San Marcos Aquatic Resources Center
June 2015

Aquatic Species Conservation and Management: Refugium Activities

San Marcos Salamander- As of 30 June 2015, 354 San Marcos salamanders were being maintained in the SMARC refugia. Five deceased salamanders were observed in the refugia this month (Table 1). In June, 30 offspring were sacrificed for the Dexter Fish Health Unit's annual fish health survey. Wild stock salamanders oviposited 30 eggs this month while their offspring did not oviposit any eggs during June (Table 1). (CSF 7.12.5.4)

Table 1.- Four-month summary of the number of salamanders held in and number of eggs produced for the refugia at the San Marcos Aquatic Resources Center. Abbreviations are as follows: RWS= refugium wild stock, WS=wild stock (specimens in quarantine), FX=offspring, JA=juveniles/adults, OV=ovipositions, and EG=eggs.

		March 2015			April 2015			May 2015			June 2015		
Species		JA	OV	EG	JA	OV	EG	JA	OV	EG	JA	OV	EG
San Marcos salamander	RWS	293	1	45	292	1	31	359	0	0	354	1	30
	FX	107	0	0	104	0	0	101	0	0	63	0	0
Quarantine	WS	0	-	-	77	-	-	0	-	-	0	-	-
Texas blind salamander	RWS	122	0	0	129	0	0	138	0	0	141	0	0
	FX	129	1	16	127	1	31	127	0	0	127	0	0
Quarantine	WS	2	-	-	8	-	-	2	-	-	2	-	-
Barton Springs salamander	RWS	33	0	0	31	0	0	31	0	0	31	0	0
	FX	623	0	0	608	0	0	609	0	0	578	0	0

Texas Blind Salamander- As of 30 June 2015, 141 wild caught Texas blind salamanders were being maintained in the SMARC refugia. EARDC (Edwards Aquifer Research and Data Center) staff collected three young salamanders from Sessom Creek Springs in June. One of the three salamanders collected during June and two remaining in quarantine from last month were incorporated into the refugia population. Two salamanders collected this month remain in the quarantine system (Table 1). No deceased wild stock adults were observed in the refugia population this month (Table 1). Wild stock Texas blind salamanders and their offspring did not oviposit eggs this month (Table1). (CSF 7.12.5.4)

Barton Springs Salamander- No salamanders were collected from Barton Springs in June (Table 1). No wild stock salamander mortalities were observed this month (Table 1). Wild stock Barton Springs salamanders and their offspring did not oviposit eggs this month (Table 1). (CSF 7.12.5.4)

Fountain Darter- On 30 June 2015, there were 705 wild stock fountain darters in the SMARC refugia. Thirteen mortalities were recovered during June from the San Marcos (lower = 3, middle = 2, and upper = 2) and Comal (upper = 2 and lower =4) rivers. On 15 June, 60 F1 darters were examined by staff from the Dexter SNARRC for fish health analyses. (CSF 7.12.5.4)

Devils River Minnow- The SMARC is maintaining two stocks of wild caught Devils River minnows (DRM) in refugia, one from San Felipe Creek (N = 160) and another from Pinto Creek (N = 88). The single Pinto Creek DRM that exhibited erratic swimming behavior was transferred to David Huffman's (TSU) laboratory in June. The fishes' skull contained metacercariae of the parasitic nematode *Macroderoides.* During May, all Pinto Creek F1 Devil River minnows were transferred to outdoor raceways. Five hundred and fifty-seven F1 juveniles were transferred to Raceway 5 and 336 were transferred to Raceway 6. These fish were produced during October 2014. In addition, a total of 63 F1 Pinto Creek adults were stocked into to Raceways 5 (N = 30) and 6 (N = 33). These F1 Pinto Creek adults were produced prior to 2014. The SMARC also continues to maintain 721 F1 DRM from San Felipe Creek in Raceway 4. Non-lethal tissue samples have been collected annually from the fish in Raceway 4 for genetic analyses. The genetic analyses of wild stock San Felipe Creek and Pinto Creek DRM is ongoing at the Dexter SNARRC. As the genetic information becomes available, it will be incorporated into a propagation/genetic management plan for DRM. On 15 June, 60 F1 San Felipe DRM were examined by staff from the Dexter SNARRC for fish health analyses. (CSF 7.12.5.4)

