



# Use of the National Drought Mitigation Center Drought Severity Classification System in the Integrated Report for Clean Water Act Sections 305(b) and 303(d)

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# Use of the National Drought Mitigation Center Drought Severity Classification System

- Texas drought began developing during late Summer 2010
  - As of August 2011, Texas climatologists stated this is worst one-year drought since Texas rainfall data started in 1895

- As part of the 2014 Integrated Report, the TCEQ introduced the concept of using drought information to characterize the impacts on ambient surface water quality - Appendix E in the Guidance for Assessment

- For the 2016 IR, additional statistical analyses will be conducted to identify candidate impairments and better characterize drought impacts

- These analyses will form the basis to justify moving a specific impairment from Category 5c (303(d) List) to Category 4c (water quality impairment not due to a specific pollutant)

# Drought Work Group

- Formed to investigate methods to more objectively evaluate potential effects of drought on in-stream water quality to improve assessments of water bodies under drought conditions
  - Provide drought context surrounding each sample event for every monitoring station and waterbody

# National Drought Mitigation Center

National Drought Mitigation Center (NDMC) based in the School of Natural Resources at the University of Nebraska-Lincoln (UNL).

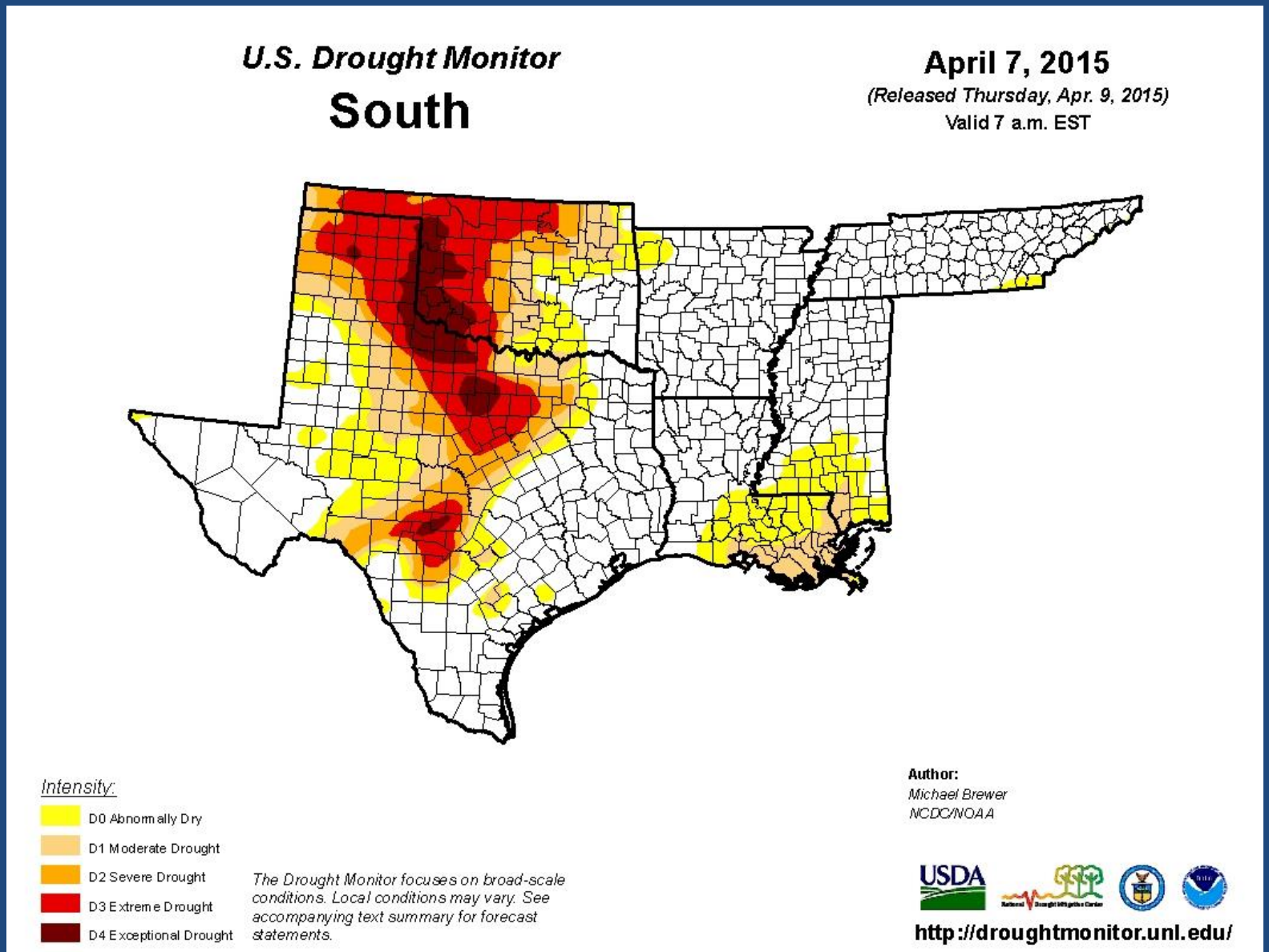
NDMC partner entities include:

- National Integrated Drought Information System (NIDIS)
- National Oceanic and Atmospheric  Administration (NOAA)
- U.S. Department of Agriculture (USDA)
- U.S. Geological Survey (USGS)
- National Climatic Data Center (NDMC)
- National Weather Service (NWS)

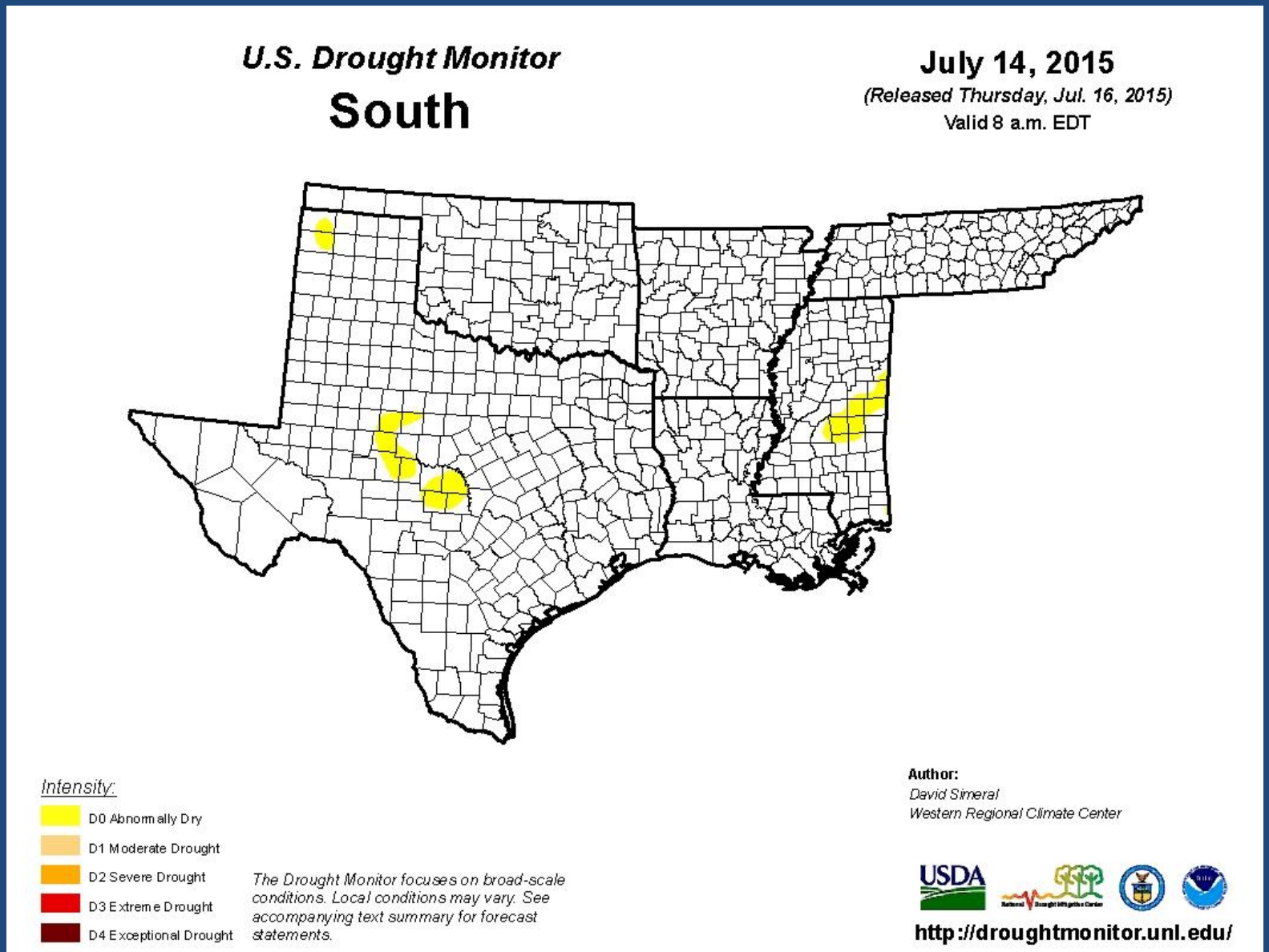
MISSION:  The National Drought Mitigation Center (NDMC) helps people and institutions develop and implement measures to reduce societal vulnerability to drought, stressing preparedness and risk management rather than crisis management.

