# Conceptual Model of Groundwater Flow in the Pecos Valley and Edwards-Trinity (Plateau) Regional Aquifers

## Stakeholder Advisory Forum #2

Thank you for signing in early.

The meeting will begin at 10:00 am, Central Daylight Time

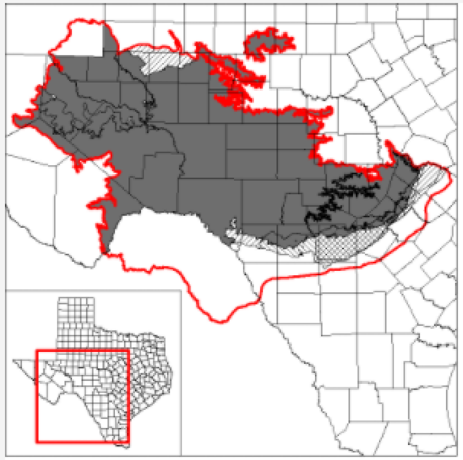
Please stay muted during the meeting and use the chat box to submit questions

Texas Water Development Board

# An audio and video recording of the meeting, presentation, and the report summarizing the meeting will be made available on the project's TWDB website

## Edwards and Trinity Regional

### Groundwater Availability Model (GAM)



In 2020, the Texas Water Development Board (TWDB) has begun to develop a regional groundwater availability model for the Edwards-Trinity (Plateau), Pecos Valley, Hill Country Trinity, and Edwards aquifers in Texas. A final report and model will be released in early 2023. Upon its release, this regional model will replace the current groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers.

In 2004, the TWDB released a groundwater availability model of the Edwards-Trinity (Plateau) and Pecos Valley aquifers in Texas.

## Draft Conceptual Model Report

**Draft Report: A Conceptual Model of Groundwater Flow in the Pecos Valley and Edwards-Trinity (Plateau) Regional Aquifers**

The Draft Report will be available for public review and comment for the following 30 working days. Please submit your written comments to Ki Cha, Ph.D. on or before Monday, March 21, 2022.

- Aquifers
- Groundwater Management Areas
- Desired Future Conditions
- Groundwater Conservation Districts
- Groundwater Data
- Groundwater Models
  - Groundwater Availability Models
  - Download GAM Files
  - Alternative Models
  - Research Projects
  - Analytical Methods
- Brackish Resources Aquifer Characterization System
- Groundwater Educational Videos
- Regional Water Planning Areas
- Special Projects

www.twdb.texas.gov/groundwater/models/gam/eddt_p/eddt_r.asp

# Agenda

GAM Program Overview

Conceptual Model for the Pecos Valley and Edwards-Trinity (Plateau) Regional Aquifers

Recharge and GW/SW Interaction

Groundwater Pumping Estimation

Modeling plans and project schedule

# GAM Program Overview

**Aim**: Develop groundwater flow models for the major and minor aquifers of Texas.

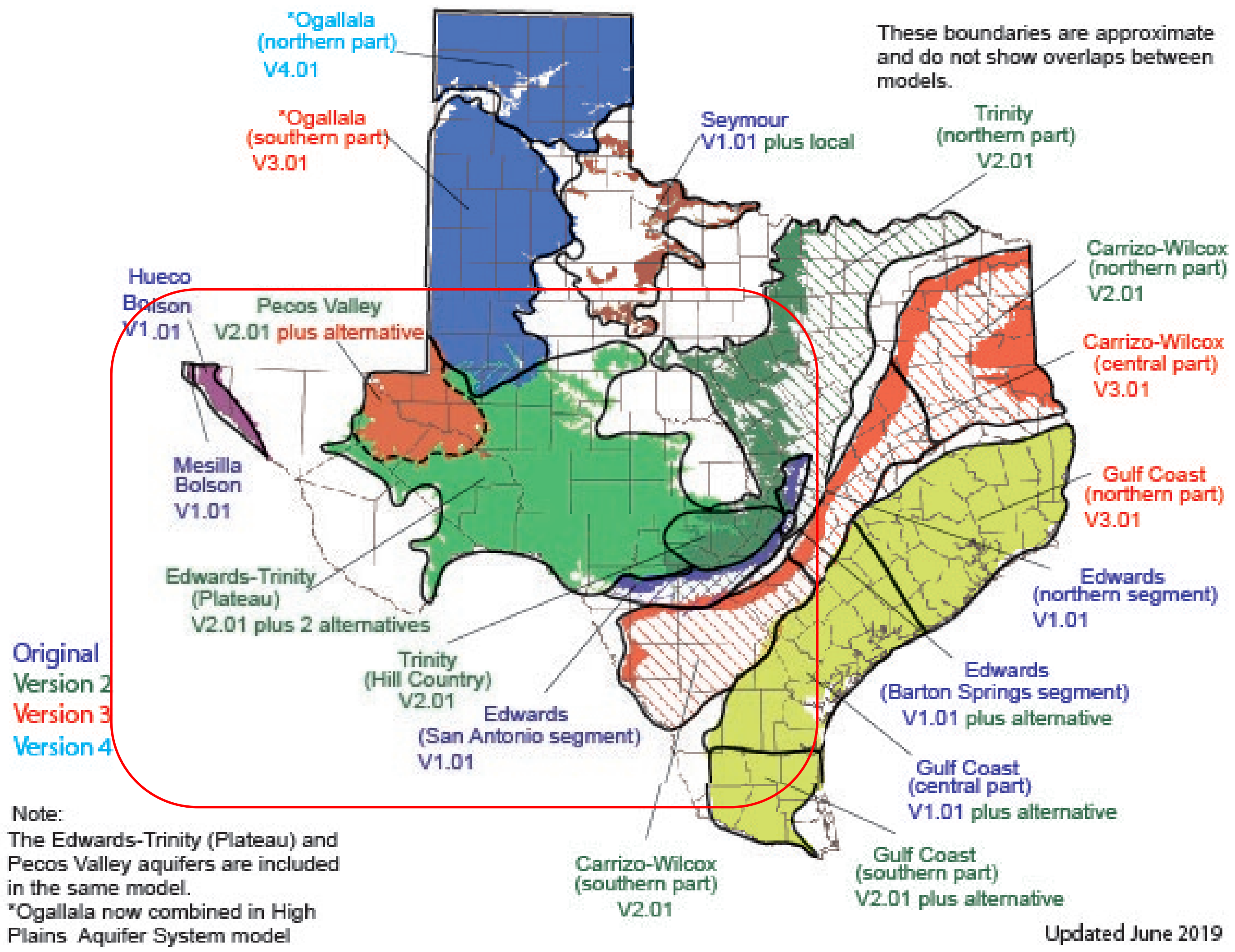
**Purpose**: Tools that can be used to aid in groundwater resources management by stakeholders.

**Public process**: Stakeholder involvement during model development process.

**Models**: Freely available, standardized, thoroughly documented. Reports, data, models are available for download from TWDB download page for models.

**Living tools**: Periodically updated.

# GAMs for Major Aquifers



# Why Stakeholder Advisory Forums?

- Keep stakeholders updated about progress of the model
- Inform how the groundwater model can, should, and should not be used
- Provide stakeholders with the opportunity to provide input and data to assist with model development

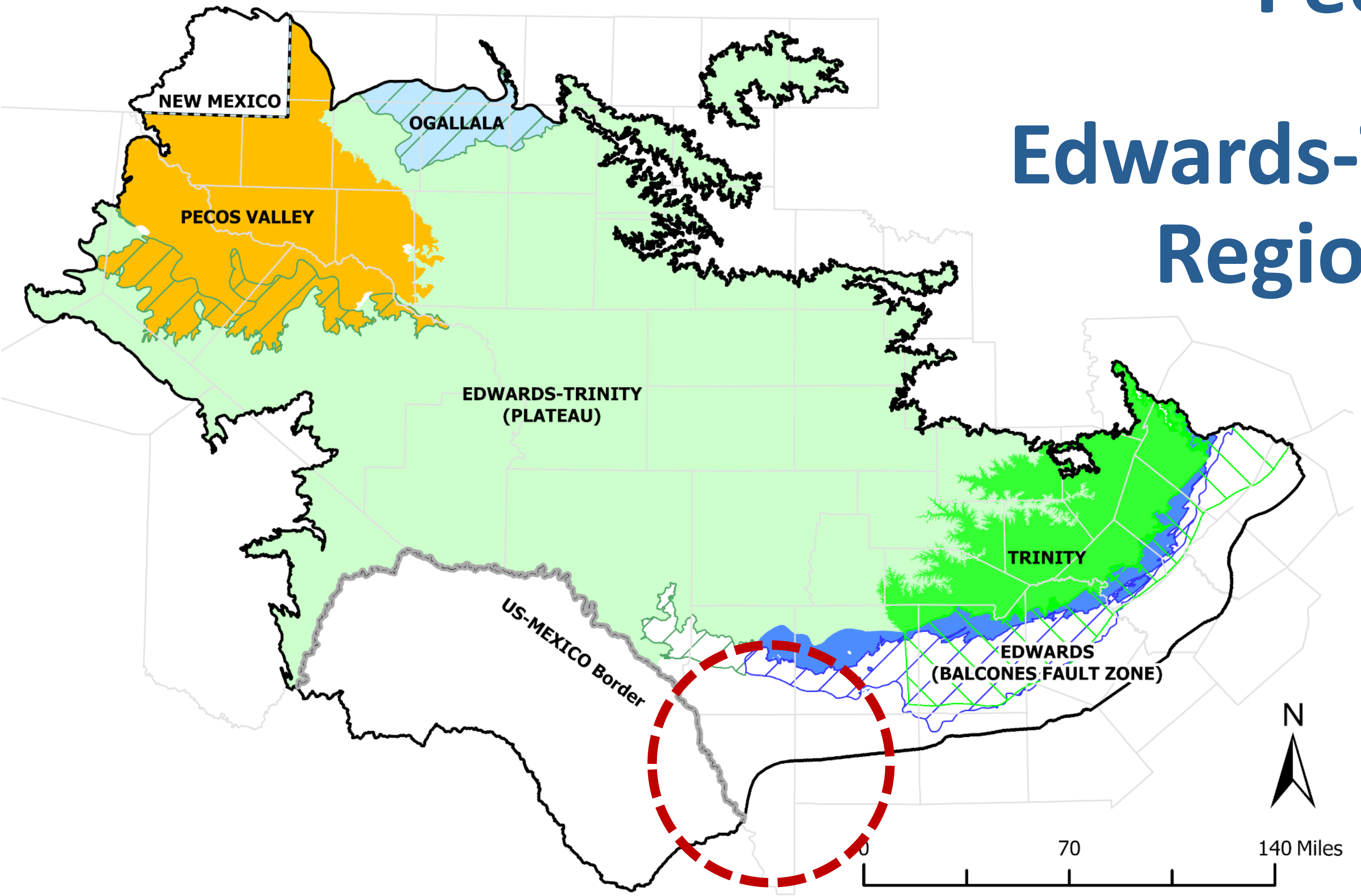
# Contact Information

**Daryn Hardwick Ph.D.**
**Manager, Groundwater Availability Modeling**
**512-475-0470**
**daryn.hardwick@twdb.texas.gov**

**Texas Water Development Board**
**P.O. Box 13231**
**Austin, Texas 78711-3231**

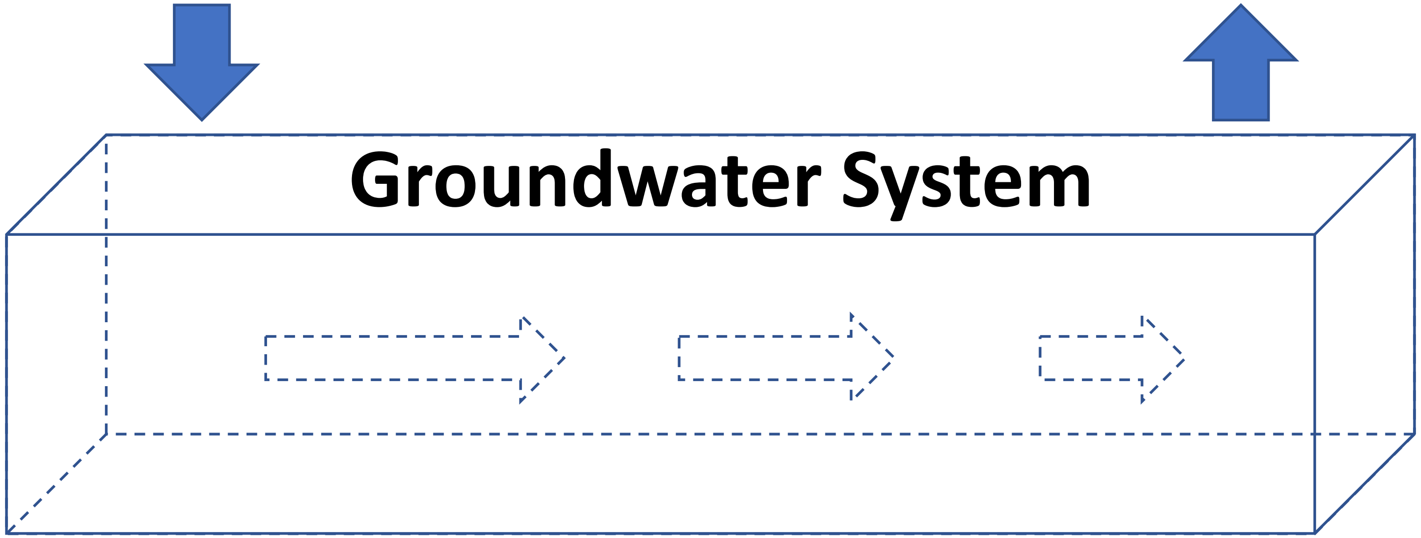
**Web information:**
**www.twdb.texas.gov/groundwater/models/gam/eddt_p/eddt_r.asp**

# Pecos Valley and Edwards-Trinity (Plateau) Regional Aquifers



# Conceptual Model is…

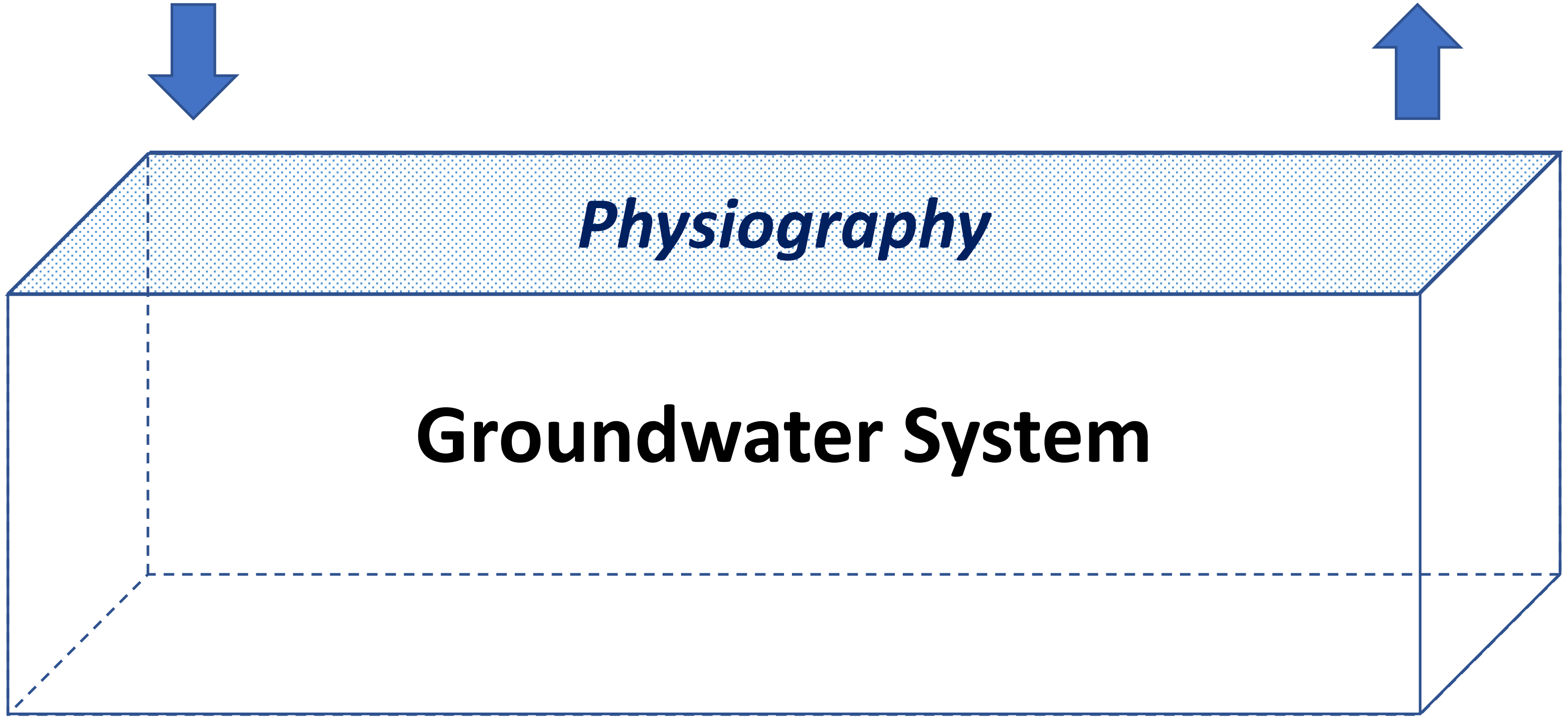
**"A generalized representation of a groundwater flow system in terms of hydrogeologic units"**
**(Anderson and Woessner)**



# Components of Conceptual Model

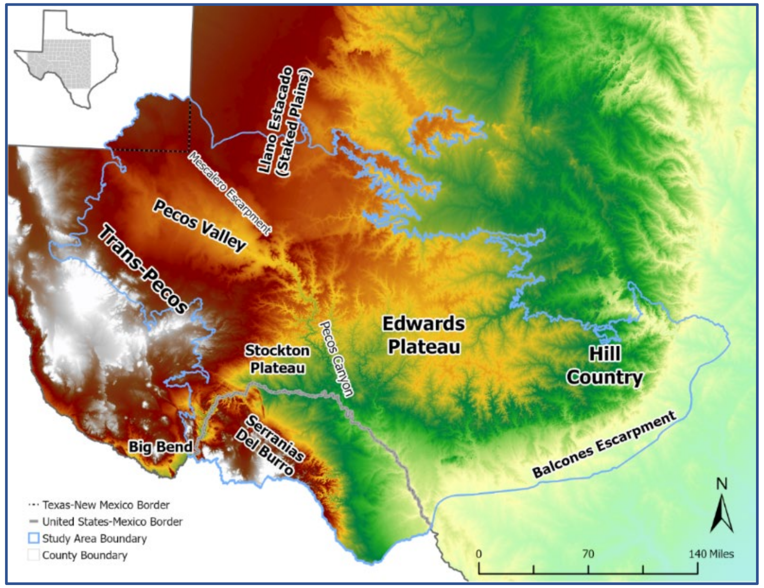
- Physiography and Climate
- Hydrostratigraphy
- Structural framework
- Water Levels/Regional GW Flow
- Recharge
- Discharge
- Rivers, streams, reservoirs, and springs
- Hydraulic properties
- Water quality

