U.S. Army Engineer Research and Development Center, Lewisville Aquatic Ecosystem Research Facility
University of North Texas, Institute of Applied Science

Big Spring Vegetation Management

Status Report

Aaron N. Schad, Lynde L. Dodd, Gary O. Dick, and Sam Atkinson

January 2017

Table of Contents

Background

In 2013, after acquisition of properties within the Great Trinity Forest, the City of Dallas (COD) requested the University of North Texas (UNT), with advice from the Lewisville Aquatic Ecosystem Research Facility (LAERF), develop, implement, and supervise a vegetation management plan for one of the only natural springs remaining in its urban footprint and located within acquired areas, Big Spring. The ecological and archeological or anthropological context of Big Spring and its surrounding areas is far-reaching, dating back 1,200 years to Native American inhabitants and to the eventual first European settlers of Dallas, thus highlighting the need for COD, with assistance from stakeholders, managers, and conservationists, to preserve this unique ecosystem and historic site. Although several areas necessitate conservation management plans in the bottomland hardwood forests of the Great Trinity Forest, the vegetation management plan focused on the area encompassed by the Big Spring Historic and Environmental Conservation Easement (Figure 1, approximately 15.42 acres, based upon City of Dallas' Department of Public Works' boundary description for the Big Spring Historic and Environmental Conservation Easement, Holt, 1-17-2014).

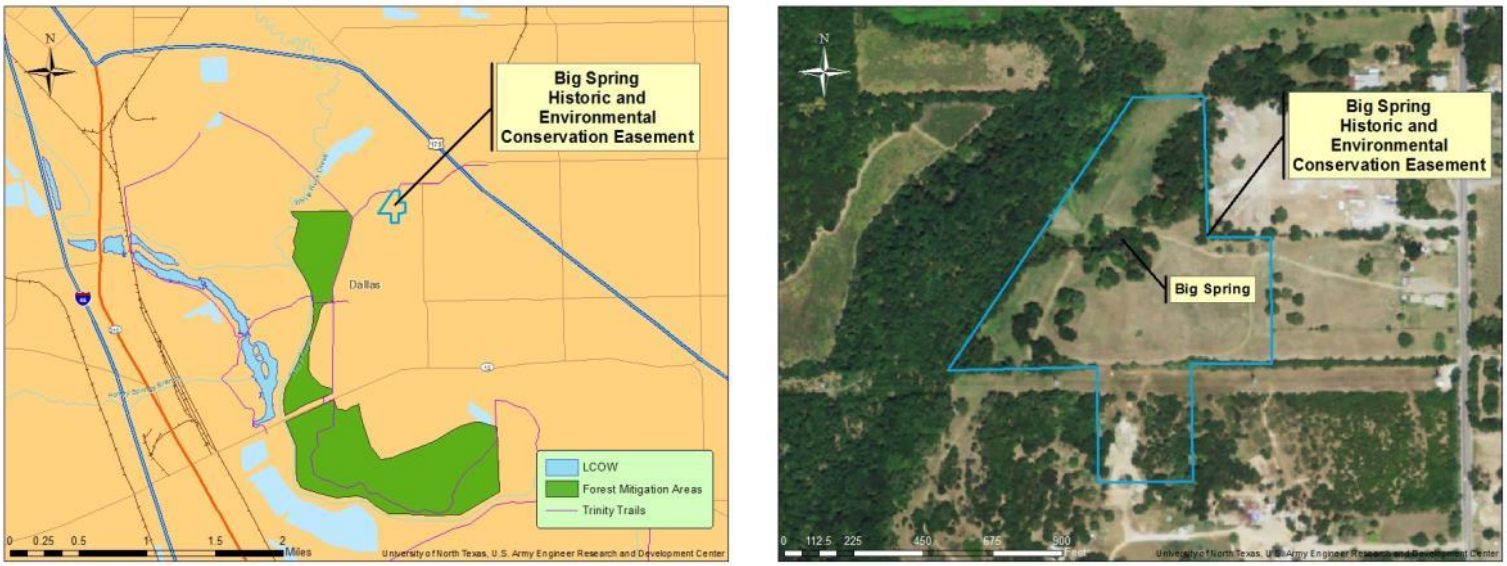

Figure 1. Big Spring Historic and Environmental Conservation Easement, Dallas, TX.

Stakeholders associated with the preservation of Big Spring include the Flora and Fauna (or Naturalist) Committee, represented by members of the Texas Master Naturalists, Texas Stream Team, Texas Parks and Wildlife, the Connemara Conservancy, and the Pemberton family, among others. In addition to interest in preservation and restoration of Big Spring, these groups possessed preliminary baseline biotic and abiotic data valuable to decision-making on management approaches best suited for the site.

To begin formulating a vegetation management plan for Big Spring, in 2014 UNT researchers, with technical advice from LAERF, assessed available baseline biotic and abiotic data and conducted biological surveys (vegetation community structure, invertebrates, and fish) of the project area (Appendix A). Additionally, UNT/LAERF gathered and examined stakeholder opinions of applicable factors which could affect preservation and restoration of Big Spring. Several meetings, discussions, and management plan

peer reviews were accomplished with environmental managers, technical advisors, stakeholders, and COD personnel to develop plan details.