Comal Springs Riffle Beetle- Approximately 84 adult wild stock Comal Springs riffle beetles, seven F1 adult offspring, and 500 larvae are being maintained at the SMARC. (CSF 7.12.5.4)

Peck's Cave Amphipod- Approximately 39 adult Peck's cave amphipods and 120 *Stygobromus* juveniles are being maintained at the SMARC. (CSF 7.12.5.4)

Texas Wild Rice- As of 30 June 2015, the SMARC had 260 Texas wild rice plants in refugia. There are 145 plants in greenhouse raceways, 80 in outdoor raceways, and 35 in quarantine along with an additional 86 plants at Uvalde NFH (Table 2). Tillers were collected during October and November from the San Marcos River (N= 10 Section B, N = 10 Section C, and N = 15 Section F) and are still being held in quarantine. Additional collection of tillers will be made as recommended within the Texas wild rice genetics report. (CSF 7.12.5.4)

On 30 June 2015, the SMARC had 22,159 (N_{2009} = 390, N_{2010} = 585, and N_{2011} = 1,941, N_{2012} = 10,152, N_{2013} = 6,550, N_{2015} = 2,541) Texas wild rice seeds in storage (Table 3). No wild seeds were collected in June as the late May flood submerged most of the flowers and scoured or dislodged the seeds. . Further assessments will occur as the water level recedes. (CSF 7.12.5.4)

Table 2.- Current number of Texas wild rice plants being maintained in refugia at the SMARC and Uvalde NFH. San Marcos River segments are defined in accordance with the USFWS 1996 Contingency Plan where each segment represents a particular stand's genetic make-up. The number of plants within each pot varies (Mean ± 1SE = 61 ± 6 stems per pot). The research stock is comprised of clones and plants produced from various river segments.

	Number of Potted Plants				
		SMARC Refugia		Uvalde NFH	
	Greenhouse	Outdoor Raceway	Quarantine	Refugia	Total
A	13	25	0	18	56
B	54	51	10	19	134
C	24	4	10	10	48
D	0	0	0	6	6
E	7	0	0	0	7
F	18	0	15	4	37
G	1	0	0	8	9
H	1	0	0	0	1
I	0	0	0	0	0
J	10	0	0	2	12
K	3	0	0	4	7
Research Stock	14	0	0	15	29
Total	145	80	35	86	346

Table 3.- Number of Texas wild rice seeds stored at the SMARC. Seeds are stored by month and year.

Month	2009	2010	2011	2012	2013	2014	2015	Total
Jan					491			491
Feb								
Mar								
Apr								
May					264		2,541	2,805
June			433		2,307			2,740
July			650		1,172			1,822
Aug					2,316			2,316
Sept				3,428				3,428
Oct		325	273	1,785				2,383
Nov	390	260	585	3,267				4,502
Dec				1,672				1,672
Total	390	585	1,941	10,152	6,550	0	2,541	22,159

Research and Restoration Activities

Comal Springs riffle beetle- In December 2014, a collaborative proposal with Randy Gibson and Professors Weston Nowlin and Benjamin Schwartz (TSU) was selected for funding by the Edwards Aquifer Habitat Conservation Plan for a series of Edwards Aquifer invertebrate studies.

The research is aimed at developing and defining basic culture techniques and requirements for both the Comal Springs riffle beetle and Peck's cave amphipod. More specifically the studies include examining different anesthetic techniques for enumeration and non-lethal examination of specimens, light and dark habitat preferences to presumably reduce stress while in captivity, and evaluation of various aquatic invertebrate captive rearing and holding systems. During June, SMARC and TSU conducted a lure survey in the spring upwellings within Spring Lake for riffle beetles and other invertebrates to be used in these studies. Comal Springs riffle beetle adults and larvae (5 adults and 7 larvae) were collected in upwellings near the headwaters along with several *Lirceolus* isopods. Due to the general rarity of the beetles in San Marcos, they were immediately returned to their respective collection location. (CSF 7.12.5.4)

