

Surface Water Quality Monitoring During Drought: 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)

Bill Harrison

Texas Commission on Environmental Quality
Water Quality Planning Division
Water Quality Monitoring and Assessment Section
Surface Water Quality Monitoring Team

bill.harrison@tceq.texas.gov

Surface Water Quality Monitoring During Drought: Use of the National Drought Mitigation Center Drought Severity Classification System

- Texas Drought began developing sometime during late Summer Of 2010;
 - As of August 2011, Texas climatologists stated this is worst One-year drought since Texas rainfall data started in 1895;
- 2011 SWQM Annual Workshop involving TCEQ and river authority staff;
 - A need was identified to develop a method to track the drought relative to SWQM activities that would be specific to each monitoring station;
- TCEQ SWQM began discussions of how to maintain SWQM activities, meet commitments on the CMS and gather meaningful data during this drought, as well as meet the needs identified during discussions at the 2011 SWQM Workshop;
 - Drought Monitoring Guidance
 - Use of the Drought Severity Classification System

Drought Work Group formed to:

- Investigate methods to more objectively evaluate the potential effects of drought on in-stream water quality to inform the assessment of water bodies under drought conditions;
 - Provide drought context surrounding each sample event for every monitoring station;
- Conduct analyses to evaluate the relationship between water quality parameters and the National Drought Mitigation Center Drought Severity Index;

Surface Water Quality Monitoring During Drought: Use of the National Drought Mitigation Center Drought Severity Classification System

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);

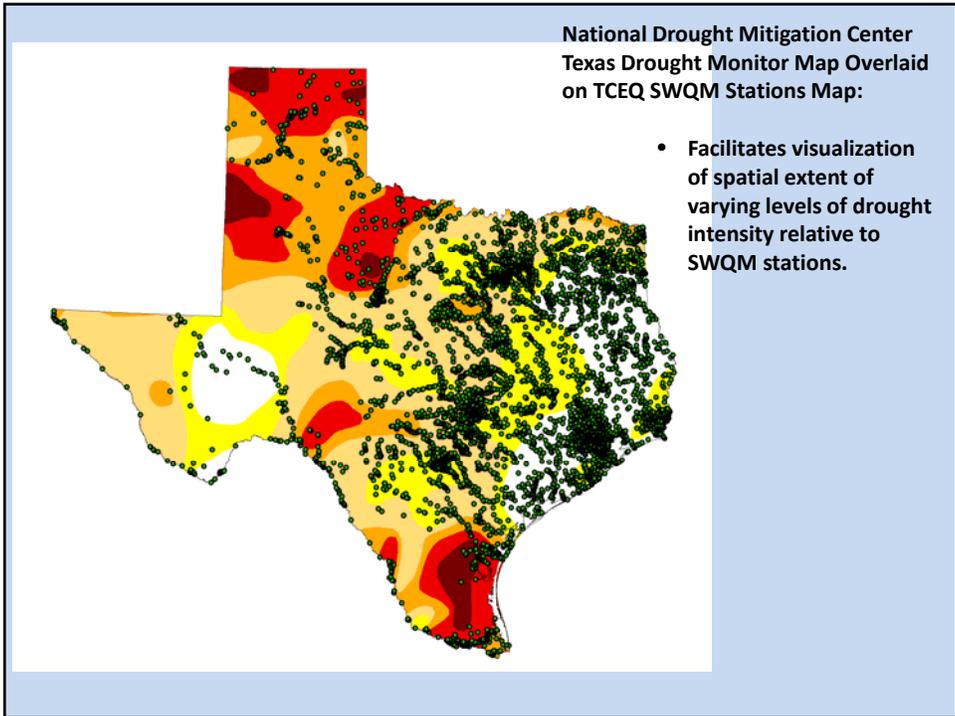
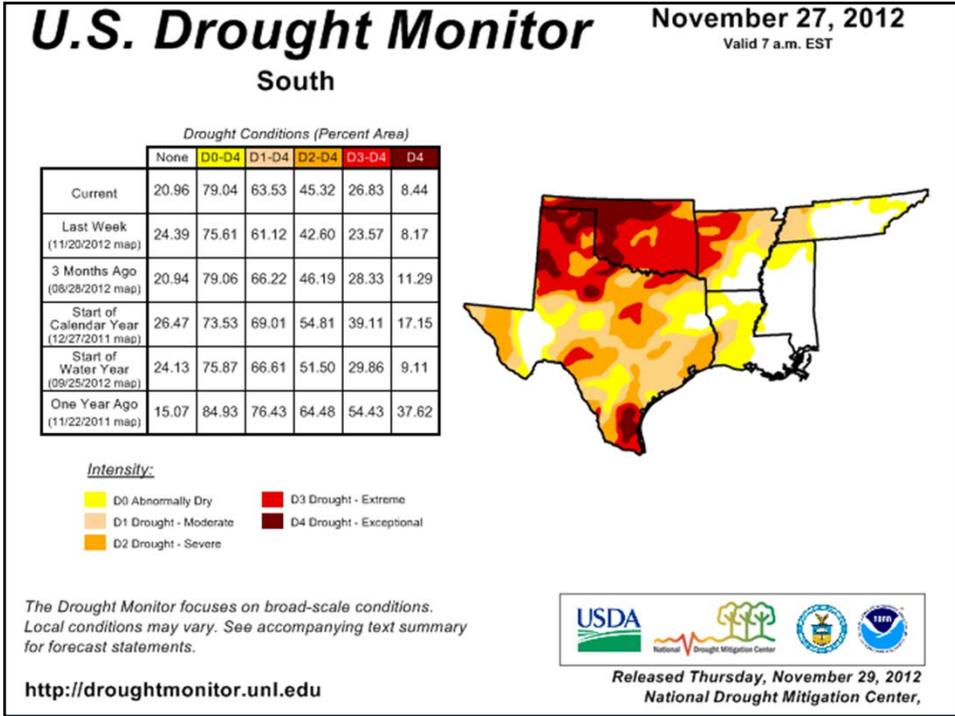
MISSION: The National Drought Mitigation Center (NDMC) helps people and institutions develop and implement measures to reduce societal vulnerability to drought, stressing preparedness and risk management rather than crisis management.