While the ecosystem management plan for this distinctive ecosystem was extensive, the primary objective of UNT/LAERF's participation was the management and conservation of Big Spring's vegetation communities and associated biota. Many factors, especially in an urban setting, can detrimentally influence high-quality biodiversity, including invasive species, erosion, sedimentation, eutrophication due to run-off, development, human interactions, flooding, and vegetation control. All of these were central to Big Spring's ecosystem management plan. The general approach to Big Spring's management plan is one which is adaptive. This means the timing of maintenance (e.g., mowing), invasive species management, and restoration or plant establishment efforts may change through time as plant community structure changes/progresses, with the documentation of restoration results, disturbances and various human interactions, and other factors which may affect management outcomes.

After the management plan was submitted to and accepted by COD from UNT/LAERF, implementation has been ongoing through 2016. To date, actions have focused on mowing coordination, invasive species management, and native plantings (Table 1). This report details specific vegetation management strategies and results as of January 2017 along with future efforts for the Big Spring Historic and Environmental Conservation Easement, Dallas, Texas (Figure 1). These management activities were based upon an adaptive management approach through minimizing disturbances, invasive species control, native species installation, and conservation management. The long-term goal is to both protect the area from disturbances and promote a diversity of habitat types to support a sustainable, healthy, and preserved ecosystem.

Table 1. 2014-2016 Big Spring vegetation management schedule and tasks

Date	Task
September 2013 - January 2014	Big Spring, Texas Horse Park, and COD cooperative support proposals submitted by UNT/LAERF to COD, Big Spring accepted; POC list developed
February 2014	Initial project meeting with COD and naturalists or stakeholders at Dallas City Hall, questionnaires developed and provided to stakeholders
March 2014	Big Spring site visit; initial biological monitoring including vegetation, macroinvertebrates, and fish
April - May 2014	Continued detailed biological monitoring (fish, macroinvertebrates, and vegetation); Stakeholder questionnaires collected, organized, and utilized; Site meeting with UNT/LAERF, COD, and stakeholders with presentation on biological monitoring and development of the collaborative Big Spring vegetation management plan
June 2014	UNT/LAERF Big Spring management plan draft developed and submitted to COD
July 2014	Coordinated COD vegetation management, delineated mowing area and observed implementation; CCFF wildfire proposal developed and submitted to COD
August 2014	CCFF wildfire proposal revised for COD; Big Spring management plan revised based upon comments from COD and stakeholders; assisted COD with tree species identification and allocation for the Texas Discovery Gardens as Fair Park; Met with COD about "no name" pond and provided recommendations and submitted a proposal to COD for the restitution of this pond
September 2014	Met with COD personnel at DFE LCOW to discuss O&M; Big Spring vegetation management plan revised and draft submitted to COD

Date	Task
October 2014	Advised, coordinated, and implemented plant relocation event from "Borrow A" to LAERF for propagation and quarantine and eventually for establishment in Great Trinity Forest; provided recommendations and insight on potential reseeding of "Borrow A"
November 2014	Big Spring vegetation management plan revised and draft submitted to COD; continued propagation of native plants for installation to meet project goals
December 2014	Meeting with COD and stakeholders to finalize management plan; continued propagation of native plants for installation to meet project goals
January 2015	Final management plan submitted to and accepted by COD; continued propagation of native plants for installation to meet project goals
February 2015	Spring vegetation management event at Big Spring organized with UNT/LAERF, COD, and naturalist stakeholders; continued propagation of native plants for installation to meet project goals
March 2015	Ecosystem management task schedule submitted to COD; Spring (March 17-18) vegetation management event with COD and naturalist stakeholders
Spring 2015	Invasive species management and select native species installations (erosion control and open niches by invasive removal); March 17-19
Summer 2015	Invasive species management, mowing coordination, and recommendations; monitor management response
Autumn / winter 2015	Invasive species management and native species installations (November 2015 Master Naturalist/UNT planting); monitor management response
Spring 2016	New UNT/LAERF vegetation management proposal submitted to COD and accepted for work through 2018
July 2016	Vegetation assessment – invasive species and survival and fitness of those planted during 2015 MN planting
August 2016	Big Spring seasonal meeting – water quality, signage, vegetation management updates, channels, mowing, feral hog abatement discussed
September 2016	Vegetation assessment – invasive species and survival and fitness of those planted during 2015 MN planting, mowing requirements assessed
October 2016	Vegetation assessment – invasive species and survival and fitness of those planted during 2015 MN planting, mowing requirements assessed, mowing deemed not required at the time
November 2016	Big Spring seasonal meeting: water quality, vegetation management updates, feral hog abatement discussed, planting postponed

Vegetation Management

Invasive species management

After the final management plan was submitted by UNT/LAERF and accepted by COD in January 2015, one of the first vegetation management goals at Big Spring was to address nuisance, invasive species. In general, nuisance species eradication is difficult; therefore, the strategy with invasive species management at Big Spring was to reduce nuisance species dominance while promoting native species dominance. Table 2 gives the invasive species of concern at Big Spring beginning in 2014.

Table 2. Nuisance aquatic, herbaceous, and woody plant species of concern for management at Big Spring, Dallas, TX.

