Water in Texas

The Meadows Center
for Water and the Environment
Texas State University


A Global Issue

OUR MISSION

Inspiring research and leadership that ensures clean, abundant water for the environment and all humanity.

RESEARC
H

EDUCATIO
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STEWARDSHI
P

LEADERSHIP

The Meadows Center for Water and the Environment
Texas State University

Texas Stream Team

- Citizen Scientist Water Quality Monitoring
- Water Resource Education

To promote:

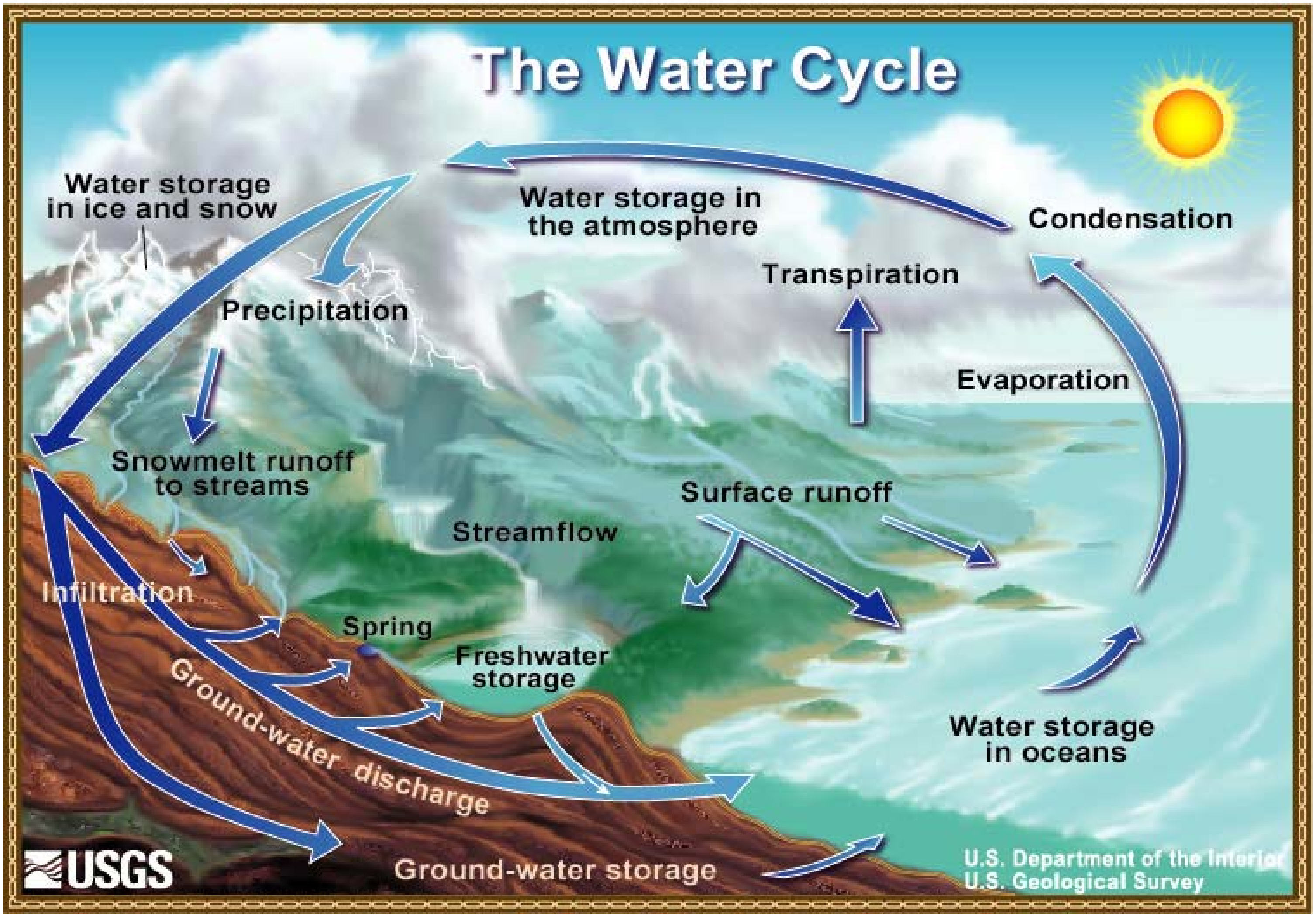
- Water Quality Education
- Non-point Source Pollution Reduction
- Watershed Awareness
- Environmental Stewardship

TCEQ

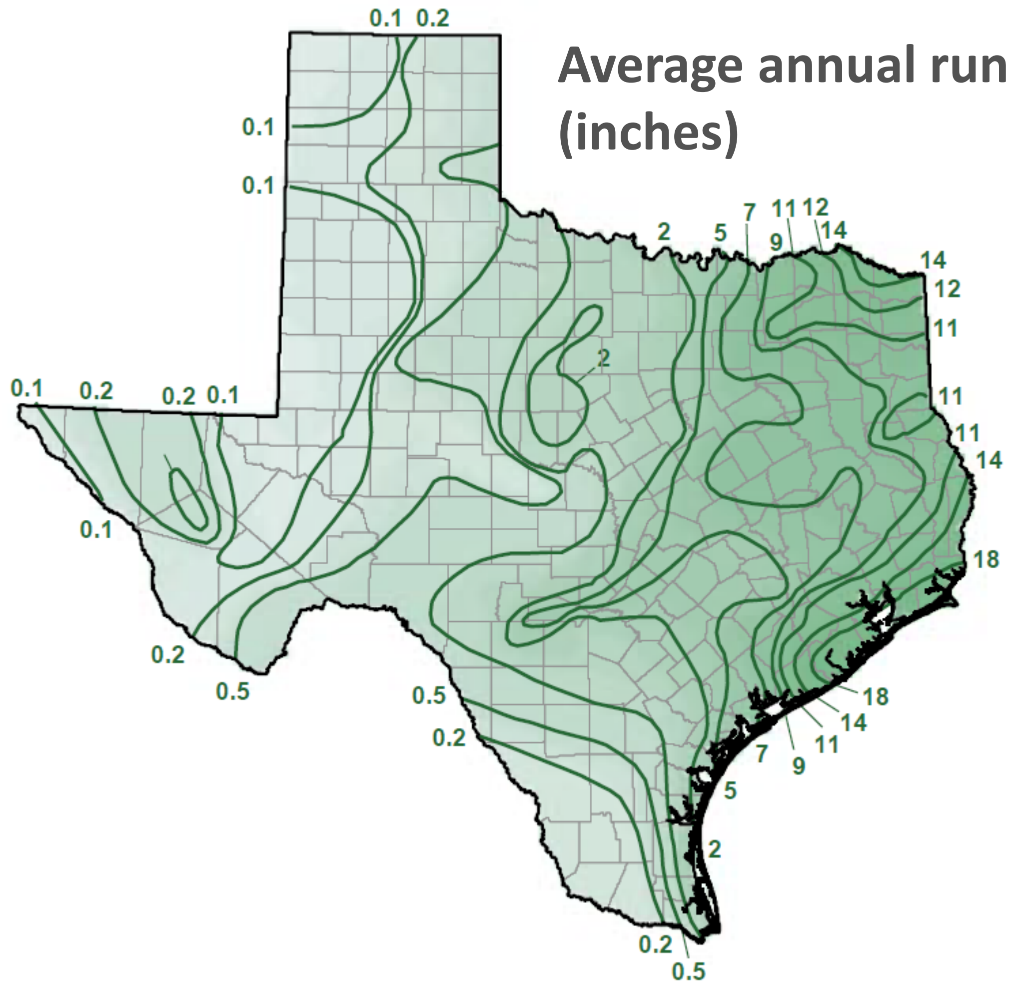
EPA United States Environmental Protection Agency

Texas Stream Team Citizen Science Programs

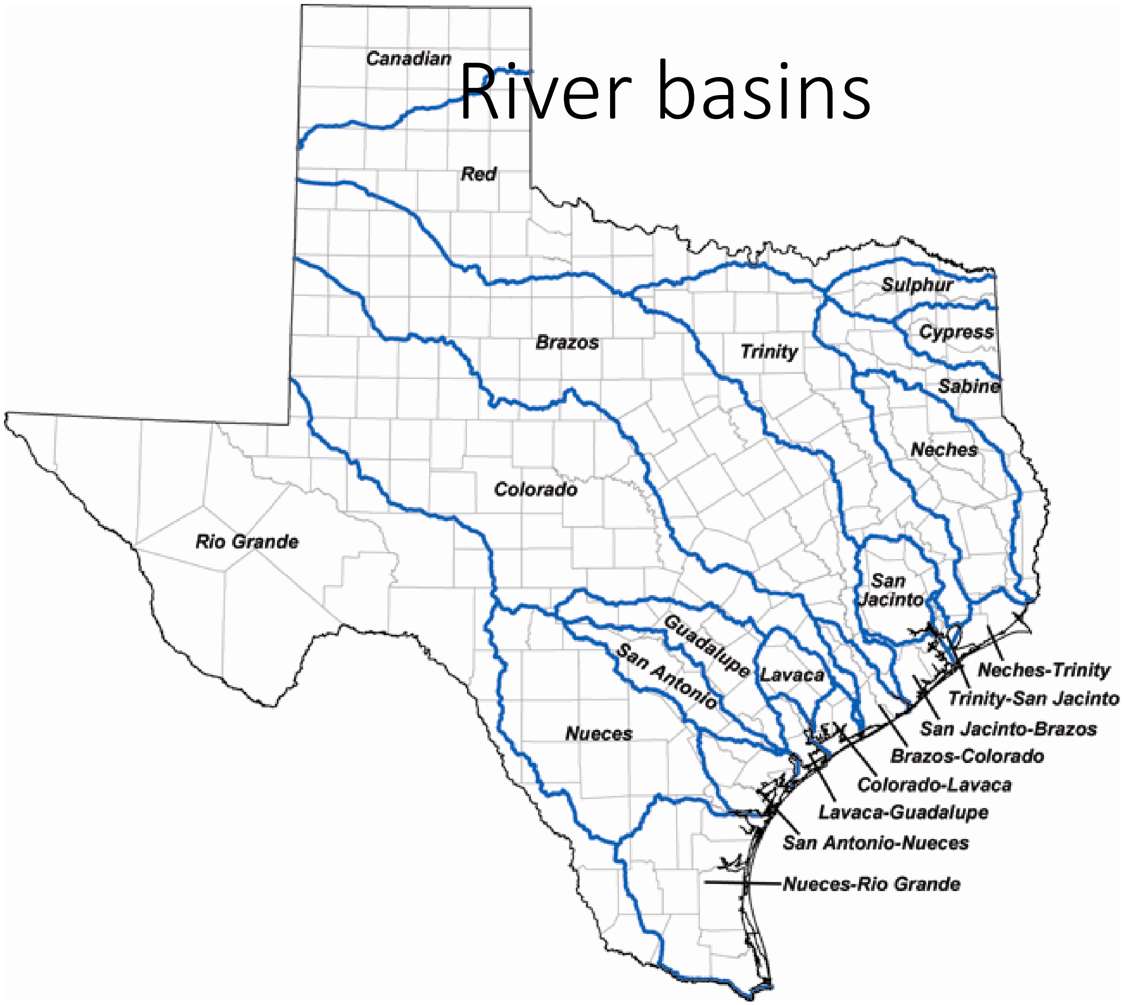
- ✓ Standard Core Water Quality Monitoring
- ✓ Probe Core Water Quality Monitoring
- ✓ Advanced Water Quality Monitoring
- ✓ Riparian Evaluation
- ✓ Macroinvertebrate Bioassessment
- ✓ Angler & Monofilament Finders


