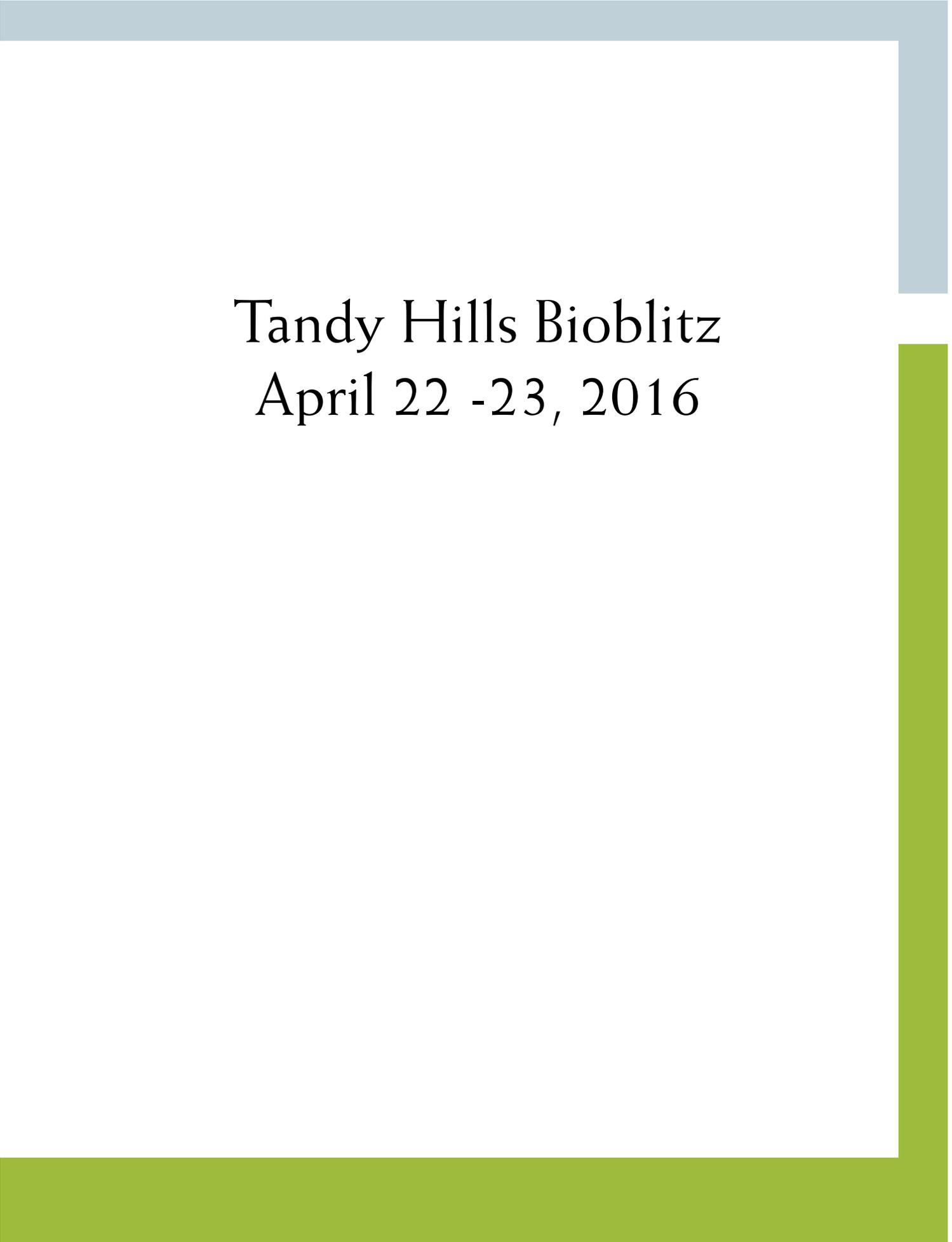




Tandy Hills Bioblitz
April 22 -23, 2016



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Tandy Hills incredible native diversity makes it a fitting place for BioBlitz.

The BioBlitz puts into motion a community driven inventory that will enhance conservation efforts in the future. — B.Benz

Foreword

The world we live in is changing. Global atmospheric temperatures are rising, every year in the last four, average global temperatures have increased. Extinction rates are somewhere between 100 and 1000 times the natural rate. The human population is growing. The human population has a net increase of 70+ million every year and though this number is decreasing slowly, the human population is increasing. Natural resource use by the human population is increasing. As a recent television add suggests that within 30 years there will be about 9 billion humans that require sustenance. Moreover, these humans will subsist on food grown on the same land under cultivation today. Humans will continue to impose their energy and nutritional requirements on the earth's biosphere. All of these factors have negative impacts on most other organisms. If human survival on Earth depends on the survival of other organisms, why wouldn't we want to know which organisms continue to survive in any particular locality? Don't we want to know what we have to work with? Don't we know when species are threatened by human population growth, human habitat modification or global climate change? How important are, and how much do humans depend on, other organisms to live? A BioBlitz is one way the global perspective can be acted upon locally.

Acknowledgements



BioBlitz Sponsors:



BioBlitz Partners:

Boy Scouts of America, Troops 12 & 180
Event Solar Power
Native Prairies Association of Texas
Prairie Keepers
Texas Master Naturalist
tiNG tiNG design
Upper Trinity Groundwater Conservation District
Friends of the Fort Worth Nature Center & Refuge

Steering Committee:

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Bruce Benz
John Tandy
Debora Young
Don Young

Karly Robinson
Anne Alderfer
Jen Schultes
Michelle Villafranca
Heather Foote



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Friends of Tandy Hills Natural Area (FOTHNA) Supporters:

Anne Alderfer	Jane Rector
Bel Air Music Showcase	Jim Marshall
Buyers Barricades	Native Plant Society of Texas
Debora & Don Young	Precision Press
Don Wheeler, Landscape Architect	Redenta's Garden Shops
Dr. Libby Gilmore	Saint Arnold Brewing
Heather Foote	Sportswear Graphics
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Frost Bank	Unity Church Fort Worth
Great Water Irrigation & Ecoscapes	West Meadowbrook Neighborhood
Greg & Mary Kay Hughes	Association
James D. Bradbury, PLLC	Whole Foods Market

The Friends of Tandy Hills Natural Area seeks to promote the ongoing conservation and restoration of its unique namesake prairie land and encourage public participation through a variety of award-winning programs. Visit the website at www.tandyhills.org. - and connect to the prairie.

This handbook and its companion video have been developed through a grant from the Conservation License Plate Program of the Texas Parks & Wildlife Department.



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Tandy Hills BioBlitz Handbook

1. Organization and Promotion: handbook

What justifies conducting a BioBlitz

A BioBlitz is an inventory of the species in a particular area (site) on a particular date. Dates should be strategic, and while many bio blitzes occur over a very short time span, we know that the more persistent volunteers are in making observations over the long term, the greater the diversity that will be recorded. The first event is often the initiation of a long-term undertaking. Community involvement will stimulate continuous and ongoing opportunity to perpetuate the inventory. If a BioBlitz represents a viable undertaking, conduct them strategically, initiating them as often as necessary to continue to add to the species inventory and increase the accuracy of the geographic distribution of the organisms that reside in and around the BioBlitz site.

A. WHAT KIND OF AREAS MIGHT QUALIFY AND HOW DOES ONE JUSTIFY A BIOBLITZ?

Municipal Parks and trails, transportation corridor rights-of-way – rail or highway, abandoned agricultural fields and pastures, and National forest and grasslands all provide suitable sites for initiating a BioBlitz. Any area that contains significant numbers of native species, interests in restoration, or concern that monitoring the area's biological diversity is necessary or worthwhile are deserving of BioBlitz actions. The size of the area shouldn't be a deciding factor. My backyard isn't particularly diverse so 0.1 ha may be the lower limit.

B. DETERMINING CHALLENGES AND OVERCOMING THE DESIRE TO LET THINGS SLIDE.

Inventories of biological diversity usually reflect the interest and capability of the participants. This reflection is never a negative. The objective of the organizers is to focus the inventory efforts of experts, para-professionals and volunteers. Systematic coverage of the BioBlitz site is the single most important priority. Observations made systematically across the site and in strategic locations can be organized by assembling teams of experts or para-professionals and volunteers at Basecamp.