Scientific name	Common name
Ambrosia trifida	Giant ragweed
Carduus nutans	Nodding plumeless thistle
Convolvulus arvensis	Field bindweed
Cynodon dactylon	Bermudagrass
Ligustrum sinense	Chinese privet
Lonicera japonica	Japanese honeysuckle
Melia azedarach	Chinaberrytree
Nasturtium officinale	Watercress
Pyrus calleryana	Callery pear
Sorghum halepense	Johnsongrass
Torillis arvensis	Spreading hedgeparsley
Triadica sebifera	Chinese tallow
Vitex agnus-castus	Lilac chaste tree

In spring of 2015, the first invasive species management methods were initiated by UNT/LAERF at Big Spring. The primary nuisance species targets at this time, based upon dominance and phenology, included the aquatic plant watercress, the herbaceous species nodding plumeless thistle, and marking woody species such as Chinese privet, Chinaberrytree, Japanese honeysuckle, and Chinese tallow (Figure 2). Watercress was hand-removed from the spring and associated aquatic areas, rinsed of fauna, and disposed of at LAERF (30+ 15 gallon tubs). Nodding plumeless thistle (a biennial) was managed by hand or hand-tools, by digging up the plant and associated taproot (250+ plants) before plants could set seed. Use of selective herbicide for these species was determined not necessary at this point. Invasive woody vegetation was flagged for later removal/treatment (Chinese tallow, Chinese privet, Chinaberrytree, Japanese honeysuckle, lilac chaste tree, and Callery pear).

***Nasturtium officinale* – watercress**

***Carduus nutans* – nodding plumeless thistle**

***Lonicera japonica* – Japanese honeysuckle**

***Vitex agnus-castus* – lilac chaste tree**

***Ligustrum sinense* – Chinese privet**

***Melia azedarach* – Chinaberrytree**

***Triadica sebifera* – Chinese tallow**

Figure 2. Aquatic, herbaceous, and woody invasive species of interest for management at Big Spring, Dallas, TX.

In summer of 2015, invasive species management focused on physical removal of spreading hedgeparsley and herbicide treatments of Bermudagrass and exotic woody vegetation. One of the most dominant invasive species at Big Spring in 2014, spreading hedgeparsley is an exotic herbaceous annual, making it a good candidate for physical or mechanical removal. Flowering in early summer, UNT/LAERF's method was to cut/mow (weed-eaters) the plant after flowering, but before it went to seed, thus producing little or less viable seed for subsequent generations and reducing its overall dominance.

Physical management of herbaceous species spreading hedgeparsley and nodding plumeless thistle were successful, with substantially reduced populations and dominance of each species in and around Big Spring. These species will continue to be monitored and selectively managed by UNT/LAERF in 2017-2018 as needed. Hand management of watercress was less successful, with recovery of the population within the spring area after removal, although dominance has been reduced especially in the largest pool area. Management efforts on watercress, to decrease its dominance, will continue through 2018.

In July 2015, herbicide injections and foliar applications of an aquatic formulation of the herbicide glyphosate were made on select exotic, invasive vegetation around Big Spring, TX, to test efficacy. One mature Chinaberrytree and four mature Chinese tallow trees were injected. Foliar applications were also made to several exotic pear saplings around the spring. In addition, three 100 x 100-ft areas of Bermudagrass were treated above the spring to ascertain efficacy. Bermudagrass treatments were expected to create areas for increased native recruitment as well as provide sites for native seeding/planting efforts (Figure 3). Foliar applications of Bermudagrass and Callery pear were successful, controlling most of the target vegetation. However, herbicide injections on larger woody vegetation (e.g., Chinaberrytree, Chinese tallow) were not. Alternative methods will be reviewed and those compatible with project goals will be evaluated in future efforts.

Figure 3. Herbicide treated Bermudagrass plots, August 2015, Big Spring, Dallas, TX.

Plant rescue/relocation

In September 2014, with assistance from Master Naturalists, UNT/LAERF participated in a native plant rescue and relocation effort in lands slated for dirt "borrowing" adjacent to Big Spring (Figure 4). Species of interest to rescue in the area included green milkweed, splitbeard bluestem, silver bluestem, purpletop tridens, purple passionflower, *Bouchea* sp., Partridge pea, and *Gaillardia* sp. During the effort, stakeholders and Master Naturalists collected mature plants and other propagules (diggings, cuttings, and seeds), which were then brought to LAERF for propagation and quarantine to minimize invasive species introduction and spread. Plants were grown to maturity and were eventually installed, with additional species, in 2015 at appropriate times during the year.

Figure 4. UNT/LAERF, Master Naturalists, and other interested stakeholders rescuing native vegetation, primarily green milkweed, to be relocated to Big Spring, Dallas, TX.

Native plantings

Native species for succession supplementation, establishment, and restoration were first installed at the Big Spring area by UNT/LAERF and stakeholders in spring 2015, following invasive species management efforts (Table 3). Species were installed at a "test" level (larger-scale plantings were done in November 2015). The primary focus of native plantings was in (a) open niches or holes left by invasive species management and (b) areas in need to soft-armoring erosion control (Figure 5). Grasses and sunflowers were planted in divots left by nodding plumeless thistle removal. Silver bluestem and Indian blanket seeds were broadcast in certain divots left from nodding plumeless thistle removal. Planting also occurred directly by the spring for erosion control and vegetation supplementation: woody vegetation was planted within buffer zone (set by management plan) of spring; American beautyberry and river plum was planted on west side in woods of project footprint; Virginia wildrye, elderberry, inland sea oats were planted along west side of spring at ridge; 25 plugs of inland sea oats were planted in an erosion prone area on west side of spring; the remaining grasses were planted on the terrace to spring slope.