Surface Water Quality Monitoring During Drought: Use of the U.S. Drought Mitigation Center Drought Severity Classification System

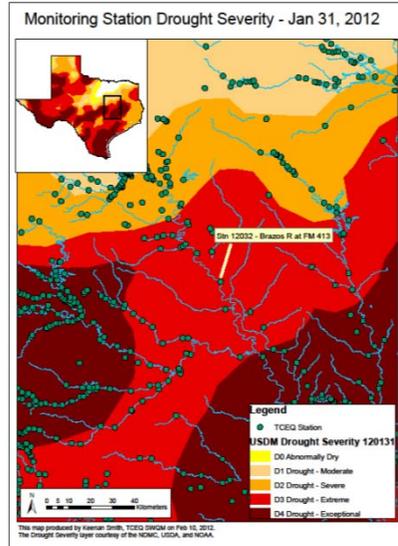
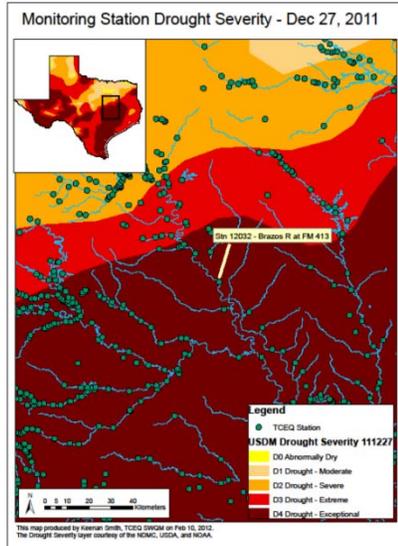
Category	Description	Possible Impacts	Ranges				
			Palmer Drought Index	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Objective Short and Long-term Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	Going into drought: short-term 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

Metrics and Scoring Criteria for Kick Samples, Rapid Bioassessment Protocol - Benthic Macroinvertebrates (Harrison, 1996)