In February, BIO-WEST Inc. staff and TSU students set cotton cloth lures in springs of the upper Devils River to attract the riffle beetle, *Heterelmis cf. glabra*. This is part of an EAA funded study (Comal Springs riffle beetle habitat connectivity study #132-14-HCP) that will compare survival of riffle beetles at the Freeman Aquatic Building facility (TSU) with the SMARC using H. cf. glabra as surrogate for the Comal Springs riffle beetle. These lures were retrieved during March and approximately 500 beetles were collected. On 16 March, TSU volunteers placed 27 Comal Springs riffle beetles and 27 common riffle beetles (*Microcylloepus pusillis*) from Comal Springs each in identical containers at both the TSU Freeman Aquatic Building (FAB) and the SMARC. A third set of containers with 27 *H. cf. glabra* were added on 23 March at both facilities. This is part of an EAA funded study (Comal Springs riffle beetle habitat connectivity study #132-14-HCP) that will compare survival of riffle beetles at the FAB with the SMARC. Beetles survived at the SMARC but did not at the FAB. Riffle beetles were then placed in a container in a raceway below FAB and those survived. The next step will be to install an activated charcoal filter for the water running into FAB. Until the FAB resolves this issue, experimentation for this project will take place at the SMARC. During May, TSU staff set up two aquatic systems in the SMARC reuse building. The aquatic systems are being used to evaluate the long term temperature limitations of the Comal Springs riffle beetle. During June, Randy Gibson and volunteers from TSU collected 20 Peck's cave amphipods, 31 Comal Springs riffle beetle adults, 38 Comal Spring riffle beetle larvae, and 9 Comal Springs dryopid beetle adults from Comal Springs. These specimens will be used for preliminary isotope analysis in an attempt to determine what these species are eating. (CSF 7.12.5.4)

Randy Gibson in collaboration with Chad Norris (TPWD) and a TSU student volunteer are developing methods for sampling eight boreholes (i.e. stainless steel cylinders measuring 30" x 4") installed vertically in Comal Springs (Spring Run 1) by USGS in cooperation with Austin ES. During March, cotton cloth lures were inserted in four of the bore holes repeating efforts that took place during low flow conditions in December 2014. During April, the lures were retrieved and no Comal Springs riffle beetles were collected. During June, Randy Gibson and Chad Norris retrieved lures placed in Spring Run 1 to sample for Comal Spring riffle beetle distribution in the run after being dewatered as a result of drought. Only 3 larvae were collected from a single spring site out of 11 sites sampled as opposed to 187 beetles (adults and larvae) from 10 of 12 springs in 2007. (CSF 7.12.5.4)

Peck's cave amphipod- The SMARC supported a proposal submitted by Dr. Benjamin Schwartz

(TSU) and Dr. Chris Nice (TSU) to the TPWD Horned Lizard License Plate Grant Program during December 2014. The proposal was accepted for funding during 2015. This grant will use methods developed in Ethridge *et al.* 2013 to explore diversity of *Stygobromus* amphipods occurring together in the Edwards Aquifer and compare them using both genetic analysis and morphological characteristics. SMARC staff will assist by providing specimens and species identifications where needed. Information from this project will be useful for identification and understanding the diversity of these rare and often cryptic sympatric species in central Texas. During June, SMARC and TPWD staff began sampling three wells and one spring in Comal County with bottle traps and a drift net for *Stygobromus*. (CSF 7.12.5.4)

Texas troglobitic water slater - During May, Randy Gibson, and TSU Professors Weston Nowlin, Benjamin Schwartz, and Chris Nice submitted a proposal to the TPWD and were selected for funding through the State Wildlife Grant system for a multiyear project on the genetics, distribution, ecological modeling, captive propagation, and physiological limitations of the Texas troglobitic water slater, *Lirceolus smithii*. In June, a few specimens of unidentified *Lirceolus*, that were collected from Spring Lake, where brought into the SMARC to test holding containers to be used for experimentation.

Texas wild rice- During April 2014, mass-flowering and seed production of Texas wild rice was observed in Section B of the San Marcos River below University Drive Bridge downstream to the river bend before the Lion's Club Tube Rental. Given that mass-seed production in the San Marcos River is uncommon, a seed germination experiment was initiated to test the viability of wild-stock seeds, compare wild and refugia produced seed germination rates, and evaluate seasonal germination patterns. To date, germination rates for river collected seeds ranged from 19 to 95%. Preliminarily, wild collected Texas wild rice seeds do not appear to exhibit seasonal germination patterns presumably because abiotic conditions within the San Marcos River are relatively constant. Seeds produced at the SMARC have a relatively similar germination rates (44 to 96%) and also do not exhibit any seasonal germination pattern. On 24 May 2015, a flood event submerged the flowering Texas wild rice and washed away or scoured the flowers and seeds. During the last week of June, only a few Texas wild rice plants in river sections A, B, and C were observed with flowers or seeds. (CSF 7.12.5.4)