The Water Cycle
Water storage in ice and snow
Water storage in the atmosphere
Condensation
Transpiration
Precipitation
Evaporation
Snowmelt runoff to streams
Surface runoff
Streamflow
Infiltration
Spring
Freshwater storage
Ground-water discharge
Water storage in oceans
USGS
Ground-water storage
U.S. Department of the Interior
U.S. Geological Survey

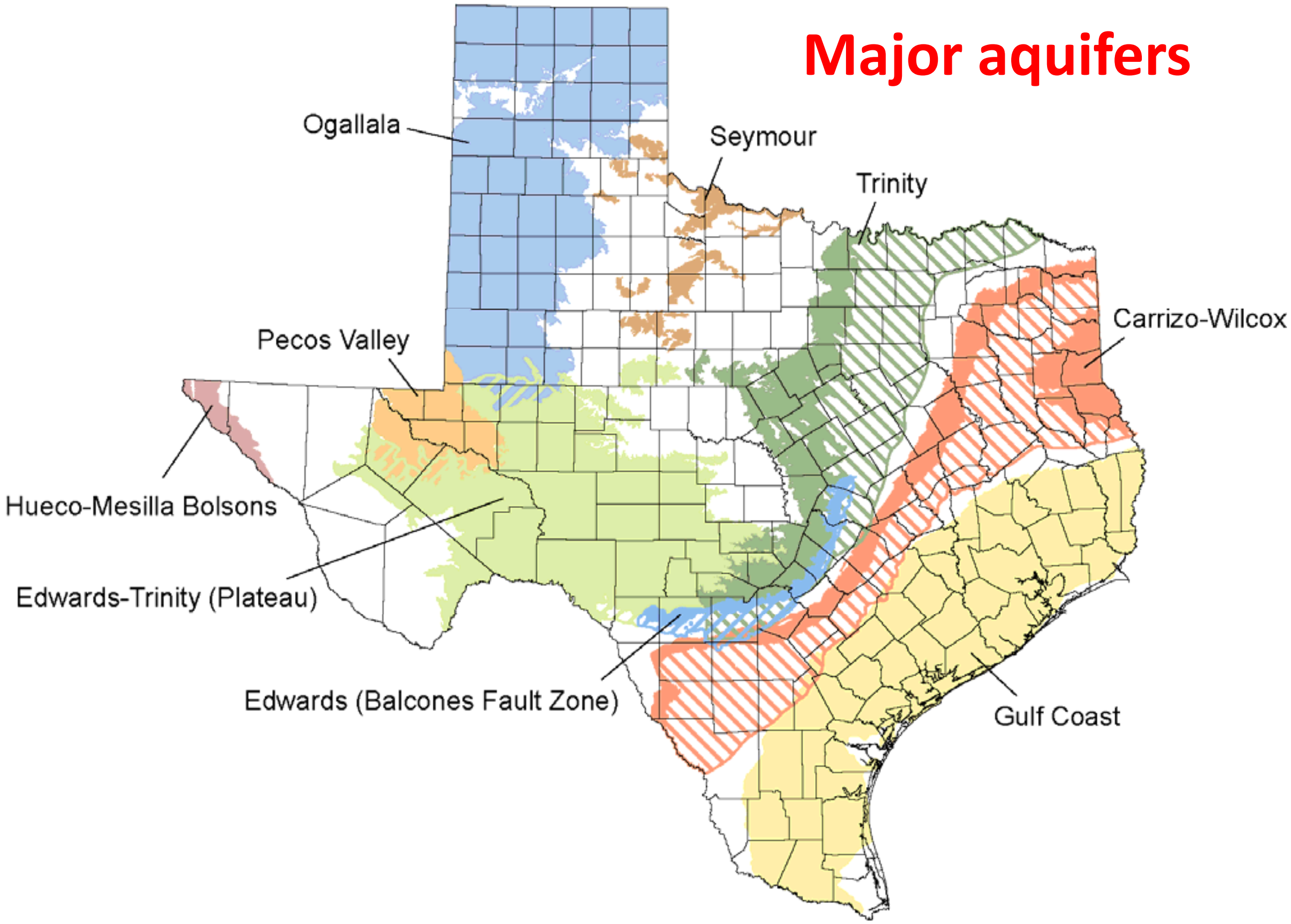
Average annual runoff (inches)



