Aquatic Life Monitoring (ALM) Overview and Introduction

Bill Harrison

Water Quality Planning Division

Water Quality Monitoring and Assessment Section

Surface Water Quality Monitoring Team

Presentation Outline

- Goals for this training.
- TCEQ/TPWD Interagency Biological Monitoring Workgroup
- What is Aquatic Life Monitoring?
- Rationale/Why do we collect and assess biological monitoring data?
- Background/history of biological monitoring and assessment in Texas;
- How do we use biological monitoring data?
- Examples of utility of biological monitoring as an effective water quality monitoring tool.

- **Goals For This Training**:
  - **Review/introduce biological sampling and assessment methods used to determine if aquatic assemblages (fish, benthic macroinvertebrates) and physical habitat in wadeable freshwater streams (generally 4th order or lower) in Texas meet aquatic life use criteria as established in the Texas Surface Water Quality Standards.**

Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Assemblage and Habitat Data
RG-416
Revised May 2014

2016 TCEQ Biological Training: Primary Subject Areas to be Covered

- Documentation
- Standardized methods
- Minimum data collection requirements
- Supplemental data requirements
- Data analysis methods

TCEQ and TPWD Interagency Bioassessment Workgroup

Established around 2000 at the request of the Executive Directors of both agencies with the directive to:

- **Develop and refine tools for the interpretation of biological data;**
  - **Regionalized indices of biological integrity (IBI);**
  - **Evaluating the health of seagrasses;**
  - **Evaluating physical habitat of aquatic systems and relating to biotic integrity;**

Develop methods to use these tools to:

- **Establish the appropriate aquatic life use for Receiving Water Asessments RWA's, Use Attainability Assessments (UAA's);**
- **Conduct routine Aquatic Life Monitoring (ALM) to determine attainment of existing Aquatic Life Use for the Integrated Report (IR);**

TCEQ and TPWD Interagency Bioassessment Workgroup

Mission Statement

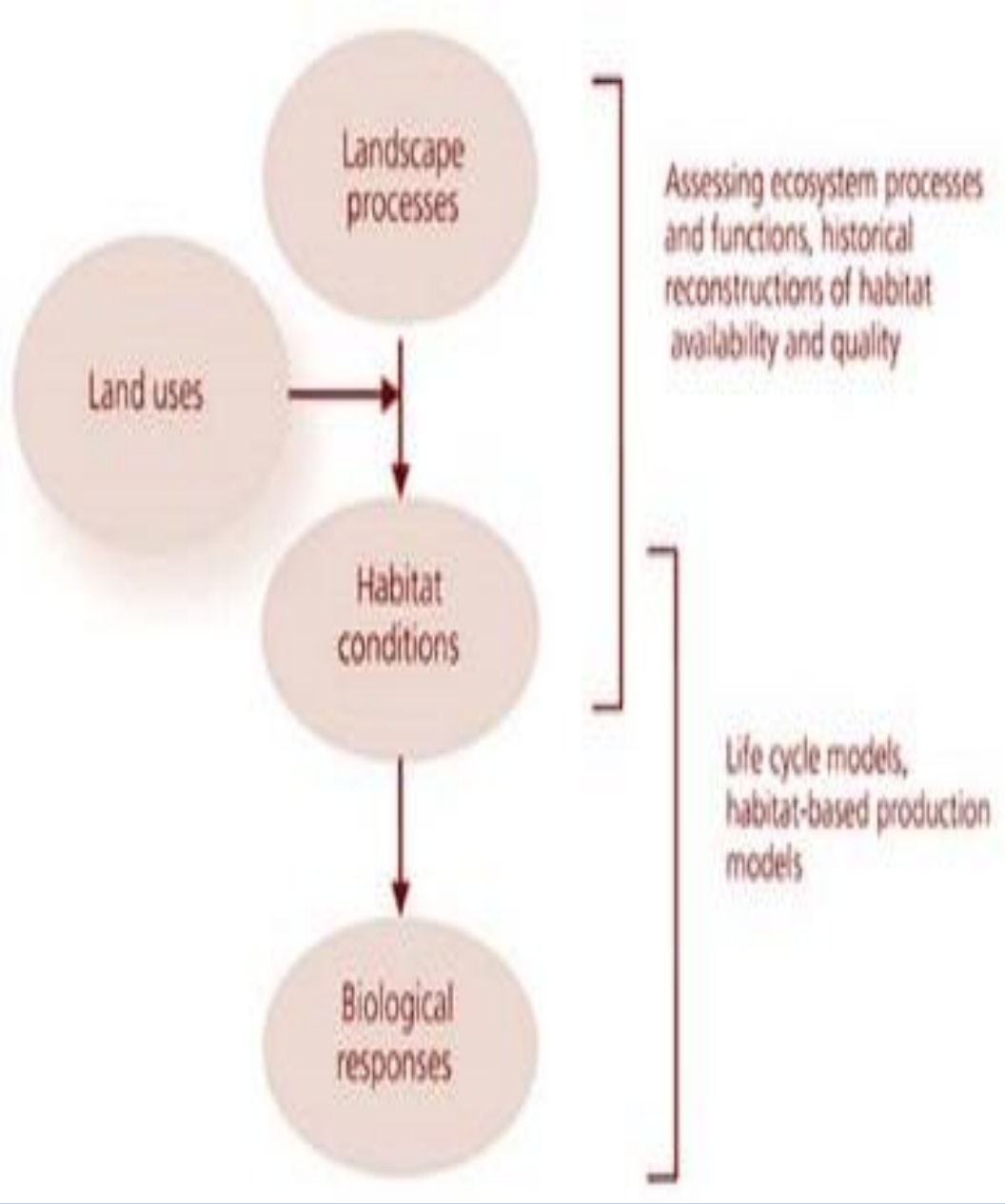
- **The mission of the TCEQ/TPWD interagency workgroup is to cooperatively participate in the development and refinement of methods for the collection and analysis of data to characterize the biotic integrity and physical habitat of aquatic systems in Texas.**

