

American Crossroads

Digitizing the Vascular Flora of the South-Central United States
Texas Oklahoma Regional Consortium of Herbaria
(TORCH TCN)

Diego Barroso, Project Manager
ADBC Summit – September 24th, 2020



South-Central US

- Oklahoma & Texas:
 - 876,859 km²
 - 11% of contiguous US
- “Crossroads” of North American ecological and biological diversity (edges of many plant species distributions)
- Key to understanding continent-wide patterns of biome evolution

37° N

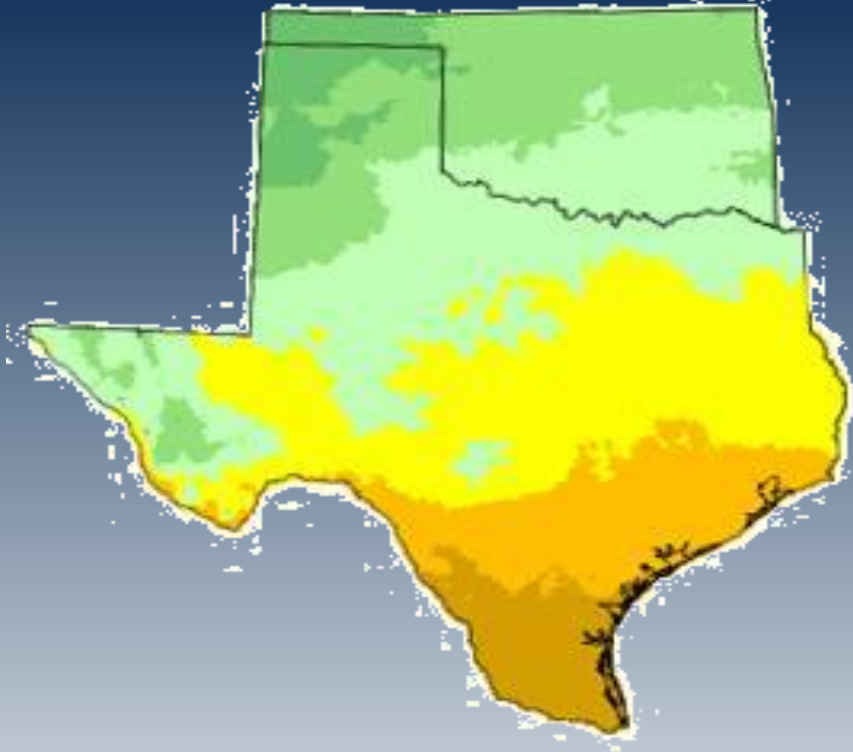
106.6° W

93.5° W

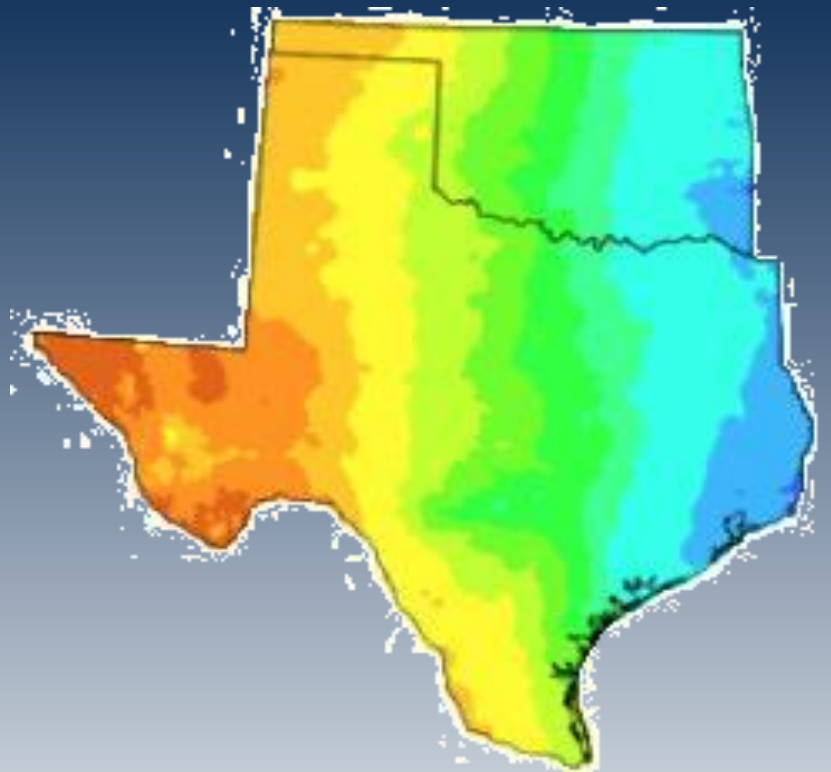


25.8° N

Environmental Gradients