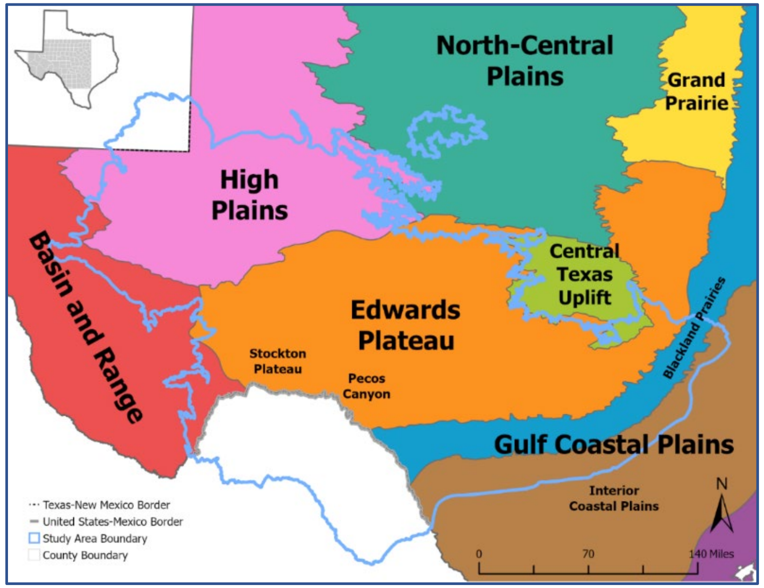
# Physiography

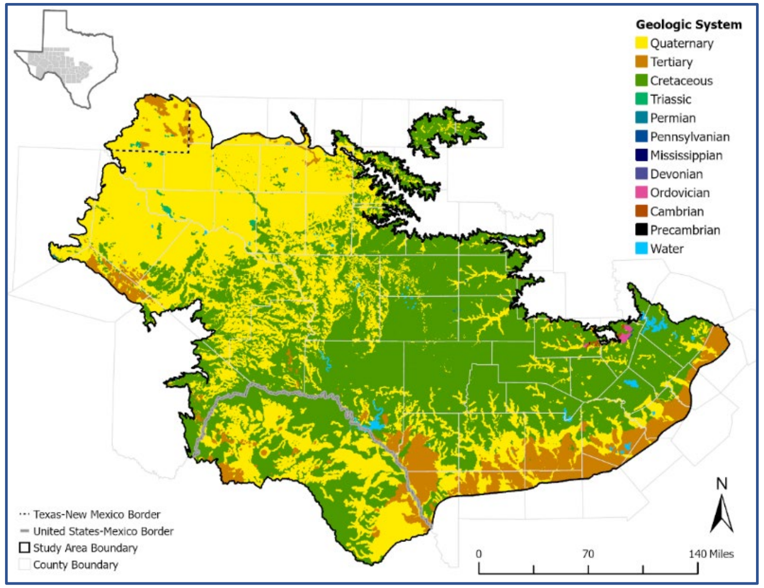


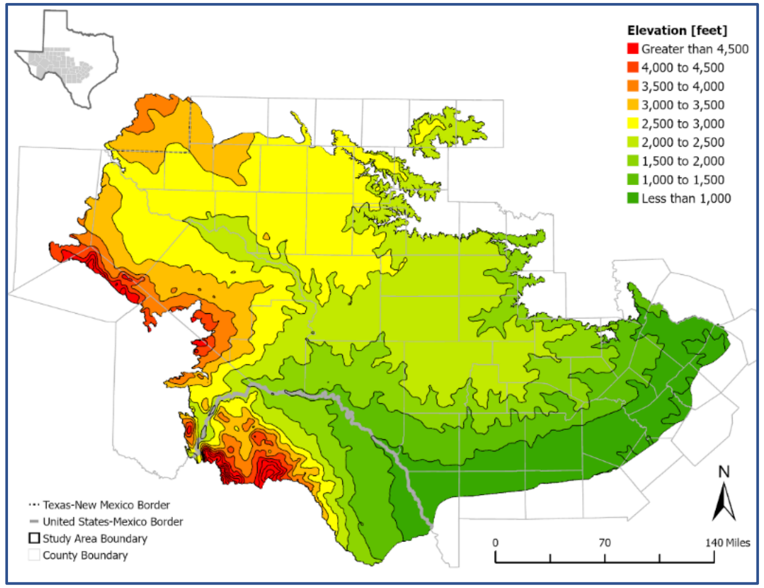
# Physiography

- Landform
- Physiographic Provinces
- Geologic System
- Land Surface Elevation



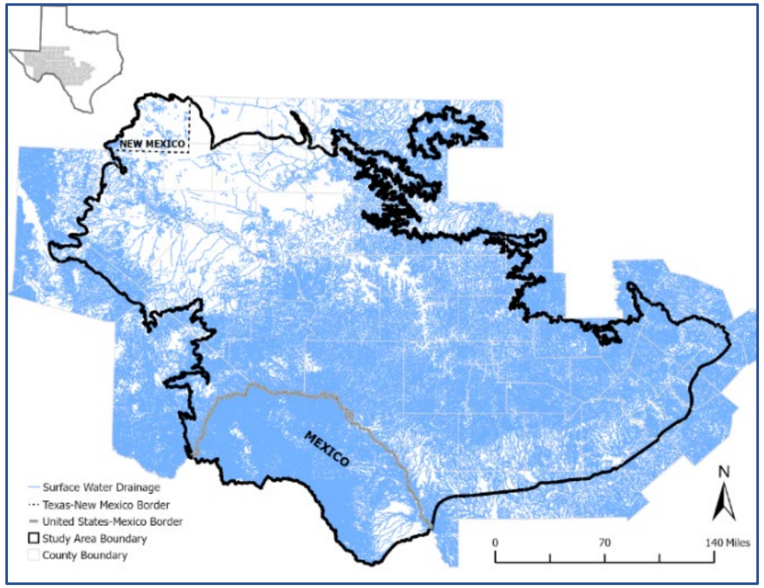



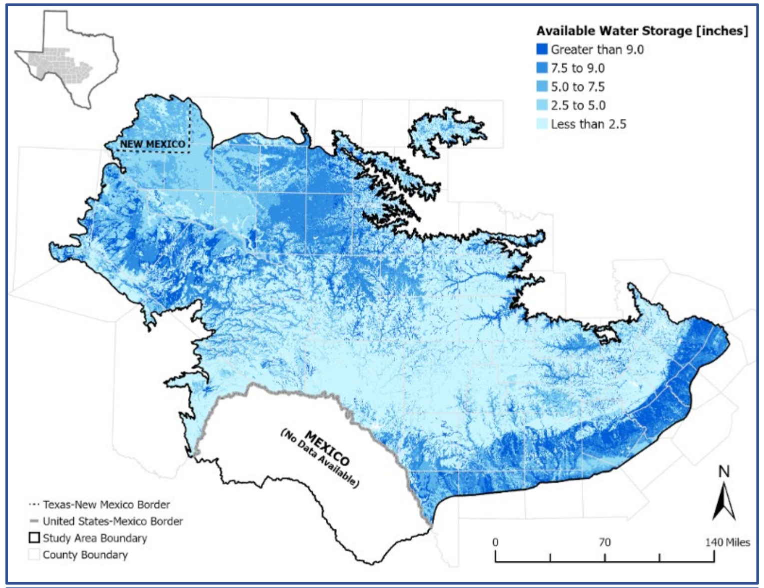



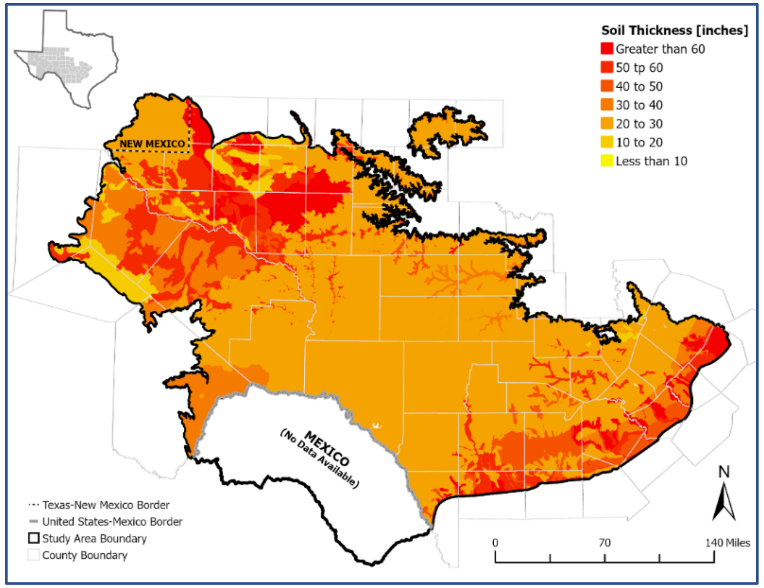



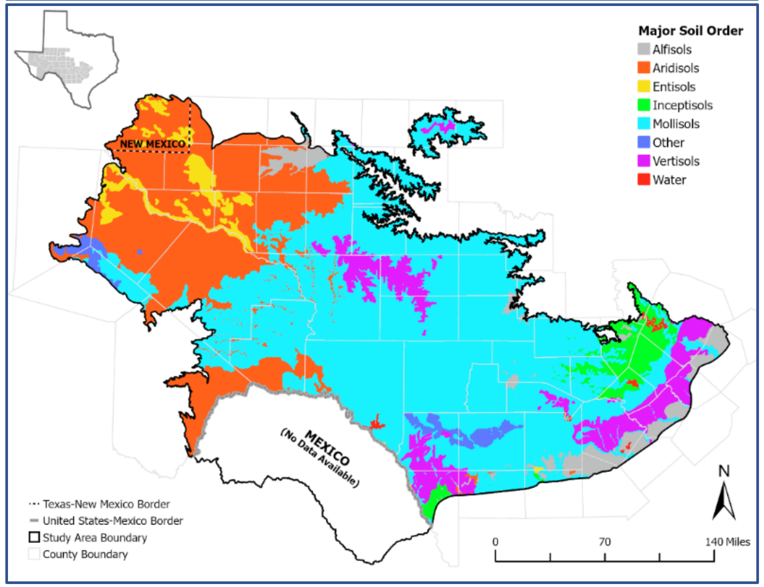
# Physiography

- Water Drainage
- Available Water Storage
- Soil Thickness
- Soil Order Types



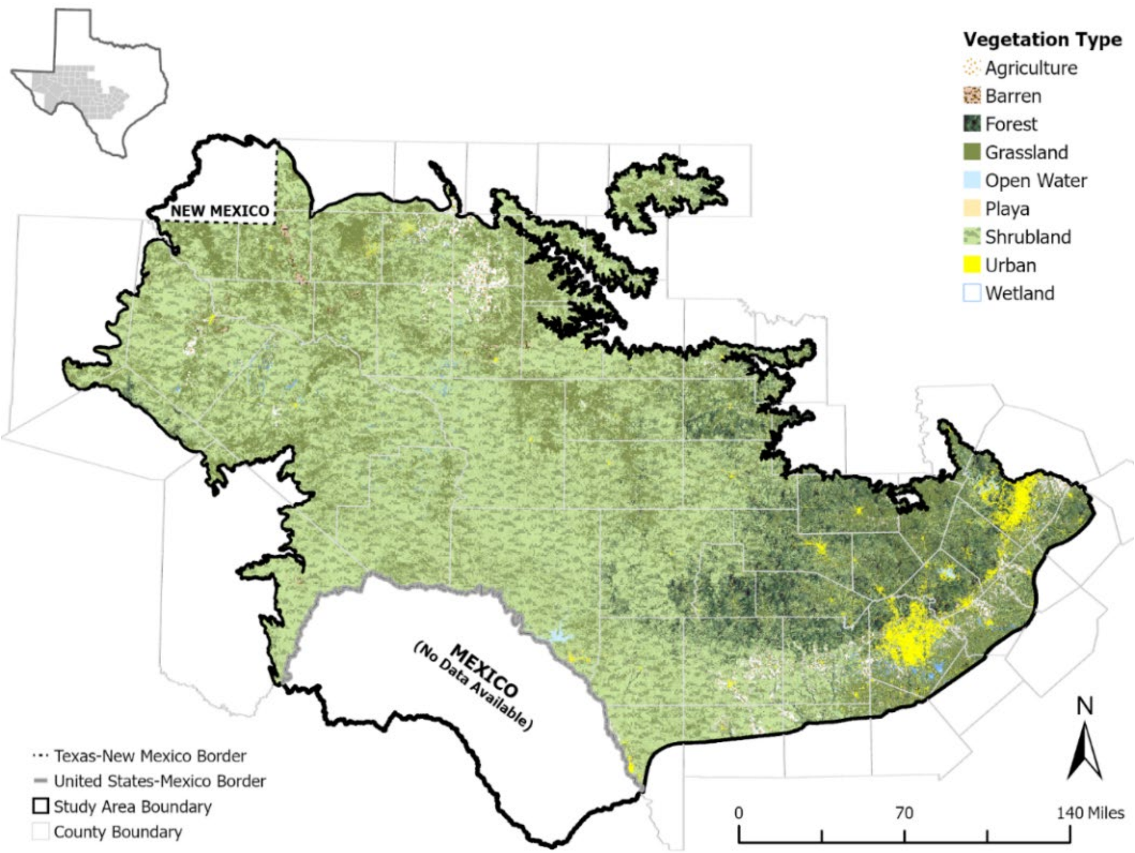



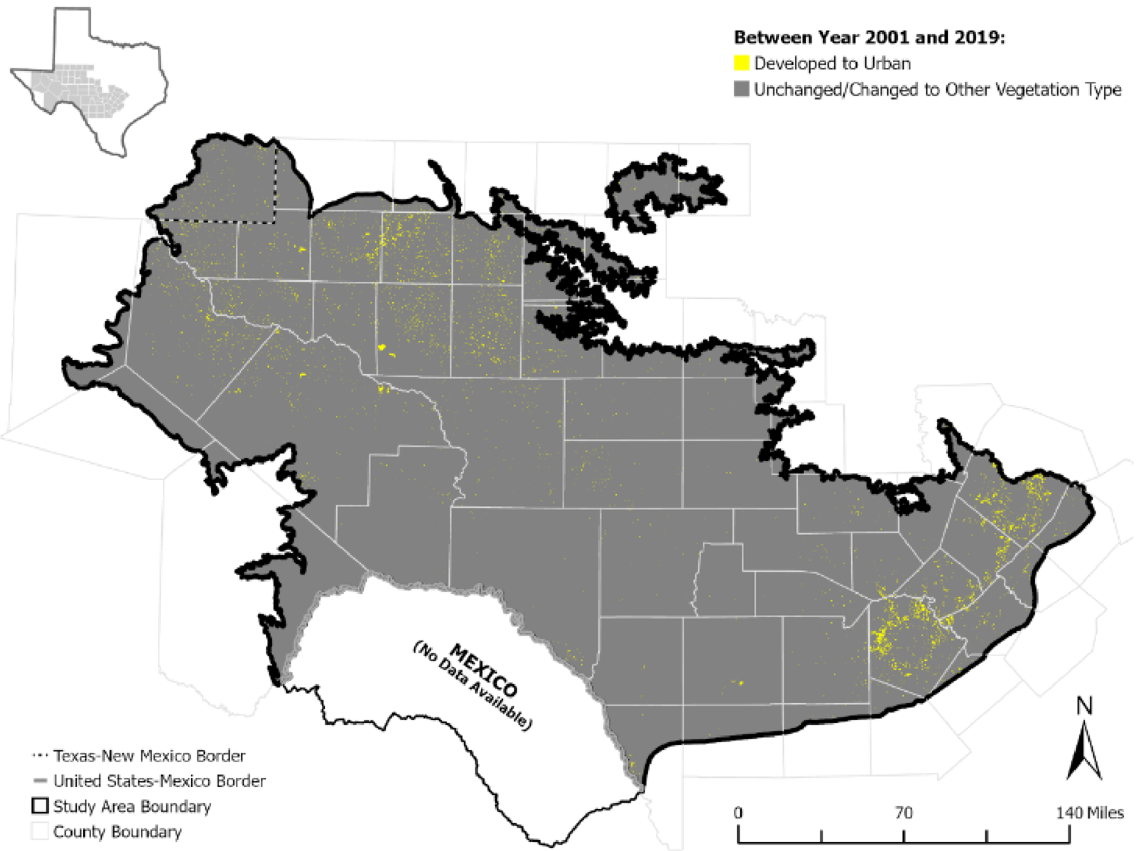



# Physiography

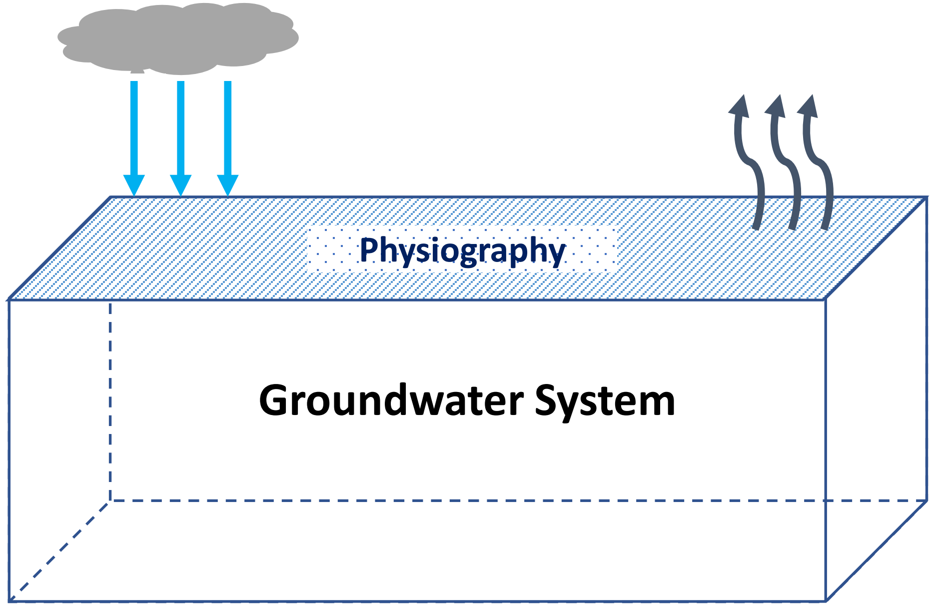
## Vegetation Type



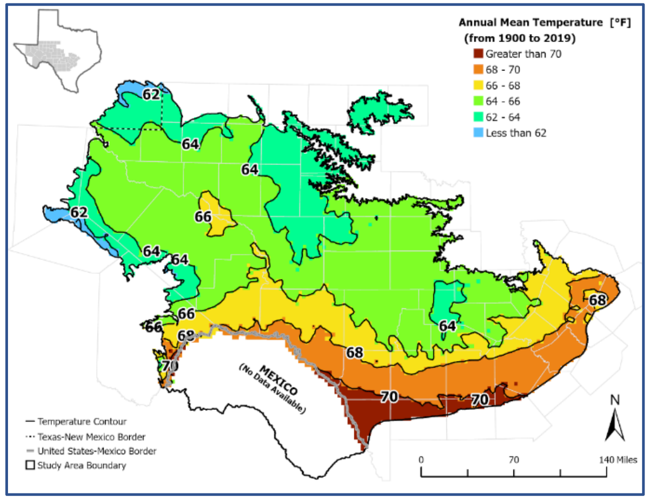

## Land Use Change



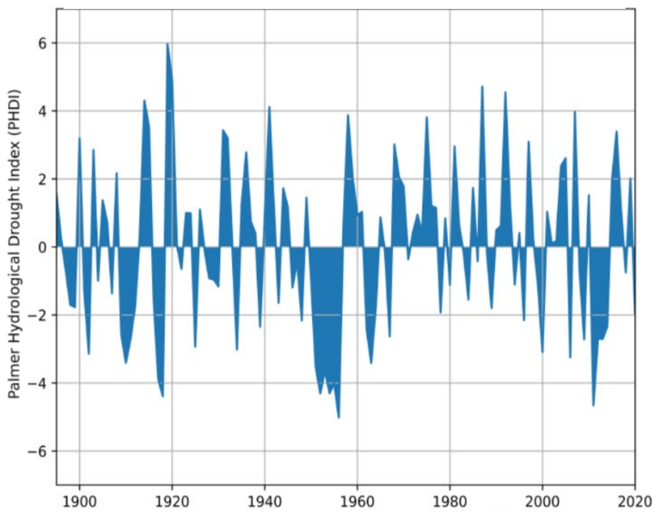
# Climate



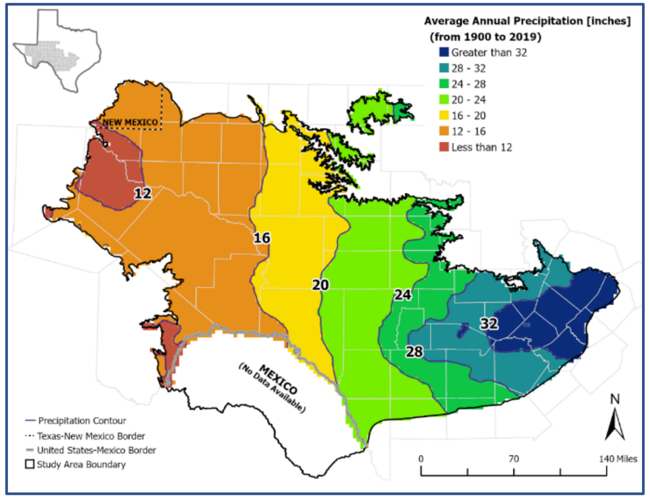

## Temperature



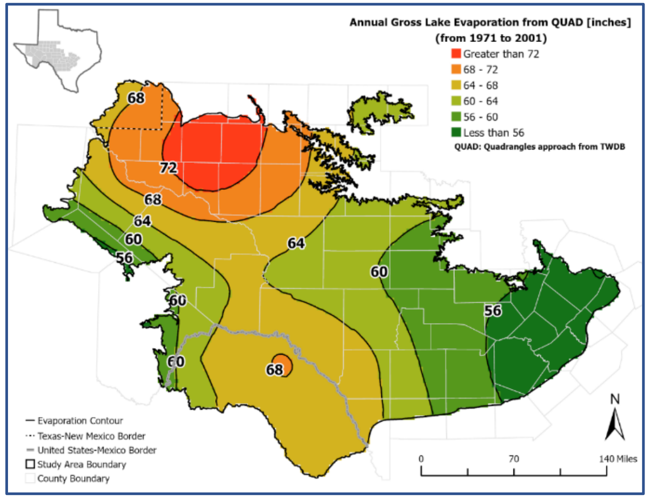

## Drought Index

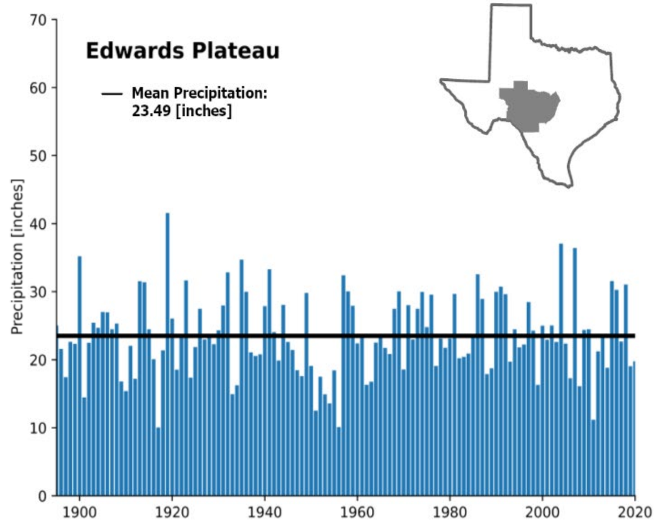



## Precipitation




## Evaporation



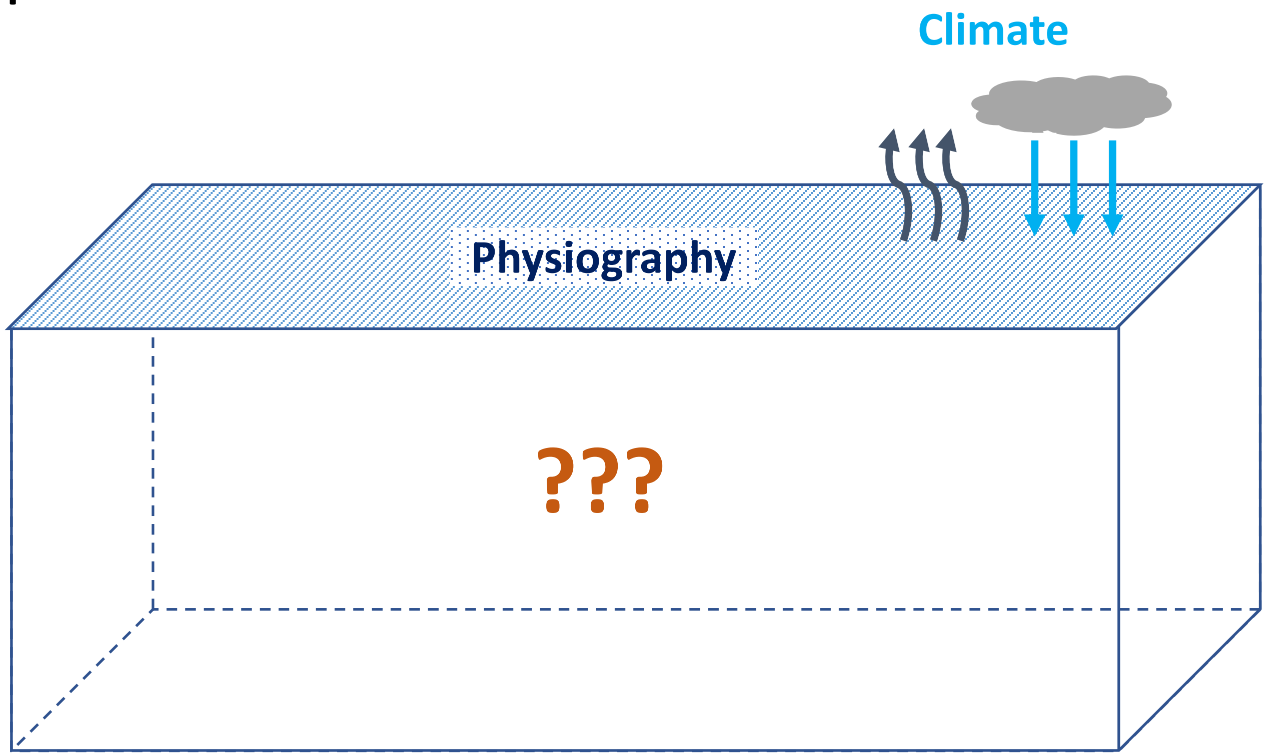
# Components of Conceptual Model

- Physiography and Climate
- Hydrostratigraphy
- Structural framework
- Water Levels/Regional GW Flow
- Recharge
- Discharge
- Rivers, streams, reservoirs, and springs
- Hydraulic properties
- Water quality

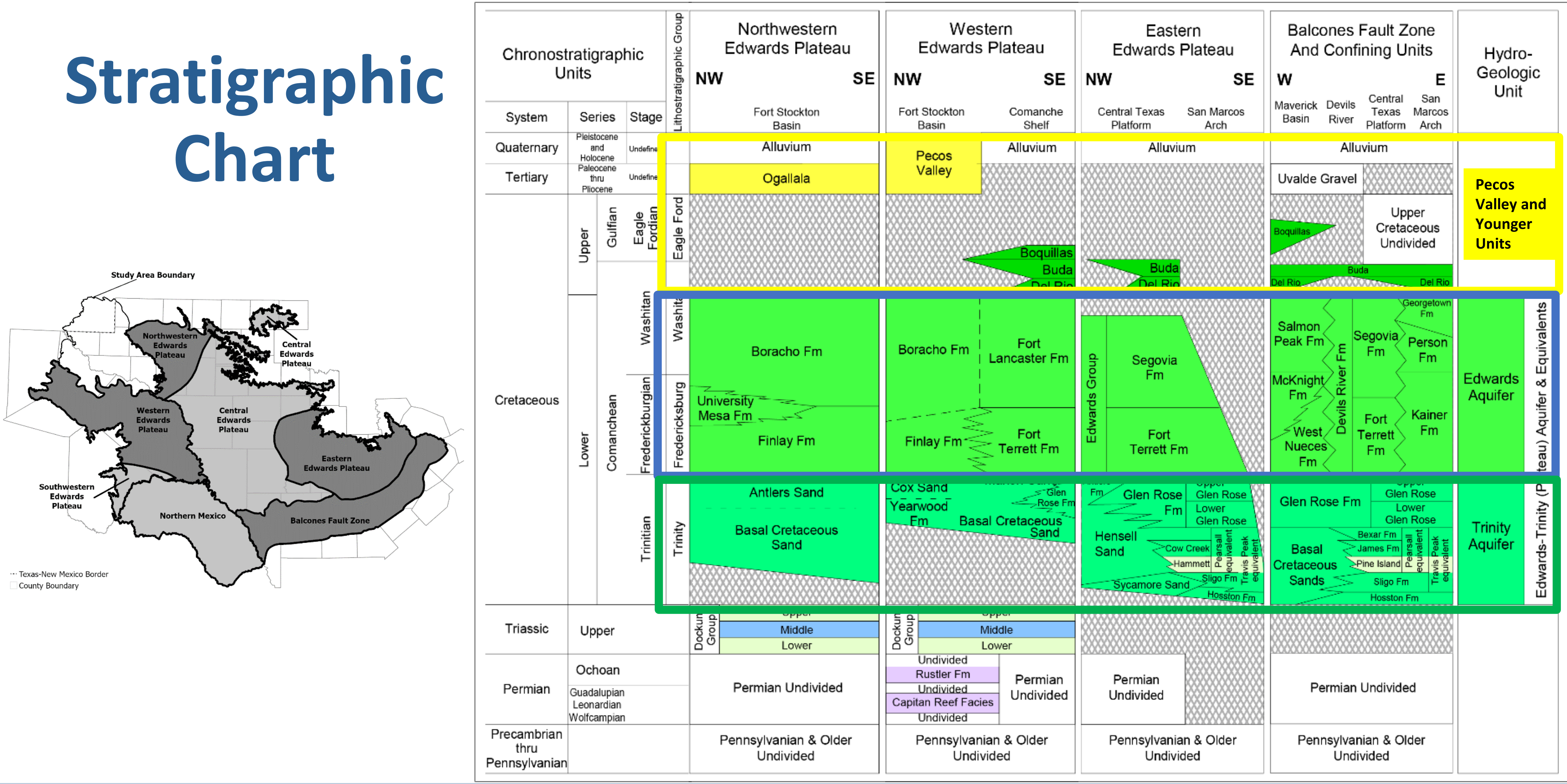
# Stratigraphy

- Vertical and lateral organization of the geologic units
  - Similar Rock Characteristics
  - Similar Rock Age

- Hydrostratigraphy
  - Grouping Rocks into Similar Aquifer Characteristics

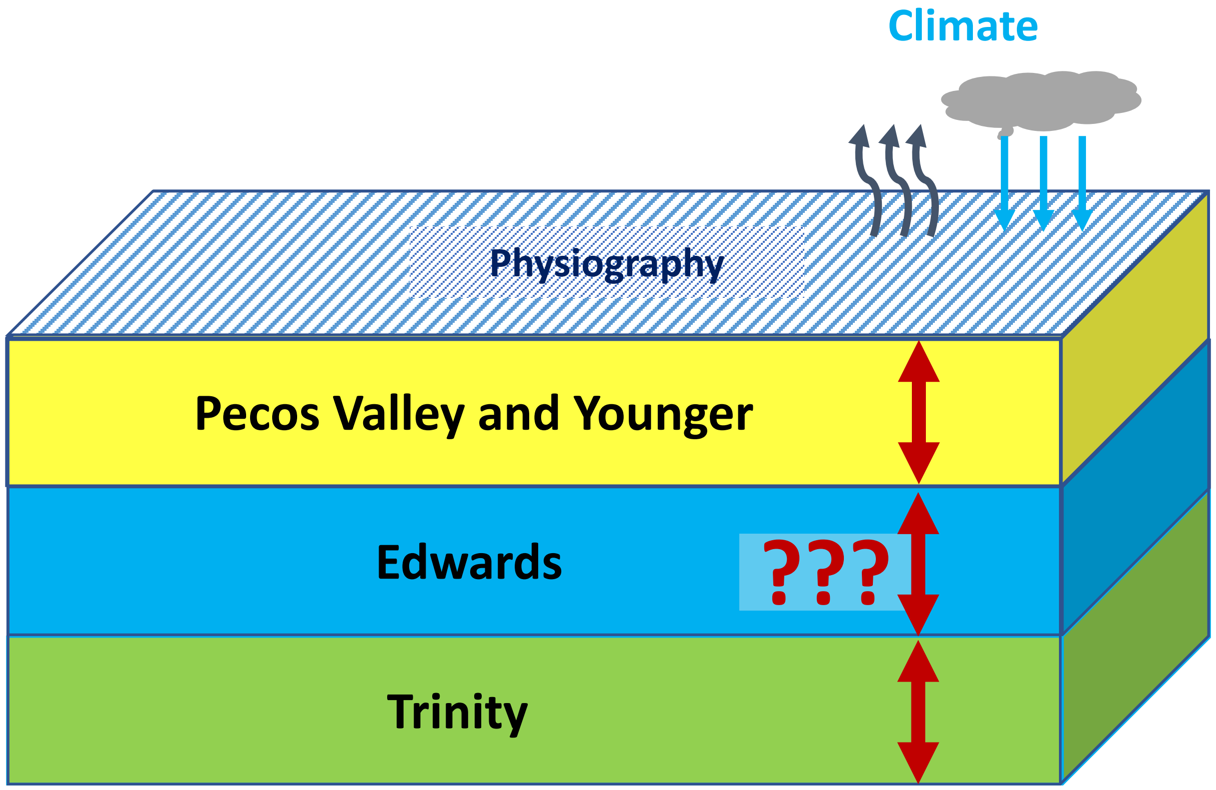


# Stratigraphic Chart

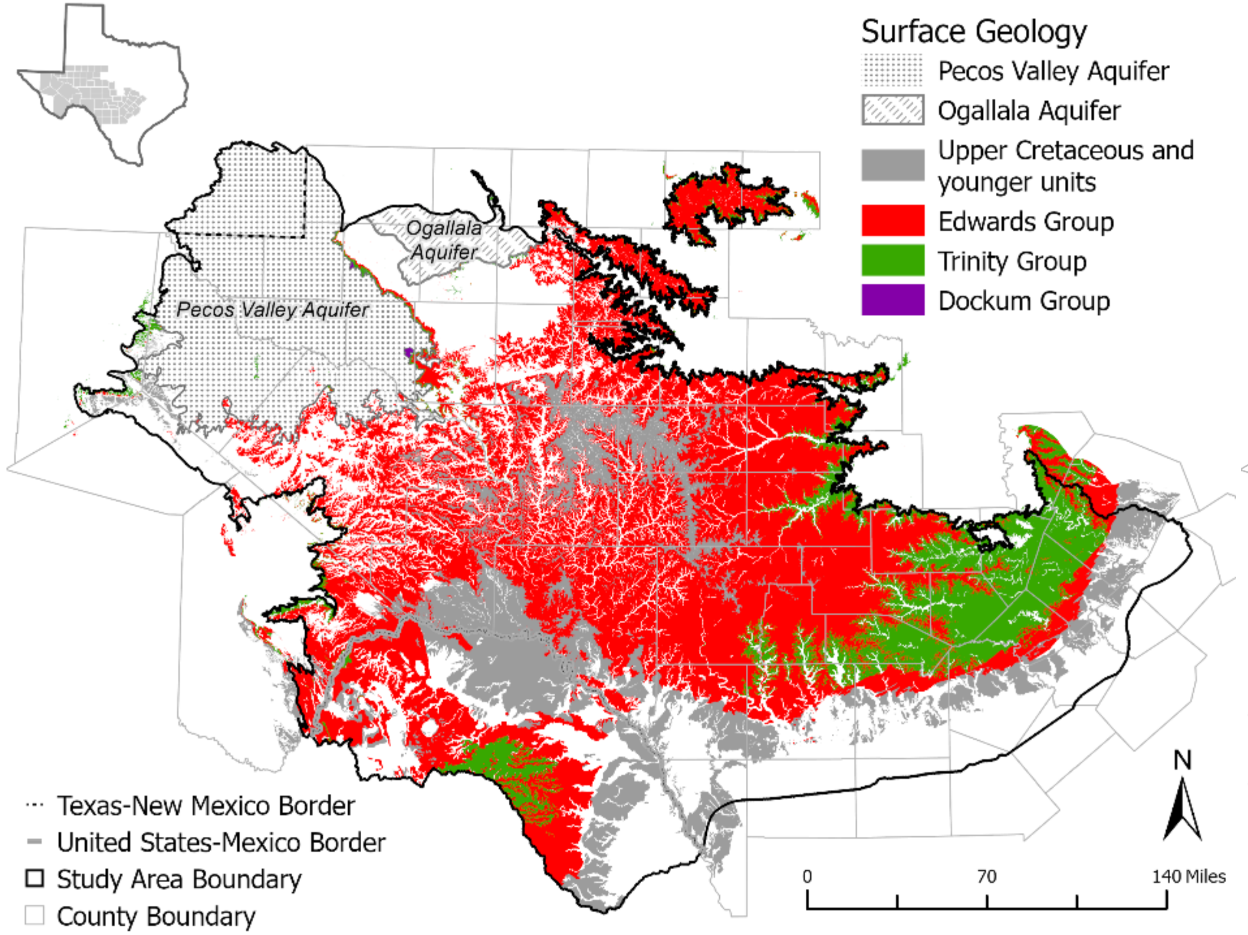


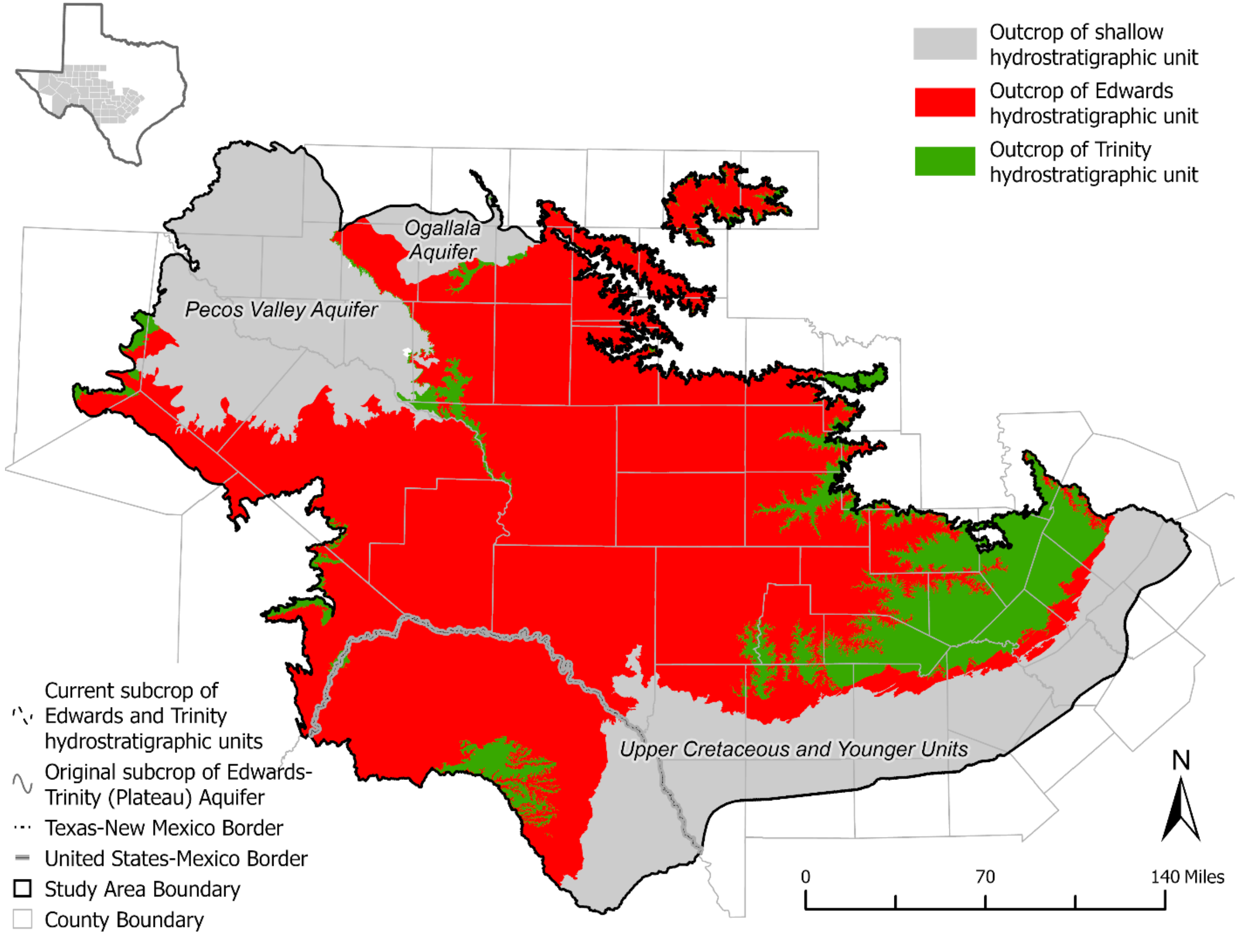
# Structural Framework

- Three Layers
- Create Top and Bottom Surfaces
- Calculate the Thickness
  - Groundwater Volume
- Data Sources
  - TWDB – GW, BRACS
  - GCDs – BSEACD, HCUWCD
  - Previous Models – TWDB, USGS
  - Previous Studies
- Assumptions/Simplifications