C. QUALITY OF DATA COLLECTION AND MAINTENANCE JUSTIFIES ALL ELSE.

Accurate documentation is the basis of a reliable inventory. Photographs are and were important at Tandy Hills. Photography is very productive with organisms larger than a centimeter, less so with organisms that are smaller. Sam Kieschnick, Texas Parks and Wildlife Department Urban Biologist, recorded almost as many insects using mercury lights during the Tandy Hills BioBlitz. Many of his insect observations were made with a camera, not a camera phone. These observations were added to the Tandy Hills BioBlitz through iNaturalist website, not the camera phone app. Sound recordings are equally valuable. The Tandy Hills BioBlitz bat survey relied on acoustic sensors deployed in a systematic fashion. Not enough good can be said for good geo-referencing. Tandy Hills now has a map of most Milkweed populations. These can now be monitored for larvae twice/year. Sampling systematically is also a good idea because volunteers can be directed to make observations strategically.

2. Approach and implementation include strategic focus on organismal diversity and community involvement.

A. INATURALIST FACILITATES OBSERVATION.

Data collection through iNaturalist is easy. Volunteers train readily to add observations using camera phones. The expert review process in

iNaturalist is productive, rapid and thorough. Hundreds of observations can be added to the BioBlitz inventory in a few hours and reviewed within a few days after the event. The observations made through iNaturalist are not without bias that is mostly due to local interests and concerns of participants and experts. Such bias is to be expected. iNaturalist hasn't been used by many experts working on microscopic organism yet. The Tandy Hills BioBlitz witnessed a dearth of observations of birds, reptiles, and amphibians. Such haphazard recording or lack thereof should be expected. Some of this bias is a result of using iNaturalist. Clearly the costs associated with using iNaturalist are outweighed by the benefits.

B. SHOULD OTHER FORMS OF DATA COLLECTION COMPLEMENTARY.

Approved voucher specimen collection should be encouraged. Voucher specimens are going to add value to the BioBlitz. Voucher specimens provide a tangible record that documents inventory efforts in perpetuity. Questions of a taxonomic nature can be addressed with voucher specimens that photographs alone cannot. Voucher specimen collection should be performed under the supervision of an herbarium or insectarium professional to maximize their long-term utility.

A few professional experts and experienced para-professional are extremely valuable. Their efforts during the event are invaluable because their knowledge and observations form the corpus around which volunteers can base their efforts. Expert and para-professionals' efforts to convert volunteer observations to Research Grade records in iNaturalist is a singular objective. This consensus opinion of Research Grade legitimizes the taxonomic inventory efforts of all participants. Training volunteers to use iNaturalist can avoid a dearth of experts on the day of the event. Pre-event training of experts and para-professionals to use iNaturalist will facilitate inventory on the day of the Blitz. The smart phone apps vary in their data recording protocols that can be circumvented if volunteers are also trained. One recommendation is to perform pre-event on-site-training. Downloading the app on site can be a challenge especially if local wireless

connectivity is limited and if volunteers' cellular data plans are restrictive. Pre-event training to use iNaturalist is best performed at the site of the BioBlitz or at a neighboring locale with unlimited wireless connectivity and instructors versed in the various smart phone platforms that are available. Organizing the expert and volunteer efforts during the event to insure all observations are recorded is important so no effort is wasted. The importance of coordinating and recording the participation of volunteers cannot be overstated. A registered volunteer's time is worth \$23.10/hour. Once field data collection begins, wise organizers set up a wide screen online monitor that exhibits in real time to participants the speed, coverage and accuracy with which the inventory is proceeding. This monitor can double as a viewing screen for wireless microscopy.

C. WHAT CAN A MAP, TRAILS, OR A SAMPLING GRID DO TO FACILITATE COMMUNITY PARTNERS AND VOLUNTEERS IN THE INVENTORY?

Organization of volunteers is very important for a BioBlitz's success. Some volunteers will not subject themselves to organized participation, others are willing and should be organized to focus on particular locations or taxa. What organizers should think about when creating a basecamp is to facilitate this organization. Maps of the park showing named locations and the sampling grid can be made available to direct volunteer efforts that improve the value of each observation. Systematic sampling where observations are recorded at locations that have strategic significance is invaluable. A systematic grid superimposed on the BioBlitz site can insure that strategic observations will permit future discovery of habitat characterization.

D. HOW TO WORK AROUND SPECIES THAT ARE DIFFICULT TO PHOTOGRAPH WITH A SMART PHONE.

iNaturalist was created to document biological diversity through macroscopic observation. Photographers find opportunity to upload their observations via the world wide web instead of using a smart phone app. The identity of the organisms documented in these photographs are subsequently ratified by volunteers, para-professionals and experts. This process convincingly corroborates the existence of any species worth

photographing. The smart phone app came later. The website is user friendly providing welcome opportunity to upload photographs, sound recordings, and nuanced observations that aid in identification.

E. KEEP TRACK OF VOLUNTEER EFFORTS: TIME VOLUNTEERED AND THE LOCATION OF OBSERVATIONS.

A BioBlitz is an event. Because of its punctual nature, registering participants is of utmost importance. Greeters that welcome each and every visitor and volunteer facilitate biodiversity inventory by documenting all participants' involvement. Much like species' richness depends on sampling effort, the number of volunteers and their efforts aid in interpretation of species diversity in the area's inventory. Likewise, the focused efforts of each volunteer communicate the interests of the BioBlitz participants. Some are interested in spiders, others birds and still others fungi. Organizers can improve the efforts of volunteers if they have documentation of the focused interests of individuals and volunteers.

The importance of geo-referencing cannot be underestimated. Systematic data collection efforts focused on arbitrary locations that document the ecological distribution of native and nonnative species is worth more than repeated observations of the same species at the same location. The latter can occur with a species whose populations are located close to base camp.

References:

The Australian Guide to Running a BioBlitz (2015): Hepburn L, Tegart P, Roetman P, von Gavel S, Niedra S, Roger E, Miller S, Fyffe T, Brenton P, Lambkin C.



Drone footage overlooking BioBlitz and downtown Fort Worth (UM Inspections)



Fort Worth ISD students participate in Kids on the Prairie at BioBlitz (Don Young)



iNaturalist tutorial at Texas Wesleyan University with Urban Biologist, Sam Kieschnick (DY)



Participating TWU biology students (DY)



iNaturalist observation of Buckeye Butterfly (DY)



Fort Worth Mayor Betsy Price being interviewed at BioBlitz (DY)



Tandy Hills became a living laboratory for students and scientists (DY)



Citizen scientists from the local community (DY)



Mayor Price and naturalists after signing of the Mayor's Monarch Pledge at BioBlitz (?)



Purple Coneflower was one of many plant species documented at BioBlitz (DY)



iNaturalist post of Saw-leaf Daisy and Preying Manits (DY)



BRIT scientists at Tandy Hills (DY)



Scientists sweeping the prairie for insect inventory (DY)



iNaturalists training session prior to BioBlitz (DY)



Sam Kieschnick inspiring kids to make observations (John Tandy)



Sam Kieschnick demonstrating projection microscope and monitor (JT)



Carpenter Bee, one of several bee species documented at BioBlitz (DY)



Rachel Richter, TPWD Urban Biologist, using special lights to attract nocturnal insects (DY)



Sam Kieschnick, preparing for a nocturnal insect observation at BioBlitz (DY)

**EARTH DAY, FRIDAY, APRIL 22 AT 6 A.M.
TO SATURDAY, APRIL 23 AT 6 P.M.**



10 am Saturday - Wild Foods Hike

Noon & 4 pm Sat. - **Twice Upon a Time Storytellers**

11- 4 pm Saturday - **Wildflower Tours at *The Best Place to See Wildflowers in North Texas* led by Texas Master Naturalists**

11-4 pm Saturday - **Play the Prairie Passport Game for a free chance to win a week of overnight summer camp donated by YMCA Camp Carter!**

11-4 pm Saturday - **Solar viewing telescopes with Fort Worth Astronomical Society**

and MORE !

