HABITAT CONSERVATION PLAN BIOLOGICAL MONITORING PROGRAM
Comal Springs/River Aquatic Ecosystem

ANNUAL REPORT

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EXECUTIVE SUMMARY

The Edwards Aquifer Habitat Conservation Plan (HCP) Biological Monitoring program activities conducted in 2015 provided insight into the transition from a prolonged drought to an average/wet year in the Comal River/Springs ecosystem. After the extremely low discharge of 2014, precipitation events during spring 2015, which continued into fall, displayed the swings in weather that are common in this region of Texas. Average monthly flows in early 2015 were below the historic average, but a major precipitation event over the Memorial Day weekend bumped average monthly discharge above the historic average for the first time since early 2011. The initial below-average discharge in the Comal River triggered a limited, low-flow, Critical Period event in January because discharge was below 150 cubic feet per second (cfs). This sampling effort included presence/absence dip-net sampling, fish community sampling, and Comal Springs riffle beetle (*Heterelmis comalensis*) sampling to evaluate potential "recovery" after the prolonged drought. A high-flow Critical Period sampling effort was triggered in November, when a major precipitation event caused flooding throughout central Texas. During that event, total system discharge in the Comal River reached 4,070 cfs on a daily average, with the majority of that water (2,530 cfs) coming in from Dry Comal Creek. The data and results from the November 2015 high-flow Critical Period event will be presented in an addendum to this report in early 2016.

Measured discharge at all spring runs during 2015 were higher than in 2014, but some springs remained below long-term study averages. Unlike 2014, water temperatures remained constant all year without going above the 26.7 ºC TCEQ water quality standard. Dissolved oxygen (DO) readings in Landa Lake varied, with the lowest concentrations occurring in late summer. With the bulk of construction wrapping up at Landa Park in 2015, recreation counts as recorded by Texas Master Naturalists increased to levels not observed since construction activities began. Recreation pressure remained highest in the New Channel during the summer months, which is when tubers descend on the spring-fed river for relief from summer temperatures.

Aquatic vegetation remained robust in most reaches with total coverage similar to study averages. The exception continues to be the Upper Spring Run Reach, where yearly fluctuations in bryophyte coverage affect fountain darter (*Etheostoma fonticola*) densities. In 2015, *Chara*, an alga with a relatively complex leaf structure, gained a foothold in the reach. Initial sampling in this vegetation indicates that fountain darters are using it as habitat. The HCP restoration activities in 2013–2015 have provided a great benefit to the Landa Lake Reach. As of mid-2015, *Hygrophila* (nonnative aquatic plant) no longer remained in the reach, and *Ludwigia* covered large swaths previously occupied by nonnative plants. These restoration activities also continued in earnest in the Old Channel Reach in 2015. *Hygrophila* was removed from a large portion of the reach, and in the river upstream. Several stands of *Ludwigia* were also planted in the reach, and most remained after the late October flooding. These restoration efforts should benefit the endangered species populations into the future and will be tracked through continued HCP biological monitoring in these areas.

Fountain darter populations reflected the benefits of native vegetation, with the highest densities found in bryophytes, *Ludwigia*, and *Cabomba*. Normalized population estimates of fountain darters were at or above the long-term study averages, perhaps a reflection of rebounding flows

in 2015. Random and fixed-station presence/absence sampling of fountain darters continue to provide a “snapshot” of the population in various vegetation types. This sampling also provides a quick way to assess the population during low flows and after high-flow events. Comal salamander (*Eurycea* sp.) populations appear to still be suffering the effects from the prolonged drought. Observations were below the long-term study average at all sites, even though wetted area was the highest it had been in years. It will be interesting to see, if higher flows persist in 2016, whether salamanders may re-occupy their traditional habitats in these spring runs.

Comal Springs riffle beetles were rarely encountered in drift data in 2015, with the majority of the drift data composed of *Stygobromus* species. Lure data indicated that adult Comal Springs riffle beetles were abundant throughout the documented habitats but still below the long-term study averages for most sites and seasons. The macroinvertebrate community in 2015 was diverse at all sites across vegetation types. Taxa that are considered fountain darter prey made up the bulk of the samples at all sites, further reflecting the benefits of native vegetation restoration for fountain darter populations.

Following the prolonged drought in Texas, the average to above-average flows in 2015 provided a unique opportunity to observe the Comal system biota as hydrological and habitat conditions improved over the course of the year. Finally, the flooding event in late October gives another unique look into how endangered species respond to environmental stressors. Overall, 2015 was one of the most unique years since the inception of this study in 2000.

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 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 determined early on and so was 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 “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 monitoring only 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 (not performed in 2015)

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 (*Etheostoma fonticola*) drop netting
   - Fountain darter presence/absence dip netting

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

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

The following section provides a description of methods for all 2015 activities, followed by a presentation of observations and results.

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 this, 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, 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 undescribed 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), one limited, low-flow Critical Period in January, and one high-flow Critical Period sampling efforts were conducted in 2015 (see Observations). Because the high-flow Critical Period event did not occur until November, these data will be included as a separate document (an addendum) to the annual report 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
Drop Nets
Dip Nets
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 were 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 2015). 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 and Critical Period 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 historical discharge measurement locations, flow partitioning in Landa Lake was initiated in 2013 and was expanded to five locations in 2014. 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

One low-flow Critical Period event was triggered in 2015 because flows remained below 150 cubic feet per second (cfs) in January. This prompted a limited data collection effort that included fountain darter sampling (presence/absence fixed and random site), and fish community sampling. In addition, a "recovery" sampling effort of Comal Spring riffle beetles was conducted from February through March to determine how these beetles responded to recovery from low flows of 2014. Flows quickly increased with more rainfall, and no more low-flow events were triggered in 2015. Flow triggers and associated activities with both low-flow sampling components are outlined in Appendix A.

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 2015.

Critical Period High-Flow Sampling

A major precipitation event on October 30 resulted in daily average discharge in the Comal River peaking at 4,070 cfs (USGS gage 08169000). The majority of the water contributing to the Comal River flows came from Dry Comal Creek, which peaked at 2,530 cfs (daily average) on the same day (USGS gage 08168797). After water clarity improved, site visits indicated that the high flows affected the vegetative community enough to justify a Critical Period sampling effort. This effort was completed in December 2015. Results and conclusions for this effort will be included in an addendum to this report, to be finalized by February 2016.

Water Quality Sampling

The objectives of the water quality analysis are to: (1) delineate and track basic water chemistry throughout the Comal River, (2) monitor controlling water quality variables (e.g., flow, temperature) with respect to the biology of HCP-covered species, (3) monitor alterations in basic water chemistry that may be attributed to anthropogenic activities, and (4) evaluate consistency with historical water quality information. Due to the consistency in water quality conditions measured over the first several years of sampling, the water quality component of the biological monitoring program was reduced in 2003. Conventional physico-chemical parameters (water temperature, conductivity, pH, dissolved oxygen, water depth at sampling point, and observations of local conditions) were taken at all drop-net sampling sites and fish community sampling locations using a calibrated, handheld HydroTech water quality sonde. It is important to note that study locations, methods, sampling schedule, and results of the comprehensive water, sediment and stormwater monitoring conducted under the HCP are presented in standalone reports (SWCA 2015, Draft).

Water Temperature Thermistors

Thermistors 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). These will be included in the 2016 Addendum. Quarterly sample collections and water chemistry analyses conducted during 2000–2002 sampling events are described in the 2002 annual report (BIO-WEST 2003).

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.

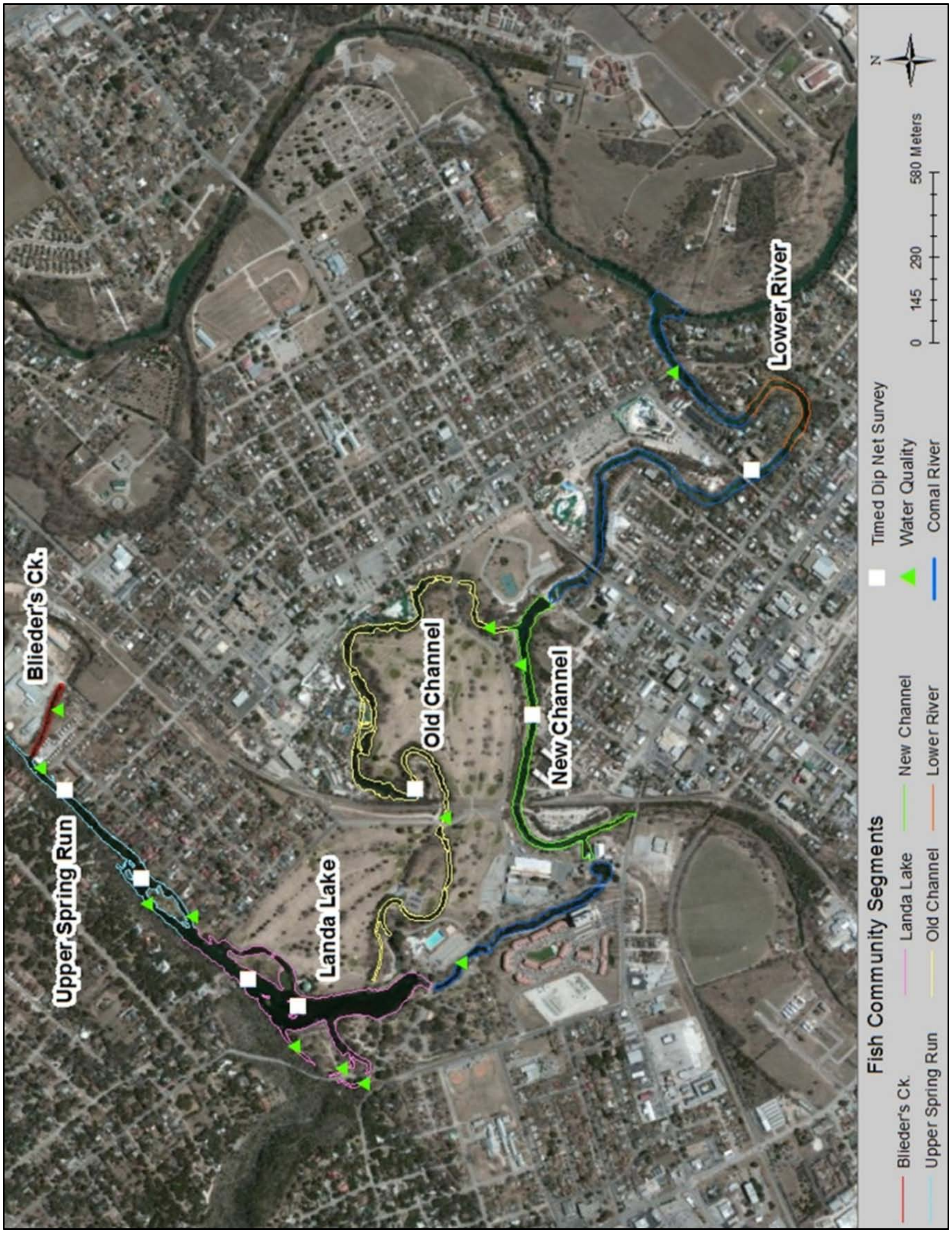


Figure 1. Fish community, water quality, and fountain darter timed dip-net surveys within the Comal River study area.

Master Naturalist Monitoring

Volunteers with the Texas Master Naturalist program continued their monitoring efforts in 2015 at select locations along the Comal system. Volunteers collected water quality and site-use data at five sites: (1) the Houston Street Site within the Upper Spring Run Reach, (2) the Gazebo site within the Landa Lake Reach, (3) the Elizabeth Avenue site upstream of the Old Channel Reach, (4) the New Channel site within the New Channel Reach, and (5) the downstream-most Union Avenue site (Figure 2). Volunteer monitoring was performed on a weekly basis, with surveys conducted primarily on Friday afternoons. At each site an Oakton Waterproof pHTestr 20 was used to assess 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., using the area 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.

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 10-foot 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 2015. All vegetation species in mixed stands were assigned a percentage of cover, which was

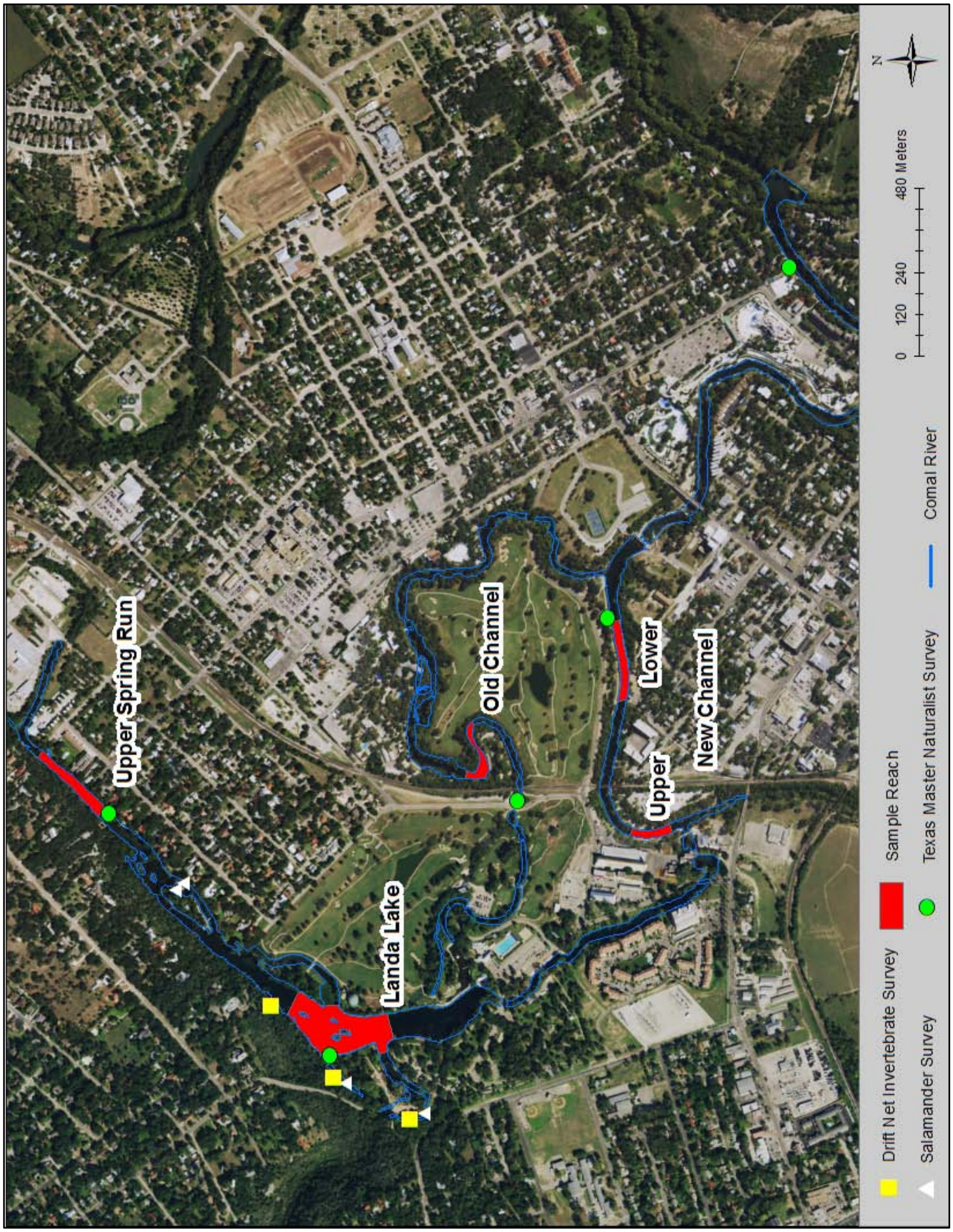


Figure 2. **Invertebrate, Comal Springs salamander, Texas Master Naturalist, and biomonitoring sample reaches (includes aquatic vegetation mapping, drop net sampling, presence/absence dip-net sampling, and macroinvertebrate community sampling) surveys within the Comal River study area.**

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.

Fountain Darter Sampling

Drop-net Sampling

A drop net is a sampling device originally designed by the USFWS to sample fountain darters and other benthic fish species. 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 dip net (1 m^2) is used within the drop net and is swept along the length of the river substrate 15 times in order to ensure complete enumeration of all fish trapped within the drop net. For sampling during this study, a drop net 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.

Drop-net 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 drop net. Fountain darters were identified, enumerated, measured for total length, and returned to the river at the point of collection. The same measurements were taken for all other fish species, except for abundant species, in which case only the first 25 individuals were measured. Fish 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 dip-net sweep.

Dip-net Sampling

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

Dip-net Timed Surveys

A dip net 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 by this means were identified, measured, recorded as number per dip-net sweep, and returned to the river at the point of collection. The presence of native and exotic snails was 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 drop-net 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. Dip net data were used to identify periods of fountain darter reproductive activity because this method was more likely to sample small fountain darters (<15 mm).

Presence/Absence Dip-net Surveys

Presence/absence dip netting is designed to be a quick, efficient, and repetitive means of monitoring the fountain darter population. Also, because it is less destructive than drop netting, 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.

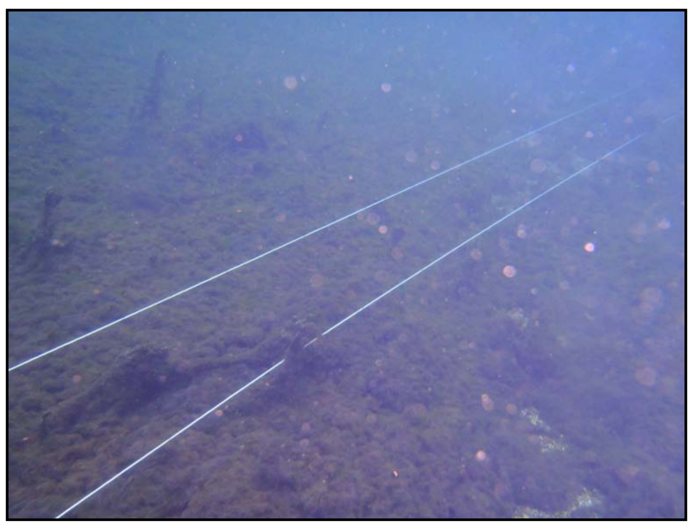
Fixed-station Dip Netting

Based on discussions with Dr. Floyd Weckerly (Texas State University and HCP Science Committee member) it was determined at the conclusion of 2013 that a new fountain darter sampling method using fixed-station sites would allow additional and more sophisticated analysis in conjunction with the 8 years of stratified random site data. Many sampling and analysis methods are known to underestimate occupancy, especially in cases where detection of the target species is not perfect (which is common). One solution for this issue is to use modeling methods designed specifically to account for imperfect detection probability (MacKenzie et al., 2002), and these methods generally require a fixed-station approach. Therefore, 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 sampled again in 2015. 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 continue, there will be a need to confidently evaluate trigger mechanisms designated in the HCP. Additionally, because of the importance associated with this sampling component by the HCP Adaptive Management decision-making process, a 2-year window of overlapping data will be 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 dip net 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 dip netter 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 all 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 employed in 2015 to efficiently 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).

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. Initial analysis focused on elucidating spatial and temporal trends in fish community structure, and comparing Critical Period to comprehensive monitoring sampling efforts.

Comal Springs Salamander Visual Observations

Presence/absence surveys for the Comal Springs salamanders were conducted by two-person crews in Spring Run 1, Spring Run 3, and near Spring Island during all 2015 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 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.

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

Within Spring Run 1, a 1-hour survey was conducted from the Landa Park Drive Bridge upstream to 9 m below the head spring orifice. Spring Run 3 was surveyed for 1 hour from the pedestrian bridge closest to Landa Lake upstream to 9 m 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.

Macroinvertebrate Sampling

Drift Net Sampling

Macroinvertebrate samples were collected via drift net at three sites in the Comal system. Two samples were taken from each site during 2014, once in spring and once in fall. During each sampling event, drift nets were placed over the 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 face 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 350 micrometers (µm). The tail of the drift net was connected to a detachable, 0.28-m-long cylindrical bucket (300-µm mesh), which were removed at 4-hour intervals during sampling, after which cup contents were sorted 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). All non-endangered invertebrates were preserved in 70% ethanol for later identification. Additionally, water quality measurements (temperature, pH, conductivity, dissolved oxygen, and current velocity) were taken at each drift-net site using a Hydrolab multiprobe and DataSonde (model 2) and a Marsh McBirney portable water current meter (model 201D).

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

Comal Springs Riffle Beetle

Cotton lure being processed.

In 2015 Comal Springs riffle beetles were collected from three reaches in the Comal system using the cotton lure methodology used in previous years. This methodology 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 matter 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 three separate times in 2015; however, because the high-flow event occurred during the fall sampling effort, these lures were cleaned and/or reset when flows receded (Table 1).

Table 1. Survey dates and number of days that deployed lures were left *in situ* at each sample reach in the course of 2015 Comal Springs riffle beetle biomonitoring. Excludes missing, silt-covered, or otherwise unusable lures.

SURVEY DATE (LURE COLLECTION)	NUMBER OF DAYS LURES *IN-SITU*		
	Spring Run 3	Western Shoreline	Spring Island
February–March (low-flow recovery)	31	31	31
April–May (spring)	29	29	29
November–December (fall) [a]	28	28	28

[a] Survey was disturbed by high-flows, but all lures were reset/cleaned following the event.

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). Crews replaced lures that had been removed in the same area they had been collected from, although occasionally lures were moved to accommodate dropping water levels and/or drying of surface water at the lure placement sites (Table 1).

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

Macroinvertebrate Community Sampling

In 2015 BIO-WEST conducted macroinvertebrate community sampling to determine species composition, relative number, and vegetation associations of macroinvertebrates at four study reaches (Figure 2).

Crews collected macroinvertebrate community samples from the Comal system during two distinct sampling efforts. Macroinvertebrates were collected from four reaches (Landa Lake, Upper New Channel, Old Channel, and Upper Spring Run) as part of each spring (May 7) and fall (October 7) comprehensive sampling events. The Lower New Channel Reach was not included because depths are too great to effectively sample. Macroinvertebrate samples were taken for each dominant vegetation type at each reach (Table 2).

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. Each grab sample contained both above- and below-ground vegetation, roots, and sediment. Crews recorded the GPS location of each grab sample taken. 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).

Table 2. Sampling efforts and dominant vegetation types by reach during 2015 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]	Spring and Fall	Spring and Fall	Spring
Ludwigia	Spring and Fall	Spring and Fall	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]	Fall

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

Please note that in 2015 we restricted our 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 2015 are presented in Appendix C.

Macroinvertebrate sampling

OBSERVATIONS

The project team conducted 2015 sampling on the dates shown in Table 3.

Table 3. Study components and sampling dates of the 2015 sampling events.

EVENT	DATES
Critical Period (low-flow <150 cfs)	
Fountain darter sampling	January 29
Fish community sampling	January 15–February 9
Comal invertebrate (lures only)	February 14, March 16
Spring	
Vegetation mapping	April 27–30
Fountain darter sampling	April 20–May 7
Fish community sampling	May 1–4
Comal Springs salamander observations	May 8
Macroinvertebrate sampling	May 7
Comal invertebrate (drift net, lures)	April 23, May 21
Summer	
Fountain darter sampling	Aug. 4–7
Fall	
Vegetation mapping	October 18–20
Fountain darter sampling	October 26–29
Fish community sampling	November 17–December 8
Comal Springs salamander observations	October 21
Macroinvertebrate sampling	October 7
Comal invertebrate (drift net, lures)	n/a [a]
Critical Period (high-flow) [a]	
Vegetation mapping	November 20–23
Fountain darter sampling	November 18–December 2
Fish community sampling	November 17–December 8
Comal Springs salamander observations	December 3
Comal invertebrate (drift net, lures)	November 19–20, November 13, December 10
Water quality grab samples	November 18

[a] Fall sampling disturbed by high-flow event.
[b] Results and discussion found in addendum (BIO-WEST 2016).

Comal Springflow

A shifting weather pattern resulted in a wet spring and fall in central Texas in 2015. The lowest total springflow occurred early in the year (Table 4) at 131 cfs. This prompted a limited (fountain darter, fish community, and Comal Springs riffle beetles) low-flow Critical Period sampling effort in January. Average monthly flows were below the historical average in early 2015, but rainfall over the course of the year and significant events in May and October resulted in flows higher than the historical average and the past 2 years (Figure 3). While significant precipitation events affected the San Marcos River in spring (BIO-WEST 2015a), there was no flooding in the Comal River until October. On October 30 a major precipitation event resulted in the total flow of the Comal River peaking at a daily average discharge of 4,070 cfs (USGS gage 08169000). Initial observations indicate that these flows led to some scouring, especially in the New Channel. This is because most of the flow contribution (2,530 cfs daily average) came from Dry Comal Creek. These flows initiated a high-flow Critical Period event, the effects of which are discussed in a 2016 Addendum to this report.

Table 4. Lowest discharge during each year of the study (2000–2015), 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

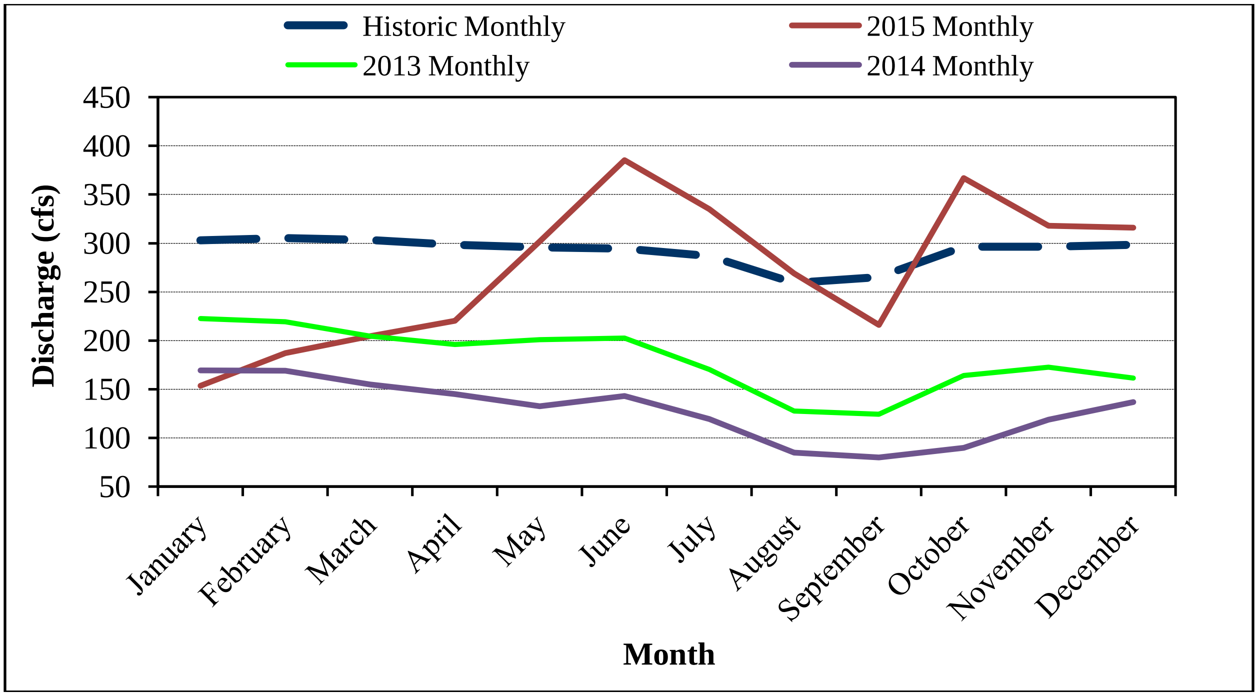


Figure 3. **Mean monthly discharge in the Comal River during the 1934–2015 period of record.**

During spring and fall 2015, discharges were measured at five sites in the Comal River (Figure 4). Measured discharge in Spring Run 1 remained between 10 and 15 cfs during the spring and fall sampling efforts (Figure 5). These flows are within one standard deviation of their respective months measured over the course of this study (2003–2015). Similarly, discharge at Spring Run 2 was below the long-term average in both spring and fall (3.2 and 2.9 cfs, respectively) in 2015 (Figure 5). Each was within one standard deviation of the study averages. Discharge in Spring Run 3 followed a similar pattern with discharge higher in the spring than fall (27.4 cfs and 25.1 cfs, respectively) (Figure 5). Additionally, both were within one standard deviation of the long-term study averages. Unlike the previous year, most all springs in the spring runs appeared to be flowing the majority of the year. Spring Run 1 was the only place where discharge was higher in fall than spring for 2015.

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 2015, discharge was higher in spring than fall (71.9 cfs and 60.3 cfs, respectively) (Figure 6), and both were higher than the long-term averages (but within one standard deviation). In 2011 the study team began measuring discharge at Upper Spring Run (Liberty St.). Like the Old Channel flows here were higher in spring than fall (11.8 cfs and 10.4 cfs, respectively, Figure 6) with both higher than the long-term average (2011–2015), but both were within one standard deviation of the mean. These are the highest flows measured at this site since 2012 (BIO-WEST 2013a).

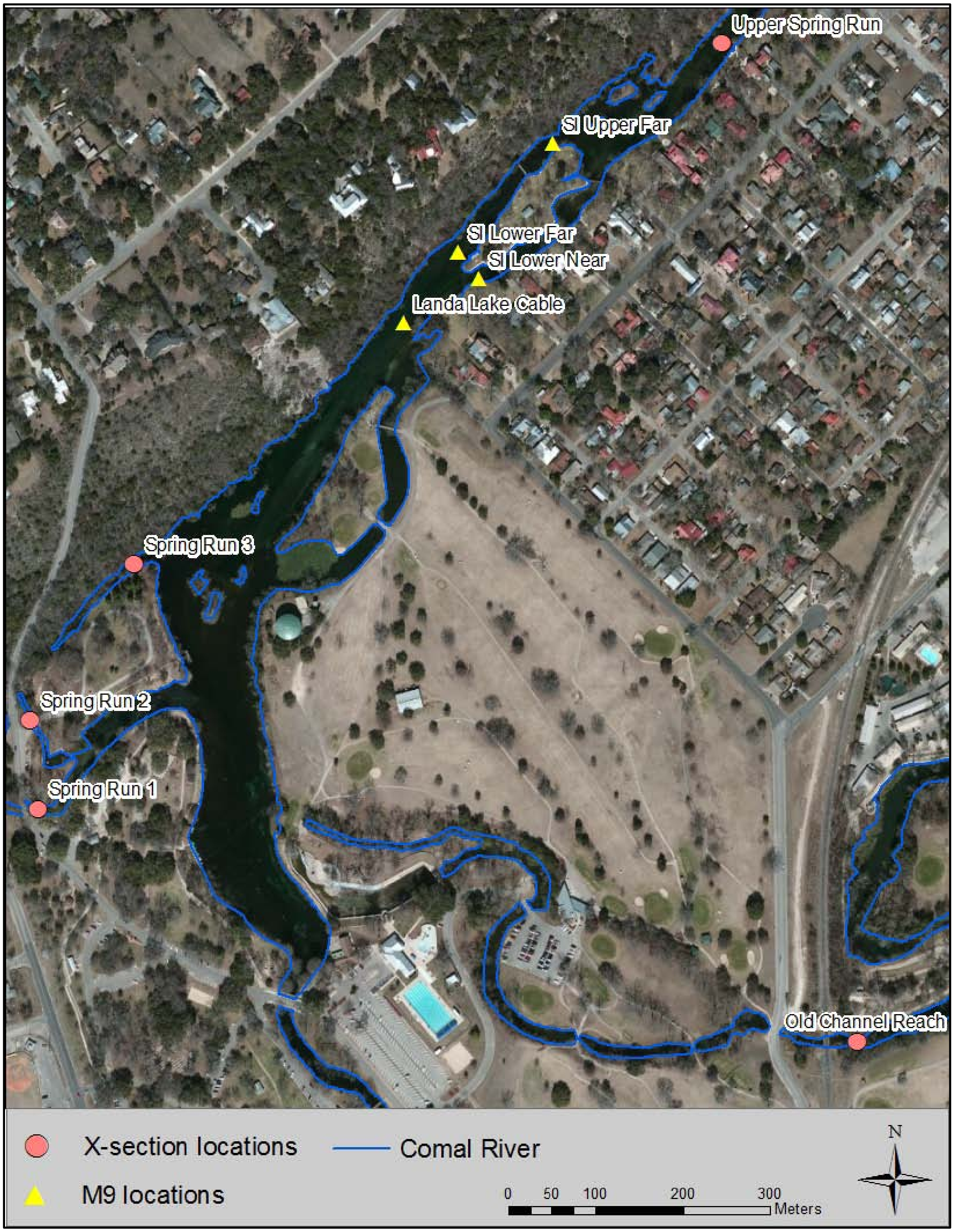


Figure 4. **Cross-section and flow partitioning (M9) discharge collection locations in the Comal River.**

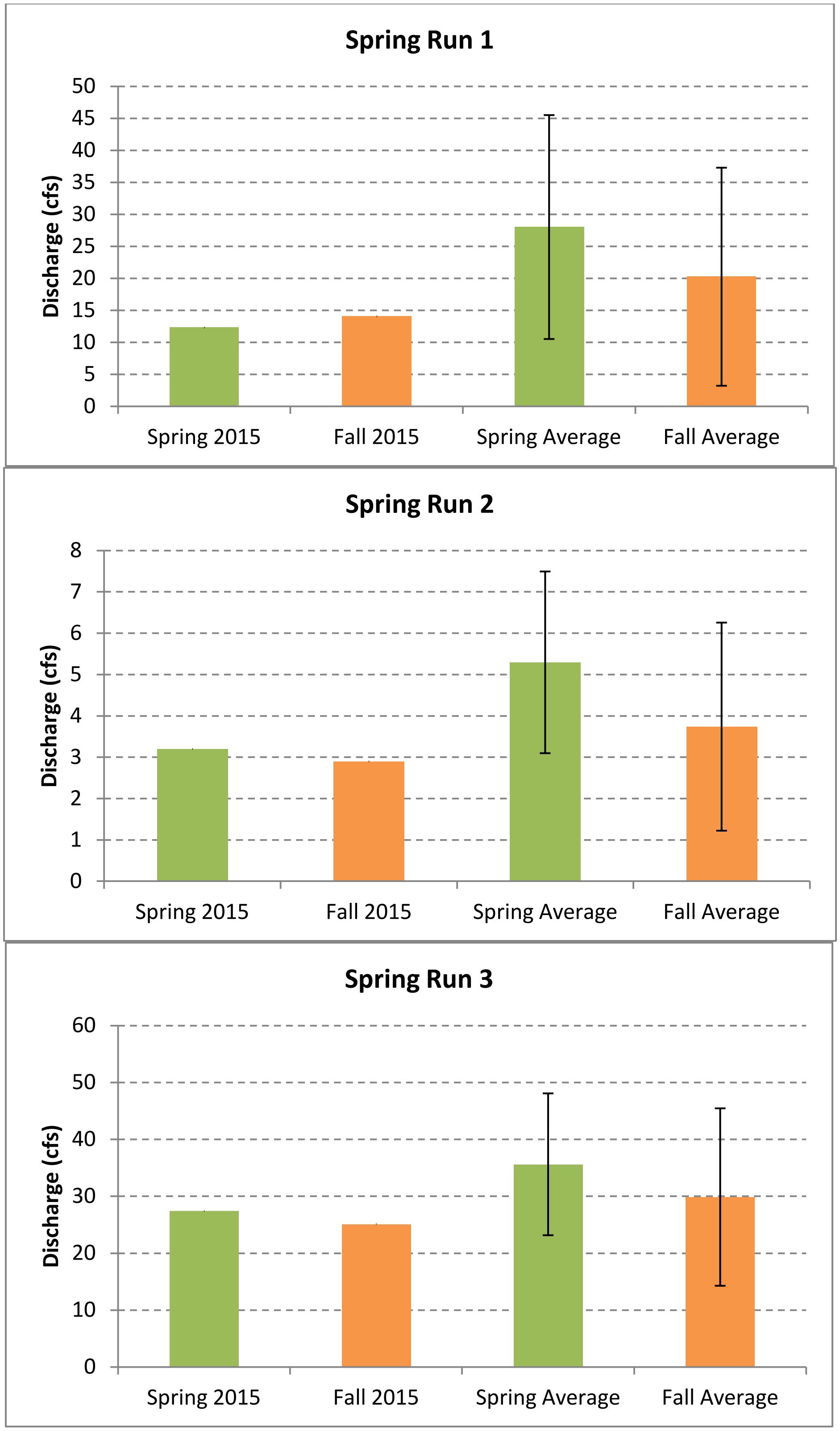


Figure 5. **Measured discharge for Spring runs 1, 2, and 3. Averages represent April/May values (spring) and October/November values (fall) from 2003 to 2015. Error bars reflect one standard deviation from mean.**

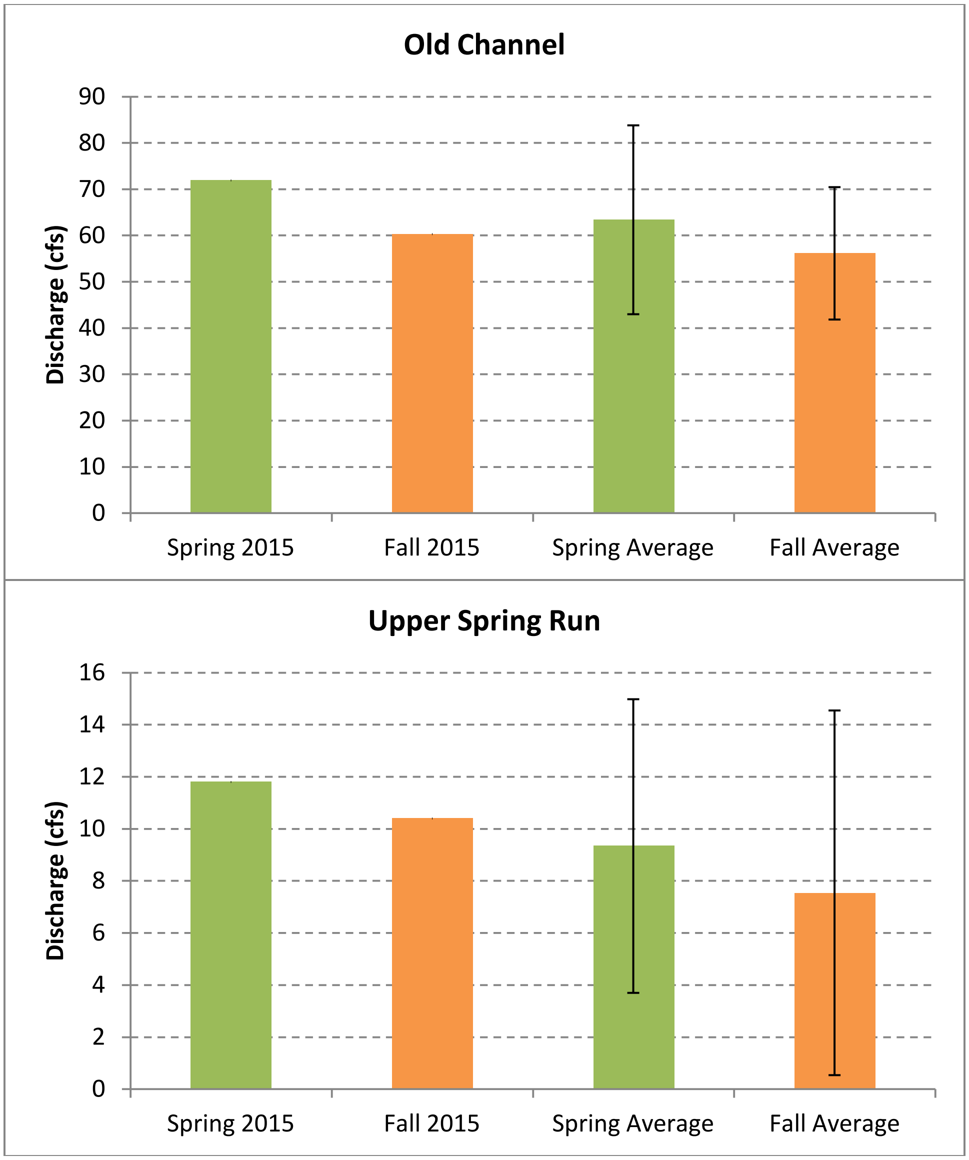


Figure 6. **Measured discharge for the Old Channel and Upper Spring Run reaches. Averages represent April/May (spring) and October/November values (fall) from 2003–2015 for the Old Channel, and 2011–2015 for Upper Spring Run. Error bars reflect one standard deviation from the mean.**

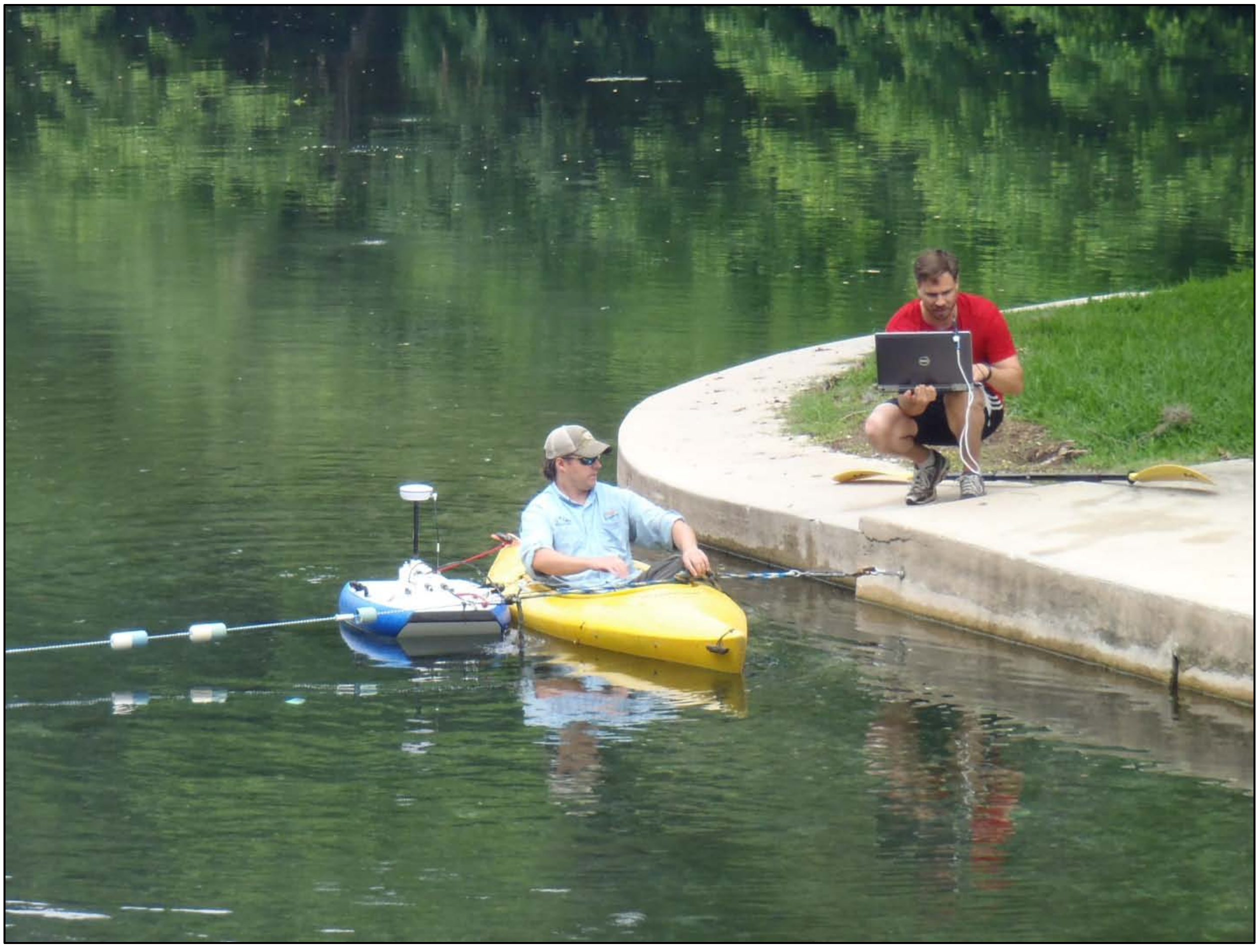
The flow-partitioning effort that began in 2013 continued in 2015, above and below Spring Island and the upstream end of Landa Lake (Figure 4). Unlike in 2014, when eight flow-partitioning efforts were completed, increased flows in the Comal River led to only two efforts (spring and fall) (Table 5) as part of the comprehensive monitoring efforts. Measurements in 2015 reflect those of 2014 with most of the discharge originating from the major spring upwellings on the western shoreline between the upstream area of Spring Island and Landa Lake (Table 5). As expected with higher total discharge in the Comal River, higher flows were observed at all transects compared to those of 2014. Of the transects measured, Upper Spring Run contributed the least to overall discharge in spring and fall (4.6% and 8.6%, respectively) as it did in 2014 (Table 6). In 2014 it was observed that spring upwellings near the top of Spring Island (river-left channel) flowed upstream towards the river-right channel and the SI Upper Far transect. While this upstream flow was not observed in 2015, the SI Upper Far transect still contributed more flow in spring (38.1 cfs, 14.9%) and fall (32.0 cfs, 14.5%) compared to the SI Lower Near transect for spring (22.0 cfs, 8.6%) and fall (29.2 cfs, 13.2%).

Table 5. Flow partitioning data from five transects in 2014–2015.

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

Table 6. Percentage of total discharge in the Comal River (USGS gage 08169000) from each flow partitioning transect in 2014–2015.

DATE	DAILY MEAN DISCHARGE (USGS)	PERCENTAGE OF TOTAL 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	1.3	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



BIO-WEST biologists using a SonTek® RiverSurveyor M9 Acoustic Doppler Current Profiler to collect flow measurements near Spring Island in April 2015.

