sp.	1	
15	*Procambarus* sp.	1	
	**Tarebia granifera -slight*		
	***Corbicula - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach): New Channel		Site: O1- Site 2	Site on map:
Date: 5/11/2016	Time: 1425-1430	Observer(s): NP,JW,IP,JG	

Overall	Species	Number	Avg. Length (mm)

COMAL 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* ***Corbicula - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		**Site:**		**Site on map:**
New Channel		H2 -Site 3		H5
Date: 5/11/2016	**Time:** 1432-1457	**Observer(s):** NP,JW,IP,JG		

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

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Procambarus* sp.	4	
	Palaemonetes sp.	1	
2	*Gambusia sp.*	1	29
	Procambarus sp.	7	
	Palaemonetes sp.	4	
3	*Lepomis miniatus*	1	52
	Etheostoma fonticola	2	26,27
	Palaemonetes sp.	10	
4	*Procambarus* sp.	2	
	Palaemonetes sp.	1	
5	*Etheostoma fonticola*	1	32
	Procambarus sp.	5	
6	*Procambarus* sp.	9	
7	*Procambarus* sp.	3	
8	*Procambarus* sp.	3	
9	No fish or crustaceans collected		
10	*Procambarus* sp.	13	
	Etheostoma fonticola	1	25
11	*Etheostoma fonticola*	1	22
12	*Etheostoma fonticola*	1	28
	Lepomis miniatus	1	57
13	No fish or crustaceans collected		
14	*Procambarus* sp.	1	
	Etheostoma fonticola	1	28
15	*Procambarus* sp.	2	
	**Tarebia granifera -slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		Site on map:
New Channel		O2- Site 4		
Date: 5/11/2016	**Time:** 1459-1505	**Observer(s):** NP,JW,IP,JG		
Overall	**Species**		**Number**	**Avg. Length (mm)**
1	*Procambarus* sp.			

COMAL 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	*Procambarus* sp.	1	
10	No fish or crustaceans collected		
	**Tarebia granifera -slight* ***Corbicula - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on map:
New Channel		C1-Site 5	C3
Date:	**Time:**	**Observer(s):**	
5/11/2016	1511-1545	NP,JW,IP,JG	

Overall	Species	Number	Avg. Length (mm)
5	*Lepomis cyanellus*		
6	*Lepomis miniatus*		
32	*Etheostoma fonticola*		
4	*Gambusia sp.*		
42	*Procambarus* sp.		
71	*Palaemonetes* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	8	25,22,17,28,15,22,16,10
	Lepomis cyanellus	1	59
	Lepomis miniatus	2	69,25
	Gambusia sp.	2	11,10
	Palaemonetes sp.	11	
2	*Etheostoma fonticola*	12	15,32,23,20,21,13,23,16,13,15,15,16
	Lepomis cyanellus	2	55,56
	Palaemonetes sp.	22	
	Procambarus sp.	1	
3	*Lepomis miniatus*	2	109,35
	Etheostoma fonticola	4	31,25,22,24
	Gambusia sp.	1	9
	Palaemonetes sp.	10	
4	*Procambarus* sp.	7	
	Lepomis miniatus	1	80
	Etheostoma fonticola	5	15,16,8,19,27
	Lepomis cyanellus	1	52
	Palaemonetes sp.	10	
5	*Procambarus* sp.	2	
	Gambusia sp.	1	10
	Palaemonetes sp.	4	
6	*Lepomis cyanellus*	1	50
	Etheostoma fonticola	1	17
	Procambarus sp.	8	
	Palaemonetes sp.	1	
7	*Procambarus* sp.	7	
	Palaemonetes sp.	2	
8	*Procambarus* sp.	2	
	Palaemonetes sp.	2	
9	*Etheostoma fonticola*	1	16
	Palaemonetes sp.	2	
10	*Palaemonetes* sp.	2	
11	*Procambarus* sp.	3	
	Palaemonetes sp.	1	
12	*Procambarus* sp.	6	
	Etheostoma fonticola	1	20
	Palaemonetes sp.	1	
13	*Procambarus* sp.	4	
	Lepomis miniatus	1	40
	Palaemonetes sp.	3	
14	*Procambarus* sp.	1	
15	*Procambarus* sp.	1	
	**Tarebia granifera -slight*		
	***Corbicula - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on map:
New Channel		C2- Site 6	C4
Date:	Time:	Observer(s):	
5/11/2016	1550-1615	NP,JW,IP,JG	