During January 2014, a study was initiated to evaluate the effects of varying flow rates on the phenology of Texas wild rice. Growth rates of Texas wild rice are measured every 2 weeks, and the plants monitored for flowering, seed production, tiller formation, and senescence. This study is on-going and currently flowering characteristics are being measured weekly. At 14 weeks, the total length (all stems and leaves) of the plants increased by more than 50% in tanks with flow, and more than doubled in total length in the tanks with the highest flow when compared to the lower flow tanks (Table 4). Since flowering began, pistil and stamen growth, seed production and flower senescence have been recorded weekly (Table 5). Seeds from the experimental plants are collected 2-3 times per week and monitored for germination. As of 31 December, 24,787 seeds (ca. 165 seeds per plant) were collected from the research plants with germination rates ranging from 31 to 100%. New flower development decreased in December while previously flowering stems have died (Table 5). From February to June 2015, fewer flowers were recorded and there was a substantial increase in the number of senescent flowering stems. (CSF 7.12.5.4)

Wade Wilson finished the final report on Texas wild rice genetics during January 2015. During June, Wade, Jeff Hutchinson, and Kenneth Ostrand submitted the Texas wild rice genetics manuscript, "Genetic diversity assessment of wild and refugia Texas wild rice (*Zizania texana*) populations, an endangered plant," to the journal Aquatic Botany. (CSF 7.12.5.4)

Table 4.- Mean growth rates (cm) and survival (%) for Texas wild rice (n = 45/treatment) grown under four water flow rates (i.e. 0.0, 0.1, 0.2, and 0.4 m/s) for 14 weeks.

Time (weeks)	Total length (cm; stems and leaves) Flow rate (m/s) 0.0	0.1	0.2	0.4
0	9.9 (0.9)	11.3 (1.3)	10.8 (1.3)	9.0 (1.0)
2	31.4 (3.1)	47.1 (7.3)	35.9 (4.6)	36.0 (4.3)
4	83.0 (6.6)	151.6 (19.1)	108.8 (13.0)	126.1 (13.9)
6	196.7 (16.2)	371.3 (39.2)	265.6 (29.2)	324.9 (31.8)
8	348.2 (29.8)	775.8 (71.2)	611.9 (53.2)	828.9 (70.5)
10	614.5 (42.4)	1372.0 (120.5)	1130.6 (94.8)	1747.6 (148.2)
12	835.7 (50.7)	1855.9 (151.0)	1640.2 (153.2)	2969.3 (233.3)
14	1068.5 (60.8)	2384.6 (185.2)	2122.9 (200.4)	4253.7 (326.0
Survival (14 wk)	100.0	97.8	100.0	91.0

Table 5. Phenological traits of Texas wild rice over 27 weeks for plants germinated from seeds and maintained at four different flow rates.

	Water flow (m/s) 0.0	0.1	0.2	0.4
First leaf blade	----------< 2 weeks after germination ----------			
Emergent stems	----------5 weeks ----------			11 weeks
Tiller development	----------13 weeks ----------			15 weeks
Flower (pistil)	17 weeks	16 weeks	15 weeks	16 weeks
Flower (stamen)	18 weeks	18 weeks	17 weeks	18 weeks
Complete flower	18 weeks	18 weeks	17 weeks	18 weeks
Mature seeds	22 weeks	20 weeks	20 weeks	22 weeks
Flower senescence	---------- 22 weeks ----------			
Stem senescence	27 weeks	25 weeks	26 weeks	26 weeks