Table 3. Herbaceous and woody plant species native to north Texas and planted for vegetation community establishment, succession supplements, restoration, or erosion control at Big Spring, Dallas, TX in March 2015.

Scientific name	Common name	Terrace	Spring
Herbaceous			
Andropogon gerardii	Big bluestem	3	-
Asclepias viridis	Green milkweed	16	-
Bouteloua dactyloides	Buffalograss	12	12
Chasmanthium latifolium	Inland sea oats	12	25
Elymus virginicus	Virginia wildrye	-	12
Helianthus grosseserratus	Sawtooth sunflower	6	-
Helianthus maximiliani	Maximilian sunflower	6	-
Nassella leucotricha	Texas wintergrass	-	12
Schizachyrium scoparium	Little bluestem	6	-
Tripsacum dactyloides	Eastern gamagrass	12	12
Woody			
Callicarpa americana	American beautyberry	-	5
Cercis canadensis	Eastern redbud	-	2
Cornus drummondii	Roughleaf dogwood	-	5
Lonicera sempervirens	Coral honeysuckle	-	4
Prunus mexicana	Mexican plum	-	1
Prunus rivularis	River plum	-	5
Sambucus nigra	Elderberry	-	10
Symphoricarpos orbiculatus	Coralberry	-	5
Viburnum rufidulum	Rusty blackhaw	-	1

Figure 5. Eroding slope (red arrows) planted for vegetative soft armoring at Big Spring, Dallas, TX

In November 2015, a larger-scale planting effort was accomplished in all areas around the Big Spring project footprint using plants from the borrow area rescue effort as well as other native species collected from in and around the project area (Figure 6). The planting was a joint effort between UNT/LAERF and North Texas Master Naturalist (NTMN) chapter. The planting focused on green milkweed, although 16 native herbaceous and 11 native woody species were installed during the efforts (Table 4). The project area was divided into six sections based upon habitat, elevation, open canopy, and vegetation community structure. These characteristics determined where plantings would occur and what species would go where. For example, in Figure 6, sections 2 and 6 would have no plantings because section 2 was already densely vegetation with an acceptably diverse suite of species, while section 6 contains the sensitive archeological site. Sections 1, 3, and 4 were at low elevations, and thus more likely to be higher in soil moisture and flood probability. Section 5, or the "upper terrace", was represented by more dry, open, upland habitat. Herbaceous vegetation was planted throughout the project area. Woody vegetation was planted throughout Sections 1, 3, and 4, but only around the perimeter of Section 5 to supplement succession and recruitment while continuing to promote prairie-like habitat in this section. Table 4 gives species and locations of plantings for each individual species. Plants were installed by hand-digging appropriate sized holes based upon pot size, de-potting and loosening plant root-balls, placing plants so the base of the above-ground portion of the plant was even with the ground, back-filling with on-site soils to minimize air spaces, and watering once after planting (Figures 7 and 8). A total of 34 different species were planted at Big Spring during the two 2015 planting events.