Workgroup Members:

- **TPWD Water Quality Program;**
- **TPWD River Studies Program;**
- **TCEQ Surface Water Quality Monitoring Team;**
- **TCEQ TMDL Team;**
- **TCEQ Water Quality Standards Development Team;**
- **TCEQ Water Quality Standards Implementation Team;**
- **TCEQ Central Office Clean Rivers Program Team;**
- **TCEQ Field Operations Regional Biologists.**

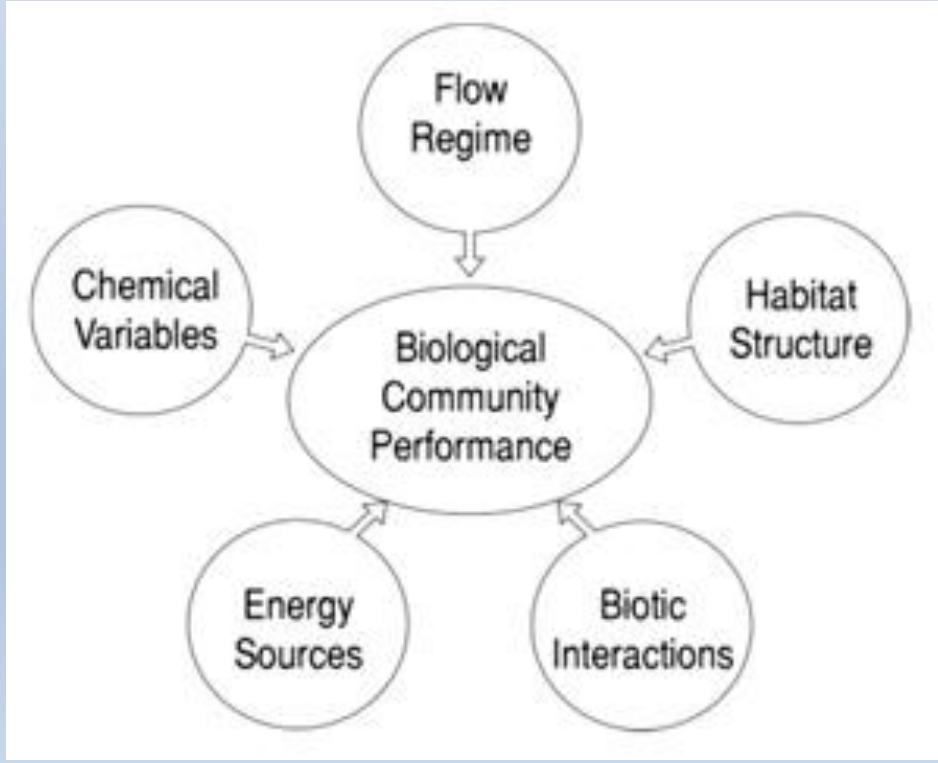
Biological Integrity

- **The species composition, diversity, and functional organization of a community of organisms in an environment relatively unaffected by pollution.**
  - **Least Disturbed Streams Study biological data provides points of reference for determining the relative biological integrity of streams with various disturbances in the watershed.**



Bioassessment: Describe Biotic Integrity of an Aquatic System

- Integrated assessment, comparing habitat, water quality and biological measures with empirically defined reference conditions;
- Reference conditions established via systematic monitoring of actual sites that represent the natural range of variation in “least disturbed” water chemistry, habitat, and biological conditions.



Least Disturbed Reference Stream

EPA defines the Reference Condition for Biological Integrity as:

- The natural biological condition of a water body, undisturbed by human activity.

TCEQ/TPWD use least disturbed reference streams to define reference conditions for Texas streams.

- Represent the “best available” streams in each of Omernik’s Level III ecoregions in Texas.

- Serve as the basis for developing benchmarks against which a biological monitoring program can assess the biological condition of test sites.

Least Disturbed Reference Streams

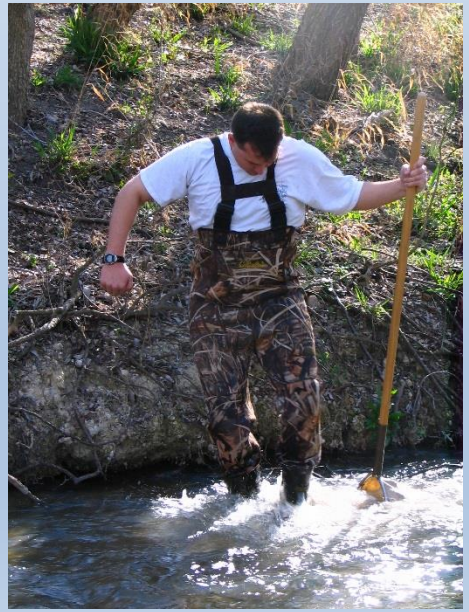
Least Disturbed Streams exhibit the following characteristics:

- Stream characteristics representative/typical of the Level III ecoregion where located;
- Little or no urban development in the watershed;
- No major point sources of pollution;
- No atypical sources of non-point pollution;
- Not channelized, or have not had major physical habitat modifications;

Characteristics and associated dissolved oxygen criteria for aquatic life use (ALU) subcategories in freshwater systems. Table 3, section 307.7, Texas Surface Water Quality Standards.

