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

HIGH FLOW ADDENDUM TO 2015 ANNUAL REPORT

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Prepared for:

Edwards Aquifer Authority
900 East Quincy
San Antonio, Texas 78215

Prepared by:

BIO-WEST, Inc.
Austin Office
1812 Central Commerce Court
Round Rock, Texas 78664-8546

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INTRODUCTION

After years of a prolonged drought, an El Niño pattern settled in over Texas fundamentally changing the weather pattern for 2015. Spring rains in central Texas contributed to higher flows and several peaks in the hydrograph not observed since 2010 (Figure 1). While flows nearly reached 1,000 cubic feet per second (cfs) in June, a high-flow sampling effort was not triggered until late October when the Comal River peaked at 4,070 cfs on October 30, 2015 (United States Geological Survey [USGS] gage 08169000). This was the highest peak in the Comal River hydrograph since 2010 when flows reached 7,280 cfs. While high flows were observed throughout the system, the majority of the volume of water in the Comal River came from Dry Comal Creek which peaked at 2,520 cfs (USGS gage 08168797) on the same date. While the flooding in the Comal River was mild compared to that of the San Marcos River, there were still disturbance effects from the high volume of water observed throughout the Comal River. The data presented below represent sampling completed following the October flood. Please note that by design, high-flow sampling efforts do not include all comprehensive monitoring components (e.g. Macroinvertebrate community sampling, see BIO-WEST 2015b, Appendix A). For sampling methodology please refer to the 2015 Comal River Comprehensive Monitoring Annual Report (BIO-WEST 2015b).

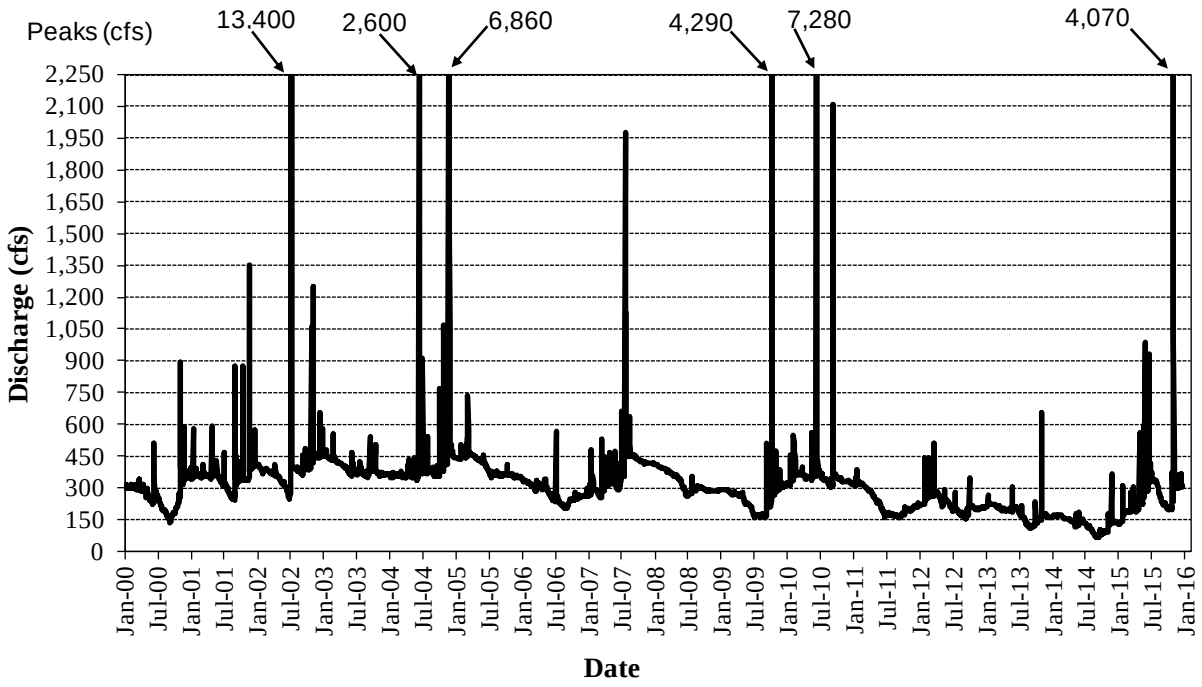


Figure 1: Comal River hydrograph presented as daily discharge over the biological monitoring period.

OBSERVATIONS

Water Quality

A summary of water quality data for the 2015 high-flow water quality sampling effort is presented in Tables 1 and 2. Values remained fairly constant throughout the system and fluctuated minimally from site to site. Temperatures varied minimally between sites during the water quality sampling events (Table 1). Dissolved oxygen (DO) concentrations met or exceeded 5.0 milligrams per liter (mg/L) at all 12 stations during the high-flow sampling effort.

Total Suspended Solids (TSS) values were very low at all of the sites in the river (all below 2.5 mg/L), reflecting the clear waters of this spring system. Although these TSS values would have been higher during the flood, all sampling was completed when flows had returned closer to average. Alkalinity was consistent between sites (Table 2), with values similar to those measured in the past (BIO-WEST 2015a). The Soluble Reactive Phosphorous (SRP) concentrations and Total Phosphorous (TP) concentrations on the Comal River were below laboratory detection limits (<0.05 mg/L and <0.02 mg/L, respectively) and below the Texas Commission on Environmental Quality's screening values of 0.1 mg/L and 0.2 mg/L, respectively for most sites. The Old Channel downstream location exhibited the highest TP concentration recorded during this sampling (Table 2).

Table 1. Summary of Comal Springs/River ecosystem physical water quality measurements from the 2015 high-flow sampling effort.

Location	Time	Depth (ft)	Temperature (°C)	DO (mg/L)	pH	Conductivity (µs/cm)
Blieder's Creek	10:45	3.0	21.56	6.36	7.35	558
Heidelberg, Main Channel	10:40	3.2	22.90	5.30	7.16	566
Island Park, Far Channel	10:25	1.7	22.83	6.28	7.23	559
Island Park, Near Channel	10:20	1.5	23.35	5.00	7.10	562
Spring Run 1	9:35	0.5	23.41	5.59	7.15	577
Spring Run 2	9:40	0.7	22.52	5.22	7.12	580
Spring Run 3	9:48	1.3	23.44	5.50	7.12	577
New Channel, upstream	9:37	3.9	22.93	6.78	7.24	570
New Channel, downstream	9:13	1.1	21.72	9.03	7.56	573
Old Channel, upstream	10:10	1.7	22.24	7.95	7.51	561
Old Channel, downstream	9:06	0.5	21.01	7.10	7.54	568
Union Avenue	8:54	1.6	21.60	8.54	7.69	568

Nitrate values exceeded 1.5 mg/L at all sites, whereas ammonium values were well below 0.5 mg/L (Table 2). The Total Nitrate (TN) values for the Comal River are influenced by the high nitrate concentrations. Spring flow is the most likely source of high nitrate values typically found

in the Comal system. The median concentration of nitrate in the Edward's Aquifer ranges from 1.4 to 1.7 mg/L (Bush et al. 1998). Nitrate values in the Comal system were fairly constant but slightly higher than average during the high-flow sampling effort. In contrast, ammonia concentrations varied among sites from <0.01 to 0.04 mg/L which were similar to values measured in October 2014 (<.01 to .04 mg/l) (BIO-WEST 2015a).

Table 2. Summary of Comal Springs/River ecosystem analytical water quality results from the 2015 high-flow sampling effort.

Location	TSS	Alkalinity (mg/L)	Ammonia (mg/L)	Nitrate (mg/L)	TN (mg/L)	SRP (mg/L)	Total P (mg/L)
Blieder's Creek	<1.43	230	<.01	2.09	2.40	<.05	<.02
Heidelberg, Main Channel	1.60	270	0.04	2.12	2.47	<.05	0.02
Island Park, Far Channel	<1.43	230	0.01	2.08	2.29	<.05	<.02
Island Park, Near Channel	<1.43	230	0.01	2.14	2.42	<.05	0.04
Spring Run 1	<1.43	230	<.01	2.21	2.60	<.05	<.02
Spring Run 2	<1.43	230	<.01	2.19	2.39	<.05	<.02
Spring Run 3	<1.43	230	<.01	2.20	2.44	<.05	<.02
New Channel, upstream	<1.43	240	<.01	2.14	2.20	<.05	<.02
New Channel, downstream	<1.43	240	0.02	2.12	2.30	<.05	<.02
Old Channel, upstream	1.70	240	0.03	2.10	2.44	<.05	0.04
Old Channel, downstream	1.60	230	0.02	2.10	2.25	<.05	0.49
Union Avenue	2.10	230	0.02	2.11	2.22	<.05	0.03

Aquatic Vegetation Mapping

Maps of aquatic vegetation observed during the high-flow critical period sampling effort are presented in Appendix A with a summary of observations per study reach presented below.

Upper Spring Run Reach

Like all reaches in the Comal River, aquatic vegetation coverage at the Upper Spring Run Reach decreased following the high-flow event in October. Total coverage decreased by more than 50% from fall (2,011.0 m^2) to the high-flow critical period (973.8 m^2); however, the total coverage was higher than the long-term high-flow average at this reach (Figure 2). Following high-flow events, lightly rooted vegetation like bryophytes typically decrease, and 2015 was no exception. Bryophyte areal coverage decreased from October (280.9 m^2) to November (35.8 m^2). Rooted vegetation like *Sagittaria* exhibited less disturbance but did show reductions in coverage from October (897.8 m^2) to November (825.3 m^2).

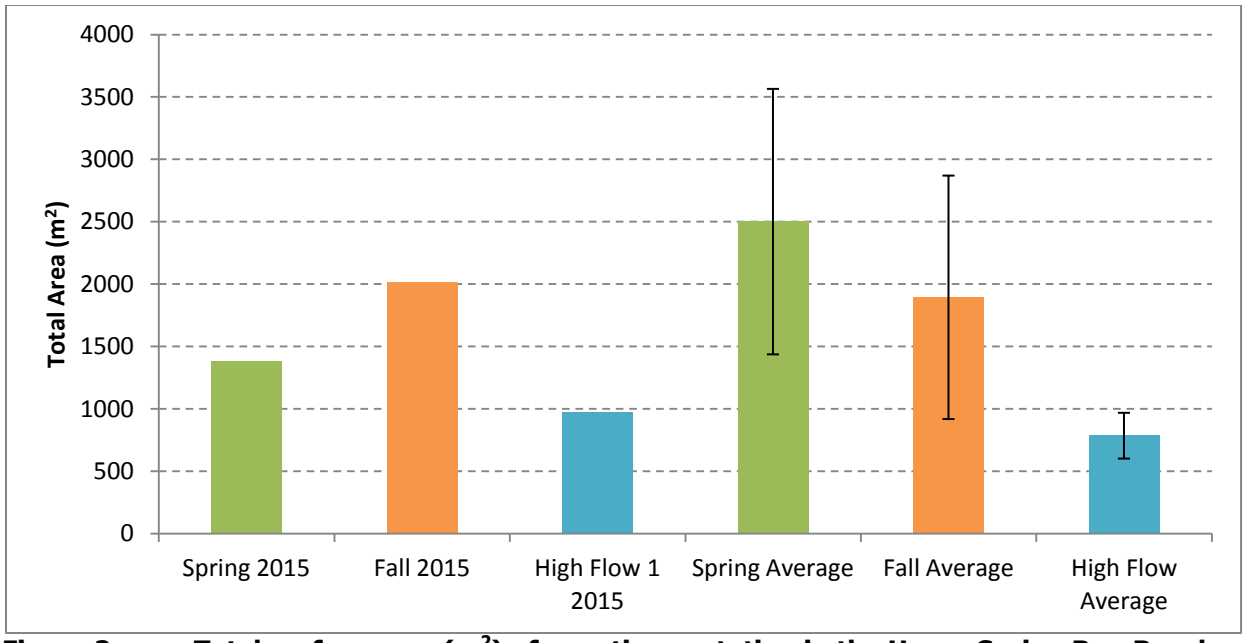


Figure 2. Total surface area (m^2) of aquatic vegetation in the Upper Spring Run Reach. Long-term study averages are provided with error bars representing one standard deviation from the mean.

Landa Lake Reach

Total surface area of aquatic vegetation also decreased in the Landa Lake Reach from fall (17,658.1 m^2) to the high-flow sampling effort (16,383.6 m^2), reflecting an 8% decrease. This is within one standard deviation of the mean for all high-flow events in the study, and similar to the fall and spring long-term study averages (Figure 3). Visual observations in the lake showed little change with no obvious areas devoid of vegetation. Additionally, the high-flow event appeared to have little effect on recently planted native vegetation from restoration efforts conducted in the lake in 2015.

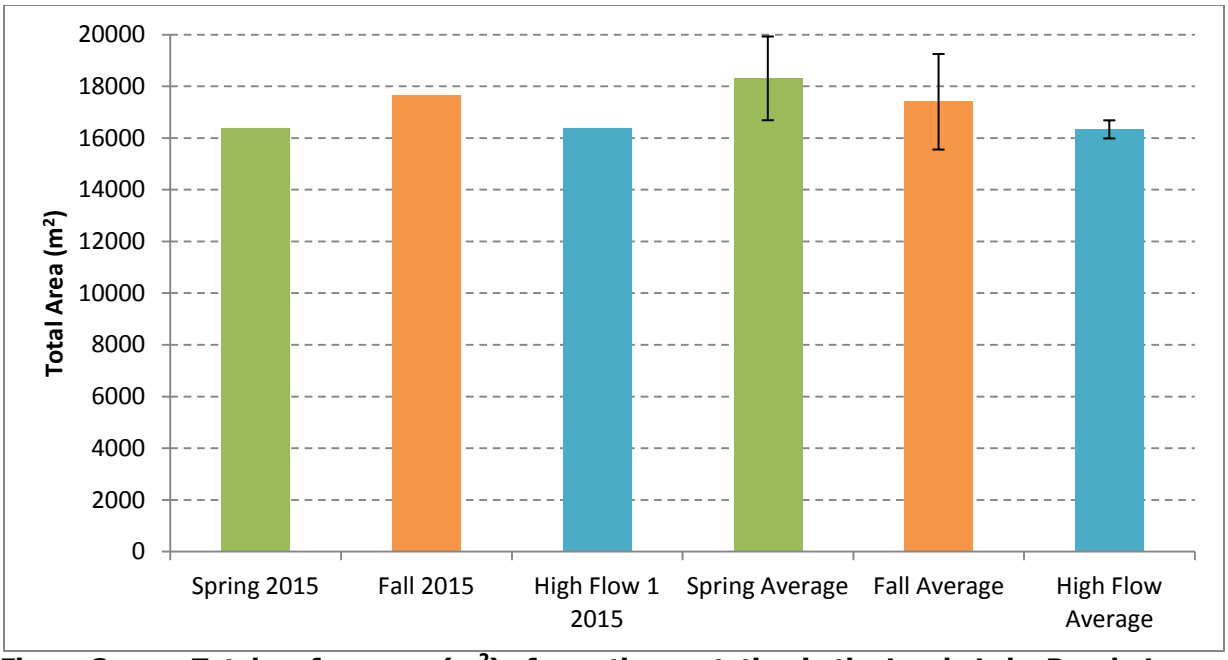


Figure 3. Total surface area (m^2) of aquatic vegetation in the Landa Lake Reach. Long-term study averages are provided with error bars representing one standard deviation from the mean.

Old Channel Reach

Unlike the Landa Lake Reach, there was a substantial amount of disturbance to the aquatic vegetation community in the Old Channel Reach. As the name implies, this reach is more channelized than Landa Lake, and high-flow events can result in greater scouring of the vegetation. Total surface area decreased by 51% from fall (1,209.7 m^2) to the high-flow sampling effort (589.8 m^2) (Figure 4). Most of this decrease is attributed to losses of *Hygrophila* (42% decrease) and bryophytes (92% decrease). While a decrease in bryophytes is expected because they are lightly rooted, the loss of *Hygrophila* better describes the higher than typical amount of water that flowed through this reach during the high-flow event. Although this decrease first appears large, it is similar to the long-term average of total aquatic vegetation in this area following high-flow events (Figure 4).

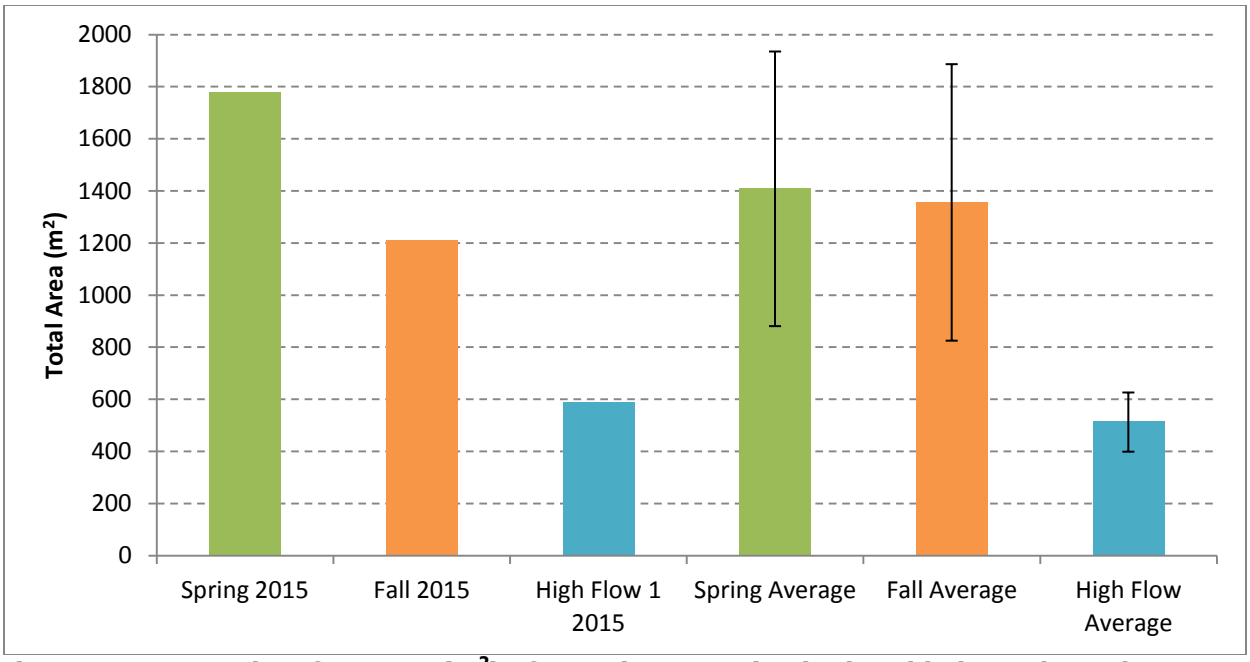


Figure 4. Total surface area (m^2) of aquatic vegetation in the Old Channel Reach. Long-term study averages are provided with error bars representing one standard deviation from the mean.

Lower New Channel Reach

The Lower New Channel Reach is entirely channelized and characterized by greater water depths. The direct influence of Dry Comal Creek typically produces greater effects to aquatic vegetation in this reach from pulse flow events. As expected, total vegetative surface area decreased from fall (3,541.3 m^2) to the high-flow sampling effort (2,288.4 m^2); a decrease of 35%. It is interesting that this decrease was actually less than the historical average for pulse events in this reach (Figure 5). This might be the result of the relative lack of high-flow events in the Comal River in recent years (the last event occurred in 2010). This long period of relatively stable flows in this reach was reflected by aquatic vegetation growth with the greatest total surface area in fall 2015 (3,541.3 m^2) since 2004 (3,576.3 m^2). As a result, this vegetation was more firmly rooted which likely limited the 2015 high-flow event disturbance.

