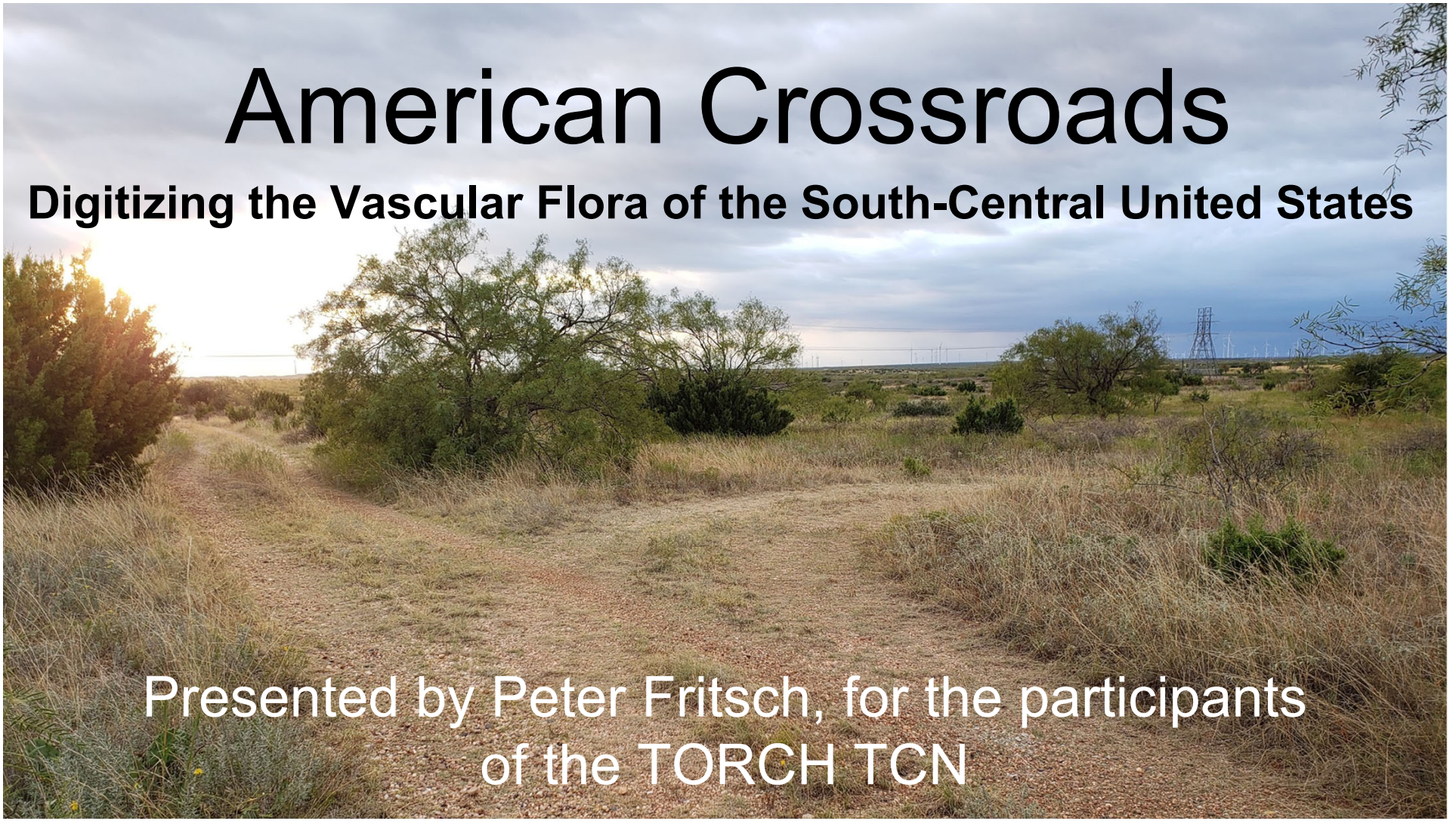


American Crossroads

Digitizing the Vascular Flora of the South-Central United States

Presented by Peter Fritsch, for the participants of the TORCH TCN

The South-Central United States

Defined here as the states of Oklahoma and Texas

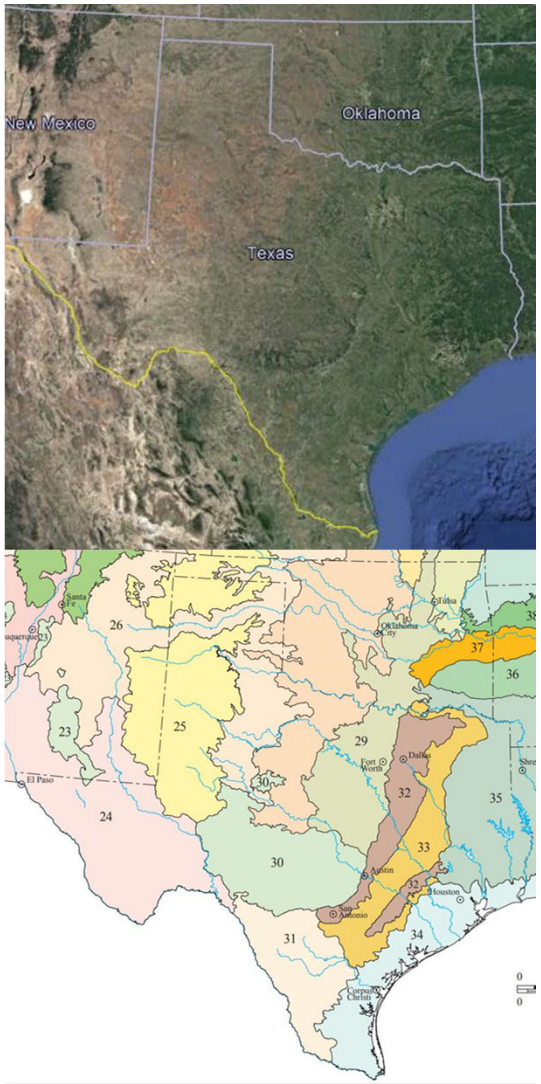
876,859 km^2, 11% of the contiguous U.S.

17 Level-III ecoregions as defined by EPA

East to west, links mesic forests with interior arid grasslands and deserts

North to south, links temperate and subtropical biomes

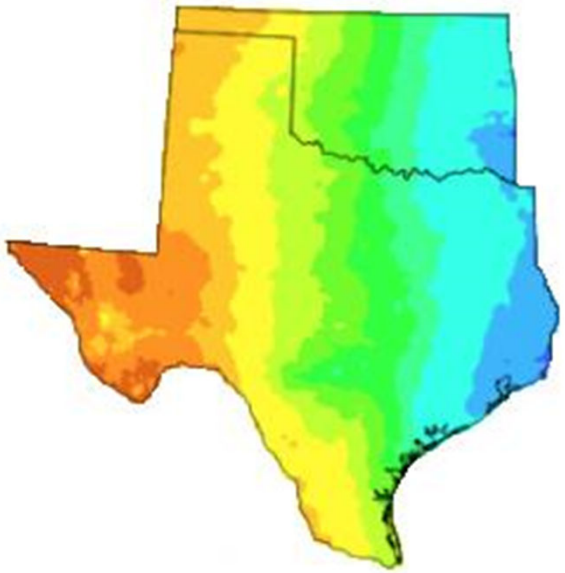
