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MEMORANDUM

TO: Nathan Pence, Chris Abernathy

FROM: Ed Oborny

DATE: January 30, 2014

SUBJECT: **INCIDENTAL TAKE ASSESSMENT FOR EARIP ITP ANNUAL REPORT**

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)		HABITAT 2013 TOTAL (m^2)	INCIDENTAL TAKE		2013 INCIDENTAL TAKE TOTAL	ITP Permit Amount	ITP Permit Remaining
	HCP Mitigation / Restoration	HCP Measures / Drought		HCP Mitigation / Restoration	HCP Measures / Drought			
COMAL SYSTEM								
Fountain Darter	4,181	2,807	**6,988**	6,272	4,211	**10,482**	797,000	786,518
Comal Springs Riffle Beetle	0	103	**103**	0	681	**681**	11,179	10,498
Comal Springs Dryopid Beetle	0	134	**134**	0	13	**13**	1,543	1,530
Peck's Cave Amphipod	0	78	**78**	0	81	**81**	18,224	18,143
SAN MARCOS SYSTEM								
Fountain Darter	3,236	7,896	**11,132**	4,854	11,844	**16,698**	549,129	532,431
San Marcos Salamander	15	336	**351**	45	1,008	**1,053**	263,857	262,804
Texas Blind Salamander	0	0	**0**	0	0	**0**	10	10
Comal Springs Riffle Beetle	0	0	**0**	0	0	**0**	n/a	n/a

PREFACE

The Incidental Take summary table was placed at the beginning of this memorandum to save everyone time flipping or scrolling through the document to get to the final answer. The Incidental Take technical memorandum 1) discusses the USFWS definition of "take" and the USFWS Biological Opinion calculation of incidental take for the ITP, and 2) describes the rationale; methodologies and results of the 2013 incidental take assessment conducted for inclusion in the EARIP ITP Annual Report. The former is included to provide the context for how the 2013 assessment was conducted. The later is necessary to document the process to a degree that could be repeated with only access to the existing biological and hydrological datasets.

This memorandum builds directly off the Item M Assessment Technical Memorandum that was submitted to EAA on December 30, 2013. As such, reference to that document is made in most instances rather than duplicating all tables, figures, and descriptions. In those instances, a reference to the Technical Memorandum is included as well as a reference to the Item M Assessment Section in the EARIP ITP Annual Report. This is simply to alert SWCA as to where linkages should be considered when incorporating this piece into the EARIP ITP Annual Report. In some cases tables and figures from the Item M assessment are provided in this memorandum to provide necessary clarity.

BACKGROUND

All discussions presented in this memorandum 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 memorandum is to characterize and quantify to the degree practical the Incidental Take that occurred in 2013 as a result of implementation of the EA HCP. This incidental take exercise builds upon the occupied habitat characterization and net disturbance assessment conducted relative to Requirement M (1a and 2a) of EARIP's ITP. 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 document include 1) HCP Mitigation and Restoration and 2) HCP Measures and Drought.

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 bio-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 memorandum pertain to the HCP Covered species that are actively authorized (Item H: 1-6) in 2013 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 2013 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 2013, 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.

ITP Incidental Take Maximum Numbers

Item H of the ITP describes the maximum amount of incidental take that is authorized by EARIP's ITP over the 15 year permit term. For the authorized species in 2013, the following maximum amounts of incidental take are as follows:

- Fountain darter: 797,000 Comal System; 549,129 San Marcos System
- Comal Springs riffle beetle: 11,179
- Comal Springs dryopid beetle 1,543
- Peck's Cave amphipod: 18,224
- Texas Blind salamander 10
- San Marcos salamander 263,857

It is important to understand the development of incidental take by the USFWS for inclusion in the ITP in order to have the proper context for the incidental take assessment being performed herein. On page 88 of the Biological Opinion, the USFWS acknowledges that the amounts of incidental take included in the ITP are estimates because the actual amounts will be a function

of the occurrence, intensity, and severity of precipitation and drought conditions that occur over the 15-year duration of the ITP.

For the Biological Opinion, the maximum numbers of incidental take noted above were estimated by using two different time period scenarios and methodologies as stated in their document,

> "To estimate the effects of incidental take that may result as an effect of the action, we assume that eight-years of average precipitation and recharge conditions and a repeat of the seven-year DOR-like event will occur over the duration of the proposed permit. We derived the projected impact of the effects of the action under average conditions and multiplied by a factor of eight to estimate the total impacts over the duration of the permit. We believe this approach results in projections that are conservative of the species considered here because the analysis presumes that adverse impacts associated with these measures are continual and recur on an annual basis. Actual impacts from many of these events are anticipated to occur irregularly or only once during the duration of the permit (such as removal of sand bars with the Comal and San Marcos rivers or replacement of water diversion infrastructure in the old and new channels of the Comal). We also generated expected impacts of a DOR-like event, and added these effects to those expected under average conditions. The beneficial effects resulting from these measures (Such as improved habitat suitability that enhances feeding or sheltering, or reduced competitions and predation) are not accounted for in this analysis. The projected impacts, therefore, represents maximum adverse impacts without accounting for the expected beneficial effects of these measures."

To summarize, the first time period and methodology included a repeat of the seven-year DOR-like event as modeled for the HCP alternative (EARIP 2011). This method calculated incidental take by reductions of habitat and corresponding loss of individuals based on density as presented in the HCP. This USFWS analysis resulted in the following maximum amounts of incidental take reported in the ITP.

- Fountain darter: 735,000 Comal System; 450,000 San Marcos System
- Comal Springs riffle beetle: 10,739
- Comal Springs dryopid beetle 1,471
- Peck's Cave amphipod: 17,360
- San Marcos salamander 233,361

The numbers of incidental take estimated for a repeat of the seven-year DOR-like event represents approximately 80% or more of the incidental take allowed for in the ITP.

Additionally, an assumption in the Biological Opinion was that the other eight years of the 15 year term would be considered "average" water years. For the average year assessment, the USFWS states, "Implementation of flow protection and springflow management measures that affect the Covered Species include: 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. During periods of average precipitation and recharge the effects of regulations and production of groundwater and implementing these flow protection and springflow management measures will not affect aquifer level impacting springflows at the Springs."

For an estimate of annual incidental take during these "average" years, the USFWS used a percentage of suitable habitat approach and density information available from existing data sources as summarized in the following sections for each covered species.

Ultimately, the sum of the seven year DOR-like numbers plus the annual number times eight years is equal to the maximum incidental take numbers provided at the start of this section.

Fountain darter: The fountain darter average year assessment as described in the Biological Opinion:

> "We project that up to 10% of fountain darter habitat could be affected by sediment removal, water-based recreation, non-native species management, operation and maintenance of flow management infrastructure, and other considered activities in any year of average conditions in the Comal System and the San Marcos River; and that up to 10% of the fountain darters in impacted areas may be displaced, injured, or killed as a result of these impacts. We project that no more than 2.5% (or approximately 10,350 square feet [961 square meters]) of suitable fountain darter habitat in Spring Lake will be impacted by these factors on an annual basis, and that a similar 10% of affected fountain daters will be displaced, injured, or killed as a result of these activities. Based on the reported fountain dater population densities for these systems described above, these impacts will generate incidental take of up to 7,750 fountain darters per year in the Comal system, up to 4,800 in the San Marcos River, and up to 7,591 per year in Spring Lake."

For fountain darters in the Comal system one takes 7,750 fountain darters per average year times 8 years for a total of 62,000. The 62,000 is then added to the 735,000 fountain darters during DOR-like event for a total of 797,000.

For fountain darters in the San Marcos system one takes 12,391 fountain darters per average year times 8 years for a total of 99,128. The 99,128 is then added to the 450,000 fountain darters during DOR-like event for a total of 549,128.