Food and Drinks available from **CHADRA** PIZZAS & CEREAL

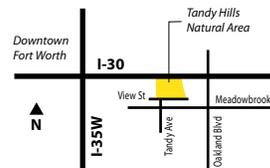
Attention: Science Nerds, Nature Lovers, Adventurers, Families, and Other Folks!

We are documenting all living species at Tandy Hills Natural Area over a continuous 36 hour time period! Scientists and naturalists from across Texas will lead and supervise photo documentation and data collection. **You** are invited to make your own contributions via the iNaturalist web app while you explore the biodiversity of this 160-acre urban prairie, just east of downtown. Visit the HQ Field tent for orientation.

MORE INFO: tandyhills.org/bioblitz

Tandy Hills Natural Area

3400 View Street Fort Worth, Texas



36 HOURS OF SCIENCE IN ACTION!

**ALL HAPPENING AT THE
"BEST PLACE TO STAND IN NORTH TEXAS*"**

* Fort Worth Star-Telegram



Event poster



U. N. Texas birdnetter, Jim Bednarz, banding one of the bird species at Tandy Hills (JT)



The sun sets on Tandy Hills BioBlitz 2016 (DY)

Tandy Hills BioBlitz Biological Diversity Inventory

Bruce Benz (2016)

Introduction

Ever greater concern over the increasing rate of species extinction and decline of plant and animal abundance (Newbold et al. Science 2016) in terrestrial habitats leads to the imperative inventory of biological diversity. The impact of rapidly increasing urban population in North Central Texas is taking its toll as areas of existing native biological diversity succumb to habitat destruction, fragmentation and degradation. Steps to avoid this onslaught include Texas Parks and Wildlife Department's Conservation License Plate grants program that funded the Tandy Hills BioBlitz. Previous studies have documented bird and flowering plant species richness and population ecology of one Texas endemic that occur in Tandy Hills. The existing management plan characterizes the locality and establishes a variety of practices to insure conservation objectives will be achieved. The area is under threat associated with its location in an urban landscape that include fragmentation, degradation and community ignorance of its objectives. The confluence of interests – conservation community, city, neighbors – found interest in a careful examination of Tandy Hills Natural Area.

The BioBlitz is a short term focused inventory of biological diversity within the confines of a designated area. The BioBlitz idea has been implemented widely. The short time frame appears to be an approach that maximizes effort per unit time. Our experience in Tandy Hills has been the same in the sense that a majority of observations were made during the planned and advertised thirty-six-hour window in April of 2016. Lead up to the event saw an increase in observations but are significantly

fewer in number than the event itself. The follow-up has seen continued effort. Numerous individuals and institutions have continued to record observations following the event. This continued effort may be peculiar to the Tandy Hills Natural Area BioBlitz if in degree but not in kind. Nevertheless, this continued recording activity is having a positive impact as we will see below.

Why have a BioBlitz at Tandy Hills Natural Area? Tandy Hills Natural Area and adjacent Stratford Park are located protected areas strategically nestled along the breaks the West Fork of the Trinity River in the Cross Timbers Ecoregion of North Central Texas. Known for its extraordinary floristic diversity, this protected area harbors at least eight and perhaps more than a dozen plant species endemic to Texas or this ecoregion. Embedded in the urban Fort Worth landscape, the riparian forest canopies are still dominated by native pecan, oaks, ash and elms, while the understory is dominated by non-native species (*Ligustrum* spp., *Nandina domestica* and *Photinia serratifolia*). While Tandy Hills prairies still boast viable populations of at least two Texas endemics (White Rosinweed, *Silphium albiflorum* and Engelmann's sage, *Salvia engelmannii*) - Goat-face grass, (*Aegilops cylindrical*), Johnson Grass, (*Sorghum halapense*), Henbit, (*Lamium amplexicaule*), among others wait on the protected area's edge that faces urban foundation plantings and the roadside invasive species of the Highway 30 right-of-way. Bird diversity has also been studied (Stevens 2007), with 74 species recorded within the park boundaries during 2007. The area thus exhibits characteristics of a protected natural area immersed in an urban landscape: native biota with intrinsic value threatened by urban forces.

Tandy Hills is as unique and valuable as any of the world-level art museums in Fort Worth, and as much a part of Fort Worth's history as The Stockyards. The land was roamed by the Comanche and other Native people, and the Old Birdville Road ran right through it back when Birdville was the County Seat, before Fort Worth took that mantle in a contested 1855 election. The Tandy family acquired it when they traveled from Kentucky to Texas in a wagon pulled by oxen back in 1854, and it became part of the Tandy Ranch. The wildflowers and other plant communities, as well as the animals, survive on the land that remains remarkably intact, saved by its

topography, good fortune and some citizens and City representatives who have cared enough to defend it at critical times from the threats of illegal dumping, organized mountain bike clubs, orienteering groups who would damage the fragile environment with large off-trail foot traffic, homeless encampments and proposals for oil and gas drilling on the property.

Planning the Tandy Hills bioblitz

The Tandy Hills Bioblitz was planned by the collective efforts of individuals from a number of organizations. These individuals represented the Friends of Tandy Hills Natural Area (FOTHNA), Texas Wesleyan University (TxWes), Teaming with Wildlife: True to Texas (TWW: TTT), the City of Fort Worth Parks and Recreation Department (PARC), Texas Parks and Wildlife Department (TPWD), and Texas Nature Trackers (TNT). Planning began in October 2015 for the event which took place during the 17-23 April 2016. Representatives from each of these organizations met approximately every 14 days during the six months leading up to the event. Planning focused on participation of experts, event logistics, basecamp creation and staffing, and volunteer participation. The success of the event was dependent on the participation of experts with the support of volunteers. Event organizers sent invitations to 57 experts. Twenty-eight of the invited experts participated on the ground in the Tandy Hills BioBlitz. Event planning established that the data collection portion of the overall event would commence at 6 a.m. on Sunday, 17 April 2016 and run continuously through 6 p.m. on Saturday, 23 April 2016 (156 total hours) and public participation in the event would begin at 6 a.m. on Friday, 22 April 2016 and conclude at 6pm on 23 April 2016 (36 total hours). The Friends of Tandy Hills Natural Area (FOTHNA) assumed responsibility for hosting the event in which organized planning meetings, engaged in event fundraising, assumed the lead in publicizing the event, and with TWW: TTT created the BioBlitz Basecamp footprint, and recorded volunteer support. Volunteers were recruited from the Crosstimbers Connection, Fort Worth Audubon Society, US Fish & Wildlife Service, Texas Christian University, Botanical Research Institute of Texas, the Cross Timbers

Chapter of the Texas Master Naturalists, Native Prairie Association of Texas, Native Plant Society of Texas, and the DFW Herpetological Society.

Methods: Location, location, location

The area and its expertise stakeholders would determine the quality of results obtained from the BioBlitz. The area's biological diversity was recognized before Wayne Clark of the Fort Worth Parks and Recreation department reported on its intrinsic values in 1980. This protected natural area is bounded on the north by IH 30, on the south by View Street and residential land holdings, on the east by Oakland and by Ben Street on the west (Figure 1). Gateway Park, a multiple use park some five times the size of THNA is located across IH 30 and a reach of the West Fork of the Trinity River. Gateway Park and the residential areas surrounding THNA on the other three sides, provide the catchment area for flora and fauna that find their way into Tandy Hills, either through the culverts beneath IH 30 or the streets and residential areas on the east, south and west.

The Trinity River is the foremost physiographic determinant of the diverse habitats of Tandy Hills Natural Area. Though now separated from the West Fork of the Trinity River riparian area proper by IH 30, Tandy Hills' topography remains a function of the watershed's geomorphology and drainage (Figure 2). Habitat variation across Tandy Hills is undoubtedly influenced by the topographic variability that influences biological diversity that helps to capture the diverse character of Cross Timbers ecoregion.

The area's reputation for richness of spring floristic displays has attracted area naturalists and taxonomic experts for decades. Spring wildflower tours have been sponsored on Earth Day by Fort Worth Parks and Recreation land managers for more than twenty years. The promise of biotic diversity attracted a diversity of expertise that proved useful in the Tandy Hills BioBlitz.