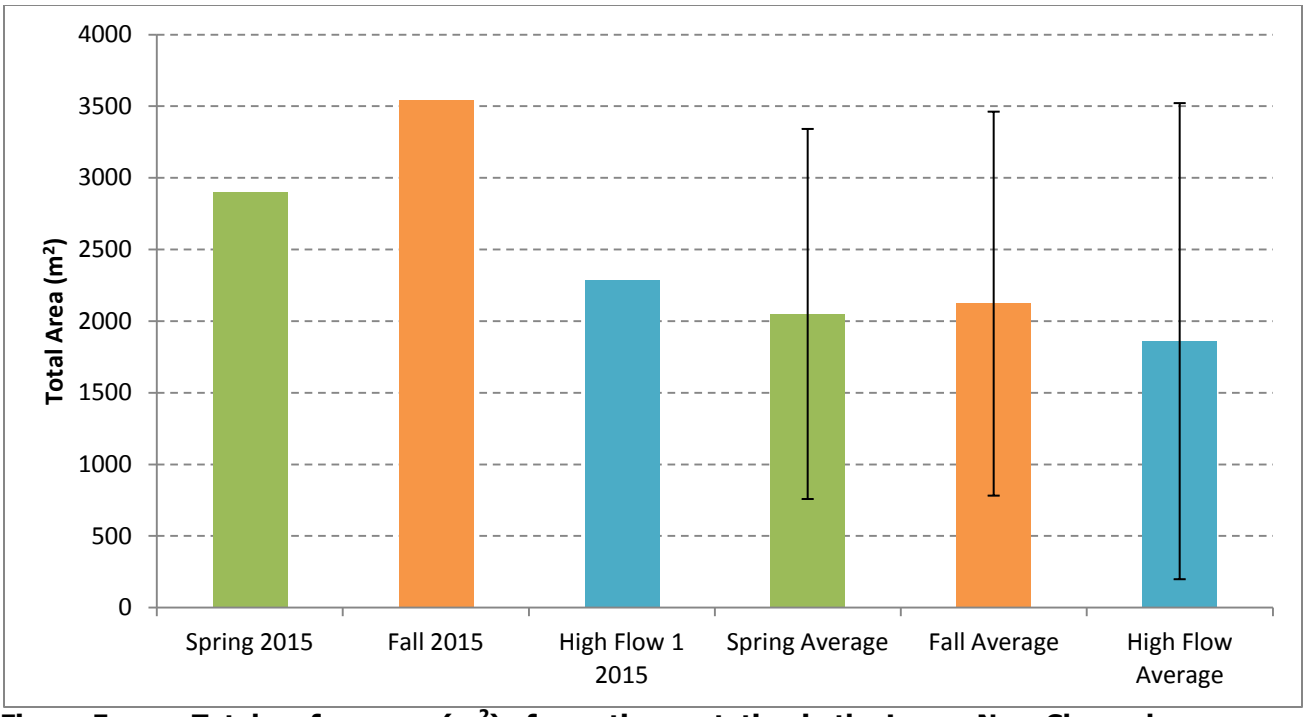


Figure 5. Total surface area (m^2) of aquatic vegetation in the Lower New Channel Reach. Long-term study averages are provided with error bars representing one standard deviation from the mean.

Upper New Channel Reach

An extension to the New Channel Reach was added in 2014 upstream of the (now) Lower New Channel Reach. 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.

Since this reach has been added to the biological monitoring study no high-flow sampling efforts had occurred until 2015. With the majority of the flows coming in from Dry Comal Creek total surface area of aquatic vegetation decreased by 64% from fall (1,057 m^2) to the high-flow sampling effort (380.6 m^2) (Figure 6). The upper portions of this reach begin mere meters from the mouth of Dry Comal Creek, and these vegetation losses were expected. Bryophytes were no longer present following the flood, and *Hygrophila* decrease by 51%. Similarly, native vegetation like *Cabomba* decreased by 56% and *Ludwigia* by 61%. If this reach rebounds similarly to the Lower New Channel Reach following high-flow events, it is expected that vegetation will increase relatively quickly following a period of stable flows.

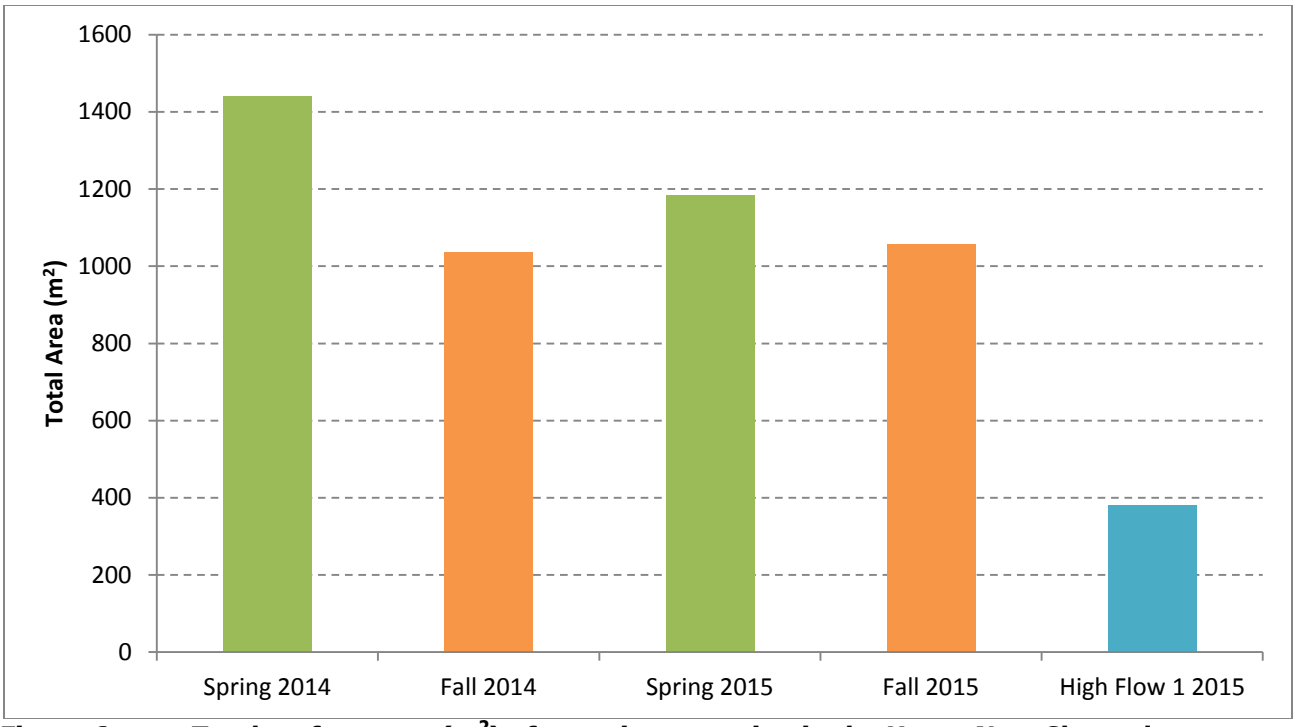


Figure 6. Total surface area (m^2) of aquatic vegetation in the Upper New Channel Reach. Long-term study averages are not provided because this reach has only been recently sampled.

Fountain Darter Sampling

Drop Nets

A total of 32 drop-net samples were conducted during the high-flow 2015 sampling effort in the Comal system. Table 3 shows the number of drop-net samples taken from each vegetation type in each reach during the sampling effort. Due to the scouring of vegetation in the Upper Spring Run reach during the flood a new vegetation type, *Nitella* was sampled. *Nitella* has been increasing in the Upper Spring Run Reach for the last few years. Also, due to higher flows in the Upper New Channel reach only four drop-net samples were completed; water at the site was too deep for effective sampling. Drop-net data sheets for 2015 are included in Appendix C.

Table 3. Number of drop-net samples collected in each vegetation type per reach during the 2015 high-flow sampling effort.

Vegetation Type	Upper Spring Run	Landa Lake	Old Channel	Upper New Channel	Total
Bryophytes		2			2
Ludwigia		2	2		4
Hygrophila			4	1	5
Sagittaria	3	2			5
Vallisneria		2			2
Cabomba		2		2	4
Nitella	3				3
Open	2	2	2	1	7
TOTAL	8	12	8	4	32

From these drop-net samples, a total of 457 fountain darters (*Etheostoma fonticola*) were collected. This is a slight increase from 412 darters that were collected during the fall sampling effort but still within the range of darters collect during the entire study (103 to 1,058 [mean=497]).

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 7). 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.

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. Both filamentous algae and bryophyte coverage in all reaches were down considerably after the October flooding. *Cabomba, Ludwigia, Sagittaria,* and *Vallisneria* are also relatively common and, therefore, provide substantial amounts of fountain darter habitat and are less prone to scouring during flood events.

Estimates of fountain darter population abundance in all reaches (Figure 8) 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. The 2015 high-flow population estimate was lower than the fall 2015 estimate but slightly higher than the high-flow average population estimate (Figure 8). High-flow estimates are typically lower because of the scouring of vegetation from the study reaches during flood events. Higher flows following flood events may also influence sampling efficiency.

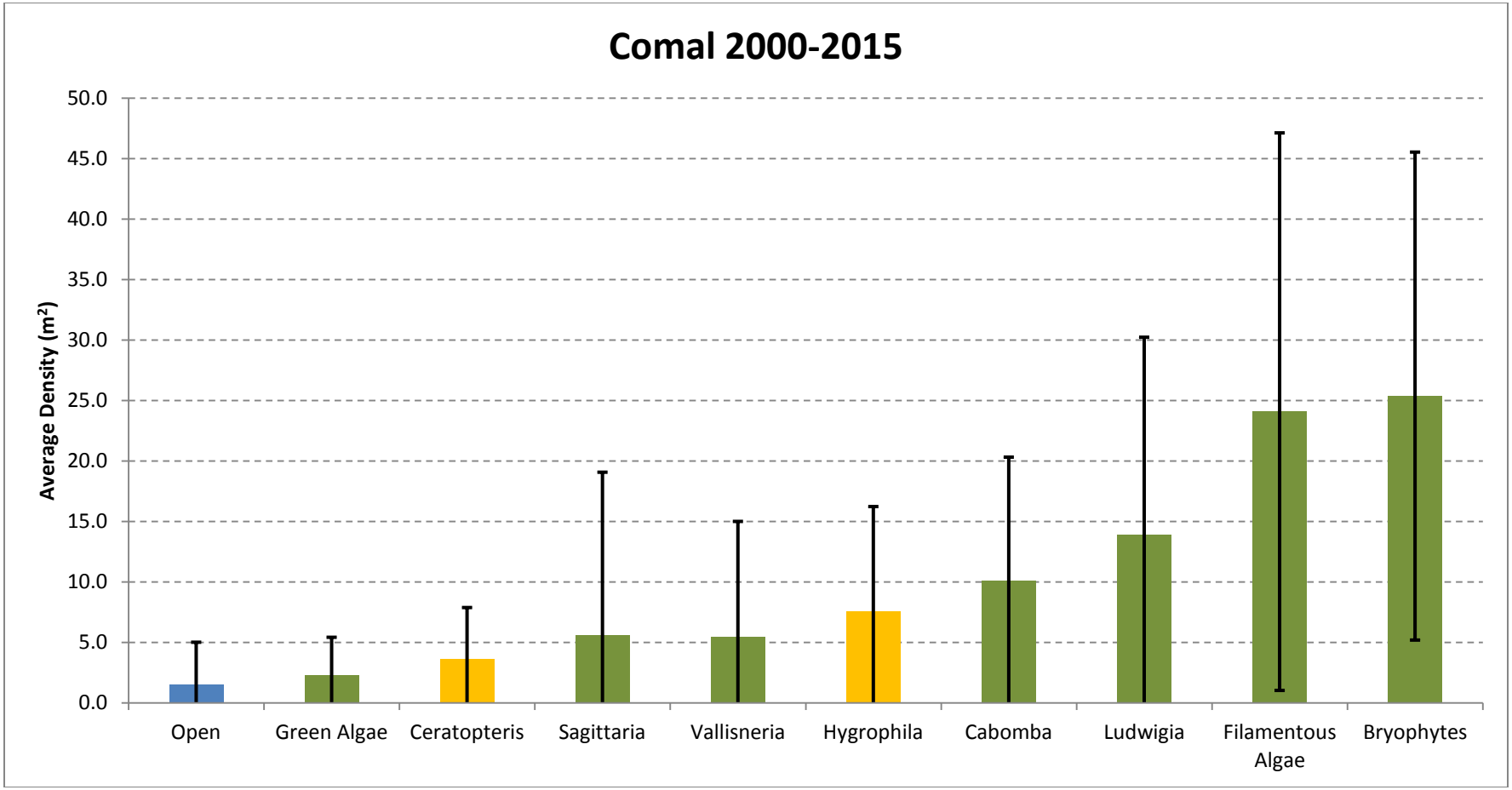


Figure 7. **Average density of fountain darters collected by vegetation type in the Comal system from 2000 to 2015. Green represents native vegetation, while yellow reflects nonnative types. Error bars are provided representing one standard deviation from the mean.**

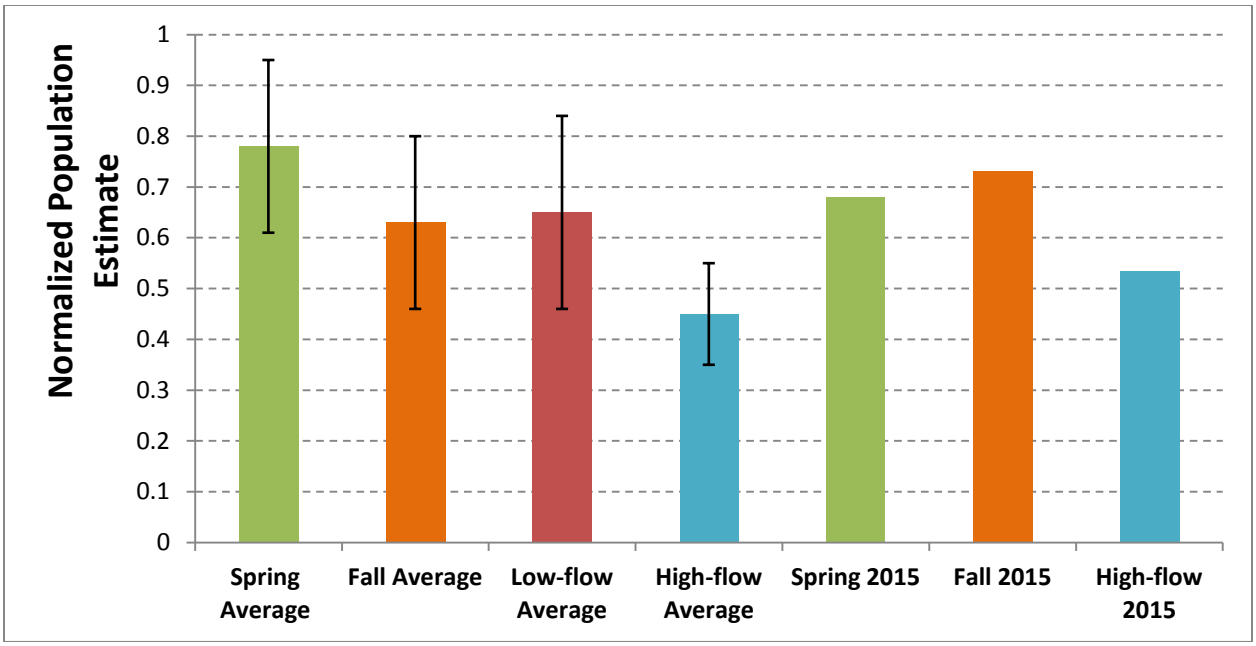


Figure 8. **Normalized fountain darter population estimates in the Comal River based on coverage of various vegetation types in the study reaches and average density of fountain darters in each type. Long-term study averages are provided with error bars representing one standard deviation from the mean.**

In addition to fountain darters, 156,148 other specimens representing 25 other fish taxa have been collected by drop netting from the Comal Springs ecosystem during the study period (2000–2015). Of these, seven are considered exotic or introduced (Table 4).

Table 4. Fish taxa and the number of each collected during drop-net sampling.

FAMILY	SCIENTIFIC NAME	COMMON NAME	STATUS	High-flow 2015	2000–2015
Cyprinidae	*Campostoma anomalum*	Central stoneroller	Native		1
	Dionda nigrotaeniata	Guadalupe roundnose minnow	Native	2	1,054
	Notropis amabilis	Texas shiner	Native	4	320
	Notropis volucellus	Mimic shiner	Native	1	34
	Pimephales vigilax	Bullhead minnow	Native		4
Characidae	*Astyanax mexicanus*	Mexican tetra	Introduced	1	440
Ictaluridae	*Ameiurus melas*	Black bullhead	Native		1
	Ameiurus natalis	Yellow bullhead	Native	3	113
Loricariidae	*Hypostomus plecostomus*	Armadillo del rio	Introduced		76
Poeciliidae	*Gambusia* sp.	Mosquitofish	Native	1,144	125,916
	Poecilia latipinna	Sailfin molly	Introduced	1	4,706
Centrarchidae	*Ambloplites rupestris*	Rock bass	Introduced		24
	Lepomis auritus	Redbreast sunfish	Introduced		146
	Lepomis cyanellus	Green sunfish	Native	4	27
	Lepomis gulosus	Warmouth	Native		33
	Lepomis macrochirus	Bluegill	Native	10	228
	Lepomis megalotis	Longear sunfish	Native		261
	Lepomis microlophus	Redear sunfish	Native		2
	Lepomis miniatus	Redspotted sunfish	Native	74	2,094
	Lepomis sp.	Sunfish	Native/Introduced	1	820
	Micropterus punctulatus	Spotted bass	Native		3
	Micropterus salmoides	Largemouth bass	Native	2	445
Percidae	*Etheostoma fonticola*	Fountain darter	Native	457	18,597
	Etheostoma lepidum	Greenthroat darter	Native	1	52
Cichlidae	*Herichthys cyanoguttatus*	Rio Grande cichlid	Introduced	13	684
	Oreochromis aureus	Blue tilapia	Introduced		67
Total				**1,718**	**156,148**

Dip Net Timed Surveys

The locations for each section of the dip net timed surveys are shown in Figure 1 in the 2015 Comal River Annual Report (BIO-WEST 2015b). Timed dip net collections were conducted four times in the Comal River during 2015: May 7 (spring), August 4 (summer), October 29 (fall) and November 18 (high-flow).

The number of fountain darters collected in the Upper Spring Run Reach during the high-flow event was significantly lower (13) than other events in 2015 (62-68). This is due to the lack of

suitable habitat in the reach from the scouring of vegetation in the reach during the October flood. The Spring Island Reach also showed a decrease in the number of fountain darters collected during the high-flow sampling effort (26) compared to other sampling events in 2015 (45-67). The Landa Lake, New Channel and Old Channel reaches all had similar numbers of fountain darters observed compared to recent years (Appendix B).

Presence/Absence Survey

In 2015, presence/absence dip netting was conducted within reaches on the Comal River during the typical spring (May), summer (August), and fall (October) sampling efforts (Figure 9). In addition, one low-flow Critical Period (<150 cfs) (January) and one high-flow Critical Period (December) sampling effort 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 66% during the high-flow sampling effort, which was lower than fall 76% (Figure 9) but still within the 5th and 95th percentiles for the study.

As shown in Figure 9, 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.