Overall	Species	Number	Avg. Length (mm)
6	*Lepomis cyanellus*		
19	*Palaemonetes* sp.		
1	*Lepomis macrochirus*		
2	*Lepomis sp.*		
10	*Gambusia sp.*		
45	*Procambarus* sp.		
52	*Etheostoma fonticola*		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis cyanellus*	3	40,42,55
	Etheostoma fonticola	3	20,11,27
	Procambarus sp.	2	
	Palaemonetes sp.	3	
2	*Lepomis macrochirus*	1	74
	Lepomis cyanellus	1	74
	Lepomis sp.	1	30
	Palaemonetes sp.	1	
3	*Lepomis cyanellus*	1	34
	Etheostoma fonticola	1	23
4	*Etheostoma fonticola*	19	22,22,20,31,15,11,15,27,20,16,15,21,15,10, 14,15,13,11,15
	Lepomis sp.	1	36
	Gambusia sp.	3	12,12,9
	Procambarus sp.	13	
	Palaemonetes sp.	4	
5	*Etheostoma fonticola*	2	15,12
	Gambusia sp.	2	11,10
	Procambarus sp.	4	
	Palaemonetes sp.	1	
6	*Procambarus* sp.	3	
	Etheostoma fonticola	4	20,34,15,19
	Gambusia sp.	4	9,10,10,9
	Palaemonetes sp.	2	
7	*Procambarus* sp.	1	
	Etheostoma fonticola	4	27,14,22,19
	Palaemonetes sp.	1	
8	*Etheostoma fonticola*	6	36,31,25,20,16,27
	Procambarus sp.	5	
	Palaemonetes sp.	5	
9	*Etheostoma fonticola*	5	15,20,14,11,11
	Procambarus sp.	1	
10	*Gambusia sp.*	1	
11	*Procambarus* sp.	1	
	Etheostoma fonticola	1	26
	Palaemonetes sp.	1	

COMAL RIVER -SPRING 2016 SAMPLING			
Dip net sweep	**Species**	**Number**	**Length (mm)**
12	*Procambarus* sp.	11	
	Etheostoma fonticola	5	25,21,12,13,16
	Lepomis cyanellus	1	
13	*Etheostoma fonticola*	2	31,13
	Palaemonetes sp.	1	
14	*Procambarus* sp.	4	
15	No fish or crustaceans collected		
	**Tarebia granifera -slight*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach): New Channel		**Site:** L1- Site 7	
Date:	**Time:**	**Observer(s):**	
Overall	**Species**	**Number**	**Avg. Length (mm)**
	Site not sampled - too deep		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach): New Channel		**Site:** L2- Site 8	
Date:	**Time:**	**Observer(s):**	
Overall	**Species**	**Number**	**Avg. Length (mm)**
	Site not sampled - too deep		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach): New Channel		**Site:** C1-Site 1	**Site on map:**
Date: 10/28/2016	**Time:** 848-912	**Observer(s):** NP,JH,JO,JG	

Overall	**Species**	**Number**	**Avg. Length (mm)**
1	*Etheostoma fonticola*		
1	*Gambusia sp.*		
4	*Lepomis cyanellus*		
17	*Lepomis macrochirus*		
6	*Lepomis miniatus*		
10	*Procambarus* sp.		

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Lepomis macrochirus*	4	38,36,38,45
	Lepomis miniatus	2	47,34
2	*Lepomis macrochirus*	3	36,35,38
	Lepomis cyanellus	1	40
	Procambarus sp.	1	
3	*Lepomis macrochirus*	5	40,41,31,37,37
	Lepomis cyanellus	1	37
	Procambarus sp.	1	
4	*Lepomis miniatus*	1	105
	Lepomis cyanellus	1	63
	Procambarus sp.	3	
5	*Lepomis miniatus*	1	73
	Lepomis macrochirus	1	32
6	*Lepomis macrochirus*	2	43,45
	Lepomis miniatus	1	53
	Etheostoma fonticola	1	27
	Procambarus sp.	1	
7	*Procambarus* sp.	1	
8	*Lepomis miniatus*	1	32
9	*Lepomis macrochirus*	1	42
	Procambarus sp.	1	
10	*Lepomis cyanellus*	1	48
11	No fish or crustaceans collected		
12	*Lepomis macrochirus*	1	42
13	*Gambusia sp.*	1	
	Procambarus sp.	1	
14	*Procambarus* sp.	1	
15	No fish or crustaceans collected		
	**Tarebia granifera -slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach): New Channel		**Site:** H1- Site 2	**Site on map:**
Date: 10/28/2016	**Time:** 917-931	**Observer(s):** NP,JH,JO,JG	