METRIC	SCORING			
	4	3	2	1
Taxa Richness	> 21	15-21	8-14	< 8
EPT Taxa Abundance	> 9	7-9	4-6	< 4
Biotic Index (HBI)	< 3.77	3.77-4.52	4.53-5.27	>5.27
% Chironomidae	0.79-4.10	4.11-9.48	9.49-16.19	< 0.79 or >16.19
% Dominant taxon	< 22.15	22.15-31.01	31.02-39.88	> 39.88
% Dominant FFG	< 36.50	36.50-45.30	45.31-54.12	> 54.12
% Predators	4.73-15.20	15.21-25.67	25.68-36.14	< 4.73 or >36.14
Ratio of Intolerant:Tolerant taxa *	> 4.79	3.21-4.79	1.63-3.20	< 1.63
% of Total Trichoptera as Hydropsychidae	< 25.50	25.51-50.50	50.51-75.50	> 75.50 or no trichoptera
# of Non-Insect Taxa	> 5	4-5	2-3	< 2
% Collector-Gatherers	8.00-19.23	19.24-30.46	30.47-41.68	< 8.00 or >41.68
% of Total Number as Elmidae	0.88-10.04	10.05-20.08	20.09-30.12	< 0.88 or >30.12
Aquatic Life Use Point Score Ranges:	Exceptional: High: Intermediate: Limited:	> 36 29-36 22-28 < 22		



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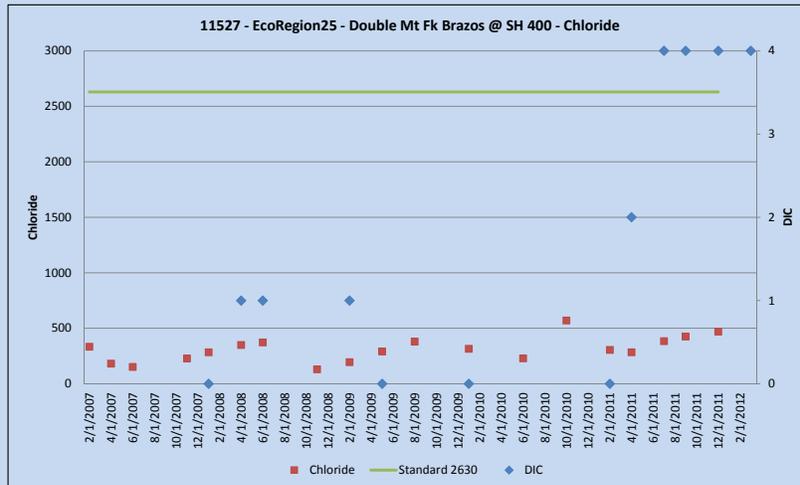


NDMC Drought Severity Code: Track Drought Conditions at SWQM Stations Over Time

STATION_ID	CNTY_NME	SEG_ID	7/5/2011	7/12/2011	7/19/2011	7/26/2011	8/2/2011	8/9/2011	8/16/2011
11658	Taylor	1236A	3	4	4	4	4	4	3
14481	Somervell	1229	3	3	4	4	4	4	4
10542	Smith	0611D	3	3	3	4	4	4	4
12159	Howard	1412B	4	4	4	4	4	4	4
17220	Erath	1255D	3	3	4	4	4	4	4
12160	Howard	1412B	4	4	4	4	4	4	4
16741	Henderson	818	2	3	3	3	3	3	3
10372	Panola	505	4	4	4	4	4	4	4
20213	Somervell	1204	3	3	4	4	4	4	4
13601	Rusk	0505F	3	3	3	3	4	4	4
11655	Taylor	1236A	3	4	4	4	4	4	3
18643	Smith	605	3	3	3	4	4	4	4
17090	Henderson	818	2	3	3	3	3	3	3
10373	Rusk	0505F	3	3	3	3	4	4	4
18437	Ellis	815	2	3	3	3	4	4	4
13849	Henderson	818	2	3	3	3	3	3	3

Example of Excel worksheet summarizing the NDMC Drought Severity Index values over time for TCEQ surface water quality monitoring stations.

Relationship Between the NDMC Drought Severity Index and Water Quality Parameters?