ALU Subcategory	Dissolved Oxygen Criteria, mg/L	Aquatic Life Attributes					
	mean/min	Habitat Characteristics	Species Assemblage	Sensitive Species	Diversity	Species Richness	Trophic Structure
Exceptional	6.0/4.0	Outstanding natural variability	Exceptional or Unusual	Abundant	Exceptionally High	Exceptionally High	Balanced
High	5.0/3.0	Highly Diverse	Usual association of regionally expected species	Present	High	High	Balanced to Slightly Imbalanced
Intermediate	4.0/3.0	Moderately Diverse	Some expected species	Very low in abundance	Moderate	Moderate	Moderately Imbalanced
Limited	3.0/2.0	Uniform	Most regionally expected species absent	Absent	Low	Low	Severely Imbalanced

Fish



Benthic Macroinvertebrates

Physical Habitat

National Summary of bioassessment programs for streams and wadeable rivers in 2001 (US EPA).

Programmatic Element	Number of Entities	
	In-place	Under Development
Assemblage Used		
Fish	41	0
Benthic Macroinvertebrates	56	1
Algae (periphyton, diatoms)	20	5
More than one assemblage	45	5

TCEQ Surface Water Quality Monitoring Program: Biological Monitoring

- What is biological monitoring/bioassessment:
  - The collection and analysis of **biological data**, primarily fish, benthic macroinvertebrates, and **physical habitat data**, as a tool to evaluate the effectiveness of TCEQ regulatory programs in maintaining water quality in states waters as described in the Texas Surface Water Quality Standards.

- **Aquatic Life Monitoring (ALM)**
  - **Routine monitoring conducted according to procedures described in SWQM Procedures Vol. 2 to derive baseline data on fish, benthic macroinvertebrates, and physical habitat to determine if designated or presumed aquatic life uses are being attained (e.g. for the Integrated Report);**
  - **<u>An approved QAP/QAPP is required prior to commencing ALM</u>!**
  - **ALM events are typically scheduled as part of the cooperative monitoring schedule;**
  - **An ALM is appropriate for routine monitoring sites, and should be representative of the water body being assessed.**
  - **Data are gathered over at least a year of sampling period with specific seasonal sampling requirements.**
  - **A minimum of two 24-hour dissolved oxygen events are required, one with each of the two aquatic life monitoring events.**
  - **If ALM samples are intended to contribute to the establishment of an appropriate aquatic-life use (e.g. UAA), then 3 additional diel events are required. Work cooperatively with appropriate TCEQ team (e.g. Water Quality Standards Development).**

TCEQ Surface Water Quality Monitoring Program: Knowledge Necessary to Carry Out Bioassessment

- General knowledge of aquatic systems in Texas;
- General knowledge of aquatic life (fish, benthic macroinvertebrates)
- General knowledge of aquatic ecology:
  - where to collect;
  - understanding of interaction of physico-chemical parameters with biota.

TCEQ Surface Water Quality Monitoring Program: Biological Monitoring, Level of Effort for Bioassessment Event

- **Depending on size and characteristics of the stream, a team of 4 – 6 staff members can generally conduct a complete bioassement event:**
- **Individual tasks (fish sampling, benthic sampling, pHab)**
  - **3 staff to conduct fish sampling (seining, electrofishing);**
  - **1 staff to conduct sampling for benthic macroinvertebrates**
  - **2 staff to conduct physical habitat assessment;**
  - **Coastal 2 – 3 staff for seining, trawling;**
  - **Coastal 1 staff for benthic macroinvertebrate sampling;**
  - **1 -2 staff for sample processing (identification, counting);**
  - **2 – 3 staff to complete the physical habitat assessment.**
  - **1-2 staff to collect water chemistry, 24-Hour D.O., and field data including flow.**

ALM: Critical Elements

Aquatic Life Monitoring Events	Minimum Number of Non-critical Index-Period Events	Minimum Number of Critical Index-Period Events
1. Characterization of the fish assemblage	1	1
2. Characterization of the benthic macroinvertebrate assemblage	1	1
3. Characterization of the stream's physical habitat	1	1
4. Instantaneous Field Measurements	1	1
5. Flow Measurement	1 - 2	1 - 3
6. 24-hour DO Monitoring^	1 - 2	1 - 3
7. Conventional water-chemistry sample*	1	1

^ A minimum of one 24-hour DO event in the non-critical and one 24-hour DO event in the critical portion of the Index Period are required.

*** Optional ALM component**

Index Period

- In order to determine ALUs or to evaluate support of existing ALUs, the TCEQ has established an *index period* during which most bioassessments of aquatic assemblages in freshwater river and stream (lotic) systems should be conducted.

- The index period was established to:
  - Minimize year-to-year variability resulting from natural events;
  - Maximize gear efficiency;
  - Maximize accessibility of targeted assemblages;
  - Allow adequate time for conducting sampling;
  - Make efficient use of available resources;
  - Ensure that a portion of the samples are collected during critical low-flow and temperature conditions.