Overall	Species	Number	Avg. Length (mm)
1	*Herichthys cyanoguttatus*		
1	*Etheostoma fonticola*		
10	*Procambarus* sp.		
1	*Lepomis cyanellus*		

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	1	
2	No fish or crustaceans collected		
3	*Procambarus* sp.	3	
4	*Herichthys cyanoguttatus*	1	25
5	*Etheostoma fonticola*	1	35
6	*Procambarus* sp.	1	
7	*Lepomis cyanellus*	1	45
	Procambarus sp.	1	
8	No fish or crustaceans collected		
9	*Procambarus* sp.	2	
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
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

COMAL RIVER -FALL 2016 SAMPLING

Location (Reach):		**Site:**	**Site on map:**
New Channel		H2 -Site 3	
Date: 10/28/2016	**Time:** 935-950	**Observer(s):** NP,JH,JO,JG	

Overall	**Species**	**Number**	**Avg. Length (mm)**
5	*Lepomis miniatus*		
1	*Gambusia sp.*		
25	*Procambarus* sp.		

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Lepomis miniatus*	4	90,102,72,78
	Procambarus sp.	2	
2	*Procambarus* sp.	4	
3	*Gambusia sp.*	1	38
4	*Procambarus* sp.	3	
5	*Lepomis miniatus*	1	130
	Procambarus sp.	1	
6	*Procambarus* sp.	2	
7	No fish or crustaceans collected		
8	*Procambarus* sp.	3	
9	No fish or crustaceans collected		
10	*Procambarus* sp.	4	
11	*Procambarus* sp.	1	
12	*Procambarus* sp.	1	
13	*Procambarus* sp.	2	
14	*Procambarus* sp.	1	
15	*Procambarus* sp.	1	
	**Tarebia granifera -slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach): New Channel		Site: O1- Site 4	Site on map:
Date: 10/28/2016	Time: 952-955	Observer(s): NP,JH,JO,JG	

Overall	Species	Number	Avg. Length (mm)

COMAL 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		
	***Corbicula - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach): New Channel		**Site:** O2- Site 5	**Site on map:**
Date: 10/28/2016	**Time:** 956-1000	**Observer(s):** NP,JH,JO,JG	

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

COMAL 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		
	***Corbicula - moderate*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach): New Channel		**Site:** C2- Site 6	**Site on map:**
Date: 10/28/2016	**Time:** 1010-1025	**Observer(s):** NP,JH,JO,JG	

Overall	**Species**	**Number**	**Avg. Length (mm)**
5	*Etheostoma fonticola*		
1	*Gambusia sp.*		
2	*Lepomis cyanellus*		
1	*Lepomis macrochirus*		
21	*Procambarus* sp.		

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Etheostoma fonticola*	1	25
	Procambarus sp.	4	
2	*Lepomis cyanellus*	1	37
3	*Gambusia sp.*	1	10
	Procambarus sp.	1	
4	No fish or crustaceans collected		
5	*Etheostoma fonticola*	4	30.20.30.23
	Procambarus sp.	4	
6	No fish or crustaceans collected		
7	*Lepomis cyanellus*	1	40
	Lepomis macrochirus	1	28
	Procambarus sp.	3	
8	*Procambarus* sp.	1	
9	*Procambarus* sp.	2	
10	*Procambarus* sp.	1	
11	*Procambarus* sp.	3	
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

COMAL RIVER -FALL 2016 SAMPLING

Location (Reach): New Channel		Site: L1- Site 7	
Date: 10/28/2016	Time:	Observer(s):	

Overall	Species	Number	Avg. Length (mm)
	Site not sampled - no Ludwigia present		
COMAL RIVER -FALL 2016 SAMPLING			
Dip net sweep	**Species**	**Number**	**Length (mm)**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach): New Channel		**Site:** L2- Site 8		
Date: 10/28/2016	**Time:**	**Observer(s):**		
Overall	**Species**		**Number**	**Avg. Length (mm)**
	Site not sampled - no Ludwigia present			
COMAL RIVER -FALL 2016 SAMPLING				
Dip net sweep	**Species**		**Number**	**Length (mm)**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		
Old Channel		H2- Site 1		
Date:	Time:	Observer(s):		
5/11/2016	901-940	JW,JG,NP		