Figure 1. Biodiversity inventory progress through July, 2013; Tandy Hills Project boundary from [iNaturalist](#) (accessed 7/25/16) super-imposed on (Google Earth Imagery ©2016 , DigitalGlobe, Landsat, Texas Orthoimagery Program, U.S. Geological Survey, USDA Farm Service Agency); north is at top. The main access into Tandy Hills Natural Area is located at the corner of Tandy Avenue and View Street along the southwestern boundary (lower left). The straight southern boundary is approximately 600 meters long. The highest density of observations occurs along this pathway into the grounds. BioBlitz basecamp was established approximately 100m north of this main entrance. A short section of the West Fork of the Trinity River is present in the satellite image at upper left adjacent to and roughly parallel to IH 30.

The city of Fort Worth focused management efforts on Tandy Hills Natural Area (THNA) during the height of the natural gas drilling in the Barnett Shale in 2006-2007. Efforts to manage the biological communities led to the creation of a master plan ([ECC ESC 2008](#)) which established guidelines for restoration. Two main objectives were established for the prairie preserve: 1) to restore the park to original habitat and 2) to protect the park from largely urban-related threats. Recommendations were based on existing inventories of flora and fauna. Ecological values such as ten endemic plant species were recognized, as were proximity to and drainage

into the Trinity River floodplain, and the variety of plant communities in various states of succession. Ecological threats were also clearly outlined and the potential for restoration by active management such as invasive species removal and burning described. This document provided a wealth of information and clear objectives for biological conservation that discussed the need to foster community involvement and natural area stewardship. Much effort – hundreds of volunteer hours - has been invested in community restoration as a result; largely the work of FOTHNA.

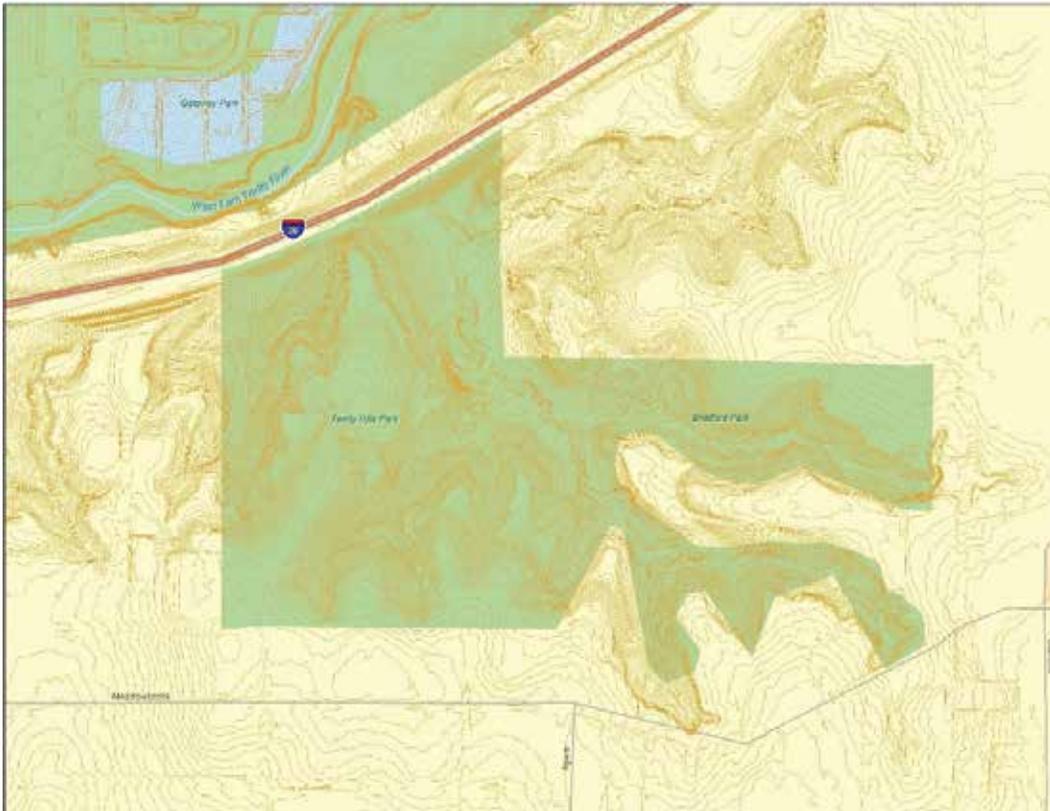


Figure 2: Tandy Hills Natural Area with topographic (two feet contour interval) detail associated with West Fork of the Trinity River. Total topographic relief is 200 ft (ca. 61.5 meters). North is at top. Straight southern boundary of park is approximately 600 ft along east-west axis. Five ephemeral channels drain Tandy Hills.

Taxonomic experts that participated in the Tandy Hills BioBlitz brought demonstrated knowledge of nearly all major terrestrial taxa (i.e., iNaturalist's "Iconic Taxa"). Species in ten major taxonomic groups were included in the inventory. The expertise that made this diverse inventory

possible stems from academic training, Master Naturalist training and lifetime vocational training. Volunteer and expert's variety of training backgrounds made the taxonomic breadth possible.

Establishing the basecamp science center:

Two complementary functions were envisioned for establishing and staffing the basecamp, to provide amenities for volunteers and to create and staff a resource area where volunteers could inquire about observations they were making and act as a clearing house where project progress could be monitored and strategic efforts forged to focus data collection. The basecamp was envisioned to provide access to the observations as they were being made. This access also assisted volunteers who wanted to insure their observations were of high quality and made in strategic areas. The basecamp also facilitated verification and promoted consensus were appropriate (agreement in iNaturalist 'speak') in real time. Experts could confirm identifications while inventory was in progress. In addition, the basecamp educated the public about the inventory's progress.

The Basecamp was the center of inventory operations. It included a number of tents that provided cold drinks, meal tickets and snacks for volunteers, sold t-shirts that advertised the event, provided maps of THNA with stations where systematic observation could be recorded, and provided scientific information that helped volunteers that might need assistance in taxonomic identification. Volunteers could also borrow equipment used in their inventory activities such as sweep nets, aspirators, GPS, and plant presses.

The base camp also provided a world wide web connection to view BioBlitz progress in iNaturalist. As observations were uploaded to iNaturalist, the basecamp computers showed the taxonomic character and location of observations made before and during the event. Taxonomic designation was assisted with availability of a dissecting microscope connected to a camera with an open IP address so the public and volunteers could download their own images of diverse biological entities at Tandy Hills.

Basecamp staff likewise facilitated community involvement. Connecting experts and volunteers virtually guaranteed community involvement in the inventory of biological diversity. The most common question posed by volunteers is the biological identity of the organisms they see. The basecamp staff provided the requisite connectivity by organizing tours, teaching the public in front of the computer monitor limning observations on the Tandy Hills Project map, and showing recently collected flowers, insects, arachnids, lichens and terrestrial invertebrates with the microscope. Volunteers were encouraged to first sign in before being led by basecamp staff to strategic locations to record observations that maximized contributions by volunteers.

Methods: iNaturalist

Rapid biological diversity inventory has been an important biological practice, especially in the Neotropics. Until recently, bioblitzes were conducted without the assistance of web-based tools. Within the last ten years, the use of iNaturalist has revolutionized rapid biodiversity inventory. This technology has many advantages and few, if any, over prior practices involving specimen collection. The relative ease with which observations can be made is a distinct advantage of using iNaturalist. iNaturalist users are encouraged to use the smart phones for making observations directly on the iNaturalist application. Thus smartphone users contribute with ease using the "phones" camera. This insures time, date and what was observed is recorded accurately and precisely. Though these photographic recordings may vary in quality based on user skill and to lesser extent on camera-phone capability, the obvious ease of making observations of flora and fauna cannot be underestimated. This facilitates geo-referencing observations (most smart phones have built in GPS, global positioning system, capability). Veteran users often prefer to use digital cameras with GPS capability or record observation location with their smart phones. Photos can be uploaded to the in-the-field iNaturalist app observation from home or work computer. Combined use of these tools maximizes the value of each observation by insuring the highest quality photographs are georeferenced.

