Symposium 2012 Proceedings

“The Texas Hill Country: A Changing Landscape”

October 4-7, 2012
Kerrville, Texas
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Keynote Presentations

Donnie Frels
Project Leader, Texas Parks and Wildlife Department,
Edwards Plateau Ecosystems Management Project

Wire and Fire: A Historical Perspective on Ecosystems Management in the Texas Hill Country

The term ecosystems management is presently utilized throughout the conservation lexicon to represent a broad array of methodologies designed to produce a variety of desired products. Unfortunately, many biologists and range managers fail to fully understand the many variables, both natural and man-made, which influence this complex process through time. Although Leopold’s tools of wildlife management are widely accepted, the use (or misuse) of these tools can lead to poorly managed and inefficient systems producing undesirable products. Often times, a manager’s first response is to begin treating symptoms of the problem without identifying the actual cause. In order to fully realize the ecological potential of a site, managers must first understand the conditions and circumstances which led to its current state. Today, the Kerr Wildlife Management Area serves as a prime example of good range stewardship based on sound ecological principles. However, historical accounts reveal a vastly different scenario. This presentation will document the decisions, practices and tools responsible for the transformation of this property from native grassland savannah, to cedar brake, to a healthy ecosystem producing a diverse array of desirable products.

Jason Singhurst
Botanist/Ecologist, Texas Parks and Wildlife Department

An Overview of the Wetland Communities and Aquatic Flora of the Edwards’ Plateau

The Edward’s Plateau presents a wide array of diverse and unique wetland habitats that is not well studied or explored. In this presentation, I will review the geologic derivation and ecological conditions that supply these unique wetlands. I will provide you a landscape profile tour beginning at the headwater spring sources, making our way down perennial flowing creeks rivers, while intercepting several unique wetland communities along the way. I will discuss ecologically intact remnants and their associated flora that were once common place in this landscape. Finally, I will discuss some of the agencies and land trusts that are protecting these wetlands through wetland mitigation and conservation banking projects.
Dr. Chip Taylor  
Founder and Director of Monarch Watch; Professor Department of Ecology and Evolutionary Biology, University of Kansas, Lawrence, KS.

Native Plants: Sustaining Biodiversity  
The diversity of plant and animal life is largely the product of the interactions of pollinators and plants. The rise of the Angiosperms over 250 million years ago and their relationships with an increasingly diverse group of organisms that facilitated pollen transfer and therefore successful reproduction by the plants has given rise to at least 250,000 plant species. These plants in turn produce the fruits, nuts, berries, seeds and foliage that support over a million insect species, and the majority of our non-marine birds and mammals. By protecting and planting stands of native plants, Native Plant Societies sustain pollinators, keystone species, which are responsible for pollinating 70% of the vegetation in many natural communities. It follows that sustaining populations of native plants throughout Texas and the United States is absolutely necessary if we wish to maintain the wildlife that is dependent on these plants.

Dr. O. W. Van Auken  
Professor of Biology and Ecology at The University of Texas at San Antonio

Past, Present and Future Plant Species and Communities of the Edwards Plateau Region of Central Texas  
The Edwards Plateau Region of central Texas is approximately five times as large as the state of New Jersey, but unfortunately its plants are less well known. The Edwards Plateau eco-region is quite diverse and is known as an area of high endemism. Vegetation types include woodlands, shrublands, savannas and grasslands. There is an east to west rainfall gradient and a south to north temperature gradient across the region. Mixed juniper, oak and mesquite woodlands are common. Deeper soils are cultivated while common soils are usually shallow, underlain by limestone and grazed. Central Texas plant communities have changed dramatically in time as have other communities worldwide. During the Pleistocene (approximately the past 2 million years), the climate of the Earth was much cooler. Roughly 11,000 to 15,000 years before the present (early Holocene) the Earth began to warm and the warming continues today. Climatic warming and concomitant de-glaciation caused major changes in the distribution and occurrences of worldwide plant communities. Over this time frame, plant species and plant communities in central Texas changed considerably as well. Pine parkland was found in present day western Texas and central Texas grasslands and savannas. These early changes occurred without the influence of man or his domestic animals. However, 150 to 200 years ago, with the coming of Europeans to central Texas, the changes and rates of change of plant communities have been unparalleled. These recent changes do not seem to have been caused directly by de-glaciation. They are not really plant invasions, as suggested by many, but are best considered encroachment, which is a movement of native plants from adjacent communities that have been in existence for a considerable time. The area covered by many central Texas woodlands has increased as
grasslands and savannas have decreased. Species in these communities have changed as well. Specific causes seem to be constant high levels of domestic herbivory coupled to reduced amounts of light, fluffy fuel and a decrease in fire intensity and frequency. It is difficult to link projected future changes in climate and patterns of herbivory and fires to future plant community composition. However, examples will be presented and examined.

William “Feather” Wilson
President, Strata Geological Services, Inc.

Hydrogeology of the Texas Hill Country
Groundwater and surface water in the Texas Hill Country is a pristine and scarce natural resource. All of the subsurface and surface water is associated in one way or another with a series of geologic units belonging to the Lower Cretaceous System that crops out and is buried beneath the Texas Hill Country. The presentation will review the aquifers and the movement of ground water in these aquifers. He will weave a picture of the social, historical and environmental impacts these aquifers will have upon the land, the people and the vegetation.
Ten Years and Beyond Being NICE!: A Panel Presentation

Abstract:
Celebrate ten years of Operation NICE! (Natives Instead of Common Exotics) and learn how to start and sustain a NICE! program from experienced and start-up chapters. Join panelists Deedy Wright (Guadalupe) and John Siemmsen (Lindheimer) as they talk about combining chapter resources to co-create a NICE! program for 2012, and Anne Adams (Boerne) and Kathy Saucier (Trinity Forks) as they lend ten years (and more) of experience hosting NICE! Panelists will review successes, challenges and future opportunities for sustaining Operation NICE! You are encouraged to join the discussion after panelist presentations. Join in lively conversation, and learn how you can support NICE! for your community.

Ten Years of Operation NICE!

Anne Adams
Past President, Boerne Chapter; Operation NICE! committee member
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The NICE! (Natives Instead of Common Exotics) program was created by the Boerne Chapter in 2002 to promote the use of native Texas plants for landscaping, with the intent of reaching a wider audience than just chapter members. It was hoped that educating the general public might create greater demand for a variety of native plants in the local nurseries. The ultimate goal was to influence wholesale growers to produce more native species for consumers to purchase. The mission statement for NICE! was to:

Save water
Save money
Nurture wildlife
Choose native Hill Country species to preserve the Hill Country heritage and habitat

A small but enthusiastic group of chapter members formed a NICE! committee, whose function was to promote a seasonally-appropriate plant each month, write and distribute care instructions, and inform participating retail nurseries of our plant selections. Our program has evolved over time according to local circumstances and the talents and contributions of our members. There have been challenges and changes, but our NICE! program is going strong as we celebrate the 10th anniversary. The State NPSOT board adopted Boerne’s NICE! idea in 2005, and the Boerne Chapter gave a statewide workshop with representatives from 13 chapters attending. This presentation will address ten years of Operation NICE! in Boerne - where we have been and where we are today.
Six Years and Going Strong: Leading Operation NICE! by Example

Kathy Saucier
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In Fall 2005 Kathy Saucier & Marilyn Blanton were asked by then chapter president Cynthia Maguire to consider co-chairing the Operation NICE! program and bring it onboard for the Trinity Forks Chapter. We formed a committee and began organizing to start with our first featured plant in spring 2006. We chose to offer a "Plant of the Season" as it would be more doable for our chapter than a "Plant of the Month", contacted nurseries and asked them to participate and picked our first year of plants. Although nurseries have come and gone through the years, our chapter has worked with a total of 16 nurseries to feature native plants to their customers. At the 2010 Symposium in Denton, TX, we offered a workshop to chapter leaders on how to start up in the NICE! program and offered many details to help them work through the logistics. We currently share our seasonal plant write-ups with the North Central and Collin County Chapters. We are currently working with 6 nurseries and are on our 6th year in the program and continue to collaborate with other NPSOT chapters and show by example the success of hosting a NICE! program.

TRINITY FORKS NICE! PROGRAM TIPS

**Biggest positives** –
Our information write-ups reach beyond our chapter and nurseries.

- Ideas: submit to local newspapers and to other organizations such as Master Naturalists, Master Gardeners, Organic Clubs, Garden Clubs, etc. to post on their website or print in their newsletter.
- Builds relationships between our members and the nursery owners.
- Provides us detailed info on some of our top plants to hand our customers at our annual plant sale.

**Biggest issues** – species choice and supply for the nurseries.

**Choosing species** –
Pick what you can handle – monthly, seasonally, twice a year or whatever.
Avoid problem plants – difficult to grow, too aggressive or gives natives a bad name.
Rotate perennials, vines, grasses, shrubs, trees, groundcovers and present it in a month that the plant looks good.

Picking species that are available by wholesale – check websites such as Tawakoni Plant Farm, Native Texas Nursery in Austin, Southwest Wholesale Nursery in Carrollton, Native American Seed for seeds.

- Communicating with your nurseries –
  - Give them a list at least 2 years out in case they plan to grow the plants themselves.
  - If the nursery can grow their own plants, offer them seed, cuttings or starts.
Stay in contact with your nursery, be available if they have problems like supply, help them understand the use & needs of the plant if they don’t already, keep their notebook and sign up to date; Use your nurseries’ experience when choosing the species for the future; they may already know some reasons why a species doesn’t sell well.

NICE! A Public Education and Nursery Partnership Program of the Guadalupe County and Lindheimer Chapters of the Native Plant Society of Texas

John Siemssen
Past President, Lindheimer Chapter; NICE! Joint Steering Committee
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Precursor Materials

- Both chapters had prior outreach programs:
  - Guadalupe County Chapter
    - Care Cards for Plant Sales
  - Lindheimer Chapter
    - Plant of the Month presented at chapter meetings
Guadalupe County Chapter
Care Cards

Cedar elm (Ulmus crassifolia)
Cedar elm is a large, multi-stemmed tree growing 30-70 ft. high and 40-80 ft. wide. Dark green leaves are small and compounded. Full foliage is yellow. Trunk has the smallest blemishes of any native tree. Stems to make the small leaves— they compost quickly. Young trees have curly wings on their branches. Cedar elm is a reasonably fast growing tree.

Growing Time: Cedar elm grows in moist to dry alkaline, sandy or clay soils. Moderate water demands. Resistant to drought and heavy pollution soils.

Growing Height: Dig hole 2 to 3 times larger than tree, with the same depth or, the nursery container. Shovel up and plant from container and gently loosen any compacted soil around the root ball. Plant at the same depth as the soil in the container. Add 3 to 5 inches of mulch.

Growing Season: Watering in spring, water well after planting, using water smartly according to directions. For at least 1 month, water deeply every 5-10 days to prevent deep roots that will not tolerate drought. May stop a watering after a rainfall of 1/2 to 1". Once established, cedar elm is very drought tolerant.

Comments: The Morning Cecropia and Quassia Mark butterflies use cedar elm for larval food. Bees eat for nectar on the tree for cover and nesting sites. Small mammals also eat the seeds. Susceptible to Dutch elm disease. Fallout is known to cause allergic reactions.

Lindheimer Chapter

Plant of the Month

Development of the
Guadalupe County / Lindheimer
NICE!™ Program

Materials
NICE!™ Program Materials
Introductory Information for Nurseries

We do:
- Develop recommendations for native Plants & soils.
- Provide free materials on planting and care. A PNPD member will visit frequently for educational materials.
- Provide staff training, if desired.
- Publicize the Native Places through clubs, newspapers, radio and electronic media.
- Promote participating nurseries.

You do:
- Suggest native plants for non-native sites.
- Contact your wholesale growers and request increases in availability.
- Order native plants from your usual suppliers.
- Inform your staff of the NICE Native Places Program.
- Display and distribute care and planting handouts.
- Increase sales of native plants.

NICE!™ Program Materials
Posters
- Large - 4 Season
- Individual Quarterly

NICE!™ Program Materials
Signage
- Sized to fit standard holders
NICE!™ Program Materials

Care Cards
Placed in 4-tiered plastic display stand

NICE!™ Program Materials
Publicity Programs

- Presentations and Articles
  - Local Radio Programs
  - Local Newspapers
  - Garden Clubs
  - Master Gardeners
  - Master Naturalists

- Posters
  - Extension offices
  - Libraries
  - Heritage Societies

- Other
  - Speakers Bureau

NICE!™ Program Materials
Public Outreach Presentation

The Problem with Exotic Plants
- Invades 5,000 feet from roadsides, lawns, and sidewalks
- Spreads with the aid of wind, water, and wildlife
- More expensive to maintain
- Use less water
- Can be more deer resistant
- Preserves our rich Texas biological heritage
- Are beautiful

The Solution is Native Plants
- Native grow here naturally
- Also attract birds, butterflies, and wildlife
- Can be more deer resistant
- Preserves our rich Texas biological heritage
- Are beautiful
NICE!™ Program Materials
Alternatives to Common Exotics

- Notebook format
- Includes trees, shrubs and vines
- Illustrated Reference for Native Alternatives to Common Exotics

Example:
Exotic – Mimosa
   Native Alternatives –
   Desert Willow
   Texas Redbud
   Mexican Plum
   Retama

NICE!™ Program Materials

Thank you!

Questions?
The Cooperative Effort of Two Neighboring Chapters

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The Lindheimer and Guadalupe Chapters of NPSOT saw an opportunity to promote public interest in using native plants in landscapes through the NICE! program. Since neither chapter felt it could support the program alone, the chapters combined their efforts to draw on the talents of both their memberships which enabled them to expand the program to two counties. They used information from the Boerne chapter as a guide and adapted the program to their situation.

A steering committee of 3 volunteers from each chapter began meeting in January, 2012. The group began by looking at the big picture and made assignments to various members to bring back information to the next meeting. The committee met every two weeks for a while as it began to make big decisions based on member input and research. By April those decisions were made and work began on producing the materials that would be needed. Signage for the nurseries, plant care cards, news releases, and PowerPoint presentations for both nursery owners and the public were created. Publicity and education plans were drawn up and approved. And a NICE! budget was proposed and approved by the chapters. All this was completed by the end of June, getting ready for a September kickoff. Meanwhile a total of six nurseries agreed to participate—three in each county. Representatives for those nurseries and NICE! publicity folks were recruited from the chapters.

A continuing project to put together a picture book showing the more common exotics and their possible native replacements is an on-going off-shoot of the NICE! program. The book will be made available to the nurseries for their reference. However, because of its size, it will take longer than a few months to complete.

The talents and cooperation shown in this effort has been incredible. We are looking forward to a successful NICE! program in Comal and Guadalupe Counties.
Image, Public Relations and NPSOT

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Abstract:
Perception is reality. What are people’s perception of native plants, your chapter and NPSOT in general? What Public Relations [PR] seeks to do is change people’s perceptions. Image and perception are important if we want to achieve our goals. This one goal in our strategic plan is what PR is all about:

“Advocate for the needs of native plants, native plant communities and their habitats with elected officials and other government officials.”

So, how do we change people’s perception, strengthen our image, and gain support for our vision of the state? This workshop deals with ideas and methods used by PR pros over the years to change perceptions. The tools cost little and make a lasting impact. It is an interactive, hands on workshop designed to impart the maximum amount of knowledge into a shortest period of time. There will be a PowerPoint presentation and handouts for participants.
Public Relations

- Just what is public relations?
  - Your Chapter already has an image and public relations...do you want what you've got? Are you influencing your image?
- I visited one place whose President was extolling the virtues of their organization and was told: “We are the best kept secret in Texas” WOW

Public Relations

- What is public relations?
  - Public Relations is communication designed to put NPSOT in the best possible light, and to earn public understanding and acceptance. Public relations works toward improving the overall image of the organization. Marketing sells a product.

Public Relations

- Why do a public relations campaign? It:
  - improves the image of your chapter
  - builds morale in members
  - impresses funders; money comes easier
  - impresses civic leaders, building civic pride
  - makes the public see you in a different light; seeing your campaign, they want to be associated with your chapter.
Public Relations

- What is a communications audit?
- A communications audit asks questions like: where are the communications bottlenecks?
- Are people you/your staff information hoarder's? Some think information is power.
- Is your “look” consistent? Examine every piece of printed matter on the Chapter.

Public Relations

- Who are the publics you want to relate to?
  - Plant lovers
  - Board Members / Elected Officials
  - Chapter members
  - Towns People
  - Suppliers

Public Relations

- Message
  - Public Relations is all about communication, BUT....
  - What message do you want to communicate to your stakeholder groups? You must formulate your messages.
Public Relations

- Groups:                                Message:
- Plant Lovers
- Officials
- Funders
- Volunteers
- Your board

Public Relations

- Medium for transmitting the message:
- Word of mouth... Cheapest and Best
- Business Cards... great Benefit/Cost
- Media Release... no cost and underused
- Media Kit... makes you look professional
- Events... great P/R... programs, sales, etc.

Public Relations

- Word of Mouth:
- Simply tell your story to everyone
- Speeches: Lions, Rotary, Kiwanis, etc.
- Presentation to Chamber of Commerce
- Presentation to City Council
- Presentation at the NPSOT conference
Public Relations

- Business Cards:
  - They are THE basic tool right after you are introduced to someone.
  - They are:
    - not expensive... you can give 2 at a time.
    - like tiny bill boards
    - easily transported  See Box of Cards

Public Relations [continued]:

- They are:
  - places where you can show creativity
    always sent with letters, proposals, news releases
  - places where you can tell your story you can even print both sides or expand and do a fold-over
- Dollar for dollar, they are THE most powerful basic PR tool in your arsenal

Public Relations

- Media Releases
  - Did you know that over 75% of what you read in most newspapers originates with a media release?
  - The process is simple:
    - The release should be about NEWS
    - It should be no more than ONE typed page at a minimal of 1 ½ lines spacing
Public Relations

- Media Releases
  - Send it to the proper person
    - Send them electronically
    - Know your editor(s) and their deadlines
  - A news release will have at least:
    - A heading; release date; suggested headline;
      about three paragraphs, with the most important
      news in the first paragraph; indentation its the
      end...like: - end - or ###
    - Your contact information

Public Relations

- Who do you send releases to?
  - The media:
    - Newspapers, radio, TV stations, magazines,
      historic societies, NPSOT, etc.
  - Get to really know the editors and reporters
  - Never, as in EVER, lie to the media
  - Understand the deadlines for each media

Public Relations

- What is a Media Kit?
  - It’s a collection of some of your PR
    materials, in a folder or envelope.
  - At a minimum it should contain:
    - Your latest media release, a
      backgrounder on NPSOT, photographs,
      information on your latest program,
      business cards
Public Relations

■ Using the Media Kit
  - Media: don’t send a media kit unless there is a big newsworthy event to cover, program, award, personality in town, etc
  - ALWAYS Keep it fresh
  - Send it to periodicals or to organizations and associations also
  - What are Electronic Media Kits KIT

Public Relations

■ Events
  - become a media event, events get press
  - present numerous opportunities for media coverage. It can be a P/R bonanza
  - required resources: time, troops and money, they also require extensive planning, coordination, partners and teamwork.
  - THINK PLANT SALE or Symposium

Public Relations

■ Public Relations Communications Plan:
  ■ This is no more than a chart featuring time on the horizontal scale and tasks/actions on the vertical scale.
  ■ It is a visual, easily understood by all
  ■ It shows your board you are thinking long term
  ■ It shows your board you are proactive.
## Public Relations

- **P/R Questions**

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## Public Relations

- **Contact Information:**

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Organizations need Promotion and Public Relations effort to communicate with your NPSOT organization’s Stakeholders.

NOTE: Advertising promotes a product or service. Public Relations promotes the organization itself and its image.

Repetition generates affirmation and acceptance. The more “they” hear your name, the greater credibility you have.

Look at the most efficient “sales” strategy with priorities on the functions.

Simply put it is:
- Keep the customers you have! Read: Members
  - Sell the customers you have more stuff!
  - Sell the customers you have higher “gross” items
- Prospect for new customers

Marketing experts estimate that it is 7 times harder to prospect and recruit new customers [members] than to keep the “customers” you have. We are trying to sell people a perception of NPSOT and its value or service to the community.

COMMUNICATION TOOLS

1. Our organization’s name: NPSOT is Simple, Catchy, Memorable, Describes what we do. I don’t think you should change your chapters name.

2. Business Cards

* Dollar for Dollar this is the most powerful tool we have.*

*Every lasting business relationship starts with a handshake and an exchange of business cards!*

Advantages:
- Cards are incredibly cheap. Give away two at a time!
- They “store” easily and they are durable.
- They are like tiny billboards
- They are the one place where you/we show “individuality”.
Uses of business cards:
· Give them away at all events.
· Send them with proposals
· Send with our annual thank you letters to our customers/suppliers.
· Send them with every letter you write.

3. Media Releases

The media release (formerly called a press release) accounts for about 75% of what you see/read in the newspapers and 50% of what you hear on radio. A press release may be the most powerful tool in keeping our name before our stakeholders.

However, several things can happen with our releases:

· Nothing
· It may get modified (cut)
· It may be printed as it is written
· It may spark an editor to dig further into our story.

4. Media Kits

A media kit is simply a pocket folder, with a nice label on it that contains: a media release, a fact sheet about our organization, our biographical sketch of yourself or your President, photographs of native plants, etc. It may also contain the NPSOT organization’s tri-fold brochure. The pocket folder will have slits for holding our business card. I have found that Duo-Tang folders make the best impression. They have a varnish finish. They look professional.

5. Signing/Logo

What is your logo? Should you get a professional [college student] to design a your sign and logo. It will save money in the long run.

6. Web Page

Someone has to know you have a web page and where to go to get information. We have information to fill a web page, but they have a useful life of 45 days. In five years it will need to be updated weekly. That just means that in today’s technological society, it needs to be updated, changed, added to. Ten years ago [2003] a survey showed only 20% of people had ever ordered a product off the web. Now, I know people that even order groceries online. An out of date web page is useless. There must be a reason for someone to contact our web page…what will that be?
7. Events / Speaking Engagements

Events are great communication vehicles. An event may be your speech to a service club like Rotary or Lions. Your annual plant sale or the chapter programs are great for P/R. Every service club has to do fifty [50] programs annually. Now this can’t be a 15 minute commercial; however, it can be some aspect of your chapter. It could be people are gardens that the Media would find interesting. We may do a workshop at a conference or exhibit our materials at a trade show. If everyone just spoke positively about your chapter, it would be a great leap forward. Also, when you speak to a group they think that you are an expert.

8. Speaker’s Bureau.

A speakers bureau is just a list of names we circulate to various groups needing speakers. It usually has contact numbers and at least a title of the talk. Be sure to hand out your cards at all events.

9. Specialty Advertising

Giveaways. Everyone likes something free. Develop an item that has utility value, looks like it cost a lot, but is very inexpensive, that can have our name imprinted on it. I only have five clients, but every year, I support their organizations financially. That makes a difference.

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MEDIA RELEASE

Trinity Forks Chapter of the Native Plant Society of Texas

For Immediate Release

Jim Varnum Presents: The Wonderful World of Leaves

Cecil Carter, President of the Trinity Forks Chapter of the Native Plant Society of Texas (NPSOT), announced today that Jim Varnum, noted Master Naturalist, will be presenting a program titled the Wonderful World of Leaves at the month’s chapter meeting, on March 22nd. Carter noted; “Jim has spoken to our chapter a number of years ago and we are really welcoming him back.”

Jim is an enthusiastic amateur botanist and he developed this program for a wide audience. Jim said; “I will answer some of your basic questions about the purpose and features of leaves, why leaves may be lobed, compound, or arranged in opposite vs. alternate fashion.” Besides familiar sunflower, oak, rose, and grass leaves, Jim presents big leaves, small leaves, plants with no leaves, plants with no green color, and other oddities of the plant world.

NPSOT meets at the Texas Women’s University Denton Campus, in the New Science Building. It is on the southern edge of the main campus. The meetings start with a short social time at 6:30pm, with refreshments in the foyer. Then the program is presented on the 2nd Floor in the large auditorium/class room, at 7:00pm.

The Native Plant Society of Texas [NPSOT] strives to preserve our state's rich heritage for future generations. NPSOT is a non-profit organization run by volunteers who works to promote native plant appreciation, research, and conservation through 31 chapters located across Texas.

For further information, contact: Cecil Carter, ccarter@mscok.edu NPSOT web site:  www.npsot.org/trinityforks
The Necessity of Water Conservation: One Reason to Go Native

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Abstract
Native. Xericape. Water-conserving. Over the years, our municipal governments in Texas have changed the preferred wording of their strategies to get us to stop wasting so much water, as they have dealt with the reality of a society that has not yet recognized the limit of our natural resources. No one in Texas can take water for granted now; and the lack/potential lack of drinking water is an impending global crisis. Although for us, native plants have great value other than simply being “water-conserving” in the landscape, the ability to decrease landscape watering may be what first attracts other members of our community to get more familiar with them. As members of the Native Plant Society of Texas, being aware of some of the global issues that influence the selection of landscaping and agricultural plantings enables us to be a part of the global discussion, and help provide our communities with solutions. You do not have to become an expert to participate in this discussion!
Here are some facts about the history and current state of water in our state, nation and world. There are many more resources where you can get more details, but this outline will provide you with enough to go to a water board meeting, a state convention, or an international discussion on conservation, and share your love of native plants as part of the global water crisis.

One of the things we all have in common is water. In one way or another, we all depend on water. The choices we make, the actions we all take, ultimately our lifestyle today as what future generations will know as ‘Texas’ tomorrow. The obvious place to start is not to waste water in the first place (Smith, Roberts, Cronkite, & Texas, 2005).

Perhaps no other natural resource of Texas is more coveted, more haggled over and more central to who we are and who we’ll be than water. Every year since the first settler forded a river, stepped on the Texas soil, water has guided our progress and shaped our
destiny (Craven, Roberts, Southern, Thompson, Benson, Texas., & KERA Dallas/Ft. Worth (Television station), 2003).

University Corporation for Atmospheric Research hydrometeorologist Matt Kelsch, summed it up this way: “We are not getting back to some ‘nice time’ when we didn’t have to worry about water. Water is going to be an issue this century; it may be the biggest issue this century not only for the United States but around the world” (Meyer, Keasley, Arkenstone, Centre Communications, & Ambrose Video Publishing, 2009).

Is water running out? From elementary school we are taught that there is always the same amount of water on Earth. But it has become evident that the ways that humans have abused water resources is decreasing our access to the most vital compound we need. As human population increases in centers with impervious cover, the evidence is that our current lifestyles have already made themselves obsolete.

Water is a major import in the Middle East, where 90% of water comes from outside sources. Daily 35,000 people die from lack of clean water. Two-thirds of rural Africans lack drinking water, yet an even higher percentage of people in the United States of America live in areas of drought or contaminated groundwater. But global warming, while bringing about drought in some countries, causes others to be flooded. The world water crisis is “the greatest crisis ever faced by the human race.” (Burroughs, Sheen & Cinema Libre Studio, 2010). Melanie Stiassney, Ph.D., of the American Museum of Natural History, found that the use of water is increasing at twice the rate of population due to water-intensive food sourcing; and that the artificial movement of water from below the ground to on the ground has actually unbalanced the earth’s weight and affected the length of days (Moyers, Hogan,
What’s Going On?

Unsustainable Agriculture

The Ogalla Aquifer, which stretches 900 miles from Nebraska to Texas, provides 27% of the irrigated land in this nation with water; but at a drop of 1-3 feet per year, over-drafting is already decreasing efficiency in irrigation (Rogers & Leal, 2010, p. 51). In the western U.S., 80% of water goes to agriculture (Powell, 2008, p. 242). The subsidized use of agricultural water in this area costs more and produces less than other uses (Reisner, 1985; Waskom, p. 12). Almost a million acres of land have accumulated so much salt through irrigated use that it may already be unrecoverable for agriculture (De Villiers, 2001, pp. 141-144). Reducing the amount of water used in agriculture by even 10% could forestall water shortages for decades (Rogers & Leal, p. 50; Powell, 2008, p. 242).