Comal Springs riffle beetle: The Comal Springs riffle beetle average year assessment as described in the Biological Opinion:

> "Because a limited amount of surface habitat may be impacted by these actions, and relying on the simplifying assumption that individuals of the species are uniformly distributed through the habitat, we project that no more than 5% of the available surface habitat could be impacted by these actions during any particular year. If 10% of the individuals of the species within the impacted area are displaced, injured, or killed as a result of these impacts, a total of 55 individuals would be exposed to take per year as a result of these restoration measures."

For Comal Springs riffle beetles one takes 55 beetles per average year times 8 years for a total of 440. The 440 is then added to the 10,739 riffle beetles during a DOR-like event for a total of 11,179.

Comal Springs dryopid beetle: The Comal Springs dryopid beetle average year assessment as described in the Biological Opinion:

> "Because a limited amount of surface habitat may be impacted by these actions, and relying on the simplifying assumption that individuals of the species are uniformly distributed through the habitat, we project that no more than 5% of the available surface habitat could be impacted by these actions during any particular year. If 10% of the individuals of the species within the impacted area are displaced, injured, or killed as a result of these impacts, a total of 9 individuals would be exposed to take per year as a result of these restoration measures."

For Comal Springs dryopid beetles one takes 9 beetles per average year times 8 years for a total of 72. The 72 is then added to the 1,471 dryopid beetles during a DOR-like event for a total of 1,543.

Peck's Cave amphipod: The Peck's Cave amphipod average year assessment as described in the Biological Opinion:

> "Because a limited amount of surface habitat may be impacted by these actions, and relying on the simplifying assumption that individuals of the species are uniformly distributed through the habitat, we project that no more than 5% of the available surface habitat could be impacted by these actions during any particular year. If 10% of the individuals of the species within the impacted area are displaced, injured, or killed as a result of these impacts, a total of 108 individuals would be exposed to take per year as a result of these restoration measures."

For Peck's Cave amphipods one takes 108 beetles per average year times 8 years for a total of 864. The 864 is then added to the 17,360 amphipods during a DOR-like event for a total of 18,224.

San Marcos salamander: The San Marcos salamander average year assessment as described in the Biological Opinion:

> "We project that up to 10% of San Marcos salamander habitat could be affected by sediment removal, water-based recreation, non-native species management and other considered activities in any year of average conditions; and that up to 10% of the San Marcos salamanders in the impacted areas may be displaced, injured, or killed as a result of these impacts. Impacts to 10% of estimated 29,000 square feet (2,750 square meters) of suitable habitat in the uppermost San Marcos River result in a total of 2,960 square feet (275 square meters) of habitat impacts per year. If 10% of the San Marcos salamanders within the affected areas are displaced, injured, or killed, a total of 154 salamanders would be subject to incidental take at this location per year. Within Spring Lake, impacts to 10% of suitable San Marcos salamander habitat results in an estimated 33,250 square feet (3,089 square meters) of annual impacts. If 10% of the salamanders within the affected areas are displaced, injured, or killed, a total of 3,658 individuals would be subject to incidental take at this location per year. The total number of San Marcos salamanders affected as a result of the action during these conditions totals 3,812 individuals per year."

For San Marcos salamanders one takes 3,812 salamanders per average year times 8 years for a total of 30,496. The 30,496 is then added to the 233,361 salamanders during a DOR-like event for a total of 263,857.

Texas blind salamander: The Texas blind salamander was not assigned an average year incidental take value in the Biological Opinion.

Texas wild-rice: Although Texas wild-rice is not afforded incidental take protection, the HCP maintains a minimum goal of 3,549 m^2 which is referenced in the Biological Opinion.

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 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.

INCIDENTAL TAKE ASSESSMENT

Prior to the incidental take assessment, specific telephone discussions were held with professionals from the USFWS Austin Ecological Services (ES) office with a follow-up meeting on January 21, 2014 at the ES office in Austin. The purpose of the meeting was to brief the USFWS professionals on the status of the Item M net disturbance assessment and to discuss methodologies and approaches being considered for the incidental take assessment. Based on those conversations, it was determined that since the HCP is a "habitat" conservation plan and the USFWS based the development of incidental take maximum numbers in the ITP on habitat, a habitat-based approach was most appropriate for the 2013 incidental take assessment.

In the Biological Opinion, the USFWS states,

> "Quantifying the impacts to and take of individuals is difficult due to the aquatic and subterranean nature of many of the species considered here. Effects of the action that might include reduction in springflow, for example, are likely to result in harm or harassment through displacement rather than in injury or death of individuals. Actual numbers of individuals that may be injured or killed may not be known because in some cases we lack the ability to effectively survey the subterranean aquatic habitats some of the species occupy, and the small size of some species and the soft and quickly decomposed bodies of other make detection of injured or dead individuals in aquatic environments uncertain. This biological opinion therefore evaluates the quantity of habitat affected as a surrogate for the level of incidental take or impacts in some cases. For the species considered here, most incidental take, or impacts, from covered activities are expected to occur in the form of harm and harassment through direct loss of habitat and indirect adverse effects resulting from the issuance of an incidental take permit under Section 10(a)(1)(B) of the Act."

The 2013 incidental take assessment is likewise founded on those underlying principles. As mentioned above, the analysis for the 2013 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 Item M net disturbance technical memorandum dated December 30, 2013. 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 2013. Although calculated independently, a foundational first step to both assessments was the documentation of "occupied" habitat for the covered species. During the ITP Item M net disturbance assessment and subsequent technical memorandum, a description and quantification of occupied habitat was completed for each covered species. 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 bio-monitoring data

(BIO-WEST 2002-2013a,b) and other existing sources for the HCP covered species as described in the Item M technical memorandum. As described in the Item M technical memorandum, specific discussions were held with professionals from the USFWS 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 bio-monitoring with documented occupancy. Over the course of the Item M assessment, specific meetings and discussions were conducted with professionals from the USFWS Aquatic Resources Center (ARC) and Austin ES to evaluate existing data sources and describe occupied habitat for each of the covered species. Figure 1 is an example of fountain darter occupied habiat in the Upper Spring Run of the Comal system.