Another of the many advantages to using this web-based inventory method is the potential accuracy of the taxonomic designation given the observation. Observations made in the field or laboratory can be viewed by hundreds of specialists who can confirm or refine initial impressions. This consensus approach avoids some of the bias of individual designations, but most importantly, confirms taxonomic designation based on what appears to be expertise of the observer and the sheer numbers of observers that agree. This is very similar to the tried and true method of specimen collection and study carried out traditionally in herbaria, insectaria and museums.

Methods: night-time attractors, white sheet and nightlights; telemetry, and mist-netting

Pedestrian survey to inventory biological diversity is and was the primary method of inventory used during the Tandy Hills BioBlitz. A variety of other methods were used as well. Radio tracking (radiotelemetry) and mist netting were used to inventory bats. The radiotelemetry study involved pedestrian survey of Tandy Hills with handheld radio trackers (iPads with appropriate software) looking for calls emitted at species-specific radio frequencies. This study was followed by mist-netting. Mist nets were also used to inventory birds. As with bats, mist-netting for birds occurred where habitat conditions for each appeared optimal and net deployment was logistically feasible.

Similarly, insect, arachnid and invertebrate cataloging was accomplished primarily by pedestrian survey. Volunteers captured or simply witnessed an insect, snail or spider on the ground or in the vegetation and recorded their observation on their smartphone or camera and then included them in iNaturalist. Naturalists also used special methods to record observations of insects. Baited pitfall traps were used to attract and capture ants and other insects. Mercury vapor and ultraviolet light traps/sheets were used to attract and photograph night-flying insects. Sweep nets were used to trap insects in vegetation as were aspirators to collect minute arthropods.

Methods: Science in iNaturalist – inventory and diversity

The source of all biological diversity data is the Tandy Hills Natural Area Project in iNaturalist. Observations – “an encounter with an organism at a particular time and location” (iNaturalist) is the basis for all inventory analysis. Prior to commencing with analysis of iNaturalist observations, repeated review was conducted of all verifiable main identifications – the initial observation recognized at any taxonomic level by any participant- by experts and volunteers. The review process of main identifications during and after the bioblitz sought to confirm or amend the initial observation leading to achieve a Research quality record of that organism in THNA. Analyses below of the bioblitz observations are focused primarily on Research quality records unless otherwise indicated.

Results:

The greatest taxonomic diversity (Tables 1a and b) was achieved during the 36-hour BioBlitz event for most iconic taxa. Plants, bird and insect records increased significantly (i.e., saw a > 50 percent difference over the 36-hour event record) after the week of the event and the event itself. The dearth of amphibians and reptiles is noteworthy, though not unanticipated recognizing that world-wide amphibian populations are dwindling. The event record of birds is remarkable recalling a greater than two-fold greater number for the THNA inventory reported in 2007 (Stevens 2007), half of the species ever recorded at THNA were identified as a result of the BioBlitz. Plant species recorded during the event number less than half the number recorded before, during and after the event indicating that continued efforts of a few individual naturalists continue to add to the list of species present at THNA. Insect species number pale by comparison to plants; expectations suggest that the number should be somewhere between three to 15 times more than plant species (Primack 2014).

Table 1a: iNaturalist Iconic Taxa recorded during the 36-hour event, the BioBlitz week and the total time since the project's creation. The number of species recorded for these iconic taxa was accomplished primarily during the 36 hour BioBlitz, except birds. The number of bird and plant species (see table 1b) increased significantly after the 36-hour BioBlitz event.

Time Frame	Amphibia	Animalia	Arachnida	Aves	Fungi
Total Project	1	1	10	32	8
BioBlitz Week	1	0	9	15	5
BioBlitz: April 22 and 23	1	0	9	12	5

Table 1b: iNaturalist Iconic Taxa, continued. Ongoing plant species inventory has continued to contribute to the species inventory since the BioBlitz.

	Insecta	Mammalia	Mollusca	Plantae	Reptilia	Prokaryotes
Total Project	163	10	4	354	9	1
BioBlitz Week	121	8	3	179	8	0
BioBlitz: April 22 and 23	102	7	3	161	7	0

The inventory today stands at 10 Arachnids, 163 Insects, one Amphibian, 32 Birds, 10 Mammals, nine Reptiles, four Mollusks, eight Fungi, and 350 Flowering Plants. A more detailed breakdown emphasizing the more speciose taxonomic categories is comprised of nine spiders and one scorpion (Arachnids), mostly Passerine species 17 of 32), 48 Poaceae, 57 Asteraceae and 31 Fabaceae (these flowering plant families dominate temperate grasslands and were studied by Granados et al. [2001] who found 59 species of grasses, 63 species of composites and 35 legumes with an estimated 437 total flowering plant inventory) as response variables in island biogeographic examination of North Central Texas Protected Natural areas. Approximately 30 introduced/potentially invasive flowering plant species were recorded at the THNA BioBlitz. This number is about half of the number reported by Granados et al. (2001) for Tandy Hills. The bioblitz estimates of species richness appear to have accomplished a very complete first step inventory.

The inventory's success can also be appreciated by examining the number of species and Research grade records over the life of the Tandy Hills project (Figures 3, 4, 5; Table 2). A substantial proportion of the observations, approximately 850 plant and 250 insects, added to the iNaturalist project occurred on April 22 and 23. The number of observations, roughly 1050 plants and 300 insects, occurred during the weeklong inventory period that included April 22 and 23. Of the total 2500 research grade observations made in THNA since its inception, approximately 75 percent are of plants and 20 percent are insects. Slightly more than 67 percent of the 3702 observations made to the THNA project thus far are Research grade. These 2500 observations identify 593 species (Table 2). Slightly less than half of all observations were made during the 36-hour blitz with about 47 percent of Research grade observations occurring during that time; an equivalent number – 50 percent - of all species were identified during the blitz (Table 2).

Table 2: iNaturalist Observations made to the Tandy Hills Natural Area project up to, during and after the BioBlitz. Approximately half of the observations and species were made during the 36-hour blitz.			
Time Frame	Total Observations	Research Grade Observations	Research Grade Species
Total Project	3702	2506	593
BioBlitz Week	235	1475	349
BioBlitz Earth Day- April 22 and 23	1859	1187	307

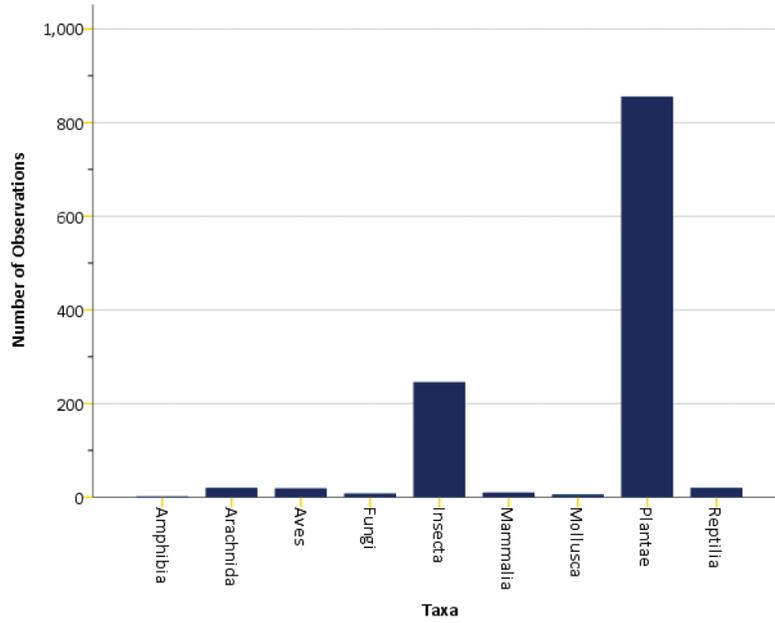


Figure 3: Earth day and succeeding Saturday iNaturalist Research grade observations according to iNaturalist iconic taxonomic designation.