Water and Wastewater

Most water supplies in the U.S. are drawn from polluted bodies of water and then filtered through physical and chemical processes to bring them up to drinking water standards (Rogers & Leal, 2010, p. 128). Water and wastewater systems across the U.S. are poorly maintained due to lack of adequate public funding. Yet sewage leaks threaten public health and degrade the environment (Rogers & Leal, p. 88). Environmental and engineering experts give the current infrastructure a “C” or “D” rating (Moyers, Hogan, Ablow, O'Neill, Moyers, Firestone, Films for the Humanities & Sciences,... WNET (Television station/ New York, NY), 2001; Meyer, Keasley, Arkenstone, Centre Communications, & Ambrose Video Publishing, 2009).
In 2007, Orange County, California, became the first municipality in this nation to recycle wastewater into drinking water (Rogers & Leal, p. 114). St. Petersburg, Florida, was the first U.S. town to recycle sewage for landscape irrigation. In 1977 the system was completed to non-residential users, and to residential users by 1990; yet because the amount of water poured onto lawns is six times the amount of water going into the sewage system, the city could not meet the demand (Rogers & Leal, p. 38-41). Even with a full system or recycled water for irrigation, otherwise unrestricted landscape watering is not sustainable.

**Uniquely American Concerns**

“Americans have long been the poster children for water gluttony” states Anita Hamilton (2011). The United States Bureau of Reclamation projects that by the year 2025 existing water supplies will not meet water demand even under normal circumstances (United States Bureau of Reclamation, 2003, p. 2). The most explosive growth is predicted to be in areas that have some of the lowest natural water supply in the nation. Something unique to the United States allows addition of fluorine compounds to drinking water. The natural level of fluorine compounds present in water varies geographically. Excessive levels of fluoride have been linked to a host of illnesses beyond fluorosis, including Alzheimer’s dementia, bone fractures, hardening of the arteries, thyroid disease, Down’s syndrome, arthritis, central nervous system damage, cardiovascular problems and breathing difficulties (Bryson, 2004, pp. 222-226).

**Texas**

Texas fell under Spanish water law as part of Nueva España, then under Mexican water law as part of Mexico. The Republic of Texas allowed people to draw water from rivers if they touched their property, as part of the “riparian doctrine” of English common
law. In the late 19th century, the state legislature granted the state all water rights and then issued them to individuals based upon land ownership seniority. The “capture rule” applied by the Supreme Court in 1904 gave property owners the right to draw from aquifers below their lands. Says Tom Kaiser of Texas A&M University, “Here we are 100 years after this rule was first adopted in 1904 and certainly technology has changed; the state of Texas has changed. Unfortunately, the rule has not kept up with technology and with our changing society. The rule very simply…rewards the biggest pump” (Smith, Roberts, Cronkite, & Texas, 2005).

Water planning originally focused on water for various human consumptions. Disputes resulted in violence. In Texas, decisions were made on the state level until 1991, when Senate Bill 1 established 16 regional water planning authorities. Each authority receives its own charge from the state. Water planning is now more comprehensive. In 1991, the Sierra Club was joined by the Guadalupe-Blanco River Authority and other parties in suing the United States Fish and Wildlife Service. The finding for the plaintiffs resulted in oversight of aquifers (Smith, Roberts, Cronkite, & Texas, 2005). Senate Bill 1 of 1997 required 50-year planning to meet water needs while protecting natural resources. Senate Bill 3 of 2007 created a process to protect environmental flows of rivers and streams and for estuary protection (Hodge, L., 2010). That year the Texas Water Development Board created the Texas Water Trust where property owners could deposit their unused water rights. Unfortunately, state law allows those downstream to use these unused waters (Sansom, Armitano, & Wassenich, 2008, pp. 199-200).

In Texas today, “water…is the quintessential limiting factor for human development of the state” (Ward, 2011, p. 1). The 2012 Water Plan of the Texas Water Development
Board projects the need for an additional 8,300,000 acre-feet of water beyond current supplies by 2060. Of these, the report states “Planning groups were unable to find economically feasible strategies to meet over 2 million acre-feet of annual needs, with the vast majority of the unmet needs in irrigation” (Texas Water Development Board, 2012, p. 174).

Closely tied with the water crisis are weather extremes. Wildfire danger is highest when unusually dry weather follows upon unusually wet (Nielsen-Gammon, 2011, p. 15). Bob Beduhn of HDR Engineering found that the central U.S. is experiencing more severe drought and also larger floods; and that the water rights have already been so “over-appropriated” that current water rights cannot be met during drought (Meyer, Keasley, Arkenstone, Centre Communications, & Ambrose Video, 2009).

Conservation

Costs of Not Conserving Water

Water is cheap, at least the amount we pay for it compared to what our use costs all of us. As we continue to use up groundwater and surface water, we use more energy. Mary Kelly of the Environmental Defense Fund points out that in order to reduce use of water, we need to conserve both energy and water; we have to be more efficient in using each to save more of the other (Smith, Roberts & Texas, 2009). The constant search for more water leads to consideration of desalination, although considered prohibitively expensive to many water-seekers:

Once we acknowledge the energy demands of supplying fresh water, two other aspects of the intersection of energy and water in water supply also become important. First, there are always tradeoffs among energy use, economic costs and benefits, social benefits, and environmental costs in providing for water supply—including, most recently, climate change considerations.
Second, as a matter of governance, the political and legal mechanisms currently available for establishing water and energy policies cannot consider all of these relevant tradeoffs explicitly and coherently.

New developments in water supply, however, may increasingly force governments to comprehensively consider the full panoply of tradeoffs involved in supplying fresh water to human populations. Specifically, the world is facing a fresh water crisis. (Craig, 2010, pp. 227-228).

Due to the overwhelming cost of desalination, expense is the focus of many discussions. This has spared some entities from the inevitable conflict over the consequences of desalination. As we can see from our brief history of water resources management in this country, our continual inability to “live within a budget” will leave us thirsty and dry no matter how much water we “find” if we do not stop wasting what we already have.

Tom Stehn of the United States Fish and Wildlife Service says, “It just makes no sense to keep taking more and more water out of the rivers. And the misconception is that water that just flows down the river and enters the bay is wasted. Well, that is just ecologically wrong. It’s what makes the bay productive” (Smith, Roberts, Cronkite, & Texas, 2005). Texans are generally aware of the continuing recovery from the brink of extinction of the whooping cranes; yet the blue crabs that are their primary diet are dependent upon freshwater inflows to the bay. The increasing international ecotourism in Texas depends on clean water.

Removal of bottomland hardwoods in east Texas has led to dirtier water and increased residential flooding. Texas Parks and Wildlife Department biologist Jim Neal estimated close to 75% of hardwood bottomlands to have been eradicated. Jim Dickson, an United States Forest Service biologist, argues that “The bottomland hardwoods are one of the most productive systems in the world; the number of species, the number of vertebrates is just tremendously high; it’s also very productive for maintaining biological diversity on a broad scale” (Smith, Roberts, Cronkite, & Texas, 2005).
Harvests from the Gulf of Mexico account for 80% of all shrimp and 62% of all oysters, as well as other seafood. Coastal development and manipulation of water resources has destroyed half of the Gulf wetlands, reefs, mangrove swamps and grass meadows (McKinney, 2011). Within the 615,000 square miles of the Gulf, there are many features that protect wildlife and humans. Thomas Shirley of the Harte Research Institute has researched the salt domes of the northern Gulf, and found the coral reefs of the southern Gulf outnumber those found in the Florida Keys. Barrier islands with adjacent coral reefs provide natural defenses against hurricanes. Oyster reefs cleanse the upper coast while sea grass meadows clean the lower coast. Faye Grubbs, a marine biologist with Texas Parks and Wildlife, found that sea grasses prevent erosion, absorb excess nutrients from stormwater runoff; and are essential to water quality through photosynthesis.

Mark Fisher, science director of the coastal fisheries for Texas Parks and Wildlife Department has noticed that the warmer winter temperatures (6-7 degrees Fahrenheit warmer since 1991) have reduced populations of flounder, dramatically increased populations of gray snapper, and have created northern migration of black mangrove and red mangrove plants along the Texas coast. He and other experts project the sea level to rise 1-2 meters this century (Smith, Roberts, & Texas, 2010).

The major impact of global warming is not warmer temperatures, but the effect on the hydrological cycle (Meyer, Keasley, Arkenstone, Centre Communications, & Ambrose Video Publishing, 2009). As less water has been available to evaporate from the earth’s surface, the earth has become more parched. National Oceanic and Atmospheric western water assessment director Brad Udall says, “Climate changes and global warming is more about changes in water than in heat” (Udall, 2009).
The Most Sensible Way

Calvin Finch of San Antonio Water System explains, “Water conservation is the least expensive way to increase available water for your community” (Smith, Roberts, Cronkite, & Texas, 2005). The Lower Colorado River Authority has found that using reservoirs costs them five times as much as funding conservation measures for the same amount of water (Hodge, 2011).

The individual people who see the effects often so eloquently get to the point. Max Shumake, a rancher, expressed his opposition to development of the Marvin Nichols Reservoir:

This is needless water. By their own figures they say that 60-65% of the water that’s used in that area is to water their lawns. You know, just think about that: You’re gonna take my place and put it under water so someone in Dallas on the edge of the desert can water their Saint Augustine grass that shouldn’t be growing there to begin with (Smith, Roberts, Cronkite, & Texas, 2005).

The Necessity of Native Plants

It is clear that the short-term American insanity known as the green grass lawn is, or soon will be, a thing of the past. The facts show that this obsession has bankrupted our own generations to the extent that in the very near future we will simply have no choice but to stop watering the lawn. And even if we found the water, the warmer climate would no longer host the very invasive and exotic species we once watered. No one can any longer ignore the warning of John Wesley Powell to Congress during his term at the Bureau of Reclamation in 1893:

When all the rivers are used, when all the creeks in the ravines, when all the brooks, when all the springs are used, when all the reservoirs along the streams are used, when all the canyon waters are taken up, when all the artesian waters are taken up, when all the wells are sunk or dug that can be dug in all this arid region, there is still not sufficient water to irrigate all this arid region.
As Clark Wilson, president and chief executive officer of Green Builders, said:

The silliest thing we do is spend a bunch of time, money, effort treating water and then spraying it out on our lawns…Having the indigenous plants that are used to the Texas climate and the Texas drought and the Texas heat, are exactly what you need to be putting in; they’re beautiful as well. Everything we can do to save energy, save water and be sustainable is no longer a fad; it’s a necessity.

Some Tools for Advocacy

There are thousands of documents addressing the growing water crisis; there are numerous books, films, global action groups. Why is this not at the top of the agenda at every level of government? The present and future of our local, regional and global water resources is too important to leave up to elected officials. As a native plant advocate, you have a tool to help lead us to sane and sustainable living. No one can know all there is to know about water sources; so don’t worry about being an expert. Just do what you have to do for a brighter future!

Going to a meeting to discuss water? Take along a copy of Water in Texas: An introduction (Andrew Sansom) to have a variety of facts ready. Regularly visit Texas Parks and Wildlife website http://texasthestateofwater.org/ for information about the current state of water in Texas and related issues; visit http://www.twdb.state.tx.us/waterplanning/swp/2012/ for the 2012 State Water Plan; visit wildflower.org for native plant tools. Want to share a movie? Check out Tapped. Next time you want to read a novel, don’t; check out Cadillac Desert (Marc Reisner) for a stranger-than-fiction read that’s sure to raise your blood pressure.
References


Accelerated Succession: KR Bluestem to Native Grass Restoration

David L. Davidson
Landowner, Kendall Co., Scientist, retired

Abstract
The invasive grass, KR Bluestem (Bothriochloa ischaemum), has covered much of the Hill Country due to overgrazing, drought, and this grass being spread by many sources. Wildlife do not want to use KR, particularly grassland bird species. To increase biodiversity, we have been seeking methods to restore native grasses to areas dominated by KR. A protocol has been developed that does, in fact, replace KR with native grasses that we call “Accelerated Succession.” Measurement of soil biotics (the numbers of bacteria, fungi, and genera of nematodes) indicates that the soil conditions present in areas where KR was killed and restored by this process are rapidly (a year or so) transformed much closer to those conditions characteristic of a mature prairie, and this has prevented the reinvasion of those areas by KR. We only have data for several years, and long-term results are necessary to determine if the trends seen will continue. Despite the drought of 2011, results are encouraging.

INTRODUCTION

We started restoration of 138 acres in eastern Kendall Co. in 1996 with almost no grass and a lot of Cedar, mostly secondary growth. Our restoration goal is to increase biodiversity [1]. By 2005, we had cleared at least half of the Cedar (Ash juniper) and grass had grown back - mainly the invasive grass King Ranch Bluestem (Bothriochloa ischaemum), hereafter abbreviated as "KR." Note, we think that KR is the only one of the "Old World Bluestems" that we have, but there also could be others. This detail seems not to be very important. Our bird surveys have indicated few grassland species, and the reason appears to be a lack of native grasses. A search of the literature reinforced the idea that grassland birds do not like KR [2 ].

To increase biodiversity, both plant and bird, replacing KR with native grasses seemed to be one of the next projects we should pursue as a restoration goal. But no solutions were found when we sought a procedure to get rid of the KR; thus, a research
project was initiated. Being life-long experimentalists, the idea was to try something and learn from the results. It was not even clear as to what the questions were. Experimentation has been coupled with a review of relevant (and extensive) literature, and on-going discussions with possibly knowledgeable people.

BACKGROUND

In 2005, we learned about efforts by The Nature Conservancy (TNC) to replace KR at a preserve west of Austin. First we tried to kill the KR with an herbicide (Roundup) - the TNC way. That treatment may have killed some of the grass, but not much. Since herbicides also kill other species besides the target, further herbicide use was abandoned.

We did not have the resources to burn our prairie in the growing-season, as suggested was beneficial by research at The Wildflower Center, so we decided to kill the KR by slow, contained heat - this is called "solarizing." A swimming pool thermal blanket (bubble type) was deployed for 3 months in our initial attempt, and it resulted in killing everything in the area covered (named Solar 1, or S1). We then reseeded with native grass and wildflower seeds, but without tilling. The winter of 2006 was dry, so we watered (sprinkled) the plot about every 7 to 10 days, trying to put down the equivalent of about 1/2 inch of rain. By spring of 2007, the results were encouraging - the seeds germinated and KR had been replaced.

Subsequently, we solarized 3 other areas adjacent to the first, but for less time and with sensors in the soil beneath the solar blanket to measure temperature. We measured 135 deg. F at mid-day with a clear sky in June for Solar 2. Thirty days, and with only a few cloudy days in June killed the KR, but not some of the forbs in Solar 2, and was equally as
effective for Solar 3, but not for Solar 4. In solar 2 & 3, we tilled the plot before spreading grass and wildflower seed. Today, autumn, winter, and spring rains result in good stands of wildflowers and some grass in Solar 1, 2, and 3; Solar 4 is covered with KR. Solar 4 failed because the solar blanket disintegrated and it was cloudier than usual while it was deployed. Our efforts appeared to be effective, but solarizing is a slow process, and our measures of "success" were photographs of before and after.

In 2007, at the Texas Invasives Conference, Dr. Barron Rector [3] put forth an hypothesis about the symbiosis between species of grasses and the biotic condition of the soil. The essence of his hypothesis was that KR, which was in place for decades, had conditioned the biology of the soil to optimize its success, and to replace KR with native grasses, the biology of the soil would have to be changed to again favor native grasses. The way to make this change involved going through the process of succession, as had occurred in the original formation of the prairie.

Dr. Rector's ideas and his hypothesis seemed worth pursuing, and it provided a possible science-based metric for further experimentation. However, succession is usually a long process, so finding some way to speed it up appeared to be of the essence.

We began to focus on the soil biology and to try to characterize the biology of soils, and how to change it, assuming that would be necessary. The first soil samples were taken in May 2008 in Solar 1 and several other areas, including one site nearby that offered promise as an example of good native prairie, but proved subsequently to be of no value.

Soil samples were sent to a service company named Soil Food Network in Corvallis, Oregon, now named Earth Fort. They measured (quantitatively) bacteria and fungi, both total and active, Protozoa (Flagellates, Amoebae, and Ciliates), Total Nematodes, Nematode
genera, and the percentage of plant roots colonized by Mycorrhizae. No mycorrhiza was found. Mycorrhiza has not been found at any site sampled on our property, to date. We are now purchasing it in powder form from Mycorrhizal Applications Company in Oregon.

We soon learned that there were no data with which to compare the results of the soil biota measurements. We have searched for a biodiverse native prairie in Kendall and Comal Counties, as might have existed prior to the onslaught of pioneers and their cattle, but have found none. During a "bioblitz" by TNC of property in Brazoria County, we took soil and root samples from Nash and Nowatni Prairies, remnants of native coastal prairie known for their biodiversity, and sent them for analysis. We are using these results as the "reference soil biology" for native grass prairie, even though the distance to this prairie is about 150 miles from our restoration site.

RESULTS

For several years, the results of the soil biota measurements were confusing, but through continued reading of the literature, searching the internet, and analyzing the results, the useful information in these data has become clearer. Specifically, we have learned that:

(1) early succession in any grassland is characterized by bacterial dominance, and this shifts to more of a balance between bacteria and fungi for a native grassland as it moves (succession) towards a climax association of species, i.e., a mature prairie.

(2) the nematode genera present in early succession change to other genera as succession proceeds, and it is possible to create an index to quantitatively relate the nematodes in the soil to the level of succession of the prairie.

(3) Mycorrhiza should be present in native grass prairies. Review of the literature indicated that mycorrhizial association occurs for native prairies in the Midwest, California, Brazoria
Co, TX, and 80% of the plants in the world have a mycorrhizal association. No mycorrhiza has been found on our restoration site; therefore, it seemed reasonable that adding mycorrhiza would be beneficial, perhaps even necessary, to reestablish a native prairie in the Hill Country. Mycorrhiza is being purchased from a supplier in Oregon.

The levels of bacteria and fungi, and the genera of nematodes present in the soil give us two metrics by which to judge the "success" of the restoration procedure that has evolved, and is described herein. First the procedure is described, then a visuals are presented that show the relationships between the metrics at various times for some of the restoration sites (Plots). Calculation of the Succession Index is done by placing the nematode genera found into one of 5 categories [6], applying a weighting factor to the abundance of each category and summing the result [7]. Please contact me for further explanation of the Succession Index and its calculation.

REPLACEMENT PROCEDURE

The procedure that has evolved and proved successful, so far, follows:

1. Kill the KR. This is necessary, and may be done in various ways. We prefer heat for smaller areas, but there are ideas as to how to go about this for larger areas [5].
2. Prepare the area for reseeding by tilling to about 2 inches deep. Break up clods and remove the big rocks (greater than about 2 inches).
3. Spread compost across the area. This provides a starter set of soil biota.
4. Mix grass and forb seeds and mycorrhiza.
5. Distribute the mix with a fertilizer spreader (or other device). It may be necessary to add sand into the mix to achieve a more uniform spread. Distribute 5 times the density of seeds that is recommended by seed supply companies.
6. Lightly brush the seed with a brush-broom or back of a garden rake so that seed is very lightly covered by soil.

7. Compress the soil. We use our feet because we don't have a roller available, which would be better.

8. We have begun covering the reseeded area with a thin layer of cut brush to discourage deer from using the area, but this may not be necessary.

The mix of species' seeds distributed depends on soil type. Consult the Natural Resource Conservation Service (NRCS) to determine for your area the soil type and a list of the grass species that were present historically in a native prairie. You may have several soil types that require different seed mixtures. We are using a seed mix for Soil Type 8 for a prairie with climax species association. For forbs, we are using the seeds of perennial wildflowers because that is what is available. There is also very little information on what forbs should be in a native grass prairie in the Hill Country. The wildflower species chosen should be those typically found in your area. Consultation with the companies that sell native grass and wildflower seeds is extremely useful and helpful. There are several Companies that service the Texas Hill Country.

RESULTS - GRAPHIC PRESENTATION OF METRICS

The ratio: fungi/bacteria vs. an Index of Succession based on the nematode genera is shown in Fig 1. There are large filled dots (red) for the values of these variables for "Native Prairie" and "KR" to give a sense of the location of the restoration plots in this context of what is being replaced and the restoration goal. Both "Native Prairie" and "KR" are the average of multiple samples, and have large values of standard deviation, omitted here for clarity. The restoration plots for which we have data are shown. The trend is generally
towards an increase in the fungal/bacteria ratio and an increase in the Succession Index from low to higher values - towards the goal of the soil biotics of a mature prairie. As is shown, not all restoration Plots began at the "fire sterilized soil" condition. This is thought to be because restoration at Plots 3 and 4 were begun 5 and 24 months after the burn scar was produced, which allowed some changes in the soil to occur. During this interval, what might be termed "natural restoration" has begun. Some forbs, and perhaps a few native grass shoots, appeared, apparently from the seed bank, but very little KR reappeared.

![Figure 1](image)

**Figure 1** Measurements of soil biotic succession: from Fire Sterilized Soil to Native Grass Prairie. Note that KR Bluestem has soil biotics different from Native Prairie.

The location of KR in **Fig. 1** indicates that the soil within which this species is growing does not have the characteristics of native prairie, but it is considerably different from sterilized soil. The progression of KR dominated prairie to a native species prairie
should result in a soil where the activity of fungi and bacteria are more in balance and a mix of nematode genera that has more fungal and fungus/root consumers. The trajectories of the restoration plots appear to be as anticipated for these changes in soil condition. Casual observation, other anecdotal information, and presentations at the Kerr Wildlife Preserve, indicate that native grasses, especially Little Bluestem, will eventually dominate a grassland in which KR is present, but where there also is a significant fraction of other grasses. The time for native grasses to replace KR is expected to be very long (30 years ?) and will be dependent on a number of variables, with rainfall and herbivory likely to be the most important.

Fig. 2. Time sequence of efforts to replace KR Bluestem with Native Grasses. The 2011 drought slowed, but did not reverse, the progression towards succession to Native Grass Prairie, except for Solar 1, which was not treated with mycorrhiza.

Another way to present the same data is shown in Fig. 2, where the Succession Index
is shown relative to time. The same trends are seen as in Fig. 1, but in this figure, the time sequence of changes in the areas being restored are more apparent.

By comparing Fig. 1 and Fig. 2, the effects of the drought are revealed. Whereas the drought resulted in a decrease in the ratio fungi/bacteria, i.e., the drought caused the soil to revert to a more bacterial state, the Succession index continued to increase, indicating that the nematode genera continued to evolve towards a soil condition indicative of a mature prairie. Solar 1 is the exception to this trend, and as noted above, Solar 1 did not receive the same treatment as the other restoration Plots. Also note in Fig. 2, Solar 1, the effect of soil moisture on the relative abundance of nematode genera.

In both figures, the effect of the 2010-2011 drought can be seen. For the Solar 1 Plot, the drought caused a decrease in both the fungus/bacteria ratio and the Succession Index. For all of the restoration Plots, the Succession Index increased through the drought, while for 2 of the 4 restoration Plots, the drought resulted in a decrease in the fungus/bacteria ratio.

We only have data for the 5 restoration Plots shown on the figures, but 4 additional Plots have been restored within the past year, so there will be data from at least 9 Plots in the future.

DISCUSSION

The mycorrhiza literature, as it pertains to grasslands, is vast, and we are familiar with, only a part of it, but several useful research results have been found. The restoration of burn scars in a forest north of Flagstaff, where thinning had resulted in brush piles that were burned, was investigated by Korb, et al. [8], who determined that areas inoculated with mycorrhiza, found locally, restored better than areas not inoculated. That work was done 11 years ago and Korb's restoration areas are currently being resurveyed to determine the long
term results of the restoration. The procedure that Korb used that produced the best results is close to that described herein.

Some recently published research [9] examined the effect of KR on the mycorrhiza and production of biomass of commingled native grasses in Oklahoma. The research used greenhouse grown plants, not field grown. The presence of KR was found to stunt the growth of native grasses and lower colonization by mycorrhiza in the native grasses as compared to KR. This result appears to confirm the need to kill the KR as Step 1 in a replacement strategy. The results also indicate the importance of mycorrhiza in the restoration process, which agrees with the work of Korb, et al., and contributes to our belief that mycorrhiza should be included in the process of restoration (Step 4).

QUESTIONS
1. **Is it necessary to add mycorrhiza to the seed mix?** We don't know, but we apparently have no mycorrhiza, so if we don't add it, there will be none. The indications from other research is that mycorrhiza is necessary.

2. **Why is there no mycorrhiza in the soil?** Probably mycorrhiza was extirpated by intense overgrazing for decades by domestic livestock.

3. **If you buy mycorrhiza from Oregon, you won't get the species that are native to our area. Isn't that a problem?** The genera of mycorrhiza purchased are the most common 4 species of Gigaspora that are found throughout the world. This genera has also been found in the fossil record at a time before Pangea broke apart. Nothing I have found has indicated that there are specific species unique to Texas, but it would be no surprise if there were. Species specific to the Hill Country at this point is of secondary concern.
4. **Does KR Bluestem have a mycorrhizal association?** Yes, at least in Oklahoma, where research [9] has shown that the association is very strong. However, KR flourishes where no mycorrhiza has been found, so it may be that KR has less of a need for mycorrhiza than native prairie grasses.

5. **Why plant so many species of native grasses and forbs (wildflowers)?** Depending on the soil type, temperature, rainfall, the age of the seeds, and how well they are planted, not all species are likely to germinate, and probably not all in the same year. We want to ensure something will grow, but do not know how to predict what will germinate or when. If irrigation is available, then it might be possible to find a different seed mix that would be as good or better than the climax related mix we are using.

6. **Why seed at several times the recommended level?** It is necessary to establish as dense a root mass as possible as soon as possible in order to prevent a reinvasion by KR. Native prairies have dense root masses. The fastest way to establish a dense root mass is to reseed heavily. We do not know just how many times the recommended level is necessary; best guess is 5 times. In addition, some of the seeds will be eaten by insects, birds, and rodents before they can germinate.

7. **Why is it necessary to kill the KR before beginning the restoration?** We have tried it both ways and have had success only by killing the KR with heat. Also, it is much easier to prepare the seed bed without live KR roots. Research has shown [9] that KR will dominate at least some species of native grasses when both are present, resulting in a poor restoration.

8. **Why only restore burn scars?** Burning brush piles provides high heat for a relatively short time. This process does not kill some of the native grass and forb seeds already in the soil, but does kill the whole KR plant. The same thing can be achieved by solarizing at lower heat.
for a much longer time. It may be possible to till or plow an area to kill the KR, but we have no experience with that.

9. **Is it necessary to add compost while preparing the seed bed?**  It is not known to what depth the fire kills the soil biotics (bacteria, fungi, nematodes, etc.), but adding compost in the restoration process ensures that the "heat sterilized soil" is inoculated with these necessary biota. This also adds some organic matter to the soil, which is beneficial.

10. **Will the restored native grass prairie be like the pre-settler prairie?** No, the climate has changed, the frequency of fire is different, and the wildlife are different. What we hope to achieve in our restoration is to change the soil to a physical and biotic condition where KR finds it difficult to grow, and to create a soil condition that gives an edge to the growth of native grasses and forbs, whatever the species mix turns out to be as the climax state is approached.

11. **When is the best time to restore?** Since water is such a critical part of the restoration process, timing to those parts of the year when rainfall is likely is best. Seeding in the autumn should be done a month before frost, and seeding in the Spring should be started only after the soil temperature is 70 deg. F or higher, and the forecast is for rain.

12. **How do you know that this restoration process will be durable?** We don't know what grass and forb species will be growing in our restored areas 5, or 15 years into the future, and no method (model) to predict this has been found. Our hope is that by changing the soil biotics to favor native grasses and forbs, some mix of native species will have formed a dense root structure characteristic of native prairies that will not allow KR, or any other exotic species, to invade. We hope that the results of the current reexamination of the burn scar restoration by Korb 11 years ago will show that the restoration is durable.
13. How long will it take to reach a climax (end of succession) prairie condition? We don't know, and it depends on many variables, such as what is in the seed bank, rainfall, fire frequency, and herbivory, all of which are unpredictable.

14. Where do the different genera of nematodes come from as the prairie changes through succession toward a climax state? We have not been able to discover how this happens. Perhaps all the nematodes are present and only when conditions are correct for their particular life cycle do they emerge.

15. What is the best method for tracking the progress of a restored prairie site towards KR replacement? Initially, analysis of the soil should indicate whether or not soil biota are being conditioned for growing native grasses. After a year or so, visually monitoring (including photography) of the area for native grasses and forbs, and determining if KR is reinvading the site, would probably be worth the effort. A detailed inventory of the grasses present at various times in the trajectory towards climax would also be valuable.