# U.S. Drought Monitor Classification Scheme: Drought Severity Index

| | | | Ranges | | | | |
|---|---|---|---|---|---|---|---|
| **Category** | **Description** | **Possible Impacts** | **Palmer Drought Index** | **CPC Soil Moisture Model (Percentiles)** | **USGS Weekly Streamflow (Percentiles)** | **Standardized Precipitation Index (SPI)** | **Objective Short and Long-term Drought Indicator Blends (Percentiles)** |
| **D0** | Abnormally Dry | Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered | -1.0 to -1.9 | 21-30 | 21-30 | -0.5 to -0.7 | 21-30 |
| **D1** | Moderate Drought | Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested | -2.0 to -2.9 | 11-20 | 11-20 | -0.8 to -1.2 | 11-20 |
| **D2** | Severe Drought | Crop or pasture losses likely; water shortages common; water restrictions imposed | -3.0 to -3.9 | 6-10 | 6-10 | -1.3 to -1.5 | 6-10 |
| **D3** | Extreme Drought | Major crop/pasture losses; widespread water shortages or restrictions | -4.0 to -4.9 | 3-5 | 3-5 | -1.6 to -1.9 | 3-5 |
| **D4** | Exceptional Drought | Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies | -5.0 or less | 0-2 | 0-2 | -2.0 or less | 0-2 |

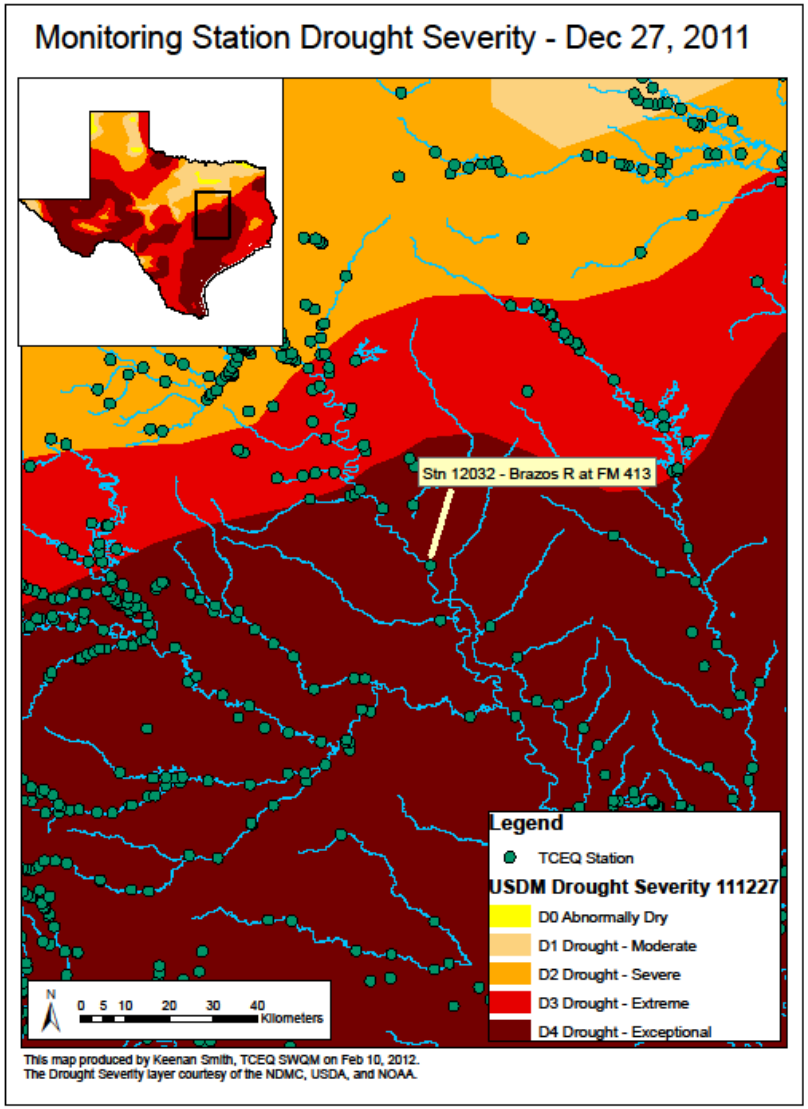


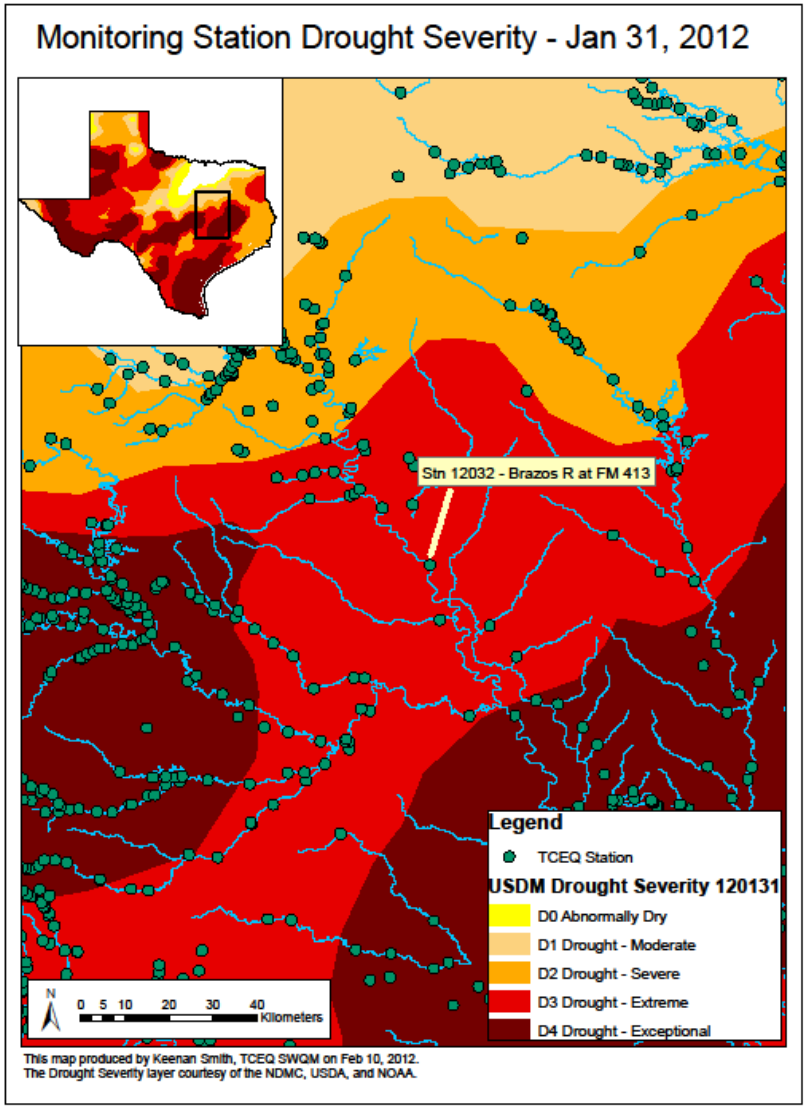

| Week | None | D0-D4 | D1-D4 | D2-D4 | D3-D4 | D4 |
|---|---|---|---|---|---|---|
| **2015-04-07** | 57.24 | 42.76 | 29.46 | 19.85 | 13.10 | 3.50 |