Water Quality Results

Temperature Thermistors

The continuously recorded water temperature thermistor data (Appendix C) provides an overview of the thermal conditions throughout the Comal system from 2000 to 2015. Gaps in readings on some graphs indicate data-quality events (e.g., theft, thermistor failure); these data were excluded from analysis. Water temperatures are most constant at or near the spring inputs and become more variable downstream as other factors (e.g., runoff, precipitation, 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 a thermistor 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 fluctuations in Blieder's Creek, whereas water

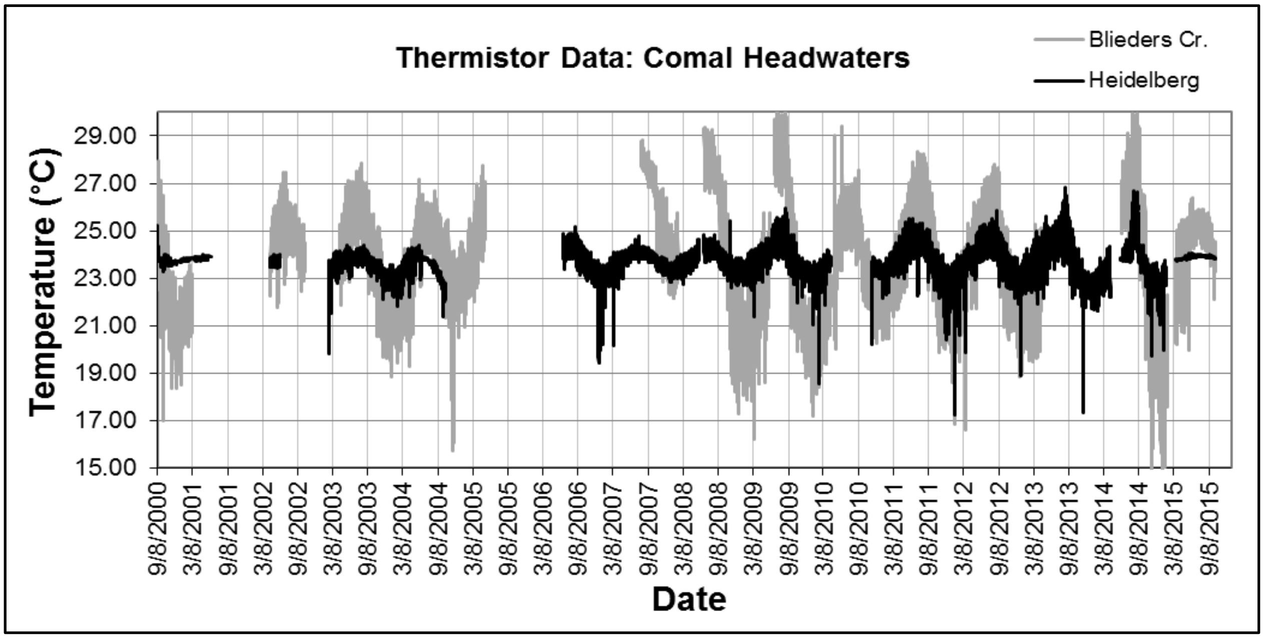


Figure 7. Water temperature (°C) data at Comal headwaters from 2000 to 2015.

temperatures at Heidelberg are relatively constant due to the constant temperature of the spring inputs. After an extended period of temperature readings that exceeded the 26.7 ºC Texas Commission on Environmental Quality (TCEQ) water quality standard for the Comal River at the Heidelberg site in 2014, there were no temperature readings above 26.7 ºC in 2015. Relatively low water temperatures exhibited in Figure 7 at Blieder's Creek were the result of local precipitation events and low air temperatures.

Sites like the Other Place, New Channel, and Old Channel had wider temperature fluctuations than sites closer to spring inputs in 2015, but had zero recordings that exceeded the TCEQ water quality standard (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 upwelling from springs throughout the lake. Detailed graphs for each site can be found in Appendix C.

Water Quality

Water quality grab samples were collected for the Critical Period high-flow event in November 2015 and will be presented in the 2016 Addendum. A more in-depth look at water and sediment quality can be found in the 2015 EAA HCP Expanded Water Quality Report (SWCA 2015, Draft).

EAA Manta 2 Sonde Data

In 2012 the Edwards Aquifer Authority (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 2015 is summarized below. These data were taken directly from the EAA Environet website (EAA 2015).

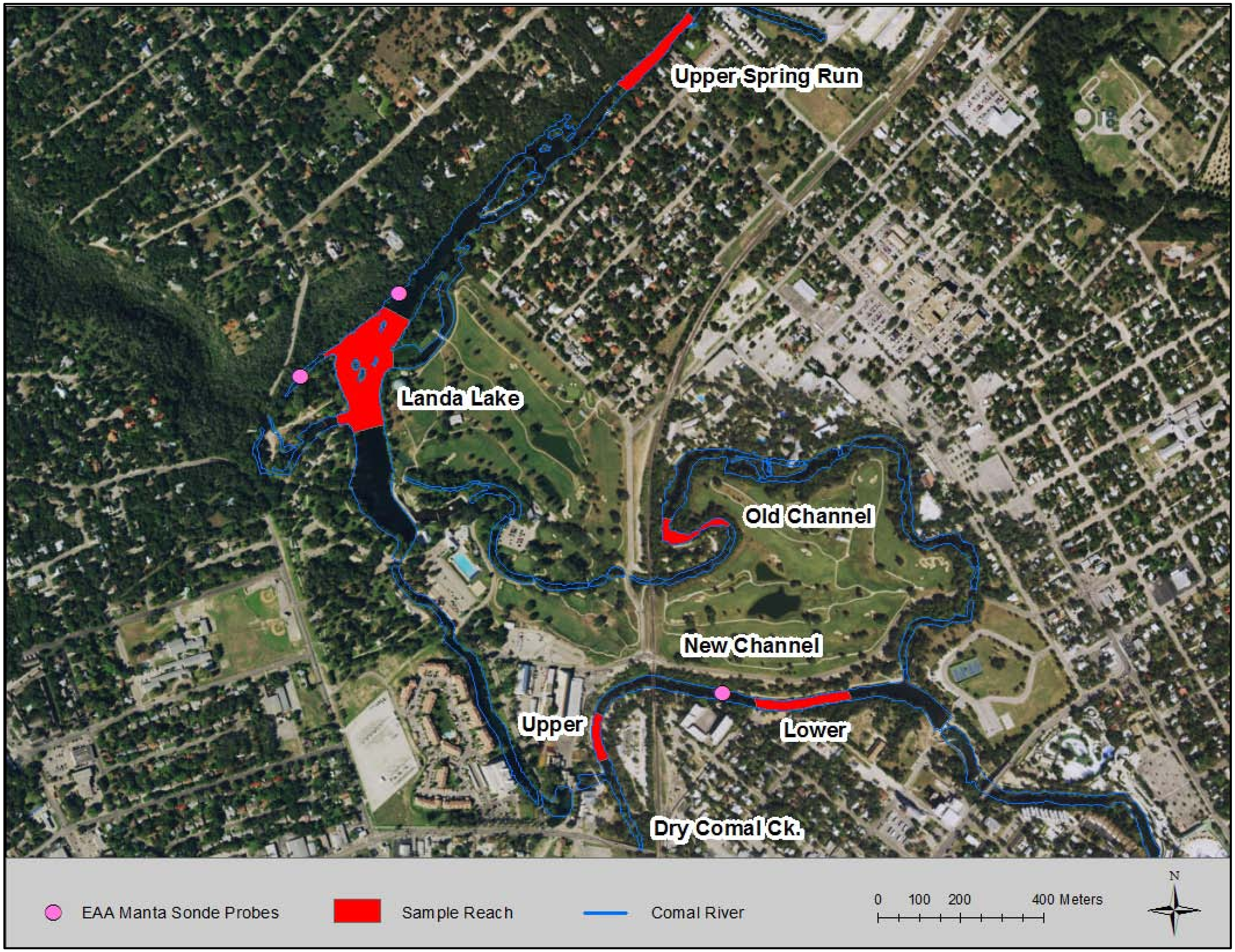


Figure 8. Edwards Aquifer Authority Manta Sonde probe locations in 2015.

Much like the temperature thermistor data collected by BIO-WEST in Spring Run 3, the EAA data showed very little variation throughout the year. Temperature data for Spring Run 3 and Spring 7 are shown in Figure 9. These temperatures are typical for areas near spring orifices like those recorded by the thermistor at Heidelberg (Figure 7). The temperature probe downstream of Dry Comal Creek in the New Channel showed greater fluctuation in temperature and is similar to Blieder's Creek, which are more heavily influenced by runoff and ambient air temperatures (Figure 10).

Dissolved oxygen (DO) in both Spring Run 3 and Spring 7 varied from 4.58 mg/l to 10.29 mg/l in 2015, while DO downstream of Dry Comal Creek showed greater fluctuation throughout the year from 5.83 mg/l to 11.53 mg/l (Figure 11). Overall, both temperature and DO were very stable in 2015. pH and conductivity observations at all three locations showed very little variation throughout the year. The pH values ranged from 6.51 to 8.24 (Figure 12) while conductivity ranged from 550 uS/cm to 600 uS/cm at all three locations (Figure 13). The flooding event of October 30 caused pH to spike while conductivity readings decreased, especially at the probe downstream of the Dry Comal Creek confluence with the New Channel. Conductivity levels decrease at all three sites due to dilution of ambient conductivity levels. The greatest decrease was exhibited at the Dry Comal Creek probe because most of the flow from this event washed into the Comal River above this location.

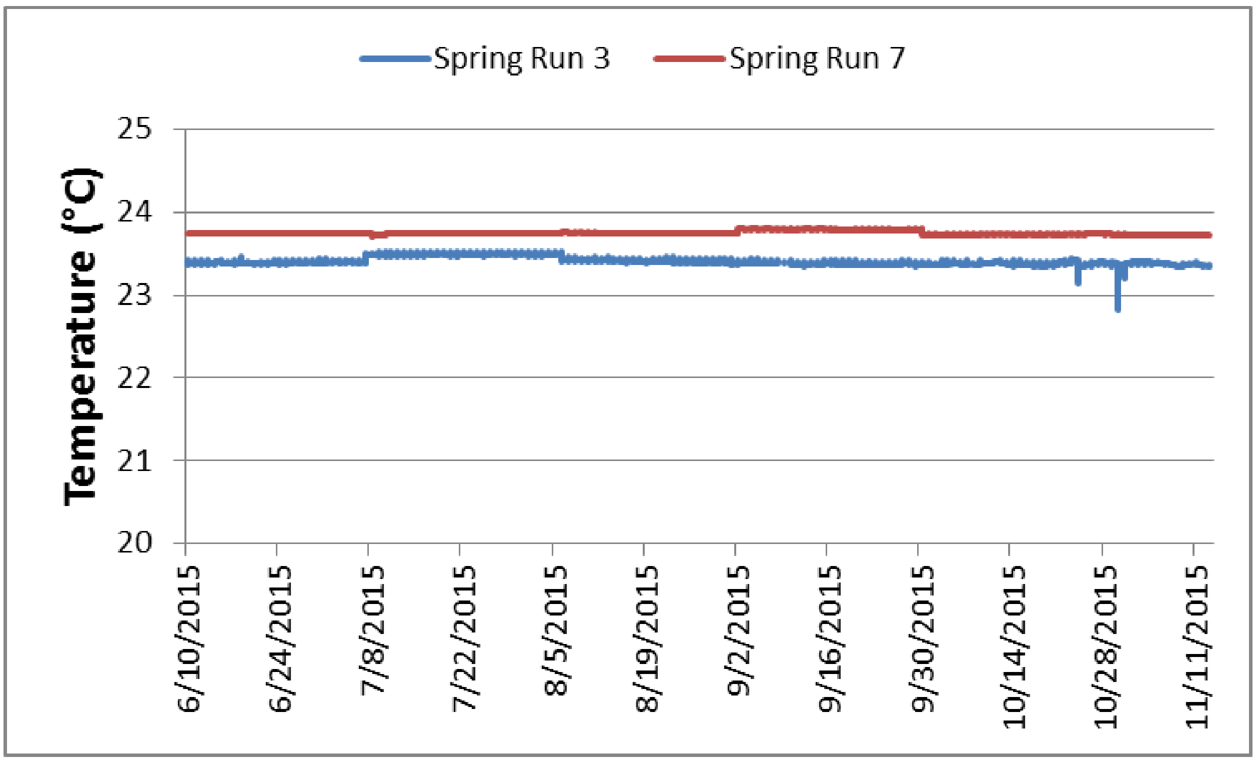


Figure 9. **Edwards Aquifer Authority Manta 2 multiprobe temperature data from Spring Run 3 and Spring 7.**

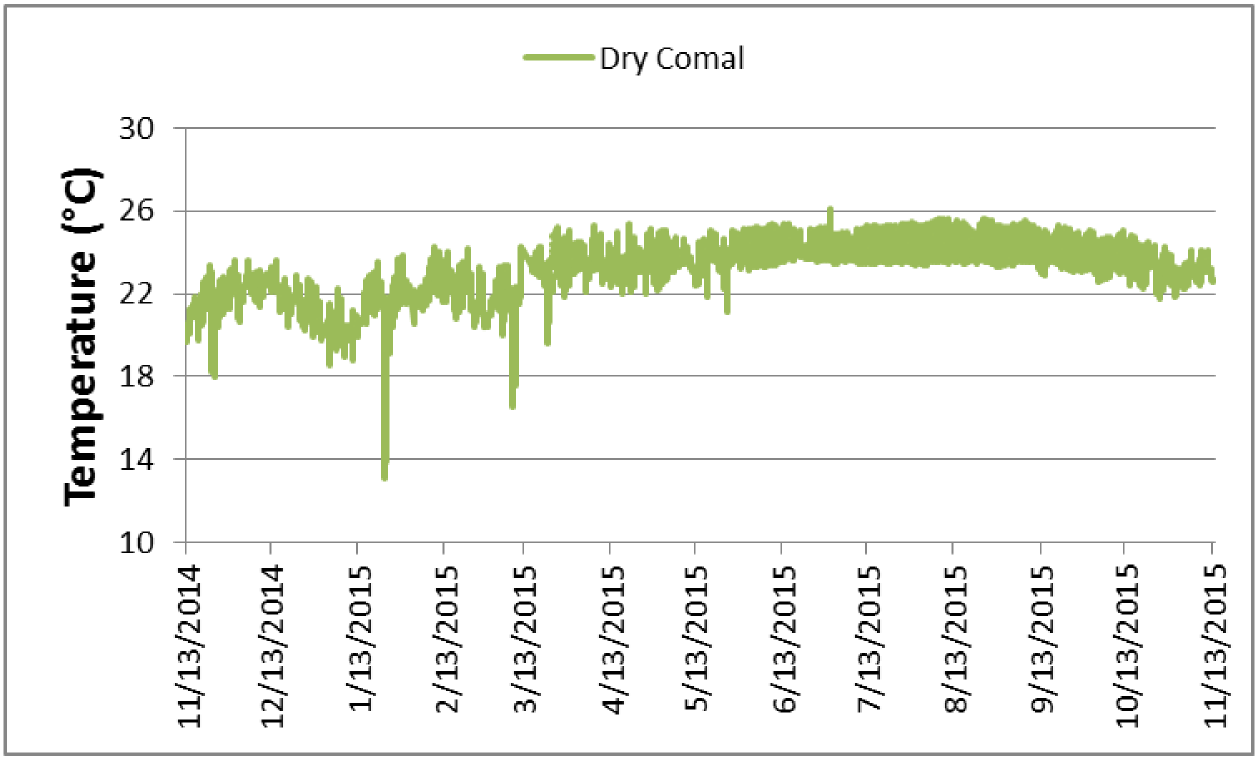


Figure 10. **Edwards Aquifer Authority Manta 2 multiprobe temperature data from the New Channel downstream of Dry Comal Creek.**

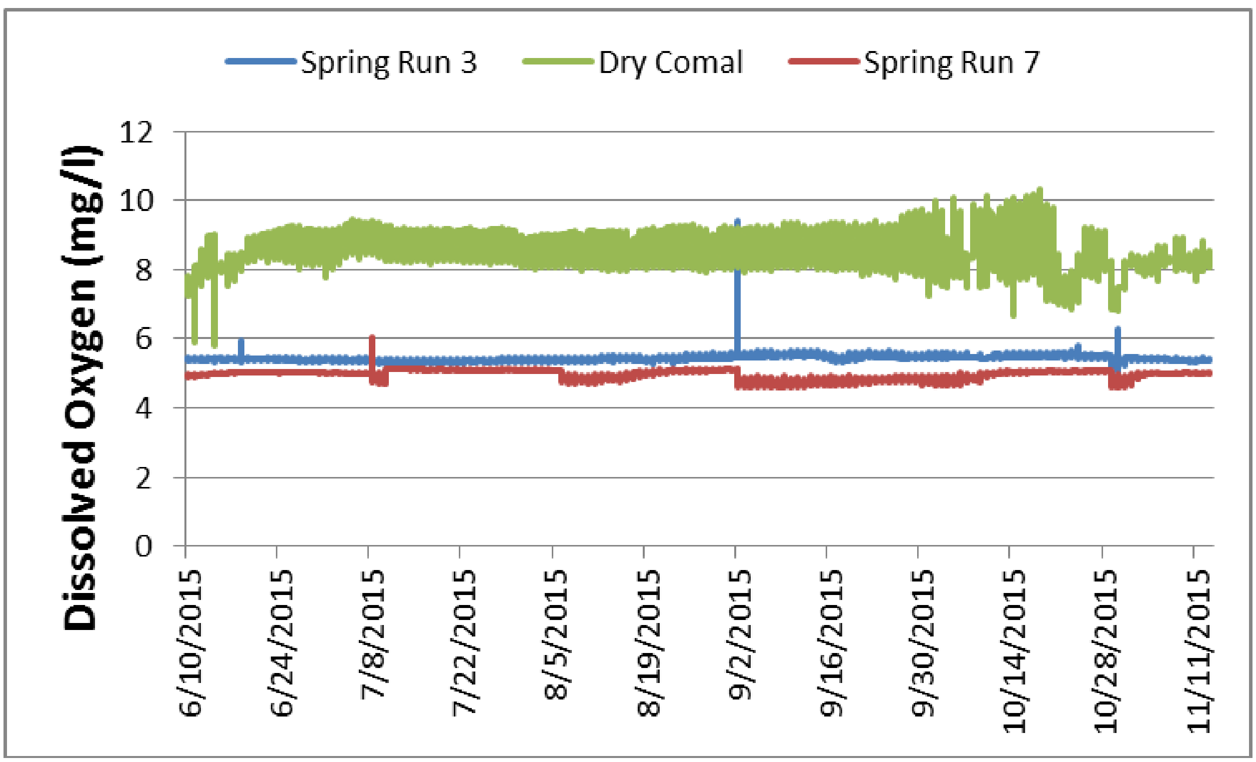


Figure 11. **Edwards Aquifer Authority Manta 2 multiprobe dissolved oxygen data in Spring Run 3, Spring 7, and downstream of Dry Comal Creek in 2015.**

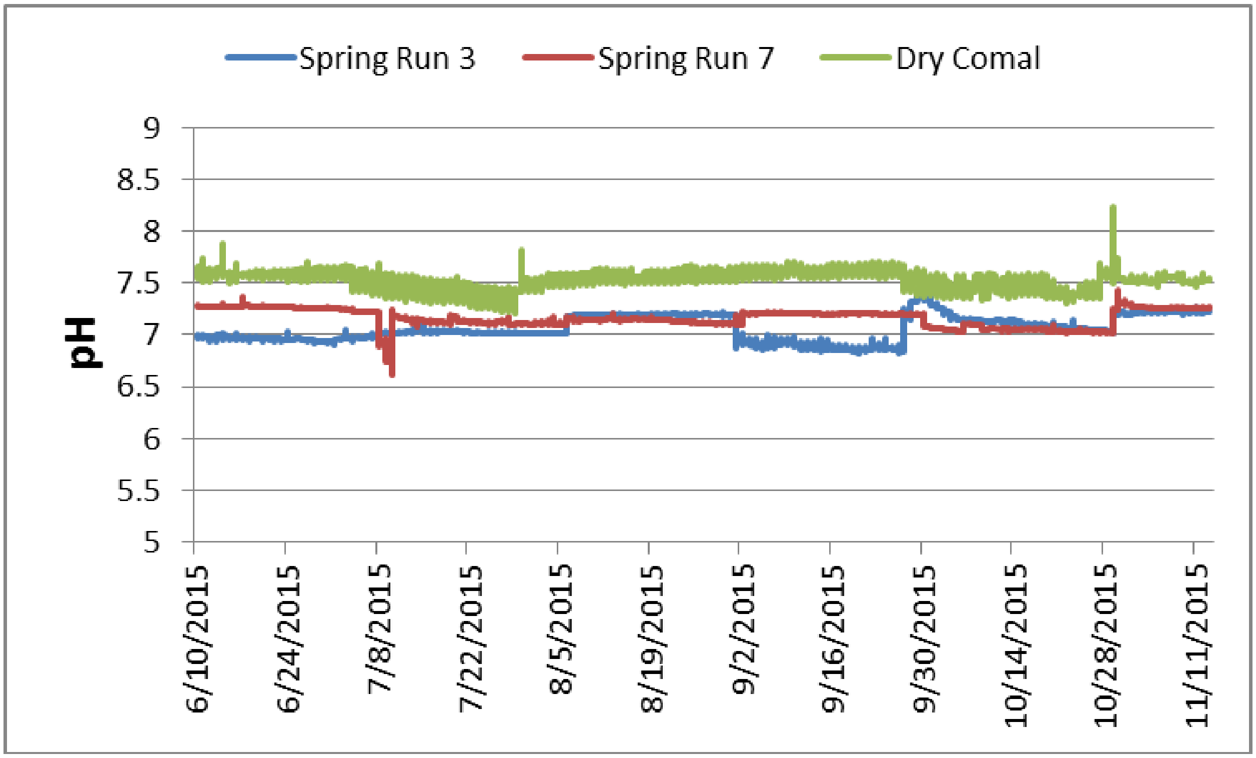


Figure 12. **Edwards Aquifer Authority Manta 2 multiprobe pH data in Spring Run 3, Spring 7, and downstream of Dry Comal Creek in 2015.**

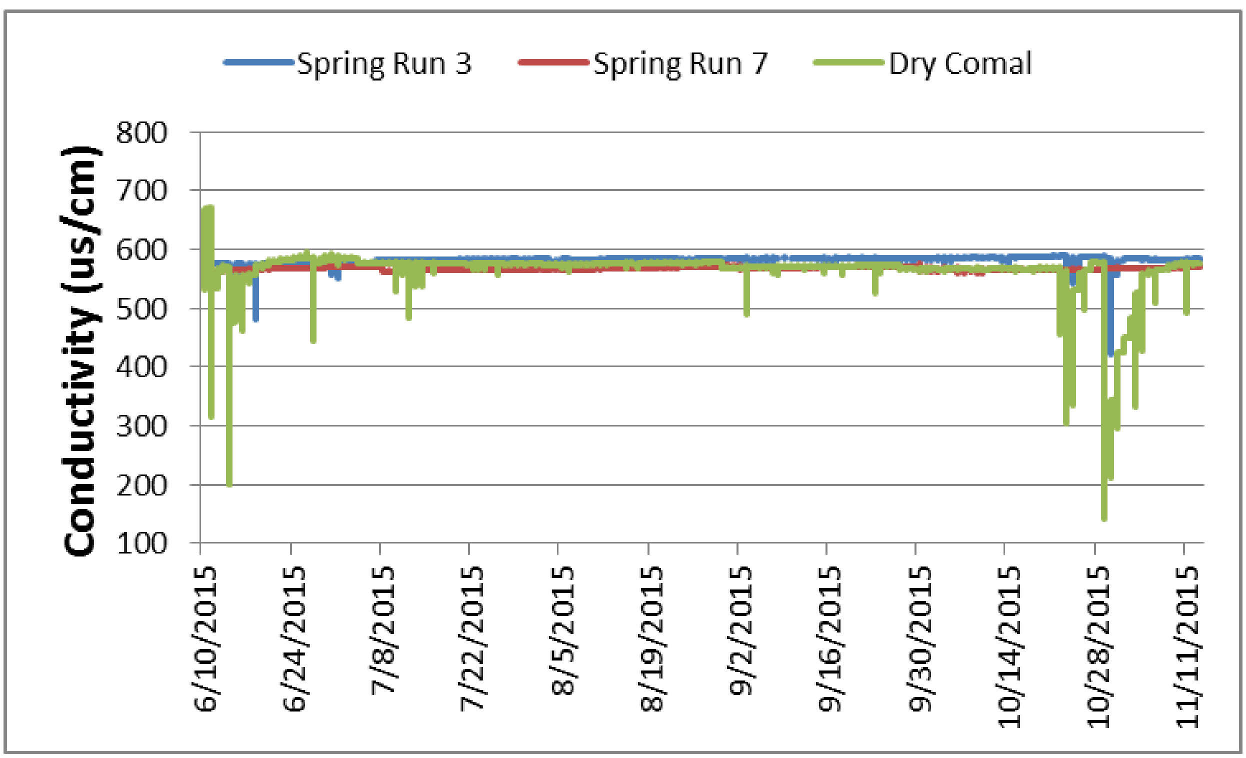


Figure 13. **Edwards Aquifer Authority Manta 2 multiprobe conductivity data in Spring Run 3, Spring 7, and downstream of Dry Comal Creek in 2015.**

City of New Braunfels Landa Lake Dissolved Oxygen Monitoring

In addition to the water-quality grab samples, 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. A full account of 2015 activities and results can be found in SWCA 2015. In summary, the mean water temperature in 2015 at the Landa Lake sonde was 23.6 °C with a standard deviation of 0.30 °C (95% of temperatures ranged from 23.26 °C to 23.85 °C) (SWCA 2015). In 2015, DO ranged from 0.02 to 10.58 mg/L, with values <2.0 mg/L reported on several occasions and values of <4.0 mg/L reported regularly during the late summer months (SWCA 2015). Wide ranges of diel DO fluctuations were observed in Landa Lake over the course of 2015, which is typical of heavily vegetated lake environments.

Texas Master Naturalist Monitoring

Water quality data collected by Master Naturalist volunteers in 2015 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) samples sites (Figure 14), whereas pH increased with distance from the springs (Figure 15). Site locations are shown in Figure 2 and numerically numbered from upstream (1) to downstream (5). The inverse relationship between these two variables is due to the presence of carbonic acid in spring waters. As CO_2 concentrations (and thus, carbonic acid concentrations) decline going downstream, pH rises. 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 the survey period (Figures 16–20). In 2015 (as in all years), the New Channel received the most recreation pressure, followed by Union Avenue and the Gazebo (Landa Lake). As in previous years, recreation use at Elizabeth Street (Old Channel) was very low (Figure 16) because this area is not located within a city park. The annual summer increase in recreation at the Upper Spring Run (most upstream site) (Figure 17) is likely a result of more people staying at the Heidelberg Lodges.

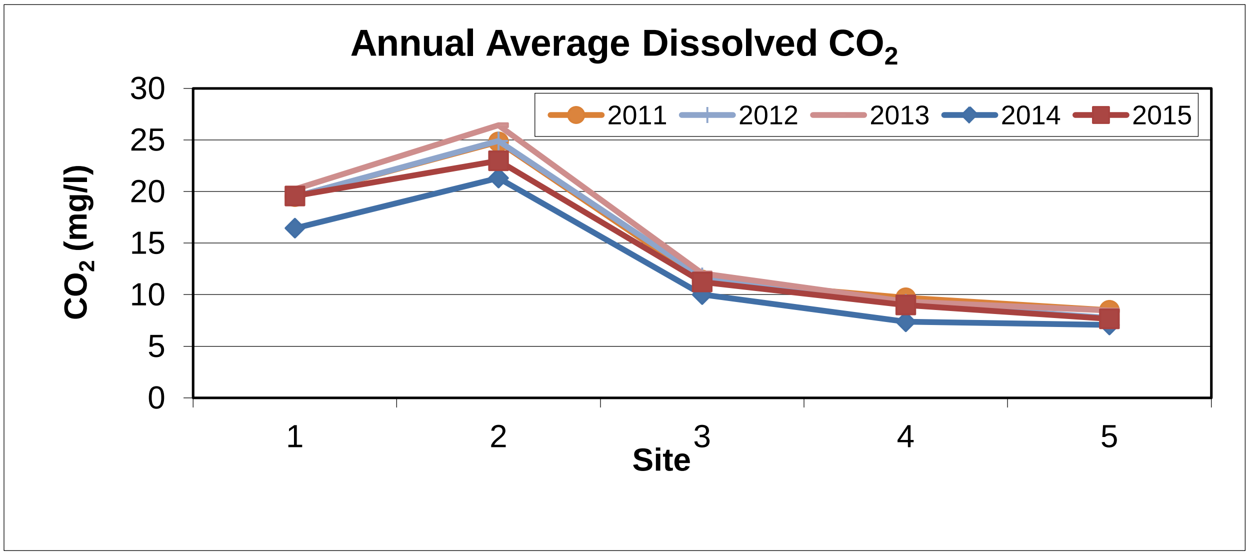


Figure 14. Annual average dissolved carbon dioxide (CO_2) concentrations at five sites on the Comal River system (2011–2015).

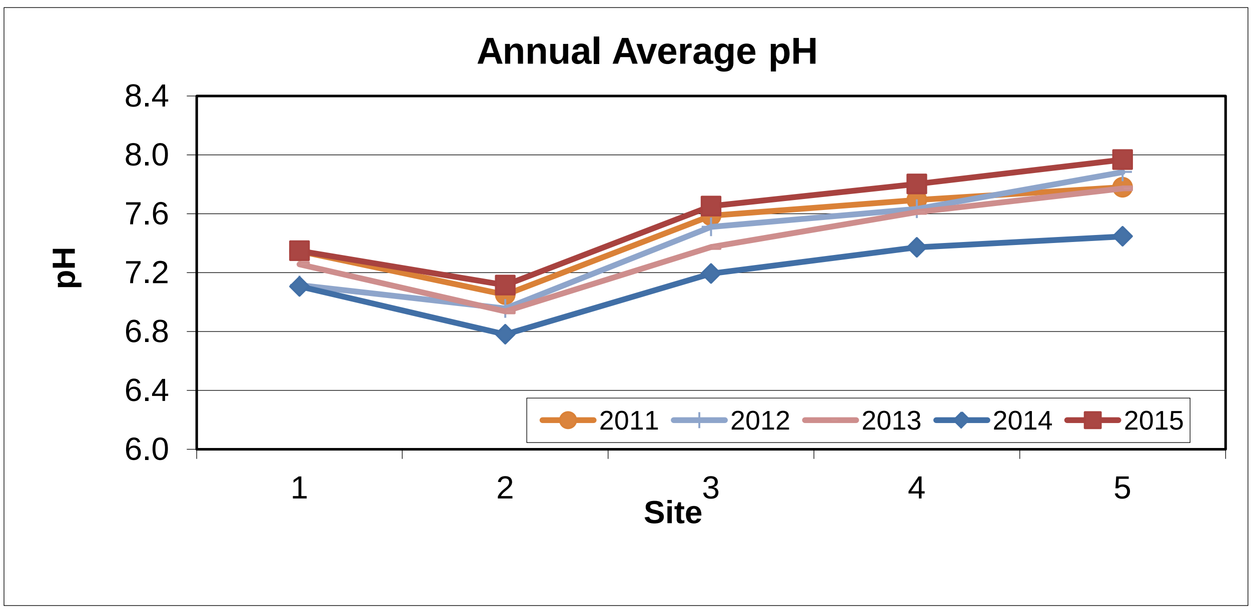


Figure 15. Annual average pH values at five sites on the Comal River system (2011–2015).

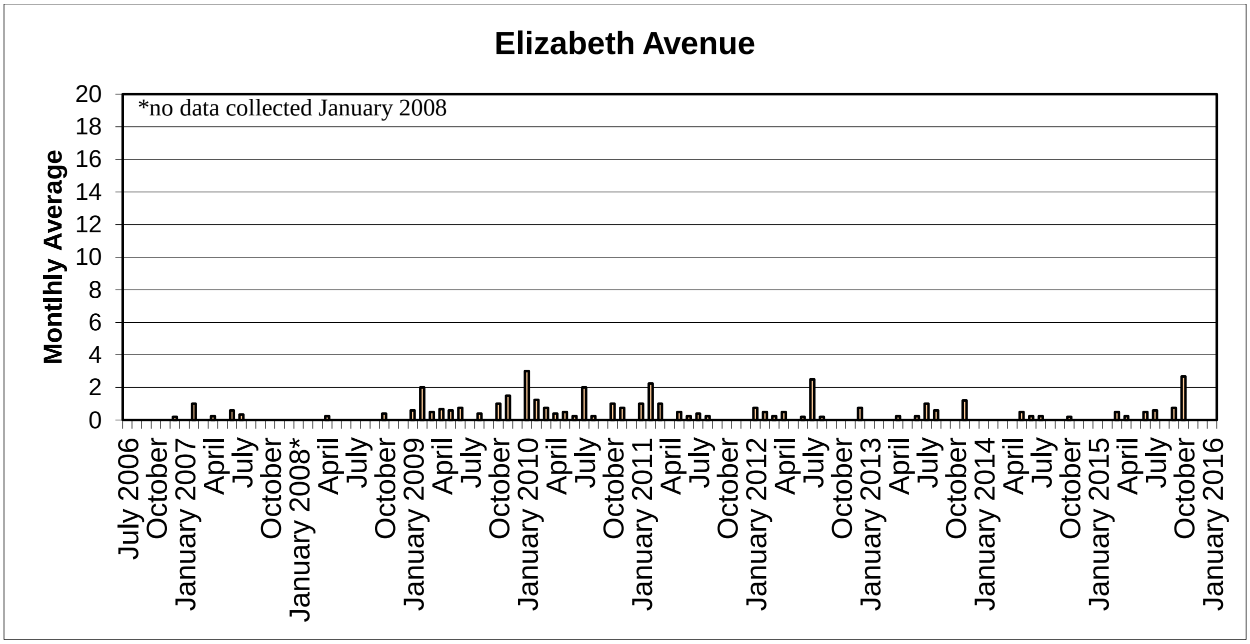


Figure 16. **Average recreational use counts at the Elizabeth Avenue site (2006–2015).**

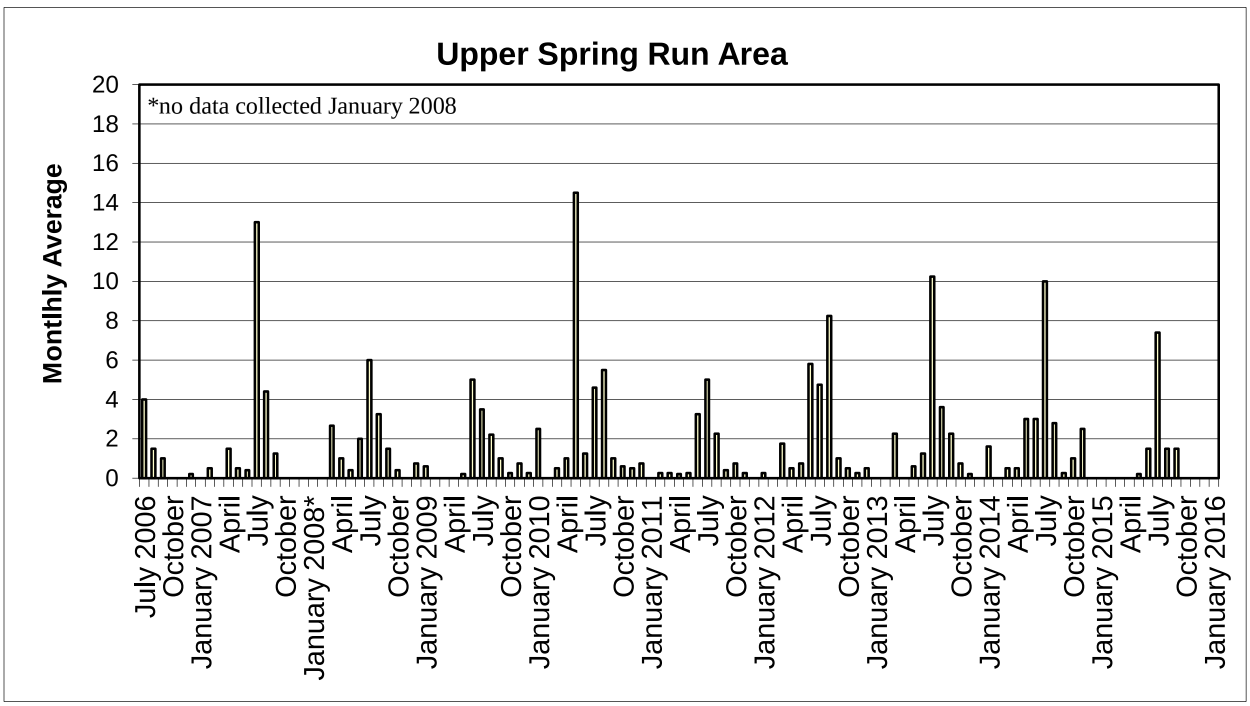


Figure 17. **Average recreational use counts at the Upper Spring Run area (2006–2015).**

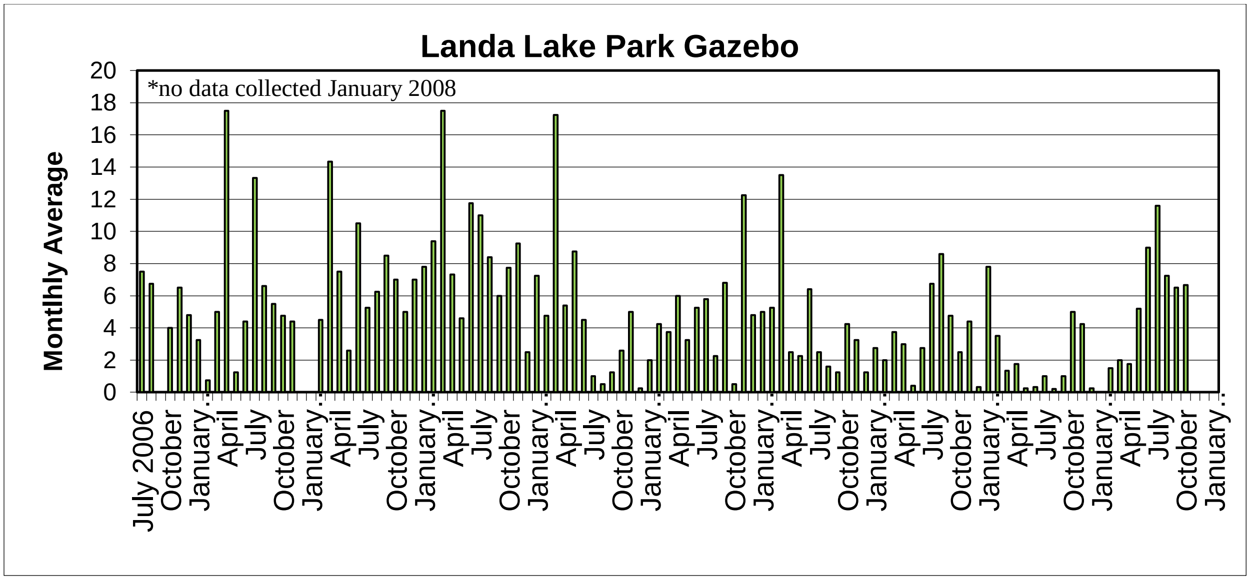


Figure 18. **Average recreational use counts at the Landa Lake Park Gazebo site (2006–2015).**

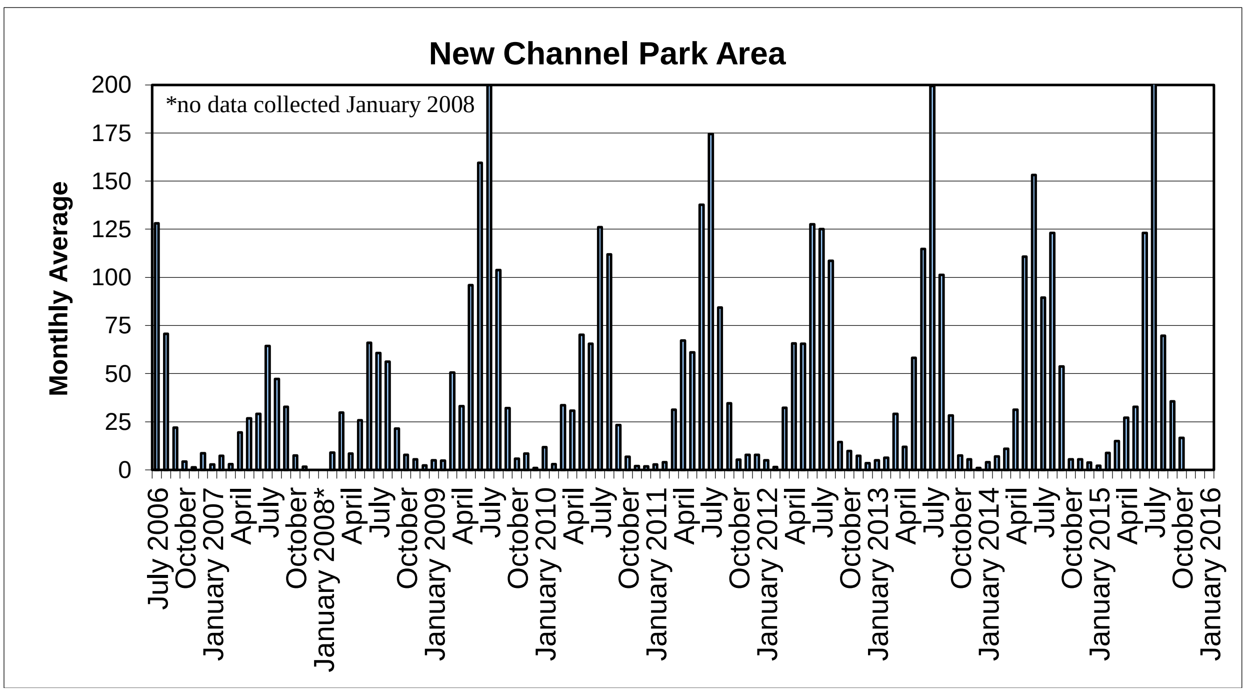


Figure 19. **Average recreational use counts at the New Channel site (2006–2015). Note: y-axis scale difference from previous figures.**

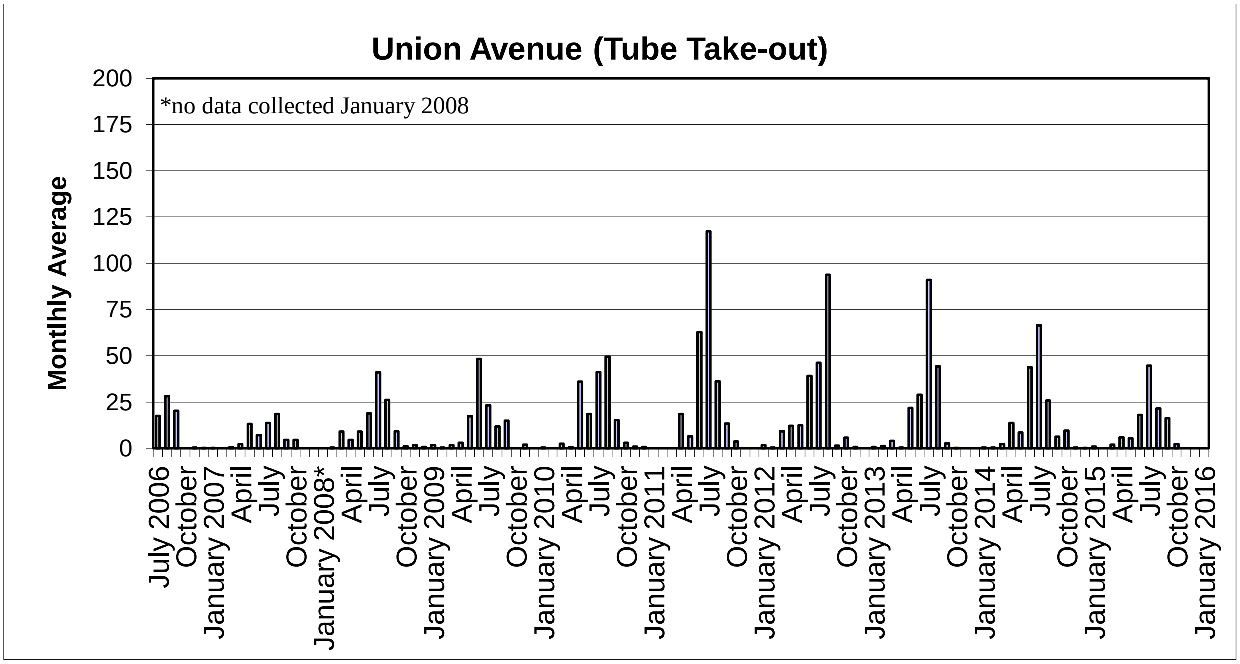


Figure 20. **Average recreational use counts at the Union Avenue site (2006–2015).**

From 2010 to 2014, the road to the Landa Park Gazebo was closed due to reconstruction of the walls throughout Landa Park. Figure 18 reflects this drop in recreation pressure and its subsequent increase in 2015. This is the first post-construction year, and the road into the part of the park with the Gazebo was re-opened, and recreation numbers were similar to those observed in 2012. It is expected that recreation pressure will continue to increase at the Gazebo site as construction concludes. As expected, the New Channel site receives the most recreation pressure, especially during the summer months (March–September, Figure 19). As ambient air temperatures increase each summer, this section of the Comal River becomes filled with tubers and others seeking relief in the cool waters. 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 20). Unlike the New Channel site, this location does not have picnic tables, so fewer people linger at this location.

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. These conditions persisted into the initial months of 2015, but spring rains quickly pushed Comal River discharge higher than the historical average. By spring, however, the total amount of aquatic vegetation in the Upper Spring Run Reach (1,381.3 m^2) was well below the long-term study average, and even lower than one standard deviation from the mean (Figure 21). This relative lack of aquatic vegetation may be due to the effects of the extremely low flows of 2014. By fall 2015 the amount of aquatic vegetation increased substantially (2,011.0 m^2), and was higher than the long-term study average (but within one standard deviation) (Figure 21). Much of the growth can be attributed to an influx of *Chara*, an alga with a relatively complex leaf structure. Although this plant has been present in Blieder's Creek for years (the mouth of which is just upstream of the site) (Figure 1), it had not flourished in the Upper Spring Run Reach until fall 2015.