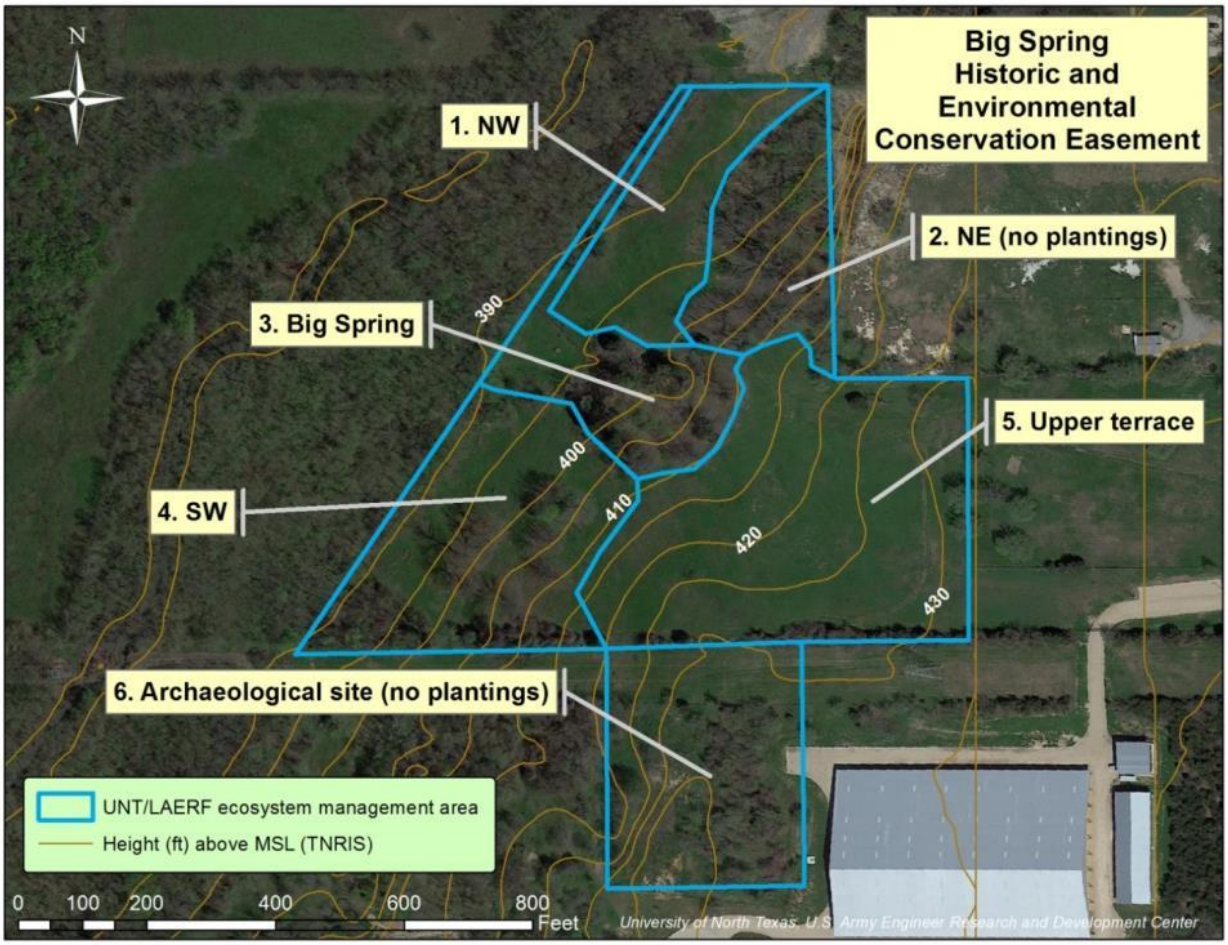

Figure 6. Big Spring Historic and Environmental Conservation Easement elevations (height ft above MSL – TNRIS) and 2015 planting sections, Dallas, TX. Northern Blackland Prairie – Level IV ecoregion of Texas (EPA, TCEQ, USGS, UTBEG 2012).

Table 4. Containerized plant species for vegetation community establishment, succession supplementation, and erosion control at the Big Spring Historic and Environmental Conservation Easement, Dallas, TX, with corresponding, targeted planting locations, in winter 2015 – 2016. All vegetation native to and collected from the Trinity River watershed in the Northern Blackland Prairie – Level IV ecoregion of Texas (EPA, TCEQ, USGS, UTBEG 2012).

Scientific name	Common name	Planting section	Numbers
	Herbaceous		
Andropogon gerardii	Big bluestem	5	15
Andropogon virginicus	Broomsedge bluestem	1,4,5	30
Asclepias viridis	Green milkweed	4,5	200
Bothriochloa laguroides	Silver bluestem	5	50
Bouteloua curtipendula	Side-oats grama	5	15
Bouteloua dactyloides	Buffalograss	5	15
Glandularia bipinnatifida	Dakota mock vervain	5	15
Helianthus grosseserratus	Sawtooth sunflower	5	15
Helianthus maximiliani	Maximilian sunflower	5	15

Hibiscus laevis	Hibiscus	1,4	15
Oenothera speciosa	Pinkladies	1,5	15
Schizachyrium scoparium	Little bluestem	5	15
Sorghastrum nutans	Indiangrass	5	15
Tridens albescens	White tridens	5	15
Tridens flavus	Purpletop tridens	5	50
Tripsacum dactyloides	Eastern gamagrass	1,4	15
	Woody		
Callicarpa americana	American beautyberry	4,5	12
Cercis canadensis	Eastern redbud	5	9
Cornus drummondii	Roughleaf dogwood	1,4,5	6
Diospyros virginiana	Common persimmon	5	18
Morus rubra	Red mulberry	1,4	50
Prunus mexicana	Mexican plum	1,4	9
Quercus macrocarpa	Bur oak	1,4	9
Quercus stellata	Post oak	5	9
Rhus lanceolata	Flameleaf sumac	5	12
Sapindus saponaria	Western soapberry	1,4,5	9
Symphoricarpos orbiculatus	Coralberry	1,3-5	6

Figure 7. Planted post oak (*Quercus stellata*) during the November 2015 UNT/LAERF, COD, MN planting event with volunteer planters.

Figure 8. Planted green milkweed (*Asclepias viridis* – left) and planted green milkweed cluster (right) during the November 2015 UNT/LAERF, COD, MN planting event.

Trinity River dynamics post-planting

The bottomland hardwood forests of the Trinity River in Dallas County, including the Big Spring area, were subject to historic flooding in 2015. From April 2015 to April 2016, 21 of the top 120 historic crests since 1908 occurred (Table 5, USGS, and NOAA). To put this in perspective, 17.5% of all recorded cresting events in about a 110 year period happened in 2015, rather than the historic 1% prior to this year; this represented a 1,750% increase in what is normally expected in terms of inundation and overbanking. This is an outlier and obviously had impacts on both the ecology and silvics within Big Spring, including plant establishment. However, crests were not the only attribute from flooding which affected plant establishment and growth. Water depth, inundation duration, and substantial sedimentation also impacted plant responses. Figures 9-11 illustrates this dynamic (USGS). Typically, areas around Big Spring start to become inundated when the Trinity River at Dallas (USGS) gauge height surpasses approximately 30-ft. Meaning from May-July 2015 some plants at lower elevations (sections 1, 3, and 4) were inundated for approximately 6-10 weeks and from October-December 2015 for 4-6 weeks.

Table 5. Recent crests (2015-2016) of the Trinity River at Dallas, including date, river crest height in feet, and historic rank of top 120 since 1908.