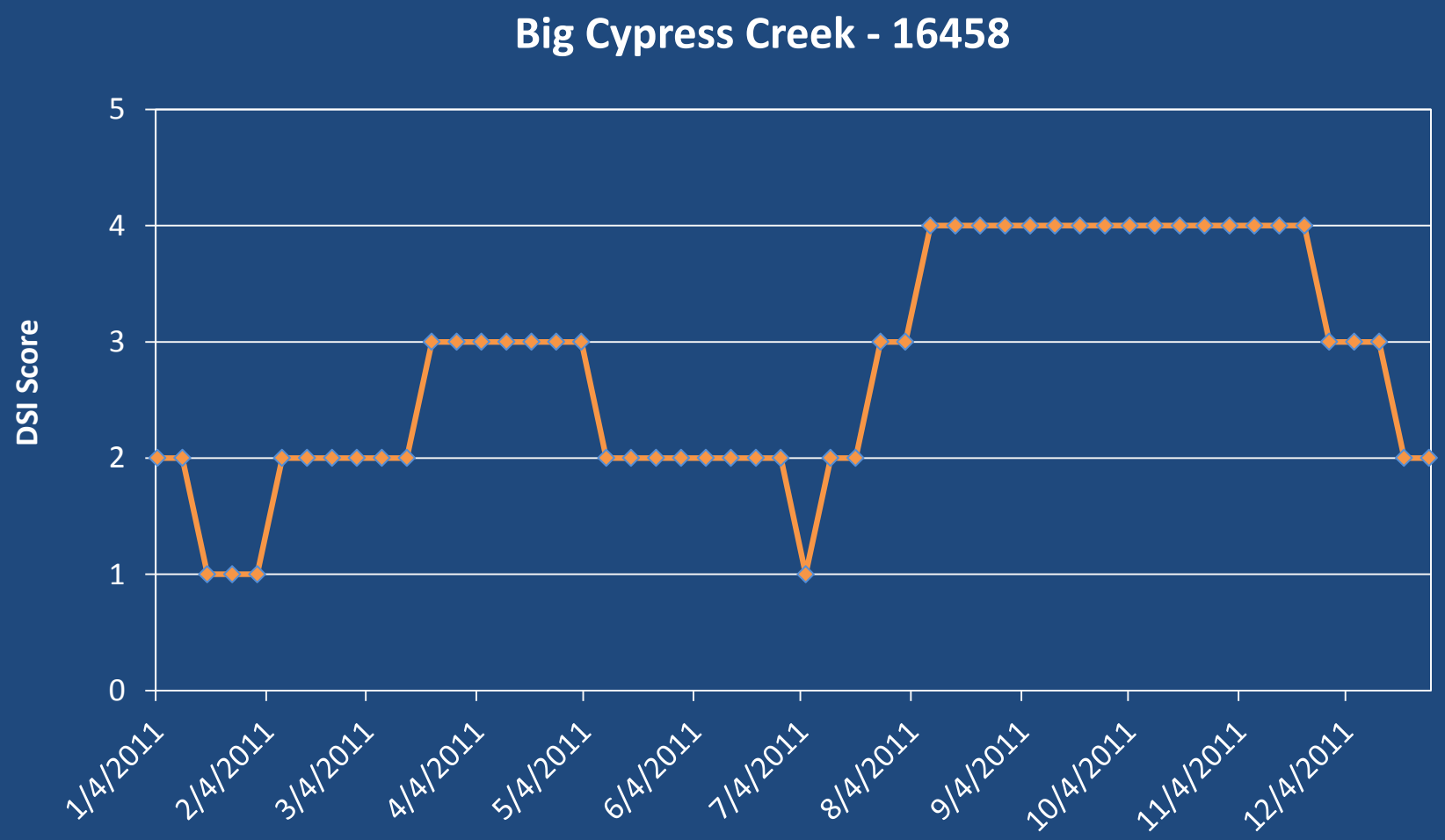

| Week | None | D0-D4 | D1-D4 | D2-D4 | D3-D4 | D4 |
|---|---|---|---|---|---|---|
| **2015-07-14** | 97.77 | 2.23 | 0.01 | 0.00 | 0.00 | 0.00 |

# Texas Drought Severity Index Values Overlaid on TCEQ SWQM Stations and Waterbody Segments

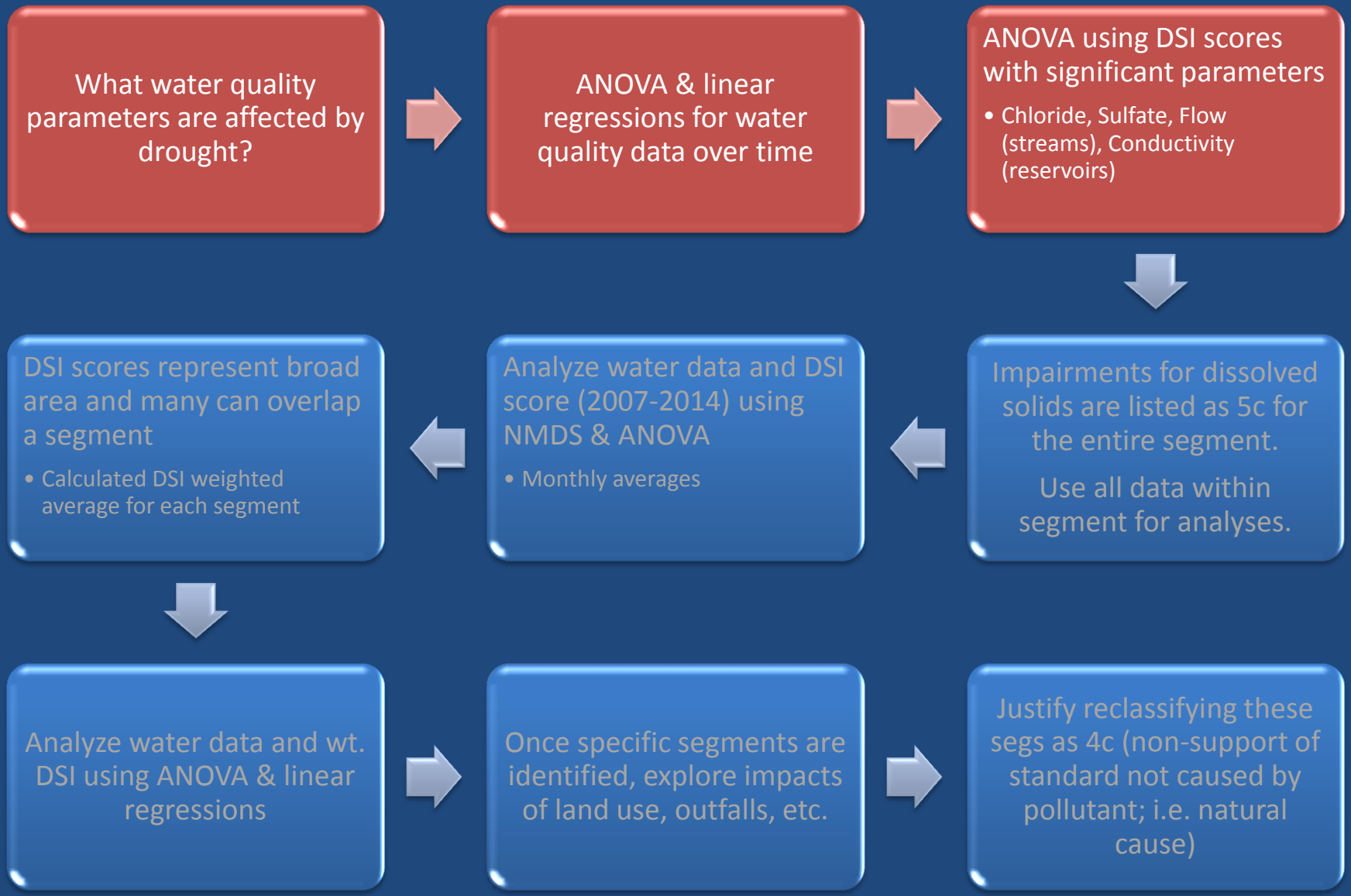


# Drought Severity Index: Tracking Drought Conditions at SWQM Stations Over Time



How do we use the DSI score to inform us about the affects of drought on water quality?


What water quality parameters are affected by drought?
ANOVA & linear regressions for water quality data over time
ANOVA using DSI scores with significant parameters
• Chloride, Sulfate, Flow (streams), Conductivity (reservoirs)
Impairments for dissolved solids are listed as 5c for the entire segment.
Use all data within segment for analyses.
Analyze water data and DSI score (2007-2014) using NMDS & ANOVA
• Monthly averages
DSI scores represent broad area and many can overlap a segment
• Calculated DSI weighted average for each segment
Analyze water data and wt. DSI using ANOVA & linear regressions
Once specific segments are identified, explore impacts of land use, outfalls, etc.
Justify reclassifying these segs as 4c (non-support of standard not caused by pollutant; i.e. natural cause)