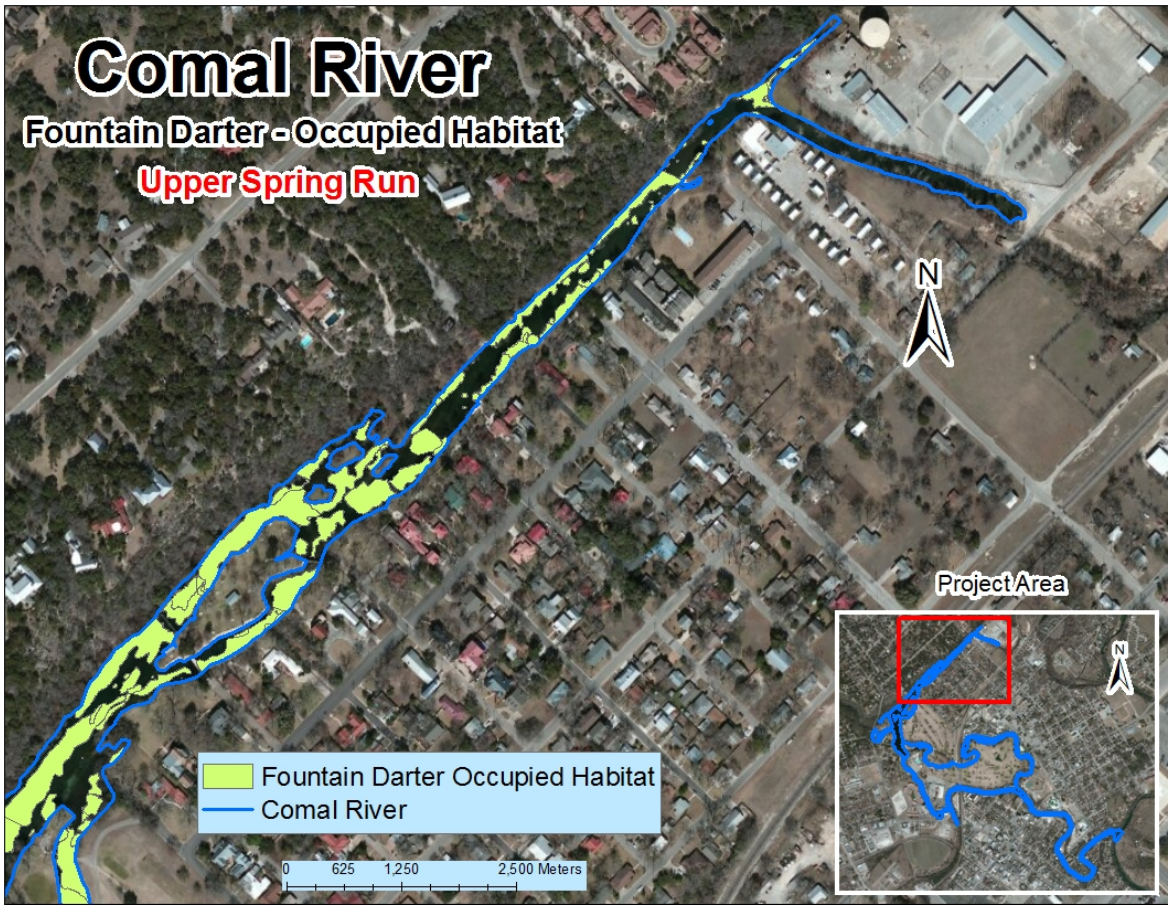

Figure 1. Fountain Darter Occupied Habitat – Upper Spring Run (Comal System)

All occupied habitat maps for the covered species are provided in the Item M technical memorandum and in Section X of the ITP annual report and thus will not be duplicated here. Table 1 summarizes the occupied habitat in m^2 for each of the covered species pertinent to the Item M assessment. As per the ITP, the baseline assessment in 2013 is representative of conditions at the issuance of the ITP (March 18, 2013). Occupied habitat per covered species per system was used for all subsequent comparisons and calculations during this assessment.

TABLE 1. Occupied Habitat Per Covered Species Per System (Duplicated from Item M memorandum)

ITEM M - SPECIES	OCCUPIED HABITAT (m^2)	NOTES AND ASSUMPTIONS
COMAL SPRINGS / RIVER		
Fountain Darter	73,410	Based on collections and known occurrence in aquatic vegetation types sampled over the course of the HCP bio-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 baseline assessment.
Comal Springs Riffle Beetle	1,383	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	113,179	Based on collections and known occurrence in aquatic vegetation types sampled over the course of HCP bio-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 bio-monitoring. Also, based on collections conducted by the USFWS 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*	4,561	* 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 Spring 2013 map of Texas wild-rice in the San Marcos River was included as a baseline for this section.

HCP MITIGATION and RESTORATION: Documentation of impacted habitat

Descriptions of the HCP minimization and mitigation measures and 2013 restoration activities 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 the ITP)
  - 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 the ITP)
  - 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 these projects, the areal extent of the project footprint has been quantified in Table 2 and depicted in figures provided in the Item M memorandum. 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. Figure 2 provides an example of a couple of HCP mitigation and restoration projects within Landa Lake of the Comal System. All project impact maps associated with HCP mitigatin and restoration activities are provided in the Item M technical memorandum and in Section X of the ITP annual report and thus will not be repeated here.

TABLE 2. Mitigation and Restoration Project Areas and Calculated Impact Area per Covered Species (Duplicated from Item M memorandum)

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	**B**	--	--	--	--			
Restoration and maintenance of native aquatic vegetation	1,793	1,681	0	0	0			
Decaying vegetation removal	**C**	--	--	--	--			
Aeration, Water Quality Sonde	4.5	4.5	0	0	0			
Gill parasite	3,394	2,485	0	0	0			
Riparian restoration and bank stabilization	**B**	--	--	--	--			
Riffle beetle restoration	547	0	0	0	0			
Non-native species removal	29.4	10.0	0	0	0			
Sediment Island removal	287.8	**D**	--	--	--			
TOTAL	6,056	4,180.5	0	0	0			
CITY OF SAN MARCOS / TEXAS STATE UNIVERSITY								
Enhancement and restoration of Texas wild-rice	**E**	--	--			--	--	--
Management of recreation specific to Exclusion zones (only)	788	39.4	--			14.8	--	--
Non-native species removal	**C**	--	--			--	--	--
Restoration and maintenance of native aquatic vegetation	5,266	3,065	0			0	0	0
Sediment removal	559	132	0			0	0	0
Access Points and Bank Stabilization	152	0	0			0	0	0
Riparian restoration	7,974	0	0			0	0	0
TOTAL	14,739	3,236.4	0			14.8	0	0

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

B Only design work conducted in 2013

C Throughout system – described in qualitative impacts discussion

D Vegetation removal adjacent to the island prior to removal is accounted for under the Native Vegetation Restoration project