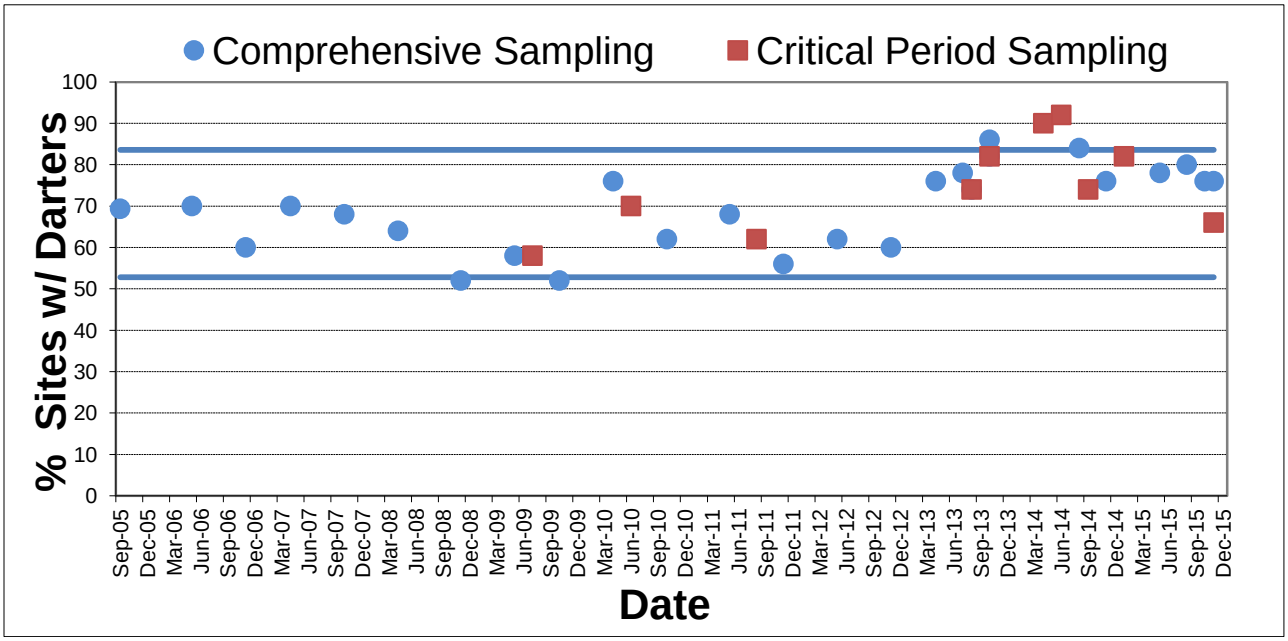


Figure 9. Percentage of sites (*n*=50) in which fountain darters were present in the Comal River. Solid blue lines mark 5th and 95th percentiles for comprehensive sampling.

Fixed-Station Survey

For a complete methodology of the fixed-station survey please see BIO-WEST 2015b. For this analysis, all high-flow data following the October flood were included. 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 River data, the model in which detection was modeled as a function of vegetation received the most support, with an AIC weight of 0.76. Under this model, initial ψ=0.94 and p varied from 0.33 to 0.75. 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=0.66) and those that had bryophytes mixed in with other vegetation (p=0.62) (Table 5). The highest detection values were for *Nitella*, 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 (fall, spring) the probability of colonization of a site is 0.43 (95 % CI: 0.33–0.52), and the probability of local extinction is 0.21 (95% CI: 0.16–0.27), thus the likelihood of an occupied site remaining so can be extrapolated as ~ 79%. The naïve (#sites occupied / #sites) and informed (modeled) estimates of occupancy for these data are presented in Table 6. 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 5. Detection probabilities for different habitat types estimated by multiple season occupancy modeling of Comal River fountain darter presence/absence data.

HABITAT	P
Algae	0.60
Bryophytes	0.66
Cabomba	0.33
Nitella	0.75
Hygrophila	0.38
Ludwigia	0.56
Sagittaria	0.64
Vallisneria	0.45
Mixed bryophytes	0.62
Mixed algae	0.49

Table 6. 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	NAIVE Ψ	MODEL Ψ
April-14	0.86	0.94
June-14	0.86	0.76
August-14	0.66	0.70
September-14	0.6	0.68
November-14	0.6	0.67
January-15	0.68	0.67
May-15	0.66	0.67
August-15	0.56	0.67
October-15	0.48	0.67
November-15	0.58	0.67

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 7). Simultaneously, there was a reduction in sites covered by some other vegetation types (Table 7). 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 7. **Change in percent of sample sites representing certain habitat types. Note the dramatic increase in open sites after the first two sampling periods, as well as after the high-flows (November) in late 2015.**

	2014					2015				
VEGETATION	**April**	**June**	**August**	**September**	**November**	**January**	**May**	**August**	**October**	**November**
Algae	10%	10%	4%	2%	8%	4%	4%	2%	4%	0%
Bryophytes	10%	8%	6%	0%	6%	8%	12%	16%	12%	6%
Cabomba	8%	8%	6%	6%	6%	8%	6%	8%	8%	8%
Nitella	0%	0%	0%	0%	0%	0%	2%	2%	2%	0%
Hygrophila	28%	28%	28%	32%	32%	29%	24%	16%	16%	16%
Ludwigia	6%	6%	4%	6%	2%	6%	6%	6%	10%	10%
Open	12%	14%	26%	32%	22%	25%	22%	24%	20%	32%
Sagittaria	8%	8%	6%	8%	8%	6%	8%	10%	10%	10%
Vallisneria	18%	18%	20%	14%	16%	14%	16%	16%	18%	18%

Visual Observations

Fountain darters were 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. 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 flooding during 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 only 15 fountain darters being observed. It will be interesting to track the anticipated recovery of habitat conditions and subsequent return of darters to this area during spring 2016 HCP comprehensive biological monitoring.

Fish Community Sampling

The fall fish community sampling effort was interrupted by the October flooding, so the completed fall data are presented here even though sampling was done after the flood. Data presented for Fall / High Flow 2015 only include the Upper Spring Run, Landa Lake, Old Channel, and New Channel reaches (Table 8). At least 23 species of fishes representing 4,947 individuals were capturing during the fish community sampling effort following the October flood. Large decreases in fountain darter densities were observed from spring to fall at the Upper Spring Run (1.5 fish/ m^2), Old Channel (0.4 fish/ m^2), and New Channel (0.06 fish/ m^2) reaches. These decreases are likely due to the higher volume of water distributing/displacing darters in the Comal River.

Table 8. 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 all sampling efforts in 2015 from six locations on the Comal River.

				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	Fall	Winter	Spring	Fall	Winter	Spring	Fall	Winter	Spring	Fall	Winter	Spring
Dionda nigrotaeniata	298	Meso	260	0.071	0	0.088	0.050	0	0.012	0.016	0.030	0	0	0	0	0	0	0	0
Notropis amabilis	467	Seine	138	0	0	0.035	0.190	0.004				0.003	0.123	0.003	0.067	0.040	0.000	0	0.018
Notropis volucellus	17	Seine	11	0	0	0	0	0				0	0	0.013	0	0	0	0	0.031
Astyanax mexicanus	322	Meso	302	0	0	0.005	0.026	0.010	0.014	0.008	0.041	0	0	0	0.017	0.006	0.000	0.002	0
Ameiurus melas	7	Seine	7	0	0	0	0	0				0	0	0	0	0.023	0	0	0
Ameiurus natalis	2	Seine	1	0	0	0	0	0				0	0	0.003	0	0	0	0	0
Ictalurus punctatus	6	Micro	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.008	0
Hypostomus plecostomus	16	Meso	12	0	0	0	0	0	0	0	0	0.004	0.004	0.009	0	0.001	0.000	0.004	0
Gambusia affinis	180	Seine	180	0.038	0.167	0.235	0	0.020				0.130	0.047	0.040	0.071	0.02	0	0	0
Gambusia geiseri	154	Seine	154	0.038	0.233	0.074	0.037	0.024				0.061	0.047	0.107	0.079	0.033	0.031	0.005	0
Gambusia	6,497	Meso	5,480	0	0	1.318	1.033	0.265	1.309	0.217	0.207	0.583	0.583	0.139	0	0	0	0	0
Poecilia latipinna	39	Seine	24	0	0	0	0	0.004				0	0	0.04	0.050	0	0	0	0
Ambloplites rupestris	6	Seine	6	0	0	0	0	0				0.012	0	0.007	0	0	0	0	0
Lepomis auritus	372	Meso	261	0	0.004	0.002	0.030	0.071	0.003	0.003	0	0.003	0.003	0.015	0.013	0.015	0.031	0.029	0.075
Lepomis cyanellus	6	Meso	2	0	0	0	0	0	0	0	0	0	0	0	0	0.002	0.000	0	0
Lepomis gulosus	5	Seine	5	0	0	0	0	0				0	0	0	0	0.01	0	0	0.009
Lepomis macrochirus	111	Meso	49	0	0.020	0	0	0.004	0	0	0	0	0	0	0.009	0.012	0.000	0	0.014
Lepomis megalotis	42	Meso	29	0	0	0	0.020	<0.001	0	0	0	0	0	0	0	0	0.001	0	0.002
Lepomis miniatus	106	Seine	90	0.086	0.078	0.028	0.030	0				0	0.030	0.003	0.029	0.073	0.010	0.081	0.004
Lepomis	395	Meso	294	0	0.049	0.044	0.064	0.011	0.001	0.006	0.002	0.009	0.009	0.011	0.024	0.023	0.004	0.062	0.022
Micropterus salmoides	221	Meso	186	0	0.037	0.026	0.021	0.028	0.005	0.001	0.047	0	0	0.0207	0.012	0.015	0.031	0.010	0.002
Etheostoma fonticola	1,657	Micro	1,492	0.125	0.200	0.592	2.083	1.508	0.600	1.792	1.867	1.158	1.033	0.442	0.275	0.608	0.058	0.075	0.233
Etheostoma lepidum	192	Micro	171	0.250	0.225	0.158	0.208	0.192	0.092	0.083	0.275	0.042	0.067	0.033	0.008	0.008	0.000	0.025	0.075
Etheostoma	274	Micro	271	0.125	0.200	0.167	0.800	0.108	0.217	0.192	0.083	0.083	0.092	0.133	0.058	0.075	0.025	0.108	0.008
Herichthys cyanoguttatus	76	Meso	51	0	0.012	0.022	0.013	0.007	0.001	<0.001	0	0.003	0.003	0.002	0.002	0.001	0.000	0	0.001
Oreochromis aureus	5	Meso	2	0	0	0	0	0	0.001	0	0.004	0	0	0	0	0	0	0	0
Total N	11,473																		

Comal Springs Salamander Visual Observations

The total number of Comal salamanders (*Eurycea* sp.) observed at all sites combined (24) was the same between the fall and the high-flow sampling effort. It is important to note that all of the sites where Comal salamander surveys are performed are upstream of the where Dry Comal Creek enters the Comal River. At the Spring Island Spring Run, no salamanders were observed for the fall and high-flow sampling efforts (Figure 10). Salamanders at this site have been infrequently encountered since going dry several times in 2014. It is perplexing that in spring 2015, 4 salamanders were observed; the most since 2004.

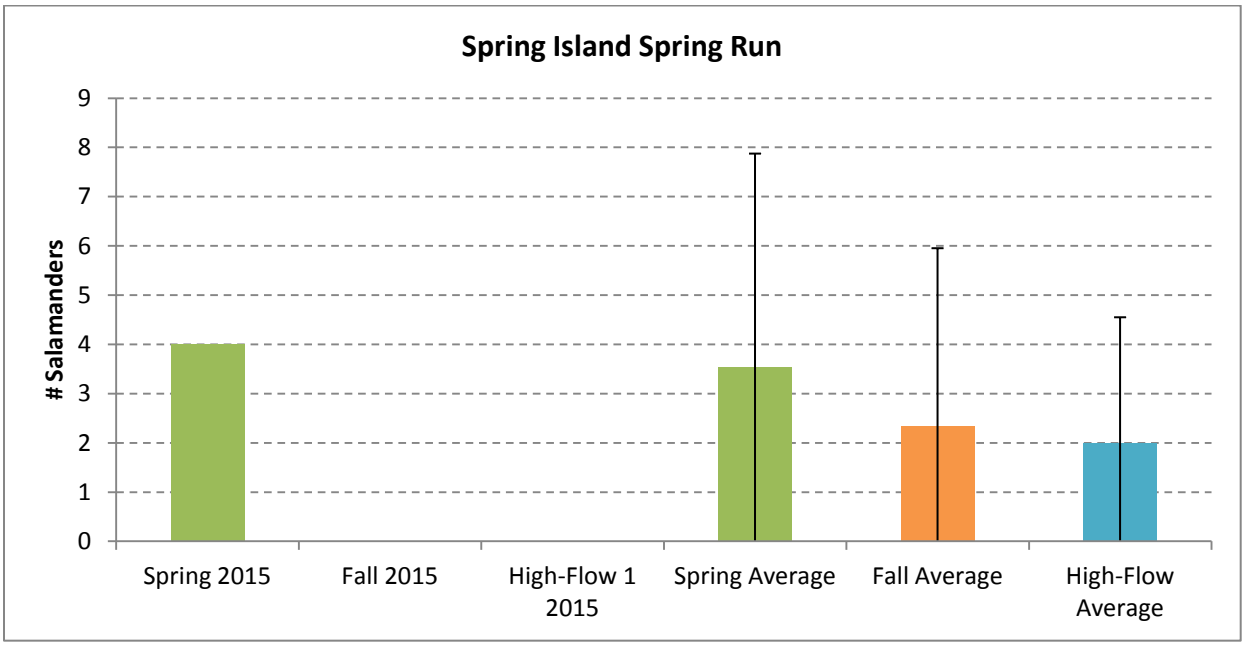


Figure 10. Salamander observations at the Spring Island Spring Run in 2015. Long-term study averages are provided with error bars representing one standard deviation from the mean.

The greatest change in salamander observations following the October flood occurred at the Spring Island East Outfall Site (Figure 11). There was only one observation in the post-flood sampling compared to 9 in the fall. This single observation was well below the long-term high flow average. While bryophytes were still present in this reach following the flood, there was a large amount of fine sediment filling the interstitial spaces between rocks. Not only does this degrade the habitat possibly pushing salamanders to better habitat, it also makes sampling difficult as an observer is met with a cloud of floating sediment upon turning over a rock.

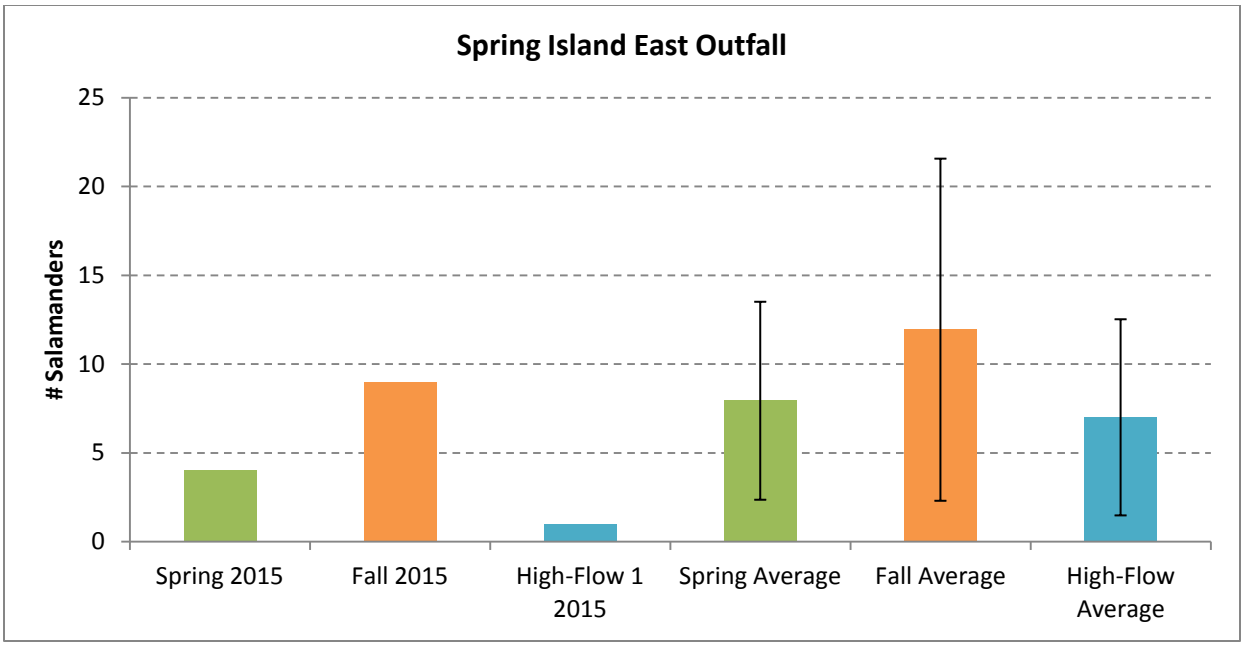


Figure 11. Salamander observations at the Spring Island East Outfall in 2015. Long-term study averages are provided with error bars representing one standard deviation from the mean.

Comal salamander observations continued to be low at Spring Run 1 in 2015 (Figure 12). Similar to the Spring Island Spring Run, this site was mostly dry in 2014. Following the October flood, observations only decreased by one to a total of 6 with 4 of the salamanders located within a large patch of *Ludwigia* that has formed in the middle of the channel. Although 2015 was a higher than average precipitation and flow year following the prolonged drought, salamander numbers in Spring Run 1 have yet to recover to pre-drought conditions.

Even throughout lower than average flows in 2014, Spring Run 3 maintained a large amount of wetted width that only expanded with the increasing flows in 2015; however, since spring 2015 salamander observations have slightly decreased (Figure 13). Only 5 salamanders were observed following the October flood when 8 were seen during the fall sampling effort.

