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

MEMORANDUM

TO:	Nathan Pence, Chris Abernathy
FROM:	Ed Oborny
DATE:	December 31, 2014
SUBJECT:	**ITEM M NET DISTURBANCE AND INCIDENTAL TAKE ASSESSMENT FOR 2014 EARIP ITP ANNUAL REPORT**

EXECUTIVE SUMMARY

The EAHCP Incidental Take Permit (ITP) requires a Net Disturbance and Incidental Take assessment to be conducted at the conclusion of each year for incorporation into the ITP Annual Report. Requirement M (1a and 2a) of the ITP specifically addresses minimization and mitigation activities associated with the HCP. This requirement stipulates that over the course of any given year no more than 10% of a covered species occupied habitat can be affected by HCP mitigation and restoration activities. Following quantification of net disturbance specific to these activities, incidental take was calculated for the disturbed areas. However, that is only part of the overall incidental take assessment. Incidental take associated with implementation of all other applicable HCP covered activities was then characterized and quantified to the degree practical. For a more detailed description of methodologies and species specific results please refer to the Item M Net Disturbance (**SECTION 1**) and Incidental Take (**SECTION 2**) assessments of this technical memorandum. As in 2013, all 2014 assessments were performed in accordance with ITP requirements.

Prior to the original assessment in 2013, specific discussions were held with professionals from the USFWS Austin Ecological Services (ES) office to establish the appropriate definition and description of “occupied” habitat and seek guidance on methodologies for calculating incidental take. Following the USFWS review of the EAA 2013 ITP Annual Report, a meeting was held on October 1, 2014 with professionals from the USFWS Austin ES, EAA, and BIO-WEST. The purpose of the meeting was to receive feedback from the USFWS on the net disturbance and incidental take assessments conducted for 2013. Based on those conversations, it was determined that only one change was needed to the methodology moving forward. This change involved the inclusion of Texas wild-rice as fountain darter occupied habitat in 2014. Although Texas wild-rice has not been routinely sampled for fountain darters over time as to not disturb this federally-listed plant, darters have been visually documented within Texas wild-rice. In 2013, the decision was made not to include Texas wild-rice as occupied fountain darter habitat on the basis it lacked routine sampling. However, upon review of the EAA 2013 ITP Annual Report, USFWS Austin ES made a formal recommendation for Texas wild-rice to be included as occupied habitat for the fountain darter in the 2014 assessment and all subsequent evaluations. As such, this slight adjustment was made to the methodology and approved by both the HCP Science Committee on November 12th as well as the HCP Implementing Committee on November 20th.

Discussions with USFWS Austin ES at the October 1, 2014 meeting also confirmed that annual incidental take should be based on the condition of the system going into the next year and not be cumulative with incidental take reported for 2013 for areas that had not recovered prior to 2014. This USFWS Austin ES comment was adhered to and that approach built into the 2014 assessment described in Section 2.

Table ES provides an overview of net disturbance percentages and a summary of incidental take for 2014. As shown in Table ES, only the fountain darter in the Comal System had a net disturbance when considering the project footprint for HCP mitigation and restoration activities overlaid on occupied habitat. The net disturbance was 2.1% of the total occupied habitat for the fountain darter. As shown in Table ES, there were no project footprints that overlapped with any of the occupied habitat for the endangered Comal invertebrates. In the San Marcos system, both the fountain darter and San Marcos salamander had a net disturbance per this assessment. The fountain darter had 4.0% of its total occupied habitat disturbed whereas the San Marcos salamander amount was lower at 1.4%. For the Texas blind salamander and Comal Springs riffle beetle, there were no activities conducted in 2014 that directly impacted any of the orifices where collections have routinely been made over the years. In summary, the 10% disturbance rule (Item M [a]) was in compliance for 2014.

A continued evaluation of Table ES shows that based on the characterization of drought in the incidental take assessment for the Comal system, conditions experienced during 2014 went beyond an average year as described in the Biological Opinion. As expected, conditions on the Comal system exceeded those observed in 2013 particularly with respect to the surface dwelling organisms (Comal Springs riffle beetle and fountain darter). The primary cause for this increase was low total system discharge which resulted in expanded amounts of exposed surface habitat within Comal Springs riffle beetle occupied habitat and loss of habitat and elevated water temperatures relative to the fountain darter in the Upper Spring Run reach. For the San Marcos system, incidental take went down in 2014 because the system did not experience as severe of drought related impacts as the previous year.

When examining 2014 impacts, conditions are nowhere near those characterized in the Biological Opinion DOR-like scenario. As such, we are confident the incidental take numbers summarized in Table ES and documented in this memorandum continue to justify the data sets used and methodologies employed in 2014 relative to performing an incidental take assessment within the context of the Biological Opinion. It is understood that adjustments to data sets and/or methodologies may be employed based on feedback from the USFWS, HCP Science Committee, HCP participants, or others as deemed appropriate by the EARIP.

Table ES. Summary of Impacted Habitat (m^2) and Net Disturbance and Incidental Take for HCP Covered Species compared against ITP Maximum Permit Amounts.

COVERED SPECIES PER SYSTEM	HCP Mitigation / Restoration		HCP Measures / Drought	Combined Impacted Habitat 2014 TOTAL (m^2)	INCIDENTAL TAKE		**2014 INCIDENTAL TAKE TOTAL**	ITP Maximum Permit Amount	2013 INCIDENTAL TAKE TOTAL	ITP Permit Maximum - (combined Year 1 and Year 2 Incidental Take)
	IMPACTED HABITAT (m^2)	NET Disturbance % OF TOTAL Occupied Habitat	IMPACTED HABITAT (m^2)		HCP Mitigation / Restoration	HCP Measures / Drought				
COMAL SYSTEM										
Fountain Darter	1,995	2.1%	2,484	**4,479**	2,993	20,067	**23,060**	797,000	10,482	763,459
Comal Springs Riffle Beetle	0	0.0%	237	**237**	0	1,564	**1,564**	11,179	681	8,933
Comal Springs Dryopid Beetle	0	0.0%	18	**18**	0	2	**2**	1,543	13	1,528
Peck's Cave Amphipod	0	0.0%	79	**79**	0	82	**82**	18,224	81	18,060
SAN MARCOS SYSTEM										
Fountain Darter	4,567	4.1%	3,372	**7,939**	6,851	5,058	**11,909**	549,129	16,698 +15*	520,508
San Marcos Salamander	30	1.4%	131	**161**	89	393	**482**	263,857	1,053	262,323
Texas Blind Salamander	0	0.0%	0	**0**	0	0	**0**	10	0	10
Comal Springs Riffle Beetle	0	0.0%	0	**0**	0	0	**0**	n/a	0	n/a

* An additional 15 darters would have been considered take in 2013 when using the revised 2014 methodology that includes Texas wild-rice as fountain darter occupied habitat.

SECTION 1: ITEM M NET DISTURBANCE ASSESSMENT

Requirement M (1a and 2a) of EAA's USFWS threatened and endangered species permit (#TE63663A-0) addresses minimization and mitigation activities associated with the HCP. The requirements for Item M (1a and 2a) are stated below directly from the permit:

1 Comal Springs, Landa Lake, and the Comal River
   a. The Permittees will limit disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals of the Comal Springs, Landa Lake, and Comal River to no more than 10% of the occupied habitat on an annual basis when implementing HCP measures such as habitat and riparian restoration efforts that may directly or indirectly affect species considered here;

2 San Marcos Springs, Spring Lake, and the San Marcos River
   a. The Permittees will limit disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals of the San Marcos Springs, Spring Lake, and the San Marcos River to no more than 10% of the occupied habitat on an annual basis when implementing HCP measures such as habitat and riparian restoration efforts that may directly or indirectly affect species considered here;

All activities described in this memorandum pertain to the HCP Covered species that are actively authorized (Item H: 1-6) in 2014 for incidental take via EAA's ITP permit. This includes:

- Fountain darter
- Comal Springs riffle beetle
- Comal Springs dryopid beetle
- Peck's Cave amphipod
- Texas Blind salamander
- San Marcos salamander

Although the Texas cave diving beetle, Texas troglobitic water slater, and Comal Spring salamander are listed in the permit, the conditions in the Permit are not active in 2014 as none of these species are presently listed as threatened or endangered with this directly acknowledged (Item H: 7-9) in the permit. Additionally, Item I of the permit acknowledges that only if the San Marcos gambusia is located or found in the study area, will take provisions apply. As this has not occurred in 2014, the San Marcos gambusia is not included in this Item M assessment. Finally, being a plant, Texas wild-rice is not allotted incidental take provisions under this federal permit, so it is not germane to the Item M assessment. However, it is noted that Texas wild-rice is included throughout this memorandum to document restoration activities in the San Marcos River.

Documentation of baseline habitat conditions: For the six actively covered HCP species (listed above) maps of occupied habitat for the Comal and San Marcos Springs/River systems were prepared in GIS, based on EAA biological monitoring data (BIO-WEST 2002 – 2013a,b, BIO-WEST 2014a,b, BIO-WEST 2015a,b) and other existing sources for the HCP covered species.

Prior to the original Item M assessment in 2013, specific discussions were held with staff from the USFWS Austin Ecological Services (ES) office to establish the appropriate definition and description of "occupied" habitat. Based on those conversations, "occupied" habitat was defined as 1) areas in the Comal and San Marcos systems where the covered species have been physically collected or visually documented, and 2) aquatic vegetation types specific to the fountain darter that have been routinely sampled over the past decade through biological monitoring with documented occupancy. Following USFWS review of the 2013 EAA ITP Annual Report, a meeting was held on October 1, 2014 with USFWS Austin ES professionals who confirmed that the definition of occupied habitat used in the 2013 assessment was appropriate with one small adjustment relative to Texas wild-rice further described in the San Marcos system fountain darter section below.

Table 1 summarizes the occupied habitat in meters squared (m^2) for each of the covered species pertinent to the Item M assessment. Figures for each species are presented following the discussion in each respective section. As per the ITP and USFWS Austin ES guidance, the 2014 assessment is representative of conditions at the start of calendar year 2014 including any mitigation / restoration measures that resulted in a change in occupied habitat for any of the covered species.

Comal System

The fountain darter has been extensively sampled throughout the Comal system via the long-term biological monitoring program conducted by EAA. Drop netting has occurred in dominant aquatic vegetation types within representative sampling reaches for over a decade. On a broader scale, dipnetting for fountain darters has occurred throughout the Comal system over time. Finally, sampling via other collection techniques, seining, snorkel, and SCUBA have been conducted in the Comal system as well. For the fountain darter Item M assessment (represented in Table 1 and Figure 1), only known collection locations and aquatic vegetation that has been routinely sampled and documented as supporting darters throughout the system were counted. Although, fountain darters have been physically collected as well as visually documented on bare substrate, this is not common in the Comal system. As such, bare substrate was not counted as occupied habitat for the fountain darter in the Comal system. Figure 1 shows the occupied habitat for the fountain darter throughout the Comal System with the quantification of area presented in Table 1.

TABLE 1 – OCCUPIED HABITAT

ITEM M - SPECIES	OCCUPIED HABITAT (m^2)	NOTES AND ASSUMPTIONS
COMAL SPRINGS / RIVER		
Fountain Darter	96,624	Based on collections and known occurrence in aquatic vegetation types sampled over the course of the HCP biological monitoring. Sampling included drop netting, dip netting, snorkel, SCUBA, and seining throughout the Comal system. Although fountain darters have been collected on bare substrate on occasion, no bare areas were included in this assessment.
Comal Springs Riffle Beetle	1,511	Based on collection of individuals via cotton lure, drift net, or quadrat sampling over the years. An area of 1 m^2 around each collection point was included but did not include any overlap between collection points.
Peck's Cave Amphipod	1,470	This species is considered subterranean and thus subsurface habitat is the more appropriate calculation. The total area of subsurface habitat for this species is presently unknown. Surface habitat was based on collection of individuals via cotton lure and drift net sampling. An area of 0.5 m^2 around each collection point was included but did not include any overlap between collection points.
Comal Springs Dryopid Beetle	350	This species is considered subterranean and thus subsurface habitat is the more appropriate calculation. The total area of subsurface habitat for this species is presently unknown. Surface habitat was based on collection of individuals via cotton lure and drift net sampling. An area of 0.5 m^2 around each collection point was included but did not include any overlap between collection points.
SAN MARCOS SPRINGS / RIVER		
Fountain Darter	112,985	Based on collections and known occurrence in aquatic vegetation types (including Texas wild-rice) sampled over the course of HCP biological monitoring. Sampling included drop netting, dip netting, snorkel, SCUBA, and seining throughout the San Marcos system. Although fountain darters have been collected on bare substrate in the river on occasion, no bare river areas were included in this baseline assessment. In contrast, bare substrate areas in Spring Lake were included for this assessment as fountain darters have frequently been observed inhabiting these areas within Spring Lake. Finally, although fountain darters have been collected further upstream in the slough arm of Spring Lake, those collections are considered seasonal at this time and thus were not included in the overall area calculated.
San Marcos Salamander	2,165	Based on observation or collection of individuals via snorkel / SCUBA over the course of HCP biological monitoring. Also, based on collections conducted by the USFWS San Marcos Aquatic Resources Center.
Texas Blind Salamander	n/a	This species is considered subterranean and thus subsurface habitat is the appropriate calculation. As such, no surface habitat was calculated as "occupied habitat" for this species.
Comal Springs Riffle Beetle	11	Based on collection of individuals via cotton lure and drift net sampling. An area of 1 m^2 around each collection point was included but did not include any overlap between collection points.
Texas wild-rice*	5,020	* As a plant, Texas wild-rice is not granted "take" protection rendering the Item M exercise not applicable. However, to assist with a calculation of mitigation and restoration measures net benefit for the City of San Marcos and Texas State University, the latest 2013 map of Texas wild-rice in the San Marcos River was included as a baseline for this section.

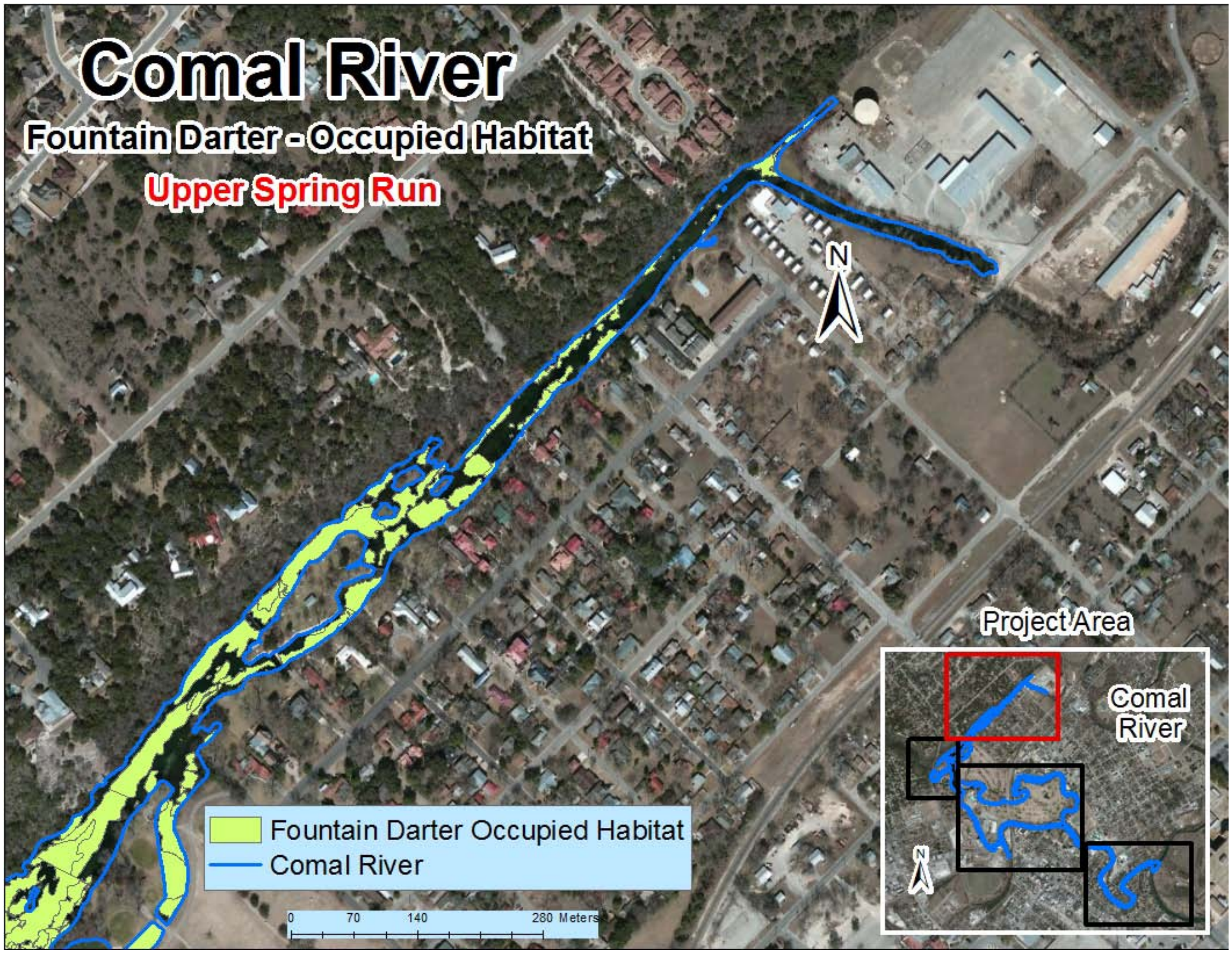


Figure 1: Fountain Darter 2014 Occupied Habitat – Upper Spring Run (Comal System)

Although not as extensive as for the fountain darter, routine sampling for the Comal Springs riffle beetle has also occurred. Over the years, sampling has been conducted by quadrats, drift netting, and cotton lures. In the early 1990's extensive sampling in the Spring Runs was conducted by Dr. David Bowles, with those data included in this assessment (Bowles et al. 2003). Additionally, Mr. Randy Gibson (USFWS San Marcos Aquatic Resource Center [SMARC]) has collected Comal invertebrates at locations throughout the system for a number of projects and for refugia purposes over time. The EAA biological monitoring program has routinely sampled for the Comal Springs riffle beetle within sample reaches in the Comal system. Finally, additional locales were noted in 2014 based on HCP critical period sampling as well as from the ZARA 2014 applied research project. As noted last year, based on the sample techniques over time and experience and guidance of Mr. Randy Gibson the determination was made to include a 1 m^2 area surrounding each known collection location to quantify overall surface area of occupied habitat for the 2014 assessment. It is anticipated that larger areas of the Comal system are actually occupied than represented in this assessment as the entire Comal system has not been thoroughly sampled. It is noted that only surface habitat area was calculated for this assessment, as the extent of subsurface habitat utilization by this species is presently unknown. Figure 2 shows the occupied habitat for the Comal Springs riffle beetle throughout the Comal System with the quantification of area presented in Table 1.

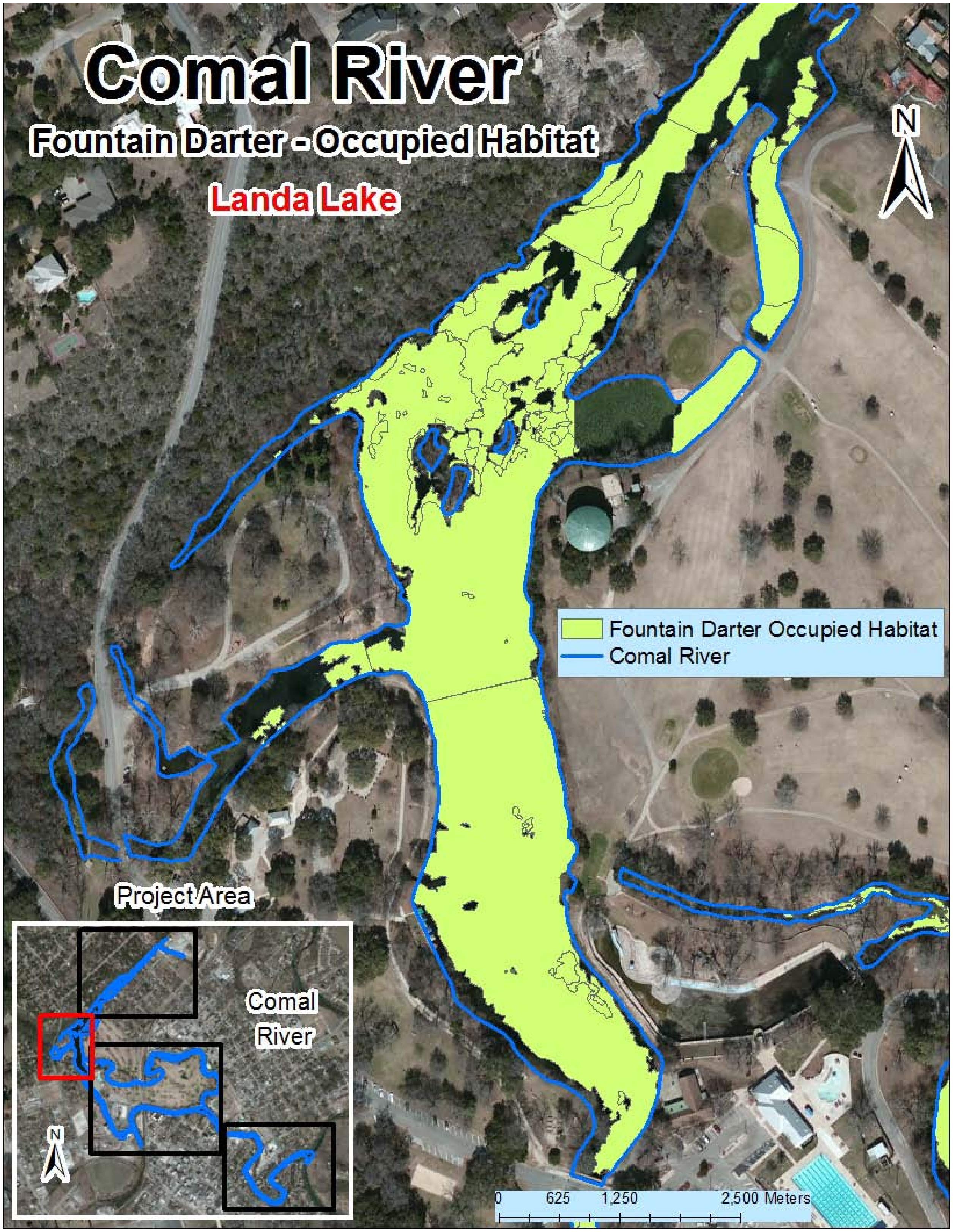
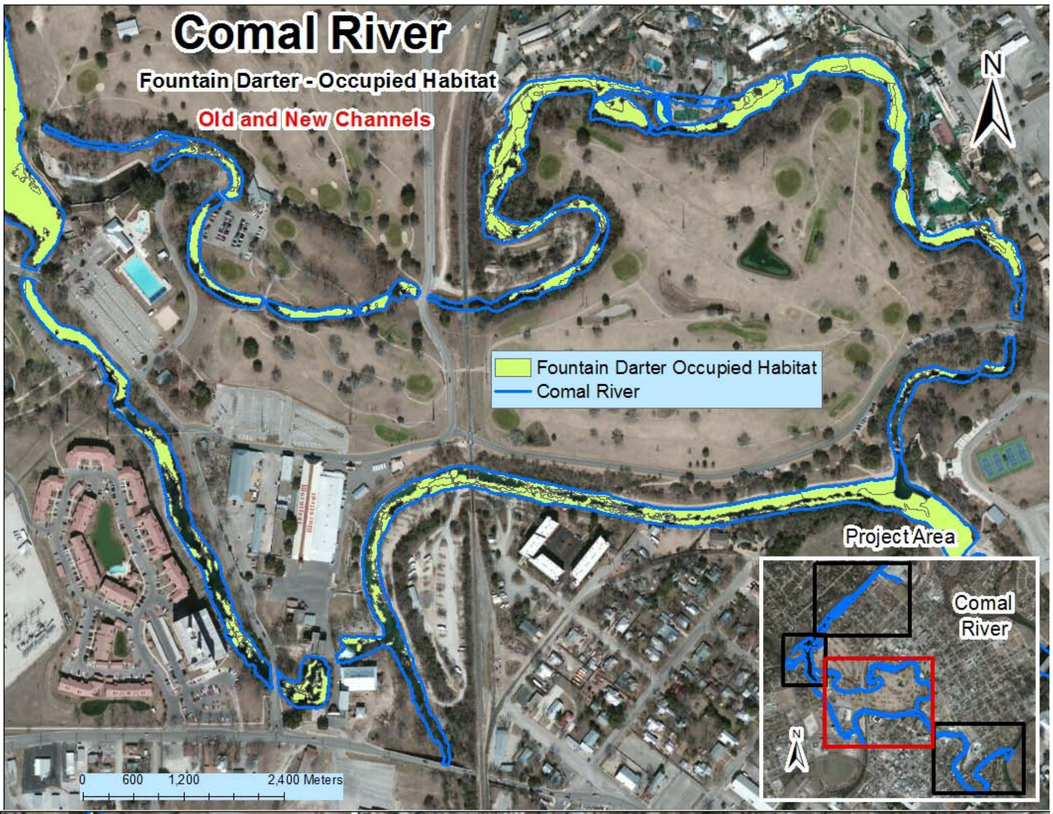


Figure 1 (continued): Fountain Darter 2014 Occupied Habitat – Landa Lake (Comal System).