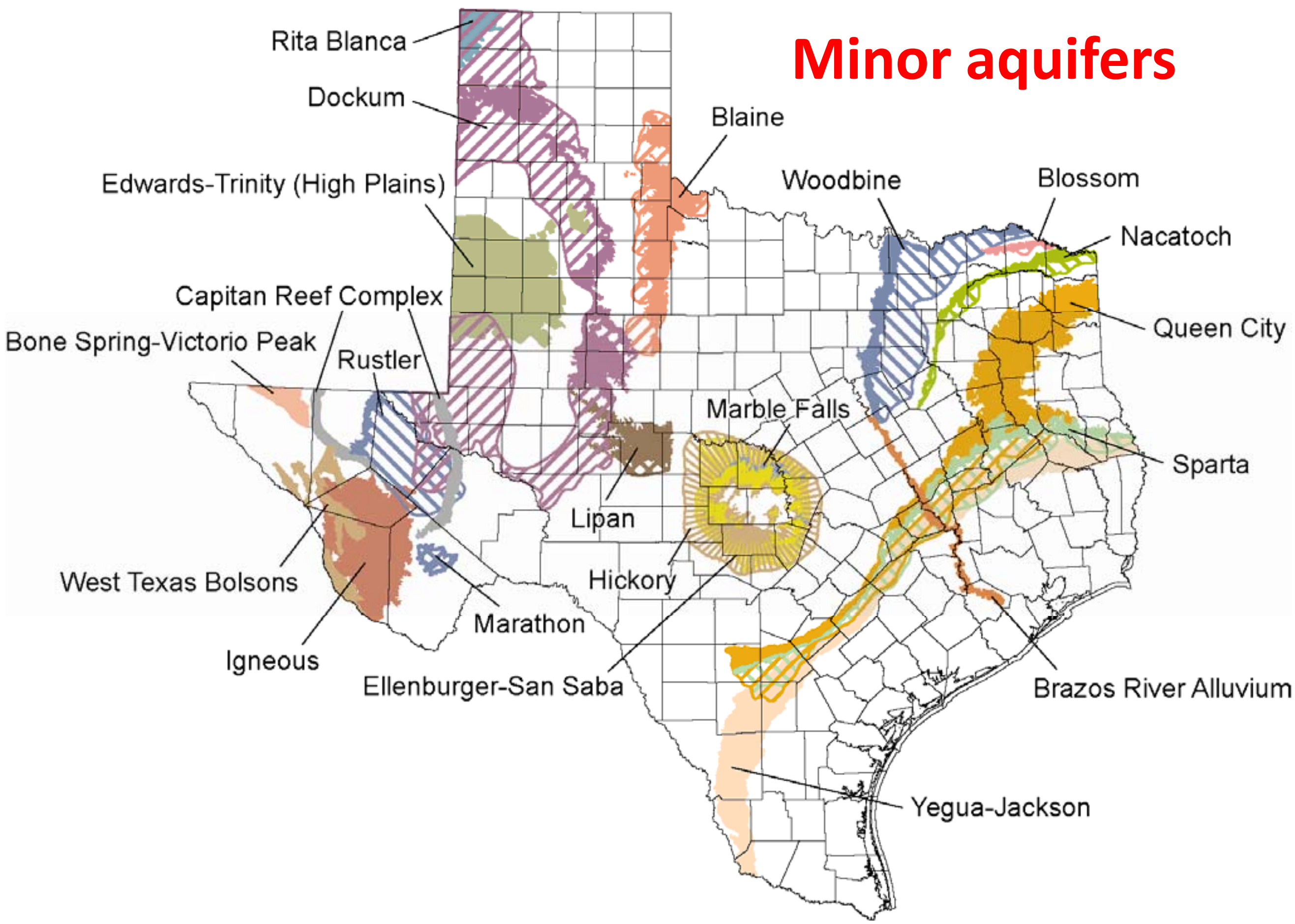
River basins

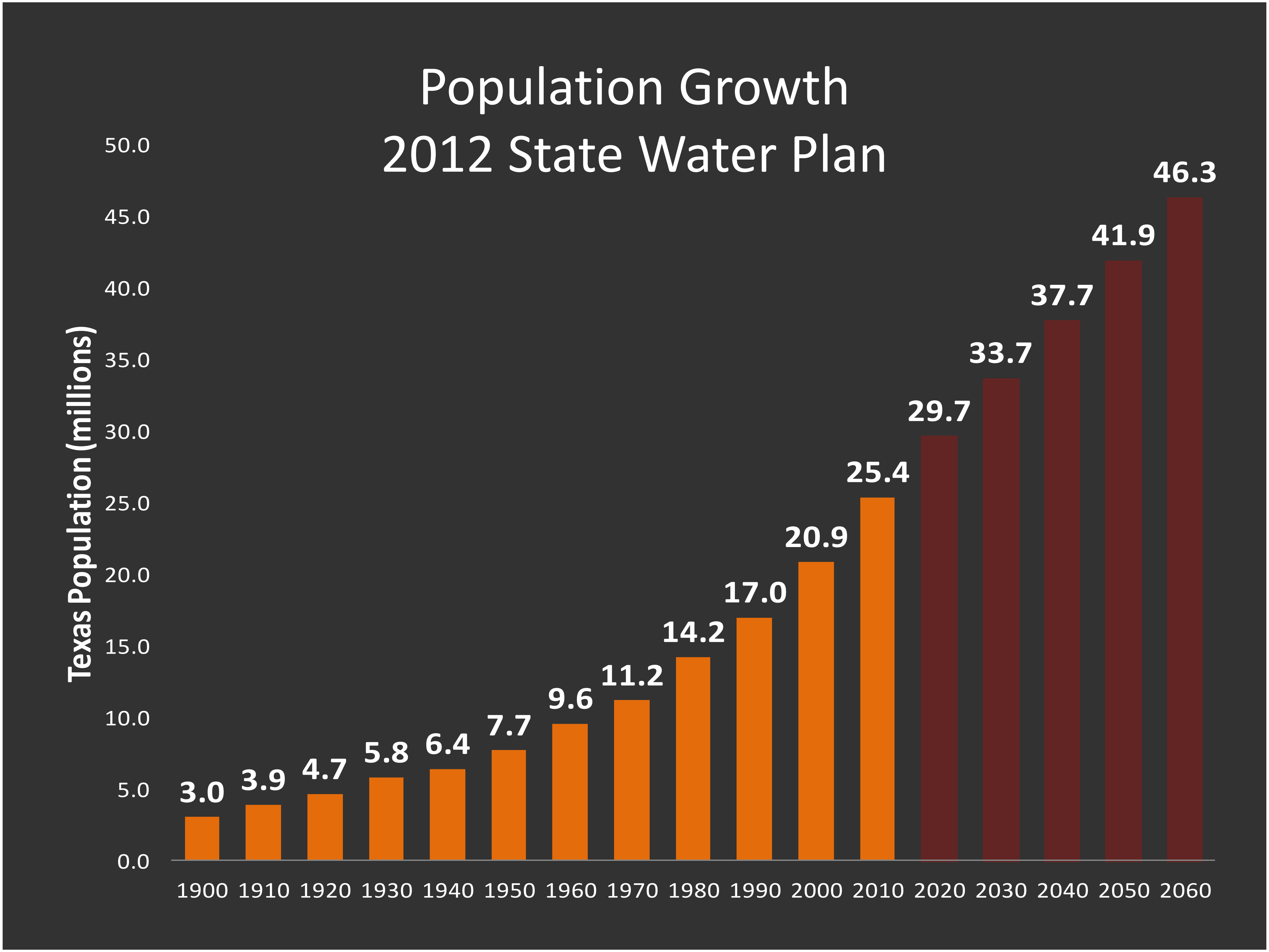


Major aquifers

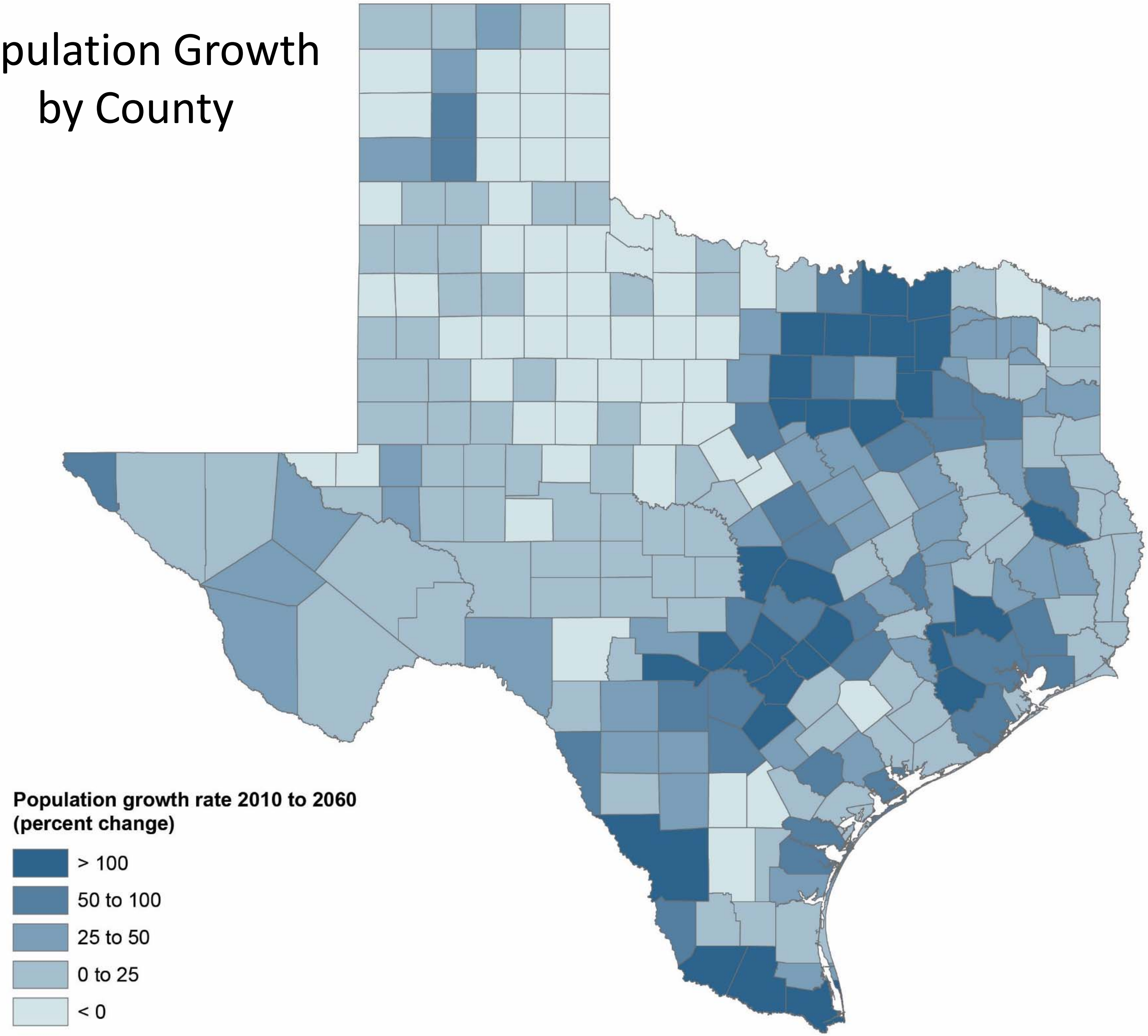


Minor aquifers



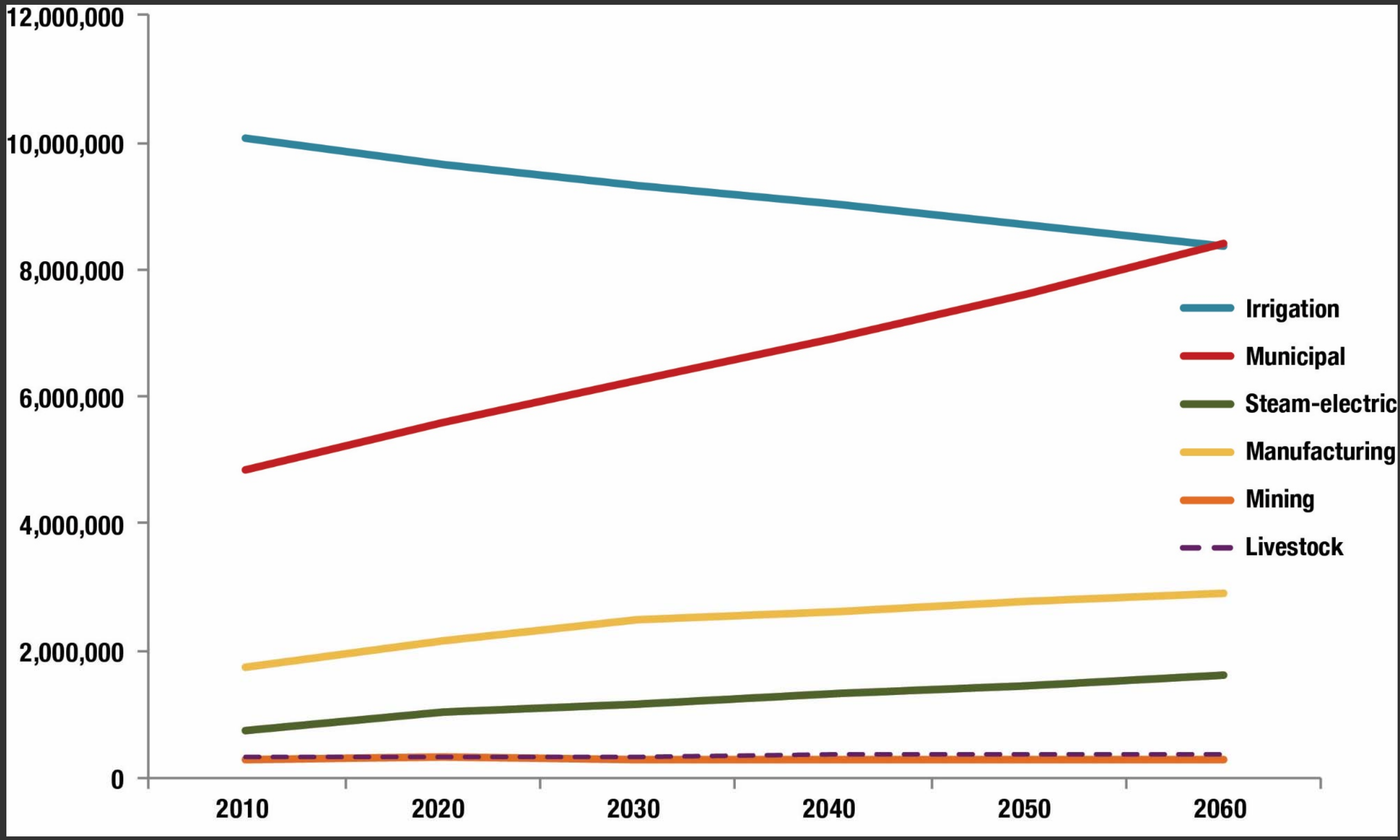

Population Growth
2012 State Water Plan
Texas Population (millions)
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
3.0
3.9
4.7
5.8
6.4
7.7
9.6
11.2
14.2
17.0
20.9
25.4
29.7
33.7
37.7
41.9
46.3
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060