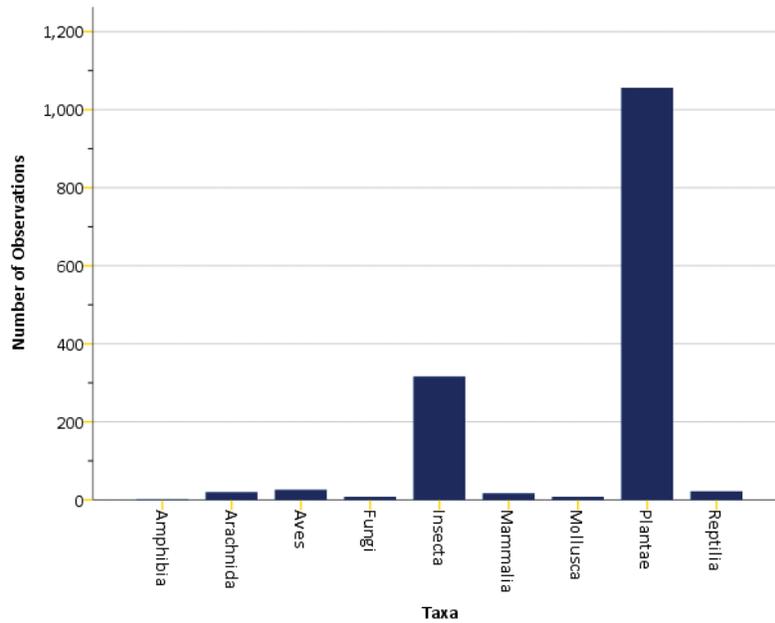


Figure 4: BioBlitz week observations by all experts and volunteers. Note that only flowering plant observations differed substantially from the number made during the 36-hour event.

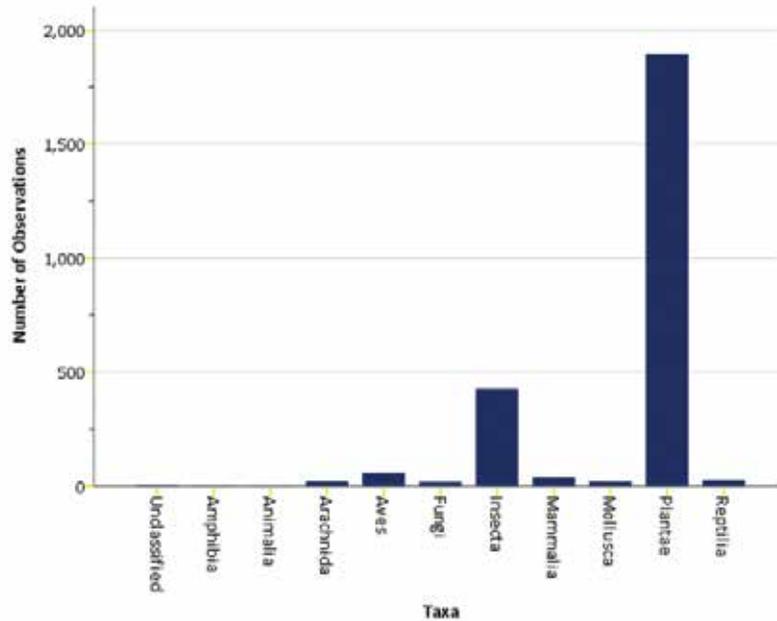


Figure 5: THNA Project observations since creation of the project in iNaturalist (up to 28 July 2016).

It is noteworthy that the greatest number of species recorded occurred on Earth day, April 22. If we examine the pace of species added to the existing list of species present at THNA, an approximate metric of effort per day can be estimated. If we examine the number of previously unreported species that were added to the existing list from the period preceding the week of the BioBlitz (Figure 3), the blitz proper generated the greatest number of species to the project over the course of its lifetime. Given the 112 species that had been newly added to the project list during the week leading up to the 36 hour bioblitz, 162 species were alone added to the project on the 22 and 23 of April that culminated the event. Similarly, the level of activity invested documenting biodiversity at THNA over the course of the projects' existence in iNaturalist (Figure 4), illustrates how well increasing intensity of activity adds substantial numbers of previously unreported species to the inventory.

The record of observations per observer over the lifetime of the project reflects the efforts put forth by participants and suggests the blitz itself contributes more evenly to the inventory. Figure 6 shows the number of research quality observations made by observers during the total project,

the week of the event and the 36-hour event itself. This histogram reflects the collective efforts of volunteers that showed up during each of these three time frames. The behavior these graphics describe is akin to the rank abundance curves that describe community diversity; to wit, the shallower the slope of the curve, the more even the distribution of observations among volunteers. Fewer volunteers made single observations during the 36-hour event than during the preceding week and, than over the course of the entire event. Without actually performing the “diversity” calculation, these graphics suggest that the intensity of the inventory during the 36-hour event generated a greater number of research quality observations than two other time periods when fewer participants were collecting observations. This lends support to the idea that higher quality might be achieved when greater collective effort is invested. The future bioblitz will redouble collective efforts that pursue the less-well-known taxa and will organize the inventory in a more geographically systematic fashion.

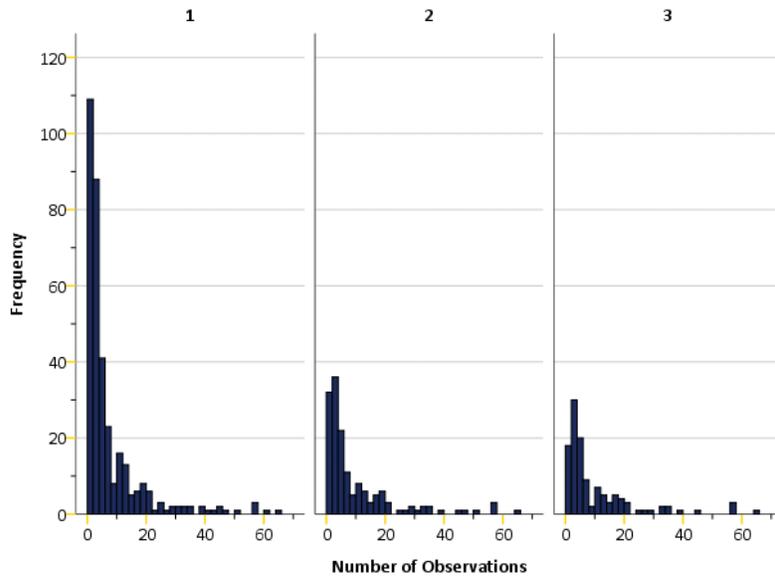


Figure 6: Histograms depicting the number of observers who made research grade observations during the (1) lifetime of the Tandy Hills project in iNaturalist, (2) week of the BioBlitz, and (3) the two day – April 22 and 23 – event.

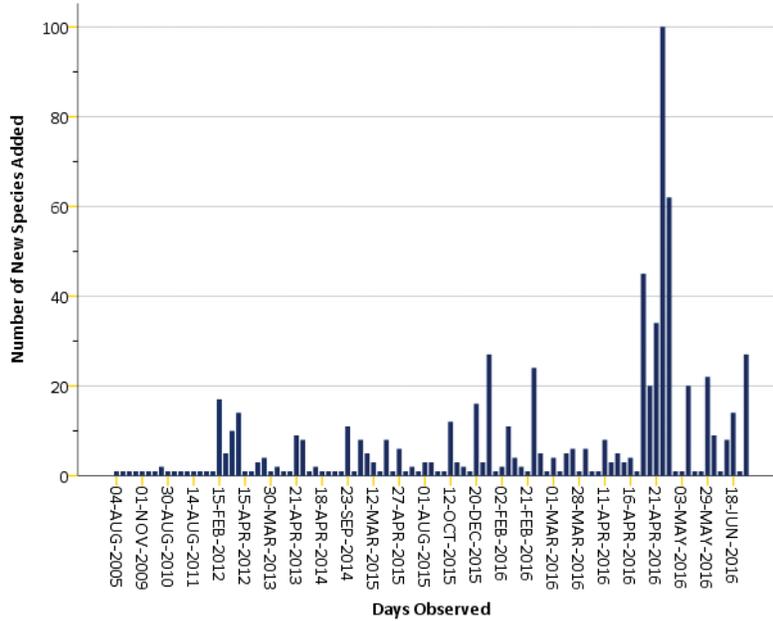


Figure 7: Novel species added to list of total species over the lifetime of the Tandy Hills Natural Area project in iNaturalist. The greatest number of species added to the growing list of taxa occurred during the week of the bioblitz, particularly April 22 and 23, 2016. Inventory efforts continue up to and including today.