16. Can tens or hundreds of acres of KR be restored using the method you have outlined? Are you sure you want to try to displace KR at any one time from such a large area? Restoring small patches at different times will create greater biodiversity than restoring large contiguous areas at the same time due to differences in the uncontrollable variables (rainfall, temperature, etc.). At least some of the steps need to be mechanized for large scale restoration work [5]. The seed catalog from Native American Seed Company also has some ideas about how to treat large areas. Failure of the restoration of large areas will be costly.

17. Will grassland bird species use the restored native grass prairie? We don't know, but hope to investigate this by observation and census and we will try to find research by others who are working to examine the same result.
CONCLUSIONS

We believe that the procedure for replacing KR Bluestem with native prairie grasses has progressed into a working solution, at least for small plots. Our proof, given the short time frame of this restoration, is the observed change in soil biota from the start of succession fairly rapidly to a condition towards the end of succession to native grass prairie. These results indicate that hypothesis of Dr. Rector is essentially correct, and the succession process he envisioned can be accelerated by the procedure described.

There are many questions related to this restoration, some of which we can answer, but many that can only be answered by continued monitoring of the restored areas. Because of the many uncontrollable variables, every plot that is converted from KR to native prairie will be an experiment; therefore, uniform, repeatable results should not be expected. To achieve restoration, persistence and continued improvement of methodology and monitoring will be required.

Related research elsewhere [8,9] is helping us to be more confident that the KR replacement procedure described herein is effective and may be durable.

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Edwards Plateau Dirty Dozen

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Note that this paper was not presented at the Symposium.

Abstract
“On a global basis…the two great destroyers of biodiversity are, first, habitat destruction and second, invasion by exotic species.” (E.O.Wilson) Exotic invasive plants cause economic or environmental damage or harm human health. They cost the United States economy $135 billion annually in control costs. Invasive plants reduce biodiversity, form monocultures, displace and compete with native plants, transform ecosystems and alter hydrologic conditions, soil characteristics, nutrient flow and fire patterns. This paper highlights the twelve plants that have been identified as particularly worrisome in the Edward’s Plateau ecoregion. The author emphasizes the importance of prevention, early detection and rapid response, suggests eradication strategies and describes ways that individuals and organizations can be part of the solution.

We are blessed with amazing biodiversity in Texas. The flora of Texas includes more than 5000 plant species. The Edwards Plateau, one of the ten ecoregions of the state, is characterized by grasslands, juniper/oak woodlands and plateau live oak or mesquite savannah. However, the Edwards Plateau is changing rapidly, and the area is experiencing increased invasion by exotic plants. There are three primary reasons for the increase.

First, burgeoning human populations are changing the Hill Country landscape dramatically. Humans are the primary dispersal vector of invasive plants. The “best predictor of non-native species-richness is human population density.” (Davis, 2009)

Second, habitat destruction to build roads, homes and businesses increases the susceptibility of the land to invasive plants. Nonnative, exotic plants are often the first to repopulate a disturbed area.
Third, the Edwards Plateau region has been identified as the most flash-flood prone area in the United States by the National Weather Service. Periodic flooding of our creeks and waterways moves propagules quickly and easily to new locations. Research indicates that water can disperse propagules farther and more easily than wind can disperse seeds.

The Invaders of Texas program defines ten ecoregions in the state of Texas and lists the twelve particularly worrisome invasive plants in each region. (EcoAlerts, 2012). Descriptions of each invasive plant are available from the Invasive Plant Database (Invaders of Texas, 2012) and from a field guide published by the U.S. Forest Service, Southern Research Station (Miller, Chambliss, Lowenstein, 2010).

**Glossy privet (Ligustrum lucidum)** was introduced to North America from China, Japan and Korea and is widely planted as an ornamental for hedges and borders. It is a fast-growing evergreen shrub approximately 25 feet to 40 feet in height with a 25 to 35 foot spreading crown. It has a dense canopy of bending branches composed of glossy green leaves. Flowers are produced in large clusters and are small, cream-colored and strongly scented. The fruits ripen into terminal clusters of purple-black ovoid drupes. Both leaves and fruit are poisonous to humans.

Ligustrum lucidum replaces mid-canopy trees in forests and can completely dominate an area of forest if not controlled. Ligustrum colonizes by root sprouts and is spread by abundant bird- and other animal-dispersed seeds. Few insects feed on it because chemicals in the leaves inhibit digestion. Ligustrum is widely believed to contribute to allergies and asthma.

Young plants may be hand pulled or pulled with the aid of a weed wrench or mattock. Cut shrubs left untreated will grow back with several branches emanating from a single
stump. Shrubs may need to be cut multiple times until they die. For large stands, plants may be sprayed with glyphosate or triclopyr herbicide in late autumn or early spring. Herbicide may also be painted on cut stumps or applied to the bark. Removal of seedlings must include the entire root system and the fruit must be collected and destroyed.

**Chinese tallowtree** (*Triadica sebifera*) is native to China and Japan where it is cultivated for the oil or tallow in its seed. This oil is used for soap and candles. It was introduced into the United States in the 1700’s in South Carolina and Georgia.

Chinese tallowtree may grow to a height of 60 feet and up to 3 feet in diameter. It is a perennial, deciduous tree with dark-green, heart-shaped leaves that turn brilliant yellow and scarlet in the fall. Dangling yellowish spikes in spring yield small clusters of three-lobed fruit that split to reveal popcorn-like seeds in fall and winter.

The tree may reach reproductive age in as little as three years and a single tree may produce up to 100,000 seeds per year. The seeds are readily transported by water and birds. It also propagates via cuttings, stumps, and roots. Fallen tallow leaves release a cyanogenic compound capable of inhibiting growth of other plants, which helps make this tree an effective invader. Chinese tallowtree invades stream banks, riverbanks, and wet areas such as ditches as well as upland sites and fallow fields. It thrives in both freshwater and saline soils.

To eradicate, apply a triclopyr or glyphosate herbicide to the basal bark in late summer or early fall. For large trees, girdle and spray or cut and spray the stump after cutting down the tree. Pull up seedlings by hand. Large land areas may be managed by mowing and the careful use of controlled burns.
**Johnson grass** (*Sorghum halepense*) was introduced in the early 1800’s and widely planted as a forage grass. It is a warm season, perennial grass with vigorous, thick, creeping rhizomes. It has a wide leaf blade with a prominent, wide, white midvein. It is a coarse grass with reddish-to purplish-black panicles, and may grow up to 8 feet tall. It grows rapidly, is highly competitive with crops, and is considered one of the 10 most noxious weeds in the world.

The seed disperses to great distances by wind, water, agricultural activities and animals. Some seed survives ingestion by birds and mammals. The glumes tightly enclose seeds and can protect seeds from decomposition in the soil for several years. It grows best on fertile, well-drained soils and is common along roadsides and creek sides. It is sometimes brought in by soil from off-site.

Johnson grass may be manually removed by pulling it up by the root. It cannot tolerate repeated, close mowing. Repeated tilling every few weeks in summer or winter may help control infestations in agricultural fields. Crop rotations that include winter crops and crops planted in late summer also help to control infestations. Sulfosulfuron may be used as a broadcast spray to control actively growing Johnson grass.

**Heavenly bamboo** (*Nandina domestica*) was introduced from eastern Asia and India in the early 1800s. It is a perennial, evergreen, erect shrub that grows to a height of 6 to 10 feet and width of 3 to 5 feet. The plant has multiple bushy cane-like stems that resemble bamboo. The leaves are soft green and may be tinged red in winter. It produces early summer terminal clusters of tiny white-to-pink flowers. If plants are grouped, shiny red spherical berries follow the flowers in fall and winter.
Nandina colonizes by spreading underground root sprouts and by animal-dispersed seeds. Berries may be toxic to cats and some grazing animals. Nandina is difficult to remove manually because even the smallest piece of root will resprout. It may be effectively controlled using glyphosate or triclopyr herbicides. For tall plants, cut the stems and then apply herbicide. Collect and destroy any fruit.

**Chinaberry tree** (*Melia azedarach*) was introduced in the mid-1800s from the Himalayas and Asia and is widely planted as a traditional ornamental. It is a fast-growing, perennial, deciduous tree with a spreading crown. It grows to a height of 50 to 60 feet and as much as 2 feet in diameter.

Chinaberry has lacy, bipinnately compound dark-green leaves that become golden-yellow in the fall. The flowers hang in long, loose clusters, each with 5 lilac petals and a dark purple center. The berries are yellow-tan, in loose drooping clusters. They ripen in the fall and remain on the tree into the next growing season. The berries are poisonous to livestock and people.

Chinaberry leaf litter raises soil pH, thus altering soil conditions for native plants and seed germination. Chinaberry reproduces on-site primarily from root sprouts or root collars, and over longer distances via abundant, bird-dispersed seeds. The most effective chemical controls are cut-stump and basal bark applications of triclopyr herbicides. Cut trees left untreated will grow back with several branches emanating from a single stump. Removal of seedlings must include the entire root system. Collect and destroy the fruit.

**Japanese Honeysuckle** (*Lonicera japonica*) was introduced as an ornamental from Japan (through England) in 1806. It is a semi-evergreen to evergreen, high-climbing, perennial, woody vine that grows up to 80 feet, with stems to 2 inches in diameter and
opposite branching. The flowers are white (or pink) and pale yellow. The fruit is a nearly spherical berry that is green, ripening to black. It is easily distinguished from native vining honeysuckle by its black fruits (natives have red to orange fruits).

Japanese Honeysuckle forms dense infestations along forest margins and right-of-ways as well as under dense canopies and as arbors high in canopies. It tends to form a monoculture, and can girdle trees as vines thicken with age, killing hosts and eventually changing forest structure. It is shade tolerant and persists by large woody rootstocks. It spreads by underground rhizomes, aboveground runners from nodes and by animal-dispersed seeds.

In loose soil, plants may be pulled up by hand, but root fragments will resprout. Repeated pulling of entire vines and root systems may be effective. Repeated mowing may slow vegetative spread and sever climbing vines, but is most effective when combined with herbicide application. Honeysuckle may be significantly reduced by cutting vines off trees to prevent them from climbing to the light necessary for stronger photosynthesis and to keep them from girdling and killing shrubs and other plants. Cut the large vines just above the soil surface and immediately treat the freshly cut stem with a glyphosate or triclopyr herbicide. Tethered goats have been used to remove honeysuckle growth.

**Giant reed** (*Arundo donax*) was brought from Western Asia, Northern Africa and the Mediterranean in the 1800’s as an ornamental plant. Since then, it has been widely planted throughout the warmer areas of the United States as an ornamental and for erosion control in the Southwest.

Giant reed is a tall, perennial grass that may grow to over 20 feet in height. Its fleshy, creeping rootstocks form compact masses from which tough, fibrous roots emerge that
penetrate deeply into the soil. The stems are corn-stalk like, gray-green and hairless. Large, plume-like, 3-foot long terminal panicles are borne in the fall.

Reproduction of giant reed is primarily vegetative, through tuberous rhizomes which root and sprout readily. The long, fibrous, interconnecting root mats choke riversides and stream channels, crowd out native plants, interfere with flood control, increase fire potential, and reduce habitat for wildlife. Large stands of giant reed change a territory from flood dependent to fire dependent habitat. It ignites easily and can create intense fires. Few herbivores browse the plant because the plant contains many toxic chemicals.

Giant reed can float miles downstream where root and stem fragments may take root and initiate new infestations. Because of this, real elimination has to be planned from the highest invasion point in a river basin to the lowest. Broad-spectrum glyphosate and/or imazapyr herbicide may be used. Late summer-early fall applications work best because plants are moving nutrients into their roots. Also effective is cutting the reed and waiting 3 to 6 weeks to spray re-growth. Small populations may be controlled by physical removal of rhizomes, although this is very labor intensive.

**Golden rain tree** (*Koelreuteria paniculata*) was introduced from China and Korea as an ornamental tree. It grows 30 to 40 feet tall. At maturity, it has a rounded crown, with a spread equal to or greater than the height. It has compound leaves that give it an overall lacy appearance. The leaves turn yellow before falling.

The tree grows moderately and bears large panicles of bright yellow flowers in the fall when few other trees bloom. The 2-inch red-purple seed pods are papery, three-compartment, bladder-like structures full of seeds. They look like Chinese lanterns.
Reproduction occurs via seed that germinates rapidly. Water may contribute to the spread of the seeds. Birds may also play a factor in the dispersal of the seed.

To eradicate Golden rain tree, freshly cut stumps of larger trees may be sprayed with herbicides to avoid resprouting. Removal should occur before seeds are produced. Small seedlings may be mowed or pulled by hand.

**Elephant ears** *(Colocasia esculenta (L.))* was introduced from Asia, India and Southeast Asia in 1910 as a substitute crop for potatoes. It is a perennial herb to 4 feet tall, with thick shoots from a large corm that may grow to 6 inches in diameter and weigh up to 6 pounds. Slender stolons are also often produced, along with offshoot corms. Leaves reach 2-3 feet in length and are heart or arrowhead shaped, green to bluish black, all emerging basally from the corm. Flowers occur at the apex of a fingerlike flower stalk and the fruit is a small berry, in clusters on the fleshy stalk. Seeds are 2-5 per berry and are generally rare.

The plant reproduces primarily vegetatively, via stem fragmentation and budding at the base of the plant. Disturbance greatly encourages its spread. It forms dense stands along streams, ditches, canals, lakes and rivers. Plants may be removed mechanically, but care must be taken to keep the plant intact, as remaining fragments will readily germinate. Plants also respond to eradication with broad spectrum glyphosate formulations for use near water.

**Paper Mulberry** *(Broussonetia papyrifera)* was introduced from China, Japan, and temperate East Asia to Polynesia in the mid-1700's. It is a deciduous tree with milky sap that grows to a maximum height of 45 feet. The leaves are densely gray-pubescent and are often lobed or mitten-shaped.

Separate male and female flowers appear in the spring. Male flower clusters are elongate, pendulous, 2 to 3 inches long, and are composed of many individual flowers.
Female flowers are globular and about 1 inch in diameter. The fruits are reddish purple to orange up to 1 inch in diameter, and appear in summer.

Paper mulberry exhibits aggressive growth and quickly invades open habitats such as forest and field edges and disturbed areas. Paper mulberry spreads both by seed and through vegetative expansion. The seeds are spread far and wide by wildlife who feed on the fruits. Manual and mechanical methods, in combination with triclopyr herbicide treatment, are effective.

Tree of heaven (*Ailanthus altissima*) was first introduced to America from Europe in 1784, although it is originally from Eastern China. It is a rapidly growing, deciduous tree that may reach 80 feet or more in height. Ailanthus has large compound leaves, 1 to 4 feet in length.

In late spring, clusters of small, yellow-green flowers appear near the tips of the branches. Seeds are produced on female trees in late summer to early fall, in flat, twisted, papery structures called samaras that are tan to pink. Samaras may persist on the trees throughout the winter. All parts of the tree, especially the flowers, have a strong, offensive odor, which some have likened to peanuts or cashews.

Tree of heaven grows rapidly and reproduces from seeds and root sprouts. Seeds are dispersed by wind and water. Viable seeds may be produced by 2- and 3-year old plants. One study reports that an individual tree may produce as many as 300,000 seeds per year.

Once established, ailanthus trees produce toxins that prevent the establishment of other plant species. The root system is aggressive enough to cause damage to sewers and foundations. Established trees also produce numerous suckers from the roots and re-sprout vigorously from cut stumps and root fragments. Nationally, ailanthus has become an
agricultural pest and may occur as seedlings that pop up by the hundreds in recently planted fields.

In addition to removing small plants by hand, the most effective method of ailanthus control seems to be through the use of triclopyr herbicides. Although it is relatively easy to kill the above ground portion, it is necessary to kill the root system to prevent or limit stump sprouting and root suckering.

**King Ranch bluestem** (*Bothriochloa ischaemum var. songarica*) presents a very serious ecological threat due to widespread planting by ranchers and highway departments. It is a perennial, warm season 18 to 48-inch tall bunchgrass with stems arising from almost a flat crown. The light green stems turn up and branch freely and turn a straw color when mature. The stems are naked at the top and each produces a terminal loose seed head. Both the sterile and fertile spikelets are conspicuous with slender, twisted, bent awns. The branches have fine silky hairs. Timely mowing, burning and herbicide application all suppress this species.

**Prevention, Early Detection and Rapid Response**

The most critical factor in the invasives challenge is prevention. The Invaders of Texas program has identified 149 invasive plants. The majority of these invasive plants have escaped cultivation from our backyards. Homeowners and businesses are inadvertently planting exotic invasive plants that wreak havoc on our ecosystems. Once the species is introduced, eradication efforts may become an overwhelming challenge.

At the November 2009 Texas Invasive Plant and Pest Council conference, Texas Parks and Wildlife Deputy Executive Director for Natural Resources Ross Melinchuk indicated, “One dollar of prevention is worth $100,000 of the cure.”
The Lady Bird Johnson Wildflower Center sponsors a program called Plantwise. In their brochure, they list the following ways you can help with the Invasives problem.

1. Know your plants
2. Use non-invasive alternatives
3. Watch out for invasive plant hitchhikers
4. Have a care if you share
5. Use only seed mixes that are invasive plant-free
6. Use weed-free soil and mulch mix
7. Be especially careful with aquatic plants
8. Keep an eye on new sprouts and volunteers
9. Dispose of invasive plants carefully
10. If you can’t part with your plant-contain it, control it, or cage it.

Education and awareness are critical to the solution. Most individuals, government agencies and businesses do not spread invasive plants intentionally. There are numerous examples of “unintended consequences” where a plant is introduced for erosion control, agricultural purposes, building materials or ornamental purposes. Learn as much as you can about the invasives challenge and share your knowledge with others. Consumers may play a key role in the control of invasives using their purchasing power.

Over the long term, the most cost-effective strategy against invasive species is preventing them from becoming established. Early detection of incipient invasions and quick coordinated responses are needed to contain invasive species before they become widespread.

**Eradication Strategies:**

Detailed eradication strategies for invasive plants in our geographic region are available in the form of a management guide published by the U.S. Forest Service, Southern Research Station (Miller, Manning, Enloe, 2010).
Effective treatments include: herbicidal methods, manual methods, mechanical methods, cultural methods, biological control, mulching and solarization.

Herbicidal methods include the use of a spray bottle or paint brush, back sprayer or broadcast spraying. Directed foliar sprays wet all leaves. Basal sprays and wipes are applied on the lower portion of woody shrub, vine and tree stems. Stem-injection (including hack-and-squirt) involves applying herbicide into downward incision cuts spaced around woody stems. Cut-treat involves applying herbicides to the outer circumference of freshly cut stumps or the entire top surface of cut stems. Spraying of soil-active herbicides may be used around certain invasives. Broadcast herbicide applications may be used for infestations that are too extensive or dense to permit selective herbicide applications.

Manual methods include hand pulling as well as use of a wide array of tools for cutting, chopping, wrenching and girdling invasive plants.

Mechanical methods use machines to clear large or dense infestations. Skid-steer loaders, mulchers, tractors and bulldozers have special attachments that may be used to reduce invasive woody plants.

Cultural methods include prescribed burning under specific and controlled conditions, the use of propane spot burners, and water-level manipulation through raising water levels through flooding or lowering water levels through drawdowns.

Biological control includes the use of insects and pathogens as well as prescribed grazing that relies on cattle, sheep, goats and horses to reduce infestations.

Mulching for weed control is the use of materials to cover the soil surface that block light. Solarization uses polyethylene sheeting to cover low growing, cultivated, mowed or
chopped invasive infestations and trap solar energy to heat the soil and space under the sheeting.

**Rehabilitation, Restoration and Reclamation**

The promotion and establishment of desirable vegetation is one of the most important phases of an integrated invasive plant management program. The goal of rehabilitation, restoration and reclamation is to establish fast-growing native plants that can outcompete and outlast any surviving nonnative plants while stabilizing and protecting the soil and water features.

**Ways that Individuals and Organizations Can Help**

The Invaders of Texas program trains volunteer citizen scientists to detect the arrival and dispersal of invasive species in their own local areas. Local citizen scientist teams locate, report and eradicate environmentally and economically harmful invasive species. These teams contribute important data to local and national resource managers who coordinate appropriate responses to control the spread of unwanted invaders. The Invaders Program is designed to move beyond awareness to action on invasive species.

We cannot eradicate all the invasive plants in our neighborhoods, parks and communities. However, volunteer citizen scientists in Texas have eradicated thousands of invasive plants. We have shared what we have learned with our friends, families, neighbors and our communities. We have spoken to the managers of local nurseries about their promotion of invasive plants, and have chosen to purchase our plants from nurseries that promote native plants. We have contributed to a statewide data base to further advance the science around invasive plants.
Anthropologist Margaret Mead said, “Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has.”

**Reference List**


The Extreme Drought of 2010-2012 and Its Effects Upon the Native Plants of the Texas Hill Country

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Abstract
Observations were made of Texas native plants of the Texas Hill Country and their reaction to the extreme drought of 2010-2012. Plant attributes, environment and soil characteristics were identified that made the observed plants extreme drought resistant.

Drought:
Drought is defined as a condition of below normal rainfall. Native plants have experienced, variable rainfall and soil moisture since their beginning. Therefore, there is no surprise that they have developed a variety of strategies to survive. The categories of drought have been developed by humans to assess the damage to their water supplies and food sources. We use drought tolerant to classify our plants that are used in our gardens and landscapes. I have always had difficulty with this classification because there are no measurable parameters defined. What do I measure to determine drought tolerance and what should I do??? When I select a Texas native plant for the garden, when does a garden native plant become drought tolerant? How much drought tolerance does it have? What plant characteristics do I consider in order to rate its drought tolerance? I will provide data for these questions below.

I have been observing the drought tolerance of Texas native plants since 1991. When I moved to Texas and became hooked on natives. I have created rainfall only portions in my landscape along with maintained planting areas surrounding the house. The roadside and driveway areas are rainfall only.

observations reported here are of Texas Hill
Country plants within my property and in the eastern portion of the Hill Country. My observations cover from 1996, when I established many Texas Native plantings, to July 2012. I made many observations and took photographs of plants and habitat during 2009-2012, a period of extreme drought in central Texas. This period saw a major drop in lake levels over a long period of time and the loss of significant soil moisture. In addition to soil moisture, plant characteristics, sunlight and environment affect a plant/s ability to survive drought. Let’s review the drought behavior for 2009-2012 and the drought monitor system. Figure 1. Drought Map 4-24-2012.

Drought Intensity: Blood Red-Exceptional

Red-Extreme Drought, Orange- moderate Drought

Yellow-Abnormally Dry, No Color-Normal

Figure 2. Texas Drought maps.
The Texas Hill Country:
The Texas Hill Country is defined differently by many authors. Since I have been studying and growing Texas native plants, many of them from the Hill Country, I have used Marshall Enquist’s definition and diagram of the Texas Hill Country for this presentation. The region consists of the Lampasas Cut Plain (dense decayed organic matter and decomposed limestone), the Ilano Uplift (decomposed granite and decayed organic matter), the Edwards Plateau (decomposed limestone and decayed organic matter).

Figure 3 Texas Hill Country

In both maps the central blood red falls within the Hill Country and is the exceptional drought classification. The plants mentioned in this article survived this exceptional drought condition.

Drought Survival:

How did plants of the Texas Hill Country survive the 2010-2012 extreme drought?

Life Cycle

Growth Factors

Leaf characteristics

Root Systems
Life Cycle:
Seed, that was dormant during the drought, germinate when adequate moisture and soil temperature are available. Fall and spring rains are the triggers for germination along with appropriate soil temperature. Rains support growth. Blue Bonnets and Indian Blanket are examples. All seed does not germinate the year after production. They contribute to the natural seed bank.

Growth Factors:
Fleabane is a low growing perennial with small, grey-green leaves. The plant can be used as a soil moisture indicator because it will start shutting down when soil moisture is reduced, its leaves will lose the green chlorophyll color becoming more gray. In decomposed limestone, it reaches no more than 4-6 inches. In areas rich with decayed organic material, it will reach over 12 inches and sprawl. Frostweed is a tall perennial whose stems contain pores for storing moisture, the stem is thick, and over one inch at the base and is generally found in the shade of trees.

Leaf Characteristics:
Size, color and behavior add to a plant’s ability to survive a drought. When one considers the frostweed (verbisina virginica), with its very large leaves, you would not consider this plant as drought survivor. However, if soil moisture becomes too scarce and its stem and leaf moisture reservoirs dry up, the plant starts dropping leaves from the bottom up. The plant will become a leafless, dormant stalk. When it rains, the stem leafs out and flowers appear.

The goldeneye (viguiera dentate) is another plant that uses this technique. The Indian Blanket (gaillardia pulchella) has a low moisture and coarse textured leaf. Greenthread
(thelesperma filifolium), an annual/perennial (if deadheaded), has very fine thread-like leaves which conserve moisture.

**Root Systems:**

Plants survive drought with fleshy, fibrous or long taproots. The Englemann Daisy (engelmannia pinnatifida) is an example of a long taproot. I have measured taproots 12-24 inches long. The Englemann Daisy has an additional fibrous section. The diameter of the top portion or the root stalk was over 4 inches.

The Engelmann daisy goes dormant during summer if the plant is not deadheaded.

The Bluebonnet has a thick, long taproot for survival during drought. The plant grows during the winter when moisture is generally available. The liatris (liatris mucronata) has a corm and a deep taproot along with thin, stiff leaves. Being a late summer, fall bloomer, the plant has adapted to the low moisture environment of July-August.

**Behavior:**

Trees turn their top surface away from the sun, leaves will begin turning brown on the edges and top growth (the portion of the leaf most sensitive to low moisture. This has been observed on goldeneye and frostweed during the drought of 2010-2012. Leaf drop, as observed on the Texas live oak is another drought survival adaptation.

**Plant Environmental Factors:**

Sunlight/Temperature

Surface Topology

Soil

Companion Plants
**Sunlight/topology/companion Planting/Surface topology:**

These factors are what I call CHANCE because they are natural random events. Sunlight and temperature affect the life processes of plants. Plants have adapted to these factors through growth, leaf properties and root systems as described above. Topology is a geological feature that determines the plants moisture resource. Slopes allow rain water runoff and therefore water doesn’t become absorbed by the soil. Depressions or other obstacles allow rain water to be absorbed into the soil. In addition, soil type, water holding capacity and water penetration ability are equally important.

**Summary:**

Texas native plant drought survival is a very broad area of study. The drought survival of Hill Country native plants and other native plants across Texas continue to amaze me. I am attempting to classify native plants with the drought definitions outlined here. No longer, can we list a plant as just drought tolerant. We must specify soil characteristics, the amount of time needed to adapt and sunlight conditions.

Let’s view some examples: see appendix A
APPENDIX A

Extreme Drought Survivors, a sample. Photographs- post 2011 extreme drought

Texas Mimosa

Texas Star, Purple Three Awn Grass

Wafer Ash

Texas Star-Annual

Texas Mimosa- Rosemary shrub lost the drought battle

Square bud Primrose
Veronia baldwini-Western Ironweed.
Salvia Farinacea, Hesperaloe

Williamson County Winecup, Englemann Daisy, Salvia Farinacea-
Purple, Austin Silver, Cedar Elm
Yellow Hesperaloe, Live Oak
NaturalPlanting age-15 years old

Damianita-all brown during 2011

Pavonia lasieopetala-Rock Rose

Note: morning dense shade-this portion gets west sun. Englemann Daisy,

Purple Spiderwort-goes dormant summer or low rainfall

Indian Blanket re-bloom 5-2012
APPENDIX B - Contains author’s observations to date. Additional data will be published in the NPSOT-Williamson County website as material becomes available.

Extreme Drought Tolerant Texas Native Plants

Tolerance depends upon:
Soil type
Moisture retention characteristics of soil
Sunlight exposure
How long established

Plant list is from the naturalized landscape of Armand Hufault (1996 to present).