		Index Period									
Jan	Feb	Mar 15	Apr	May	Jun	Jul 1	Aug	Sep 30	Oct 15	Nov	Dec
		Non-Critical Period				Critical Period			Non-Critical Per.		

- **Two bioassessment events:**
  - Both should be conducted during the index period March 15 to October 15, with only one of the two events occurring between July1 and September 30. An effort should be made to collect both samples from the same index period.
- **More than two bioassessment events:**
  - If more than two bioassessment events are considered, then the period of study should be two or more years, with two events or more samples per year.
  - More than two samples collected during the same year may be considered as long as all events occur during the Index with one-half to two-thirds of the events occurring between July 1 and September 30.

*Sample events are conducted at about one month apart and during periods of moderate to low flow but above the 7Q2.

Note that if sampling spans two years the QA document will need to be updated!

Work Flow for a Typical ALM Event

1. Deploy data sonde for diel D.O. measurements and collect conventional water chemistry sample if included;
2. Aquatic biologists conduct “stream reconnaissance” to identify optimal sample reach;
3. Determine reach length;
4. Establish lower end of the reach;
5. Macroinvertebrate biologist begin sampling in best identified macroinvertebrate habitat;
6. Fish biologists begin sample collection at lower end of the reach;
7. Physical habitat crew lays out the reach and begins transect measurements at the lower end of the reach;
8. Process and preserve all water chemistry and biological samples;
9. Retrieve data sonde the next day.

Why Use Biological Assessment Data? **Legal/Regulatory Requirements**:

- **Federal Clean Water Act Section 101(a).** The objective of this Act is to restore and maintain the chemical, physical, and **biological integrity** of the Nation's waters.

- **Title 40, Chapter 130 CFR.** States must establish appropriate monitoring procedures to collect, compile and analyze…data on, chemical and **biological components** of water quality…

- **Texas Water Code Sec. 26.0135.** WATERSHED MONITORING AND ASSESSMENT OF WATER QUALITY. (a) To ensure clean water, **the commission (TCEQ) shall establish the strategic and comprehensive monitoring of water quality and the periodic assessment of water quality in each watershed and river basin** of the state;

- **TAC, Title 30, Part 1, Chapter 220, Subchapter A, Rule 220.1:** The monitoring program shall provide data to identify significant, long-term water quality trends, characterize water quality conditions, support the wastewater discharge permitting process including support for the total maximum daily load process as necessary, and classify unclassified streams. The assessments must include a review of..., **biological health of aquatic life**, …, and other factors that affect water quality within the watershed.

- **Texas Surface Water Quality Standards Section 307.1.** General Policy Statement: ***It is the policy of this state…to maintain the quality of water in the state consistent with public health,…and protection of terrestrial and aquatic life.***

Why Use Biological Assessment Data?:
Ecological/Biological Rationale

- Biological assemblages reflect overall ecological integrity (i.e., chemical, physical, and biological integrity). Therefore, bioassessments directly assess the status of a water body relative to the primary goal of the Clean Water Act (CWA).

- Bioassessment provides a direct measure of what aquatic life use criteria (e.g. D.O., toxics) in the TSWQS's are meant to protect.

- **Biological assemblages integrate the effects of different stressors as well as integrating the stresses over time and thus provide a broad measure of their aggregate impact over time.**

- Routine biological monitoring of assemblages can be relatively inexpensive, particularly compared to cost of assessing toxic pollutants.

- The status of biological assemblages is of direct interest to the public as a measure of a pollution free environment.

Value of Biological Data

- **Provides direct measure of the effectiveness of TCEQ water quality management strategies;**
- **Effective tool for planning Water Quality Monitoring and Management activities;**
- **Public can relate to and value an evaluation of the Condition of biological assemblages, especially fish.**

TCEQ Biological Monitoring Program

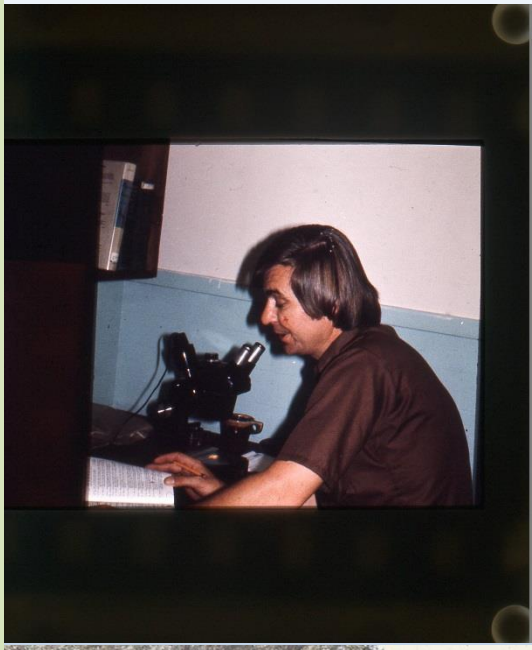
By the seat of our pants???