North-to-South: mean January temp 0 °C to 18°C,
through 5 plant hardiness zones



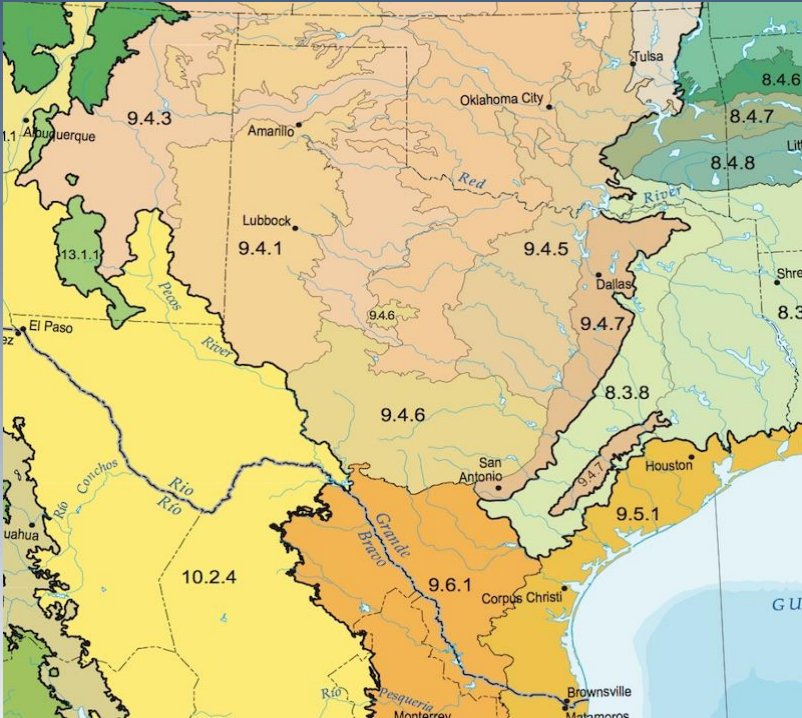
West-to-East: mean annual precipitation
<12.5 cm to >150 cm (1 cm / 10 km), with
abrupt peaks in west Texas and the Ozarks

©National Center for Atmospheric Research

<https://climatedataguide.ucar.edu/climate-data/prism-high-resolution-spatial-climate-data-united-states-maxmin-temp-dewpoint>

Ecological diversity

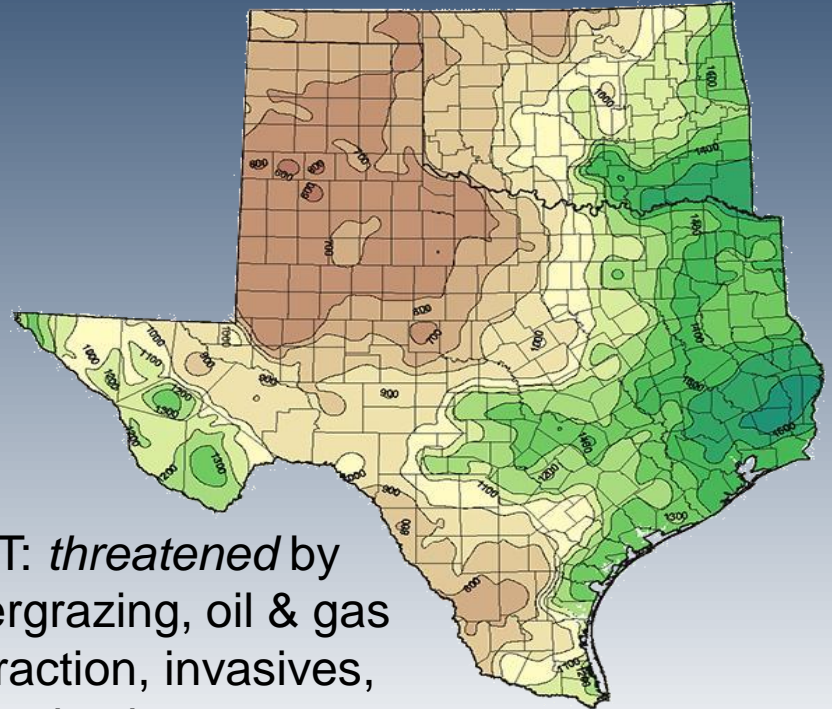
4 EPA Level-I Ecoregions: Great Plains, Eastern Temperate Forests, North American Desert, Temperate Sierras.
17 Level-III Ecoregions