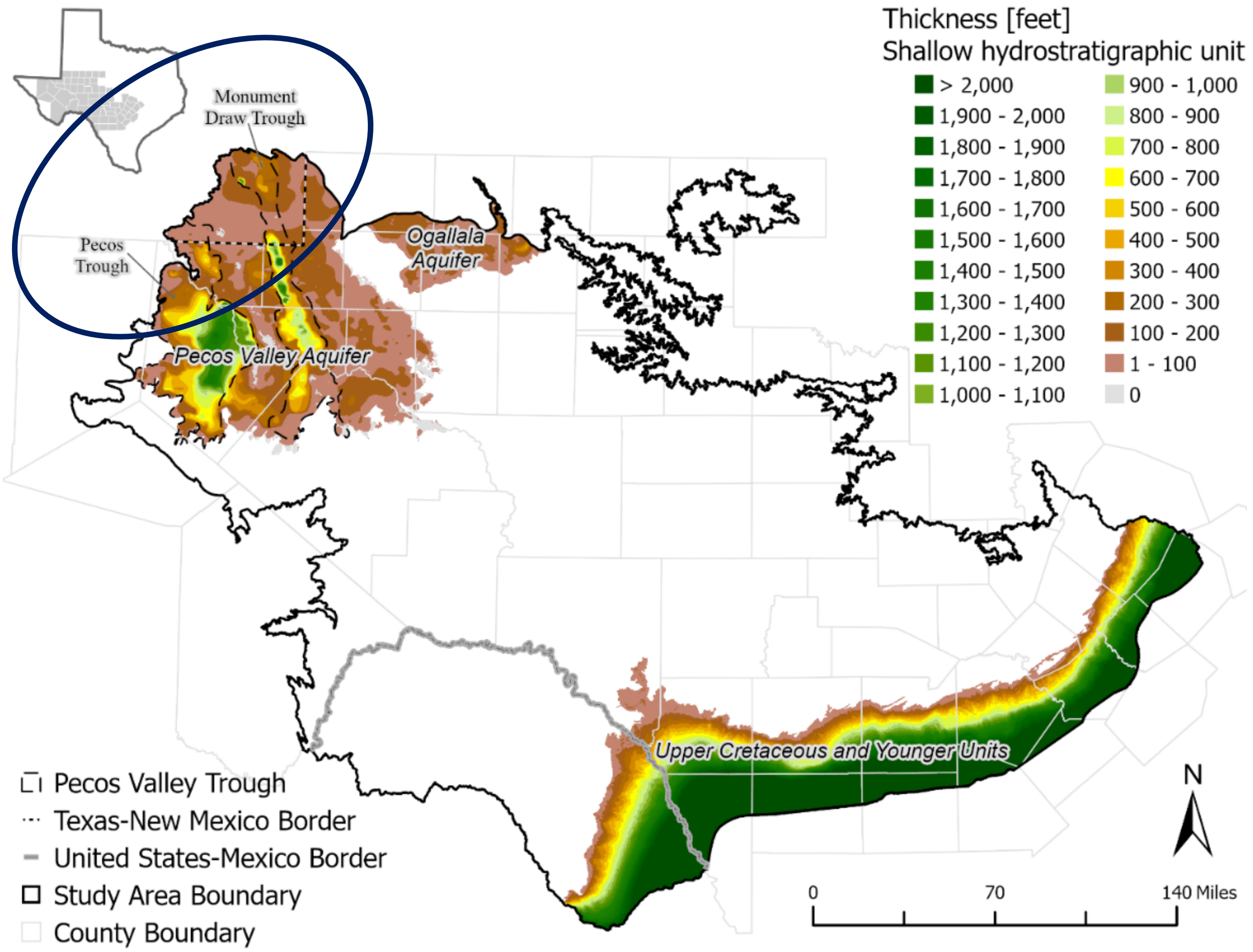


# Surface Geology

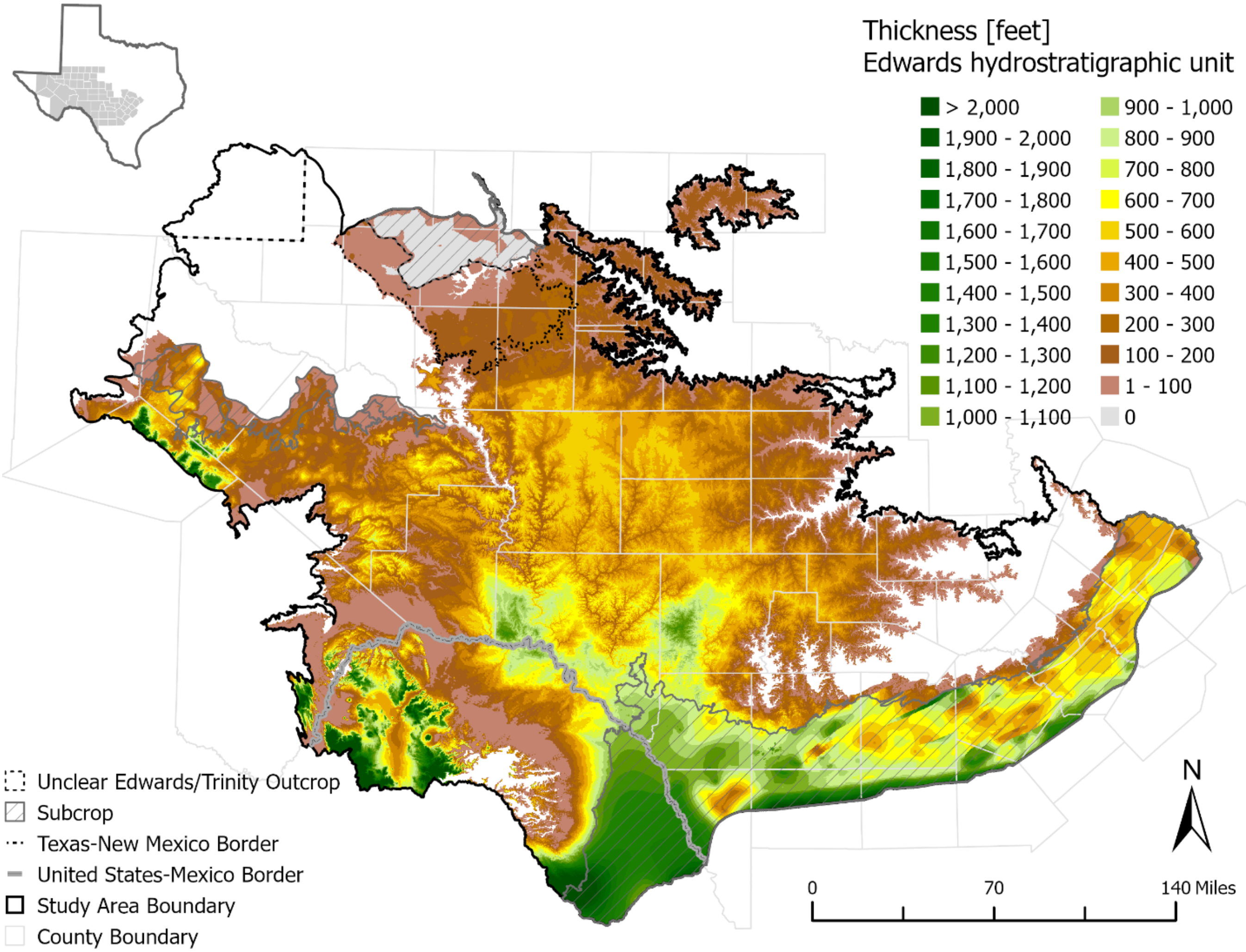


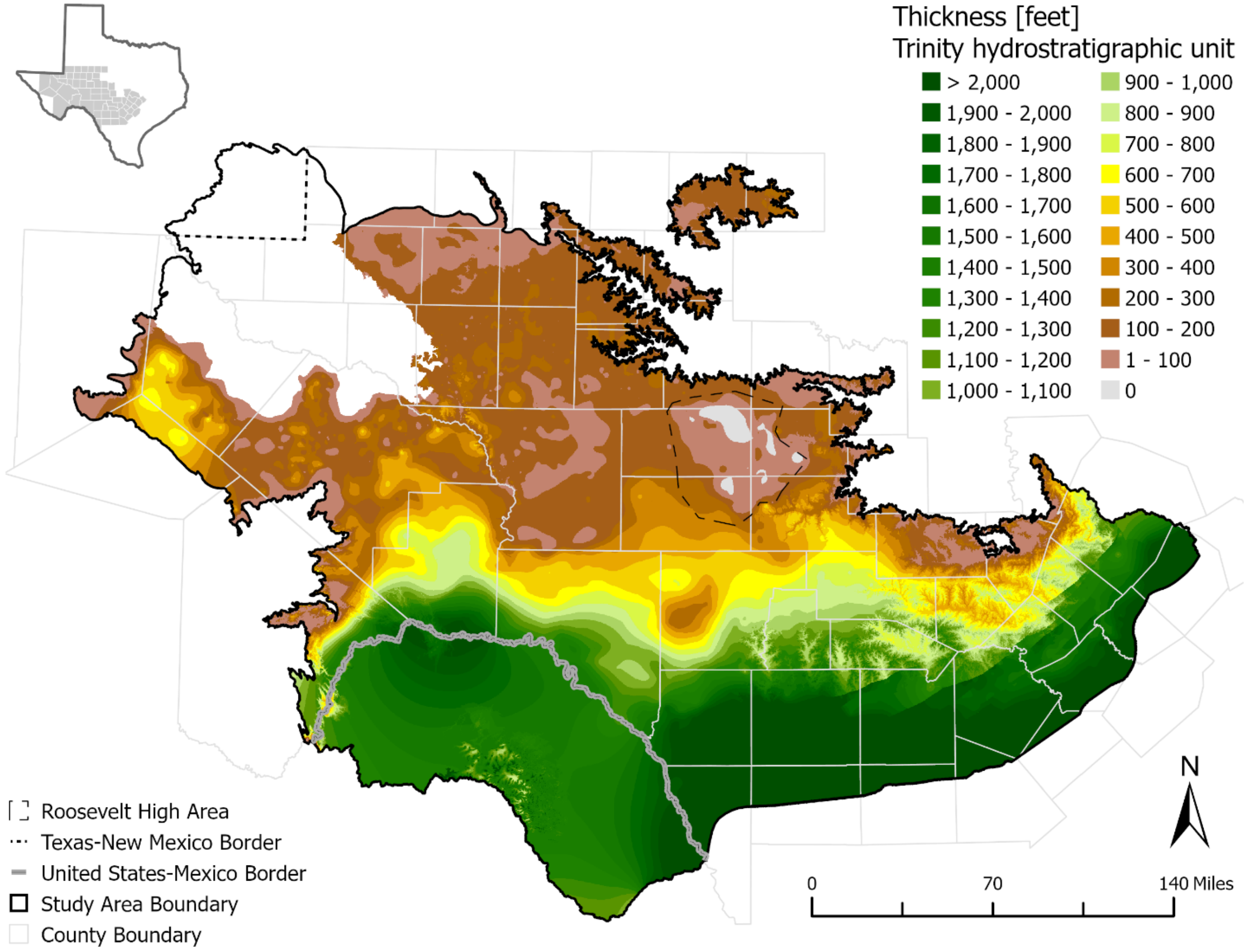
# Thickness of Younger Unit (Layer 1)



# Thickness of the Edwards Unit (Layer 2)



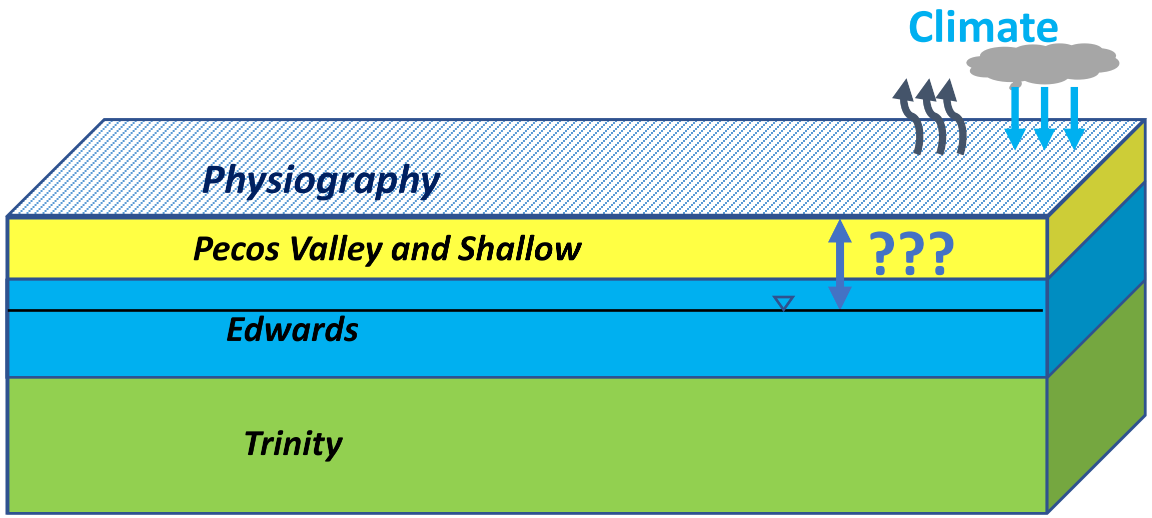
# Thickness of the Trinity Unit (Layer 3)

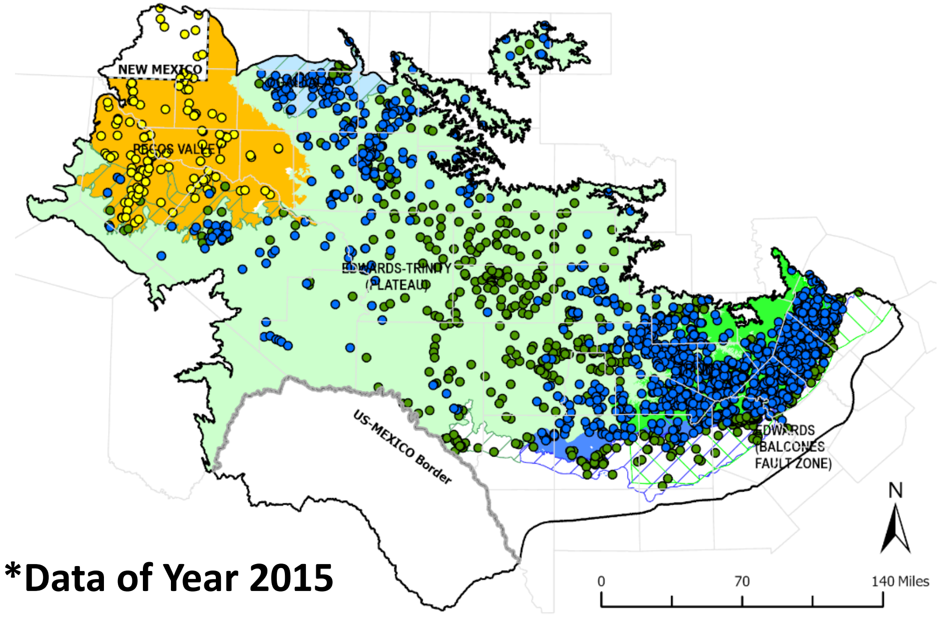


# Components of Conceptual Model

- Physiography and Climate
- Hydrostratigraphy
- Structural framework
- Water Levels/Regional GW Flow
- Recharge
- Discharge
- Rivers, streams, reservoirs, and springs
- Hydraulic properties
- Water quality

# Water Levels




*Data of Year 2015

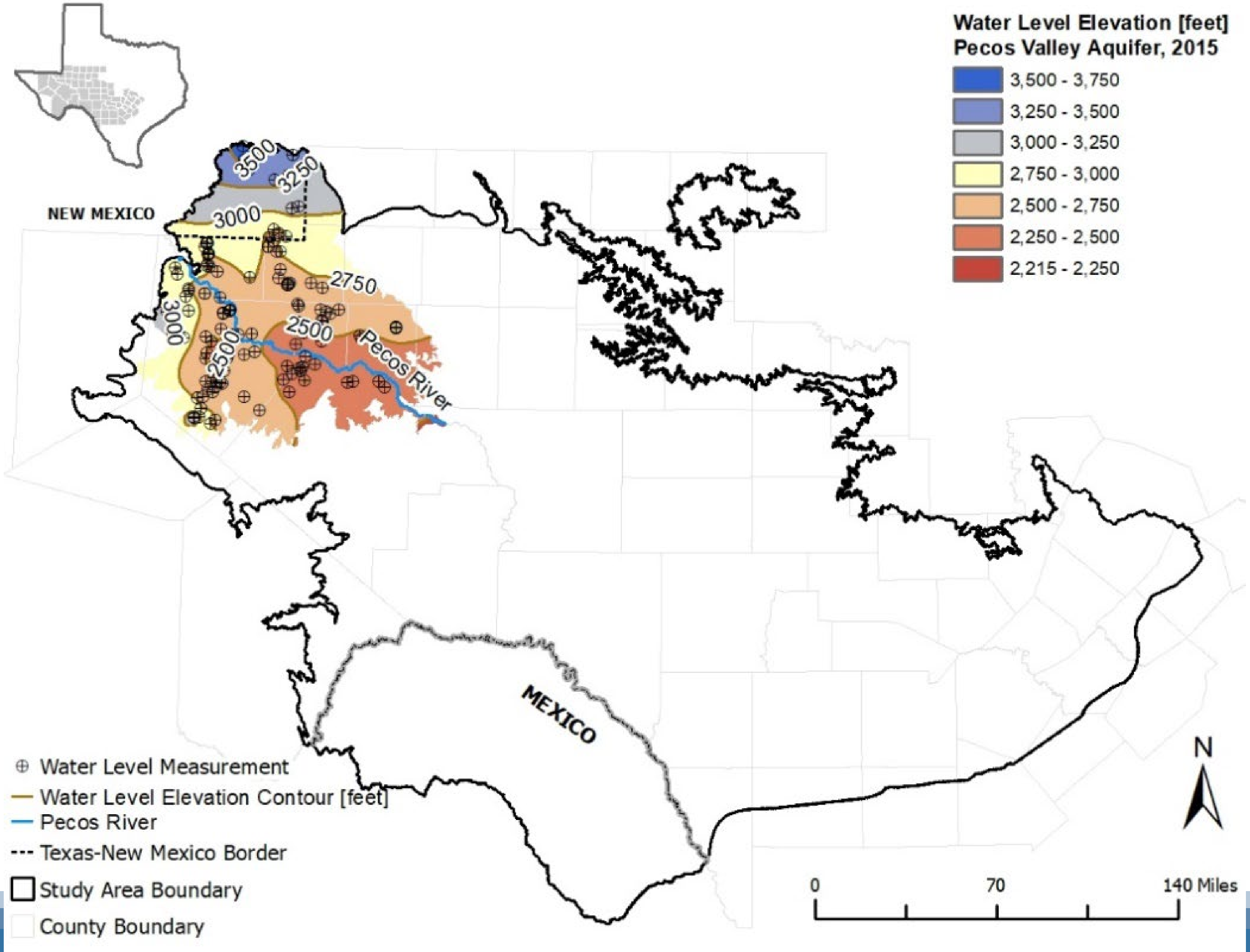
## Data Sources

- TWDB, TCEQ, USGS
- GCDs
- Previous Models

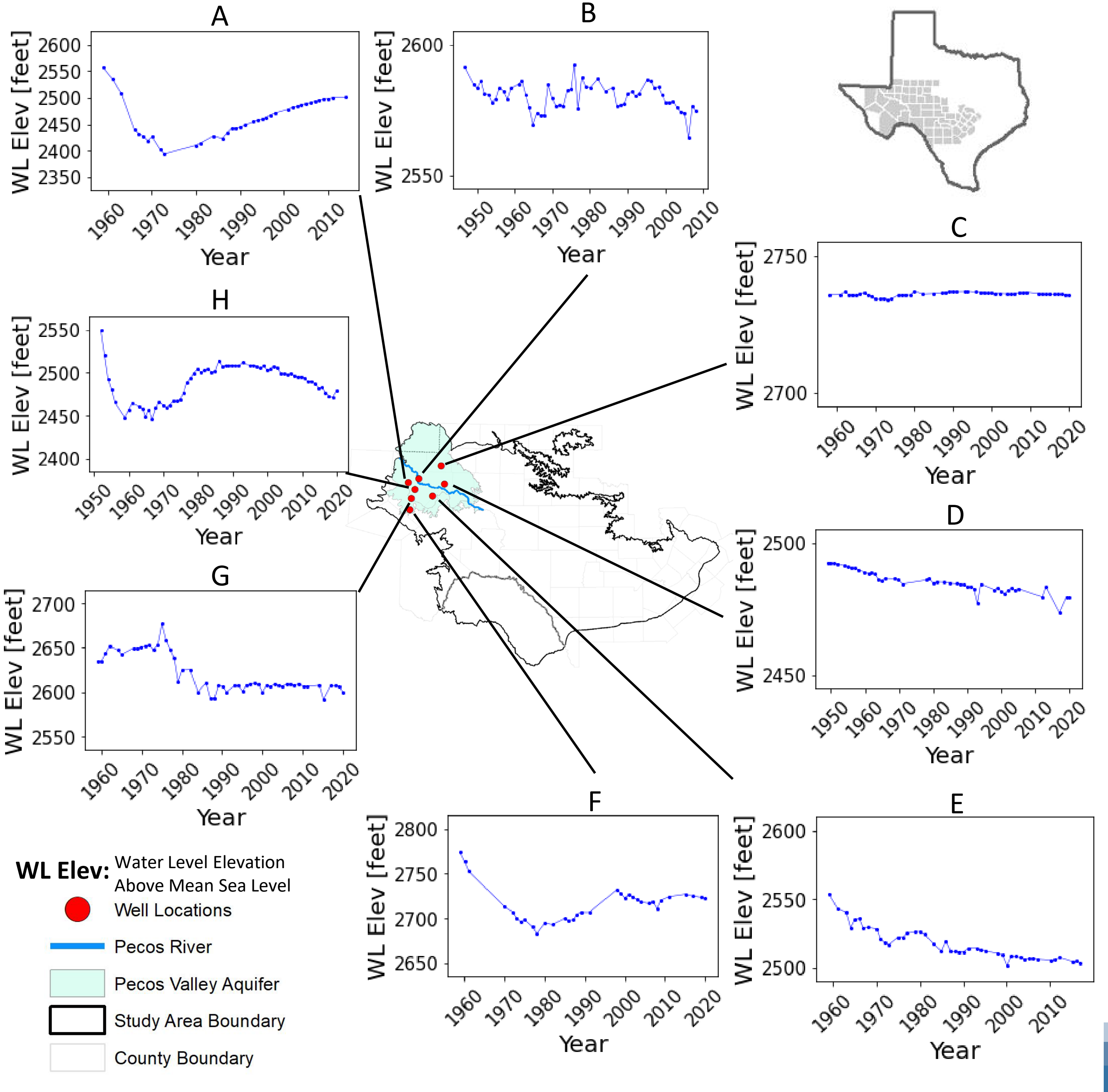
### Number of Data Points

| | Unit | | |
|---|---|---|---|
| Year | Pecos Valley | Edwards | Trinity |
| 1950 | 227 | 422 | 251 |
| 1980 | 258 | 334 | 426 |
| 2000 | 79 | 419 | 719 |
| 2015 | 132 | 582 | 1458 |