Jeff Hutchinson initiated a study to evaluate several Texas wild rice planting patterns in the San Marcos River with individual and groups of Texas wild rice. Five plots were set up in the San Marcos River on 19 May 2014 to evaluate planting methods of Texas wild rice tillers, seedlings, and mature plants. The plots were setup to be monitored at 4 month intervals and, if successful, supplemental planting will occur in each plot and every 12 months thereafter. The goal is to develop a method to establish Texas wild rice in lower sections of the San Marcos River where it is uncommon. A 4-inch rainfall event on 25 May 2014 resulted in a 7 to 8 foot rise in water level

that caused the loss of 10% of the newly planted Texas wild rice. On 29 May 2014, all Texas wild rice plants that were scoured out during the 25 May flood were replaced. Two additional plots of Texas wild rice were established in the same general area on 12 June 2014 by Jeff Hutchinson and Josh Roberts. In these plots, 25 and 20 Texas wild rice seedling ca. 3 months old and 0.75 m in length were planted in a 0.25 m^2 clump. During monitoring on 21 June 2014, all the Texas wild rice, regardless of planting pattern, in each of the seven plots was intact and looked robust. During July, the plots were checked twice and the seedlings and a single Texas wild rice plant from a 2 ½ gallon pot were washed out or had not survived. Conversely, it appears that the tillers and mature plants had doubled in size based on length and width. The plots were measured during the Texas wild rice survey. At 4 months post-planting, all treatment plots had increased in area coverage (Table 6). On 7 October 2014, two supplemental plots of Texas wild rice were planted in the vicinity of the plots bringing the total number of plots to 12 (5 research plots and 7 supplemental plots). During the February 2015 evaluation, all treatments had increased in area coverage, and one plot of peat pots was no longer present. Survival rates were ≥ 80% for all treatments except seedlings. During the February 2015 evaluation, an additional four Texas wild rice plots were planted (5 research plots and 11 supplemental plots). In April 2015, Jeff Hutchinson and Leah Murray planted five additional experimental plots of Texas wild rice in the lower section of the San Marcos River. Texas wild rice plants were of various life history forms and ages. Plants were either seedlings grown from seeds or tillers and varied in age and size. Plants were grown in 2.5 gallon pots, 4 inch plastic pots, and peat pots. The plots established in April are intended to replicate 2014 efforts. The plots will be supplemented with additional planting throughout the summer and fall, if needed. Plots will be monitored every 4 months to evaluate protocols used to establishment Texas wild rice in the lower San Marcos reaches. The flood on 24 May 2015 likely scoured a large proportion of the planted Texas wild rice. A cursory survey of the plots on 25 June 2015 revealed a loss of plants and biomass due to the flood. However, the water was 2 feet deeper than normal and murkier making observations in the river difficult. A quantitative survey will be conducted as habitat conditions improve and allow for appropriate data collection. (CSF 7.12.5.4)

Table 6.- Texas wild rice planted in 2014 at various life history forms and ages and monitored for above ground biomass (area coverage) eight months post-planting. Table values represent the means (n = 5) and standard error for each treatment. Plants that did not survive were excluded from analysis.

Treatment	Mean area coverage (m^2) and SE			Survival (%)
(age at time of planting)	May 2014	Sept 2014	Feb 2015	8 mo post-planting
Tiller (unknown)	0.12 (0.02)	0.45 (0.04)	0.62 (0.08)	100
Seedlings (2 wk)	0.01 (<0.01)	0.14 (0.06)	0.32 (0.06)	60
8 weeks (peat pot)	0.21 (0.03)	1.26 (0.31)	1.69 (0.37)	80
6 months (plastic pot)	0.15 (0.03)	0.82 (0.18)	1.42 (0.36)	100
2 years (plastic pot)	0.47 (0.04)	0.56 (0.07)	1.04 (0.29)	80

Milkweed and Native Wildflowers – During March 2015, Jeff Hutchinson and Leah Murray received a $7,000 grant from the USFWS Texas Oklahoma Pollinator and Monarch Partnership to establish milkweed and native wildflower plots in the blackland prairie at the SMARC. Experimental plots were established in the blackland prairie to determine the best way to create more milkweed habitat for the monarch butterfly (till vs. no till, watering vs. no watering, seedlings vs. direct seeding). Volunteers with the SMARC Friends Group assisted with setting up the plots. During 21 to 28 April 2015, two 67 m line transects were monitored in each of the six 1- acre plots and all vegetation along the transects were recorded to document post-treatment cover. Application of the treatment, seeding, and plantings will occur in the plots during June to August. SMARC staff is also propagating milkweed for planting at Balcones National Wildlife Refuge. Seeds of antelope horn (*Asclepias asperula*; Asclepiadaceae) collected at Balcones NWR have germinated in the green house as of 20 March 2015. In addition, seeds of Green Milkweed Vine (*Matelea reticulate*; Asclepiadaceae) have germinated. Seeds from antelope horn were collected from sites in San Marcos, New Braunfels, and Inks Dam NFH in late May, and collections will continue for all milkweed species throughout the summer. Seeds taken from the green pods of antelope horn germinated within 5-6 days following potting. During May, there was record rainfall with rain occurring about every day of the month and the prairie soil is saturated. Once the soil dries up, treatments and planting will begin in the plots at SMARC. During June, seeds of milkweed and wildflowers were collected cataloged and stored for future restoration efforts. (CSF 7.12.5.4)

