Surface Water Quality Standards 101

Jill Csekitz, Group Leader
Water Quality Standards
Texas Commission on Environmental Quality

Brian Haggard, Thad Scott, and Erin Grantz
University of Arkansas

Why do we Need Standards?

- Clean Water Act
  - Section 303 Water Quality Standards and Implementation Plans
- Texas Water Code
  - Chapter 26 Water Quality Control

1972 Amendments to the CWA

- Established structure for regulating pollutants discharged into "waters of the US"
- Required each state to adopt standards for all intrastate waters and provided for EPA review, approval, and disapproval
- Made it unlawful for any person to discharge into waters of the US unless permitted
- Funded construction of sewage treatment plants under grants programs

CWA: Major Sections

- 101 Goals and Policy
- 301 Technology Based Effluent Limits (*Best Available Technology*)
- 302 Water Quality Based Effluent Limits (*when technology-based is not adequate*)
- 303 WQ Standards and Implementation
- 305 Water Quality Inventory
- 402 Point Source Permitting

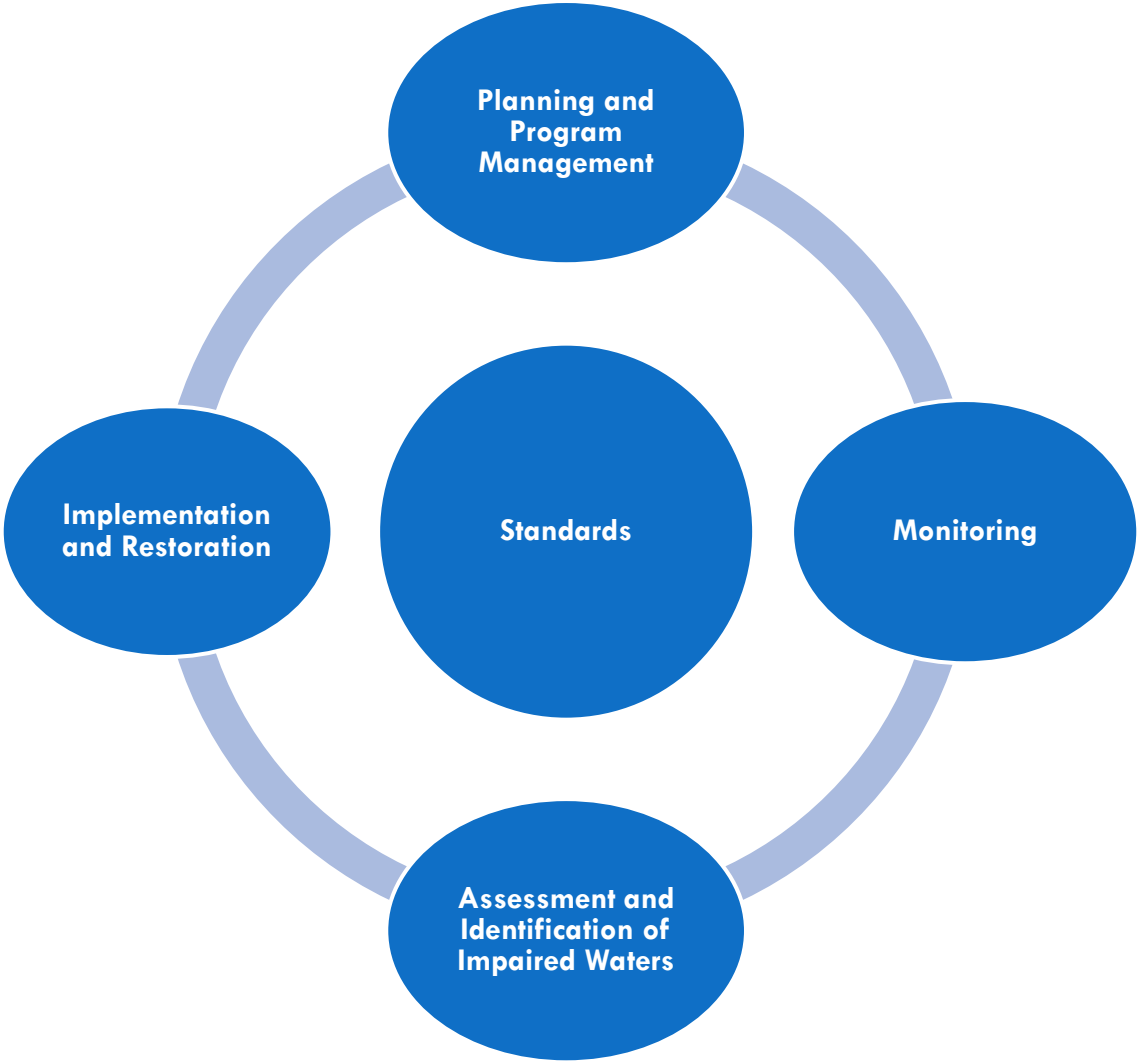
What does the CWA Say about Standards?