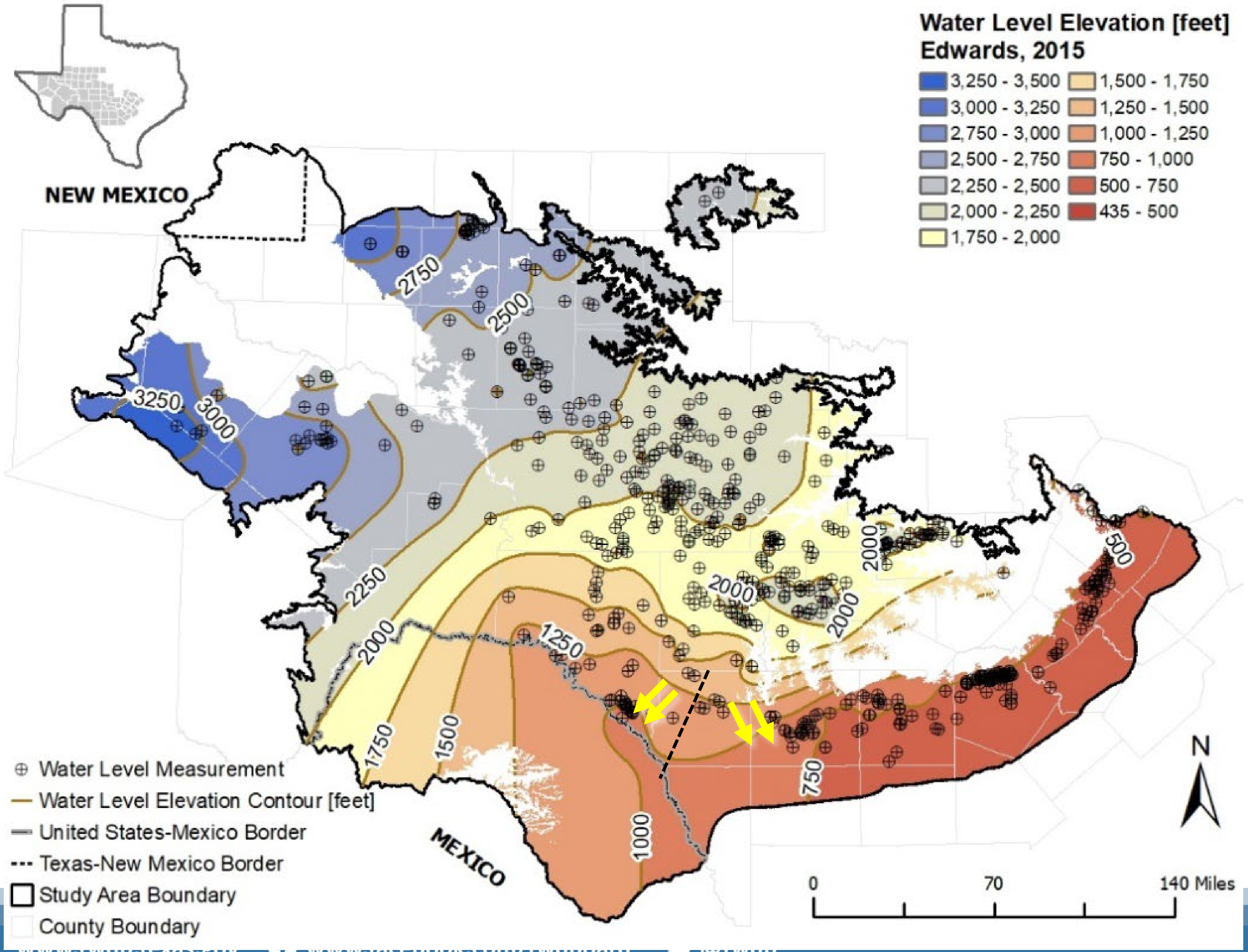
# Pecos Valley Aquifer



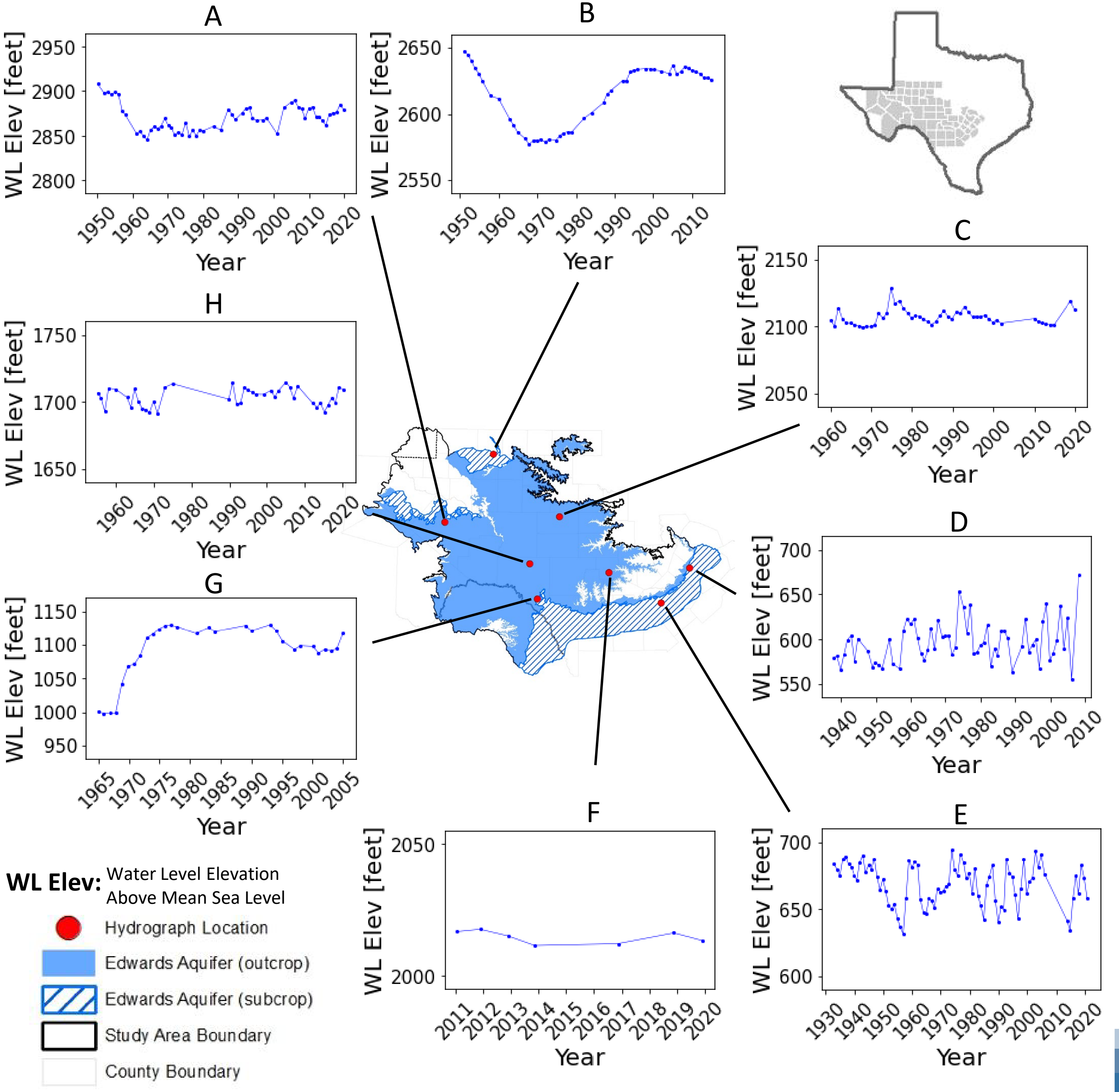
# Pecos Valley Aquifer



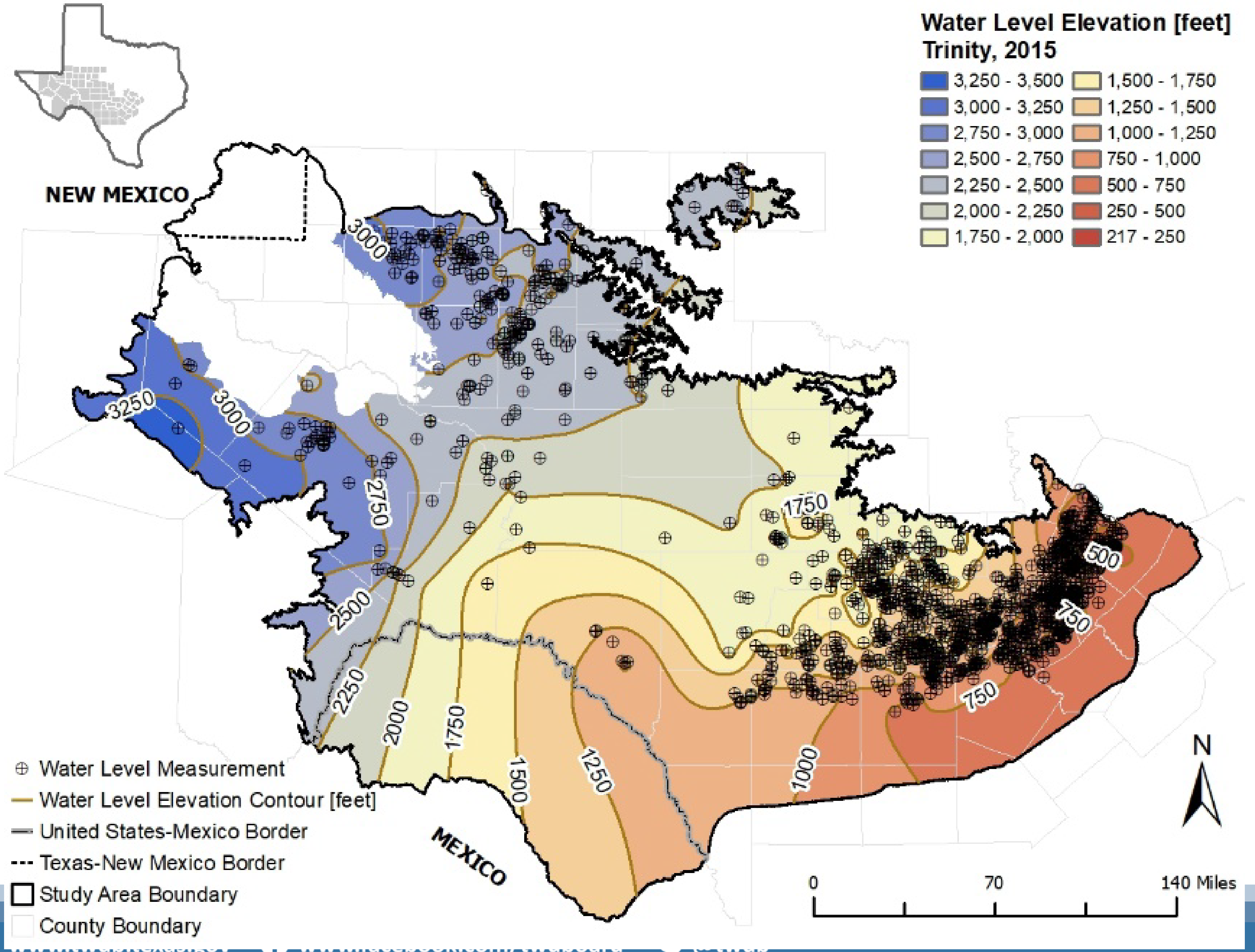
# Edwards Unit



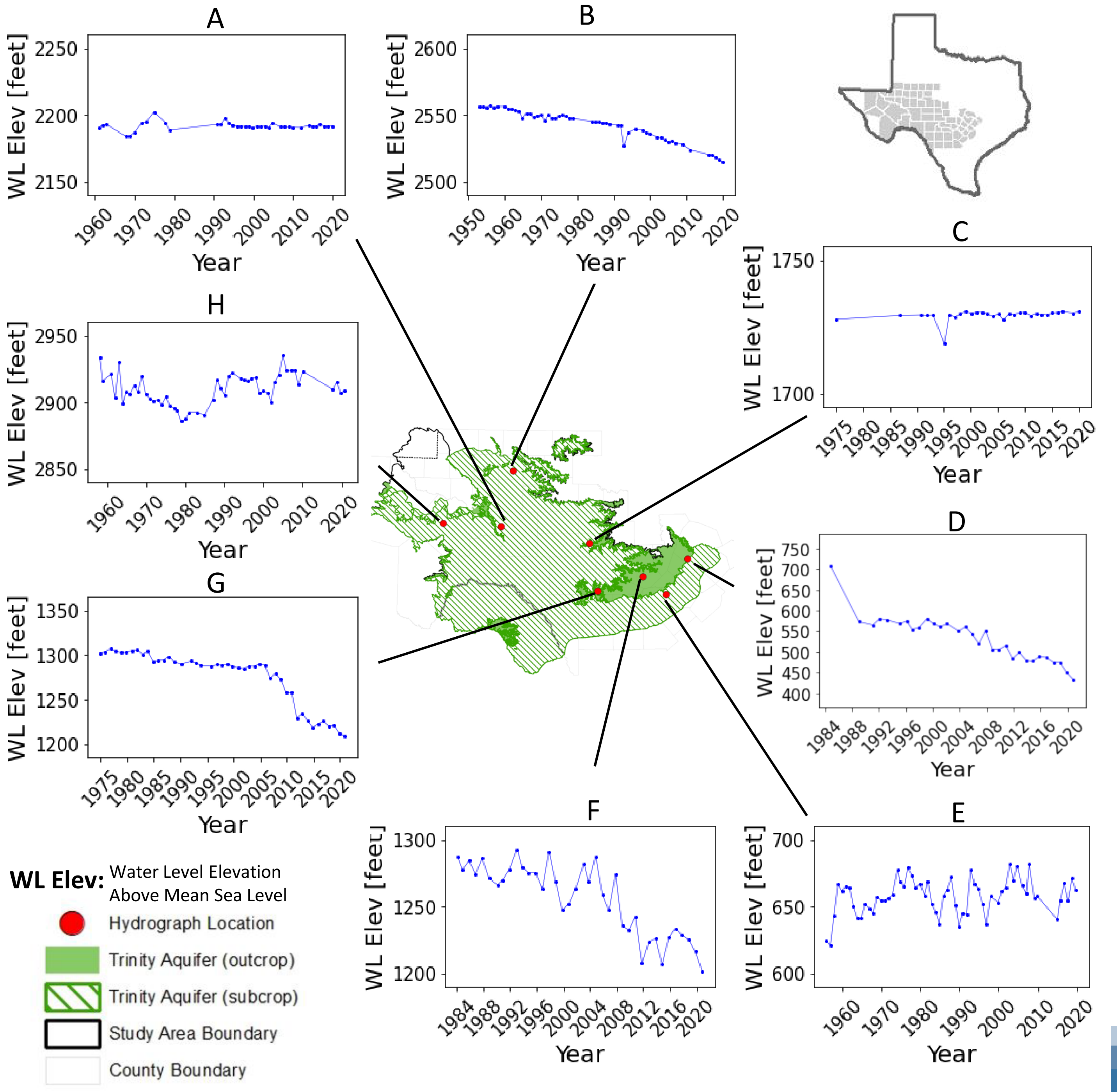
# Edwards Unit



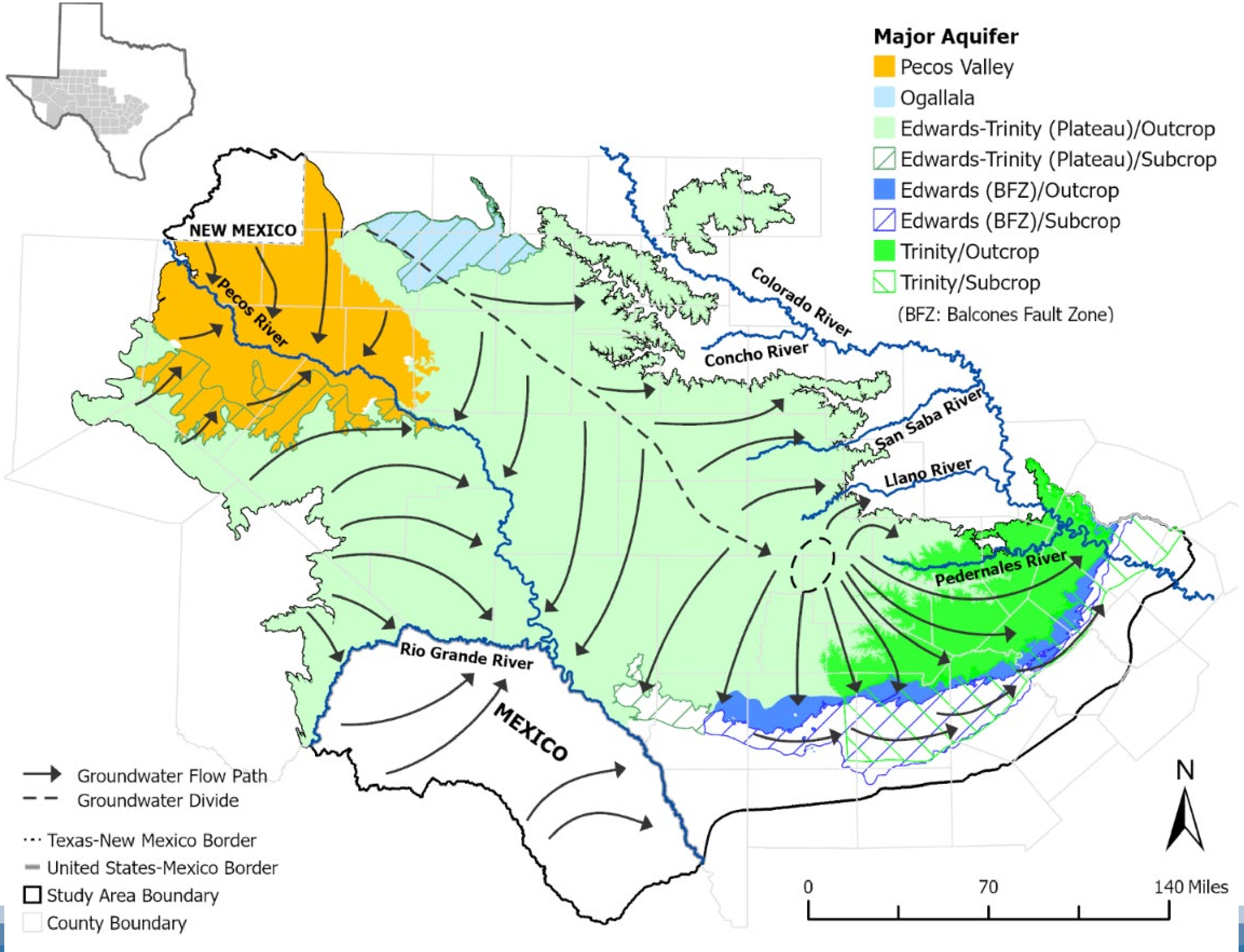
# Trinity Unit



# Trinity Unit



# Groundwater Flow Path



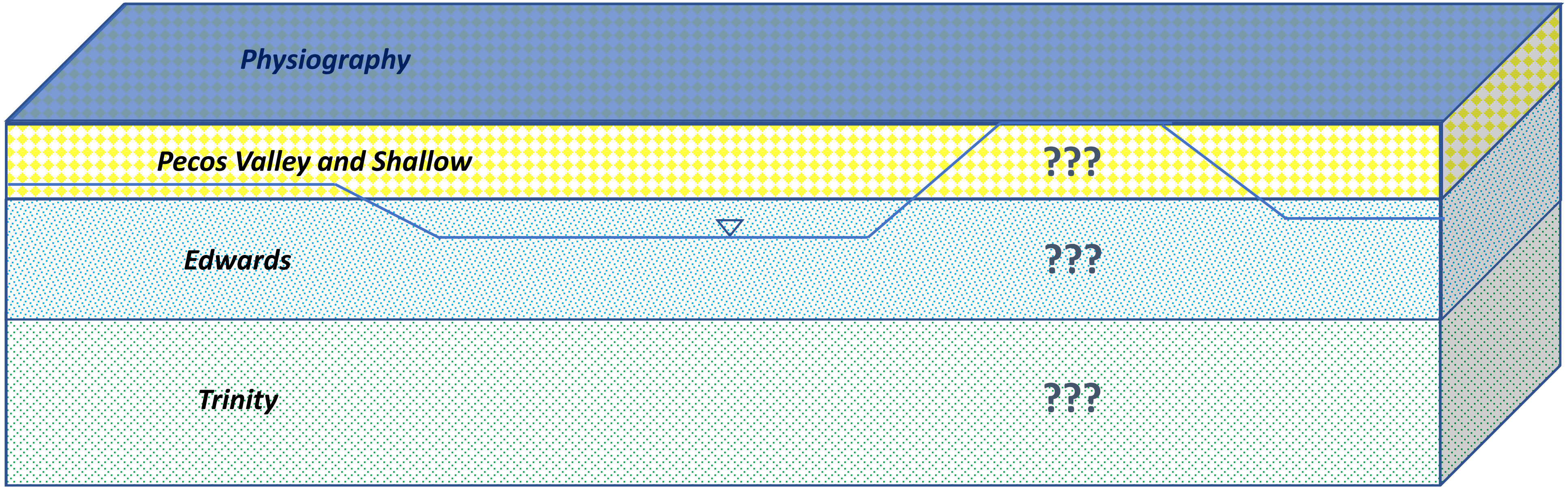
# Components of Conceptual Model

- Physiography and Climate
- Hydrostratigraphy
- Structural framework
- Water Levels/Regional GW Flow
- Recharge
- Discharge
- Rivers, streams, reservoirs, and springs
- Hydraulic properties
- Water quality

# Components of Conceptual Model

- Physiography and Climate
- Hydrostratigraphy
- Structural framework
- Water Levels/Regional GW Flow
- Recharge
- Discharge
- Rivers, streams, reservoirs, and springs
- Hydraulic properties
- Water quality

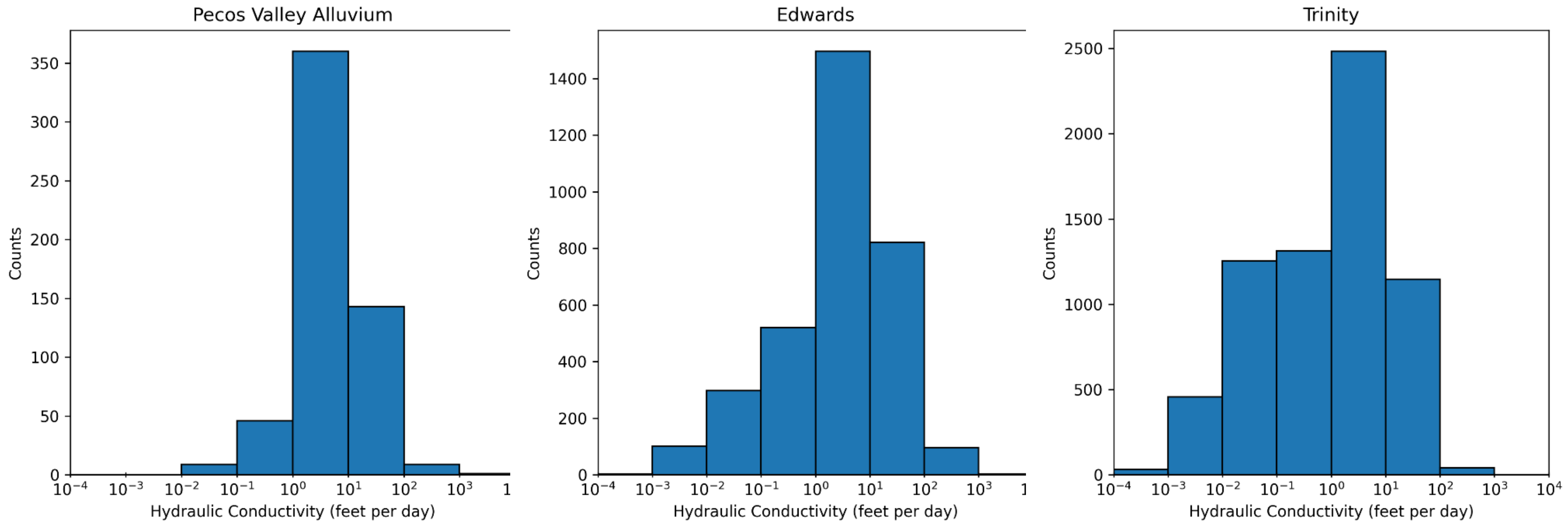
# Hydraulic Properties



# Hydraulic Conductivity (*K*)

**Hydraulic Conductivity, often symbolized with K, is a measure of how easily water flows through the aquifer**

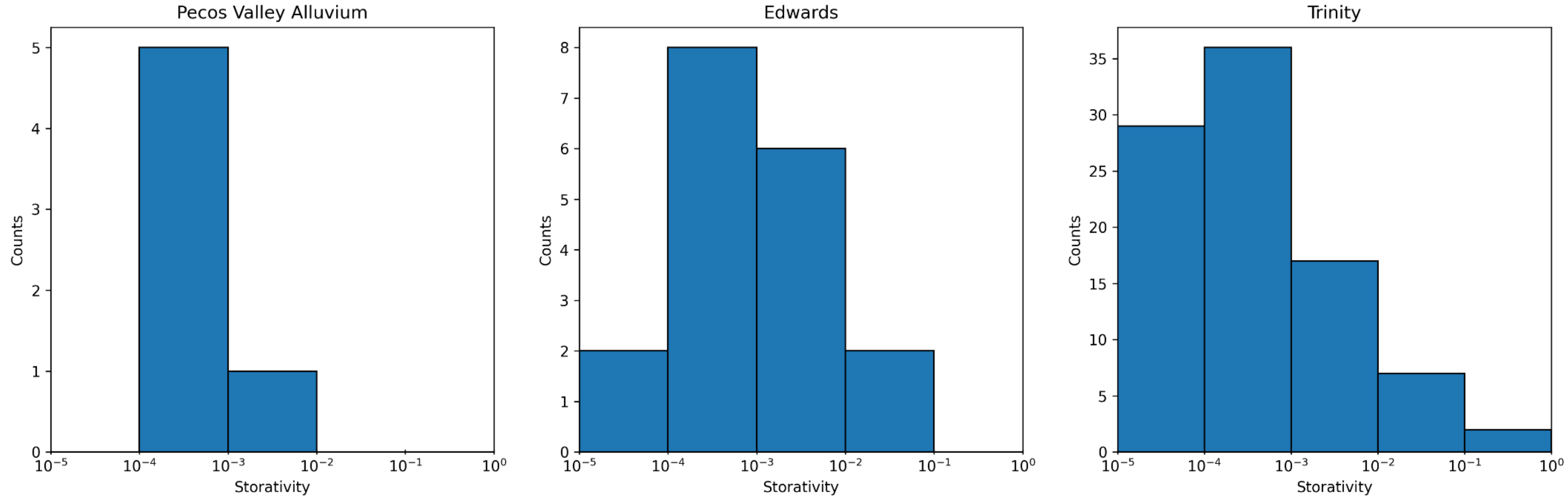
| Hydraulic Conductivity | Pecos | Edwards | Trinity |
|---|---|---|---|
| Median [feet per day] | 5.8 | 4.1 | 1.4 |



# Storativity (*S*)

**Storativity is measures of the volume of water an aquifer can hold (measured from aquifer tests)**

| Storativity | Pecos | Edwards | Trinity |
|---|---|---|---|
| Median (x $10^{-4}$) | 2.5 | 7.5 | 3.0 |



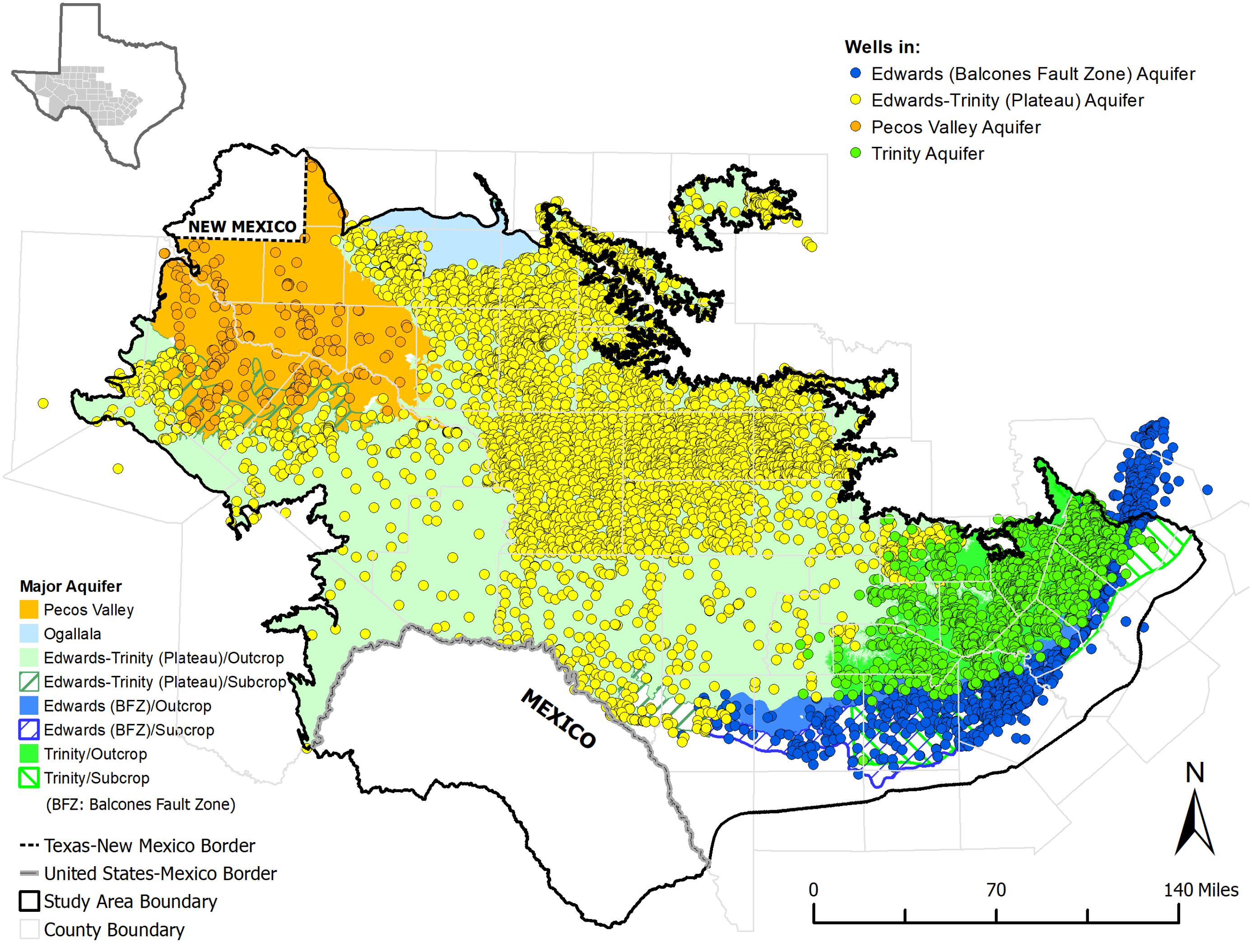
# Components of Conceptual Model

- Physiography and Climate
- Hydrostratigraphy
- Structural framework
- Water Levels/Regional GW Flow
- Recharge
- Rivers, streams, reservoirs, and springs
- Hydraulic properties
- Discharge
- Water quality

# Water Quality

- Recharge Condition
- Relative Ages
- General Flow Direction

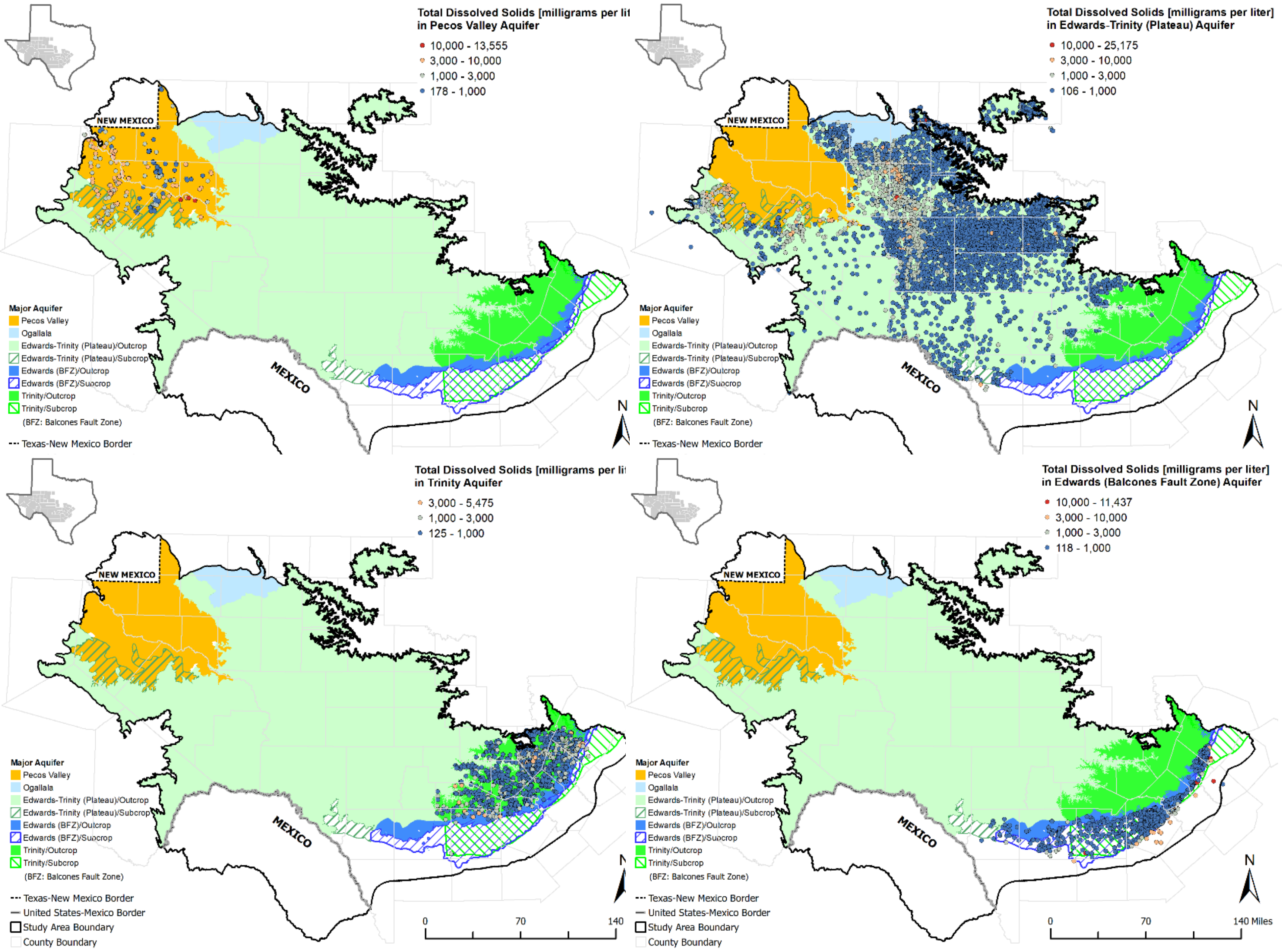
- Major Elements
- Isotopes



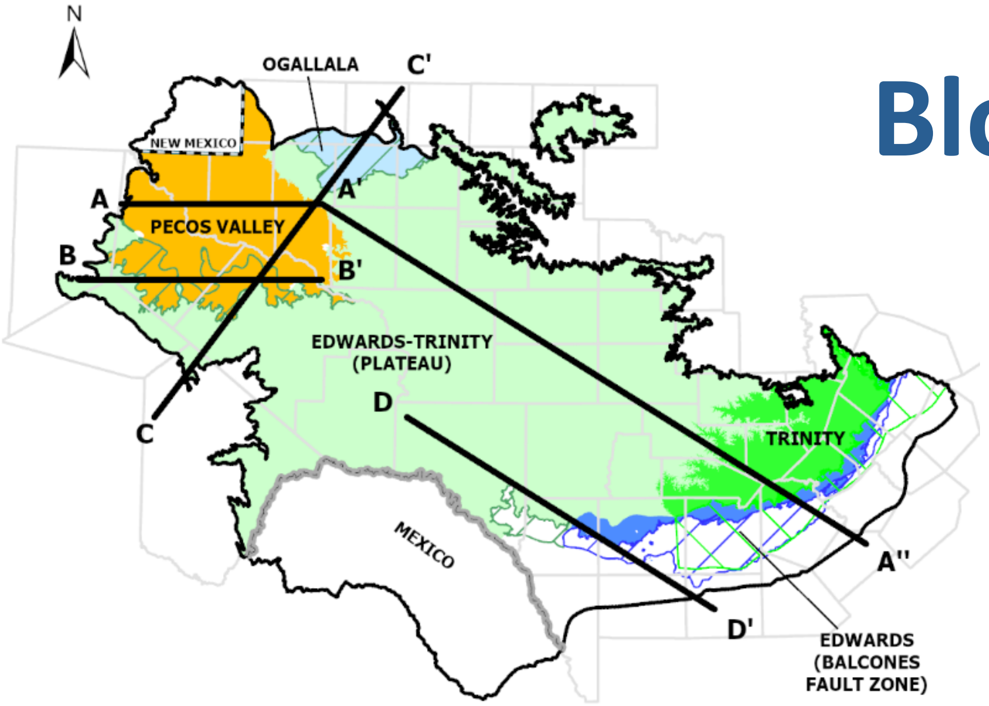
# Total Dissolved Solids (TDS)

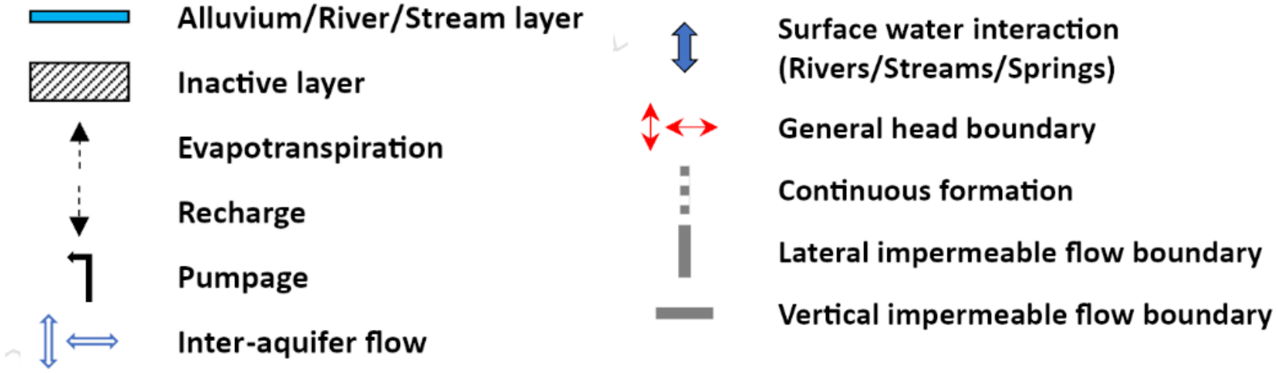
- TDS
  - Measure of salts in groundwater

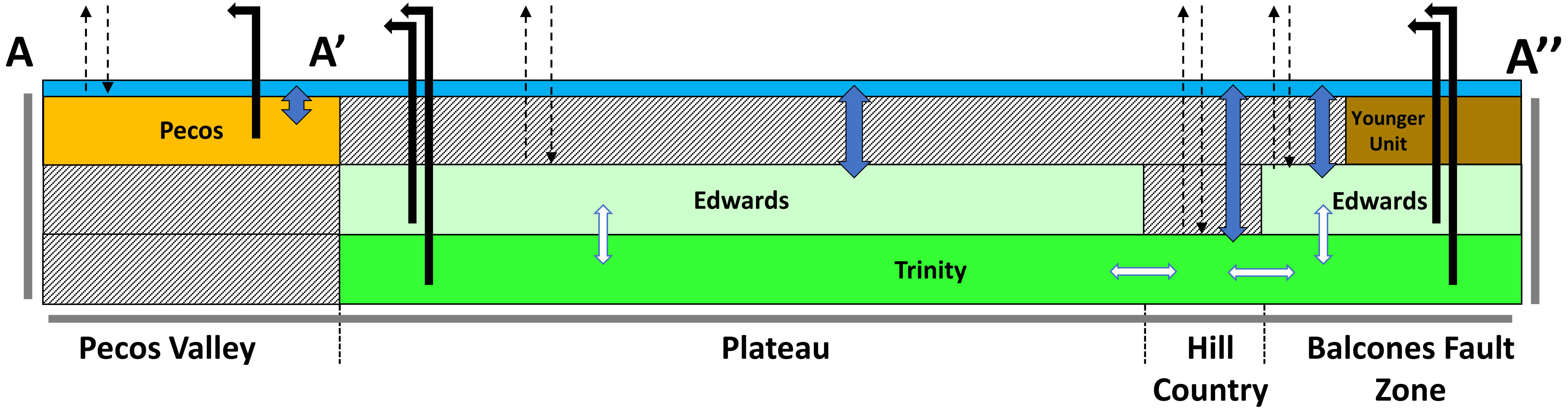
- Boundary of Freshwater
- Source of Recharge
- Cross-Formation Flow



# Block Diagram



# Q&A

Questions?

# Development of Estimates of Recharge and Surface Water- Groundwater Interactions for Aquifers in Central and West Texas

Texas Water Development Board

LRE WATER
CONNECTING WATER TO LIFE

wsp

IRP Water
Consultants in water resources

TWDB Contract # 2048302455

Stakeholder Advisory Forum Meeting, February 25, 2022

Rohit R. Goswami, Ph.D., PE (TX)

# Technical Approach

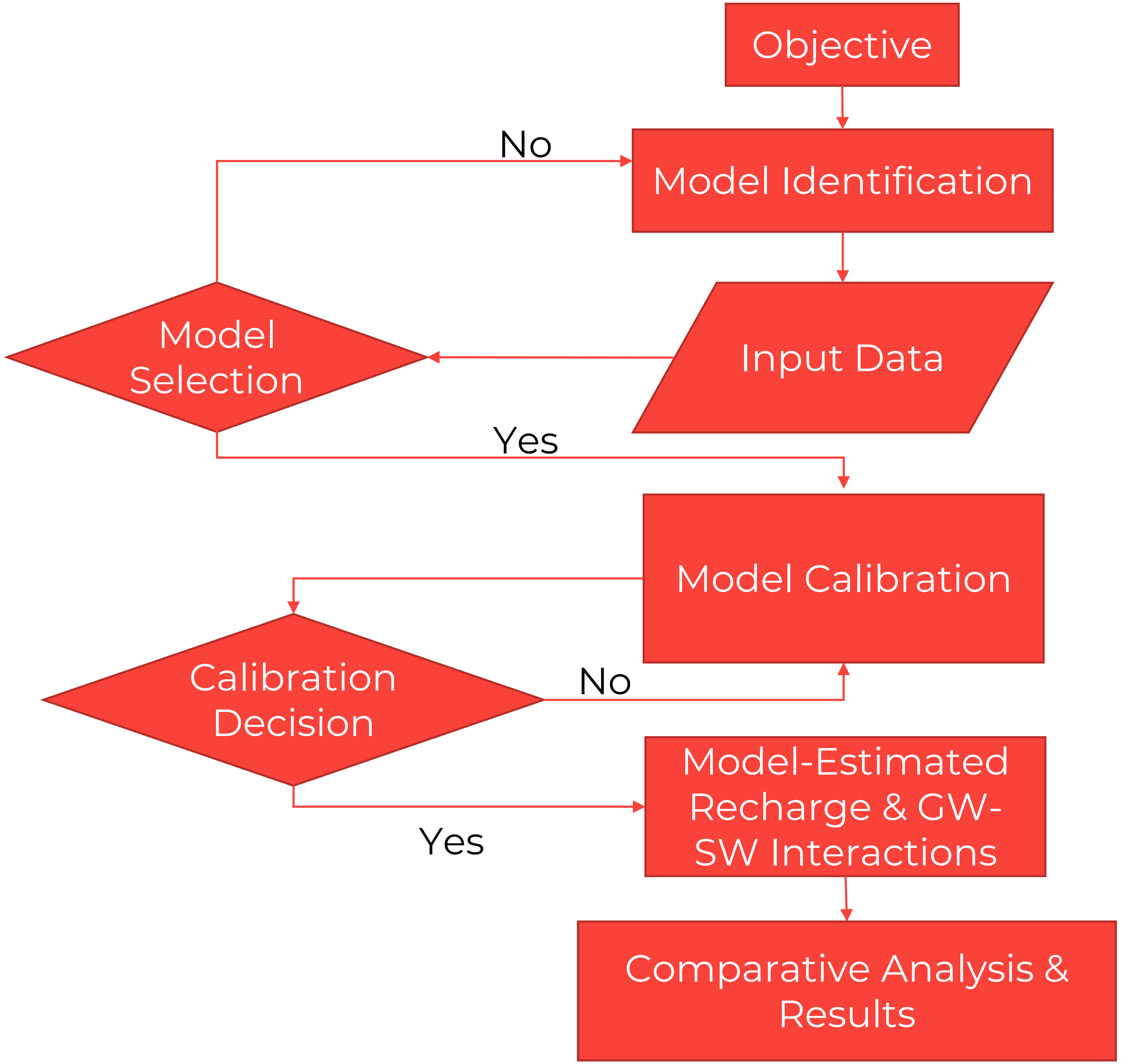
- Estimate:
  - *groundwater recharge*
  - *groundwater-surface water (GW-SW) interactions*

- Technical approach:
  - *water balance modeling*
  - *streamflow analyses*

- Identification of Models
  - *literature and information review*
  - *Three models – SWB, SWAT, GW Toolbox (RECESS, RORA)*
  - *Baseflow separation methods*

- Data

# Workflow


Objective
Model Identification
Input Data
Model Selection
No
Yes
Model Calibration
Calibration Decision
No
Yes
Model-Estimated Recharge & GW-SW Interactions
Comparative Analysis & Results