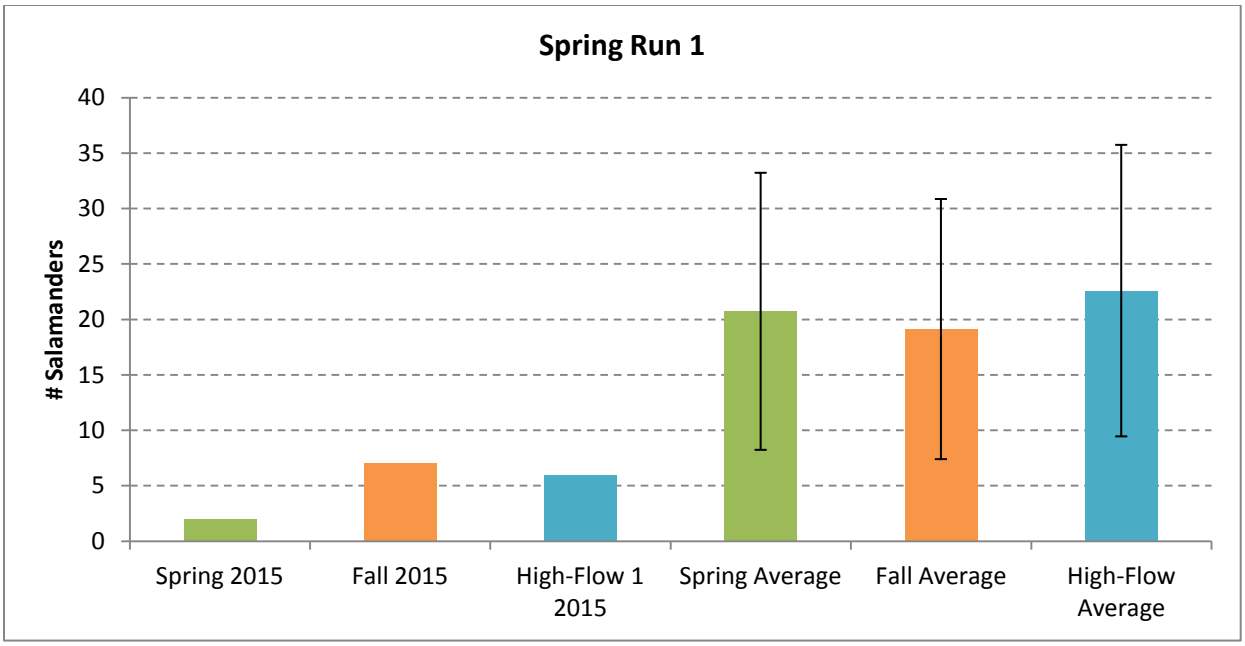


Figure 12. **Salamander observations at the Spring Run 1 in 2015. Long-term study averages are provided with error bars representing one standard deviation from the mean.**

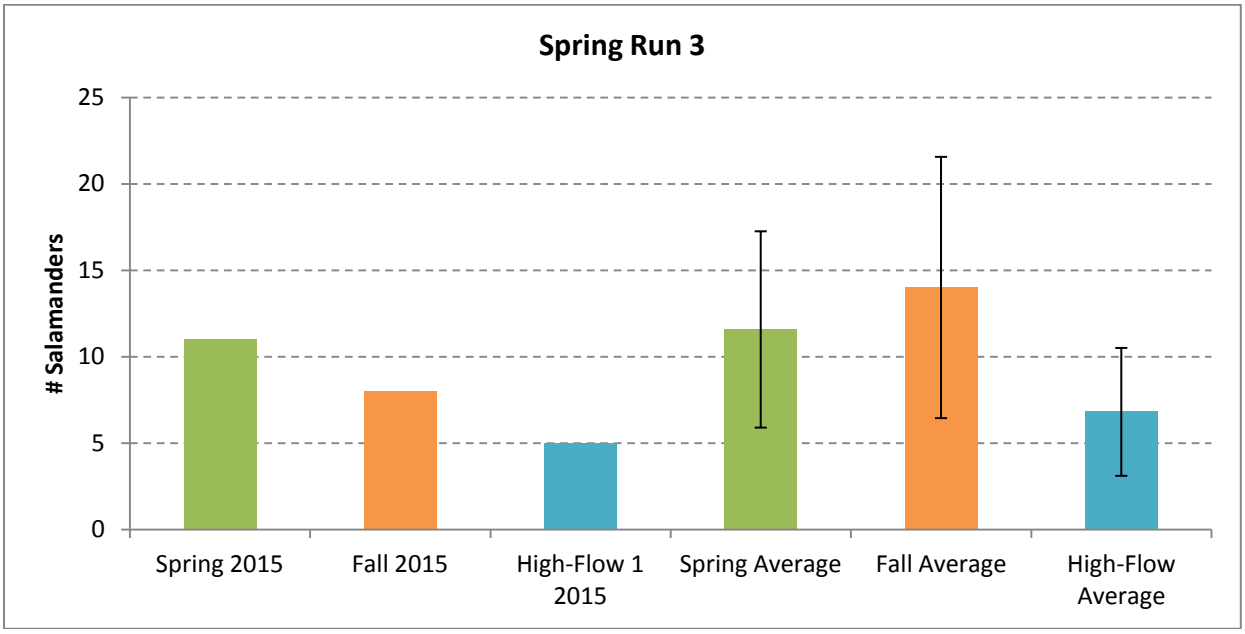


Figure 13. **Salamander observations at the Spring Run 3 in 2015. Long-term study averages are provided with error bars representing one standard deviation from the mean.**

CONCLUSIONS

Although the impacts caused by the 2015 October flood was relatively mild compared to previous flooding events during the course of this study, there were some disturbances noted. Poorly-rooted vegetation was scoured at all sites with bryophytes losing the most surface area. As in the past, it is likely bryophytes will re-occupy these areas following a period of stable flows. While the fountain darter population estimate in the Comal River decreased following the flood, it is still within the long-term study averages, and is expected to increase in 2016 (as it has following flooding events in the past). The beauty of the HCP long-term, multi-faceted biological monitoring program is the late 2015 flooding/scour event allows another excellent opportunity to track the habitat and biota responses this upcoming spring.

Collected debris in the Old Channel following the October flood.

REFERENCES

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. Comal River Aquatic Ecosystem 2015 Annual Report. Edwards Aquifer Authority. 75 p. plus Appendices.

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

U.S. Geological Survey (USGS). 01/2016. Provisional data for Texas. Location: http://tx.waterdata.usgs.gov/niwis/help/provisional.

APPENDIX A: AQUATIC VEGETATION MAPS

Upper Spring Run Reach

COMAL RIVER

New Braunfels, Texas

Aquatic Vegetation Study Reach
November 2015

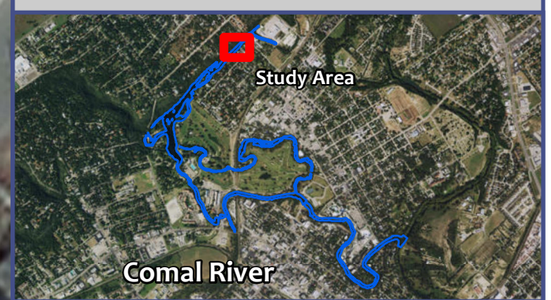
Surveyed: November 22, 2015

UPPER SPRING RUN

Study Reach	4,835.4 m^2

Vegetation Types

Bryophytes	35.8 m^2
Sagittaria	825.3 m^2
Cabomba	2.0 m^2
Ludwigia	0.8 m^2
Nitella	109.9 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

Landa Lake Reach

COMAL RIVER

New Braunfels, Texas

Aquatic Vegetation Study Reach
November 2015

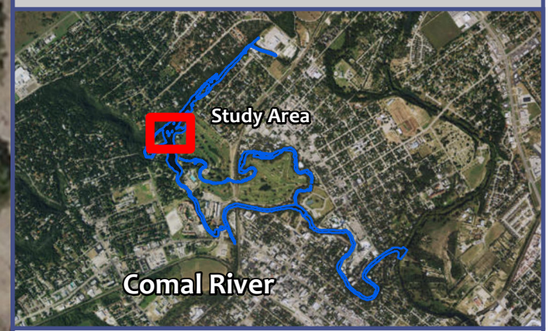
Surveyed: November 20, 2015

LANDA LAKE

Study Reach	23,428.9 m^2

Vegetation Types

Bryophytes	728.6 m^2
Bacopa	4.3 m^2
Cabomba	239.5 m^2
Ludwigia	473.6 m^2
Nuphar	166.9 m^2
Sagittaria	2,758.8 m^2
Vallisneria	12,011.9 m^2



0 50 100 200 Feet

0 20 40 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

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

Upper New Channel Reach

COMAL RIVER

New Braunfels, Texas

Aquatic Vegetation Study Reach
November 2015

Surveyed: November 23, 2015

UPPER NEW CHANNEL

Study Reach	2,023.0 m^2

Vegetation Types

Cabomba	203.0 m^2
Hygrophila	146.4 m^2
Ludwigia	31.2 m^2

0 20 40 80 Feet

0 10 20 Meters

N

BIO-WEST
www.bio-west.com
512.990.3954

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

Lower New Channel Reach

COMAL RIVER

New Braunfels, Texas

Aquatic Vegetation Study Reach
November 2015

Surveyed: November 23, 2015

LOWER NEW CHANNEL

Study Reach 4,258.8 m²

Vegetation Types

Cabomba	2,194.1 m²
Hygrophila	94.3 m²

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

Old Channel Reach

COMAL RIVER

New Braunfels, Texas

Aquatic Vegetation Study Reach
November 2015

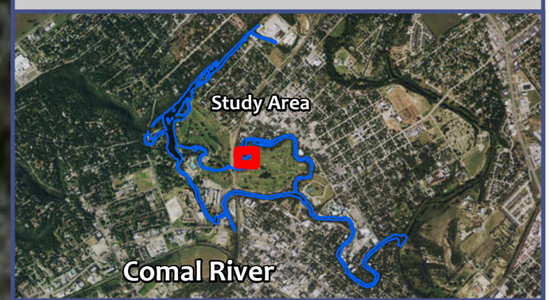
Surveyed: November 22, 2015

OLD CHANNEL

Study Reach	2,797.4 m^2

Vegetation Types

Bryophytes	3.4 m^2
Hygrophila	535.8 m^2
Ludwigia	7.1 m^2
Nuphar	43.5 m^2



0 25 50 100 Feet

0 10 20 Meters

N

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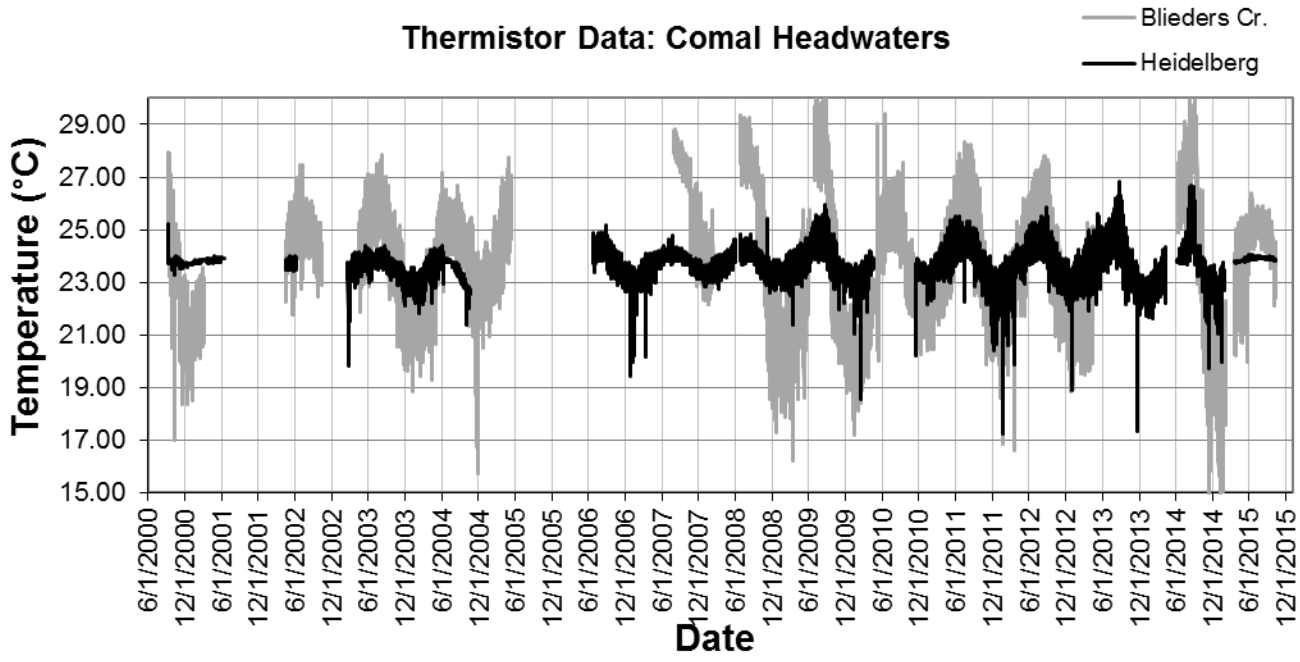
Projection: UTM, NAD 83, 14 North
Map Revised: December 3, 2014

APPENDIX B: DATA AND GRAPHS

Thermistor Graphs


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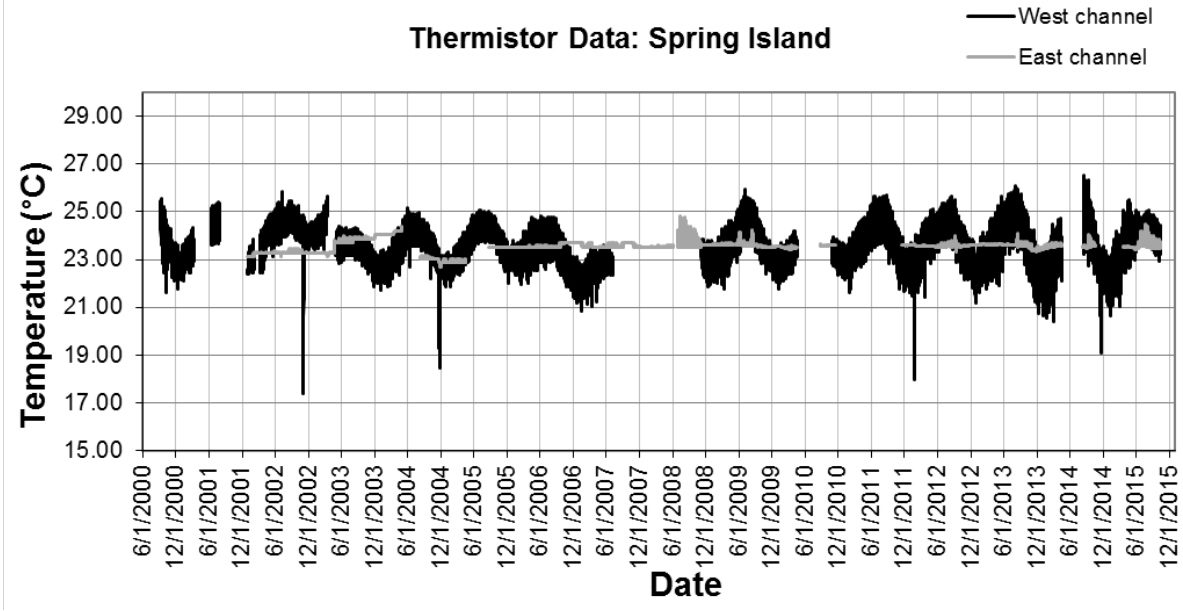
27.00
25.00
23.00
21.00
19.00
17.00
15.00
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
6/1/2006
12/1/2006
6/1/2007
12/1/2007
6/1/2008
12/1/2008
6/1/2009
12/1/2009
6/1/2010
12/1/2010
6/1/2011
12/1/2011
6/1/2012
12/1/2012
6/1/2013
12/1/2013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


Thermistor Data: Spring Island
West channel
East channel
Temperature (°C)
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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
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12/1/2011
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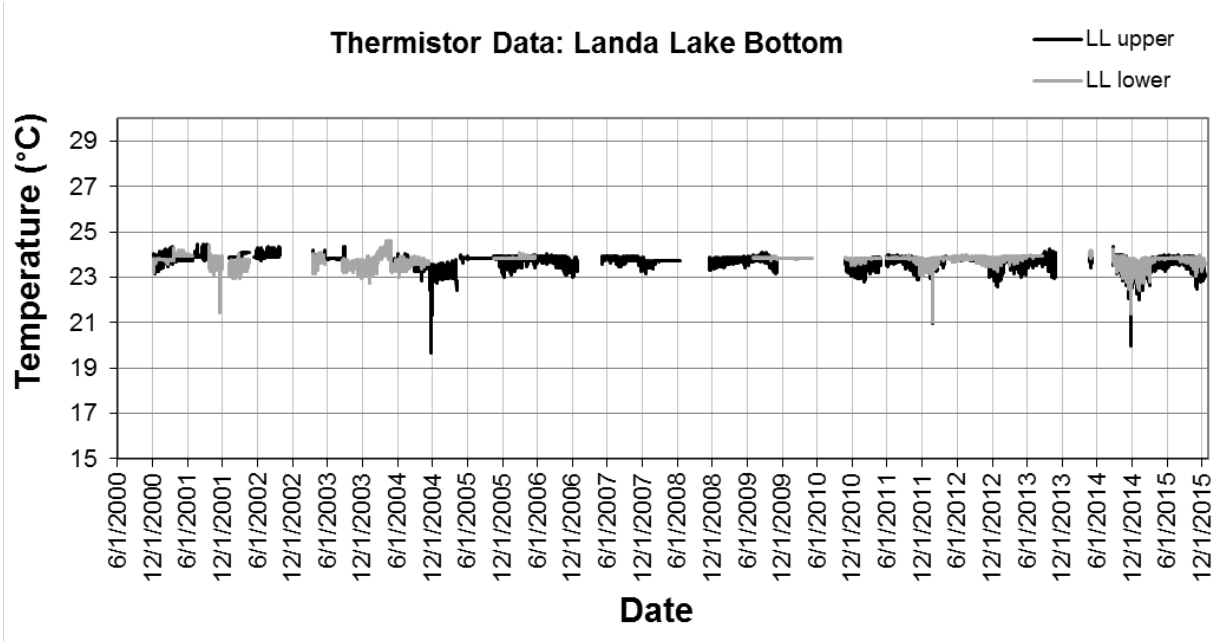
12/1/2015
Date


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
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12/1/2011
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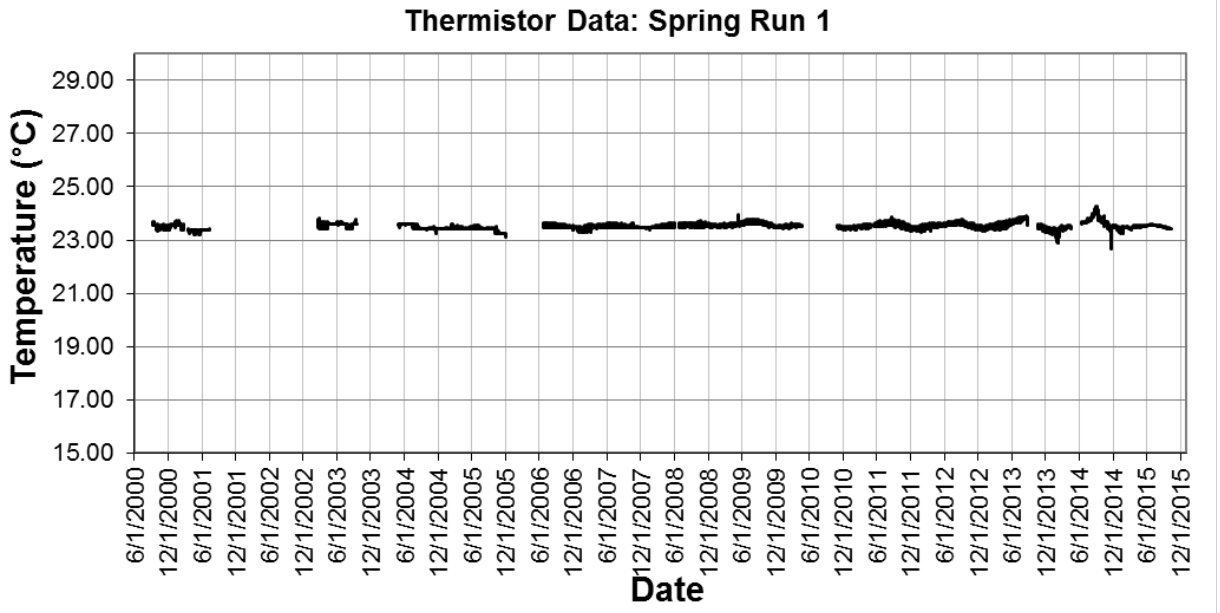
6/1/2015
12/1/2015
Date