Plants in decomposed limestone with a low volume of decayed organic material
Texas Mimosa
Texas Persimmon
Agave
Zexmania
Skeleton leaf Goldeneye

Plants in a mixture of decomposed limestone and Blackland Prairie decayed vegetative clay and good drainage
Yucca Pallida x twisted leaf yucca
Yucca Pallida
Hesperaloe parviflora (yellow and coral)
Texas Pistache
Retama—in bloom 9/1/2011

Well-drained mixture of decayed organic material and coarse mineral particles
Observed Extreme Drought Survivors post 8/31/2011
Bacharis Neglecta (Poverty Weed shrub)
Grey leaved Aster
Texas Mimosa
Texas Pistache
Twisted Leaf Yuccca
Nolina (both varieties)
Prickly Pear Cactus
Cholla
Retama
Bush Sunflower
Texas Roadside Natives: Post 2011 Extreme Drought- Extreme Drought Survivors
Late March –April 2012

FM 1105
Butterweed-Annual

Natives along Lakeway Dr. Georgetown
White standing winecup
Black eyed Susan

FM 487 East Natives along Davilla from US195 East to US377 south to Giddings
East to Elgin
Yellow Lupine -US 290 west from Texas 377
White Yarrow-US290 at Texas 195 North at Elgin

East from US95 to Davilla at Davilla Cemetary - get wildflower seeds about May-June
Lady Tresses

FM 487 West past Winery
Standing Winecup
Larkspur East left from mailbox 4801 and west from curve at CR234

Southwest Parkway from US 71 Southwest Austin, Texas
Purple Scullcap-wrightii
Missouri Primrose- Texana
Nerve-Ray Daisy-tertragonotheca texana
Parralena 2-8 inches,yellow, Spring-Fall

FM1431 East from IH 35
Lantana Horrida

FM 1431 Lago Vista Limestone roadside
Damanita

Cliffs FM2222 on ramp to Loop 360 right
Fragrant Mistflower - Eupatorium havanese
Maidenhair Fern

FM 971 East by cemetery
Texas Hyacinth

CR311 east to IH35 by cement culvert near goats
Texas Four O’clock

CR 311 west after catalpa tree
Purple spiderwort
Antelope horns milkweed
Sawleaf daisy
Engelmann daisy
Greenthread

FM 971 East- Before Sign CR335-Blackland Soil-Ditch
Green Milkweed
Bundleflower
Ironweed
Texas Wild Hyacinth

References:

Enquist, Marshall, *Wildflowers of the Texas Hill Country*, Lone Star Botanical, Austin, Texas, 1987

Drought maps and definitions, the National Drought Mitigation Center (NDMC), the U.S. Department of Agriculture (USDA) and the National Oceanic and Atmosphere Association (NOAA).

[www.wildflower.org](http://www.wildflower.org)
Abstract
This presentation will explore the evolution of the Texas Hill Country region beginning over a billion and one-half years ago to the present. What is so special about this region? In addition to the geological history, the talk will cover the past and present inhabitants, the changes that have occurred since settlement, and what the future might hold. The Edwards Plateau, which includes the Hill Country, is one of the most diverse biological regions on the planet. Although it covers only 17 per cent of the state, more than 40 per cent of the flora and 60 per cent of the birds are found here. Over 100 million bats call the Hill Country home during the summer months. Very colorful insects, including butterflies and dragonflies also call this region home. The presentation will conclude with a brief discussion regarding stewardship of our land and natural resources.

The Texas Hill Country is a special place deep in the heart of Texas not only for the people who live there, but millions of visitors annually who want to have the experience of being there. When the first European settlers began their discovery of this special place almost 200 years ago, this wild and beautiful landscape began to change and is continuing to change under heavy development pressure. This article will examine what is special about the region and what we can do to keep it that way for future generations to enjoy. Only one driving trip through the region is necessary to capture your attention as you witness spectacular vista after vista carved by flowing clear water streams ranging in size from creeks to rivers. Closer examination reveals a great diversity of plants and animals that also call the Hill Country home. Although large cities and densely populated areas occur along the southern and eastern margins, the overall character of the region remains rural. The elevation, ranging around 2,000 feet above sea level, produces a dryer and more comfortable climate.
for denizens of the region. Singularly or cumulatively, these reasons add up to a special place.

The Texas Hill Country is located along the south and east perimeter of the Edwards Plateau, one of ten vegetation or biomes occurring in the state. Each of the ten vegetation zones is influenced by rainfall, temperature, soil and topography. For the most part, the Edwards Plateau is a limestone plateau dissected by numerous rivers working northwestward into the plateau. In the eastern portion of the plateau is a window of older sedimentary, metamorphic, and igneous rocks, called the Llano Uplift, which produces different soil types (acidic) from the alkaline soils found on the remainder of the plateau. The Llano Uplift area is not considered a separate vegetation zone despite the differences in rock types. Annual precipitation rates across the state produce north-south contours ranging from 56 inches of annual precipitation in the far east Beaumont area to 8 inches in the far west El Paso area. In the Edwards Plateau the average mean precipitation ranges from 32 inches on the eastern side to 12 inches on the western side. As an example of the fluctuation that can occur, I recorded over 60 inches of rain in the Fredericksburg area in 2007 and approximately 10 inches the following year. These fluctuations appear to be cyclic with varying length of the cycles.

Maps showing the average mean temperature ranges across the state trend perpendicular to the contours of the average rainfall totals. In the Lower Rio Grande Valley the average mean temperature is 74 degrees Fahrenheit compared to just 56 degrees in the Texas Panhandle. In the Edwards Plateau the variation is only five degrees ranging from 70 to 65 degrees. As with rainfall amounts varying in cycles, so do the temperatures; however, the effect of temperatures on plant growth is less an impact than are rainfall amounts.
Combined drought and high temperatures in 2011 produced serious damage for all vegetation, especially trees.

Texas is not only a large state but one with a complex geological history dating back more than one billion years, a state in which all major time periods left a geological record. A comparison of the state’s vegetation zones with the geological map show the outlines of the ten vegetation zones to be closely tied to the geological boundaries. An excellent example of the close ties of geology and vegetation is vegetation area 4, the Blackland Prairie, which mirrors the outcrops of the Upper Cretaceous formations. The principle reason for this overlap of geological formations with vegetation zones relates to soil texture, composition and chemistry producing conditions favorable to selected plant communities that thrive under these conditions. Acidic vs. alkaline, sand vs. clay, drainage, and depth of soil are examples of these conditions.

**Geology**

The geological history of the Texas Hill Country begins approximately 1.4 billion years ago when two plates collided along what is now the southern margin of the North American Plate. The approaching plate was an island arc, possibly related to the South American Plate. When two plates collide, the denser oceanic crust subducts beneath the lighter continental crust producing a deep oceanic trench. This deep trench filled with approximately 60,000 feet of sediments derived earlier from the North American continent and later from the approaching land mass. Heat and pressure from the burial of these 60,000 feet of sediments began to melt these sediments in the deepest part of the trough and formed metamorphic rocks.
Increased heat and pressure produced bodies of igneous magma that began to move upward through the metamorphic rocks much like “lava lamps” rely on heated lighter blobs moving up through a cooler denser medium. These magma bodies of granitic composition crystalized into rock about 1.1 billion years ago in the roots of a mountain chain before reaching the surface. The subsequent erosion of that mountain chain exposed granite bodies encased in the metamorphic rocks that now make up the Llano Uplift area, of which Enchanted Rock is a very visible topographic feature.

At approximately 550 million years ago, the region went through an extension period when the area was stretched producing a basin and range setting where clastic rocks filled the grabens during several incursions of the sea covering the area. During the high sea level periods, widespread limestone deposition occurred in shallow seas. About 300 million years ago the region went through a second collision of plates producing very similar conditions that had occurred here a billion years earlier. The resulting mountains were the ancestral Quachita Mountains, the roots of which are buried between the Hill Country and Austin. The rocks of the buried mountain range are exposed in the Marathon area in West Texas and the Quachita Mountains in southeast Oklahoma.

Following a long period of quiescence, the mountains were eroded leaving a fairly flat topographic surface that remained flat until approximately 100 million years ago in Cretaceous time. At this time there was a significant worldwide rise in sea level which ultimately covered what is now Central Texas. The Gulf of Mexico, which had become a major depository of sediments, began to move inland towards the Llano Uplift area. At the same time an oceanic plate was approaching the western edge of the North American Plate and producing a deep oceanic trench where the current Rocky Mountains lie. Eventually the
rising sea from the Gulf of Mexico merged with the aforementioned trench to the north producing a waterway from Texas to the current Alaska area.

As the rising seas approached the Central Texas area, the initial sedimentary rocks were clastics similar to the fluvial deposits being deposited in the current coastal plain of Texas. As the sea continued to rise, more of the area was flooded reducing the source of clastic materials to be deposited, and thereby creating bays and lagoons similar to the current bays along the current Gulf of Mexico. Marl and limestone were being deposited in the ancient bays and lagoons. Eventually the whole region was submerged creating a broad shallow warm sea where thousands of feet of limestone were deposited.

By the end of the Cretaceous Period, the Rocky Mountains emerged and the worldwide sea level rise culminated, leaving the Central Texas region a flat expanse of limestone outcrops. Beginning about 10 million years ago, the rapidly filling Gulf of Mexico created an equilibrium imbalance with the thinner section of sedimentary rock to the north. To relieve this imbalance of rock pressure, a fault system, now known as the Balcones Fault System, began to develop over the deeply buried Ouachita Mountain system, historically a major zone of weakness in the world wide plate system.

The gradual net result of the movement along the Balcones Fault System was that the area to the northwest rose approximately two thousand feet relative to the southeastward sinking Gulf of Mexico basin. Drainage systems feeding into the Gulf of Mexico began to work their way northwestward into the newly developed Edwards Plateau Region. The streams cut deep canyons into the limestone sediments creating what is now known as the Texas Hill Country. Hard resistant limestone beds cap the mesas as the streams continue to cut into the Hill Country landscape.
Just over 100,000 years ago huge ice floes made their way southward into what are now the mid-western states. Although the ice floes did not reach the Texas region, the associated climate was very temperate. Coniferous forests and savannahs developed across what is now Texas. Global warming following the last Ice Age wiped out the temperate habitats; however, two tree species, Bigtooth Maple and Texas Madrone remain in specific deep canyons within the Texas Hill Country.

**Edward Plateau River Systems**

While carving many canyons in the Hill Country the drainages encountered a large number of aquifers within the Lower Cretaceous Glen Rose and Edwards limestone sections. As each drainage system cut down into the geologic section, aquifers were exposed producing springs that formed creeks and rivers. The larger springs formed beautiful clear water rivers all across the Edwards Plateau. The larger clear water rivers whose origins begin in the Hill Country include the Atascosa, Comal, Devils, Frio, Guadalupe, James, Llano, Medina, Nueces, Pedernales, Sabinal and San Antonio. Development pressure, irrigation and recent droughts have impacted all springs by reducing their annual discharge rates.

**Settlement in the 1850s**

The settlement of the Hill Country in the mid-nineteenth century produced a significant alteration of the landscape, as forests and woodlands were cleared for agricultural purposes, properties were fenced to contain the large numbers of introduced cattle, sheep, and goats, and natural wildfires were reduced, or eliminated. The net result was a proliferation of Ashe juniper, also called cedar, which had been mainly confined to canyons prior to settlement. Overgrazing reduced the grass and forb populations. Live oaks also took
advantage of the reduced wildfires and proliferated across the Edwards Plateau. The face of much of the Edwards Plateau changed from a savannah grasslands to ashe juniper/oak woodlands.

The large increase in woody plants also impacted the water levels and spring flow of many aquifers across the region and the overgrazing exposed soil zones to erosion which removed much of the top soil. Without the root systems of the grasses and forbs to channel water into the aquifers, the recharge of the aquifer systems was reduced. Former springs either dried up or produced very limited quantities of water into the stream drainages. The past couple of decades has seen improved land stewardship practices applied to the region. The use of managed burning practices to reduce and maintain ashe juniper coupled with mechanical removal of ash juniper has allowed grasses and forbs to increase. Wildlife management valuation has increased as new owners of agricultural lands are not relying on ranching operations to sustain the livelihood of the property owners, thereby reducing the grazing pressure on the land. Hunting and recreation is now often replacing livestock production as the desired use of the properties.

More recently the Hill Country has seen a proliferation of oak wilt, a fungus that attacks live and red oaks. One might consider this oak wilt invasion along with wildfires to be nature’s way of leveling the playing field between woodlands and prairies/savannas. Eliminating the screwworm fly caused a huge increase in the white-tailed deer population in the Hill Country, an increase which resulted in keeping many young tree saplings from reaching maturity. The recent introduction of exotic ungulates adds to the pressure of tree growth. The drought of 2011 caused a large number of trees to die thereby reducing even further the tree populations including ashe junipers.
Fortunately many of the new residents moving into the region are willing to consider good land stewardship practices, such as managed burns, rotational grazing and wildlife management to improve the quality of their wildlife habitats. A secondary positive result from these initiatives is that the recharge of the aquifers will improve as grass and forb root systems funnel water back into the subsurface as well as return some of our former springs. The best example of excellent land stewardship practices producing habitat and water restoration is at Selah Ranch near Johnson City, where J. David Bamberger took 5,000 acres of forlorn habitat and restored it to viable and vibrant habitat for wildlife and ranching operations.

**Hill Country Wildlife Diversity**

Located midway between the lush vegetation of the Big Thicket and pine forests of East Texas and the dry Chihuahuan Desert to the west, the Edwards Plateau alternates between rainy and dry weather cycles. Likewise, the region is located between the subtropical temperatures in the Lower Rio Grande Valley and the colder temperatures of the Llano Estacado to the north. The climate of the Hill Country region features moderate seasonal temperatures with lower humidity. Much of the Edwards Plateau features Cretaceous limestone and alkaline soils while the Llano Uplift area’s igneous and metamorphic rocks produce more acidic soils. It can be said that this Central Texas region is the mixing zone of plants and animals from the north, south, east and west that results in a rich diversity of wildlife.

**Native Plants**

The Edwards Plateau contains approximately 40 percent of the vascular plants found in Texas while only covering 17 percent of the surface of the state. In addition to the reasons
for the diversity expressed above, the region’s topography also varies from hills and canyons in the southeast to a broad plateau to the northwest that has yet to reach the dissection levels produced by the many streams in the Hill Country. Wildflowers are a trademark of the Hill Country, and their diversity reflects the many soil types, topography, and moderate climate. Although the flora diversity comes from all directions, the greatest connection between the neighboring vegetation zones is that between zone 10 in the Trans-Pecos and zone 7 of the Edwards Plateau, which I call the 7/10 connection. The zone 10 plants have soil types and drier desert climate similar to the western half of the Edwards Plateau’s zone 7; therefore, western plants found tolerable living conditions and expanded their ranges eastward.

Whether you live in the Edwards Plateau or not, the easiest way to know what plants to bring to your garden is to look at the wildflowers and plants that grow well along roadways with similar soils, topography and drainage as those of your property. Factors that should be considered are soil type, wet or dry habitats, sun vs shade and topography. If the conditions along the roadways are similar to your property, seeding and transplanting should be successful. The only caution is that in caring for these “transplants,” make sure that similar restraint of TLC (tender loving care) is applied. Excessive TLC is the one of the deadly prescriptions for native plants. These plants want to be left alone to thrive.

**Reptiles**

If we journey back in time approximately 100 million years ago, the area we now know as the Texas Hill Country would have been a very inhospitable place. The dinosaur dynasty would have been in full gear with reptiles of all sorts and sizes roaming the region consuming before being consumed. Fossil tracks of various dinosaur species that occur in the Cretaceous Glen Rose limestones reveal both carnivores and herbivores plodding through
muds in the shallow water estuaries and bays. In addition to the terrestrial reptiles, early relatives of birds were taking to the air in all sizes, the largest being the *Quetzalcoatlus*, flying reptiles with wingspreads of 39 feet.

Although the dinosaurs disappeared abruptly around 65 million years ago, the Central Texas area has not hosted reptiles with the power and size found during the Cretaceous time. Our current reptile species are confined to snakes, lizards and turtles, none of which can overwhelm their prey by size. Hill Country residents learn to live with the four poisonous species of snakes and a variety of colorful non-poisonous varieties. Horned lizards were common less than 50 years ago but are no longer present, or are rare. The most interesting area lizard today is the alligator lizard of one foot length with tiny short legs.

**Mammals**

Prior to settlement of the region, the mid-grass prairies and savannahs were home to large herds of migrating herbivores, namely bison and antelope. During the pre-historic temperate times when glaciation was present to the north, the region was dominated by huge mammals including mammoths, large bison, saber-toothed tigers and a host of species that have long disappeared from the planet. The bison and antelope also have disappeared, leaving white tailed and mule deer as the largest native ungulates. Bears and wolves prowled the woodlands prior to settlement and they too have vanished, leaving the region to smaller predators, such as coyotes, foxes and bobcats. A large predator, the mountain lion, is still present, but in few numbers.

What is present in very large numbers are Mexican free-tailed bats whose numbers approximate 100 million during the summer months. These bats call numerous caves, bridges and buildings home as they spend their summer months in the Hill Country. For example,
approximately 20 million bats reside in Bracken Cave just northwest of San Antonio. Collectively these 100 million bats consume around one thousand tons of insects nightly, many of which are harmful pests to area agricultural interests. Try to imagine what a pile of two million pounds of moths and other night flying insects would look like; such a pile of insects is almost inconceivable to imagine. This insect consumption is not a one day event, but a daily event for four months. Witnessing the emergence of bats at one of the larger caves is a spectacular event by any standard for comparison.

**Birds**

Two thirds of the more than 630 species of birds documented in Texas have been recorded in the Edwards Plateau region. The principal reason for this diversity is the central location of the region between the forested areas to the east and the desert region to the west, as well as between the sub-tropical and brush covered habitats in the Lower Rio Grande Valley and South Texas and the high plains of the Llano Estacado to the north. Eastern and western species tend to overlap, as well as birds from the north and south. This region is also located on the central migration flyway, one of four such flyways found in North America. A number of species, such as White-winged Doves, Black-bellied Whistling Ducks, and Greater Kiskadee Flycatchers are expanding their ranges northward while the Mississippi Kites are extending their breeding ranges southward into the Hill Country region.

The Hill Country hosts two endangered species, the Golden-cheeked Warbler and the Black-capped Vireo; both species have had losses because of their limited breeding ranges, loss of habitat, and cowbird nest parasitism. Cowbird trapping programs have been very successful in reducing the cowbird population across the breeding ranges, and thus raising hope that the status of these endangered species can be upgraded to “threatened” status.
**Butterflies**

The life story of butterflies revolves around what could be termed the “the beauty and the beast.” Butterflies are among the world’s most colorful and beautiful insects; however, in the life cycle of butterflies the larval stage includes many shapes and forms of caterpillars that appear more beastly than beautiful. Only four percent of the world’s 17,000 butterfly species live in North America (750 species) and sixty percent of these species can be found in Texas. The subtropical Lower Rio Grande Valley has the most butterflies (325 species), and the Edwards Plateau likely has roughly one third of the Texas species. Some of the tropical butterflies wander northward after the breeding season into the Hill Country. Butterfly census surveys are lacking compared to bird surveys, but are catching up.

Butterflies and moths belong to the same family, *Leptidoptera*, but moths greatly outnumber butterflies species in North America by a factor of ten to one. Daytime-flying butterflies are more colorful than the night-flying moths. Butterflies use their color to help them hide among flowers while moths use their earth-tone colors to hide from predators during the day. Butterflies and moths have divided the larval plant resources among themselves, so that they can all survive, including their larval plant hosts. The plants and insects have evolved together allowing the insects to counter toxins developed by plants for defense purposes. For example, only members of the Monarch family can digest milkweeds. This ability also helps the insects protect themselves from their bird predators.

Butterflies and their larval stages are also excellent mimics and camouflage artists. For example, the Viceroy butterfly looks remarkably like members of the monarch family; therefore birds do not risk attacking them for the fear of toxins carried in the monarch family larvae. Some swallowtail butterfly larvae look like bird droppings, while other caterpillars
appear to look like heads of reptiles to avoid predators. Survival depends on both plants and insects countering the defenses developed over time by their rivals.

The Hill Country is located along the migration routes of the Monarch butterflies as they fly south from the northern states and Canada to over-winter in tropical Mexico. Each fall many thousands of Monarchs pass through the area every day. Finding an overnight staging area where thousands of butterflies congregate is a spectacular sight. The traveling butterflies rely on fall blooming thoroughworts, bonesets, and frostweeds to nourish them along the travel route.

**Dragonflies**

Dragonflies and their close relatives, damselflies belong the insect family *Odonata*. Like butterflies, odonates are colorful, but the similarity ends there as they are voracious predators with an interesting history and lifestyle. Dragonflies only have three stages in their life cycles compared to four for butterflies and moths; the difference being that the odonate larvae turn into adults without entering into a chrysalis stage. Odonate larvae spend their entire lives in water as nymphs and naiads while the butterfly larvae exist as caterpillars. Dragonflies are generally larger than damselflies and are stronger fliers with helicopter-like maneuverability.

After spending from one month to eight years in the larval stage, the odonate larvae leave their watery home by crawling onto a stick or rock and emerge directly from the nymph stage to an adult. The process generally occurs at night and takes a couple of hours to complete. After inflating their wings, the young adults must dry out for several additional hours before becoming strong enough to fly. From that time until the adult odonate is dry enough to fly, they are very vulnerable to predators, especially birds.
Odonates are among the world’s oldest creatures, having survived for over 320 million years, including four major worldwide extinctions. They occur on all of the continents except the polar regions. Approximately 5,500 species of odonates occur worldwide with 430 occurring in North America. Seventy percent of Texas’ 200 odonate species occur in the Edwards Plateau. As with other wildlife families, the Edwards Plateau exhibits a great diversity of dragonflies and damselflies.

The code for survival for odonates is “eat before you are eaten.” Although they are generally less than five inches long, they are among the most voracious of predators. Incidentally, they consume all their prey on the wing. Although their six legs are used to grasp prey and perch, they cannot walk. Capable of flying at 35 miles per hour, dragonflies are among the fastest flying insects in the world, while having unparalleled mobility in flight. Equipped with excellent eyesight, these creatures may be considered among the greatest predators. With all of these interesting attributes, dragonfly watching is rapidly becoming a preferred interest among nature enthusiasts.

**Changing Forces**

The Edwards Plateau has dramatically changed in the past two hundred years and likely will not return to the savannah and woodland habitats of the past, but must be protected from increasing development, overgrazing, power line right-of-ways, introduced invasive plants and animals, rising numbers of feral cats and hogs, and expanding white-tailed deer populations. What can you do to help us keep the wonderful diversity of wildlife and the most scenic land in the state? Feel the pride, get involved, be good land stewards, protect our land and water resources and get others to join you.
Spicewood Ranch After 23 Years of Restoration: What We Have Accomplished and Learned

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Abstract
Spicewood Ranch After 23 years of Restoration- What We Have Accomplished and Learned

When restoration on the 1200 acre Spicewood Ranch started in 1988, the vegetation was typical of much of the Texas Hill Country. Most of the palatable native grass species were gone or greatly reduced with KR bluestem dominating, and the surviving forb and woody plants were reduced to unpalatable species such as Mexican hat, horsemint, live oak and Texas persimmon.

Restoration practices, including controlled burns, cedar removal, deer reduction, high fencing, seeding, exotic species control, and deer exclosures for research have significantly improved conditions. Successful reestablishment of woody species and perennial forbs has been dependent on developing a sequence for their reintroduction. We start with those species that are only slightly palatable to the reduced deer population, and then gradually add more palatable species as allowed by the increase of available forage and decrease in deer browse pressure. Locally harvested wild seed is often used for these reintroductions, with planting sometimes starting within exclosures to increase available seed quantities.

Background

Spicewood Ranch is located approximately 30 miles West of Austin between Spicewood, Texas and the Colorado River. The Harte family acquired the first parcel of Spicewood Ranch in 1972. At the start of active restoration in 1988 it included 540 acres, and now, with the acquisition of adjacent and nearby tracts, it includes 1200 acres. The underlying geology of the ranch is Hensel Sand, Cow Creek Limestone, alluvial terraces and recent alluvial soil. Alligator Creek runs through the ranch, providing year round water in places. In addition to prairies and live oak (Quercus fusiformis) woodlands, the original plant communities were most likely live oak savannas and cedar (Juniperus ashei) breaks on the
Hensel Sands; a pecan (*Carya illinoinensis*)/elm (*Ulmus* spp.) riparian woodland along upper Alligator Creek; a very open rocky riparian community where lower Alligator Creek cuts through the Cow Creek limestone; xeric ferns and other fissure adapted species supported on steep rocky cliffs along lower Alligator Creek; and post oak (*Quercus stellata*) savannas in the patches of deeper gravel alluvial terrace soils. Along the Colorado River, in geologically recent alluvial soils, there was a riparian community that was eliminated by the construction, filling and extreme fluctuations of Lake Travis.

As with most of the Texas Hill Country, the ranch vegetation was drastically altered through management practices of immigrants of European heritage after their conquest of Texas. The ranch lost a significant percent of its plant species to the combined effects of fencing, heavy grazing and browsing by goats, sheep, cows and horses, elimination of burns traditionally set by indigenous peoples, suppression of natural fire, and a large reduction or elimination of key species such as buffalo, wolves, mountain lion and screw worm.

At the start of restoration, the woody component of the ranch was reduced almost exclusively to such species as live oak, Texas persimmon (*Diospyros texana*), agarita (*Mahonia trifoliolata*), snakewood (*Colubrina texensis*), cedar, mesquite (*Prosopis glandulosa*) and prickly pear (*Opuntia* spp.), which are inedible to browsers with the exception of their fruits. The few individuals of other more edible woody species found in small numbers on the ranch provide clues to the composition of original vegetation and the cause of its demise. Large post oak, deciduous yaupon (*Ilex decidua*), and a few Mexican plum (*Prunus mexicana*) surviving on the ranch are old individuals with their main growth above the browse line of deer, their suckers and lower branches browsed off and with no new seedling production. Other species have only survived in locations inaccessible to goats,
sheep and deer, such as two evergreen sumac (*Rhus virens*) bushes and several rock rose (*Pavonia lasiopetala*) found hanging off sides of the cliffs, or the creek plum (*Prunus rivularis*) tucked between an old fence and a greenbriar (*Smilax bona-nox*) thicket. Likewise the forb component was reduced to inedible species such as Mexican hat (*Ratibida columnifera*), horse mint (*Monarda citriodora*), indian blanket (*Gaillardia pulchella*), camphorweed (*Hererotheca subaxillaris*) and broomweed (*Gutierreza* spp.). Grazing pressure almost eliminated palatable little bluestem (*Schizachyrium scoparium*), Indian grass (*Sorghastrum nutans*), gama grass (*Tripsacum dactyloides*), and many other native grasses. As these disappeared, ranchers were encouraged by “experts” to replace them with KR bluestem (*Bothriochloa ischaemum*), klein grass (*Panicum coloratum*) and, more recently, with Lehman’s love grass (*Eragrostis lehmanniana*).

**Restoration**

In 1988 restoration of Spicewood Ranch was initiated by Kay Wagenknecht Harte, who became interested in and wrote about habitat restoration in the mid 70’s while a graduate student at UT Austin and later Texas A&M. Since her death, restoration work at the ranch has been continued by Chris Harte and their son Will. The first goal for the management program is to learn the potential for native plant species and their habitats in the various niches of the ranch. The second goal is to restore individual species, communities and processes as we discover the critical details of the restoration process, especially as to how they can be utilized on large land parcels.

This process has included controlled burns, cedar management, exotic species management, harvesting wild seed, seeding, high fencing, test exclosures, experimental research and monitoring.
**Controlled burns**

Controlled burns were initiated in 1988 on several open fields to determine if fire could be used on the ranch to reduce cedar encroachment and open up the thatch of KR bluestem in the farm fields for the seeding of native species. Since that first effort, controlled burns have been utilized for 18 years, mostly in January-February but twice in June. Over the years the size of areas where burns were conducted has increased based on our improving ability to safely use this tool, our better understanding of its proper use, the acquisition of new properties and in response to other ranch activities such as cedar cutting. In February 2011 our first annual public burn was conducted on a 20 acre field as an educational demonstration for ranch neighbors and other visitors who were invited to watch and, for some, participate in the burn. This event was cancelled in 2012 because of the drought and burn ban, but is planned to be offered again in February 2013.

**Cedar Management**

In fields being restored to prairie, cedar trees are being eliminated through controlled burns. In other parts of the ranch there are scattered large live oak trees which appear to be remnant savannas with a significant encroachment of mid-size cedar. Here we are using a skid steer tree axe shear to first cut out the thick cedar which, if burned in a crown fire, would probably kill the large oaks and create a more dangerous fire. After removal of cedar, the open soils (no KR bluestem) provide an ideal seed bed for our grass and forb seed mixes. Within a year or two these areas often have enough fuel to carry a slow burn under the oaks, sometimes lifting the oak canopy through scorching, but not killing them.