©Commission for Environmental Cooperation

Plant diversity

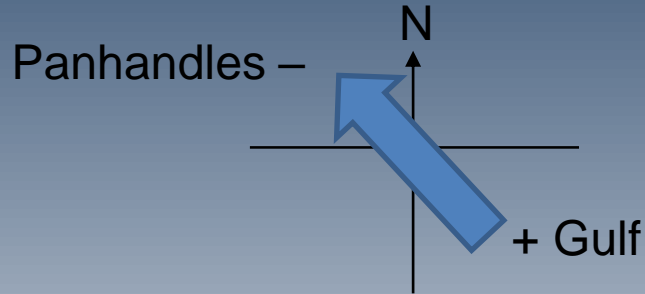
- 4945 native vascular plant species, 31% of all native species in the US & Canada
- Texas is 2nd in species richness among US states, with 325 endemics



BUT: *threatened* by overgrazing, oil & gas extraction, invasives, urbanization, etc.

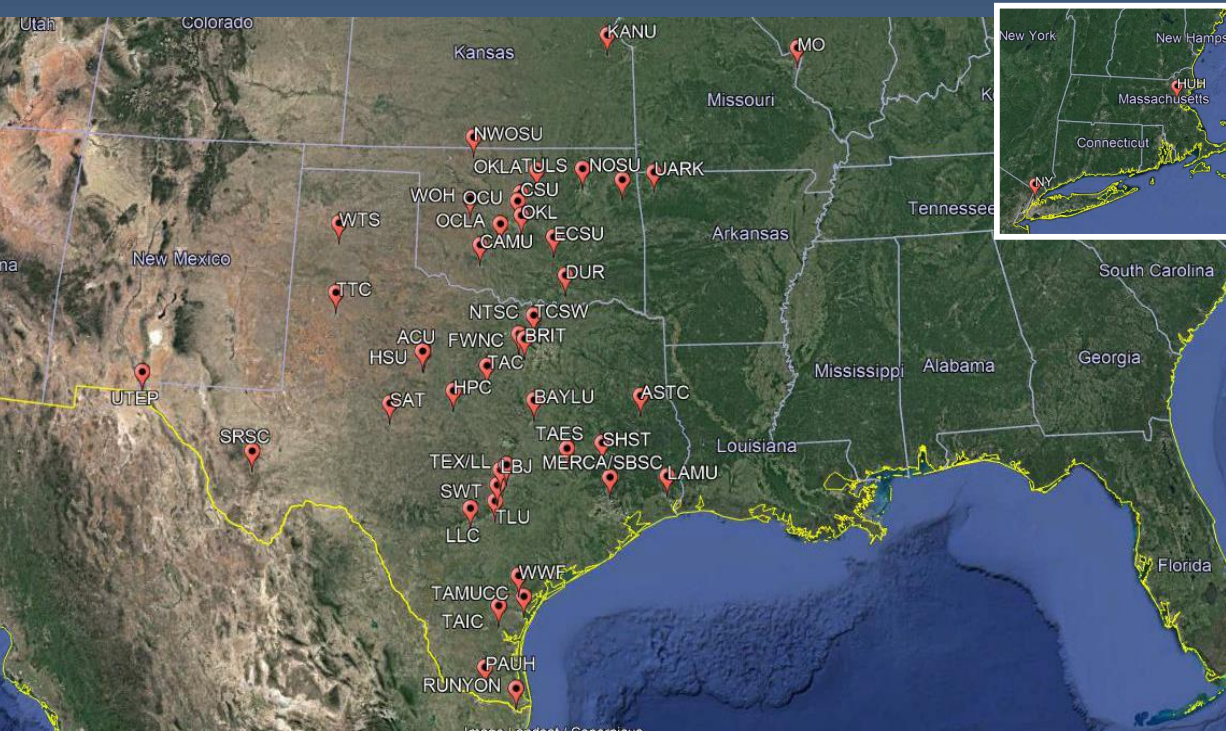
Research Hypotheses

- Geographic patterns in phylogenetic diversity:
 - Diversity will decline with latitude as tropical lineages drop out
 - Diversity will decline with precipitation



- Vegetation responses to climate change will be large and species-specific
- Species distribution (niche) models will be improved with substrate data (rather than relying only on climate data)

TORCH TCN: Documenting the plant diversity of Texas & Oklahoma



©GoogleEarth

- 4-year grant to digitize almost 2 million specimens collected within these 2 states.
- 1.7 million of these from 41 TORCH herbaria (small, medium, large), and 0.3 million from 5 herbaria outside OK & TX (plus U.S. National Herbarium).
- 5 collaborative leads, 10 subawards, 31 providers

Objectives

- To disseminate the digitized data through our Symbiota portal <http://portal.torcherbaria.org>
- Develop, implement, and share innovative strategies to increase workflow efficiency (emphasis on automation)
- To recruit and engage students and citizen scientists in project-based broader-impact activities

TORCH Web Portal

<http://portal.torcherbaria.org>

TORCH

The Texas Oklahoma Regional Consortium of Herbaria