TCEQ Aquatic Life Monitoring: History 60's, '70's and 80's

- TCEQ Biological Monitoring began in 1967
  - mainly fishes and benthic macroinvertebrates;
  - collection methods were not standardized so provided some presence/absence information

- Least Impacted Streams Studies began in mid-1980's
  - Effort to describe range of ALU category expectations based on Aquatic Life Monitoring;
  - Initial effort to implement standardized collection methods

- Assessment of Six Least Disturbed Unclassified Texas Streams (1989);
  - Demonstrated ability to identify a range biotic integrity (ALU Categories) based on Aquatic Life Monitoring



TCEQ Aquatic Life Monitoring: History 1990's

- Texas Aquatic Ecoregion Project (1992);
  - Fish, benthic macroinvertebrate and physical habitat data collected at 72 Least Disturbed Streams
  - Data were used to derive metric sets (IBI's) used to assign fish, and benthic macroinvertebrates to aquatic life categories.
    - Statewide IBI for fishes;
    - Mean Point Score for Benthics collected with Surber;
- Rapid Bioassessment Workshop in San Antonio (1990)
  - IBI for qualitative RBA benthic macroinvertebrate samples (1996);
- Regionalized IBI for quantitative benthic macroinvertebrate samples collected with Surber Sampler (1997);
- TCEQ Receiving Waters Assessment Manual (1999)

TCEQ Aquatic Life Monitoring: History 2000's

- TCEQ and TPWD Interagency Biological Monitoring Workgroup (2000)
- Biological assessments first included in the 305(b); report/Integrated Report (2000);
- TPWD Regionalized Fish IBI's (2002);
- TCEQ Aquatic Life Monitoring Training in Austin (2005);
- U.S. EPA 3rd party review of TCEQ biological assessment program and follow-up (2008 & 2010 respectively);
- Revived the Texas Least Disturbed Streams Project (2010);
- Draft regionalized IBI's for benthic macroinvertebrate samples collected according to Rapid Bioassessment (RBA) protocols (2015);
- TCEQ Aquatic Life Monitoring Training in Austin (2016);

TCEQ Programs That Use Bioassessement Data

- Surface Water Quality Monitoring Program
- Field Operations Division
- Total Maximum Daily Load Program (TMDL)
- Wastewater Permitting/Enforcement
- Clean Rivers Program
- Instream Uses/Water Rights (SB2 work)
- Water Quality Standard and Implementation Teams

Uses of Biological Assessments: TCEQ Surface Water Quality Monitoring Program

- **Watershed Protection Plans, e.g Watershed Protection Plan for the Pecos River;**
- **Water Rights, e.g. DOW Senior Call on Brazos;**
- **Special Studies, e.g. potential instream effects of toxics, municipal/industrial wastewater treatment plants such as Patrick Bayou, San Jacinto River Waste Pits;**
- **National Aquatic Resource Surveys, e.g. National Rivers and Streams Assessment, National Lakes Assessment, Coastal Assessment;**
- **Comparative analysis of biological assessments conducted by outside entities, e.g. N. Sulphur River, etc.;**
- **<u>Baseline/Routine monitoring</u> of biotic assemblages to evaluate water quality in states waters. Used in producing the Integrated Report (305b)**

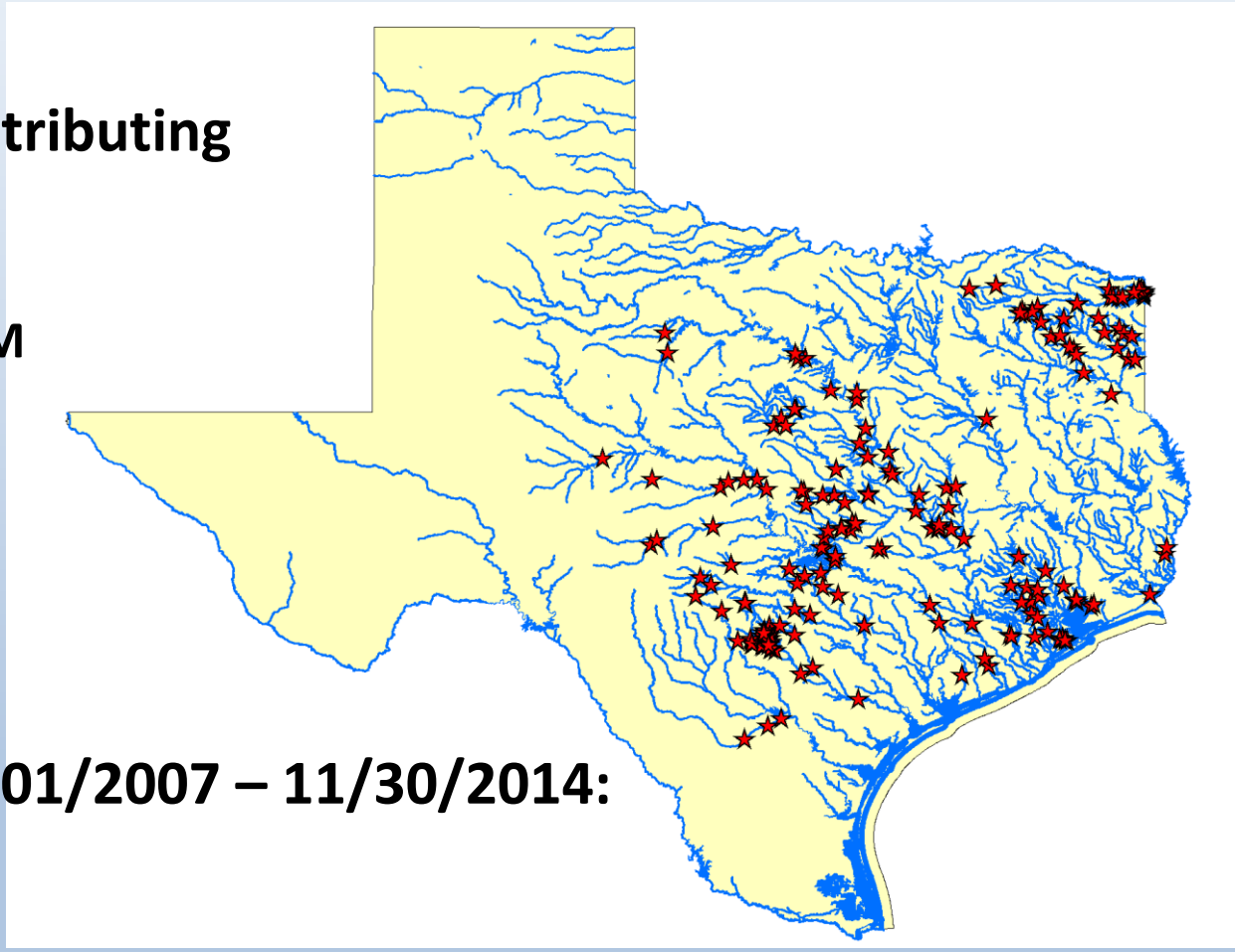
Examples of Uses of Biological Assessments: TCEQ Surface Water Quality Monitoring Program