Overall	Species	Number	Avg. Length (mm)
13	*Etheostoma fonticola*		
16	*Gambusia sp.*		
1	*Hypostomus plecostomus*		
1	*Lepomis miniatus*		
1	*Lepomis sp.*		
125	*Palaemonetes* sp.		
56	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Palaemonetes* sp.	61	
	Gambusia sp.	10	20,25,18,20,19,10,23,15,16,15
	Etheostoma fonticola	5	22,22,22,19,22
	Procambarus sp.	2	
	Hypostomus plecostomus	1	21
2	*Procambarus* sp.	22	
	Gambusia sp.	4	11,17,15,10
	Palaemonetes sp.	28	
	Lepomis sp.	1	11
3	*Procambarus* sp.	10	
	Palaemonetes sp.	11	
4	*Procambarus* sp.	5	
	Etheostoma fonticola	1	24
	Gambusia sp.	1	17
	Palaemonetes sp.	11	
5	*Procambarus* sp.	5	
	Lepomis miniatus	1	24
	Gambusia sp.	1	12
	Etheostoma fonticola	3	22,20,27
	Palaemonetes sp.	5	
6	*Palaemonetes* sp.	5	
7	*Etheostoma fonticola*	1	19
	Palaemonetes sp.	1	
	Procambarus sp.	2	
8	*Etheostoma fonticola*	1	22
9	*Procambarus* sp.	3	
10	*Procambarus* sp.	1	
	Palaemonetes sp.	2	
11	*Etheostoma fonticola*	1	28
12	*Etheostoma fonticola*	1	20
	Palaemonetes sp.	1	
13	*Procambarus* sp.	3	
14	*Procambarus* sp.	1	
15	*Procambarus* sp.	2	
	*** Tarebia granifera - slight*		
	**Corbicula - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on map:
Old Channel		H1-Site 2	
Date:	**Time:**	**Observer(s):**	
5/11/2016	940-1015	JW,JG,NP	

Overall	Species	Number	Avg. Length (mm)
15	*Etheostoma fonticola*		
6	*Gambusia sp.*		
10	*Hypostomus plecostomus*		
2	*Lepomis miniatus*		
3	*Lepomis sp.*		
97	*Palaemonetes* sp.		
31	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Palaemonetes* sp.	43	
	Procambarus sp.	5	
	Etheostoma fonticola	8	27,21,22,28,18,20,27,20
	Lepomis sp.	2	16,24
	Gambusia sp.	3	18,17,20
	Hypostomus plecostomus	5	17,20,18,19,21
2	*Lepomis miniatus*	1	29
	Hypostomus plecostomus	2	18,22
	Gambusia sp.	2	32,19
	Palaemonetes sp.	31	
	Procambarus sp.	5	
3	*Lepomis miniatus*	1	94
	Etheostoma fonticola	2	19,21
	Hypostomus plecostomus	1	22
	Palaemonetes sp.	6	
	Procambarus sp.	4	
4	*Hypostomus plecostomus*	1	16
	Procambarus sp.	5	
	Palaemonetes sp.	6	
5	*Procambarus* sp.	4	
	Etheostoma fonticola	2	28,19
	Gambusia sp.	1	16
	Palaemonetes sp.	7	
6	*Hypostomus plecostomus*	1	16
	Etheostoma fonticola	1	24
	Lepomis sp.	1	13
	Procambarus sp.	2	
	Palaemonetes sp.	1	
7	*Palaemonetes* sp.	1	
8	*Etheostoma fonticola*	1	20
	Palaemonetes sp.	1	
9	No fish or crustaceans collected		
10	*Procambarus* sp.	2	
11	*Etheostoma fonticola*	1	21
	Palaemonetes sp.	1	
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	*Procambarus* sp.	3	
15	*Procambarus* sp.	1	
	*** Tarebia granifera - slight*		
	**Corbicula - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on map:
Old Channel		R1- Site 3	R3
Date: 5/11/2016	**Time:** 1017-1103	**Observer(s):** JW,JG,NP	