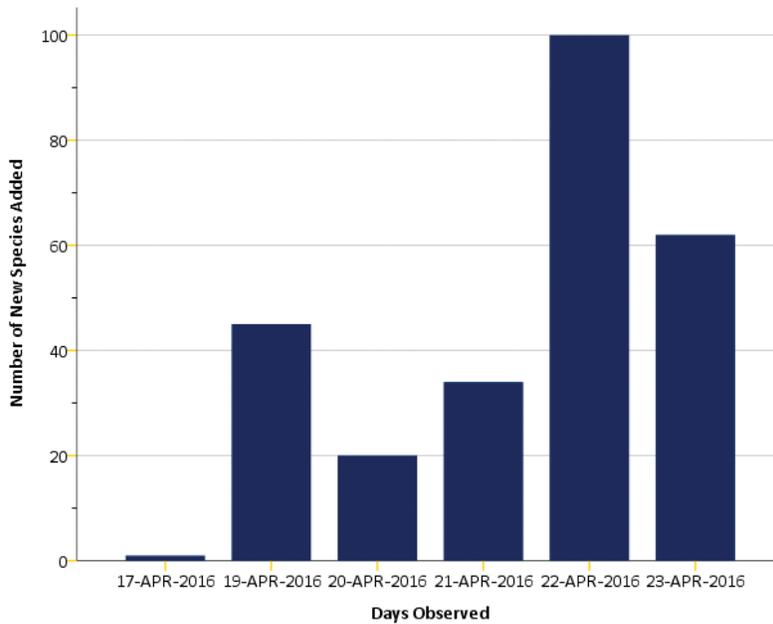


Figure 8: Novel species added to the growing list of THNA taxa during the week-long period preceding the 36-hour event. Inventory efforts on Earth Day - April 22 - are almost double that of the following Saturday.

Geographic coverage during the bioblitz (Figure 1) is uneven. Most observations were made within 200 meters of basecamp. The edges of THNA received very little scrutiny with the exception of the southern perimeter along View street. This is likely due to ease of access or volunteers conserving energy. The drainages the form the dominant topographic feature of THNA are somewhat distant (400-500 meters) from the basecamp and the tangled understory dominated by privets (*Ligustrum* spp.), photinias (*Photinia serratifolia*), and heavenly bamboo (*Nandina domestica*) together with green briar (*Smilax bona-nox*) make forest inventory difficult and unpleasant.

Observers interest and persistence varied widely (Figure 9). We were fortunate that Bob O'Kennon, Sam Kieschnick, Jeff Quayle, and Judith Lopez Sikora who all logged at least 100 observations and at least 100 species on, during or following the April 22-23 Tandy Hills Natural Area BioBlitz.

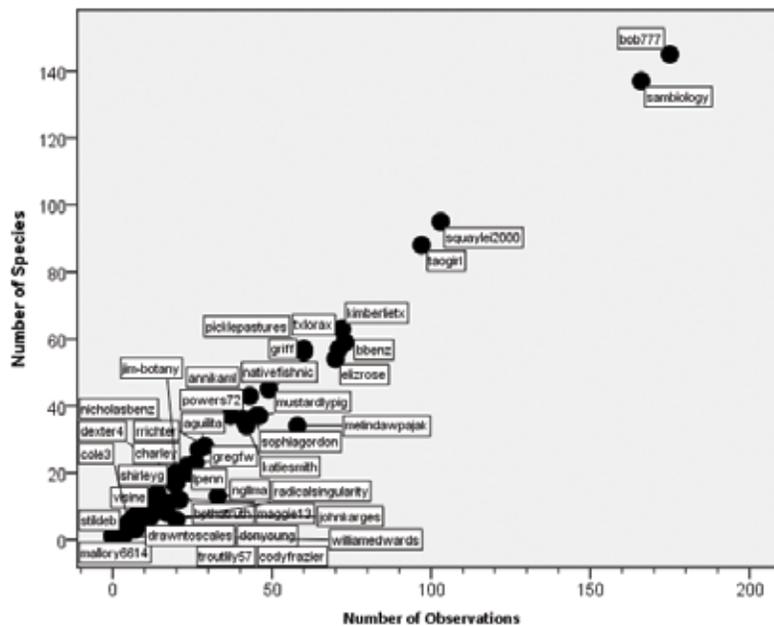


Figure 9: Number of species included in the inventory as a function of the number of observations made by experts and volunteers. Note that a line of best fit would have very high predictive value because very few observers record a species more than once. This is a challenge that needs to be overcome. The value of bioblitz is much greater if geographic distribution and habitat specificity can be characterized by all species that are included in the iNaturalist inventory.

Our efforts were focused on inventory. Such an inventory is expected to produce a long list of the "typical suspects;" those flashes of color/species one sees in the springtime while hiking, riding or driving. The inventory also registered species of conservation need; those with restricted range, narrow habitat specificity and small population size. Species of greatest conservation need (SGCN) observed during the BioBlitz proper include two species of birds, one reptile and one plant species. The two species of birds include the Painted Bunting (*Passerina ciris*), the Scissor-tailed Flycatcher (*Tyrannus forficatus*); one plant species, the Topeka Purple-coneflower (*Echinacea atrorubens*), and one reptile, the Texas Blind Snake (*Rena dulcis*). In addition to the aforementioned, a single insect whose current habitat appears threatened was observed one day before the THNA BioBlitz week. Sam Kieschnick, the now famous Texas Parks and Wildlife Department, Urban Biologist, captured and recorded the presence of a Southern Plains Bumblebee (*Bombus fraternus*) at Tandy Hills. This species, according to Jessica Beckham's iNaturalist post indicates the species is rare. The fact that these rare species are included in the THAN BioBlitz inventor cannot be overestimated. Rarity is often associated with a species being extinction prone. Rarity and more specifically endemism is associated with susceptibility to the extinction vortex (Primack 2012). The extinction vortex begins with rarity and small population size. Both are associated with demographic stochasticity and genetic drift, each in turn contributing to furthering the susceptibility to extinction of the species', which is linked ultimately to reduction of populations and their local extinction (also known as extirpation).

These features are common to a subset of the species found in Tandy Hills. Reference to some of these species was made in the Tandy Hills Master Plan (ECC ESC 2008). Tandy Hills Natural Area is located near the eastern margin of the Cross Timber Ecoregion. This ecoregion is located in Texas, Oklahoma and Kansas (TPWD Cross Timbers Wildlife District). The US Forest Service estimates that more than 75 percent of the Cross Timbers ecoregion has been cleared for agricultural purposes. Thus the current biodiversity dilemma: Rare plant communities containing rare species confront habitat conservation challenges that expose them to uniquely

precarious situation. Tandy Hills inventory has identified ten species whose distribution (BONAP; Kartesz 2015) suggests they are natives of the Cross Timbers Ecoregion and of Tandy Hills Natural Area (Figs 11a-c). Species whose geographic distributions co-occur suggest that they all have similar suitable habitat conditions. Such habitat conditions appear to co-occur in Tandy Hills. This would suggest that conservation efforts in Tandy Hills would insure that the unique mix of species characteristic of Cross Timbers ecoregion might be expected.

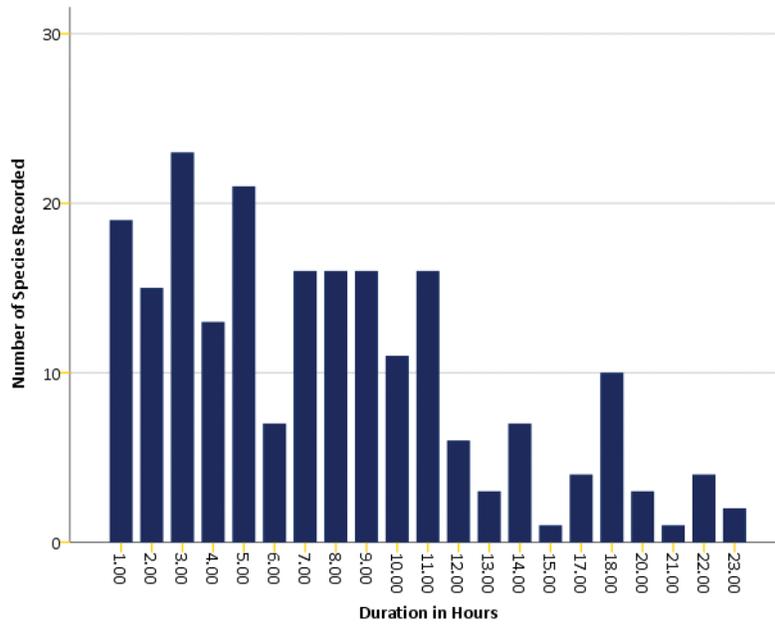


Figure 10: Relationship between the duration of observation during the Tandy Hills Natural Area BioBlitz and the number of species recorded. Calculated based on the first and last observation recorded in iNaturalist, time duration is not very precise and is prone to exaggeration. Nevertheless, the median duration- 8 hours- provides a useful estimate of average species recorded. Inventory by a single individual or a few individuals might take as long as 50 eight hour days.