- Development of the Index of Biotic Integrity (IBI) to be used in establishing and evaluating support of Aquatic Life Use Subcategories for waters in the state (Least Disturbed Streams Project);
- Biological assessments for the Statewide Water Quality Inventory (305b Report).
- Senate Bill 2 Instream Flow Project (Trinity River, Guadalupe River, Brazos River);
  - Biological data used to Determine flow conditions necessary to support a sound ecological environment in Texas rivers and streams

TCEQ Surface Water Quality Monitoring Program: Biological Monitoring for the 2016 Integrated Report

Monitoring Entities Contributing Biological Data for IR:

- **TCEQ Regional Biologists**
- **TCEQ Central Office SWQM**
- **River Authorities**
- **Texas Parks and Wildlife**

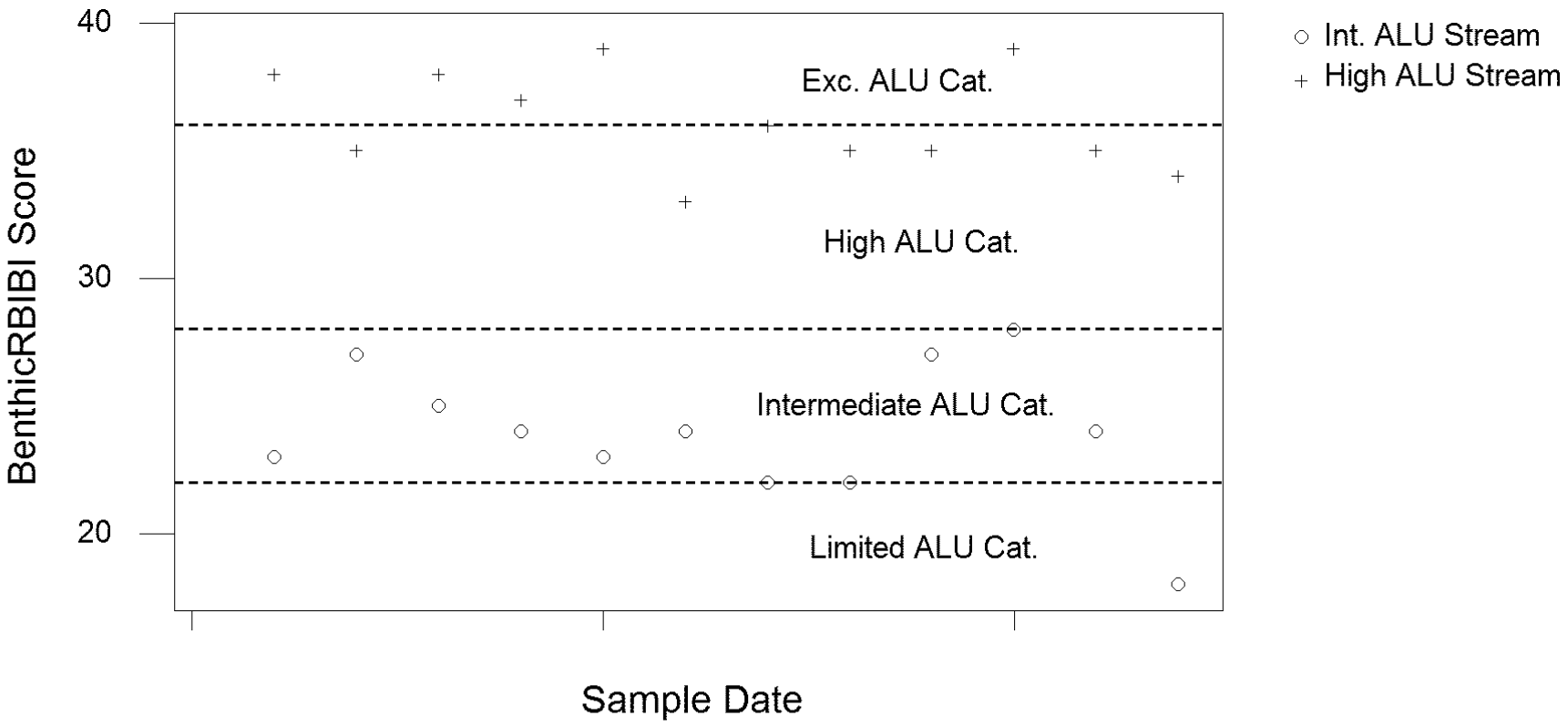


Over the 7-YR Period 12/01/2007 – 11/30/2014:

- **382 Assessment Units**
- **992 Biological Sample Events.**

- Characteristics of Good Water Quality Monitoring Indicators
  - Indicators that convey meaningful information about the resource of interest;
  - Variables that give a relatively repeatable signal when the system is at equilibrium;
  - Variables that can differentiate between systems with different intrinsic characteristics;
  - Variables that give a detectable signal when disturbance disrupts the equilibrium state.