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

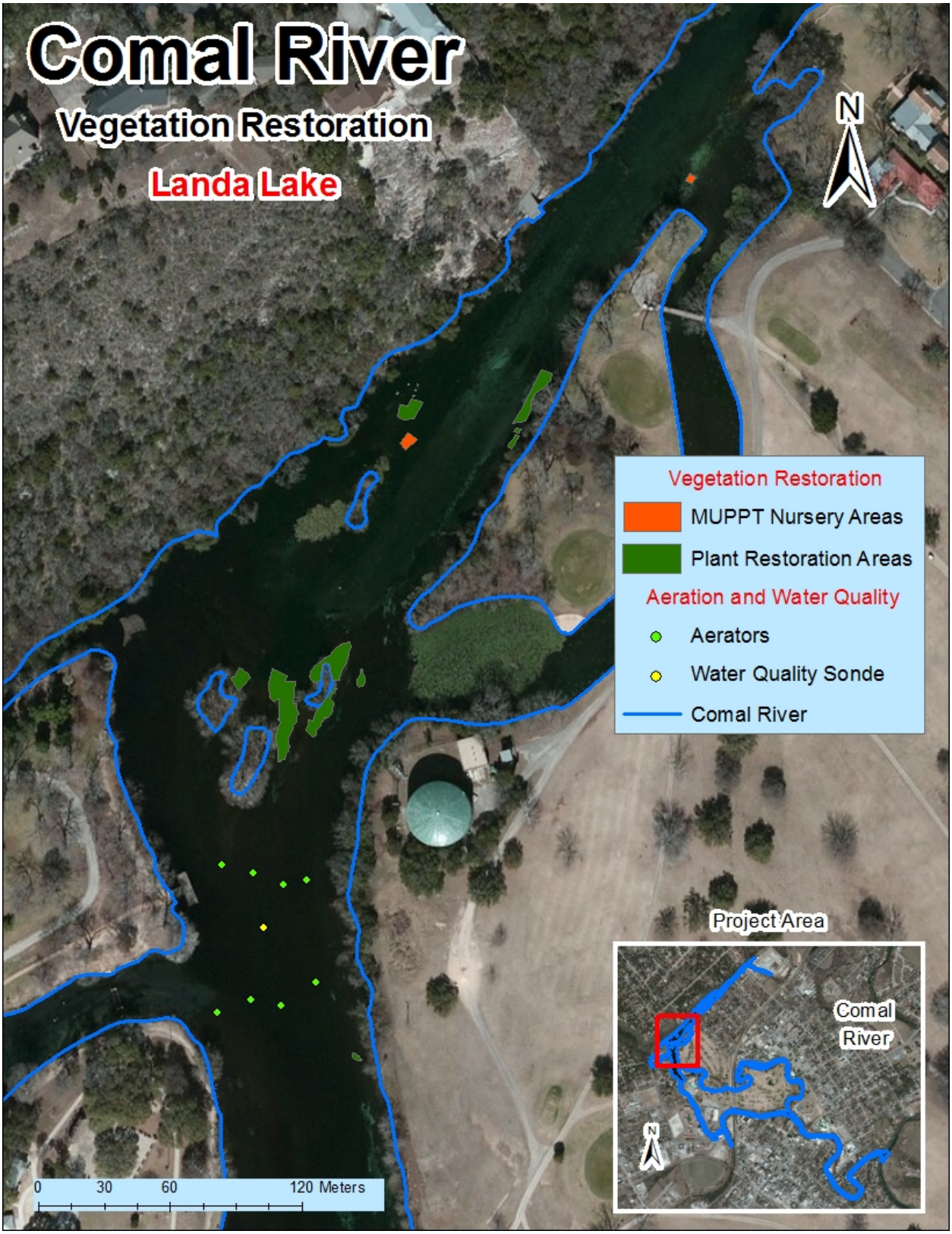

Figure 2. Restoration and Maintenance of Native Aquatic Vegetation project and Aeration and Water quality sonde project – Landa Lake (Comal system)

As described in the net disturbance memorandum (Section X, EARIP ITP Annual Report), 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). 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 qualitatively described.

Table 3 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.

TABLE 3. HCP Mitigation / Restoration Net Disturbance area per species per system

COVERED SPECIES	Total Occupied Habitat (m^2)	HCP Mitigation / Restoration Impact Area (m^2)
CITY OF NEW BRAUNFELS		
Fountain Darter	73,410	4,181
Comal Springs riffle beetle	1,383	0
Comal Springs dryopid beetle	350 [A]	0
Peck's Cave amphipod	1,470 [A]	0
CITY OF SAN MARCOS / TEXAS STATE UNIVERSITY		
Fountain Darter	113,179	3,236
San Marcos salamander	2,165	14.8
Texas blind salamander	[B]	0
Comal Springs riffle beetle	11	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.

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 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 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. For the Texas blind salamander and Comal Springs riffle beetle, there were no activities conducted in 2013 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 2013 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 in the previous section, 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 bio-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 2013 relative to HCP measures and drought.

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

Figure 3. Representative Sample Reaches (4) for the Comal System and Corresponding River Section.

Figure 4. Representative Sample Reaches (3) for the San Marcos System and Corresponding River Section.

Figure 4 cont. Representative I35 Sample Reach and Corresponding Lower River Section in the San Marcos System.

Figure 5 shows the correlation between bryophytes and total system discharge in the Upper Spring Run sample reach of the Comal River excluding flood events which highly alter the level of bryophytes present. This relationship is not surprising as it has been documented during field observations that increased total system discharge also increases spring upwellings within the Upper Spring Run sample reach which is beneficial to bryophytes.

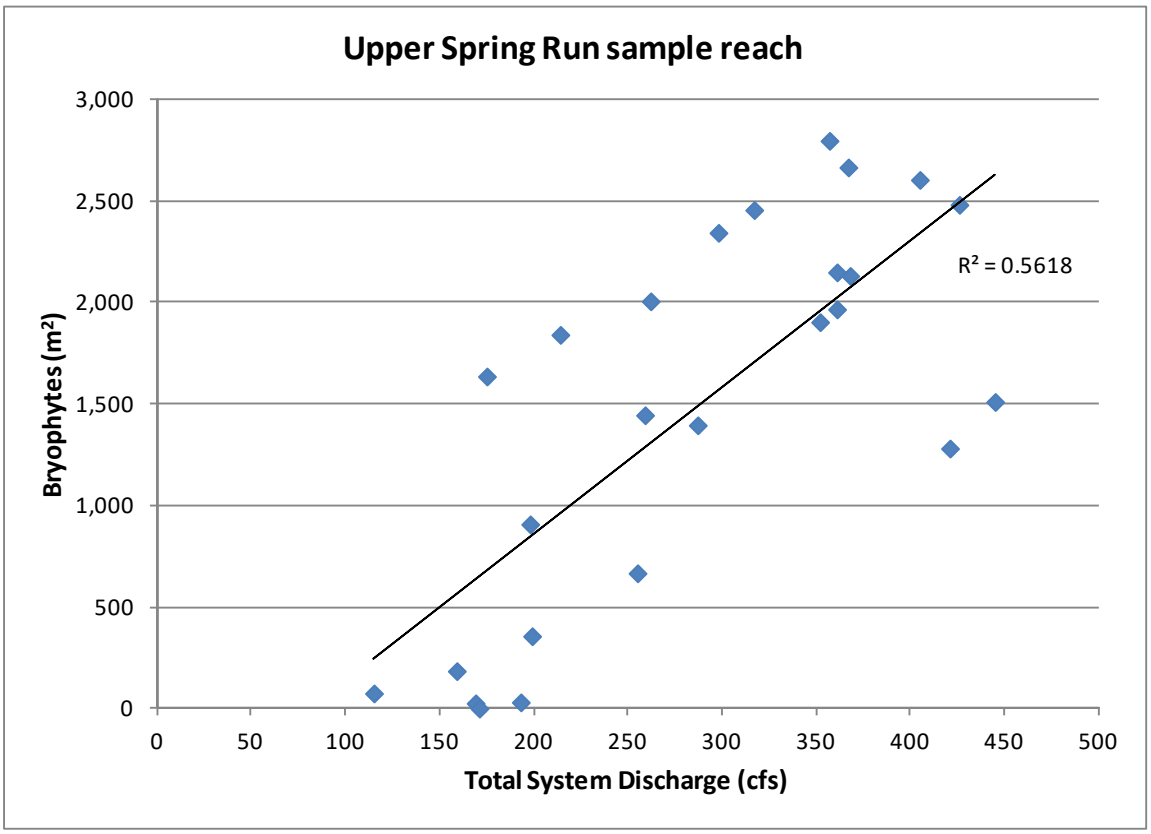

Figure 5. Correlation between bryophytes and total system discharge excluding flood / high-flow influenced events in the Upper Spring Run sample reach.

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.

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

"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 6 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.