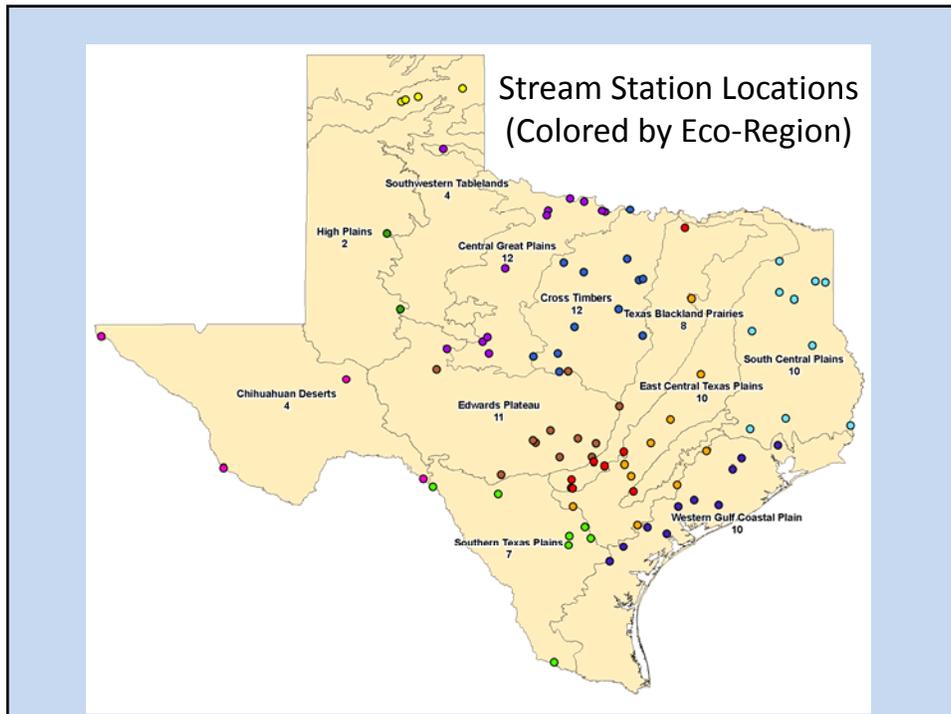


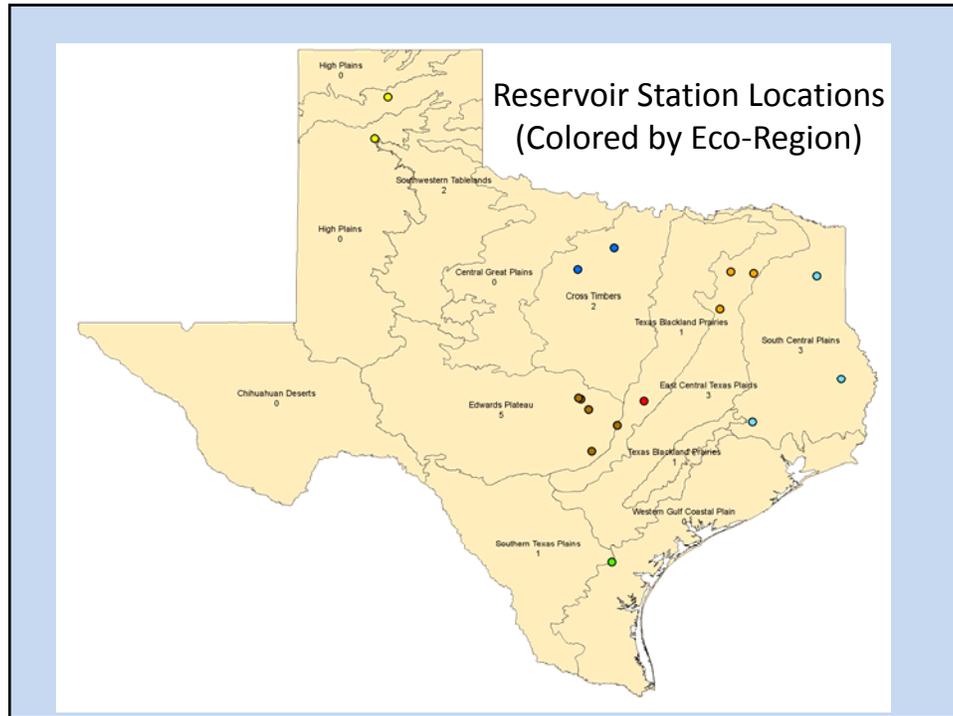
Statistical Analysis

- Question:
 - Can we detect a statistically meaningful quantifiable relationship between the NDMC Drought Severity Index and Surface Water Quality Monitoring Data?
 - Is there a statistically meaningful relationship between change in the drought intensity code and change in water quality parameters?