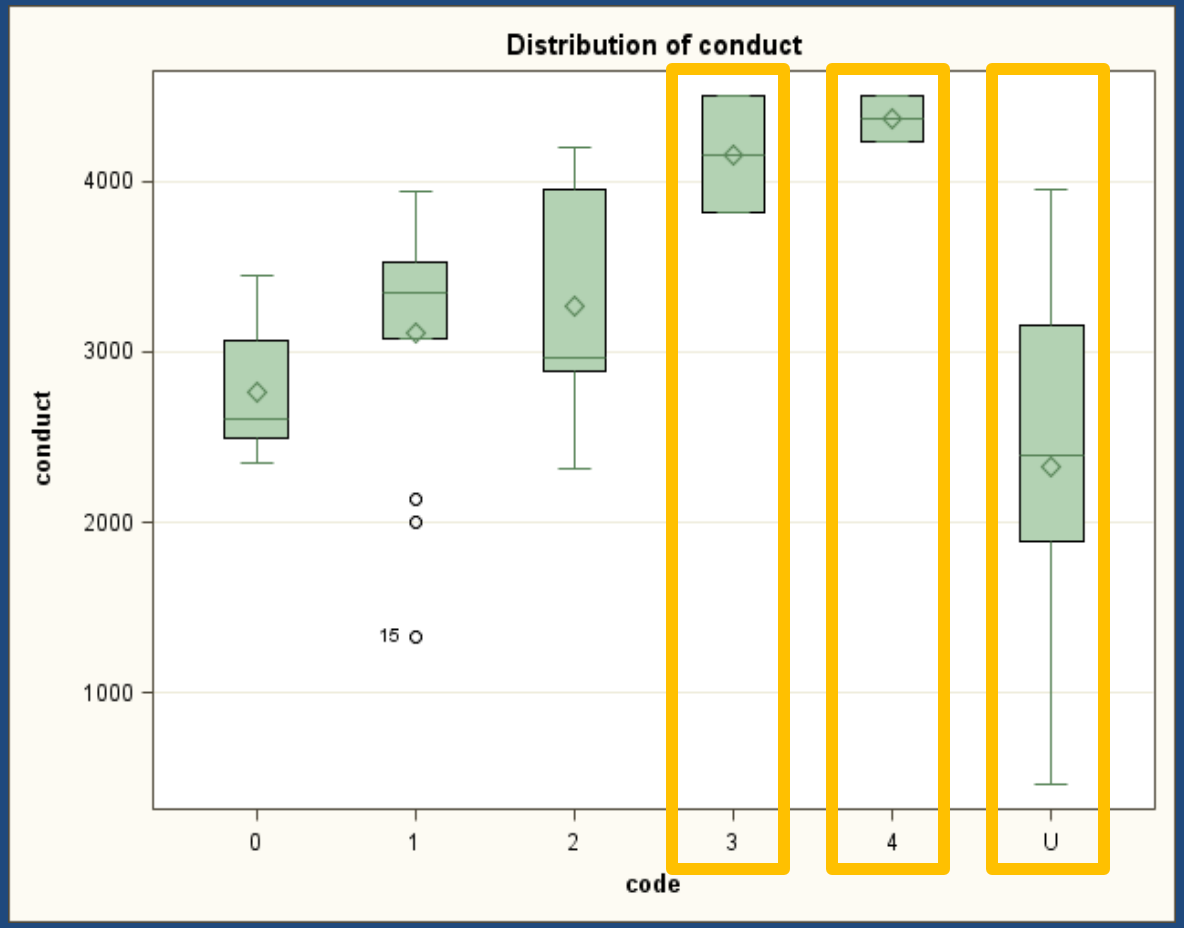
# Initial Exploratory Statistical Analysis of the Relationship Between the DSI Score and TCEQ Surface Water Quality Data

- Can we detect a quantifiable relationship between the DSI Scores and Surface Water Quality Monitoring Data?
  - Is there a statistically meaningful relationship between change in the DSI score and change in water quality parameters?

# Initial Exploratory Statistical Analysis of the Relationship Between the DSI Score and TCEQ Surface Water Quality Data

- Drought Severity Index is categorical not continuous
- Single Factor Analysis of Variance (ANOVA)
  - Drought Severity Index values represent “treatments”
    - Category D0 – Abnormally Dry
    - Category D1 – Moderate Drought
    - Category D2 – Severe Drought
    - Category D3 – Extreme Drought
    - Category D4 – Exceptional Drought

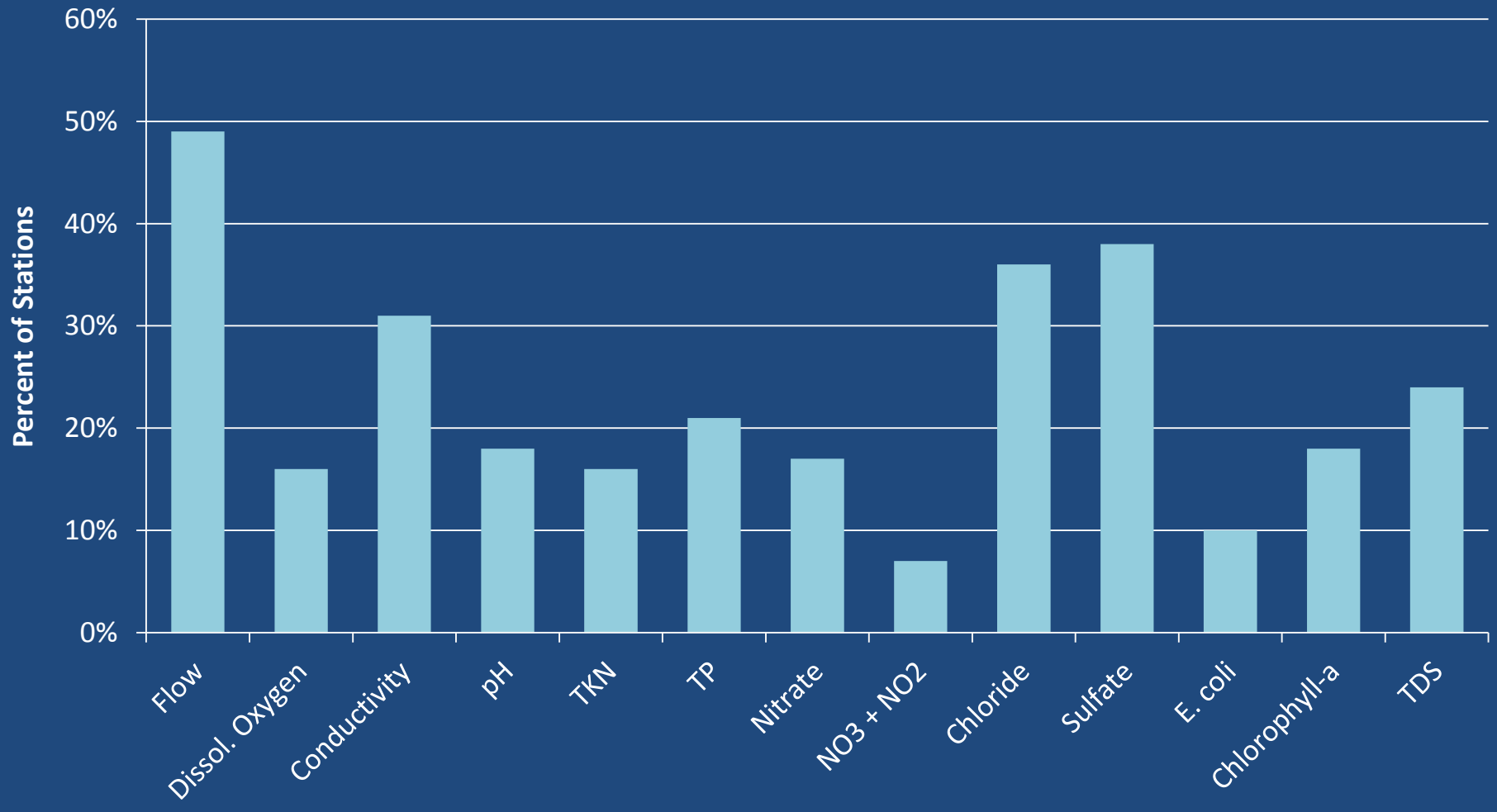
# ANOVA Results for the Effects of Different Levels of Drought Intensity (Treatment) on Conductivity (Response Variable) at TCEQ SWQM Station: 11864, Brazos River at FM 4