- States shall adopt standards and submit to EPA (*the Administrator*)
- From time to time, but at least once every three years…
  - States shall hold hearings on standards
  - Adopt revisions as necessary
- The EPA shall promulgate standards to meet requirements of the CWA

What About the Texas Water Code?

- The commission by rule shall set water quality standards and may amend the standards from time to time
  - The commission shall develop standards based on all quality assured data obtained by the commission, including the local watershed and river basin database described by Section 26.0135(c)(2)….That's CRP!
  - The commission shall hold hearings on standards and provide notice in the *Texas Register*
  - The Commission shall notify affected parties
  - Standards shall be published

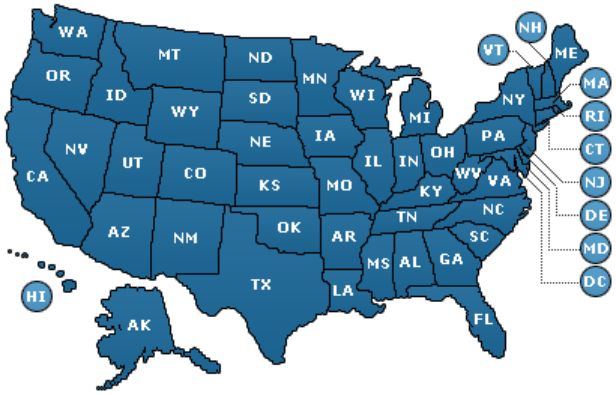
How do Standards Impact our Programs?



Components of Standards

- Designated Uses
  - Reflect the state's management goals for the water body
    - Examples: Aquatic Life Use, Contact Recreation, Public Water Supply
- Criteria
  - Established to protect designated uses
- Antidegradation
  - Policy and Implementation to protect existing uses, high quality waters, and Outstanding National Resource Waters

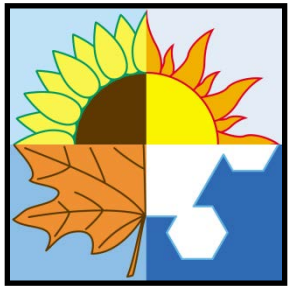
Scale of Standards



National

State-wide

Site-specific



Seasonal

Event-specific

Standards Development and Data

- Use of monitoring data is integral to standards development
- Needed to describe historical conditions
- Needed to describe the "highest attainable use"
  - Least disturbed water bodies
- Standards set initially with very limited data
  - Highest level of protection presumed attainable
    - Use Attainability Analyses (UAAs) needed to justify standards change

Standards Protective of Historical Ambient Conditions

- Data Needs: long, consistent data record, collected at locations representative of ambient conditions
- Examples
  - Dissolved minerals (TDS, chloride, sulfate)
  - pH
  - Temperature

Demonstrating the Highest Attainable Use

- Data needs are extensive
- Aquatic Life Use
  - Need to demonstrate oxygen levels sufficient to protect aquatic communities, including propagation
    - UAAs with diurnal DO, biological monitoring, flow, water quality
- Contact Recreation Use
  - Need to demonstrate if existing recreation use is present, and level of risk associated with ingesting water while recreating
    - Rec Codes
    - RUAAs with historical interviews, observation of activities, physical stream measurements

Nutrients in Standards

- Narrative and Numeric Criteria
  - Protective of multiple uses including recreation, aquatic life and public water supplies
- 1967: "The surface waters in the state shall be maintained in an aesthetically attractive condition".
- 1988 - 2014 : "…Nutrients from permitted discharges or other controllable sources shall not cause excessive growth of aquatic vegetation which impairs an existing or designated use".

Nutrients in Standards: Numeric Criteria

- 1998: EPA directed states to develop numeric criteria for nitrogen and phosphorus
- 2010: Adoption of 75 site-specific criteria for reservoirs (chl-a)
  - 39 criteria approved by EPA in 2013
- 2014: Updated development plan

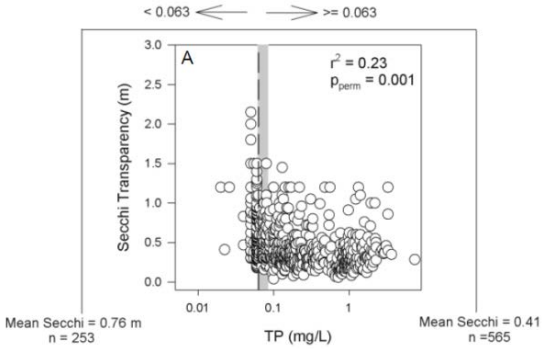
How Does WQS Use Nutrient Data?