“American Crossroads” of North American ecological and biological diversity; key element in understanding continent-wide patterns of biome evolution

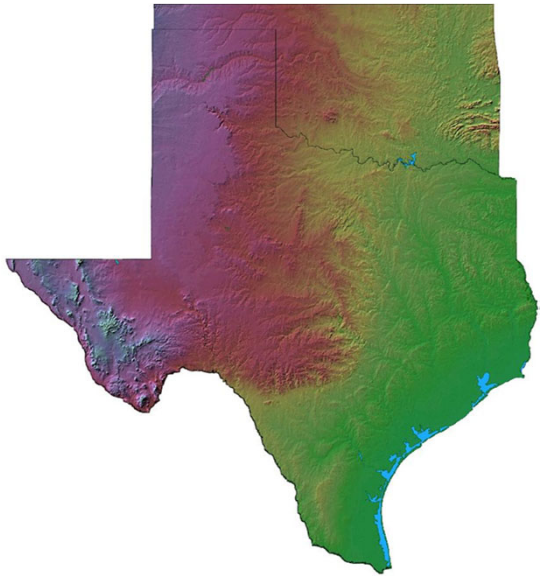


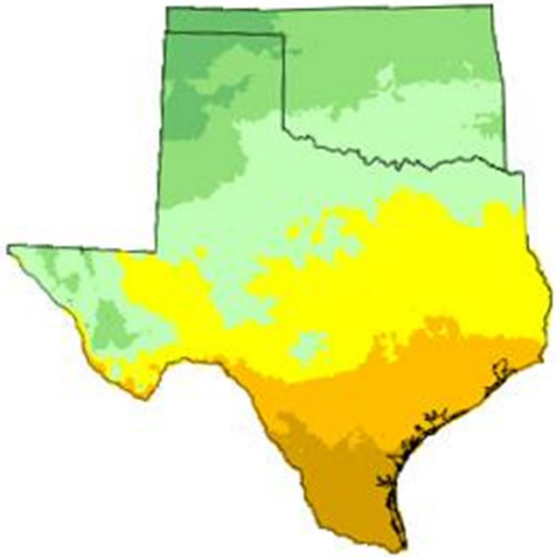
Extreme environmental gradients

East to west, mean annual precipitation >150 cm to < 12.5 cm (1 cm every 10 km); landscape tilts from sea level to 1300 m; abrupt peaks in W TX and Ozarks

North to south, mean January temp 0°C to 18°C though 5 plant hardiness zones







Intricate patchwork of geology and soils

Surface exposures range from Holocene alluvial deposits to 1.6 billion-year-old outcrops