Spring 2015			Summer 2015			Autumn 2015			Winter/spring 2016		
Date	ft	Rank	Date	ft	Rank	Date	ft	Rank	Date	ft	Rank
4/25/2015	30.69	111	6/23/2015	38.25	40	10/24/2015	38.48	33	1/8/2016	35.00	63
5/9/2015	32.42	85	7/9/2015	30.72	109	10/31/2015	36.83	54	1/15/2016	31.13	104
5/11/2015	36.03	57	7/11/2015	30.12	117	11/18/2015	30.85	107	1/20/2016	30.35	114
5/18/2015	38.70	28				11/28/2015	41.08	15	2/24/2016	34.25	73
5/29/2015	41.98	10				12/14/2015	35.13	62	3/10/2016	34.03	75
						12/28/2015	38.30	36	3/18/2016	32.26	88
									3/25/2016	32.00	93

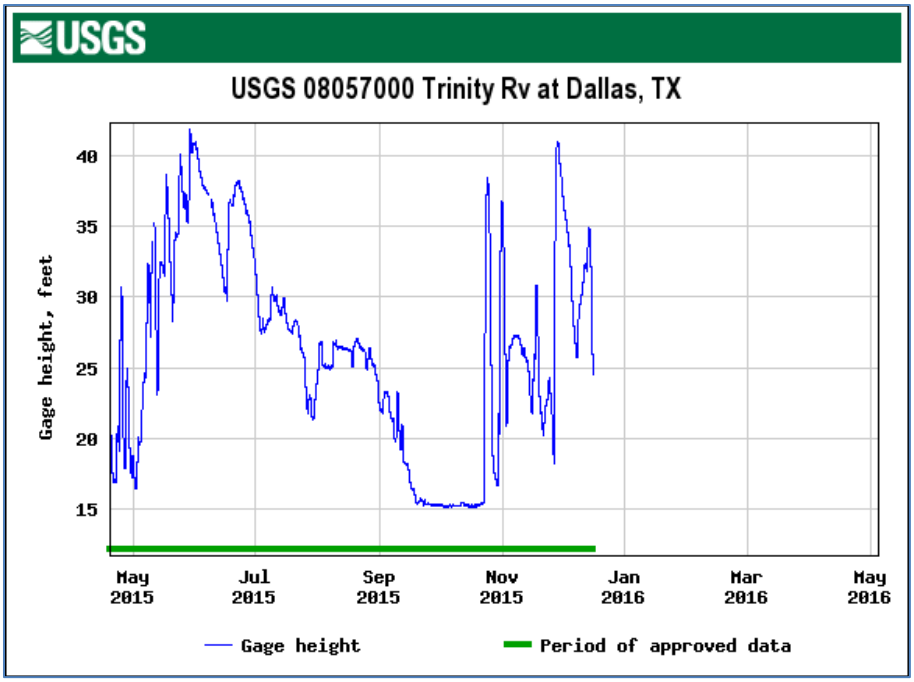

Figure 9. USGS Trinity River at Dallas gage height from April 2015 – May 2016; Big Spring areas generally receive overbanking waters at 30-ft (USGS).

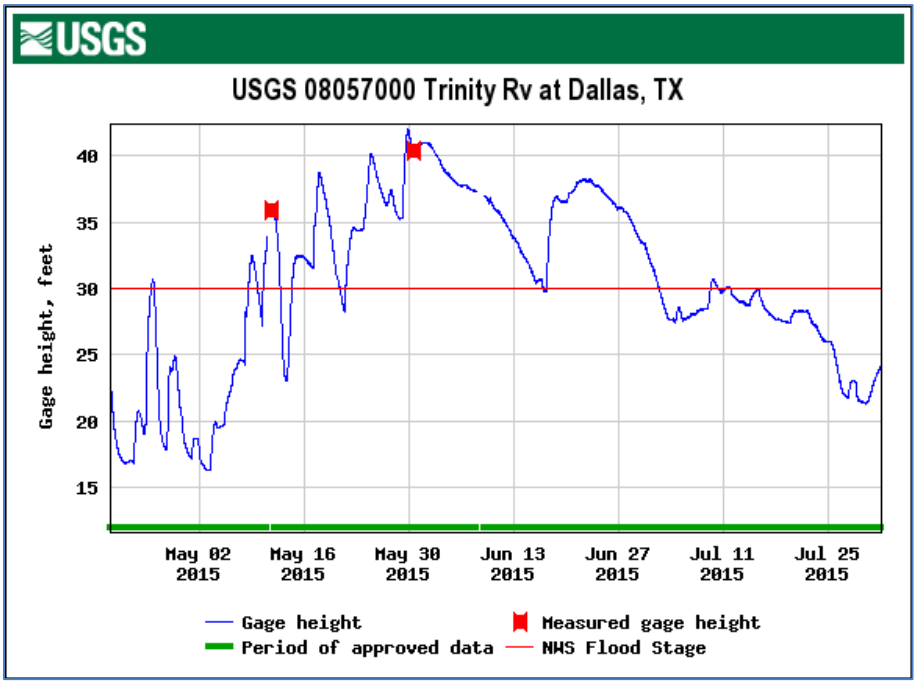

Figure 10. USGS Trinity River at Dallas gage height from April 2015 – July 2015; Big Spring areas generally receive overbanking waters at 30-ft. Plants were potentially inundated for 6-10 weeks during this period (USGS).