Population Growth by County

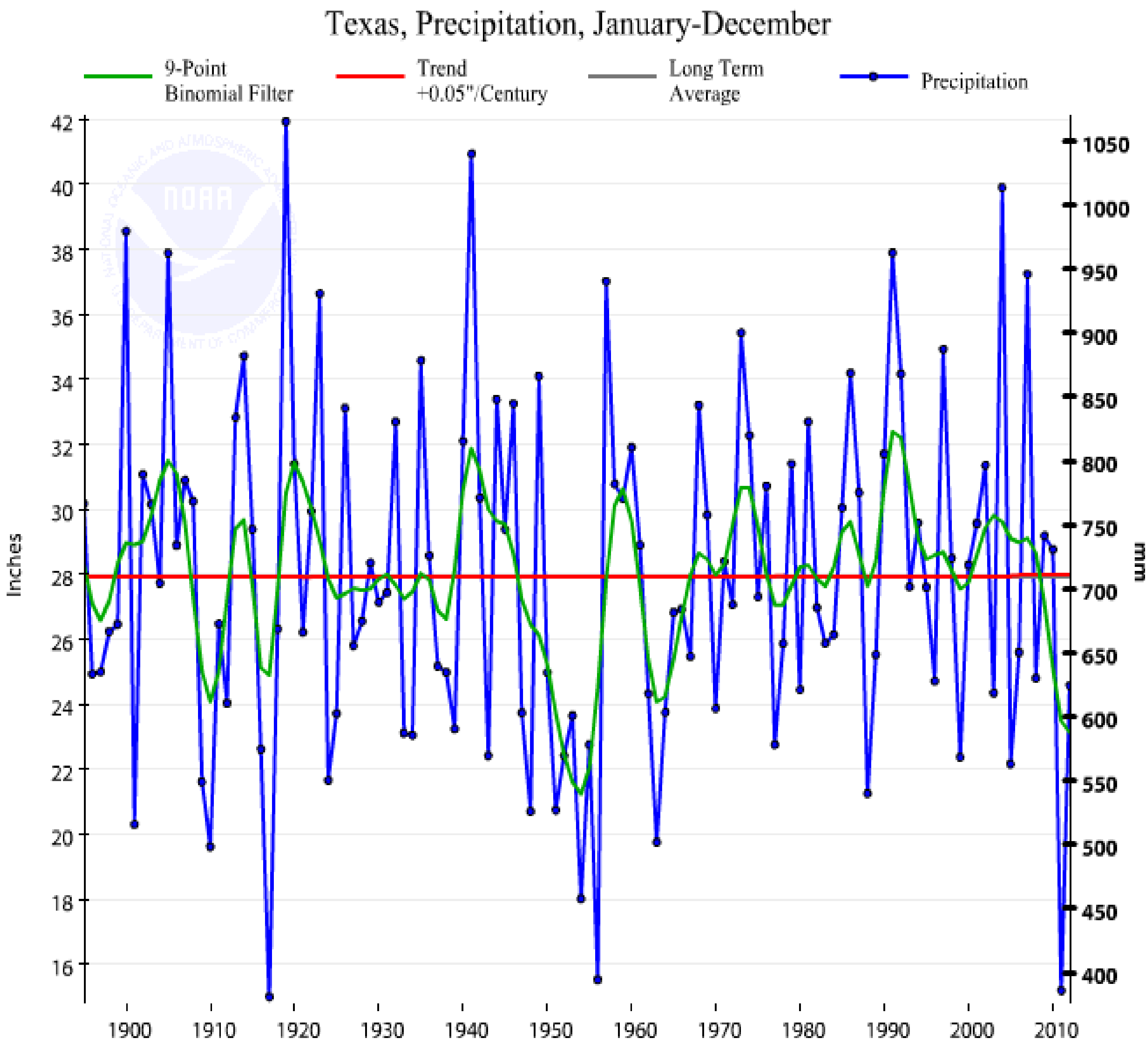



http://www.texastribune.org/tribpedia/environmental-problems-and-policies/?page=5

Water Demand Projections (acre-ft per year)



The Drought of Record


Texas, Precipitation, January-December
9-Point Binomial Filter
Trend +0.05"/Century
Long Term Average
Precipitation
Inches
mm
42
40
38
36
34
32
30
28
26
24
22
20
18
16
1050
1000
950
900
850
800
750
700
650
600
550
500
450
400
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010


55

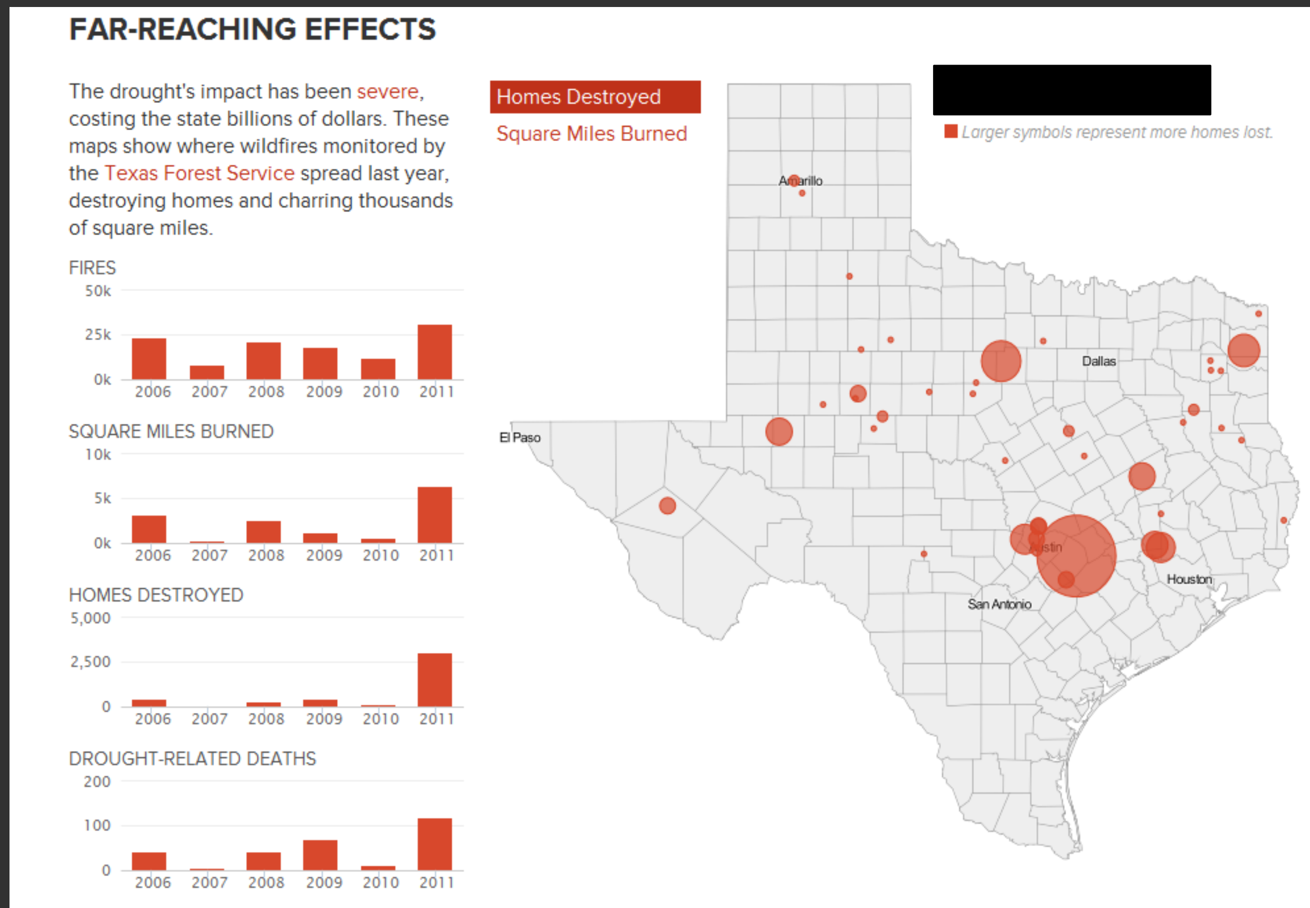
2011 Drought Impacts

$7.62 Billion in Agricultural Losses

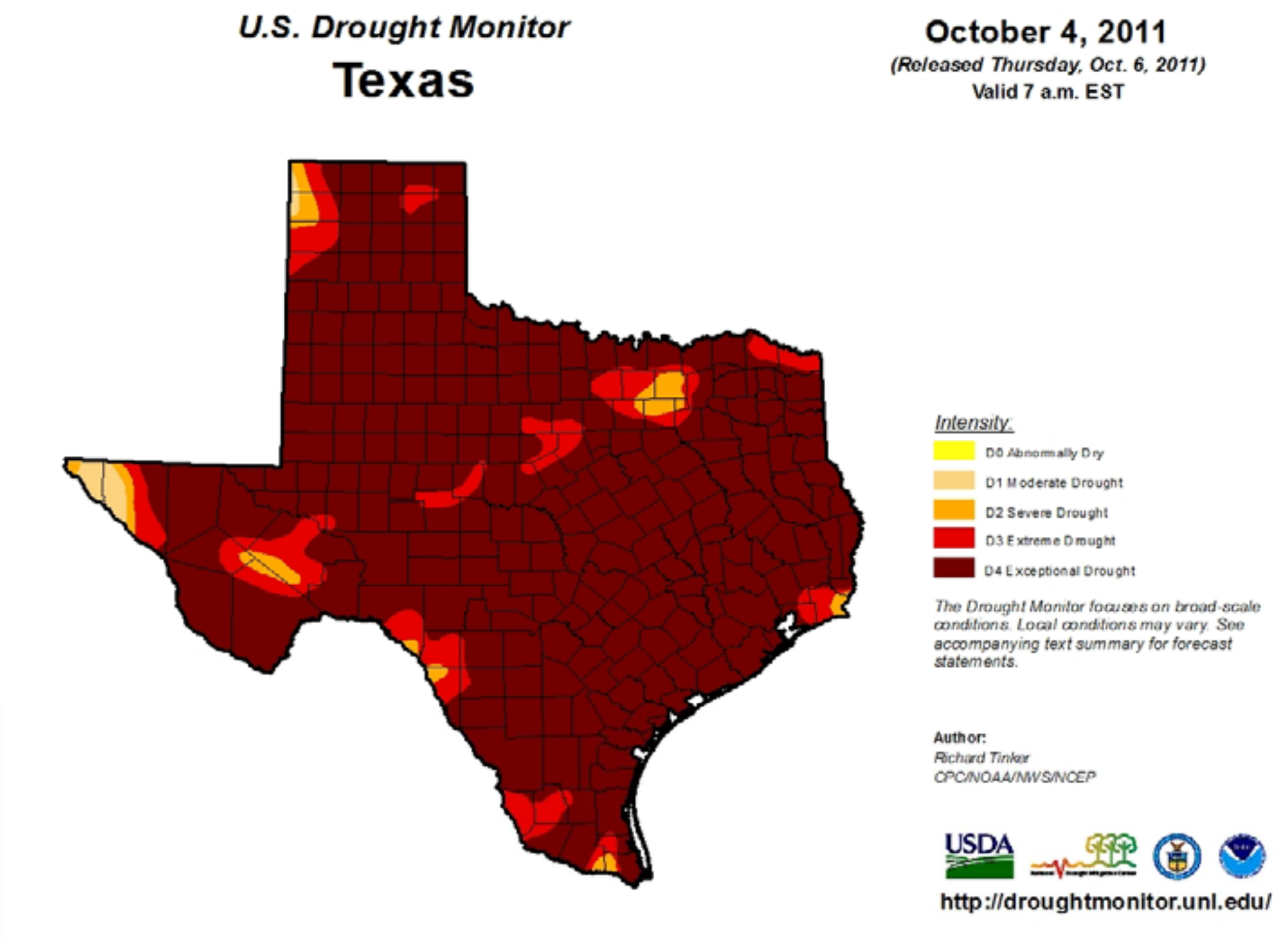
115,000 Jobs

2500 Homes Burned

No End in Sight



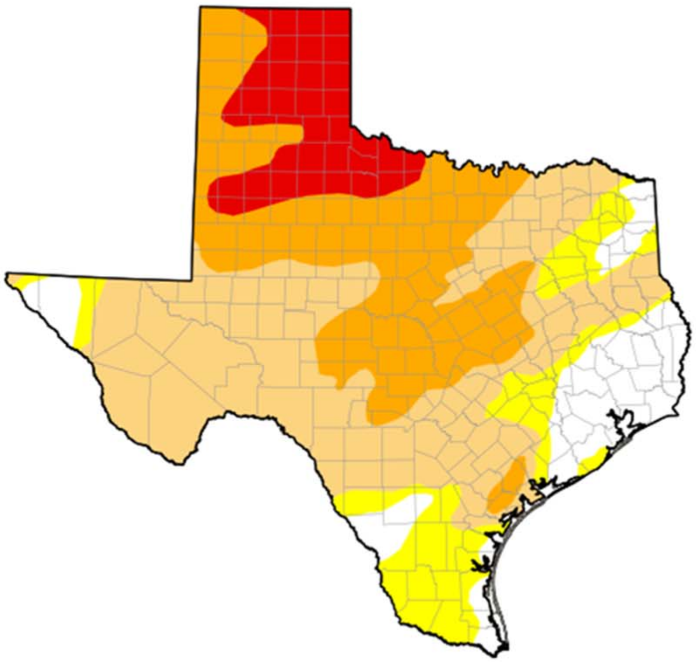
http://stateimpact.npr.org/texas/drought/