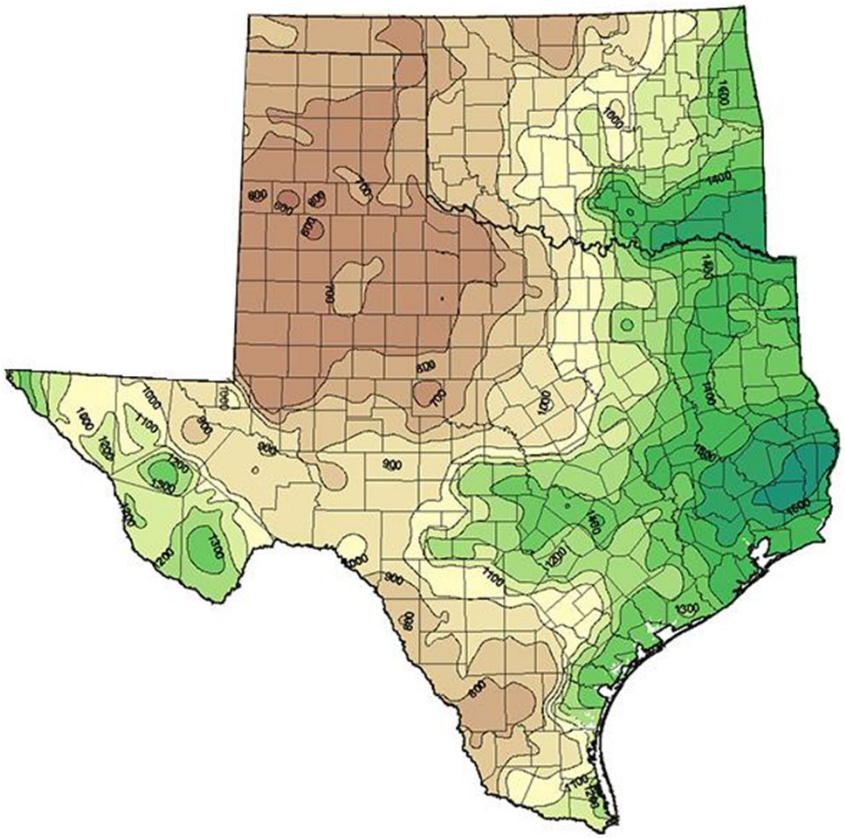
100 different major soil types

Plant diversity in Oklahoma and Texas

4945 native vascular plant species in 213 families, constituting 31% of all native species in North America north of Mexico

Texas second among states in vascular plant species diversity, and 325 plant taxa are restricted to the state

Richest centers of plant diversity are the Ozark Highlands, Big Thicket, Edwards Plateau, and Trans-Pecos Texas

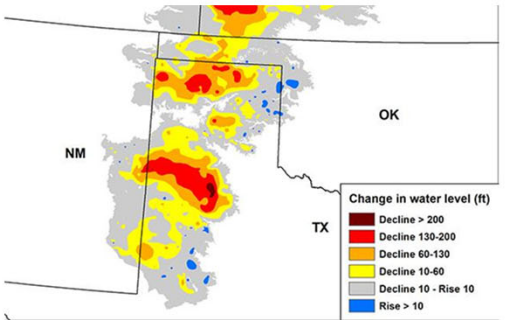


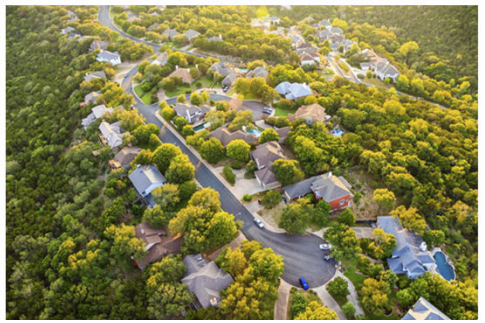
Threats to plant diversity in Oklahoma and Texas

Overgrazing, oil and gas extraction, exotic and invasive organisms, fire suppression, pollution, hydrological changes, urbanization