Thermistor Data: Spring Run 1
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25.00
23.00
21.00
19.00
17.00
15.00
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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
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12/1/2011
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12/1/2013
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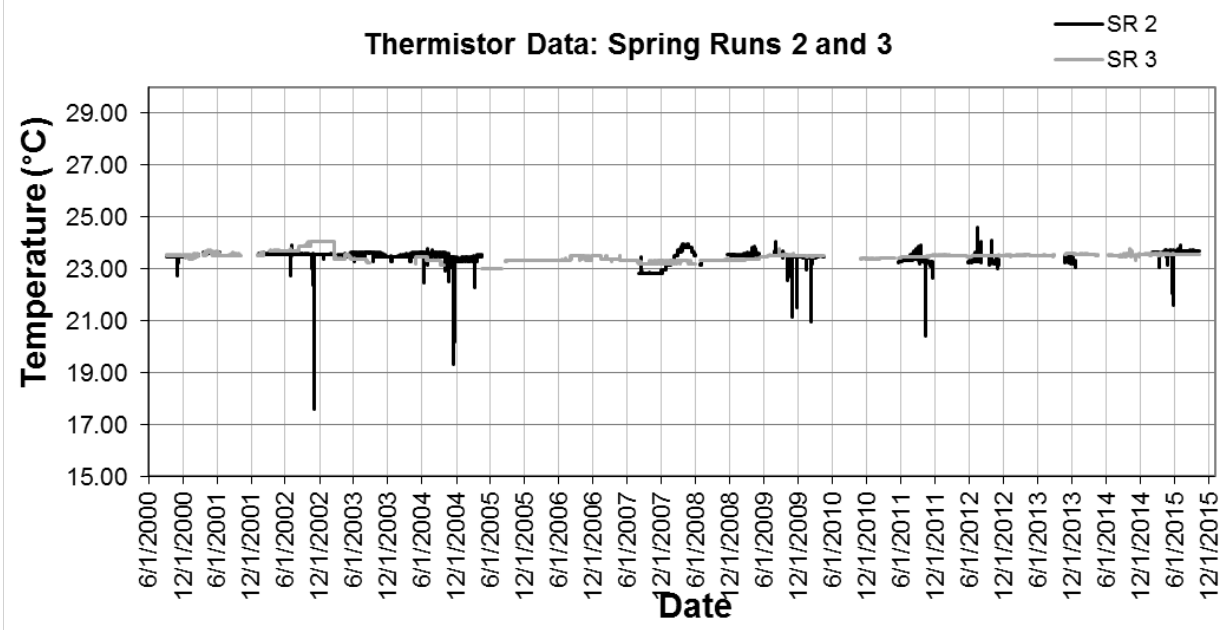
12/1/2014
6/1/2015
12/1/2015
Date


Thermistor Data: Spring Runs 2 and 3
SR 2
SR 3
Temperature (°C)
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27.00
25.00
23.00
21.00
19.00
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15.00
6/1/2000
12/1/2000
6/1/2001
12/1/2001
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12/1/2011
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12/1/2015
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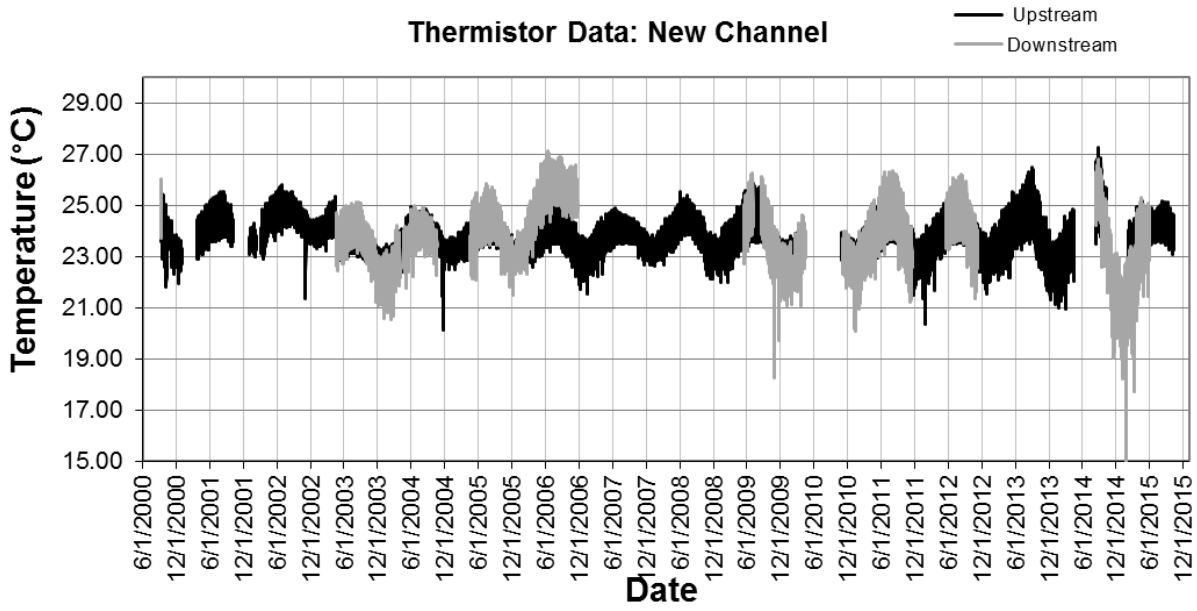
Thermistor Data: New Channel
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Downstream
Temperature (°C)
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23.00
21.00
19.00
17.00
15.00
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
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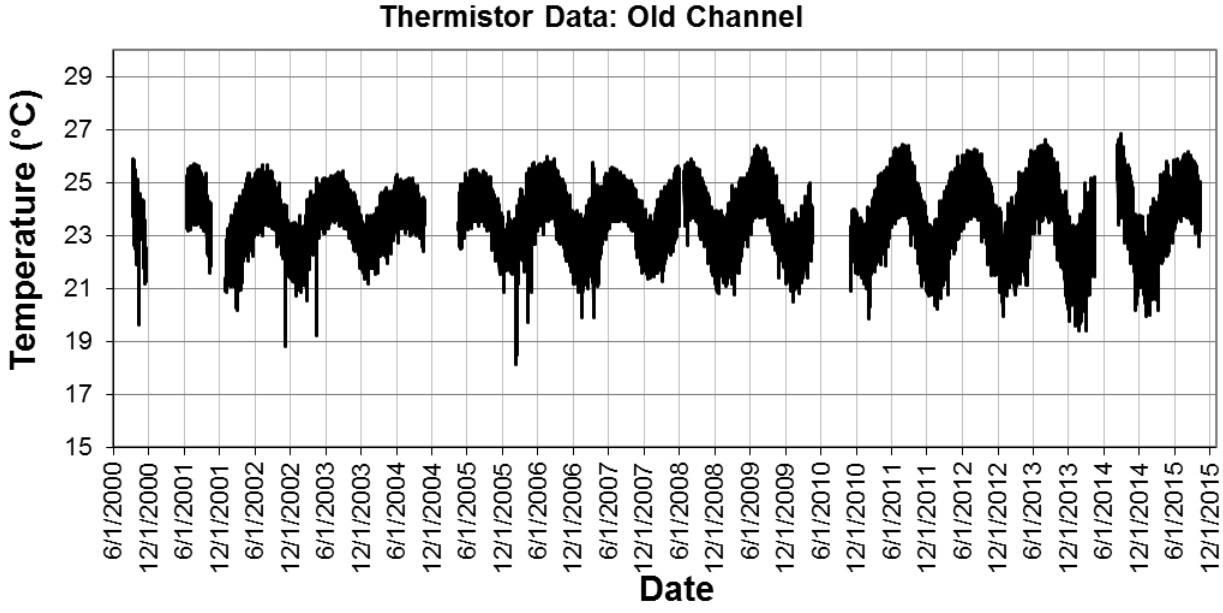
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Temperature (°C)
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27
25
23
21
19
17
15
6/1/2000
12/1/2000
6/1/2001
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12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
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12/1/2011
6/1/2012
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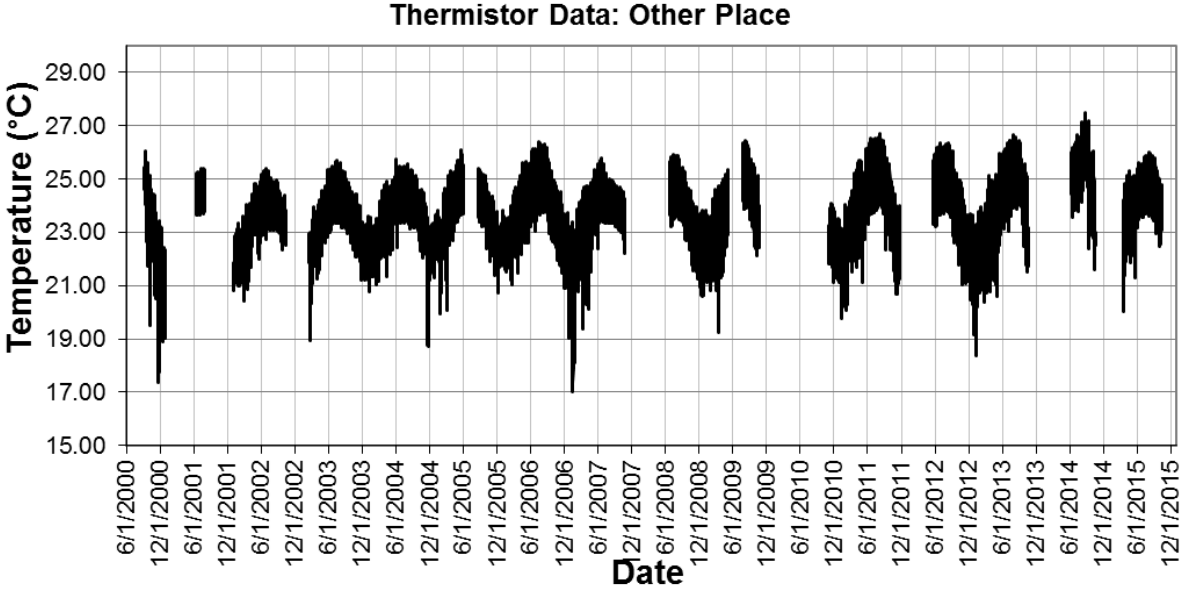
12/1/2013
6/1/2014
12/1/2014
6/1/2015
12/1/2015
Date


Thermistor Data: Other Place
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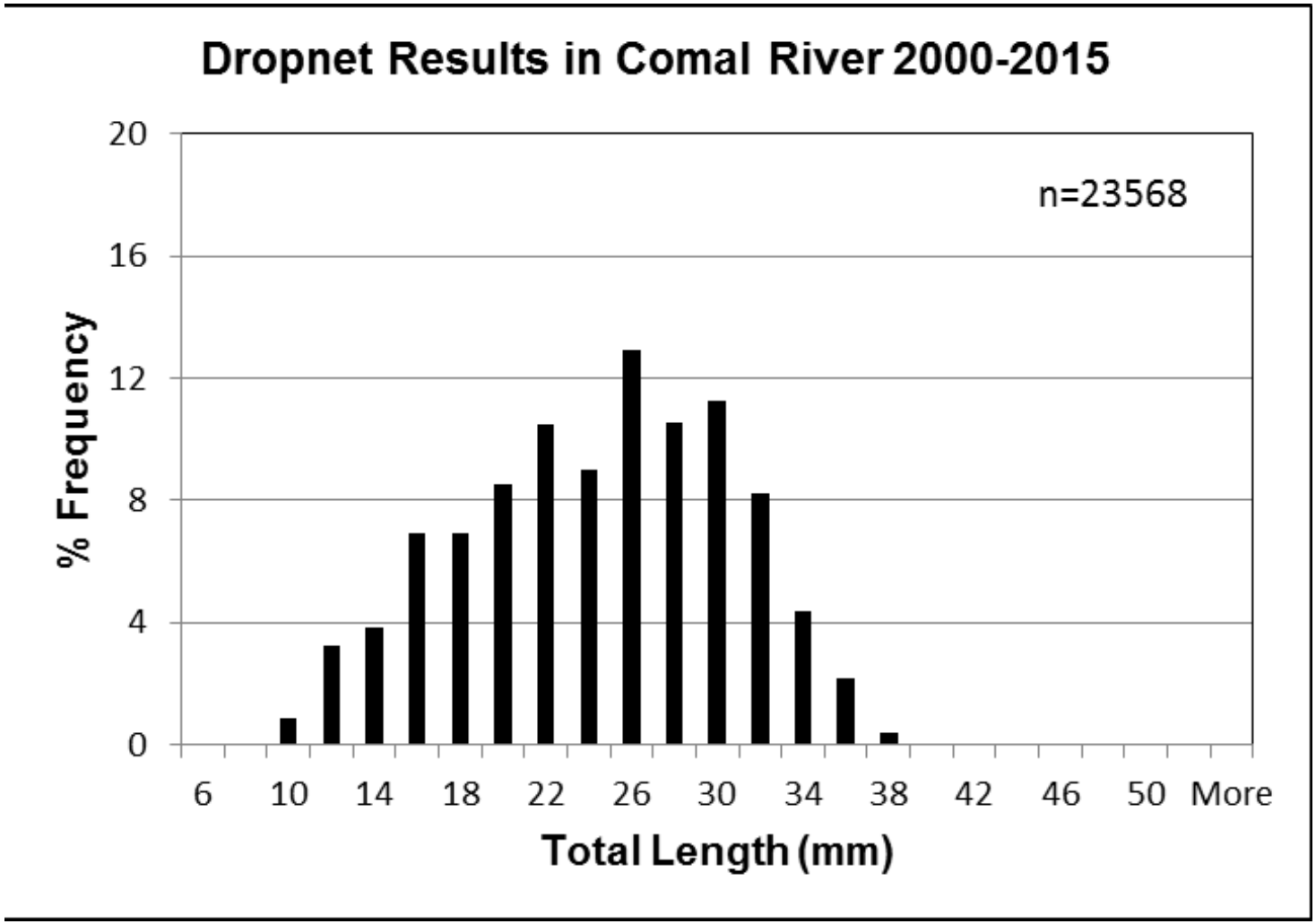
27.00
25.00
23.00
21.00
19.00
17.00
15.00
6/1/2000
12/1/2000
6/1/2001
12/1/2001
6/1/2002
12/1/2002
6/1/2003
12/1/2003
6/1/2004
12/1/2004
6/1/2005
12/1/2005
6/1/2006
12/1/2006
6/1/2007
2/1/2007
6/1/2008
12/1/2008
6/1/2009
12/1/2009
6/1/2010
12/1/2010
6/1/2011
12/1/2011
6/1/2012
12/1/2012
6/1/2013
12/1/2013
6/1/2014
12/1/2014
6/1/2015
12/1/2015
Date

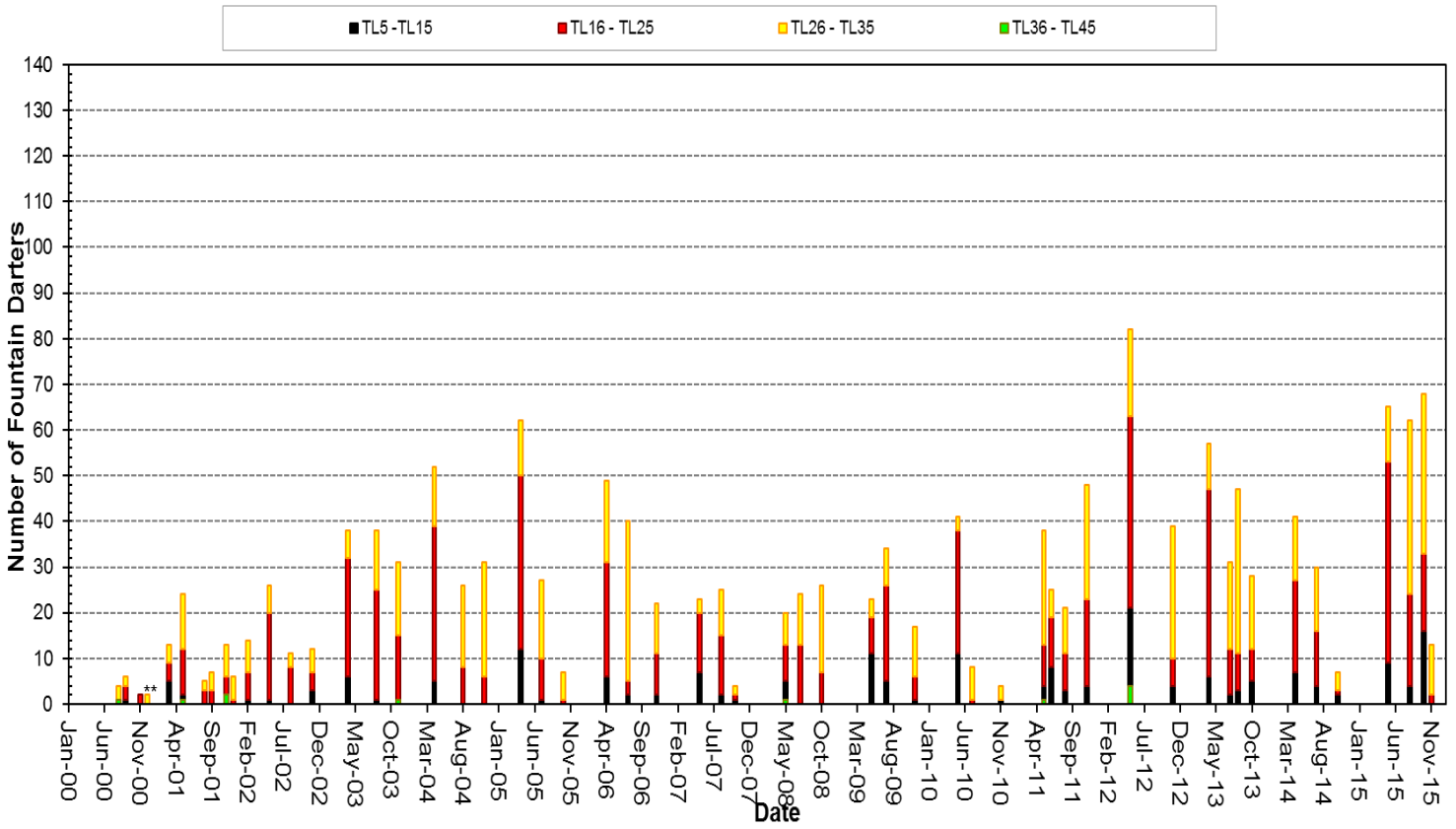
Drop Net Graph


Dropnet Results in Comal River 2000-2015
n=23568
% Frequency
0
4
8
12
16
20
6
10
14
18
22
26
30
34
38
42
46
50
More
Total Length (mm)