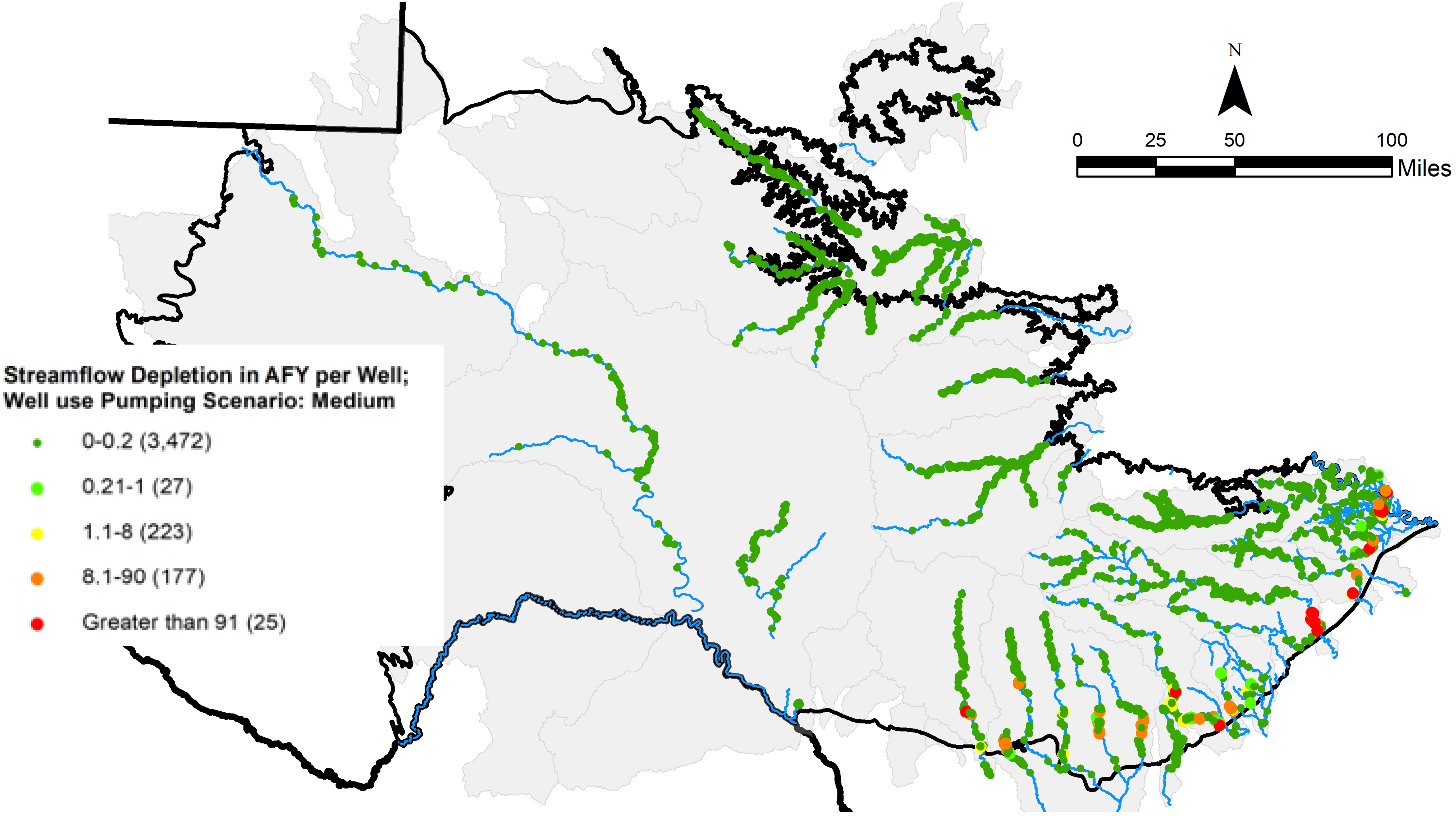
# Data

| Data | Format | Anticipated Source |
|---|---|---|
| Watershed delineation | ESRI | USGS/NHD |
| Daily Precipitation | ESRI ASCII Grid (float) | PRISM Climate Group |
| Daily Max Temperature | ESRI ASCII Grid (float) | PRISM Climate Group |
| Daily Min Temperature | ESRI ASCII Grid (float) | PRISM Climate Group |
| Soil hydrologic group | ESRI ASCII Grid (integer) | gNATSGO |
| Available water capacity | ESRI ASCII Grid (float) | gNATSGO |
| Land use/land cover | ESRI ASCII Grid (integer) | USGS |
| Runoff curve numbers | Lookup table | USDA |
| Rooting depth | Lookup table | LANL |
| Precipitation interception | Lookup table | Horton (1919) |
| Impervious surface | ESRI ASCII Grid (float) | Output from SWAT |

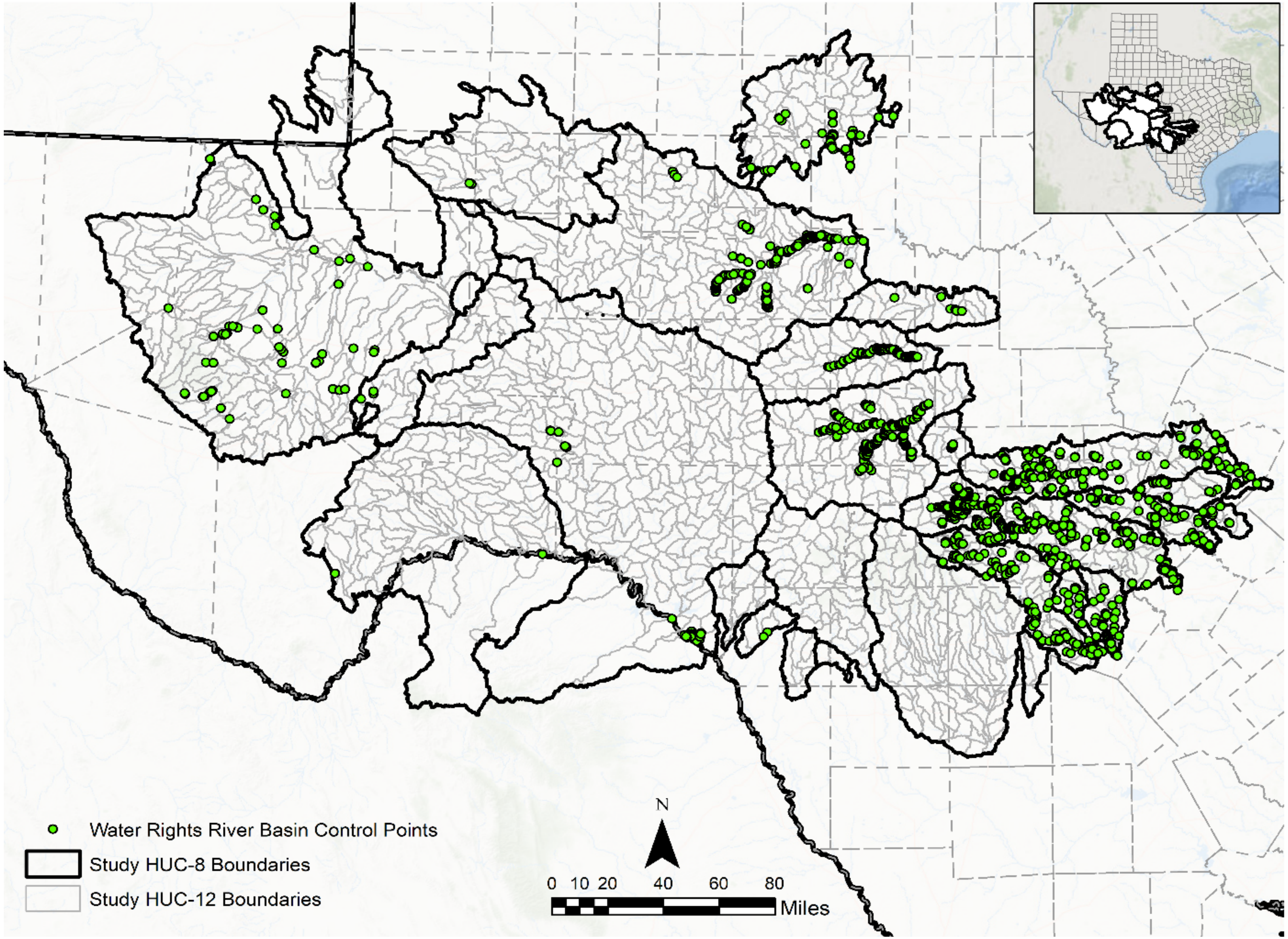
# Data

| Data | Anticipated Source | Example Variables of interest |
| --- | --- | --- |
| Soil moisture | MesoNet | soil_moisture |
| Max temp | MesoNet | Gage height |
| Min temp | MesoNet | Flow |
| Dew point | MesoNet | ET |
| 24 hour precipitation | MesoNet | Biomass |
| Solar radiation | MesoNet | |
| Wind speed | MesoNet | |
| Relative humidity | MesoNet | |
| Streamgauge data | USGS | |
| ET | Remote-Sensing | |

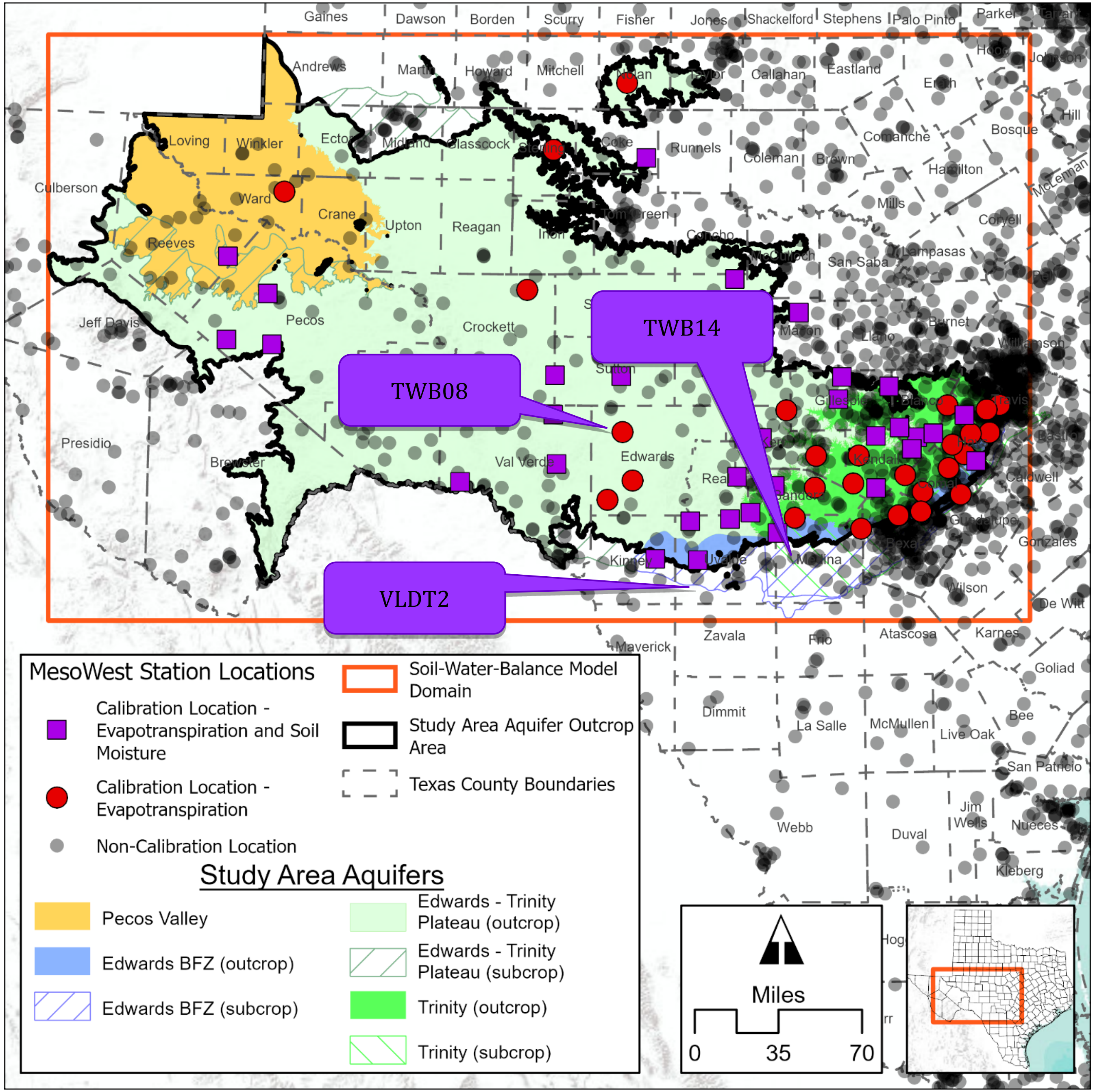
# Streamflow depletion



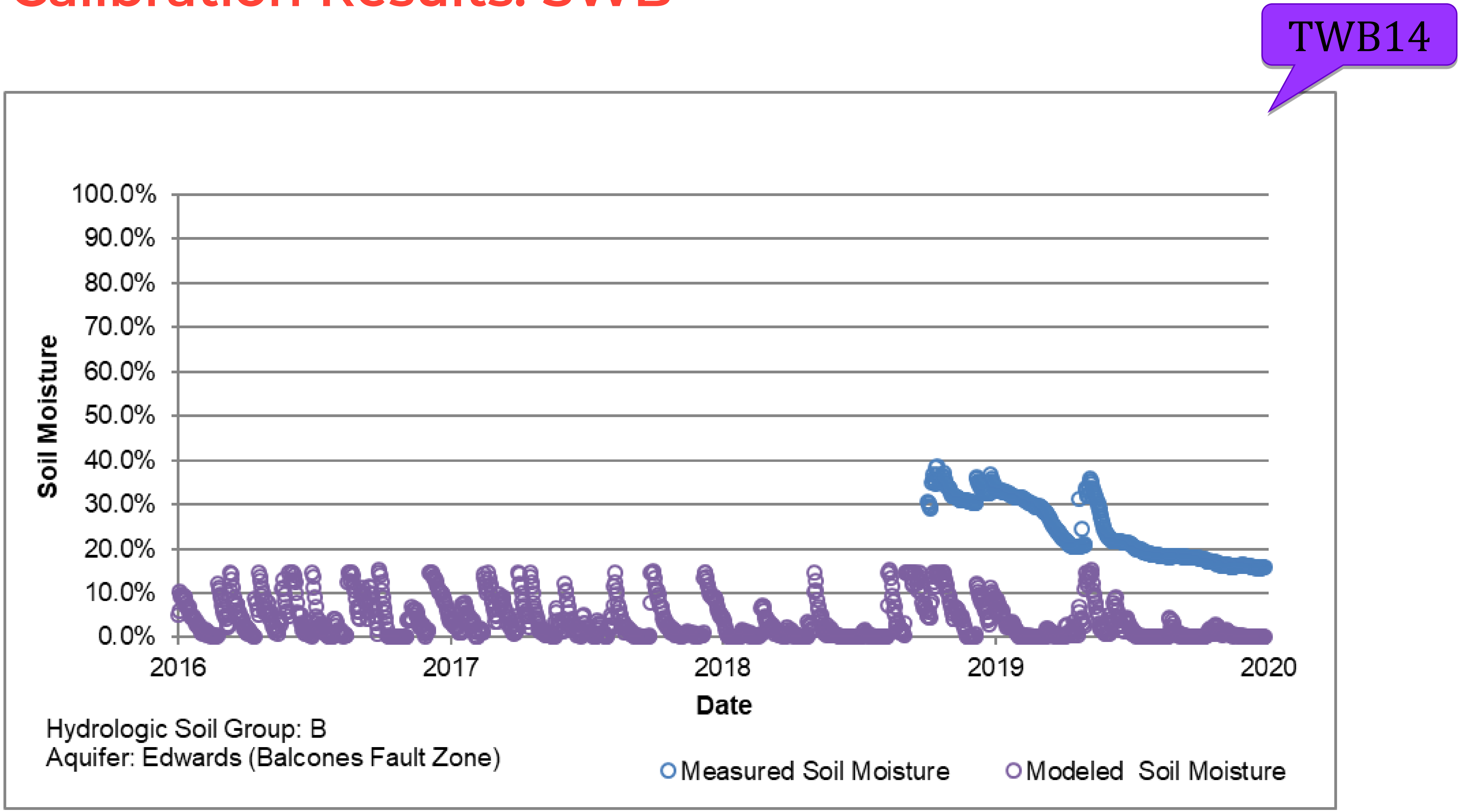
# Surface water Takings



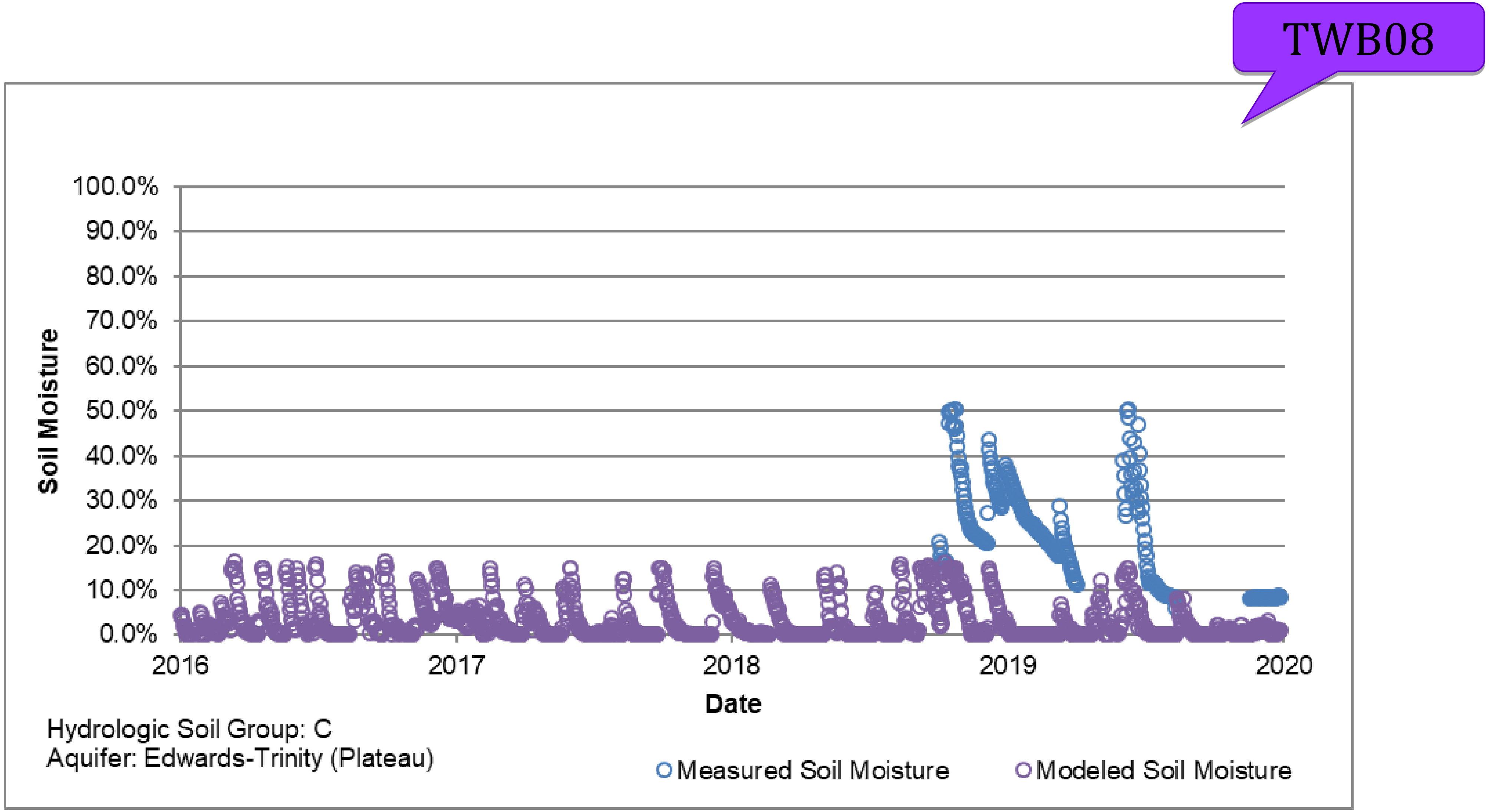
# Calibration Results: SWB



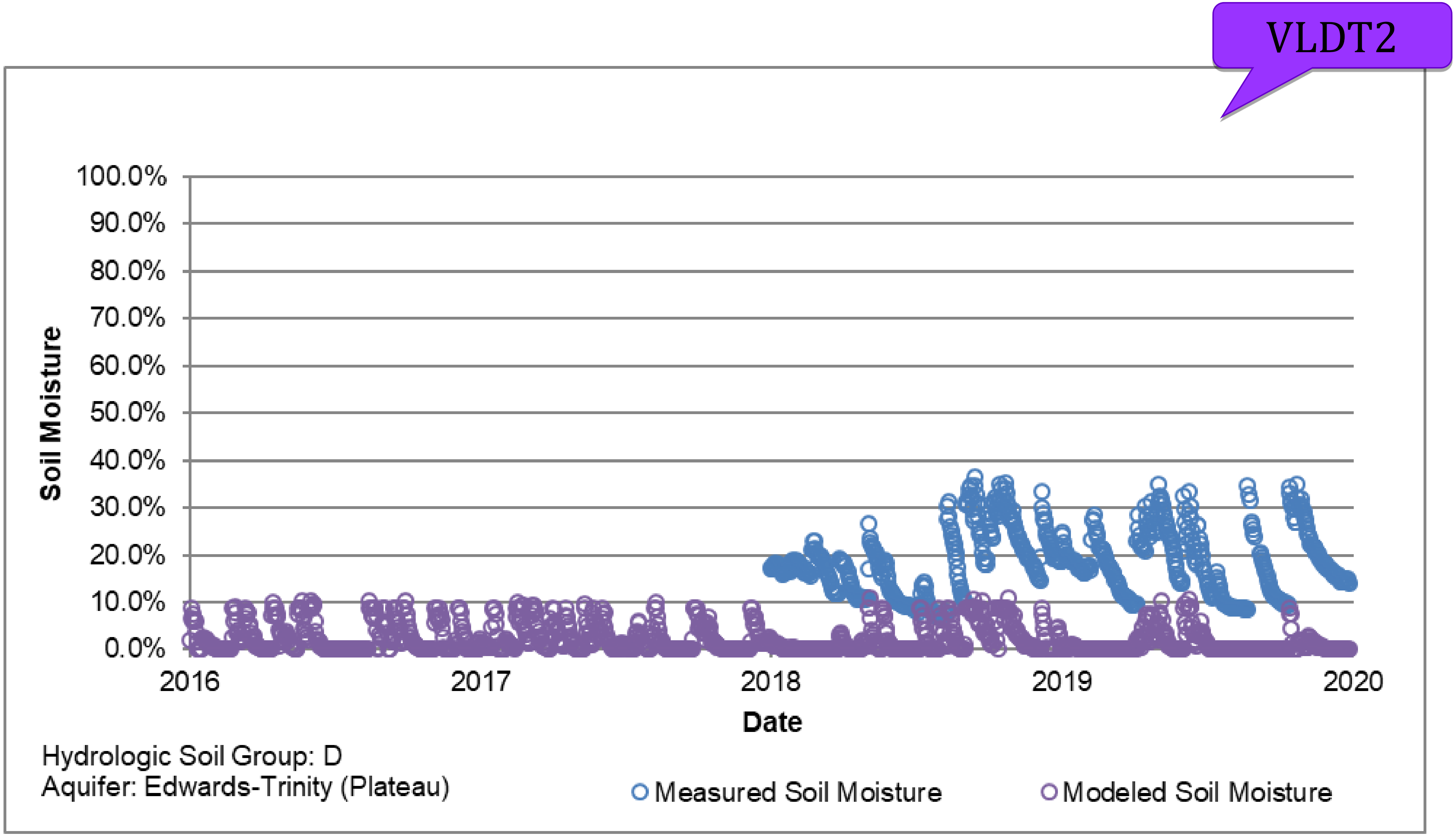
# Calibration Results: SWB



# Calibration Results: SWB



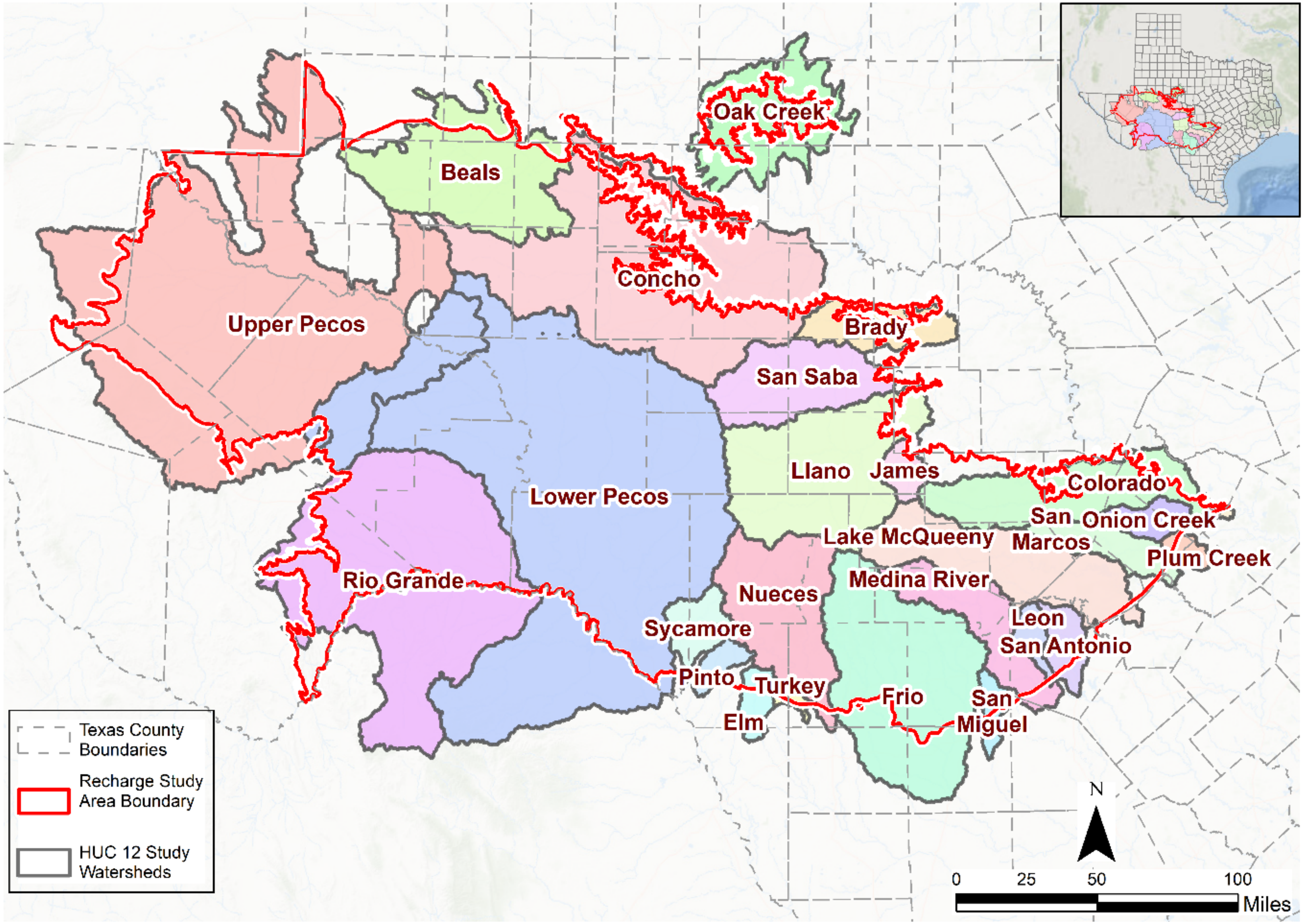
# Calibration Results: SWB



# Calibration Results: SWB

| Statistical Measure | Soil Moisture | Soil Moisture, Daily Change | Soil Moisture, Change from Initial | Soil Moisture, Extrema Change |
|---|---|---|---|---|
| Measurements | 12,432 | 12,335 | 12,404 | 1,857 |
| Measurement Minimum | 0.01 | 0.00 | 0.00 | 0.00 |
| Measurement Maximum | 0.67 | 0.37 | 0.48 | 0.47 |
| Measurement Average | 0.26 | 0.01 | 0.08 | 0.05 |
| Measurement Range | 0.66 | 0.37 | 0.48 | 0.00 |
| Mean Error | 0.21 | 0.00 | 0.04 | 0.00 |
| Mean Absolute Error | 0.22 | 0.01 | 0.07 | 0.03 |
| Root Mean Square Error | 0.24 | 0.02 | 0.09 | 0.06 |

# Calibration Results: SWAT



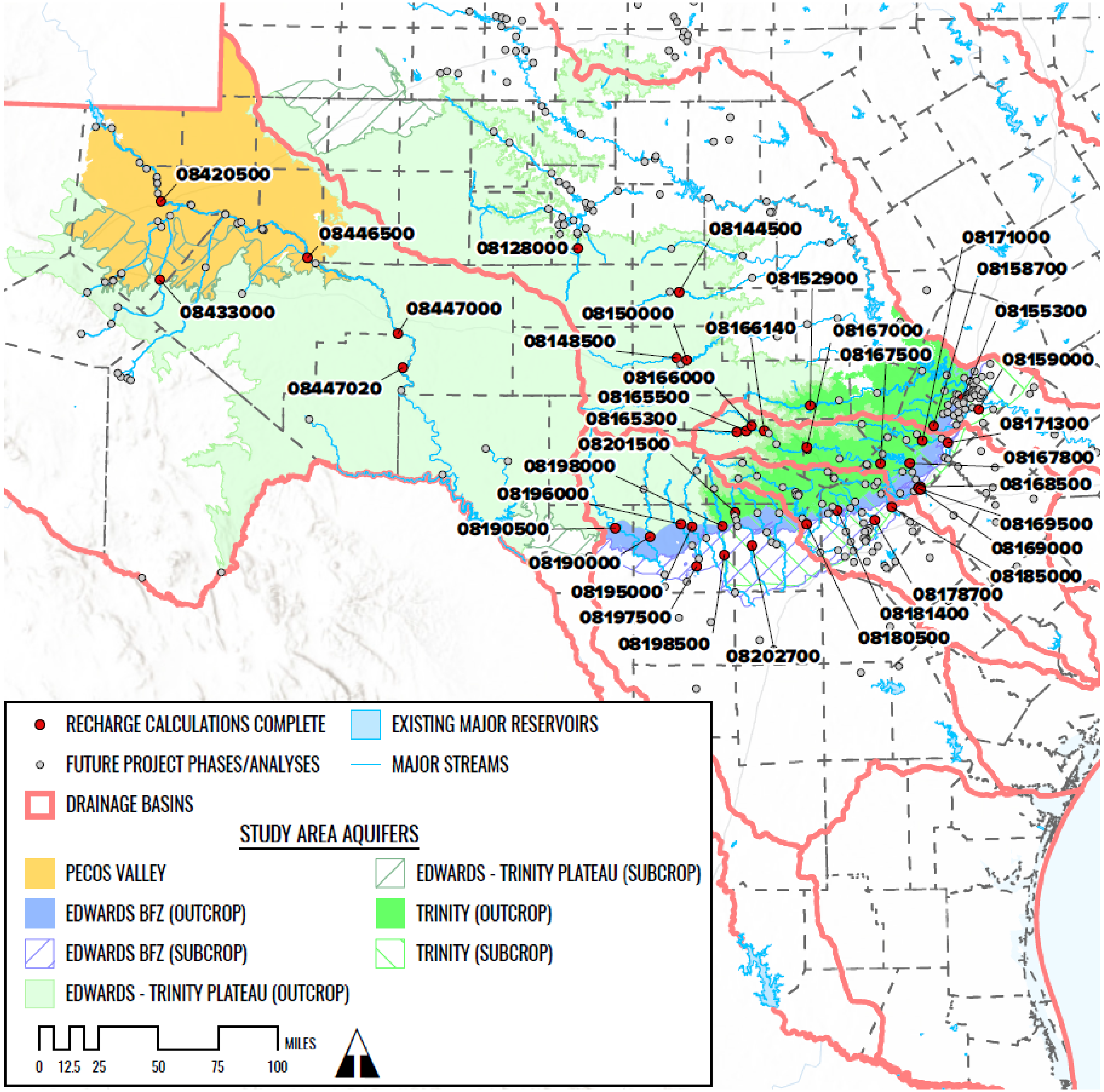
# Calibration Results: SWAT

| Watershed | Sub-basin ID | Gage ID | R2 | NSE | PBIAS | Mean_sim (Mean_obs) | StdDev_sim (StdDev_obs) |
|---|---|---|---|---|---|---|---|
| Beals | 6 | 08123800 | 0.35 | 0.19 | -6.3 | 0.82(0.77) | 2.26(2.30) |
| Brady | 3 | 08144800 | 0.16 | 0.06 | 9.8 | 0.01(0.01) | 0.01(0.01) |
| Conchos | 75 | 08128400 | 0.13 | 0.11 | 40.7 | 0.17(0.29) | 0.27(0.94) |
| Conchos | 08 | 08129300 | 0.54 | 0.51 | -18 | 0.28(0.24) | 0.52(0.89) |
| Conchos | 12 | 08130500 | 0.34 | 0.23 | -33.7 | 0.23(0.17) | 0.68(0.75) |
| Lake Mcqueeny | 10 | 08165500 | 0.52 | 0.09 | 0.6 | 1.94(1.95) | 3.72(2.69) |
| Lake Mcqueeny | 14 | 08166200 | 0.54 | 0.22 | 15.8 | 3.00(3.57) | 5.94(4.58) |
| Lake Mcqueeny | 25 | 08167000 | 0.79 | 0.74 | 21.1 | 5.79(7.34) | 13.70(12.81) |
| Lake Mcqueeny | 35 | 08167500 | 0.77 | 0.74 | 18.9 | 10.33(12.74) | 25.00(24.42) |
| Lake Mcqueeny | 40 | 08168500 | 0.32 | 0.00 | 23.9 | 12.37(16.25) | 28.24(25.50) |
| Leon | 5 | 08181480 | 0.83 | 0.77 | -25.7 | 1.55(1.24) | 2.59(3.79) |
| Llano | 3 | 08150000 | 0.72 | 0.68 | 36.5 | 3.36(5.30) | 8.62(10.00) |
| Llano | 26 | 08148500 | 0.72 | 0.71 | -1.3 | 1.12(1.11) | 2.13(2.80) |
| Llano | 48 | 08149900 | 0.98 | 0.95 | 33.7 | 1.83(2.76) | 5.77(6.48) |
| Lower Pecos | 88 | 08447000 | 0.67 | 0.36 | 15.4 | 0.75(0.89) | 1.80(1.31) |
| Medina | 10 | 08178880 | 0.73 | 0.71 | 2.3 | 4.03(4.13) | 8.58(12.31) |
| Medina | 24 | 08180700 | 0.48 | 0.06 | -18.3 | 6.11(5.16) | 19.24(14.45) |
| Medina | 29 | 08181500 | 0.62 | 0.51 | 17.3 | 7.29(8.81) | 21.06(19.20) |