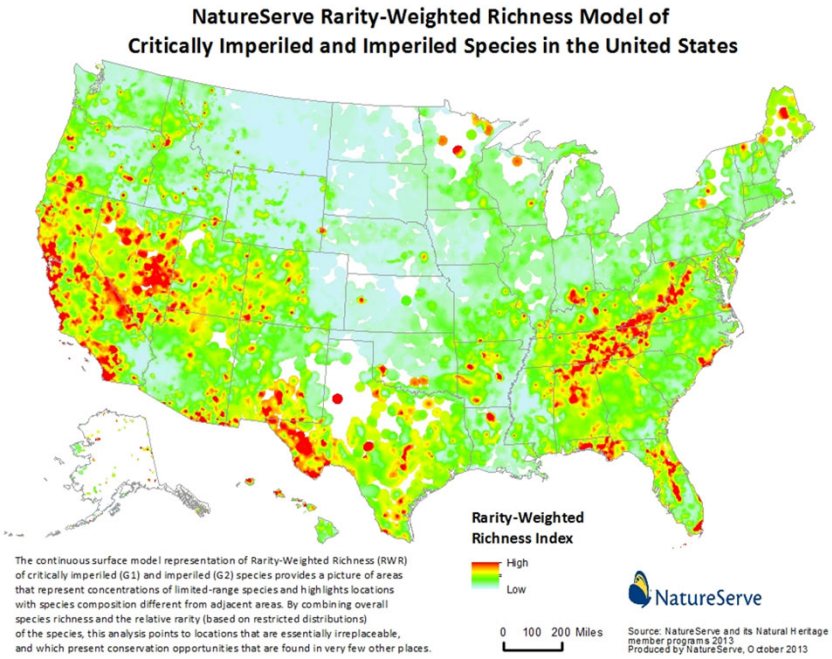




Threats to plant diversity in Oklahoma and Texas

Two globally ranked hotspots, i.e., the North American Coastal Plain (Gulf Coastal Plain) and the Madrean Pine-Oak Woodlands (Trans-Pecos region)



Documenting the plant diversity of Oklahoma and Texas

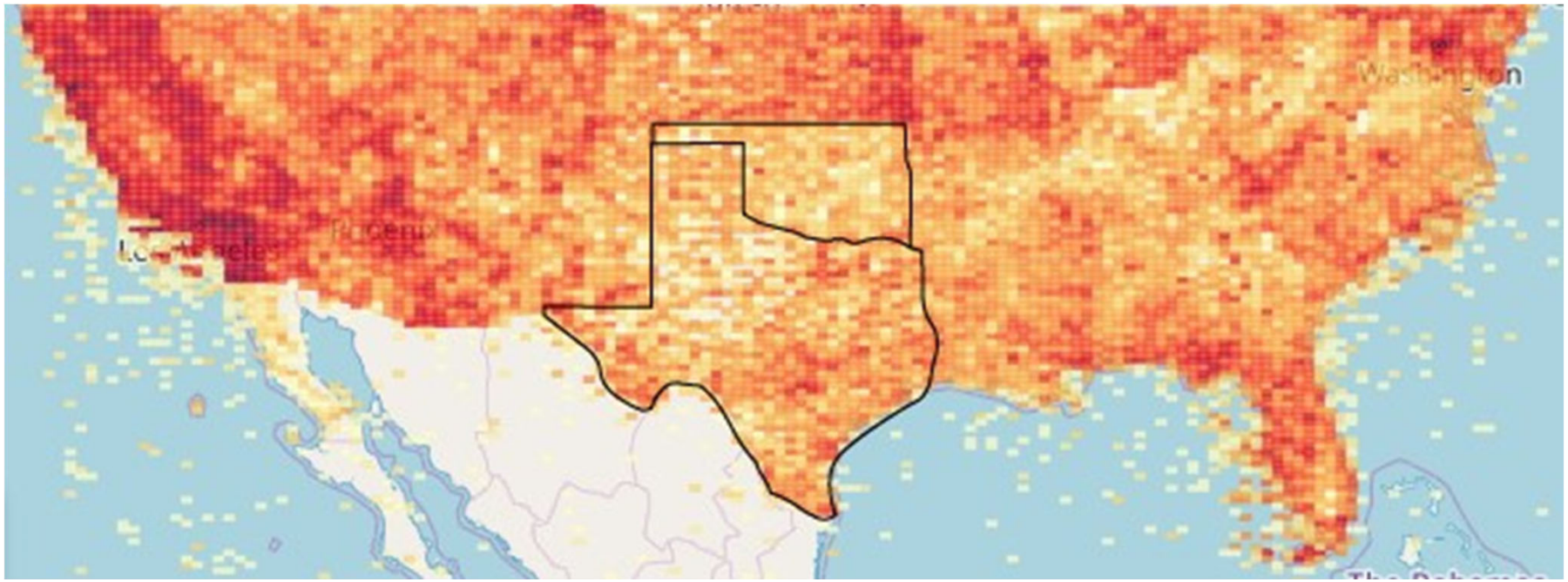
The 41 largest herbaria of Oklahoma and Texas contain ca. 1.7 million specimens collected within these states

They comprise a mix of large (> 1 million), mid-sized, and small herbaria

Several herbaria outside the region hold critically important historical collections (prior to ca. 1900)

Documenting the plant diversity of Oklahoma and Texas

Heat map of digitized collections of vascular plants in the iDigBio database for the southern half of the U.S. (2018)



Consequences of the gap in plant digitization in the South-Central United States

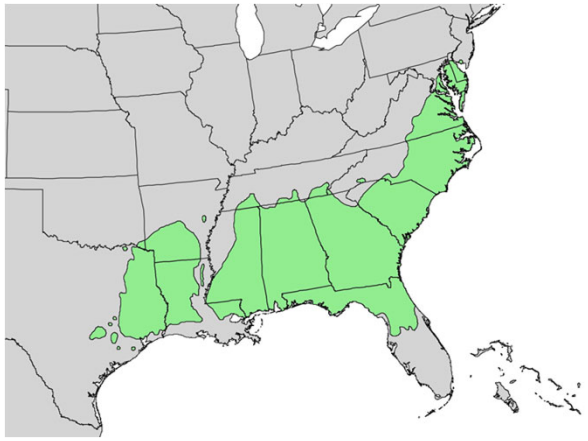
Plant species richness in the contiguous U.S. is concentrated in the southern half of the country