However, in selected areas of the ranch, dense cedar breaks are being left for several purposes. One area of approximately 100 acres dominated by large cedar is big enough to
potentially become golden-cheek warbler territory, although monitoring has so far not located this species here. These large cedars are being left to meet their nesting requirements, and we have initiated improvements to the other vegetation of this area to provide more food for this bird. The second reason that some large blocks of cedar are being left is to eventually provide a nursery for many species of woody plants targeted for reintroduction to the ranch. Our observations and research in our deer-exclosure test plots indicate that many of the desirable woody species are mostly dependent on the soil niche under cedars to germinate and grow to a certain size. Then, after a crown fire through the cedars (or mechanical removal), a diverse collection of these woody species resprout in a circle around the remaining cedar stump. Therefore, we believe these cedar break nurseries are a critically important piece of our restoration plan for the eventual restoration of the missing woody component of the ranch.

**Exotics Species Management**

Some exotic invasive species which have limited distribution on the ranch, such as Johnson grass (*Sorghum halepense*), bermuda grass (*Cynodon dactylon*), Lehman’s love grass, Vasey grass (*Paspalum urvillei*) and bull thistle (*Circium sp.*), we are treating with glyphosate. KR bluestem and klein grass are being combated with the planting of larger native grass species. Several exotic woody invasives, such as Chinaberry (*Melia azedarach*) and bamboo (*Phyllostachys aurea*), are being cut and the fresh cuts painted with glyphosate. Feral hogs are being both trapped and hunted.

**Deer Management**

Some parcels of the ranch have been high fenced to facilitate the reduction of the deer population so restoration of browse plant species can proceed more efficiently. Hunting has
also been used as an income source for the restoration effort. We are determining the appropriate deer level based on what we observe about their utilization and/or elimination of restoration species we are monitoring and attempting to restore. We have reduced the effect of deer browse on our target species in two ways: first by reducing deer numbers and second by increasing the number and quantity of more desirable browse species. Improving available browse will allow us to either increase deer population or to successfully reintroduce additional plant species that are even more vulnerable to deer browse. We have a long way to go with restoration before we choose to increase deer population.

**Grass Reintroduction**

In 1995, cattle were removed from most of the ranch parcels to facilitate conversion of the grasslands from non-native to native. The old cleared farm fields have been seeded with mixes of prairie grasses and forbs purchased from commercial growers and wild harvested especially for the restoration effort.

**Forb Species Re-introducion**

Our initial seedings of forb species appeared to have almost no success, and this spurred our efforts to create deer exclosures to learn what would survive within them. The results eventually led us to high fencing most sections of the ranch and reducing the deer population. The results of this process were transformative. A year after we reduced the deer herd, in one five acre field we noticed in late summer a giant oval of sunflowers around the field. We could see exactly where our tractor had driven around the field four years before, where we had seeded an oval strip with a mix that contained several forbs, including Maximilian sunflower (*Helianthus maximiliani*). The Maximilian had sprouted years before but, since browsing pressure was so high, no flowers had been seen.
So now in most of the ranch it has been our goal to lower the deer population to a point where species which were likely once present on the ranch can be restored. There is no single deer population level that will allow all target species to survive reintroduction. Rather, for these plant species there is a range of edibility from basically poisonous to extremely palatable, and likewise, a continuum of browse pressure levels that will allow survival of different species. Our strategy for reintroducing forbs and woody species has been to test and find which species can just barely survive the current existing browse conditions, get seed for those species of suitable local genotype, increase our seed quantities in plots in our exclosures if necessary, and then introduce those species in our next annual seeding. We then try to build up a large enough population of those species to both withstand and provide some deer browse. In the early years of reintroduction these forbs can be severely browsed, but eventually they are strong enough to produce and drop seed so that single plants become small colonies. In time these colonies provide enough seed for us to harvest for our next seeding of additional new areas and parcels. We have succeeded in the reestablishment of some very important forb species in this manner, including plateau goldeneye (*Viguiera dentata*), gay feather (*Liatris mucronata*), standing cypress (*Ipomopsis rubra*), bush sunflower (*Simsia calva*), purple prairie clover (*Dalea purpurea*), and Engelmann daisy (*Engelmannia peristenia*).

Each species that successfully enters this process increases the available browse. This means with the same deer population and the same weather conditions (!), new species of slightly higher edibility might be able to survive outside our exclosures, and other previous introductions might be less severely impacted. Improved browse conditions have also meant some other species which were virtually gone from the site have started to reappear and
increase on their own. These are species which were still present in small quantities on the ranch, such as winecup (*Callirhoe involucrata*) and prairie larkspur (*Delphinium carolinianum*), but were not seen for two decades. They were perhaps protected deep in a prickly pear patch, perhaps dormant in the seed bank, or possibly not quite as edible as other species that seem to have been completely eliminated on the ranch.

**Woody Plant Species Reintroduction**

Restoration of the ranch’s woody species takes the most patience. Our goal is to develop a method usable on a large scale which is not dependent on planting, watering and putting protective cages around individual containerized plants. However we sometimes do exactly that at first, to learn how an individual species will grow, reproduce and survive deer browse. An example is our 13-year experimentation with evergreen sumac. In an exclosure we planted 30 seeds of sumac in a row, each seed approximately one foot apart, 2/3 in cedar needle duff under a cedar grove and 1/3 extending away from the cedar duff into full sun. Half of the seeds under cedar were within our exclosure and half outside the fence. Most of the seeds under cedar inside the exclosure have grown to sizable plants. No seedlings outside the cedar canopy have ever appeared, essentially confirming our observations and theory about the nursery effect of the soil niche under cedar. Two seedlings appeared outside the exclosure under cedar, but quickly disappeared, presumably from deer browse. After 6 years some of these new sumacs were producing seed, and the next year we were finding tiny seedlings 4 to 18 feet away from the parent plants, but only under cedars and not outside the canopy. Several would occasionally appear outside the fence, but until recently they would never survive existing browse conditions. As of three years ago evergreen sumac seedlings have started to survive outside this and other exclosures, although in last year’s drought we
seem to have lost half of those. We infer from this that browse conditions are improving, and we believe it is because of the increase in available browse we are providing with the successes we have had with our reintroduced forb species. In November of 2010 we harvested approximately 60,000 evergreen sumac seeds from a nearby site (in approximately 3 hours of hand harvesting). In January 2011 we hand scattered that seed throughout an approximately 8-acre cedar break outside any exclosure and waited for rains which never came. In 2012, however, we have started seeing tiny sumac seedlings where we scattered seed. It is too early to know whether they will survive the summer weather and whether deer will browse them after they grow bigger than ½ inch tall. If they don’t survive the deer it will only mean that the site is not quite ready for evergreen sumac, but it will be soon. We are in earlier stages of the same process with other selected woody species.

The ranch has approximately 50 acres of large, old growth post oak scattered in 5-15 acre patches in deeper gravel soils. In all these areas, with diligent searching, not a single post oak younger than perhaps 75 years or more has been located. When a 30-acre parcel was acquired in 2001 which was 50% post oak habitat, it was decided to high fence the whole parcel and remove all deer. Several years later our first post oak seedlings on the entire ranch were found near the dripline of the large old trees. In February of 2010 a slow controlled burn was allowed to go through an area containing about a third of the known seedlings, which were several years old and 1-2 feet tall. This fire burned most of the seedlings down to or near ground level. Even after the drought of summer 2011, virtually all of the burned seedlings survived and are very close in size range to the nearby unburned seedlings. The post oak populations on the ranch were in fact slowly dying out through the combination of old trees dying through the normal aging process and no recruitment of post oak seedlings.
because of the unnatural imbalance of the deer population and available browse on the ranch.

We now know for certain we have options for reviving this post oak habitat on the ranch. These dying post oak communities have also been observed in many ranches and public lands in the Hill Country.

**Seeding Program**

In February–March of each year, we initiate a seeding program on selected areas of the ranch. We try to seed any area that has been cleared of cedar during the past year. After our burns we evaluate the results, and sometimes for the first time we can seed an area which has been made accessible by the burn. In our larger fields, where a burn has removed last year’s grass thatch, we may do an additional seeding even if we have seeded parts of that field previously. When we seed a large field we do not try to seed the whole field because of limited resources, including seed. Instead we make passes through the field 20 to 50 feet apart, choosing to get narrow strips of new species all over the field rather than getting a smaller section continuously covered. Then we hope for some slow spreading from those strips. We usually spread seed manually from a tractor while towing a drag harrow behind to improve seed soil contact. In this manner we are able to seed brushy areas where in places we can barely get a tractor through. Sometimes in the old farm fields we are able to disc prior to seeding in part to disrupt the root system of the dominant KR bluestem of these areas.

**Seed harvesting**

For some grass and forb species we are attempting to reestablish, there are reasonable options to purchase commercial seed of appropriate genotype. For some of these species, such as standing cypress, we have found once we have established reasonable stands on the ranch, it is cost efficient to hand harvest these species rather than purchase the seed for the
next sections of the ranch. For many species the only source is to harvest locally. For
harvesting we use three methods, (1) by hand, (2) using a Grin Reaper, a collecting box and
bag attached to a string trimmer that we invented and patented in 1988, and (3) a tractor
reaper we constructed in 1990 for large scale cutting and collecting of tops of grasses and
forbs. We process seed minimally, only trying to shatter seed heads into individual seed, but
not trying to separate seed from plant debris. For some species such as simpson’s rosinweed
(*Silphium simpsonii*) and Texas green-eyes (*Berlandiera texana*), local remnants are so rare
we might actually start with only a handful of seed, conservatively collected. We have
currently planted these two species in two of our exclosures using 4 inch potted plants which
were propagated from seed in our nursery. Soon we will try a small seeding of these species
outside an exclosure to see how they do under current browse conditions, and hopefully we
will be able to harvest reasonable amounts of seed for larger seedings when conditions are
appropriate.

**Remarks**

The great reduction of browse of high quality native species, the over grazing of the
grasslands, the high deer population and the presence of some very persistent exotic species
on Spicewood Ranch clearly present great challenges. Unfortunately these problems in fact
also represent the dominant current conditions of a high percent of the Hill Country. Our
experiences on the Spicewood Ranch have demonstrated what may be possible for
restoration in the Texas Hill Country, and the patience and perseverance required for the job.
Native Landscape Certification Program

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The Native Landscape Certification Program aims to increase responsible stewardship and use of native plants by making commonplace the knowledge, appreciation, and care of native plants and their environments in Texas. In 2006, as president of NPSOT’s San Antonio Chapter, I noticed that our new members, especially seemed unsure of themselves and slow in gaining confidence. This resulted in their reluctance to volunteer with us and a rather anemic new-member recruitment. On occasion, I would meet someone who had arrived with enthusiasm at our meetings only to disappear to get involved with another group, such as Master Naturalists, where they could learn something quickly and then easily join a volunteer activity.

At the same time, the community was undergoing a rancorous political struggle to create a tree ordinance that would save natural areas from wholesale destruction during development. A handful of activists were struggling valiantly at the risk of being maligned and even sued by big developers who also complained to the city if their employees were too vigorous in enforcement. Stuck in the middle was the city arborist, Debbie Reid, who was a friend. She saw a need to reach folks in the development field and change their culture to allow responsible stewardship of the land, at least what was left of it.

As Debbie had been a founder of the Master Naturalists program, which eventually spread throughout the nation, and I saw the benefits of its design, we cooked up the idea of certifying people as a way to attest to their knowledge about native plants. That would get
our members educated quickly, provide certification and continuing education for all sorts of professionals, and provide the chapter with a platform for supplying volunteers to help with NPSOT-generated projects.

Of course, there are environmental reasons to speed up the learning curve and cultural change. We can’t wait much longer to stop the ignorance and blithe introduction of non-native that don’t support nature while sometimes becoming invasive. We can’t wait to reduce the use of pesticides and water to maintain mal-adapted landscapes either. In San Antonio 40% of the water used in the summer is for landscape irrigation. The rich diversity and complexity of our ecosystems is continuing to be lost with urban sprawl. And we are close to non-attainment in our air quality and can’t wait much longer to stop using 2-cycle combustion engines to manicure these landscapes before our lungs give out.

Unfortunately, there has been a severe lack of knowledge of identification and use of these plants and many native plants are not available for purchase. The Native Plant Certification Program is designed to address the first of these deficiencies that limit the use and appreciation of Texas native plants. The second is already being addressed through Project NICE’s collaborations with growers, nurseries, and newspapers to bring new plants to the public.

The Native Landscape Certification Program

The Native Landscape Certification Program is intended to contribute to a migration of Texans back to nature that will reap priceless benefits for our families, environment, and economy. Richard Louv in Last Child in the Woods, points out that the baby boomers are the last generation of Americans to share an intimate, familial attachment to the land and
water, while the importance of nature to our well-being has been demonstrated by numerous studies correlating improved learning, an increased sense of well-being, and reduced crime in neighborhoods with trees and parks. In addition, folks don’t save something they don’t love, so we want to help them do so.

The program is a series of four courses of increasing sophistication that teaches Best Management Practices (BMPs) for native plant landscape and habitat preservation and introduction. Presentations are PowerPoint documents, with BMPs separated from locally-specific knowledge to allow for adoption by NPSOT chapters outside of our region. Targeted audiences are NPSOT members, landscape architects, architects, landscaper designers and nurserymen, Master Naturalists, teachers, citizens, Master gardeners, engineers, and more.

Level 1 is a one-day introductory discussion of the value of native plants in landscapes as well as the need for the protection and use of natives in construction and established landscapes. This is a great entry-level introduction for even the most casual of learners and can be the basis for ongoing public education. It describes the ecoregions of the area, in our case Bexar County, which has four ecoregions represented. It talks about the cultural needs of plants, water and light needs, and design qualities. The class is taught adjacent to a natural area so we can provide instruction in native plant identification, including trees, shrubs, forbs and grasses, their use in the landscape, as well as common exotics found in the landscape. At each level they are introduced to forty plants, the most recognizable being featured in Level 1, known to be native to and historically found in our area.
Having gotten a committee of experts together in 2007, Level 1 was first offered in 2009 and again in 2010 for a total of 150 enthusiastic students. Because of the volunteer nature of the planning and the increased complexity of the program at Level 2, we did not offer the class in 2011 to give us time to complete Level 2.

Level 2 separates the dilettantes from the potential informed citizen, volunteer enthusiast and leader. It addresses the BMPs associated with development, including the decisions on what plants to keep, how to protect them during construction, what to choose to plant in new beds, and how to manage them afterwards. It describes local ordinances and the political process for creating and revising them, such as the tree ordinance. It covers irrigation and maintenance, landscape design, the cultural and environmental value native plants can bring to common landscaping practices, the negative impact of invasive species introduced into the landscape, and the substitution of particular natives for particular exotics.

This spring we inaugurated Level 2 as well as offering Level 1 again. Eight-five people took Level 1 and forty-five graduated on to Level 2. I was quite please to hear the enthusiastic words from Level 2 students for what had, after almost three years of planning, begun to seem like old information to me. Relieved, it now became clear that I had to finish what I started and proceed to the development of the next level. (By this time, Debbie had retired and joined the foreign legion to escape the politics. Ok, well, at least the Peace Corps, where she spent three happy years in the mountains of Mexico. A surprisingly less intense sort of politics. She is presently tooling across the country in her pickup to California. I’m a little jealous.)

Each level of the program uses experts in their fields to provide content who have
valiantly stayed with the task until completion. Then new specialists are recruited with particular expertise appropriate to the new level. We’ve included the Coordinator for the Master Naturalists Program to assure we enhance their program rather than duplicate it. Some of NPSOT’s best and brightest have provided their own expertise to edit the content, to provide testing materials and design the test that is given at the end of each class. I am humbled by the dedication they have shown to the vision. Debbie was instrumental in passing her vision on to several of our most important contributors that has kept them going through the many months of work. She also provided her considerable expertise to the content.

My role has been to coordinate, call meetings, act as advocate for the future student, keep everyone focused on the goal and the audience, do publicity, organize classes, etc. Now I’ve added fundraising, as it has become clear that I can’t do much more without support since we are now offering two classes and planning the third. To date, we have received $5,000 from the John Newman Family Charitable Trust and $10,000 from the Shield-Ayres Foundation.

Each level has been defined by an original vision that is modified as we proceed. We are in the process of reviewing that vision informed by what we have produced so far. Future topics may include: deeper details on the geology, soils, climate, and ecological processes of our region; land use issues; drought, flood, and desertification; plant community characteristics; choosing the right plant for the right landscape or ecological use; maintaining landscapes; succession in the landscape; irrigation; rainwater use; basic environmental restoration principles and practices; riparian plants; supporting state and local conservation plans and programs; urban development using environmental principles such as Low Impact
Development and Sustainable Sites Initiative; potential advocacy approaches; working with the public; field surveys, or preserving habitats.

Level 4 will define the dedicated volunteer or expert and will be available only to NPSOT members. Designed to be self-perpetuating, Level 4 students (and possibly Level 3) will teach the lower levels and/or provide other services to NPSOT programs or community projects in exchange for credits that will maintain their yearly certification. Further education will also be given credit. Students receive certificates for each level and a website is being planned where graduates who wish can be listed along with their certification levels and status and links to their websites or emails. This will attract professionals who want to add the certification to their credentials, with some built-in publicity for them.

Collaborative Partners have been RVK Architects, City of San Antonio, Alamo Area Master Naturalists, Texas Parks and Wildlife, Boerne Chapter of the Native Plant Society of Texas, and Northeast Independent School District.

Project Personnel include Mark Bird, City Arborist, City of San Antonio; Michael Nentwich, San Antonio City Forester; Larry Hicks, Landscape Architect, RVK Architects; Judit Green, Urban Biologist, Texas Parks and Wildlife Department; and Thea Platz, Outdoor Education Specialist, Northeast Independent School District. NPSOT members who have helped include Betty Dunn, Director Cytogenetics Program, Department of Clinical Laboratory Sciences, UT Health Science Center, NPSOT-Boerne member; Kathy Ward, PhD, Geologist retired from the Center for Science and Mathematics Education at Our Lady of the Lake University, NPSOT-Boerne member; Liz Branch, Coordinator, Alamo Area Master Naturalists, retired teacher and NPSOT-Boerne member. Lottie Millsaps, was in the
first Master Naturalist class and helped start the San Antonio chapter of NPSOT. And Bea Caraway, former NPSOT-SA Chapter President and Associate Professor, Trinity University, Coates Library. Others have stepped forward to help us conduct the classes and keep track of enrollment.

The outcomes we hope for are a stronger, more active chapter with improved service to the community, which appears to be happening, at least partly due to the program. We look forward to increased use and cultural acceptance of native plants in urban landscapes and rejection of invasives, improved marketability of native plants, a greater sense of place for residents and visitors, appreciation by landowners of their land’s natural assets, increased community rejection of destruction of natural resources, increased production of native plants by the horticulture industry, increased presence of “desirable” wildlife species in urban landscapes and reduced undesirable wildlife, such as grackles, and increased advocacy by licensed professionals for native plants.
Riparian Plants of the Texas Hill Country – Their Functional Importance

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Abstract: Riparian areas comprise only about one to three percent of the total landscape, yet their contributions to maintaining healthy creeks and rivers are beyond measure. Likewise, the specialized plants that occupy these narrow riparian areas are of disproportionally great importance. Riparian plant communities provide the following basic functional attributes: dissipate the energy of floodwaters; reduce the velocity and erosive forces of floodwaters; help stabilize banks and maintain proper channel dimensions; trap and stabilize sediment in the floodplain; increase organic matter content of riparian soil. When these primary functional attributes are intact, other secondary functions will also be provided, including floodwater retention; recharge of shallow alluvial aquifers; storage of water in the “riparian sponge;” and sustenance of base flow. Landowners, managers and policy makers who understand the vital role of healthy riparian vegetation are in a better position to help insure the proper management and stewardship of these areas for the benefit of all Texans.

Texans have loved their creeks and rivers for many generations. This is especially true in our beloved Hill Country where the abundance of clean running water is prized. The earliest settlers of the region naturally established near the best and most reliable sources of water. This is where they built their homes, raised their families, grew their herds and cultivated their crops. Since that time, urban and rural folks alike have a special affinity for creeks and rivers. Here is where we enjoy camping, fishing, hunting, swimming, splashing, birding, skipping rocks, and experiencing nature at its finest.

Although Texans have always placed high value on creeks, rivers and springs, it is only recently that the art and science of understanding and managing these areas has become more widespread. The term “riparian” is relatively new to most Texas naturalists and landowners, having become a regular part of our vocabulary only in the last 10 or 15 years.
Riparian areas are the narrow strips of land adjacent to creeks, rivers, and other bodies of water. These are the transition areas where land meets water.

Riparian land is special and unique due to the interaction of flooding, ground water, erosion, deposition and the specialized vegetation that holds it all together. Although riparian land is special and valuable, it usually only makes up one to three percent of the total landscape. Due to its high intrinsic value, riparian areas have been called “ribbons of gold” with their ecological value far surpassing the relatively small acreage they cover.

**Function Produces Values**

The values provided by healthy riparian areas are vitally important to every person whether or not they live near a creek or river. All of society benefits from the value of high quality water and sustained flows. Livestock ranchers place great value on the abundance of high quality forage that often exists in the riparian area. Wildlife managers and birders value the critical importance of riparian habitats for travel corridors, diverse cover types, food and water. Anglers appreciate the value of stable channels, deep pools, riffles, undercut banks, submerged logs, shade, and other aquatic habitat features. Botanists, nature lovers, landowners, campers, canoeists, and just about everyone seems to especially enjoy the richness, beauty and aesthetic value of an intact creek / riparian area.

Yet, even though we appreciate these values provided by creeks, rivers and riparian areas, we seldom think about the inner workings that support these values. When the creek / riparian area is functioning properly, the natural physical processes will be in equilibrium, which in turn, will insure that the values we desire are produced and maintained. The basic attributes of a functioning riparian area are listed below. When these functional attributes are present, they provide the basis for the values we demand.
Dissipate stream energy
Protect banks / stabilize channels
Reduce excessive erosion
Slow the velocity of floodwater
Sediment is dropped when energy is reduced
Sediment is trapped and stabilized
Sediment builds floodplains
Floodplains provide floodwater retention
Sediments enriched by organic matter store water (riparian sponge)
Shallow alluvial aquifer is recharged during out-of-bank flow
More water available to sustain base flow over time

Riparian plants and plant communities are the key to healthy, functional riparian areas. The right kinds and amounts of riparian plants help dissipate the energy of floodwaters, which in turn reduces erosion, provides bank stability, traps sediment, builds floodplains, retains floodwater, stores water, improves groundwater recharge, and helps sustain base flow. A practical and attractive field guide entitled *Your Remarkable Riparian* covers most of the important riparian plants of the Hill Country. The field guide was developed by the Nueces River Authority and can be viewed online at:


**Stability Rating and Functional Groups of Riparian Plants**

One of the primary attributes of riparian plants is their ability to stabilize banks, channels and floodplains. Riparian plants differ in their ability to provide this necessary stability, which is most critical during flooding. A stability rating system has been developed
for many Texas riparian plants based on work first done by Dr. Al Winward, retired riparian ecologist with the U. S. Forest Service. [http://www.fs.fed.us/rm/pubs/rmrs_gtr047.pdf](http://www.fs.fed.us/rm/pubs/rmrs_gtr047.pdf) The stability rating is on a scale of 1 to 10, with 10 being the strongest and equivalent to large anchored boulders. A rating of 1 is equivalent to un-vegetated bare soil. Texas ratings were developed by cursory observation and experience and are subject to revision. In the higher energy streams of the Hill Country, plants with a stability rating of 7 are considered to be strong enough to provide a basic level of functional stability. In the lower energy streams of some other regions, such as the Blackland Prairie, Rolling Plains, Rio Grande Plains, Coastal Plains and Piney Woods, a rating of 6 or higher provides adequate stability. Tables 1, 2 and 3 list stability ratings for common Hill Country riparian plants.

Riparian plants are divided into two primary functional groups plus a third intermediate group to help people understand their basic roles. Colonizers are those species that are the first to establish on freshly deposited sediment. Colonizer species have the ability to establish and spread rapidly, often by vegetative means such as stolons, rhizomes, or mat-forming plants that root at the nodes. The root systems of colonizer plants are usually weak and shallow; their function is not to stabilize but rather to establish the first critical layer of vegetation until stronger rooted species can start growing. Colonizer species usually have a stability rating of 2 – 5. Some of the common native colonizer plants in the region include water pennywort, water hyssop, water primrose, water bentgrass, several species of flatsedge and porcupine sedge.

Stabilizer plants are those with very strong, deep, binding root systems, that can stand up to moderately high flow events such as 10 – 30 year floods. Stabilizer plants for Hill Country streams usually have stability ratings of 7 – 10. Stabilizer plants are usually large,
robust plants that have the ability to physically dissipate the energy of fast moving floodwater. Hence, both the top growth and the rooting characteristics of stabilizer species provide important functions. Some of the more important native stabilizer sedges and grasses in the region include Emory sedge, sawgrass, bulrush, switchgrass, eastern gamagrass, and Lindheimer muhly. Common woody stabilizer plants include button bush, black willow, little walnut, and bald cypress.

A third intermediate category includes those plants that exhibit some characteristics of both colonizers and stabilizers. This hybrid group often has the ability to spread rapidly providing colonizer value, and have moderate root strength in between that of colonizers and stabilizers. Plants in this group normally have stability ratings of 5 or 6. Important plants in this colonizer/stabilizer group include spikerush, true rush, knotgrass, rice cutgrass, bushy bluestem, goldenrod, and scouring rush. Woody plants that fulfill this intermediate niche include baccharis, brickellbush, and sycamore.

**Wetland Indicator Categories**

Each plant species in the United States is assigned one of five regional wetland indicator categories according to how much wetness the species tolerates or requires. This information is useful to help interpret riparian vegetation.

Obligate Wetland (OBL) species almost always occur in wet areas.

Facultative Wetland (FACW) species usually occur in wet areas but occasionally are found in non-wet areas.

Facultative (FAC) species are equally likely to occur in wet or non-wet areas.

Facultative Upland (FACU) species usually occur in non-wet areas but occasionally are found in wet areas.
Obligate Upland (UPL) species are almost always found in non-wet areas.

This information is helpful because it tells the observer whether or not water is being stored in the riparian area. The presence of OBL or FACW species indicates that the riparian area is storing water in the so-called riparian sponge. These species only occur where there is a high water table or saturated soil during all or part of the year. Conversely, a riparian area dominated by FACU or UPL species indicates a lack of water being stored in the ground. The presence of these upland species tells the observer that the riparian area is relatively dry and therefore is missing a key attribute of riparian function. Facultative (FAC) species are important in Hill Country creeks and rivers because they can tolerate a wide range of soil moisture conditions. During abnormally dry periods, when water levels and water tables drop, FAC species have the ability to survive until moisture conditions improve.

Wetland indicator categories for any species can be found at the USDA PLANTS database at [http://plants.usda.gov](http://plants.usda.gov). Tables 1, 2 and 3 provide wetland indicator category for common Hill Country riparian plants.

**Plant Communities**

Most of the riparian plant work in Texas has focused on individual plant species; however, on the creek bank, multiple plant species normally occur together as plant communities. A plant community comprised of several species is usually better suited for providing the stability, energy dissipation and sediment trapping than is a single species. The different rooting characteristics, different growth forms, different seasons of growth, and different reproductive strategies combine for a synergistic effect that is of greater benefit. For example, baccharis, sycamore, spikerush and bushy bluestem each have modest Stability
Ratings of only 5 or 6. However, when they occur together, their combined root strength provides an estimated rating of 7 and their ability to dissipate energy is greater than any of the species alone. A great deal of work remains to be done in Texas to describe the important riparian plant communities and their functional attributes.

**Large Wood**

One of the more important, but indirect attributes of riparian trees is the assimilation of large logs and dead fallen trees into the channel, substrate, banks and floodplains. Only fairly recently in Texas has the importance of large wood been realized. The natural lodging of large wood in and near the channel helps to dissipate energy, and to slow the movement of sediment, helping to build and stabilize banks. With time, much of this wood is partially or completely buried in the sediments, where it then becomes a structural part of the channel. Many people still believe that large woody debris should be removed from channels and riparian areas to hasten the flow of water. However, this practice often leads to increased erosion, bank failure and other problems. More people are now becoming aware of the importance of retaining large wood in creek and river areas.