[Home](#) [Search](#) [Images](#) [Checklists & Floras](#) [Interactive Tools](#)

[Log In](#) [New Account](#) [Sitemap](#)

Welcome to TORCH Data Portal

The Texas Oklahoma Regional Consortium of Herbaria (TORCH) was developed to advocate for and to organize approximately 4 million plant specimens across more than 50 herbaria in the two-state region. Learn more about TORCH and its members at torcherbaria.org.

The TORCH data portal provides access to specimen data and associated images from our herbaria to facilitate botanical research for the purpose of conservation, management, and education. This is an open access portal powered by Symbiota (symbiota.org). Our data records are aggregated by iDigBio (idigbio.org; the National Resource for Advancing Digitization of Biodiversity Collections, funded by the National Science Foundation). New records are made available as specimens are digitized (imaged, databased, and georeferenced) by participating herbaria. If you are interested in assisting with digitization efforts, please contact the appropriate curator or collections manager.

To learn more about the features and capabilities of the Symbiota software used by this portal, visit the [Symbiota Help Pages](#).

Search Taxon



HIDE CAPTION

Asclepias brachystephana. Image by: Patrick Alexander.

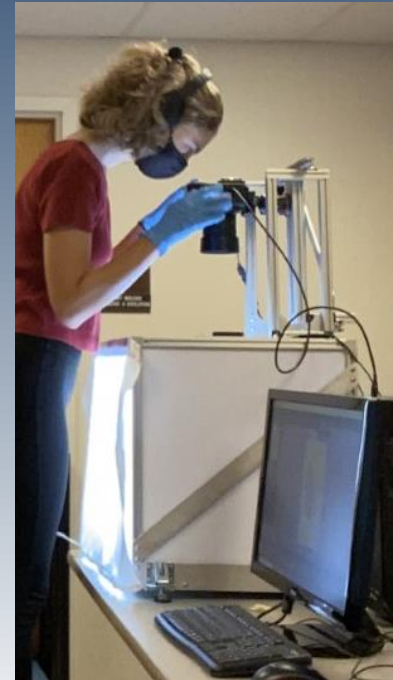


TORCH Innovations – Imaging Station

- Custom LED lightbox and camera stand developed by Jason Best, TORCH Technological Innovator.
- 2 stations were delivered; 4 more in preparation.