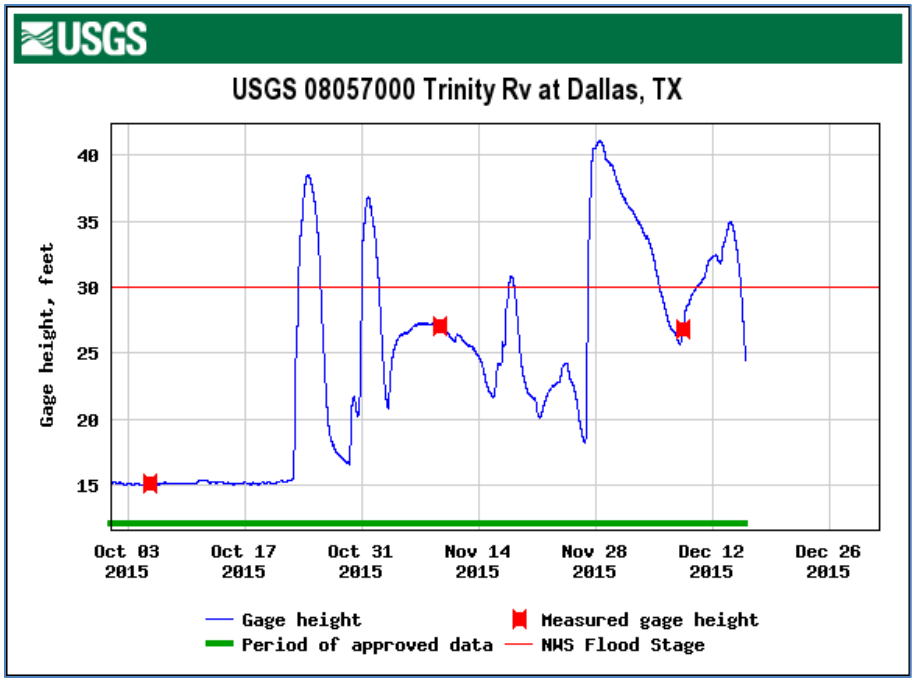

Figure 11. USGS Trinity River at Dallas gage height from October 2015 – December 2015; Big Spring area generally receives overbanking waters at 30-ft. Plants were potentially inundated for 4-6 weeks during this period (USGS).

Planting assessments

A total of 34 different species were planted throughout the Big Spring project footprint in 2015. These plantings were assessed during 2016 to aid in species selection for future plantings in 2017 and 2018. Although mortality increased at the extreme end of lower elevation at Big Spring, most likely because of the inundation from the Trinity River flooding events, certain species were able to survive in all sections of the planting efforts. The most successful species during observations throughout 2016 included green milkweed, sumac, eastern redbud, sawtooth and Maximilian sunflowers, Mexican plum, big bluestem, western soapberry, and bur and post oaks (Figures 12 and 13). These species will be the primary focus of future planting efforts. However, it is typical for perennial graminoids during their first year of establishment not to produce robust or even observable above ground biomass, which may have been the case in 2016; thus these species will continue to be candidates for native plant establishment in the Big Spring project area in 2017-2018. Table 6 gives the full species candidate list for plantings in 2017-2018, although some maybe added pending approval from COD and stakeholders.

August 2015

October 2015

July 2016

July 2016

Figure 12. Planted sawtooth sunflower (*Helianthus grosseserratus*) during spring 2015 event (top row, summer 2015); flowering and seeding green milkweed (*Asclepias viridis*) thriving in July 2016, planted during the November 2015 UNT/LAERF, COD, MN planting event (middle row); eastern redbud (*Cercis Canadensis*) (bottom left) and sunflowers (bottom right) planted in November 2015, thriving in July 2016

Figure 13. Planted Big bluestem (*Andropogon gerardii*) during the November 2015 UNT/LAERF, COD, MN planting event (left), same individual plant flowering and seeding in July 2016 (right).

Table 6. Containerized plant species for vegetation community establishment, succession supplementation, and erosion control at the Big Spring Historic and Environmental Conservation Easement, Dallas, TX, with corresponding, targeted planting locations, for future plantings in 2017-2018.

Scientific name	Common name	Planting section
Herbaceous		
Andropogon gerardii	Big bluestem	5
Andropogon virginicus	Broomsedge bluestem	1,4,5
Asclepias viridis	Green milkweed	4,5
Bouteloua dactyloides	Buffalograss	5
Glandularia bipinnatifida	Dakota mock vervain	5
Helianthus grosseserratus	Sawtooth sunflower	5
Helianthus maximiliani	Maximilian sunflower	5
Hibiscus laevis	Hibiscus	1,4
Oenothera speciosa	Pinkladies	1,5
Panicum virgatum	Switchgrass	5
Schizachyrium scoparium	Little bluestem	5
Silphium radula	Roughstem rosinweed	1,4,5
Sorghastrum nutans	Indiangrass	5
Tridens albescens	White tridens	5
Tridens flavus	Purpletop tridens	5
Tripsacum dactyloides	Eastern gamagrass	1,4

Vernonia fasciculata	Prairie ironweed	5
Woody		
Callicarpa americana	American beautyberry	4,5
Cercis canadensis	Eastern redbud	5
Cornus drummondii	Roughleaf dogwood	1,4,5
Diospyros virginiana	Common persimmon	5
Morus rubra	Red mulberry	1,4
Prunus mexicana	Mexican plum	1,4
Quercus macrocarpa	Bur oak	1,4
Quercus stellata	Post oak	5
Symphoricarpos orbiculatus	Coralberry	1,3-5
Ungnadia speciosa	Mexican buckeye	1,4,5
Viburnum rufidulum	Rusty blackhaw viburnum	1,4,5