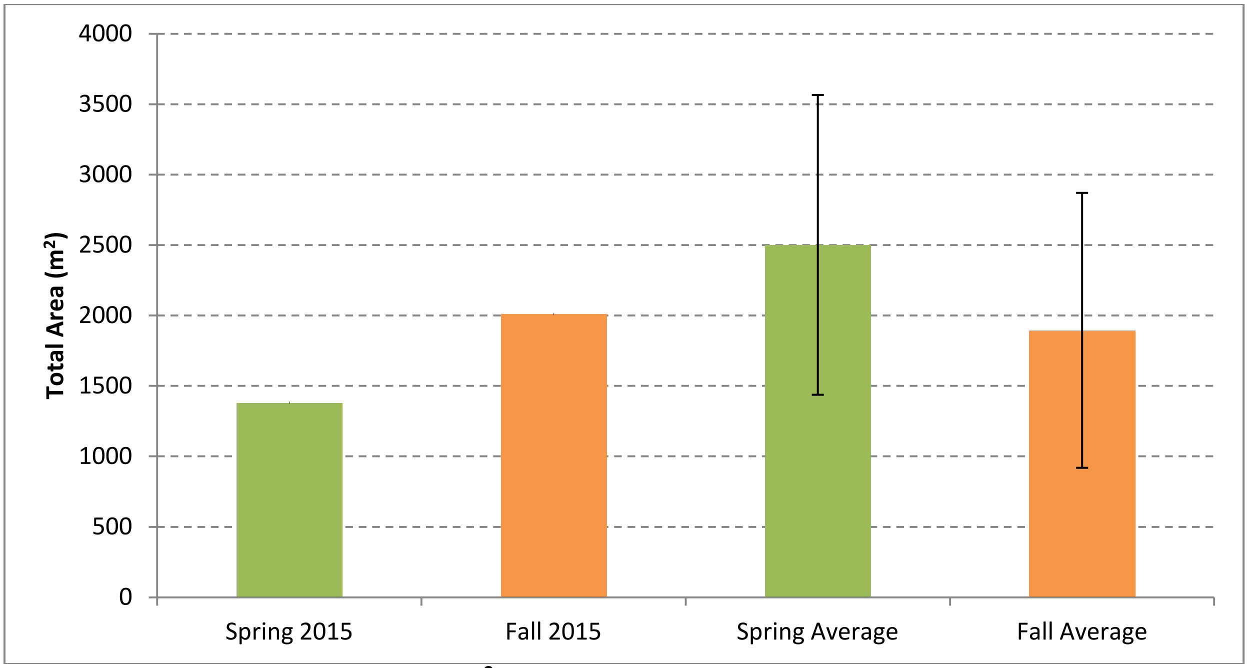


Figure 21. Total surface area (m^2) of aquatic vegetation in the Upper Spring Run Reach. Long-term study averages are provided with error bars representing one standard deviation from the mean.

Landa Lake Reach

Although total surface area of aquatic vegetation in the Landa Lake Reach in spring 2015 (16,395.9 m^2) was lower than the long-term study average (and lower than one standard deviation), much of this decrease can be attributed to City of New Braunfels walls project as well as HCP restoration activities in 2013–2014 (Figure 22). During those 2 years, all nonnative *Hygrophila* was removed from the reach. Immediately prior to removal this plant covered 522.9 m^2 (spring 2013) of the Landa Lake Reach. These restoration activities also sought to re-vegetate much of the reach with native plants, particularly *Ludwigia*, *Sagittaria*, and *Cabomba*. The other major component of this project was "aquatic gardening" in which biologists sought to remove any lingering *Hygrophila* plants and, more importantly, keep vegetation mats off newly planted native species.

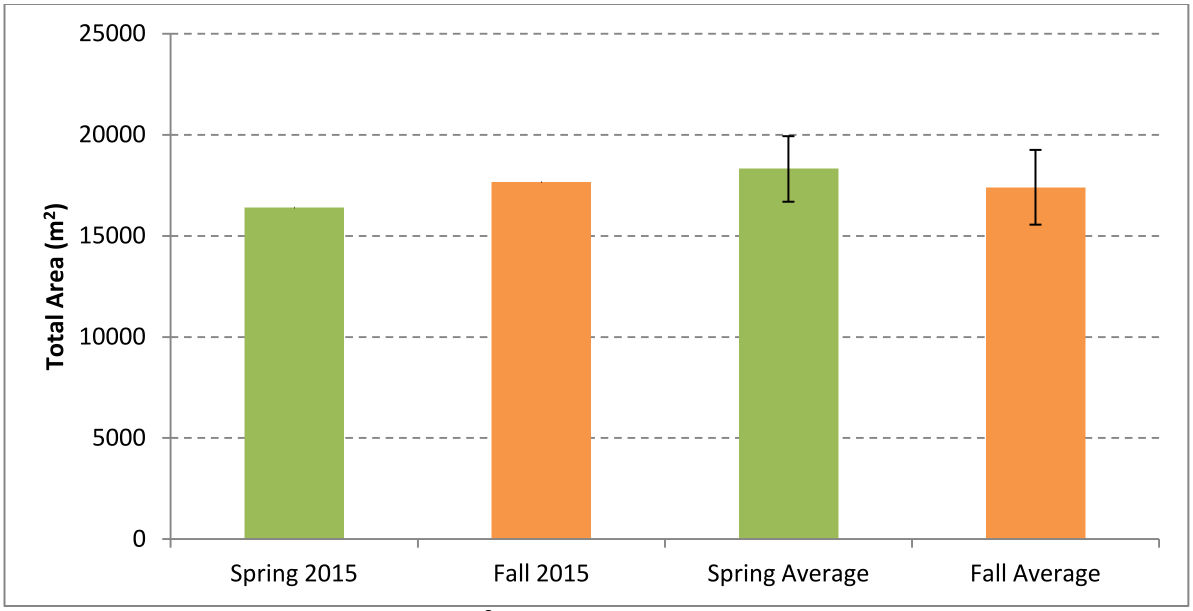


Figure 22. Total surface area (m^2) of aquatic vegetation in the Landa Lake Reach. Long-term study averages are provided with error bars representing one standard deviation from the mean.

Recently planted Ludwigia in the Landa Lake Reach.

The increased flows of 2015 coupled with continued HCP restoration efforts had a positive effect on the aquatic vegetation with fall total coverage (17,658.1 m^2) rebounding to higher than the long-term study average. Further monitoring of this important reach will allow for a better understanding of how these restoration efforts have contributed to the overall health of the system.

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 alga was one of the dominant plants, which contributed to a large fountain darter population because high densities of fountain darter were found in this plant. 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 in 2015 sought to reverse this trend by introducing native plants back into the reach. In spring 2015, however, *Hygrophila* was still the dominant plant, covering 1,474.2 m^2 of the Old Channel Reach. The total amount of vegetation here (1,777.8 m^2) was above the long-term study average, but within one standard deviation (Figure 23). During summer 2015, removal of *Hygrophila* began in earnest. By fall, only 920.3 m^2 of *Hygrophila* remained, and *Ludwigia* had once again gained a foothold in this reach. These removal efforts resulted in total coverage in the fall (1,355.8 m^2) being lower than the study average, but within one standard deviation (Figure 23). Continued restoration efforts will likely result in further re-establishment of native plants within the Old Channel Reach.

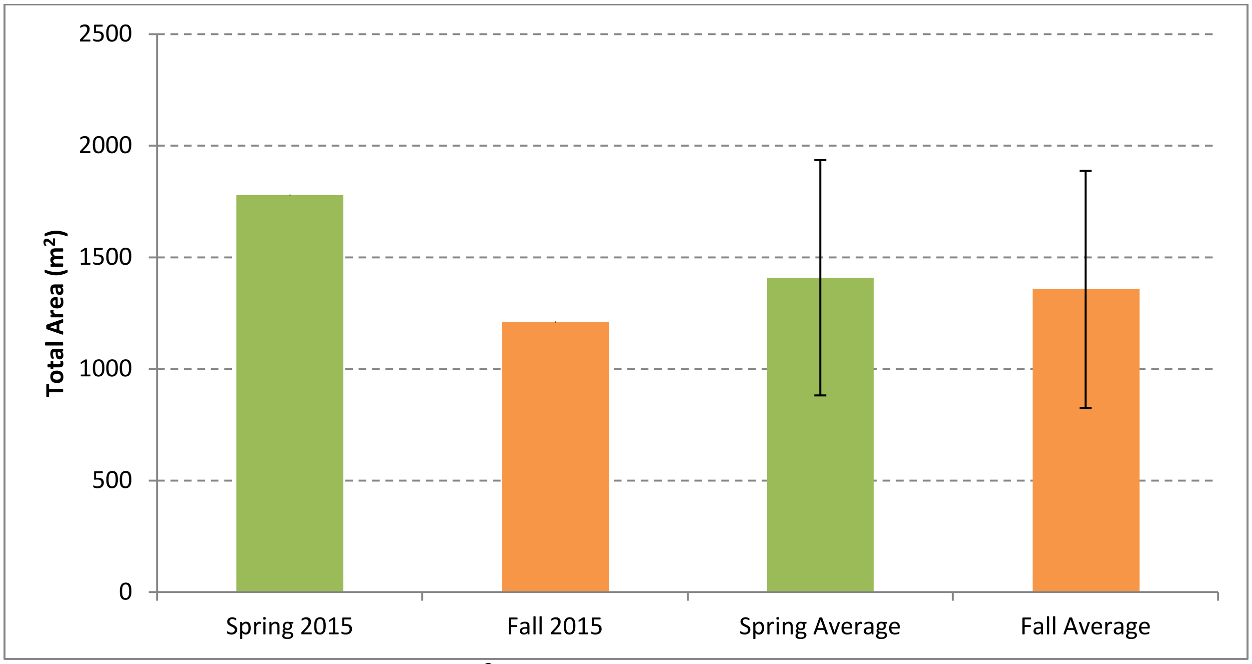
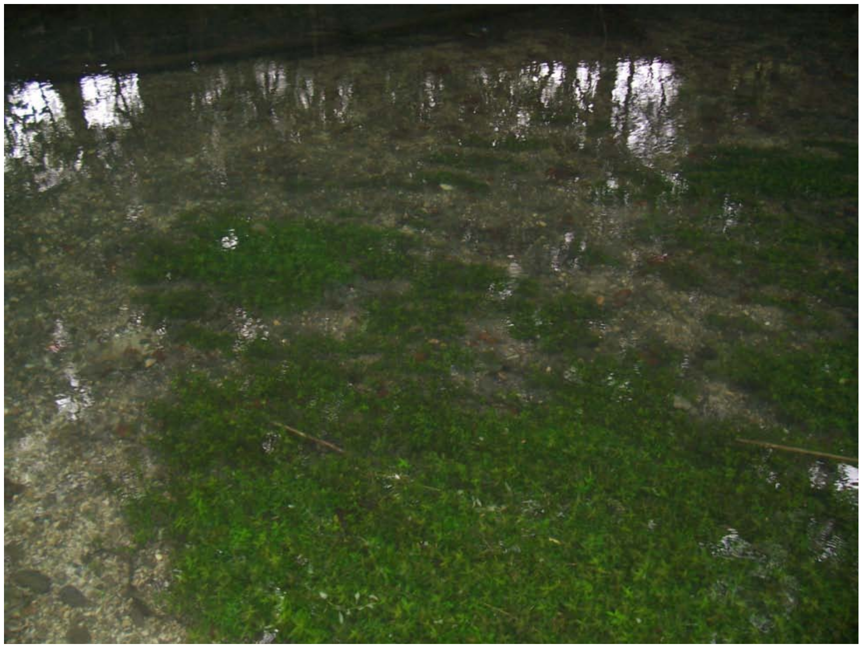


Figure 23. **Total surface area (m^2) of aquatic vegetation in the Old Channel Reach. Long-term study averages are provided with error bars representing one standard deviation from the mean.**



Hygrophila in the Old Channel Reach prior to removal.

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, the lower-than-average flows during the prolonged drought of 2013 through early 2015 led to a flourishing of aquatic vegetation. *Cabomba* and *Hygrophila* have come to dominate this reach because there had been no flushing flows to scour them out in recent years. The total surface area in spring 2015 (2,898.1 m^2) reflects this trend; that total is well above the study average (Figure 24). This trend continued into fall 2015 (3,541.3 m^2), with total surface area exceeding that of the study average and higher than one standard deviation. This is the highest total since 2004, exemplifying the lack of flushing flows here in recent years. The October 2015 high-flow event will determine how well rooted these plants are, considering much of the flow in the Comal River originated from Dry Comal Creek, which enters the river upstream of the Lower New Channel Reach.

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 flash-flood-like flows coming down Dry Comal Creek during precipitation events.

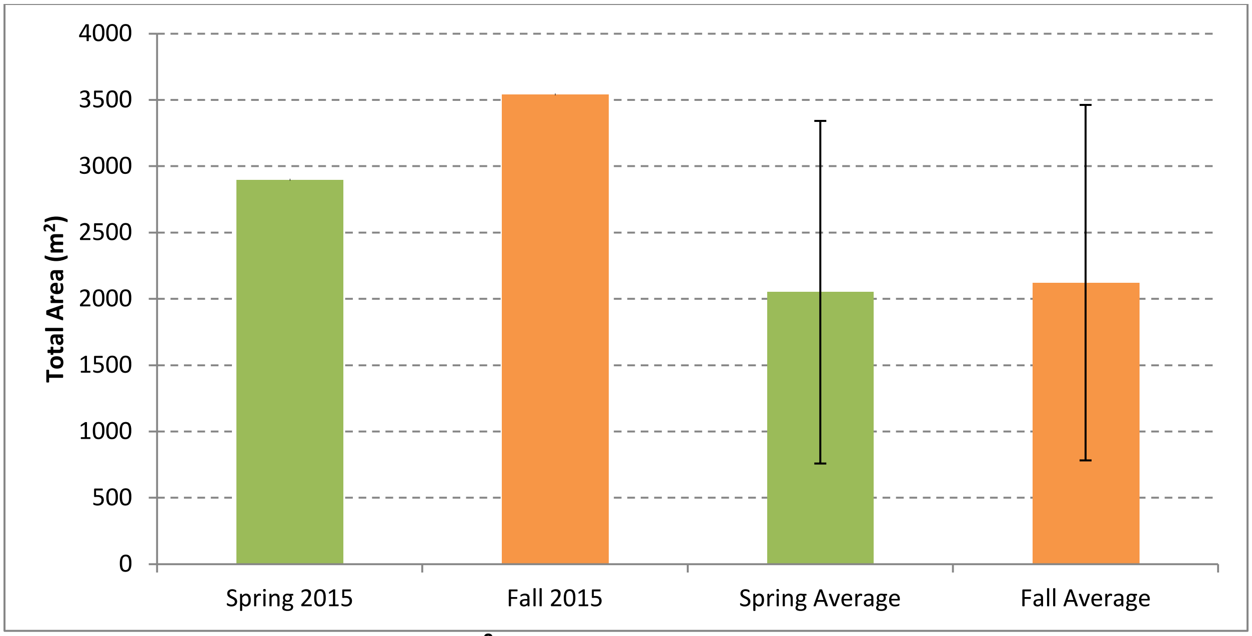


Figure 24. **Total surface area (m²) of aquatic vegetation in the Lower New Channel Reach. Long-term study averages are provided with error bars representing one standard deviation from the mean.**

Data presented in Figure 25 do not include study average because only four mapping events have occurred thus far. Total surface area of aquatic vegetation increased from fall 2014 (1,036.3 m²) to spring 2015 (1,183.6 m²) with much of this increase attributed to increases in *Cabomba* and *Hygrophila* coverage (Figure 25). The amount of aquatic vegetation decreased slightly to 1,057.5 m² by fall 2015. Like the Lower New Channel Reach, this reach is susceptible to scouring flows due to its channelized nature. In addition, Dry Comal Creek enters the system ~20 m upstream of this reach. As a result, it is expected that the high-flow event in October likely had major effects on the aquatic vegetation of this reach. These data will be presented and discussed in the aforementioned 2016 Addendum.

Fountain Darter Sampling Results

Drop Nets

A total of 65 drop-net samples were conducted during 2015 comprehensive sampling in the Comal system. Table 7 shows the number of drop-net samples taken from each vegetation type in each reach during the three sampling efforts. Unfortunately, changing conditions in the Upper New Channel Reach associated with an increase in flows allowed for only four drop-net samples to be completed; water at the site was too deep for effective sampling. Drop-net data sheets for 2015 are included in Appendix D.

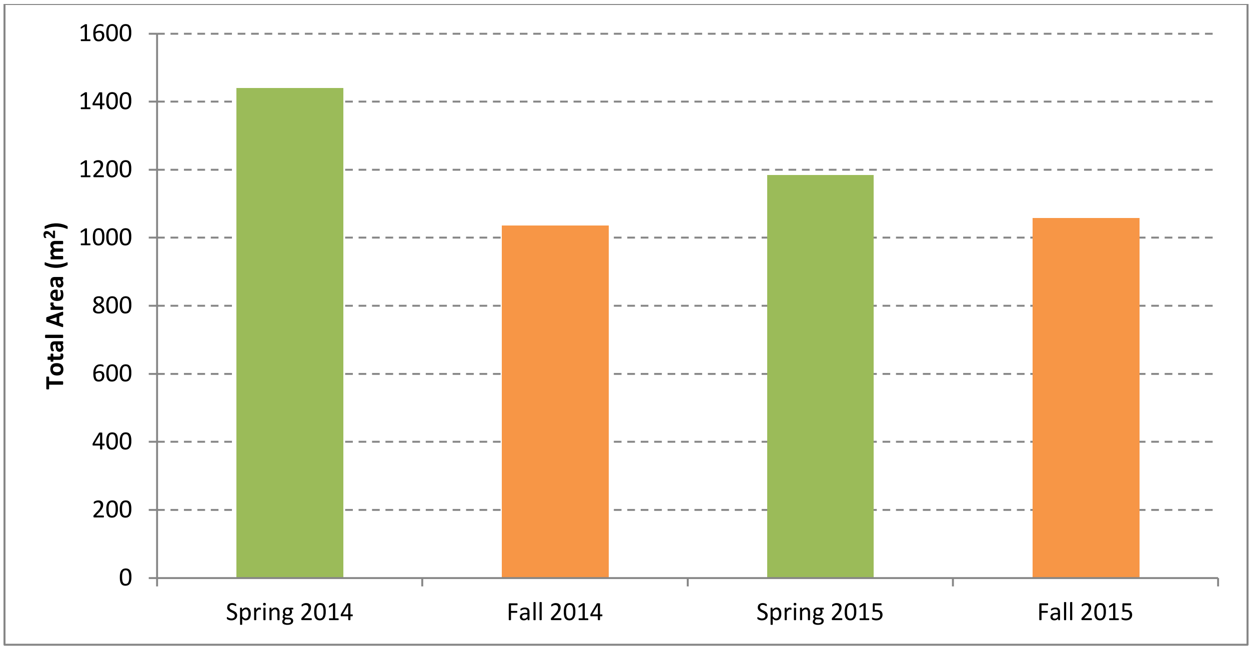


Figure 25. **Total surface area (m^2) of aquatic vegetation in the Upper New Channel Reach.**

Table 7. **Number of drop-net samples collected in each vegetation type per reach during 2015 sampling efforts.**

VEGETATION	SPRING (APRIL 29–May 1)				FALL (OCTOBER 26–28)				TOTAL
	Upper Spring Run	Landa Lake	Old [a] Chan.	Upper New Chan.	Upper Spring Run	Landa Lake	Old Chan.	Upper New Chan.	
Bryophytes	2	2	2		2	2	2		12
Ludwigia		2	2			2	2		8
Hygrophila	1		2	2			2	2	9
Sagittaria	2	2			2	2			8
Vallisneria		2				2			4
Cabomba		2		2		2		2	8
Green Algae					2				2
Open	2	2	2	2	2	2	2		14
TOTAL	7	12	8	6	8	12	8	4	65

[a] Both *Ludwigia* sites were located just downstream of Golf Course Road Bridge in newly restored section of the Old Channel because there was no *Ludwigia* to sample within the study reach.

From these drop-net samples, a total of 1,173 fountain darters were collected in 2015. Of these, 7 61 darters were collected during spring sampling, and 412 were collected during fall. Although effort has varied slightly between events, the number of fountain darters captured per sampling event has ranged from 103 to 1,058 (mean=497) in 44 separate sampling events since the beginning of the comprehensive monitoring study in 2000.

Drop-net data collected from 2000 to 2015 show that average densities of fountain darters in the various vegetation types ranged from 1.5/m^2 in open sites to 25.4/m^2 in bryophyte-dominated sites (Figure 26). Although variation is high, native vegetation types that provide thick cover at or near the substrate such as bryophytes and filamentous algae (24.1/m^2) tend to have the highest fountain darter densities, whereas open substrate with no vegetation has relatively low densities. Unfortunately, filamentous algae have not been dominant in any reach since 2004, so no drop-net samples have been taken in previous years. Filamentous algae were once the dominant vegetation type in the Old Channel Reach; however, that has been replaced in recent years by other types of vegetation. This has resulted in an overall decrease in abundance of fountain darter in this reach (see dip-net data).

Filamentous algae and bryophytes, which provide the best fountain darter habitat, are also most susceptible to scouring during high-flow events and have shown considerable fluctuation in coverage over the 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 2015c).

Estimates of fountain darter population abundance in all reaches (Figure 27) were based on the changes in vegetation composition and abundance, and the average density of fountain darters found in all vegetation types from 2000–2015. Population abundance estimates are similar for spring, fall, and low-flow events from 2000–2015. The spring 2015 population estimate was lower than the long-term study average, but within one standard deviation, while the fall 2015 estimate was higher than the long-term average, and also within one standard deviation of the mean (Figure 27). Additionally, both were higher than the averages for high and low-flow events. High-flow estimates are typically lower, most likely because of the scouring of vegetation from the study reaches during flood events. Higher flows following flood events may also influence sampling efficiency. Comparisons to the population estimate for the October 2015 high-flow event will further our understanding of what scouring flows can do to darter populations (which will be discussed in the aforementioned 2016 Addendum).

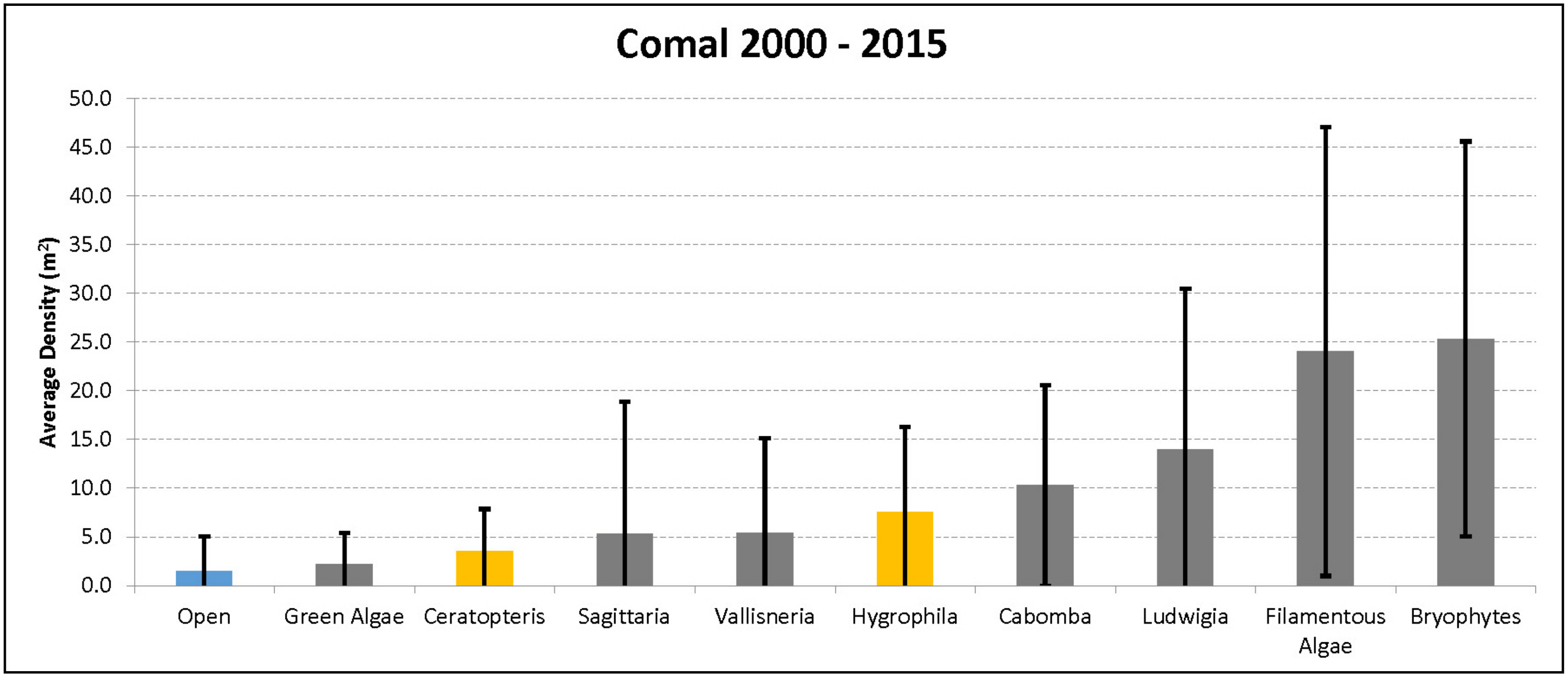


Figure 26. Average density of fountain darters collected by vegetation type in the Comal system from 2000 to 2015. Error bars are provided representing one standard deviation from the mean.

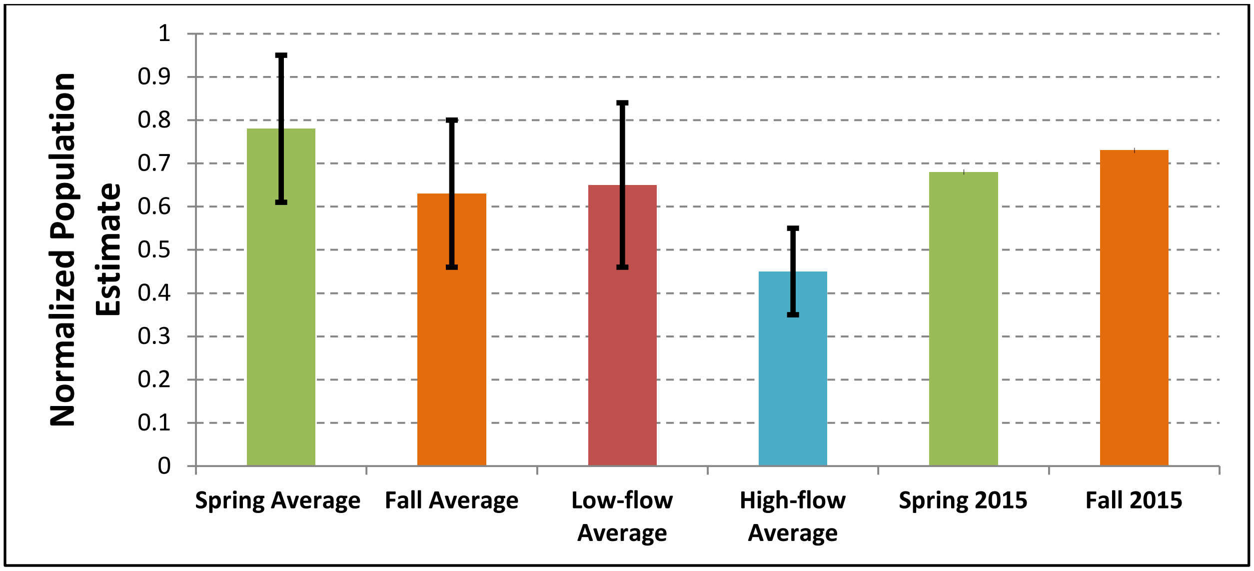


Figure 27. **Normalized fountain darter population estimates in the Comal River based on coverage of various vegetation types in the study reaches and average density of fountain darters in each type. Long-term study averages are provided with error bars representing one standard deviation from the mean.**

The length frequency distribution for fountain darters collected by drop nets from the Comal system during spring and fall sampling events from 2000–2015 is presented in Figures 28 and 29. Small fountain darters (from 12 to 22 mm total length) are more abundant in spring samples, than fall, which is dominated by larger fountain darters, from 24 to 38 mm total length. Analysis of length frequency data 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, 136,290 other specimens representing 24 other fish taxa have been collected by drop netting from the Comal system during the study period (2000–2015). Of these, seven are considered exotic or introduced (Table 8). 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. Largemouth bass (*Micropterus salmoides*) were surprisingly abundant in 2015; 253 were captured, which represents more than half of the total largemouth bass caught in the previous 14 years. Most of these were limited to one drop-net sampling event in bryophytes at the Upper Spring Run Reach in spring 2015. It is unclear why there was such successful reproduction for this species this year.

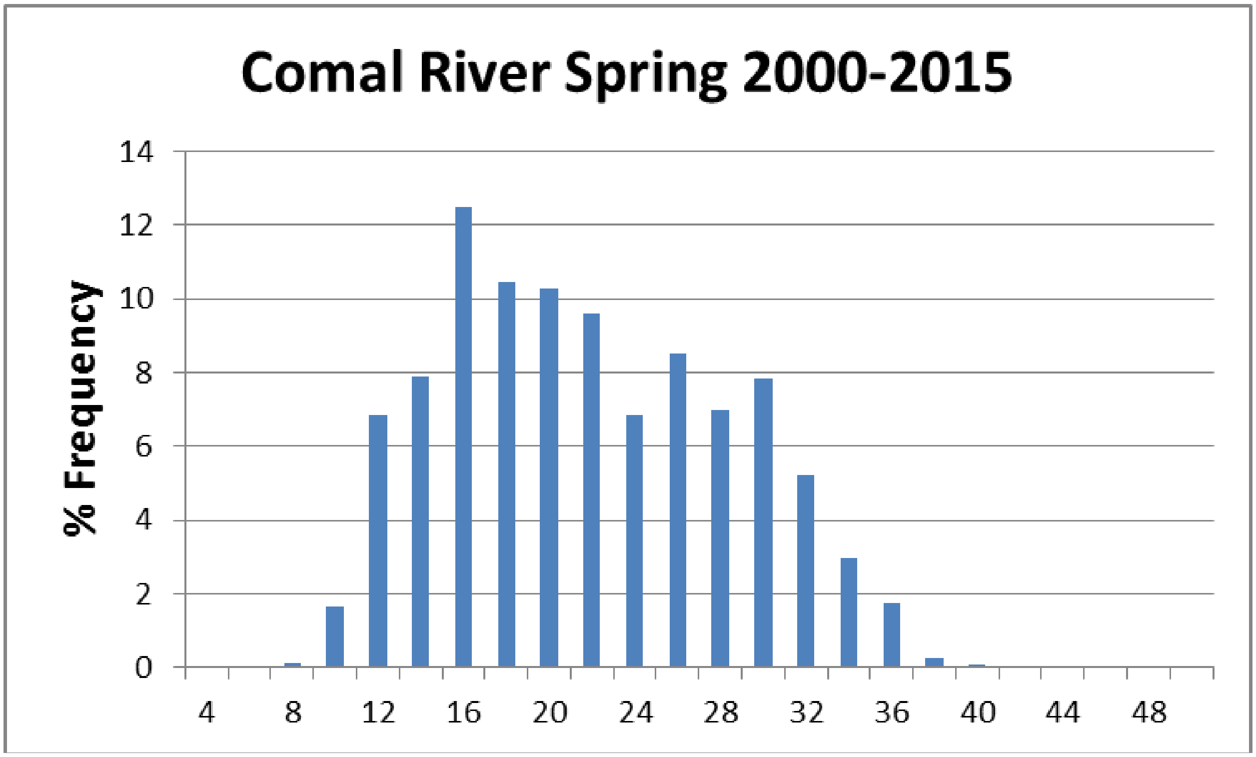


Figure 28. Length frequency distribution of fountain darters collected from the Comal system during all spring events (2000–2015).

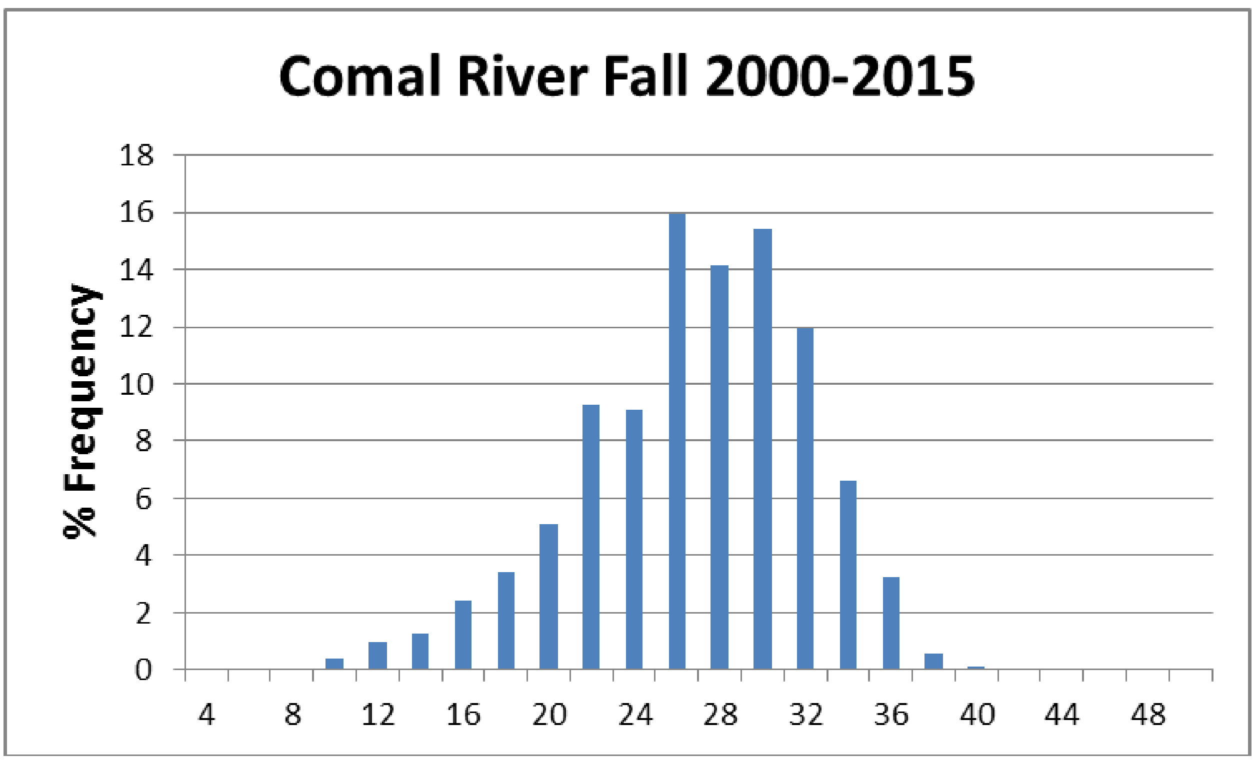


Figure 29. Length frequency distribution of fountain darters collected from the Comal system during all fall events (2000–2015).

Table 8. Fish taxa and the number of each collected during drop-net sampling.

FAMILY	SCIENTIFIC NAME	COMMON NAME	STATUS	2015	2000–2015
Cyprinidae	*Campostoma anomalum*	Central stoneroller	Native		1
	Dionda nigrotaeniata	Guadalupe roundnose minnow	Native	6	1,052
	Notropis amabilis	Texas shiner	Native	89	316
	Notropis volucellus	Mimic shiner	Native	1	33
	Pimephales vigilax	Bullhead minnow	Native		4
Characidae	*Astyanax mexicanus*	Mexican tetra	Introduced	7	439
Ictaluridae	*Ameiurus melas*	Black bullhead	Native		1
	Ameiurus natalis	Yellow bullhead	Native	2	110
Loricariidae	*Hypostomus plecostomus*	Armadillo del rio	Introduced	5	76
Poeciliidae	*Gambusia* sp.	Mosquitofish	Native	2,349	124,772
	Poecilia latipinna	Sailfin molly	Introduced	32	4,705
Centrarchidae	*Ambloplites rupestris*	Rock bass	Introduced		24
	Lepomis auritus	Redbreast sunfish	Introduced	3	146
	Lepomis cyanellus	Green sunfish	Native	13	23
	Lepomis gulosus	Warmouth	Native	1	33
	Lepomis macrochirus	Bluegill	Native	5	218
	Lepomis megalotis	Longear sunfish	Native	3	261
	Lepomis microlophus	Redear sunfish	Native		2
	Lepomis miniatus	Redspotted sunfish	Native	106	2,020
	Lepomis sp.	Sunfish	Native/Introduced	37	819
	Micropterus punctulatus	Spotted bass	Native		3
	Micropterus salmoides	Largemouth bass	Native	253	443
Percidae	*Etheostoma fonticola*	Fountain darter	Native	1,173	18,140
	Etheostoma lepidum	Greenthroat darter	Native		51
Cichlidae	*Herichthys cyanoguttatus*	Rio Grande cichlid	Introduced	6	671
	Oreochromis aureus	Blue tilapia	Introduced	1	67
Totals				4,092	154,430

Other potential impacts of exotic fish species include negative effects of exotic sailfin catfish (Siluriformes: Loricariidae) on algae and vegetation communities that serve as fountain darter habitat. Although these fish are rarely captured in drop nets, based on data from fish community sampling 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. Removal efforts have seemed to have some effect on the population as they were encountered less in drop nets in 2015.

Sailfin molly caught during drop-net sampling.

The number of fountain darters collected in the Upper Spring Run Reach in 2015 was significantly higher than what we have observed in the last several years (62–68). This is likely due to the higher-quality bryophytes and higher flows observed in 2015 than recent years. See Appendix C for more information. The Spring Island, Landa Lake, New Channel and Old Channel reaches all had similar numbers of fountain darters observed compared to recent years (Appendix C). The Other Place Reach showed a considerable increase in both the total number (79) and small 5–15 mm size class (56) of fountain darters observed in the fall sampling event. Similar to the Upper Spring Run Reach, this is likely due to the overall improved quality of vegetation and higher flows observed in 2015. A larger dataset is needed to understand flow-dependent relationships with fountain darter abundance in this section of river.

Overall, size class distributions of fountain darters from dip netting correlate well with those of drop netting: 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.

Presence / Absence Survey

In 2015, presence/absence dip netting was conducted within reaches on the Comal River during the typical spring (May), summer (August), fall (October), and high-flow Critical Period (December, data presented in 2016 addendum) sampling efforts (Figure 30). In addition, one

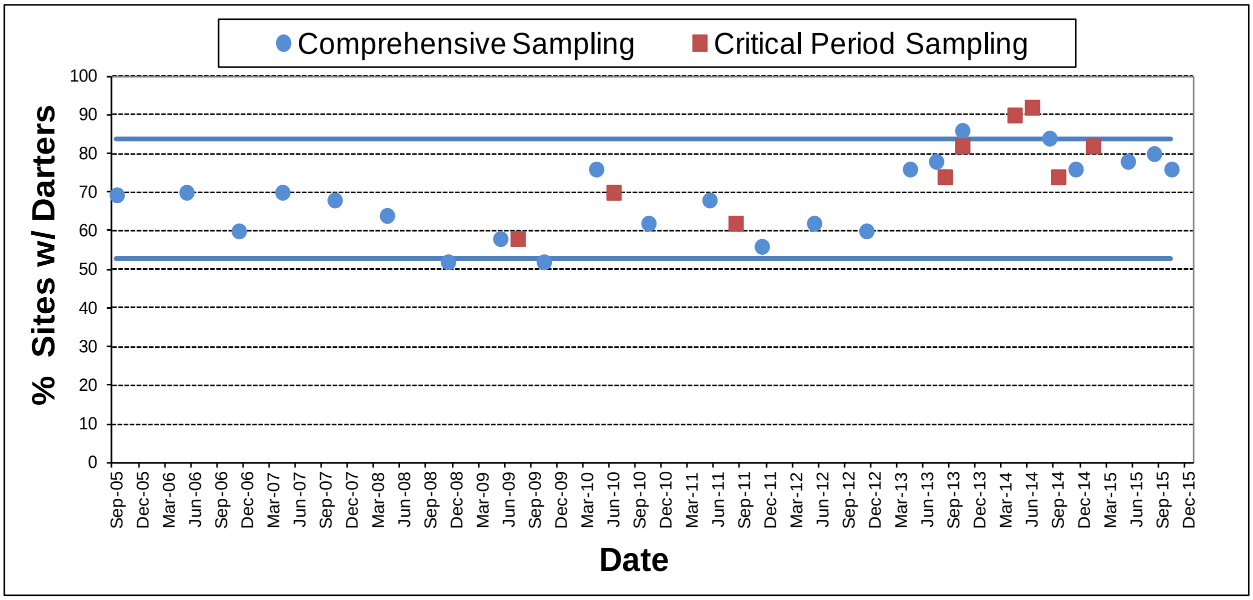


Figure 30. **Percentage of sites (n=50) in which fountain darters were present. Solid blue lines mark 5th and 95th percentiles for comprehensive sampling.**

low-flow Critical Period (<150 cfs) sampling effort (January) was conducted. 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 low-flow Critical Period sampling effort, decreased by spring (78%), increased in summer (80%), and decreased to 76% by fall (Figure 30). These percentages are all within the 5^{th} and 95^{th} percentiles for the study. They are slightly lower than 2014 but higher than the long-term comprehensive sampling average (70%).

As shown in Figure 30, the lowest percentage of fountain darters observed to date has been 52%, recorded during comprehensive sampling in fall 2008 and fall 2009. The June 2014 value was 92%, which is the highest value to date. In 2014 fountain darter presence was above what was expected based on previous years due to several factors:

- Clumping of fountain darters into limited bryophytes in the Upper Spring Run Reach, bryophytes are targeted for dip netting, and although there are few left, the remaining vegetation is loaded with fountain darters.

- High densities of fountain darters in restored *Ludwigia* around the islands in Landa Lake.

- Good habitat conditions in both the Old Channel and New Channel Reaches due to lack of any recent scouring flood pulses.

The return to “normal” flow in 2015 reduced the clumping effect, likely distributing fountain darters more evenly throughout the reaches.

Fixed-Station Survey

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 and 2015) were analyzed using the multiple season occupancy model methods (MacKenzie, Nichols, Hines, Knutsin, & Franklin, 2003) implemented in PRESENCE v10.0 (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 dip-net 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 six primary sampling periods (seasonal sampling events) each composed of four secondary samples (repeated dip-net samples). All reasonable candidate models for the case of each drainage were compared using Akaike information criterion (AIC) and AIC weight following established best practices (Burnham & Anderson, 1998).

The "best" candidate model was selected based on lowest AIC and highest AIC weight (which is often interpreted as the probability of that model being the "best" of those tested). These models provide estimates of ψ (psi, probability of occupancy) and p (detection probability) for the sites sampled. Ψ may be modeled as a function of site covariates, or factors that are descriptive of sites that do not change over the study period. Unfortunately, due to the dynamic nature of the morphology of the study stream, as well as unavoidable heterogeneity consequent of recreation impacts, habitat structure (vegetation/cover) did not meet this criteria as this changed for some sites over the study period. Ψ was therefore modeled as static ("ψ (.)") within primary periods, but allowed to vary among primary periods. On the other hand, p was modeled as static ("p (.)"), as well as varying by cover or vegetation type.

Of the candidate models of the Comal data, the model in which detection was modeled as a function of vegetation received the most support, with an AIC weight of 0.87. Under this model, initial ψ=0.90 and p varied from 0.42 to 0.77. Detection (the probability that the species would be detected in a single secondary sample given that the site was occupied) was high for sites whose habitat consisted of bryophytes (p=0.68) and those that had bryophytes mixed in with other vegetation (p=0.61) (Table 9). The highest detection values were for Chara and Sagittaria, however these estimates may not yet be as accurate as fewer sites are sampled that have this vegetation type. This model estimates that between primary periods (seasons) the probability of colonization of a site is 0.34 (95 % CI: 0.22–0.46), and the probability of local extinction is 0.25 (95% CI: 0.18–0.32), thus the likelihood of an occupied site remaining so is 75%. The naïve (#sites occupied / #sites) and informed (modeled) estimates of occupancy for these data are presented in Table 10. Clearly, both naive and model estimates of occupancy were higher in the first sample collected in spring 2014, dropped significantly the next season, and have remained more or less stable since (consistent with the results of the previous section). It is likely that this was due to changes in vegetative cover at sample sites that has occurred over time due to numerous factors, including recreation, high and low-flow periods, and sampling impacts.

Table 9. Detection probabilities for different habitat types estimated by multiple season occupancy modeling of Comal River fountain darter presence/absence data.

HABITAT	P
Algae	0.53
Bryophytes	0.68
Cabomba	0.43
Chara	0.77
Hygrophila	0.42
Ludwigia	0.64
Sagittaria	0.72
Vallisneria	0.48
Mixed bryophytes	0.61
Mixed algae	0.42

Table 10. Estimates of site occupancy in 2014 and 2015 by fountain darters in the Comal River from multiple season occupancy modelling, as well as naïve occupancy (proportion of sites observed occupied) for comparison.

SAMPLE	MODEL Ψ	NAÏVE Ψ
Spring 2014	0.90	0.86
Summer 2014	0.71	0.66
Fall 2014	0.63	0.6
Spring 2015	0.60	0.66
Summer 2015	0.59	0.56
Fall 2015	0.58	0.48

After the first sampling period, there was an increase in the number of sites consisting of open habitat (no vegetative cover), from 12% open sites to 26% (Table 11). Simultaneously, there was a reduction in sites covered by some other vegetation types (Table 11). These changes in habitat characteristics of sites among sampling periods not only are likely to cause some changes in 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 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.

Table 11. Change in percent of sample sites representing certain habitat types. Note the dramatic increase in open sites after the first sampling period.