Most of the land area within biodiversity hotspots of the U.S. is also situated in the south

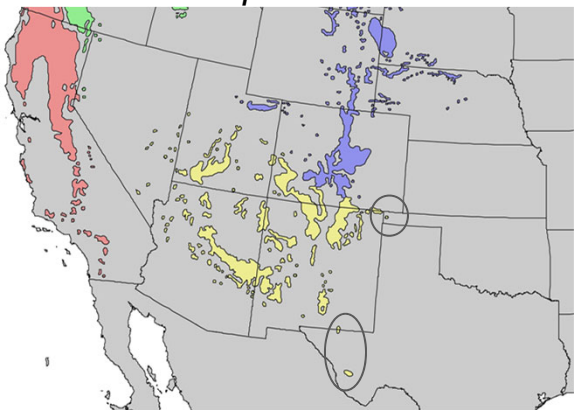
The edges of many plant species distributions occur somewhere within the region. Peripheral isolates often have unusual morphological or genetic traits

The steep environmental gradients in the region can produce dramatic clines within species

Pinus taeda



Pinus ponderosa



The Texas and Oklahoma Regional Consortium of Herbaria (TORCH)

Formed in 2008

Advocates for the herbaria of Oklahoma and Texas

Steering Committee of nine members and website (https://www.torcherbaria.org/)

Digitization has been occurring to various degrees at many of the TORCH herbaria

Ten TORCH conferences have been held more or less annually since 2010

Objective: establish a TCN under the auspices of TORCH for digitizing vascular plant specimens collected in Oklahoma and Texas

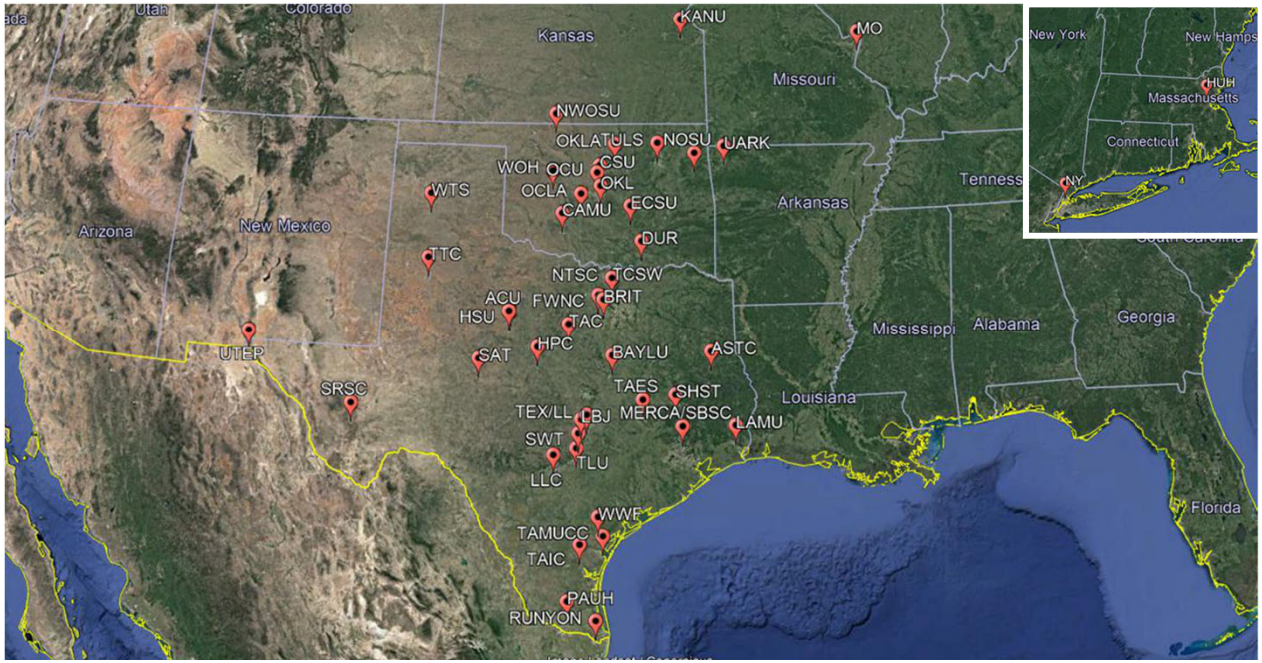
Disseminate the digitized data through an integrated Symbiota platform

Develop and implement innovative strategies to increase workflow efficiency

Recruit and engage students and citizen scientists in project-based broader-impact activities

Specimens and herbaria

Ca. 2 million specimens total, 1.7 million from 41 TORCH herbaria and 0.3 million from 5 herbaria outside of Oklahoma and Texas (plus NMNH)



