Biological Monitoring Using Macroinvertebrates as Bioindicators of Water Quality



Topics of interest

Factors Affecting Macroinverts

- Large scale Factors
 - Ecoregions of Texas
 - Drainage Basins
 - Stream Geomorphology
- Important Concepts
 - River Continuum Concept
 - Flood Pulse Concept
- Local Factors
 - Physical-Chemical Factors
 - Water Quality Parameters

Biomonitoring

- Trophic Guilds
- Tolerance Index
- A case study
 Pedernales Watershed

Ecoregion types in Texas



Drainage Basins

- Each stream in a drainage system drains a certain area, called a drainage basin.
- In a single drainage basin, all water flowing in the basin drains into the same stream.
- Drainage basins can range in size from a few km², for small streams, to extremely large areas, such as the Mississippi River drainage basin which covers about 40% of the contiguous United States.
- A divide separates each drainage basin from other drainage basins.



Stream Geomorphology





Important Concepts

- River Continuum Concept
- Flood Pulse Concept

River Continuum Concept 1980, Vannote et al.

As a river flows from headwaters to the lower reaches, there will be a change in the relationship between the production and consumption of the living organisms.

There is also change in taxa based on their feeding habits.



Flood Pulse Concept 1989, Junk et al.

The lateral connectivity between the wetlands and uplands is explained by the Flood Pulse Concept.



Local Factors

Physical-Chemical factors

- 1. Dissolved oxygen,
- 2. Higher temperatures,
- 3. Excessive turbidy
- 4. Toxicants
- 5. Eutrophication
- 6. Municipal/Industrial wastewater discharge

Local Factors

Physical-Chemical factors

- 1. Degraded habitat
- 2. Deforestation/development/construction
- 3. Urbanization/industrialization
- 4. Agricultural operations
- 5. Artificial channelization or habitat alteration
- 6. Upstream impoundment, lake or pond
- 7. Drought conditions

Temperature



Conductivity



pН



Dissolved Oxygen



Turbidity



Biomonitoring

Evaluation of the condition of a water body using biological surveys and other direct measurements of the resident biota in surface waters.

Why Benthic macroinvertebrates

- visible to naked eye
- inhabit substrate for at least part of their life cycle
- species vary in their sensitivity to polluted waters

Macroinvertebrate Lifecycle



Inomplete Metamorphosis

Mayfly, Stonefly, Dragonfly, Damselfly, True bugs (Hemiptera)



Complete Metamorphosis

Caddisfly, Dobsonfly, Beetles, Aquatic moths, True Flie (Diptera),

The Texas Commission on Environmental Quality (TCEQ) sets and implements standards for surface water quality to improve and maintain the quality of water in the state.

The **Surface Water Quality Monitoring** (SWQM) Program monitors and evaluates physical, chemical, and biological characteristics of aquatic systems as a basis for effective policy.

- <u>SWQM Procedures Manual, Vol. 1</u> Physical and Chemical Monitoring Methods
- <u>SWQM Procedures Manual, Vol. 2</u> Methods for Collecting and Analyzing Biological Assemblage and Habitat Data

Temperature; Conductivity; pH; Dissolved Oxygen; Turbidity





Trophic Guilds

some common macroinvertebrate taxa



Mayfly

Feeding Guild: Collector







adult

Stonefly





Feeding Guild: <u>Shredder</u>



Caddisfly

Feeding Guild: Collector







Riffle Beetle





Feeding Guild: Scraper



Dragonfly





Feeding Guild: Predator



Dobsonfly (hellagrammite)

Feeding Guild: Predator



Blackfly

Feeding Guild: <u>Filterer</u>





Mussels

Glochidia Larva



Feeding Guild: Filterer





most pollution <u>sensitive</u> e.g. Stoneflies

most pollution *tolerant* e.g. Midges & Leeches





require high DO, clear water, high quality riffles contain hemoglobin, tolerate lower DO, prefer soft substrate, less sensitive to toxins

Bioindicator quick worksheet

Bugs as Bioindicators - is your creek clean or polluted?

Freshwater macroinvertebrates (greater than 0.5 mm in size) are generally used to indicate water quality of a freshwater body as they are sensitive to physical and chemical changes that occur in water. Their lower mobility compared to fish, long life-span, and greater diversity makes them useful bioindicators. Some of these need very clean water to live; others can thrive in polluted water. By identifying the different types of macroinvertebrates in a stream, we can learn if the water in the stream is clean or polluted.

Directions

Mark the picture of each type of animal you find from your creek. Add the points for the marked animals from all columns and get the score to determine your Creek Condition.

Creek Condition		
Clean	more than 18	
Ok	9 - 19	
Maybe Polluted	less than 10	1

My Creek is: Clean _____ or OK _____ or maybe Polluted



a case study : Pedernales Watershed Effects of Arundo (Arundo donax) Management on Aquatic Communties

- What: Effects of Arundo a non-native plant
- Where: Barons Creek an urban Hill Country stream in Fredericksburg, TX.
- Objective:
 - Study the effects of invasive Arundo on aquatic communities

Barons Creek, Fredericksburg, TX



Index of Biotic Integrity Scores



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Invertebrate community patterns in Native vs Arundo stands



Sampling Location

-) Native vegetation
- Arundo stands

Sites



Arundo management Project video clip

https://youtu.be/bcZ5KtSRppA?t=273

QUESTIONS