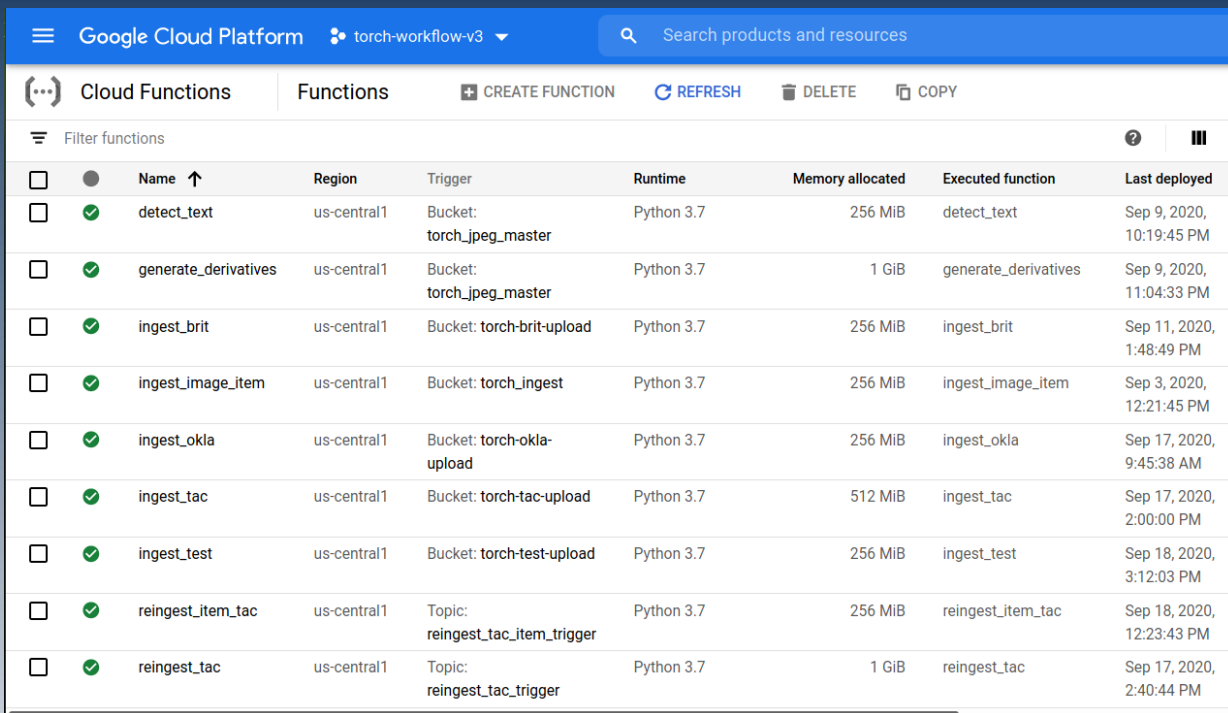


J. Best and D. Rivas assembling lightbox at BRIT



Lightbox in use by S. Hubbard at OKLA

TORCH Innovations – Image Processing



The screenshot shows the Google Cloud Platform interface for Cloud Functions. The page title is "Google Cloud Platform" with a sub-header "torch-workflow-v3". A search bar is present. The main content area is titled "Cloud Functions" and "Functions". There are buttons for "CREATE FUNCTION", "REFRESH", "DELETE", and "COPY". A "Filter functions" dropdown is visible. The table below lists several functions with their details.