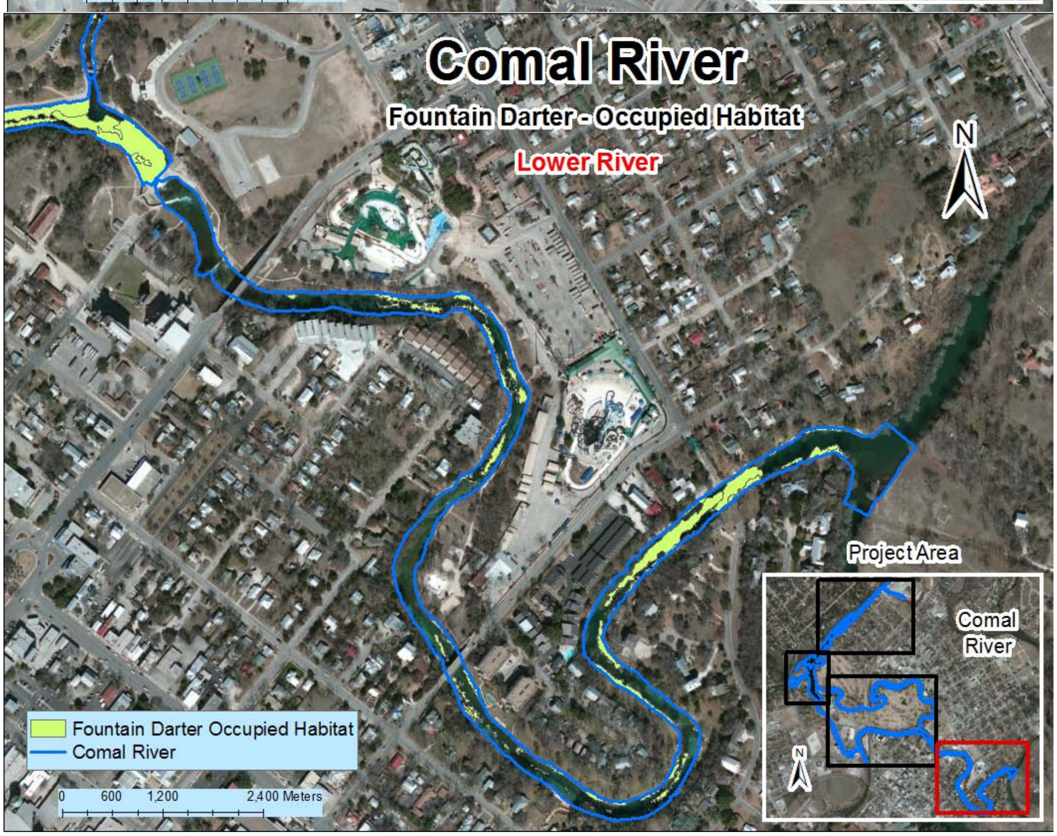


Figure 1 (continued): Fountain Darter 2014 Occupied Habitat – Old and New Channels (Top) and Lower Comal River (bottom) - (Comal System).

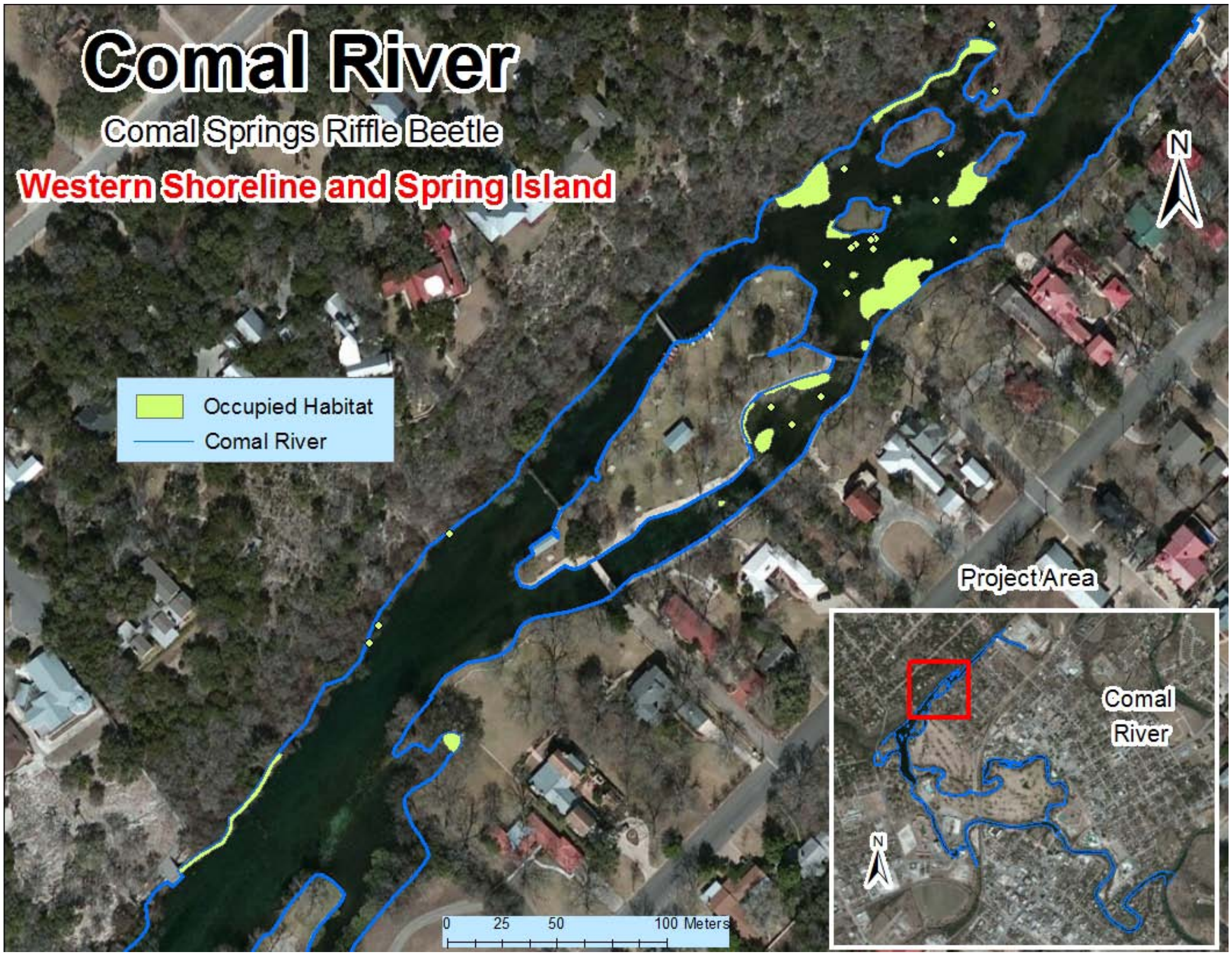


Figure 2: Comal Springs Riffle Beetle 2014 Occupied Surface Habitat – Spring Island and Western Shoreline areas (Comal System).

As described in the HCP, both the Peck's cave amphipod and Comal Springs dryopid beetle are subterranean species. Peck's cave amphipods are frequently found at the surface primarily in areas that Comal Springs riffle beetles are collected, whereas the Comal Springs dryopid beetle is less commonly found. As it is presumed that these subterranean invertebrates are not suited for survival in surface conditions, the decision was made to quantify 0.5 m^2 around the orifices that these species have been collected in the Comal system. As for the riffle beetle, sampling for these species over the years has been conducted by quadrats, drift netting, and cotton lures. Dr. Bowles and Mr. Gibson's data were again reviewed in detail as was the EAA biological monitoring database. For these two species, it is presumed that the majority of their occupied habitat is located subsurface. However, it is not possible to quantify the subsurface occupied habitat for these species at this time. Rather, the orifices where they have been collected are documented for further evaluation of potential impacts to these areas later in this memorandum. Figures 3 and 4 show occupied habitat for the Peck's Cave amphipod and Comal Springs dryopid beetle, respectively, throughout the Comal System with the quantification of surface habitat area presented in Table 1.

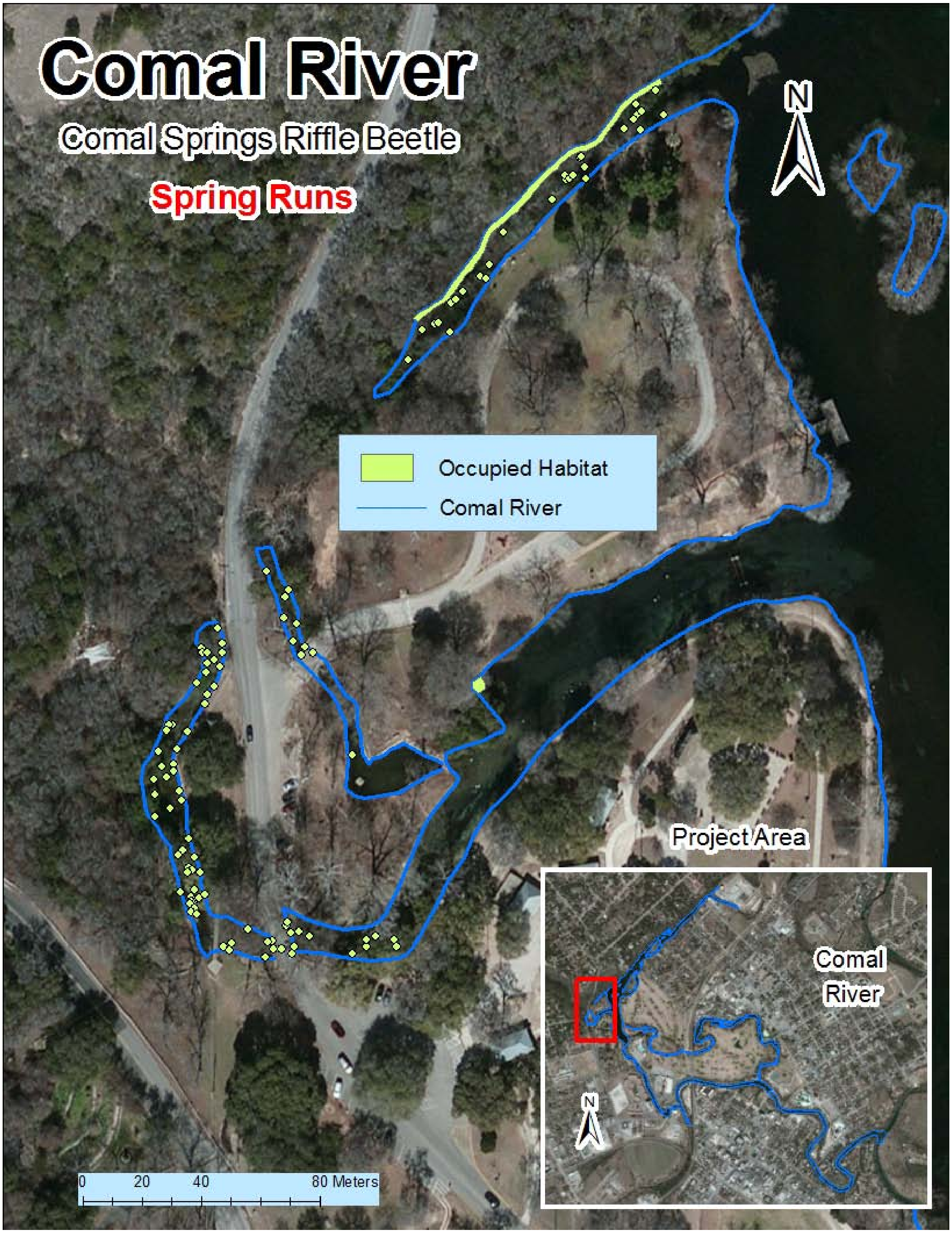


Figure 2 (continued): Comal Springs Riffle Beetle Occupied Surface Habitat – Spring Runs (Comal System).

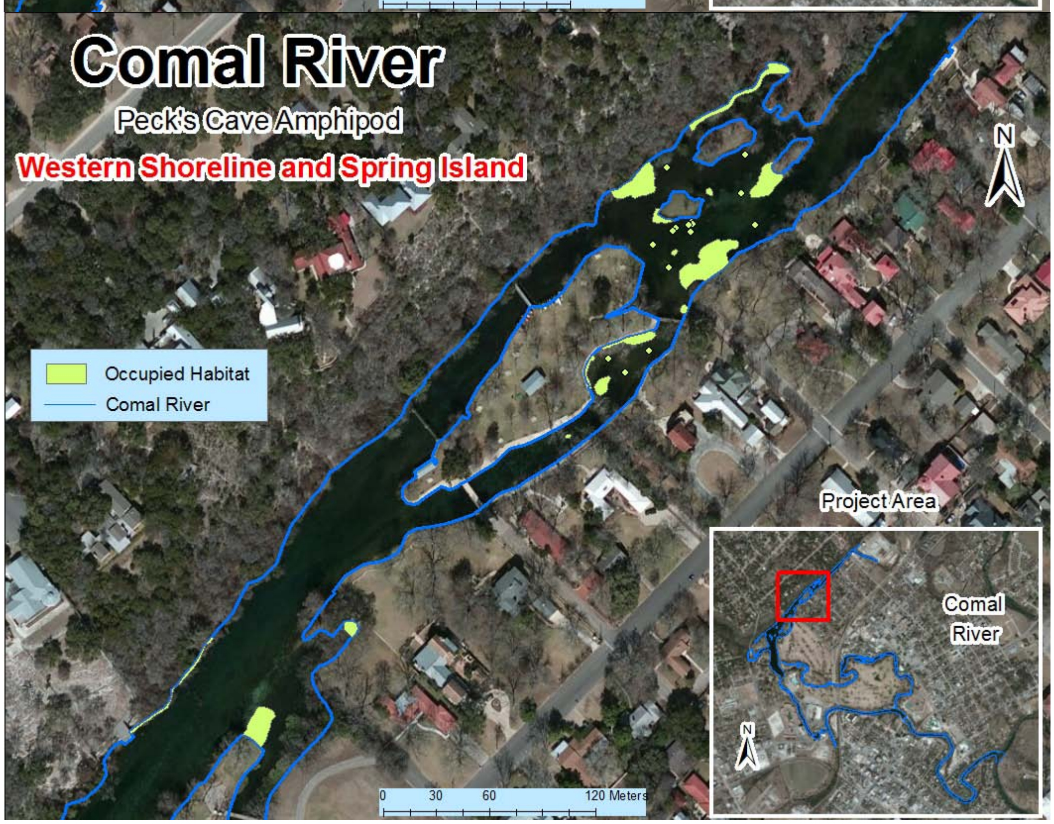


Figure 3: Peck's Cave Amphipod Occupied Surface Habitat – Upper Spring Run (top) and Spring Island and Western Shoreline areas (bottom) - (Comal System).

Figure 3 (continued): Peck's Cave Amphipod Occupied Surface Habitat – Spring Runs (Comal System).

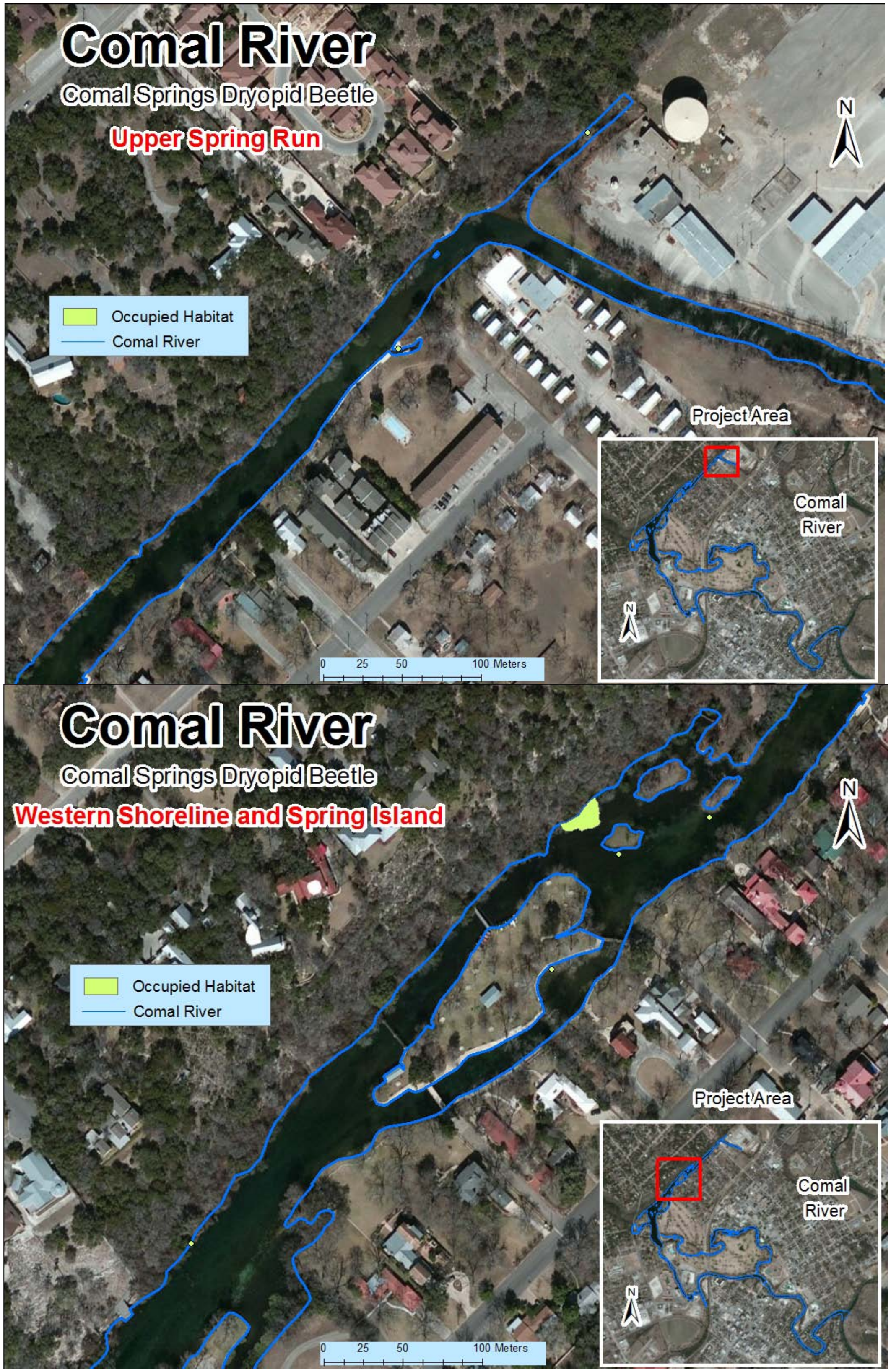


Figure 4: Comal Springs Dryopid Beetle Occupied Surface Habitat – Upper Spring Run (top) and Spring Island and Western Shoreline areas (bottom) - (Comal System).

Figure 4 (continued): Comal Springs Dryopid Beetle Occupied Surface Habitat – Spring Runs (Comal System).

San Marcos System

The fountain darter has been extensively sampled throughout the San Marcos system via the long-term biological monitoring program conducted by EAA as well as activities conducted by Texas State University over the years. For EAA biological monitoring, drop netting has occurred in dominant aquatic vegetation types within representative sampling reaches for over a decade. On a broader scale, dipnetting for fountain darters has occurred throughout the San Marcos system relative to EAA biological monitoring. Finally, sampling via other collection techniques, seining, snorkel, and SCUBA have been conducted in the San Marcos system over time by many researchers. For the fountain darter Item M assessment, only known collection locations and aquatic vegetation that has been routinely sampled with documented occupancy throughout the system were counted.

Although Texas wild-rice has not been routinely sampled for fountain darters over time as to not disturb this federally-listed plant, darters have been visually documented within Texas wild-rice. In 2013, the decision was made not to include Texas wild-rice as occupied fountain darter habitat since it lacked routine sampling. However, upon review of the EAA 2013 ITP Annual Report, the USFWS Austin ES made a formal recommendation for Texas wild-rice to be included as occupied habitat for the fountain darter in the 2014 assessment and all subsequent evaluations. As such, this slight adjustment was made to the methodology and approved by both the HCP Science Committee on November 12th as well as the HCP Implementing Committee on November 20th.

Similar to the Comal system, although fountain darters have been physically collected and visually documented on bare substrate in the San Marcos River, this is not a common occurrence in the river. As such, bare substrate was not counted as occupied habitat for the fountain darter in the San Marcos River. In contrast, bare substrate and algae areas in Spring Lake were included for this assessment as fountain darters have frequently been observed inhabiting these areas within Spring Lake. Finally, although fountain darters have been collected further upstream in the slough arm of Spring Lake, those collections are considered seasonal at this time and thus were not included in the overall area calculated. Figure 5 shows the occupied habitat for the fountain darter throughout the San Marcos system with the quantification of area presented in Table 1.

The San Marcos salamander has been routinely sampled over the years by both the EAA biological monitoring program as well as by the USFWS SMARC for refugia collection purposes. Additional efforts relating to master's thesis and other research have been conducted by Texas State University as well as sampling efforts specific to construction projects involving maintenance to Spring Lake Dam (western and eastern spillways). SCUBA and snorkel sampling has been conducted in the eastern spillway below Spring Lake Dam as well as the Big Riverbed and Hotel areas of Spring Lake over the past decade. In addition, the USFWS SMARC has sampled nearly all the spring orifices and surrounding areas within Spring Lake. The known collection locations and occupied habitat are depicted in Figure 6 and quantified in Table 1. It is likely that the overall distribution of San Marcos salamanders is a bit larger in Spring Lake as not all bare substrate areas have been sampled to date. However, for the 2014 assessment, only documented collection areas were included.

As documented in the HCP, the Texas blind salamander is an aquifer/cave dwelling species. Unlike the subterranean Comal invertebrates which can be found in and around orifices in surface habitat at times, blind salamanders are collected as they are expelled from the aquifer. As such, there is no surface habitat designated for the Texas blind salamander as footnoted in Table 1. Known collection areas are depicted in Figure 7 for later use in the net disturbance assessment.

Although not as extensive as in the Comal systems, sampling for the Comal Springs riffle beetle has occurred in the San Marcos system. Following up on an earlier documentation of this species in the San Marcos system via drift net, Mr. Randy Gibson set cotton lures throughout the upper portion of the San Marcos system with the main focus occurring in Spring Lake. During those and subsequent efforts, the only documented occupied habitat has been the Hotel Area in the uppermost portion of Spring Lake (Gibson et al. 2008; Gonzales 2008). As for this species in the Comal system, the determination was made to include a 1 m^2 area surrounding each known collection location to quantify overall surface area of occupied habitat for the 2014 assessment. It is noted that only surface habitat area was calculated for this assessment, as the extent of subsurface habitat utilization by this species is presently unknown. Figure 8 shows the occupied habitat for the Comal Springs riffle beetle in the San Marcos system with the quantification of area presented in Table 1.

Although Texas wild-rice is not allotted take projection in the ITP, its 2013 September coverage was included (Figure 9 and Table 1) in this assessment for informational purposes regarding restoration and enhancement. The 2013 coverage is included as the baseline for 2014 activities involves using the conditions present at the start of 2014.