**Evaluating Riparian Vegetation**

A subjective method of evaluating the functional adequacy of riparian vegetation is used in the protocol known as PFC, or Proper Functioning Condition. [ftp://ftp.blm.gov/pub/nstc/techrefs/Final%20TR%201737-15.pdf](ftp://ftp.blm.gov/pub/nstc/techrefs/Final%20TR%201737-15.pdf) This protocol is widely used on BLM land in the western states and has been used to a limited extent in Texas. Seven important vegetation attributes, summarized below can be visually appraised to determine if riparian vegetation is adequate to provide for basic riparian function:
Adequate reproduction of key riparian plants as exhibited by multiple age classes and/or expansion of colony forming species.

Adequate riparian plant diversity, including several species of stabilizing herbaceous and/or woody plants as appropriate for the site.

The presence of several OBL, FACW and FAC species that indicate good soil moisture conditions (i.e. riparian sponge.)

The presence of plants or plant communities with adequate stability rating to provide necessary bank and channel stabilization (SR of 7 or higher in the Hill Country)

Adequate plant vigor to insure good root development, seed production and recruitment.

At least 70% coverage of stabilizing plant communities along each bank.

The growth of medium and large trees on the banks that will provide a future source of large wood.

**Conclusion**

The right kinds and amounts of native riparian plants and plant communities is the key to healthy, functional riparian areas. In the Texas Hill Country where creeks and rivers are such a vital element of the landscape, properly functioning riparian areas will help provide the values that all Texans cherish – water quality, sustained flows, wildlife habitat, fish and aquatic habitat, livestock forage, and various recreational and aesthetic values.

Learning to identify key riparian plants and their functional roles is one of the important steps to understanding and managing riparian areas in a more sustainable and beneficial manner.
Table 1. Common Riparian Grasses, Sedges and Rushes of the Texas Hill Country with Stability Rating and Wetland Indicator

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Stability Rating</th>
<th>Wetland Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spikerushes *</td>
<td>Eleocharis sp. *</td>
<td>6</td>
<td>OBL</td>
</tr>
<tr>
<td>Emory sedge</td>
<td>Carex emoryi</td>
<td>9</td>
<td>OBL</td>
</tr>
<tr>
<td>Sawgrass</td>
<td>Cladium mariscus</td>
<td>9</td>
<td>OBL</td>
</tr>
<tr>
<td>Bulrushes *</td>
<td>Scirpus sp. *</td>
<td>9</td>
<td>OBL</td>
</tr>
<tr>
<td>Porcupine sedge</td>
<td>Fuirena simplex</td>
<td>5</td>
<td>OBL</td>
</tr>
<tr>
<td>Rice cutgrass</td>
<td>Leersia oryzoides</td>
<td>6</td>
<td>OBL</td>
</tr>
<tr>
<td>Southern wildrice</td>
<td>Zizaniopsis miliacea</td>
<td>9</td>
<td>OBL</td>
</tr>
<tr>
<td>Water bentgrass</td>
<td>Agrostis semiverticillata</td>
<td>4</td>
<td>OBL</td>
</tr>
<tr>
<td>Flatsedges *</td>
<td>Cyperus sp. *</td>
<td>5</td>
<td>OBL-FACW</td>
</tr>
<tr>
<td>Rushes *</td>
<td>Juncus sp. *</td>
<td>6</td>
<td>OBL-FACW</td>
</tr>
<tr>
<td>White top sedge</td>
<td>Dichromena sp.</td>
<td>5</td>
<td>FACW</td>
</tr>
<tr>
<td>Knotgrass</td>
<td>Paspalum distichum</td>
<td>6</td>
<td>FACW</td>
</tr>
<tr>
<td>Hairyseed paspalum</td>
<td>Paspalum pubiflorum</td>
<td>6</td>
<td>FACW</td>
</tr>
<tr>
<td>Bushy bluestem</td>
<td>Andropogon glomeratus</td>
<td>5</td>
<td>FACW</td>
</tr>
<tr>
<td>Aparejograss</td>
<td>Muhlenbergia utilis</td>
<td>6</td>
<td>FACW</td>
</tr>
<tr>
<td>Barnyardgrass</td>
<td>Echinocloa muricata</td>
<td>4</td>
<td>FACW</td>
</tr>
<tr>
<td>Switchgrass</td>
<td>Panicum virgatum</td>
<td>9</td>
<td>FAC</td>
</tr>
<tr>
<td>Eastern gammagrass</td>
<td>Tripsacum dactyloides</td>
<td>9</td>
<td>FAC</td>
</tr>
<tr>
<td>Lindheimer muhly</td>
<td>Muhlenbergia lindheimeri</td>
<td>8</td>
<td>FAC</td>
</tr>
<tr>
<td>Wildrye</td>
<td>Elymus sp.</td>
<td>5</td>
<td>FAC</td>
</tr>
<tr>
<td>Broadleaf uniola</td>
<td>Chasmanthium latifolium</td>
<td>6</td>
<td>FAC</td>
</tr>
</tbody>
</table>

* These genera have several species, which are grouped together here with generally similar function.
Table 2. Common Riparian Forbs and Ferns of the Texas Hill Country with Stability Rating and Wetland Indicator

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Stability Rating</th>
<th>Wetland Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water willow</td>
<td>Justicia americana</td>
<td>7</td>
<td>OBL</td>
</tr>
<tr>
<td>Water primrose</td>
<td>Ludwigia sp.</td>
<td>3</td>
<td>OBL</td>
</tr>
<tr>
<td>Water hyssop</td>
<td>Bacopa monnieri</td>
<td>3</td>
<td>OBL</td>
</tr>
<tr>
<td>Water pennywort</td>
<td>Hydrocotyle verticillata</td>
<td>4-5</td>
<td>OBL</td>
</tr>
<tr>
<td>Scouring rush</td>
<td>Equisetum laevigatum</td>
<td>6</td>
<td>OBL</td>
</tr>
<tr>
<td>Bidens beggar's-ticks</td>
<td>Bidens sp.</td>
<td>5</td>
<td>OBL</td>
</tr>
<tr>
<td>Cardinal flower</td>
<td>Lobelia cardinalis</td>
<td>5</td>
<td>FACW</td>
</tr>
<tr>
<td>Tall aster</td>
<td>Aster praealtus</td>
<td>6</td>
<td>FACW</td>
</tr>
<tr>
<td>Large buttercup</td>
<td>Ranunculus macranthus</td>
<td>6</td>
<td>FACW</td>
</tr>
<tr>
<td>Bog nettle</td>
<td>Boehmeria cylindrica</td>
<td>5</td>
<td>FACW</td>
</tr>
<tr>
<td>Rattlepod</td>
<td>Sesbania sp</td>
<td>3</td>
<td>FACW</td>
</tr>
<tr>
<td>Tall goldenrod</td>
<td>Solidago altissima</td>
<td>6</td>
<td>FACW</td>
</tr>
<tr>
<td>Frogfruit</td>
<td>Phyla nodiflora</td>
<td>4</td>
<td>FAC</td>
</tr>
<tr>
<td>Late boneset</td>
<td>Eupatorium serotinum</td>
<td>5</td>
<td>FAC</td>
</tr>
<tr>
<td>Shield fern</td>
<td>Thelypteris ovata</td>
<td>6</td>
<td>FAC</td>
</tr>
</tbody>
</table>
Table 3. Common Riparian Woody Plant and Vines of the Texas Hill Country with Stability Rating and Wetland Indicator

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Stability Rating</th>
<th>Wetland Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bald cypress</td>
<td>Taxodium distichum</td>
<td>10</td>
<td>OBL</td>
</tr>
<tr>
<td>Buttonbush</td>
<td>Cephalanthus occidentalis</td>
<td>8</td>
<td>OBL</td>
</tr>
<tr>
<td>Black willow</td>
<td>Salix nigra</td>
<td>7</td>
<td>FACW</td>
</tr>
<tr>
<td>Arroyo willow</td>
<td>Salix lasiolepis</td>
<td>7</td>
<td>FACW</td>
</tr>
<tr>
<td>Spiny aster</td>
<td>Aster spinosus</td>
<td>8</td>
<td>FACW</td>
</tr>
<tr>
<td>Box elder maple</td>
<td>Acer negudo</td>
<td>6</td>
<td>FACW</td>
</tr>
<tr>
<td>Sycamore</td>
<td>Platanus occidentalis</td>
<td>6</td>
<td>FAC</td>
</tr>
<tr>
<td>Cottonwood</td>
<td>Populus deltoides</td>
<td>7</td>
<td>FAC</td>
</tr>
<tr>
<td>Pecan</td>
<td>Carya illinoicensis</td>
<td>6</td>
<td>FAC</td>
</tr>
<tr>
<td>Little walnut</td>
<td>Juglans microcarpa</td>
<td>7</td>
<td>FAC</td>
</tr>
<tr>
<td>Willow baccharis</td>
<td>Baccharis neglecta</td>
<td>6</td>
<td>FAC</td>
</tr>
<tr>
<td>American elder</td>
<td>Sambucus canadensis</td>
<td>6</td>
<td>FAC</td>
</tr>
<tr>
<td>Roughleaf dogwood</td>
<td>Cornus drummondii</td>
<td>6</td>
<td>FAC</td>
</tr>
<tr>
<td>Sugar hackberry</td>
<td>Celtis laevigata</td>
<td>6</td>
<td>FAC</td>
</tr>
<tr>
<td>American elm</td>
<td>Ulmus americana</td>
<td>6</td>
<td>FAC</td>
</tr>
<tr>
<td>Cedar elm</td>
<td>Ulmus crassifolia</td>
<td>6</td>
<td>FAC</td>
</tr>
<tr>
<td>Chinquanpin oak</td>
<td>Quercus muhlenbergii</td>
<td>6</td>
<td>FAC</td>
</tr>
<tr>
<td>Lindheimer indigo</td>
<td>Indigofera lindheimer</td>
<td>5</td>
<td>FAC</td>
</tr>
<tr>
<td>Wafer ash</td>
<td>Ptelea trifoliata</td>
<td>6</td>
<td>FAC</td>
</tr>
<tr>
<td>Dewberry</td>
<td>Rubus trivialis</td>
<td>4</td>
<td>FAC</td>
</tr>
<tr>
<td>Greenbriar</td>
<td>Smilax bona-nox</td>
<td>5</td>
<td>FAC</td>
</tr>
<tr>
<td>Poison ivy</td>
<td>Toxicodendron radicans</td>
<td>5</td>
<td>FAC</td>
</tr>
<tr>
<td>Live oak</td>
<td>Quercus fusiformis</td>
<td>6</td>
<td>FACU</td>
</tr>
<tr>
<td>Netleaf hackberry</td>
<td>Celtis reticulata</td>
<td>5</td>
<td>FACU</td>
</tr>
<tr>
<td>Red mulberry</td>
<td>Morus rubra</td>
<td>6</td>
<td>FACU</td>
</tr>
<tr>
<td>Western soapberry</td>
<td>Sapindus drummondii</td>
<td>6</td>
<td>FACU</td>
</tr>
<tr>
<td>Black walnut</td>
<td>Juglans nigra</td>
<td>6</td>
<td>FACU</td>
</tr>
<tr>
<td>Gravelbar brickllbush</td>
<td>Brickellia dentata</td>
<td>5</td>
<td>UPL</td>
</tr>
</tbody>
</table>
Fire in Oak-Juniper Woodlands: What Happens After the Smoke Clears?

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Abstract
Wildfires are a part of the Texas landscape and many species are well adapted to survive them. In 1996, a wildfire burned more than 10000 acres of oak-juniper woodlands on Fort Hood. A second wildfire in 2009 re-burned some of the same area. Vegetation recovery after the fires was rapid. Most of the woody plant species found in unburned woodlands are still present after the fires, but the vegetation structure is very different, making the areas excellent habitat for the endangered black-capped vireo (at least temporarily). Ashe juniper, the most common species in unburned woodlands and a crucial habitat component for the endangered golden-cheeked warbler, is still almost completely absent from the burned areas. I will discuss what the fires can teach us about the ecological history of the Edwards Plateau and how to balance the needs of birds with varying habitat requirements.

The past few years have been hot and dry in most of Texas. Drought, as is often the case, has contributed to extensive wildfires throughout the state. For native plant lovers, the images of charred ground, blackened stumps, and leafless branches can be difficult to bear. For many native plant species, however, fire is not a disaster. Surprisingly little is known about the history of wildfires in the oak-juniper woodlands of the Texas Hill Country before European settlement, although it is clear that wildfires did occur. Early observers mentioned seeing evidence of fires, both in grasslands and woodlands, but their accounts are spotty. Native Americans throughout North America used landscape-scale fire for a variety of purposes. Fire in open savannas and grasslands can be, and often are, ignited by lightning; denser woodlands with few understory grasses likely burned less often. While early accounts vary, there were likely more savannas and grasslands
in the Hill Country before grazing and fire suppression decreased the number and size of wildfires. However, woody vegetation was present too, so there must also have been areas where fire burned rarely.

One way to overcome this uncertainty about the historic prevalence of wildfires is to look at the response of plants to present-day wildfires. Plant responses to fire have been shaped by thousands of years of evolution, and the relatively short period of fire suppression will not have changed those responses. In this paper, I will describe the responses of woodlands on the Fort Hood Military Reservation to two wildfires and examine what those responses can teach us about the ecological history of the Hill Country.

Fort Hood, located in Bell and Coryell Counties, is at the northern edge of the Edwards Plateau and is sometimes placed into a separate, smaller ecoregion called the Lampasas Cut Plain. The vegetation on the installation has many affinities with that of the Hill Country (oak-juniper woodlands, live oak (*Quercus fusiformis*) savannas, and little bluestem grasslands are all common), but also shows influences of the Cross Timbers in its post oak (*Quercus stellata*) and blackjack oak (*Quercus marilandica*) savannas. Fort Hood is home to large populations of two federally endangered songbirds: the golden-cheeked warbler and the black-capped vireo. Golden-cheeked warblers nest in mature oak-juniper woodlands. They construct their nests out of the peeling bark from Ashe juniper (*Juniperus ashei*) trees and forage in a wide variety of tree species. Black-capped vireos, on the other hand, nest in short, dense, open shrub-lands. They are less selective about the shrub species present than they are about vegetation structure. These vireos build their nests fairly close to the ground (usually less than 4 feet), so they require dense leaf cover at those heights to conceal their nests.
In February 1996, military training activities started three grassland fires. Weather was hot (95 to 100°F), windy, and very dry. The fires moved into adjacent oak-juniper woodlands, where they became crown fires (fires that jump from one tree canopy to the next). By the time the fires were finally controlled, they had burned more than 6,000 acres of golden-cheeked warbler habitat (10,000 acres total).
The fires were so intense that, in most of the burned areas, leaf litter, entire shrubs, and even tree side branches had all burned up. Only blackened tree trunks and rocks, some shattered by the heat, remained. By July, however, many of the apparently dead trees had new green growth sprouting from their bases, and some of the re-sprouts on sloped sites were already almost 6 feet tall.

In the years following the wildfire, almost all of the plant species grew back, mostly by re-sprouting from their roots. A few species that do particularly well in disturbed areas, like Roosevelt weed (*Baccharis neglecta*) and prairie flameleaf sumac (*Rhus lanceolata*), became much more abundant than before the fire for a few years. The most common oak species—Texas red oak (*Quercus buckleyi*), shin oak (*Quercus sinuata* var. *breviloba*), Texas live oak (*Quercus fusiformis*), and post oak (*Quercus stellata*)—all remained very common. Texabama croton (*Croton alabamensis* var. *texensis*), a rare plant that had not reproduced on Fort Hood in years, suddenly had dozens of seedlings. By 2010 (14 years after the fire), the woodlands on the slopes were just as tall as those in unburned areas, although the tree trunks are still considerably smaller. On the mesas and in the valleys, the vegetation is still shorter than before the fire.

One species almost completely absent from the burned areas is Ashe juniper: unlike most of the other woody plants in the area, Ashe juniper does not re-sprout after being top-killed. In fact, the first individuals more than 6 feet tall were not found until 2005. This slow recovery is surprising, given that grasslands must be burned every 3 to 5 years to keep Ashe juniper at bay. One possible reason is that most juniper seeds fall close to the parent tree and
there were few surviving trees in the burned area to provide seed. Furthermore, the few seeds that did germinate faced very strong competition from the re-sprouting hardwoods. Juniper seedlings grow slowly, especially when shaded, and many seedlings died in the first few years.

The slow return of Ashe juniper to the burned areas is bad news for the golden-cheeked warbler. At the current rate of increase, it will be decades before Ashe juniper is again a major component of the woodland canopy. The black-capped vireo, on the other hand, has been using the burned areas extensively. Because the vegetation on the slopes grew tall more quickly, the vireos used the slopes only for the first three years. On the mesa tops, black-capped vireos are still nesting in areas burned in the 1996 fire, although even some of those areas are now becoming too tall.

In April 2009, another wildfire started adjacent to the original burned areas. Weather conditions were somewhat less severe, but the fire burned a total of 1500 acres, 890 of which had burned in the first wildfire. This fire’s effect on the vegetation has, surprisingly, been somewhat different than that of the first fire. As expected, all the same species re-sprouted, but they sprouted many more stems than after the first fire. Shin oak and Texas red oak had twice as many stems in 2009 as they had in 1996; poison ivy (*Toxicodendron radicans*) and prairie flame-leaf sumac had more than ten times as many stems. For most species, the increase didn’t last and their stem density decreased from 2009 to 2011 (after the first fire, most species’ density had increased from 1996 to 1998). The great increase in stem density is likely due to a combination of factors. First, many plants lose the ability to re-sprout as they get larger. At the time of the second fire, the average stem size was considerably smaller than at the time of the first time. Second, the second fire burned under
less extreme conditions, so the plants’ root crowns were not burned as severely. Finally, rainfall in 2009 was much higher than in 1996 (41 inches vs. 31 inches).

While the overall number of stems in 2009 was much higher than in 1996, the number of tall stems was somewhat lower. This slightly slower growth means that the twice-burned woodlands will probably be suitable black-capped vireo habitat for longer than they were after the first fire, and that they will take even longer to become golden-cheeked warbler habitat again.

So, what can we learn about the ecological history of the Texas Hill Country from these fires? First, most of the woody plants are clearly adapted to fires, even fires as often as once a decade. Some species, like Texabama croton, prairie flame-leaf sumac, and Roosevelt weed, thrive when burned. Second, Ashe juniper is, for all practical purposes, eliminated from woodlands by crown fire. For Ashe juniper to have been a dominant presence in the Hill Country before settlement, and for golden-cheeked warblers to have nesting habitat, there must have been many places that burned only rarely. These places may have been on rocky slopes or mesas, where there are not enough fine fuels (such as grasses) to carry fires under most conditions. Finally, fires must have been large enough and occurred in wooded areas often enough that black-capped vireos always had short, open shrub-lands for nesting habitat. At the same time, fires could not have been so frequent that the woody plants stopped re-sprouting, as they will if burned every year.

These conclusions build a picture of the Hill Country as a shifting mosaic of grasslands, shrub-lands, and woodlands. Woody plants, particularly Ashe juniper, would have been a constant presence on dry, rocky sites. Slopes were probably more wooded than mesas or valleys, since the trees regrow faster there. The number of trees and shrubs in the
grasslands would have ebbed and flowed, depending on how recently and how severely a site had been burned. Fires were relatively common, but likely burned mostly in the grasslands with occasional forays into woodlands, where they created or rejuvenated shrub-lands.

Today, we must balance the needs of two endangered birds in a landscape where fire is no longer a constant presence. While there is likely more habitat for golden-cheeked warblers than black-capped vireos in the Hill Country, regenerating golden-cheeked warbler habitat is a long, slow process. Black-capped vireo habitat, on the other hand, can be more easily (if expensively) created using prescribed fire or various mechanical treatments. I suggest that we create and maintain black-capped vireo habitat in existing shrub-lands and shrubby, open woodlands while protecting mature woodlands from wildfire to the extent that we can. Still, if wildfire happens, as it inevitably does, we can rest assured that this land has seen fire before, and that there will one day be trees here again.

Selected references


Cedar: Myth and Management

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Abstract
What the Hill Country looked like before settlement by European man will be explained, in addition to what happened as a consequence of settlement and how that relates to cedar (Ashe Juniper). The characteristics of cedar, including rainwater interception will be discussed as well as what will happen if we “Let nature take its course”. Finally, the “Do’s and Don’ts” of cedar management in the Edwards Plateau will be discussed.

Cedar, as it is commonly called in most areas where it grows, is actually not cedar at all, but juniper. There are several species of juniper in Texas. The two most widespread are Ashe juniper (*Juniperus ashei*), also called Blueberry cedar, and Redberry cedar (*Juniperus pinchotii*). Ashe juniper occupies most all of the Edwards Plateau in central Texas and some parts west, whereas Redberry cedar is found mostly in the Trans-Pecos and parts of the panhandle, with some overlap between the two species.

In spite of persistent beliefs by some to the contrary, these junipers are natives, with many written records from the early 1800s and fossil records indicating it may date back to the Pleistocene.

Although we refer to the fruit of these junipers as berries, in fact junipers are gymnosperms. Botanically, what we call berries are actually fleshy cones.

Cedar is native, natural, xeric, evergreen, and almost disease-free. It is an important seasonal food source for birds and deer, and provides important cover and shelter for many wildlife species. Where it was most common historically, on steep slopes in canyons, it serves to intercept raindrops and partially protects the soil from erosion.
It is true that cedar has encroached onto previous grasslands and savannas of the Hill Country in the last 100-150 years. In order to understand that phenomenon, it is important to understand what changes in the ecosystem have led to that encroachment.

In the Early 1800s there was, on average, more open grasslands and savannas in the Hill Country, especially on the flatter areas, and the grasses were on average taller and more dense. Both hardwoods and cedar were most numerous on slopes along creeks and rivers. Having said that, it would be a mistake to believe the common myth that the Hill Country was a “sea of grass”. There were obviously areas of open grasslands but also many areas of woodlands and cedar brakes. Bison grazed the area heavily, occasionally, and then moved on, and it is estimated that wildfires (grassfires) burned most of the area every 3 to 10 years, started by lightning or, accidentally or intentionally, by the Native Americans.

People of European ancestry began settling Texas in significant numbers in the early 1800s and continued into the mid-1800s and the early 20th century. The Native Americans were pushed back as settlers moved further and further west. The settlers brought with them livestock which grazed the land continuously and they killed predators to protect their livestock. As the grasses were grazed continuously, which had never happened before, the amount of grass was significantly reduced, and with fewer Native Americans around, these two factors reduced the frequency, intensity and size of wildfires.

Natural plant succession would normally be expected to take a grassland first to a savanna and then to a more woody ecosystem as woody species take over smaller vegetation. But, before settlement, frequent fires prevented woody species from becoming established on the more open grasslands because fire would kill small woody species. After settlement, the
amount of grass to carry a fire and the number of fires occurring were both reduced, allowing
natural plant succession to move the Hill Country toward a more-woody ecosystem. This
also made areas which were too open for preferred deer habitat, much better deer habitat.

The reduction of fires allowed cedar to become much more widely and more densely
established. However, over time, especially after barbed wire was available in the 1880s,
much of the cedar was cut for fence posts and it was highly valued, thus again reducing the
amount of cedar cover.

With fewer predators and more woody habitats, deer populations increased in spite of
huge numbers being taken by settlers and by commercial hunters. With the last natural
predator of white-tailed deer, the screw worm, eliminated in the 1960s, deer populations have
shot up resulting in populations capable of now destroying all new root sprouts and saplings
of hardwoods. We are now to the point where much of the Hill Country no longer has any
more replacement hardwoods to take the place of dying mature oaks, cherries, cedar elms,
walnuts, and hackberries.

But cedar is about the last thing a deer or anything else wants to eat, so new small
cedar bushes grow undisturbed into mature trees. And metal “T” posts have replaced cedar
posts as preferred fence posts. So cedar continues to increase where man does not control it.
At the Kerr Wildlife Management Area, a 96 acre hardwood savanna was high fenced with
no animals inside in the 1960s to “let Nature take its course”. It is now a dense cedar brake.

The results of an experiment on rainwater interception by cedar were presented at a
symposium in 1997. The results were widely interpreted by many to indicate that cedar
intercepts 80% of the rainfall during a rainstorm. We all know that if we are outside in a
shower and we run under a tree, we can keep from getting wet—for a while. But we also know that eventually, if it rains long enough or hard enough, we will get wet. Once the leaves of the tree have caught all of the raindrops they can hold, all subsequent raindrops will not adhere to the leaves but will fall to the ground. The principle applies to all vegetation, from a grass to the largest tree.

The amount of rain a plant can capture on the surface of the leaves depends on the type of leaf, but mainly on the size of the plant. So in a light shower, a large percentage of rain may be caught by the vegetation and never reach the ground. But in a heavy rain, the plant leaves will be thoroughly wet very quickly and most of the rain will fall to the ground.

Subsequent studies seem to indicate that the amount of rainwater interception that was indicated by that earlier report is probably much too high. But it is certainly true, however, that cedar bushes, because they are evergreen, have a dense leaf structure and grow into dense thickets, do intercept some rainfall which eventually just evaporates back into the atmosphere. If the cedar were replaced with smaller plants, especially native bunch grasses, less of the rainfall would be intercepted and more would reach the ground.

So while removing cedar and replacing it with native grasses is certainly likely to result in more rainwater infiltrating into the ground, and some of it may help replenish the water table for seeps and springs or even the aquifer, the magnitude of the improvement may be somewhat in question. Also, the size of the property and the underling geology may be more important in determining whether any improved spring flow will be observed.

So what is a landowner to do? Regardless of the rainwater issue, large, dense stands of cedar are a monoculture and thus a poor habitat for any wildlife, it reduces the amount of
grazeable acres, and if it is not controlled it will eventually take over and crowd out most other vegetation. Managing cedar is just like managing livestock, or wildlife numbers, or invasive exotics—it is just part of owning land in the Hill Country. Removing cedar and replacing it with native grasses MAY result in visible improvements in seeps, springs and creeks.

What is unquestionable is that if you do nothing, cedar will continue to increase in both size and numbers and the health of the habitat will decline.

How to reduce cedar is a complicated issue. What makes sense for small properties may be totally impractical for large ranches, and vice versa. The best rule of thumb is to use the mechanical method (bulldozer, skid-steer tractor with shears, or chain saws) that does the least damage to the ground and other vegetation that you can afford. Most large ranches use bulldozers, which are the most damaging but are the cheapest for large properties. Bobcats with shears are probably the most commonly used method, while using chain saws is frequently the choice of individual landowners doing it themselves, and this is the least damaging and most flexible of all methods.

Once the area has been cleared of the large cedar bushes, over the next three to seven years, small cedar bushes will come up were the old cedar was cut or under hardwood trees where birds sit. These small cedars are best removed by hand loppers before the stems get to be over about an inch in diameter. Where practical, prescribed burning is a very inexpensive and beneficial tool to remove small cedars.
Identifying, Managing, and Augmenting Resources for Native Bees

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Abstract
Several hundred native bee species occur across the Edwards Plateau, some occurring nowhere else in Texas. These bees represent the most important pollinators of native plants in this ecoregion, playing critical roles in the maintenance of many of the region’s plant communities. Despite their profound ecological influence, native bees have largely received little to no consideration as far as habitat management or restoration is concerned. Native bees have two very basic needs, food in the form of nectar and pollen from flowers and suitable nesting sites. By meeting one or both of these needs, home gardeners to ranch owners can make real contributions to native bee conservation.

Pollination is one of the most fundamental processes sustaining agricultural and ecological systems. In Texas, most plant pollination is carried out by bees. The non-native European honeybee (Apis mellifera) is our most well-known bee species, first brought to North America in 1621. Following additional releases in the 19th and 20th centuries, European honeybee populations expanded to encompass much of the United States. In the last twenty years, hybrids of African and European honeybee subspecies have spread across the southern United States. These “Africanized” honeybees exhibit much different behaviors from the semi-domesticated European honeybee, most infamously their propensity to aggressively defend their colonies in heightened numbers.

Although non-native honeybees tend to garner the most public attention, there are actually several hundred bee species that are native to Texas. Species that were here long before the honeybee and that are essential to the state’s diverse native plant communities. Bumblebees
are among the most familiar; their black and yellow bodies are easy to recognize as they buzz from flower to flower. Like honeybees, bumblebees are social insects that live in colonies comprised of a queen and her daughter workers that will protect their nest site if disturbed. Bumblebee colonies are much smaller in size though, containing only 100-200 workers compared to the 20,000 or more workers in a honeybee colony.