Exploratory Analysis of Statistical Relationship Between the NDMC Drought Severity Index and TCEQ SWQM Data

- **Station selection:**
 - Adequate data (SWQMIS)
 - Represent all Eco-Regions

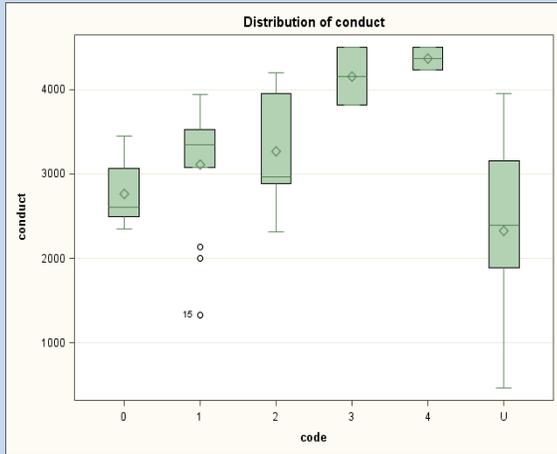




Initial Exploratory Statistical Analysis of the Relationship Between the NDMC Drought Severity Index and TCEQ Surface Water Quality Data

- 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

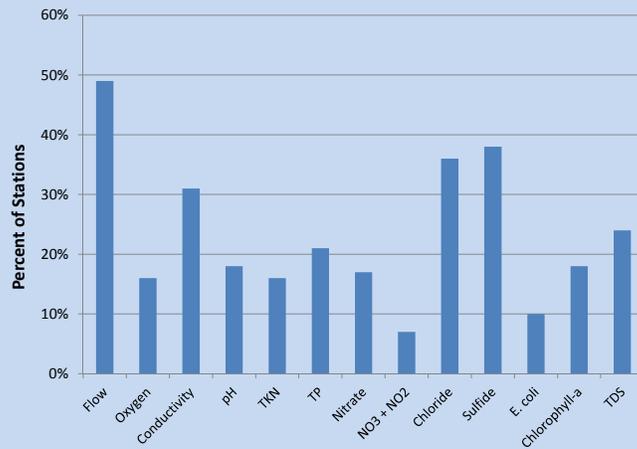
ANOVA Results for the Effects of Different Levels of Drought Intensity (Treatment) on Conductivity (Response Variable) at TCEQ SWQM Station: 11864, Brazos River at FM 4