U.S. Drought Monitor
Texas
October 4, 2011
(Released Thursday, Oct. 6, 2011)
Valid 7 a.m. EST
Intensity:
D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.
Author:
Richard Tinker
CPC/NOAA/NWS/NCEP
USDA
http://droughtmonitor.unl.edu/

Things Have Improved

- In 2015, the most severe drought conditions in Texas receded
- Reservoir storage in Texas as a whole average 86% full

Drought Monitor map of Texas for the week ending 2018-02-20



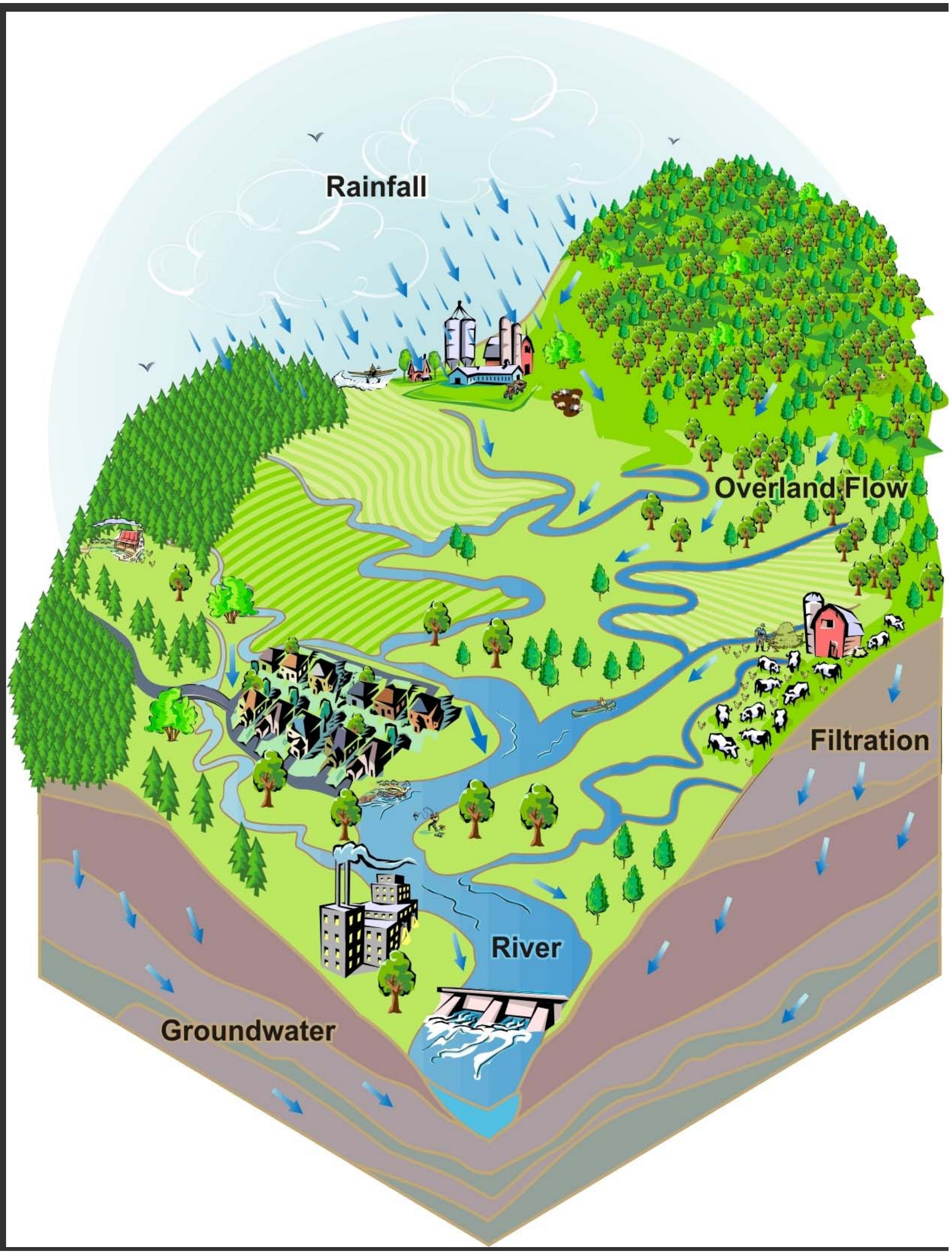
	D0 - Abnormally Dry	88.10% of Texas
	D1 - Moderate Drought	70.76% of Texas
	D2 - Severe Drought	37.56% of Texas
	D3 - Extreme Drought	11.13% of Texas
	D4 - Exceptional Drought	0.00% of Texas
	No Drought	11.90% of Texas

Drought Monitor classes are cumulative - if a region is in D2, it is also in D1 and D0. The statistics above represent these cumulative values. Also, note that class D0 - Abnormally Dry is not technically drought and represents a transition into or out of drought conditions.

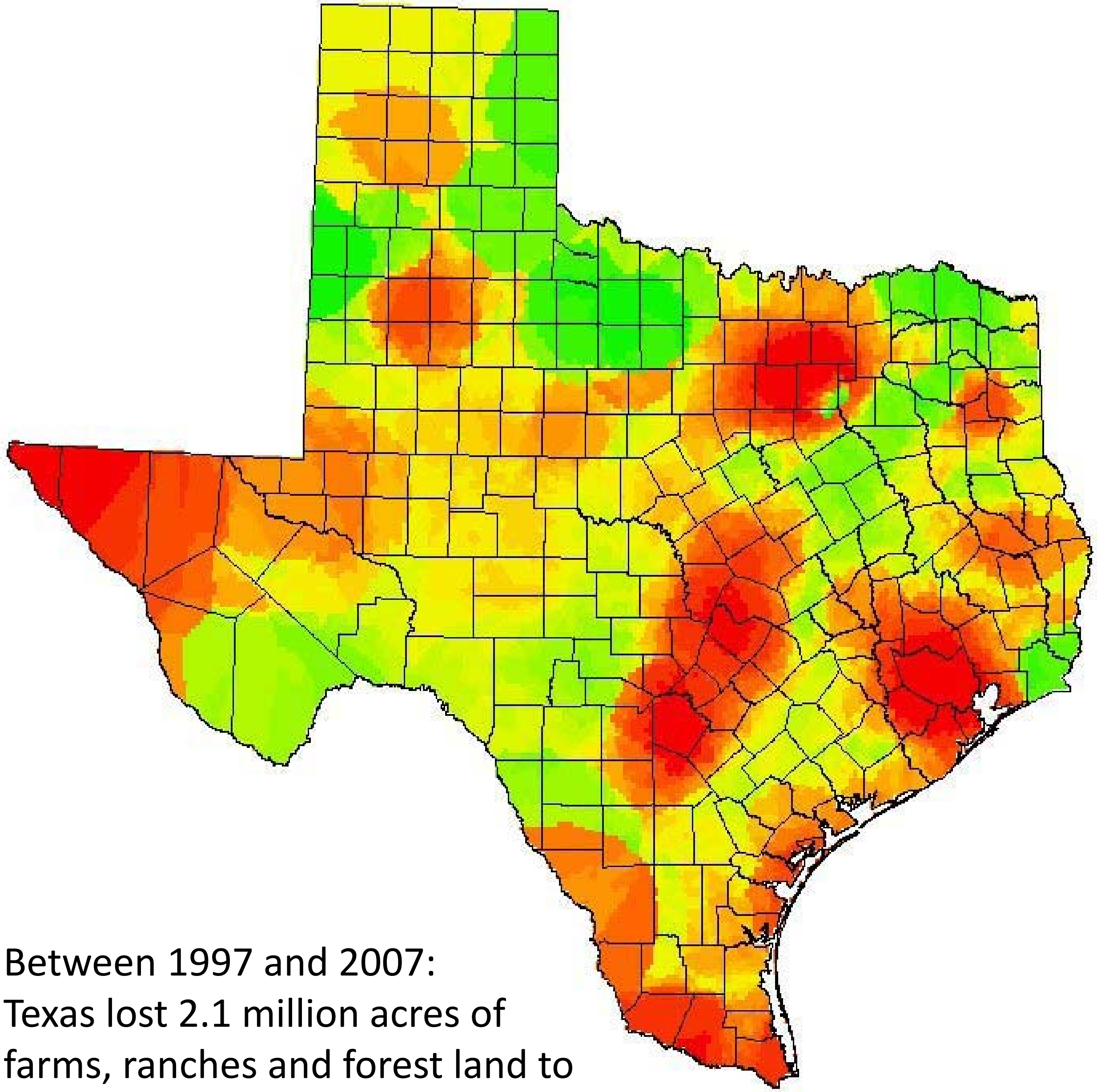

WHAT CAN WE DO?