Social bees are very much the exception when it comes to Texas bee diversity. The vast majority of native bees in the state are solitary species in which an individual female establishes and provisions a nest site all on her own. Unlike honeybees and bumblebees, solitary bees do not attempt to defend their nest sites through mass stinging attacks. These “single-mothers” are the sole caretakers of their nests and simply cannot afford the risk of injury or death, unlike honeybee colonies which have many expendable, non-reproductive workers.

Solitary bees tend to be small and less frequently observed than their social cousins. They may even be hard to identify as a “bee” given their wide range of shapes, sizes, and color patterns. Although less well-known, solitary bees such as carpenter bees (Xylocopa), leaf-cutter bees (Megachile), mason bees (Osmia), mining bees (Andrena), squash bees (Peponapis), and sunflower bees (Diadasia) are responsible for a significant amount of pollination in agricultural and ecological systems.

Conservation Challenges and the Value of Native Bees
In the U.S., the European honeybee has been in a well-documented decline since the 1950s as a result of agricultural intensification, diseases, parasites, pesticides, and stagnant honey prices. Unabated loss of this bee will have significant repercussions for large-scale, intensive agriculture to be sure. The pollination service of European honeybees to U.S.
agriculture has an annual value well in excess of $15 billion. However, it will not be an ecological calamity. The conservation challenges facing native bees are where the real concerns for natural ecosystems lay.

Many native bees are now thought to be experiencing population declines. Research has documented range reductions for several bumblebee species across North America. Franklin’s bumblebee (*Bombus franklini*) has been petitioned for protection under the U.S. Endangered Species Act. Eighteen native bees are considered species of greatest conservation need by Texas Parks and Wildlife Department. A principle factor driving native bee decline is widespread habitat destruction, specifically the loss of flower-rich grasslands, savannas, and woodlands. Open natural communities represent optimal habitat for native bees as they support diverse assemblages of flowering plants and relatively abundant nest sites.

Even if native bees are declining why should we be concerned? The answer to that question is simple once one realizes most native plants in North America require pollination by insects to produce fruit and viable seed; fruit and seed that in turn support terrestrial ecosystems. That’s not even taking into account the dozens of agricultural crops we humans use that require insect-pollination.

Of all the insects that visit flowers, from beetles, butterflies, and wasps, bees are the most important pollinators. Two traits make bees preeminent pollinators. First, they purposefully collect pollen to feed their offspring. The act of foraging for this food source results in the transfer of pollen from flower to flower. During a single day, a female bee may visit several hundred flowers, depositing pollen all along the way. Second, bees tend to be specific about the flowers they visit. During a foraging trip, a female bee may only visit the flowers of a
particular plant species. The benefit of such foraging preferences is that the plants' pollen is not deposited on the flowers of a different plant species and wasted.

Native bee pollination is critical to the maintenance of Texas diverse ecosystems. Many of the berries, nuts, and seeds consumed by birds, mammals, and other insects are the result of bee pollination of native herbaceous and woody plants. Along with their substantial ecological contributions, native bees have proven to be more efficient and effective pollinators than honeybees for such agricultural crops as apples, blueberries, pumpkins, squash, tomatoes, and watermelons. The added benefit to farmers from native bees is that their services are essentially free if adequate natural habitat is maintained around crops to support healthy populations of these pollinators.

Native Bee Needs

Native bees have two basic needs; food in the form of nectar and pollen from flowers and a suitable place to nest and lay eggs. By meeting one or both of these needs, home gardeners and rural landowners can make real contributions to native bee conservation. While some native bees are only active for short, discrete periods (a few weeks), most species benefit from sites containing a diverse array of native herbaceous and woody plants that provide a succession of flowers from spring into early fall. Bumblebees, for instance, require a near continuous supply of nectar and pollen, from spring to early fall, to complete colony development.

The nesting habits of native bees can be classified into two broad categories, cavity-nesters and ground-nesters. The majority of native bees in Texas are members of the latter group and either nest in burrows dug of their own labor in bare soil, pre-existing underground cavities (rodent burrows), or within clumps of vegetation. Species that nest in dead wood
generally use tunnels left by wood-boring beetle larvae in standing dead trees, under the loose bark, or in dry, hollowed-out pithy stems.

**Identify and Protect**

Now that you know the very basics of what native bees need, the next step is recognizing those resources on your property that bees are already using to forage or nest. Once identified, you can protect these sites and adjust management practices to preserve them over time.

**Nectar and Pollen**

Survey your property to see if it already contains patches of flowering native herbaceous plants (forbs) or groups of flowering native shrubs and trees. There are a number of good books and online resources for identifying Texas native plants. Observe these patches at different times of day to see which plant species are being heavily used by bees and other flower-foragers (beetles, butterflies, flies, and wasps). These are plants to protect, and potentially perpetuate, within the framework of your property’s management plan. Sites that host good native bee plants will likely require some level of management on your part to maintain, particularly if the area is prone to native woody plant encroachment or contains competing non-native plants.

**Nest Sites**

Existing nest resources will be a little harder to recognize than patches of flowers but general nesting habitats across a property can be identified and protected. Standing dead trees, downed wood, dried stalks of yucca, and thickets of blackberry, sumac, or elderberry represent potential nesting habitat for dead wood-nesting bees. The safe and prudent
retention of standing dead trees and downed wood will not only provide natural nesting sites for cavity-nesting bees but a range of invertebrate and vertebrate wildlife as well.

Well-drained, sparsely vegetated patches of bare ground are preferred nesting habitat for many solitary bees. While sparsely vegetated ground may seem unsightly to some, there are often underlying reasons some areas simply don’t support much vegetation (thin soils, deep sands). Avoid ground disturbance (disking, tilling, vehicle traffic) of these areas to maintain and promote nesting aggregations of ground-nesting bees. Conversely, sites containing dense stands of clump-forming native grasses and a layer of deep thatch represent potential bumblebee nesting habitat. Let open, grassy portions of your property grow unchecked and undisturbed for a few years to promote nest resources for these bees.

Adapt Management Practices
Management practices, such as burning, cattle grazing, and haying/mowing, can limit woody plant encroachment, suppress non-native plants, and enhance native herbaceous plant diversity. However, these practices should be implemented with the needs of native bee in mind as they have the potential to reduce or even eliminate floral resources and nest sites. The prescriptions below are general guidelines to maintain areas with existing native bee habitat on your property.

When applying any practice to a property, especially in terms of protecting native bee populations, it is critical to avoid treating an entire site in one season. A site that is burned or hayed in its entirety in the dormant season will virtually eliminate those native bees that are overwintering in dry stalks, stems, and twigs. Implementing these practices during the growing season will remove nearly all nectar and pollen resources. Instead, only treat 30%-

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50% of a site leaving the remainder untouched. Untreated areas of the property will serve as critical refugia for species to recolonize the burned, grazed, or hayed/mowed portion.

**Prescribed burns** should be conducted from fall into early spring. Avoid burns during the growing season. Allow sufficient time between burns (three to six years) for thatch to accumulate and enable insect populations in burned sections to recover.

**Cattle grazing** should be short duration and designed to protect areas containing nectar and pollen resources. Grazing intensity may be low or high depending upon the goals of your management plan. Low intensity, short duration grazing during the dormant season will have the least impacts on native bee resources. High intensity, short duration grazing may be called for in restoration efforts to increase seed germination or control non-native grasses. Grazing with animals other than cows, like goats that feed more heavily on nectar and pollen-bearing forbs, should be approached with caution.

**Haying/mowing** should be restricted to the fall and winter to maximize availability of flowering plants to native bees. Avoid mowing to low; instead maintain a minimum cutting height of six to eight inches. If haying/mowing must be conducted during the growing season, leave blocks or strips uncut to retain some stands of flowers and nest sites.

Try to apply as many of the techniques above as possible. Reliance upon a single practice year after year, such as prescribed burning alone, can lead to loss of certain plant species and a shift to a more homogeneous community. Applying a range of practices will result in a more heterogeneous and healthy landscape. Your property’s plant communities are dynamic and your management needs to be as well.
**Supplement and Create: Nectar and Pollen**

A survey of your property may reveal deficiencies in available foraging and/or nesting resources. There are steps you can take to augment these, however. Increasing the diversity of flowering plants on your property is probably one of the more rewarding. It may also be the most critical step as nectar and pollen resources are often more of a limiting factor for native bee populations than nest sites. When augmenting floral diversity at a site, Texas native plants are your best choice as these are the plant species native bees have evolved with and that are best adapted to the state’s climate. Table 1 contains a number of native plant species that are suitable for the Edwards Plateau ecoregion.

Incorporate good-quality bee plants into your property that will provide flowers from early spring, summer, into early fall. Robust sources of nectar and pollen during each of these three periods will meet the needs of a wide range of native bees. A good starting point is ensuring that you have a minimum of three plant species flowering in each season for a total of at least nine species on your property; if you are able to accommodate even more species all the better. Some smaller sites may not be able to establish nine species, however. In that case, simply work to provide a succession of flowers with as many native plant species as you are able to plant and maintain.

Exactly how you increase native plant diversity at your site will depend upon the current state of the area you wish to manage. In home landscapes, establish groups of single species plantings. Masses of the same species are more attractive to native bees and make foraging more efficient and economical. If reseeding a large site, obtaining an as-local-as-possible seed mix is not only helpful for establishment success but also aids in the protection of existing local gene pools. Areas heavily invaded by non-native plants may require relatively
intensive efforts to convert your property to a more bee-friendly state. Conversely, your property may be in relatively good shape and would simply benefit from the addition of a few native plant species to increase floral diversity. In that case, a light disking and reseeding with a native seed mix may be all that is required. A site visit by a TPWD biologist will help to identify your property’s specific issues and the actions that need to be taken to help you meet your management goals.

**Supplement and Create: Nest Sites**

The second piece of the puzzle in conserving native bee populations is to increase available nesting habitats. Ground-nesting solitary bee species need access to sun-exposed, well-drained patches of sparsely-vegetated ground. For home landscapes, leaving portions of your flower beds devoid of mulch is one option that will provide some habitat to ground-nesting bees. Piling up well-drained sandy or sandy loam soils and/or digging pits and filling them with the same soil mix are additional options. For the latter, dig a pit one and a half to two feet deep and at least four to six feet square in an open, well-drained spot and fill with the soil mix. These sites may require annual maintenance to maintain their open character. Maintenance should be conducted in the fall or winter and not result in soil disturbance to protect bees overwintering underground.

A lack of dead wood nesting habitat can be addressed by installing wooden nest blocks; bird houses for bees essentially. Nest blocks should be eight or more inches in height and must be constructed from untreated lumber. A range of dimensions, from 2x4, 4x4, to 4x8, can be used. Holes of varying diameters, from 1/4” to 3/8”, should be drilled into the blocks spaced 3/4” apart. Don’t drill completely through but rather about 1/2” from the back of the block. Attach a roof to provide protection from intense sun and rain. Face nesting blocks to
the southeast to catch morning sun and affix firmly to a building, fence, or post, at least three feet above the ground, so they do not sway in the wind. Unlike the real dangers of honeybee colonies in suburban and urban landscapes, the bees that use these nest blocks are all native solitary species that do not defend their nests.

If you are lucky, solitary bees will fill the drilled blocks with bee larvae, capping the entrance with mud or plant fibers. Blocks can be left in place throughout the winter or brought into a shed or unheated garage to protect next year’s crop of solitary bees from hungry woodpeckers. Be sure to return the blocks outdoors in late winter or very early spring to allow the bees to exit their chambers.

Learn More

These guidelines and suggestions are not exhaustive and are, in fact, just the tip of the iceberg. The Xerces Society for Invertebrate Conservation has been leading the way in the recent push to conserve native bees. They have produced a wealth of information that is available online (www.xerces.org/bringbackthepollinators/) and in print (Attracting Native Pollinators: Protecting North America’s Bees and Butterflies, Storey Publishing). If you are interested in Texas-centric bumblebee efforts, visit www.texasbumblebees.com to learn more about efforts to research and conserve these pollinators.
Table 1. Native plant species of the Edwards Plateau attractive to native bees.

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<th>Species</th>
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<td>Creek plum (<em>Prunus rivularis</em>)</td>
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<td>Texas mountain laurel (<em>Sophora secundiflora</em>)</td>
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<td>Mexican plum (<em>Prunus mexicana</em>)</td>
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<td>Mexican redbud (<em>Cercis canadensis var. mexicana</em>)</td>
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<td>Texas almond (<em>Prunus minutiflora</em>)</td>
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<td>Escarpment black cherry (<em>Prunus serotina var. eximia</em>)</td>
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<td>Giant spiderwort (<em>Tradescantia gigantea</em>)</td>
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<td>Texas redbud (<em>Cercis canadensis var. texensis</em>)</td>
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<td>Blue curls (<em>Phacelia congesta</em>)</td>
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<td>Texas bluebonnet (<em>Lupinus texensis</em>)</td>
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<td>White prickly poppy (<em>Argemone albiflora</em>)</td>
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<td>Mexican buckeye (<em>Ungnadia speciosa</em>)</td>
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<td>Texas verbena (<em>Verbena halei</em>)</td>
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<td>Winecup (<em>Callirhoe involucrata</em>)</td>
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<td>Blanco crabapple (<em>Malus ioensis var. texana</em>)</td>
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<td>Engelmann's sage (<em>Salvia engelmannii</em>)</td>
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<td>Prairie penstemon (<em>Penstemon cobaea</em>)</td>
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<td>Rusty blackhaw (<em>Viburnum rufidulum</em>)</td>
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<td>Fragrant sumac (<em>Rhus aromatica</em>)</td>
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<td>Golden prairie clover (<em>Dalea aurea</em>)</td>
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<td>Indigo bush (<em>Amorpha fruticosa</em>)</td>
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<td>Roughleaf dogwood (<em>Cornus drummondii</em>)</td>
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Table 1. cont., Native plant species of the Edwards Plateau attractive to native bees.

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<td>White Barbara's-buttons (<em>Marshallia caespitosa</em>)</td>
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<td>Prickly pear (<em>Opuntia engelmannii var. engelmannii</em>)</td>
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<td>Green milkweed (<em>Asclepias viridis</em>)</td>
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<td>Green-flowered milkweed (<em>Asclepias asperula</em>)</td>
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<td>Missouri evening-primrose (<em>Oenothera macrocarpa</em>)</td>
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<td>Texas thistle (<em>Cirsium texanum</em>)</td>
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<td>Mealy blue sage (<em>Salvia farinacea</em>)</td>
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<td>American basket-flower (<em>Centaura americana</em>)</td>
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<td>Cockspur hawthorn (<em>Crataegus crus-galli</em>)</td>
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<td>Common prickly pear (<em>Opuntia macrorhiza</em>)</td>
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<td>Narrow-leaf coneflower (<em>Echinacea angustifolia</em>)</td>
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<td>Purple horsemint (<em>Monarda citriodora</em>)</td>
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<td>Firewheel (<em>Gaillardia pulchella</em>)</td>
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<td>Mexican hat (<em>Ratibida columnifera</em>)</td>
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<td>Smooth sumac (<em>Rhus glabra</em>)</td>
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<td>Partridge pea (<em>Chamaecrista fasciculata var. fasciculata</em>)</td>
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<td>Texas kidneywood (<em>Eysenhardtia texana</em>)</td>
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<td>White prairie clover (<em>Dalea multiflora</em>)</td>
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<td>Buttonbush (<em>Cephalanthus occidentalis</em>)</td>
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<td>Bluewood (<em>Condalia hookeri</em>)</td>
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<td>Wooly ironweed (<em>Vernonia lindheimeri</em>)</td>
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<td>Gray golden-aster (<em>Heterotheca canescens</em>)</td>
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<td>Leavenworth's eryngo (<em>Eryngium leavenworthii</em>)</td>
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<tr>
<td>Baldwin's ironweed (<em>Vernonia baldwinii</em>)</td>
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Table 1. cont., Native plant species of the Edwards Plateau attractive to native bees.

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<tr>
<td>Black prairie clover (<em>Dalea frutescens</em>)</td>
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<tr>
<td>Dotted gayfeather (<em>Liatris punctata</em>)</td>
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<td>Julia'goldenrod (<em>Solidago juliae</em>)</td>
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<td>Narrow-leaf gayfeather (<em>Liatris mucronata</em>)</td>
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<td>Prairie goldenrod (<em>Solidago nemoralis</em>)</td>
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<td>Western rough goldenrod (<em>Solidago radula</em>)</td>
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<td>Maximilian sunflower (<em>Helianthus maximiliani</em>)</td>
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<td>Big blue sage (<em>Salvia azurea</em>)</td>
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<td>Meadow aster (<em>Symphyotrichum pratense</em>)</td>
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<td>Texas aster (<em>Symphyotrichum drummondii var. texanum</em>)</td>
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BIOGRAPHIES

Anne Adams - Boerne Chapter, NICE! Committee. After completing her master’s degree in Botany, Anne worked for ten years in environmental consulting, conducting field studies in aquatic biology and terrestrial vegetation. Upon moving to Boerne in 1993, she volunteered at the Cibolo Nature Center, where she helped initiate the Citizen Science Research program. As a CNC staff member from 2006 to 2010, she was the data manager and trained volunteers in research protocols for Wildlife Field Research. In addition she has presented workshops on aquatic and riparian ecology. Anne’s passion for native plants coincides with her interests in gardening, hiking, and general nature study. As a member of the Boerne Chapter of NPSOT, she has held the offices of Secretary and President, enjoys propagating plants for the annual plant sale, and has served on the NICE! committee since 2002.

Cecil Carter
Cecil Carter has been a management consultant to colleges and other non-profit organizations for the past 13 years. Cecil is on 6 different non-profit boards, including the Trinity Forks Chapter (TF) of NPSOT. Cecil is the President of TF and has served as chapter Publicity Chairman and Program Chairman. He has been a Chief Information Officer of a public company, and he teaches Public Relations and Image Perception as a continuing education course at Murray State College. He has delivered over 500 papers, workshops and seminars on various management subjects. For 20 years, he served on the adjunct faculty of Oklahoma State University’s Oklahoma City branch where he taught public relations and other management related courses.

Rachel Cywinski
Rachel Cywinski grew up in arid west Texas, and is well aware of how precious water is. Rachel completed degrees in international business, business economics, logistics management, American Sign Language and secondary education at Baylor University, Palo Alto College, San Antonio College, and the University of the Incarnate Word. She is currently a doctoral candidate in mathematics education at University of the Incarnate Word; her dissertation research focuses upon reduction of mathematics anxiety among community college students in developmental mathematics courses. Since 2004, Rachel has continuously worked for the Alamo Community College District in numerous “temporary” assignments, teaching college mathematics and dual credit high school/college statistics and calculus. She is also a graduate research assistant at the University of the Incarnate Word.

Rachel’s passion was soccer until 1997, when a tractor-trailer driver ran a red light and permanently disabled her. Since then, Rachel has been a persistent advocate for civil rights; and her passion has been native plants and gardening. She volunteers with the National
Park Service, Texas Master Naturalists, Lady Bird Johnson Wildflower Center, Native Plant Information Network, Invaders of Texas/Citizen Scientists, and community and environmental groups, and is active in a Christian fellowship that uses American Sign Language as its primary language.

Rachel first joined the Native Plant Society of Texas during the time when members would exchange seeds by mailing envelopes to each other. Although her dues have lapsed sometimes in between now and then while she was a student, she has always volunteered when possible, including serving as programming coordinator of the San Antonio chapter for 3 years. Rachel was one of the members who urged the NPSOT to add a “lifetime” membership category so that her dues would never expire again!

**David L. Davidson**
Landowner in Kendall Co.; Scientist, retired; we have been restoring our 138 ac. property for 16 years.

**Donnie Frels**
- Grew up along the Texas coast at Rockport, Texas. Currently living and working near Hunt, Texas. Married with two children. Graduated Texas A&M University 1985: B.S. Wildlife Science
- 1985-1988: Wildlife Manager for San Jose Cattle Company, Aransas County, Texas. Responsible for planning and implementing wildlife habitat operations on the 32,000 acre private ranch owned by Bass family of Fort Worth.
Cheryl Hamilton, Ph.D.
Cheryl Hamilton is a member of the NPSOT San Antonio and Boerne Chapters. She is a Citizen Scientist with the Balcones Chapter of the Invaders of Texas Program and an Alamo Area Master Naturalist. Previous NPSOT submissions include Citizen scientists make a difference in the NPSOT News, Summer 2011.

Armand Hufault
- Retired IBM Engineer.
- MSEE University of Vermont.
- Studying Central Texas native plants since 1991.
- Owner operator of Armand Hufault's Salvas and Perennials(specializing in Central Texas Native Plants).
- Founder and Member of NPSOT Williamson County Chapter.
- Past member, docent, and lecturer at the Ladybird Johnson Wildflower Center.
- Past Texas Native Plant Landscaper

Bill Lindemann
- Born: October 12, 1937, Gonzales County, Texas
- Graduated Gonzales High School in 1955
- University of Texas Graduate (BS-60, MA-63) in geology
- Married for 51 years: two children, three grandchildren
- Worked for 32 years with Exxon as Exploration Geologist
- Explored for Oil and Gas, Uranium, Coal, Synthetic Fuels, and Copper
- Lived in Australia for three years; worked extensively in Indonesia, Thailand, China and other Far East countries.
- Retired in 1994 to Fredericksburg
- Have written a weekly birding column in the Fredericksburg Standard Radio-Post and the Kerrville Daily Times since 1997; currently only writing for the Kerrville Daily Times
- Former President of the Native Plant Society of Texas (2001 and 2006)
- Awarded the Nancy Benedict Memorial Award by the Native Plant Society of Texas (10/03) for an act of Conservation/Public Service for establishing the Fredericksburg
- Nature Center and the Friends of the Fredericksburg Nature Center organization
- Awarded the Benny J. Simpson Fellows Award by the Native Plant Society of Texas (10/06) for service by a member for the enrichment of the society
- President of the Board of Directors for the Friends of the Fredericksburg Nature Center (FFNC currently operating nature trails in Lady Bird Johnson City Park, Fredericksburg)
- President of the Hill Country Land Trust. Also serves on the Board of Directors for the Hill Country Historical Foundation.
- Received a “Star of Texas” award by the Gillespie County Historical Society in 2006 for his work in creating the Fredericksburg Nature Center and for the preservation of the natural and historical heritage of the Texas Hill Country
- Co-chair of the “Wings Over the Hills” nature festival committee
- Frequent speaker in the Hill Country on natural history subjects to schools, garden clubs, professional and service organizations
- Teaches classes on birding and nature at nature centers and adult education schools
- Current interest: Promoting historical and natural preservation in the Texas Hill Country through education, outreach and example.

David Mahler
David Mahler is the ecologist for Environmental Survey Consulting, a company that specializes in site analysis, seed harvesting, habitat restoration, restoration landscaping, naturalistic rockwork, wetland and pond construction, and park and trail design and construction. He has been a pioneer in site-specific restoration in Central Texas since initiating restoration projects at Wild Basin Preserve in 1982 while he was their first Executive Director. David has developed techniques and equipment for harvesting and utilizing high diversity seed mixes, and has designed and installed several habitat display areas at the Lady Bird Johnson Wildflower Center. He attended the first NPSOT meeting in Denton instigated in part by Carroll Abbott and has been a member since. He is a founding board member of the Society for Ecological Restoration International.

Melissa Miller
Melissa Miller is a former President of the San Antonio NPSOT chapter and former President of the NPSOT state organization. Melissa is a non-profit consultant, grant writer and landscape designer who co-founded the NLCP program and currently serves as chairperson for the program.
Steve Nelle
Steve Nelle is a recently retired Wildlife Biologist with the Natural Resources Conservation Service where he served for 35 years in Central Texas, South Texas and West Texas. His main job has been to assist private landowners plan and carry out comprehensive range-wildlife-watershed management on ranches. In the last 12 years, he has taken a special interest in creeks and rivers and riparian areas. He says that although Texans love their creeks and rivers, most people do not really understand much about them. Nelle has received training from some of the very best riparian experts in the country and has been trying to bring the message of healthy functional creeks to Texas landowners and policy makers. He has learned that a functional riparian area provides great benefits not only to the landowner but to everyone downstream. As the population of Texas continues to grow, and more demands are placed on creeks, rivers and the finite water supply, landowners and citizens alike need to understand how to protect and restore riparian areas for the benefit of all Texans. Nelle is a graduate of Texas Tech where he studied Range and Wildlife Management. He resides in San Angelo.

Charlotte Reemts
Charlotte Reemts has been working for The Nature Conservancy for more than 7 years. She studies Identifying, Managing, and Augmenting Resources for Native Bees

Kathy Saucier
Trinity Forks Chapter, NICE! Co-chairman. Kathy Saucier is a graduate of Texas A&M in biomedical science. In the 90's, she served on the board of directors for the Elm Fork Nature Preserve Association in Carrollton and trained with Texas Parks & Wildlife as a Texas Wildscapes instructor. She has been a member of NPSOT for 20 years and has earned the Benny J. Simpson Fellows Award by fellow NPSOT members in 2008. As an avid photographer, she has earned multiple 1st & 2nd place awards in the Charlene Barnard Memorial Award by the Amarillo Chapter. She has given programs on Nature Photography, Sharing Natives (helping members pot extra plants for the annual plant sale) and Caterpillar Gardening with Native Plants. She is also very active in the Trinity Forks Chapter annual spring plant sale coordinating member donations along with two consignment nurseries including introducing those growers to new native species.

John Siemssen
Lindheimer Chapter member. John is a Past President of the Lindheimer Chapter of NPSOT (Comal County) and is also a Texas Master Naturalist. He has had a lifelong love of plants, but was not able to pursue it professionally, instead becoming a Chemical Engineer. When he retired in 2001, he finally was able to get back to his original interests, and continues to be active in NPSOT.
Jason Singhurst
Jason Singhurst has served as a botanist/ecologist in Texas for the past 17 years for Texas Parks and Wildlife Department. Jason received a B.S. and M.S. from Stephen F. Austin State University. He has conducted field-oriented research on the vegetation ecology of the West Gulf Coastal Plain for the past 19 years. His expertise includes natural areas inventory, plant community ecology, plant taxonomy, and land management. He has described five plant species new to science that are endemic (restricted) to Texas. He has extensive field knowledge and experience with rare plant species in Texas. He has published over 70 scientific publications and in 2008 co-authored a book on “Rare Plants of Texas.”

Jim Stanley
Jim Stanley grew up in the High Plains of West Texas. After a career as a chemist in both academia and industry, he retired, with his wife Priscilla, to Kerrville in 2000. Jim and Priscilla were in the first class of the Hill Country Chapter in 2002. Jim organized the Land Management Assistance Program of the Chapter in 2004 which has now aided over 300 landowners living on over 25,000 acres. He served 3 years as Chapter president. He is the author of “Hill Country Landowner’s Guide” published by Texas A & M Press in 2009, and for the past 2 years has written the weekly column, “Hill Country Naturalist”, for the Kerrville Daily Times.

Dr. Chip Taylor
Founder and Director of Monarch Watch; Professor Department of Ecology and Evolutionary Biology, University of Kansas, Lawrence, KS.
Trained as an insect ecologist, Chip Taylor has published papers on species assemblages, hybridization, reproductive biology, population dynamics and plant demographics and pollination. Starting in 1974, Chip Taylor established research sites and directed students studying Neotropical African honey bees (killer bees) in French Guiana, Venezuela, and Mexico. In 1992, as the bee research was coming to an end, Taylor founded Monarch Watch, an outreach program focused on education, research and conservation relative to monarch butterflies. Through the last 20 years Monarch Watch has enlisted the help of volunteers to tag monarchs during the fall migration. This program has produced many new insights into the dynamics of the monarch migration.

Seven years ago, in recognition that habitats for monarchs are declining at a rate of 6000 acres a day in the United States, Monarch Watch created the Monarch Waystation program. The goal of this program is to inspire the public, schools and others to create habitats for monarch butterflies and to assist Monarch Watch in educating the public about the decline in resources for monarchs, pollinators and all wildlife that share the same habitats.
"I have been studying the effects of climate on monarch populations for several years and climate change really has me worried. Higher temperatures are likely to negatively affect monarch populations by reducing reproductive success and altering the distribution and abundances of milkweed species on which the monarchs depend."

**Dr. O. W. Van Auken**

Dr. Van Auken is a professor of Biology and Ecology at The University of Texas at San Antonio and has been at UTAS for 35 years. He received a B.S. degree in Biology from High Point College in North Carolina, an M.S. in Zoology at the University of Utah and stayed to complete his Ph.D. in Physiological Plant Ecology. He studied growth rates of salt tolerant phytoplankton. Upon graduation he came to Texas as an Assistant Professor at Texas State University. From there he moved to Southwest Research in San Antonio for five years before taking a position as a plant ecologist at UTSA.