Native Aquatic Plants - Native aquatic and terrestrial plants currently are being propagated and maintained in the SMARC greenhouse in fiberglass tanks and under outdoor irrigation systems for the City of San Marcos's native aquatic plant restoration efforts. Plant transfers to the City of San Marcos began in March 2013 to meet the restoration goals outlined in the Edwards Aquifer Habitat Conservation Plan. In 2014, the SMARC provided a total of 12,551 aquatic and terrestrial plants including Texas wild rice to the City of San Marcos. In January 2015, spring flows increased enough to allow planting activities under the City's 10(a)(1)(B) permit to resume. As of 30 June 2015, 5,160 aquatic plants were provided to the City of San Marcos since the start of 2015. The City received 3,690 Texas wild rice seedlings, 1,085 creeping water primrose willow, 11 arrowhead, 223 water stargrass, and 45 Illinois pondweed plants for their restoration efforts. SMARC staff continues to maintain and propagate additional plants for future restoration work. (CSF 7.12.5.4)

During March to May, native seeds of riparian and terrestrial plants were collected from City of San Marcos properties along the San Marcos River. Seeds were collected from grasses, forbs, shrubs, and trees and are being stored at the SMARC in labeled containers. The seeds will be used for future planting. Volunteer planting days were held on 18 and 27 March at Rio Vista Park area, and a total of 530 plants were provided by the SMARC and planted in areas where non-native trees were removed (Table 7). The SMARC hosted its first Volunteer Planting Day to re-vegetate the San Marcos River Banks on Wednesday 18 March 2015 in coordination with the City of San Marcos near Playscape Park. Total attendance was approximately 30 people. The area will be fenced off for up to 10 years so plants can establish themselves. The SMARC hosted its second Volunteer Planting Day with 16 Phoenix High School students on 27 March 2015 on the San Marcos River in coordination with the City of San Marcos at Rio Vista Park.

Planting days were also held on 4, 18, and 24 April to plant native vegetation propagated at the SMARC. Planting areas were bare from recreational use and invasive plant removal efforts and presumably have a high erosion potential. On June 24, a planting day was held along the San Marcos River by I-35 to restore an eroded gully on a steep incline that was eroding into a stand of Texas wild rice during rain events. (CSF 7.12.5.4)

Table 7. Aquatic and terrestrial plants provided to the City of San Marcos for restoration work in and along the San Marcos River during 2015.

Aquatic Plants		
Arrowhead	*Sagittaria platyphylla*	117
Creeping primrose willow	*Ludwigia repens*	1,085
Illinois pondweed	*Potamogeton illinoensis*	45
Texas wild rice	*Zizania texana*	3,690
Water stargrass	*Heteranthera liebmannii*	223
		∑ = 5,160
Terrestrial Plants		
American elm	*Ulmus americana*	15
Anaqua	*Ehretia anacua*	22
Baby blue eyes	*Nemophila phacelioides*	20
Bald cypress	*Taxodium distichum*	35
Beautyberry	*Callicarpa americana*	8
Black willow	*Salix nigra*	20
Box elder	*Acer negundo*	31
Brushy bluestem	*Andropogon virginicus*	30
Buttonbush	*Cephalanthus occidentalis*	30
Cedar elm	Ulmus crassifolia	14
Cottonwood	*Populus deltoids*	14
Crow-foot sedge	*Carex crus-corvi*	25
Dewberry	*Rubus trivialis*	1
Eastern gamagrass	*Tripsacum dactyloides*	70
Eastern redbud	*Cercis canadensis*	6
Elderberry	*Sambucus canadensis*	52
Emory's sedge	*Carex emoryi*	110
Inland sea oats	*Chasmanthium latifolium*	55
Lean flatsedge	*Cyperus setigerus*	12
Mexican buckeye	*Ungnadia speciose*	12
Mexican plum	*Prunus mexicana*	11
Pecan	*Carya illinoinensis*	6