Overall	Species	Number	Avg. Length (mm)
1	*Dionda nigrotaeriata*		
65	*Etheostoma fonticola*		
2	*Gambusia sp.*		
2	*Lepomis sp.*		
31	*Palaemonetes* sp.		
88	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Palaemonetes* sp.	12	
	Procambarus sp.	11	
	Etheostoma fonticola	23	28,25,23,27,26,24,16,15,24,30,27,28,15,17,15, 13,27,24,28,16,11,12,16
	Lepomis sp.	1	9
2	*Etheostoma fonticola*	11	15,12,27,34,25,27,21,18,16,15,16
	Lepomis sp.	1	13
	Palaemonetes sp.	11	
	Procambarus sp.	6	
3	*Procambarus* sp.	13	
	Etheostoma fonticola	3	23,24,10
	Palaemonetes sp.	3	
4	*Etheostoma fonticola*	13	25,15,26,20,22,30,27,25,29,25,31,16,26
	Gambusia sp.	1	10
	Procambarus sp.	14	
	Palaemonetes sp.	3	
5	*Etheostoma fonticola*	3	26,25,26
	Palaemonetes sp.	1	
	Procambarus sp.	7	
6	*Procambarus* sp.	7	
7	*Etheostoma fonticola*	5	21,24,26,23,12
	Procambarus sp.	7	
8	*Procambarus* sp.	8	
	Etheostoma fonticola	3	20,27,32
9	*Procambarus* sp.	8	
	Etheostoma fonticola	1	20
10	*Dionda nigrotaeriata*	1	14
	Etheostoma fonticola	1	25
	Procambarus sp.	4	
11	*Etheostoma fonticola*	1	29
	Procambarus sp.	1	
12	*Gambusia sp.*	1	26
	Etheostoma fonticola	1	22
	Palaemonetes sp.	1	
	Procambarus sp.	2	
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

COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:		
Old Channel		O1-Site 4		
Date: 5/11/2016	Time: 1109-1115	Observer(s): JW,JG,NP		
Overall	**Species**		**Number**	**Avg. Length (mm)**

COMAL 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
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on map:
Old Channel		R2 - Site 5	
Date:	**Time:**	**Observer(s):**	
5/11/2016	1120-1215	JW,JG,NP	

Overall	Species	Number	Avg. Length (mm)
77	*Etheostoma fonticola*		
3	*Gambusia sp.*		
20	*Palaemonetes* sp.		
103	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	39	31,16,21,29,29,29,28,22,18,22,21,26,19,18,26,16,32,28,31, 31,28,15,25,30,35,27,32,26,12,13,19,17,18,15,17,13,17,18
	Gambusia sp.	3	10,15,11
	Palaemonetes sp.	7	
	Procambarus sp.	19	
2	*Etheostoma fonticola*	2	17,12
	Procambarus sp.	20	
3	*Etheostoma fonticola*	6	34,32,29,25,21,27
	Procambarus sp.	28	
	Palaemonetes sp.	1	
4	*Etheostoma fonticola*	12	28,22,26,27,27,16,28,22,15,18,14,18
	Procambarus sp.	9	
5	*Etheostoma fonticola*	3	17,17,18
	Palaemonetes sp.	8	
	Procambarus sp.	17	
6	*Etheostoma fonticola*	2	21,24
7	*Etheostoma fonticola*	6	15,27,13,16,13,16
	Palaemonetes sp.	1	
	Procambarus sp.	1	
8	*Etheostoma fonticola*	3	15,18,19
9	*Etheostoma fonticola*	4	28,11,18,12
	Procambarus sp.	3	
10	*Procambarus* sp.	2	
11	*Procambarus* sp.	1	
	Palaemonetes sp.	1	
12	*Procambarus* sp.	2	
13	No fish or crustaceans collected		
14	*Procambarus* sp.	1	
	Palaemonetes sp.	1	
15	*Palaemonetes* sp.	1	
	*** Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach): Old Channel		**Site:** O2-Site 6	**Site on map:**
Date: 5/11/2016	**Time:** 1218-1222	**Observer(s):** JW,JG,NP	
Overall	**Species**	**Number**	Avg. Length (mm)

COMAL 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
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach):		Site:	Site on map:
Old Channel		L1- Site 7	L4
Date:	Time:	Observer(s):	
5/11/2016	1228-1245	JW,JG,NP	