We can’t build our way out of this

All of Our Watersheds and Recharge Zones Are On Private Land



direct recharge



Between 1997 and 2007:
Texas lost 2.1 million acres of farms, ranches and forest land to other uses

Texas

loses more land from rural uses each year

than any other state

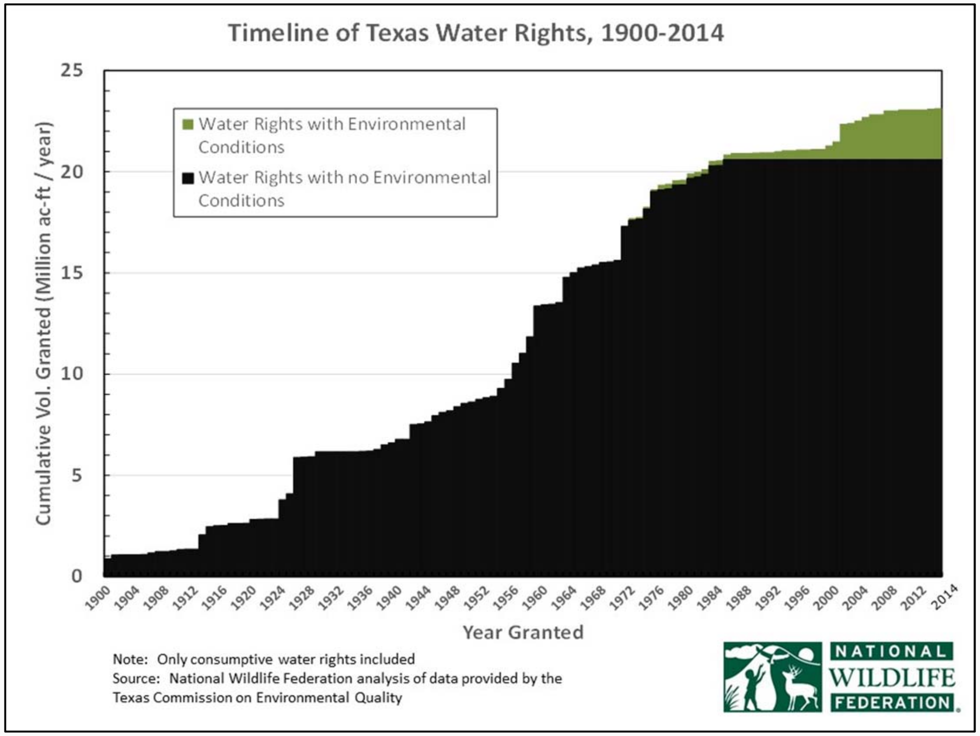

The number one water quality threat in Texas is from
nonpoint source pollution

Water Conservation Stamp issued in 1960


Conserved Water is Expected to Make Up 1/3 of the Municipal Water Supply in Texas
The Easiest Water for Us to Get is the Water We Already Have

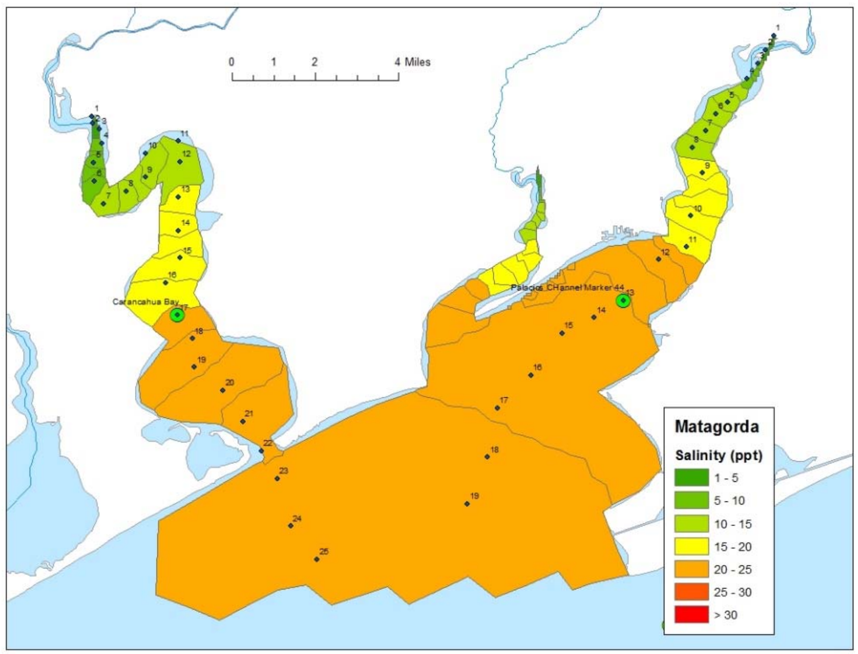

Environmental Flows

Texas needs environmental flows

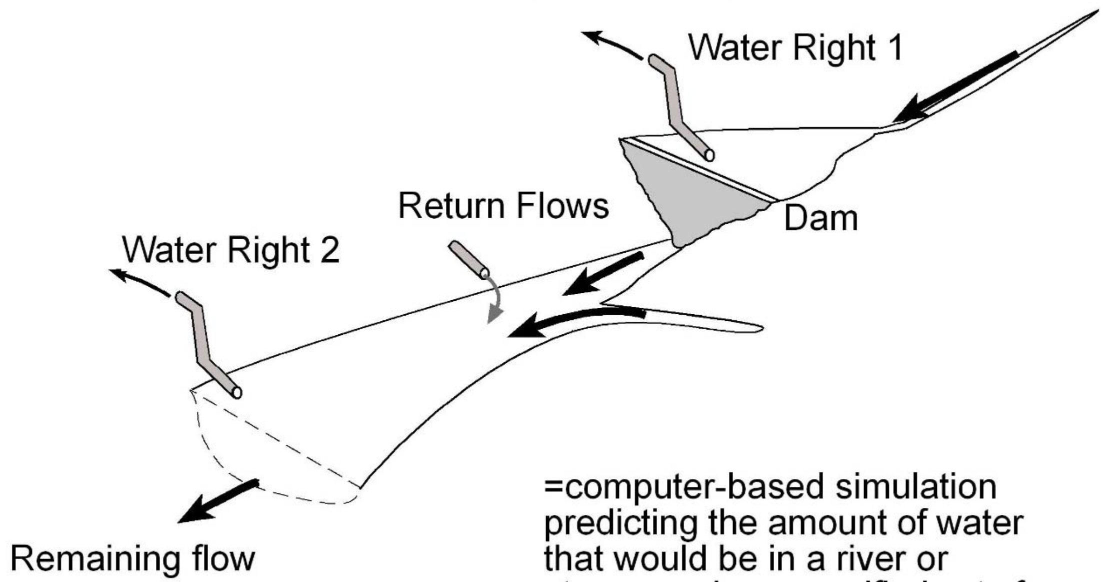


- Only **ten percent** of water rights consider environmental flows
- Senate Bill 3 does not address flows for **historic water rights**

DETERMINE RELATIONSHIP BETWEEN INFLOWS AND SALINITY

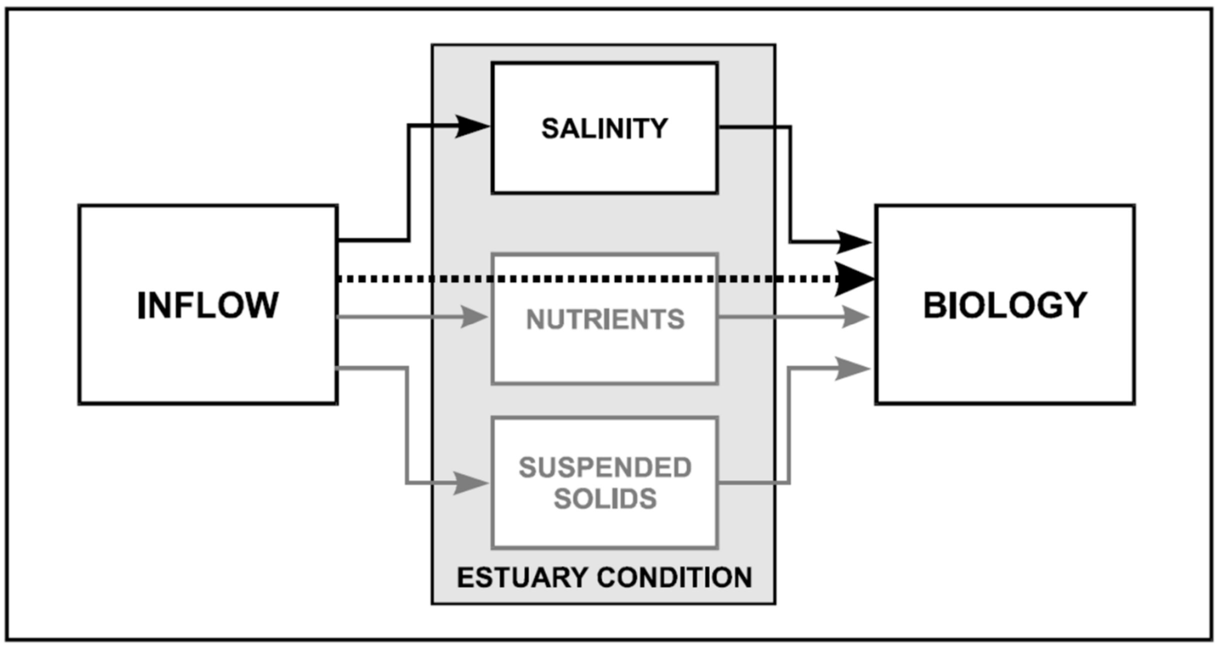


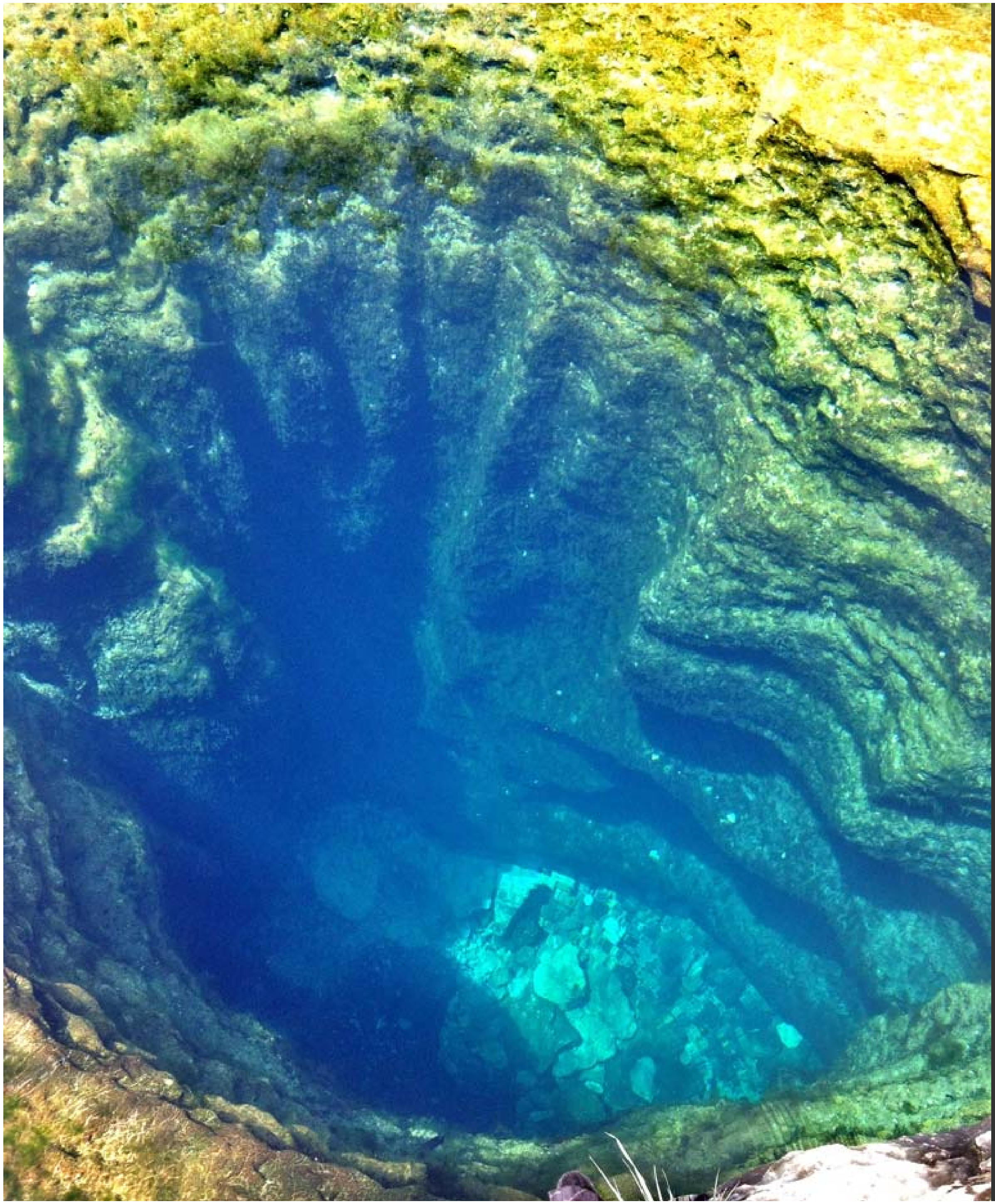
ASSESS THE RELIABILITY OF THE WATER RIGHT