Pencil cactus	*Opuntia leptocaulis*	40
Pink mimosa	*Mimosa borealis*	12
Prickly pear cactus	*Opuntia macrorhiza*	15
Red buckeye	*Aesculus pavia*	8
Retama	*Parkinsonia aculeate*	12
Rough-leaf dogwood	*Cornus drummondii*	3
Switchgrass	*Panicum virgatum*	40
Sycamore	Platunus occidntalis	22
Texas mountain laurel	*Sophora secundiflora*	20
Texas rush	*Juncus texanus*	60
Trumpet creeper	*Campsis radicans*	4
		$\sum = 835$

Leadership in Science and Technology: Publications, extension activities/meetings, and presentations

During June, all SMARC biological staff were involved with data analysis and manuscript preparation or revision. So far this fiscal year, five articles have been published by peer-reviewed journals, three other articles have been accepted for publication, and nine articles have been submitted but not yet accepted. (CSF 5.3.7)

Publications- Randy Gibson and co-authors submitted a manuscript entitled "*Macroderoides spiniferus* (Digenea: Macroderoididae) metacercariae from the cranial bones of cypriniform fishes of West Texas Springs: A new threat to the survival of the federally protected minnow *Dionda diaboli* (Cyprinidae)" to the Journal of Parasitology during June. (CSF 5.3.7)

Lily Swanbrow, a graduate student at TSU, completed a thesis titled "Effects of turbidity on anti-predator response and foraging behavior in the fountain darter, *Etheostoma fonticola*." She successfully defended her thesis on 2 April 2012. A manuscript, co-authored with Kenneth Ostrand, has been completed and was submitted for publication in Transactions of the American Fisheries Society during April 2014. Unfortunately, the manuscript was not accepted. It was reformatted and submitted to the American Midland Naturalist in December 2014. The manuscript was accepted pending revision on 11 June 2015. (CSF 5.3.7)

Jeff Hutchinson and Kenneth Ostrand have completed a draft manuscript titled "Texas wild rice (*Zizania texana* Hitchc.) propagule production and survival in outdoor ponds as influenced by water depth and velocity". The manuscript was submitted during May to the Native Plants Journal. In October the article was accepted pending revisions. A revised manuscript addressing the reviewer's comments was submitted in December 2014. The article was returned and requires a few more editorial changes that are being made by Jeff Hutchinson. (CSF 5.3.7)

Wade Wilson (SWNARRC), Jeff Hutchinson, and Kenneth Ostrand submitted "Genetic diversity assessment of wild and refugia Texas wild rice (*Zizania texana*) populations, an endangered plant" to Aquatic Botany on 24 June 2015. (CSF 5.3.7)

Extension activities/meetings- On 17 June, Randy Gibson and Pete Diaz (TXFWCO), and Weston Nowlin (TSU) retrieved cotton cloth lures from inside orifices formed by flowing water through the eastern spillway of Spring Lake dam and no Comal Springs riffle beetles or other rare invertebrates were collected. This activity was performed on the request of Austin ES to help formulate the biological opinion associated with proposed dam repair.

On 18 June Kenneth Ostrand participated in the FTC conference call. Joel Bader has taken Linda Andreasen place as the FTC liaison in headquarters. The conference call was used to introduce Joel and for FTC leaders to field questions.

On 26 June 2015, Randy Gibson and Ken Ostrand attended meeting of the Edwards Aquifer Habitat Conservation Plan National Academy of Sciences (NAS) Recommendation Review Work Group to discuss NAS recommendations for monitoring of the Comal Springs riffle beetle.

On 24 June, Randy Gibson assisted Pete Diaz with salamander and invertebrate surveys of Salado Springs, Bell County, Texas, and collected rare and potentially undescribed species.

Staff Training

Juan Martinez traveled to Balcones NWR and completed Agriculture Tractor and Skid Steer training on 23 and 24 June.