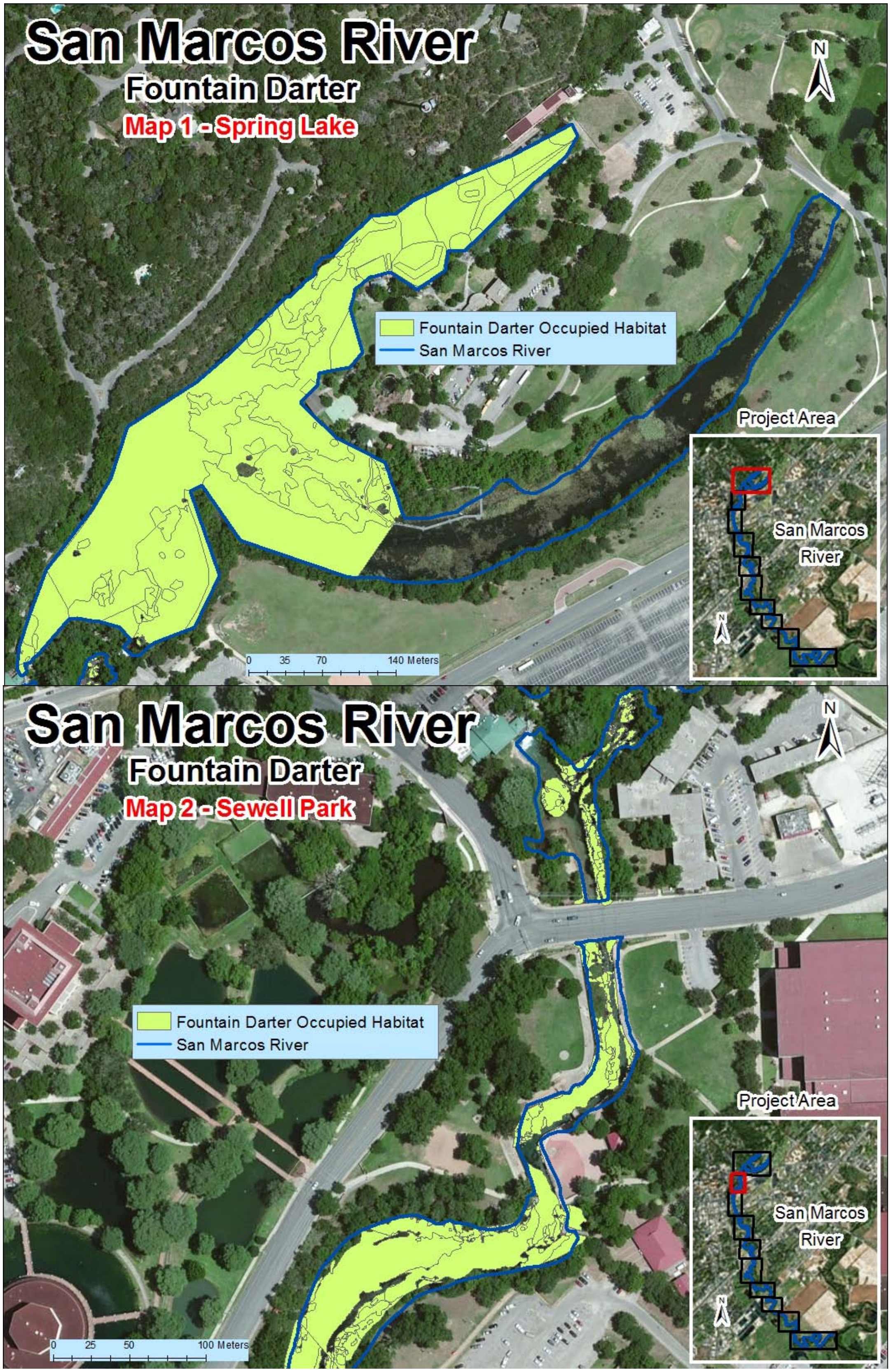


Figure 5: Fountain Darter 2014 Occupied Habitat – San Marcos System

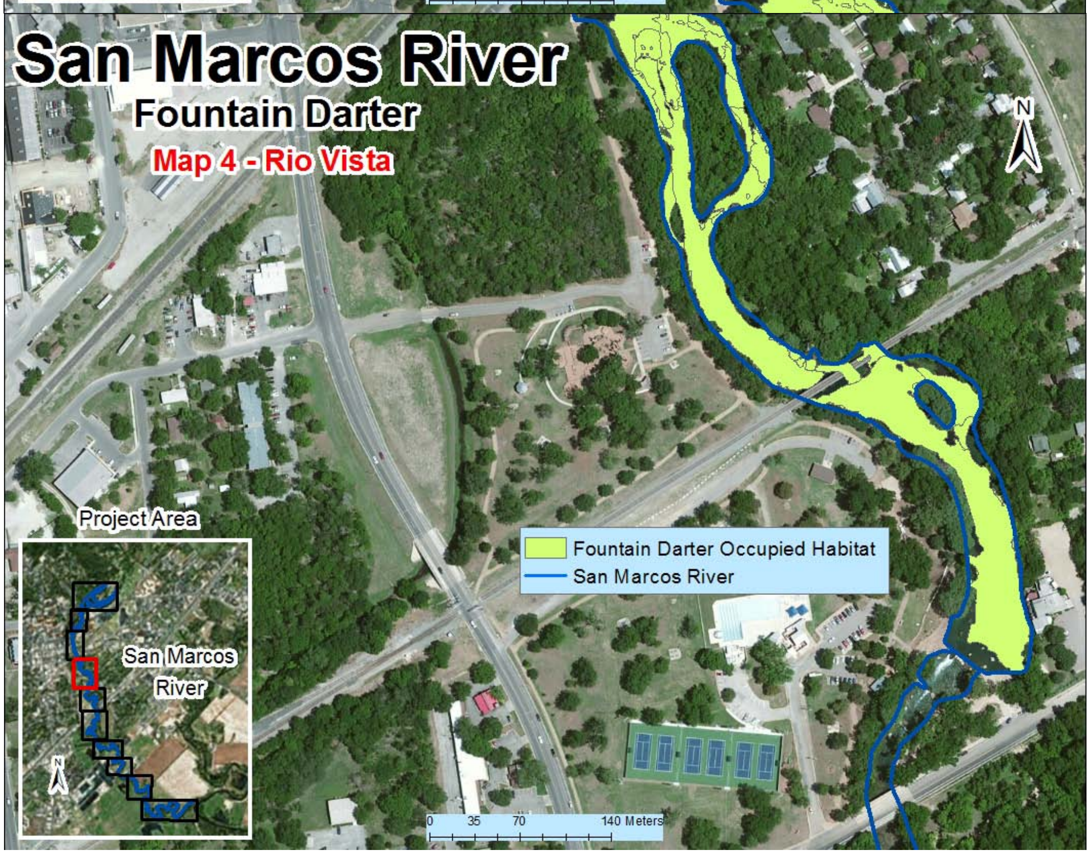
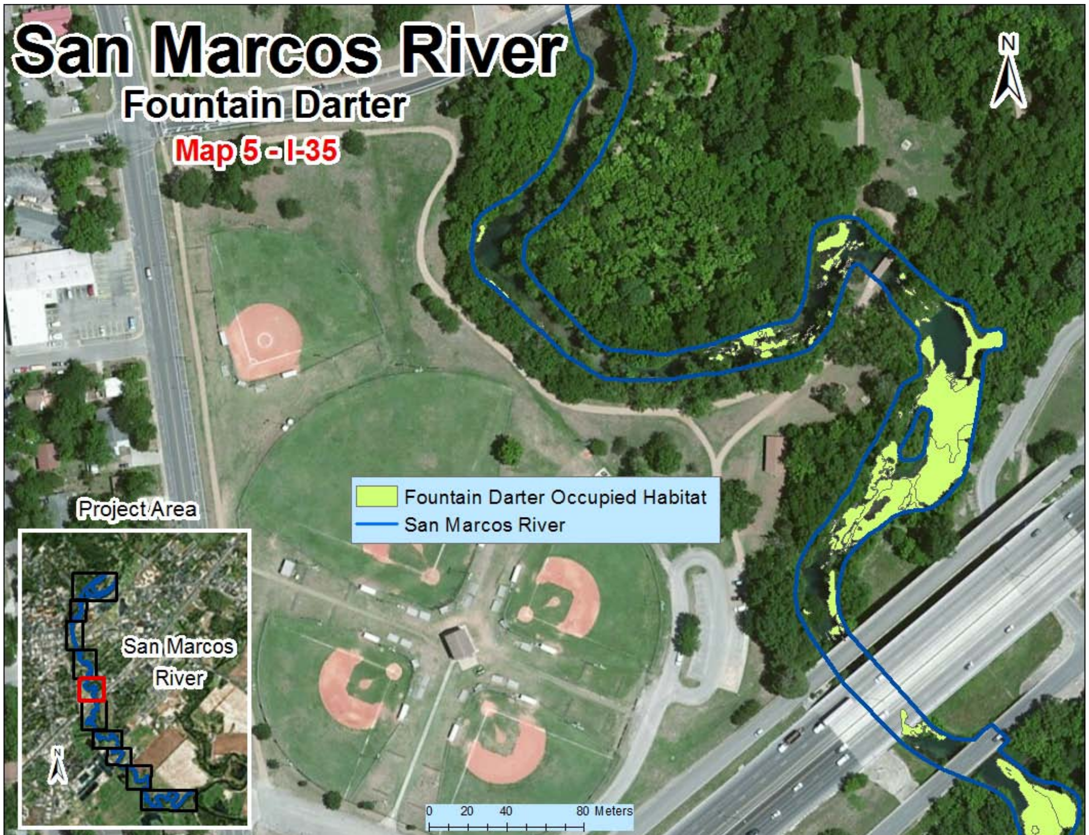


Figure 5 (continued): Fountain Darter 2014 Occupied Habitat – San Marcos System



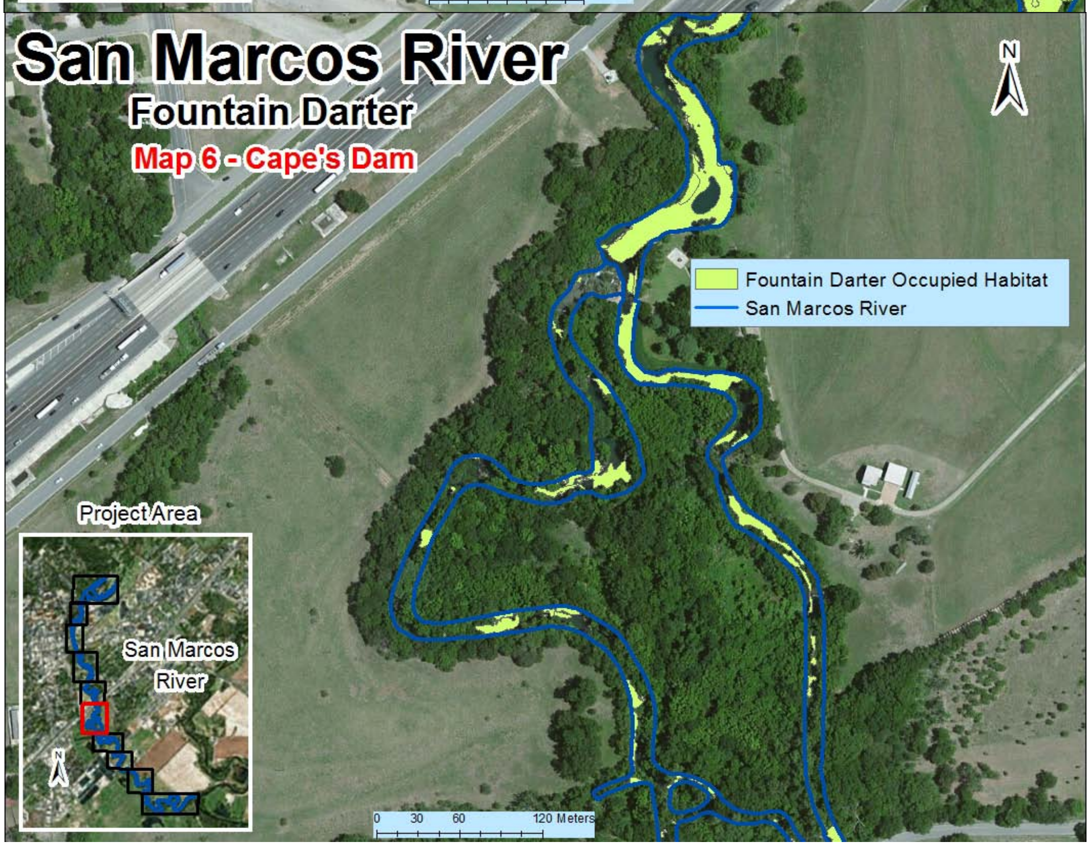


Figure 5 (continued): Fountain Darter 2014 Occupied Habitat – San Marcos System

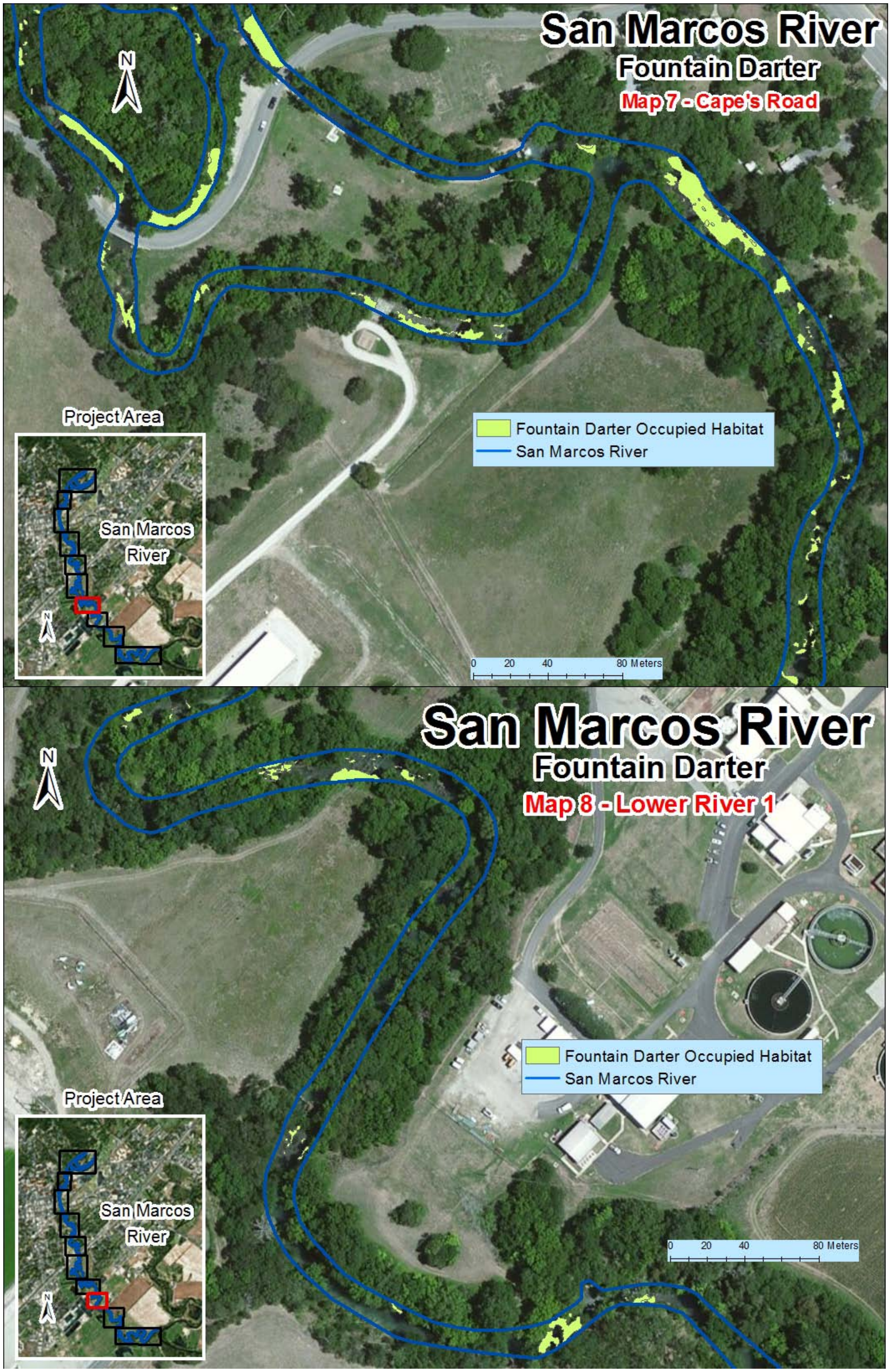


Figure 5 (continued): Fountain Darter 2014 Occupied Habitat – San Marcos System

Figure 5 (concluded): Fountain Darter 2014 Occupied Habitat – San Marcos System

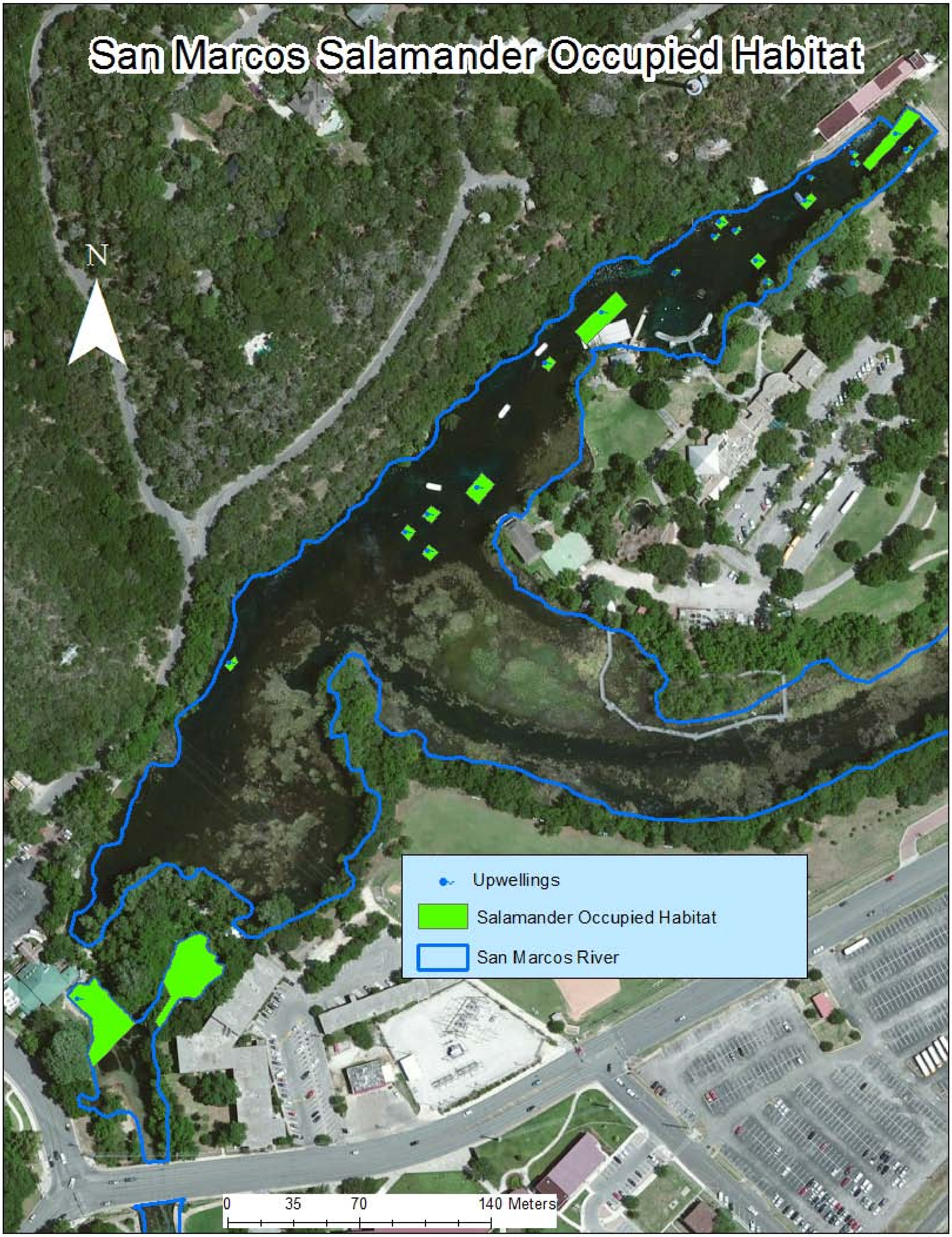


Figure 6: San Marcos Salamander 2014 Occupied Habitat – San Marcos System

Figure 7: Texas Blind Salamander Routine Collection Locations – San Marcos System

Figure 8: Comal Springs riffle beetle Surface 2014 Occupied Habitat – San Marcos System