Example: Index of Biotic Integrity Ability Distinguish Between Aquatic Life Use Categories For Two Streams With Different ALU in ER 33/35



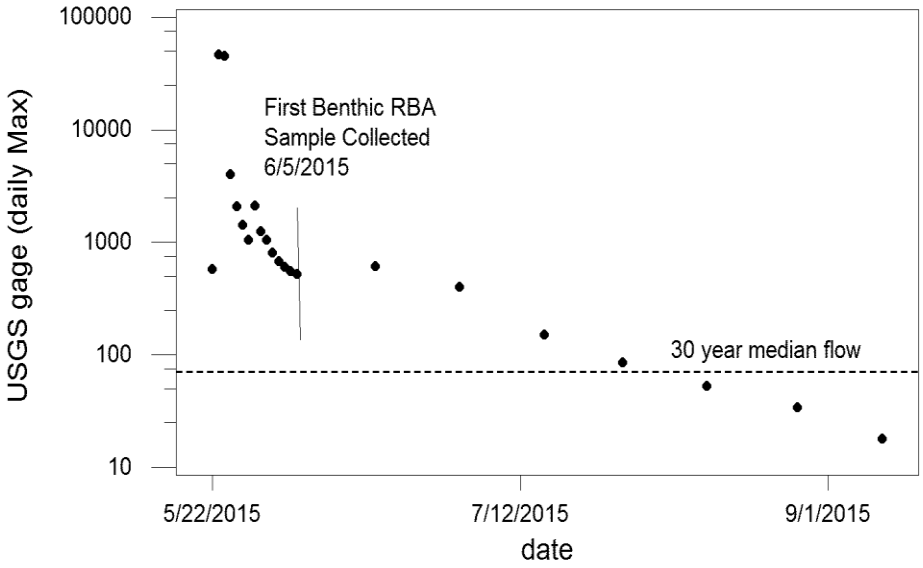
307 .7 of the TSWQS narrative description of Aquatic Life Use Subcategories

High Aquatic Life Use Category:

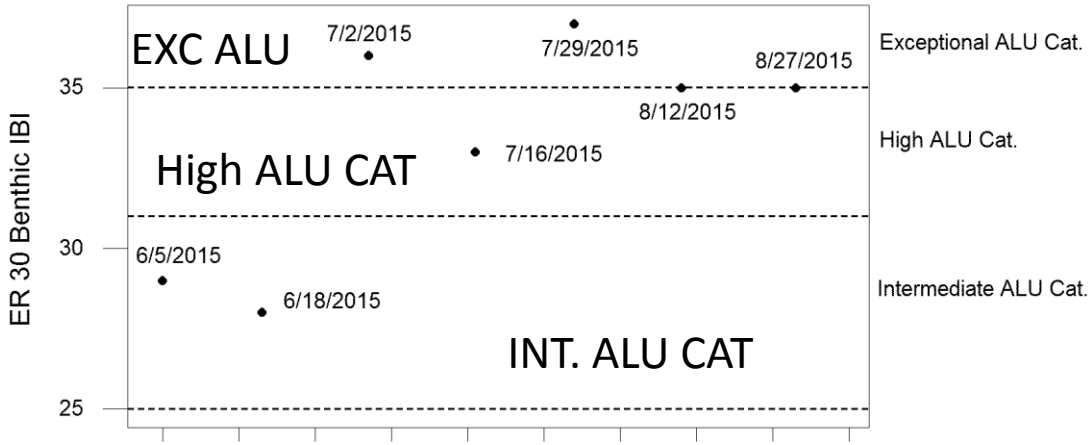
- Highly diverse habitat
- Sensitive spp. Present
- High Diversity
- Balanced/slightly Imbalanced Trophic Structure

Intermediate Aquatic Life Use Category

- Moderately diverse habitat
- Very low abundance of sensitive spp.
- Moderate Diversity
- Moderately Imbalanced Trophic Structure



Flow data for Medina R. flood 05/2015



IBI scores for benthic samples at two week intervals following flood event.

Example: IBI's ability to detect disturbance of system equilibrium caused by disturbance.