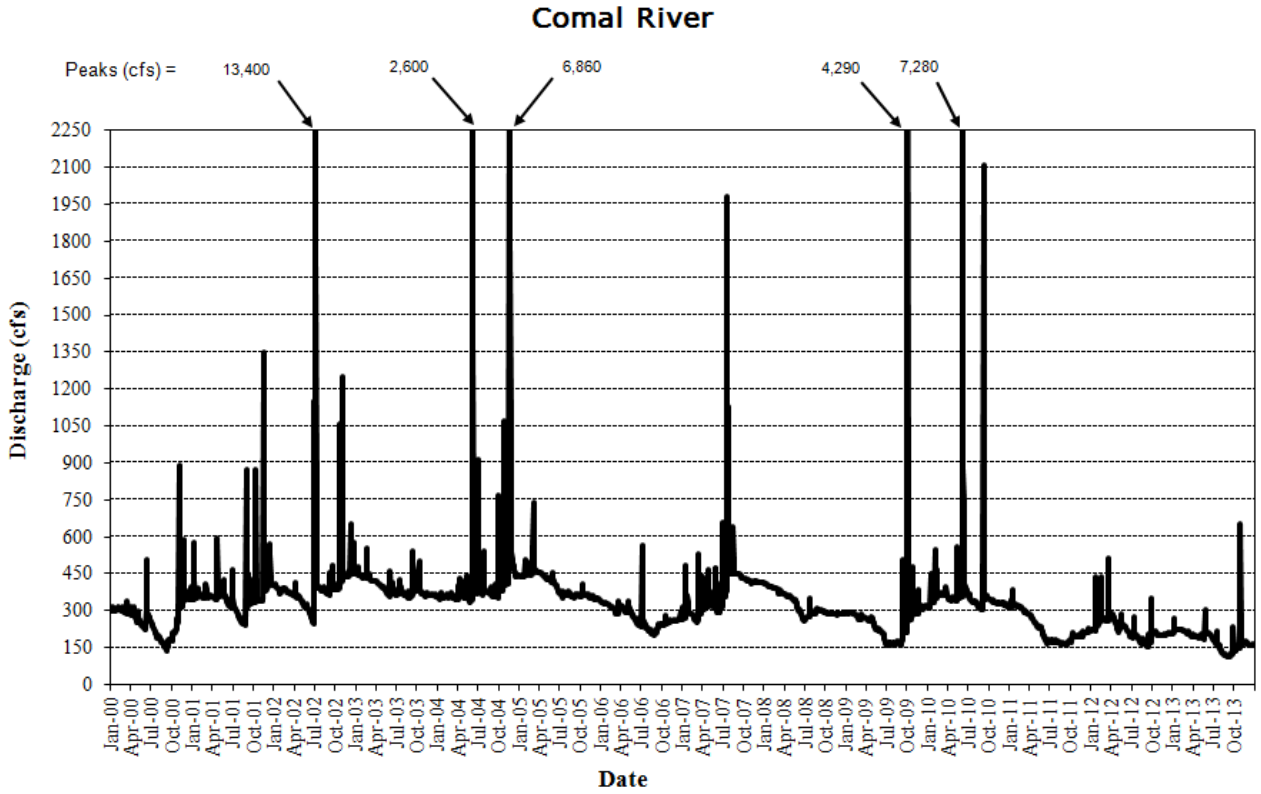

Figure 6: Comal River hydrograph presented as daily discharge over the bio-monitoring period.

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 this past October which followed the fall aquatic vegetation mapping, thus not affecting 2013 data. Figure 7 depicts the San Marcos River hydrograph over the bio-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

"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

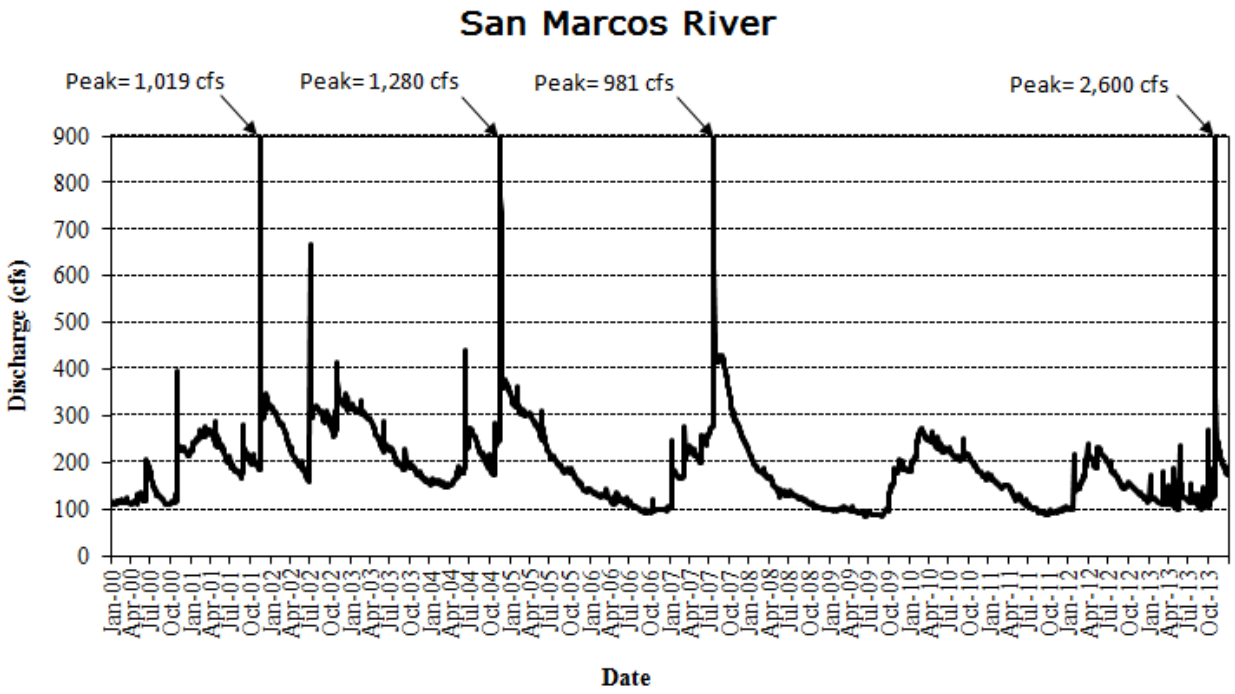

Figure 7: San Marcos River hydrograph presented as daily discharge over the bio-monitoring period.

Table 6 shows the percentage retention in aquatic vegetation observed from spring to fall for average and drought years as well as individually for 2013. 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%
2013 Actual	48%	94%	92%	111%	62%	73%	81%

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 2013 (Table 6) shows that it was similar to a typical drought in the Upper Spring Run and Landa Lake sample reaches, but had a more notable effect on the Old Channel and New Channel sample reaches. Figure 8 depicts the spring and fall aquatic vegetation within the Upper Spring Run sample reach in 2013.

The total system discharge for Comal Springs in 2013 approached 110 cfs in late summer which was the lowest recorded discharge since the initiation of the bio-monitoring program in 2000. Even with discharge to the Old Channel controlled by culverts from Landa Lake, overall reduction in discharge eventually causes reductions entering the Old Channel as well. It appeared this was the case in late summer 2013 along with the building up of floating aquatic vegetation impacting flow into the Old Channel. The temporary reduced discharge condition or mini-pulse sent down the Old Channel when the debris was subsequently removed may have been the cause for the decline observed in the Old Channel sample reach in 2013 relative to previous drought years.

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.