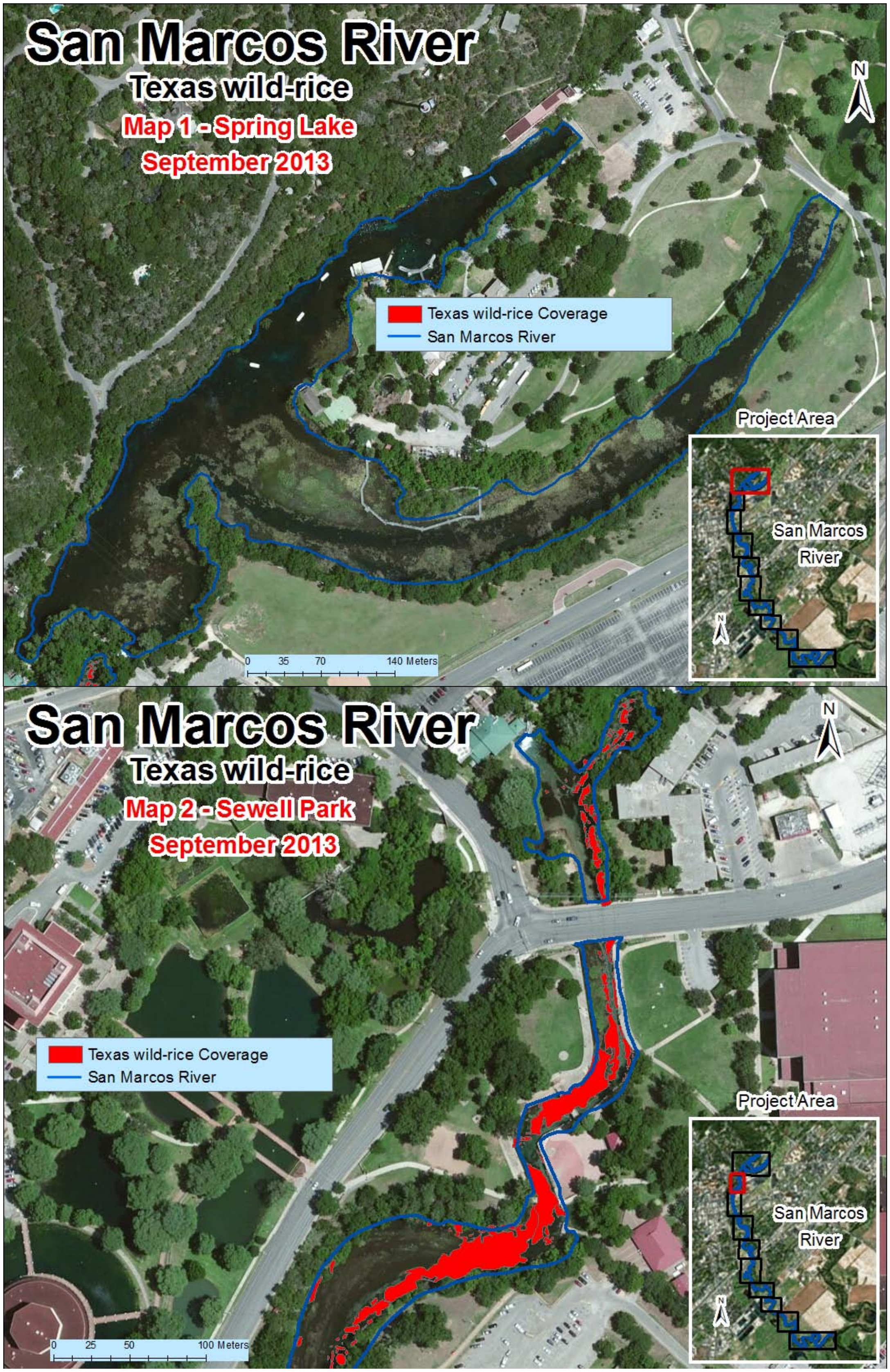


Figure 9: Texas wild-rice – 2013 Coverage - San Marcos System

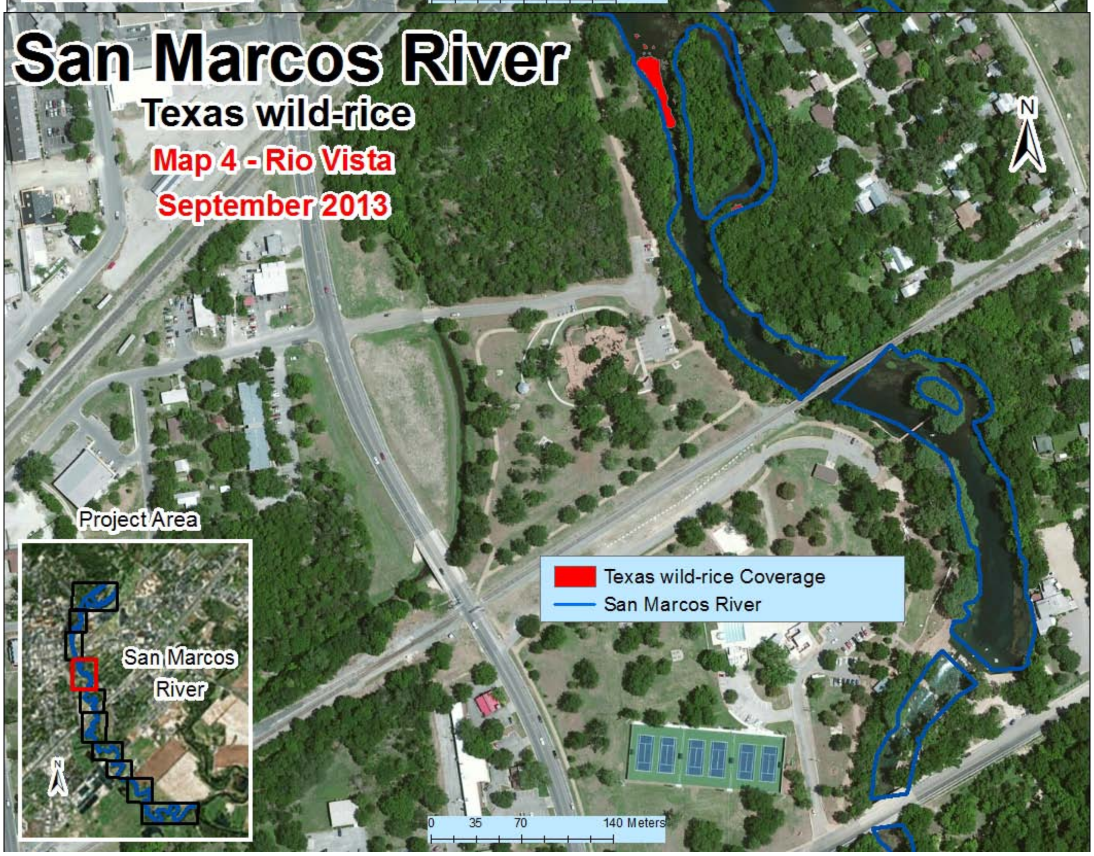


Figure 9 (continued): Texas wild-rice – 2013 Coverage - San Marcos System

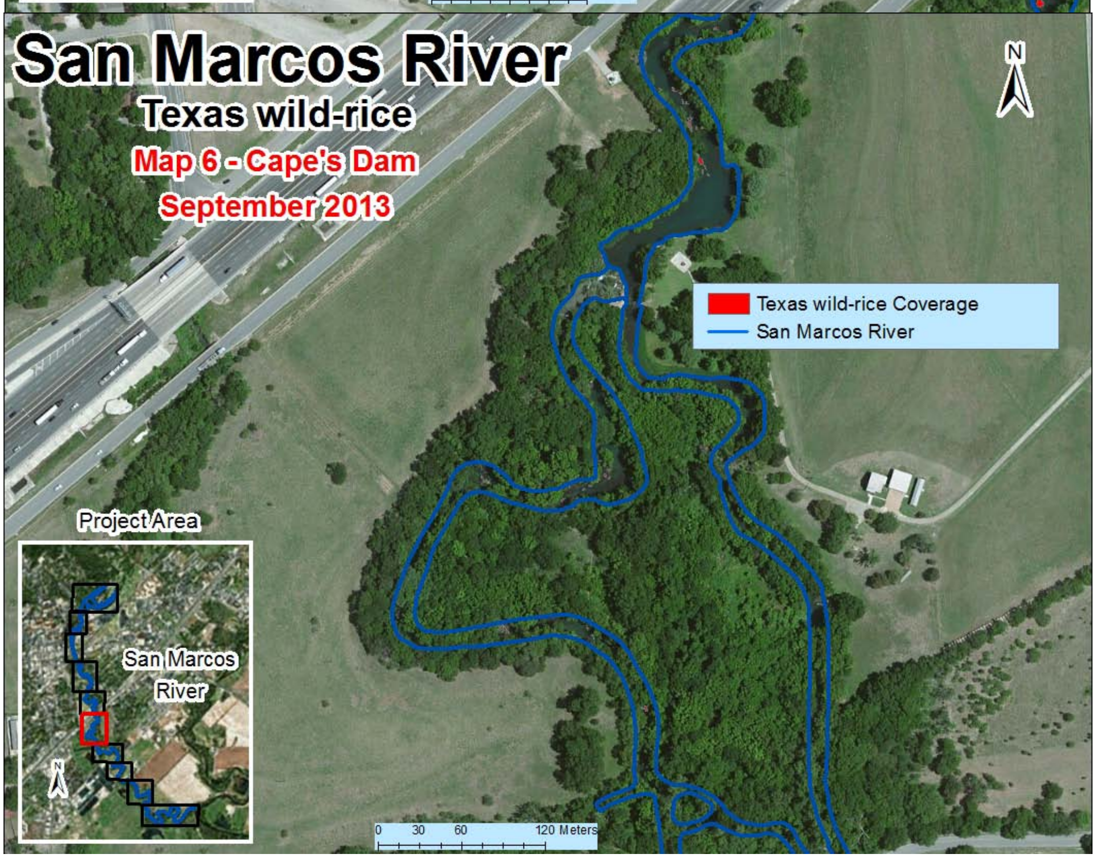


Figure 9 (continued): Texas wild-rice – 2013 Coverage - San Marcos System

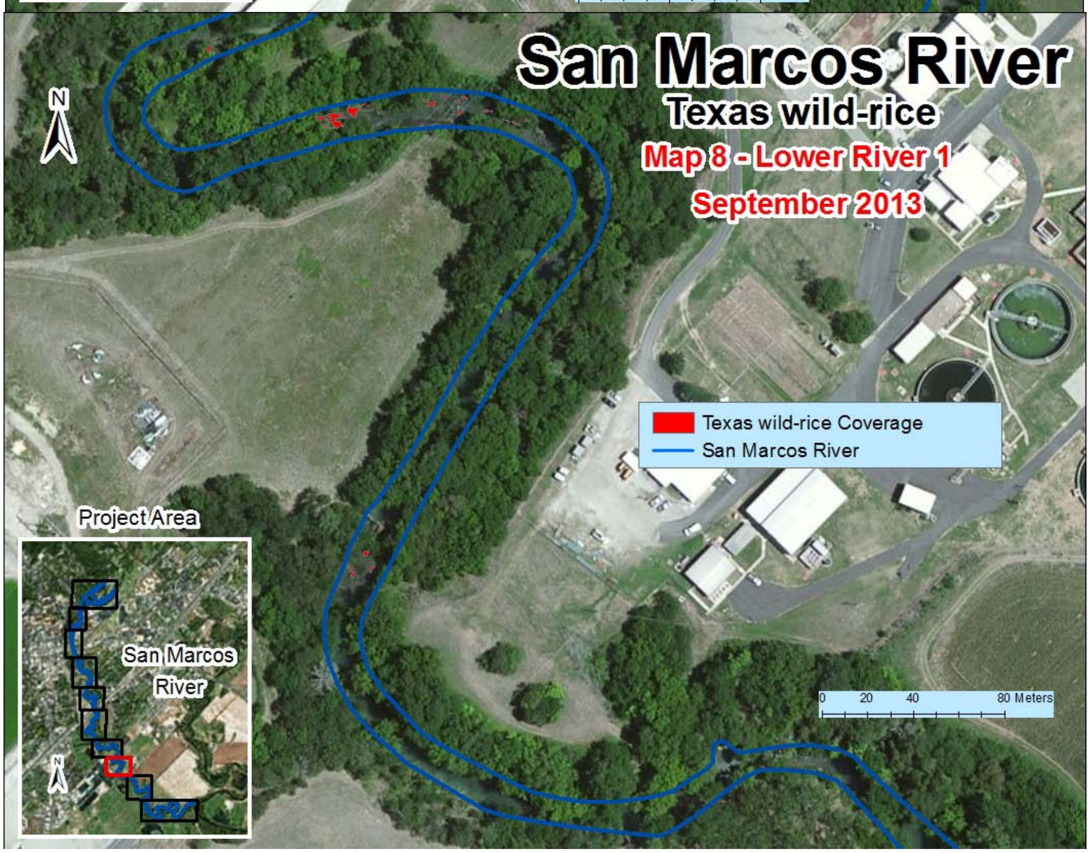


Figure 9 (continued): Texas wild-rice – 2013 Coverage - San Marcos System

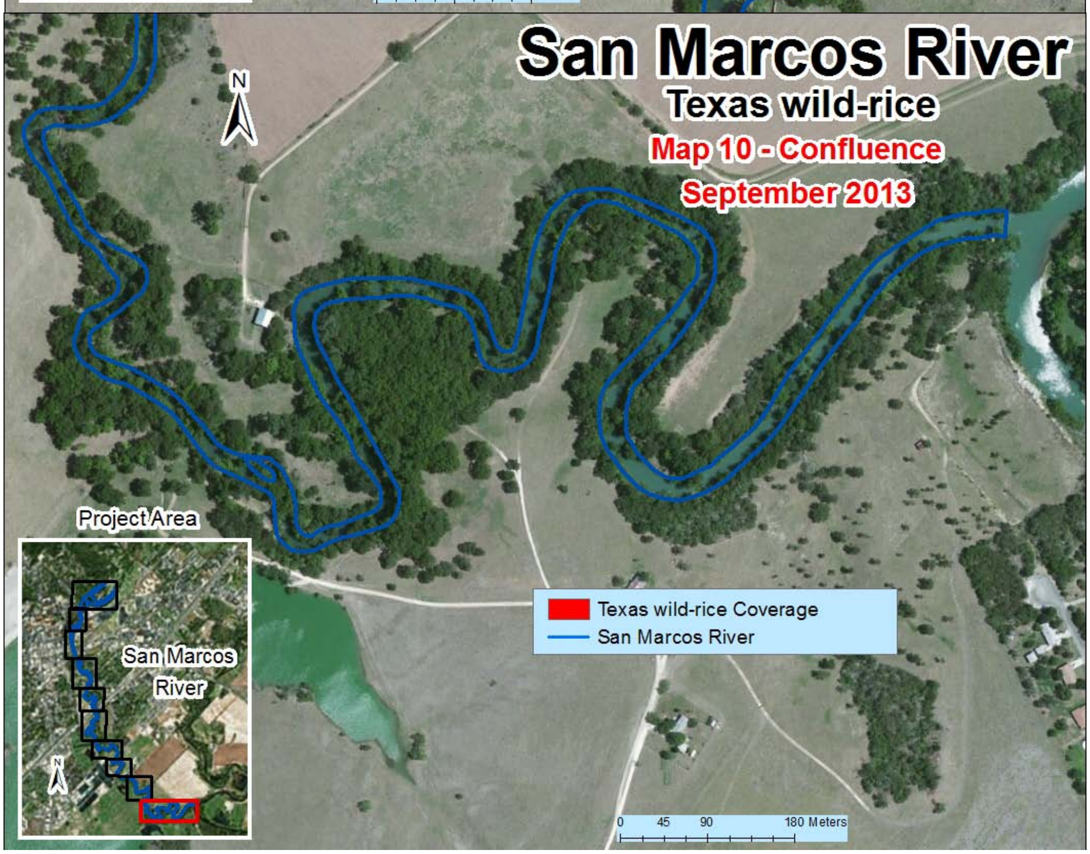


Figure 9 (concluded): Texas wild-rice – 2013 Coverage - San Marcos System

Documentation of HCP mitigation areal extent per project: Descriptions of the HCP minimization and mitigation measures for the City of New Braunfels, City of San Marcos, and Texas State University are presented in the ITP Annual Report (Sections 3.2, 3.3, and 3.4, respectively) and will not be duplicated in this memorandum.

Item M of the ITP requires an assessment of the direct HCP mitigation and restoration activities conducted each year. The direct HCP mitigation and restoration activities relative to Item M are listed below for the City of New Braunfels, City of San Marcos and Texas State University.

- City of New Braunfels (projects derived from Item 2f in permit)
    - Flow-split management
    - Restoration and maintenance of native aquatic vegetation (Old Channel and Landa Lake)
    - Decaying vegetation removal
    - Aeration and water quality sonde in Landa Lake
    - Gill parasite
    - Riparian restoration and bank stabilization
    - Riffle beetle restoration
    - Non-native species removal
    - Sediment Island removal
- City of San Marcos and Texas State University (projects derived from Item 3d and the second 4e in permit)
    - Enhancement and restoration of Texas wild-rice
    - Management of recreation specific to State Scientific Areas (only)
    - Non-native species removal
    - Restoration and maintenance of native aquatic vegetation
    - Sediment removal
    - Access Points and Bank Stabilization
    - Riparian restoration

For 2014 activities pertinent to these projects, the areal extent of the project footprint has been quantified in Table 2 and depicted in subsequent figures per project. The project footprints were then overlaid on the occupied habitat maps in GIS and calculations of “Impact” area were performed. The results for each project and covered species are presented in Table 2.

Comal System

Of the projects listed above and presented in Table 2, the **Riparian restoration and bank stabilization** study only involved project design in 2014. There were no on the ground construction or field activities that constituted an impacted project footprint for this project in 2014. As such, no project area footprint map is included for this project. It is anticipated that on the ground activities in 2014 will occur should total system discharge stay above 130 cfs and if so, project area maps will be required next year.

The **Flow-split management** project was completed in spring 2014 and involved portions of Landa Lake and the Old Channel. Activities included the placement of temporary bladder dams in Landa Lake to divert water flow so that the smaller two culverts could be capped at both the upstream Landa Lake inlet and downstream Old Channel outlet. Additionally, a bladder dam was used to divert flow from the main culvert so that a new gate could be installed and a series of baffle blocks be placed on the downstream apron to provide greater turbulence for aeration purposes. The 2014 project footprints for the flow-split management project are depicted in Figure 10 and quantified in Table 2.

The **restoration and maintenance of native aquatic vegetation** project involved restoration activities in both Landa Lake and the Old Channel of the Comal system. These activities included the removal of non-native aquatic vegetation and subsequent restoration of native aquatic vegetation in its place. The 2014 project footprints for native vegetation restoration are depicted in figures 11 and 12 with areas (m^2) quantified in Table 2. Additionally, the MUPPT nursery area used to propagate native aquatic vegetation for restoration activities is also considered part of the project footprint (Figure 11).

As noted in Table 2, the project footprint of the Native Aquatic Vegetation restoration effort in the Comal system encompassed 1,986 m^2 which overlapped with 1,646.5 m^2 of occupied fountain darter habitat. There was not any overlap with occupied habitat for the endangered Comal invertebrates. Although not quantified for this assessment, disturbance from foot traffic to and from these locations and from slightly elevated turbidity during non-native vegetation removal did temporarily occur.

The **Sediment Island removal** project in the Old Channel was completed in 2013 and thus no calculations were included in the 2014 evaluation for that finished project. Activities associated with supplemental planting of native aquatic vegetation in that section of the Old Channel were covered under native aquatic restoration project.

As presented in 2013, there is no project footprint map for the **Decaying Vegetation Removal** project as it was conducted throughout the main portion of Landa Lake and the New Channel on an as needed basis when floating mats of aquatic vegetation had built up. As such, no quantified area of impact was designated in 2014 for this project in Table 2. Temporary disturbance resulting from foot traffic within fountain darter occupied habitat did occur as well as slightly elevated turbidity downstream from immediate work zone.

The **Aeration and water quality** sonde project consisted of the installation of a series of aerators in Landa Lake as well as the installation of a water quality sonde in the lake for continual real-time measurements. The original project footprint for these components was small (Figure 11, Table 2) and considered the same in 2014 to accommodate any maintenance, calibration or repair activities that were conducted this year. As the aerators and water quality sonde were placed within native aquatic vegetation, there was a direct overlap with 4.5 m^2 of occupied fountain darter habitat. As noted for other projects, short-term and limited exposure disturbance is experienced from foot traffic when calibrating the water quality sonde or maintenance of the aerators is required.

The **Gill parasite** project involved snail density quadrat sampling that disturbed the entire substrate in multiple locations (Figure 13, Table 2). The overall project footprint involved 15 m^2 with 11 m^2 overlapping with fountain darter occupied habitat. For all Gill Parasite project activities (snail density sampling and water sampling cross sections) temporary disturbance from foot traffic in and around the areas/transects as well as slightly elevated turbidity downstream did occur.

TABLE 2 – Mitigation and Restoration Project Areas and Calculated Impact Area per Covered Species

HCP ACTIVITY	Project Footprint Area (m^2)	"Impact Area" Overlap with Occupied Habitat for Covered Species (m^2)						
		Fountain darter	Comal Springs riffle beetle	Comal Springs dryopid beetle	Peck's Cave amphipod	San Marcos salamander	Texas blind salamander	Texas wild-rice [A]
CITY OF NEW BRAUNFELS								
Flow-split management	3,407	306	--	--	--			
Restoration and maintenance of native aquatic vegetation	1,986	1,646.5	0	0	0			
Decaying vegetation removal	**B**	--	--	--	--			
Aeration, Water Quality Sonde	4.5	4.5	0	0	0			
Gill parasite	15.0	11.0	0	0	0			
Riparian restoration and bank stabilization	**C**	--	--	--	--			
Riffle beetle restoration	483	0	0	0	0			
Non-native species removal	35	27	0	0	0			
Sediment Island removal	Completed in 2013 – No activities in 2014							
TOTAL	5,930	1,995	0	0	0			
CITY OF SAN MARCOS / TEXAS STATE UNIVERSITY								
Enhancement and restoration of Texas wild-rice	**D**	--	--			--	--	--
Management of recreation specific to Exclusion zones (only)	2,137	153	--			29.5	--	--
Non-native species removal	**B**	--	--			--	--	--
Restoration and maintenance of native aquatic vegetation	5,070	3,808	0			0	0	0
Sediment removal	255	255	0			0	0	0
Access Points and Bank Stabilization	2,822	351	0			0	0	0
Riparian restoration	93,146	0	0			0	0	0
TOTAL	103,430	4,567	0			29.5	0	0

A Texas wild-rice not formally needed for the Item M assessment but included for informational purposes

B Throughout system – described in qualitative impacts discussion

C Only design work conducted in 2014

D Project footprint is accounted for in Native Aquatic Vegetation restoration project

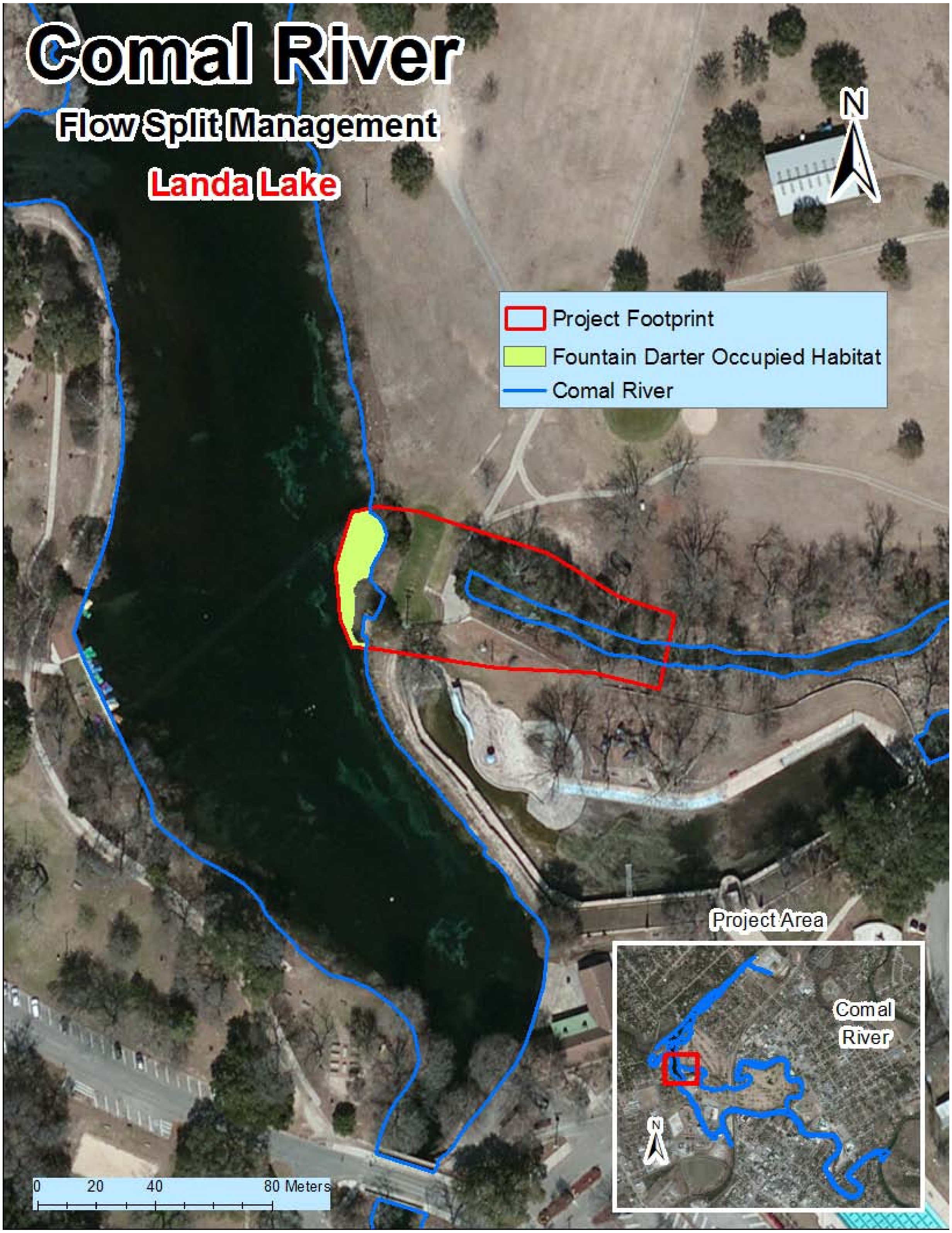


Figure 10: Flow-split management footprint and fountain darter occupied habitat.

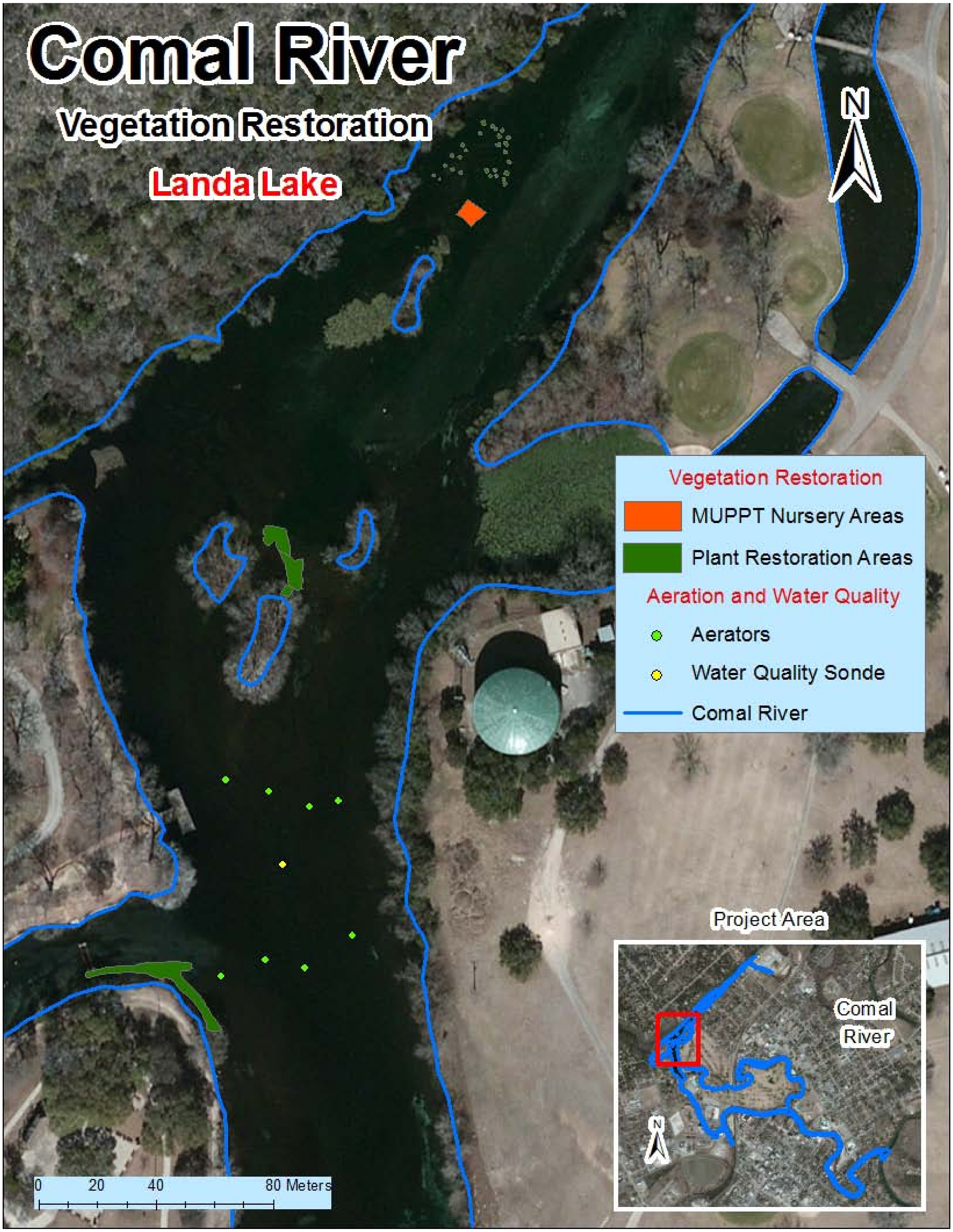


Figure 11: Restoration and Maintenance of Native Aquatic Vegetation project and Aeration and Water quality sonde project – Landa Lake (Comal system)

Figure 12: Restoration and Maintenance of Native Aquatic Vegetation project and Sediment Island removal project – Old Channel (Comal River)

The **Riffle beetle restoration** project involved only on shore activities in 2014 (Figure 14). The project footprint was made up of erosion control zones that were constructed along the banks of the western shoreline and Spring Run 3. Although the project footprint consisted of 483 m^2, all of this area was out of the water and thus did not overlap with any Covered Species occupied habitat.