- Taxa Loss
- Relative dominance of taxa changes
- Balance of Trophic Structure Interrupted
- Loss of Sensitive Taxa

Current Strategy for accomplishing Bioassessments: Ad Hoc Teams referred to informally as the Virtual Bioassessment Team (VBAT)

- Ad Hoc teams comprised of TCEQ central office, regional office, river authority;

- Cooperative consolidation of biological monitoring resources to accomplish state-scale projects as well as projects targeting specific water bodies:

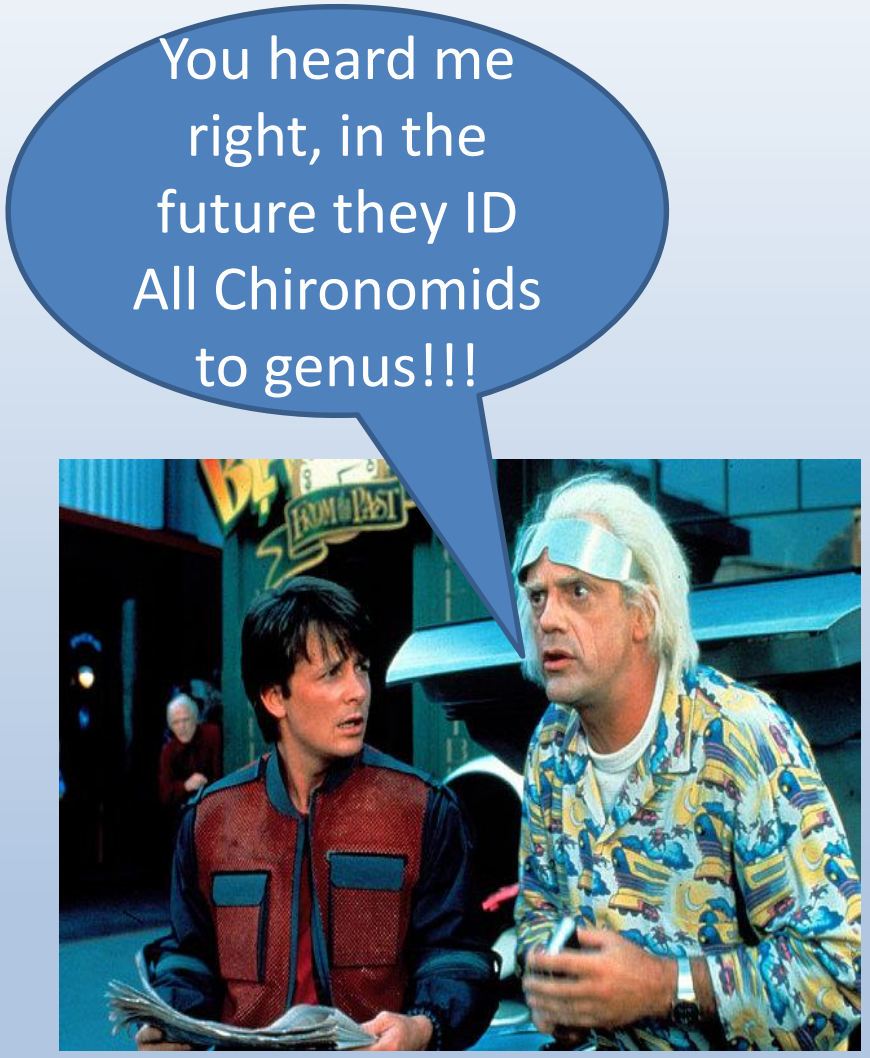
- National Aquatic Resource Surveys (NLA, NRSA, Wetlands, Coastal)

- TCEQ State Level Studies (Least Disturbed Streams, Fish Tissue)

- Water Body Specific (Use Attainability Analyses, Routine Aquatic Life Monitoring, Required Water Quality Assessments (Integrated Report) using guidance in biological monitoring fact sheets

Future Directions for TCEQ Aquatic Life Monitoring

- Improve capacity for use of more sophisticated causal analysis techniques to link results of bioassessments to impairments;
- Increased taxonomic resolution, especially for benthic macroinvertebrate groups such as the chironomidae;
  - Refined tolerance values for macroinvertebrates and fish;
- Expanding the least disturbed streams inventory;
- Take advantage of advances in geospatial technology and application in watershed analysis.
- Increase coverage for routine ALM



Summary

- TCEQ Aquatic Life Monitoring sampling and data analysis methods have been developed over a period of at least 40 years.
- Most ALM methods developed in the context of the TCEQ and TPWD interagency workgroup on Aquatic Life Monitoring.
- Data analysis thus far indicates that these methods collectively provide effective water quality monitoring tools that:
  - Provide repeatable results;
  - Can be carried out with a reasonable level of effort, and the VBAT can coordinate additional staff if needed;
  - Can be used to accurately set and assess aquatic life use categories;
  - Can be used to detect impairments resulting from disturbance.
  - Plenty of interesting valuable work needed in the future!

Texas Parks and Wildlife Department Scientific Collection Permit

- ALM activities require Scientific Collection Permit Issued by TPWD;
- Carry the permit when conducting activities authorized by the permit;
- Notify TPWD Law Enforcement Office in the region of the field activities 24 – 72 hours prior to collection activities;
- Annual report of all taxa collected required in order for permit to remain valid;
- Permit specifically excludes collection or impact on THREATENED OR ENDANGERED SPECIES. USFWS Permit???

TPWD Scientific Collection Permit

- **TCEQ Primary Permit Holder and Contact:**
  - **Pat Bohannon**
  - **Pat.Bohannon@tceq.texas.gov**
  - **512/239-5255**
- **Texas Parks and Wildlife Contact**
  - **Christopher Maldonado**
  - **Christopher.Maldonado@tpwd.texas.gov**
  - **512/389-4647**

Questions?

Contact Information:

Bill Harrison
Telephone: 512/239-4602
Email:
bill.harrison@tceq.texas.gov