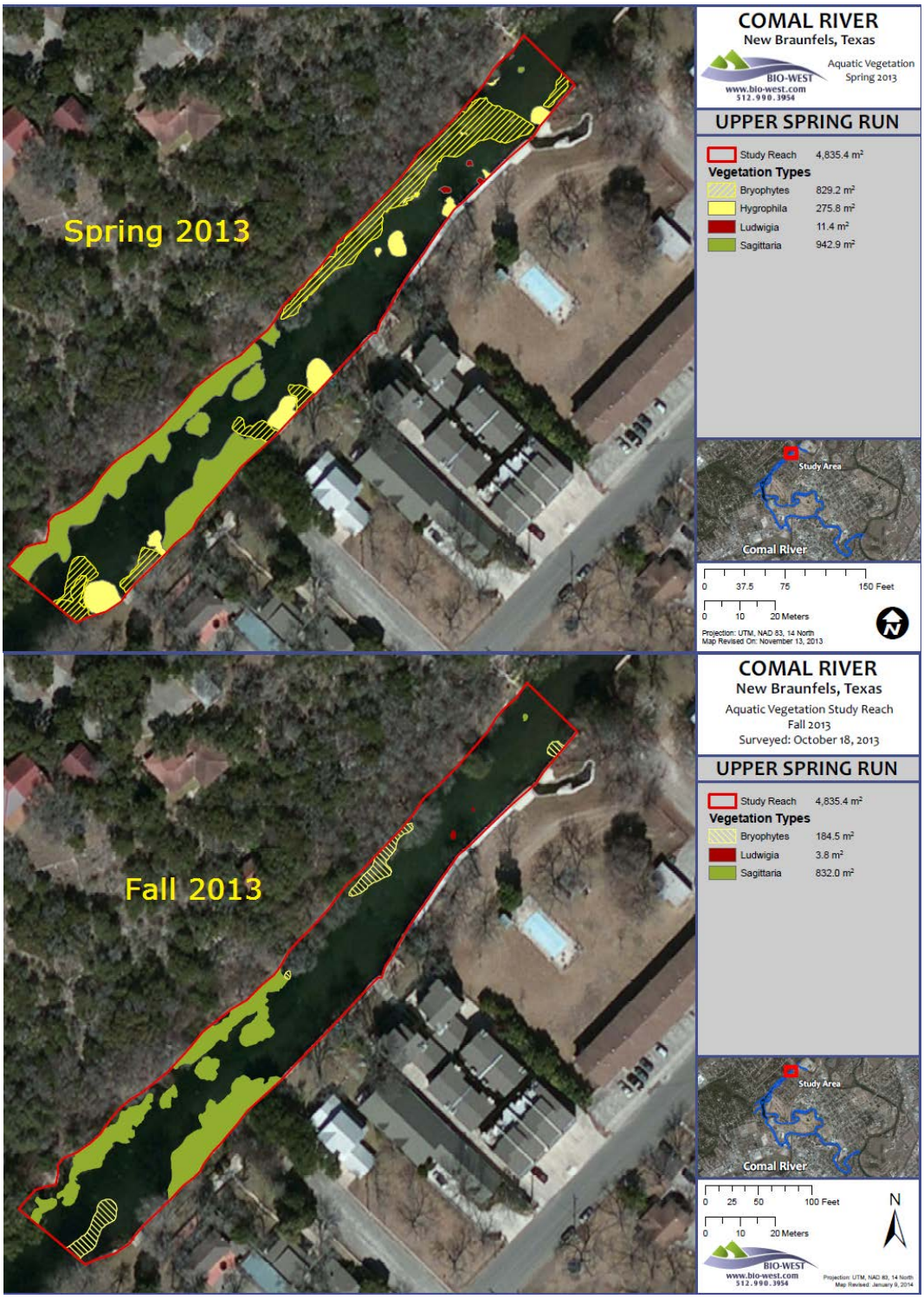

Figure 8. Spring and Fall 2013 Aquatic Vegetation Maps – Upper Spring Run sample reach (Comal system)

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 2013 (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 2013. Using the Upper Spring Run sample reach as an example, there is an 85% retention during average years but only a 48% retention in 2013. 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% - 48% = 37%) 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 2,887 m^2. The 37% difference from the reach is applied to the 2,887 m^2 from the entire section resulting in a habitat impact of 1,068 m^2. For this incidental take assessment, the 1,068 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%
2013 Actual	48%	94%	92%	100%	62%	73%	81%
	HABITAT CALCULATIONS applied to river sections						
Difference between Average and 2013 (%)	37%	0%	8%	0%	23%	19%	18%
Total Fountain Darter Occupied Habitat (m^2) per entire river section	2,887	21,236	21,738	27,549	1,406	30,071	10,335
2013 Total Impacted Area (m^2)	1,068	0	1,739	0	323	5,713	1,860

As evident in Table 7, only the Upper Spring Run and Old Channel sections exhibited impacted habitat conditions in 2013 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 2013 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 2013 (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 were provided in the December 30, 2013 memorandum or Section X of the EARIP ITP annual report. In 2013, disturbances pertaining to HCP measures and drought to the Comal invertebrate species were the drying of surface area in Spring Run 1, Spring Run 2, Spring Run 4 and the Spring Island area in late summer/fall, the use of the kiddie pool in Spring Run 2, and the placement of a permanent water quality sonde in Spring Run 7 on the western shoreline of Landa Lake.

With HCP measures in place, the continued drought resulted in the drying of surface habitat within Spring Run 1, Spring Run 2 and Spring Run 4 (uppermost part of Upper Spring Run) as well as areas on and adjacent to Spring Island. 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.

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

Covered Species	2013 Impacted Occupied Habitat Area (m^2)		
	Main Spring Runs	Spring Island	TOTAL
Comal Springs riffle beetle	26	77	103
Comal Springs dryopid beetle	134	0	134
Peck's Cave amphipod	1	77	78

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 Spring Island area; the main area of disturbance

for the Comal Springs dryopid beetle was Spring Run 2; and the main area of disturbance for the Peck's Cave amphipod was adjacent to Spring Island.

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 2013 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 2013, 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 2013 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 23% 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 23% which resulted in an impacted area of 336 m^2. To stay consistent with each other covered species in this assessment, the exclusion zone in the eastern spillway (125 m^2) was not counted as a benefit nor subtracted from the impacted area. However, along with other activities that resulted in a net benefit in habitat, this HCP mitigation measure is discussed in the benefits sections at the conclusion of this memorandum.

Texas blind salamander: There is no surface habitat documented in the Item M assessment for the Texas blind salamander. There were no aquifer impacts noted via HCP measures or the drought in 2013, 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 2013 baseline coverage was 4,561 m2 in April 2013. When the full system mapping was again conducted in August/September 2013, the total area was recorded as 5,019 m^2. Both values are 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. Approximately 383 m^2 of Texas wild-rice was added in 2013 directly from enhancement activities conducted by the City of San Marcos and Texas State University.

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. As this is year 1 of a 15 year ITP term, it is understandable if the USFWS feels that the impacted habitat determination is as far as the HCP can go this inaugural year. However, to provide a comparison to the EARIP ITP permit amounts, the decision was made to go beyond just impacted habitat.

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. This was evident in the Biological Opinion which used a percentage of a percentage rule in the conversion of habitat area to individual incidental take as described at the beginning of this memorandum. Although the 2.5% of 10%, or 10% of 5% choices in the Biological Opinion could be criticized as arbitrary, the complexity of this assessment is understood and the professional judgment of the USFWS respected. As previously described, the foundational components employed by the USFWS (determination of impacted habitat, then subsequent conversion to individual incidental take numbers) were followed for this assessment. However, for this assessment, the utilization of existing datasets and subsequent application of methodologies and calculations were expanded in most cases.

Regardless of methodology, it is important that the Incidental Take analysis be conducted within the context of the underlying EARIP ITP. For instance, it could be interpreted that incidental take occurs anytime that someone steps in the water to swim, casts a line in the river to fish, etc., etc. It doesn't take long following that train of thought to conclude that the entire river was affected by humans over the course of 2013. So the calculation could simply be to take all fountain darter occupied habitat (≈73,000 m^2) in the Comal system and multiply that number times the average density (11.4 per m^2) of darters in the Comal System. The result would be incidental take of 832,200 darters which exceeds the ITP permitted amount in its entirety. To exceed the permit in 2013 which proved to be a year slightly worse than average, but not even approaching DOR-like conditions shows that particular interpretation does not fit within the context of the USFWS analysis in the biological opinion.

In the average year determination in the Biological Opinion, the USFWS used an average density of the covered species to multiply by impacted habitat in most cases. A description of their methodology is provided at the start of this memorandum. It is our interpretation that incidental take should be 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. This is also a founding principal of the USFWS analysis considering eight average years calculated in one manner, and the DOR-like conditions calculated in another.

The word stressful in the previous paragraph 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. During the 2013 HCP restoration activities, the City of San Marcos and Texas State University collected individual species data on all specimens collected during aquatic vegetation restoration and sediment removal activities. During these activities, the process for non-native aquatic vegetation removal is to first traverse throughout the area intended for removal in order to encourage any covered species to vacate the immediate project area. The non-native aquatic vegetation is then removed and taken to the bank to be further searched for any covered species. Any individual covered or native species are then returned to the river. During 2013 activities, 10 individual fountain darters were captured while sifting through approximately 1,500 m^2 of non-native aquatic vegetation. Of course, these individuals were returned to the river, but had they not been, this represents an example of mortality relative to complete disturbance followed by denuding an entire area. When calculating fountain darter mortality from this data set, the resulting value is 0.007 darters per m^2. Therefore, it can be presumed that actually mortality from all HCP measures in 2013 would be extremely low. However, should the amount of occupied habitat be significantly less and the fountain darters exhibit a clumping behavior with no surrounding habitat to move to when startled, mortality would be expected to increase.