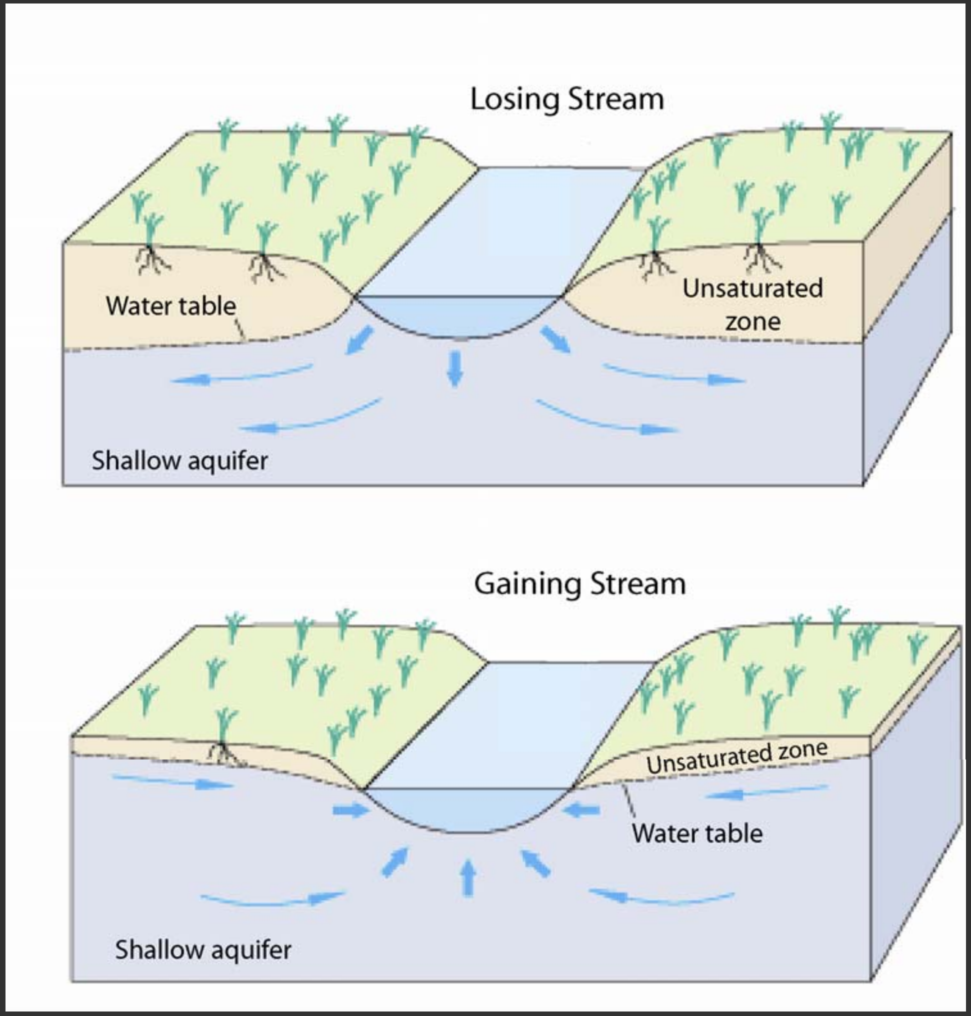
=computer-based simulation predicting the amount of water that would be in a river or stream under a specified set of conditions

ASSESS THE ECOLOGICAL BENEFITS OF CANDIDATE WATER RIGHTS

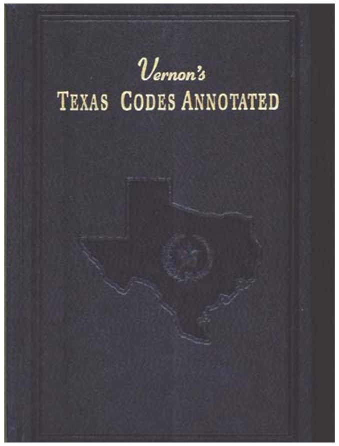




Surface Water and Groundwater Management


Losing Stream
Water table
Unsaturated zone
Shallow aquifer
Gaining Stream
Unsaturated zone
Water table
Shallow aquifer

USGS



Water Code

- **State water**
  - **Rivers, streams, lakes, bays, storm water, and floodwater**
  - **Includes "underflow"**
- **Groundwater**
  - **"…water percolating below the surface of the earth."**

KEY RESEARCH TAKE-AWAYS (2014-2017)

- ~23% of annual inflow to Lake Travis comes from Pedernales River with half of this inflow originating from groundwater.
- The river is in relatively good shape.
- Land cover has not changed significantly.
- The Pedernales acts as a groundwater catchment in Southwestern Travis County and Northern Hays County.

Innovation and Technology


2


Water
for
Texas
Water for Texas
Financial assistance
provided by
Texas Water
Development Board

Winners

And Losers


THE MEADOWS CENTER
FOR WATER AND THE ENVIRONMENT
TEXAS STATE UNIVERSITY

Will Small Amounts Of Freshwater Inflow Matter?

Paul Montagna

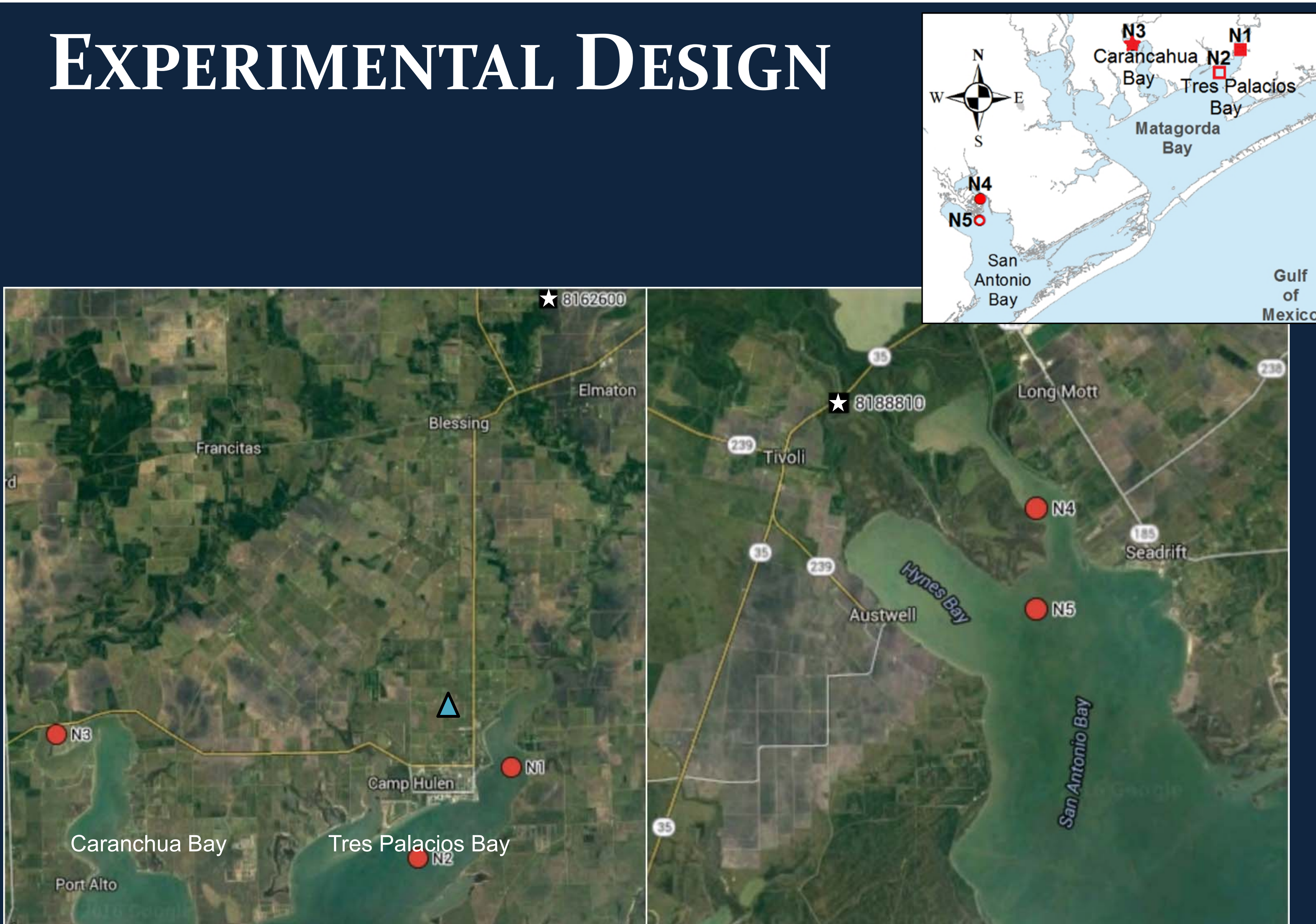
Texas A&M University Corpus Christi

Harte Research Institute for Gulf of Mexico Studies

Acknowledgements

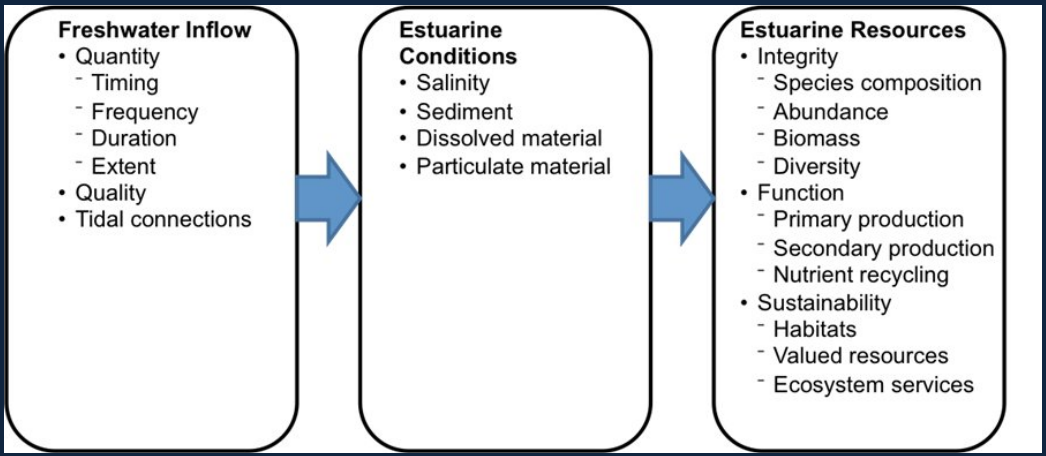
- Part of the NFWF Texas Environmental Flows Initiative
- Results extracted from two Masters Theses:
  - Cheyanne Olson (hydrology and water quality)
  - Hanna Ehrmann (benthos and sediment quality)