Grant organizational structure

Herbaria: 5 Leads, 11 Subawards, and 31 Providers

Personnel:

Project Directors: The 6 PIs of the 5 Leads (Collaborative proposals): P. Fritsch (BRIT-Primary Lead), M. Fishbein (OKLA), A. Moore, B. Hoagland (OKL), D. Spalink (TAMU), G. Yatskievych (TEX)

Executive Team: the 6 PIs plus a full-time Project Manager, a full-time Data Manager, and a 0.3-time Technical Innovator (J. Best)

16 Institutional Coordinators (at PI and Subaward herbaria)

TORCH Steering Committee in advisory capacity, at annual meeting

Workflow

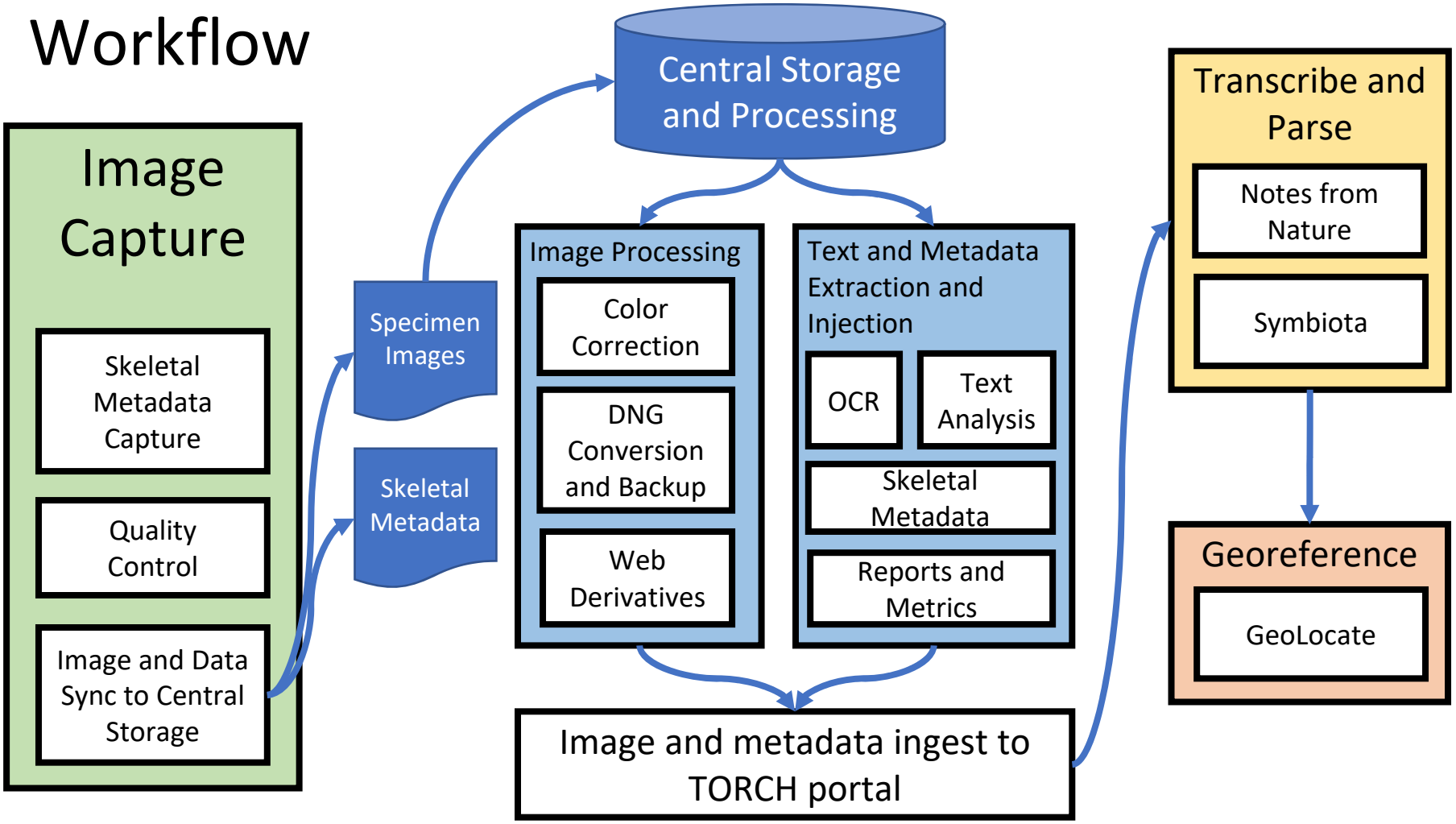


Image Capture
Skeletal Metadata Capture
Quality Control
Image and Data Sync to Central Storage
Specimen Images
Skeletal Metadata
Central Storage and Processing
Image Processing
Color Correction
DNG Conversion and Backup
Web Derivatives
Text and Metadata Extraction and Injection
OCR
Text Analysis
Skeletal Metadata
Reports and Metrics
Image and metadata ingest to TORCH portal
Transcribe and Parse
Notes from Nature
Symbiota
Georeference
GeoLocate