Dip Net Graphs

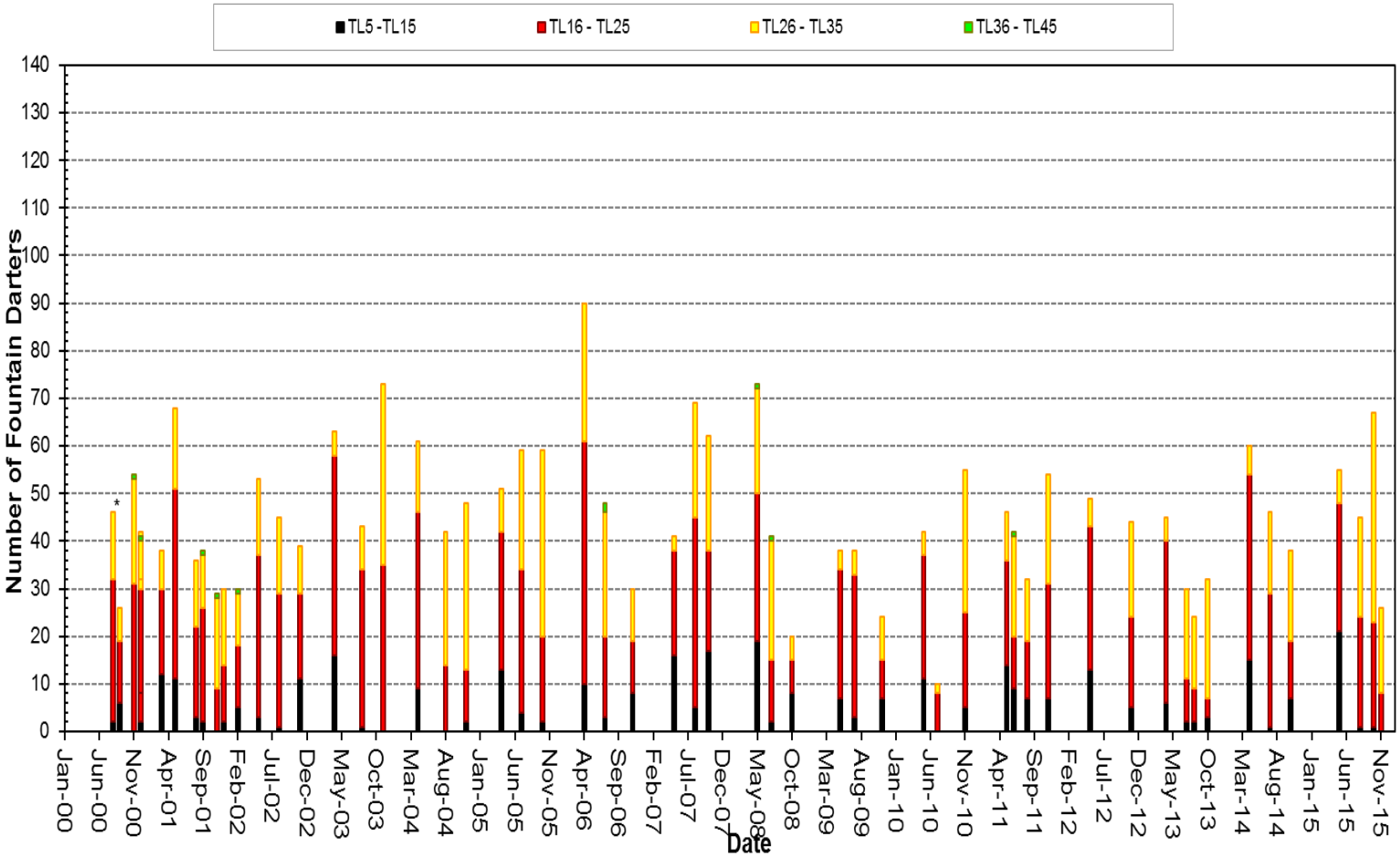
* - Sample time = 1 hr
All others = 30 min

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



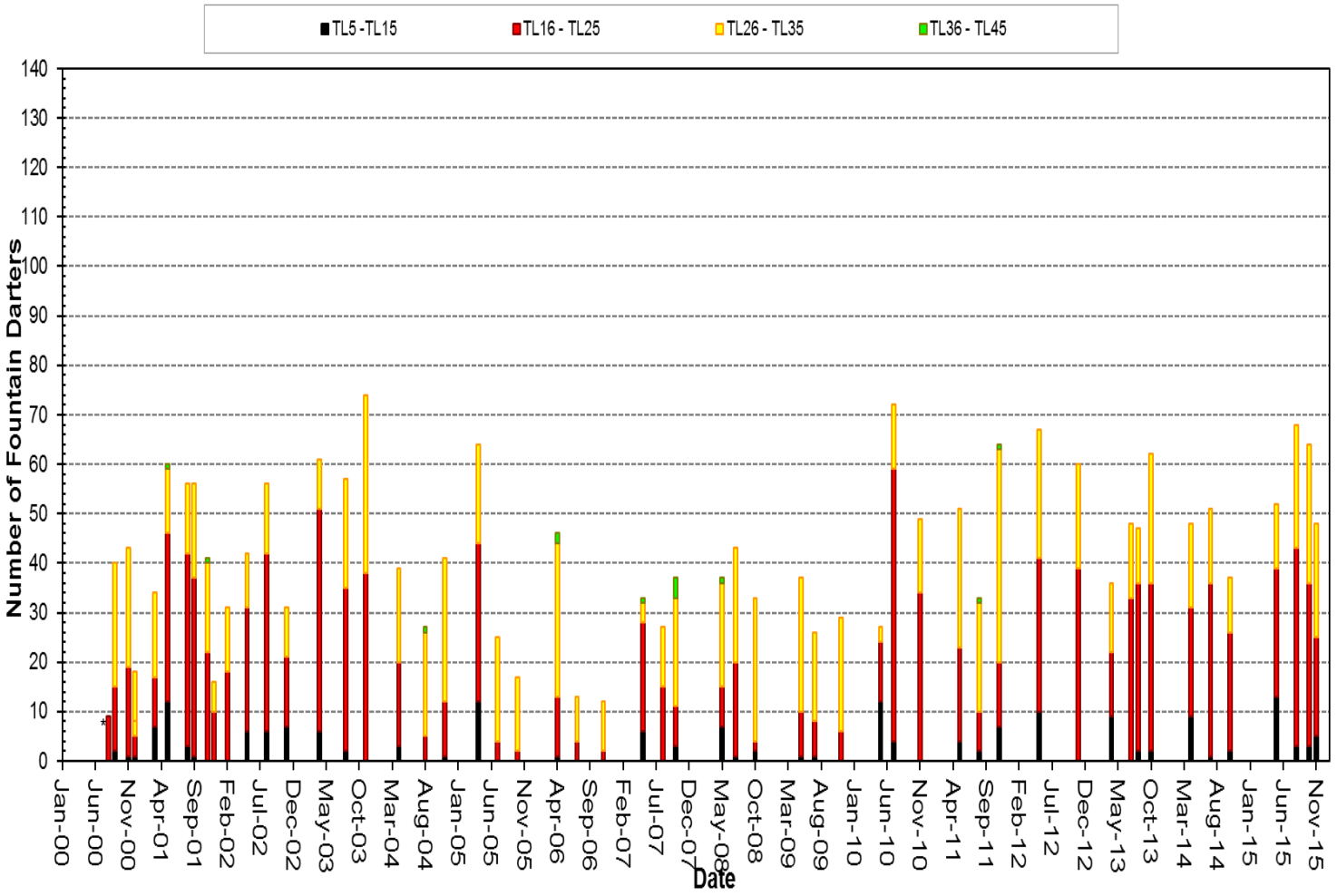
* - Sample time = 1 hr 45 min
All others = 30 min

Fountain Darters Collected from the Spring Island (Section 4U-M) Dip Net Results - Comal River



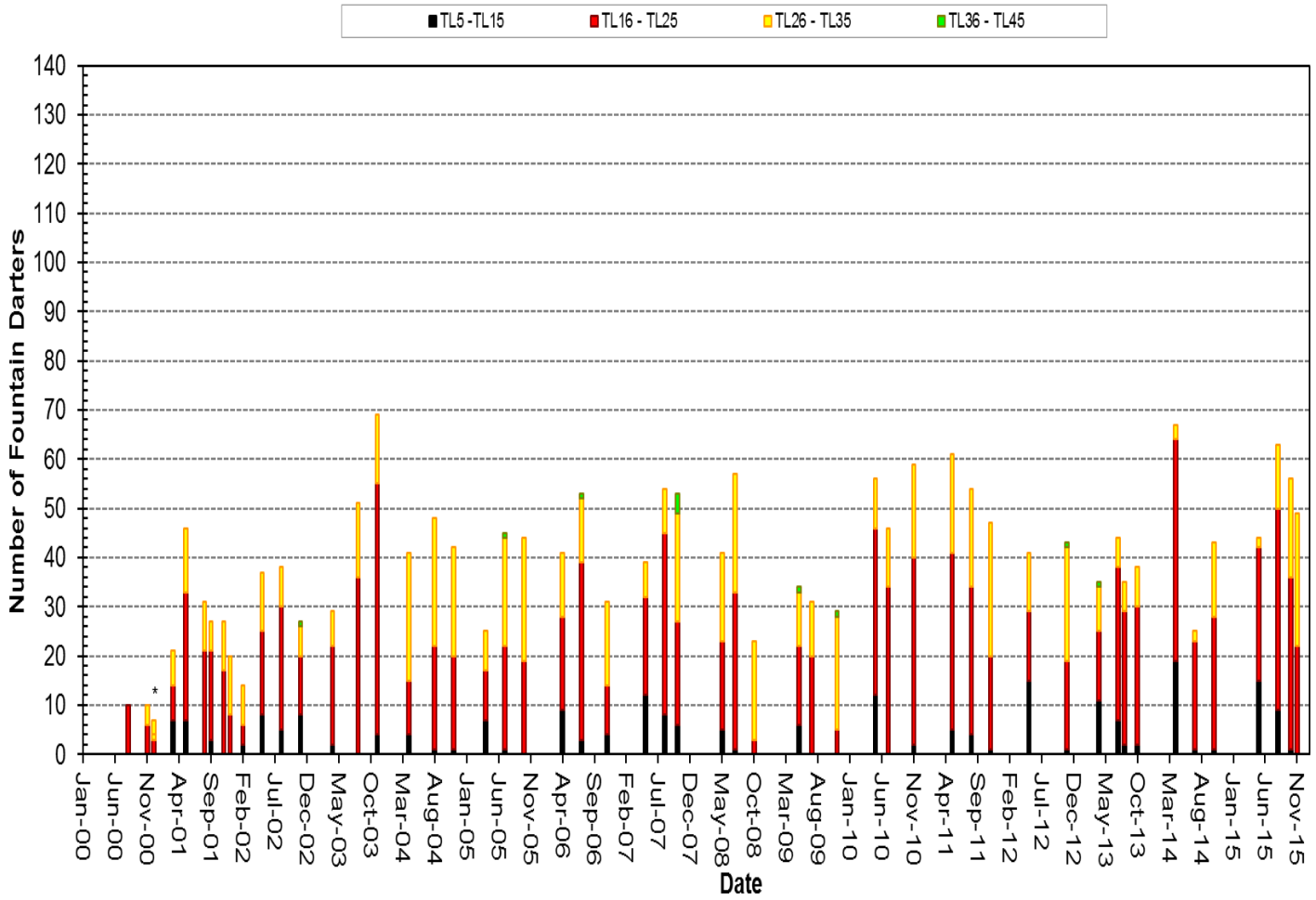
* - Sample time = 1 hr 15 min
All others = 30 min

Fountain Darters Collected from the Landa Lake Reach (Section 4L) Dip Net Results - Comal River

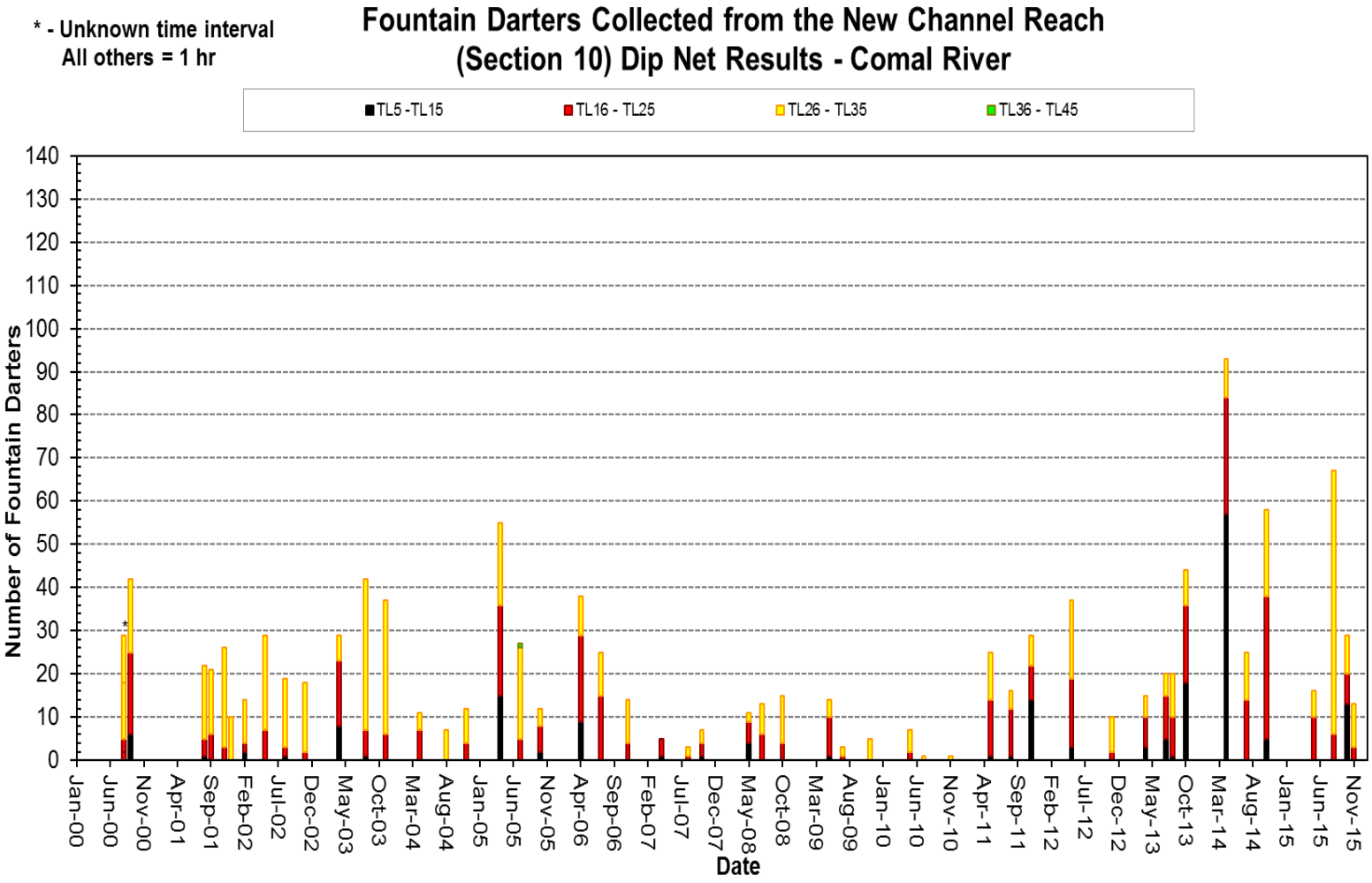


*-Sample Time = 15 Min
All Others = 30 Min

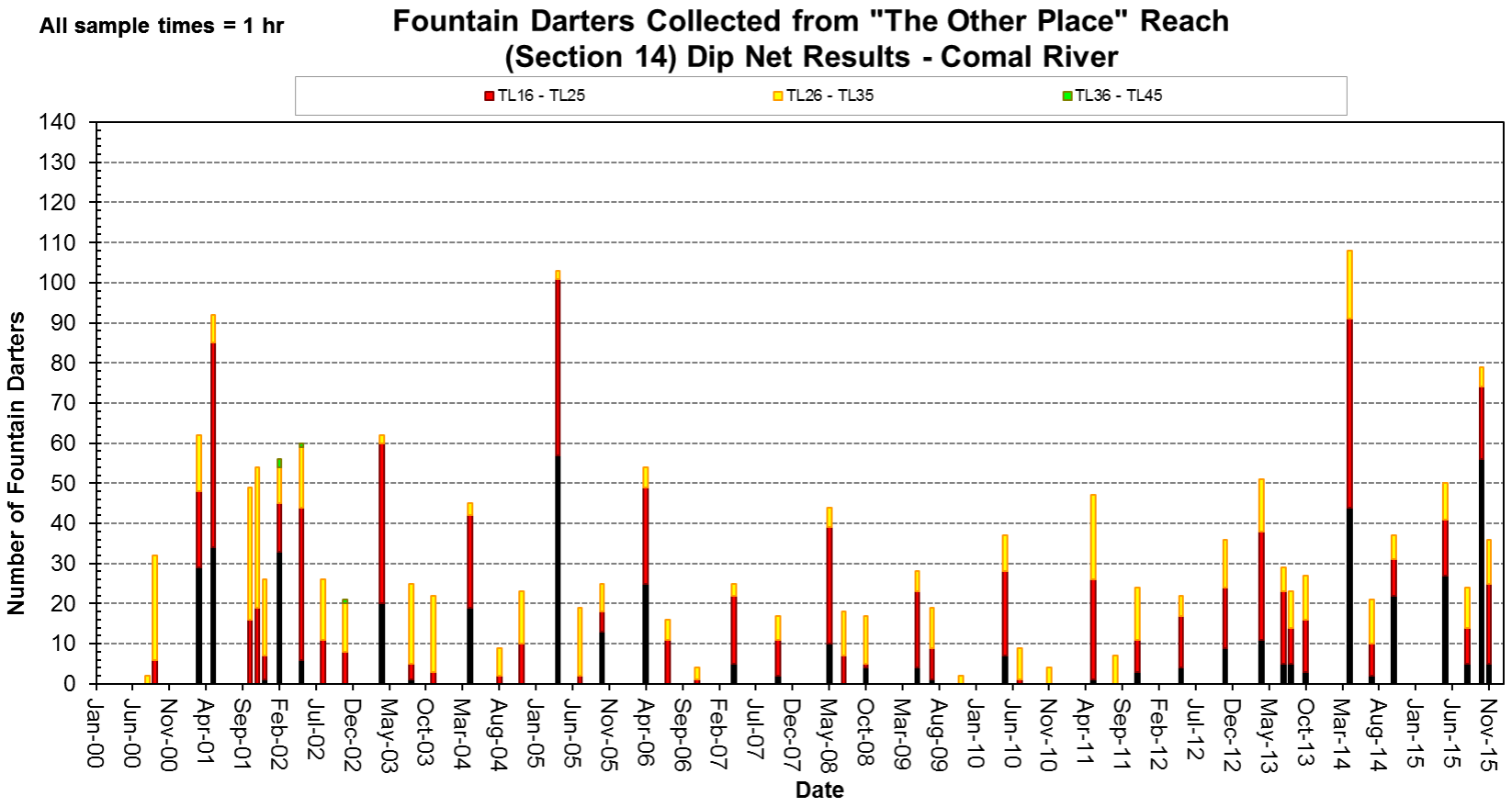
Fountain Darters Collected from the Landa Lake Reach (Section 5) Dip Net Results - Comal River