- Goal: Determine how much nutrients are too much?
- Examine stressor – response and environmental relationships
  - Requires both stressor (nutrient) and response (Ex. chlorophyll a) , and adequate geo-spatial info.
- Evaluate impacted versus least-disturbed water bodies
  - Requires both types of water bodies to be monitored for an extended period of time
- Evaluate long-term trends and historical variability
  - Requires consistent, historical data record
- Incorporate variability by evaluating median, mean, or percentiles

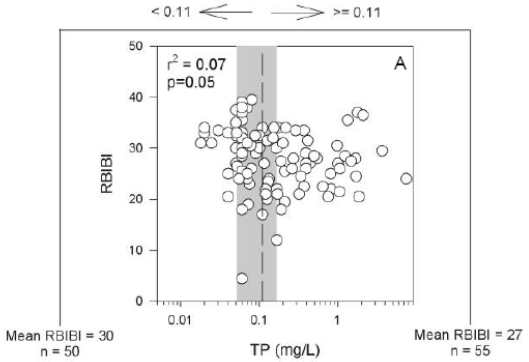
Stressor Response Analysis

- Identify thresholds in nutrient concentrations that resulted in measureable changes in biological response:
  - Stressor
    - TP
    - TN
    - Dissolved nutrient species
  - Response
    - Secchi depth
    - 24hr DO flux
    - Sestonic Chla
    - Benthic and Fish IBI (Streams only)

- Effects of TP on Secchi depth in Streams

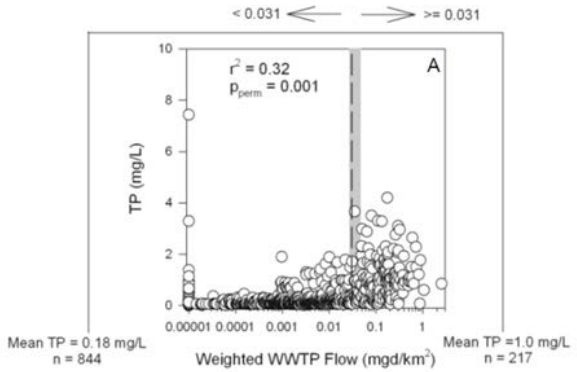


- Effects of TP on benthic IBI



Streams: Categorical Results

- Groupings more effective for predicting TP than TN
- Although model not as strong as TP, TN analyses indicated similar thresholds in categorical grouping
- Groupings were more effective for nutrient concentration than biological response



Parameter	Predictor	r^2
TP	Weighted WWTP	0.32
TP	Basin/ Level III	0.24
Chl-a	Basin/ Level III	0.15
TN	Basin/ Level III	0.14
Chl-a	WWTP	NS

Difficulties Encountered with Data

- Censored data
- Data comparability
- Incomplete data records
- Not enough data
- Data not available to determine relationships

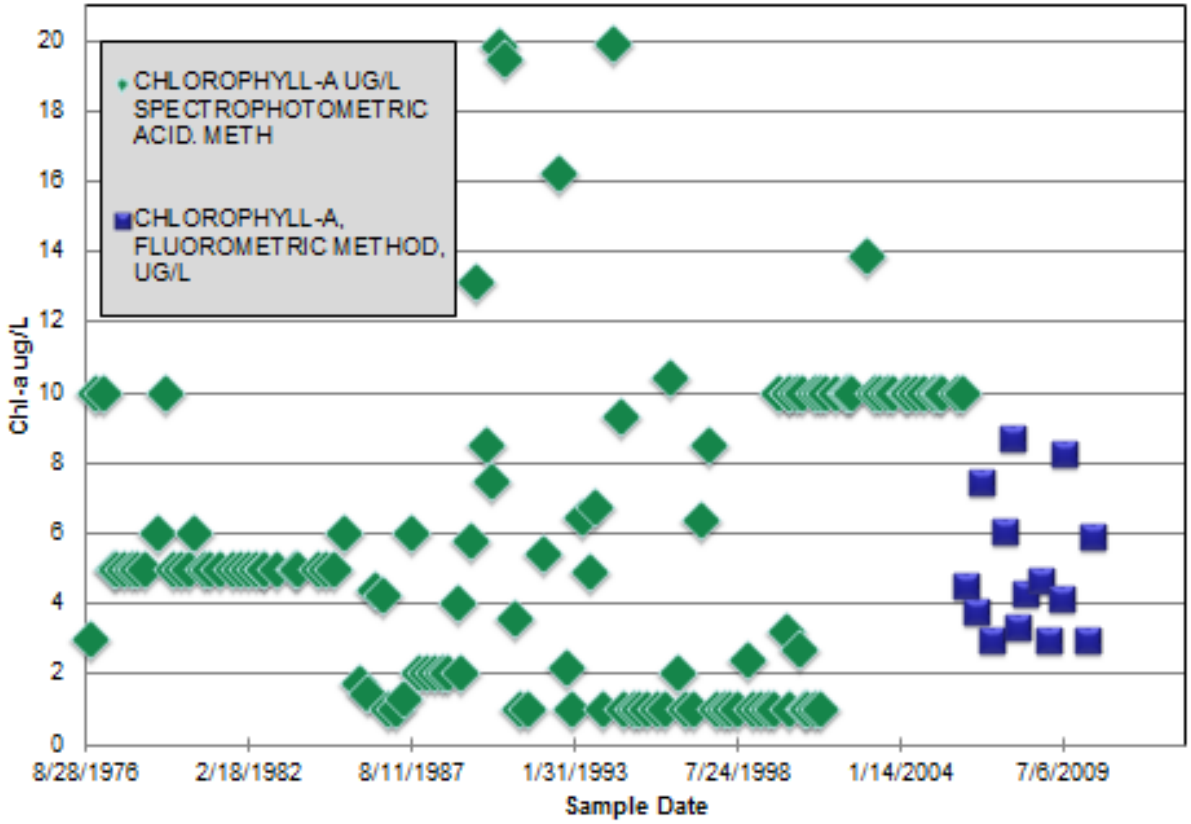
Why do Censored Data Matter for Texas? (from Haggard, Scott, and Grantz)