TYPE	SPRING 2014	SUMMER 2014	FALL 2014	SPRING 2015	SUMMER 2015	FALL 2015
Algae	10%	4%	8%	4%	2%	4%
Bryophytes	10%	6%	6%	12%	16%	12%
Cabomba	8%	6%	6%	6%	8%	8%
Chara	0%	0%	0%	2%	2%	2%
Hygrophila	28%	28%	32%	24%	16%	16%
Ludwigia	6%	4%	2%	6%	6%	10%
Open	12%	26%	22%	22%	24%	20%
Sagittaria	8%	6%	8%	8%	10%	10%
Vallisneria	18%	20%	16%	16%	16%	18%

Visual Observations

Fountain darters were again observed in the deepest portions of Landa Lake (depths greater than 2 m) during all 2015 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. In last year's report, the low darter numbers present in the fall 2014 visual survey was highlighted with a suggestion to " track the response in spring 2015 should total system discharge remain low or rebound to more average conditions" (BIO-WEST, 2014a). In fact, with a rebounding of total system discharge, the habitat conditions in this deeper portion of Landa Lake in spring 2015 were excellent exhibiting near total (95 percent) bryophyte coverage. As typical throughout the year, by fall 2015, a decline in percent bryophyte coverage (65%) was experienced. Also typical to years past, fountain darter counts of 97 (spring) and 47 (fall) closely tracked the available habitat in this deeper portion of the lake. Following the intense flooding during late October 2015, a subsequent darter visual dive was conducted on December 15. At this time, extensive scour of bryophytes in the deeper portion of the lake had occurred resulting in only 10% coverage of bryophytes within the sampling grid, and a dismal 15 fountain darters being observed. Again, the beauty of this long-term monitoring program is the late 2015 flooding/scour event allows another excellent opportunity to track the habitat and darter response next spring.

Fish Community Sampling

Twenty-two species of fishes and 9,497 individuals were identified and enumerated among six locations on the Comal River observed in January (winter) and May (spring) 2015 (Table 12). The January effort was conducted as part of the low-flow Critical Period sampling because flows were less than 150 cfs. The flooding event in late October delayed the fall fish community sampling effort; as a result these data will be presented in the 2016 Addendum.

Table 12. **Total number (TotalN) of individuals and species, gear type of efficient catch per unit effort (CPUE), number of individuals for gear type specified, and CPUE (number of individuals per square meter) quantified during winter and spring, 2015 from six locations on the Comal River. Seines were not used in Blieder's Creek during spring or in Landa Lake (depths were too great).**

				Blieder's Creek		Upper Spring Run		Landa Lake		Old Channel		New Channel		Lower Comal River	
Species	Total N	Gear type	N for gear type	Winter	Spring	Winter	Spring	Winter	Spring	Winter	Spring	Winter	Spring	Winter	Spring
Dionda nigrotaeniata	257	Meso	222	0.071	0	0.088	0.050	0.012	0.016	0	0	0	0	0	0
Notropis amabilis	416	Seine	137	0	0	0.035	0.190			0.003	0.123	0.067	0.040	0	0.018
Notropis volucellus	13	Seine	7	0	0	0	0			0	0	0	0	0	0.031
Astyanax mexicanus	249	Meso	229	0	0	0.005	0.026	0.014	0.008	0	0	0.017	0.006	0.002	0
Ameiurus melas	7	Seine	7	0	0	0	0			0	0	0	0.023	0	0
Ictalurus punctatus	5	Micro	1	0	0	0	0	0	0	0	0	0	0	0.008	0
Hypostomus plecostomus	11	Meso	7	0	0	0	0	0	0	0.004	0.004	0	0.001	0.004	0
Gambusia affinis	168	Seine	168	0.038	0.167	0.235	0			0.130	0.047	0.071	0.02	0	0
Gambusia geiseri	122	Seine	122	0.038	0.233	0.074	0.037			0.061	0.047	0.079	0.033	0.005	0
Gambusia	5,549	Meso	4,825	0	0	1.318	1.033	1.309	0.217	0.583	0.583	0	0	0	0
Poecilia latipinna	27	Seine	12	0	0	0	0			0	0	0.050	0	0	0
Ambloplites rupestris	4	Seine	4	0	0	0	0			0.012	0	0	0	0	0
Lepomis auritus	290	Meso	190	0	0.004	0.002	0.030	0.003	0.003	0.003	0.003	0.013	0.015	0.029	0.075
Lepomis cyanellus	6	Meso	2	0	0	0	0	0	0	0	0	0	0.002	0	0
Lepomis gulosus	5	Seine	5	0	0	0	0			0	0	0	0.01	0	0.009
Lepomis macrochirus	106	Meso	47	0	0.020	0	0	0	0	0	0	0.009	0.012	0	0.014
Lepomis megalotis	38	Meso	27	0	0	0	0.020	0	0	0	0	0	0	0	0.002
Lepomis miniatus	100	Seine	89	0.086	0.078	0.028	0.030			0	0.030	0.029	0.073	0.081	0.004
Lepomis	369	Meso	278	0	0.049	0.044	0.064	0.001	0.006	0.009	0.009	0.024	0.023	0.062	0.022
Micropterus salmoides	146	Meso	114	0	0.037	0.026	0.021	0.005	0.001	0	0	0.012	0.015	0.010	0.002
Etheostoma fonticola	1,177	Micro	1,027	0.125	0.200	0.592	2.083	0.600	1.792	1.158	1.033	0.275	0.608	0.075	0.233
Etheostoma lepidum	128	Micro	111	0.250	0.225	0.158	0.208	0.092	0.083	0.042	0.067	0.008	0.008	0.025	0.075
Etheostoma	232	Micro	229	0.125	0.200	0.167	0.800	0.217	0.192	0.083	0.092	0.058	0.075	0.108	0.008
Herichthys cyanoguttatus	69	Meso	45	0	0.012	0.022	0.013	0.001	0.000	0.003	0.003	0.002	0.001	0	0.001
Oreochromis aureus	3	Meso	1	0	0	0	0	0.001	0	0	0	0	0	0	0
Total N	9,497														
Procambarus	461	Seine	190	0	0.033	0	0.093			0	0.077	0	0.45	0	0.004

Fountain darter densities increased from winter to spring at Blieder's Creek, Upper Spring Run, Landa Lake, and Lower Comal River in 2015. Densities decreased slightly from winter (1.16 fish /m^2) to spring (1.03 fish/ m^2) at the Old Channel site corresponding with a relatively stable hydrograph making it unclear why densities decreased here and at no other sites. Similar patterns were observed for greenthroat darter (*Etheostoma lepidum*) densities among sites, though at most sites an order of magnitude less than fountain darters. Among all sites, fountain darter densities were greater at Upper Spring Run and Landa Lake, followed by Old Channel, New Channel, Blieder's Creek, and Lower Comal River. Green sunfish (*Lepomis cyanellus*) were the only species caught in 2015 that were not caught in 2014; however, blacktail shiner (*Cyprinella venusta*), redear sunfish (*Lepomis microlophus*), and smallmouth bass (*Micropterus dolomieu*) were caught in 2014 and not in 2015 (Table 12).

Comal Springs Salamander Visual Observations

Biologists conducted three Comal Springs salamander presence/absence surveys in the Comal system in 2015. Two were part of regularly scheduled spring and fall comprehensive monitoring efforts, and one was part of high-flow Critical Period sampling that will be presented in the 2016 Addendum. Compare this to 2014, when flows were substantially lower, which triggered 10 sampling events throughout the year. Increased flows in 2015 in the Comal River resulted in all spring runs having flowing water and, presumably, better salamander habitat. This is reflected in photographs taken in 2014 and 2015 (Figure 31). At the Spring Island Spring Run (Spring Run 6) this wetted habitat yielded four salamander observations in spring (Figure 32), the highest number observed here since summer 2004, and higher than the long-term study average, but well within the variability that characterizes this sight. By fall the habitat looked similar, but no salamanders were observed (Figure 32). Salamander observations at the Spring Island East Outfall site displayed the opposite trend with higher numbers observed in fall than spring (9 and 4, respectively) (Figure 33). Bryophytes covered much of the site in spring and fall, but in fall there was an additional layer of green algae covering the bryophytes. It is unclear whether this had an effect on the increased numbers, but future observations may give a better understanding.

Figure 31. Photographs showing flow cessation and subsequent wetting of Spring Run 6 at Spring Island; left photograph was taken September 17, 2014, and right photograph on April 24, 2015. Photographs are of the lower portion of Spring Run 6 with view towards the southeast.

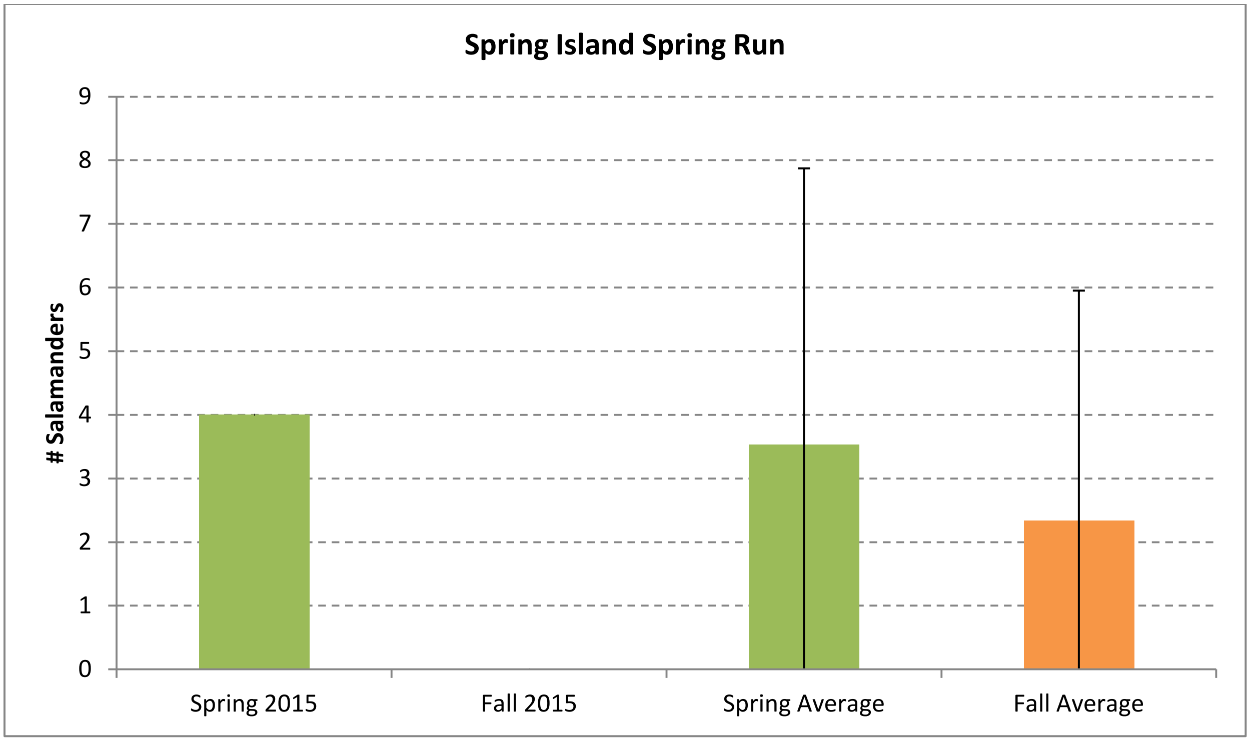


Figure 32. **Salamander observations at the Spring Island Spring Run in 2015. Long-term study averages are provided with error bars representing one standard deviation from the mean.**

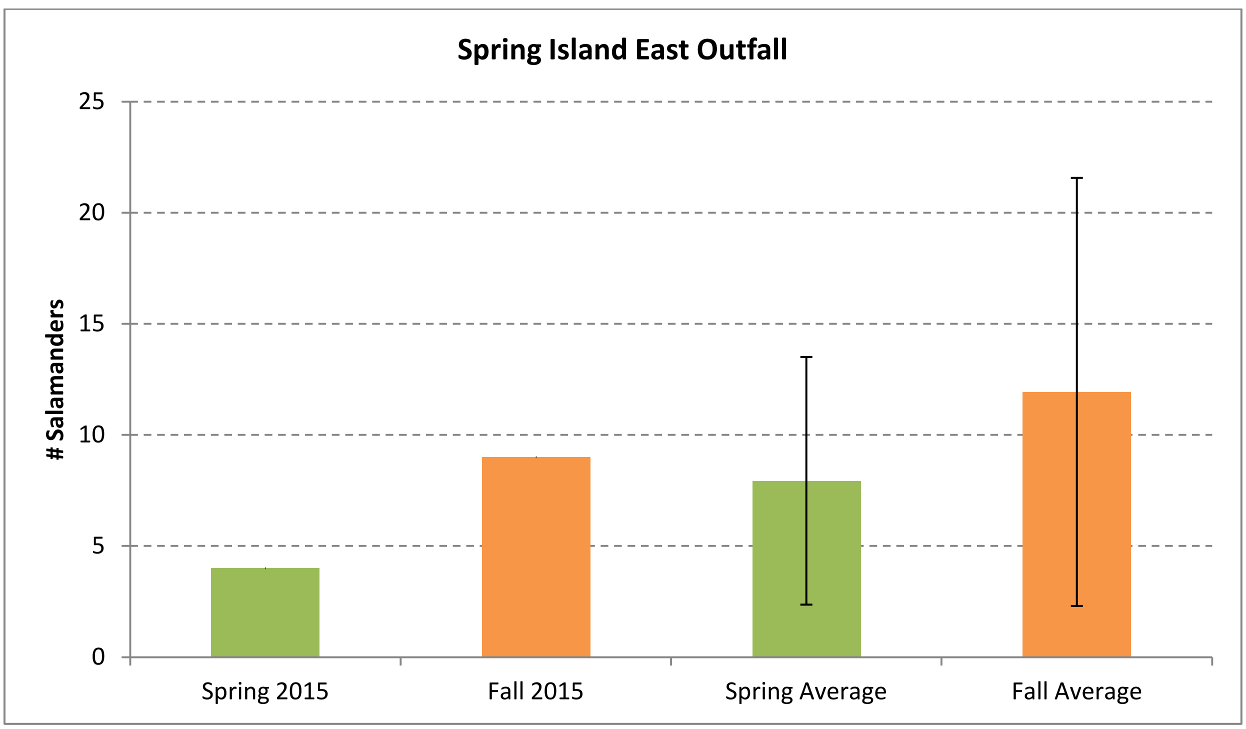


Figure 33. **Salamander observations at the Spring Island East Outfall in 2015. Long-term study averages are provided with error bars representing one standard deviation from the mean.**

Like the Spring Island sites, both Spring Run 1 and Spring Run 3 had flowing water throughout 2015. The difference in habitat availability at Spring Run 1 is exemplified by photos taken in fall 2014 and spring 2015 (Figure 34). This did not translate to very many salamander observations during either sampling effort (Figure 35). Only two salamanders were observed in spring, the lowest since mid-summer of 2014. This was lower than the long-term average and outside one standard deviation of the mean for this site. By fall, numbers increased to seven, which was also below the long-term average and standard deviation (Figure 35). These low numbers could be an after effect of the extremely low flows in 2014 with salamander numbers not having yet recovered. Additionally, reconstruction of the wall in Spring Run 1 in 2014 may also have led to the depression of salamander numbers, and may take time for the population to recover. Whether this is a result of movement out of the site or just an anomaly is unclear, but future observations should further our understanding.

Unlike Spring Run 1, Spring Run 3 had a substantial amount of wetted habitat in 2014, and with increased flows, continued into 2015. While some spring heads along the river left shoreline were dry in 2014, all were covered with water in 2015. Eleven salamanders were observed in spring, which is lower than the long-term average, but within one standard deviation (Figure 36). This was the highest number since the spring/summer of 2014 when over 20 salamanders were observed. Numbers in fall decreased slightly in fall to eight observations, which was also below the long-term average but within one standard deviation (Figure 36).

Figure 34. Photographs showing flow cessation and subsequent wetting of Spring Run 1. The left photograph was taken August 21, 2014, and the right photograph on April 24, 2015. Note the presence of terrestrial vegetation and lack of wetted habitat in the left photograph.

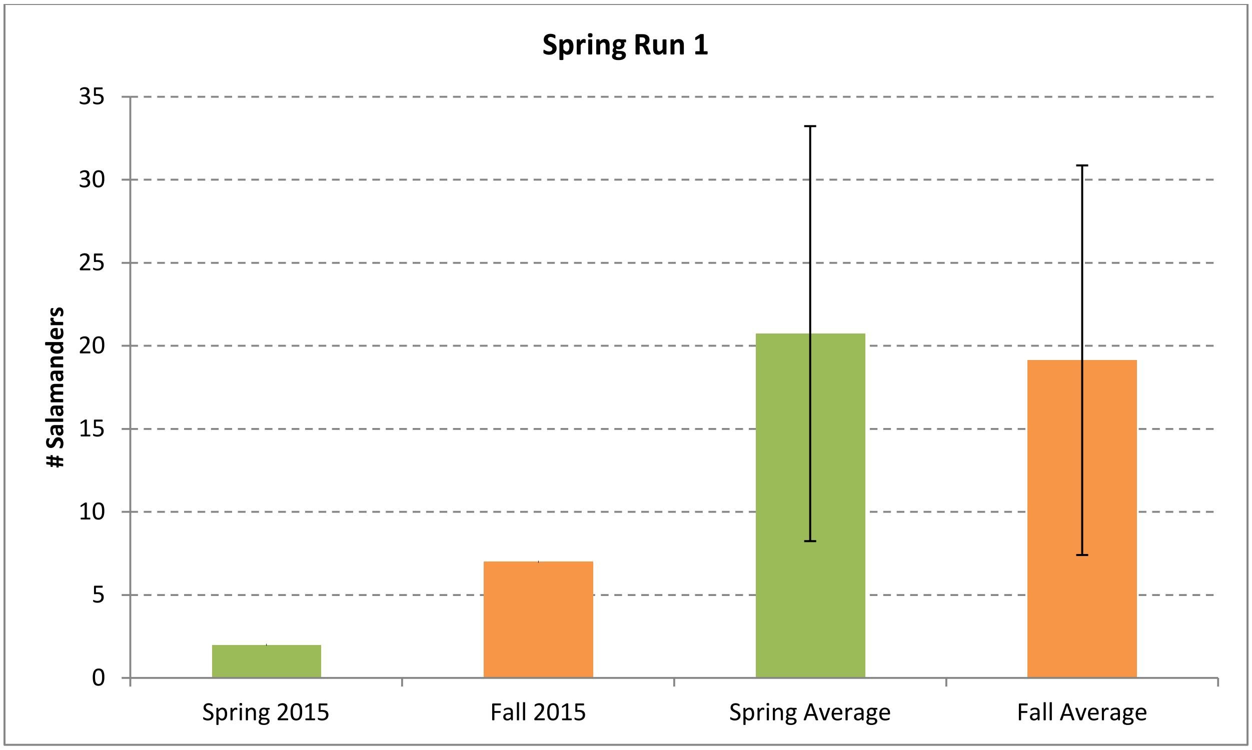


Figure 35. **Salamander observations at the Spring Run 1 in 2015. Long-term study averages are provided with error bars representing one standard deviation from the mean.**

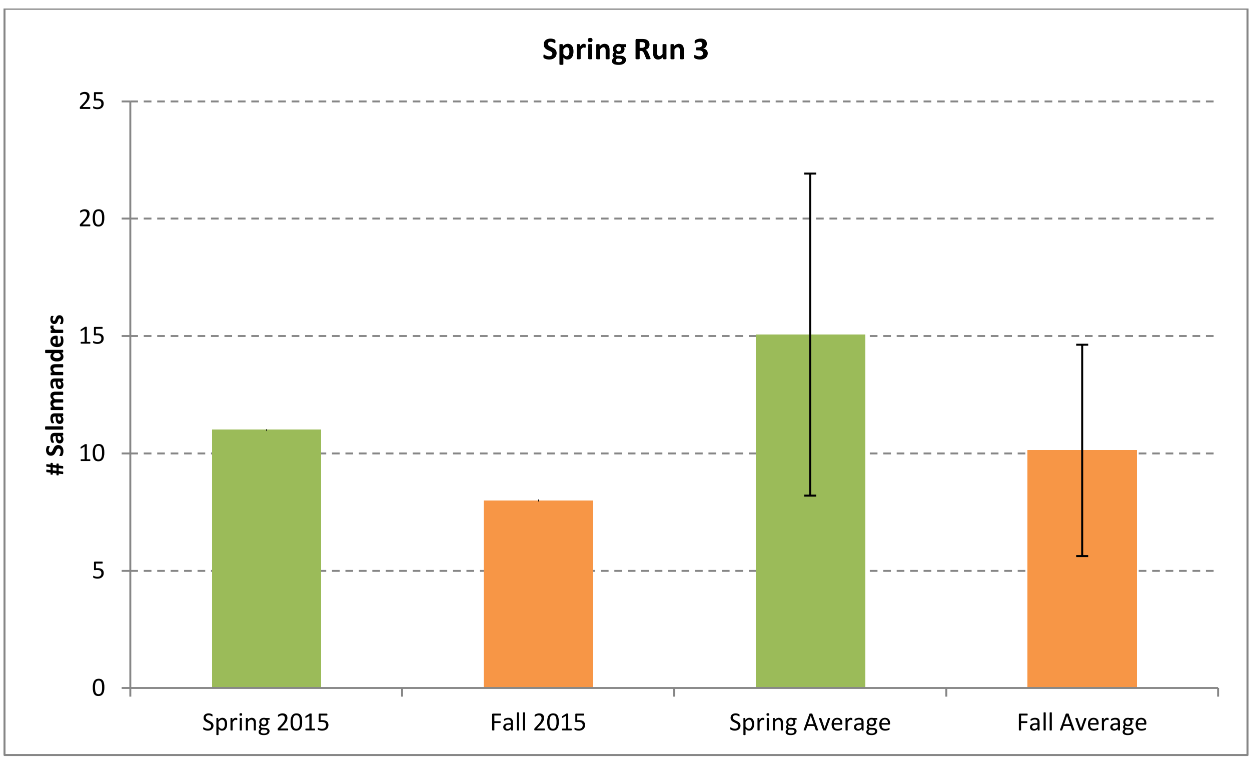


Figure 36. **Salamander observations at the Spring Run 3 in 2015. Long-term study averages are provided with error bars representing one standard deviation from the mean.**

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 2015. 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 described study reaches.

Drift Net Sampling

Water quality data associated with each 2015 drift net sampling event are presented in Table 13. In 2015 at least eight species were collected during drift net sampling efforts in Spring Run 1, Spring Run 3, and an upwelling along the Western Shoreline of Landa Lake (Spring 7) (Table 14). Drift nets with 150 micron mesh were used at all sites in 2015 resulting in the capture of two new species, not observed before in this study. *Texanobathynella bowmani* (Figure 37) is a tiny, primitive crustacean that has been collected in an adjacent Panther Canyon well in 2014. Also captured was *Comaldessus stygius*, a beetle larva similar to *Haideoporus texanus*. *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 5 larvae were collected in drift net sampling in 2015 (Table 14). None were collected at the Western Shoreline site. This site did have the greatest number of organisms captured (743) in 2015 with the majority of them *Stygobromus* species. The fewest number of organisms captured during both sampling efforts (379) was at Spring Run 1.

Table 13. Water quality measurements taken in conjunction with drift net sampling in 2015 at Comal Springs. Values represent the average of two readings (before and after drift sampling).

PARAMETER [a]	SPRING RUN 1		SPRING RUN 3		WESTERN SHORELINE	
	APRIL	NOV	APRIL	NOV	APRIL	NOV
Temperature (°C)	23.1	23.0	23.1	23.3	23.7	23.7
Conductivity (µS/cm)	533	582	527	573	500	551
pH	7.6	7.0	7.6	7.1	7.4	6.6
Dissolved oxygen (mg/L)	5.3	5.9	5.2	5.7	4.9	5.3
Current velocity (m/s)	0.31	0.37	0.28	0.41	0.13	0.17

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

Table 14. Total numbers of troglobitic and endangered species collected at each site during April and November, 2015. Federally endangered species are designated with (E), A=adult beetles, L=larvae, P=probable pupae.

INVERTEBRATE	RUN 1	RUN 3	UPWELLING	TOTAL
Total Drift Net Time (hours)	48	48	48	144
Crustaceans				
Amphipoda				
Crangonyctidae				
Stygobromus pecki (E)	7	12	26	45
Stygobromus russelli				
Stygobromus bifurcatus				
Stygobromus flagellatus				
Stygobromus spp.	76	134	293	503
All *Stygobromus*	83	146	320	549
Hadziidae				
Mexiweckelia hardeni	37	28	1	66
Sebidae				
Seborgia relicta	39	35	22	96
Bogidiellidae				
Artesia subterranea	4			4
Parabogidiella americana				
Ingolfiellidae				
Ingolfiella n. sp	1	1		2
Isopoda				
Asellidae				
Lirceolus (2 spp.)	77	102	27	206
Cirolanidae				
Cirolanides texensis			4	4
Thermosbaenacea				
Monodellidae				
Tethysbaena texana				
Bathynellacea				
Parabathynellidae				
Texanobathynella bowmani		1	1	2
Arachnids				
Hydrachnoidea				
Hydryphantidae				
Almuerzothyas comalensis				
Insects				
Coleoptera				
Dytiscidae				
Comaldessus stygius	3 A, 2 L		1 L	6
Haideoporus texanus (adults)				
Dryopidae				
Stygoparnus comalensis (E)				
Elmidae				
Heterelmis comalensis (E)	2 L	3 L		5

Figure 37. *Texanobathynella bowmani* **captured in Comal County, Texas.**

Comal Springs Riffle Beetle

There were 3 sampling efforts in 2015 specifically for Comal Springs riffle beetles. The initial sampling was conducted in February/March as part of a recovery evaluation immediately following an extended period of total system discharge below 150 cfs. The fall sampling effort was interrupted due to the October flooding event, so lures were reset at all sites, and thus only a high-flow sampling effort was formally conducted. Data presented below summarizes densities of adult Comal Springs riffle beetles from 2015 in the context of the long-term study.

Densities at lures in Spring Run 3 were highly variable in 2015. During the follow-up to low-flow sampling, the density of adult beetles was 3.7/lure, which was substantially lower than the previous effort in fall 2014 (7.0/lure). This was well below the long-term study average (7.7/lure) for low-flow sampling, but within one standard deviation (Figure 38). Lure density increased dramatically by spring (11.0/lure), which was below the long-term average but within one standard deviation of the mean. This increase coincided with an increase in discharge due to precipitation events in the spring. It is likely that this inundated springs along river-left in the spring run that may have had limited flow previously. Comal Springs riffle beetle density immediately following the high flow event (2.7/lure) was the lowest recorded since the study began (Figure 38). This is likely a result of the flooding event, which deposited sediment on many of the lures due to runoff from the steep hill on the river left side of the spring run.

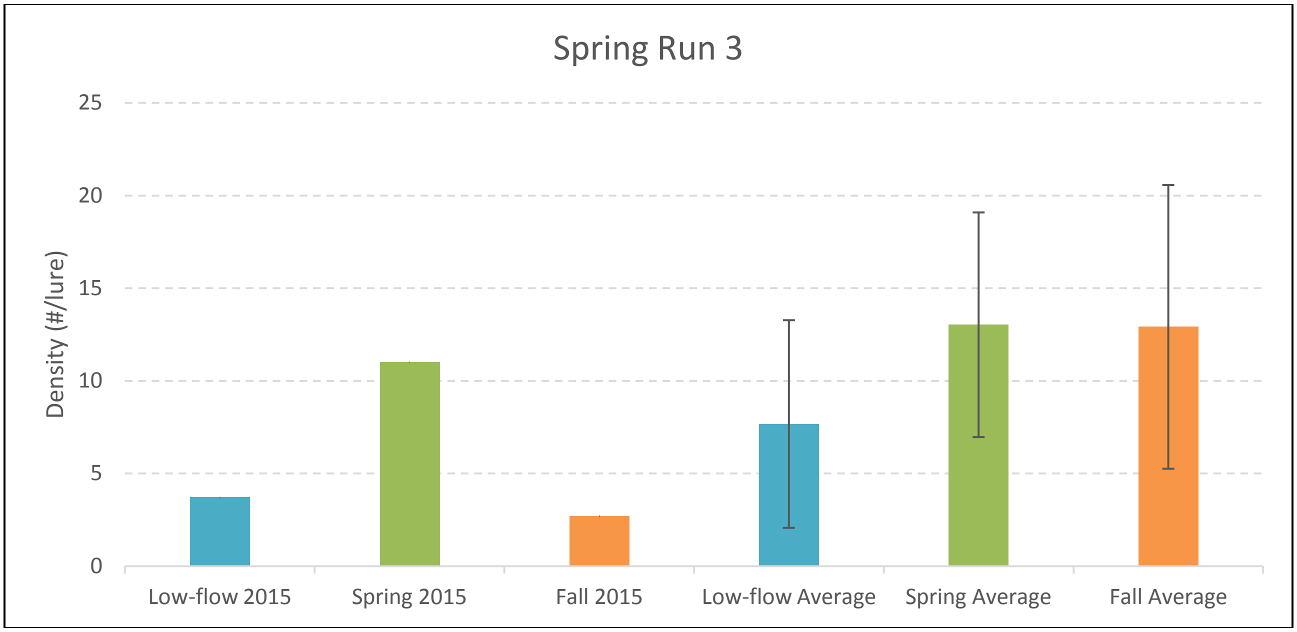


Figure 38. Densities of adult Comal Springs riffle beetles at the Spring Run 3 site during 2015 in the Comal River. Long term study averages are provided with error bars representing one standard deviation from the mean.

Densities of adult Comal Spring riffle beetles followed a similar pattern at the Western Shoreline site, but differences between sampling efforts were less dramatic (Figure 39). However, the density during the low-flow sampling effort (3.0/lure) was the lowest observed since the inception of the study. This was a substantial decrease from fall 2014 (8.7/lure), and below the long-term study average and outside one standard deviation. While densities increased by spring (4.9/lure), they were again below the long-term study average (though within one standard deviation). Densities post-high flow decreased slightly (4.3/lure), but were still well below the study average (Figure 39). It is unusual in the context of this study for numbers to be this low, and may be an effect of the prolonged drought that ended in early 2015 coupled with precipitation events in late 2015 that increased sedimentation at the spring heads.

Similarly, Comal Springs riffle beetle density at the Spring Island site during the low-flow sampling effort was low (2.0/lure), which was lower than study average but within one standard deviation of the mean (Figure 40). As flows approached historical averages, the density of adult beetles increased dramatically (7.9/lure), slightly above the spring long-term average. Like the other study sites, the post-high flow density (5.7/lure) was lower than the study average. Again, this is likely due to disturbance effects of the late October flooding event.

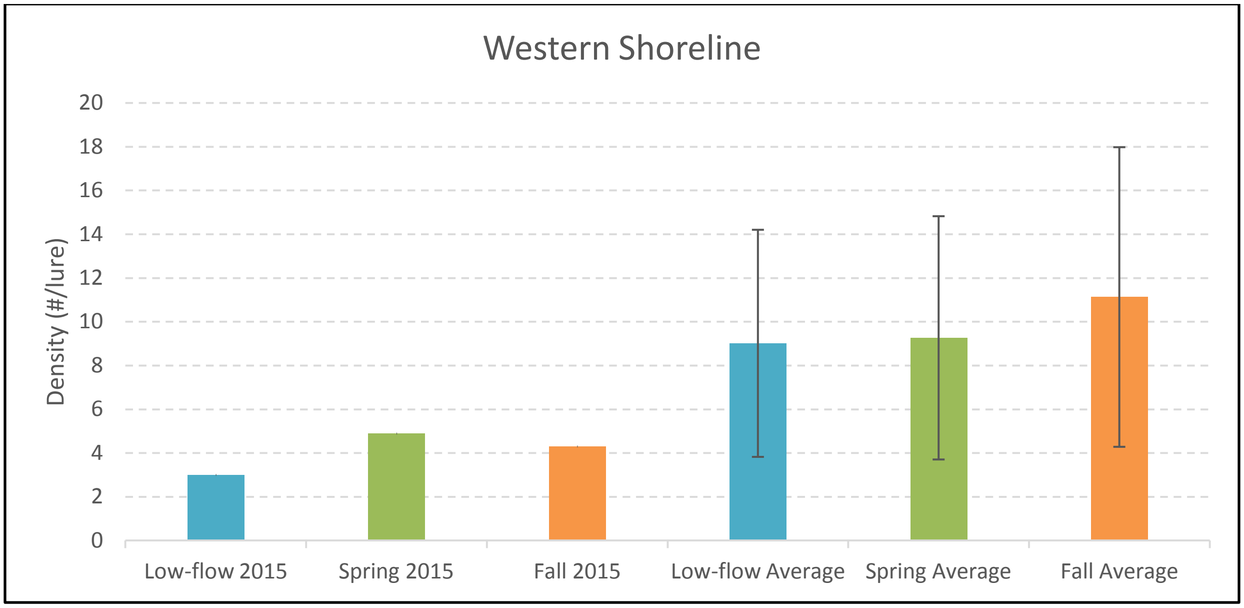


Figure 39. **Densities of adult Comal Springs riffle beetles at the Western Shoreline site during 2015 in the Comal River. Long term study averages are provided with error bars representing one standard deviation from the mean.**

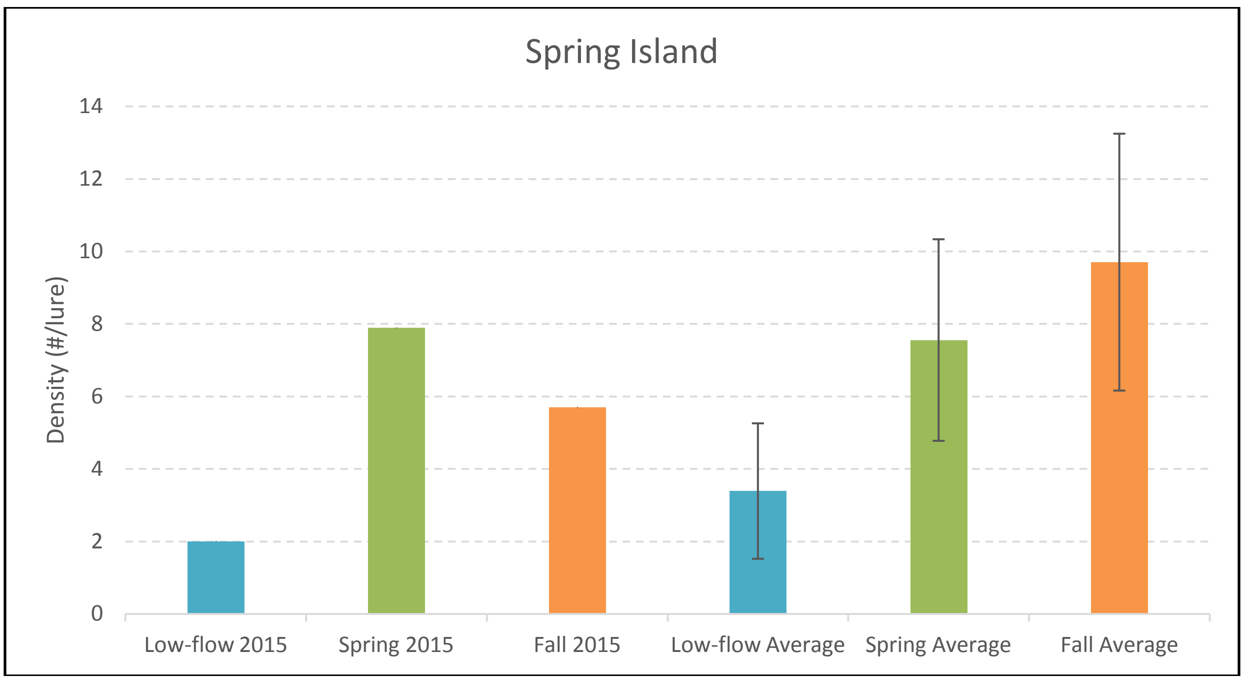


Figure 40. **Densities of adult Comal Springs riffle beetles at the Spring Island site during 2015 in the Comal River. Long term study averages are provided with error bars representing one standard deviation from the mean.**

Macroinvertebrate Community Sampling

In 2015, macroinvertebrate community sampling efforts in the Comal system collected 3,533 organisms during spring, and 5,386 organisms during fall (counts include Cladocera, Euhirundea, Gastropoda, Oligochaeta, Ostracoda). For spring and fall sampling efforts, the Upper New Channel Reach had the highest total organism abundance (*n*=4,130, 46.3%), followed by the Old Channel Reach (*n*=3,173, 35.6%), Landa Lake (*n*=1,235, 13.8%), and the Upper Spring Run Reach (*n*=381, 4.3%) (Table 15). However, the high relative abundance of macroinvertebrates at the Upper New Channel Reach is largely due to the large number of snails collected at the site: for combined fall and spring sampling efforts, the Upper New Channel featured the highest number and second highest relative proportion of snails collected within an individual reach (*n*=2,986, 72.3%), followed by the Old Channel (*n*=2,187, 68.9%), Landa Lake (*n*=919, 74.4%), and the Upper Spring Run reaches (*n*=53, 13.9%). 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*=328, 86.1%), followed by Old Channel (*n*=986, 31.1%), Upper New Channel (*n*=1,144, 27.7%) , and Landa Lake reaches (*n*=316, 25.6%).

Between 2015 spring and fall sampling efforts, organisms were collected from 11 distinct taxonomic orders/classes, 24 distinct families, and 35 taxonomic subfamilies/genera/species from the Comal system (Table 16). Amphipoda and Gastropoda comprised over 90% of all organisms sampled during spring and fall 2015 (27% [*n*=2,377] and 69% [*n*=6,145], respectively) (Figure 41). Taxonomic diversity varied between reaches (Figure 42). Gastropods were the most commonly encountered macroinvertebrate at all reaches except for the Upper Spring Run Reach where amphipods were most common (Figure 42).

Table 15. Summarized count and taxonomic richness data from 2015 spring and fall macroinvertebrate collection events in the Comal system.

REACH	NUMBER ORGANISMS COLLECTED	NUMBER ORGANISMS COLLECTED (ALL MACROINVERTEBRATES EXCEPT SNAILS)	FOUNTAIN DARTER PREY ORGANISMS	NUMBER OF UNIQUE TAXA IDENTIFIED
Landa Lake	1,235	316	293	26
Upper New Channel	4,130	1,144	1,109	24
Old Channel	3,173	986	950	20
Upper Spring Run	381	328	307	20
All sites	8,919	2,774	2,659	38

Table 16. Number of distinct macroinvertebrate taxa and taxonomic orders/classes, families, and genera identified from each reach during 2015 spring, and fall sampling events. [a, b]

2015 SAMPLING EVENT	NUMBER OF TAXONOMIC ORDERS/CLASSES COLLECTED [a]	NUMBER OF TAXONOMIC FAMILIES COLLECTED [b]	NUMBER OF TAXONOMIC SUBFAMILIES/GENERA /SPECIES COLLECTED [b]
Spring	11	20	24
Fall	9	22	31
Total	11	24	35

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

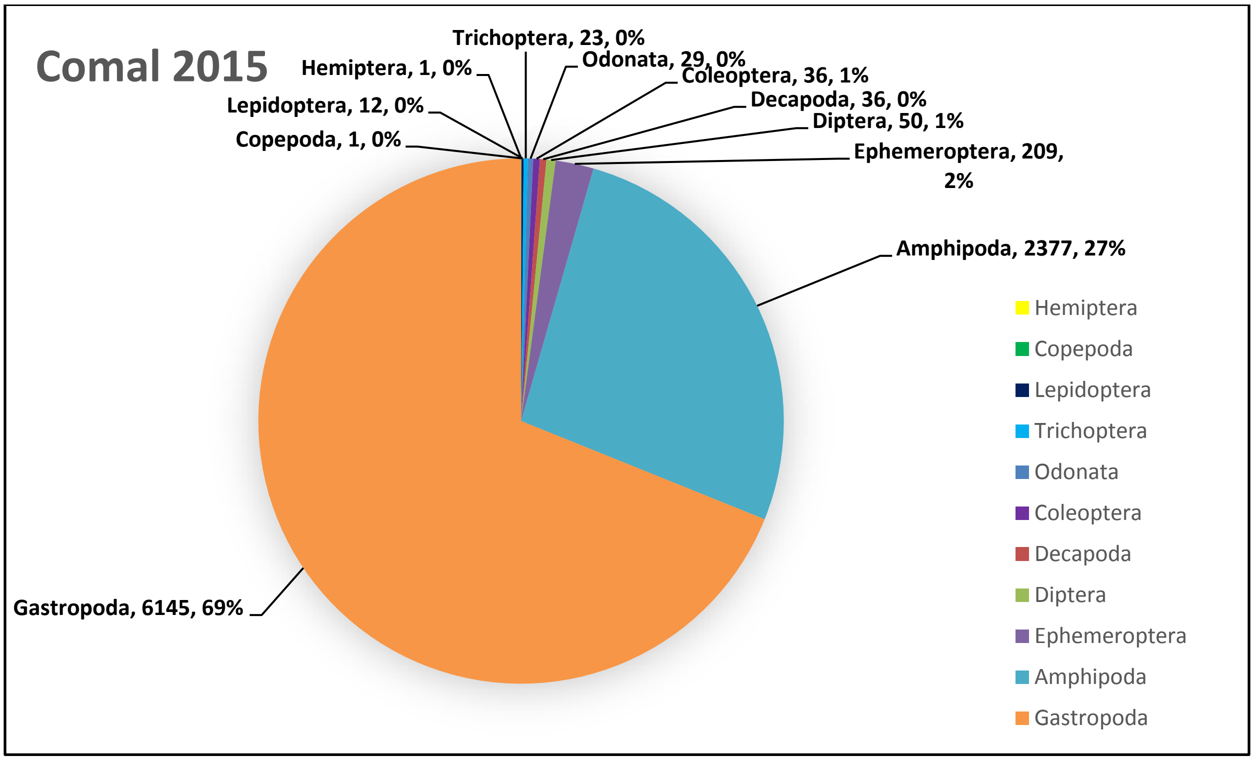


Figure 41. Relative percentage of macroinvertebrate abundance by order/class from combined 2015 spring and fall sampling efforts in the Comal system; data labels show frequency and relative percent abundance of each order/class collected. Includes orders/classes Cladocera, Hirundea, Gastropoda, Oligochaeta, and Ostracoda.

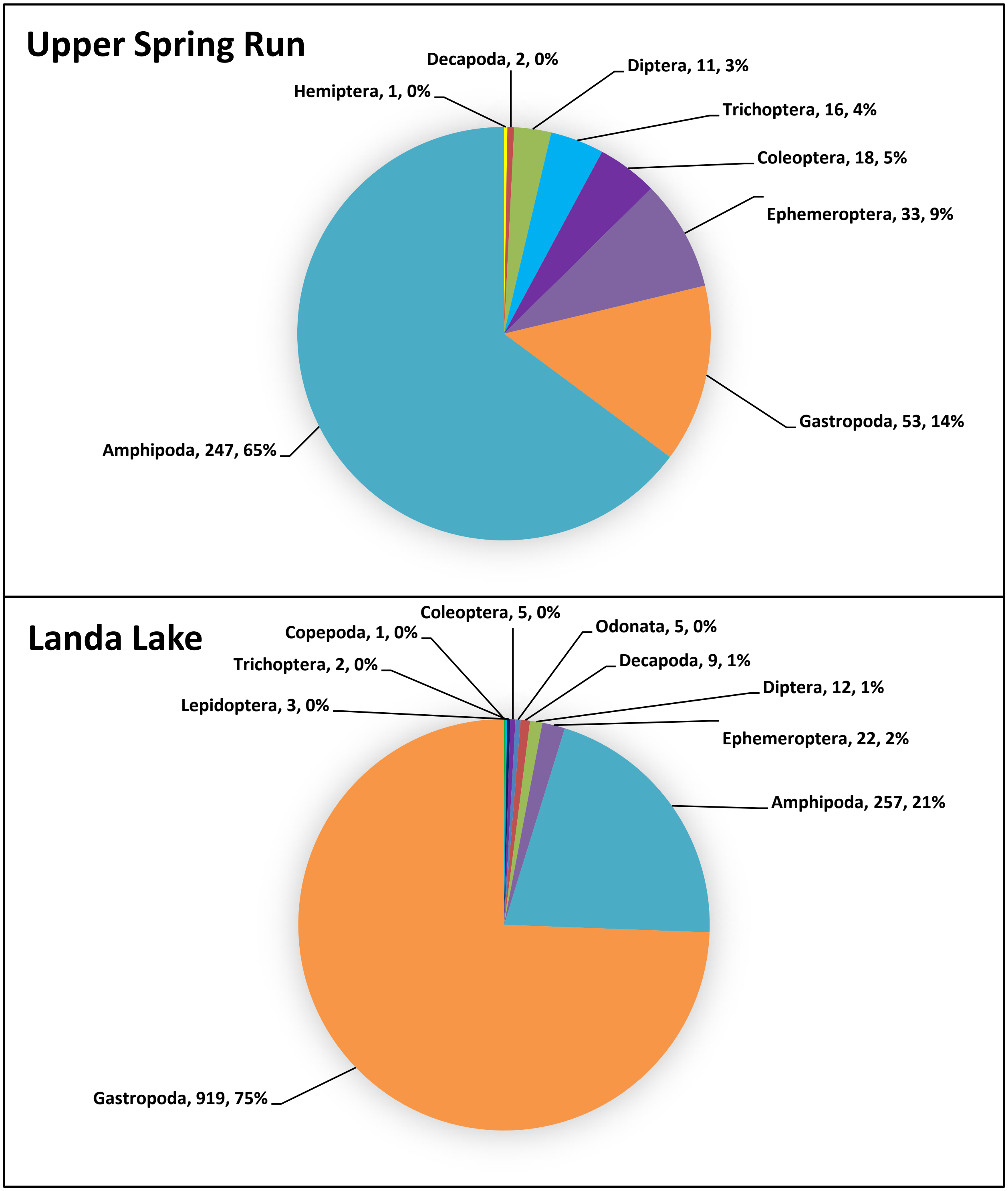


Figure 42. **Frequencies and relative percentage of macroinvertebrate abundance by order/class from combined 2015 spring and fall sampling efforts in each study reach; data labels show frequency and relative percent abundance of each order/class collected.**

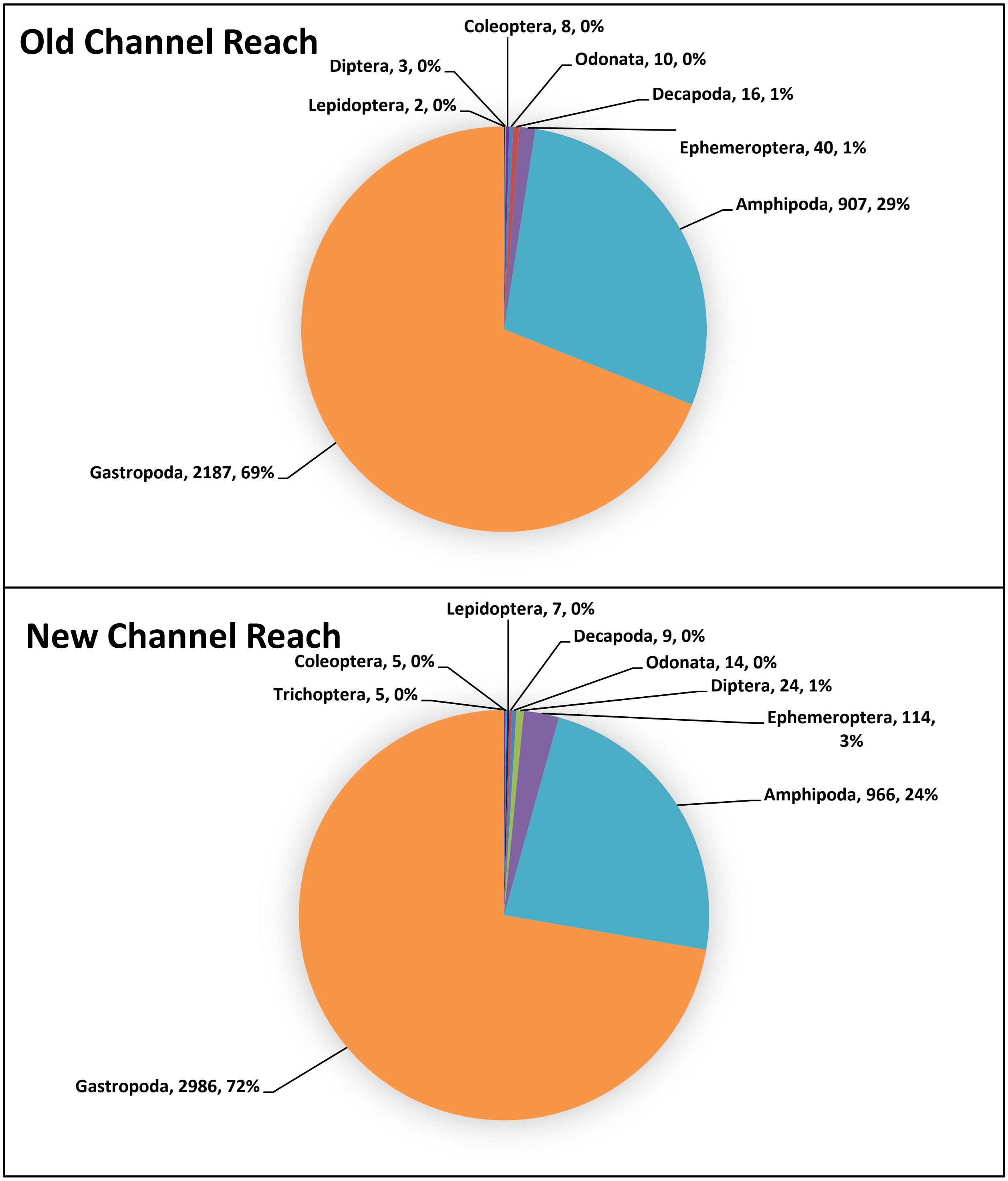


Figure 42. **(Continued.) Frequencies and relative percentage of macroinvertebrate abundance by order/class from combined 2015 spring and fall sampling efforts in each study reach; data labels show frequency and relative percent abundance of each order/class collected.**

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 17). The reach with the highest relative abundance of macroinvertebrate prey taxa collected during 2015 spring and fall sampling efforts was the Upper New Channel (*n*=1,109, 41.7%), followed by Old Channel (*n*=950, 35.7%), Upper Spring Run (*n*=307, 11.5%), and Landa Lake (*n*=293, 11.0%). Fountain darter prey taxa comprise the vast bulk of all non-snail macroinvertebrates collected at each reach: 96.9% at Upper New Channel, 96.3% at Old Channel, 93.6% at Upper Spring Run, and 92.7% at Landa Lake.