Facilities and equipment

On 1 and 2 June, a National Safety Inspection was conducted at SMARC as part of a review of the Region 2's safety program by headquarters (HQ). The inspection team consisted of Chip Murphy (Region 9 Safety Manager and HQ Representative), Pat McDermott (Region 2 Safety Manager), and Steve McEvoy (Region 2 Safety Specialist). To prepare for the visit, SMARC staff worked to resolve safety issues found during the annual regional safety evaluation conducted by Pat McDermott (Region 2 Safety Officer) on 29 and 30 April. Jeff Hutchinson (CDSO), Valentin Cantu (Assistant CDSO), and Juan Martinez (maintenance mechanic with previous OSHA safety training) assisted the inspection team gain access to offices and buildings at the SMARC and FWCO facilities. .

During June, eight additional electrical outlets were installed in the greenhouse to facilitate operation of small pumps in twenty 1x1x4 foot tanks set up for aquatic plant research.

Randy Gibson, Dr. Glenn Longley (TSU; EARDC) and a graduate student, Laura McCalla, collaborated on a project to monitor the SMARC water wells and other water wells upstream and downstream of the site of the proposed Paso Robles housing development and golf course. This large-scale development occurs near two wells that supply all the water for the SMARC. Although initial land clearing was planned to start in December 2010, the project has been repeatedly delayed, allowing us to obtain baseline information on water quality prior to any development. It is unknown what effects the development and subsequent chemical usage (herbicides, pesticides, reuse water) by the golf course and home owners will have on the water quality of the aquifer and on listed aquatic species held at the SMARC. Water quality sampling

began during February 2011 and continued to July 2012. Some water samples from Hunter well contained relatively high levels of total coliform. This may indicate the influence of nearby recharge features that needs further investigation. Laura McCalla's thesis was completed in December 2012. The SMARC continues to constantly (every 15 min.) monitor temperature and conductivity in both wells. Monitoring has not detected any substantial changes that could represent possible pollution events. The EARDC received funding from Texas Commission on Environmental Quality –Supplemental Environmental Project Program to continue periodic monitoring of SMARC and City of San Marcos wells for two more years. From 8 to 12 June, water quality samples were collected from the SMARC and City of San Marcos wells. On 9 June, water samples were collected from the SMARC wells by the EAA for yearly analysis of contaminants and pharmaceuticals.

During June, Randy Gibson continued to manage computer software and troubleshoot operating and software issues at the SMARC.

On 9 June, Kenneth Ostrand and Valentin Cantu, began draining the 1-acre (47,650 ft^2) pond to begin the process of cleaning it. The pond is still in the process of drying after a series of thunderstorms in June. SMARC staff will use the assistance of and be trained by UNFH staff, who are more experienced in cleaning large ponds and have specialized equipment that will facilitate cleaning.

During June, Valentin Cantu led a crew of four to seven Community Service Restitution (CSR) volunteers to trim and cut grass at the SMARC. CSR volunteers built additional bird screens for raceways to protect Devil's River minnows (DRM) from bird predation, repaired pipe leaks to the DRM chlorination/sand filter system, acid washed and cleaned five of six DRM tank systems, assembled six amphipod traps with two different gravel substrates in raceways to test which would attract more amphipods, collected amphipods for listed salamanders and fish, pressure washed additional diversion spring net components, dug down behind the shop until the 2" municipal water pipeline was found so that a safety shower could be plumbed behind the shop, removed a faulty drum filter motor and replaced it with a new backup motor, cleaned the battery terminals to a tractor to get it started, removed a large outdated USFWS sign secured by difficult to remove rusty bolts, and repaired the pull cord on a push mower.

During June, construction continued on the new main office parking lot and on the gravel road around the PAD, Barton Springs, and Greenhouse buildings. The project is being completed by M B Home Construction Service. During June, excavation and installation of engineered fill for the parking lot was completed. The concrete for curb, parking lot, and sidewalk was poured. The existing gravel road to and around Greenhouse was near completion by the end of the month. Needed rains during May and June has slowed completion of the project.

Visitors

On 16 June, the Southwestern Fish Health Unit visited the SMARC to conduct an annual Fish Health Survey on the facility's listed and non-listed fish and salamanders.

On 17 June, Valentin Cantu provided a tour for a student.

On 10 June, Randy Gibson led an entomology walk through the SMARC prairie for the Master Naturalists and home school students and discussed pollinators and invertebrate diversity.

On 22 June, Matt Paterson from NCTC began his week-long detail at the SMARC. While at the SMARC, Matt assisted with animal and plant collection and care. He also spent a significant amount of time reviewing planning documents to assist with NCTC course development relating to refugia and conservation programs.