Workflow innovations

- Image capture client for quality control and metadata capture
  - Blur detection and other QC measures
  - Immediate file rename based on barcode/catalog number
- Centralized backup of raw images immediately after capture
- Centralized automated image processing
  - Color correction
  - Application of technical and descriptive metadata
  - Conversion to DNG
  - Generation of JPG web derivatives
- Fast image and skeletal metadata ingest into TCN portal
- Centralized OCR and text analysis
  - Organizing specimens into thematic groups across all participants for NfN Expeditions

Hypotheses relating to the biodiversity of Oklahoma and Texas

1. Patterns of phylogenetic diversity and species richness will exhibit complex relationships with respect to ecological and spatial gradients
    a. Phylogenetic diversity is expected to decline with increasing latitude, as tropical and subtropical lineages differentially reach their range limits
    b. Phylogenetic diversity is expected to be low in the Chihuahuan Desert relative to the Gulf Coast
    c. The diversity of environmental gradients and substrates in the region, in concert with the region's position as a biogeographic crossroads, is expected to drive extreme species richness

Hypotheses relating to the biodiversity of Oklahoma and Texas

2. Vegetation responses to climate change in the south-central U.S. will be dramatic and species-specific
3. Species distribution models for plants in the South-Central U.S. that incorporate substrate information, or that are based solely on substrate, will outperform models based solely on climatic data (edaphic heterogeneity hypothesis)

Broader impacts: community engagement

We will engage statewide nonprofit organizations that focus on plants and nature: Master Naturalists, Master Gardeners, and native plant societies

Members of these organizations will be incentivized by: inherent interest in native plants; required to perform a specified number of volunteer hours for certification; direct engagement with researchers and institutions; individual and group acknowledgment within organizations; digital achievement badges; and activities for mobility-limited members

Higher rates of accuracy in data transcription and georeferencing than normal can be expected from the members of these groups

Broader impacts: community engagement

BRIT has engaged these three Texas plant enthusiast organizations through various field and herbarium activities, including label transcription, which will serve as the model for the project

We will use the Notes from Nature interface, which will include a tracking module for statistics so individual and chapter productivity can be compared

Some members will be invited to annual TORCH meetings

Broader impacts: student education and training

20 students will participate in five 10-week Digitization Internship sessions, four interns per Lead

Interns will be assigned a set of area- or taxon-based specimen datasets to transcribe and georeference and then build a project based on their entered data, the results of which will be presented at TORCH meetings each August

Onsite or online lectures and workshops by Senior Personnel will comprise ca. 30% of their internship

Student digitization technicians will be invited to attend these lectures and workshops

iDigBio Education and Outreach division: open invitation (plea) to advise and contribute

Thanks to:

National Science Foundation

Integrated Digitized Biocollections

Lead and Subaward PIs

TORCH, especially co-founders Amanda Neill and Wayne Elisens

Supplementary Document: List of Participants

[1]Primary Lead Institution, [2]Other Lead Institution, [3]Subaward Institution
[a]Primary Principal Investigator, [b]Other Principal Investigator, [c]Project Manager, [d]Technical Innovator, [e]Institutional Coordinator, [f]Notes from Nature Lead.

[3]Baylor University (BAYLU)
[e]Robert Doyle, Professor, Dept. of Biology

[e]Joseph White, Professor, Dept. of Biology

[1]Botanical Research Institute of Texas (BRIT)
[d]Jason Best, Director of Biodiversity Informatics

[a]Peter Fritsch, Vice President of Research; Director of the Herbarium

[e]Tiana Rehman, Herbarium Collections Manager

[c]Michael Denslow, TORCH TCN Project Manager

[3]Harvard University (HUH)
[e]Charles Davis, Professor, Dept. of Organismic and Evolutionary Biology; Director, Harvard University Herbaria

[3]Missouri Botanical Garden (MO)
[e]James Solomon, Curator of Vascular Plants

[3]Northeastern State University (NOSU)
[e]Mark Paulissen, Professor, Dept. of Natural Sciences

[2]Oklahoma State University (OKLA)
[b,e]Mark Fishbein, Professor and Herbarium Director, Dept. of Plant Biology, Ecology, and Evolution

[3]Sam Houston State University (SHST)
[e]Will Godwin, Professor Emeritus, Dept. of Biological Sciences

[2]Texas A&M University-College Station (TAES)
[b,e]Daniel Spalink, Assistant Professor; Director of the Tracy Herbarium

[3]Texas A&M University-Corpus Christi (TAMUCC)
[e]Barnabas Daru, Assistant Professor, Dept. of Biology; Director of the Ruth O'Brien Herbarium

[3]Texas Tech University (TTC)
[e]Matt Johnson, Assistant Professor, Dept. of Biological Sciences; Director, Reed Herbarium

[3]The New York Botanical Garden (NY)
[e]Barbara Thiers, Vice President for Science Administration; Director, Steere Herbarium