Table 17. Average abundance of fountain darter prey taxa collected per sampling event by reach and vegetation type; values are from 2015 spring, fall, and combined macroinvertebrate collection efforts in the Comal system.

REACH	VEGETATION SAMPLED	NO. OF FOOD SOURCE ORGANISMS PER VEGETATION TYPE IN SPRING 2015 [a]	NO. OF FOOD SOURCE ORGANISMS PER VEGETATION TYPE IN FALL 2015[a]	AVERAGE NO. OF FOOD SOURCE ORGANISMS PER VEGETATION TYPE IN 2015 [c]
Landa Lake	Bryophytes	28, n=1	78, n=1	53.0±35.35, n=2
Landa Lake	*Cabomba*	35, n=1	12, n=1	23.5±16.26, n=2
Landa Lake	*Ludwigia*	9, n=1	63, n=1	36.0±38.18, n=2
Landa Lake	*Sagittaria*	24, n=1	40, n=1	32.0±11.31, n=2
Landa Lake	*Vallisneria*	not sampled [b]	4, n=1	not sampled [b]
Up. New Channel	*Cabomba*	148, n=1	137, n=1	142.5±7.78, n=2
Up. New Channel	*Hygrophila*	53, n=1	514, n=1	283.5±325.98, n=2
Up. New Channel	*Ludwigia*	125, n=1	132, n=1	128.5±4.95, n=2
Old Channel	Bryophytes	110, n=1	416, n=1	263.0±216.37, n=2
Old Channel	*Cabomba*	7, n=1	10, n=1	8.5±2.12, n=2
Old Channel	*Hygrophila*	4, n=1	64, n=1	34.0±42.43, n=2
Old Channel	*Ludwigia*	22, n=1	8, n=1	15.0±9.90, n=2
Old Channel	*Sagittaria*	139, n=1	170, n=1	154.4±21.92, n=2
Upper Spring Run	Bryophytes	65, n=1	129, n=1	97.0±45.25, n=2
Upper Spring Run	Green algae	not sampled [b]	47, n=1	not sampled [b]
Upper Spring Run	*Hygrophila*	10, n=1	not sampled [b]	not sampled [b]
Upper Spring Run	*Sagittaria*	3, n=1	53, n=1	28.0±35.35, n=2

[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 2015 (spring and fall combined).

Taxonomic makeup of organisms in fountain darter prey taxa varied somewhat between reaches (Figure 43), with Diptera comprising a higher proportion of the group at the Landa Lake and

Upper Spring Run reaches than at any of the other sites. Ephemeroptera were most abundant at the New Channel (*n*=114, 10%) and Upper Spring Run (*n*=33, 11%) reaches (Figure 43).

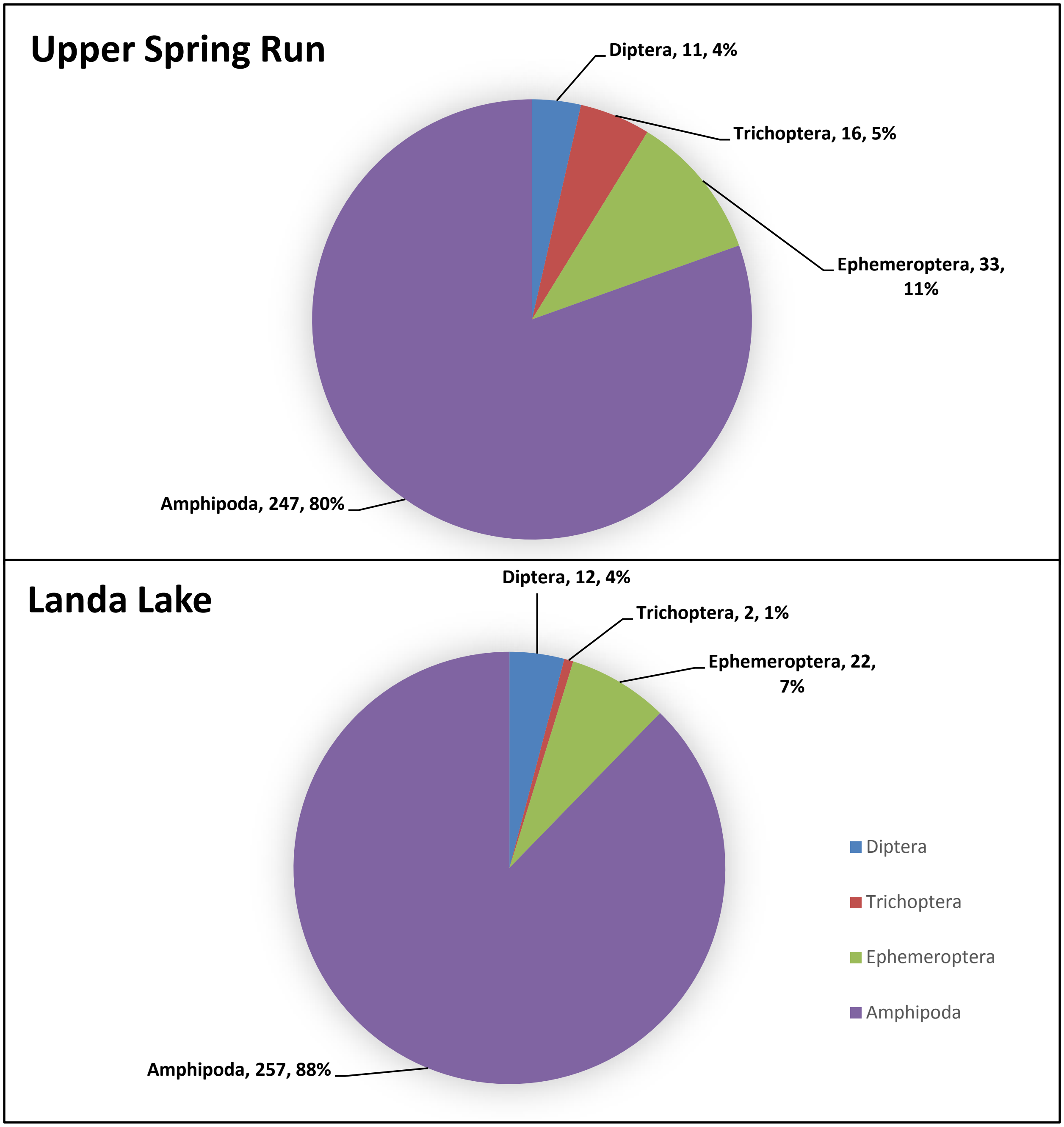
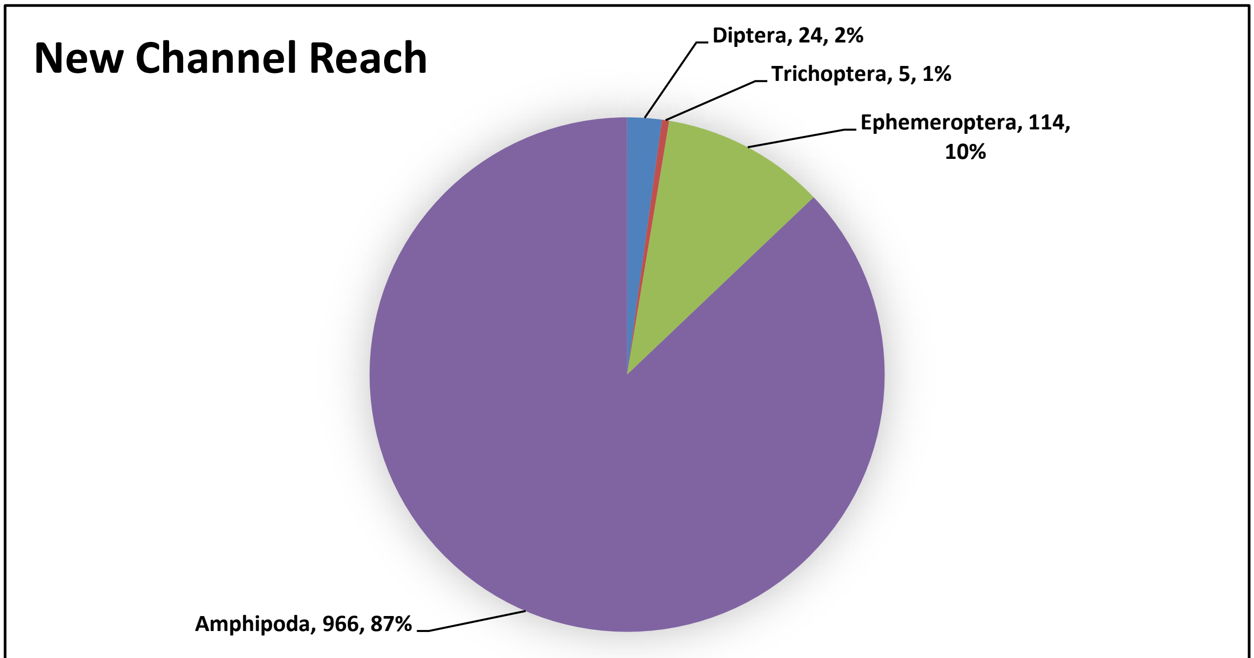


Figure 43. **Relative percent abundance of four macroinvertebrate orders/classes (Amphipoda, Diptera, Ephemeroptera, and Trichoptera) representative of fountain darter food sources collected from four sample reaches in the Comal system during 2015 spring and fall sampling.**



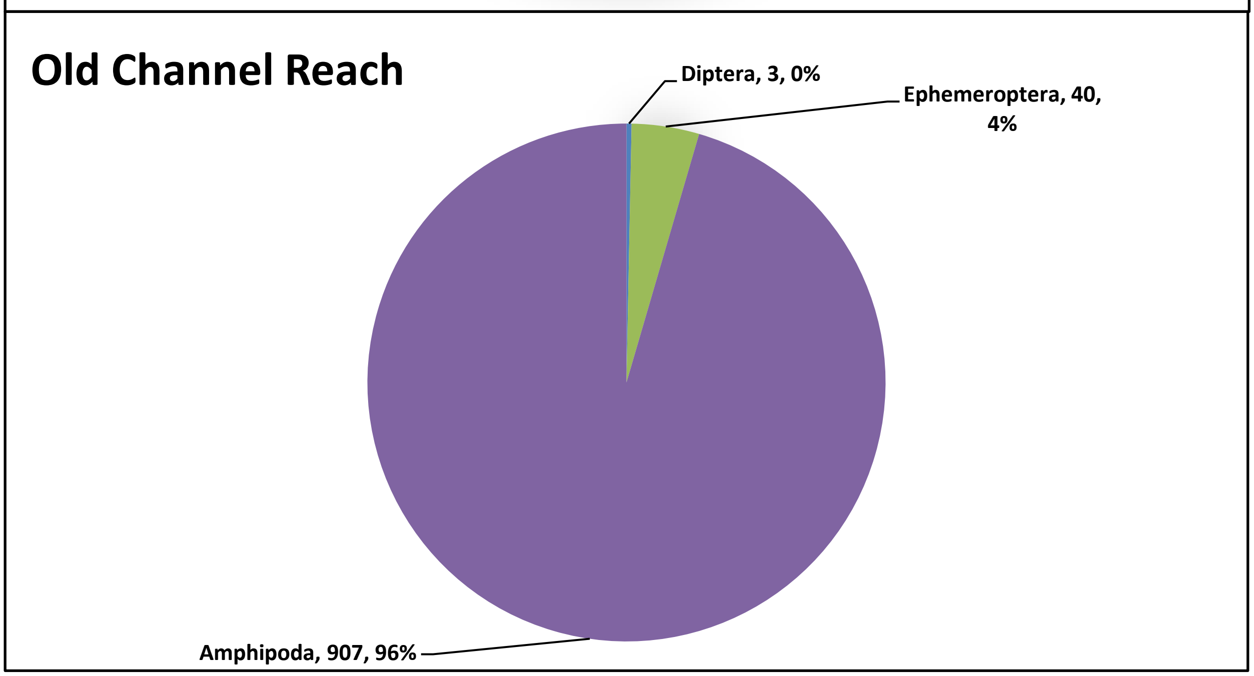


Figure 43. **(Continued.) Relative percent abundance of four macroinvertebrate orders/classes (Amphipoda, Diptera, Ephemeroptera, and Trichoptera) representative of fountain darter food sources collected from four sample reaches in the Comal system during 2015 spring and fall sampling.**

CONCLUSION

Discharge conditions in 2014 were at their lowest level for the longest duration since 1989 in the Comal system. During 2014, Spring Run 1 nearly ceased to flow, and the channel was severely restricted. The spring runs at Spring Island were dry at times, and a large gravel island was exposed at the eastern outflow of the island. Large vegetation mats dotted Landa Lake, shading out vegetation and restricting photosynthesis. Surface-dwelling, endangered invertebrate habitat was severely impacted throughout much of 2014 when springheads ceased flow. However, despite these conditions, the biota including the endangered fountain darter were able to weather the storm. Impacts to habitat and numbers did occur in 2013 and 2014 as documented in previous annual reports, but not throughout the entirety of the Comal system.

By April 2015, monthly average flow climbed back above the historic average, and then precipitation events became the dominant force in a record year for rainfall in central Texas. The spring runs returned to flowing like they have in above average discharge years, though Comal salamander populations remained low, which postulates that recovery may take more than a single year of average flows. Fountain darters rebounded strongly by expanding back into areas (i.e. Upper Spring Run) that were notably impacted in 2014; while overall, normalized population estimates were similar to the long-term study average. As in 2014, aquatic vegetation at the Upper Spring Run Reach remained sparse, but fountain darters were using the habitat that was available. Aquatic vegetation within the other study reaches remained similar to the study averages, and appeared healthy at most reaches. As a result, the macroinvertebrate community continued to be robust, and fountain darter prey availability plentiful. Continued HCP restoration efforts in the Old Channel and Landa Lake reaches ensured native aquatic vegetation remained viable, and provided high-quality habitat for the fountain darter.

Because above or near-average discharge was the story of 2015 in the Comal River concurrent with recovery of impacted habitat, a flooding event in late October was almost expected. Although not nearly as severe as the flows that inundated the San Marcos River in late October, a high volume of water travelling down Dry Comal Creek and Blieder’s creek scoured out areas of aquatic vegetation while depositing sediment in various locations throughout the system. The biological data associated with the post-high flow event have been collected and the results will be presented in the 2016 Addendum.

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 2015c. 2015 Native Aquatic Vegetation Restoration in Landa Lake and Old Channel of the Comal River. November 6, 2015. Prepared for City of New Braunfels, TX, 40pp. plus Appendices.

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

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). 12/2015. Water quality monitors. 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., Lachman, G. B., Droege, S., Royle, J. A., & Langtim, C. A. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology, 83(8), 2248-2255.

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

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. 2015. Edwards Aquifer Habitat Conservation Plan Draft Expanded Water Quality Monitoring 2015 Annual Report. Edwards Aquifer Authority. In Press.

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 2015

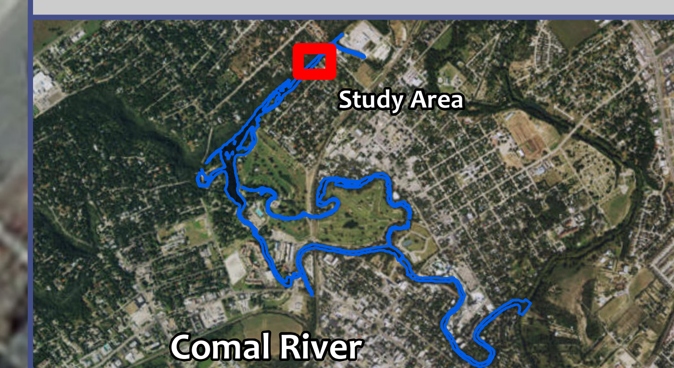
Surveyed: April 27, 2015

UPPER SPRING RUN

Study Reach	4,835.4 m^2

Vegetation Types

Bryophytes	243.7 m^2
Sagittaria	827.8 m^2
Cabomba	5.2 m^2
Hygrophila	23.1 m^2
Ludwigia	5.2 m^2
Chara	276.2 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 3, 2014

COMAL RIVER
New Braunfels, Texas

Aquatic Vegetation Study Reach
October 2015

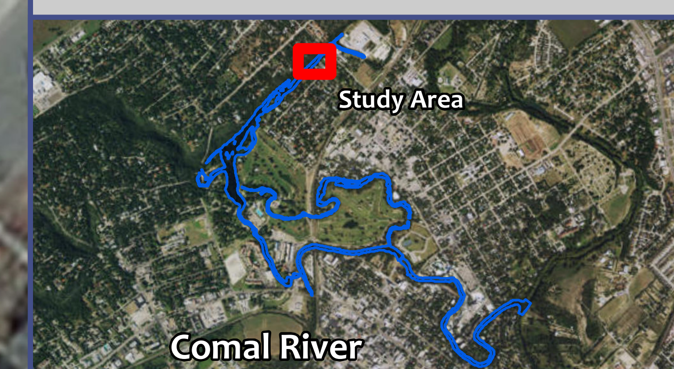
Surveyed: October 19, 2015

UPPER SPRING RUN

Study Reach	4,835.4 m^2

Vegetation Types

Bryophytes	280.9 m^2
Green Algae	574.8 m^2
Sagittaria	897.8 m^2
Cabomba	9.9 m^2
Ludwigia	6.2 m^2
Nitella	241.4 m^2



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0 10 20 Meters

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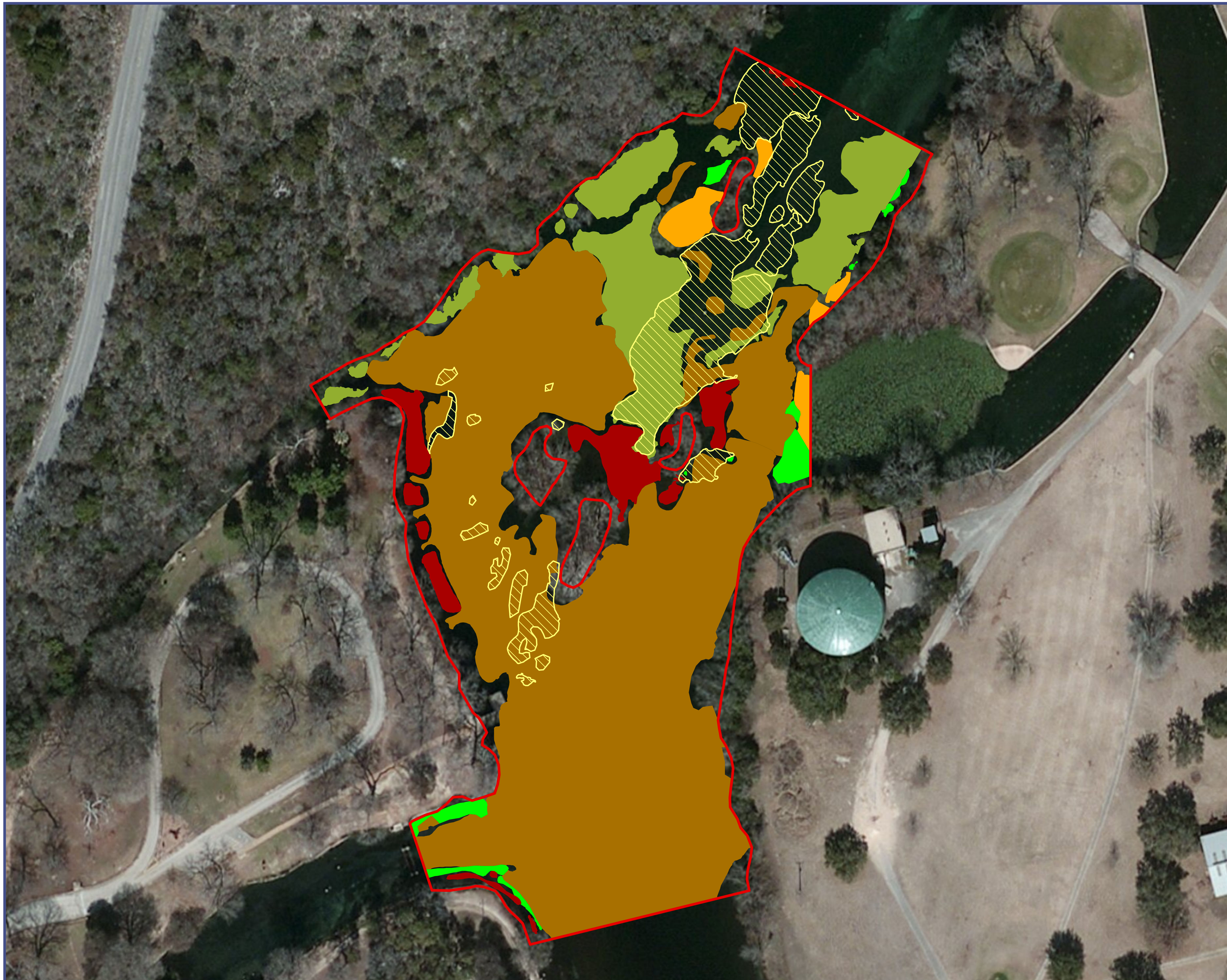
Projection: UTM, NAD 83, 14 North
Map Revised: December 3, 2014

Landa Lake Reach

COMAL RIVER
New Braunfels, Texas

Aquatic Vegetation Study Reach
April 2015
Surveyed: April 29, 2015

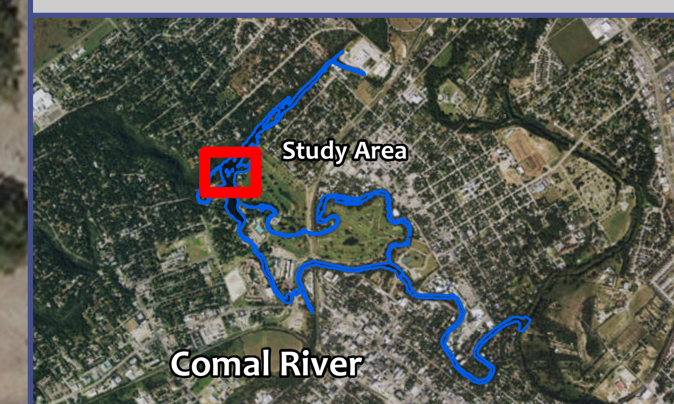


LANDA LAKE

Study Reach	23,428.9 m^2

Vegetation Types

Bryophytes	1,395.3 m^2
Cabomba	261.4 m^2
Ludwigia	577.8 m^2
Nuphar	178.4 m^2
Sagittaria	2,269.8 m^2
Vallisneria	11,713.1 m^2



0 50 100 200 Feet
0 20 40 Meters
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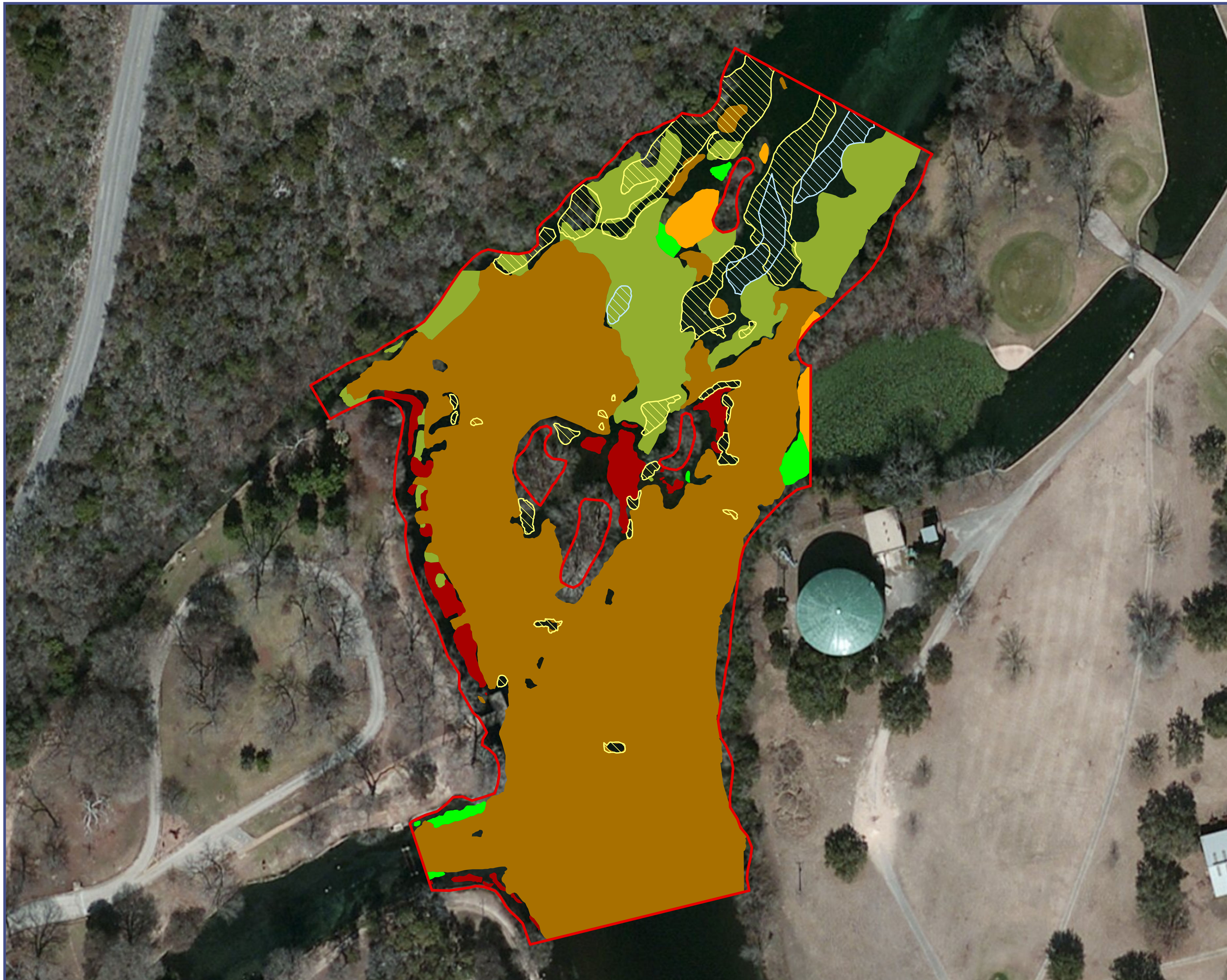
BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: December 3, 2014

COMAL RIVER
New Braunfels, Texas

Aquatic Vegetation Study Reach
October 2015

Surveyed: October 19, 2015

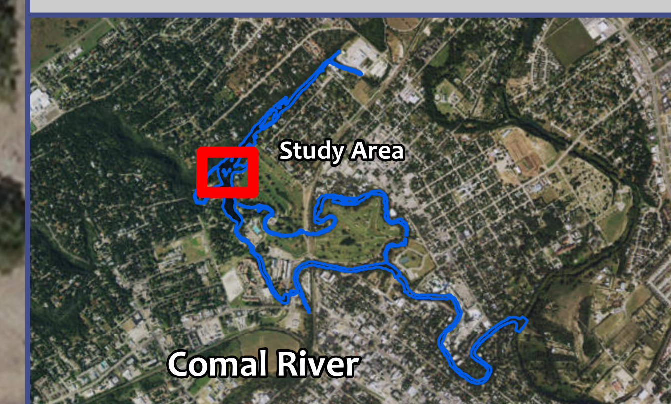


LANDA LAKE

Study Reach	23,428.9 m^2

Vegetation Types

Bryophytes	1,691.6 m^2
Green Algae	221.1 m^2
Cabomba	286.9 m^2
Ludwigia	436.7 m^2
Nuphar	139.6 m^2
Sagittaria	2,621.0 m^2
Vallisneria	12,255.0 m^2



0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
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Projection: UTM, NAD 83, 14 North
Map Revised: December 3, 2014

Upper New Channel Reach

COMAL RIVER

New Braunfels, Texas

Aquatic Vegetation Study Reach
April 2015

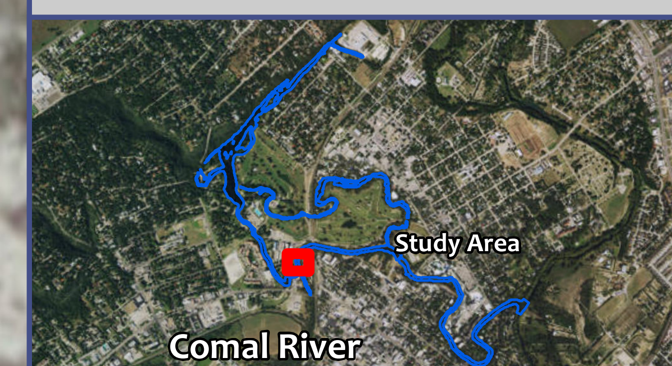
Surveyed: April 30, 2015

UPPER NEW CHANNEL

Study Reach	2,023.0 m^2

Vegetation Types

Bryophytes	9.6 m^2
Cabomba	816.7 m^2
Hygrophila	268.1 m^2
Ludwigia	89.2 m^2



0 20 40 80 Feet

0 10 20 Meters

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BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: December 8, 2014

COMAL RIVER
New Braunfels, Texas

Aquatic Vegetation Study Reach
October 2015

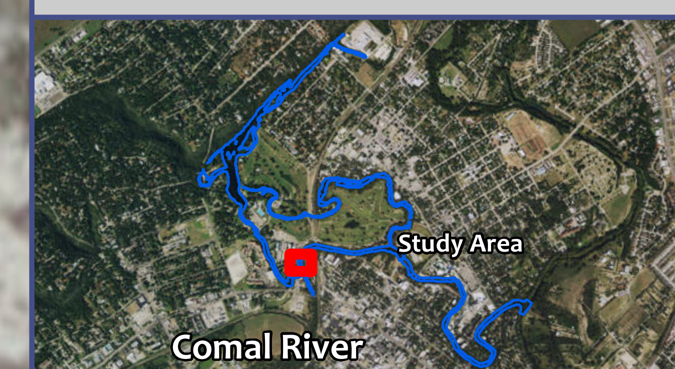
Surveyed: October 20, 2015

UPPER NEW CHANNEL

Study Reach	2,023.0 m^2

Vegetation Types

Bryophytes	213.7 m^2
Cabomba	465.1 m^2
Hygrophila	299.8 m^2
Ludwigia	79.0 m^2



0 20 40 80 Feet

0 10 20 Meters

N

BIO-WEST
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512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: December 8, 2014

Lower New Channel Reach

COMAL RIVER

New Braunfels, Texas

Aquatic Vegetation Study Reach
February 2015

Surveyed: February 10, 2015

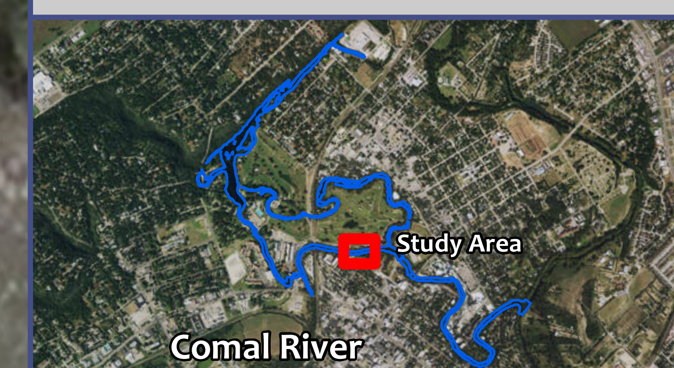
LOWER NEW CHANNEL

Study Reach 4,258.8 m^2

Vegetation Types

Cabomba 2,618.2 m^2

Hygrophila 279.9 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 5, 2014

COMAL RIVER
New Braunfels, Texas

Aquatic Vegetation Study Reach
October 2015

Surveyed: October 20, 2015

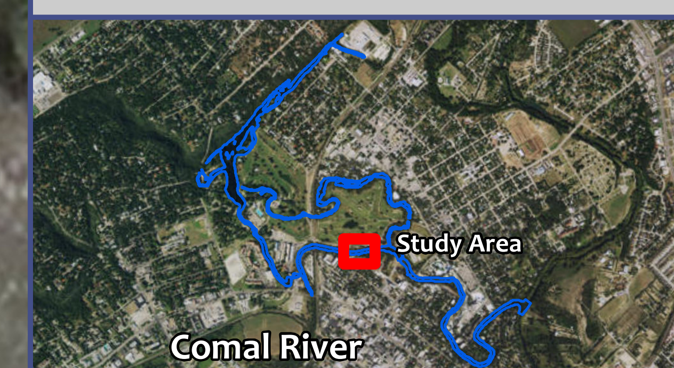
LOWER NEW CHANNEL

Study Reach 4,258.8 m^2

Vegetation Types

Cabomba 3,045.5 m^2

Hygrophila 495.8 m^2



0 25 50 100 Feet

0 10 20 Meters

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BIO-WEST
www.bio-west.com
512.990.3954

Projection: UTM, NAD 83, 14 North
Map Revised: December 5, 2014

Old Channel Reach

COMAL RIVER
New Braunfels, Texas

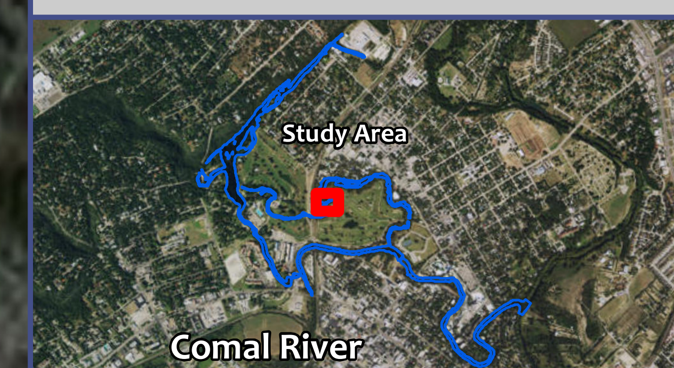
Aquatic Vegetation Study Reach
April 2015
Surveyed: April 27, 2015

OLD CHANNEL

Study Reach	2,797.4 m^2

Vegetation Types

Bryophytes	180.7 m^2
Hygrophila	1,474.2 m^2
Nuphar	122.9 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 3, 2014

COMAL RIVER
New Braunfels, Texas

Aquatic Vegetation Study Reach
October 2015

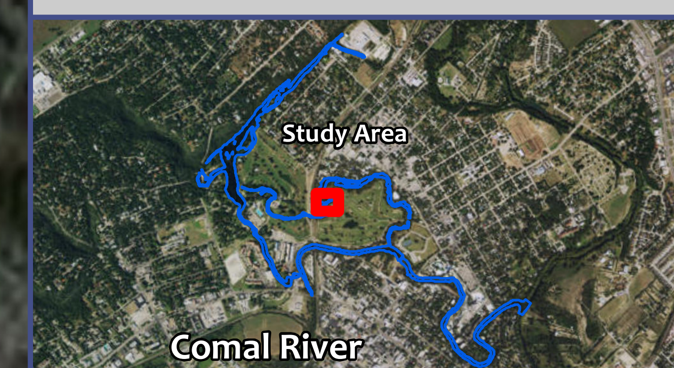
Surveyed: October 18, 2015

OLD CHANNEL

Study Reach	2,797.4 m^2

Vegetation Types

Bryophytes	214.4 m^2
Hygrophila	920.3 m^2
Ludwigia	25.6 m^2
Nuphar	49.4 m^2



0 25 50 100 Feet
0 10 20 Meters
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BIO-WEST
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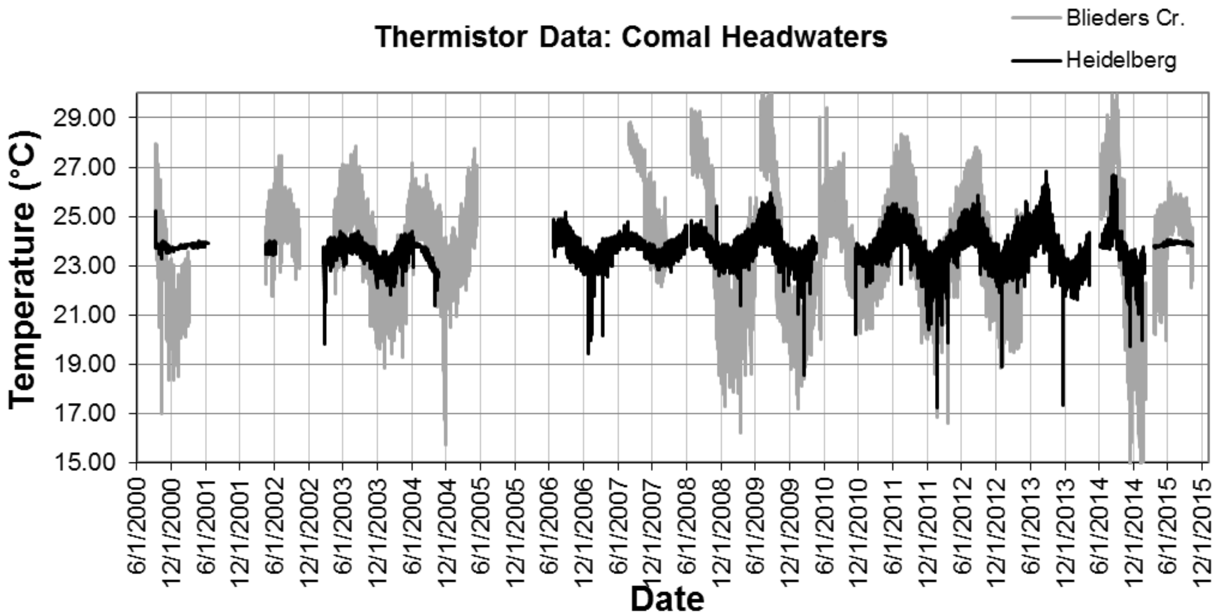
Projection: UTM, NAD 83, 14 North
Map Revised: December 3, 2014

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
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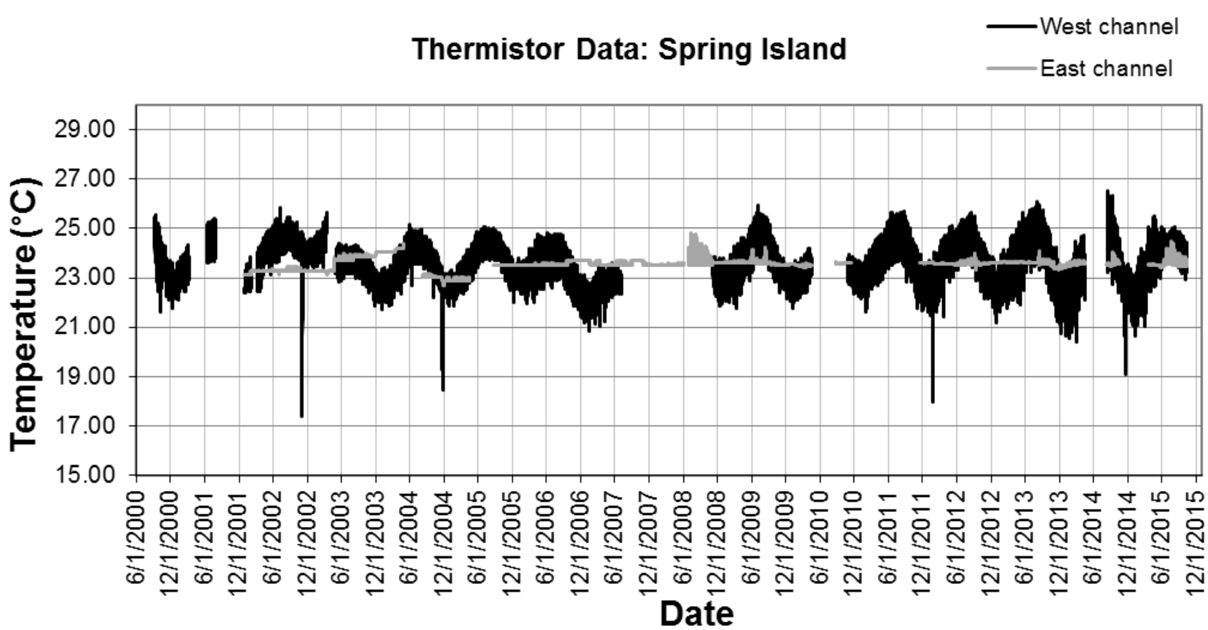
6/1/2015
12/1/2015
Date