The **Non-native species removal** project involved using four fyke nets during each trapping session. Fyke nets are passive traps that have 50-foot leads that guide fish into a 12-foot long by 3-foot wide hoop net. Additionally, three gill nets were used in the central portion of Landa Lake and a series of nutria traps were deployed along the banks of the Comal system. The fyke nets, gill nets and nutria trap locations are depicted in Figure 15. The footprint of the fyke nets, gill nets and nutria traps is presented in Table 2 along with the overlap of fountain darter occupied habitat. In addition to these activities, biologists snorkeled early in the morning and late in the afternoon (high times of fish activity) in areas of high fish density and speared non-native fish as well as hand picking giant ramshorn snails. Temporary disturbance resulting from foot traffic within fountain darter occupied habitat did occur around the fyke nets as well as slightly elevated turbidity downstream when nets were being placed, checked, and removed.

Figure 13: Gill Parasite project – Snail Quadrat Locations

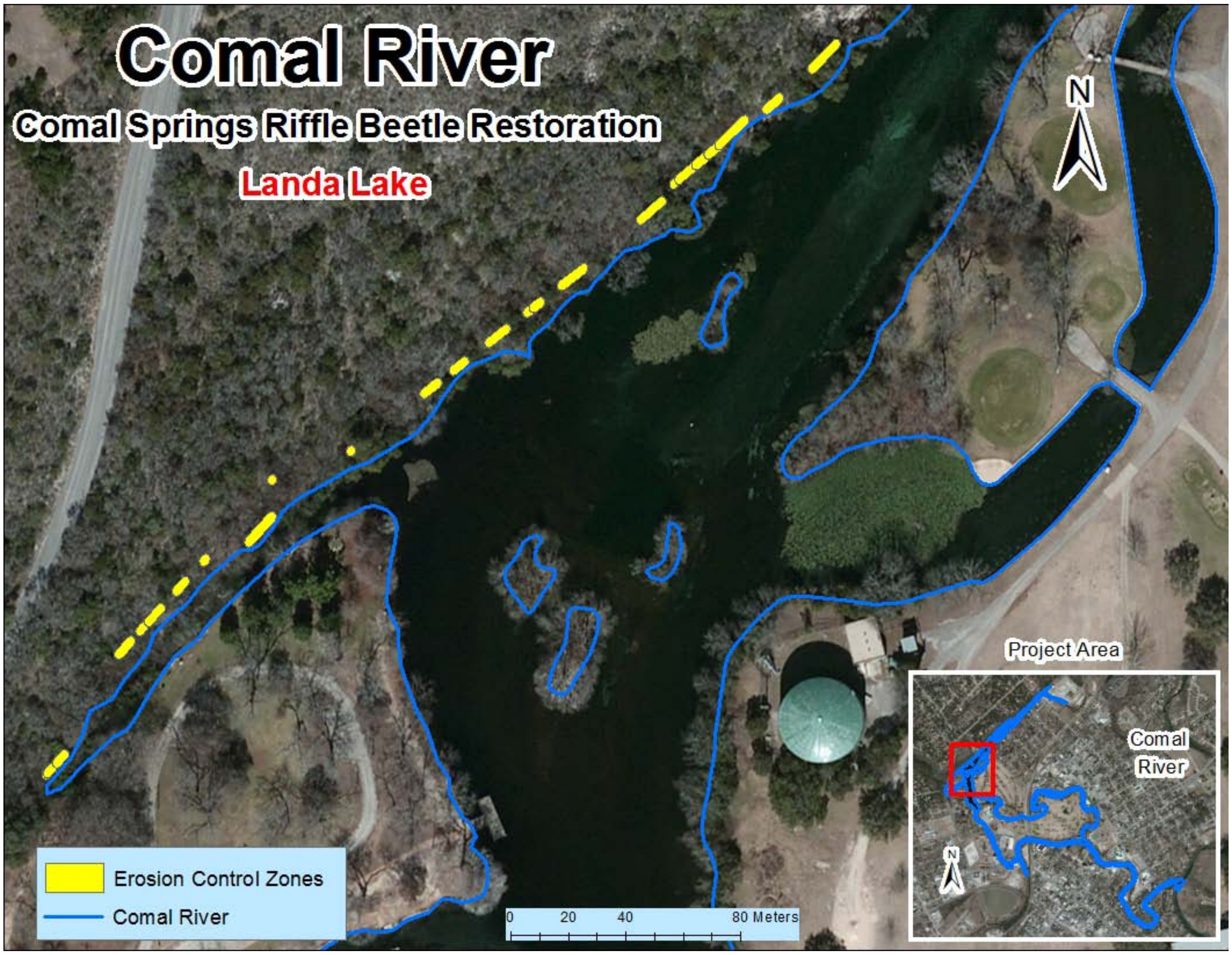


Figure 14: Comal Springs Riffle Beetle Restoration project – Comal System.

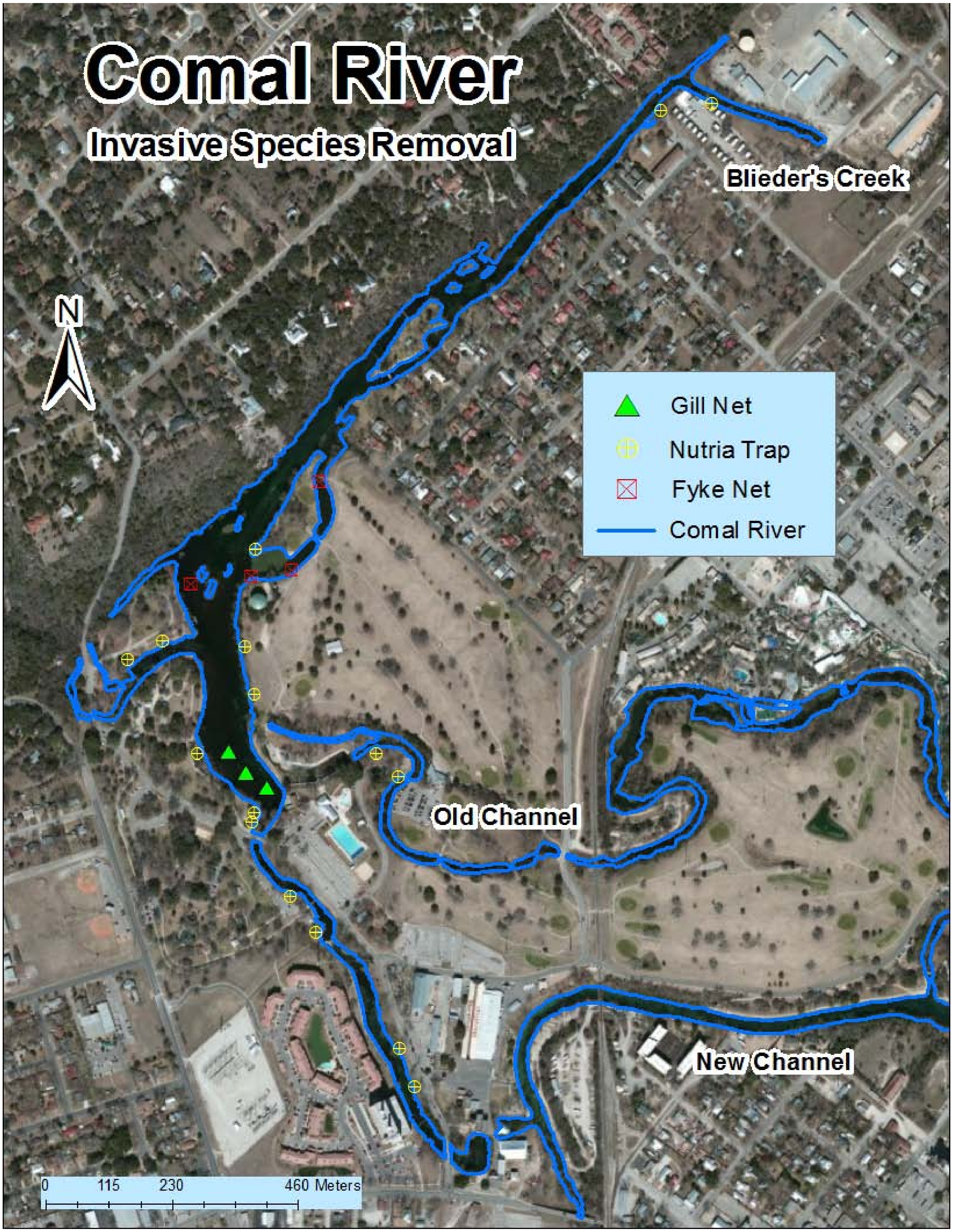


Figure 15: Non-native Animal Species Removal Project – Comal System.

San Marcos System

The **Enhancement and restoration of Texas wild-rice** and **Restoration and maintenance of native aquatic vegetation** project areas are depicted in Figure 16. As described in the ITP Annual Report, select non-native aquatic vegetation was removed from these areas allowing native vegetation (including Texas wild-rice) to expand over 2014. Native aquatic vegetation was also planted in cleared areas within these sections to promote restoration activities where practical and appropriate. As evident in Table 2, the working project area supports a footprint of 5,070 m^2. Of that amount, 772 m^2 was existing Texas wild-rice in September 2013 which was not disturbed during activities. Subtracting the 772 m^2 from the 5,070 m^2 equals a foot print of 4,298 m^2 of which 3,808 m^2 overlaps with fountain darter occupied habitat (other than non-disturbed Texas wild-rice) (Table 2). Although not quantified for this assessment, disturbance from foot traffic to and from these locations and from slightly elevated turbidity during non-native vegetation and sediment island removal did temporarily occur.

There were five **Exclusion zones** incorporated within the State Scientific Area in 2014 for the management of recreation (Figure 17) which resulted in the protection of approximately 2,137 m^2. The upstream exclusion zone in the eastern spillway below Spring Lake Dam was strategically placed over fountain darter and San Marcos salamander occupied habitat as well as Texas wild-rice. Although this area overlaps each of these covered species occupied habitats, the majority of the project footprint is a net benefit from the exclusion of recreation in these areas. The impact area calculated for this upstream zone was 0.5 meters wide by 81 meters long (≈41 m^2) for the placement of t-posts and boom surrounding the protection area. The second exclusion zone is just below the second pedestrian bridge in Sewell Park which includes both fountain darter occupied habitat and Texas wild-rice. The impact area calculated for this middle zone was 0.5 meters wide by 63.6 meters long (≈32 m^2) for the placement of t-posts and boom surrounding the protection area. There are two zones near Bicentennial Park with these areas overlapping with fountain darter occupied habitat as well as Texas wild-rice. However, again the majority of this overlap is considered a net benefit. The impact area listed in Table 2 represents the 0.5 m wide by 123.9 meters long (total length of both zones, ≈62 m^2) area for the placement of the t-posts and booms as well as foot traffic to patrol this area. The most downstream exclusion zone is located downstream of Cheatham St., with an impact area of 0.5 meters wide by 37.2 meters long (≈19 m^2) for the placement of t-posts, etc. as described above. As such the total disturbance area for the five exclusions zones was 152.8 m^2. Temporary disturbance of slightly elevated turbidity to downstream areas did result from foot traffic to patrol and maintain these areas.

There is no project footprint map for the **Non-native species removal** project as it was conducted throughout Spring Lake and the San Marcos River without permanent or temporary installation of equipment. Most work was conducted via snorkel or SCUBA in areas of high fish density with non-native fish being speared.

The **Sediment Removal** project areas are depicted on Figure 18. Fine sediment was carefully removed from within these boundaries following the protocols described in Section 3.3 of the ITP Annual Report. The overall project footprint was 255 m^2 with complete overlap of fountain darter occupied habitat in the San Marcos River (Table 2). Temporary disturbance from foot traffic to and from these locations and from slightly elevated turbidity during fine sediment removal did occur. The footprint for the **Bank stabilization** project (2,822 m^2) is also depicted on

Figure 18. While most of this work took place on land, there was some overlap (351 m^2) associated with fountain darter occupied habitat.

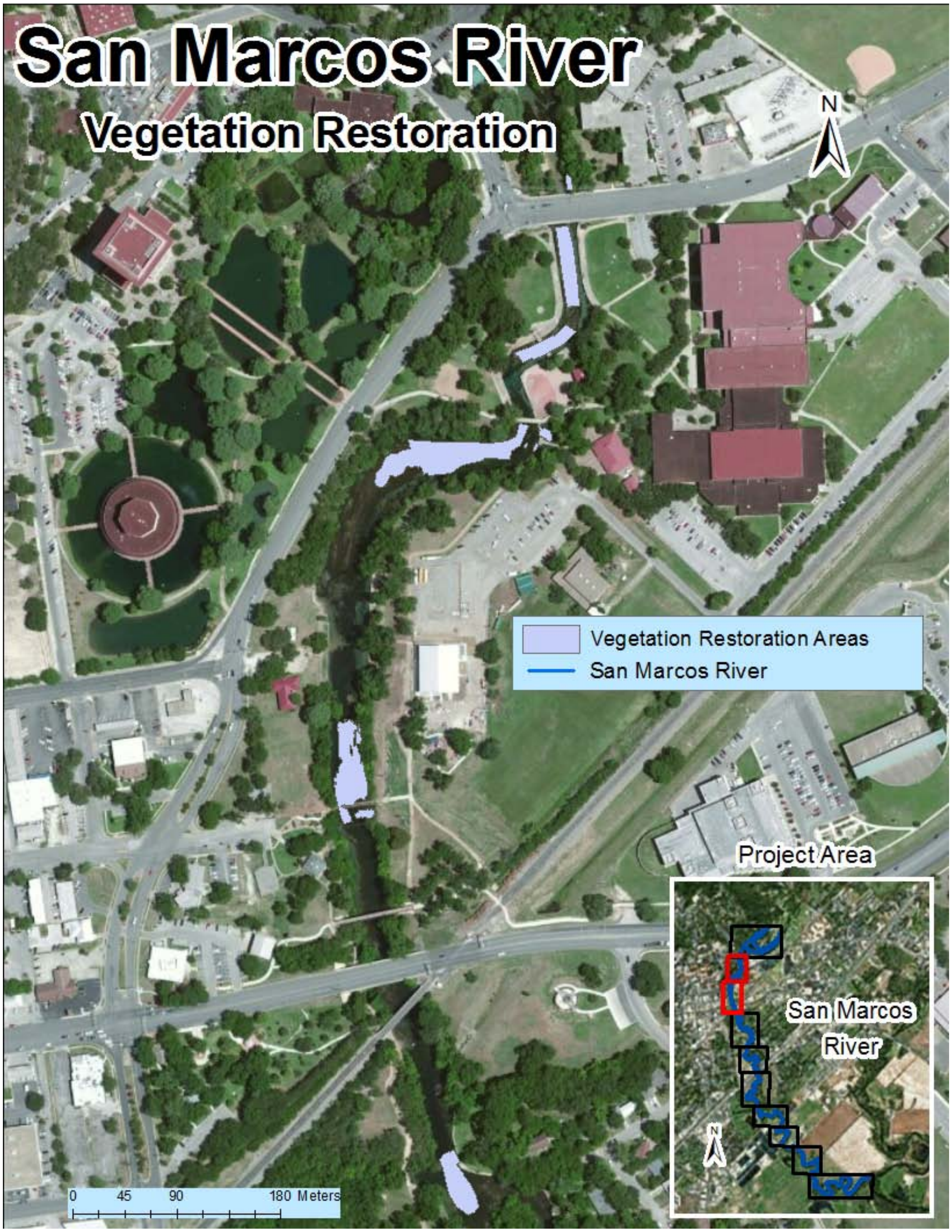


Figure 16: Restoration and Maintenance of Native Aquatic Vegetation and Enhancement of Texas wild-rice projects – San Marcos River.

Figure 17: 2014 Exclusion Zones within State Scientific Area for Recreation control – San Marcos River.

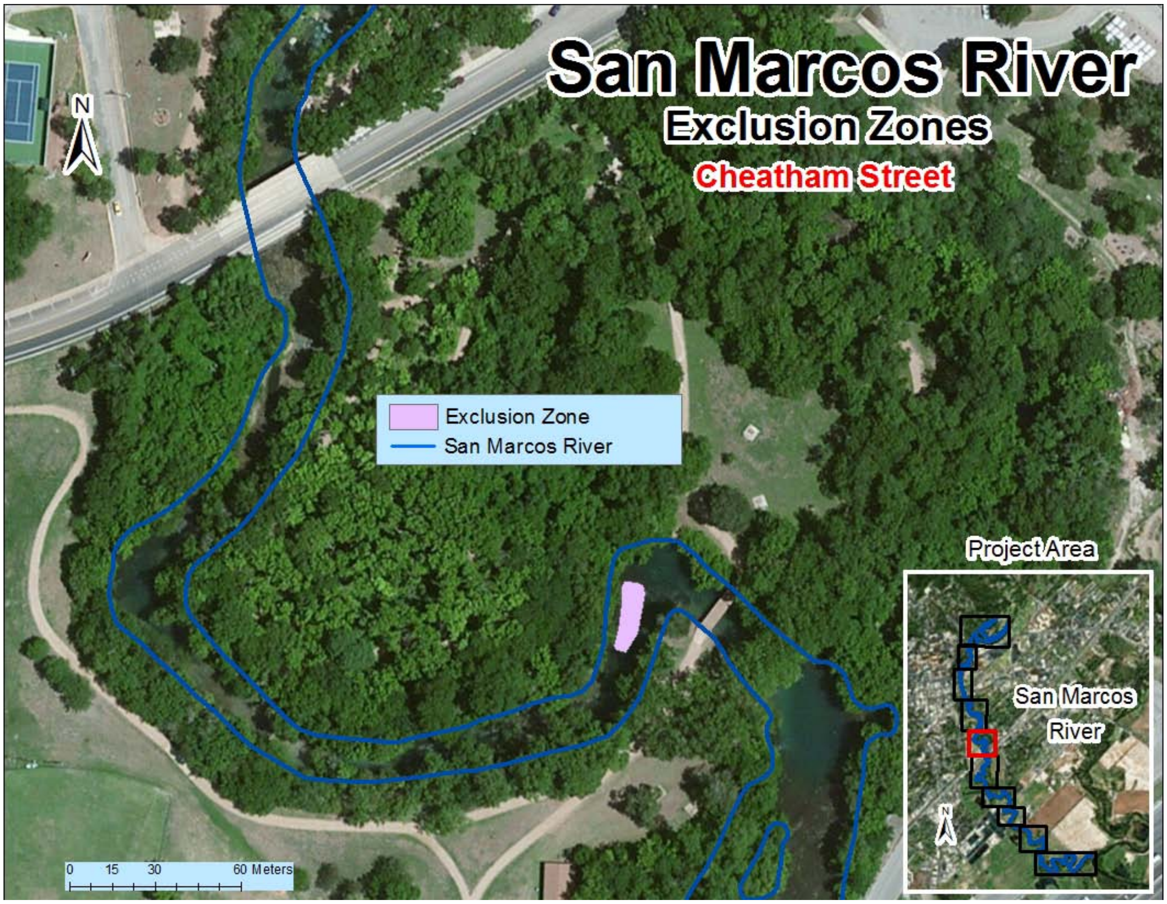


Figure 17 (continued): 2014 Exclusion Zones within State Scientific Area for Recreation control – San Marcos River.

The **Riparian restoration** project along the San Marcos River in 2014 involved the largest project footprint (93,146 m^2) of any HCP restoration project in either spring system to date. The restored areas are depicted on Figure 19 and quantified in Table 2. As with the bank stabilization project, the riparian restoration project took place on the banks and water's edge and did not overlap with any occupied habitat for the covered species.

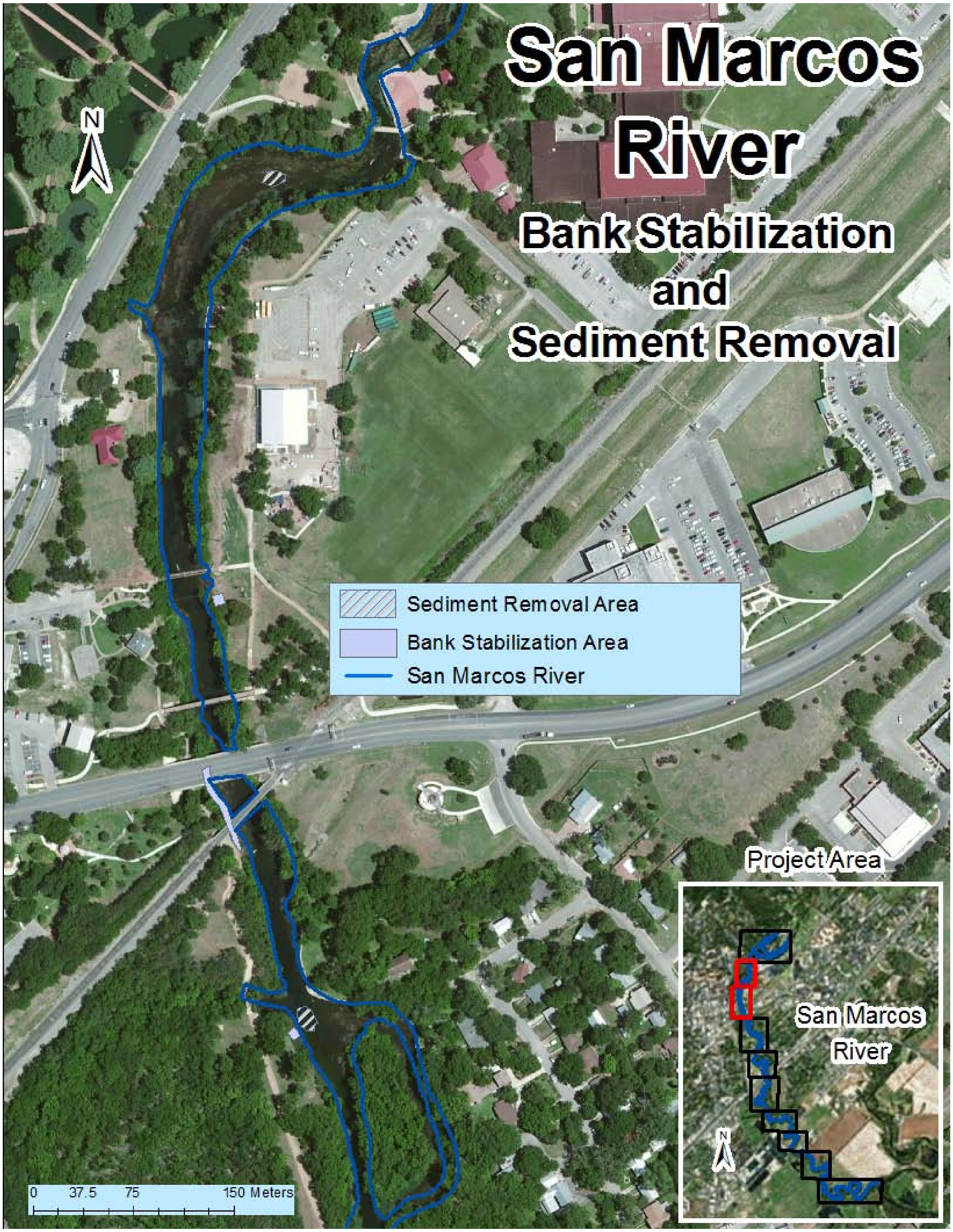


Figure 18: 2014 Sediment Removal and Bank Stabilization areas – San Marcos River.

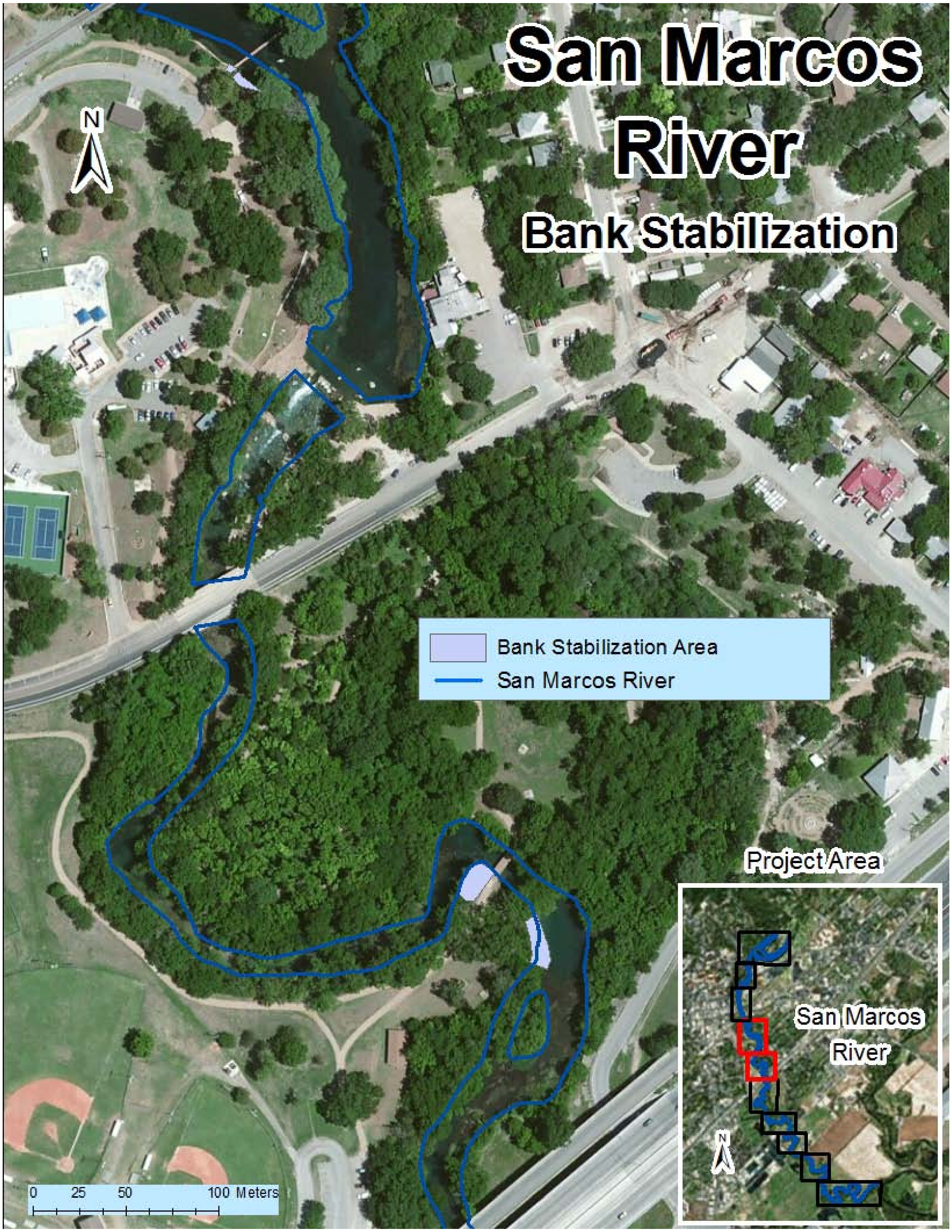


Figure 18 (continued): 2014 Sediment Removal and Bank Stabilization areas – San Marcos River.