Data from 2007-2012; 59 observations

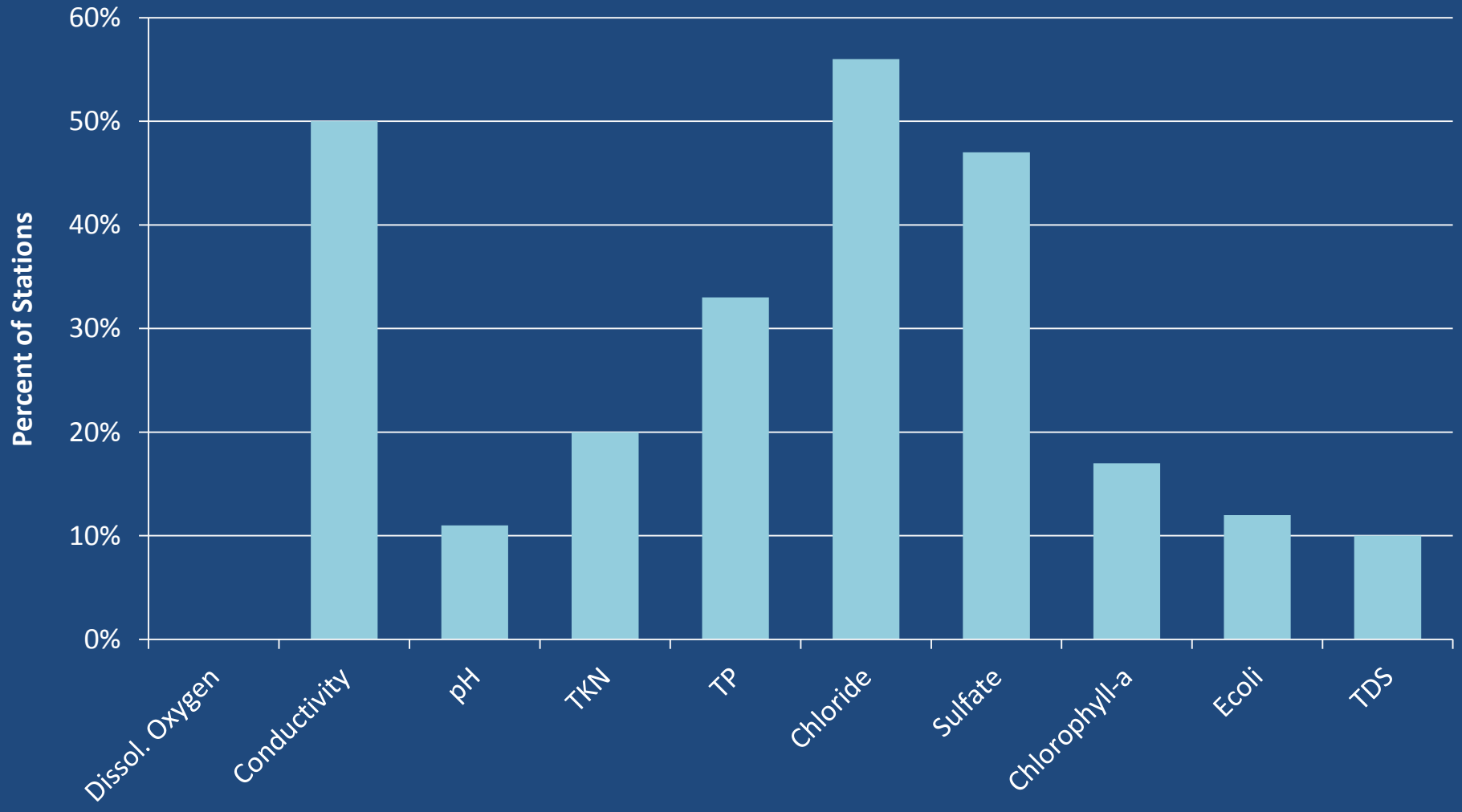
# Rates of Significance by Parameter for 90 Stream Stations

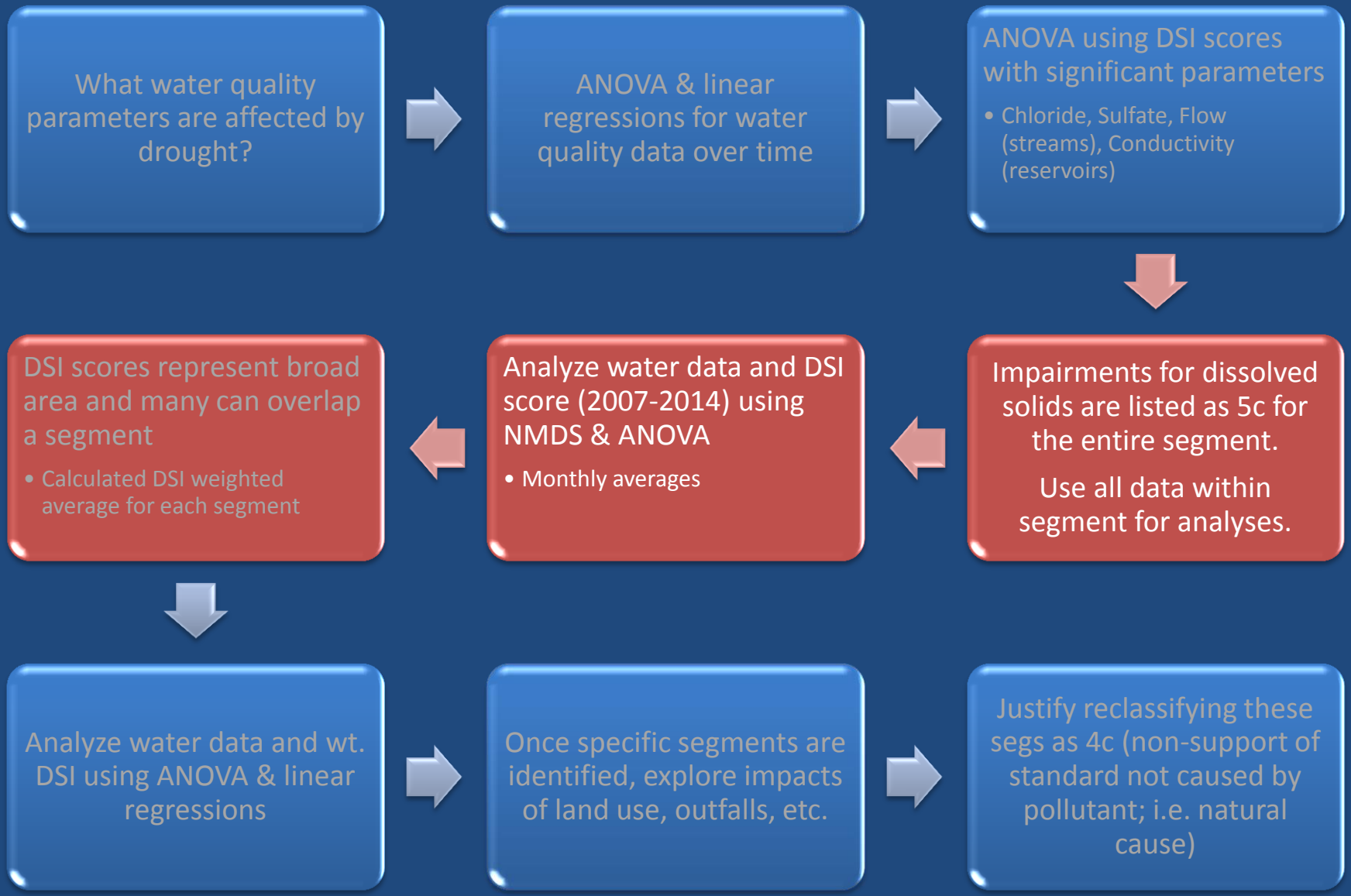
## (ANOVA Analyses)