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
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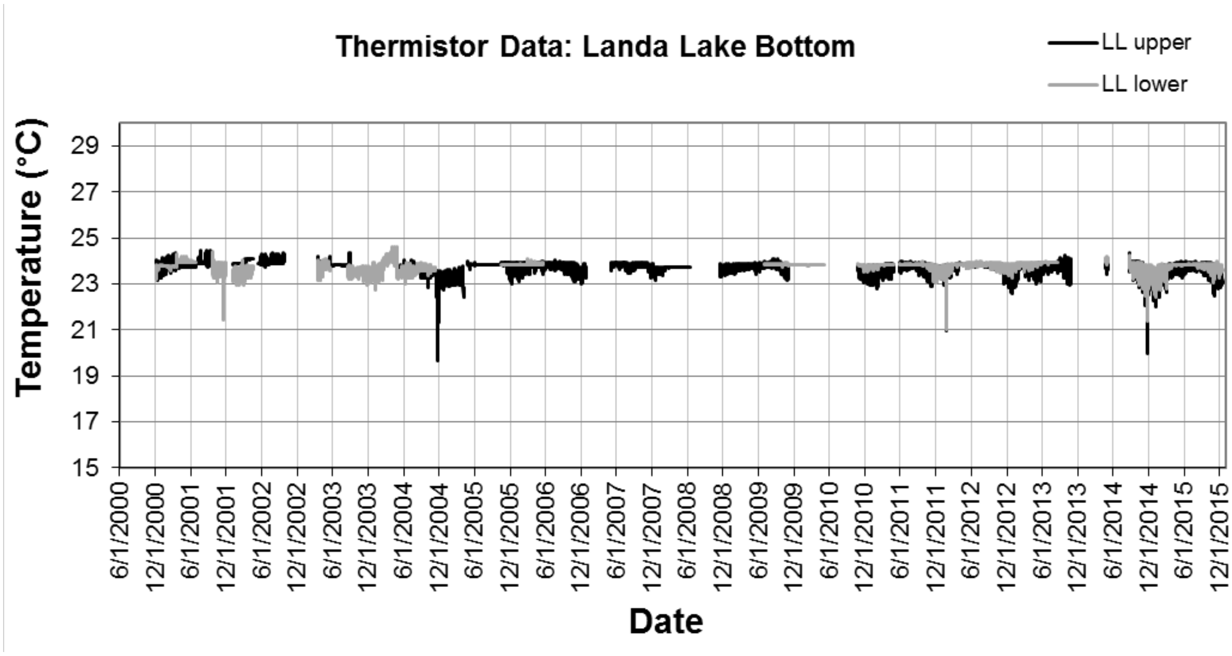
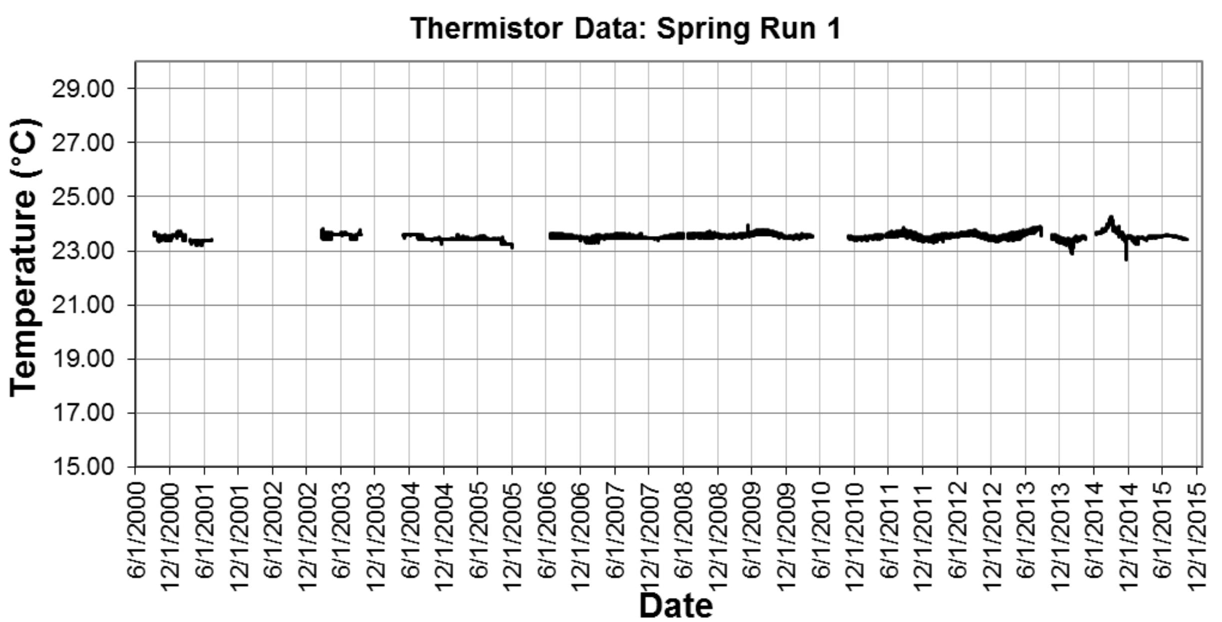
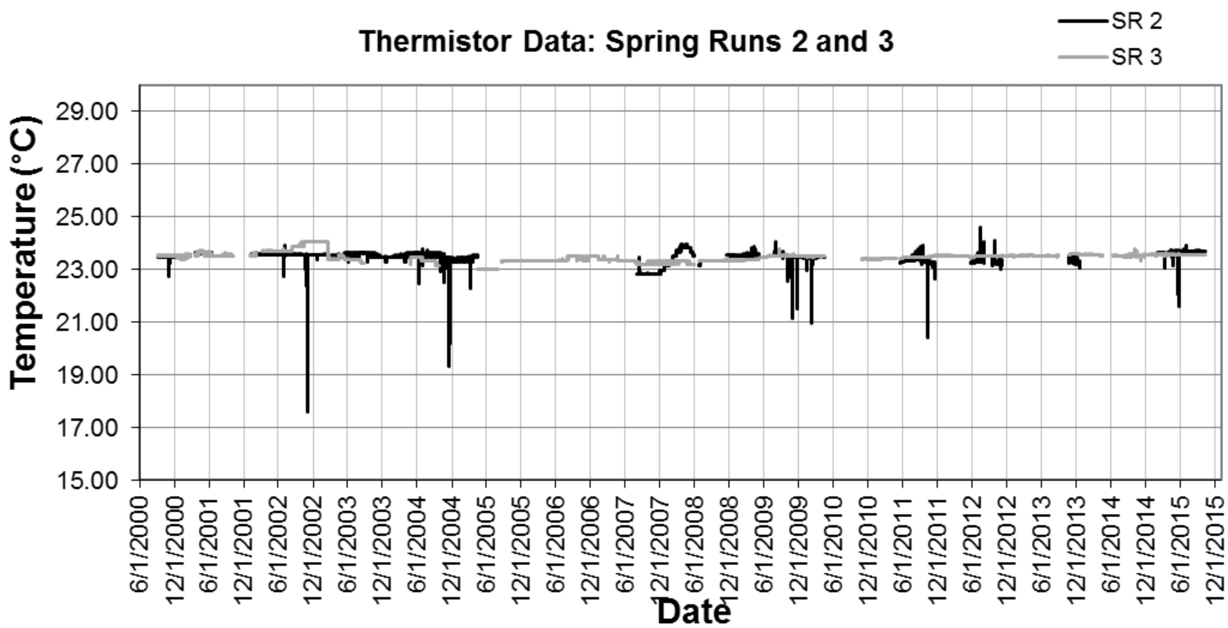
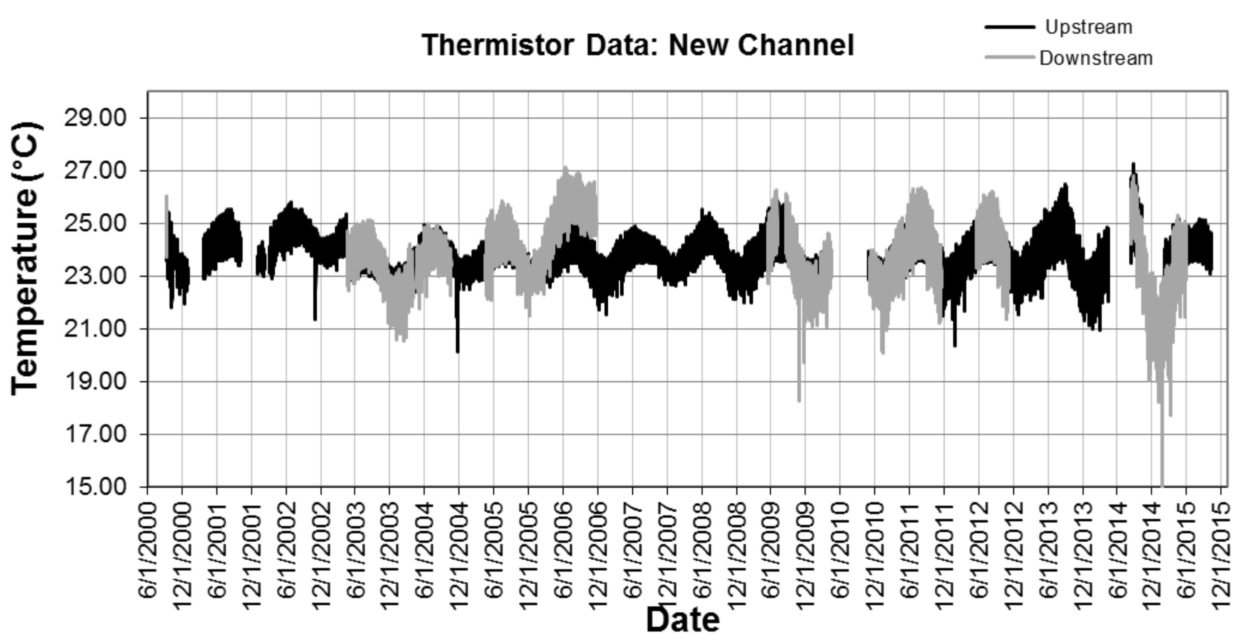
6/1/2015
12/1/2015
Date


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
Date

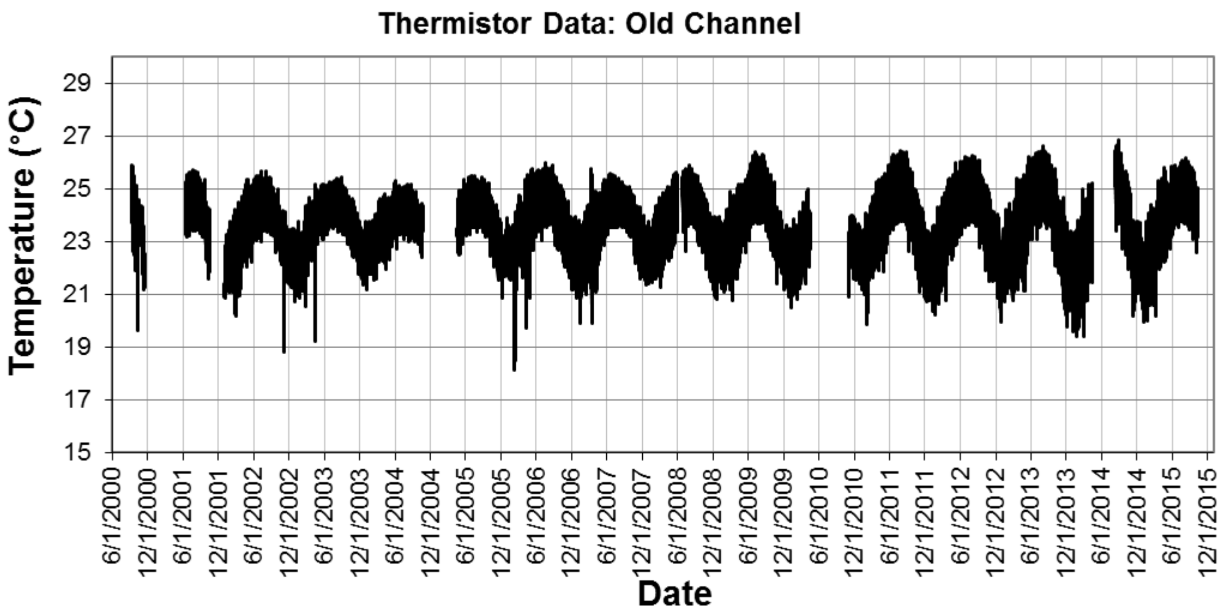

Thermistor Data: Spring Run 1
Temperature (°C)
29.00
27.00
25.00
23.00
21.00
19.00
17.00
15.00
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
6/1/2006
12/1/2006
6/1/2007
12/1/2007
6/1/2008
12/1/2008
6/1/2009
12/1/2009
6/1/2010
12/1/2010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

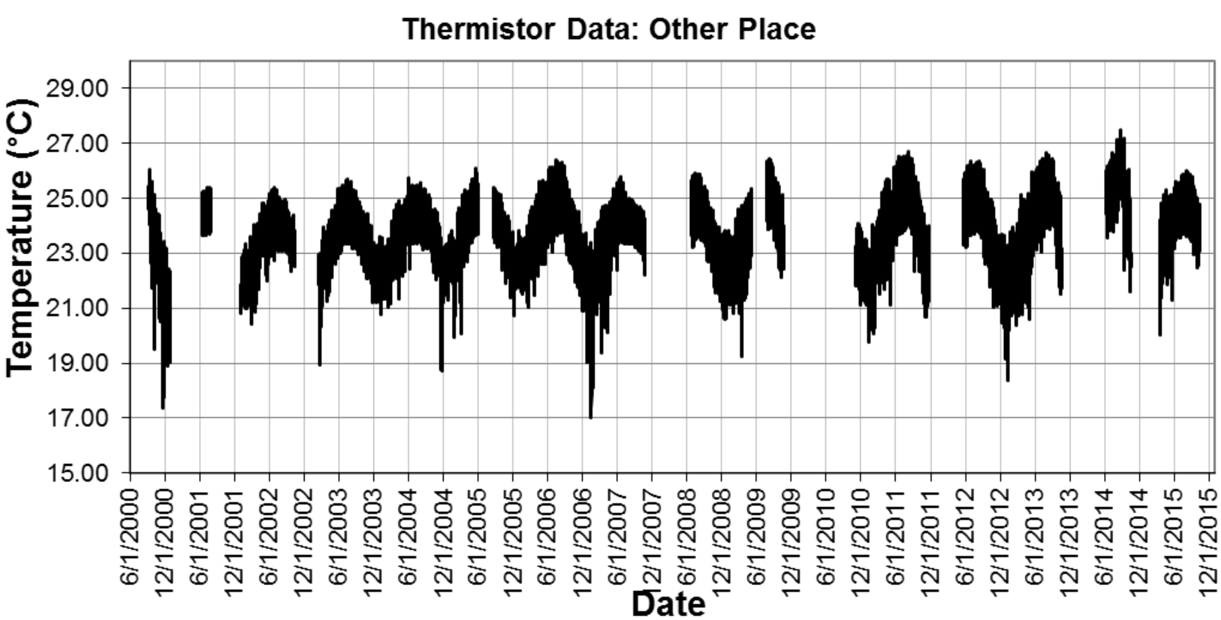


Thermistor Data: Spring Runs 2 and 3
SR 2
SR 3
Temperature (°C)
29.00
27.00
25.00
23.00
21.00
19.00
17.00
15.00
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
6/1/2006
12/1/2006
6/1/2007
12/1/2007
6/1/2008
12/1/2008
6/1/2009
12/1/2009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

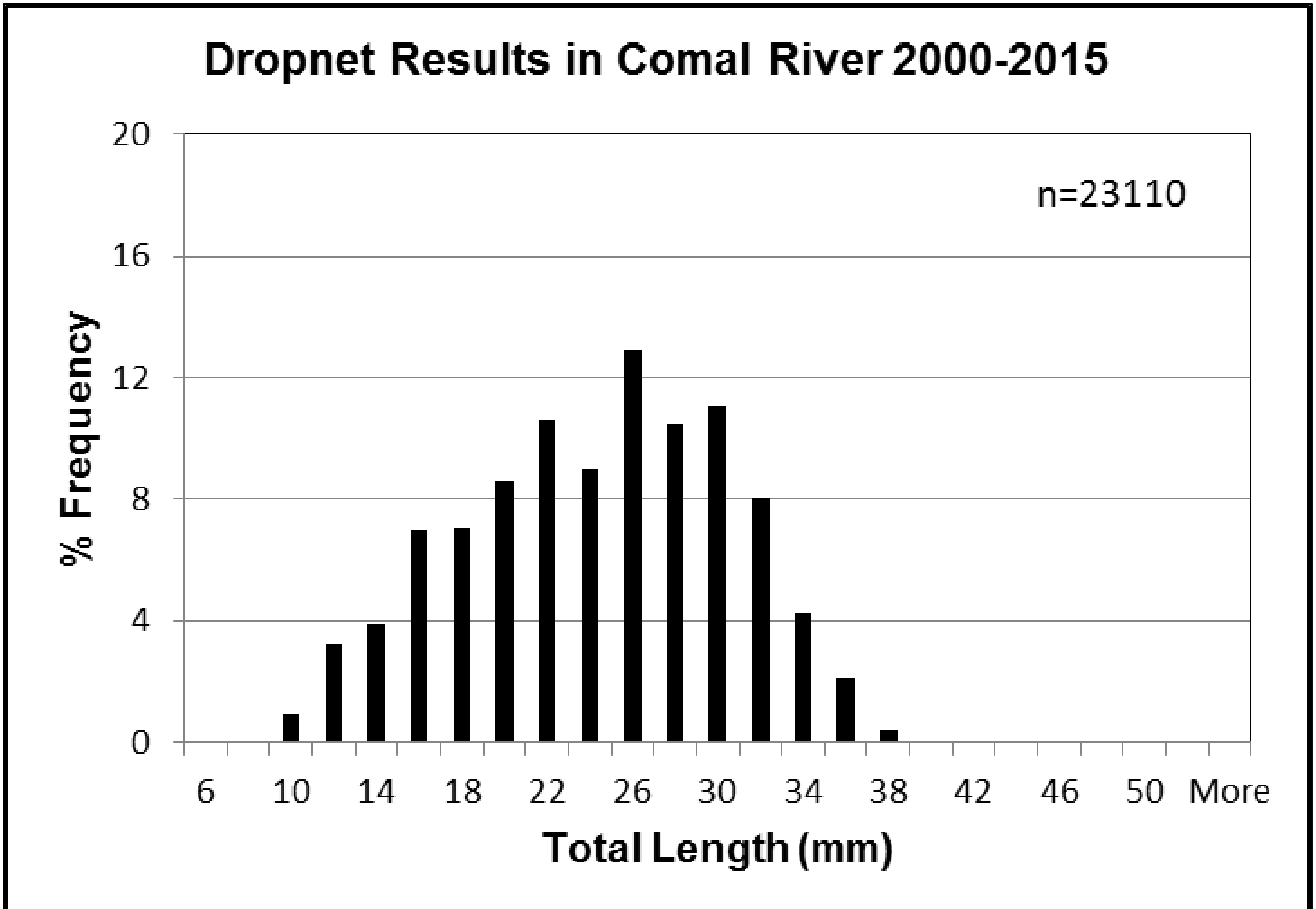


Thermistor Data: New Channel
Upstream
Downstream
Temperature (°C)
29.00
27.00
25.00
23.00
21.00
19.00
17.00
15.00
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
6/1/2006
12/1/2006
6/1/2007
12/1/2007
6/1/2008
12/1/2008
6/1/2009
12/1/2009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


Thermistor Data: Old Channel
Temperature (°C)
Date


Thermistor Data: Other Place
Temperature (°C)
Date

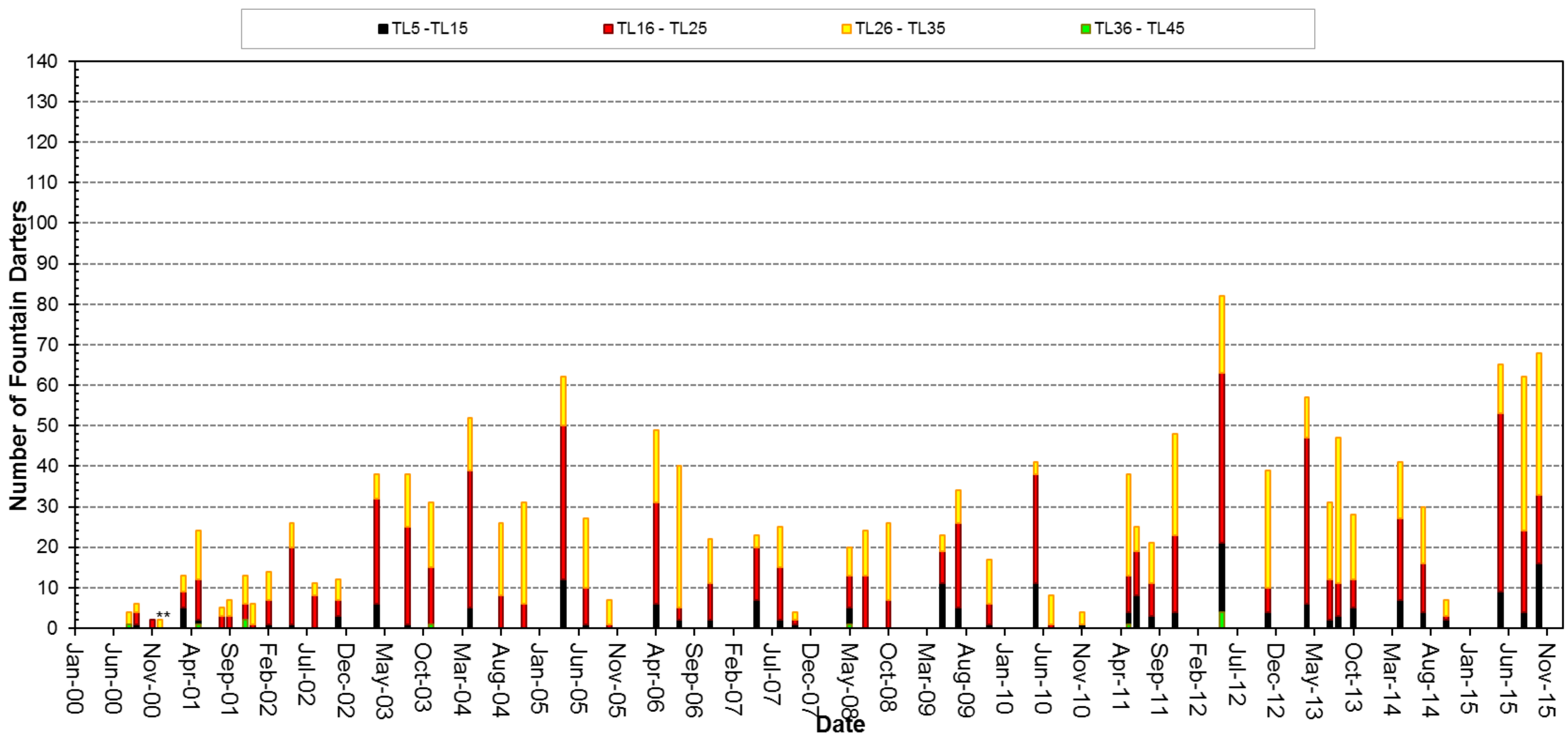
Drop Net Graph

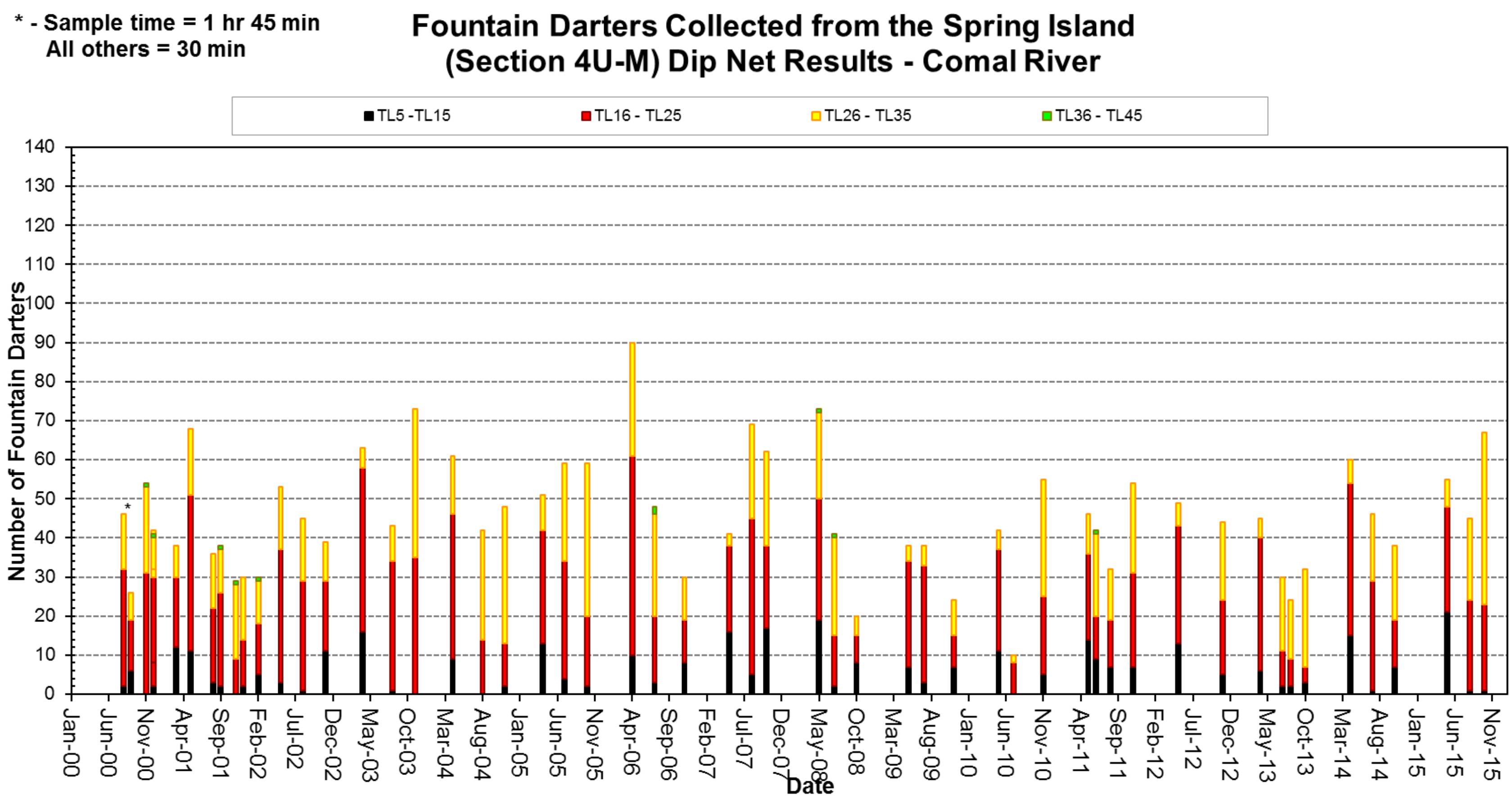

Dropnet Results in Comal River 2000-2015
n=23110
% Frequency
20
16
12
8
4
0
6
10
14
18
22
26
30
34
38
42
46
50
More
Total Length (mm)

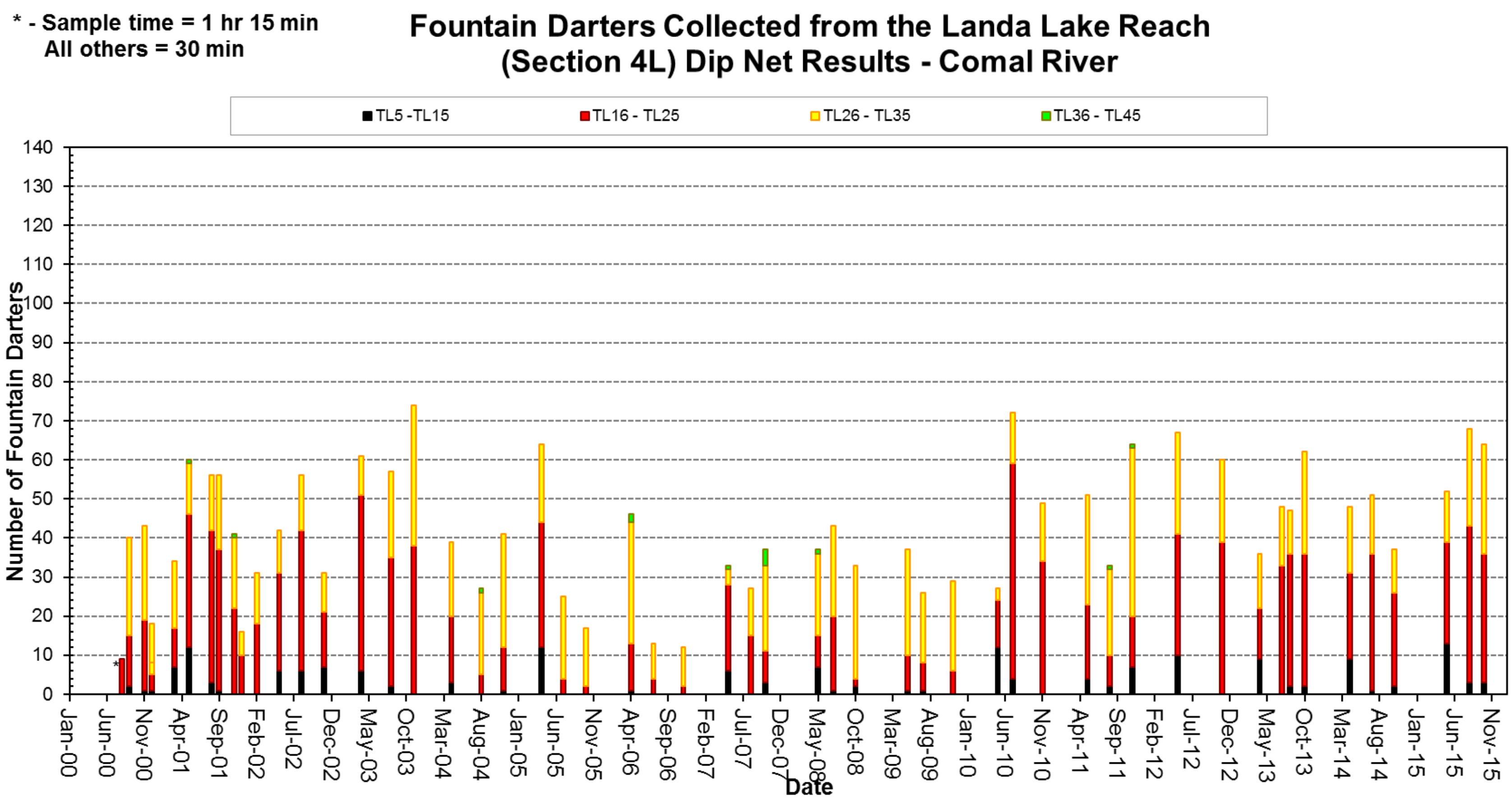
Dip Net Graphs

* - Sample time = 1 hr
All others = 30 min

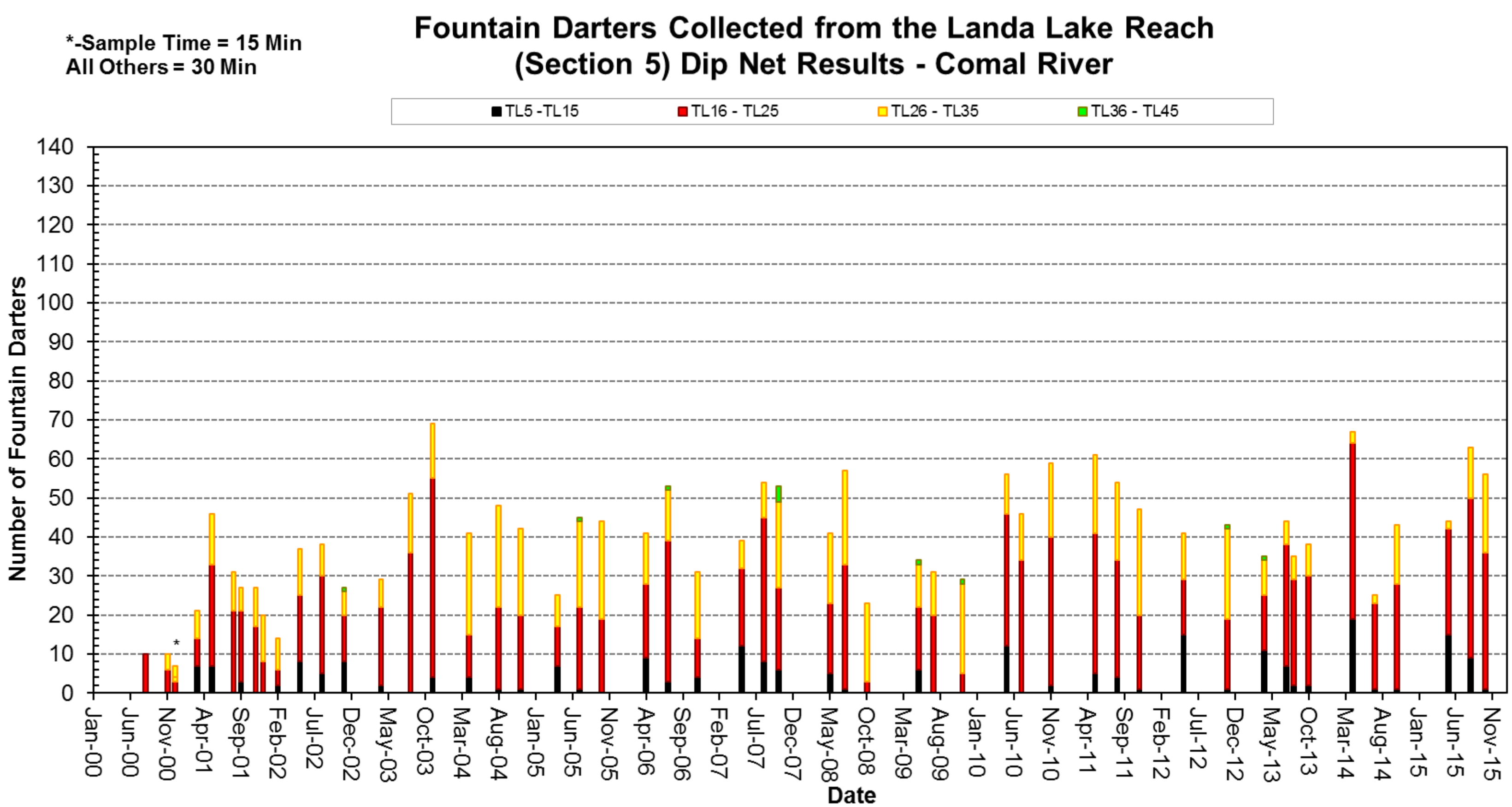
Fountain Darters Collected from the Upper Spring Run (Section 3) Dip Net Results - Comal River



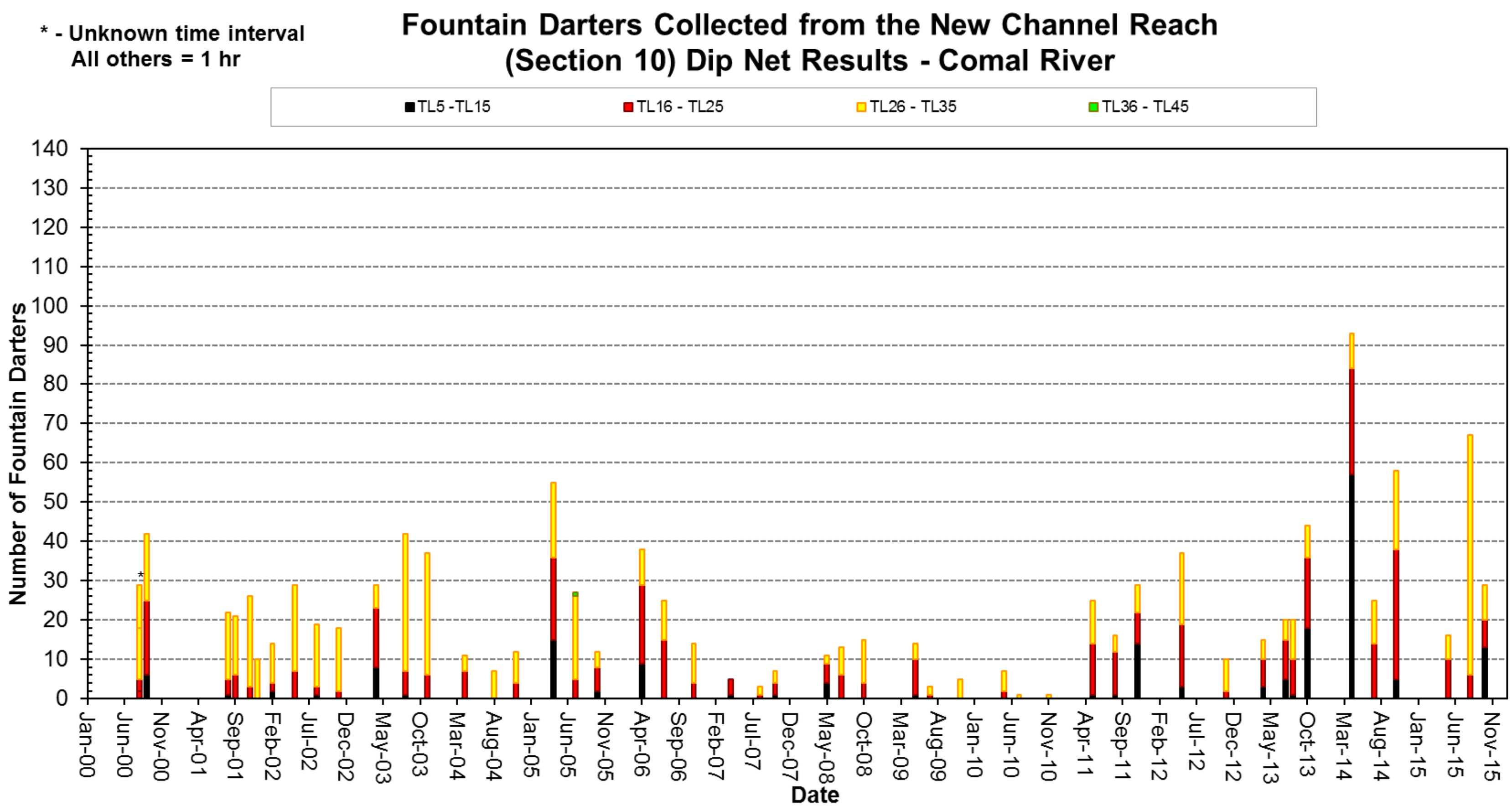

* - Sample time = 1 hr 45 min
All others = 30 min
Fountain Darters Collected from the Spring Island
(Section 4U-M) Dip Net Results - Comal River
TL5 -TL15
TL16 - TL25
TL26 - TL35
TL36 - TL45
Number of Fountain Darters
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Date
Jan-00
Jun-00
Nov-00
Apr-01
Sep-01
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



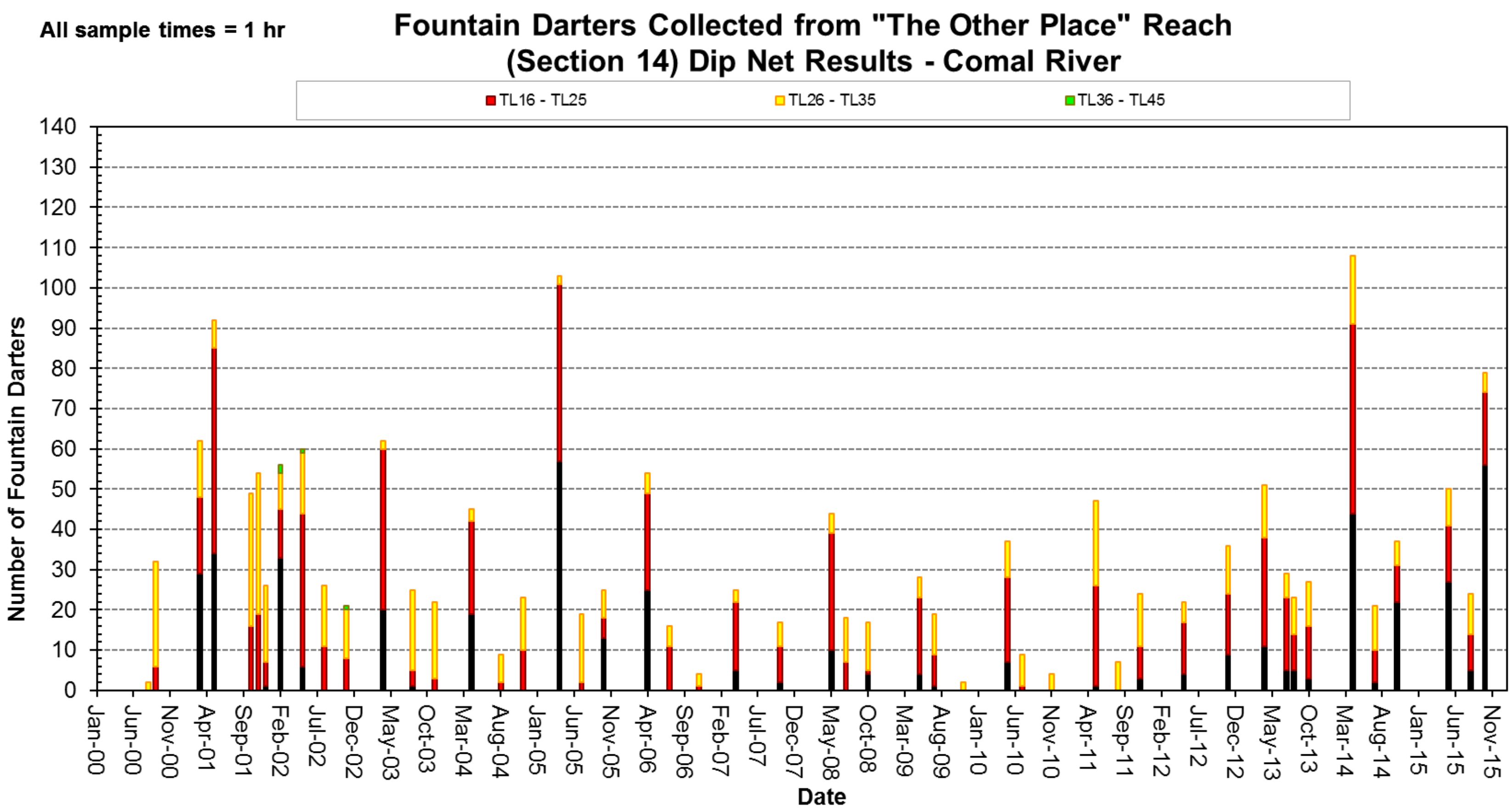
* - Sample time = 1 hr 15 min
All others = 30 min
Fountain Darters Collected from the Landa Lake Reach
(Section 4L) Dip Net Results - Comal River
TL5 -TL15
TL16 - TL25
TL26 - TL35
TL36 - TL45
Number of Fountain Darters
Date
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Jan-00
Jun-00
Nov-00
Apr-01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

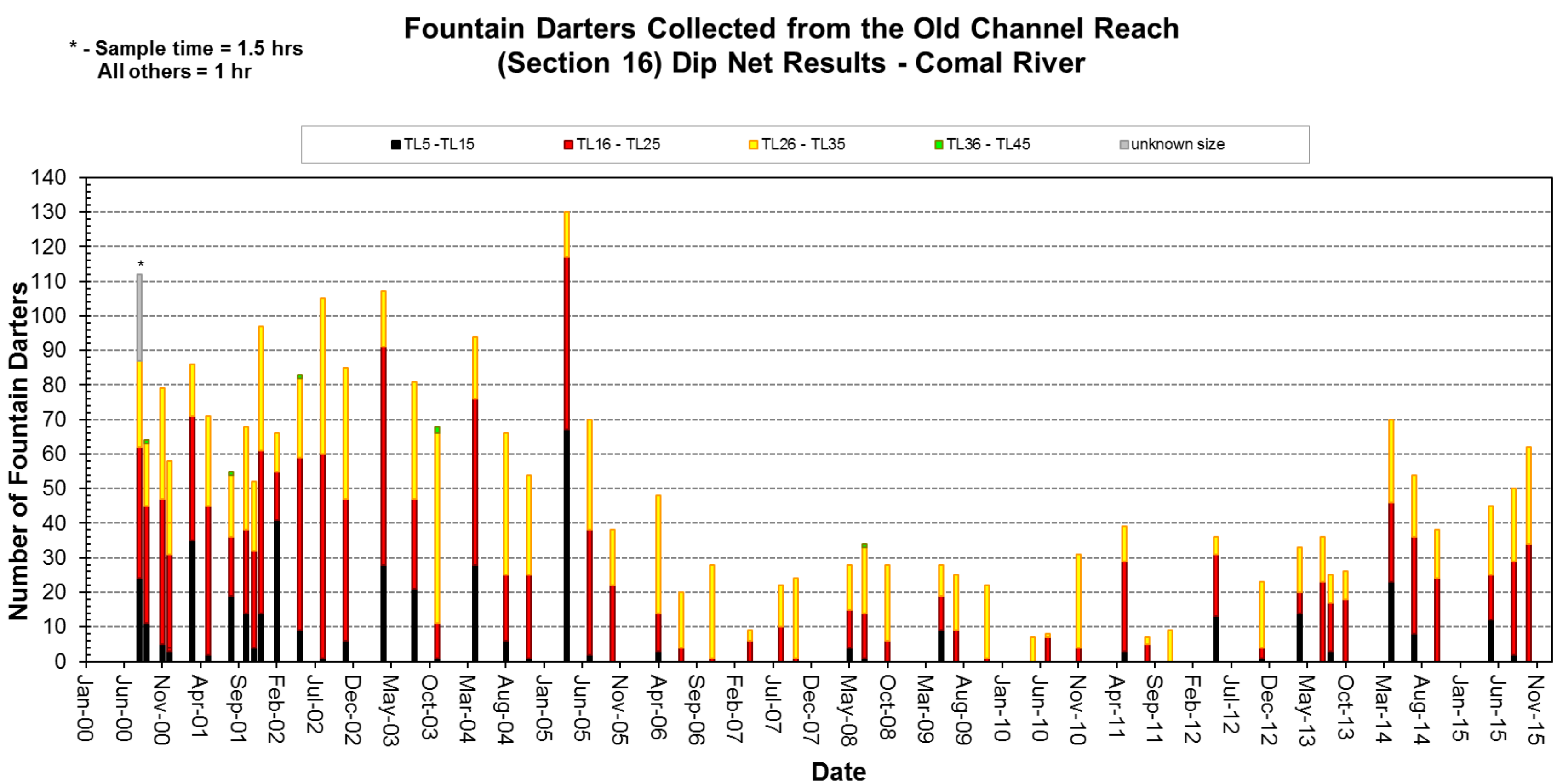


*-Sample Time = 15 Min
All Others = 30 Min
Fountain Darters Collected from the Landa Lake Reach
(Section 5) Dip Net Results - Comal River
TL5 -TL15
TL16 - TL25
TL26 - TL35
TL36 - TL45
Number of Fountain Darters
Date



* - Unknown time interval
All others = 1 hr
Fountain Darters Collected from the New Channel Reach
(Section 10) Dip Net Results - Comal River
TL5 -TL15
TL16 - TL25
TL26 - TL35
TL36 - TL45
Number of Fountain Darters
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Jan-00
Jun-00
Nov-00
Apr-01
Sep-01
Feb-02
Jul-02
Dec-02
May-03
Oct-03
Mar-04
Aug-04
Jan-05
Jun-05
Nov-05
Apr-06
Sep-06
Feb-07
Jul-07
Dec-07
May-08
Oct-08
Mar-09
Aug-09
Jan-10
Jun-10
Nov-10
Apr-11
Sep-11
Feb-12
Jul-12
Dec-12
May-13
Oct-13
Mar-14
Aug-14
Jan-15
Jun-15
Nov-15
Date


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
Date



Fountain Darters Collected from the Old Channel Reach
(Section 16) Dip Net Results - Comal River
* - Sample time = 1.5 hrs
All others = 1 hr
TL5 -TL15
TL16 - TL25
TL26 - TL35
TL36 - TL45
unknown size
Number of Fountain Darters
Date
0
10
20
30
40
50
60
70
80
90
100
110
120
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

Macroinvertebrate Data

Spring

Order/Class	Family	Genus	OCR-HYG	OCR-LUD	OCR-BRY	OCR-CAB	OCR-SAG	LL-LUD	LL-BRY	LL-CAB	LL-SAG	NC-HYG	NC-LUD	NC-CAB	USR-HYG	USR-SAG	USR-BRY
Ephemeroptera	Baetidae	Callibaetis										1					1
"	"	Camelobaetidius															
"	"	Fallceon quilleri		1							1		3				
"	"	Baetis															
"	Ephemeridae	Hexagenia													1		
"	Leptohyphidae	Tricorythodes	1		3		2	1	1	9	2	2	16	13	1		13
"	Caenidae	Caenis								1							
Odonata	"	Enallagma	2			1							2	1			
"	Gomphidae	Aphylla			1				1								
Hemiptera	Mesovelidae	Mesovelia													1		
Trichoptera	"	Oxytheria								2				1			
Lepidoptera	Crambidae	Early Instar/Pupa															
Lepidoptera	Crambidae	Paraponyx								1			3				
Coleoptera	"	Microcylloepus pusillus		1			1							1			
"	Psephinidae	Psephenus					1										13
Diptera	Chironomidae	Chironomini								6			7			2	
"	"	Tanytarsini											2				
"	"	Tanypodinae											2				
"	"	Orthocladinae								1			1				
"	"	Pseudochironomini											1				
"	Psychodidae	Psychoda										1					
Amphipoda	Hyalellidae	Hyalella	3	21	107	7	137	8	27	16	21	49	93	134	8	1	51
Decapoda	Cambaridae			3	2	1	1	1	2			2	1	1			
Copepod									1								
Gastropoda	Thiaridae	M. tuberculata	1	2		1		4		20	1					1	1
"	"	Terabia	182	206	115	169	292	90	49	72	112	361	251	375	1	1	3
"	Planorbidae	Helisoma	1					1				1	1				
"	Pleuroceridae	Elimia	5	6				49	4	3	16	4					8
"	Hydrobiidae		52	3	1	2	1	4		55		34	57	74	3	2	2
	Lymnaeidae																
"	Physidae	Physa			1							2	1	2	1		

Fall

Order/Class	Family	Genus	OCR-HYG	OCR-LUD	OCR-BRY	OCR-CAB	OCR-SAG	LL-LUD	LL-BRY	LL-CAB	LL-SAG	LL-VAL	NC-HYG	NC-LUD	NC-CAB	USR-SAG	USR-BRY	USR-ALG
Ephemeroptera	Baetidae	Callibaetis							1				1				4	
"	"	Fallceon quilleri											2					
"	Ephemeridae	Hexagenia	3			1				2						1		
"	Leptohyphidae	Tricorythodes	4		13	6	6	2			2		55		21		2	7
"	Caenidae	Caenis														1		
"	"	Stenonema														2		
Odonata	Ceonagrionidae	Early Instar											5					
"	"	Argia	1		1				1									
"	"	Enallagma	2		2					2			4		2			
"	"	Dromogomphus									1							
Trichoptera	Leptoceridae	Oecetis											1					
"	Hydroptilldae	Oxytheria													3			15
"	Polycentropodidae	Polycentropus														1		
Lepidoptera	Crambidae	Paraponyx	1				1							4				
"	"	Oxyelophila c.f.						2										
"	"	Crambidae																
"	"	Acentria																
"	"	Neargyractis																
	Hydrophilidae	Berosus																
"	"	Peltodytes																
"		Neoelmis																
Coleoptera	Elmidae	Microcylloepus pusillus	2	1	1									3				
"	"	Hexacylloepus ferrugineus	1															
"	"	Dubiraphia											1					
"	Psephinidae	Psephenus									5							5
Diptera	Chironomidae	Chironomid Pupae										1	1	1		2		
"	"	Chironomini											1		1	1		3
"	"	Tanytarsini	1										1	1				
"	"	Tanypodinae	1			1		2	1						1	3		
"	"	Orthocladinae										1		1	1			
"	"	Pseudochironomini													1			
Amphipoda	Hyalellidae	Hyalella	55	8	403	2	164	59	76	10	38	2	452	129	109	42	123	22
Decapoda	Cambaridae		3		5		1	2	2		1	1	3	1	1		2	
Gastropoda	Thiaridae	M. tuberculata							1	7								
"	"	Terabia	422	204	273	164	1	105	135	31	10	37	917	84	429	3	18	
"	Planorbidae	Helisoma			2								1					
"	Pleuroceridae	Elimia	1		8			32	49	1		27	6	1	2	1	3	1
"	Ancylidae															1		
"	Hydrobiidae		38	8		26				3			93	5	285	3		
"	Physidae	Physa							1									

APPENDIX D: DROP NET RAW DATA

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		**Site:**		
Upper Spring Run		R1-Site 1		
Date:	**Time:**	**Observer(s):**		
4/29/2015	925-955	JH,JW,NP,TJ		
Overall	**Species**		**Number**	**Avg. Length (mm)**
29	*Etheostoma fonticola*			
254	*Micropterus salmoides*			
46	*Procambarus* sp.			