He has worked with undergraduates, M.S. and Ph.D. students and published over one hundred papers in books and various journals including Ecology, Plant Ecology, Oecologia, the American Journal of Botany, the Canadian Journal of Microbiology, the Texas Journal of Science, the Southwestern Naturalist and others.

Dr. Van Auken’s research interests are physiological plant ecology, especially gas exchange phenomena and species interactions. He has a broad background in biology and ecology including training in physiology, anatomy, and conservation biology and studies with a diverse array of organisms. He has had a number of research grants and contracts in various areas of biology and in many parts of the USA. This broadness of training has been an asset in the development of his biological thought, and has been essential for his work.

Dr. Van Auken is currently studying species interactions in temperate woodlands and grasslands in central Texas and the southwestern U.S. including both common and rare species. He is studying these species to understand interference or competition and its role in determining species distributions and community composition. He is also interested in the role of disturbances on community development and succession. These studies are contemplated to improve understanding of species interactions.

**Michael Warriner**

Michael Warriner is the invertebrate biologist for Texas Parks and Wildlife Department. A native of Arkansas, he has worked on issues related to bumblebee conservation since 2005.
**William “Feather” Wilson**
William Feathergail Wilson, PG 21, grew up on a Hill Country Ranch in Comal County. He received three degrees from the University of Texas at Austin (B.A.-English–’57, B.S. – Geology -‘60, M.A. - Geology-‘62) after graduating from New Braunfels High School. His experience includes petroleum geology, hydrogeology, professional writing, teaching, ranching and a few other things. He taught as an Adjunct Professor of Geology at the University of Texas at San Antonio and internationally for OGCI. Mr. Wilson worked as a frontier exploration geologist in 52 countries in positions that ranged from Geologist to Vice President with several major and large independent oil companies. He now resides on a small ranch near Tarpley, Texas in south-central Bandera County, Texas. He is a State of Texas Licensed Geologist, PG 21, and a State of Texas Licensed Real Estate Broker. He is the President and sole employee of Strata Geological Services, Inc. working as consultant across the State of Texas.

**Deedy Wright**
Guadalupe Chapter, NICE! coordinator. Deedy Wright is a life-long Texas gardener. Her particular interests are in native plants, xeriscape, and wildlife. She has been an active member of the Native Plant Society of Texas since 1993 and helped organize the Guadalupe County Chapter of NPSOT in 2007. She has completed the GoNativeU courses on growing and using native plants from the Johnson Wildflower Center and UT, and the landscape design study program sponsored by the National Garden Clubs and TAMU. In 2001, she became a certified Master Gardener. She is a Master Gardener propagation and vegetable specialist, conducting workshops for both Master Gardeners and the public and is active in the speakers’ bureau of the Guadalupe County Master Gardeners. A retired teacher, Deedy has taught adult continuing education classes on various gardening topics for both the Northeast and Schertz-Cibolo-Universal City Independent School Districts. In addition, she is an avid reader of gardening books and spends too much money on Amazon.com!
FIELD TRIPS

THURSDAY, OCTOBER 4, FIELD TRIPS
#T1 Site: Honey Creek State Natural Area (Bulverde)
#T2 Site: Kerr Wildlife Management Area (west of Kerrville)
#T3 Site: Cibolo Nature Center (Boerne)
#T4 Site: Riverside Nature Center (Kerrville)

FRIDAY, OCTOBER 5, FIELD TRIPS
#F1 Site: Riverside Nature Center & the Ertel Home & Gardens
#F2 Site: Kerrville/Schreiner Park Butterfly Garden & Riverside Nature Center
#F3 Site: Flora of Enchanted Rock State Natural Area (Llano & Gillespie Counties)
#F4 Site: Trees of Enchanted Rock State Natural Area (Llano & Gillespie Counties)
#F5 Site: Parcels of Historic Giles Ranch (between Fredericksburg & Comfort)
#F6 Site: “Grass & Range Land” Property of Dan Behringer & Phyllis Muska (Harper)
#F7 Site: Selah – Bamberger Ranch Preserve (Johnson City)
#F8 Site: Bear Dog Ranch – Property of Sue Tracy (Medina)
#F9 Site: Garden Nursery Tours – 2 nurseries specializing in Texas natives
  #Nursery 1 - Natives of Texas, 4256 Medina Hwy, Kerrville
#F10 Site: Nature Conservancy’s Love Creek Preserve (Medina)
#F11 Site: Stowers Ranch on the Guadalupe River (Hunt)
#F12 Site: Native American Seed (Junction)
#F13 Site: Hill Country State Natural Area (Bandera)
#F14 Site: Lost Maples State Natural Area (Vanderpool)

SUNDAY, OCTOBER 7, FIELD TRIPS
#S1 Site: 2 Private Properties in Settler’s Ridge (Fredericksburg)
#S2 Site: Private Residential Property of Ann and Delmar Cain (Boerne)
#S3 Site: “Grass & Range Land” Property of Dan Behringer & Phyllis Muska (Harper)
#S4 Site: Fredericksburg Nature Center Trail & Cross Mountain
THURSDAY, OCTOBER 4, FIELD TRIPS

#T1 Site: Honey Creek State Natural Area (Bulverde)
Description: The vegetative diversity of the Honey Creek property is one of its most compelling features: Ashe juniper, live oak, agarita and Texas persimmon dominate the dry, rocky hills and grasses such as Lindheimer’s muhly and sideoats grama find just enough soil in the cracks to persist. As juniper and baccharis are being removed from the upland oats, stands of native grasses are increasing, and Indian grass, little blue stem, and switchgrass are reasserting their dominance. As one moves down into the canyon of the creek itself, one is struck by the increase of cedar elm and older junipers and the rather abrupt appearance of Spanish oak, pecan, walnut and Mexican buckeye. As the terrain levels out in the narrow flood plain and the creek itself, the dominant species are bald cypress and sycamore and an associated assortment of other flood plain species such as Texas palmetto, columbine and maidenhair fern occur along the rock banks. Spatter dock floats on the creek surface, and a number of emergent plants are plainly visible in the clear blue-green water.

Topics to be covered include area history just prior to area European habitation to the present: vegetative history; endemic plants from prairie through transition zone to riparian; area geology; creek description and source; Q & A. Note: a printed plant list compiled for Honey Creek SNA will be made available.
Leader: Wilt Shaw: past President Boerne NPSOT; current board member and past President, Friends of Guadalupe River State Park/Honey Creek; Texas Master Naturalist
Website: http://www.tpwd.state.tx.us/state-parks/honey-creek/

#T2 Site: Kerr Wildlife Management Area (west of Kerrville)
Description: Kerr WMA Is owned and operated by the Texas Parks and Wildlife Department. This area was selected as a land base for the Edwards Plateau ecological area to develop and manage wildlife habitats and populations of indigenous wildlife species, provide a site where research of wildlife populations and habitat can be conducted under controlled conditions, and to provide public hunting and appreciative use of wildlife in a manner compatible with the resource. The Area’s primary mission is to function as a wildlife management, research, and demonstration site for trained personnel to conduct wildlife related studies and provide resultant
information to resource managers, landowners, and other interested groups or individuals to acquaint them with proven practices in wildlife habitat management.
Principal wildlife species found on the Kerr Wildlife Area include white-tailed deer, bobwhite quail, javelin, wild turkey, mourning dove, fox squirrel, raccoon, skunk, armadillo, ringtail “cat”, rabbit, gray fox, and many species of reptiles and migratory birds.
An indoor power point presentation will be followed by outdoor activities, tour of cedar break, etc.
Leader: Kerr WMA Guide
Website: http://www.tpwd.state.tx.us/huntwild/hunt/wma/find-a-wma/list/?id=12

#T3 Site: Cibolo Nature Center (Boerne)
Description: The Cibolo Nature Center is 100 acres of Hill Country trails and wilderness. The center provides education, research, entertainment and outdoor activities for more than 100,000 visitors a year, while promoting sound stewardship of land, water and wildlife. The center embraces four distinct ecosystems: riparian forest; live oak savannah, tall-grass prairie and spring-fed marsh. Features also include a butterfly and “milkweed patch” garden and demonstration gardens.
Leader: CNC Guide
Website: www.cibolo.org/

#T4 Site: Riverside Nature Center (Kerrville)
Description: RNC is a publicly supported nonprofit organization created as an urban wildlife and native plant sanctuary/arboretum. The 5 acre property, located at the junction of the Guadalupe River and Town Creek, is a living demonstration of possibilities for restoring an urban area as a wildlife habitat and showcase for native plants.

The Center is landscaped with over 140 species of trees, a wide range of native shrubs and grasses, and some 200 species of wildflowers. Demonstration gardens include a butterfly garden, xeric border ethnobotany berm, sensory garden, meandering walking paths and a natural area wildlife habitat trail along the river. The Center volunteers are working diligently to restore the meadow area damaged by the 2011 record drought. Part of that project is the recently installed rainwater collection system. RNC sponsors and/or hosts a variety of public educational programs.
Leader: Self-guided
Website: http://www.riversidenaturecenter.org/
FRIDAY, OCTOBER 5, FIELD TRIPS

#F1 Site:  Riverside Nature Center & the Ertel Home & Gardens

Group A  Riverside Nature Center (Kerrville)
Description:  RNC is a publicly supported nonprofit organization created as an urban wildlife and native plant sanctuary/arboretum. The 5 acre property, located at the junction of the Guadalupe River and Town Creek, is a living demonstration of possibilities for restoring an urban area as a wildlife habitat and showcase for native plants.

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Leader:  RNC Docent
Website:  http://www.riversidenaturecenter.org/

Group B  Home of Richard & Stephanie Ertel
Description:  This house has a stucco exterior and a clay plaster interior with very thick walls. It is a one story, approximately 2,000 square foot home set on a south-facing hillside in a natural setting. The water supply is entirely water catchment from a 20,600 gallon tank. They also have an off-grid solar power system and solar hot water. All appliances are energy saving models and they use composting type toilets. They use grey water for irrigation of the landscape.

Leaders:  Richard & Stephanie Ertel, homeowners
Website:  NA

#F2 Site:  Kerrville/Schreiner Park Butterfly Garden & Riverside Nature Center

Group A  Kerrville/Schreiner Park Butterfly Garden
Description:  The Butterfly Garden was designed and installed in 2000 by the Friends of Kerrville/Schreiner State Park. The garden is approximately 104’ X 104’ and is enclosed by a deer proof fence. In the middle of the garden is a fire ring with seating with a raised
circular bed separating this area from the remainder of the garden. There are several mulched paths marked by flags for the milkweed, which are used for data collection. In 2006, the garden was certified as a Monarch Way Station.

The Kerrville/Schreiner Park is a beautiful 517 acre recreational and camping park along the Guadalupe River five miles SE of downtown Kerrville. Originally a CCC project in the early 1930s, the park was next operated by TPWD and in 2004 was transferred back to the city of Kerrville.

Features include campsites and trails on both sides of HWY 173, which splits the park into 2 sides; the larger hill side and the smaller river side. Here you will find a representative sampling of Hill Country landscape, with juniper, live oak, and Spanish oak on the hills and arroyos. Other plants include redbud, sumac, buckeye, pecan, mesquite, and many varieties of flowers. Walking the trails on both sides of the highway will show that the birds and vegetation on the limestone uplands trails are very different from the river bottom habitat below. The park is home to an abundance of wildlife including whitetail and axis deer, lizards, rabbits, fox, butterflies and more.

**Leader:** Cathy Downs & other K/SP Guides  
**Website:** [http://www.kerrville.org/](http://www.kerrville.org/)

**Group B: Riverside Nature Center (Kerrville)**  
**Description:** As described in #F1 above, this field trip will include the RNC along with the Kerrville/Schreiner Park Butterfly Garden. The group will be divided in 2 & start at the Butterfly Garden and then proceed to the RNC.  
**Leader:** RNC Docent  
**Website:** [http://www.riversidenaturecenter.org/](http://www.riversidenaturecenter.org/)

**#F3 Site: Flora of Enchanted Rock State Natural Area (Llano & Gillespie Counties)**  
**Description:** Enchanted Rock SNA is part of a geologic region known as the Llano Uplift. A characteristic feature is a central basin having a rolling floor studded with rounded granite hills 400 – 600 feet high. Rocks forming both the basin and hills are among the oldest in the state. Enchanted rock is a large, pink, crystalline, granite mass formed during the Precambrian Era nearly a billion years ago. It is one of the largest batholiths (underground rock formation uncovered by erosion) in the U.S.

The four major plant communities are mesquite grassland, floodplain, open oak woodland and granite rock. On the bare granite summit vernal pools (shallow weather pits with thin granite soil) are ecologically significant. The depressions shelter plants and animals uniquely adapted to extremes of temperature and weather. The pools support fairy shrimp which survive total desiccation as fertilized eggs, hatch into larvae and grow into adults every time water collects after sufficient rainfall. Successional stages in the
vernal pools are: algae and quillworts to liverworts and stonecrop to sedges to annuals and to grassland. Inappropriate use threatens them.

Leader: Bill Lindemann, past State President NPSOT, past President Fredericksburg NPSOT Chapter
Website: Park site: [http://www.tpwd.state.tx.us/state-parks/enchanted-rock](http://www.tpwd.state.tx.us/state-parks/enchanted-rock)
Wildflower List 18 pages, Bird List 12 pages: [http://www.friendsofenchantedrock.com](http://www.friendsofenchantedrock.com)

#F4 Site: Trees of Enchanted Rock State Natural Area (Llano & Gillespie Counties)
Description: This field trip will explore the diversity of trees in this unique area of the Hill Country.
Leader: Robert Edmonson, Biologist - Texas Forest Service
Website: [http://www.tpwd.state.tx.us/state-parks/enchanted-rock](http://www.tpwd.state.tx.us/state-parks/enchanted-rock)

#F5 Site: Parcels of Historic Giles Ranch (between Fredericksburg & Comfort)
Description: Hike along Block Creek, as well as a canyon and a rocky hillside. Expect to see Hill Country species including escarpment black cherry, Texas ash, lacey oak, Texas mulberry, sycamore-leaf snowbell, agarita and more. We will I.D. trees, shrubs, wildflowers, grasses and cover some ethnobotany (historical uses of plants for food, medicine, dyes, etc). Be prepared to walk the hills. We will do a combination of hiking and driving to areas on this property. Originally part of the historic Giles Ranch, the properties are owned today by descendants of the noted 19th-20th century architect, Alfred Giles, known for his design of many Texas courthouses and other public buildings.
Leader: Patty Leslie Pasztor, co-author of “Texas Trees”

#F6 Site: “Grass & Range Land” Property of Dan Behringer & Phyllis Muska (Harper)
Description: This private ranch is composed of 55 acres of native savanna and bottom-lands near the headwaters of the Pedernales River southwest of Fredericksburg. The trip will feature native grasses including the “Big Four” of the Hill Country – Big Bluestem, Little Bluestem, Switchgrass, and Eastern Gamagrass. We also examine typical forbs of the Edwards Plateau. Bring your favorite Texas grass book.
Leader: Jim Stanley, Master Naturalist & author of “Hill Country Landowner’s Guide”
Website: NA
#F7 Site:  Selah – Bamberger Ranch Preserve (Johnson City)  
Description: The Preserve is a 5,500 acre ranch that has been described as the largest habitat restoration project on private land in Texas. You can learn about the environment while pausing to reflect on the beauty and serenity of Hill Country nature.

On the tour, you may discover dinosaur tracks, hunt for Cretaceous fossils, see the Chiroptorium, a man-made cave built to house 1 million bats, and visit the largest herd of the endangered Schimitar-horned Oryx in the world of which they have documented and registered genetics. Selah has hiking trails, a nature trail with interpretive signs identifying native plants and Madrone Lake where people can swim, fish or enjoy looking into the clear water. The ranch was purchased in 1969 with the specific purpose of restoring habitat; priorities lean to 51% to preserve nature with 49% to use the ranch as an educational tool. The tour will include a wagon ride and some walking.  
Leaders: Colleen Gardner  
Website: [www.bambergerranch.org](http://www.bambergerranch.org)

#F8 Site:  Bear Dog Ranch – Property of Sue Tracy (Medina)  
Description: This property consists of about 80 acres of grassland, oak-pecan savannah and riparian areas along Bauerlein Creek and the West Prong of the Medina River. It has been fenced and protected from deer for the past 20 years. The landscaping around Sue’s home was installed over 15 years ago and incorporates only plants native to the Edwards Plateau, including native prairie grasses. The walking tour will follow mowed pathways around the house and along the waterways. Sue has been very involved in native plant protection and restoration on her own property and over the years has given presentations on naturalistic landscape design, decorative use of native grasses, oak wilt prevention and control and native ferns.  
Leader: Sue Tracy, homeowner  
Website: NA

#F9 Site:  Garden Nursery Tours – 2 nurseries specializing in Texas natives

#Nursery 1 - Natives of Texas, 4256 Medina Hwy, Kerrville  
Description: A unique setting with mostly native plants, in a natural, hilly country setting. The nursery is located in a ravine along beautiful Spring Creek and is part of the 116 acre Spring Creek Ranch which features native stands of Madrone trees and other unique vegetation. The nursery grows a number of “hard to find” Texas native plants. After the visit to Natives of Texas, the group will travel to Medina Nursery.
Leader: David Winningham, owner
Website: www.nativesoftexas.com

Nursery #2 - Medina Garden Nursery, 13417 State Hwy 16, Medina
Description: Another unique nursery with mostly native plants in a rural setting. Special features include caliche garden, shade garden and butterfly gardens. If time permits, we will take a short walk down to the river, which takes you to an area with frostweed, which in October is a feeding ground for migrating monarchs. Owner, Ernesto has lived on the property for over 20 years and has been in the Texas native plant business for over eleven years. Medina Garden Nursery also grows a number of “hard to find” Texas native plants.
Leader: Ernesto, owner
Website: www.medinagarden@hctc.net

#F10 Site: Nature Conservancy’s Love Creek Preserve (Medina)
Description: Love Creek Preserve is located just south of Medina and includes a number of rare and endangered plants, including Tobusch fishhook cactus, endangered birds such as the golden-cheeked warbler and black-capped vireo, to name a few. Also, there are rare salamanders in the creek. Love Creek flows through the Conservancy’s 1,400 acre preserve for 2 ¼ miles before it joins with the West Prong of the Medina River, eventually contributing to the Edwards Aquifer. The Preserve protects a representation of the most diverse habitats in the nation and some of the most scenic land in Texas.
Leader: Charlotte Reemts &/or Rebecca Flack
Website: http://www.nature.org

#F11 Site: Stowers Ranch on the Guadalupe River (Hunt)
Description: This 11,800 private acre ranch is rolling terrain, with numerous hills offering spectacular views of sweeping valleys, deep draws and dramatic cliffs. The presence of live water, including segments of the Guadalupe River, is one of its most distinguishing features. Stowers Ranch has been a land and wildlife management ranch since 1904. Jason Singhurst will lead the group with the focus on riparian vegetation of the Hill Country and highlight many of the plants that he will discuss in his keynote presentation on Friday morning.
Leader: Jason Singhurst, TPWD Biologist & co-author of “Rare Plants of Texas”
Website: http://www.stowersranch.com/about/landscape
#F12 Site: Native American Seed (Junction)
Description: Much of the water that recharges our aquifers, feeds our thousands springs and maintains our rivers and streams is filtered through deep rooted native plants. Every citizen, urban and rural, can explore and utilize the full pallet of readily available native wildflowers, prairie grasses and diverse native mixes when engaging in land management activities. By working together to restore native vegetation, we can all help maintain an adequate supply of fresh, quality groundwater for our future. Native plants and grasses know exactly how to live right here with no extra care.

Founded in 1988, Native American Seed does not use, sell or promote alien plant species that adversely affect the economy and ecology of Texas’ natural habitats and the bioregions they invade. Native American Seed of Junction, Texas is based at the center of nine eco-regions. Our mission is to help people restore the earth by offering a wide diversity of 100% native species. Experience the natives – wildlife viewing, birding and photography while touring the Native American Seed farm. Enjoy an evolving ecological restoration or river hardwood forest, mesquite flats and upland rolling hill country. This will be a walking tour.
Leader: Emily Neiman, the daughter of founders & owners Bill & Jan Neiman
Website: www.seedsource.com

#F13 Site: Hill Country State Natural Area (Bandera)
Description: Tucked away in the rugged terrain southwest of Bandera is Hill Country State Natural Area, an undeveloped and secluded retreat comprised of 5400 acres of undeveloped Hill Country terrain. Approximately 40 miles of multiuse trails wind up grassy valleys, cross spring-fed streams and climb steep limestone hills.
Leader: Park Ranger
Website: http://www.tpwd.state.tx.us/state-park/hill-country

#F14 Site: Lost Maples State Natural Area (Vanderpool)
Description: Lost Maples SNA sits on a beautiful, rugged canyon of the upper Sabinal River and features a large population of Bigtooth Maples and Madrone trees. The park is an outstanding example of Edwards Plateau flora and fauna. It is a combination of steep, rugged limestone canyons; springs; plateau grasslands; wooded slopes; and clear streams. The large, isolated stand of uncommon Uvalde Big-tooth Maple produces fall foliage can be spectacular. Over 11 miles of trails some with moderate hiking conditions and others with steep climbs to the tops of the canyon and hills. Rare species of birds, such as the green kingfisher, can be seen year-round. The endangered black-capped vireo and Golden-cheeked warbler nest and feed in the park in spring and early summer. Wild animals include gray fox, white-tailed deer, armadillo, raccoon, bobcat, rock squirrel and javelin.
Leader: Park Ranger Richard Trece
Website: http://www.tpwd.state.tx.us/state-parks/lost-mapolles
SUNDAY, OCTOBER 7, FIELD TRIPS

#S1 Site: 2 Private Properties in Settler’s Ridge (Fredericksburg)

Group A Four Acre Wildscape Home of Ward & Pat Miller
Description: This designated “Wildlife Habitat” with unique gardens and wildscapes, daily attracts wild turkeys, white-tailed deer, a host of wild birds, including hummingbirds and numerous butterflies. Featured are several diverse styles of gardening including traditional foundation plantings of Texas natives, well adapted stock in terraced beds, fenced enclosed back garden on the very challenging back slope, a great creek bed drainage design, a pondless waterfall, and true wildscaping to provide food, water, shelter and space to a variety of wildlife. The landscape design began at the completion of their home in 2001, dealing with terracing and footpath flow of the front gardens, to significant elevation changes to the back of their property. With extensive use of prairie restoration in the front, side and back of their property, this helps cut back on mowing.
Leader: Ward Miller, homeowner; Vice President Fredericksburg NPSOT, Master Naturalist

Group B 4 Acre Wildscape Home of Kathy & Will Lyles
Description: Of the 4 acres, about 1 ½ acres are under cultivation, with some unusual fencing to keep out the deer. There are hundreds of native trees, shrubs and flowers; most introduced to the property. Kathy’s special interest is in planting larval plants for butterflies. You will see dozens of native larval plants for many species of butterflies and caterpillars. You will get to walk by her dry creek bed and rain pond installed to slow the water flowing across the land. There is a large vegetable garden with drip irrigation and a “secret garden”. The draw at the back of the property has been “enhanced” with cedar steps, a footbridge and terraced with cedar logs. Kathy enjoys using natural materials, especially those found on her property.
Leader: Kathy Lyles, homeowner

#S2 Site: Private Residential Property of Ann and Delmar Cain (Boerne)
Description: The Cain property is located on 6 ½ acres on Spring Creek, ½ mile from its convergence with the Guadalupe River. The land includes an upper portion, where the residence is located, which has typical Hill Country trees including ash juniper, shin oak, cedar elm, live oak, Spanish oak, gum bumelia and hackberry. Behind the residence, a limestone cliff that lines Spring Creek has sycamore leaf snowbell, Roemer's acacia, kidney wood, and canyon mock-orange. Along the banks of spring fed Spring Creek are cypress, palmetto, bushy bluestem, chatter-box orchid, green dragon, basswood, pecan, sycamore and red buckeye. There is a trail along the cliff with rock steps down to the creek bottom. The tour will not be handicap accessible, but certain spots can be viewed from an automobile. A plant list is available on request.
Leader: Delmar Cain, the homeowner, stayed in a Holiday Inn once and has some knowledge of the plants on the property. He was Boerne Chapter, NPSOT President for 2010-1011.

#S3 Site: “Grass & Range Land” Property of Dan Behringer & Phyllis Muska (Harper)
Description: This private ranch is composed of 55 acres of native pasture and bottom-lands near the headwaters of the Pedernales River southwest of Fredericksburg. The trip will feature native grasses including the “Big Four” of the Hill Country – Big Bluestem, Little Bluestem, Switchgrass, and Eastern Gamagrass. We also examine typical forbs of the Edwards Plateau. Bring your favorite Texas grass book.
Leader: Jim Stanley, Master Naturalist & author of “Hill Country Landowner’s Guide”

#S4 Site: Fredericksburg Nature Center Trail & Cross Mountain

Stop #1: Fredericksburg Nature Center Trail
Meet at the entrance to the Nature Trail in Lady Bird Johnson Municipal Park (Fredericksburg)
Description: Inside the LBJ Municipal Park (150 acres) is a unique ten acre nature center built and maintained by the Friends of Fredericksburg Nature Center. This area is an unusual blend of diversity due to its geologic location and Live Oak Creek. There are over 6,000 feet of trails that wind through the seven distinct and scenic habitats. The old growth live oak forest, prairie, post oak savannah, wetlands, riparian areas, cedar brake and dry brush land intrigue and delight visitors anytime of the year. Add the springs and seeps, lake islands, mud flats and lake aquatics; you have 11 habitats within easy walking distance. In addition, a 650 foot long handicapped accessible trail has a geology and rock exhibit, a butterfly garden, a bird blind and feeding area, and a scenic view across Live Oak Creek into the riparian area, prairie and live oaks. Bring water bottles, wear hat & comfortable walking shoes.
Leader: Bill Lindemann, past State President NPSOT, past President Fredericksburg NPSOT Chapter
Website: http://www.fredericksburgnaturecenter.org/

Stop #2: Group will caravan to Cross Mountain after FNC
Description: This marl (lime-rich mud or mudstone) and limestone hill, elevation 1,951 ft, was used as an Indian lookout, signal point prior to early settlers. The hill was first recorded and described by the German geologist Dr. Ferdinand Roemer in 1847. When John Christian Durst arrived with his family in 1847; he received a town lot and ten acres of land which included the hill. On finding a timber cross on the hill top, he named it “Kreuzberg” or Cross Mountain. Subsequent crosses were erected with illumination beginning in 1946. Over 130 plants have been identified within the 16 acre park. Trails go around the base and up to the summit.
Leader: Bill Lindemann, past State President NPSOT, past President Fredericksburg NPSOT Chapter
#S5 Site:  Old Tunnel Wildlife Management Area – Nature Trail
(between Comfort & Fredericksburg)
**Description:** This wildlife area, managed by the TPW encompasses 16 acres. While most noted for the huge bat population in the abandoned railroad tunnel on the site, the property also boasts 150+ species of plants. Features include: cedar elm, Ashe juniper, escarpment black cherry, live and shin oak and hackberry; understory trees and shrubs include Texas persimmon, Mexican buckeye, agarita, elbowbush, Texas kidneywood, Eve’s necklace and possumhaw. Frostweed, sotol, twist-leaf and Buckley’s yuccas are common forbs. A half-mile nature trail includes a steep stair-stepped trail to the level bottom area.
**Leader:** OLWMA Guide
**Website:** [http://www.tpwd.state.tx.us/huntwild/hunt/wma/find-a-wma/list/?id=17](http://www.tpwd.state.tx.us/huntwild/hunt/wma/find-a-wma/list/?id=17)

#S6 Site:  Cibolo Nature Center (Boerne)
**Description:** The Cibolo Nature Center is 100 acres of Hill Country trails and wilderness. The center provides education, research, entertainment and outdoor activities for more than 100,000 visitors a year, while promoting sound stewardship of land, water and wildlife. The center embraces four distinct ecosystems: riparian forest; live oak savannah, tall-grass prairie and spring-fed marsh. Features also include a butterfly and “milkweed patch” garden and demonstration gardens.
**Leader:** CNC Tour Guide
**Website:** [www.cibolo.org/](http://www.cibolo.org/)
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