# Rates of Significance by Parameter for 17 Reservoir Stations

## (ANOVA Analyses)

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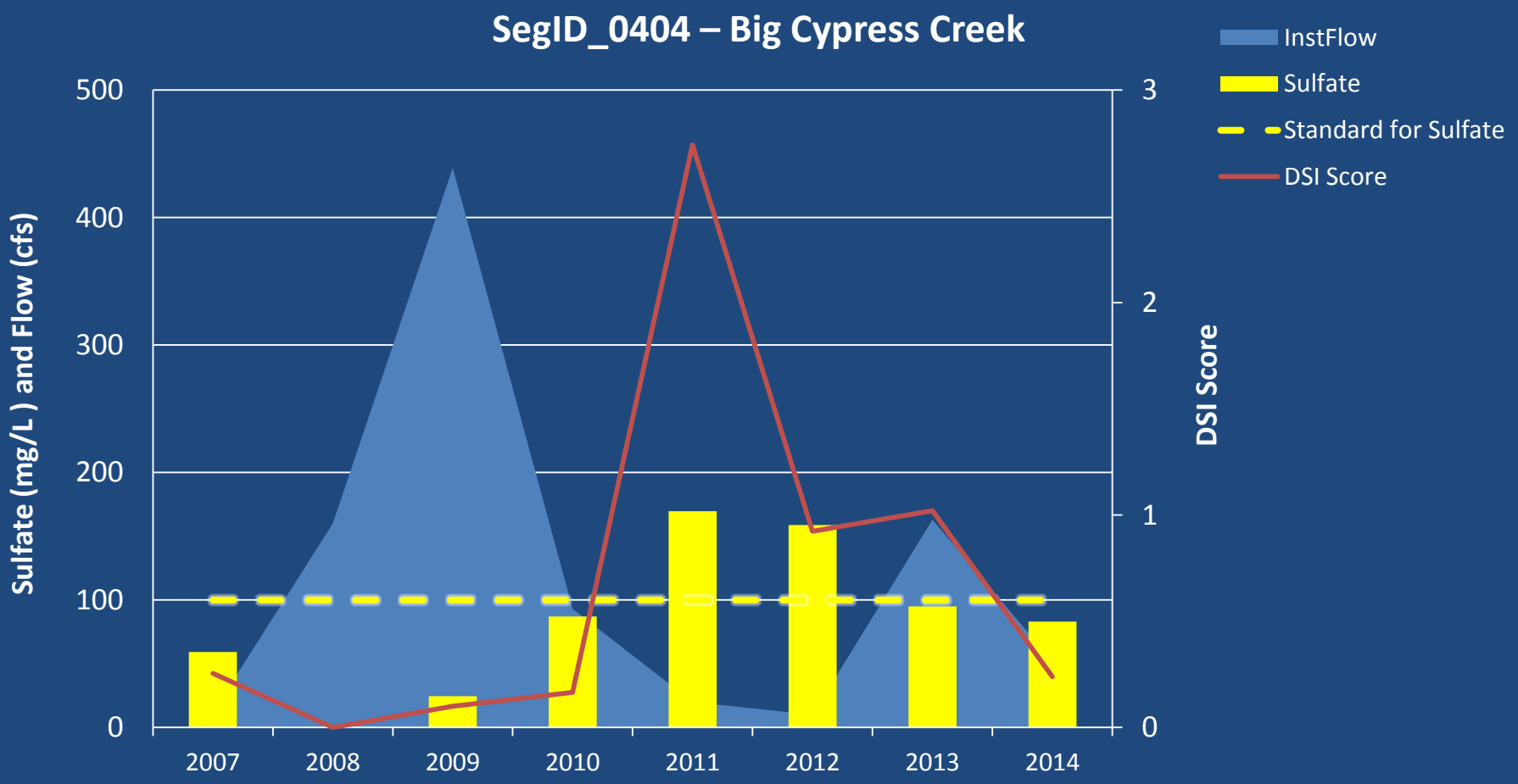
# Calculating DSI Score by Segment
## 2007-2014 Calendar Years

- Calculate monthly and annual DSI average for each new segment listed in draft 2014 Integrated Report
  - Monthly average for each station
  - Monthly average for each segment
  - Annual average for each segment

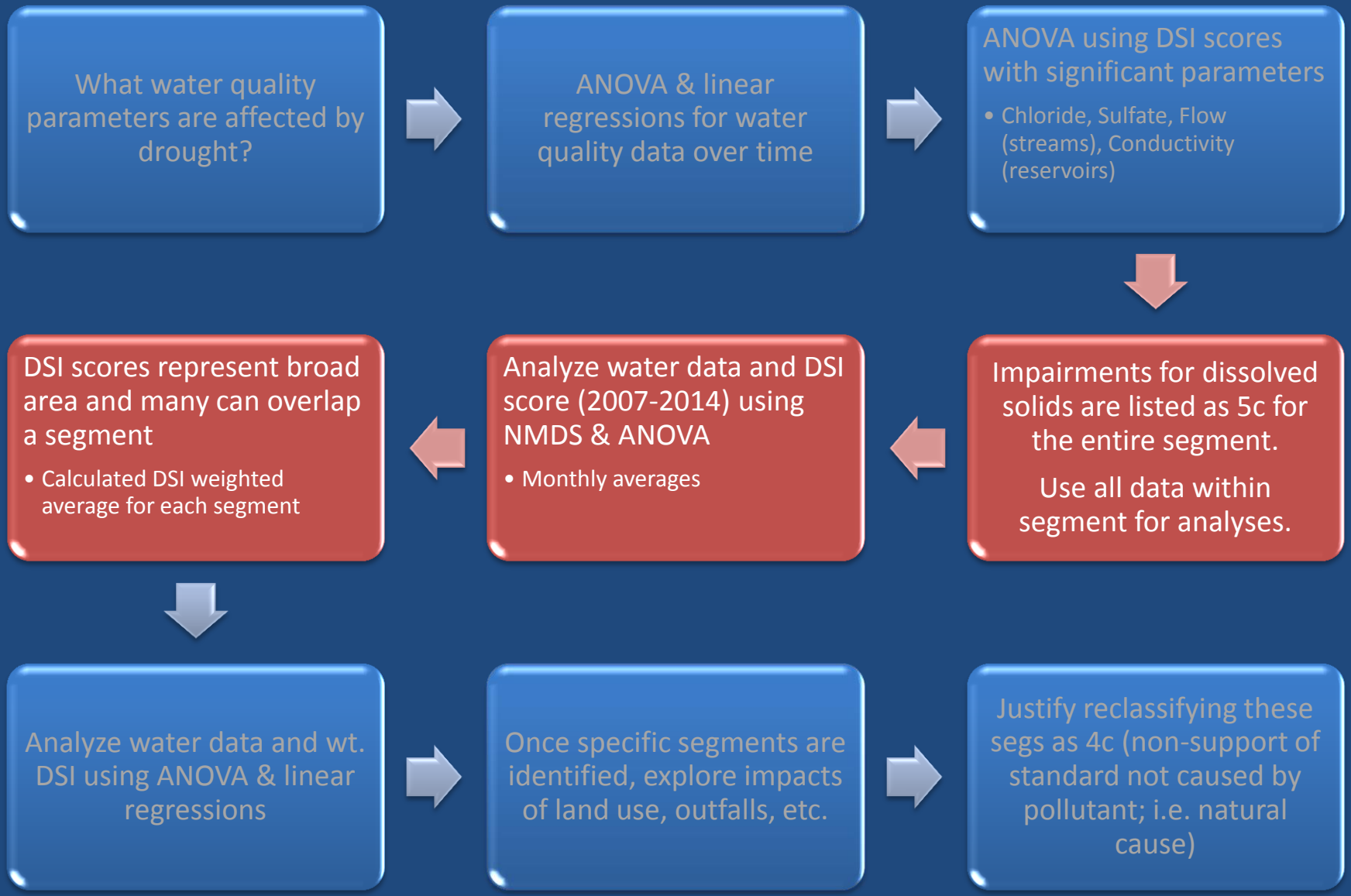
| STATION ID | SEG ID | 8/7/2012 | 8/14/2012 | 8/21/2012 | 8/28/2012 |
|---|---|---|---|---|---|
| 10302 | 404 | 4 | 4 | 4 | 4 |
| 10303 | 404 | 2 | 2 | 1 | 1 |
| 10304 | 404 | 2 | 2 | 1 | 1 |
| 10305 | 404 | 2 | 2 | 1 | 1 |
| 10306 | 404 | 1 | 1 | 0 | 0 |
| 10307 | 404 | 2 | 2 | 1 | 1 |
| 10308 | 404 | 2 | 2 | 1 | 1 |
| 10309 | 404 | 2 | 2 | 1 | 0 |
| 10310 | 404 | 1 | 1 | 0 | 1 |
| 10311 | 404 | 2 | 2 | 1 | 1 |
| 13631 | 404 | 2 | 2 | 1 | 0 |
| 15257 | 404 | 1 | 1 | 0 | 0 |
| 16015 | 404 | 1 | 1 | 0 | 0 |
| 16457 | 404 | 1 | 1 | 1 | 1 |
| 16458 | 404 | 1 | 1 | 0 | 0 |
| 16460 | 404 | 1 | 1 | 0 | 0 |
| 20706 | 404 | 3 | 3 | 3 | 3 |
| 20707 | 404 | 2 | 2 | 1 | 0 |

# Relationship Between the DSI Score and Water Quality Parameters?



# Factors that potentially complicate the relationship between the Drought Severity Index and in-stream Surface Water Quality