Mowing and community development

As a part of the initial vegetation management plan at Big Spring, it was UNT/LAERF's responsibility to assess mowing requirements, necessity, and demarcations with the general idea to be used only as a physical technique to remove or reduce the occurrence of nuisance or invasive vegetation, increase habitat diversity, or create small access paths for researchers and educational purposes. Before 2014, the land in and around Big Spring was mowed frequently, generally more than once annually. Between 2014 and 2017, there have been two coordinated (COD/UNT/LAERF) mowing efforts, one in August 2014 and one in October 2015, only focused on the "upper terrace" section of Big Spring. These mowing efforts were selective, avoiding beneficial native volunteer and planted vegetation, and made at an 8 - 10" height (Figure 14). A mow in 2016 was deemed to not be necessary as it would be a detriment to native vegetation recruitment and plantings which had begun to establish and Bermudagrass, the primary invasive species in the upper terrace, would perhaps benefit from a mow. The necessity of annual selective mows will continued to be considered based upon vegetation community and habitat diversity. As of January 2017, decreasing the mowing schedule and making it more selective has allowed for increased native vegetation recruitment around the project area to occur (Figure 15).

Figure 14. Big Spring selective mow of the upper terrace section in October 2015

2014

2015

2016

Figure 15. Big Spring 2014-2016 emergent or upland areas (left) and aquatic area (right) vegetation community structure development through time after previous (2014 and prior) normal manicuring mowing schedule

UNT/LAERF 2014-2016 Management Summary

1. Schedule
    a. January 2014 – Dec. 31 2015
2. Scope of work
    a. Document baseline information for use in management of the spring, including historical and current biological monitoring (2014)
    b. Develop a long-term ecosystem management plan for Big Spring and surrounding area (2014)
    c. Implement management plan and monitor progress of preservation of the spring (2015)

UNT/LAERF 2017-2017 Proposed Management

1. Schedule
    a. December 2016 – December 2018
2. Scope of work
    a. Implement management plan and seasonally monitor preservation and ecological function of Big Spring
        i. Nuisance or invasive species (management and control)
            1. Continue selective management of invasive species. Hand-remove watercress from spring and associated aquatic areas. Manage invasive nodding plumeless thistle by hand or hand-tools. Target invasive woody vegetation for removal (Chinese tallow, Chinese privet, Chinaberrytree, Japanese honeysuckle, lilac chaste tree, and Callery pear). Monitor summer phenological candidates, including Johnsongrass, spreading hedgeparsley, and Bermudagrass, as well as autumn and winter phenological candidates such as woody exotic vegetation and giant ragweed.
        ii. Mowing coordination
            1. Assess mowing requirements, necessity, and demarcations. If mowing is required, timing and height is to-be-determined by target species' life history and phenology, usually late summer / early autumn at 8 - 10" height.
        iii. Native species (succession supplementation, establishment, and restoration)
            1. Full-scale planting efforts will be completed on an as needed basis. Native species candidates in Table 6; more species can be added to this list as deemed appropriate for Big Spring's ecosystem, including seeding mixes, such as the Native American Seed Blackland Prairie Mix.
        iv. Monitor previous native plantings to guide future full-scale plantings.

Points of Contact

Aaron Schad
Research Biologist
Lewisville Aquatic Ecosystem Research Facility
201 E. Jones Street
Lewisville, TX 75057
210-379-2936
Aaron.Schad@unt.edu
anschad@gmail.com

Lynde Dodd
USACE technical advisor / Research Biologist
Lewisville Aquatic Ecosystem Research Facility
201 E. Jones Street
Lewisville, TX 75057
972-436-2215
lyndedodd@laerf.org

Dr. Gary Dick
USACE technical advisor / Research Ecologist
Lewisville Aquatic Ecosystem Research Facility
201 E. Jones Street
Lewisville, TX 75057
972-436-2215
garydick@laerf.org

Appendix A

Taxa collected during May 2014 fauna sampling efforts in aquatic areas at Big Spring, Dallas, TX. D-nets were used for macroinvertebrate (and similar-sized organisms) sampling; Backpack electroshock unit was used to sample fish.

Order	Family	Genus
Actinopterygii	Poeciliidae	*Gambusia*
Amphipoda	Dogielinotidae	*Hyallela*
Bivalvia (class)	Corbiculidae	Not confirmed
Coleoptera	Ptilodactylidae	Not confirmed
Decapoda	Cambaridae	*Baricambarus*
Diptera	Chironomidae	Chironominae (SF)
Diptera	Chironomidae	Tanypodinae (SF)
Diptera	Ceratopogonidae	*Bezzia*
Gastropoda	Physidae	*Physa*
Gastropoda	Lymnaeidae	*Fossaria*
Hemiptera	Corixidae	*Hesperocorixa*
Odonata	Cordulidae	*Neurocordulia*
Odonata	Coenagrionidae	*Argia*
Odonata	Gomphidae	Not confirmed
Oligochaeta (subclass)	Naididae	Not confirmed
Ostracoda (class)	Not confirmed	Not confirmed
Tardigrades (phylum)	Not confirmed	Not confirmed
Trichoptera	Hydroptilidae	*Orthotrichia*