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Micropterus salmoides*	225	30,30,30,20,30,30,20,29,25,32,25,25,30,23,25, 26,25,26,30,27,28,31,34,25,30
	Etheostoma fonticola	4	15,10,12,20
2	*Procambarus* sp.	28	
	Etheostoma fonticola	6	11,15,20,15,20,12
3	*Etheostoma fonticola*	5	15,19,17,17,11
	Procambarus sp.	3	
	Micropterus salmoides	17	
4	*Procambarus* sp.	1	
	Etheostoma fonticola	1	11
5	*Procambarus* sp.	7	
	Etheostoma fonticola	1	22
6	*Etheostoma fonticola*	2	21,18
7	*Etheostoma fonticola*	4	30,16,21,18
	Micropterus salmoides	6	
8	*Etheostoma fonticola*	1	25
9	*Micropterus salmoides*	6	
	Procambarus sp.	2	
10	*Procambarus* sp.	2	
	Etheostoma fonticola	1	16
11	No fish or crustaceans collected		
12	*Etheostoma fonticola*	1	33
13	*Etheostoma fonticola*	1	13
	Procambarus sp.	1	
14	*Etheostoma fonticola*	2	16,20
	Procambarus sp.	2	
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		Site:		
Upper Spring Run		S2- Site 2		
Date: 4/29/2015	Time: 958-1013	Observer(s): JH,JW,NP,TJ		
Overall	**Species**		**Number**	**Avg. Length (mm)**
2	*Lepomis miniatus*			
1	*Etheostoma fonticola*			
44	*Procambarus* sp.			
1	*Astyanax mexicanus*			
1	*Lepomis sp.*			

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	15	
	Etheostoma fonticola	1	28
2	*Astyanax mexicanus*	1	13
	Procambarus sp.	10	
3	*Procambarus* sp.	2	
	Lepomis miniatus	1	24
4	*Lepomis sp.*	1	12
	Procambarus sp.	3	
5	*Procambarus* sp.	5	
6	*Procambarus* sp.	1	
7	*Procambarus* sp.	8	
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	*Lepomis miniatus*	1	60
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 2015 SAMPLING

Location (Reach): Upper Spring Run		**Site:** S1 -Site 3	
Date: 4/29/2015	**Time:** 1015-1031	**Observer(s):** JH,JW,NP,TJ	

Overall	**Species**	**Number**	**Avg. Length (mm)**
11	*Lepomis miniatus*		
1	*Lepomis auritus*		
1	*Ameiurus natalis*		
42	*Procambarus* sp.		
3	*Lepomis sp.*		
1	*Astyanax mexicanus*		

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Lepomis miniatus*	2	32,22
	Lepomis auritus	1	79
	Ameiurus natalis	1	35
	Procambarus sp.	9	
	Lepomis sp.	3	13,15,18
2	*Lepomis miniatus*	4	80,34,24,25
	Astyanax mexicanus	1	15
3	*Lepomis miniatus*	1	21
	Procambarus sp.	6	
4	*Lepomis miniatus*	2	25,32
	Procambarus sp.	4	
5	*Procambarus* sp.	7	
6	*Procambarus* sp.	2	
	Lepomis miniatus	1	24
7	*Procambarus* sp.	2	
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	*Procambarus* sp.	4	
11	*Procambarus* sp.	1	
12	*Lepomis miniatus*	1	35
	Procambarus sp.	1	
13	*Procambarus* sp.	4	
14	*Procambarus* sp.	2	
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		Site:		
Upper Spring Run		O1- Site 4		
Date:	**Time:**	**Observer(s):**		
4/29/2015	1035-1052	JH,JW,NP,TJ		
Overall	**Species**		**Number**	**Avg. Length (mm)**
9	*Etheostoma fonticola*			
1	*Procambarus* sp.			

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	1	12
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	*Etheostoma fonticola*	1	16
5	*Etheostoma fonticola*	1	15
6	*Etheostoma fonticola*	2	16,11
7	*Etheostoma fonticola*	1	16
8	*Procambarus* sp.	1	
9	*Etheostoma fonticola*	1	20
10	No fish or crustaceans collected		
11	*Etheostoma fonticola*	2	26,17
12	*Etheostoma fonticola*	1	9
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 2015 SAMPLING

Location (Reach):		Site:	Site on Map:
Upper Spring Run		H1 -Site 5	H2
Date:	Time:	Observer(s):	
4/29/2015	1054-1114	JH,JW,NP,TJ	

Overall	Species	Number	Avg. Length (mm)
10	*Lepomis sp.*		
1	*Palaemonetes* sp.		
12	*Lepomis miniatus*		
1	*Lepomis auritus*		
20	*Etheostoma fonticola*		
4	*Gambusia sp.*		
5	*Dionda nigrotaeniata*		
32	*Procambarus* sp.		
2	*Micropterus salmoides*		
1	*Lepomis macrochirus*		

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	4	33,26,24,26
	Gambusia sp.	2	30,20
	Micropterus salmoides	1	45
	Dionda nigrotaeniata	1	38
2	*Lepomis sp.*	4	25,22,25,23
	Lepomis miniatus	2	50,31
	Etheostoma fonticola	2	13,18
	Gambusia sp.	1	22
	Dionda nigrotaeniata	2	35,35
	Procambarus sp.	7	
3	*Etheostoma fonticola*	2	16,23
	Lepomis miniatus	2	21,35
	Dionda nigrotaeniata	1	19
	Procambarus sp.	2	
4	*Etheostoma fonticola*	1	29
	Gambusia sp.	1	18
	Lepomis sp.	5	20,19,22,23,9
	Procambarus sp.	2	
	Palaemonetes sp.	1	
5	*Lepomis miniatus*	2	26,25
	Etheostoma fonticola	1	11
	Lepomis macrochirus	1	68
	Lepomis sp.	1	12
	Procambarus sp.	3	
6	*Micropterus salmoides*	1	95
	Etheostoma fonticola	4	22,32,12,17
7	*Etheostoma fonticola*	5	35,18,24,25,18
	Lepomis miniatus	1	24
	Procambarus sp.	2	
8	*Etheostoma fonticola*	3	18,22,20
	Procambarus sp.	1	
9	*Dionda nigrotaeniata*	1	65
	Procambarus sp.	4	
10	*Procambarus* sp.	2	
	Etheostoma fonticola	1	15
11	*Procambarus* sp.	1	
12	*Lepomis miniatus*	1	28
	Procambarus sp.	1	
13	*Procambarus* sp.	7	
	Lepomis auritus	1	62
14	*Etheostoma fonticola*	1	27
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach): Upper Spring Run		**Site:** R2- Site 6	
Date: 4/29/2015	**Time:** 1120-1131	**Observer(s):** JH,JW,NP,TJ	
Overall	**Species**	**Number**	**Avg. Length (mm)**
25	*Etheostoma fonticola*		
3	*Procambarus* sp.		

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	3	15,20,18
2	*Etheostoma fonticola*	3	20,23,22
3	*Etheostoma fonticola*	6	16,20,26,21,15,23
4	*Etheostoma fonticola*	2	25,32
	Procambarus sp.	1	
5	*Etheostoma fonticola*	1	25
6	No fish or crustaceans collected		
7	*Etheostoma fonticola*	6	15,14,15,12,20,24
	Procambarus sp.	2	
8	*Etheostoma fonticola*	3	16,20,11
9	No fish or crustaceans collected		
10	*Etheostoma fonticola*	1	17
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 2015 SAMPLING

Location (Reach):		Site:	Site on Map:	
Upper Spring Run		O2- Site 7		
Date:	**Time:**	**Observer(s):**		
4/29/2015	1134-1138	JH,JW,NP,TJ		

Overall	Species	Number	Avg. Length (mm)

COMAL RIVER -SPRING 2015 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 2015 SAMPLING

Location (Reach):		Site:	Site on Map:
Upper Spring Run		R1-Site 1	R3
Date:	**Time:**	**Observer(s):**	
10/26/2015	922-949	JH,JW,ME,TL	

Overall	Species	Number	Avg. Length (mm)
17	*Etheostoma fonticola*		
28	*Procambarus* sp.		
1	*Palaemonetes* sp.		
1	*Gambusia sp.*		
1	*Lepomis sp.*		
89	*Notropis amabilis*		
1	*Dionda nigrotaeniata*		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	5	29,31,31,30,34
	Procambarus sp.	16	26,25,26,30,27,28,31,34,25,30
	Lepomis sp.	1	15
	Notropis amabilis	25	35,35,48,25,30,44,35,38,34,33,38,47,34,42,32, 33,17,23,28,32,38,32,12,30,46
	Dionda nigrotaeniata	1	17
2	*Etheostoma fonticola*	1	34
	Notropis amabilis	9	
	Gambusia sp.	1	12
	Procambarus sp.	1	
3	*Notropis amabilis*	20	
	Palaemonetes sp.	1	
4	*Notropis amabilis*	14	
	Etheostoma fonticola	1	31
5	*Etheostoma fonticola*	6	37,30,24,34,21,16
	Procambarus sp.	3	
	Notropis amabilis	7	
6	*Etheostoma fonticola*	1	26
	Notropis amabilis	3	
7	*Notropis amabilis*	7	
8	*Procambarus* sp.	1	
9	*Notropis amabilis*	3	
10	*Etheostoma fonticola*	1	27
11	*Procambarus* sp.	4	
	Etheostoma fonticola	1	21
12	*Etheostoma fonticola*	1	34
	Notropis amabilis	1	
13	*Procambarus* sp.	3	
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		Site:	
Upper Spring Run		S1 -Site 2	
Date: 10/26/2015	**Time:** 951-1007	**Observer(s):** JH,JW,ME,TL	

Overall	Species	Number	Avg. Length (mm)
4	*Lepomis miniatus*		
1	*Micropterus salmoides*		
7	*Procambarus* sp.		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	1	
	Micropterus salmoides	1	44
2	*Lepomis miniatus*	1	45
	Procambarus sp.	2	
3	*Lepomis miniatus*	1	56
	Procambarus sp.	1	
4	No fish or crustaceans collected		
5	*Procambarus* sp.	1	
	Lepomis miniatus	1	72
6	*Lepomis miniatus*	1	48
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	*Procambarus* sp.	1	
11	*Procambarus* sp.	1	
12	No fish or crustaceans collected		
13	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 2015 SAMPLING

Location (Reach):		Site:	
Upper Spring Run		S2- Site 3	
Date:	**Time:**	**Observer(s):**	
10/26/2015	1010-1022	JH,JW,ME,TL	

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

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	1	55
	Procambarus sp.	1	
2	*Micropterus salmoides*	1	48
3	*Micropterus salmoides*	1	45
	Procambarus sp.	1	
4	No fish or crustaceans collected		
5	*Gambusia sp.*	1	40
	Lepomis miniatus	1	90
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	*Lepomis miniatus*	1	50
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	*Procambarus* sp.	1	
	Lepomis miniatus	1	43
14	*Procambarus* sp.	1	
15	*Lepomis miniatus*	1	62
	Procambarus sp.	1	

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach): Upper Spring Run		**Site:** O1- Site 4	
Date: 10/26/2015	**Time:** 1024-1027	**Observer(s):** JH,JW,ME,TL	
Overall	**Species**	**Number**	**Avg. Length (mm)**

	COMAL RIVER -FALL 2015 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 -FALL 2015 SAMPLING

Location (Reach):		Site:	Site on Map:
Upper Spring Run		O2- Site 5	
Date:	**Time:**	**Observer(s):**	
10/26/2015	1029-1039	JH,JW,ME,TL	

Overall	Species	Number	Avg. Length (mm)
COMAL RIVER -FALL 2015 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 -FALL 2015 SAMPLING

Location (Reach): Upper Spring Run		**Site:** R2- Site 6	
Date: 10/26/2015	**Time:** 1043-1054	**Observer(s):** JH,JW,ME,TL	
Overall	**Species**	**Number**	**Avg. Length (mm)**
1	*Etheostoma fonticola*		
4	*Procambarus* sp.		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Procambarus* sp.	3	
2	*Procambarus* sp.	1	
3	*Etheostoma fonticola*	1	33
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	No fish or crustaceans collected		
7	No fish or crustaceans collected		
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		Site:		
Upper Spring Run		A1- Site 7		
Date: 10/26/2015	**Time:** 1059-1123	**Observer(s):** JH,JW,ME,TL		
Overall	**Species**		**Number**	**Avg. Length (mm)**
15	*Etheostoma fonticola*			
2	*Lepomis sp.*			
9	*Procambarus* sp.			

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	3	
2	*Etheostoma fonticola*	1	14
3	No fish or crustaceans collected		
4	*Etheostoma fonticola*	3	32,16,16
	Lepomis sp.	1	10
5	*Procambarus* sp.	2	
	Etheostoma fonticola	1	21
6	*Procambarus* sp.	2	
7	*Procambarus* sp.	1	
	Etheostoma fonticola	1	13
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	*Etheostoma fonticola*	2	13,13
	Lepomis sp.	1	9
11	*Etheostoma fonticola*	1	10
12	*Procambarus* sp.	1	
	Etheostoma fonticola	2	17,13
13	*Etheostoma fonticola*	1	20
14	*Etheostoma fonticola*	3	21,16,15
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach): Upper Spring Run		**Site:** A2- Site 8	
Date: 10/26/2015	**Time:** 1125-1149	**Observer(s):** JH,JW,ME,TL	
Overall	**Species**	**Number**	**Avg. Length (mm)**
9	*Etheostoma fonticola*		
5	*Lepomis sp.*		
5	*Procambarus* sp.		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	4	18,23,12,13
	Procambarus sp.	1	
	Lepomis sp.	1	7
2	*Procambarus* sp.	1	
3	*Procambarus* sp.	3	
	Lepomis sp.	3	12,5,7
	Etheostoma fonticola	1	12
4	*Etheostoma fonticola*	1	18
5	No fish or crustaceans collected		
6	*Etheostoma fonticola*	1	13
7	No fish or crustaceans collected		
8	*Etheostoma fonticola*	1	20
9	*Etheostoma fonticola*	1	11
10	No fish or crustaceans collected		
11	*Lepomis sp.*	1	7
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 -SPRING 2015 SAMPLING

Location (Reach):		Site:		
Landa Lake		C1- Site 1		
Date:	**Time:**	**Observer(s):**		
4/30/2015	930-958	JW,JH,NP,TJ		
Overall	**Species**		**Number**	**Avg. Length (mm)**
1	*Lepomis miniatus*			
202	*Gambusia* sp.			
23	*Etheostoma fonticola*			
33	*Procambarus* sp.			
22	*Palaemonetes* sp.			

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	1	73
	Gambusia sp.	63	10,12,16,12,12,15,11,16,11,25,10,27,30,17,9,16,11,12, 15,20,16,19,10,25,15
	Etheostoma fonticola	6	10,10,12,20,26,22
	Procambarus sp.	8	
	Palaemonetes sp.	8	
2	*Etheostoma fonticola*	1	23
	Gambusia sp.	72	
	Palaemonetes sp.	4	
3	*Etheostoma fonticola*	4	17,28,17,23
	Palaemonetes sp.	3	
	Procambarus sp.	5	
	Gambusia sp.	26	
4	*Etheostoma fonticola*	2	27,19
	Gambusia sp.	15	
	Procambarus sp.	3	
	Palaemonetes sp.	4	
5	*Gambusia* sp.	5	
	Etheostoma fonticola	1	28
	Procambarus sp.	1	
	Palaemonetes sp.	2	
6	*Etheostoma fonticola*	1	30
	Procambarus sp.	2	
	Gambusia sp.	9	
7	*Etheostoma fonticola*	1	23
	Gambusia sp.	3	
8	*Procambarus* sp.	5	
	Gambusia sp.	2	
9	*Procambarus* sp.	1	
	Gambusia sp.	1	
	Palaemonetes sp.	1	
10	*Etheostoma fonticola*	1	25
11	*Procambarus* sp.	2	
	Gambusia sp.	1	
12	*Etheostoma fonticola*	3	20,20,14
	Procambarus sp.	2	
	Gambusia sp.	3	
13	*Etheostoma fonticola*	2	24,21
14	*Procambarus* sp.	3	
	Gambusia sp.	2	
15	*Etheostoma fonticola*	1	21
	Procambarus sp.	1	
16	No fish or crustaceans collected		
	***Melanoides-slight*		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach): Landa Lake		Site: V2 -Site 2		
Date: 4/30/2015	Time: 1001-1025	Observer(s): JW,JH,NP,TJ		
Overall	**Species**		**Number**	**Avg. Length (mm)**
4	*Lepomis miniatus*			
2	*Etheostoma fonticola*			
24	*Procambarus* sp.			
26	*Palaemonetes* sp.			
2	*Poecilia latipinna*			
339	*Gambusia* sp.			

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	166	21,12,10,15,12,15,24,32,20,29,17,12,26,30,20,15,25,27, 21,20,25,24,23,20,30
	Procambarus sp.	3	
	Palaemonetes sp.	8	
	Poecilia latipinna	2	35,49
2	*Lepomis miniatus*	1	98
	Etheostoma fonticola	1	15
	Procambarus sp.	1	
	Palaemonetes sp.	3	
	Gambusia sp.	77	
3	*Gambusia* sp.	57	
	Palaemonetes sp.	3	
4	*Gambusia* sp.	1	
	Palaemonetes sp.	12	
5	*Lepomis miniatus*	1	60
	Procambarus sp.	1	
	Gambusia sp.	24	
6	*Gambusia* sp.	8	
	Procambarus sp.	1	
7	*Lepomis miniatus*	1	78
	Procambarus sp.	1	
	Gambusia sp.	2	
8	*Etheostoma fonticola*	1	10
	Procambarus sp.	4	
	Gambusia sp.	2	
9	*Procambarus* sp.	1	
	Gambusia sp.	2	
10	No fish or crustaceans collected		
11	*Procambarus* sp.	6	
	Lepomis miniatus	1	92
12	*Procambarus* sp.	2	
13	No fish or crustaceans collected		
14	*Procambarus* sp.	2	
15	*Procambarus* sp.	2	
	**Tarebia granifera - slight*		
	***Melanoides-slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		Site:		
Landa Lake		V1- Site 3		
Date:	**Time:**	**Observer(s):**		
4/30/2015	1029-1046	JW,JH,NP,TJ		
Overall	**Species**		**Number**	**Avg. Length (mm)**
2	*Etheostoma fonticola*			
1	*Lepomis miniatus*			
68	*Gambusia* sp.			
17	*Procambarus* sp.			
3	*Palaemonetes* sp.			
1	*Herichthys cyanoguttatus*			

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	1	22
	Lepomis miniatus	1	110
	Gambusia sp.	20	10,10,15,9,9,9,9,9,24,10,11,14,9,7,11,10,10,10,10,10
	Procambarus sp.	3	
	Palaemonetes sp.	1	
2	*Etheostoma fonticola*	1	25
	Gambusia sp.	27	16,20,12,10,10
	Procambarus sp.	3	
	Palaemonetes sp.	2	
3	*Procambarus* sp.	1	
	Gambusia sp.	9	
4	*Gambusia* sp.	1	
5	*Gambusia* sp.	5	
	Procambarus sp.	3	
6	*Procambarus* sp.	1	
	Gambusia sp.	2	
7	*Herichthys cyanoguttatus*	1	78
	Procambarus sp.	1	
	Gambusia sp.	1	
8	*Gambusia* sp.	2	
9	*Gambusia* sp.	1	
10	*Procambarus* sp.	1	
11	*Procambarus* sp.	2	
12	No fish or crustaceans collected		
13	*Procambarus* sp.	1	
14	*Procambarus* sp.	1	
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		Site:		
Landa Lake		R1 - Site 4		
Date:	Time:	Observer(s):		
4/30/2015	1054-1134	JW,JH,NP,TJ		

Overall	Species	Number	Avg. Length (mm)
62	*Etheostoma fonticola*		
114	*Procambarus* sp.		
74	*Gambusia* sp.		
40	*Palaemonetes* sp.		
1	*Astyanax mexicanus*		
1	*Eurycea sp.*		

COMAL RIVER -SPRING 2015 SAMPLING

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

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach): Landa Lake		**Site:** R2- Site 5	
Date: 4/30/2015	**Time:** 1136-1203	**Observer(s):** JW,JH,NP,TJ	
Overall	**Species**	**Number**	**Avg. Length (mm)**
53	*Etheostoma fonticola*		
16	*Gambusia* sp.		
13	*Procambarus* sp.		

COMAL RIVER -SPRING 2015 SAMPLING

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

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach): Landa Lake		**Site:** C2 -Site 6	
Date: 4/30/2015	**Time:** 1233-1255	**Observer(s):** JW,JH,NP,TJ	
Overall	**Species**	**Number**	**Avg. Length (mm)**
72	*Gambusia* sp.		
20	*Procambarus* sp.		
1	*Poecilia latipinna*		
2	*Etheostoma fonticola*		
18	*Palaemonetes* sp.		

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	17	23,27,19,34,15,13,16,37,33,16,15,20,26,10,34,22,18
	Poecilia latipinna	1	28
	Procambarus sp.	3	
	Palaemonetes sp.	10	
2	*Gambusia* sp.	11	34,25,17,25,10,10,24,24
	Etheostoma fonticola	2	22,23
	Procambarus sp.	6	
	Palaemonetes sp.	4	
3	*Gambusia* sp.	19	
	Palaemonetes sp.	2	
4	*Procambarus* sp.	3	
	Gambusia sp.	3	
5	*Gambusia* sp.	4	
6	*Gambusia* sp.	4	
	Procambarus sp.	4	
7	*Procambarus* sp.	1	
	Gambusia sp.	3	
8	*Gambusia* sp.	5	
9	*Palaemonetes* sp.	1	
	Gambusia sp.	3	
10	*Gambusia* sp.	1	
11	*Procambarus* sp.	1	
	Gambusia sp.	1	
12	*Procambarus* sp.	1	
13	*Procambarus* sp.	1	
14	*Gambusia* sp.	1	
15	*Palaemonetes* sp.	1	
	***Melanoides-slight*		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach): Landa Lake		Site: H1 - Site 7	
Date: 4/30/2015	**Time:** 1301-1325	**Observer(s):** JW,JH,NP,TJ	
Overall	**Species**	**Number**	**Avg. Length (mm)**
2	*Lepomis miniatus*		
54	*Procambarus* sp.		
34	*Etheostoma fonticola*		
41	*Gambusia* sp.		
8	*Palaemonetes* sp.		

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	6	17,16,11,12,11,8
	Gambusia sp.	10	21,11,10,11,10,10,10,10,10,10
	Procambarus sp.	3	
2	*Lepomis miniatus*	1	40
	Procambarus sp.	5	
	Etheostoma fonticola	12	31,21,16,21,20,17,26,20,16,13,20
	Gambusia sp.	2	9,10
	Palaemonetes sp.	7	
3	*Procambarus* sp.	2	
	Etheostoma fonticola	2	14,20
	Gambusia sp.	1	13
4	*Procambarus* sp.	5	
	Etheostoma fonticola	6	23,12,15,21,21,16
	Gambusia sp.	1	9
5	*Etheostoma fonticola*	1	20
	Procambarus sp.	4	
6	*Etheostoma fonticola*	1	23
	Procambarus sp.	9	
	Gambusia sp.	3	10,9,11
7	*Gambusia* sp.	18	12,13,28,30,11,10,10,9
	Palaemonetes sp.	1	
	Etheostoma fonticola	2	16,16
	Procambarus sp.	4	
8	*Procambarus* sp.	3	
9	*Procambarus* sp.	9	
10	*Procambarus* sp.	2	
	Gambusia sp.	1	
11	*Procambarus* sp.	2	
	Etheostoma fonticola	3	29,26,15
	Gambusia sp.	5	
12	*Procambarus* sp.	2	
13	*Procambarus* sp.	1	
14	*Procambarus* sp.	2	
15	*Etheostoma fonticola*	1	29
16	*Procambarus* sp.	1	
	Lepomis miniatus	1	50
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		Site:	
Landa Lake		L2- Site 8	
Date:	Time:	Observer(s):	
4/30/2015	1330-1408	JW,JH,NP,TJ	

Overall	Species	Number	Avg. Length (mm)
52	*Etheostoma fonticola*		
20	*Poecilia latipinna*		
1	*Lepomis miniatus*		
34	*Palaemonetes* sp.		
45	*Procambarus* sp.		
160	*Gambusia* sp.		
2	*Poecilia formosa*		

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	60	35,32,22,24,11,10,25,28,18,21,23,23,10,31,22,20,32,30, 21,13,15,20,25,12,20
	Poecilia latipinna	11	35,42,40,45,38,29,43,30,30,45,33,
	Etheostoma fonticola	23	13,18,30,14,16,17,22,11,13,11,13,13,15,10,13,11,13,30, 11,17,14,12,10
	Poecilia formosa	2	23,15
	Palaemonetes sp.	13	
2	*Etheostoma fonticola*	8	16,28,16,21,28,12,15,16
	Poecilia latipinna	5	46,30,33,27,36
	Palaemonetes sp.	11	
	Procambarus sp.	3	
	Gambusia sp.	23	
3	*Procambarus* sp.	4	
	Poecilia latipinna	1	45
	Palaemonetes sp.	2	
	Gambusia sp.	25	
	Etheostoma fonticola	2	8,10
4	*Gambusia* sp.	17	
	Etheostoma fonticola	2	28,16
	Procambarus sp.	4	
	Palaemonetes sp.	2	
5	*Procambarus* sp.	6	
	Etheostoma fonticola	9	27,30,28,16,13,23,12,12,12
	Poecilia latipinna	2	40,37
	Gambusia sp.	17	
6	*Etheostoma fonticola*	1	15
	Lepomis miniatus	1	75
	Palaemonetes sp.	3	
	Procambarus sp.	6	
	Gambusia sp.	10	
7	*Etheostoma fonticola*	3	30,19,29
	Palaemonetes sp.	2	
	Procambarus sp.	7	
	Gambusia sp.	1	
8	*Procambarus* sp.	5	
	Gambusia sp.	3	
9	*Procambarus* sp.	5	
	Etheostoma fonticola	3	15,29,18
	Gambusia sp.	2	
10	*Gambusia* sp.	1	
	Procambarus sp.	1	
11	*Poecilia latipinna*	1	60
	Etheostoma fonticola	1	14
12	*Gambusia* sp.	1	
	Procambarus sp.	1	
13	No fish or crustaceans collected		
14	*Procambarus* sp.	1	
15	*Procambarus* sp.	2	
	Palaemonetes sp.	1	
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		**Site:**	
Landa Lake		H2 - Site 9	
Date:	**Time:**	**Observer(s):**	
4/30/2015	1412-1436	JW,JH,NP,TJ	

Overall	**Species**	**Number**	**Avg. Length (mm)**
39	*Etheostoma fonticola*		
70	*Procambarus* sp.		
19	*Gambusia* sp.		

COMAL RIVER -SPRING 2015 SAMPLING

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

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		Site:	
Landa Lake		L1- Site 10	
Date:	**Time:**	**Observer(s):**	
4/30/2015	1437-1500	JW,JH,NP,TJ	

Overall	Species	Number	Avg. Length (mm)
33	*Gambusia* sp.		
44	*Etheostoma fonticola*		
3	*Lepomis miniatus*		
6	*Palaemonetes* sp.		
18	*Procambarus* sp.		

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	9	22,17,22,13,27,13,10,12,14
	Gambusia sp.	15	12,15,22,26,17,20,20,15,13,10,10,12,12,10,12
	Procambarus sp.	2	
2	*Gambusia* sp.	5	18,15,12,13,10
	Etheostoma fonticola	9	26,20,17,28,17,19,20,11,10
	Procambarus sp.	3	
	Palaemonetes sp.	2	
3	*Lepomis miniatus*	1	127
	Gambusia sp.	4	10,15,20,9
	Etheostoma fonticola	2	18,9
	Palaemonetes sp.	3	
4	*Etheostoma fonticola*	6	19,15,11,10,12,14
	Gambusia sp.	4	15
5	*Lepomis miniatus*	1	130
	Etheostoma fonticola	3	22,15,10
	Procambarus sp.	1	
6	*Etheostoma fonticola*	6	13,10,11,11,11,12
	Procambarus sp.	1	
7	*Etheostoma fonticola*	1	30
	Procambarus sp.	5	
	Gambusia sp.	1	
8	*Etheostoma fonticola*	2	30,11
	Procambarus sp.	1	
	Gambusia sp.	1	
9	*Palaemonetes* sp.	1	
	Procambarus sp.	2	
	Gambusia sp.	1	
	Etheostoma fonticola	1	13
10	*Etheostoma fonticola*	1	18
	Gambusia sp.	1	
	Procambarus sp.	1	
11	*Procambarus* sp.	1	
	Etheostoma fonticola	3	11,11,9
12	*Gambusia* sp.	1	
13	*Lepomis miniatus*	1	95
	Etheostoma fonticola	1	7
14	*Procambarus* sp.	1	
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach): Landa Lake		**Site:** O2 - Site 11	
Date: 4/30/2015	**Time:** 1504-1509	**Observer(s):** JW,JH,NP,TJ	
Overall	**Species**	**Number**	**Avg. Length (mm)**
1	*Etheostoma fonticola*		

COMAL RIVER -SPRING 2015 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	16
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 2015 SAMPLING

Location (Reach):		Site:		
Landa Lake		O1 - Site 12		
Date:	**Time:**	**Observer(s):**		
4/30/2015	1512-1518	JW,JH,NP,TJ		
Overall	**Species**		**Number**	**Avg. Length (mm)**

COMAL RIVER -SPRING 2015 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 -FALL 2015 SAMPLING

Location (Reach):		Site:	
Landa Lake		L2- Site 1	
Date:	**Time:**	**Observer(s):**	
10/26/2015	1240-1301	JW,JH,ME,TL	

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

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	7	31,28,26,30,21,18,11
	Procambarus sp.	7	
2	*Gambusia* sp.	3	20,28,19
	Procambarus sp.	7	
	Etheostoma fonticola	1	16
3	*Procambarus* sp.	7	
	Lepomis miniatus	1	104
	Gambusia sp.	7	21,33,25,25,22,16,16
4	*Procambarus* sp.	5	
	Gambusia sp.	1	22
5	*Gambusia* sp.	1	12
6	No fish or crustaceans collected		
7	*Gambusia* sp.	1	16
8	*Etheostoma fonticola*	1	31
	Procambarus sp.	1	
9	*Etheostoma fonticola*	2	32,24
10	*Etheostoma fonticola*	1	34
	Gambusia sp.	2	32,29
11	*Procambarus* sp.	1	
	Etheostoma fonticola	1	32
12	*Procambarus* sp.	1	
13	*Procambarus* sp.	2	
	Gambusia sp.	1	22
14	*Etheostoma fonticola*	1	17
15	*Procambarus* sp.	1	
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		Site:		
Landa Lake		C2 -Site 2		
Date:	**Time:**	**Observer(s):**		
10/26/2015	1309-1405	JW,JH,ME,TL		
Overall	**Species**		**Number**	**Avg. Length (mm)**
346	*Gambusia* sp.			
23	*Etheostoma fonticola*			
78	*Procambarus* sp.			
10	*Palaemonetes* sp.			

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	7	25,30,26,26,9,16,20
	Procambarus sp.	3	
2	*Procambarus* sp.	6	
	Gambusia sp.	72	11,14,31,27,18,24,26,22,21,20,6,6,15,15,12,14,13,35
	Palaemonetes sp.	2	
3	*Gambusia* sp.	124	
	Etheostoma fonticola	1	28
	Procambarus sp.	3	
4	*Gambusia* sp.	11	
	Etheostoma fonticola	5	32,30,30,32,31
	Procambarus sp.	9	
	Palaemonetes sp.	1	
5	*Gambusia* sp.	41	
	Etheostoma fonticola	1	35
	Procambarus sp.	9	
6	*Gambusia* sp.	17	
	Procambarus sp.	7	
7	*Procambarus* sp.	6	
	Etheostoma fonticola	4	32,23,33,30
	Gambusia sp.	19	
8	*Procambarus* sp.	2	
	Gambusia sp.	5	
9	*Etheostoma fonticola*	1	31
	Procambarus sp.	6	
10	*Etheostoma fonticola*	1	30
	Procambarus sp.	2	
11	*Etheostoma fonticola*	2	27,26
	Procambarus sp.	8	
	Gambusia sp.	8	
12	*Gambusia* sp.	4	
13	*Etheostoma fonticola*	3	30,31,34
	Procambarus sp.	4	
	Gambusia sp.	7	
14	*Etheostoma fonticola*	1	28
	Gambusia sp.	2	
	Procambarus sp.	2	

COMAL RIVER -FALL 2015 SAMPLING			
Dip net sweep	**Species**	**Number**	**Length (mm)**
15	*Etheostoma fonticola*	1	29
	Gambusia sp.	9	
	Procambarus sp.	4	
16	*Etheostoma fonticola*	1	35
	Gambusia sp.	7	
	Palaemonetes sp.	7	
	Procambarus sp.	4	
17	*Etheostoma fonticola*	1	27
	Gambusia sp.	3	
	Procambarus sp.	1	
18	*Etheostoma fonticola*	1	29
	Gambusia sp.	10	
	Procambarus sp.	1	
19	*Procambarus* sp.	1	
	***Melanoides-slight*		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		Site:		
Landa Lake		C1- Site 3		
Date:	**Time:**	**Observer(s):**		
10/26/2015	1415-1444	JW,JH,ME,TL		
Overall	**Species**		**Number**	**Avg. Length (mm)**
22	*Procambarus* sp.			
15	*Etheostoma fonticola*			
75	*Gambusia* sp.			
1	*Lepomis miniatus*			
5	*Poecilia latipinna*			
1	*Lepomis sp.*			
6	*Palaemonetes* sp.			

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	4	
	Etheostoma fonticola	2	30,28
	Gambusia sp.	8	34,24,12,12,12,11,12,9
	Lepomis sp.	1	23
	Palaemonetes sp.	2	
2	*Procambarus* sp.	3	
	Etheostoma fonticola	4	28,30,28,25
	Gambusia sp.	6	12,36,12,15,32,18
	Poecilia latipinna	1	21
3	*Etheostoma fonticola*	1	33
	Gambusia sp.	5	36,24,12,10,20
4	*Gambusia* sp.	3	12,12,15
	Etheostoma fonticola	3	32,27,20
	Procambarus sp.	4	
5	*Gambusia* sp.	12	15,17,12
	Procambarus sp.	3	
6	*Etheostoma fonticola*	1	27
	Poecilia latipinna	1	24
	Procambarus sp.	4	
	Gambusia sp.	22	
7	*Poecilia latipinna*	1	18
	Gambusia sp.	5	
8	*Lepomis miniatus*	1	26
	Gambusia sp.	3	
	Poecilia latipinna	1	21
	Palaemonetes sp.	2	
9	*Etheostoma fonticola*	1	32
	Gambusia sp.	2	
10	*Poecilia latipinna*	1	20
	Gambusia sp.	2	
	Procambarus sp.	1	
11	*Palaemonetes* sp.	1	
	Etheostoma fonticola	2	26,26
	Gambusia sp.	4	
	Procambarus sp.	1	
12	*Etheostoma fonticola*	1	24
	Procambarus sp.	1	
	Gambusia sp.	1	
13	*Gambusia* sp.	1	
14	*Procambarus* sp.	1	
	Palaemonetes sp.	1	
15	*Gambusia* sp.	1	
	***Melanoides-slight*		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		**Site:**	
Landa Lake		L1- Site 4	
Date:	**Time:**	**Observer(s):**	
10/26/2015	1450-1515	JW,JH,ME,TL	

Overall	**Species**	**Number**	**Avg. Length (mm)**
48	*Gambusia* sp.		
33	*Procambarus* sp.		
4	*Palaemonetes* sp.		
25	*Etheostoma fonticola*		
1	*Lepomis miniatus*		
1	*Lepomis sp.*		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Gambusia* sp.	15	19,20,10,16,36,22,14,17,19,15,33,14,11,12,12
	Procambarus sp.	4	
	Palaemonetes sp.	3	
	Etheostoma fonticola	2	22,28
	Lepomis sp.	1	11
2	*Palaemonetes* sp.	1	
	Procambarus sp.	2	
	Gambusia sp.	9	15,16,12,12,14,12,14,13,10
3	*Gambusia* sp.	7	14
	Procambarus sp.	3	
4	*Etheostoma fonticola*	4	20,23,24,25
	Procambarus sp.	2	
	Gambusia sp.	7	
5	*Etheostoma fonticola*	4	20,28,26,24
	Procambarus sp.	3	
6	*Etheostoma fonticola*	9	27,30,24,27,30,24,27,19,27
	Gambusia sp.	4	
	Procambarus sp.	2	
7	*Procambarus* sp.	6	
	Etheostoma fonticola	2	25,24
	Gambusia sp.	1	
8	*Procambarus* sp.	6	
	Etheostoma fonticola	1	23
	Gambusia sp.	2	
9	*Procambarus* sp.	1	
10	*Procambarus* sp.	1	
11	*Etheostoma fonticola*	1	20
	Procambarus sp.	1	
12	*Procambarus* sp.	1	
	Gambusia sp.	2	
	Lepomis miniatus	1	56
13	*Etheostoma fonticola*	2	29,35
	Gambusia sp.	1	
14	*Procambarus* sp.	1	
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach): Landa Lake		**Site:** O1 - Site 5	
Date: 10/26/2015	**Time:** 1516-1530	**Observer(s):** JW,JH,ME,TL	
Overall	**Species**	**Number**	**Avg. Length (mm)**
3 5	*Etheostoma fonticola* *Gambusia* sp.		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	1	26
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	*Gambusia* sp.	1	23
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	*Gambusia* sp.	1	15
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	*Gambusia* sp.	2	29,18
15	*Etheostoma fonticola*	1	22
16	*Etheostoma fonticola*	1	25
17	*Gambusia* sp.	1	25
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		Site:	
Landa Lake		V2 -Site 6	
Date:	**Time:**	**Observer(s):**	
10/27/2015	918-943	JW,JH,ME,TL	
Overall	**Species**	**Number**	**Avg. Length (mm)**
39	*Procambarus* sp.		
6	*Lepomis miniatus*		
56	*Gambusia* sp.		
13	*Palaemonetes* sp.		
5	*Etheostoma fonticola*		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	6	
	Lepomis miniatus	1	127
	Gambusia sp.	12	18,20,35,25,19,34,10,10,11,16,12,17
	Palaemonetes sp.	5	
	Etheostoma fonticola	1	29
2	*Etheostoma fonticola*	1	33
	Procambarus sp.	3	
	Palaemonetes sp.	3	
	Gambusia sp.	4	15,21,20,18
3	*Procambarus* sp.	6	
	Gambusia sp.	12	19,21,19,18,19,23,11,25,20
	Palaemonetes sp.	1	
4	*Procambarus* sp.	1	
	Gambusia sp.	1	
5	*Gambusia* sp.	4	
	Procambarus sp.	3	
	Palaemonetes sp.	2	
6	*Etheostoma fonticola*	2	34,31
	Procambarus sp.	2	
	Gambusia sp.	4	
	Palaemonetes sp.	1	
7	*Procambarus* sp.	5	
	Gambusia sp.	8	
8	*Lepomis miniatus*	1	90
	Procambarus sp.	4	
	Etheostoma fonticola	1	
	Gambusia sp.	4	
9	*Lepomis miniatus*	1	35
	Procambarus sp.	2	
	Gambusia sp.	2	
	Palaemonetes sp.	1	
10	*Lepomis miniatus*	2	90,105
	Procambarus sp.	2	
11	*Gambusia* sp.	2	
	Procambarus sp.	1	
12	*Procambarus* sp.	1	
	Gambusia sp.	1	
13	*Procambarus* sp.	3	
	Gambusia sp.	2	
14	*Lepomis miniatus*	1	41
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		Site:	
Landa Lake		H1 - Site 7	
Date:	**Time:**	**Observer(s):**	
10/27/2015	947-1009	JW,JH,ME,TL	

Overall	Species	Number	Avg. Length (mm)
61	*Procambarus* sp.		
5	*Etheostoma fonticola*		
78	*Gambusia* sp.		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	45	10,13,14,12,12,30,35,32,26,17,12,15,22, 20,10,12,22,20,10,12,15,10,10,16,18
	Procambarus sp.	1	
2	*Etheostoma fonticola*	2	25,30
	Procambarus sp.	2	
	Gambusia sp.	2	
3	*Procambarus* sp.	5	
	Gambusia sp.	17	
4	*Procambarus* sp.	9	
	Etheostoma fonticola	1	25
	Gambusia sp.	8	
5	*Gambusia* sp.	1	
	Procambarus sp.	4	
6	*Procambarus* sp.	5	
	Etheostoma fonticola	1	24
7	*Procambarus* sp.	5	
8	*Procambarus* sp.	5	
	Gambusia sp.	2	
9	*Procambarus* sp.	6	
10	*Procambarus* sp.	2	
	Gambusia sp.	1	
11	*Procambarus* sp.	3	
	Etheostoma fonticola	1	28
	Gambusia sp.	2	
12	*Procambarus* sp.	6	
13	*Procambarus* sp.	1	
14	*Procambarus* sp.	6	
15	*Procambarus* sp.	1	
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		**Site:**		
Landa Lake		V1- Site 8		
Date:	**Time:**	**Observer(s):**		
10/27/2015	1011-1033	JW,JH,ME,TL		

Overall	**Species**	**Number**	**Avg. Length (mm)**
1	*Herichthys cyanoguttatus*		
36	*Procambarus* sp.		
39	*Palaemonetes* sp.		
73	*Gambusia* sp.		
1	*Lepomis miniatus*		
1	*Ameiurus natalis*		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Lepomis miniatus*	1	86
	Gambusia sp.	29	27,17,21,19,20,17,24,13,30,18,17,21,15,17,13,13,20,22, 10,11,19,21,14,12,10
	Procambarus sp.	8	
	Palaemonetes sp.	8	
2	*Procambarus* sp.	3	
	Palaemonetes sp.	19	
	Gambusia sp.	16	
3	*Herichthys cyanoguttatus*	1	52
	Procambarus sp.	4	
	Palaemonetes sp.	7	
	Gambusia sp.	5	
4	*Gambusia* sp.	2	
	Procambarus sp.	3	
	Palaemonetes sp.	1	
5	*Procambarus* sp.	2	
	Gambusia sp.	7	
	Palaemonetes sp.	2	
6	*Ameiurus natalis*	1	110
7	*Procambarus* sp.	1	
8	*Procambarus* sp.	2	
	Gambusia sp.	2	
9	*Procambarus* sp.	2	
10	*Gambusia* sp.	4	
	Procambarus sp.	1	
11	*Procambarus* sp.	2	
	Palaemonetes sp.	1	
	Gambusia sp.	1	
12	*Procambarus* sp.	2	
	Gambusia sp.	2	
13	*Procambarus* sp.	3	
	Gambusia sp.	2	
	Palaemonetes sp.	1	
14	*Procambarus* sp.	2	
15	*Procambarus* sp.	1	
	Gambusia sp.	3	
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		Site:	
Landa Lake		H2 - Site 9	
Date:	**Time:**	**Observer(s):**	
10/27/2015	1035-1100	JW,JH,ME,TL	

Overall	Species	Number	Avg. Length (mm)
18	*Etheostoma fonticola*		
2	*Lepomis miniatus*		
2	*Palaemonetes* sp.		
3	*Herichthys cyanoguttatus*		
26	*Procambarus* sp.		
142	*Gambusia* sp.		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Herichthys cyanoguttatus*	2	44,30
	Procambarus sp.	5	
	Gambusia sp.	60	13,38,15,26,15,15,13,20,19,17,19,14,15, 15,20,12,10,20,23,16,11,8,20,22,20
	Etheostoma fonticola	3	30,30,21
2	*Etheostoma fonticola*	4	30,25,26,25
	Lepomis miniatus	1	
	Gambusia sp.	15	
3	*Etheostoma fonticola*	3	30,25,20
	Procambarus sp.	1	
	Palaemonetes sp.	2	
	Gambusia sp.	44	
4	*Lepomis miniatus*	1	74
	Etheostoma fonticola	2	27,30
	Gambusia sp.	4	
5	*Etheostoma fonticola*	2	25
	Procambarus sp.	4	
	Gambusia sp.	8	
6	*Etheostoma fonticola*	2	25,25
	Procambarus sp.	1	
7	*Procambarus* sp.	4	
	Gambusia sp.	6	
8	*Procambarus* sp.	1	
	Gambusia sp.	2	
9	*Herichthys cyanoguttatus*	1	33
	Procambarus sp.	1	
10	*Procambarus* sp.	4	
11	*Procambarus* sp.	3	
	Etheostoma fonticola	1	29
	Gambusia sp.	2	
12	*Etheostoma fonticola*	1	24
	Procambarus sp.	1	
	Gambusia sp.	1	
13	*Procambarus* sp.	1	
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		Site:		
Landa Lake		R1 - Site 10		
Date:	**Time:**	**Observer(s):**		
10/27/2015	1104-1146	JW,JH,ME,TL		
Overall	**Species**		**Number**	**Avg. Length (mm)**
58	*Etheostoma fonticola*			
99	*Procambarus* sp.			
20	*Gambusia* sp.			
5	*Palaemonetes* sp.			