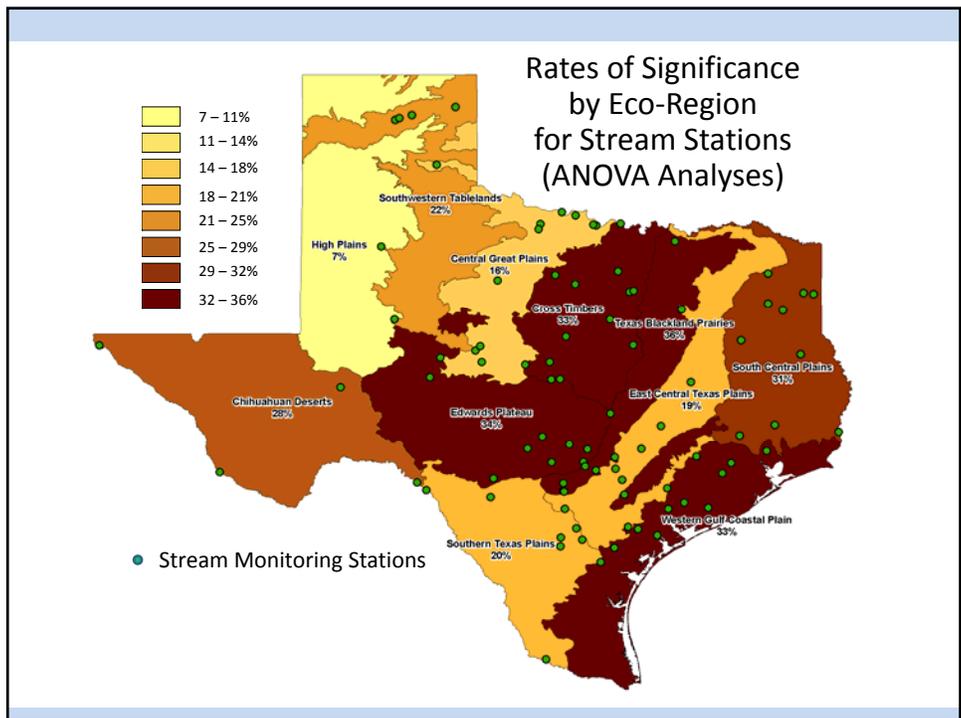
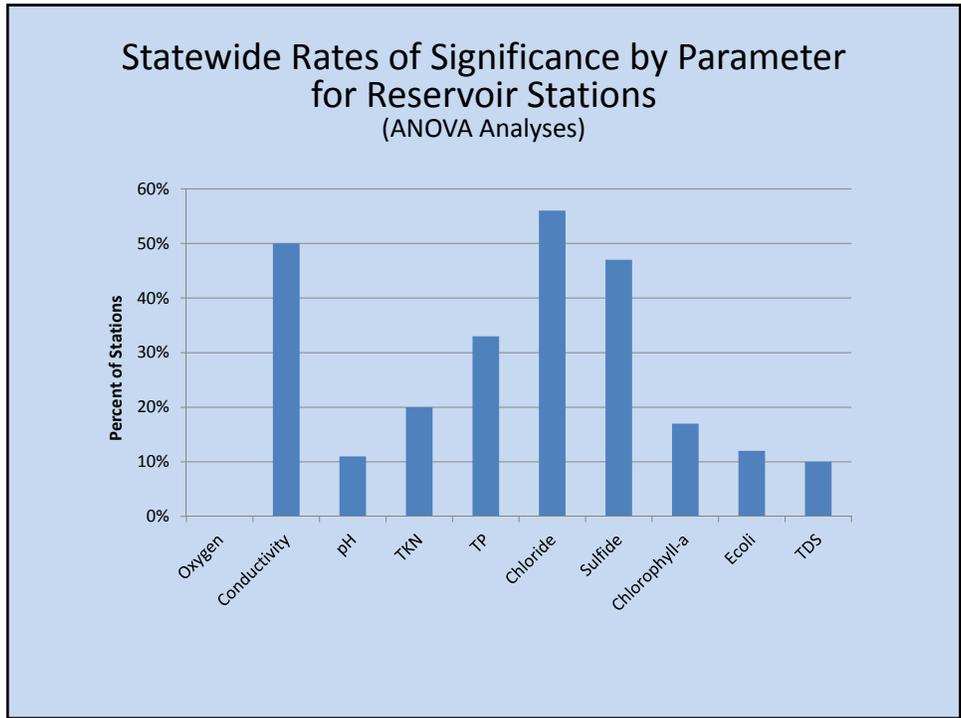