Overall	Species	Number	Avg. Length (mm)
19	*Etheostoma fonticola*		
6	*Gambusia sp.*		
1	*Hypostomus plecostomus*		
16	*Lepomis miniatus*		
20	*Palaemonetes* sp.		
10	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	11	101
	Etheostoma fonticola	3	33,27,19
	Gambusia sp.	1	20
	Procambarus sp.	2	
	Palaemonetes sp.	1	
2	*Lepomis miniatus*	1	81
	Etheostoma fonticola	4	22,21,17,14
	Palaemonetes sp.	6	
	Procambarus sp.	2	
3	*Lepomis miniatus*	1	20
	Gambusia sp.	3	20,20,28
	Etheostoma fonticola	4	21,13,20,6
	Palaemonetes sp.	7	
	Procambarus sp.	2	
4	*Gambusia sp.*	1	24
	Etheostoma fonticola	1	24
	Procambarus sp.	1	
	Palaemonetes sp.	1	
5	*Etheostoma fonticola*	1	22
	Gambusia sp.	1	24
	Palaemonetes sp.	2	
6	*Lepomis miniatus*	1	68
	Etheostoma fonticola	2	25,35
	Procambarus sp.	2	
7	*Etheostoma fonticola*	2	19,15
8	*Palaemonetes* sp.	2	
9	*Etheostoma fonticola*	1	13
10	*Etheostoma fonticola*	1	18
11	*Lepomis miniatus*	2	88,63
12	*Hypostomus plecostomus*	1	16
13	No fish or crustaceans collected		
14	*Palaemonetes* sp.	1	
15	*Procambarus* sp.	1	
	*** Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2016 SAMPLING

Location (Reach): Old Channel	**Site:** L2-Site 8	**Site on map:**
Date: 5/11/2016	**Time:** 1250-1315	**Observer(s):** JW,JG,NP

Overall	Species	Number	Avg. Length (mm)
29	*Etheostoma fonticola*		
15	*Gambusia sp.*		
1	*Hypostomus plecostomus*		
6	*Lepomis miniatus*		
2	*Lepomis sp.*		
25	*Palaemonetes* sp.		
27	*Procambarus* sp.		

COMAL RIVER -SPRING 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	5	
	Palaemonetes sp.	13	
	Lepomis sp.	1	31
	Gambusia sp.	6	25,26,14,20,22,14
	Etheostoma fonticola	10	24,26,27,25,19,16,20,24,15,16
2	*Palaemonetes* sp.	8	
	Procambarus sp.	6	
	Etheostoma fonticola	7	25,18,20,19,21,15,17
	Gambusia sp.	3	9,25,29
	Lepomis sp.	1	18
3	*Lepomis miniatus*	1	61
	Gambusia sp.	2	29,16
	Etheostoma fonticola	1	14
	Procambarus sp.	3	
	Palaemonetes sp.	2	
4	*Procambarus* sp.	3	
	Etheostoma fonticola	3	16,21,15
5	*Lepomis miniatus*	3	69,23,51
	Etheostoma fonticola	2	21,19
	Procambarus sp.	2	
6	*Palaemonetes* sp.	1	
	Procambarus sp.	4	
	Etheostoma fonticola	1	29
	Lepomis miniatus	1	29
7	*Hypostomus plecostomus*	1	19
	Etheostoma fonticola	1	17
	Procambarus sp.	1	
8	*Procambarus* sp.	1	
9	*Procambarus* sp.	1	
	Gambusia sp.	1	21
10	*Etheostoma fonticola*	3	25,25,18
	Gambusia sp.	1	32
	Procambarus sp.	1	
	Palaemonetes sp.	1	
11	*Etheostoma fonticola*	1	20
12	*Gambusia sp.*	2	26,28
13	*Lepomis miniatus*	1	68
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	*** Tarebia granifera - slight* **Corbicula - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Site on map:
Old Channel		H1-Site 1	H4
Date:	Time:	Observer(s):	
10/27/2016	1229-1256	JH,JG,JO,DS	

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

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia sp.*	7	11,21,23,26,25,20,11
	Etheostoma fonticola	1	26
	Palaemonetes sp.	4	
	Procambarus sp.	6	
2	*Procambarus* sp.	1	
	Lepomis miniatus	1	81
	Gambusia sp.	4	22,22,27,9
	Etheostoma fonticola	1	26
3	*Etheostoma fonticola*	2	21,16
	Lepomis miniatus	1	76
	Gambusia sp.	1	
4	*Etheostoma fonticola*	1	25
5	*Procambarus* sp.	3	
6	*Procambarus* sp.	5	
	Lepomis macrochirus	1	24
7	No fish or crustaceans collected		
8	*Procambarus* sp.	1	
9	*Gambusia sp.*	1	36
	Lepomis miniatus	1	39
	Procambarus sp.	2	
10	*Etheostoma fonticola*	1	24
11	*Etheostoma fonticola*	1	26
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	*Etheostoma fonticola*	1	23
16	No fish or crustaceans collected		
	*** Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Site on map:
Old Channel		R1- Site 2	R3
Date:	Time:	Observer(s):	
10/27/2016	1300-1341	JH,JG,JO,DS	

Overall	Species	Number	Avg. Length (mm)
64	*Etheostoma fonticola*		
2	*Gambusia sp.*		
1	*Dionda nigrotaeniata*		
2	*Lepomis sp.*		
31	*Palaemonetes* sp.		
88	*Procambarus* sp.		