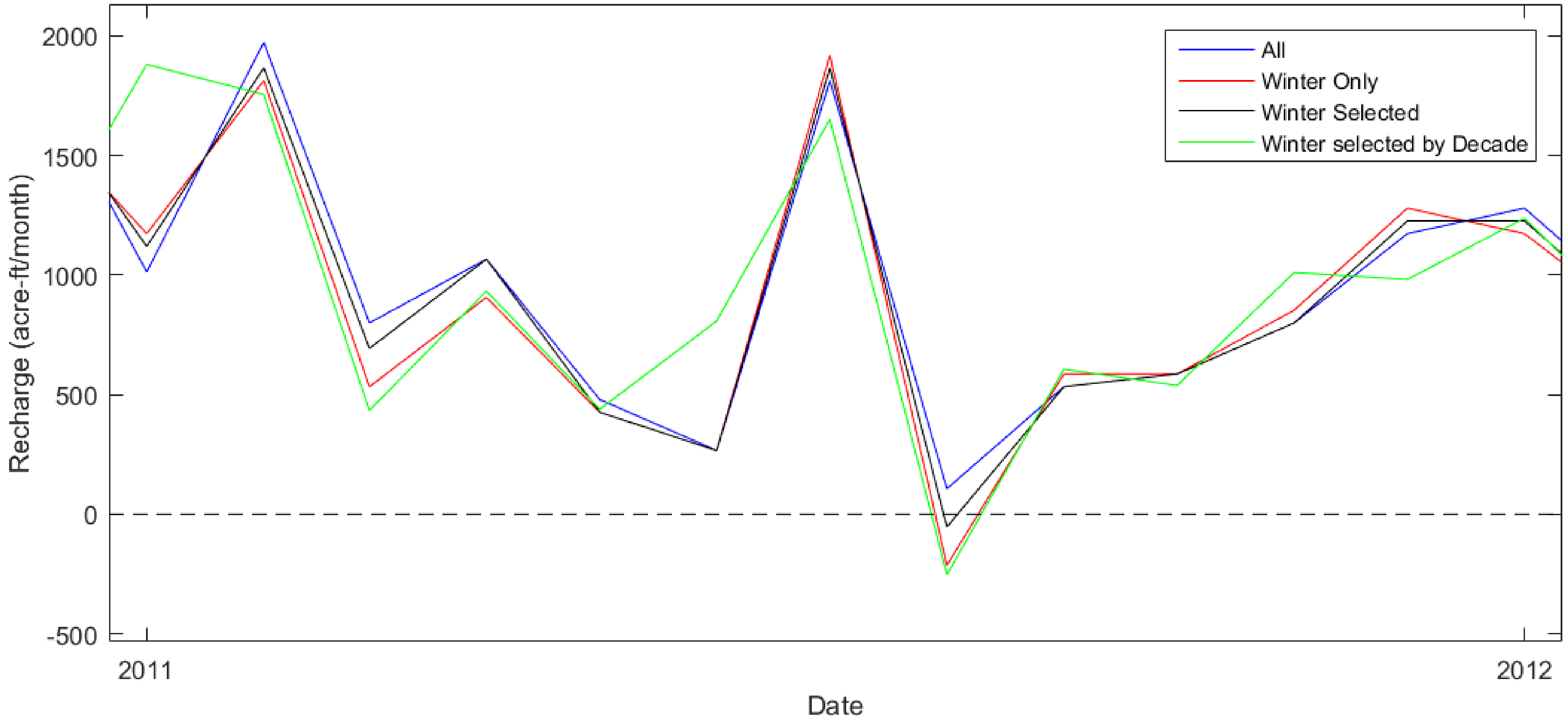
# Calibration Results: SWAT

| Watershed | Sub-basin ID | Gage ID | R2 | NSE | PBIAS | Mean_sim (Mean_obs) | StdDev_sim (StdDev_obs) |
|---|---|---|---|---|---|---|---|
| Onion Creek | 4 | 08158700 | 0.54 | 0.44 | 2.1 | 1.49(1.53) | 2.94(2.81) |
| Onion Creek | 5 | 08158827 | 0.63 | 0.12 | -116.4 | 2.43(1.12) | 4.30(3.13) |
| Pecos Head | 70 | 08424500 | 0.13 | -0.33 | 27.5 | 0.41(0.56) | 0.85(0.83) |
| Pecos Head | 25 | 08431700 | 0.04 | -0.82 | -2.3 | 0.92(0.90) | 1.66(1.46) |
| Plum Creek | 3 | 08172400 | 0.77 | 0.77 | -11.4 | 1.77(1.58) | 3.54(3.93) |
| Rio Grande | 20 | 08376300 | 0.15 | 0.14 | -14.8 | 0.02(0.02) | 0.06(0.15) |
| San Antonio | 5 | 08178800 | 0.70 | 0.35 | -46.5 | 2.13(1.46) | 3.47(2.55) |
| San Antonio | 9 | 08178565 | 0.63 | 0.50 | 39.5 | 2.34(3.86) | 3.47(4.21) |
| San Marcos | 9 | 08171000 | 0.69 | 0.66 | -0.4 | 4.85(4.83) | 9.35(9.34) |
| San Marcos | 13 | 08171400 | 0.56 | -0.42 | -5.3 | 9.44(8.97) | 13.38(7.69) |
| San Saba | 30 | 08144500 | 0.43 | 0.42 | 22.6 | 0.99(1.28) | 2.02(3.34) |
| Nueces | 19 | 08190000 | 0.68 | 0.60 | 53 | 2.49(5.29) | 7.85(9.59) |
| Nueces | 38 | 08190500 | 0.48 | 0.26 | -62.1 | 1.35(0.83) | 4.01(3.49) |
| Nueces | 46 | 08192000 | 0.60 | 0.55 | 0.5 | 4.56(4.58) | 13.14(13.21) |

# USGS Toolbox



# USGS Toolbox



# Alternate Recharge Estimation: modified SCS CN method

- Uses SCS curve number
- Simple
- MODIS data for ET
  - future application
- Rapid assessment
- SMAP data
  - future application

$$R = max(0, P - q - I_a - S - ET)$$

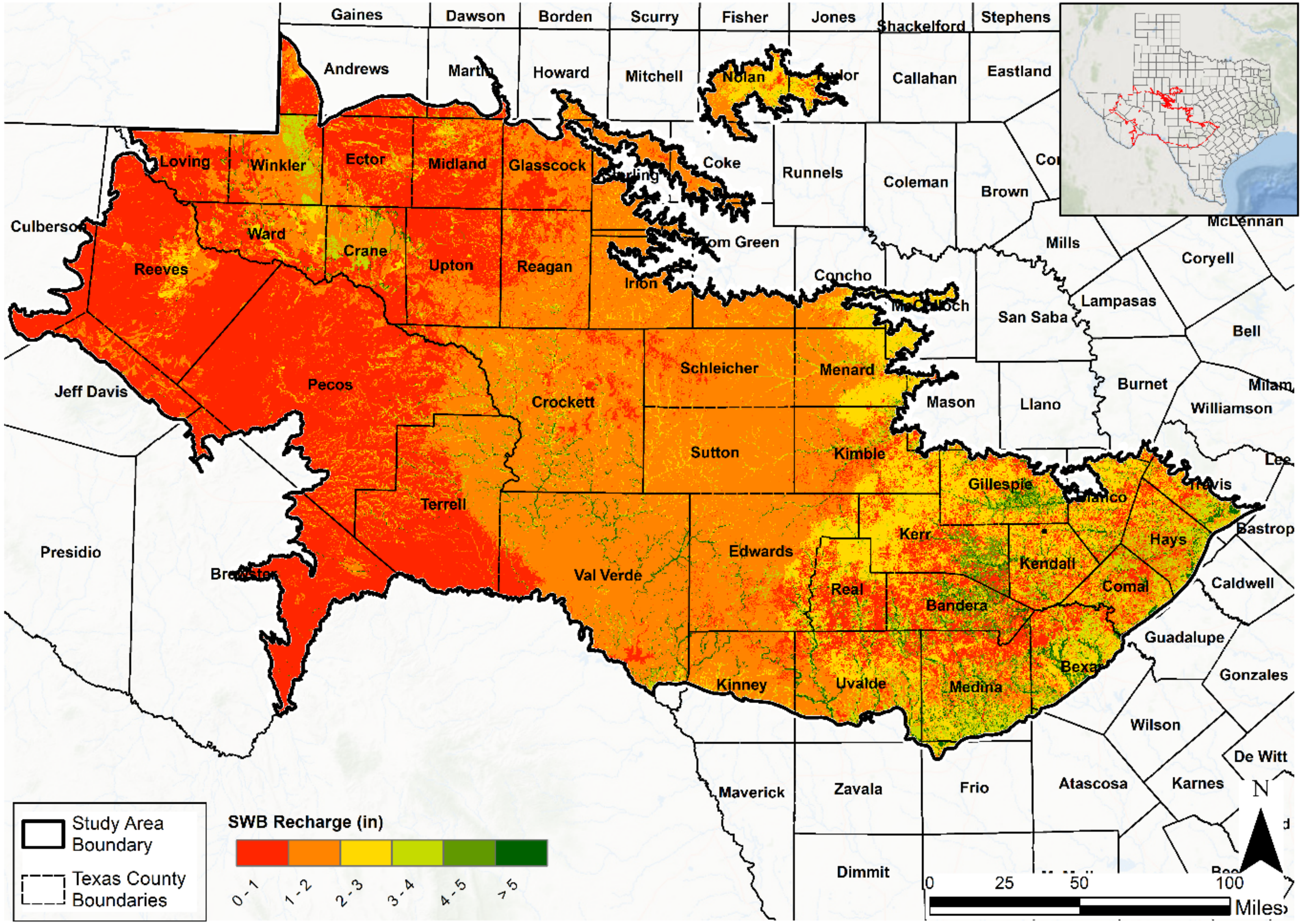
$$q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad I_a = 0.2S \qquad S = \frac{1000}{CN} - 10$$

Adjustments to curve numbers based on antecedent moisture conditions

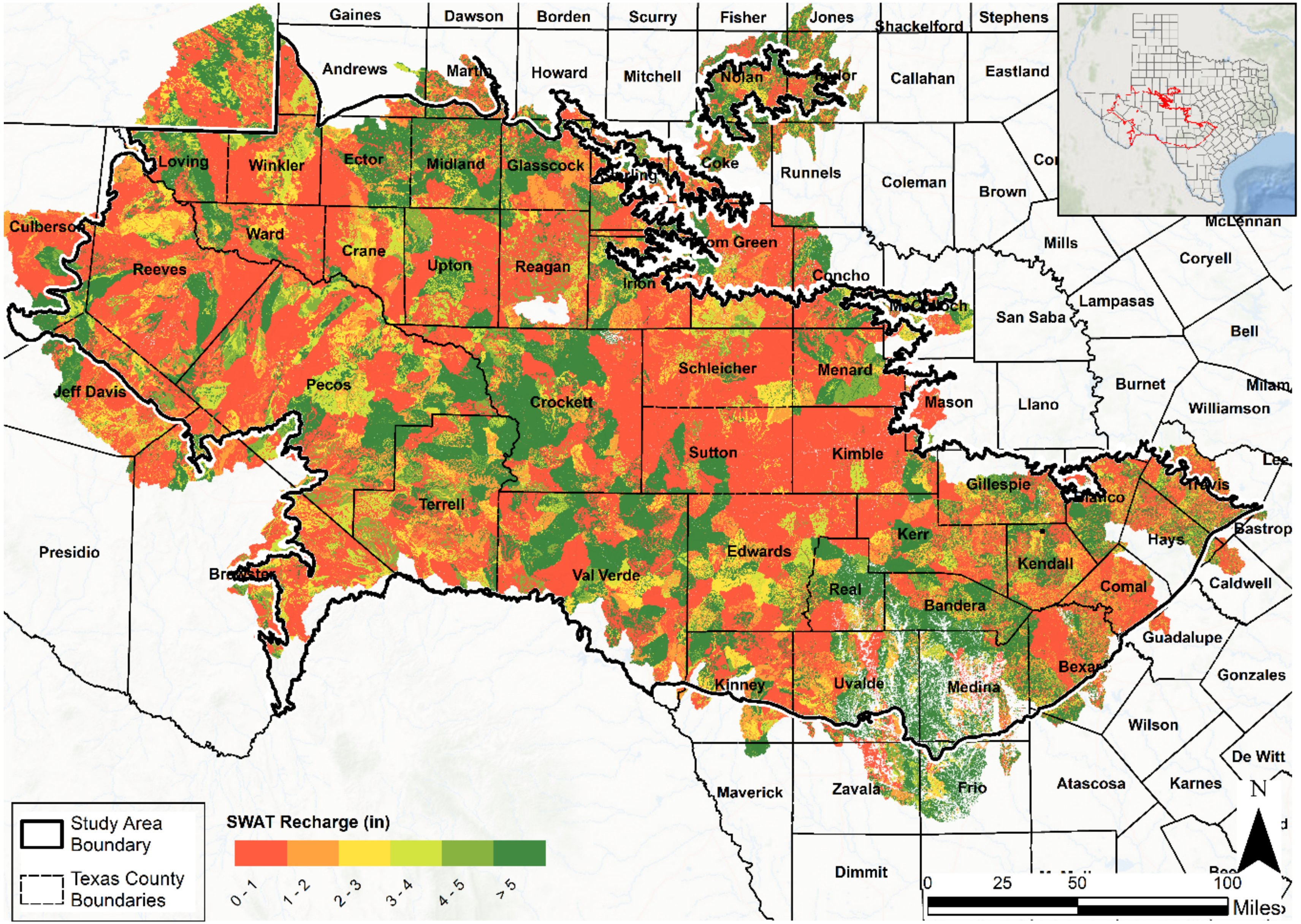
| | | 5-Day Antecedent Rainfall Criteria | |
|---|---|---|---|
| **Condition** | Formula | Growing Season<br>March 15-October 15 | Dormant Season<br>October 16-March 14 |
| **I – Dry** | $CN_I = \frac{4.2CN}{10 - 0.058CN}$ | RT < 1.4 in | RT < 0.5 in |
| **II - Average** | CN | 1.4 in ≤ RT ≤ 2.0 in | 0.5 in ≤ RT ≤ 1.0 in |
| **III - Wet** | $CN_{III} = \frac{23CN}{10 + 0.13CN}$ | RT > 2.0 in | RT > 1.0 in |

RT = Total rainfall for the previous 5-days

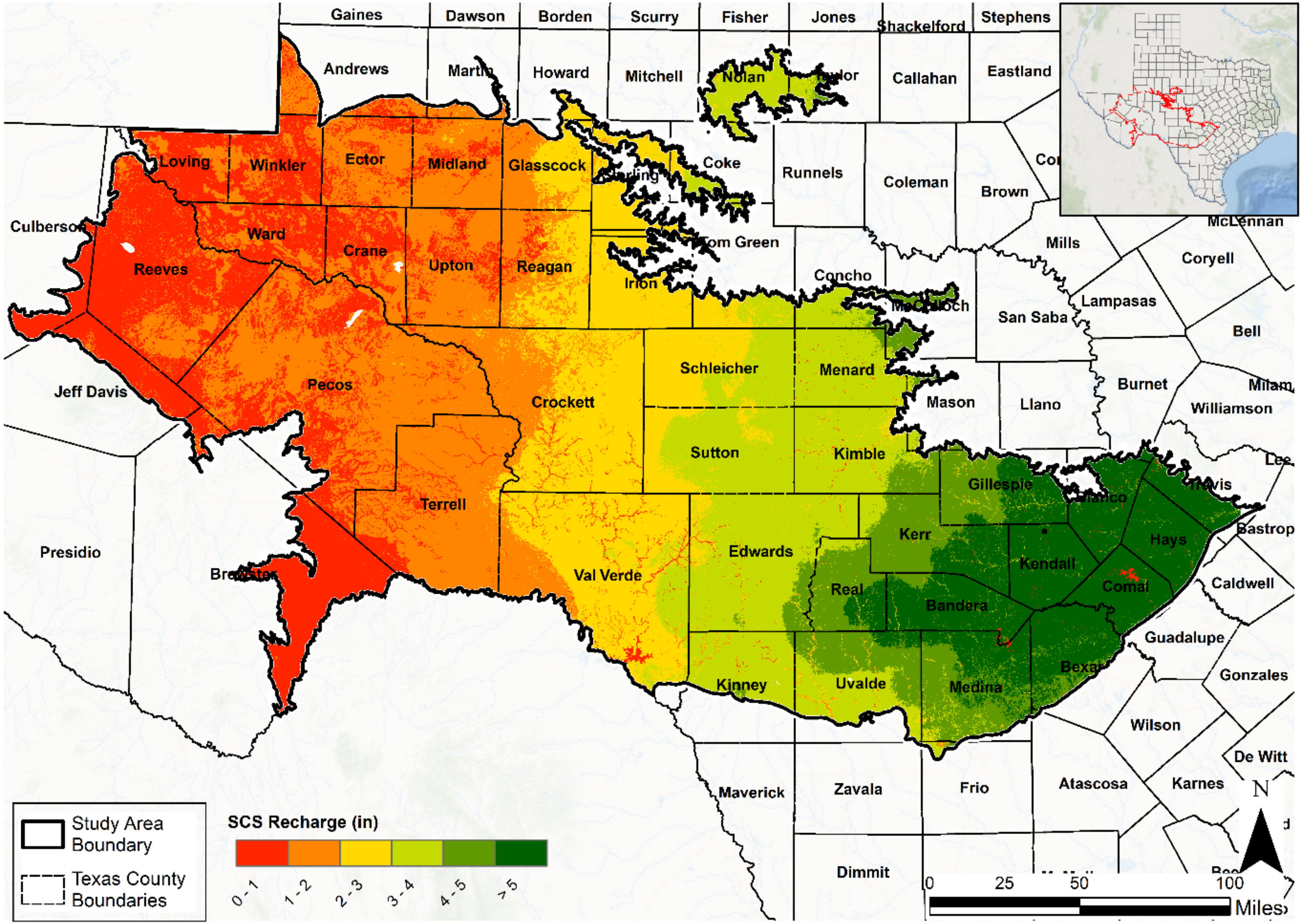
# Comparative Analysis: Recharge (SWB)



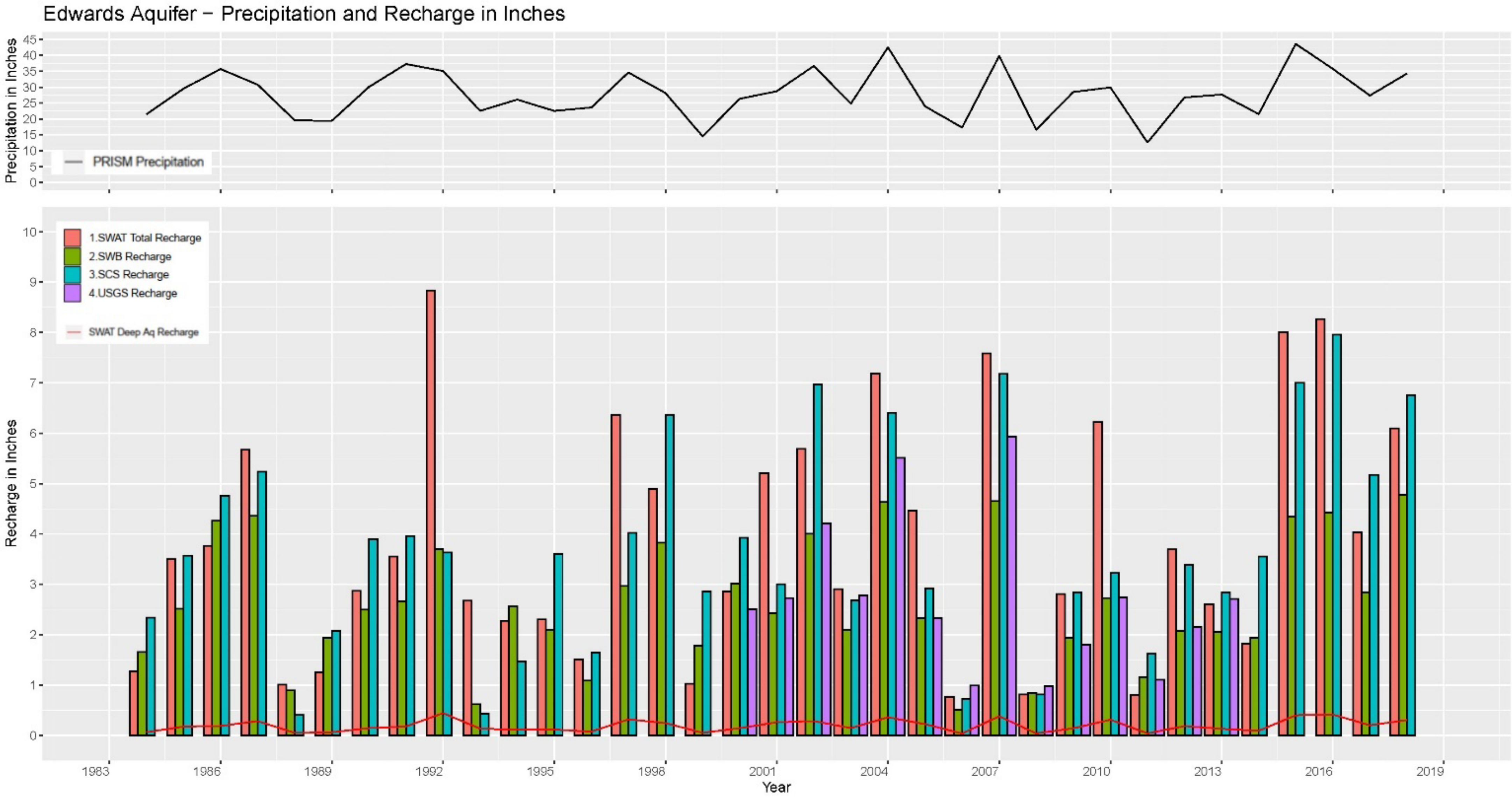
# Comparative Analysis: Recharge (SWAT)



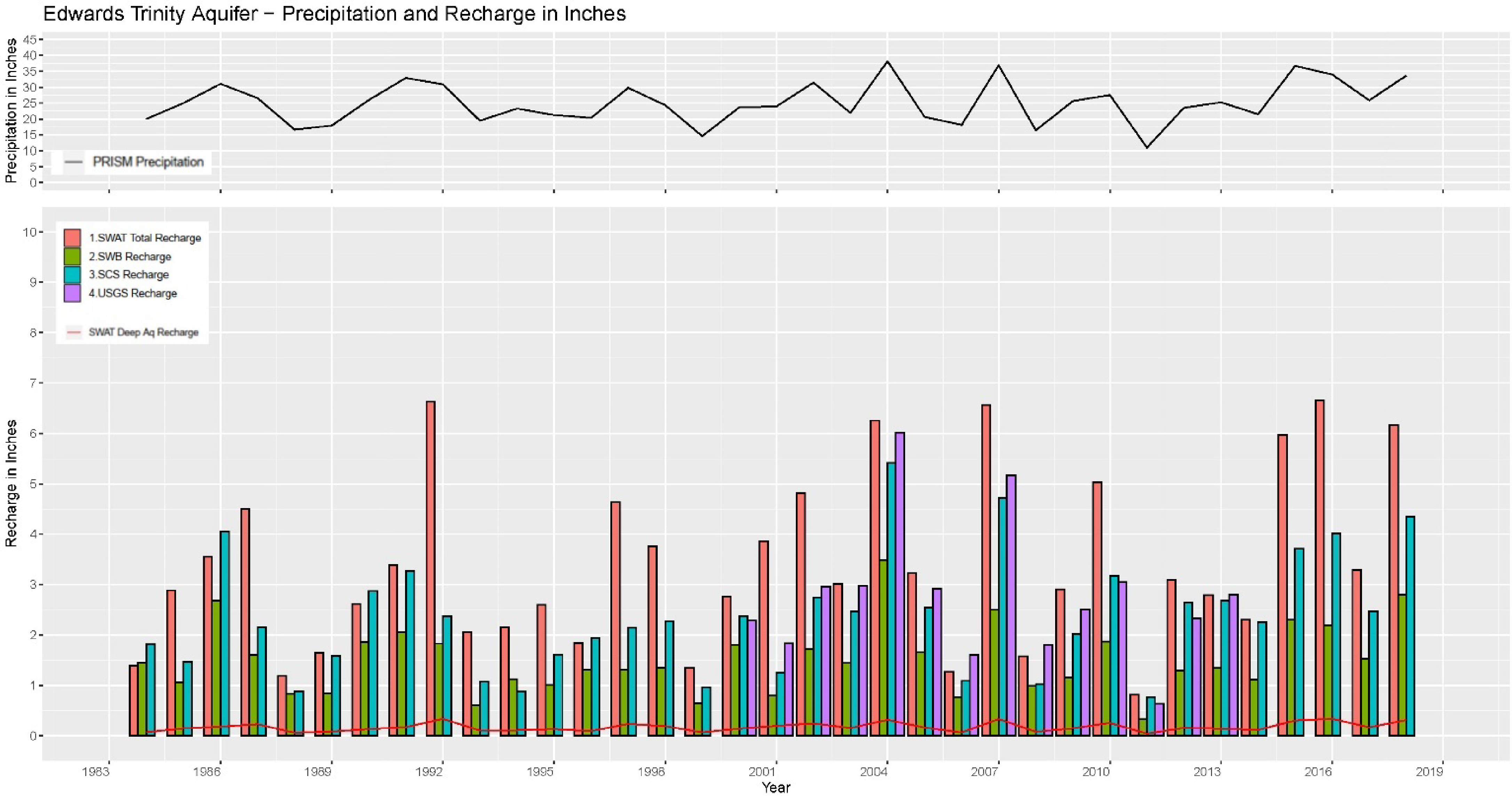
# Comparative Analysis: Recharge (modified SCS method)



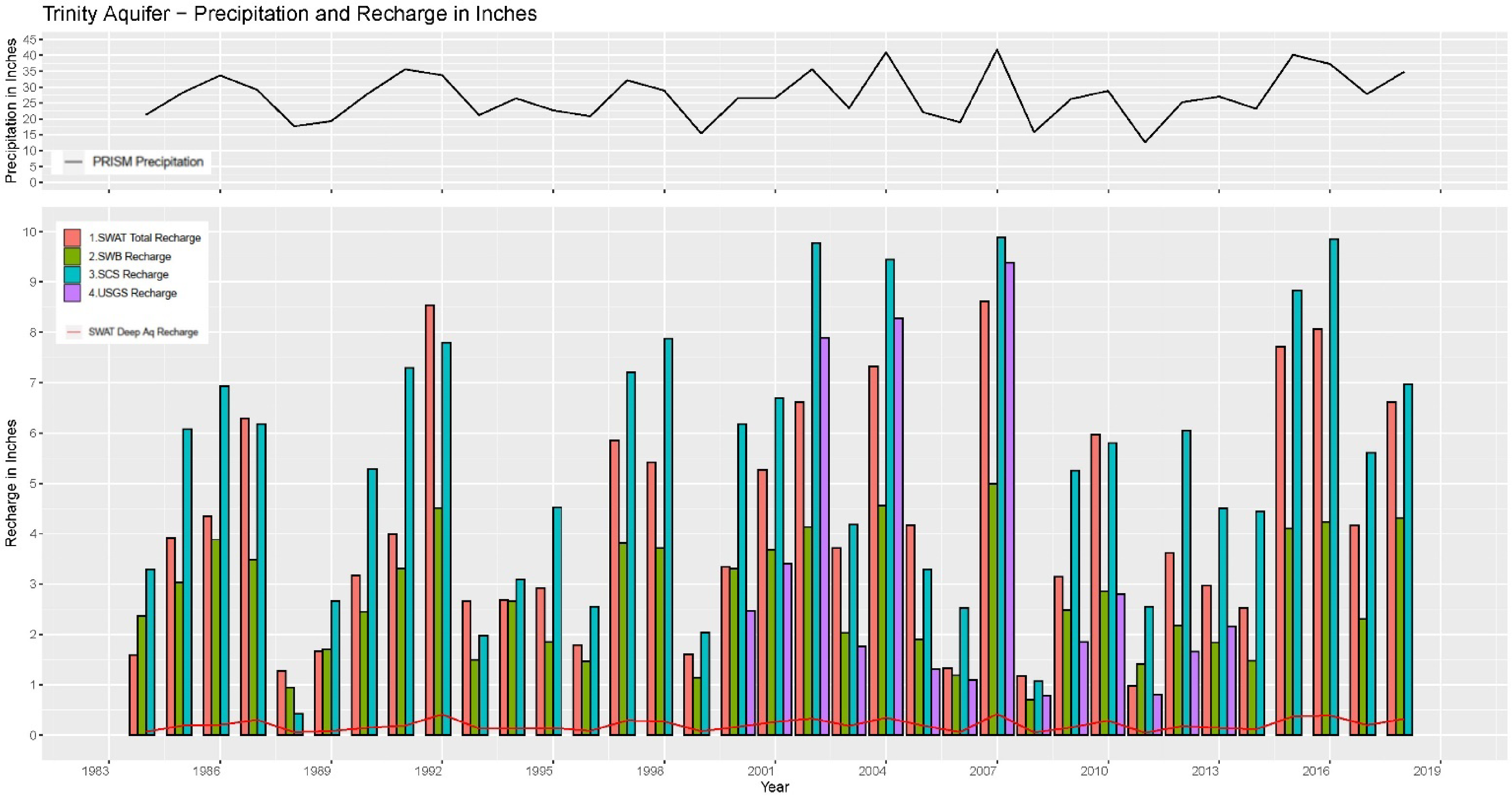
# Comparative Analysis: Inter-model



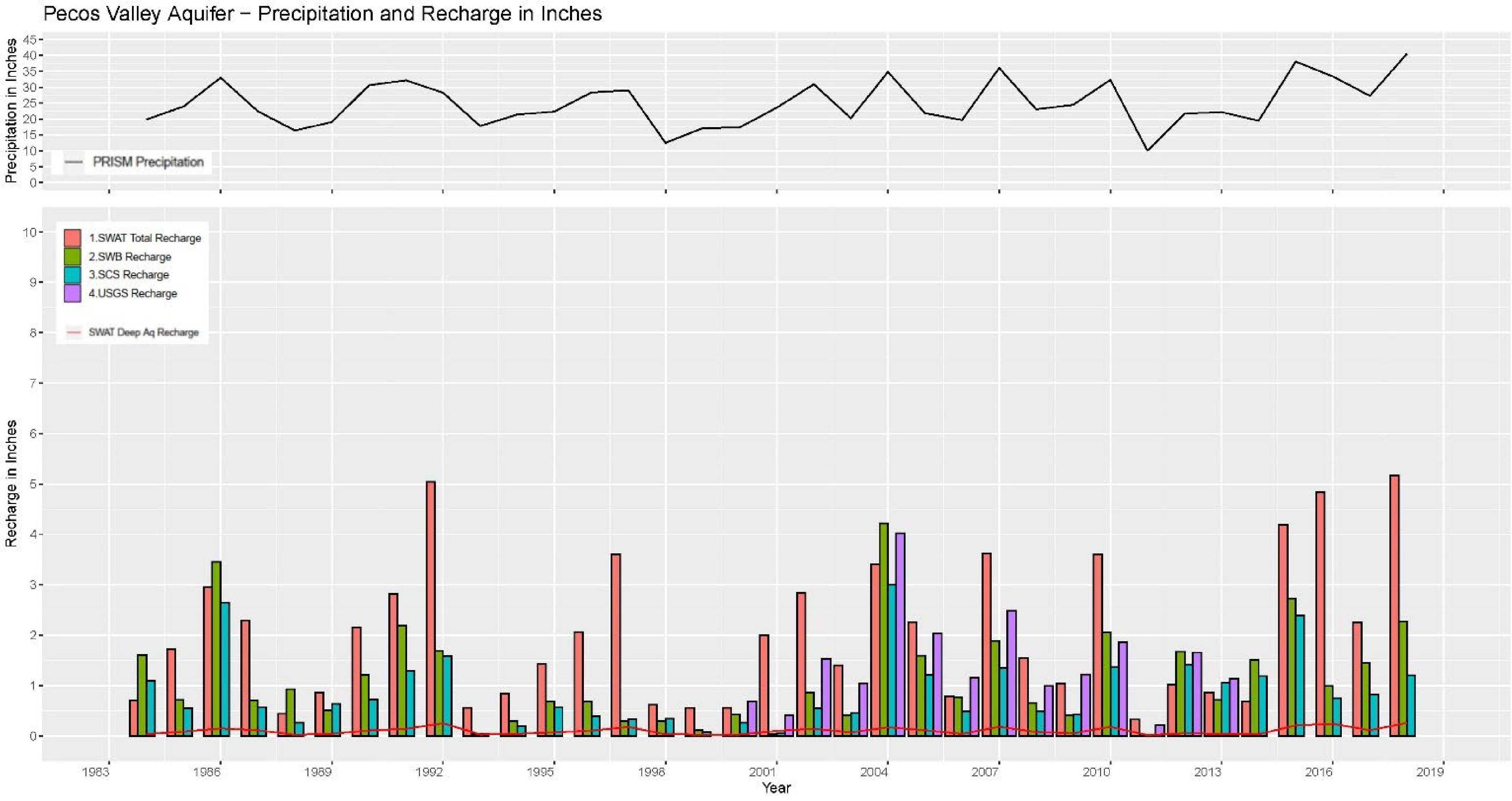
# Comparative Analysis: Inter-model



# Comparative Analysis: Inter-model



# Comparative Analysis: Inter-model



# Comparative Analysis: Inter-model

| Aquifer | Recharge (Root Mean Square Error) [inches] | | | | | |
|---|---|---|---|---|---|---|
| | USGS vs SWAT | USGS vs SWB | USGS vs SCS | SWAT vs SWB | SWAT vs SCS | SWB vs SCS |
| **Edwards-Trinity** | 1.06 | 1.46 | 0.45 | 2.26 | 1.47 | 1.03 |
| **Edwards** | 1.57 | 0.53 | 1.06 | 1.91 | 1.48 | 1.46 |
| **Trinity** | 1.64 | 1.94 | 2.42 | 1.89 | 1.67 | 3.06 |
| **Pecos Valley** | 0.85 | 0.45 | 0.67 | 1.47 | 1.67 | 0.45 |