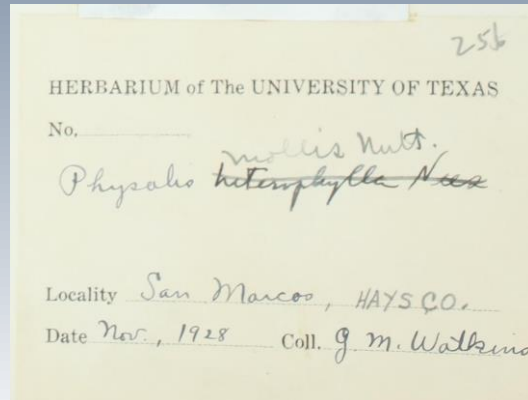
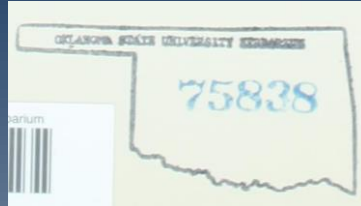
<input type="checkbox"/>	<input checked="" type="radio"/>	Name ↑	Region	Trigger	Runtime	Memory allocated	Executed function	Last deployed
<input type="checkbox"/>	<input checked="" type="radio"/>	detect_text	us-central1	Bucket: torch_peg_master	Python 3.7	256 MiB	detect_text	Sep 9, 2020, 10:19:45 PM
<input type="checkbox"/>	<input checked="" type="radio"/>	generate_derivatives	us-central1	Bucket: torch_peg_master	Python 3.7	1 GiB	generate_derivatives	Sep 9, 2020, 11:04:33 PM
<input type="checkbox"/>	<input checked="" type="radio"/>	ingest_brit	us-central1	Bucket: torch-brit-upload	Python 3.7	256 MiB	ingest_brit	Sep 11, 2020, 1:48:49 PM
<input type="checkbox"/>	<input checked="" type="radio"/>	ingest_image_item	us-central1	Bucket: torch_ingest	Python 3.7	256 MiB	ingest_image_item	Sep 3, 2020, 12:21:45 PM
<input type="checkbox"/>	<input checked="" type="radio"/>	ingest_okla	us-central1	Bucket: torch-okla-upload	Python 3.7	256 MiB	ingest_okla	Sep 17, 2020, 9:45:38 AM
<input type="checkbox"/>	<input checked="" type="radio"/>	ingest_tac	us-central1	Bucket: torch-tac-upload	Python 3.7	512 MiB	ingest_tac	Sep 17, 2020, 2:00:00 PM
<input type="checkbox"/>	<input checked="" type="radio"/>	ingest_test	us-central1	Bucket: torch-test-upload	Python 3.7	256 MiB	ingest_test	Sep 18, 2020, 3:12:03 PM
<input type="checkbox"/>	<input checked="" type="radio"/>	reingest_item_tac	us-central1	Topic: reingest_tac_item_trigger	Python 3.7	256 MiB	reingest_item_tac	Sep 18, 2020, 12:23:43 PM
<input type="checkbox"/>	<input checked="" type="radio"/>	reingest_tac	us-central1	Topic: reingest_tac_trigger	Python 3.7	1 GiB	reingest_tac	Sep 17, 2020, 2:40:44 PM

Developed by Jason Best at BRIT; now in production use with images from Tarleton University (TAC), a TORCH data provider.

After user uploads archival JPEGs/DNGs with Filezilla Pro, GCP:

- 1) Scans barcodes and renames files
- 2) Generates web derivatives and URLs
- 3) Performs OCR
- 4) Ingests and sorts into TACC storage at TEX

TORCH Innovations – Computer Vision for object detection and data extraction (linking legacy databases)



- Tensorflow Model trained on ~50 images per herbarium stamp
- Finds Accession Stamp and Number, barcode, Main Label, Annotation Labels
- OVPD: 380k records; TAES: 233k records

Developed by TORCH Data Manager Clay Barrett at OKLA

TORCH collaboration and Community Engagement

Symbiota Sandbox

Home Search Images Arizona Flora Vouchered Inventory Example Interactive Tools Crowdsourcing Tools

Home >> Collection Search Page >> University of Texas collab with BRIT Details

University of Texas collab with BRIT (TEX4BRIT)

Data Editor Control Panel

- Add New Occurrence Record
- Create New Records Using Image
- Add Skeletal Records
- Edit Existing Occurrence Records
- Add Batch Determinations/Nomenclatural Adjustments
- Print Specimen Labels
- Print Annotations Labels
- Occurrence Trait Coding Tools
- Batch Georeference Specimens
- Loan Management

Administration Control Panel

- View Posted Comments
- Edit Metadata and Contact Information

- 28 TEX students transcribed 27,000 BRIT records, as part of a collaboration between the two institutions during COVID-19 closures. (George Yatskievych & Amber Horning)

Notes from Nature

Transcribe museum records!