[3]University of Florida (FLAS)
[f]Rob Guralnick, Associate Curator, Dept. of Natural History

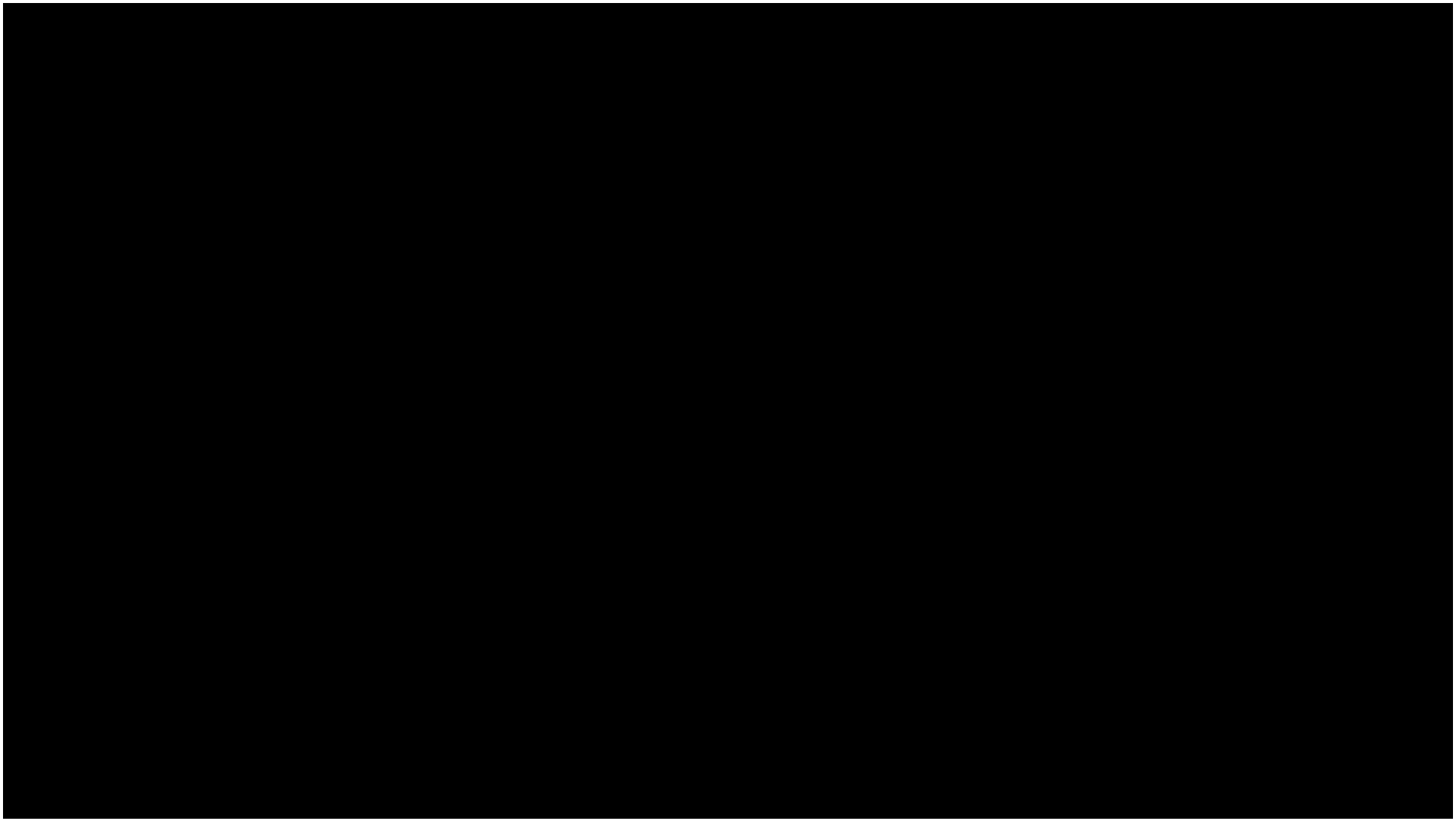
[3]University of Kansas (KANU)
[e]Craig Freeman, Scientist, Kansas Biological Survey; Senior Curator, McGregor Herbarium

[2]University of Oklahoma (OKL)
[b,e]Abigail Moore, Assistant Professor and Curator, Bebb Herbarium, Dept. of Microbiology and Plant Biology

[b]Bruce Hoagland, Professor, Coordinator of the Oklahoma Natural Heritage Inventory, Dept. of Geography and Environmental Sustainability

[2]University of Texas at Austin (TEX/LL)
[b,e]George Yatskievych, Curator and Lecturer, Plant Resources Center, Dept. of Integrative Biology

[3]University of Texas at El Paso (UTEP)
[e]Michael Moody, Associate Professor, Department of Biology; Co-curator, UTEP Herbarium



Other aspects of the region

Southerly location in the contiguous U.S.; only indirectly affected by Pleistocene glaciation

Phylogenetic and biogeographic history involving four major floristic provinces