# Comparative Analysis: Inter-model

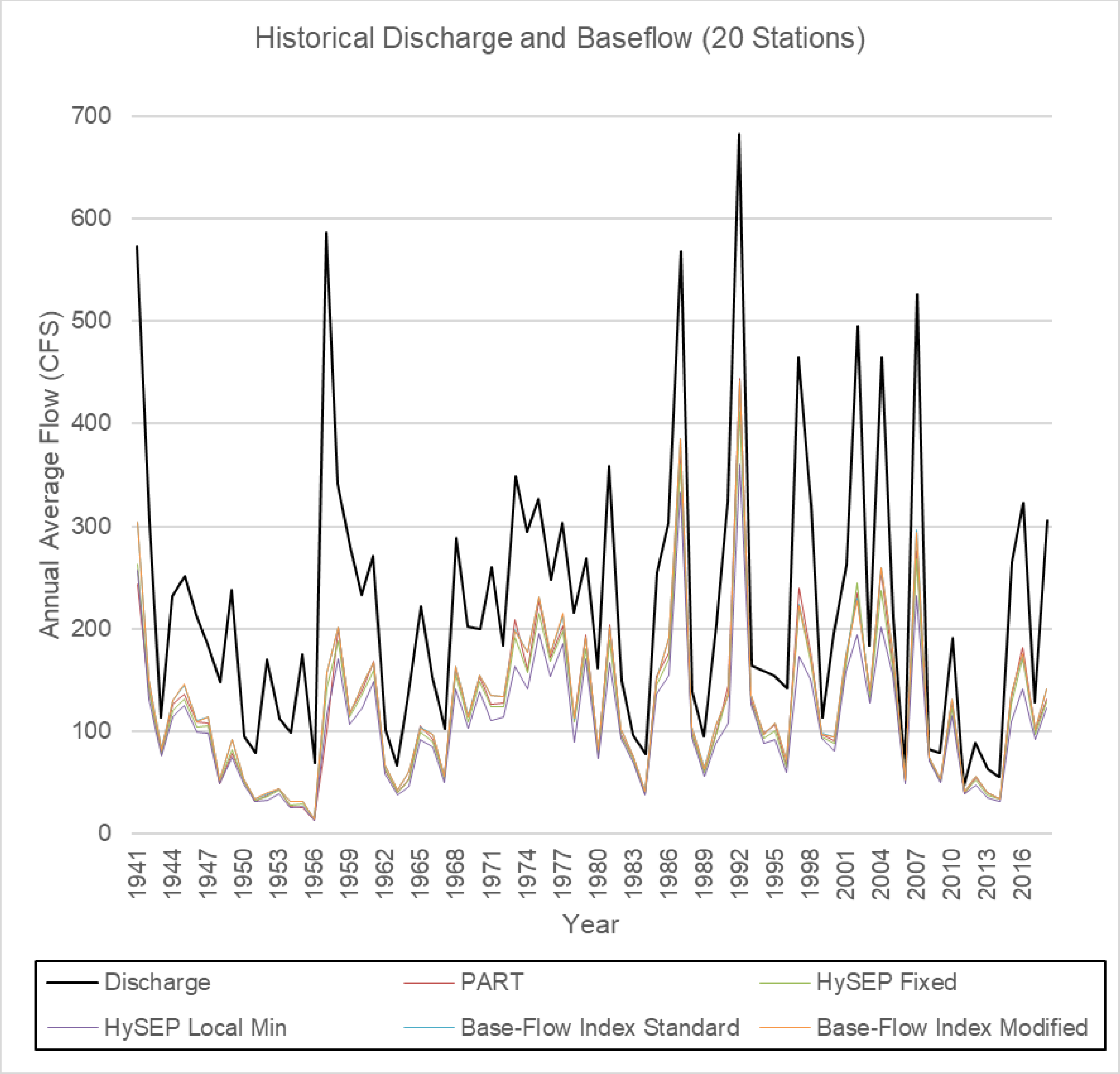
| Aquifer | Recharge ($R^2$) | | | | | |
|---|---|---|---|---|---|---|
| | USGS vs SWAT | USGS vs SWB | USGS vs SCS | SWAT vs SWB | SWAT vs SCS | SWB vs SCS |
| **Edwards-Trinity** | 0.78 | 0.96 | 0.95 | 0.62 | 0.63 | 0.91 |
| **Edwards** | 0.79 | 0.92 | 0.89 | 0.71 | 0.61 | 0.85 |
| **Trinity** | 0.79 | 0.87 | 0.85 | 0.85 | 0.8 | 0.87 |
| **Pecos Valley** | 0.53 | 0.93 | 0.91 | 0.32 | 0.3 | 0.92 |

# ML Application: Future Use

- Random Forest method
- MODIS data for ET
- Trained on SWAT output
- $R^2$= 0.85, RMSE= 2.24 in/yr

| Feature | MDI | Permutation Importance |
|---|---|---|
| Precipitation | 33.4% | 1.306 ± 0.001 |
| Potential Evapotranspiration | 15.8% | 0.262 ± 0.0001 |
| Evapotranspiration | 50.8% | 1.220 ± 0.001 |

# Comparative Analysis: Baseflow separation



# Groundwater-surface water interactions: Comparative Analysis

| Method | Mean | 10th Percentile | 50th Percentile | 90th Percentile |
|---|---|---|---|---|
| PART | 98.23 | 0.00 | 10.79 | 226.93 |
| HySEP Fixed | 117.70 | 0.00 | 11.03 | 233.90 |
| HySEP Local Minimum | 105.76 | 0.00 | 9.71 | 213.12 |
| HySEP Slide | 117.40 | 0.00 | 11.07 | 234.73 |
| Base-Flow Index Standard | 132.29 | 0.00 | 11.12 | 249.71 |
| Base-Flow Index Modified | 132.15 | 0.00 | 11.08 | 249.00 |
| **Coefficient of Variation** | **0.11** | **0.00** | **0.05** | **0.05** |

# Recommendations

— Parameters with the highest impact

— Evapotranspiration
  — Remote-sensing products

— SWB and modified SCS are highly correlated
  — ET calculation, no routing

— Use all model results to constrain recharge & baseflow in GAMs

— Baseflow estimates as soft targets

— Use at least two models for future studies
  — SWAT (routing, provides detailed water budget, baseflow components)
  — modified SCS method (systemic error can be minimized)

# Acknowledgements

- Dr. Raghavan Srinivasan, Ph.D., PE (Independent Consultant) (Texas A&M University)
- Dr. Jordan Furnans, Ph.D., PE, PG (LRE Water)
- Mike Keester, PG
- Dr. Jim McCord, Ph.D.
- Uvashree Mohandass Janani, EIT
- Jay Fagan (WSP)
- Isaac Johnson (WSP)
- Kate Richards (WSP)
- Colton Herrera (WSP)
- James Bethune

# Q&A

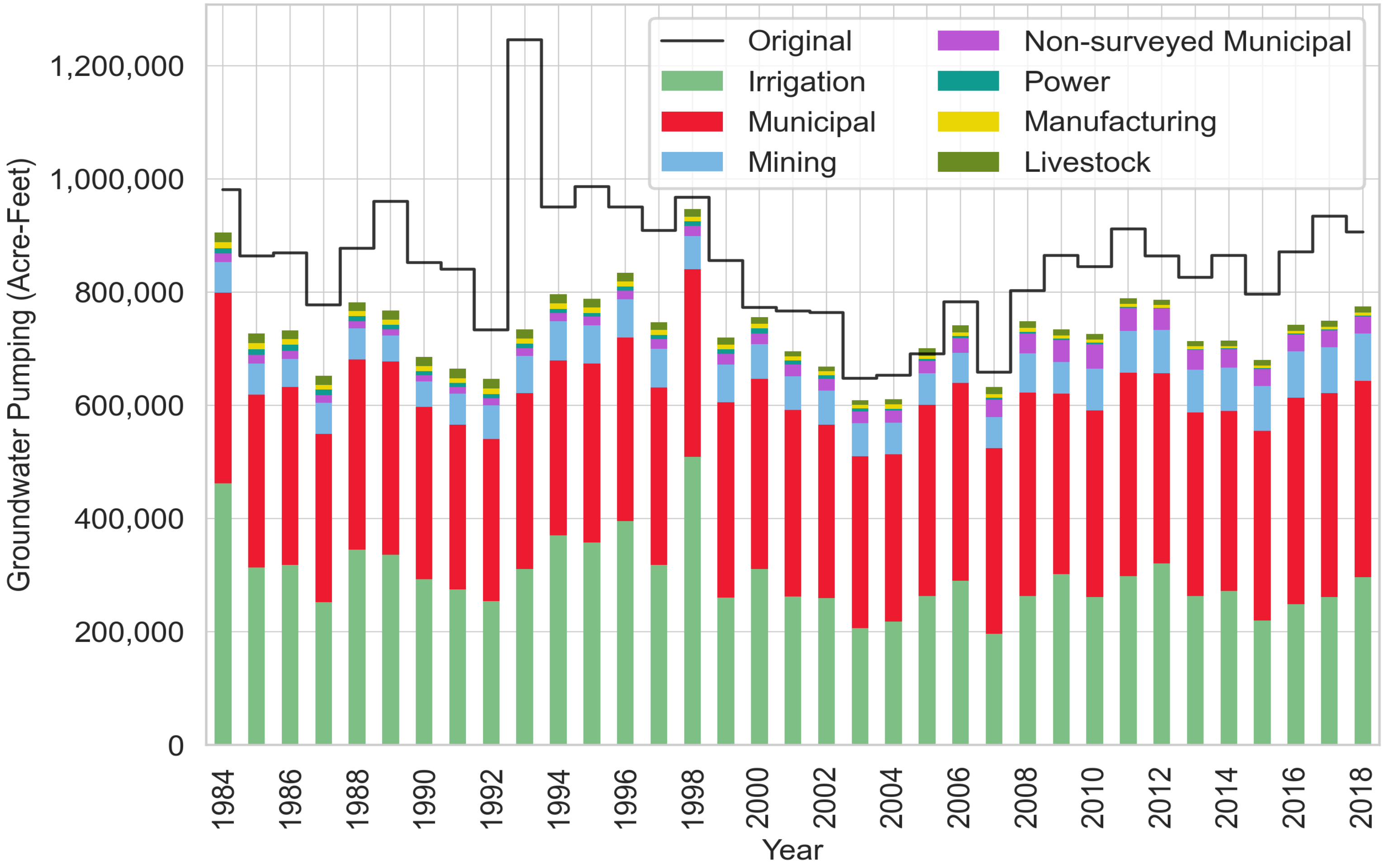
Questions?

# ESTIMATION OF GROUNDWATER PUMPING VOLUMES, LOCATIONS, AND AQUIFERS FOR WEST TEXAS

February 25, 2022


Team: **LRE Water, LLC**

| | |
|---|---|
| WSP, Inc | (Mining & Municipal) |
| Thornhill Group | (Non-Surveyed Municipal) |
| Michelle A. Sutherland, LLC | (Manufacturing) |



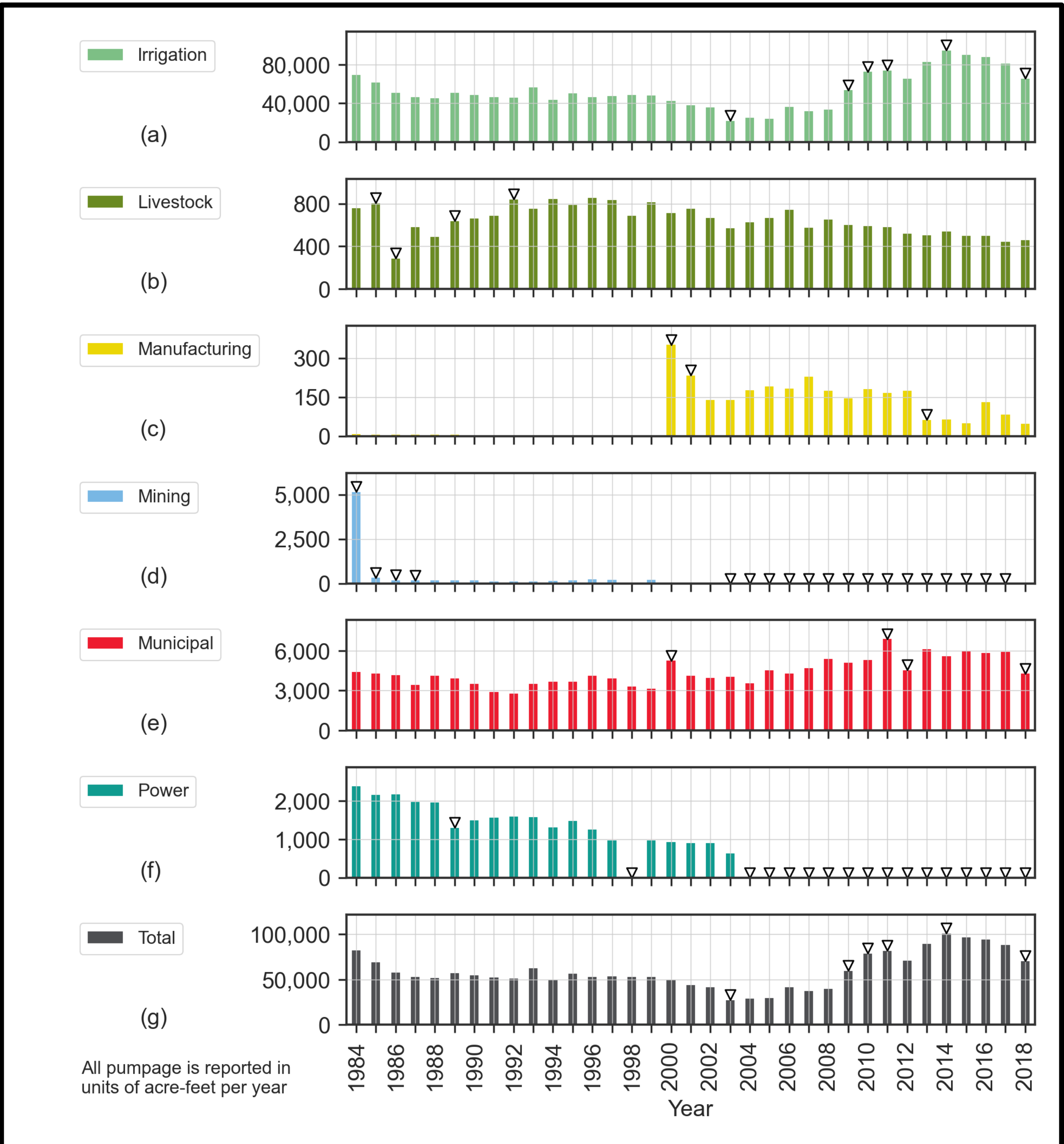

**Consider Water Uses By Category**

- Irrigation
- Municipal
  - Surveyed
  - Non-Surveyed (Rural)
- Mining
- Livestock
- Power
- Manufacturing

**Project Steps**

- Review TWDB Data – Find anomalies
- Develop workplan to fix anomalies
- Implement workplan
- Assign pumpage to locations
- ArcGIS Tool for Creating MODFLOW Pumping Files

LRE WATER




# ANOMALY DETECTION TASK #1 – OCTOBER 2020

3 Methods developed & Tested:

- Manual Review & Professional Judgement
- Year-to-year Change Analysis
- Statistical Analysis using Standard Deviation Criterion

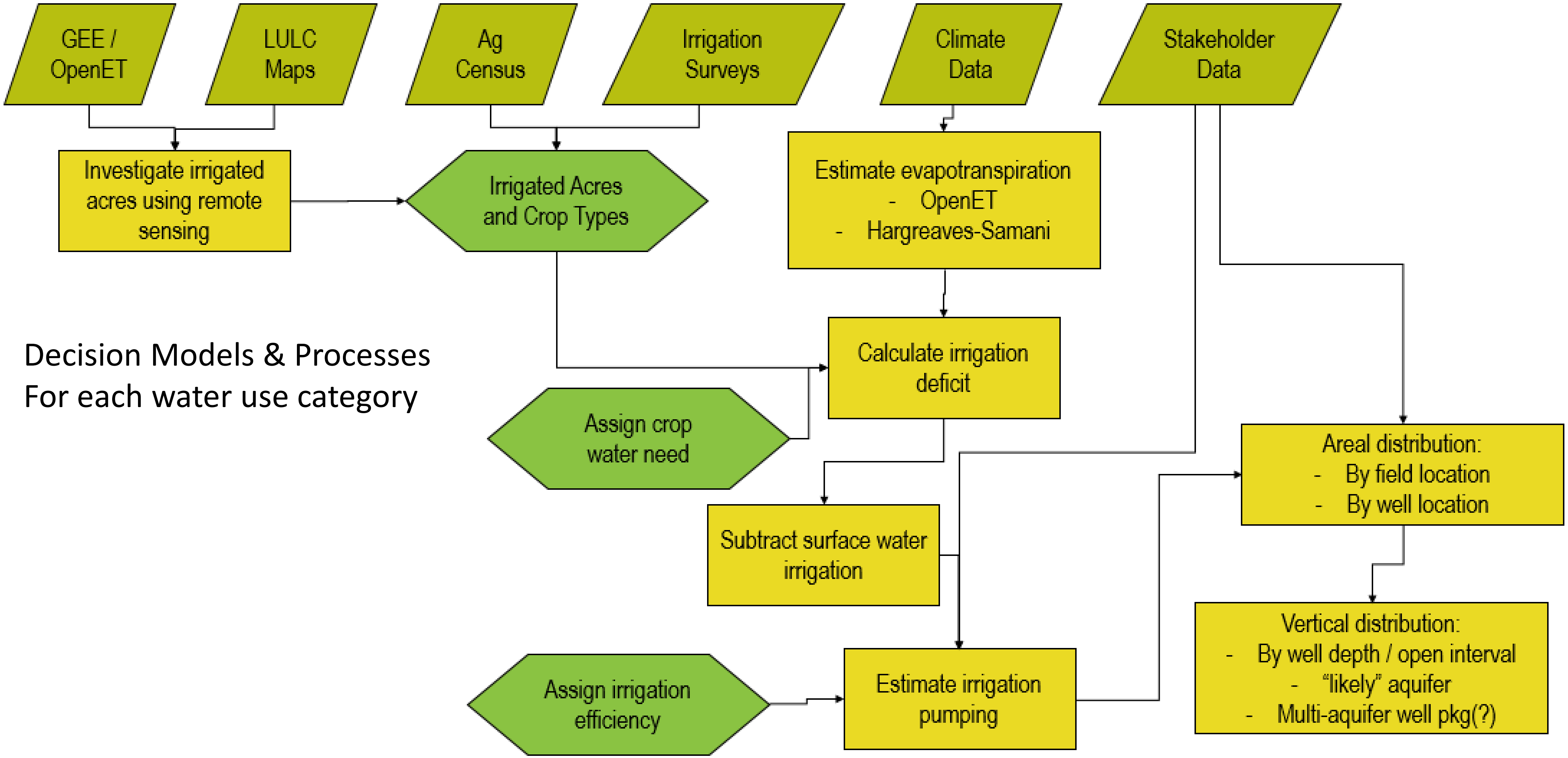
Methods returned similar results

Automated methods = faster

Anomalies were **not** focus of task 3

Review & Revise entire datasets

# DATA REVIEW WORKPLAN
# TASK #2 – JANUARY 2021

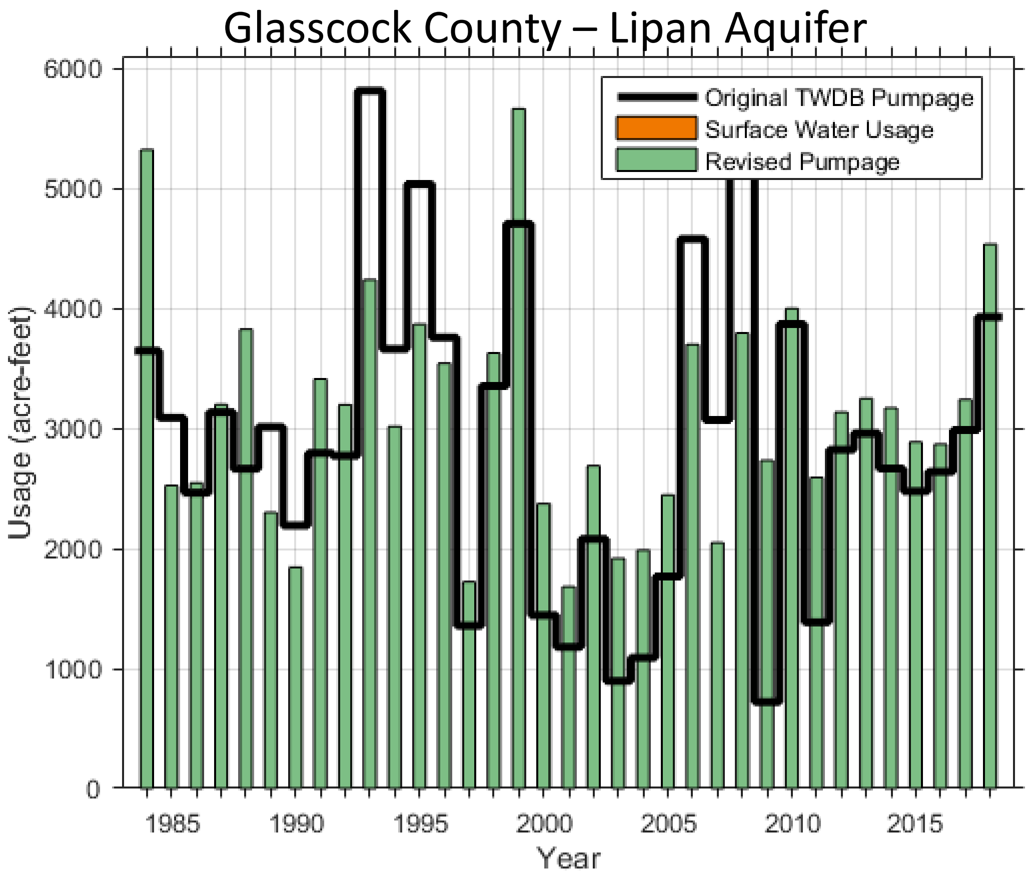


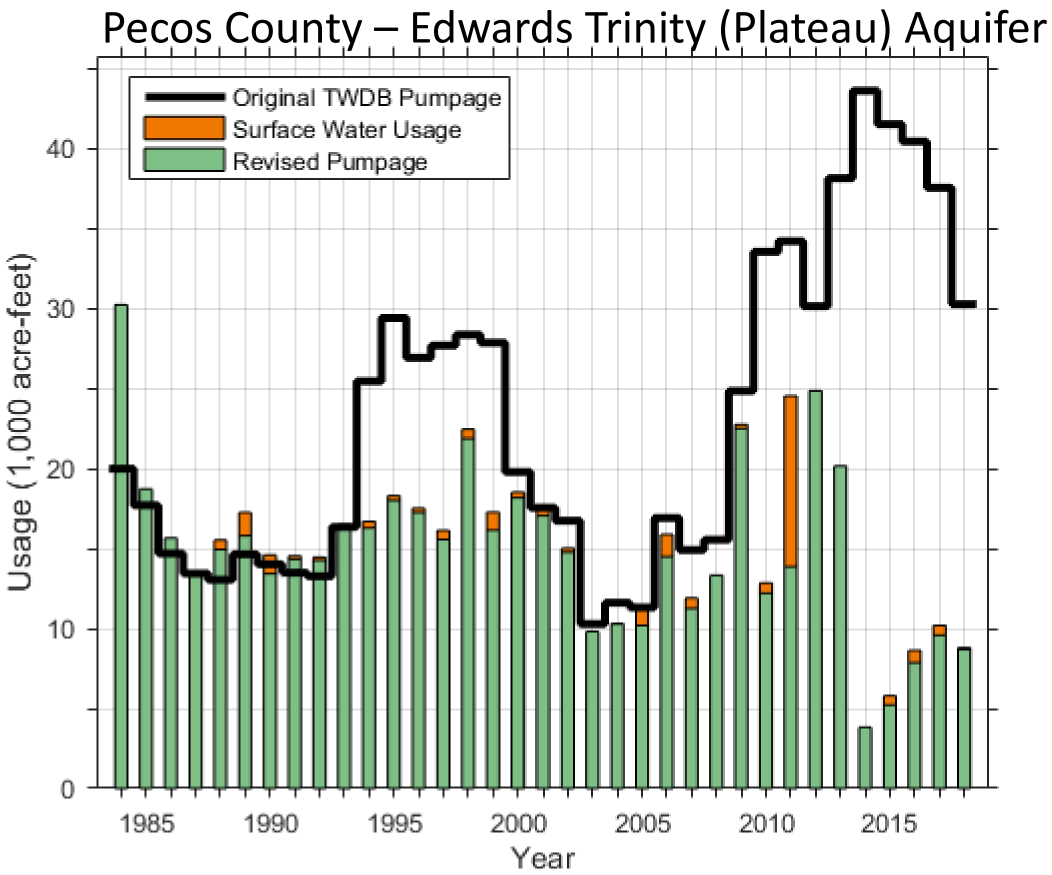

Decision Models & Processes
For each water use category

WATER

# DATA REVISION TASK #3 – OCTOBER 2022

Irrigation:

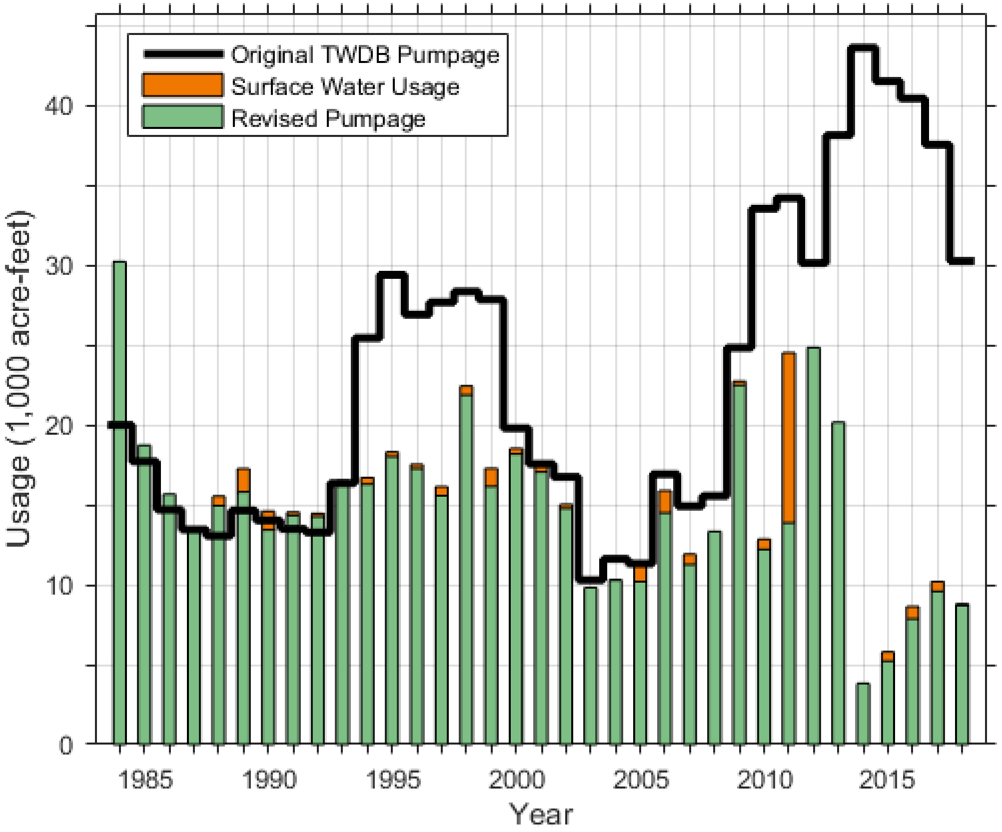


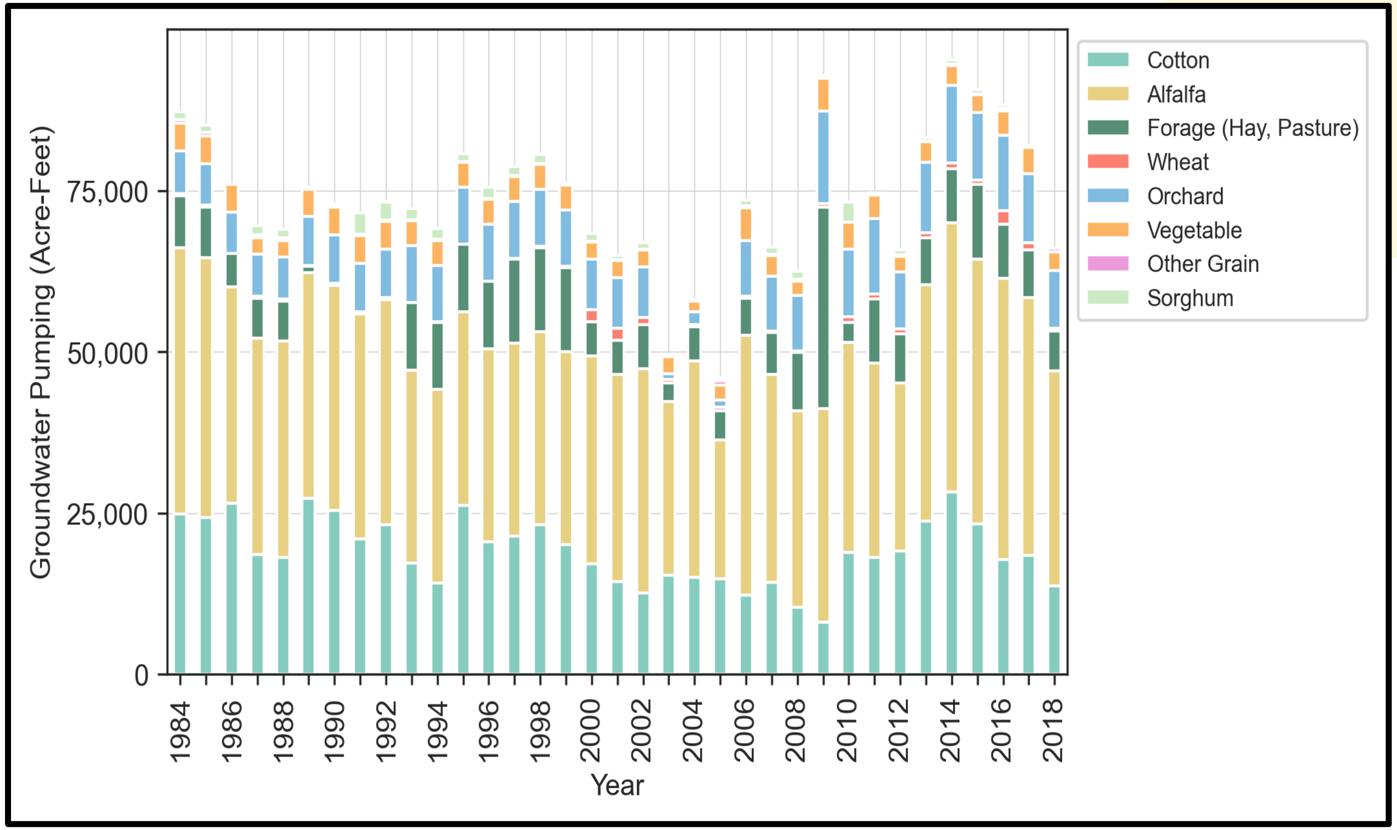

LRE WATER

# DATA REVISION TASK #3 – OCTOBER 2022

Irrigation: Pecos County:
Local Knowledge Differences




Based on Acreage, Climate, Rainfall Patterns

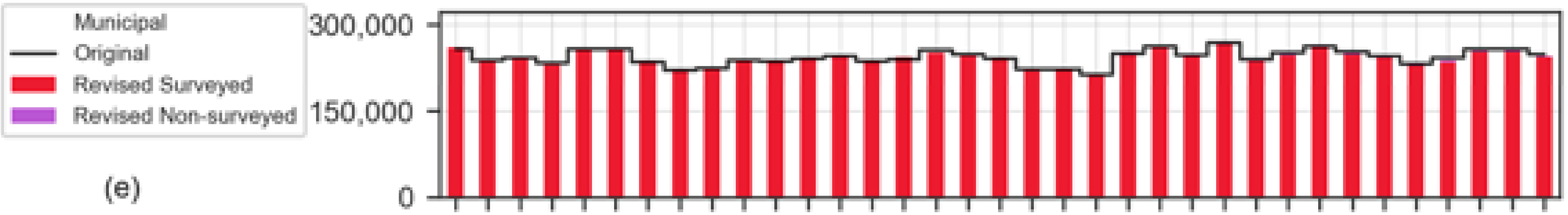



Based on Acreage & Per-Crop Water Use Data, MPGCD

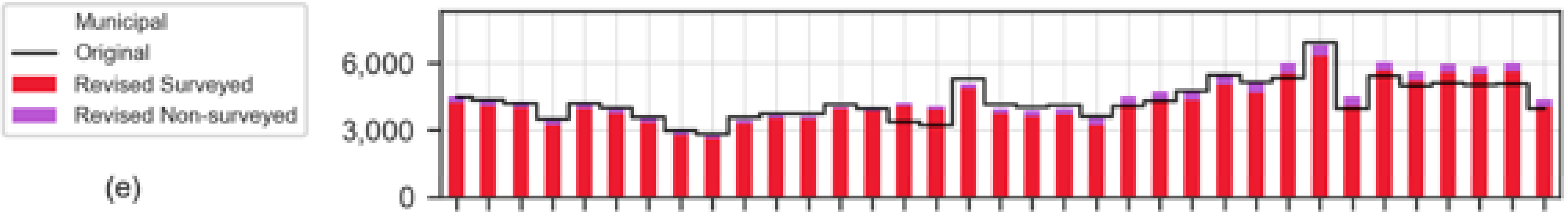
LRE WATER

# DATA REVISION
# TASK #3 – OCTOBER 2022

## Municipal Surveyed & Non-surveyed




Bexar County Balcones Fault Zone Aquifer



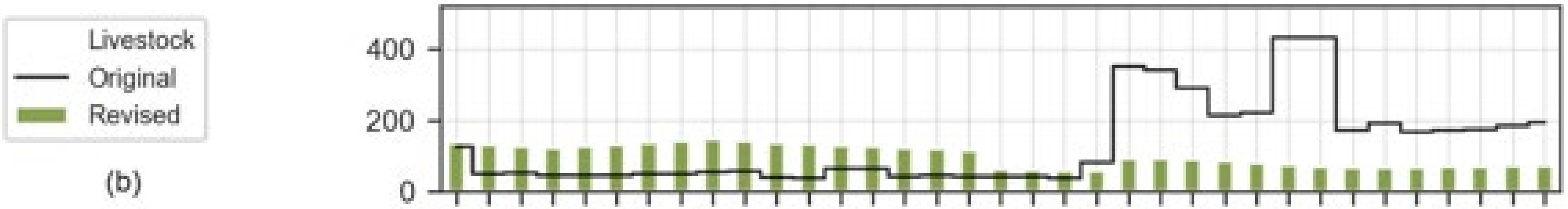

Pecos County Edwards Trinity (Plateau) Aquifer

Bexar County:

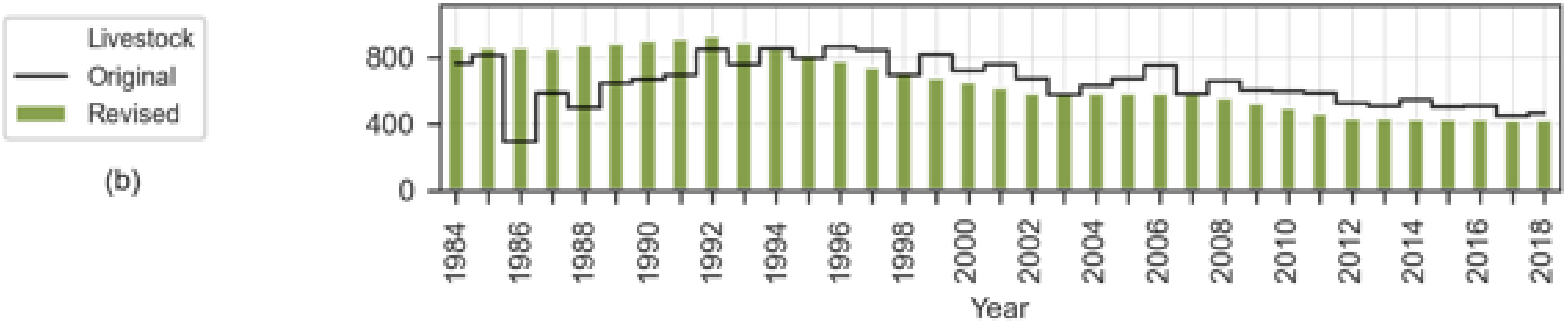
Based on Acreage & Per-Crop Water Use Data, MPGCD

# DATA REVISION
# TASK #3 – OCTOBER 2022

Livestock




Bexar County Balcones Fault Zone Aquifer




Pecos County Edwards Trinity (Plateau) Aquifer

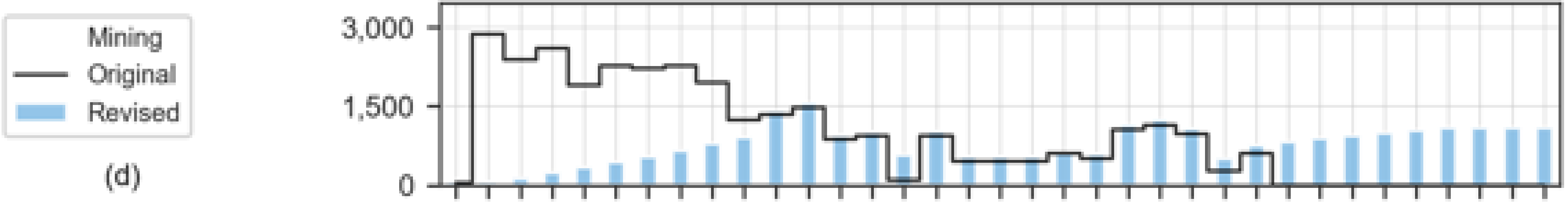
Based on Animal Counts & Water Use Per Animal

| Animal | Median Water Use (gallons per animal per day) |
|---|---|
| Cattle | 12 |
| Chickens | 0.06 |
| Hogs | 3.5 |
| Sheep | 2.0 |

LRE WATER

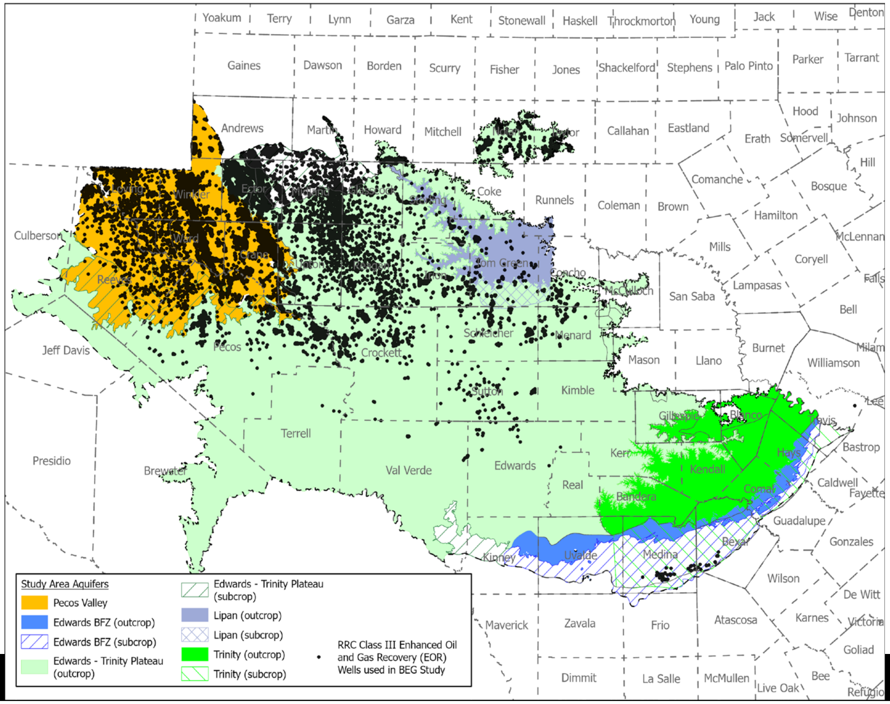
# DATA REVISION TASK #3 – OCTOBER 2022

## Mining



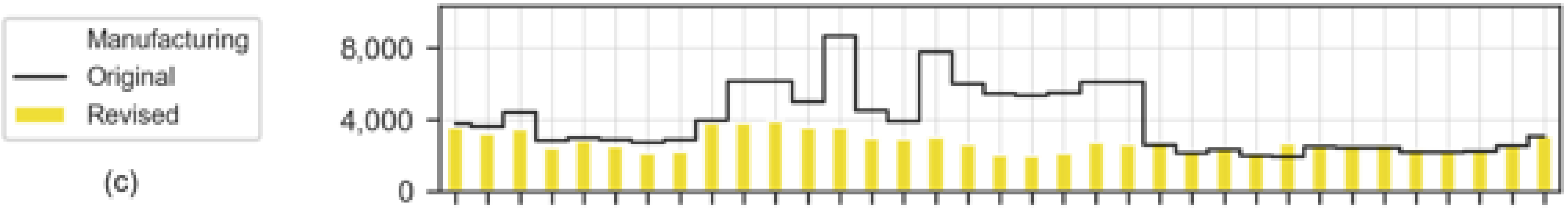

Reeves County
Pecos
Valley
Aquifer

Based on:
Enhanced Oil & Gas Recovery Wells
Water Usage Estimates
USGS Estimates
Original TWDB Water Use Survey Data

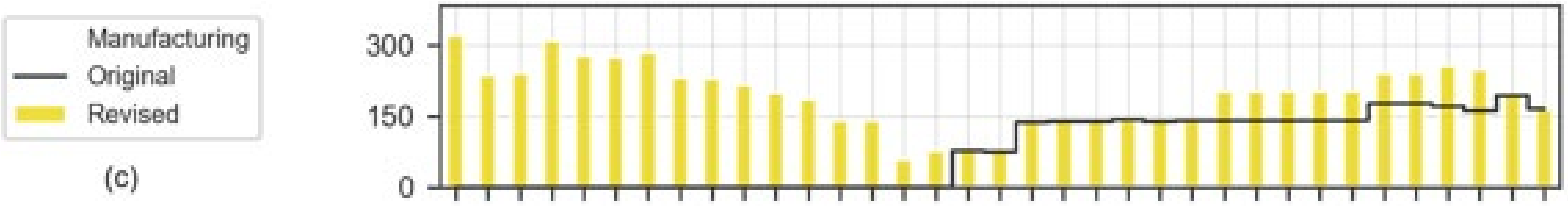


# DATA REVISION
# TASK #3 – OCTOBER 2022

Manufacturing




Bexar County Balcones Fault Zone Aquifer

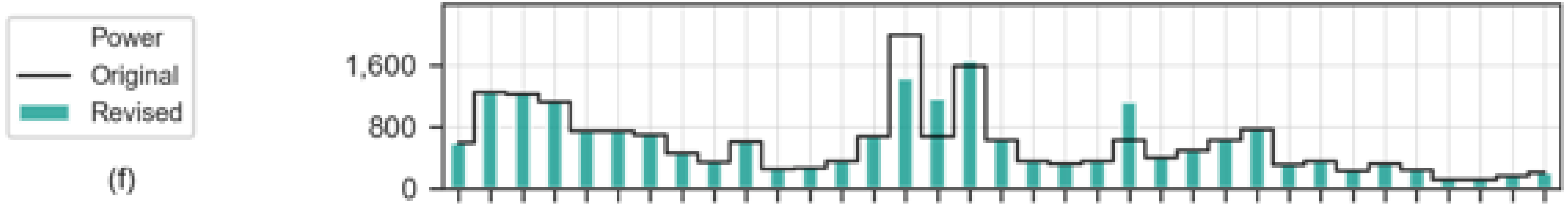



Midland County Edwards Trinity (Plateau) Aquifer

Based on:
Research & Review of Reporting Entities
Often missing reporting, incorrect aquifer designations

# DATA REVISION
# TASK #3 – OCTOBER 2022

Power




Bexar County
Balcones
Fault
Zone
Aquifer

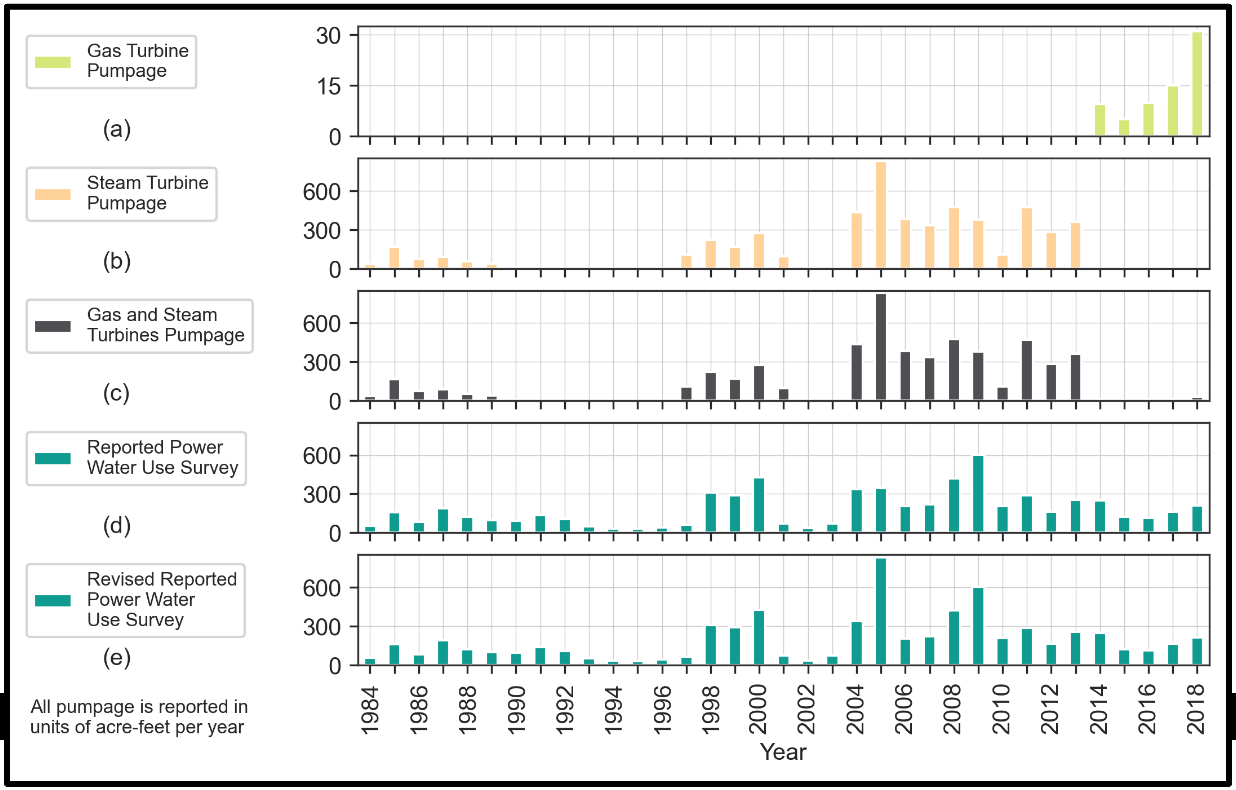
**<u>Based on:</u>**

Research & Review of Reporting Entities

Time-history of power generator type

Operational History

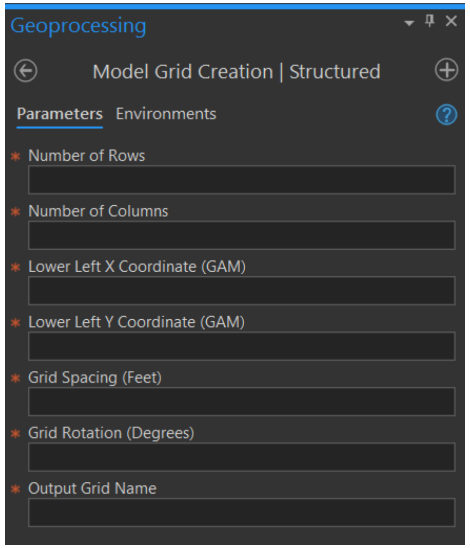
Average water consumption per generator

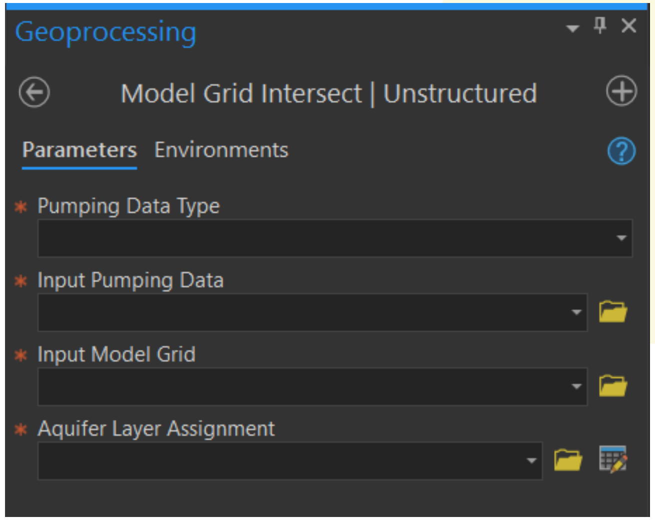


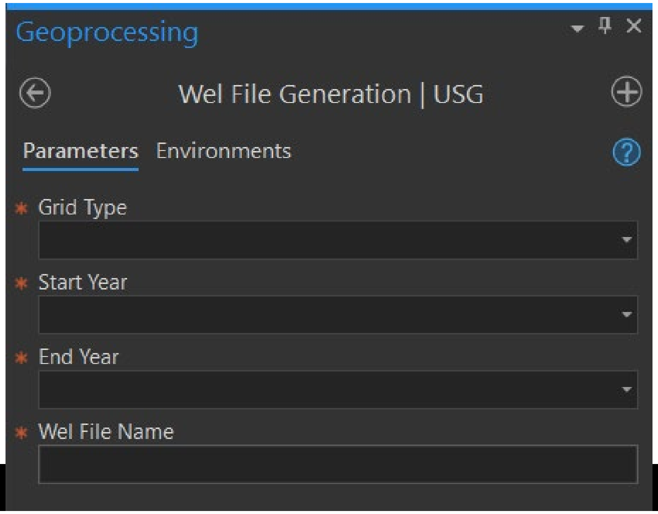
# CREATION OF MODFLOW PUMPING FILES

## ArcGIS Pro Well File Toolbox

- Create custom structured groundwater availability model grids.
- Intersect attributed point and areal pumping data with both structured and unstructured groundwater availability model grids.
- Convert intersected point and areal pumping datasets into Wel files usable in USGS MODFLOW-2005, MODFLOW 6, and MODFLOW USG software.



# DISCUSSION

Estimation of groundwater pumping volumes, locations, and aquifers for west Texas

February 25, 2022

Jordan Furnans, PhD, PE, PG
512-736-6485
Jordan.Furnans@lrewater.com

# Modeling Plans

- Model code
  - MODFLOW **U**n**S**tructured **G**rid (USG)
- Grid
  - Variable Grid Sizes (Quadtree)
    - Streams (330 ft – 1 mi)
- Local Models
  - Hill Country portion of Trinity
  - Nolan Island

# Project Schedule*

## Project Start
(Jan. 2020)

**SAF Meeting**
Apr. 2020

## Conceptual Model
(Jan. 2020 ~ Feb. 2022)

**Conceptual Model Report**
Feb. 2022

**SAF Meeting**
Feb. 2022

## Numerical Model
(Nov. 2021 ~ Feb. 2023)

**Steady-State Model**
Nov. 2021~May. 2022

**Transient Model**
Jun. 2022~ Jan. 2023

**SAF Meeting**
Feb. 2023

**Numerical Model Report (Draft)**
Feb. 2023

## Completion
(Apr. 2023)

**Numerical Model Report (Final)**
~Apr. 2023

**Groundwater Model For Edwards and Trinity Region**
~Apr. 2023

***Schedule is Tentative**

# Q&A

Questions?

# Contact Information

**Daryn Hardwick, Ph.D.**
**Manager, Groundwater Modeling**
**512-475-0470**
**daryn.hardwick@twdb.texas.gov**

**Ki Cha, Ph.D.**
**Lead modeler, Groundwater Modeling**
**512-463-5604**
**ki.cha@twdb.texas.gov**

**Web information:**
**http://www.twdb.texas.gov/groundwater/models/gam/eddt_p/eddt_r.asp**

**Questions:**

**Part 1:**

Q: What is the specific yield for the Pecos Valley?

A: Based on previous studies, the range of specific yield is from 0.1 to 0.3. We will set the initial condition as 0.2 and calibrate the value.

Q: How New Mexico portion of Pecos Velley included in the model? Assume the model was extended into New Mexico, how the stress will be simulated for future planning? How the Red Bluff reservoir was included in the model?

A: New Mexico area will be included in this model as a boundary condition. We don't have recharge or pumping analysis for the New Mexico area. So, we will not be able to simulate the stress given in New Mexico area. The Red Bluff reservoir is slightly outside of the model boundary, so it was not included in the model.

Q: Have you incorporated any climate change impacts in your modeling construct.

A: We don't have any specific components that include the climate change situation in our model.

**Part 2**

Q: I thought that the soil water balance method is good only for plastic sediment and not limestone bedrocks. Any comments on that?

A: We've been discussing that throughout this project and that's why we have multiple model approach. One model might not be very good for application in a certain area and that's where you have these multiple models that are used to give a competing result or a comparative result.

Q: If you can explain why recharge in the Trinity is higher than in the Edwards?

A: Recharge in Edwards after 2000 is high and SWAT is consistently estimating high recharge, they are comparable to recharge in Trinity. Lower recharge in Edwards is happening from the estimates using Soil Water Balance method which might not be good for clastic sediments.

Q: What percentage of the precipitation ended up as recharge?

A: They are varying depending on the location. Please check the report, the values are in the report.

**Part 3**

Q: Did you consider domestic exempt use in your pumping categories?

A: The domestic exempt use would have factored into the non-surveyed municipal usage category.

Q: How significate might exempt wells be. (i.e. wells primarily used by individuals for domestic house use not accounted for in the presented categories)

A: In general, they weren't a large fraction of water usage. But they all get factored in. It maybe five percent of overall municipal use depending on which county you're looking at and what year.

Q: Couldn't surface water for irrigation be analyzed using the water rights database by TCEQ and could possibly assist with analyzing the goundwater and surface-water splits?

A: Yes. We have reported information by county and year of how much surface water was used for irrigation. We don't know where it was used, we don't know when it was used. So, we had to make estimates. The problem with TCEQ's database, at least the one that's publicly available is it's incomplete and it's never quality controlled and it wasn't updated past 2014 the last time I looked at it.
So, we found some useful information there and it's the same data that Rohit used and talked about in his depletion analysis. So, it did factor into the calculations. But basically, we found in most cases we couldn't rely upon it, especially in earlier periods of the of the time frame of the project.

Q: Your data seems to imply that many entities over-report their water use to the TWDB Water Use Survey. Can you think of any incentives that would drive them to over-report? Or are the gaps mostly explained by water being assigned to the wrong water use and/or aquifer?

A: I don't know that there's any incentives to over report water use. I'm actually a little surprised in that you think that entities are over reporting. That wasn't the conclusion that I had in looking at the data and the entities that are reporting were generally manufacturing in some municipal entities and it didn't seem like they were over reporting I got more of the feeling that they were pretty spot on.

Q: When allocating pumping to the MODFLOW well package, did you assign pumping to specific wells? or just model grid?

A: It was assigned to specific wells. It's assigned to whatever model grid you specify. We overlay that grid spatially on our data set and find where we assign pumpage being used geographically and where that responds to the model grid location.

Q: Are you posting the recharge/SW/GW reports and pumping posted for review? if so, where? Will the deadline be 3/21/22- same as TWDB conceptual model report?

A: Yes, we will post those reports on our website when the studies are completed. We will receive the comments for 30 days from the date we posted.

Questions in Email

**Reports**

Q: I have downloaded a copy of the draft conceptual model report. When will the draft reports for the recharge and pumping components be available?

A: The pumping project is completed by the end of February 2022. So, the final report for pumping will be available soon. For the Recharge Project, we are currently reviewing the draft final, and we will be able to upload it when we have the final deliverables for the recharge project.

**Recharge**

Q: The presentation on Feb. 25 included a variety of comparisons with alternative methods. Were any comparisons made with estimates from the current GAM or the alternative GAM? Is that part of the scope of work?

A: The current draft report deliverable does not contain comparative analyses with recharge estimates from the current or alternative GAM. The task is not the part of the scope of work.

**Pumping**

Q: During the presentation, there were a couple of examples of how the new estimates were developed. I will review the report and any associated data, but if I understood the presentation, the estimated pumping for irrigation in Pecos County from the Edwards-Trinity (Plateau) appears to much lower than the data from MPGCD.

The tool to convert the pumping estimates into MODFLOW files appears to take county-aquifer estimates and evenly distribute them across the grid without consideration of the location of wells or the locations of pumping. This tool does not appear to be useful as described.

A: We can have discussion regarding the estimated pumping for irrigation in Pecos County from the Edwards-Trinity (Plateau) once the report is available online.

The tool uses pumping assigned to specific geographic locations when those locations are known. So, we do have pumping assigned to specific locations/wells, not evenly distribute them across the grid. We also have it assigned to general locations for livestock and non-surveyed municipal usage. I believe the tool will be very useful.

**GAM Update**

Q: There was a slide that provided some details on the GAM update that is not included in the conceptual model report. The slide show is also not yet available on the project website, so if I am misquoting this I apologize.

Why is MODFLOW-USG selected as the code rather than MODFLOW-6? MODFLOW-6 can handle the quadtree grid. MODFLOW-6 treats horizontal anisotropy better than MODFLOW-USG. Finally, MODFLOW-6 is designed to facilitate the development of local-scale models and provide a more seamless exchange between the regional model and the local-scale model.

A: Yes, you are correct. I said I am going to use MODFLOW-USG for this model. I am considering to use the CLN package for the streams. When I do the preliminary work, the CLN package can reduce the running time significantly compared to SFR. Since MODFLOW 6 does not have a CLN package yet, I planned to use MODFLOW-USG.

However, I agree with your point that using MODFLOW-6 would facilitate local models and provide seamless exchange between the regional and local models. Also, I've learned using CLN on a regional scale would be challenging to converge. So, I may have to use a different package for streams. In that case, there will be no reason to use MODFLOW-USG.

So, I will first try both MODFLOW-USG and MODFLOW-6 codes to develop the model and see which works better.

**Comment Deadline**

Q: Please consider extending the deadline to review the material (conceptual model report and the reports of the recharge and pumping). I would also hope that there is an opportunity to meet over zoom to discuss these and potentially other questions once the material is available for review.

A: The current review date I asked for the conceptual model report is March 21st. Please let me know if you need more time for this review.

For the recharge and pumping studies, those are contracted research studies, and they are not our property until the end of the study, and we cannot receive the public comments before the completion of the study. We are receiving the final deliverables of the pumping study, so we will be able to share it in a couple of weeks. The recharge study will need more time to complete.

**Attendee List**

| First | Last | Email |
|---|---|---|
| Natalie | Ballew | natalie.ballew@twdb.texas.gov |
| Bill | Hutchison | billhutch@texasgw.com |
| Rohit | Goswami | |
| Jordan | Furnans | Jordan.Furnans@lrewater.com |
| Amanda | Maloukis | a.maloukis@trinityglenrose.com |
| Grayson | Dowlearn | grayson.dowlearn@twdb.texas.gov |
| Monica | Jacobs | |
| Allison | Strube | |
| Cole | Walker | |
| Jevon | Harding | jevon.harding@twdb.texas.gov |
| Hannah | Gilbreath, | |
| Paul | Tybor | ptybor@gmail.com |
| Rhetta | Yanez | glasscockgroundwater@yahoo.com |
| Shirley | Wade | shirley.wade@twdb.texas.gov |
| Leah | Martinsson | julia@texasgroundwater.org |
| Rebecca | Storms | rebecca.storms@twdb.texas.gov |
| Ian | Jones | |
| Roberto | Anaya | Roberto.Anaya@twdb.texas.gov |
| James | Beach | james.beach@advancedgw.com |
| Kamran | Syed | wrapgtm.hydro@state.nm.us |
| Evan | Strickland | Evan.Strickland@twdb.texas.gov |
| Alyssa | Balzen | |
| Micaela | Pedrazas, | MICAELA.PEDRAZAS@LREWATER.COM |
| Radu | Boghici | |
| Meredith | Allen | |
| Uva | | uvashreemohan@gmail.com |
| Jerry | | |
| Alan | Lee | abrownel@earthlink.net |
| Daryn | Hardwick | daryn.hardwick@twdb.texas.gov |
| Ki | Cha | gotomeeting2@twdb.texas.gov |
| Donelle | Robinson, | |
| Brian | Leiker | |
| JJ | Weatherby | |
| Mike | Keester | mike.keester@rwharden.com |
| Atri | Sen | atri.sen@wsp.com |
| Isaac | Johnson | isaac.johnson@wsp.com |
| Ty | Edwards | mpgcd@mpgcd.org |
| Zhuping | Sheng | zsheng@yahoo.com |
| Daniel | Lupton | dlupton@intera.com |

| | | |
|---|---|---|
| Dirk | Aaron | daaron@cuwcd.org |
| Stephanie | Wong, | |
| Stephen | Acheampong | stepheny.acheampong@state.nm.us |
| Ronald | Fieseler | manager@blancogw.org |
| Andrew | Sansom | |
| Brian | Hunt | brian.hunt@beg.utexas.edu |
| Cindy | Ridgeway | |
| Allison | Strube | |
| Srini | | |
| Changbing | Yang | cyang@edwardsaquifer.org |
| Genell | Hobbs | kinneyh2o@att.net |
| Diana | Thomas | scuwcd@verizon.net |
| Olga | Bauer | olga.bauer@twdb.texas.gov |
| Meredith | Allen | |
| Joseph | DuMenil | joedum75@gmail.com |