* - Unknown time interval
All others = 1 hr

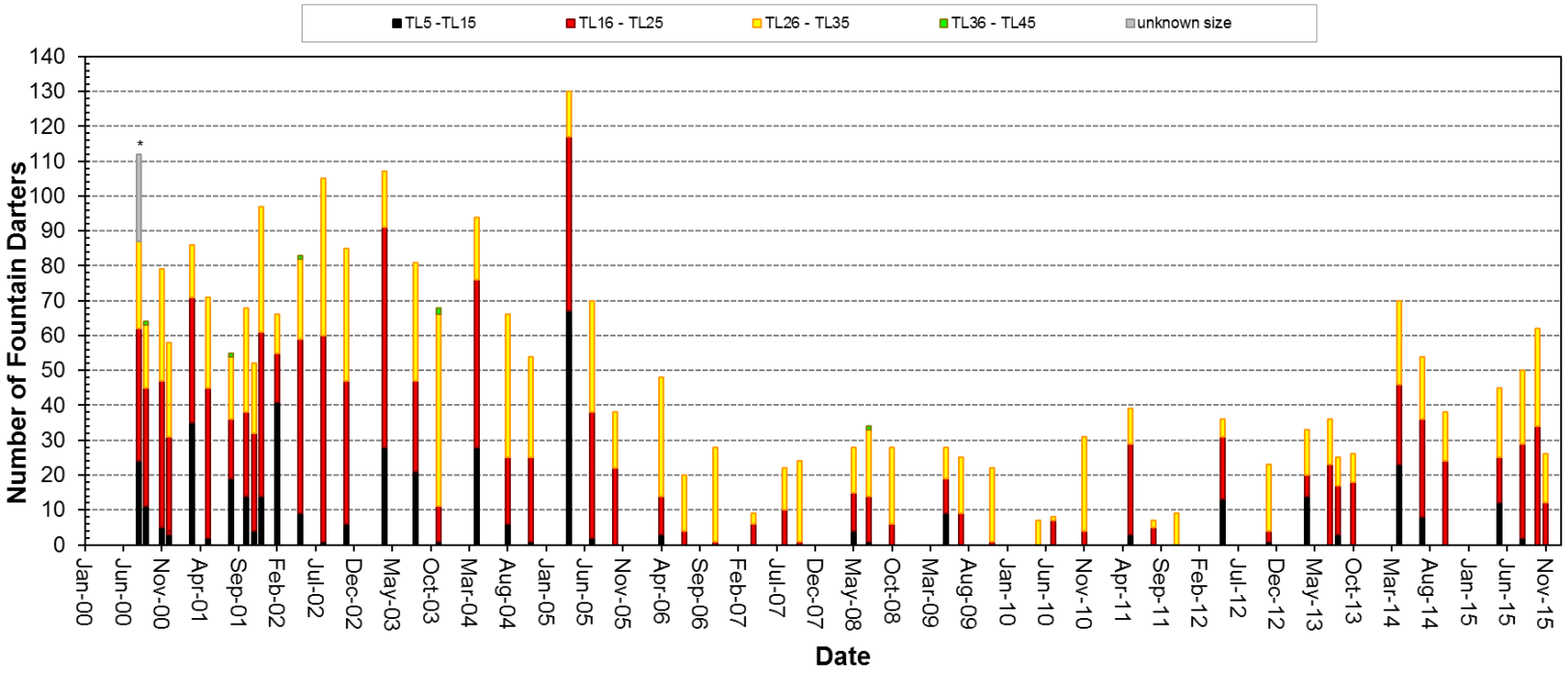


All sample times = 1 hr



* - Sample time = 1.5 hrs
All others = 1 hr

Fountain Darters Collected from the Old Channel Reach (Section 16) Dip Net Results - Comal River



APPENDIX C: DROP NET RAW DATA

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:	Site on Map:
Upper Spring Run		N1-Site 1	
Date:	**Time:**	**Observer(s):**	
11/30/2015	930-955	JG,JW,NP	

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

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	28	30,33,32,27,30,21,34,29,03,31,33,31,34,26,30, 20,29,31,32,29,27,23,33,31,34,27,25,33
	Palaemonetes sp.	9	
	Procambarus sp.	10	
	Gambusia sp.	4	18,21,17,20
	Lepomis sp.	1	23
2	*Etheostoma fonticola*	1	32
	Procambarus sp.	14	
3	*Procambarus* sp.	4	
	Etheostoma fonticola	6	29,29,33,30,34,30
4	*Procambarus* sp.	2	
	Etheostoma fonticola	1	33
5	*Etheostoma fonticola*	2	31,22
6	*Etheostoma fonticola*	10	30,28,25,29,32,32,31,34,34,30
7	*Etheostoma fonticola*	1	30
8	*Etheostoma fonticola*	2	31,29
9	*Etheostoma fonticola*	7	21,30,25,29,32,25,32
10	*Etheostoma fonticola*	1	18
11	*Etheostoma fonticola*	6	30,29,30,30,25,33
	Lepomis miniatus	1	41
	Procambarus sp.	1	
12	No fish or crustaceans collected		
13	*Etheostoma fonticola*	4	27,25,31,30
	Procambarus sp.	1	
14	*Palaemonetes* sp.	1	
15	*Procambarus* sp.	1	
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:	Site on Map:
Upper Spring Run		O2- Site 2	
Date:	**Time:**	**Observer(s):**	
11/30/2015	956-1000	JG,JW,NP	

Overall	Species	Number	Avg. Length (mm)

COMAL RIVER -HIGH FLOW 1 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 -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:	Site on Map:
Upper Spring Run		S1 -Site 3	S3
Date:	**Time:**	**Observer(s):**	
11/30/2015	1003-1017	JG,JW,NP	

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

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Micropterus salmoides*	1	82
	Lepomis miniatus	1	34
	Procambarus sp.	2	
2	*Lepomis miniatus*	1	92
	Procambarus sp.	1	
3	*Lepomis miniatus*	2	46,83
	Procambarus sp.	1	
4	*Procambarus* sp.	9	
5	*Procambarus* sp.	4	
6	*Procambarus* sp.	3	
7	*Procambarus* sp.	2	
8	*Procambarus* sp.	1	
9	*Procambarus* sp.	2	
10	*Procambarus* sp.	1	
11	*Procambarus* sp.	2	
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	No fish or crustaceans collected		
15	*Procambarus* sp.	3	

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:	
Upper Spring Run		O1- Site 4	
Date:	**Time:**	**Observer(s):**	
11/30/2015	1021-1024	JG,JW,NP	
Overall	**Species**	**Number**	**Avg. Length (mm)**

COMAL RIVER -HIGH FLOW 1 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 -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:
Upper Spring Run		S2- Site 5
Date:	**Time:**	**Observer(s):**
11/30/2015	1026-1046	JG,JW,NP

Overall	Species	Number	Avg. Length (mm)
4	*Herichthys cyanoguttatus*		
1	*Palaemonetes* sp.		
17	*Lepomis miniatus*		
7	*Etheostoma fonticola*		
69	*Procambarus* sp.		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Herichthys cyanoguttatus*	1	52
	Lepomis miniatus	1	37
	Etheostoma fonticola	2	36,34
	Procambarus sp.	6	
2	*Procambarus* sp.	3	
	Herichthys cyanoguttatus	1	92
	Lepomis miniatus	4	71,95,93,52
3	*Lepomis miniatus*	2	83,79
	Procambarus sp.	6	
4	*Procambarus* sp.	13	
	Lepomis miniatus	2	133,32
5	*Lepomis miniatus*	1	49
	Procambarus sp.	5	
	Palaemonetes sp.	1	
6	*Lepomis miniatus*	1	94
	Herichthys cyanoguttatus	2	35,43
	Procambarus sp.	8	
7	*Etheostoma fonticola*	1	29
	Lepomis miniatus	1	79
	Procambarus sp.	6	
8	*Lepomis miniatus*	5	62,62,57,76,51
	Procambarus sp.	4	
9	*Procambarus* sp.	4	
10	*Procambarus* sp.	1	
11	*Etheostoma fonticola*	2	83,31
	Procambarus sp.	2	
12	*Etheostoma fonticola*	1	29
13	*Procambarus* sp.	1	
14	*Procambarus* sp.	2	
15	*Procambarus* sp.	5	
	Etheostoma fonticola	1	35
16	*Procambarus* sp.	3	
	**Tarebia granifera* - slight		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):	Site:
Upper Spring Run	N2- Site 6
Date:	**Time:**	**Observer(s):**
11/30/2015	1048-1113	JG,JW,NP

Overall	Species	Number	Avg. Length (mm)
30	*Etheostoma fonticola*		
8	*Gambusia sp.*		
1	*Lepomis cyanellus*		
5	*Lepomis miniatus*		
1	*Micropterus salmoides*		
3	*Herichthys cyanoguttatus*		
49	*Palaemonetes* sp.		
53	*Procambarus* sp.		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Procambarus* sp.	10	
	Etheostoma fonticola	4	33,29,31,29
	Palaemonetes sp.	27	
	Gambusia sp.	5	25,18,9,11,12
2	*Palaemonetes* sp.	4	
	Lepomis miniatus	2	51,31
	Etheostoma fonticola	2	29,37
	Procambarus sp.	9	
3	*Palaemonetes* sp.	8	
	Etheostoma fonticola	8	30,28,34,31,31,27,28,33
	Herichthys cyanoguttatus	1	35
	Gambusia sp.	2	32,16
	Procambarus sp.	6	
4	*Micropterus salmoides*	1	79
	Palaemonetes sp.	2	
5	*Procambarus* sp.	8	
	Herichthys cyanoguttatus	1	35
	Palaemonetes sp.	5	
6	*Etheostoma fonticola*	5	33,31,32,31,21
	Palaemonetes sp.	2	
	Gambusia sp.	1	20
	Procambarus sp.	1	
7	*Lepomis miniatus*	2	30,40
	Etheostoma fonticola	4	30,27,33,36
	Procambarus sp.	6	
	Palaemonetes sp.	1	
8	*Herichthys cyanoguttatus*	1	38
	Lepomis cyanellus	1	44
	Etheostoma fonticola	4	26,29,31,33
	Procambarus sp.	4	
9	*Procambarus* sp.	1	
10	*Procambarus* sp.	3	
11	*Etheostoma fonticola*	1	25
	Procambarus sp.	1	
12	*Procambarus* sp.	1	
	Etheostoma fonticola	1	24
13	*Procambarus* sp.	2	
14	*Lepomis miniatus*	1	44
	Etheostoma fonticola	1	31
	Procambarus sp.	1	
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:	Site on Map:
Upper Spring Run		S3- Site 7	S4
Date:	**Time:**	**Observer(s):**	
11/30/2015	1115-1129	JG,JW,NP	

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

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	4	60,43,55,66
	Procambarus sp.	2	
2	*Procambarus* sp.	1	
3	*Lepomis miniatus*	1	68
	Procambarus sp.	4	
4	No fish or crustaceans collected		
5	*Procambarus* sp.	2	
6	*Procambarus* sp.	2	
7	*Lepomis miniatus*	3	58,61,48
	Procambarus sp.	1	
8	*Lepomis miniatus*	1	80
9	No fish or crustaceans collected		
10	*Lepomis miniatus*	1	105
11	*Lepomis miniatus*	3	80,65,68
	Procambarus sp.	1	
12	*Lepomis miniatus*	2	78,75
13	*Procambarus* sp.	1	
14	No fish or crustaceans collected		
15	*Procambarus* sp.	1	
	**Tarebia granifera* - slight		
	**Melanoides* - slight		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:
Upper Spring Run		N3- Site 8
Date:	**Time:**	**Observer(s):**
11/30/2015	1137-1156	JG,JW,NP

Overall	Species	Number	Avg. Length (mm)
14	*Etheostoma fonticola*		
1	*Dionda nigrotaeniata*		
4	*Gambusia sp.*		
1	*Palaemonetes* sp.		
12	*Procambarus* sp.		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

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

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		**Site:**
Landa Lake		L2- Site 1
Date:	**Time:**	**Observer(s):**
12/1/2015	922-939	JW,JJ,JG,NP

Overall	**Species**	**Number**	**Avg. Length (mm)**
19	*Gambusia* sp.		
13	*Procambarus* sp.		
1	*Herichthys cyanoguttatus*		
7	*Etheostoma fonticola*		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Gambusia* sp.	11	15,18,23,20,21,17,13,29,12,17,12
	Etheostoma fonticola	1	26
2	*Gambusia* sp.	3	27,19,16
3	*Etheostoma fonticola*	3	30,32,32
	Gambusia sp.	2	16,13
4	*Gambusia* sp.	2	17,19
5	*Procambarus* sp.	3	
	Etheostoma fonticola	1	33
6	*Procambarus* sp.	1	
7	*Procambarus* sp.	1	
8	*Procambarus* sp.	1	
9	*Etheostoma fonticola*	2	20,22
	Procambarus sp.	4	
	Gambusia sp.	1	15
10	*Procambarus* sp.	1	
11	*Herichthys cyanoguttatus*	1	37
	Procambarus sp.	1	32
12	No fish or crustaceans collected		
13	No fish or crustaceans collected		
14	*Procambarus* sp.	1	
15	No fish or crustaceans collected		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:
Landa Lake		C2 -Site 2
Date:	**Time:**	**Observer(s):**
12/1/2015	951-1033	JW,JJ,JG,NP

Overall	Species	Number	Avg. Length (mm)
457	*Gambusia* sp.		
23	*Etheostoma fonticola*		
67	*Procambarus* sp.		
19	*Palaemonetes* sp.		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	97	31,22,20,10,10,10,8,27,23,19,32,28,29,25,37,21,26, 10,20,10,41,22,10,15,24
	Etheostoma fonticola	3	34,24,30
	Palaemonetes sp.	13	
	Procambarus sp.	10	
2	*Gambusia* sp.	178	
	Palaemonetes sp.	4	
3	*Gambusia* sp.	113	
	Etheostoma fonticola	1	34
4	*Etheostoma fonticola*	5	33,22,30,21,21
	Gambusia sp.	39	
	Procambarus sp.	11	
5	*Palaemonetes* sp.	1	
	Etheostoma fonticola	7	32,27,30,31,26,25,30
	Procambarus sp.	9	
	Gambusia sp.	6	
6	*Etheostoma fonticola*	1	27
	Procambarus sp.	5	
7	*Etheostoma fonticola*	1	34
	Procambarus sp.	7	
	Gambusia sp.	4	
	Palaemonetes sp.	1	
8	*Procambarus* sp.	3	
	Gambusia sp.	4	
9	*Etheostoma fonticola*	3	26,24,19
	Procambarus sp.	3	
	Gambusia sp.	1	
10	*Etheostoma fonticola*	1	34
	Gambusia sp.	6	
	Procambarus sp.	2	
11	*Procambarus* sp.	4	
	Gambusia sp.	4	
12	*Etheostoma fonticola*	1	33
	Procambarus sp.	4	
	Gambusia sp.	3	
13	*Procambarus* sp.	4	
14	*Procambarus* sp.	3	
15	*Gambusia* sp.	2	
	Procambarus sp.	2	
	Marisa cornuarietis	7	43,43,47,40,27,37,30
	***Melanoides-slight*		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		**Site:**
Landa Lake		C1- Site 3
Date:	**Time:**	**Observer(s):**
12/1/2015	1039-1103	JW,JJ,JG,NP

Overall	**Species**	**Number**	**Avg. Length (mm)**
19	*Procambarus* sp.		
14	*Etheostoma fonticola*		
181	*Gambusia* sp.		
5	*Lepomis miniatus*		
22	*Palaemonetes* sp.		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Gambusia* sp.	81	18,35,13,36,19,27,23,17,30,13,15,11,20,15,15,12,22,32, 10,13,18,20,25,20,32
	Etheostoma fonticola	1	31
	Palaemonetes sp.	7	
	Procambarus sp.	4	
2	*Etheostoma fonticola*	3	25,32,31
	Gambusia sp.	21	
	Palaemonetes sp.	11	
	Procambarus sp.	8	
3	*Etheostoma fonticola*	1	32
	Procambarus sp.	3	
	Palaemonetes sp.	2	
	Gambusia sp.	44	
4	*Gambusia* sp.	17	
	Etheostoma fonticola	1	34
	Palaemonetes sp.	1	
5	*Lepomis miniatus*	1	45
	Etheostoma fonticola	2	32,25
	Gambusia sp.	11	
	Procambarus sp.	1	
6	*Gambusia* sp.	2	
7	*Etheostoma fonticola*	1	26
	Palaemonetes sp.	2	
	Gambusia sp.	1	
8	*Etheostoma fonticola*	1	29
	Lepomis miniatus	1	
	Procambarus sp.	1	
	Gambusia sp.	1	
9	*Lepomis miniatus*	1	50
10	*Procambarus* sp.	1	
	Palaemonetes sp.	1	
11	*Lepomis miniatus*	1	98
	Gambusia sp.	1	
	Palaemonetes sp.	1	
	Procambarus sp.	1	
12	*Etheostoma fonticola*	1	32
13	No fish or crustaceans collected		
14	*Lepomis miniatus*	1	36
	Gambusia sp.	1	
15	*Gambusia* sp.	1	
	Marisa cornuarietis	1	38
	***Melanoides-slight*		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:
Landa Lake		V2 -Site 4
Date:	**Time:**	**Observer(s):**
12/1/2015	1110-1130	JW,JJ,JG,NP

Overall	Species	Number	Avg. Length (mm)
36	*Procambarus* sp.		
6	*Lepomis miniatus*		
2	*Gambusia* sp.		
2	*Herichthys cyanoguttatus*		
3	*Ameiurus natalis*		
2	*Palaemonetes* sp.		
4	*Etheostoma fonticola*		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	1	22
	Palaemonetes sp.	1	
	Etheostoma fonticola	1	23
	Ameiurus natalis	1	48
	Procambarus sp.	1	
2	*Gambusia* sp.	1	11
	Procambarus sp.	2	
3	*Etheostoma fonticola*	1	33
	Herichthys cyanoguttatus	1	39
	Lepomis miniatus	1	45
	Procambarus sp.	3	
	Palaemonetes sp.	1	
4	*Lepomis miniatus*	3	100,89,80
	Ameiurus natalis	1	97
	Procambarus sp.	4	
5	*Lepomis miniatus*	1	110
	Procambarus sp.	6	
6	*Procambarus* sp.	3	
7	*Herichthys cyanoguttatus*	1	38
	Procambarus sp.	5	
8	*Procambarus* sp.	1	
	Lepomis miniatus	1	67
	Etheostoma fonticola	2	30,17
9	*Procambarus* sp.	1	
10	*Procambarus* sp.	2	
11	*Procambarus* sp.	2	
12	*Procambarus* sp.	2	
13	No fish or crustaceans collected		
14	*Procambarus* sp.	3	
15	*Ameiurus natalis*	1	
	Procambarus sp.	1	
	Marisa cornuarietis	1	35

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:
Landa Lake		O1 - Site 5
Date:	**Time:**	**Observer(s):**
12/1/2015	1135-1143	JW,JJ,JG,NP

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

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	1	15
2	*Etheostoma fonticola*	1	19
	Procambarus sp.	1	
3	No fish or crustaceans collected		
4	No fish or crustaceans collected		
5	*Etheostoma fonticola*	1	25
6	*Gambusia* sp.	1	27
7	No fish or crustaceans collected		
8	*Palaemonetes* sp.	1	
9	No fish or crustaceans collected		
10	No fish or crustaceans collected		
11	*Lepomis miniatus*	1	44
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 -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:
Landa Lake		H2 - Site 6
Date:	**Time:**	**Observer(s):**
12/1/2015	1145-1209	JW,JJ,JG,NP

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

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

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

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:
Landa Lake		L1- Site 7
Date:	**Time:**	**Observer(s):**
12/1/2015	1212-1240	JW,JJ,JG,NP

Overall	Species	Number	Avg. Length (mm)
23	*Gambusia* sp.		
42	*Procambarus* sp.		
5	*Palaemonetes* sp.		
23	*Etheostoma fonticola*		
3	*Lepomis miniatus*		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia* sp.	17	32,22,26,20,10,11,31,17,10,17,13,13,12,13,10,10,15
2	*Palaemonetes* sp.	1	
	Etheostoma fonticola	5	29,34,24,34,16
	Gambusia sp.	1	28
3	*Procambarus* sp.	7	
	Etheostoma fonticola	2	24,15
	Lepomis miniatus	1	70
	Palaemonetes sp.	2	
	Gambusia sp.	2	
4	*Procambarus* sp.	7	
	Gambusia sp.	1	20
	Lepomis miniatus	2	32,37
	Etheostoma fonticola	5	30,29,30,30,27
5	*Procambarus* sp.	6	
	Palaemonetes sp.	1	
	Etheostoma fonticola	1	26
6	*Gambusia* sp.	1	35
	Procambarus sp.	2	
7	*Procambarus* sp.	7	
	Gambusia sp.	1	17
	Etheostoma fonticola	2	15,21
8	*Procambarus* sp.	2	
	Palaemonetes sp.	1	
	Etheostoma fonticola	2	28,12
9	*Etheostoma fonticola*	3	29,15,27
	Procambarus sp.	3	
10	*Etheostoma fonticola*	1	24
11	*Procambarus* sp.	2	
12	*Procambarus* sp.	2	
	Etheostoma fonticola	1	29
13	*Procambarus* sp.	1	
14	*Etheostoma fonticola*	1	29
15	*Procambarus* sp.	3	
	***Melanoides-slight*		
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:
Landa Lake		V1- Site 8
Date:	**Time:**	**Observer(s):**
12/1/2015	1318-1340	JW,JJ,JG,NP