Figure 19: 2014 Riparian Restoration areas – San Marcos River.

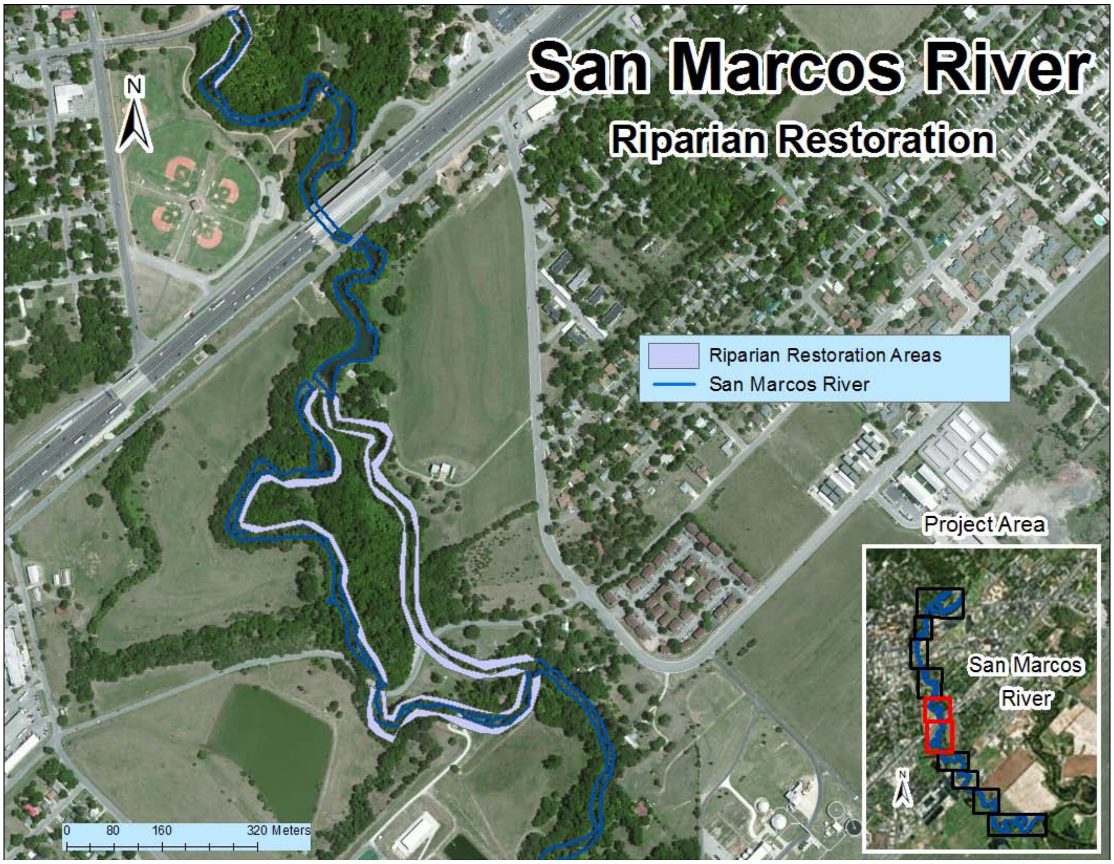


Figure 19 (continued): 2014 Riparian Restoration areas – San Marcos River.

Net Disturbance Assessment:

As described above, the baseline maps of occupied habitat versus the HCP project footprint maps were examined to quantify the area of potential effects from mitigation and restoration activities as required in Item M (1a and 2a). This included a system-wide assessment of net disturbance and net benefit. The focus was on quantifying the direct impacts (removal of non-native vegetation, removal of sediment, permanent placement of equipment, etc.) via areal coverage of activity, but temporary disturbance from slightly elevated turbidity and increased foot traffic were also described.

Table 3 shows the Net Disturbance calculation which is simply the sum of all project impact area that is overlaying baseline occupied habitat for a given covered species per system. As shown in Table 3, only the fountain darter in the Comal System had a net disturbance when considering the project footprints overlaid on occupied habitat. The net disturbance was 2.1% of the total occupied habitat for this species. As shown in Table 2, there were no project footprints that overlapped with any of the occupied habitat for the endangered Comal invertebrates. Additionally, for the subterranean species, there was no project impacts noted that directly affected spring orifices that could have resulted into changes to subterranean habitat.

TABLE 3 - NET DISTURBANCE AREA AND PERCENTAGE OF TOTAL PER SPECIES PER SYSTEM

COVERED SPECIES	Total Occupied Habitat (m^2)	Net Disturbance	
		Impact Area (m^2)	% of Total
CITY OF NEW BRAUNFELS			
Fountain Darter	96,624	1,995	2.1%
Comal Springs riffle beetle	1,511	0	0
Comal Springs dryopid beetle	350 [A]	0	0
Peck's Cave amphipod	1,470 [A]	0	0
CITY OF SAN MARCOS / TEXAS STATE UNIVERSITY			
Fountain Darter	112,985	4,567	4.0%
San Marcos salamander	2,165	29.5	1.4%
Texas blind salamander	[B]		
Comal Springs riffle beetle	11	0	0

[A] Although a minimal amount of surface habitat was documented for the baseline and comparison purposes, this species is subterranean and utilizes subsurface habitat.
[B] No surface habitat documented for this species.

In the San Marcos system, both the fountain darter and San Marcos salamander had a net disturbance per this assessment. The fountain darter had 4.0% of its total occupied habitat disturbed whereas the San Marcos salamander amount was lower at 1.4%. For the Texas blind salamander and Comal Springs riffle beetle, there were no activities conducted in 2014 that directly impacted any of the orifices where collections have routinely been made over the years. As such, no direct impacts to subterranean or aquifer habitat was experienced from 2014 HCP mitigation and restoration measures in the San Marcos system. In summary, the 10% disturbance rule (Item M [a]) was in compliance for 2014.

One difference between 2013 and 2014 HCP mitigation and restoration efforts was the enforcement of Provision M (b) of the HCP ITP. Provision M (b) states that:

"Permittees will suspend [based upon river discharge] activities such as habitat restoration and riparian restoration that may result in disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals or invertebrates" (USFWS, 2010).

For the Comal system, the discharge at which Provision M comes into effect is 130 cfs, whereas it is 120 cfs for the San Marcos system. This provision restricted HCP mitigation and restoration activities in both systems for extended periods of time in 2014. Upon further clarification of provision M by the USFWS in early fall, certain activities and modified approaches to limit disturbance were resumed. However, the amount of work that was conducted in 2014 was considerably less then performed in 2013 which is reflected in the incidental take numbers for this category in Section 2.

SECTION 2 - INCIDENTAL TAKE

All discussions presented in this section relate back to the USFWS Biological and Conference Opinions for the Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan – Permit TE-63663A-0 (Consultation No. 21450-2010-F-0110), hereafter, Biological Opinion. The goal of this section is to characterize and quantify to the degree practical the Incidental Take that occurred in 2014 as a result of implementation of the EA HCP. This incidental take exercise builds upon the occupied habitat characterization and net disturbance assessment discussed in Section 1 relative to Requirement M (1a and 2a) of EARIP's ITP. As discussed above, the net disturbance assessment specifically addressed mitigation and restoration activities associated with the HCP. However, that net disturbance quantification represents only the baseline component of one aspect of the incidental take assessment. In addition to assigning incidental take to the disturbed areas from HCP mitigation and restoration activities, this assessment characterizes and quantifies to the degree practical the incidental take associated with implementation of all other applicable HCP covered activities. Thus, the two categories carried forward through this section include 1) HCP Mitigation and Restoration and 2) HCP Measures and Drought.

BACKGROUND

To fully comprehend the assessment, it is vital to understand what "take" and "incidental take" actually are. Section 8 of the Biological Opinion describes and defines "Take" as follows, "Take is defined by the Service as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is further defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns, which include, but are not limited to, breeding, feeding and sheltering (50 CFS §17.3). Harm is also further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns, including breeding, feeding, and sheltering. Incidental take is defined by the Service as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity." As such and as referenced above, the goal of this assessment is to characterize and quantify Incidental Take to the degree practical.

Specific to the EARIP ITP, an incidental take assessment is relative to Items S and T as described below.

Item S 3. "The Permittees will develop and oversee a monitoring program to identify and assess potential impacts, including incidental take, from Covered Activities and provide a better understanding and knowledge of the species' life cycles and desirable water quality- and springflow-related habitat requirements of the Covered Species (Section 6.3 of the HCP)."

Item T 3i. "Effects on the Covered Species or Permit Area"

An intensive monitoring program is in place and being performed for the HCP. In fact, the biological monitoring program was instrumental in assessing the effects on the Covered species described in this memorandum.

Item G of EARIP's ITP addresses the covered animal species that are authorized for incidental take. There are 10 animal species with take authorization and 1 plant species for impact assessment only. All activities described in this section pertain to the HCP Covered species that are actively authorized (Item H: 1-6) in 2014 for incidental take via EARIP's ITP. This includes the fountain darter, Comal Spring riffle beetle, Comal Spring dryopid beetle, Peck's Cave amphipod, Texas blind salamander, and San Marcos Salamander. Although the Texas cave diving beetle, Texas troglobitic water slater, and Comal Spring salamander are listed in the permit, the conditions in the ITP are not active in 2014 as none of these species are presently listed as threatened or endangered with this directly acknowledged (Item H: 7-9) in the ITP. Additionally, Item I of the permit acknowledges that only if the San Marcos gambusia is located or found in the study area, will take provisions apply. As this has not occurred in 2014, the San Marcos gambusia is not included in this assessment. Finally, being a plant, Texas wild-rice is not allotted incidental take provisions under this federal permit.

HCP Covered Activities

Item L of EARIP's ITP outlines the covered activities under this permit. There are responsibilities associated with all five (EAA, City of New Braunfels, City of San Marcos, Texas State University, and San Antonio Water system) HCP participants. A detailed list and description of these activities are presented in the HCP (EARIP 2011) and thus are only presented in outline form below. All activities outlined are considered included in this assessment to the degree practical and appropriate at this time.

Edwards Aquifer Authority

- a Programs that implement the statutory function of the EAA Act
- b Minimization and Mitigation Activities

City of New Braunfels

- a Recreational activities within the City of New Braunfels's jurisdiction
- b Management of Ecosystems of Comal Springs, Landa Lake, and the Comal River
- c Diversion of water from the Comal River in accordance with State law
- d Maintenance and operation of the spring-fed pool
- e Operation of boats on the Comal River and Landa Lake
- f Minimization and Mitigation Activities
    - Flow split management
    - Native Aquatic vegetation restoration
    - Management of public recreation
    - Decaying vegetation removal and dissolved oxygen management
    - Management of harmful non-native animal species
    - Monitoring and management of gill parasite
    - Prohibition of hazardous materials transport
    - Restoration of native riparian vegetation
    - Reduction of non-native species introduction and live bait prohibition
    - Litter collection and floating vegetation management
    - Management of Golf Course Diversions and operations
    - Impervious cover / water quality protection
    - Removal of sediment

City of San Marcos

a Recreational activities within the City of San Marcos's jurisdiction
b Operation of boats on the San Marcos River and Spring Lake
c Routine, minor repairs of infrastructure and facilities
d Minimization and Mitigation Activities

Enhancement and restoration of Texas wild-rice
Management of public recreation
Management of aquatic vegetation and litter
Prohibition of hazardous materials transport
Reduction of non-native species introduction
Removal of harmful erosion-related sediment below Sewell Park
Designation of permanent access points and bank stabilization
Management of non-native plant species
Management of harmful non-native and predator species
Restoration of native riparian vegetation
Implementation of a City of San Marcos septic system registration and permitting program
Management of potentially contaminated runoff
Implementation of a City of San Marcos household hazardous waste program
Implementation of water quality protection and an impervious cover limitation program

Texas State University

a Recreational activities within the University's jurisdiction
b Educational activities
c Management of the ecosystems of the San Marcos River and Springs
d Permitted diversion of water from Spring Lake and the San Marcos River
e Operation and maintenance of the University golf course and grounds
f Minimization and Mitigation Activities

Enhancement and restoration of Texas wild-rice
Management of public recreation
Management of aquatic vegetation from Sewell Park to City Park
Removal of harmful erosion-related sediment in Spring Lake and from Spring Lake Dam
Management of surface water diversion
Restoration of native riparian vegetation
Removal of harmful erosion-related sand bar in Sessom's Creek
Management of research programs in Spring Lake
Reduction of non-native species introduction
Management of non-native plant species
Management of harmful non-native and predator species

San Antonio Water System

a Pumping from the Edwards Aquifer and for use and operation of the SAWS ASR
b Minimization and Mitigation Activities

Use of SAWS ASR for Springflow protection
Phase II Expanded Use of the SAWS ASR

The Biological Opinion summarizes the covered activities into two main types, 1) flow protection and springflow management measures including changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, implementation of the VISPO program or equivalent necessary measures, and reductions of surface water diversions and 2) other covered activities including but not limited to sediment removal, water-based recreation, non-native species management, operation and maintenance of flow management infrastructure, and other considered activities. The Biological Opinion acknowledged that impacts from flow protection and springflow management measures would not be anticipated during average years, while impact from all other HCP activities could occur in all years.

2014 INCIDENTAL TAKE ASSESSMENT

Following the USFWS review of the EAA Annual Report, a meeting was held on October 1, 2014 with professionals from the USFWS Austin Ecological Services (ES) office, Edwards Aquifer Authority, and BIO-WEST. The purpose of the meeting was to receive feedback from the USFWS on the Item M net disturbance assessment and Incidental Take Assessment conducted for 2013. Based on those conversations, it was determined that only one change was needed to the methodology moving forward. This change involved the inclusion of Texas wild-rice as fountain darter occupied habitat. Discussions with USFWS also confirmed that annual incidental take should be based on the condition of the system going into the new year and not be cumulative with incidental take reported for 2013 for areas that had not recovered prior to 2014. This USFWS comment was adhered to and that approach built into the 2014 assessment described herein.

The 2014 incidental take assessment described in this section was conducted in the same manner as the 2013 assessment with the slight change (noted above) of including Texas wild-rice as fountain darter habitat. As in 2013, the analysis for the 2014 incidental take assessment was broken down into two distinct categories for carrying forward throughout the assessment. The first category involves HCP mitigation and restoration activities specifically accomplished within the two springs ecosystems. These projects were the focus of the SECTION 1 - Item M net disturbance assessment. The second category pertains to covered activities that are foundational components (flow protection and springflow management measures) and on-going activities (water borne recreation, water diversions, existing water management infrastructure and operation, etc.).

Each category is assessed independently below and then summed to represent the total amount of incidental take observed in 2014. Although calculated independently, a foundational first step to both assessments was the documentation of "occupied" habitat for the covered species as described in SECTION 1 (Table 1).

As described in SECTION 1, the baseline maps of occupied habitat versus the HCP project footprint maps were examined to quantify the area of potential effects from mitigation and restoration activities in Item M (1a and 2a) (Table2). The focus was on quantifying the direct impacts (removal of non-native vegetation, removal of sediment, permanent placement of equipment, etc.) via areal coverage of activity, but temporary disturbance from slightly elevated turbidity and increased foot traffic were also qualitatively described.

Table 3 in SECTION 1 shows the net disturbance calculation which is the sum of all project impact area that is overlaying baseline occupied habitat for a given covered species per system.

As shown in Table 3, only the fountain darter in the Comal System had a net disturbance when considering the project footprint overlaid on occupied habitat. As shown in Table 3, there were no project footprints that overlapped with any of the occupied habitat for the endangered Comal invertebrates. Additionally, for the subterranean species, there were no project impacts noted that directly affected spring orifices that could have resulted into changes to subterranean habitat.

In the San Marcos system, both the fountain darter and San Marcos salamander had a net disturbance per the Item M assessment (Table 3). For the Texas blind salamander and Comal Springs riffle beetle, there were no activities conducted in 2014 that directly impacted any of the orifices where collections have routinely been made over the years. As such, no direct impacts to subterranean or aquifer habitat was experienced from 2014 HCP mitigation and restoration measures in the San Marcos system.

HCP MEASURES and DROUGHT: Documentation of impacted habitat for all other applicable HCP Covered Activities

In addition to characterizing the impacted habitat from direct HCP mitigation measures and restoration activities as described SECTION 1, this assessment also addresses impacted habitat from all other applicable HCP Covered activities. As previously referenced, these other activities will be referred to as "HCP measures and drought" throughout the remainder of this assessment. As with the net disturbance assessment and Biological Opinion, this evaluation uses impacted habitat as the foundation for subsequent analysis. A discussion for each covered species is presented below.

Fountain darter:

A wealth of aquatic vegetation data over time is available per the long-term biological monitoring that has been conducted by EAA since 2000. The health and abundance of the fountain darter is strongly tied to the quantity and quality of aquatic vegetation present in both the San Marcos and Comal systems. As such, the determination was made to use the existing aquatic vegetation data to characterize and quantify the amount of impacted habitat that occurred in 2014 relative to HCP measures and drought.

Spring and fall sampling efforts for aquatic vegetation have been conducted in seven sample reaches (4 in Comal and 3 in San Marcos) since 2002. The sample reaches for the Comal System are shown in Figure 20 and include the Upper Spring Run sample reach, Landa Lake sample reach, New Channel sample reach, and Old Channel sample reach. The sample reaches for the San Marcos system are shown in Figure 21 and include the Spring Lake Dam sample reach, City Park sample reach, and the I35 sample reach. For both systems (Figures 20 and 21), the corresponding river section that corresponds to each sample reach is also shown.

The first step in this analysis was to compile all the spring and fall coverage of individual aquatic vegetation species from each of the seven sample reaches over time. All rooted aquatic vegetation per reach per event was combined into a total aquatic vegetation amount. Green algae were not included in the assessment because it is not rooted, is poor quality fountain darter habitat, and has a high level of variability from year to year. Although bryophytes are not rooted, they were included in the assessment for the slow moving sample reaches of Landa Lake and the Upper Spring Run in the Comal system only. The main river sections that support a defined channel and greater velocities result in highly variable conditions for the non-rooted bryophytes in the New and Old Channels of the Comal River and all three reaches in the San Marcos River. However, in the Landa Lake and Upper Spring Run sample reaches, relationships between bryophytes and total system discharge are apparent, and bryophytes provide high quality fountain darter habitat in these reaches.

Table 4 shows the total aquatic vegetation (m^2) present in each of the 4 study reaches in the Comal system over time. The color coding in Table 4 relates to "average" years [green], "flood event" years [blue], and "drought" years [orange]. Average years were determined as any year that exhibited over 225 cfs total system discharge throughout the entire year. The 225 cfs value was selected as it is the long-term average flow management objective specified in the HCP (EARIP 2011). In addition to being over 225 cfs, an average year for this assessment did not exhibit any flood events during the year or previous fall that substantially altered the aquatic vegetation within a given sample reach. If a flood event occurred in this manner and altered either the spring or fall aquatic vegetation amount, that year was discarded from the analysis. Finally, a drought year was determined as any year that exhibited total system discharge that went below 225 cfs at some point during the year. Concurrently, that drought year did not exhibit any flood events within the year that altered the aquatic vegetation in the sample reaches or it was discarded.

Figure 20. Sample Reaches (4) for the Comal System and Corresponding River Section.

Figure 21. Sample Reaches (3) for the San Marcos System and Corresponding River Section.

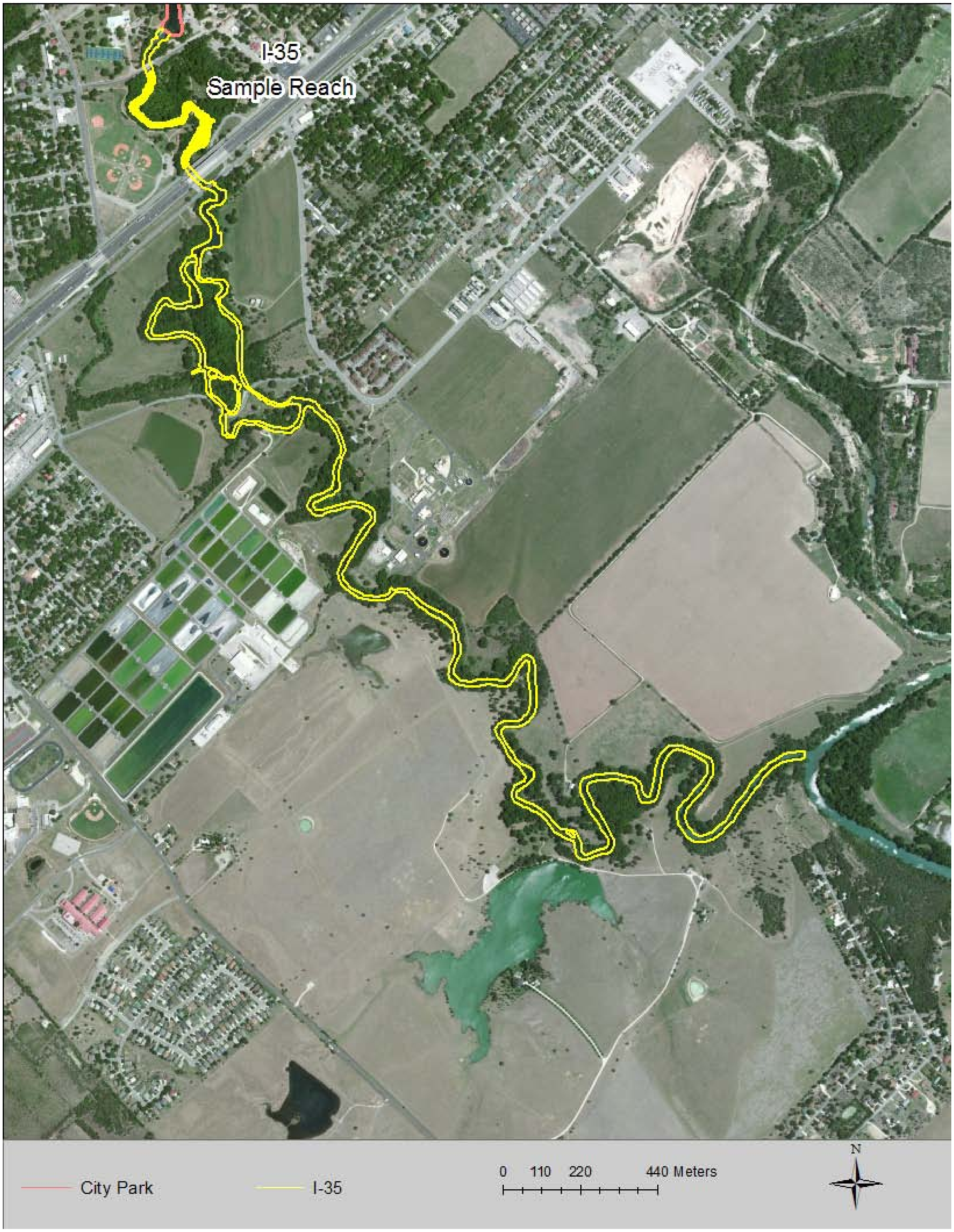


Figure 21 cont. I35 Sample Reach and Corresponding Lower River Section in the San Marcos System.

Table 4. Total Aquatic Vegetation in the Spring and Fall per reach on the Comal System over time.