Additionally, water temperature conditions during 2013 were suitable throughout both systems for the reproduction and success of the fountain darter (Figures 9 and 10). A presentation of water temperature data from all thermistors over time is available in the 2013 bio-monitoring annual reports (BIO-WEST, 2014a, 2014b). 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 may have represented 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 bio-monitoring in both systems. The USFWS approach used the average density for covered species from the same bio-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 25^{th}, 50^{th} (median), 75^{th}, and 90^{th} 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.

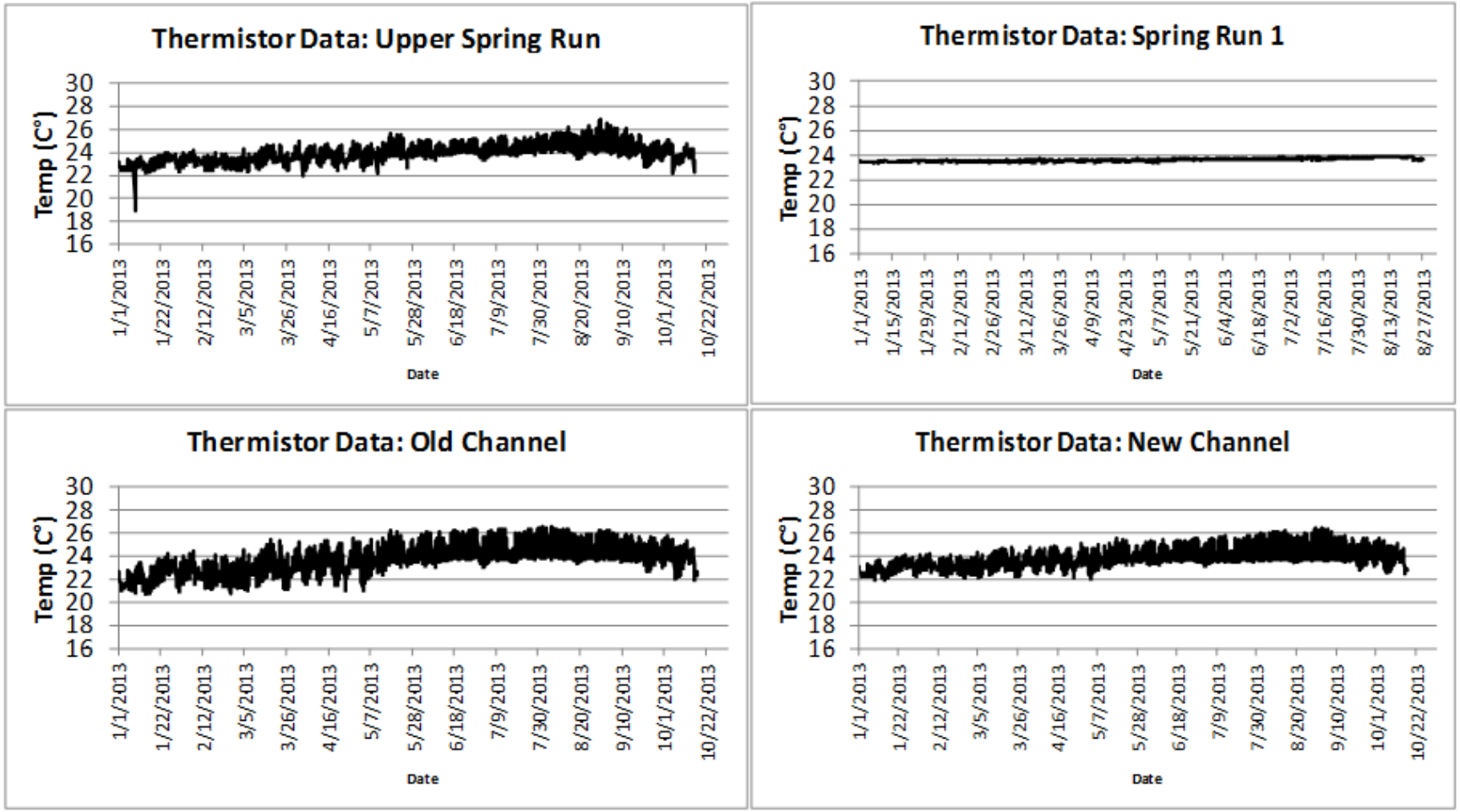

Figure 9: Thermistor data collected during 2013 at four select sites extending upstream to downstream in the Comal System.

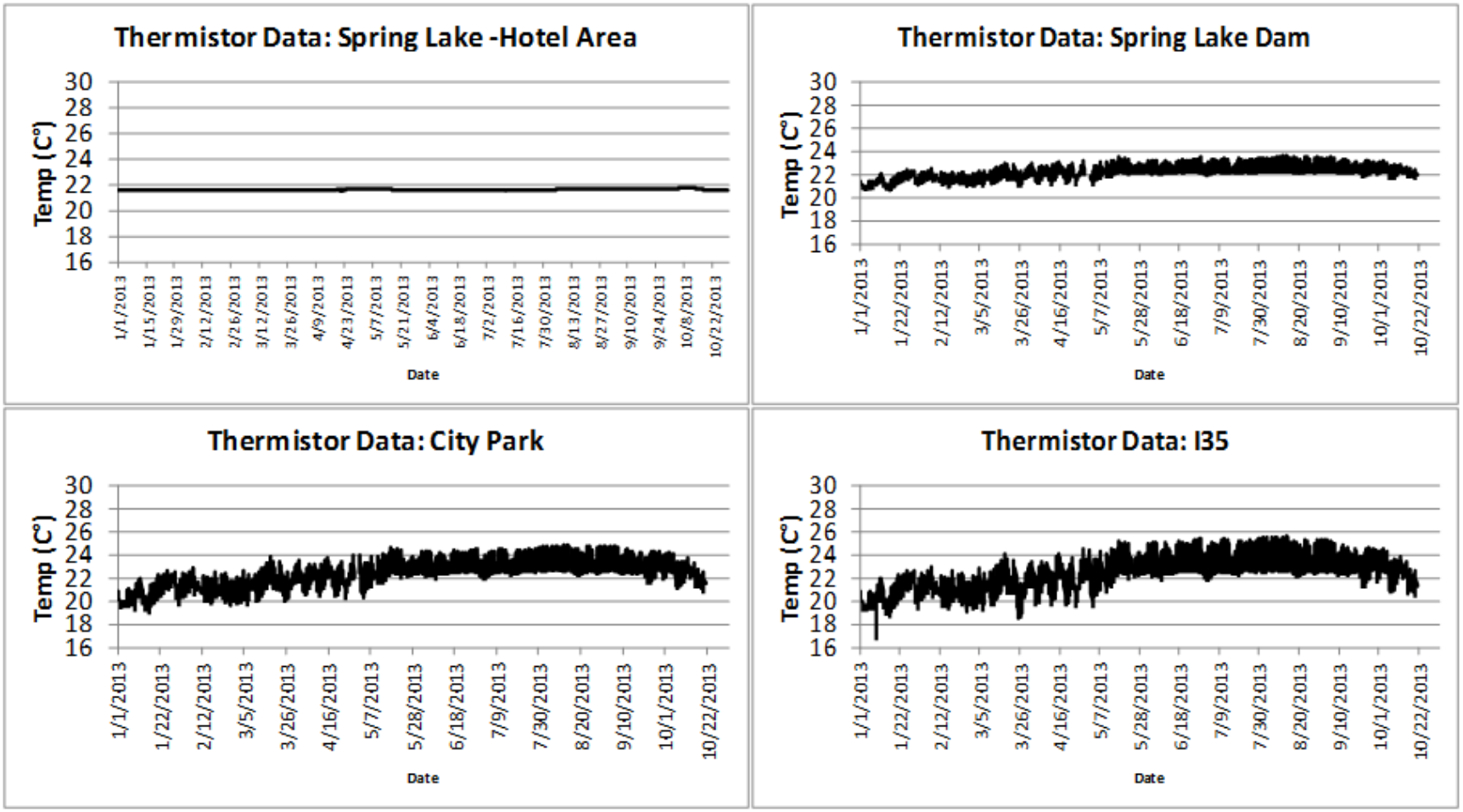

Figure 10: Thermistor data collected during 2013 at four select sites extending upstream to downstream in the San Marcos System.