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

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	4	135,98,122,82
	Procambarus sp.	6	
	Palaemonetes sp.	5	
	Gambusia sp.	53	28,20,16,17,30,29,10,22,15,15,18,17,13,16,21,23, 20,17,14,27,17,20,28,19,20
2	*Etheostoma fonticola*	1	22
	Gambusia sp.	14	
	Palaemonetes sp.	1	
	Procambarus sp.	1	
3	*Lepomis miniatus*	1	162
	Etheostoma fonticola	2	23,17
	Procambarus sp.	5	
4	*Gambusia* sp.	4	
5	*Gambusia* sp.	5	
	Procambarus sp.	9	
6	*Etheostoma fonticola*	1	26
	Procambarus sp.	2	
	Gambusia sp.	3	
7	*Gambusia* sp.	1	
	Procambarus sp.	2	
8	*Procambarus* sp.	2	
	Gambusia sp.	2	
9	*Gambusia* sp.	1	
	Procambarus sp.	1	
10	*Procambarus* sp.	2	
	Gambusia sp.	1	
11	*Etheostoma fonticola*	1	11
	Palaemonetes sp.	1	
12	*Gambusia* sp.	5	
	Procambarus sp.	1	
13	*Lepomis miniatus*	1	40
	Procambarus sp.	1	
14	*Etheostoma fonticola*	1	24
15	*Palaemonetes* sp.	1	
	**Tarebia granifera - moderate*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		**Site:**
Landa Lake		H1 - Site 9
Date:	**Time:**	**Observer(s):**
12/1/2015	1345-1410	JW,JJ,JG,NP

Overall	**Species**	**Number**	**Avg. Length (mm)**
77	*Procambarus* sp.		
1	*Poecilia latipinna*		
4	*Lepomis miniatus*		
2	*Herichthys cyanoguttatus*		
24	*Etheostoma fonticola*		
118	*Gambusia* sp.		
11	*Palaemonetes* sp.		
1	*Dionda nigrotaeniata*		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Gambusia* sp.	93	29,19,20,22,17,15,20,14,17,20,16,14,12, 24,19,13,26,12,15,22,20,25,14,23,25,20,15
	Dionda nigrotaeniata	1	47
	Etheostoma fonticola	7	29,27,30,26,23,30,14
	Palaemonetes sp.	5	
	Procambarus sp.	1	
2	*Procambarus* sp.	8	
	Lepomis miniatus	1	28
	Herichthys cyanoguttatus	1	39
	Etheostoma fonticola	4	26,36,30,31
	Gambusia sp.	8	
	Palaemonetes sp.	4	
3	*Procambarus* sp.	10	
	Etheostoma fonticola	2	24,29
	Gambusia sp.	7	
	Palaemonetes sp.	2	
4	*Etheostoma fonticola*	3	26,28,31
	Procambarus sp.	4	
	Gambusia sp.	1	
5	*Procambarus* sp.	10	
6	*Procambarus* sp.	8	
7	*Etheostoma fonticola*	3	26,37,29
	Lepomis miniatus	1	70
	Procambarus sp.	7	
	Gambusia sp.	1	
8	*Lepomis miniatus*	1	35
	Etheostoma fonticola	2	24,21
	Procambarus sp.	8	
	Gambusia sp.	5	
9	*Etheostoma fonticola*	2	32,21
	Procambarus sp.	6	
10	*Procambarus* sp.	2	
	Herichthys cyanoguttatus	1	40
11	*Lepomis miniatus*	1	82
	Procambarus sp.	1	
	Gambusia sp.	1	
12	*Poecilia latipinna*	1	34
13	*Procambarus* sp.	2	
	Gambusia sp.	1	
14	*Etheostoma fonticola*	1	23
	Procambarus sp.	6	
	Gambusia sp.	1	
15	*Procambarus* sp.	4	
	**Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):	Site:	Site on Map:
Landa Lake	R2- Site 10	R3

Date:	Time:	Observer(s):
12/1/2015	1415-1450	JW,JJ,JG,NP

Overall	Species	Number	Avg. Length (mm)
59	*Etheostoma fonticola*		
3	*Palaemonetes* sp.		
7	*Gambusia* sp.		
161	*Procambarus* sp.		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	4	29,31,27,29
	Gambusia sp.	1	14
	Procambarus sp.	9	
	Palaemonetes sp.	1	
2	*Etheostoma fonticola*	22	27,22,30,31,34,27,38,29,32,20,30,29,33,32,35,30,32,29,32,33,32,26
	Procambarus sp.	53	
	Palaemonetes sp.	1	
	Gambusia sp.	1	15
3	*Etheostoma fonticola*	8	29,30,31,28,23,34,31,32
	Gambusia sp.	2	16,11
	Procambarus sp.	35	
4	*Procambarus* sp.	17	
	Etheostoma fonticola	5	26,31,22,32,32
	Gambusia sp.	1	17
5	*Etheostoma fonticola*	6	35,30,19,29,25,33
	Procambarus sp.	7	
6	*Etheostoma fonticola*	1	29
	Procambarus sp.	8	
7	*Etheostoma fonticola*	7	30,31,30,32,21,28,32
	Procambarus sp.	8	
8	*Etheostoma fonticola*	3	27,29,24
	Procambarus sp.	10	
9	*Procambarus* sp.	8	
	Palaemonetes sp.	1	
10	*Procambarus* sp.	1	
11	*Etheostoma fonticola*	1	28
	Gambusia sp.	1	15
	Procambarus sp.	2	
12	*Procambarus* sp.	1	
13	*Etheostoma fonticola*	1	25
	Gambusia sp.	1	17
14	*Procambarus* sp.	2	
15	*Etheostoma fonticola*	1	34
16	No fish or crustaceans collected		
	**Tarebia granifera - moderate*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		**Site:**
Landa Lake		R1 - Site 11
Date:	**Time:**	**Observer(s):**
12/1/2015	1455-1519	JW,JJ,JG,NP

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

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Etheostoma fonticola*	2	27,14
	Procambarus sp.	29	
2	*Procambarus* sp.	11	
	Etheostoma fonticola	8	27,34,33,30,15,24,29,14
3	*Procambarus* sp.	9	
4	*Etheostoma fonticola*	11	21,23,29,31,24,28,21,30,27,29,17
	Procambarus sp.	3	
5	*Etheostoma fonticola*	2	30,28
	Procambarus sp.	7	
6	*Procambarus* sp.	6	
	Etheostoma fonticola	2	31,33
7	*Etheostoma fonticola*	6	28,35,21,30,20,32
	Gambusia sp.	2	18,14
	Procambarus sp.	3	
8	*Procambarus* sp.	3	
9	*Procambarus* sp.	1	
10	*Etheostoma fonticola*	2	24,29
11	*Etheostoma fonticola*	1	31
	Procambarus sp.	1	
12	*Etheostoma fonticola*	3	26,27,32
13	*Etheostoma fonticola*	3	30,27,23
14	*Etheostoma fonticola*	1	35
	Procambarus sp.	1	
15	*Etheostoma fonticola*	1	30
	Gambusia sp.	1	23
	Procambarus sp.	1	
16	*Etheostoma fonticola*	1	27
17	No fish or crustaceans collected		
	**Tarebia granifera - moderate*		

DROP NET - FIELD DATA SHEETS
COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		**Site:**	
Landa Lake		O2 - Site 12	
Date:	**Time:**	**Observer(s):**	
12/1/2015	1522-1533	JW,JJ,JG,NP	
Overall	**Species**	**Number**	**Avg. Length (mm)**
61	*Gambusia* sp.		
18	*Etheostoma fonticola*		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

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

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:	Site on map:
New Channel		C1-Site 1	
Date:	**Time:**	**Observer(s):**	
12/2/2015	924-952	JJ,JW,NP,JG	

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

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis cyanellus*	1	32
	Lepomis macrochirus	2	26,29
	Gambusia sp.	3	16,17,16
	Procambarus sp.	15	
2	*Gambusia sp.*	1	12
	Procambarus sp.	2	
	Lepomis macrochirus	1	24
3	*Lepomis cyanellus*	1	35
	Etheostoma fonticola	1	26
	Gambusia sp.	1	12
	Lepomis macrochirus	1	27
	Procambarus sp.	13	
4	*Procambarus* sp.	10	
	Palaemonetes sp.	1	
	Etheostoma fonticola	1	18
5	*Procambarus* sp.	2	
	Etheostoma fonticola	1	25
6	*Procambarus* sp.	1	
7	*Procambarus* sp.	3	
8	*Procambarus* sp.	12	
9	*Lepomis macrochirus*	2	24
	Procambarus sp.	5	
10	*Procambarus* sp.	1	
11	*Procambarus* sp.	4	
12	*Etheostoma fonticola*	1	29
	Procambarus sp.	1	
13	*Etheostoma fonticola*	1	22
	Procambarus sp.	5	
14	No fish or crustaceans collected		
15	*Etheostoma fonticola*	1	30
	Lepomis miniatus	1	64
		95	
16	No fish or crustaceans collected		
	**Tarebia granifera -slight*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:	Site on map:
New Channel		C2- Site 2	
Date:	**Time:**	**Observer(s):**	
12/2/2015	956-1012	JJ,JW,NP,JG	

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

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Lepomis miniatus*	1	40
	Lepomis cyanellus	1	46
	Lepomis macrochirus	1	30
	Procambarus sp.	1	
2	*Lepomis macrochirus*	1	32
	Lepomis miniatus	1	46
3	No fish or crustaceans collected		
4	*Lepomis macrochirus*	1	35
5	No fish or crustaceans collected		
6	*Etheostoma fonticola*	1	29
	Lepomis cyanellus	1	37
7	No fish or crustaceans collected		
8	*Procambarus* sp.	1	
9	*Procambarus* sp.	1	
10	*Procambarus* sp.	1	
11	*Lepomis macrochirus*	1	34
12	No fish or crustaceans collected		
13	*Procambarus* sp.	1	
14	No fish or crustaceans collected		
15	*Procambarus* sp.	1	
	**Tarebia granifera -slight*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:	Site on map:
New Channel		O1- Site 3	
Date:	**Time:**	**Observer(s):**	
12/2/2015	1020-1030	JJ,JW,NP,JG	

Overall	Species	Number	Avg. Length (mm)
3	*Gambusia sp.*		
5	*Procambarus* sp.		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia sp.*	1	12
	Procambarus sp.	1	
2	*Gambusia sp.*	1	24
	Procambarus sp.	2	
3	*Gambusia sp.*	1	10
4	No fish or crustaceans collected		
5	No fish or crustaceans collected		
6	*Procambarus* sp.	1	
7	*Procambarus* sp.	1	
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 -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:	Site on map:
New Channel		H1- Site 4	
Date:	**Time:**	**Observer(s):**	
12/2/2015	1033-1049	JJ,JW,NP,JG	

Overall	Species	Number	Avg. Length (mm)
25	*Palaemonetes* sp.		
1	*Gambusia sp.*		
1	*Herichthys cyanoguttatus*		
18	*Procambarus* sp.		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Palaemonetes* sp.	21	
	Herichthys cyanoguttatus	1	40
	Procambarus sp.	1	
2	*Procambarus* sp.	1	
	Palaemonetes sp.	1	
3	*Procambarus* sp.	2	
	Palaemonetes sp.	1	
4	*Procambarus* sp.	4	
5	*Procambarus* sp.	3	
6	No fish or crustaceans collected		
7	*Palaemonetes* sp.	2	
	Procambarus sp.	1	
8	*Procambarus* sp.	1	
9	*Gambusia sp.*	1	28
	Procambarus sp.	1	
10	No fish or crustaceans collected		
11	No fish or crustaceans collected		
12	*Procambarus* sp.	3	
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 -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		**Site:**	
New Channel		H2 -Site 5	
Date:	**Time:**	**Observer(s):**	
12/2/2015			
Overall	**Species**	**Number**	**Avg. Length (mm)**
	Site not sampled - too deep		

COMAL RIVER -HIGH FLOW 1 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 -HIGH FLOW 1 2015 SAMPLING

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

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

COMAL RIVER -HIGH FLOW 1 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 -HIGH FLOW 1 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 -HIGH FLOW 1 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 -HIGH FLOW 1 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 -HIGH FLOW 1 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 -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:
Old Channel		H2- Site 1
Date:	**Time:**	**Observer(s):**
11/30/2015	1245-1309	NP,JG,JW

Overall	Species	Number	Avg. Length (mm)
107	*Gambusia sp.*		
4	*Etheostoma fonticola*		
3	*Palaemonetes* sp.		
4	*Procambarus* sp.		
2	*Notropis amabilis*		
1	*Astyanax mexicanus*		
1	*Notropis volucellus*		
1	*Lepomis miniatus*		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Gambusia sp.*	63	30,32,31,19,25,24,25,25,20,19,20,25,20,15,18,23,30,22, 20,21,20,22,18,25
	Notropis amabilis	2	33,30
	Palaemonetes sp.	1	
2	*Gambusia sp.*	6	
3	*Lepomis miniatus*	1	65
	Notropis amabilis	2	34,36
	Gambusia sp.	7	
	Procambarus sp.	2	
4	*Astyanax mexicanus*	1	24
	Etheostoma fonticola	1	25
	Gambusia sp.	20	
	Palaemonetes sp.	1	
5	*Gambusia sp.*	2	
	Procambarus sp.	1	
	Palaemonetes sp.	1	
6	*Etheostoma fonticola*	1	32
	Gambusia sp.	2	
7	*Etheostoma fonticola*	2	24,33
	Gambusia sp.	2	
8	No fish or crustaceans collected		
9	*Notropis volucellus*	1	35
	Gambusia sp.	1	
10	*Gambusia sp.*	1	
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	*Procambarus* sp.	1	
14	*Gambusia sp.*	1	
15	No fish or crustaceans collected		
	*** Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:
Old Channel		H3- Site 2
Date:	**Time:**	**Observer(s):**
11/30/2015	1311-1340	NP,JG,JW

Overall	Species	Number	Avg. Length (mm)
24	*Etheostoma fonticola*		
16	*Gambusia sp.*		
1	*Lepomis miniatus*		
23	*Palaemonetes* sp.		
19	*Procambarus* sp.		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

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

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:	Site on map:
Old Channel		H4 - Site 3	R3
Date:	**Time:**	**Observer(s):**	
11/30/2015	1342-1404	NP,JG,JW	

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

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Palaemonetes* sp.	2	
	Procambarus sp.	2	
	Gambusia sp.	4	13,29,23,22
2	*Gambusia sp.*	1	15
	Procambarus sp.	4	
	Palaemonetes sp.	1	
3	*Lepomis miniatus*	2	110,67
	Gambusia sp.	2	14,23
4	*Gambusia sp.*	1	29
5	*Gambusia sp.*	1	30
	Etheostoma fonticola	2	32,35
	Procambarus sp.	1	
	Palaemonetes sp.	1	
6	*Gambusia sp.*	1	29
7	*Procambarus* sp.	1	
8	No fish or crustaceans collected		
9	No fish or crustaceans collected		
10	*Etheostoma fonticola*	1	30
11	No fish or crustaceans collected		
12	No fish or crustaceans collected		
13	*Gambusia sp.*	1	24
14	No fish or crustaceans collected		
15	No fish or crustaceans collected		

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

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:	Site on map:
Old Channel		H1-Site 4	H3
Date:	**Time:**	**Observer(s):**	
11/30/2015	1406-1425	NP,JG,JW	

Overall	Species	Number	Avg. Length (mm)
7	*Procambarus* sp.		
3	*Gambusia sp.*		
12	*Etheostoma fonticola*		
29	*Palaemonetes* sp.		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	Species	Number	Length (mm)
1	*Etheostoma fonticola*	2	25,30
	Palaemonetes sp.	8	
2	*Procambarus* sp.	1	
3	*Etheostoma fonticola*	2	20,24
	Palaemonetes sp.	9	
4	*Etheostoma fonticola*	1	31
	Palaemonetes sp.	1	
5	*Palaemonetes* sp.	1	
6	*Etheostoma fonticola*	2	32,30
	Palaemonetes sp.	1	
7	*Etheostoma fonticola*	1	31
	Palaemonetes sp.	4	
	Gambusia sp.	2	18,12
	Procambarus sp.	2	
8	*Etheostoma fonticola*	1	32
	Palaemonetes sp.	4	
9	*Procambarus* sp.	1	
10	*Gambusia sp.*	1	20
	Etheostoma fonticola	2	31,28
11	*Procambarus* sp.	2	
12	*Palaemonetes* sp.	1	
13	*Etheostoma fonticola*	1	25
	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 -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		**Site:**	
Old Channel		O1-Site 5	
Date:	**Time:**	**Observer(s):**	
11/30/2015	1428-1431	NP,JG,JW	
Overall	**Species**	**Number**	**Avg. Length (mm)**

COMAL RIVER -HIGH FLOW 1 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 -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		**Site:**	
Old Channel		L1- Site 6	
Date:	**Time:**	**Observer(s):**	
11/30/2015	1435-1505	NP,JG,JW	
Overall	**Species**	**Number**	**Avg. Length (mm)**
26	*Etheostoma fonticola*		
44	*Gambusia sp.*		
62	*Palaemonetes* sp.		
23	*Procambarus* sp.		

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Dip net sweep	**Species**	**Number**	**Length (mm)**
1	*Gambusia sp.*	14	15,18,27,15,15,15,15,16,15,13,15,17,13,15
	Procambarus sp.	3	
	Palaemonetes sp.	25	
2	*Gambusia sp.*	14	22,15,13,15,13,14,12,10,14,20,10
	Etheostoma fonticola	4	30,20,30,23
	Palaemonetes sp.	22	
	Procambarus sp.	1	
3	*Etheostoma fonticola*	2	28,31
	Gambusia sp.	12	
	Palaemonetes sp.	6	
4	*Etheostoma fonticola*	2	23,26
	Procambarus sp.	6	
	Palaemonetes sp.	2	
5	*Procambarus* sp.	1	
6	*Etheostoma fonticola*	7	29,31,23,20,23,31,25
	Procambarus sp.	4	
7	*Gambusia sp.*	2	
	Procambarus sp.	2	
	Palaemonetes sp.	3	
8	*Etheostoma fonticola*	5	30,25,28,26,25
	Procambarus sp.	1	
9	*Etheostoma fonticola*	1	35
	Palaemonetes sp.	3	
	Gambusia sp.	1	
	Procambarus sp.	1	
10	*Etheostoma fonticola*	1	30
	Palaemonetes sp.	1	
11	*Etheostoma fonticola*	2	32,26
	Gambusia sp.	1	
12	*Procambarus* sp.	2	
13	*Etheostoma fonticola*	1	24
	Procambarus sp.	2	
14	No fish or crustaceans collected		
15	*Etheostoma fonticola*	1	27
16	No fish or crustaceans collected		
	***Melanoides - slight*		
	***Corbicula - slight*		
	*** Tarebia granifera - slight*		

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:
Old Channel		L2-Site 7
Date:	**Time:**	**Observer(s):**
11/30/2015	1510-1531	NP,JG,JW

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

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

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

DROP NET - FIELD DATA SHEETS

COMAL RIVER -HIGH FLOW 1 2015 SAMPLING

Location (Reach):		Site:	Site on map:
Old Channel		O2-Site 8	
Date:	**Time:**	**Observer(s):**	
11/30/2015	1535-1538	NP,JG,JW	

Overall	Species	Number	Avg. Length (mm)

COMAL RIVER -HIGH FLOW 1 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		