- TP and Spectrophotometric Chl-a in Texas Reservoirs, since 2000
  - 37% of TP reported below LOQ
  - 26% of chl-a reported below LOQ

- Common LOQ's:
  - Chl-a: 10 µg/L
  - TP: 0.050-0.060 mg/L

Trophic class	Chl-a (ug/L)	TP (mg/L)
Oligotrophic	<2.6	<0.012
Mesotrophic	2.6 – 20	0.012 – 0.024
Eutrophic	20 – 56	0.024 – 0.096
Hypereutrophic	56 – 155+	0.096 – 0.384+

Multiple Reporting Levels and Methods



Implications of Using Censored Data

(from Haggard, Scott, and Grantz)

Treatment of censored observations affects analytical outcomes.

- Substituting values for censored observations introduced trends to the data
- Applicability of statistical methodologies is limited for Texas due to highly censored datasets with high detection limits
- Missing or introduced information from highly censored stations may obscure low-range nutrient thresholds
- Multiple answers to the same question = uncertainty for policy makers

States need datasets with lowest QL's possible


Problems
Solutions

Statistical Methods to Deal with Censored Data (from Haggard, Scott, and Grantz)

- Each method has strengths and weaknesses
- The %censored data and size of dataset determine which method is used.

	Amount of Available Data	
Percent Censored	<50 Observations	>50 Observations
< 50% censored	Kaplan-Meier	Kaplan-Meier
50-80% censored	Regression order statistics	Maximum likelihood estimate
>80% censored	Not recommended	Not recommended

No appropriate statistical method for stations with >80% censored data

Summary of Censored Data Treatments

(from Haggard, Scott, and Grantz)

For both response variables, the value of the TP threshold almost always differed between approaches to handling censored data

	Primary TP threshold (mg/L)	
Method	**Chl-a**	**Secchi**
SubQL	0.063	0.063
Sub1/2QL	0.039	0.039
Statistics (0-80%)	0.063	0.049
Hybrid (0-100%)	0.049	0.025

Comparing across methods

(from Haggard, Scott, and Grantz)

- For chl-a vs. TP models,
  - Subbing ½QL appeared to underestimate the TP threshold
  - Subbing QL resulted in a reasonable approximation of thresholds found using statistical methods

- For Secchi vs. TP models,
  - Different TP threshold for each dataset
  - Thresholds from subbing QL and statistics (0-80%) functionally similar, both in eutrophic range
  - But, hybrid dataset threshold suggested that important information was lost when highly censored stations were excluded, potential low range threshold obscured

How is WQS Working With Data Providers?

- Include data providers in project planning and notification
- Contract WQS projects like UAAs to data providers (Ex. SARA and BRA)
- Make the most out of the data we have:
  - Identify better ways to deal with censored data
  - Use long-term station medians to incorporate variability (Ex. nutrients and response variables)
    - Try to identify stressor/ response relationships among existing data
- Identify needed parameters and those that could be discontinued (Ex. Transition samling from O-P to TP)
- Participate in method development (Ex. Directly measured TN)
- Your local knowledge and expertise is invaluable

How to Get Involved

- Surface Water Quality Standards Advisory Workgroup
- Nutrient Criteria Development Advisory Workgroup

Questions

- Jill Csekitz

  Jill.csekitz@tceq.texas.gov

  512.239.3136