PROJECT CATEGORY

All Plants Bugs Butterflies Labs Magnified

Marine Invertebrates

Active Projects ▲ HIDE SECTION

TORCH Texas Oklahoma Regional Consortium of Herbaria

ES HERBARIUM

NYBG

- 23 Weekly #TranscriptionThursdays #ArmchairBotanist sessions since WeDigBio Lite in April (Tiana Rehman & Jessica Lane)
- 728 volunteers completed 7,500 record transcriptions in 8 Notes from Nature expeditions (7 BRIT, 1 OKLA)

Broader Impacts: Community Engagement

- Engaging statewide organizations: Master Naturalists, Master Gardeners, and native plant societies, who have an inherent interest in native plants.
- Members are incentivized by: volunteer hours being required for certification; direct interaction with researchers and institutions; individual and group acknowledgment by the community; digital achievement badges; and opportunities for remote work and participation (especially during COVID-19).
- Better accuracy in data transcription, and valuable “boots-on-the ground” experience (beneficial to georeferencing efforts)

Student training opportunities



- 10-week Digitization Internships for 20 undergraduate students (postponed due to COVID-19)
- Projects to be taxon-based or delimited by geographic area, and presented at TORCH meetings each August
- 14 graduate students supported

During Year 1...

- 88 people across 15 different institutions contributed at least 1 person-month's worth of work to the TORCH TCN.
- 80,000 specimens barcoded
- 105,000 specimens imaged (COVID-19 highlighted advantages of first imaging specimens)
- 240,000 new specimen records
- 119,000 records georeferenced
- 18 of 46 participating institutions have a presence on the TORCH Symbiota Portal, contributing a total of 2.37 million records (72% with images, 30% with geocoordinates), including 722,000 from Texas and Oklahoma.

Thanks to:



National Science Foundation



Integrated Digitized Biocollections

Lead and Subaward PIs

Staff and Student Digitizers

Volunteers

Ed Gilbert (Symbiota help)

Baylor University (BAYLU)

Robert Doyle, Professor, Dept. of Biology

Joseph White, Professor, Dept. of Biology

Botanical Research Institute of Texas (BRIT)

Diego Barroso, TORCH TCN Project Manager

Jason Best, Director of Biodiversity Informatics

Peter Fritsch, Vice President of Research;

Director of the Herbarium

Tiana Rehman, Collections Manager

Harvard University (HUH)

Charles Davis, Professor, Dept. of Organismic

and Evolutionary Biology; Director, Harvard

University Herbaria

Missouri Botanical Garden (MO)

James Solomon, Curator of Vascular Plants

The New York Botanical Garden (NY)

Barbara Thiers, Vice President for Science

Administration; Director, Steere Herbarium

Northeastern State University (NOSU)

Elizabeth Waring, Assistant Professor, Dept. of

Biology

Oklahoma State University (OKLA)

Mark Fishbein, Professor and Herbarium

Director, Dept. of Plant Biology, Ecology, and

Evolution

Clay Barrett

TORCH TCN Data Manager

Sam Houston State University (SHST)

Justin Williams, Professor and Curator,

Dept. of Biological Sciences

Will Godwin, Professor Emeritus, Dept. of

Biological Sciences

Texas A&M University-College Station

(TAES)

Daniel Spalink, Assistant Professor; Director

of the Tracy Herbarium

Texas A&M University-Corpus Christi

(TAMUCC)

Barnabas Daru, Assistant Professor, Dept. of

Biology; Director of the Ruth O'Brien

Herbarium

Texas Tech University (TTC)

Matt Johnson, Assistant Professor, Dept. of

Biological Sciences; Director, Reed Herbarium

University of Florida (FLAS)

Rob Guralnick, Associate Curator, Dept. of

Natural History

University of Kansas (KANU)

Craig Freeman, Scientist, Kansas Biological

Survey; Senior Curator, McGregor Herbarium

University of Oklahoma (OKL)

Abigail Moore, Assistant Professor and

Curator, Bebb Herbarium, Dept. of

Microbiology and Plant Biology

Bruce Hoagland, Professor, Coordinator of the

Oklahoma Natural Heritage Inventory, Dept. of

Geography and Environmental Sustainability

University of Texas at Austin (TEX/LL)

George Yatskievych, Curator and Lecturer,

Plant Resources Center, Dept. of Integrative

Biology

Amber Horning, Collections Manager

University of Texas at El Paso (UTEP)

Michael Moody, Associate Professor,

Department of Biology; Co-curator, UTEP

Herbarium