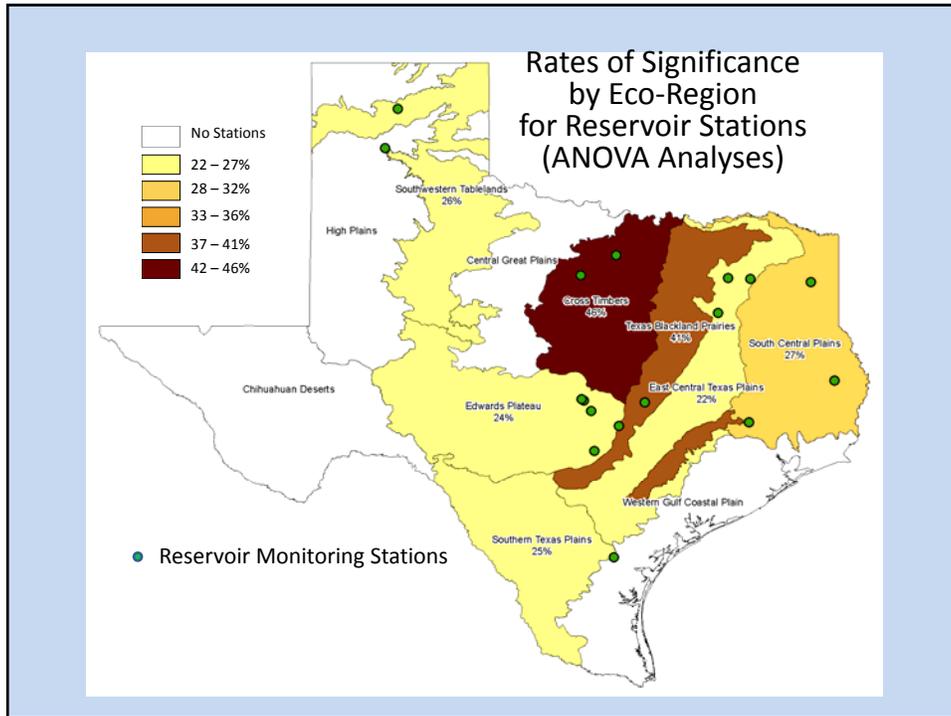
Comparisons significant at the 0.05 level are indicated by ***

code Comparison	Difference Between Means	Simultaneous 95% Confidence Limits	
4 - 3	208.3	-1925.1 2341.8	
4 - 2	1028.8	-748.3 2946.4	
4 - 1	1254.2	-520.9 3029.4	
4 - 0	1597.5	-250.1 3445.1	
4 - U	2033.5	316.1 3750.9	***
3 - 4	-208.3	-2341.8 1925.1	
3 - 2	890.4	-691.3 2472.6	
3 - 1	1045.9	-451.0 2542.8	
3 - 0	1389.2	-193.0 2971.4	
3 - U	1825.1	397.2 3253.1	***
2 - 4	-1028.8	-2946.4 748.3	
2 - 3	-890.4	-2472.6 691.8	
2 - 1	-155.5	-894.7 1205.7	
2 - 0	498.8	-669.8 1667.3	
2 - U	934.7	-14.6 1884.0	
1 - 4	-1254.2	-3029.4 520.9	
1 - 3	-1045.9	-2542.8 451.0	
1 - 2	-155.5	-1205.7 894.7	
1 - 0	343.3	-706.9 1393.4	
1 - U	779.2	-19.9 1578.4	
0 - 4	-1597.5	-3445.1 250.1	
0 - 3	-1389.2	-2971.4 193.0	
0 - 2	-498.8	-1667.3 669.8	
0 - 1	-343.3	-1393.4 706.9	
0 - U	436.0	-513.3 1385.3	
U - 4	-2033.5	-3750.9 -316.1	***
U - 3	-1825.1	-3253.1 -397.2	***
U - 2	-934.7	-1884.0 14.6	
U - 1	-779.2	-1578.4 19.9	
U - 0	-436.0	-1385.3 513.3	

Statewide Rates of Significance by Parameter for Stream Stations (ANOVA Analyses)







- **Factors that potentially complicate the relationship between the NDMC Drought Severity Code and In-stream Surface Water Quality:**
 - **Municipal outfalls**
 - **Reservoir releases**
 - **Spring flow**
 - **Water extraction**
 - **Instantaneous grab sampling of WQ data**
 - **Broad-scale intent of Drought Monitor map**

Proposal: Use the National Drought Mitigation Center Drought Severity Index 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 to reduce the potential to falsely list or delist waterbodies where changes in water quality are due to natural conditions, in this case, drought.

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.”