- **Municipal outfalls**
- **Reservoir releases**
- **Spring flow**
- **Water extraction**
- **Land use**
- **Instantaneous grab sampling of WQ data**
- **Broad-scale intent of Drought Monitor map**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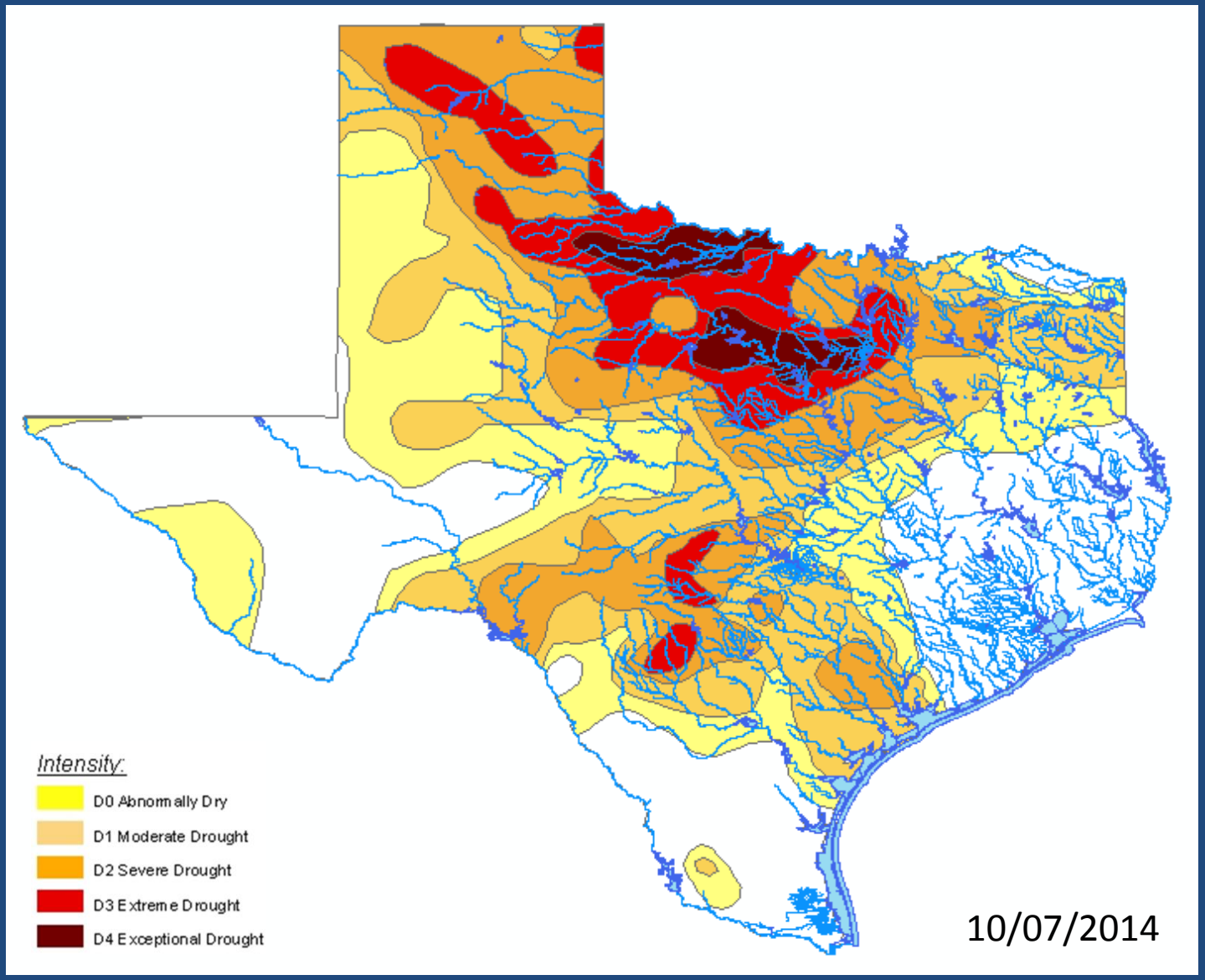
# Texas Drought Severity Index Values Overlaid on TCEQ SWQM Waterbody Segments

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# Candidate Impairments

- Statistical analyses
  - Chi-square/t-test
  - Linear Regression
  - ANOVA/MANOVA
  - Geostatistical analysis
  - SWAT modeling
    (Soil and Water Assessment Tool)

# Candidate Impairments

- Waterbody Selection
  - Adequate data (SWQMIS)
  - New segments listed as Cat. 5 for Dissolved Solids

- Rita Blanca Lake
- Lake Wichita
- Mackenzie Reservoir
- Big Cypress Creek
- Chambers Creek
- San Gabriel River
- E.V. Spence Reservoir
- O.C. Fisher Lake
- Onion Creek
- Hondo Creek
- Amistad Reservoir

# Proposal

Use the National Drought Mitigation Center Drought Severity Index (DSI) in the Texas Integrated Report to better inform decisions as to whether in-stream water quality observed at TCEQ surface water quality monitoring stations could be related to drought conditions in the contributing watershed.

- Overall goal would be to use the DSI in conjunction with additional data (i.e., landscape, water quality, meteorological) to justify that a specific impairment is not due to a pollutant (Category 4c).

# Category 4c

This category is reserved for those water bodies where the impairment is caused by stressors other than specific pollutants that can be allocated under a TMDL. This may also include situations where water quality degradation is not due to a specific pollutant.

- Natural low flow conditions of water which prevent the attainment of the use.
- Physical conditions related to the natural features of the water body which preclude attainment of the use.
- Naturally occurring pollutant concentrations not attributed to waste discharges or the activity of man which prevents attainment of criteria not related to human health, e.g., aquatic life use criteria.

# Regulatory Rationale: Texas Surface Water Quality Standards

- Section 307.4(a): "**General criteria** do not apply to those instances when surface water, as a result of natural phenomena, exhibit characteristics beyond the limits established by this section."
- Section 307.6(a): "With the exception of numeric human health criteria, **toxic criteria** do not apply to those instances where surface water, solely as a result of natural phenomena, exhibit characteristics beyond the limits established by this section."
- Section 307.7(a): "**Site-specific criteria** do not apply to those instances when surface waters exceed criteria due to natural phenomena."

# Summary

- Identified a need to quantify effects of drought relative to SWQM water quality data
- The Drought Severity Index (DSI) provides a mechanism to track relative drought conditions state-wide over a period of time
- Identified water quality parameters most associated with changes in drought conditions
- Calculated DSI weighted scores for segments
- Analyze water quality data for new dissolved solids impairments identified in the draft 2014 Integrated Report
- If results indicate an impairment is due to drought conditions, we propose to place that water body in Category 4c, based on provisions of the Texas Surface Water Quality Standards related to the effects of natural phenomena


Use of the National Drought Mitigation Center
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QUESTIONS?
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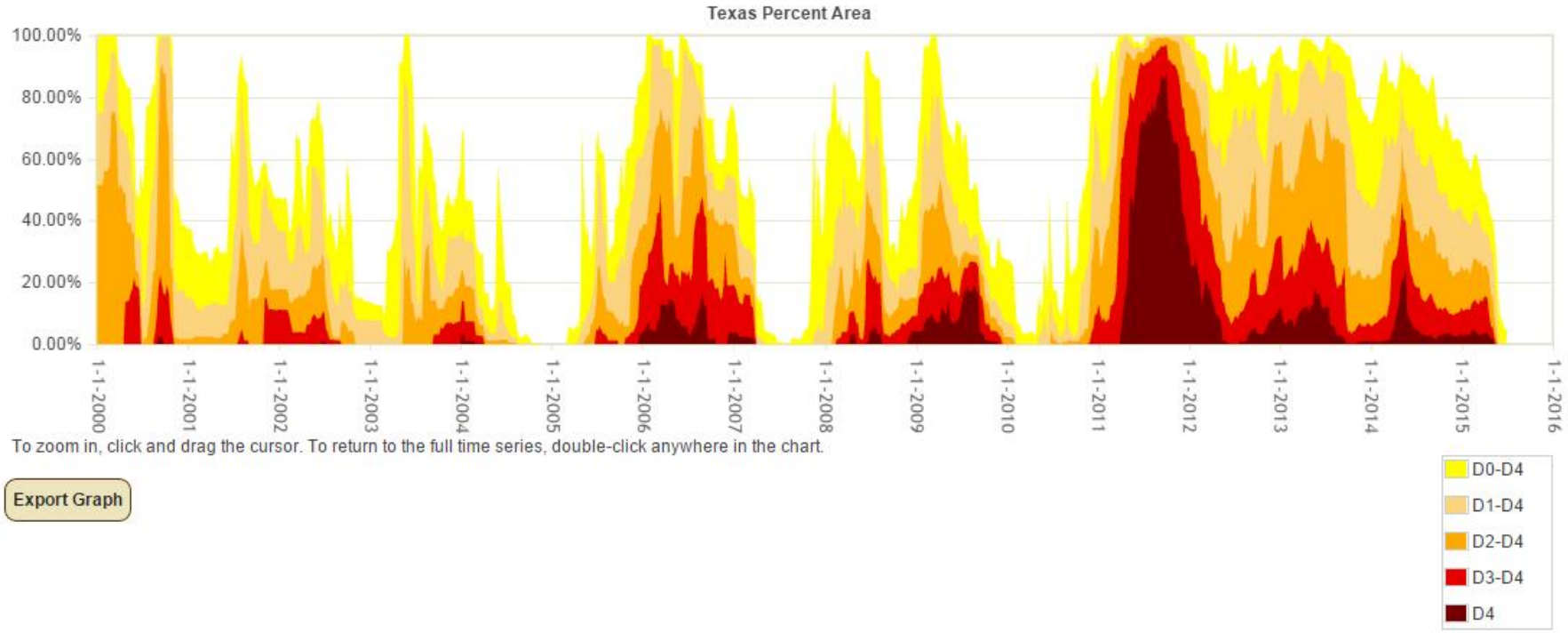
# U.S. Drought Monitor Statistics Graph

State: Texas

Legend




To zoom in, click and drag the cursor. To return to the full time series, double-click anywhere in the chart.