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	7	18,22,26,26,26,22,26
	Lepomis miniatus	1	75
	Procambarus sp.	11	
2	*Etheostoma fonticola*	1	27
	Procambarus sp.	9	
3	*Procambarus* sp.	5	
	Etheostoma fonticola	1	29
4	*Etheostoma fonticola*	1	22
	Procambarus sp.	2	
5	*Etheostoma fonticola*	5	27,28,25,27,22
	Procambarus sp.	4	
6	*Procambarus* sp.	2	
7	*Procambarus* sp.	3	
8	*Etheostoma fonticola*	2	21,17
9	*Etheostoma fonticola*	1	27
10	*Procambarus* sp.	1	
11	*Procambarus* sp.	2	
12	*Etheostoma fonticola*	1	30
13	*Etheostoma fonticola*	2	24,25
	Gambusia sp.	1	12
14	*Etheostoma fonticola*	2	26,11
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach): Old Channel		**Site:** O1-Site 3	
Date: 10/27/2016	**Time:** 1343-1356	**Observer(s):** JH,JG,JO,DS	

Overall	**Species**	**Number**	**Avg. Length (mm)**
1	*Etheostoma fonticola*		
8	*Notropis amabilis*		
COMAL RIVER -FALL 2016 SAMPLING			
Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Etheostoma fonticola*	1	25
2	*Notropis amabilis*	3	17,17,27
3	No fish or crustaceans collected		
4	*Notropis amabilis*	1	18
5	*Notropis amabilis*	2	30,22
6	*Notropis amabilis*	1	20
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	*Notropis amabilis*	1	25
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* **Melanoides - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	
Old Channel		H2- Site 4	
Date:	**Time:**	**Observer(s):**	
10/27/2016	1358-1419	JH,JG,JO,DS	

Overall	Species	Number	Avg. Length (mm)
12	*Etheostoma fonticola*		
1	*Etheostoma lepidum*		
8	*Gambusia sp.*		
3	*Lepomis macrochirus*		
2	*Lepomis miniatus*		
42	*Palaemonetes* sp.		
21	*Procambarus* sp.		

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia sp.*	1	29
	Procambarus sp.	3	
	Palaemonetes sp.	6	
	Lepomis macrochirus	1	23
2	*Etheostoma fonticola*	2	25,27
	Procambarus sp.	8	
	Gambusia sp.	7	30
	Palaemonetes sp.	7	
3	*Lepomis miniatus*	1	46
	Etheostoma fonticola	4	27,22,23,27
	Palaemonetes sp.	14	
	Procambarus sp.	9	
4	*Etheostoma fonticola*	2	27,22
	Lepomis miniatus	1	35
	Palaemonetes sp.	2	
5	*Palaemonetes* sp.	3	
	Procambarus sp.	1	
	Etheostoma fonticola	1	23
6	*Palaemonetes* sp.	4	
7	*Etheostoma lepidum*	1	38
	Etheostoma fonticola	1	26
8	*Palaemonetes* sp.	2	
	Lepomis macrochirus	1	31
9	*Palaemonetes* sp.	1	
10	*Palaemonetes* sp.	1	
11	*Lepomis macrochirus*	1	38
	Etheostoma fonticola	1	26
12	No fish or crustaceans collected		
13	*Palaemonetes* sp.	2	
14	*Etheostoma fonticola*	1	26
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:		Site on map:
Old Channel		L1- Site 5		
Date:	**Time:**	**Observer(s):**		
10/27/2016	1420-1435	JH,JG,JO,DS		

Overall	Species	Number	Avg. Length (mm)
12	*Etheostoma fonticola*		
7	*Gambusia sp.*		
2	*Herichthys cyanoguttatus*		
1	*Lepomis macrochirus*		
8	*Lepomis miniatus*		
1	*Notropis amabilis*		
2	*Palaemonetes* sp.		
19	*Procambarus* sp.		