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 resulted in 484 individual drop net samples for the Comal system and 301 individual drop net samples from the San Marcos system. Densities over bare substrate were not included in the descriptive statistics. 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 bio-monitoring in the San Marcos system. Densities within the San Marcos River (26 samples) and Spring Lake (52 samples) 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 – 603 total samples). 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 (392 total samples). In the case of the Comal Springs dryopid beetle, only 46 individuals have been collected in 392 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. Based on Gibson (2011) and Bowles and Stanford (2003), the Biological Opinion estimated the total surface population of Comal springs dryopid beetles in the Comal Spring system to be 1,839 individuals (USFWS Biological Opinion). 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 bio-monitoring data is limited to 46 Comal Springs dryopid beetle observations over time, 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 25th 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 2013 occupied habitat (73,410 m^2) would result in 5,873 m^2 and 40,376 m^2, respectively. These impacted habitats multiplied against the corresponding densities would result in an incidental take of 8,810 (5,873*1.5) or 458,268 (40,376 * 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%

Using the density schedule in Table 10 and the impacted habitat areas calculated in tables 3, 7, 8, and in the text, the following incidental take calculations are made for each covered species.

Fountain darter:

Table 11 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.

Table 11. 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
2013 Impacted Area (m^2)	4,181	2,807	3,236	7,896	0	0
Total Occupied Habitat (m^2)	73,410	73,410	41,812	41,812	71,368	71,368
% of Occupied Habitat Impacted	5.70%	3.82%	7.74%	18.88%	0.00%	0.00%
Corresponding Percentile Density (individual/m^2)	1.50	1.50	1.50	1.50	--	--
2013 Incidental Take Estimate	6,272	4,211	4,854	11,844	0	0
2013 TOTAL INCIDENTAL TAKE PER SYSTEM	10,482		16,698			

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.

Comal Springs invertebrates:

Table 12 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 10% 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.

Table 12. 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
2013 Impacted Area (m^2)	0	103	0	134	0	78
Total Occupied Habitat (m^2)	1,383	1,383	350	350	1,470	1,470
% of Occupied Habitat Impacted	0.00%	7.46%	0.00%	38.17%	0.00%	5.32%
Corresponding Percentile Density (individual/m^2)	--	6.60	--	0.10	--	1.04
2013 Incidental Take Estimate	0	681	0	13	0	81
2013 TOTAL INCIDENTAL TAKE	681		13		81	

San Marcos salamander: Table 13 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 2013, all impacted area was below Spring Lake Dam so only the San Marcos River 25th percentile density was applied.

Table 13. 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
2013 Impacted Area (m^2)	15	336	0	0
Total Occupied Habitat (m^2)	1,454	1,454	711	711
% of Occupied Habitat Impacted	1.03%	23.11%	0.00%	0.00%
Corresponding Percentile Density (individual/m^2)	3.00	3.00	--	--
2013 Incidental Take Estimate	45	1,008	0	0
2013 TOTAL INCIDENTAL TAKE	1,053			

Texas blind salamander: There was no impacted habitat reported for the Texas blind salamander in 2013, thus no incidental take was calculated for the Texas blind salamander in 2013.

Texas wild-rice: Although Texas wild-rice is not allotted take projection in the ITP, its 2013 baseline coverage was 4,561 m^2 in April 2013 and 5,019 m^2 in September 2013.

COMPILATION OF RESULTS AND SUMMARY

Table 14 summarizes the 2013 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 2013.

Table 14. 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)		HABITAT 2013 TOTAL (m^2)	INCIDENTAL TAKE		2013 INCIDENTAL TAKE TOTAL	ITP Permit Amount	ITP Permit Remaining
	HCP Mitigation / Restoration	HCP Measures / Drought		HCP Mitigation / Restoration	HCP Measures / Drought			
COMAL SYSTEM								
Fountain Darter	4,181	2,807	**6,988**	6,272	4,211	**10,482**	797,000	786,518
Comal Springs Riffle Beetle	0	103	**103**	0	681	**681**	11,179	10,498
Comal Springs Dryopid Beetle	0	134	**134**	0	13	**13**	1,543	1,530
Peck's Cave Amphipod	0	78	**78**	0	81	**81**	18,224	18,143
SAN MARCOS SYSTEM								
Fountain Darter	3,236	7,896	**11,132**	4,854	11,844	**16,698**	549,129	532,431
San Marcos Salamander	15	336	**351**	45	1,008	**1,053**	263,857	262,804
Texas Blind Salamander	0	0	**0**	0	0	**0**	10	10
Comal Springs Riffle Beetle	0	0	**0**	0	0	**0**	n/a	n/a

Based on the characterization of drought in this assessment, conditions experienced during 2013 went beyond an average year as described in the Biological Opinion. However, when examining 2013 impacted habitat, those same conditions were nowhere near conditions characterized in the Biological Opinion DOR-like scenario. As such, we are confident the incidental take numbers summarized in Table 14 justify the data sets used and methodologies employed in 2013 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.

A few Items identified for specific consideration at this time include possibly subtracting the occupied habitat area within the immediate exclusions zones in the San Marcos system from the overall impacted habitat area; how best to deal with the spring to fall habitat characterization for the fountain darter moving forward should an extreme flood event be experienced within a given year; and should additional factors such as water temperature and/or turbidity somehow be directly incorporated into the scaled density approach.

HCP Mitigation and Restoration Benefits

Although not germane to the 2013 incidental take assessment, it is important to put the 2013 mitigation and restoration activities described in this memorandum only as "impacts" into context with the HCP long-term biological goals. Table 4 in the December 30, 2013 memorandum (Section X in EARIP ITP Annual Report) provided an overview of some of the net benefits relative to increasing the quality and quantity of covered species habitat in the Comal and San Marcos ecosystems.

In summary, over 1,350 m^2 of native aquatic vegetation was restored in the Comal system in 2013. Over 1,000 m^2 of benefit to fountain darter occupied habitat was accomplished with native vegetation restoration, sediment removal, and protection within the two established exclusion zones. San Marcos salamander occupied habitat (125 m^2) and Texas wild-rice (455 m^2) were both protected in the San Marcos River via the exclusions zones that were in place during peak summertime recreation activities. Finally, 383 m^2 of Texas wild-rice was actively restored in the San Marcos River in 2013.

Although it may not be appropriate to incorporate the restoration activities within the incidental take assessment from a benefit standpoint, all direct restoration will fold into the baseline to be established for 2014. For the enforcement measures such as the two exclusion zones, it is worth considering inclusion in the incidental take equations by removing the occupied habitat protected in these areas from the overall impacted habitat area. This was not done in 2013 but may be an appropriate calculation moving forward. Regardless, continuing to increase, enhance and protect covered species habitat supports the path towards accomplishing the HCP long-term biological goals and objectives.

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