Export Graph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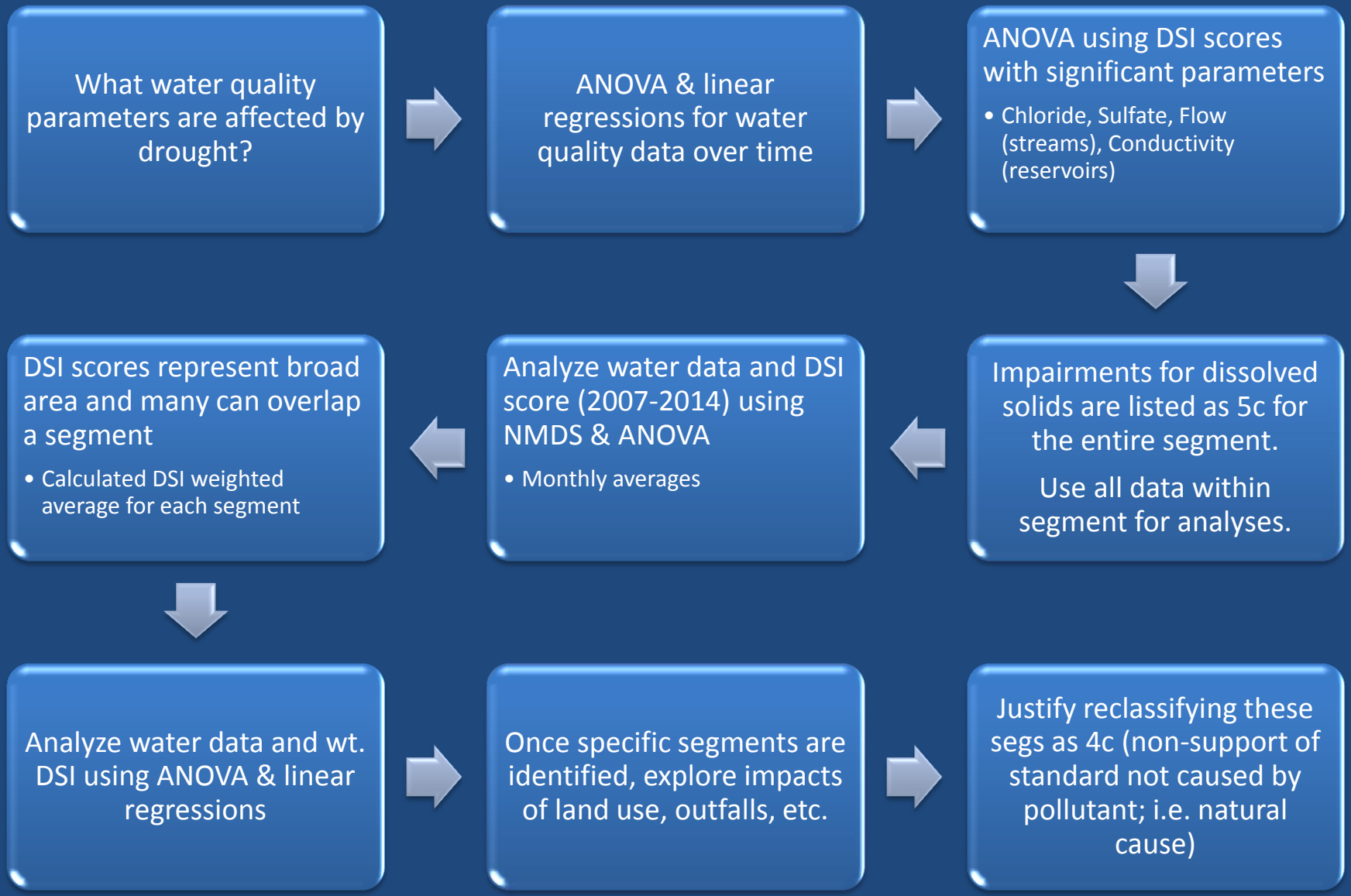
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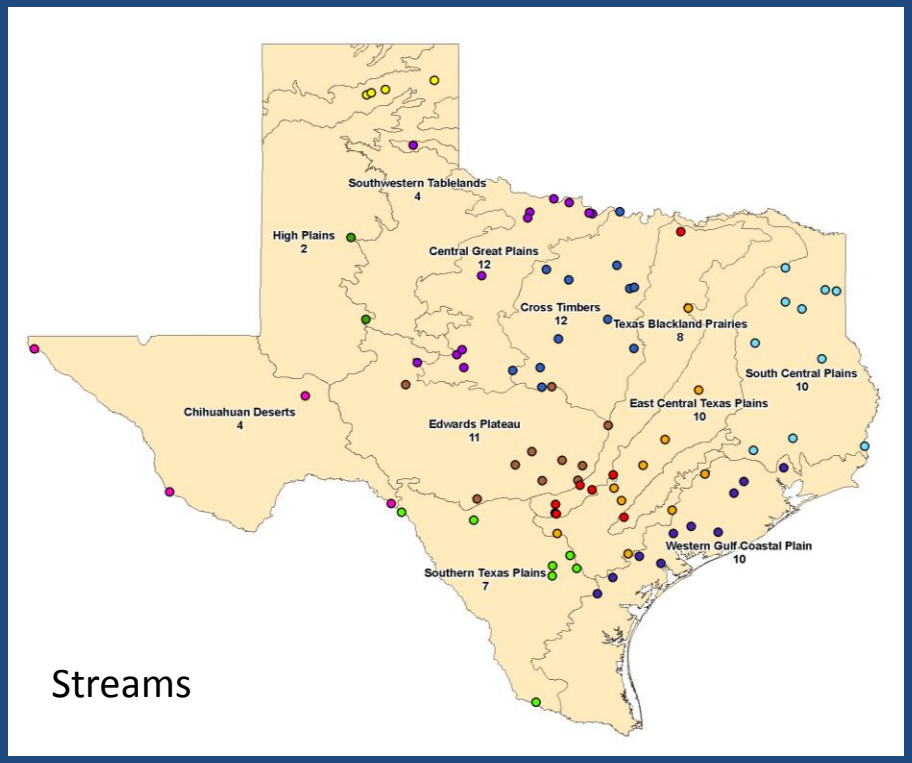
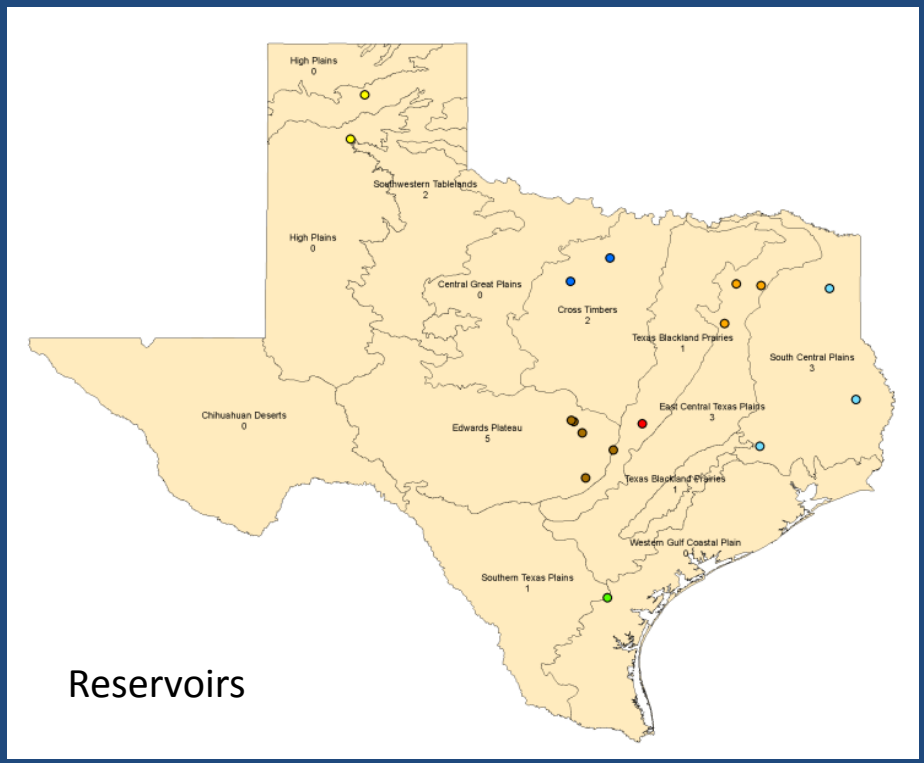
# SWQM Stations Analyzed




Streams




Reservoirs