Season	Upper Spring Run Reach			Landa Lake Reach			Old Channel Reach			New Channel Reach		
	Date	Total System Discharge (cfs)	Total Aquatic Vegetation (m^2)	Date	Total System Discharge (cfs)	Total Aquatic Vegetation (m^2)	Date	Total System Discharge (cfs)	Total Aquatic Vegetation (m^2)	Date	Total System Discharge (cfs)	Total Aquatic Vegetation (m^2)
Spring_02	5/14/2002	323	1569	5/16/2002	317	19497	5/15/2002	321	509	5/15/2002	321	3304
Fall_02	10/28/2002	421	2701	10/29/2002	417	19033	10/28/2002	421	486	11/21/2002	440	2555
Spring_03	4/22/2003	405	3909	4/23/2003	405	19351	4/24/2003	405	554	4/22/2003	405	3259
Fall_03	11/3/2003	368	2743	11/4/2003	364	17946	11/5/2003	361	872	11/5/2003	361	3588
Spring_04	4/22/2004	361	2744	4/25/2004	372	17241	4/21/2004	363	1226	4/21/2004	363	3576
Fall_04	10/19/2004	385	1584	10/20/2004	384	16102	10/21/2004	383	1173	10/19/2004	385	623
Spring_05	4/15/2005	445	2376	4/15/2005	445	18431	4/20/2005	444	1291	4/21/2005	443	18
Fall_05	10/3/2005	361	2968	10/4/2005	361	16754	10/5/2005	360	1752	10/3/2005	361	220
Spring_06	4/24/2006	298	3108	4/26/2006	294	17617	4/27/2006	294	1843	4/25/2006	296	325
Fall_06	11/7/2006	259	2574	11/13/2006	260	16870	11/13/2006	260	1760	11/16/2006	258	869
Spring_07	4/23/2007	317	3668	4/26/2007	333	18954	4/24/2007	315	1774	4/27/2007	343	1223
Fall_07	10/11/2007	426	3907	10/15/2007	426	19083	10/18/2007	423	1769	10/18/2007	425	1
Spring_08	4/17/2008	357	4218	4/22/2008	356	19908	4/18/2008	363	1587	4/18/2008	363	1566
Fall_08	10/23/2008	287	2470	10/28/2008	285	17310	10/24/2008	288	1647	10/24/2008	288	2895
Spring_09	4/22/2009	262	3278	4/24/2009	259	19640	4/27/2009	276	1731	4/22/2009	262	2695
Fall_09	10/13/2009	275	1819	10/14/2009	275	16330	10/15/2009	272	1823	10/15/2009	272	173
Spring_10	4/23/2010	352	2949	4/26/2010	349	19010	4/27/2010	349	1842	4/28/2010	347	230
Fall_10	10/22/2010	346	548	10/25/2010	335	15967	10/26/2010	336	1495	10/22/2010	346	363
Spring_11	4/25/2011	255	1345	4/26/2011	251	17703	4/25/2011	255	1814	4/27/2011	248	538
Fall_11	11/4/2011	193	789	11/7/2011	194	16049	11/8/2011	193	1954	11/4/2011	193	1484
Spring_12	5/5/2012	214	2792	5/6/2012	242	19349	5/9/2012	225	1942	5/21/2012	244	1999
Fall_12	10/31/2012	199	1348	10/29/2012	201	19735	10/31/2012	199	1939	10/31/2012	199	2569
Spring_13	4/10/2013	198	2143	4/11/2013	197	23092	4/11/2013	197	1527	4/12/2013	196	2596
Fall_13	10/18/2013	159	1020	10/18/2013	159	21595	10/21/2013	154	1402	10/22/2013	149	2893
Spring_14	4/7/2014	149	1511	4/8/2014	147	19233	4/4/2014	147	1319	4/15/2014	143	3249
Fall_14	10/24/2014	144	861	10/23/2014	145	17759	10/27/2014	141	1502	10/28/2014	141	3400

"AVERAGE YEAR" Total System discharge of >225 cfs throughout the year
"DROUGHT YEAR" Total System discharge of < 225 cfs discharge at some point within the year
"FLOOD DISTURBANCE" Flood event affecting reach at some point between spring and fall or late fall previous year

As evident in Table 4, average and drought years were fairly consistent amongst reaches, but the Upper Spring Run and New Channel sample reaches were affected more frequently from flood-related high flow events. In late 2001, several pulse events propagated in the upper watershed and came primarily down Blieders Creek, whereas in many of the other years the majority of the pulses came down Dry Comal Creek and directly through the New Channel sample reach. The large event in June 2010 was the only high-flow event that negatively affected all four study reaches. It is also quite evident that drought conditions experienced in 2009 have extended through the present time, with a temporary reprieve provided by the extreme 2010 high-flow event. Figure 22 is the Comal River hydrograph over the bio-monitoring time period which also includes the daily average peak flows experienced in 2002, 2004, 2007, 2009 and 2010.

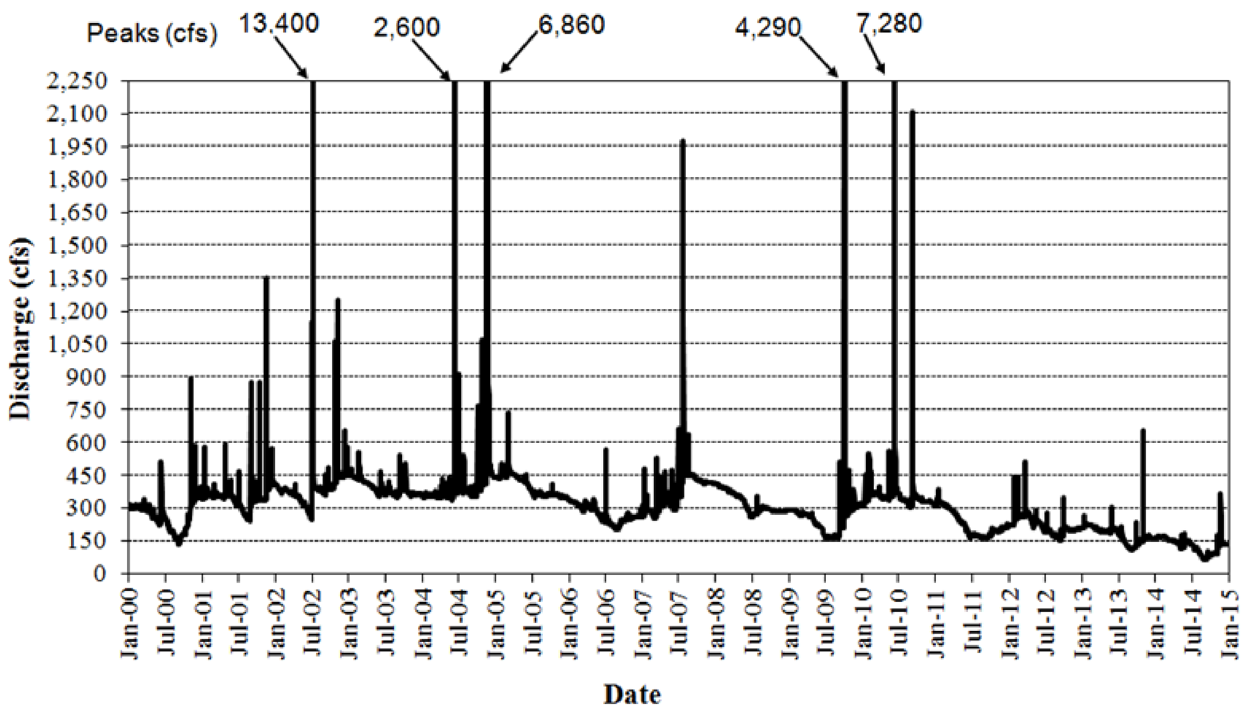


Figure 22: Comal River hydrograph presented as daily discharge over the biological monitoring period.

Table 5 shows the total aquatic vegetation (m^2) present in each of the 3 study reaches in the San Marcos system over time. Average years for the San Marcos River were determined as any year that exhibited over 140 cfs total system discharge throughout the entire year. The 140 cfs value was selected as it is the long-term average flow management objective specified in the HCP (EARIP 2011). Unlike the Comal system, there were no scouring events exhibited during the sample period that substantially altered the aquatic vegetation within the sample reaches. The largest high-flow event during the sample period occurred in October 2013. Figure 23 depicts the San Marcos River hydrograph over the biological monitoring time period which also includes daily average peak flows and dates experienced.

Table 5. Total Aquatic Vegetation in the Spring and Fall per reach on the San Marcos System over time

Season	Spring Lake Dam reach			City Park reach			I35 reach		
	Date	Total System Discharge (cfs)	Total Aquatic Vegetation (m^2)	Date	Total System Discharge (cfs)	Total Aquatic Vegetation (m^2)	Date	Total System Discharge (cfs)	Total Aquatic Vegetation (m^2)
Spring_02	5/8/2002	201	1673	5/7/2002	201	4905	5/6/2002	201	891
Fall_02	10/23/2002	263	1519	10/21/2002	258	4566	10/22/2002	259	685
Spring_03	4/11/2003	286	1778	4/9/2003	284	4976	4/10/2003	285	797
Fall_03	10/30/2003	179	1619	10/20/2003	190	4351	10/21/2003	187	684
Spring_04	4/15/2004	156	1725	4/13/2004	154	4620	4/14/2004	155	543
Fall_04	10/15/2004	179	1184	10/11/2004	181	4413	10/12/2004	178	900
Spring_05	4/11/2005	297	1084	4/13/2005	294	4243	4/12/2005	295	401
Fall_05	9/28/2005	182	1123	9/26/2005	183	4055	9/27/2005	184	556
Spring_06	4/19/2006	116	1225	4/17/2006	111	4617	4/18/2006	114	474
Fall_06	11/3/2006	97	1061	11/2/2006	97	4171	11/2/2006	97	902
Spring_07	4/18/2007	218	1385	4/17/2007	219	3554	4/19/2007	218	903
Fall_07	10/10/2007	325	1098	10/8/2007	332	4258	10/11/2007	322	840
Spring_08	4/16/2008	160	1426	4/14/2008	162	4748	4/17/2008	161	608
Fall_08	10/22/2008	107	1182	10/20/2008	108	3992	10/21/2008	108	784
Spring_09	4/28/2009	95	1236	4/29/2009	94	4307	4/29/2009	94	759
Fall_09	10/16/2009	153	802	10/12/2009	148	2690	10/12/2009	148	739
Spring_10	4/22/2010	253	1205	4/21/2010	255	4545	4/20/2010	254	626
Fall_10	10/20/2010	199	971	10/19/2010	201	3816	10/21/2010	198	653
Spring_11	4/28/2011	125	1400	4/21/2011	133	4457	4/22/2011	132	688
Fall_11	11/2/2011	94	998	11/1/2011	94	3050	11/3/2011	93	488
Spring_12	5/3/2012	190	1240	5/1/2012	191	4148	5/4/2012	190	474
Fall_12	10/24/2012	147	1091	10/23/2012	146	3103	10/25/2012	146	289
Spring_13	4/17/2013	108	2064	4/20/2013	108	5074	4/24/2013	107	495
Fall_13	10/14/2013	120	1283	10/10/2013	109	3699	10/11/2013	108	402
Spring_14	4/21/2014	123	1198	4/17/2014	123	3123	4/23/2014	121	1745
Fall_14	10/26/2014	105	911	10/17/2014	106	2663	10/18/2014	105	1519

"AVERAGE YEAR" Total System discharge of >140 cfs throughout the year
"DROUGHT YEAR" Total System discharge of < 140 cfs discharge at some point within the year

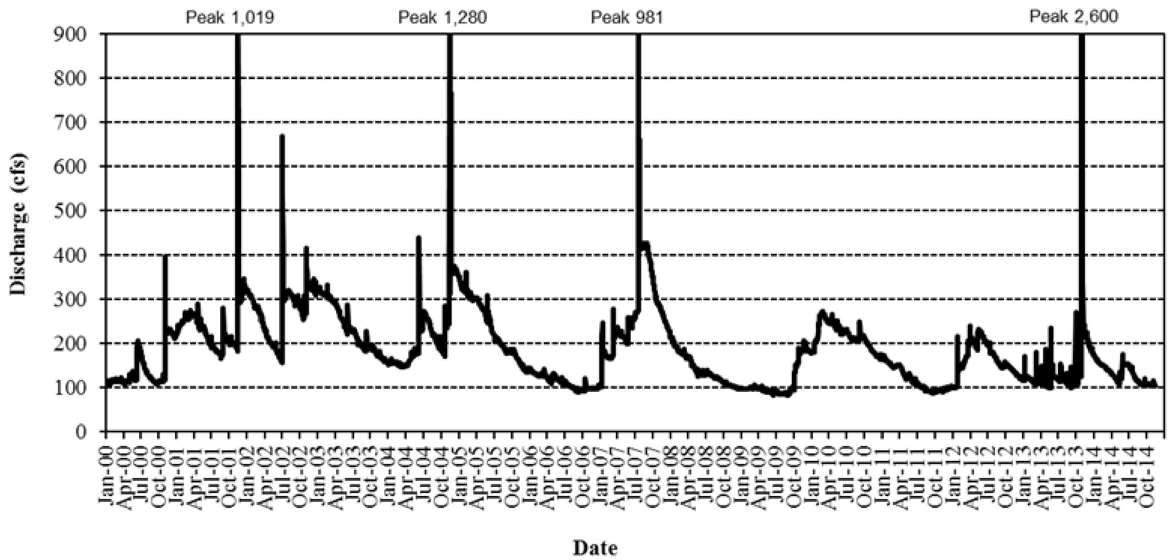


Figure 23: San Marcos River hydrograph presented as daily discharge over the biological monitoring period.

Table 6 shows the percentage retention in aquatic vegetation observed from spring to fall for average and drought years as well as individually for 2014. As evident in Table 6, only the Upper Spring Run and Landa Lake sample reaches show a decline in overall aquatic vegetation from spring to fall during average years, with the Upper Spring Run sample reach exhibiting the largest decline. This is not surprising for any of the reaches in the Comal system. The Upper Spring Run sample reach exhibits the largest decline (15% decline or 85% retention, Table 6) as this stretch typically gets large green algae blooms in late summer resulting in a die off of bryophytes. Additionally, this reach of river is comparatively shallower and thus recreational activities play a more substantial role in affecting aquatic vegetation over the summer months. Landa Lake rooted aquatic vegetation remains extremely stable from year to year with only a 6% decline (94% retention, Table 6) resulting mainly from bryophytes. The bryophytes within Landa Lake show spring to fall variability but not to the level as experienced in the Upper Spring Run sample reach. Additionally, the green algae build-up in Landa Lake is considerably less than further upstream and there are only limited recreational activities in Landa Lake.

In the more channelized sections of the river with greater overall velocities, Old Channel and New Channel sample reaches, the lower discharge typically observed in the fall results in greater amounts of aquatic vegetation (over 100% retention indicating increases). The Old Channel sample reach is bordered by private property and thus, limited to no recreation occurs in this reach. The New Channel increase in aquatic vegetation from spring to fall is somewhat surprising considering the high level of recreation that occurs in this sample reach. However, this stretch of the New Channel is deep and most all the recreation is tubing that occurs on the surface. It is evident that the bulk of aquatic vegetation disturbance in the New Channel is from pulse scour events rather than recreation.

Table 6. Percentage Retention of aquatic vegetation from Spring to Fall per sample reach per system.

Scenario	Percentage Retention in Aquatic Vegetation from Spring to Fall						
	Comal System Sample Reaches				San Marcos System Sample Reaches		
	Upper Spring Run	Landa Lake	Old Channel	New Channel	Spring Lake Dam	City Park	I35
Average Flow Condition Years	85%	94%	108%	117%	85%	92%	99%
Drought Years	50%	92%	101%	135%	72%	76%	110%
2014 Actual	57%	92%	114%	105%	76%	85%	87%

During average drought conditions (as characterized by this assessment) observed to date, the same trend holds with the Upper Spring Run and Landa Lake sample reaches showing spring to fall declines in aquatic vegetation, with no declines evident in the Old and New Channel sample reaches. The Old Channel is controlled by culverts allowing for stable flow even during drought which is the likely explanation. In the New Channel sample reach, due to the combined effects of removing flood pulse events from the assessment, decreased water velocities, and consistently deeper depths (for the most part), aquatic vegetation growth from spring to fall increases even more during drought. A closer look at 2014 (Table 6) shows that it was similar to a typical drought in all sample reaches. This was impressive considering that the total system discharge for Comal Springs in 2014 approached 65 cfs in late summer which was the lowest recorded discharge since 1989.

In the San Marcos system, both the Spring Lake Dam (15% decline or 85% retention) and City Park (8% decline or 92% retention) sample reaches experienced declines in aquatic vegetation during average years while the I35 sample reach remained stable (Table 6). During average drought conditions (as characterized by this assessment) observed to date, the same trend holds with the Spring Lake Dam (72% retention) and City Park (76% retention) sample reaches but to a greater degree, while aquatic vegetation in the I35 reach on average increases. This is a similar phenomenon as the New Channel sample reach at Comal, in that when discharge is lower, velocities are lower and the existing aquatic vegetation expands. This also highlights the role river recreation plays in the San Marcos River.

The two upstream sample reaches (Spring Lake Dam and City Park) are highly recreated compared to the I35 reach. However, one has to be careful not to jump to the conclusion that all the impacts in these upstream reaches are from recreation only based on the observation that the I35 reach actually increases during average drought years. The reason for caution is that the declines in aquatic vegetation in these two upstream reaches are a combination of the level of recreation coupled with the lower than average water depths. This point is emphasized when looking back at the New Channel on the Comal River which experiences intense recreational pressure, but relatively little to no impact to aquatic vegetation because of the greater water depths. A closer look at 2014 (Table 6) for the San Marcos River shows spring to fall declines to aquatic vegetation is evident in all three sample reaches.

Table 7 shows the conversion process from percentage retention between spring and fall aquatic vegetation during average years when compared directly to 2014. Using the Upper Spring Run sample reach as an example, there is an 85% retention during average years but only a 57% retention in 2014. This implies that under average conditions a 15% decline in aquatic vegetation is observed from spring to fall each year. This amount is considered a pre-HCP condition because 1) it is calculated based on routine conditions prior to the HCP, and 2) during average years, a lot of HCP measures would not be actively engaged. As such, the difference in retention (85% - 57% = 28%) is the value used to assess the overall loss of fountain darter occupied habitat within this river section. The total fountain darter occupied habitat designated for the Upper Spring Run is 1,659 m^2. The 28% difference from the reach is applied to the 1,659 m^2 from the entire section resulting in a habitat impact of 465 m^2. For this incidental take assessment, the 465 m^2 is considered the amount of habitat that was impacted by the HCP Measures and Drought category.

Table 7. Total Impacted Area (m^2) for the fountain darter based on percentage retention of aquatic vegetation from Spring to Fall per sample reach per system.

Scenario	Percentage Retention in Aquatic Vegetation from Spring to Fall						
	Comal System Sample Reaches				San Marcos System Sample Reaches		
	Upper Spring Run	Landa Lake	Old Channel	New Channel	Spring Lake Dam	City Park	I35
Average Flow Condition Years	85%	94%	100%	100%	85%	92%	99%
2014 Actual	57%	92%	100%	100%	76%	85%	87%
	HABITAT CALCULATIONS applied to river sections						
Difference between Average and 2014 (%)	28%	2%	0%	0%	9%	7%	12%
Total Fountain Darter Occupied Habitat (m^2) per entire river section	1,659	49,588	19,061	26,316	957	32,406	9,243
2014 Total Impacted Area (m^2)	465	825	0	0	86	2,181	1,105

As evident in Table 7, only the Upper Spring Run and Landa Lake sections exhibited impacted habitat conditions in 2014 on the Comal System. It should be noted that benefits from increased aquatic vegetation were not considered in this analysis. As such, all percentage retentions greater than 100% in Table 6 were adjusted to 100% in Table 7 for the determination of impacted habitat. In the San Marcos system, all three study reaches showed reductions in percentage retention from spring to fall in aquatic vegetation in 2014 and thus, resulted in impacted habitat within each of the San Marcos River sections.

Comal Springs Invertebrates:

To calculate the impacted habitat area for the Comal Springs riffle beetle, Comal Springs dryopid beetle, and Peck's Cave amphipod, areas of disturbance in 2014 (not including the HCP mitigation and restoration measures assessed separately) were assessed and area of impact quantified by overlapping area of disturbance and occupied habitat. The occupied habitat maps for each of the Comal invertebrates are described in SECTION 1. In 2014, disturbances pertaining to HCP measures and drought to the Comal invertebrate species were the drying of surface area in the spring runs, western shoreline, and Spring Island area in late summer/fall.

With HCP measures in place, the continued drought resulted specifically in the drying of surface habitat in Spring Run 1, Spring Run 2, Spring Run 3, Spring Run 4, Spring run 5, along the western shoreline of Landa Lake, and within the Spring Island area. This disturbance resulted in the largest amount of calculated impacted habitat area. Please note that the overall area of exposed substrate in the system was greater than quantified in Table 8, as that value represents only the exposed surface substrate overlapping with occupied habitat for each covered species. This approach was used to stay consistent with the occupied habitat approach used for each covered species. Additionally, any impacted area calculated in 2013 that was not re-wetted at any time during 2014 was subtracted from the 2014 total per USFWS guidance. This was done to avoid duplicative counting of incidental take for areas that were impacted and counted the previous year.

Table 8. Total Impacted Area (m^2) for the Comal Springs Invertebrates.

Covered Species	2014 Impacted Occupied Habitat Area (m^2)			
	Main Spring Runs	Western Shoreline	Spring Island	TOTAL
Comal Springs riffle beetle	191	105	44	340
Comal Springs dryopid beetle	144.5	7	0.5	152
Peck's Cave amphipod	42	53	62	157

For Comal Springs riffle beetles, occupied habitat included a 1 m^2 surface area around known observation points, while a 0.5 m^2 surface area surrounding documented observation points for the Comal Springs dryopid beetle and Peck's Cave amphipod were included. No attempt was made to characterize subsurface habitat in this assessment. If a documented occupied habitat point had exposed substrate, it was included regardless of potential downward migration.

When comparing the occupied habitat maps, the main areas of disturbance for the Comal Springs riffle beetles were Spring Run 1 and the western shoreline; the main area of disturbance for the Comal Springs dryopid beetle was Spring Run 2; and disturbance for the Peck's Cave amphipod was spread fairly equally amongst all areas.

San Marcos salamander:

As San Marcos salamander habitat below Spring Lake Dam and in Spring Lake remains fairly consistent from spring to fall, there was no attempt to quantify habitat changes similar to the fountain darter aquatic vegetation assessment. Additionally, there was no drying of surface habitat in the San Marcos system in 2014 as reported in the Comal system. As such, there was no quantification of disturbance using exposed surface area overlapping with occupied habitat. Although not applicable in 2014, the exposed surface area calculation will likely be used in subsequent years that exhibit that type of disturbance. Therefore, the only known disturbance of occupied San Marcos salamander habitat in 2014 was from recreational activities coupled with lower than average discharge conditions below Spring Lake dam.

As there is not a quantification of recreation in this sample reach, the percentage of retention of aquatic vegetation in the Spring Lake dam reach calculated for the fountain darter was used for the San Marcos salamander as a surrogate for disturbance. As shown in Table 7, there was a 9% change in aquatic vegetation retention in the Spring Lake Dam study reach. To calculate the impact to San Marcos salamander habitat, the total occupied San Marcos salamander habitat below the dam (1,454 m^2) was multiplied by 9% which resulted in an impacted area of 131 m^2. To stay consistent with each other covered species in this assessment, the exclusion zone in the eastern spillway was not counted as a benefit nor subtracted from the impacted area.

Texas blind salamander: There is no surface habitat documented in the Item M assessment (SECTION 1) for the Texas blind salamander. There were no aquifer impacts noted via HCP measures or the drought in 2014, and thus, no impacted habitat is reported for the Texas blind salamander in this assessment.

Texas wild-rice: Although Texas wild-rice is not allotted take projection in the ITP, its full system coverage was 6,203 m^2 in summer 2014. This value is well above the established minimum (3,549 m^2) included in the Biological Opinion. In addition, the increase in Texas wild-rice coverage shows progress towards the long-term biological goal for this species.

INCIDENTAL TAKE CALCULATIONS

The next step in the analysis is converting the impacted habitat area to incidental take of individuals so that a comparison can be made to the ITP permit. It is understood and should be emphasized that multiple ways of making a conversion from habitat area to incidental take can be performed, all of which involve a level of subjectivity and professional judgment. Based on USFWS acceptance following the Year 1 assessment, the calculations for 2014 were conducted in the same manner.

In 2014, incidental take was again scaled in accordance with the condition of the system at that particular time. For instance, incidental take caused by a reduction of 10% of the occupied habitat in the system is not the same proportionally to a condition where 40%, 70%, or 90% of the occupied habitat is removed from the system. The rationale is that when only a small amount of habitat is removed, a large portion of quality habitat remains for the covered species to utilize. However, when larger portions of occupied habitat are reduced, the situation inherently becomes more stressful for the individuals. The word stressful is important in that take is more than just mortality as discussed at the start of this memorandum. In the Biological Opinion, the USFWS defines Take as "…. to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is further defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns, which include, but are not limited to, breeding, feeding and sheltering (50 CFS §17.3). Harm is also further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns, including breeding, feeding, and sheltering."