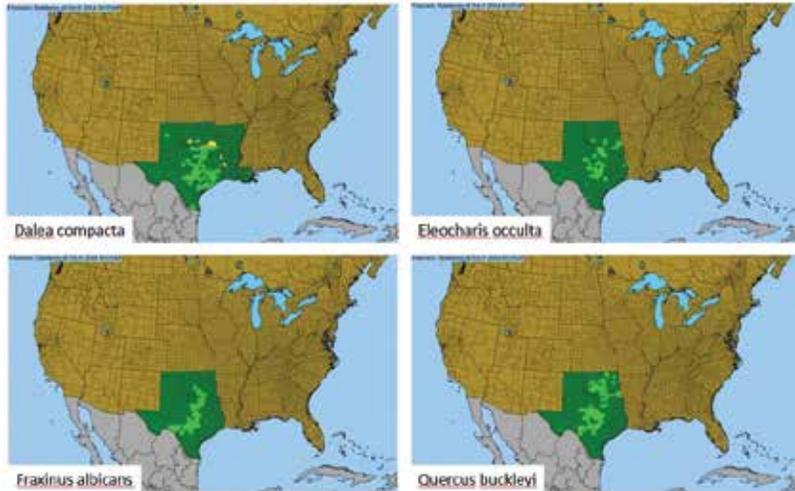


Figure 11a: Plant species occurring in Tandy Hills Natural Area suspected of being typical of Cross Timbers ecoregion and endemic to the North Central Texas-Central Oklahoma temperate grassland. Maps courtesy of [BONAP](#).

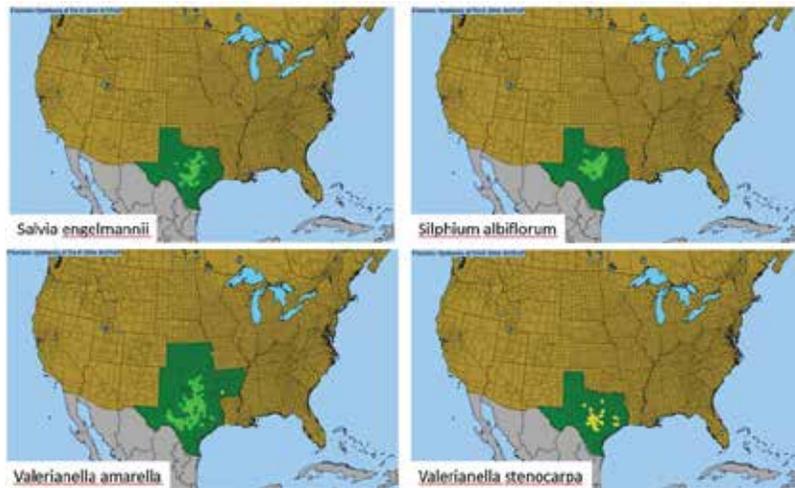


Figure 11b: Plant species occurring in Tandy Hills Natural Area suspected of being typical of Cross Timbers ecoregion and endemic to the North Central Texas-Central Oklahoma temperate grasslands. Maps courtesy of [BONAP](#).



Figure 11c: Plant species occurring in Tandy Hills Natural Area suspected of being typical of Cross Timbers ecoregion and endemic to the North Central Texas-Central Oklahoma temperate grasslands. Maps courtesy of [BONAP](#).

Summary:

Our efforts identified two species of birds, one snake, and one species of flowering plant that are currently listed on the TPWD list of Species of Greatest Conservation Need or on the Rare Plant Communities list as part of the natural heritage data centers mandate and the [Texas Conservation Action Plan](#).

Biogeography of the Cross Timber Ecoregion. Tandy Hills Natural Area is representative of the Cross Timbers Ecoregion as described by [NatureServe](#). Many Tandy Hills' species natural habitat is found wholly or largely within the Cross Timbers Ecoregion. Tandy Hills Natural Area is a 65-hectare relic of the Trinity River breaks that crosscuts the Cross Timbers Ecoregion. Species found in Tandy Hills that have a small geographic range defined by this ecoregion can continue to find/keep refuge in this protected natural area, this we can be certain of. Species occurring in Tandy Hills whose geographic range roughly coincides with the Cross Timbers Ecoregion include *Dalea compacta*, *Eleocharis occulta*, *Fraxinus albicans*, *Quercus buckleyi*, *Salvia engelmannii*, *Silphium albiflorum*, *Valerianella amarella*, *V. stenocarpa*, *Warnockia scutellarioides* and *Yucca pallida* (Figure 11). A number of additional plant species that have been reported from THNA in the past, based on phytogeographic suggestion, or have not been recorded yet that are also roughly co-localized with the Cross Timber ecoregion include *Corydalis curvisiliqua*, *Dalea tenuis*, *Lezpedeza texana*, *Lesquerella engelmannii*, and *Yucca neocopina*.

The Tandy Hills BioBlitz lead up to and the follow up identified approximately 600 (research quality observations, nearly 900 species including those without consensus), and accumulated more than 3750 observations and involved more than 160 naturalists. Since the event, the tireless efforts of numerous individuals, nearly 600 species have been confirmed (i.e., given the Research grade status).

Most of the species reported in Tandy Hills are plants and insects. The number of species will undoubtedly increase rapidly with continued focus on insects. Numerous species of birds, spiders, mammals, reptiles, and other invertebrates were also recorded. The evidence to date confirms the high integrity of communities characteristic of the Cross Timbers ecoregion, existing in Tandy Hills, and unique to North Central Texas and Southern Oklahoma. Two species of birds (Painted Bunting [*Passerina ciris*], the Scissor-tailed Flycatcher [*Tyrannus forficatus*]; and occurring at THNA are on the list of "Texas Species of Greatest Conservation Need," (SGCN); as is one plant species, the Topeka purple-conflower (*Echinacea atrorubens*), and one reptile, the Texas Blind Snake (*Rena dulcis*) as well as the Southern Plains bumblebee that appears to have declined recently in Texas.

In addition, two of Texas Parks and Wildlife's "Rare communities," {the Bur Oak - Shumard Oak Mixed Bottomland Forest and the *Schizachyrium scoparium* - *Andropogon gerardii* - *Sorghastrum nutans* - *Bifora americana* Mollisol Herbaceous Vegetation} are well also represented in THNA.

Twelve species of plants occurring in THNA appear to be endemic to the Cross Timbers ecoregion (Figure 11a-c); Such rare species are noted for their conservation importance because without such efforts, many succumb to the extinction vortex {small populations, narrow geographic range, specific habitat conditions}. Tandy Hills offers opportunity to avoid extinction of these unique organisms.

The BioBlitz also calls to attention the critical role of the Urban Biologists. Their efforts were instrumental to the success of the Tandy Hills Natural Area BioBlitz. Training volunteers to use iNaturalist facilitated data

collection tremendously. Their contribution to the effort would account for 90 percent or more of the project's success. It would have been much less successful if they hadn't been present.

The BioBlitz put into motion a community driven inventory that will enhance conservation efforts in the future.

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"The biotic richness of Tandy Hills Natural Area will soon become obvious to all.

The intrinsic value of nature makes the best argument for conservation."

— Bruce Benz, Biology Department, Texas Wesleyan University