EXPERIMENTAL DESIGN



5 Stations in 3 Bays, 12 monthly sampling periods/one year

FRESHWATER INFLOW & WATER QUALITY



“Domino Theory” Source: Montagna et al. 2013

- Many different biological responses within estuaries are affected by water quality, which is effected by inflow
- Inflow drives water quality, which drives ecological health
- The responses can be summarized with multivariate statistics

Analytics Approach

Summarize Flow Data

- Flow = Q

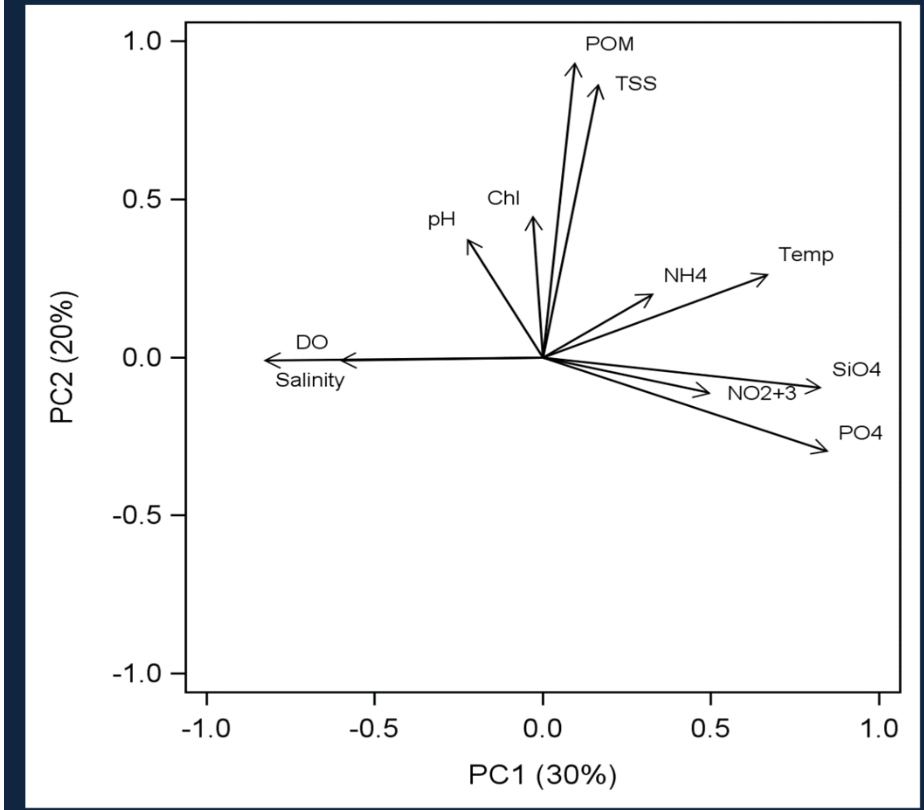
Multivariate Analysis of WQ Data

- FWI index using PC scores

Calculate Flow Required

- $\log(Q+1) = ae^{-bS}$
- Where Q is discharge and S is FWI index

RELATIONSHIPS AMONG WATER QUALITY VARIABLES



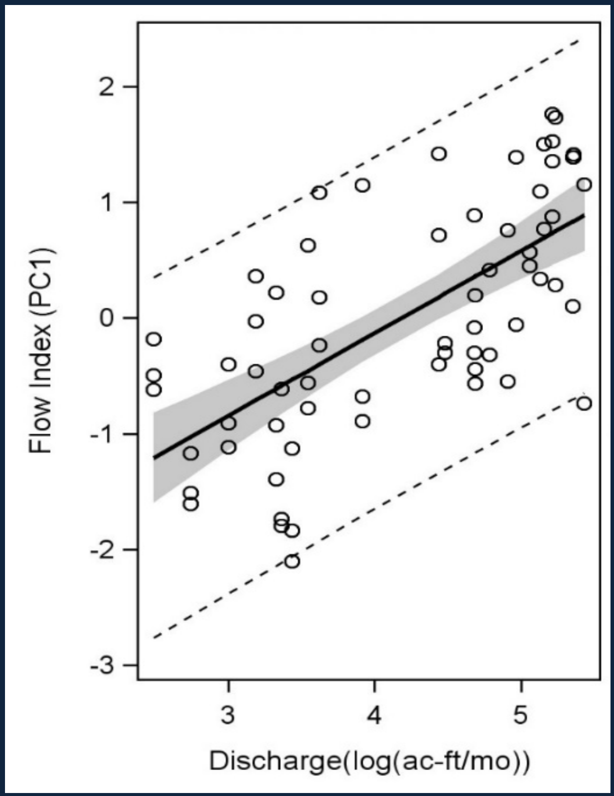
Principal components analysis (PCA) variable loads for hydrographic characteristics using PC1 and PC2, stations N1-N5, from September 2015 to September 2016.

- The first two principal components (PC1 and PC2) explained 30% and 20% respectively for a total of 50% of the variation in hydrographic variables
- The PC1 axis represents a Freshwater Inflow (FWI) index, where a decrease in salinity (or increase in freshwater inflow) is associated with increased nutrient concentrations

WATER QUALITY RESPONSE TO DISCHARGE

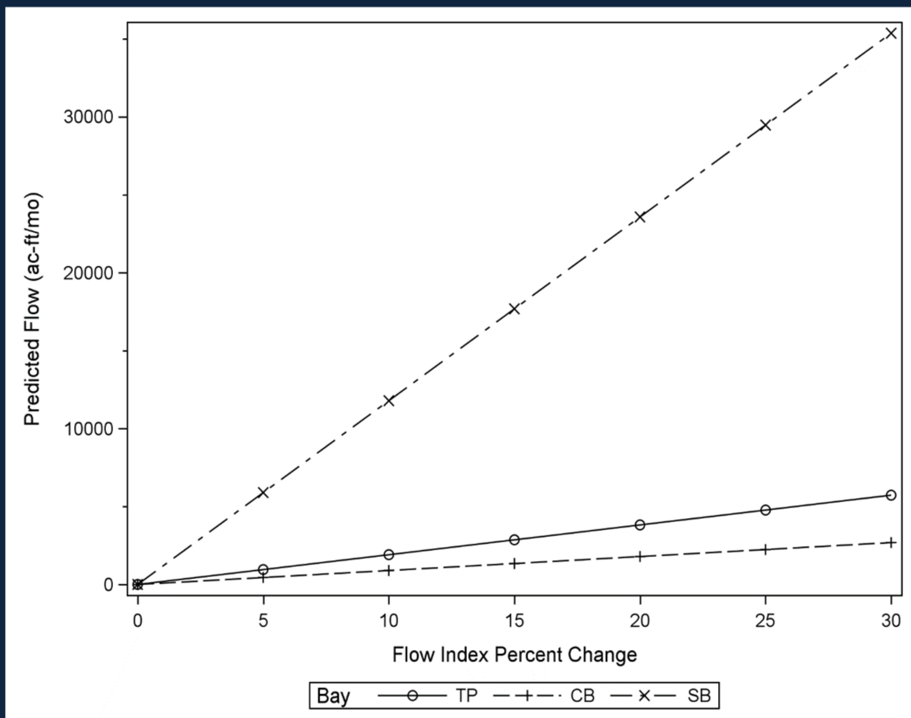
Pearson Correlation Coefficients	
Prob > |r| under H0: Rho=0	
	Discharge(ac-ft/mo)
Salinity (PSU)	-0.58208 **<.0001**
Dissolved Oxygen (mg/L)	0.0982 0.4364
pH	-0.05358 0.6716
Total Suspended Solids (mg/L)	-0.07815 0.5361
Particulate Organic Matter (mg/L)	-0.03466 0.784
Phosphate (µmol/L)	0.44101 **0.0002**
Silicate (µmol/L)	0.49693 **<.0001**
Nitrate + Nitrite (µmol/L)	0.44746 **0.0002**
Ammonium (µmol/L)	0.1064 0.3989
Chlorophyll-*a* (µg/L)	0.04201 0.7397

Pearson correlation coefficients and p values for discharge versus water quality variables



Linear regression on flow index (PC1 sample scores) and log discharge (ac-ft/mo)

FLOW REQUIRED TO MAINTAIN WATER QUALITY



Percent change estimate in flow index (PC1) values and corresponding estimates for flow (ac-ft/mo) at Tres-Palacios Bay, Carancahua Bay, and San Antonio Bay

	Corresponding flow (ac-ft/mo)	
	Tres-Palacios Bay	
Percent Change	Estimate	90% CI
0%	-1	(-1, 0)
5%	954	(554, 1355)
10%	1909	(1109, 2710)
15%	2864	(1664, 4064)
20%	3819	(2220, 5419)
25%	4774	(2775, 6774)
30%	5729	(3330, 8128)
	Carancahua Bay	
Percent Change	Estimate	90% CI
0%	-1	(2, 0)
5%	448	(-83, 981)
10%	896	(-168, 1963)
15%	1344	(-253, 2944)
20%	1792	(-338, 3926)
25%	2241	(-423, 4907)
30%	2689	(-508, 5889)
	San Antonio Bay	
Percent Change	Estimate	90% CI
0%	0	(0, 0)
5%	5894	(4379, 7409)
10%	11788	(8759, 14818)
15%	17683	(13138, 22227)
20%	23577	(17518, 29636)
25%	29471	(21898, 37045)
30%	35366	(26277, 44454)

Percent change estimate in flow index (PC1) values and corresponding estimates for flow (ac-ft/mo)

MANAGEMENT IMPLICATIONS
SIGNIFICANCE OF FINDINGS

- Development of the percent-of-flow-index approach provides a framework for analyzing how specific amounts of diverted flow diverted may alter water quality conditions in specific bays
- It is a generic approach
- We can use this approach to determine the amount of flows that may be needed for diversions to maintain or restore water quality conditions