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	21	
	Etheostoma fonticola	11	31,23,29,23,22,26,28,22,28,25,25
	Gambusia sp.	3	12,14,16
	Palaemonetes sp.	1	
2	*Etheostoma fonticola*	8	33,27,26,20,25,17,30,26
	Procambarus sp.	28	
	Gambusia sp.	1	11
3	*Procambarus* sp.	21	
	Etheostoma fonticola	4	28,24,14,25
4	*Etheostoma fonticola*	10	32,29,22,26,20,27,21,26,20,26
	Procambarus sp.	9	
	Gambusia sp.	1	26
5	*Etheostoma fonticola*	1	23
	Procambarus sp.	2	
6	*Procambarus* sp.	7	
	Etheostoma fonticola	7	30,24,30,25,33,32,17
	Gambusia sp.	3	18,18,20
	Palaemonetes sp.	1	
7	*Etheostoma fonticola*	3	20,20,30
	Gambusia sp.	3	14,12,16
	Palaemonetes sp.	1	
8	*Etheostoma fonticola*	1	20
	Procambarus sp.	1	
	Palaemonetes sp.	1	
9	*Etheostoma fonticola*	2	30,22
	Procambarus sp.	1	
10	*Etheostoma fonticola*	2	27,12
	Procambarus sp.	4	
	Gambusia sp.	1	10
11	*Etheostoma fonticola*	3	32,16,25
	Gambusia sp.	3	
	Procambarus sp.	1	
12	*Etheostoma fonticola*	3	32,25,12
	Palaemonetes sp.	1	
	Procambarus sp.	4	
13	*Etheostoma fonticola*	1	28
	Gambusia sp.	2	27,25
14	*Etheostoma fonticola*	2	20,28
	Gambusia sp.	1	10
15	*Gambusia* sp.	2	22,21
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		Site:		
Landa Lake		O2 - Site 11		
Date:	**Time:**	**Observer(s):**		
10/27/2015	1148-1156	JW,JH,ME,TL		
Overall	**Species**		**Number**	**Avg. Length (mm)**
6	*Gambusia* sp.			
COMAL RIVER -FALL 2015 SAMPLING				
Dip net sweep	**Species**		**Number**	**Length (mm)**
1	No fish or crustaceans collected			
2	*Gambusia* sp.		2	15,19
3	*Gambusia* sp.		1	15
4	*Gambusia* sp.		1	24
5	*Gambusia* sp.		1	28
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	19
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 -FALL 2015 SAMPLING

Location (Reach): Landa Lake		**Site:** R2- Site 12	
Date: 10/27/2015	**Time:** 1159-1228	**Observer(s):** JW,JH,ME,TL	

Overall	Species	Number	Avg. Length (mm)
73	*Etheostoma fonticola*		
1	*Palaemonetes* sp.		
17	*Gambusia* sp.		
18	*Procambarus* sp.		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	20	30,17,38,24,30,28,32,27,27,24,17,17,35,30,22,21,25,30,22,15
	Gambusia sp.	4	16,15,15,12
2	*Etheostoma fonticola*	11	17,18,27,24,28,28,23,18,22,2,16
	Gambusia sp.	1	16
3	*Procambarus* sp.	8	
	Etheostoma fonticola	11	25,28,28,25,28,25,20,21,24,12,12
	Gambusia sp.	1	16
	Palaemonetes sp.	1	
4	*Procambarus* sp.	1	
	Etheostoma fonticola	4	21,19,23,24
	Gambusia sp.	6	31,15,21,20,20,30
5	*Etheostoma fonticola*	12	32,31,22,25,22,28,32,27,27,25,26,27
	Procambarus sp.	3	
6	*Etheostoma fonticola*	3	22,27,22
	Procambarus sp.	1	
7	*Gambusia* sp.	1	23
	Etheostoma fonticola	6	29,25,27,30,28,18
8	*Etheostoma fonticola*	1	22
9	*Procambarus* sp.	1	
	Etheostoma fonticola	1	17
10	*Etheostoma fonticola*	1	30
11	*Etheostoma fonticola*	1	25
	Gambusia sp.	1	27
12	*Procambarus* sp.	3	
	Etheostoma fonticola	1	20
13	*Gambusia* sp.	2	17,12
	Etheostoma fonticola	1	25
14	*Gambusia* sp.	1	17
15	*Procambarus* sp.	1	
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		Site:		
New Channel		C2- Site 1		
Date:	**Time:**	**Observer(s):**		
5/1/2015	902-931	JH,JW,NP,TJ		

Overall	Species	Number	Avg. Length (mm)
5	*Lepomis megalotis*		
2	*Lepomis macrochirus*		
8	*Lepomis miniatus*		
1	*Lepomis sp.*		
22	*Etheostoma fonticola*		
8	*Gambusia sp.*		
51	*Procambarus* sp.		
16	*Palaemonetes* sp.		

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis megalotis*	3	65,30,30
	Lepomis macrochirus	1	44
	Lepomis miniatus	1	39
	Lepomis sp.	1	17
	Etheostoma fonticola	5	15,22,26,16,10
	Gambusia sp.	2	11,18
	Procambarus sp.	4	
	Palaemonetes sp.	8	
2	*Lepomis miniatus*	1	63
	Palaemonetes sp.	1	
3	*Lepomis miniatus*	3	62,26,32
	Etheostoma fonticola	2	20,30
	Gambusia sp.	4	21,20,20,17
	Procambarus sp.	1	
	Palaemonetes sp.	2	
4	*Gambusia sp.*	2	20,25
	Etheostoma fonticola	1	26
	Lepomis megalotis	1	50
	Lepomis miniatus	1	13
	Procambarus sp.	5	
5	*Etheostoma fonticola*	3	26,18,14
	Procambarus sp.	4	
6	*Etheostoma fonticola*	1	30
	Lepomis megalotis	1	25
	Procambarus sp.	6	
	Palaemonetes sp.	1	
7	*Etheostoma fonticola*	2	31,32
	Palaemonetes sp.	1	
8	*Procambarus* sp.	9	
	Palaemonetes sp.	2	
	Etheostoma fonticola	1	18
9	*Lepomis miniatus*	1	52
	Etheostoma fonticola	1	26
	Procambarus sp.	1	
10	*Etheostoma fonticola*	1	21
	Procambarus sp.	4	

COMAL RIVER -SPRING 2015 SAMPLING			
Dip net sweep	**Species**	**Number**	**Length (mm)**
11	*Etheostoma fonticola*	2	22,21
12	*Etheostoma fonticola*	1	30
	Procambarus sp.	7	
	Palaemonetes sp.	1	
13	*Lepomis miniatus*	1	52
	Procambarus sp.	2	
14	*Procambarus* sp.	4	
	Etheostoma fonticola	1	14
15	*Etheostoma fonticola*	1	29
16	*Lepomis macrochirus*	1	30
	Procambarus sp.	4	
	**Tarebia granifera -slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach): New Channel		**Site:** H2 -Site 2	
Date: 5/1/2015	**Time:** 937-1003	**Observer(s):** JH,JW,NP,TJ	
Overall	**Species**	**Number**	**Avg. Length (mm)**
2	*Lepomis miniatus*		
2	*Lepomis sp.*		
13	*Etheostoma fonticola*		
1	*Gambusia sp.*		
1	*Palaemonetes* sp.		
9	*Procambarus* sp.		

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	1	17
	Lepomis sp.	1	13
	Procambarus sp.	2	
2	*Lepomis miniatus*	1	28
	Procambarus sp.	1	
3	*Lepomis sp.*	1	30
	Etheostoma fonticola	1	15
4	No fish or crustaceans collected		
5	*Etheostoma fonticola*	1	21
6	*Procambarus* sp.	1	
	Etheostoma fonticola	2	28,13
7	*Procambarus* sp.	2	
8	*Gambusia sp.*	1	13
	Etheostoma fonticola	2	18,15
9	*Etheostoma fonticola*	1	13
10	*Procambarus* sp.	1	
11	*Etheostoma fonticola*	2	26,15
12	No fish or crustaceans collected		
13	*Lepomis miniatus*	1	112
	Etheostoma fonticola	1	19
14	No fish or crustaceans collected		
15	*Palaemonetes* sp.	1	
	Etheostoma fonticola	1	16
16	*Etheostoma fonticola*	1	10
	Procambarus sp.	1	
17	*Procambarus* sp.	1	
	**Tarebia granifera -slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		Site:	Site on map:
New Channel		H1- Site 3	H4
Date:	**Time:**	**Observer(s):**	
5/1/2015	1005-1028	JH,JW,NP,TJ	

Overall	Species	Number	Avg. Length (mm)
31	*Palaemonetes* sp.		
19	*Etheostoma fonticola*		
5	*Gambusia sp.*		
5	*Lepomis miniatus*		
3	*Lepomis sp.*		
1	*Lepomis cyanellus*		
7	*Procambarus* sp.		

COMAL RIVER -SPRING 2015 SAMPLING

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

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach): New Channel	**Site:** O1- Site 4	**Site on map:**	
Date: 5/1/2015	**Time:** 1036-1042	**Observer(s):** JH,JW,NP,TJ	
Overall	**Species**	**Number**	**Avg. Length (mm)**

COMAL RIVER -SPRING 2015 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 2015 SAMPLING

Location (Reach): New Channel	**Site:** O2- Site 5	**Site on map:**	
Date: 5/1/2015	**Time:** 1046-1048	**Observer(s):** JH,JW,NP,TJ	
Overall	**Species**	**Number**	**Avg. Length (mm)**

COMAL RIVER -SPRING 2015 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 2015 SAMPLING

Location (Reach):		Site:	Site on map:
New Channel		C1-Site 6	C3
Date:	Time:	Observer(s):	
5/1/2015	1100-1121	JH,JW,NP,TJ	

Overall	Species	Number	Avg. Length (mm)
8	*Lepomis cyanellus*		
20	*Etheostoma fonticola*		
1	*Lepomis miniatus*		
75	*Procambarus* sp.		
1	*Gambusia sp.*		
14	*Palaemonetes* sp.		

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis cyanellus*	3	52,50,35
	Etheostoma fonticola	8	22,25,21,28,24,24,20,16
	Lepomis miniatus	1	32
	Procambarus sp.	9	
	Gambusia sp.	1	12
	Palaemonetes sp.	9	
2	*Etheostoma fonticola*	7	18,23,20,19,28,30,28
	Lepomis cyanellus	2	35,30
	Procambarus sp.	5	
	Palaemonetes sp.	2	
3	*Lepomis cyanellus*	2	25,32
	Etheostoma fonticola	1	24
	Procambarus sp.	12	
4	*Etheostoma fonticola*	1	32
	Lepomis cyanellus	1	30
	Procambarus sp.	5	
5	No fish or crustaceans collected		
6	*Etheostoma fonticola*	2	24,27
	Procambarus sp.	13	
7	*Procambarus* sp.	4	
	Palaemonetes sp.	2	
8	*Procambarus* sp.	8	
	Palaemonetes sp.	1	
9	*Procambarus* sp.	6	
10	*Procambarus* sp.	2	
11	*Procambarus* sp.	7	
12	*Etheostoma fonticola*	1	26
	Procambarus sp.	1	
13	*Procambarus* sp.	1	
14	*Procambarus* sp.	2	
15	No fish or crustaceans collected		
	**Tarebia granifera -slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 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 2015 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 2015 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 2015 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 2015 SAMPLING

Location (Reach):		Site:	Site on map:
New Channel		C2- Site 1	C4
Date:	**Time:**	**Observer(s):**	
10/28/2015	902-942	JH,JW,NP,ME	

Overall	Species	Number	Avg. Length (mm)
1	*Lepomis gulosus*		
14	*Lepomis miniatus*		
2	*Lepomis macrochirus*		
27	*Palaemonetes* sp.		
47	*Procambarus* sp.		
13	*Etheostoma fonticola*		
2	*Lepomis sp.*		
1	*Gambusia sp.*		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis gulosus*	1	64
	Lepomis miniatus	4	35,35,46,31
	Palaemonetes sp.	4	
	Procambarus sp.	9	
	Etheostoma fonticola	2	26,17
	Lepomis sp.	1	12
2	*Lepomis miniatus*	1	55
	Procambarus sp.	7	
	Palaemonetes sp.	6	
	Gambusia sp.	1	10
3	*Lepomis miniatus*	1	32
	Procambarus sp.	3	
	Palaemonetes sp.	1	
4	*Lepomis miniatus*	1	47
	Procambarus sp.	8	
	Lepomis sp.	1	11
	Etheostoma fonticola	3	33,23,20
	Palaemonetes sp.	5	
5	*Etheostoma fonticola*	1	35
	Procambarus sp.	2	
	Palaemonetes sp.	3	
6	*Etheostoma fonticola*	1	22
	Procambarus sp.	3	
7	*Procambarus* sp.	1	
8	*Lepomis miniatus*	2	28,42
	Lepomis macrochirus	1	30
	Etheostoma fonticola	1	10
	Procambarus sp.	3	
9	*Lepomis macrochirus*	1	27
10	*Lepomis miniatus*	1	58
	Etheostoma fonticola	2	30,28
	Procambarus sp.	5	
	Palaemonetes sp.	3	
11	*Procambarus* sp.	1	
	Etheostoma fonticola	2	30,17
	Lepomis miniatus	1	35

COMAL RIVER -FALL 2015 SAMPLING			
Dip net sweep	**Species**	**Number**	**Length (mm)**
12	*Lepomis miniatus*	1	78
	Etheostoma fonticola	1	26
	Procambarus sp.	1	
	Palaemonetes sp.	3	
13	*Lepomis miniatus*	1	40
	Procambarus sp.	1	
	Palaemonetes sp.	1	
14	*Lepomis miniatus*	1	47
	Procambarus sp.	2	
	Palaemonetes sp.	1	
15	*Procambarus* sp.	1	
	**Tarebia granifera -slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		Site:		Site on map:
New Channel		C1-Site 2		
Date:	Time:	Observer(s):		
10/28/2015	948-1030	JH,JW,NP,ME		

Overall	Species	Number	Avg. Length (mm)
8	*Lepomis cyanellus*		
12	*Lepomis miniatus*		
1	*Lepomis macrochirus*		
25	*Etheostoma fonticola*		
8	*Lepomis sp.*		
7	*Gambusia sp.*		
57	*Procambarus* sp.		
64	*Palaemonetes* sp.		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	6	40,42,36,30,39,38,
	Lepomis macrochirus	1	82
	Etheostoma fonticola	6	32,25,28,26,9,13
	Lepomis sp.	2	11,11
	Gambusia sp.	2	13,11
	Procambarus sp.	6	
	Palaemonetes sp.	20	
2	*Etheostoma fonticola*	4	32,23,33,10
	Gambusia sp.	4	23
	Lepomis cyanellus	2	40,50
	Lepomis sp.	3	13,10,8
	Palaemonetes sp.	18	
3	*Lepomis miniatus*	3	47,44,43
	Etheostoma fonticola	4	32,27,19,24
	Lepomis sp.	1	12
	Palaemonetes sp.	10	
	Procambarus sp.	4	
	Gambusia sp.	1	11
4	*Procambarus* sp.	11	
	Lepomis cyanellus	3	40,40,45
	Etheostoma fonticola	1	32
5	*Procambarus* sp.	8	
	Palaemonetes sp.	3	
6	*Procambarus* sp.	8	
	Etheostoma fonticola	2	26,15
	Lepomis sp.	1	11
	Palaemonetes sp.	3	
7	*Etheostoma fonticola*	1	21
	Palaemonetes sp.	1	
	Procambarus sp.	2	
8	*Etheostoma fonticola*	5	33,27,12,17,14
	Procambarus sp.	5	
	Lepomis cyanellus	1	42
	Lepomis miniatus	1	60
	Lepomis sp.	1	9
9	*Etheostoma fonticola*	1	33
	Procambarus sp.	3	

COMAL RIVER -FALL 2015 SAMPLING			
Dip net sweep	**Species**	**Number**	**Length (mm)**
10	*Lepomis cyanellus*	1	44
	Lepomis miniatus	1	62
	Procambarus sp.	2	
	Palaemonetes sp.	2	
11	*Procambarus* sp.	2	
	Palaemonetes sp.	2	
	Etheostoma fonticola	1	14
12	*Palaemonetes* sp.	1	
13	*Palaemonetes* sp.	2	
	Procambarus sp.	3	
14	*Lepomis miniatus*	1	41
	Palaemonetes sp.	1	
	Procambarus sp.	1	
15	*Lepomis cyanellus*	1	42
	Procambarus sp.	2	
	Palaemonetes sp.	1	
	**Tarebia granifera -slight*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -FALL 2015 SAMPLING

Location (Reach): New Channel		**Site:** H2 -Site 3	
Date: 10/28/2015	**Time:** 1034-1056	**Observer(s):** JH,JW,NP,ME	
Overall	**Species**	**Number**	**Avg. Length (mm)**
4	*Lepomis miniatus*		
2	*Lepomis sp.*		
5	*Etheostoma fonticola*		
3	*Gambusia sp.*		
7	*Palaemonetes* sp.		
3	*Procambarus* sp.		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	1	64
	Etheostoma fonticola	1	32
	Gambusia sp.	2	22,27
	Palaemonetes sp.	2	
2	*Palaemonetes* sp.	1	
	Etheostoma fonticola	2	12,12
3	No fish or crustaceans collected		
4	*Lepomis miniatus*	1	52
5	*Gambusia sp.*	1	20
	Etheostoma fonticola	1	20
	Lepomis sp.	2	12,15
	Palaemonetes sp.	2	
6	*Palaemonetes* sp.	1	
	Etheostoma fonticola	1	14
7	*Lepomis miniatus*	1	33
	Procambarus sp.	1	
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	*Procambarus* sp.	1	
	Palaemonetes sp.	1	
11	*Procambarus* sp.	1	
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	*Lepomis miniatus*	1	70
15	No fish or crustaceans collected		
	**Tarebia granifera -slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		Site:	Site on map:
New Channel		H1- Site 4	
Date:	**Time:**	**Observer(s):**	
10/28/2015	1102-1121	JH,JW,NP,ME	

Overall	Species	Number	Avg. Length (mm)
17	*Palaemonetes* sp.		
5	*Gambusia sp.*		
2	*Lepomis miniatus*		
5	*Lepomis cyanellus*		
13	*Procambarus* sp.		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	2	78,80
	Gambusia sp.	1	17
	Procambarus sp.	1	
	Palaemonetes sp.	9	
2	*Procambarus* sp.	1	
	Gambusia sp.	1	15
3	*Lepomis cyanellus*	2	48,42
	Gambusia sp.	1	19
	Procambarus sp.	1	
4	*Lepomis cyanellus*	1	125
	Palaemonetes sp.	1	
	Procambarus sp.	1	
	Gambusia sp.	1	30
5	*Palaemonetes* sp.	1	
6	*Palaemonetes* sp.	2	
7	*Gambusia sp.*	1	20
	Palaemonetes sp.	2	
8	*Lepomis cyanellus*	1	81
9	*Palaemonetes* sp.	2	
10	*Procambarus* sp.	1	
11	*Procambarus* sp.	3	
12	No fish or crustaceans collected		
13	*Procambarus* sp.	1	
14	*Procambarus* sp.	3	
	Lepomis cyanellus	1	36
15	*Procambarus* sp.	1	
	**Tarebia granifera -slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach): New Channel		**Site:** O1- Site 5	**Site on map:**
Date:	**Time:**	**Observer(s):**	

Overall	**Species**	**Number**	**Avg. Length (mm)**
	Site not sampled - too deep		

COMAL RIVER -FALL 2015 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 2015 SAMPLING

Location (Reach): New Channel		Site: O2- Site 6	Site on map:
Date:	Time:	Observer(s):	

Overall	Species	Number	Avg. Length (mm)
	Site not sampled - too deep		

COMAL RIVER -FALL 2015 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 2015 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 -FALL 2015 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 2015 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 -FALL 2015 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 2015 SAMPLING

Location (Reach): Old Channel		**Site:** O2-Site 1	**Site on map:**
Date: 4/29/2015	**Time:** 1227-1244	**Observer(s):** NP,JH, TJ,JW	

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

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	**Species**	**Number**	Length (mm)
1	*Gambusia sp.*	12	31,34,36,30,25,27,26,21,36,20,22,23
	Etheostoma fonticola	4	12,13,13,14
2	*Gambusia sp.*	5	31,32,25,32,20
	Etheostoma fonticola	1	25
	Procambarus sp.	1	
3	*Gambusia sp.*	2	33,34
4	*Etheostoma fonticola*	1	25
	Gambusia sp.	1	20
5	*Etheostoma fonticola*	1	16
6	*Etheostoma fonticola*	1	19
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	*Etheostoma fonticola*	1	26
13	*Gambusia sp.*	1	18
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		
	*** Tarebia granifera - slight*		
	***Melanoides-slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		Site:		
Old Channel		R1- Site 2		
Date:	**Time:**	**Observer(s):**		
4/29/2015	1247-1322	NP,JH, TJ,JW		
Overall	**Species**		**Number**	**Avg. Length (mm)**
50	*Etheostoma fonticola*			
4	*Gambusia sp.*			
29	*Procambarus* sp.			

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	10	30,25,26,25,19,16,11,16,15,11
	Procambarus sp.	4	
2	*Procambarus* sp.	7	
	Etheostoma fonticola	2	13,10
3	*Etheostoma fonticola*	7	30,30,28,26,25,25,12
	Procambarus sp.	4	
4	*Etheostoma fonticola*	6	27,11,25,23,30,15
5	*Etheostoma fonticola*	10	26,32,25,32,31,30,27,24,28,32
	Gambusia sp.	2	15,10
	Procambarus sp.	4	
6	*Etheostoma fonticola*	3	22,31,16
	Procambarus sp.	7	
7	*Etheostoma fonticola*	2	28,26
8	*Procambarus* sp.	2	
9	No fish or crustaceans collected		
10	*Etheostoma fonticola*	3	29,32,14
11	*Gambusia sp.*	1	15
	Etheostoma fonticola	1	15
12	*Etheostoma fonticola*	3	30,29,18
	Gambusia sp.	1	18
13	*Etheostoma fonticola*	2	31,25
14	*Etheostoma fonticola*	1	36
	Procambarus sp.	1	
15	No fish or crustaceans collected		
	*** Tarebia granifera - moderate*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		Site:	Site on map:
Old Channel		H1-Site 3	H3
Date:	**Time:**	**Observer(s):**	
4/29/2015	1328-1351	NP,JH, TJ,JW	

Overall	Species	Number	Avg. Length (mm)
1	*Herichthys cyanoguttatus*		
14	*Etheostoma fonticola*		
17	*Gambusia sp.*		
1	*Procambarus* sp.		
3	*Palaemonetes* sp.		
1	*Lepomis sp.*		
2	*Plecostomus sp.*		

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Herichthys cyanoguttatus*	1	70
	Etheostoma fonticola	3	29,20,15
	Gambusia sp.	4	32,27,24,10
	Palaemonetes sp.	1	
2	*Gambusia sp.*	3	25,26,21
	Plecostomus sp.	1	20
	Etheostoma fonticola	1	15
	Palaemonetes sp.	1	
3	*Gambusia sp.*	1	20
	Etheostoma fonticola	1	15
4	*Etheostoma fonticola*	3	29,28,25
	Gambusia sp.	3	24,22,26
	Lepomis sp.	1	14
5	*Plecostomus sp.*	1	19
	Palaemonetes sp.	1	
	Etheostoma fonticola	1	17
6	*Procambarus* sp.	1	
	Gambusia sp.	1	19
7	*Etheostoma fonticola*	1	20
	Gambusia sp.	2	12,13
8	*Gambusia sp.*	2	21,23
9	*Etheostoma fonticola*	1	30
10	*Etheostoma fonticola*	1	30
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	*Etheostoma fonticola*	1	21
14	No fish or crustaceans collected		
15	*Etheostoma fonticola*	1	29
	Gambusia sp.	1	12
16	No fish or crustaceans collected		
	*** Tarebia granifera - moderate*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach): Old Channel		**Site:** O1-Site 4	
Date: 4/29/2015	**Time:** 1354-1400	**Observer(s):** NP,JH, TJ,JW	
Overall	**Species**	**Number**	**Avg. Length (mm)**
5	*Gambusia sp.*		
COMAL RIVER -SPRING 2015 SAMPLING			
Dip net sweep	**Species**	**Number**	**Length (mm)**
1	No fish or crustaceans collected		
2	No fish or crustaceans collected		
3	No fish or crustaceans collected		
4	*Gambusia sp.*	2	33,32
5	No fish or crustaceans collected		
6	*Gambusia sp.*	2	31,30
7	No fish or crustaceans collected		
8	*Gambusia sp.*	1	25
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 2015 SAMPLING

Location (Reach):		Site:	
Old Channel		H2- Site 5	
Date:	**Time:**	**Observer(s):**	
4/29/2015	1402-1420	NP,JH, TJ,JW	

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

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia sp.*	4	20,30,20,25
	Etheostoma fonticola	1	22
	Palaemonetes sp.	7	
2	*Etheostoma fonticola*	1	26
	Procambarus sp.	1	
	Plecostomus sp.	1	19
3	*Etheostoma fonticola*	1	30
	Lepomis miniatus	1	55
4	*Etheostoma fonticola*	1	30
	Gambusia sp.	1	21
	Palaemonetes sp.	1	
	Plecostomus sp.	1	15
5	*Palaemonetes* sp.	2	
	Gambusia sp.	1	22
6	*Palaemonetes* sp.	2	
	Procambarus sp.	1	
7	*Etheostoma fonticola*	1	26
	Procambarus sp.	1	
8	*Procambarus* sp.	2	
9	*Gambusia sp.*	1	20
10	No fish or crustaceans collected		
11	*Etheostoma fonticola*	2	36,30
	Procambarus sp.	1	
12	No fish or crustaceans collected		
13	*Procambarus* sp.	1	
14	*Palaemonetes* sp.	1	
15	No fish or crustaceans collected		
	*** Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		Site:	Site on map:
Old Channel		R2 - Site 6	R3
Date:	**Time:**	**Observer(s):**	
4/29/2015	1438-1524	NP,JH, TJ,JW	

Overall	Species	Number	Avg. Length (mm)
150	*Etheostoma fonticola*		
28	*Gambusia sp.*		
2	*Palaemonetes* sp.		
170	*Procambarus* sp.		

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	46	14,36,30,28,25,14,16,20,16,15,20,26,18,30,13,12,30, 13,14,15,29,24,20,23,15,21,20,13,13,17,32,30,19,20, 20,17,16,14,14,15,15,16,15,15,19,13
	Gambusia sp.	10	13,18,18,12,16,15,15,15,15,10
	Palaemonetes sp.	1	
	Procambarus sp.	10	
2	*Gambusia sp.*	7	15,20,20,15,18,10,10
	Etheostoma fonticola	31	20,31,20,11,14,21,19,20,32,30,17,20,16,15,29,13,21, 15,15,17,16,13,17,19,22,15,11,15,14,11,12
	Procambarus sp.	38	
3	*Etheostoma fonticola*	19	30,16,19,15,15,25,19,13,19,26,16,27,14,16,14,21, 19,15,10
	Gambusia sp.	3	13,11,12
	Procambarus sp.	30	
	Palaemonetes sp.	1	
4	*Etheostoma fonticola*	8	23,33,17,10,16,13,18,11
	Gambusia sp.	1	13
	Procambarus sp.	19	
5	*Gambusia sp.*	4	12,15,15,10
	Etheostoma fonticola	12	13,20,16,30,23,22,17,16,30,17,24,11
	Procambarus sp.	19	
6	*Etheostoma fonticola*	10	14,12,11,16,30,32,20,15,13,21
	Procambarus sp.	6	
7	*Etheostoma fonticola*	3	12,15,26
	Procambarus sp.	7	
8	*Etheostoma fonticola*	10	16,19,22,16,34,15,15,26,18,19
	Procambarus sp.	4	
	Gambusia sp.	1	
9	*Procambarus* sp.	12	
	Etheostoma fonticola	4	14,15,15,15
10	*Etheostoma fonticola*	2	22,15
	Procambarus sp.	11	
11	*Etheostoma fonticola*	2	14,15
12	*Procambarus* sp.	10	
	Gambusia sp.	1	
13	*Etheostoma fonticola*	3	26,17,14
	Gambusia sp.	1	
	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 2015 SAMPLING

Location (Reach):		**Site:**		
Old Channel		L1- Site 7		
Date:	**Time:**	**Observer(s):**		
4/29/2015	1527-1556	NP,JH, TJ,JW		
Overall	**Species**		**Number**	**Avg. Length (mm)**
47	*Gambusia sp.*			
27	*Procambarus* sp.			
1	*Lepomis sp.*			
5	*Lepomis miniatus*			
37	*Etheostoma fonticola*			
6	*Palaemonetes* sp.			

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia sp.*	15	12,20,20,32,22,22,20,15,19,2320,19,15,17,15
	Etheostoma fonticola	3	13,23,15
	Palaemonetes sp.	1	
	Procambarus sp.	1	
2	*Gambusia sp.*	7	21,20,25,19,15,18,19
	Etheostoma fonticola	4	20,19,15,13
	Lepomis miniatus	1	24
	Palaemonetes sp.	1	
3	*Etheostoma fonticola*	5	20,20,28,19,15
	Gambusia sp.	6	20,23,18,22
	Procambarus sp.	3	
	Palaemonetes sp.	1	
4	*Lepomis miniatus*	1	62
	Etheostoma fonticola	3	12,20,15
	Gambusia sp.	5	
	Palaemonetes sp.	1	
	Procambarus sp.	2	
5	*Etheostoma fonticola*	2	10,16
	Gambusia sp.	3	
6	*Lepomis miniatus*	2	82,50
	Etheostoma fonticola	4	20,10,27,10
	Procambarus sp.	2	
	Palaemonetes sp.	2	
	Gambusia sp.	4	
7	*Lepomis miniatus*	1	84
	Etheostoma fonticola	3	15,16,21
	Procambarus sp.	6	
8	*Etheostoma fonticola*	1	15
9	*Etheostoma fonticola*	8	18,15,17,20,18,21,20,9
	Lepomis sp.	1	12
	Procambarus sp.	7	
	Gambusia sp.	3	
10	*Procambarus* sp.	5	
	Gambusia sp.	1	
	Etheostoma fonticola	1	18
11	*Etheostoma fonticola*	2	17,35
12	*Gambusia sp.*	2	
13	*Etheostoma fonticola*	1	34
	Procambarus sp.	1	
14	*Gambusia sp.*	1	
15	No fish or crustaceans collected		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -SPRING 2015 SAMPLING

Location (Reach):		Site:	
Old Channel		L2-Site 8	
Date:	**Time:**	**Observer(s):**	
4/29/2015	1600-1623	NP,JH, TJ,JW	

Overall	Species	Number	Avg. Length (mm)
86	*Gambusia sp.*		
19	*Etheostoma fonticola*		
9	*Palaemonetes* sp.		
26	*Procambarus* sp.		
1	*Lepomis auritus*		

COMAL RIVER -SPRING 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia sp.*	25	15,19,18,11,13,18,20,15,24,20,15,21,21, 20,19,30,10,20,15,18,20,12,22,22,20
	Etheostoma fonticola	2	17,15
	Procambarus sp.	5	
	Palaemonetes sp.	4	
2	*Etheostoma fonticola*	1	17
	Gambusia sp.	17	
	Palaemonetes sp.	5	
3	*Etheostoma fonticola*	1	35
	Gambusia sp.	1	
	Procambarus sp.	1	
4	*Etheostoma fonticola*	1	18
	Gambusia sp.	6	
	Procambarus sp.	3	
5	*Etheostoma fonticola*	5	18,26,23,22,15
	Procambarus sp.	2	
	Gambusia sp.	32	
6	*Etheostoma fonticola*	3	11,20,20
7	*Etheostoma fonticola*	2	33,19
	Procambarus sp.	2	
8	*Gambusia sp.*	3	
	Etheostoma fonticola	1	18
9	*Lepomis auritus*	1	86
	Etheostoma fonticola	1	17
	Procambarus sp.	3	
10	*Gambusia sp.*	1	
11	*Etheostoma fonticola*	1	26
	Procambarus sp.	2	
12	*Procambarus* sp.	4	
13	*Procambarus* sp.	2	
	Gambusia sp.	1	
14	*Etheostoma fonticola*	1	23
	Procambarus sp.	2	
15	No fish or crustaceans collected		
	*** Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		**Site:**	
Old Channel		R1- Site 1	
Date: 10/27/2015	**Time:** 1320-1353	**Observer(s):** ME,JH, TL,JW	
Overall	**Species**	**Number**	**Avg. Length (mm)**
21	*Etheostoma fonticola*		
2	*Gambusia sp.*		
1	*Lepomis miniatus*		
4	*Palaemonetes* sp.		
21	*Procambarus* sp.		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Etheostoma fonticola*	3	27,27,25
	Gambusia sp.	1	16
	Palaemonetes sp.	3	
2	*Gambusia sp.*	1	26
	Etheostoma fonticola	3	20,29,23
	Procambarus sp.	2	
3	*Procambarus* sp.	5	
	Etheostoma fonticola	1	28
4	*Etheostoma fonticola*	5	35,26,23,22,27
	Procambarus sp.	2	
	Palaemonetes sp.	1	
5	*Etheostoma fonticola*	3	32,24,32
	Procambarus sp.	2	
6	*Procambarus* sp.	4	
7	*Etheostoma fonticola*	1	24
	Procambarus sp.	2	
8	*Procambarus* sp.	1	
9	*Procambarus* sp.	2	
	Lepomis miniatus	1	53
	Etheostoma fonticola	1	20
10	*Etheostoma fonticola*	1	23
	Procambarus sp.	1	
11	*Etheostoma fonticola*	2	26,22
12	*Etheostoma fonticola*	1	30
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 2015 SAMPLING

Location (Reach):		Site:	Site on map:
Old Channel		H1-Site 2	H3
Date:	Time:	Observer(s):	
10/27/2015	1400-1434	ME,JH, TL,JW	

Overall	Species	Number	Avg. Length (mm)
79	*Procambarus* sp.		
4	*Astyanax mexicanus*		
34	*Gambusia sp.*		
1	*Hypostomus plecostomus*		
34	*Etheostoma fonticola*		
1	*Poecilia latipinna*		
11	*Palaemonetes* sp.		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	11	
	Astyanax mexicanus	1	56
	Gambusia sp.	15	22,20,29,12,15,27,28,17,21,12,14,24,20,14
	Hypostomus plecostomus	1	59
	Etheostoma fonticola	9	21,25,26,24,22,25,20
	Poecilia latipinna	1	27
	Palaemonetes sp.	5	
2	*Astyanax mexicanus*	2	55,40
	Gambusia sp.	7	18,21,31,28,25,17,15
	Etheostoma fonticola	8	31,26,27,31,24,32,27,24
	Procambarus sp.	15	
	Palaemonetes sp.	2	
3	*Gambusia sp.*	1	21
	Astyanax mexicanus	1	73
	Etheostoma fonticola	10	25,32,27,22,22,27,22,22,22,21
	Procambarus sp.	11	
4	*Palaemonetes* sp.	1	
	Procambarus sp.	8	
	Etheostoma fonticola	1	33
	Gambusia sp.	1	30
5	*Gambusia sp.*	2	24
	Etheostoma fonticola	2	21,20
6	*Procambarus* sp.	3	
	Palaemonetes sp.	1	
	Gambusia sp.	1	
	Etheostoma fonticola	1	21
7	*Etheostoma fonticola*	2	22,22
	Palaemonetes sp.	1	
	Procambarus sp.	12	
	Gambusia sp.	3	
8	*Etheostoma fonticola*	1	31
	Procambarus sp.	6	
	Palaemonetes sp.	1	
	Gambusia sp.	2	
9	*Procambarus* sp.	5	
10	*Procambarus* sp.	4	
11	*Gambusia sp.*	1	
12	No fish or crustaceans collected		
13	*Procambarus* sp.	3	
	Gambusia sp.	1	
14	No fish or crustaceans collected		
15	*Procambarus* sp.	1	
	*** Tarebia granifera - moderate*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		Site:	
Old Channel		H2- Site 3	
Date:	**Time:**	**Observer(s):**	
10/27/2015	1435-1500	ME,JH, TL,JW	

Overall	Species	Number	Avg. Length (mm)
15	*Gambusia sp.*		
12	*Etheostoma fonticola*		
7	*Palaemonetes* sp.		
20	*Procambarus* sp.		
1	*Notropis volucellus*		
1	*Lepomis miniatus*		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia sp.*	1	26
	Procambarus sp.	3	
	Etheostoma fonticola	2	23,27
	Palaemonetes sp.	2	
2	*Procambarus* sp.	1	
	Palaemonetes sp.	1	
3	*Palaemonetes* sp.	1	
	Etheostoma fonticola	4	20,30,25,26
	Notropis volucellus	1	37
	Procambarus sp.	3	
4	*Gambusia sp.*	8	20,18,15,18,12,12,13,11
	Etheostoma fonticola	1	23
	Palaemonetes sp.	1	
	Procambarus sp.	2	
5	*Procambarus* sp.	2	
	Etheostoma fonticola	1	29
	Palaemonetes sp.	1	
6	*Gambusia sp.*	4	14,20,18,13
	Etheostoma fonticola	2	23,24
	Procambarus sp.	2	
	Palaemonetes sp.	1	
7	*Procambarus* sp.	1	
8	*Etheostoma fonticola*	2	27,23
	Gambusia sp.	1	20
9	*Procambarus* sp.	1	
10	*Lepomis miniatus*	1	89
	Gambusia sp.	1	15
11	No fish or crustaceans collected		
12	*Procambarus* sp.	2	
13	No fish or crustaceans collected		
14	*Procambarus* sp.	2	
15	*Procambarus* sp.	1	
	*** Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach):		Site:	
Old Channel		L2-Site 4	
Date: 10/27/2015	**Time:** 1503-1532	**Observer(s):** ME,JH, TL,JW	
Overall	**Species**	**Number**	**Avg. Length (mm)**
3	*Lepomis miniatus*		
130	*Gambusia sp.*		
15	*Etheostoma fonticola*		
17	*Palaemonetes* sp.		
1	*Oreochromis aureus*		
29	*Procambarus* sp.		

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	2	56,55
	Gambusia sp.	35	20,20,23,8,12,20,20,15,11,15,22,18,18,22,31,15,12,26,25,24,20,18,10,17,15,28,22,20
	Etheostoma fonticola	2	23,23
	Palaemonetes sp.	3	
	Oreochromis aureus	1	30
	Procambarus sp.	1	
2	*Lepomis miniatus*	1	50
	Etheostoma fonticola	3	25,28,28
	Gambusia sp.	51	
	Procambarus sp.	9	
	Palaemonetes sp.	7	
3	*Etheostoma fonticola*	6	25,28,26,21,26,22
	Palaemonetes sp.	4	
	Gambusia sp.	19	
4	*Etheostoma fonticola*	1	23
	Gambusia sp.	19	
	Procambarus sp.	5	
5	*Etheostoma fonticola*	2	20,26
	Procambarus sp.	9	
	Gambusia sp.	3	
6	*Procambarus* sp.	2	
	Gambusia sp.	1	
7	*Palaemonetes* sp.	3	
8	No fish or crustaceans collected		
9	*Etheostoma fonticola*	1	24
	Procambarus sp.	3	
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	*Gambusia sp.*	1	
14	No fish or crustaceans collected		
15	*Gambusia sp.*	1	
	*** Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach): Old Channel		**Site:** R2 - Site 5	**Site on map:** R3
Date: 10/27/2015	**Time:** 1536-1610	**Observer(s):** ME,JH, TL,JW	

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

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Etheostoma fonticola*	3	30,27,32
	Lepomis miniatus	1	35
2	*Etheostoma fonticola*	2	25,34
3	*Procambarus* sp.	4	
4	*Procambarus* sp.	4	
5	*Etheostoma fonticola*	2	21,24
6	*Procambarus* sp.	2	
	Etheostoma fonticola	1	30
7	*Procambarus* sp.	1	
8	*Procambarus* sp.	1	
9	No fish or crustaceans collected		
10	*Procambarus* sp.	1	
11	No fish or crustaceans collected		
12	*Etheostoma fonticola*	1	25
	Procambarus sp.	1	
13	No fish or crustaceans collected		
14	*Etheostoma fonticola*	1	32
	Procambarus sp.	1	
15	No fish or crustaceans collected		
	** *Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach): Old Channel		**Site:** O1-Site 6	
Date: 10/27/2015	**Time:** 1602-1610	**Observer(s):** ME,JH, TL,JW	
Overall	**Species**	**Number**	**Avg. Length (mm)**
COMAL RIVER -FALL 2015 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 -FALL 2015 SAMPLING

Location (Reach):		**Site:**		
Old Channel		L1- Site 7		
Date:	**Time:**	**Observer(s):**		
10/27/2015	1611-1630	ME,JH, TL,JW		
Overall	**Species**		**Number**	**Avg. Length (mm)**
6	*Etheostoma fonticola*			
3	*Lepomis miniatus*			
27	*Gambusia sp.*			
3	*Palaemonetes* sp.			
1	*Procambarus* sp.			

COMAL RIVER -FALL 2015 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Etheostoma fonticola*	2	24,23
	Lepomis miniatus	1	56
	Gambusia sp.	7	24,24,22,20,30,17,24
	Palaemonetes sp.	1	
2	*Gambusia sp.*	4	32,22,16,25
3	*Gambusia sp.*	6	20,22,25,18,18,19
	Procambarus sp.	1	
4	*Gambusia sp.*	2	22,20
	Etheostoma fonticola	1	30
5	*Gambusia sp.*	5	30,20,30,28,34
	Etheostoma fonticola	1	22
6	*Gambusia sp.*	1	20
7	No fish or crustaceans collected		
8	*Lepomis miniatus*	1	81
9	*Palaemonetes* sp.	1	
10	*Gambusia sp.*	1	
11	*Lepomis miniatus*	1	66
	Etheostoma fonticola	1	22
12	*Palaemonetes* sp.	1	
	Etheostoma fonticola	1	23
13	No fish or crustaceans collected		
14	*Gambusia sp.*	1	
15	No fish or crustaceans collected		
	*** Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -FALL 2015 SAMPLING

Location (Reach): Old Channel		**Site:** O2-Site 8	**Site on map:**
Date: 10/27/2015	**Time:** 1632-1637	**Observer(s):** ME,JH, TL,JW	

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

COMAL RIVER -FALL 2015 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*		