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia sp.*	3	22,10,17
	Etheostoma fonticola	3	26,25,20
2	*Lepomis miniatus*	2	75,41
	Gambusia sp.	1	12
	Notropis amabilis	1	22
	Herichthys cyanoguttatus	1	23
3	*Lepomis macrochirus*	1	27
	Etheostoma fonticola	1	25
	Procambarus sp.	4	
4	*Etheostoma fonticola*	2	30,24
5	*Herichthys cyanoguttatus*	1	30
	Gambusia sp.	2	18,13
	Procambarus sp.	6	
6	*Etheostoma fonticola*	1	24
	Procambarus sp.	2	
7	*Procambarus* sp.	1	
8	*Lepomis miniatus*	1	71
	Etheostoma fonticola	2	21,22
9	*Gambusia sp.*	1	17
	Etheostoma fonticola	1	22
10	*Lepomis miniatus*	1	44
11	*Lepomis miniatus*	2	70,45
	Palaemonetes sp.	2	
	Procambarus sp.	1	
12	*Lepomis miniatus*	1	45
	Procambarus sp.	1	
13	*Lepomis miniatus*	1	36
14	*Procambarus* sp.	1	
15	*Etheostoma fonticola*	1	25
	Procambarus sp.	1	
16	*Etheostoma fonticola*	1	26
	Procambarus sp.	2	
17	No fish or crustaceans collected		
	*** Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach): Old Channel		**Site:** R2 - Site 6	**Site on map:**
Date: 10/27/2016	**Time:** 1459-1534	**Observer(s):** JH,JG,JO,DS	

Overall	**Species**	**Number**	**Avg. Length (mm)**
36	*Etheostoma fonticola*		
8	*Gambusia sp.*		
42	*Procambarus* sp.		

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Etheostoma fonticola*	16	30,26,22,32,30,22,22,25,22,26,30,26,25,29,26,25
	Gambusia sp.	3	12,14,10
	Procambarus sp.	17	
2	*Procambarus* sp.	13	
	Etheostoma fonticola	9	25,24,28,25,24,29,24,28,25
3	*Etheostoma fonticola*	5	27,21,24,30,22
	Procambarus sp.	4	
4	*Gambusia sp.*	1	14
	Procambarus sp.	1	
5	*Procambarus* sp.	1	
	Etheostoma fonticola	1	30
6	*Procambarus* sp.	3	
	Etheostoma fonticola	1	24
	Gambusia sp.	2	14,14
7	*Procambarus* sp.	1	
8	No fish or crustaceans collected		
9	*Gambusia sp.*	1	12
	Procambarus sp.	1	
10	*Etheostoma fonticola*	1	29
11	*Etheostoma fonticola*	1	24
12	*Etheostoma fonticola*	2	28,23
13	No fish or crustaceans collected		
14	*Gambusia sp.*	1	16
15	*Procambarus* sp.	1	
	*** Tarebia granifera - slight*		
	**Melanoides - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach): Old Channel		**Site:** O2-Site 7	**Site on map:**
Date: 10/27/2016	**Time:** 1537-1541	**Observer(s):** JH,JG,JO,DS	

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

COMAL RIVER -FALL 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
COMAL RIVER -FALL 2016 SAMPLING

Location (Reach):		Site:	Site on map:
Old Channel		L2-Site 8	L3
Date:	**Time:**	**Observer(s):**	
10/27/2016	1543-1600	JH,JG,JO,DS	

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

COMAL RIVER -FALL 2016 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	1	24
	Palaemonetes sp.	7	
	Gambusia sp.	1	15
	Procambarus sp.	3	
2	*Procambarus* sp.	1	
3	*Gambusia sp.*	1	15
	Procambarus sp.	1	
	Palaemonetes sp.	1	
4	*Lepomis macrochirus*	1	25
	Etheostoma fonticola	1	27
5	*Etheostoma fonticola*	2	25,24
	Procambarus sp.	1	
6	No fish or crustaceans collected		
7	*Lepomis miniatus*	1	45
	Procambarus sp.	1	
8	*Gambusia sp.*	1	15
9	*Procambarus* sp.	1	
10	*Etheostoma fonticola*	2	26,32
	Procambarus sp.	1	
11	*Gambusia sp.*	1	12
	Procambarus sp.	1	
12	*Gambusia sp.*	1	12
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		