Using Comparative Long-term Benthic Data For Adaptive Management Of Freshwater Inflow To Three Basins

Melissa Rohal and Paul Montagna

TWDB Interagency Agreement # 18000122236
Project Purpose

• Complete analyses of long-term benthic archive samples to evaluate the adequacy of the freshwater inflow standards adopted as part of the Senate Bill 3 adaptive management process

• Support Basin and Bay Area Stakeholders Committees (BBASC) of three basins:
  • CL (Colorado and Lavaca Rivers and Matagorda and Lavaca Bays) BBASC
  • GSA (Guadalupe, San Antonio, Mission, & Aransas Rivers and Mission, Copano, Aransas, & San Antonio Bays) BBASC
  • Nueces (Nueces River and Corpus Christi and Baffin Bays) BBASC
GSA BBASC Work Plan Needs

• Guadalupe Estuary Specific
  • Tier 1 Priorities:
    • Priority 1 Life Cycle Habitat & Salinity Studies for Key Faunal Species
    • Priority 3 Rangia Clam Investigations
  • Tier 3 Priorities:
    • Nutrient Load & Concentration Monitoring
Approach to Link Inflow and Living Resources

• Inflow Has Indirect Effects: “Domino Theory”
• We will link estuary conditions to benthic response using multivariate analysis and non-linear models to find optimal salinity ranges.


### Bioindicators Used by BBEST’s

<table>
<thead>
<tr>
<th>Bay System</th>
<th>Indicator Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galveston Bay, 2009</td>
<td>Eastern oyster, <em>Dermo</em>, <em>Oyster drill</em>, Wild celery, Gulf menhaden, Blue catfish, Mantis shrimp, Pinfish</td>
</tr>
<tr>
<td>Brazos River, 2012</td>
<td>Salinity, Nutrients, Sediment supply</td>
</tr>
<tr>
<td>Lavaca and Matagorda Bays, 2011</td>
<td><em>Eastern oyster</em>, <em>Dermo</em>, <em>Oyster drill</em>, brown shrimp, white shrimp, Blue crab, Gulf menhaden and Atlantic croaker, Benthic infauna</td>
</tr>
<tr>
<td>Mission, Copano, Aransas, and San Antonio Bays, 2011</td>
<td><em>Eastern oyster</em>, <em>Atlantic rangia</em>, <em>brown rangia</em>, white shrimp, Blue crab</td>
</tr>
<tr>
<td>Nueces, Corpus Christi, and Baffin Bays, 2011</td>
<td><em>Eastern oyster</em>, <em>Atlantic rangia</em>, Smooth cordgrass, benthic infauna, Blue crab, Atlantic croaker, nutrient cycling, sediment loading</td>
</tr>
<tr>
<td>Lower Laguna Madre, 2012</td>
<td>Seagrasses</td>
</tr>
</tbody>
</table>

But, it’s not only *Rangia*, it’s all benthos!
Benthos are Excellent Bioindicators Because they Cannot Move

- Sessile
- Relatively long-lived
- Diverse
- Well known
- Respond to food from above

Benthos are Excellent Bioindicators
Because they are Integrators

- Sediments are the memory of the ecosystem
- Benthos affected first and most
- Thus, benthos are integrators
  - overlying water column is dynamic
  - benthos sample and integrate ephemeral events over long timescales

Source: Montagna et al. 1996, CCBNEP #8
http://cbbep.org/publications/virtuallibrary/ccbnep08.pdf
Importance of Long-Term Research*

• Provides a unique perspective on environmental processes, dynamics of populations and communities of organisms

• Ecological relationships can be obscured in short term studies by common features such as time lags, natural variability, nonlinear relationships, interactive drivers, or relatively slow processes

• Led to major scientific discoveries

Maintained the Long-Term Program Via Synergies

• First TWDB studies began in 1987 with focus on San Antonio Bay
• Many synergistic projects in San Antonio Bay
  • Federal = EPA, NASA, NOAA, NFWF, NSF, USGS
  • State = TARP, TRDF, TCEQ, TGLO, TPWD, TXSG
  • Other = CBBEP, CCBNEP, Private Foundations (3)
• Current Projects:
  • NOAA – “The Hydrological Switch: A Novel Mechanism Explains Eutrophication and Acidification of Estuaries”
  • NSF – “RAPID: Capturing the Signature of Hurricane Harvey on Texas Coastal Lagoons”
Importance of the Comparative Approach

Texas Coast-wide Inflow Gradient Provides a Perfect Natural Experiment

Inflow Balance (1000 ac-ft/month)

-500 0 500 1000 1500

Inflow (TWDB): 1941-2009
TX Estuaries Long-Term Studies

- 3 Estuaries studied since 1987
- Water and sediment quality measured at fixed stations
- Image of turbidity gradients after a flooding event

- Climatic, across estuary gradient
  - 2 Positive Estuaries = LC and GE
  - 2 Neutral Estuaries = MA and NC
  - 1 Negative Estuary = LM

- Inflow, within estuary gradient
  - Secondary bay with two stations
  - Primary bay with two stations
Inflow Drives Estuary Conditions

Effect of hydrological variability on the biogeochemistry of estuaries across a regional climatic gradient

Paul A. Montagna §, 1,* Xingping Hu 2, Terence A. Palmer, 1 Michael Wetzel 3

1Harte Research Institute for Gulf of Mexico Studies, Texas A&M University-Corpus Christi, Corpus Christi, Texas
2Department of Physical and Environmental Sciences, Texas A&M University-Corpus Christi, Corpus Christi, Texas
3Department of Life Sciences, Texas A&M University-Corpus Christi, Corpus Christi, Texas
Salinity Variability Drives Integrity

Is Salinity Variability a Benthic Disturbance in Estuaries?

Amanda D. Van Diggelen\textsuperscript{1,2} • Paul A. Montagna\textsuperscript{1}
Effects of Droughts in 8 Texas Bays

**Blue Crabs**
- Abundance
- Size (width)
- Juvenile Abundance
- Juvenile %

**Shrimp**
- Abundance
- Size (length)
- Juvenile Abundance
- Juvenile %

**Water Quality**
- Nitrate + Nitrite
  - Reduced loading
- Chlorophyll
  - Reduced nutrients
- pH
  - Reduced photosynthesis
Current Discoveries – Benthos are Declining Everywhere Except Upper San Antonio Bay

<table>
<thead>
<tr>
<th>Metric</th>
<th>Est</th>
<th>LC</th>
<th>GE</th>
<th>NC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abundance</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Biomass</td>
<td>↓</td>
<td>↑</td>
<td>→</td>
<td>←</td>
</tr>
<tr>
<td>Diversity</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td></td>
</tr>
</tbody>
</table>
## Tasks and Timelines

**01-Feb-2018 to 31-Aug-2019**

<table>
<thead>
<tr>
<th>Tasks</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q2</td>
<td>Q3</td>
</tr>
<tr>
<td>Archive analysis</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Quarterly reports</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Draft Final Report</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Report</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17