Proposed Steps to Implement the Use of the NDMC Drought Severity Index in the 2014 Integrated Report

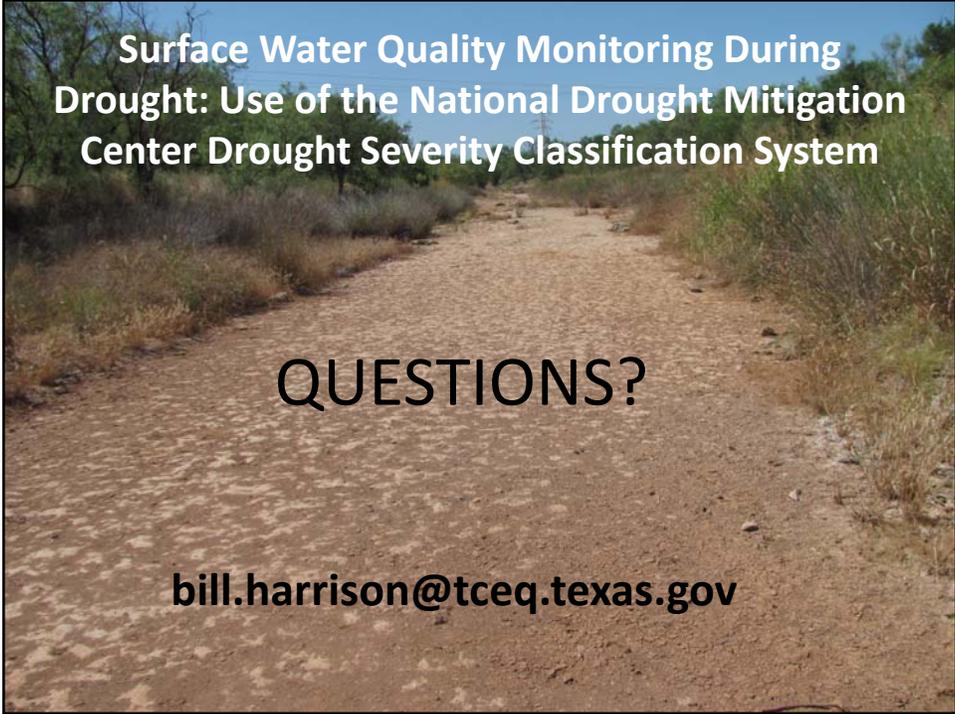
- **For water bodies where new impairments, concerns, and/or delistings have been identified:**
 - Review Excel spreadsheets with the monitoring stations and the weekly drought severity index (DSI) during the period of interest for the assessment unit (AU) for which the impairment has been identified;
 - Determine if any of the DSI values indicate that the geographic region surrounding the monitoring station/AU indicate the presence of drought conditions (e.g. values for the DSI D0 – D4);
 - Determine the temporal extent of drought conditions antecedent to the date of collection of water quality samples that exceed criteria, by reviewing the weekly values indicated by the DSI for the monitoring station;
 - Based on this review, if the temporal extent and severity of drought indicated by the DSI could potentially affect instream water quality then the relationship between the water quality parameter of concern and the DSI will be examined by developing graphs that provide a visualization of this relationship;

If, after following steps described in previous slide, it appears that observed in-stream water quality conditions are likely related to drought conditions in the watershed we propose to:

- **Place the waterbody in Category 4: Water quality standard is not supported or is threatened for one or more designated uses but does not require the development of a TMDL.**
 - **Category 4c: Nonsupport of the water quality standard is not caused by a pollutant.**

SUMMARY

- A need was identified to develop a method to track the potential effects of drought relative to TCEQ surface water quality monitoring activities that would be specific to each monitoring station;
- The Drought Severity Index as derived by the National Drought Mitigation Center provides a mechanism to track relative drought conditions under which surface water quality samples were collected on a site/date specific basis as well as a way to evaluate antecedent conditions of the drought prior to sample collection;
- **We propose to use the Drought Severity Index in a systematic manner to provide a more objective evaluation of the potential effects of drought on in-stream water quality in the Integrated Report process;**
- Based on the analysis methodology described in this presentation, if it appears that drought conditions likely contributed to impairments identified in a water body in the Integrated Report, we propose to place that water body in category 4c, based on provisions of the Texas Water Quality Standards related to the effects of natural phenomena, such as droughts on water quality.



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QUESTIONS?

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