To explain the concept of non-proportional take as occupied habitat is reduced, it is important to start with mortality, but as described in 2013, incidental take goes beyond mortality. Habitat disturbances including physical (aquatic vegetation, silt-free substrate, etc.) and chemical (standard water quality parameters such as water temperature and dissolved oxygen) play a role in incidental take calculations as well. This is important in that one of the further definitions of "Harass" is that it annoys the individual or modifies its habitat to such an extent that behavior patterns (including breeding) are impaired. Of course there are other behavioral components that may be disrupted either through direct annoyance of the individual or through habitat modifications, such as feeding and sheltering. During HCP measures and drought, the loss or modification of habitat described in the previous section by definition clearly caused take beyond mortality. Considering that mortality represents a very small proportion of that number, characterizing the remaining amount becomes very important.

To start this assessment, we examined the densities of the covered species recorded over time via EAA biological monitoring in both systems. The USFWS approach used the average density for covered species from the same biological monitoring program to make calculations in the biological opinion in many instances. For this assessment, the density statistics were broken down further to explore the component of scaling incidental take as habitat conditions get worse. Table 9 shows the density statistics chosen for each of the covered species. The 25th, 50th (median), 75th, and 90th percentile along with the mean density are included. Furthermore, only the spring and fall data sets since 2002 were used for these density statistics. The rationale is that under drought or following high-flow events the densities within aquatic vegetation types may not be representative of average conditions with which to apply to incidental take. Additionally, as more and more critical period (low and high) events get added, it skews the data set towards those events.

Table 9. Descriptive statistics of Covered Species density by System

Covered Species	Density (individuals per m^2) Descriptive Statistics (Percentiles and Mean)				
	25	Median	Mean	75	90
Fountain Darter					
Comal system	1.50	6.00	11.35	15.50	29.30
San Marcos system	1.50	3.50	5.90	7.00	13.00
Comal Springs riffle beetle	6.60	9.10	10.71	12.40	19.38
Comal Springs dryopid beetle[A]	-	-	0.10	-	-
Peck's Cave amphipod	1.04	1.67	2.05	2.33	4.33
San Marcos salamander					
San Marcos River	3.00	6.00	6.08	8.50	10.5
Spring Lake	10.00	12.00	13.17	16.25	19.00

[A] Too few collected to use full set of descriptive statistics

The same spring and fall sample sets were used for each covered species. Fountain darter densities are presented by system and are comprised of drop net sampling in aquatic vegetation types used in the occupied habitat assessment. This approach deviates from the USFWS analysis in that only an average density calculated from both systems combined with all sample dates was included in the Biological Opinion.

For this assessment, San Marcos salamander densities were developed from the quantitative snorkel/SCUBA sampling being conducted during biological monitoring in the San Marcos system. Densities within the San Marcos River and Spring Lake occupied habitat were broken out separately as done in the Biological Opinion.

Densities for the Comal Springs riffle beetles were generated from the cotton lure sampling at three locations (Spring Run 3, Western Shoreline, and Spring Island area). Densities for the Peck's Cave amphipod were generated from the drift net sampling conducted over the main orifices at Spring Run 1, Spring Run 3, and Spring Run 7. In the case of the Comal Springs dryopid beetle, only 46 individuals have been collected in 398 samples to date using the drift net sampling methodology. As such, only the mean is presented for the Comal Springs dryopid beetle in Table 9. The Biological Opinion estimated the total surface population of Comal springs dryopid beetles in the Comal Spring system to be 1,839 individuals (USFWS 2010). To calculate their incidental take, they used a 5%, 10% rule based on an even distribution of individuals to come up with 9 individuals (1839 *.05 *.10 = 9.2). In doing so, the underlying assumption forced was that the overall area was 1,839 square feet or 1 individual per square foot. One individual per square foot equals 0.09 per m^2. Although the biological monitoring data has limited Comal Springs dryopid beetle observations, the calculated density of 0.10 individuals per m^2 is in line with the Biological Opinion estimate.

To account for a scaled approach for calculating incidental take (increased impacts with increased levels of habitat loss); the following schedule (Table 10) was used to determine which density statistic to multiply by impacted habitat area to generate the incidental take estimate. The schedule is based on remaining occupied habitat per covered species per system. For example, if 8% of the total occupied habitat was impacted for the fountain darter in the Comal system that would leave 92% of the occupied habitat for the fountain darter. For the incidental take calculation, the 25^{th} percentile density for the fountain darter (1.5 darters per m^2) would be used to multiply against the total impacted area. However, if 55% of the fountain darter occupied habitat was impacted, that would leave 45% and correspond to the mean (11.35 darters per m^2) value. In this specific example, 8% and 55% reductions in 2014 occupied habitat (96,624 m^2) would result in 7,730 m^2 and 53,143 m^2, respectively. These impacted habitats multiplied against the corresponding densities would result in an incidental take of 11,595 (7,730*1.5) or 603,173 (53,143 * 11.35) fountain darters, respectively. Please note the above example was simply an illustration that as the habitat conditions get worse for the fountain darter (i.e. more clumping, less high quality habitat to move to, higher water temperatures affecting breeding, etc.) specific to all HCP measures and drought, the resulting incidental take is not only larger in numbers but proportionally larger as well.

Table 10. Density assignment schedule based on remaining occupied habitat

Remaining Occupied Habitat Percentage	Corresponding Density Statistic
100 to 75	25%
74 to 50	Median
49-25	Mean
24-10	75%
9-0	90%

As noted in last year's memorandums, no standard water quality parameters were outside of a suitable range for the covered species thus they were not considered for causes of incidental take. In 2014, water temperature conditions within the Upper Spring Run reach elevated outside of the typically observed range resulting in the potential for impacts to fountain darter life stages and reproductive success based on literature (Brandt et al. 1993, Bonner et al. 1998, McDonald et al. 2007). Although spawning success and larval growth show declines in a laboratory setting at temperatures over 27 °C, it is a conservative temperature trigger; the lethal limit (50% mortality) for larval fountain darters is 31.9° C and approximately 3.0° C higher for adults (Brandt et al. 1993, Bonner et al. 1998, McDonald et al. 2007). Figures 24 and 25 show water temperature ranges longitudinally down each system over the course of 2014. A presentation of water temperature data from all thermistors over time is available in the 2014 biological monitoring annual reports (BIO-WEST 2015a, 2015b). In addition to being outside of the normally observed range for water temperature, HCP biological monitoring data specific to the fountain darter showed decreases in fountain darter numbers in the Upper Spring Run reach over the course of 2014 (BIO-WEST 2015b). As such, a density assignment scale was developed for water temperature specific to the fountain darter. This scale is presented in Table 11 with the corresponding density statistic increasing per elevated temperature ranges. This scale is to be used in combination with the density assignment schedule for remaining occupied habitat percentage (Table 10), with the higher of the two applied to that specific reach when making final calculations of incidental take.

In 2014, dissolved oxygen (DO) within the central portion of Landa Lake ranged from 0.76 to 25.83 mg/L, with values < 2.0 mg/L reported on several occasions and < 4.0 mg/L reported regularly during the late summer months (SWCA 2014). Diel DO fluctuations observed in Landa Lake over the course of 2014 were typical of heavily vegetated lake environments with wide ranges observed. The lower than average total system discharge resulted in slower turnover times in the lake which likely facilitated these wide swings in DO over the course of a day. No biological impacts were noted during 2014 in biological monitoring data collected in Landa Lake (BIO-WEST 2015b) and thus dissolved oxygen was not incorporated into the incidental take analysis this year. However, the large amount of observations of < 4.0 mg/L during 2014 in Landa Lake has stimulated additional HCP applied research on this topic to be conducted in 2015. Consideration of this parameter in future years' incidental take calculations may be appropriate following an observed negative biological response.

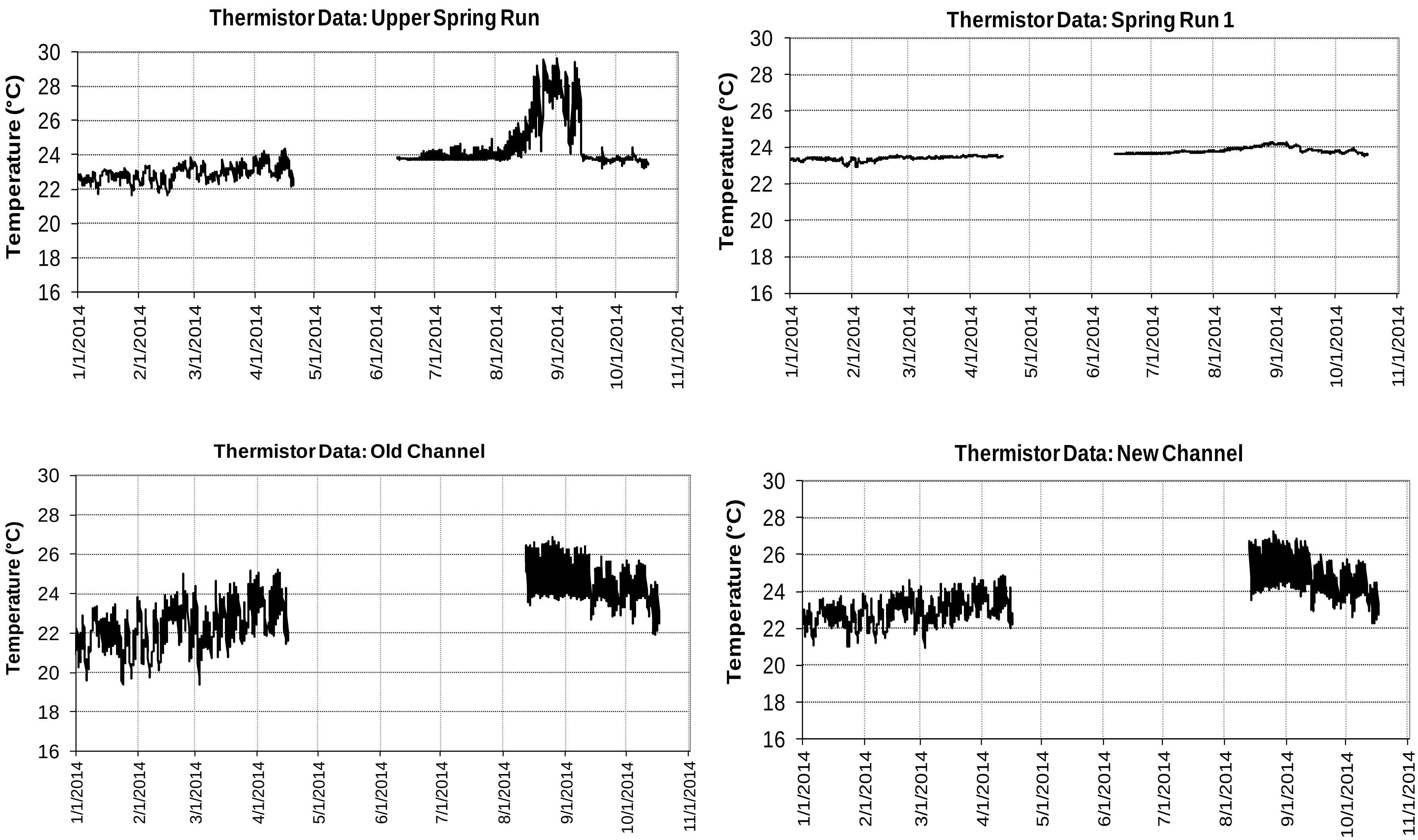


Figure 24: Thermistor data collected during 2014 at four select sites extending upstream to downstream in the Comal System.

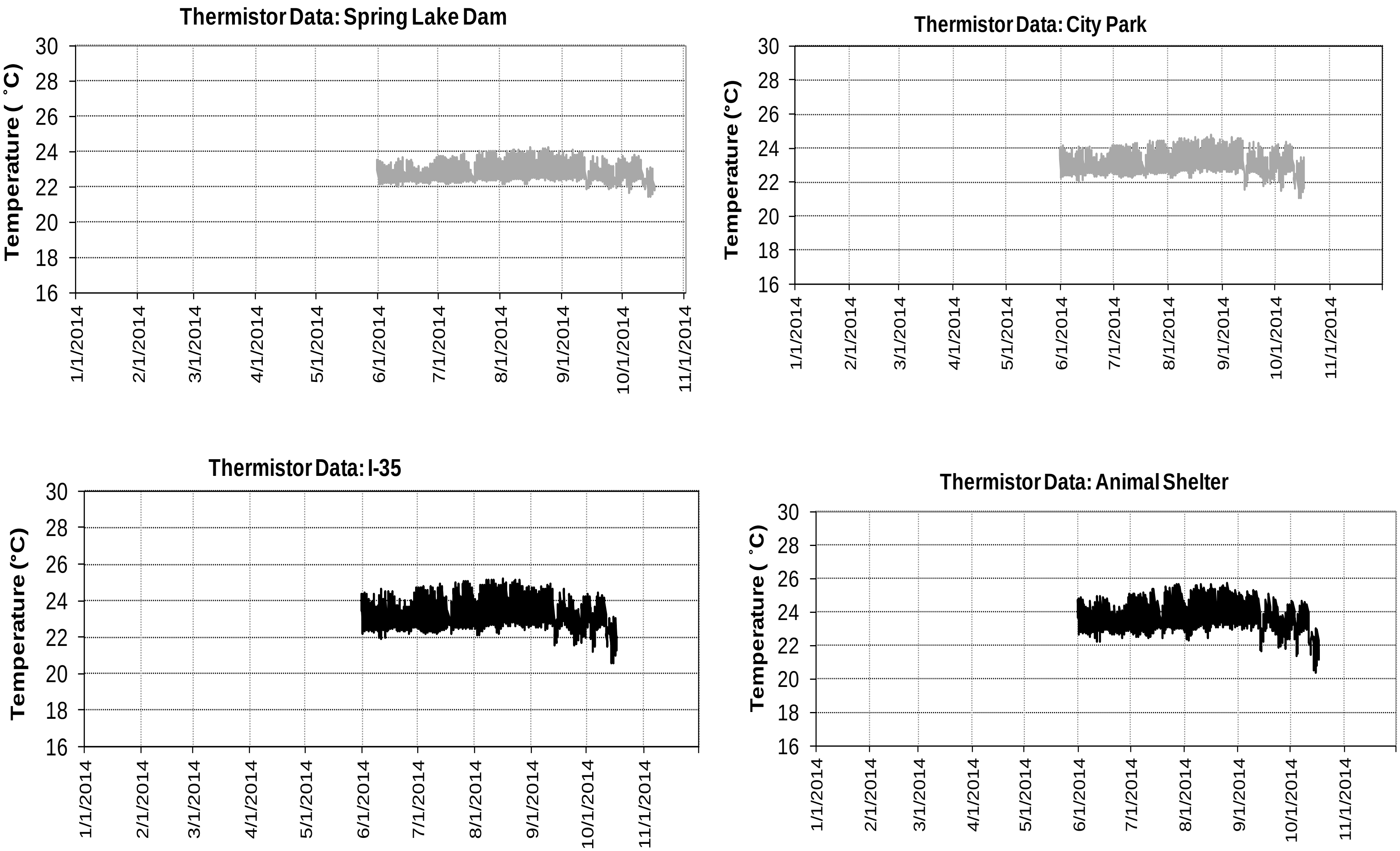


Figure 25: Thermistor data collected during 2014 at four select sites extending upstream to downstream in the San Marcos System.

Table 11. Density assignment schedule based on water temperature range within reach

Water Temperature range (°C)	Corresponding Density Statistic
< 27	25%
27 to 29	Median
29 to 31	Mean
31 to 33	75%
> 33	90%

Using the density schedules in Tables 10 and 11, impacted habitat areas calculated in tables 3, 7, 8, and in the text, and upon review of the water temperature data in Figure 24 for the Upper Spring Run reach the following incidental take calculations were made for each covered species.

Fountain darter:

Table 12 shows the incidental take calculated for the fountain darter in the Comal system and San Marcos system (San Marcos River and Spring Lake) relative to HCP mitigation and restoration activities as well as the HCP measures and drought. In all instances the percentage of impacted areas was less than 20% of the total occupied habitat and thus the 25th percentile density was applied to each reach. However, as noted above, the range of water temperatures at the Upper Spring Run reach of the Comal system were above typically observed conditions. This water temperature condition resulted in two changes to the incidental take calculation specific to the Upper Spring Run reach. This first is that the 2014 impacted area for the Upper Spring Run reach was adjusted from 465 m^2 which was the calculated impacted aquatic vegetation in the reach (Table 7) to 1,659 m^2 which is the full amount of fountain darter occupied habitat in this reach. Secondly, according to Figure 24 and Table 11, the density statistic for the Upper Spring Run reach was adjusted to the mean density statistic (11.35 darters / m^2) for the Comal system as per Table 9. As shown in Table 12, the higher of the two density statistics (11.35 vs. 1.5) was applied for the calculation of incidental take for the Upper Spring Run reach of the Comal system.

It is important to keep the two categories (HCP mitigation / restoration and HCP measures / drought) separate in the analysis. The rationale is that HCP mitigation and restoration activities have a mandate to stay under 10% of the total occupied habitat or cease. Additionally, there is another clause in Item M of the ITP that these activities should cease under certain low-flow triggers if undesirable impacts are encountered. As such, any impacts from the HCP measures or drought should be calculated independently for an accurate comparison in future drought years.

Table 12. Calculated Incidental Take for the fountain darter per system based on impacted habitat.

FOUNTAIN DARTER PARAMETERS	COMAL SYSTEM			SAN MARCOS SYSTEM			
				San Marcos River		Spring Lake	
	HCP Mitigation / Restoration	HCP Measures / Drought		HCP Mitigation / Restoration	HCP Measures / Drought	HCP Mitigation / Restoration	HCP Measures / Drought
		Upper Spring Run Reach	Rest of Comal System				
2014 Impacted Area (m^2)	1,995	1,659	825	4,567	3,372	0	0
Total Occupied Habitat (m^2)	96,624	96,624		42,606	42,606	70,379	70,379
% of Occupied Habitat Impacted	2.06%	2.57%		10.72%	7.91%	0.00%	0.00%
Corresponding Habitat Percentile Density (individual/m^2)	1.50	1.50	1.50	1.50	1.50	--	--
Water Temperature Percentile Density adjustment	N/A	11.35	N/A	N/A	N/A	--	--
2014 Incidental Take Estimate	2,993	18,830	1,237	6,851	5,058	0	0
2014 TOTAL INCIDENTAL TAKE PER SYSTEM	23,060			11,909			

Comal Springs invertebrates:

Table 13 shows the incidental take calculated for the Comal Springs riffle beetle, Comal Springs dryopid beetle, and Peck's Cave amphipod relative to the HCP mitigation and restoration activities as well as the HCP measures and drought. For both the Comal Springs riffle beetle and Peck's Cave amphipod the percentage of impacted areas was less than 25% of the total occupied habitat and thus the 25th percentile density was applied. As previously stated, only the mean is presently available for use in calculating incidental take for the Comal Springs dryopid beetle. Finally, an adjustment to total impacted area in 2014 was made relative to areas impacted in 2013 that did not recover in 2014 (Table 13). For this calculation, the 2013 area was subtracted from the total 2014 area to determine the additional impacted area for 2014. The additional area for 2014 was then multiplied by the corresponding percentile density to calculate 2014 Incidental take per respective species. This calculation was straight forward this year as the springs / upwelling areas impacted in 2013 never recovered (surface habitat remained dry) over the course of the 2014. In subsequent years where discharge is restored and surface habitat rewetted followed by another reduction in discharge, a formal definition "recovered" will need to be vetted with the USFWS and HCP Science committee, in order to appropriately make this calculation.

Table 13. Calculated Incidental Take for the endangered Comal Springs invertebrates based on impacted habitat.

COMAL INVERTEBRATES PARAMETERS	Comal Springs Riffle Beetle		Comal Springs Dryopid Beetle		Peck's Cave Amphipod	
	HCP Mitigation / Restoration	HCP Measures / Drought	HCP Mitigation / Restoration	HCP Measures / Drought	HCP Mitigation / Restoration	HCP Measures / Drought
2014 Total Impacted Area (m^2)	0	340	0	152	0	157
Total Occupied Habitat (m^2)	1,511	1,511	350	350	1,470	1,470
% of Occupied Habitat Impacted	0.00%	22.50%	0.00%	43.43%	0.00%	10.68%
2014 Additional Impacted area (2014 Total - 2013 impacted area (m^2) that did not recover	--	237	--	18	--	79
Corresponding Percentile Density (individual/m^2)	--	6.60	--	0.10	--	1.04
2014 Incidental Take Estimate	0	1,564	0	2	0	82
2014 TOTAL INCIDENTAL TAKE	1,564		2		82	

San Marcos salamander: Table 14 below shows the incidental take calculated for the San Marcos salamander in the San Marcos system (San Marcos River and Spring Lake) relative to the HCP mitigation and restoration activities as well as the HCP measures and drought. In all instances the percentage of impacted areas was less than 25% of the total occupied habitat and thus the 25th percentile density was applied. In 2014, all impacted area was below Spring Lake Dam so only the San Marcos River 25th percentile density was applied.

Table 14. Calculated Incidental Take for the San Marcos salamander based on impacted habitat.

SAN MARCOS SALAMANDER PARAMETERS	SAN MARCOS SYSTEM			
	San Marcos River		Spring Lake	
	HCP Mitigation / Restoration	HCP Measures / Drought	HCP Mitigation / Restoration	HCP Measures / Drought
2014 Impacted Area (m^2)	29.5	131	0	0
Total Occupied Habitat (m^2)	1,454	1,454	711	711
% of Occupied Habitat Impacted	2.03%	9.01%	0.00%	0.00%
Corresponding Percentile Density (individual/m^2)	3.00	3.00	--	--
2014 Incidental Take Estimate	89	393	0	0
2014 TOTAL INCIDENTAL TAKE	482			

Texas blind salamander: There was no impacted habitat reported for the Texas blind salamander in 2014, thus no incidental take was calculated for the Texas blind salamander in 2014.

Texas wild-rice: Although Texas wild-rice is not allotted take projection in the ITP, its 2013 end of year baseline coverage was 5,020 m^2 which had expanded to 6,203 m^2 in September 2014.

COMPILATION OF RESULTS AND SUMMARY

Table 15 summarizes the 2014 impacted habitat area and incidental take attributed to the HCP relative to the ITP permit amount. All covered species with the exception of the Texas blind salamander experienced incidental take during 2014.

Table 15. Summary of Impacted Habitat (m^2) and Incidental Take for HCP Covered Species compared against ITP Permit Amounts.

COVERED SPECIES PER SYSTEM	IMPACTED HABITAT (m^2)		Combined Impacted Habitat 2014 TOTAL (m^2)	INCIDENTAL TAKE		2014 INCIDENTAL TAKE TOTAL	ITP Maximum Permit Amount	2013 INCIDENTAL TAKE TOTAL	ITP Permit Maximum - (combined Year 1 and Year 2 Incidental Take)
	HCP Mitigation / Restoration	HCP Measures / Drought		HCP Mitigation / Restoration	HCP Measures / Drought				
COMAL SYSTEM									
Fountain Darter	1,995	2,484	**4,479**	2,993	20,067	**23,060**	797,000	10,482	763,459
Comal Springs Riffle Beetle	0	237	**237**	0	1,564	**1,564**	11,179	681	8,933
Comal Springs Dryopid Beetle	0	18	**18**	0	2	**2**	1,543	13	1,528
Peck's Cave Amphipod	0	79	**79**	0	82	**82**	18,224	81	18,060
SAN MARCOS SYSTEM									
Fountain Darter	4,567	3,372	**7,939**	6,851	5,058	**11,909**	549,129	16,698 +15*	520,508
San Marcos Salamander	30	131	**161**	89	393	**482**	263,857	1,053	262,323
Texas Blind Salamander	0	0	**0**	0	0	**0**	10	0	10
Comal Springs Riffle Beetle	0	0	**0**	0	0	**0**	n/a	0	n/a

* An additional 15 darters would have been considered take in 2013 when using the revised 2014 methodology that includes Texas wild-rice as fountain darter occupied habitat.

Based on the characterization of drought in this assessment, conditions experienced during 2014 went beyond an average year as described in the Biological Opinion. As expected, conditions on the Comal system exceeded those observed in 2013 particularly with respect to the surface dwelling organisms (Comal Springs riffle beetle and fountain darter). The primary cause for this increase was low total system discharge which resulted in expanded amounts of exposed surface habitat within Comal Springs riffle beetle occupied habitat and loss of habitat and elevated temperatures relative to the fountain darter in the Upper Spring Run reach. For the San Marcos system, incidental take went down in 2014 because the system did not experience as severe of drought related impacts as the previous year.

When examining 2014 impacts, those same conditions are nowhere near conditions characterized in the Biological Opinion DOR-like scenario. As such, we are confident the incidental take numbers summarized in Table 14 continue to justify the data sets used and methodologies employed in 2014 relative to performing an incidental take assessment within the context of the Biological Opinion. It is understood that adjustments to data sets and/or methodologies may be employed based on feedback from the USFWS, HCP Science Committee, HCP participants, or others as deemed appropriate by the EARIP.

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