MISSING: A Graph, A Model, and a Proof of Concept

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A Presentation to the
Trinity and San Jacinto Rivers and Galveston Bay
Basin and Bay Expert Science Team
January 15, 2009
Scientific Concepts

• “There should also always be a continual questioning of the basic assumptions from which interpretations, “answers” and model outputs are deprived and corrections made where justified.” [SAC 2004 p.1-6]

• “…scientific progress is convergent, and is self-correcting.”

• “In science, there are many instances of important concepts or procedures that ultimately proved to be wrong.” [SAC 2004 p.6-27]
Misconceptions

• “There appears to be little argument that environmental flows are important and necessary for maintaining the ecological health of the Texas’ rivers and streams and its bays and estuaries; the difficult question is: what flow regime is required to assure the state’s ecosystems are adequately protected.” [SAC 2004, p.1-1]

• ‘beneficial inflows’ means “a salinity, nutrient, and sediment loading regime adequate to maintain an ecologically sound environment in the receiving bay and estuary system that is necessary for the maintenance of productivity of economically important and ecologically characteristic sport or commercial fish and shellfish species and estuarine life upon which such fish and shellfish are dependent.” [SAC 2004 p.1-9]
• “The employment of the intensive catch data of the TPWD Coastal Fisheries monitoring program is admirable. This data collection program, in which a variety of gear is used to rigorously sample the organisms present in each of the Texas bays, has been underway for decades, and is a magnificent resource for the study of these estuaries.”
• The BBEST faces a daunting task and looming deadline.

• To find our path, we must

  FOLLOW THE DATA !!!
Operational Paradigm

• Freshwater Inflow Affects Fishery Productivity

• If this paradigm is correct, why is it so difficult, with many decades of flow and fisheries-dependent data, and more than 30 years of fishery-independent coastal fisheries monitoring data, to demonstrate?

• Benthic mollusks indicate inflow effects, but does this extend to the top predator fishes level?
Freshwater Inflow Requirements

• TxRR – Rainfall Runoff model for ungauged flows
• TxEMP – Estuarine Mathematical Programming model to determine optimal annual inflows and estuarine fisheries harvests.
• Species Spatial Distribution models for a number of finfishes and shellfishes.
• TxBLEND – hydrodynamic circulation model to evaluate effects on salinity distribution and bay circulation.
• Missing – conceptual ecosystem model
FRESHWATER INFLOW

WATER

DISSOLVED SUBSTANCES

SUSPENDED SUBSTANCES

AUTOTROPHIC FOOD WEB

HETEROTROPHIC FOOD WEB

SALINITY

PHYTO-PLANKTIVOROUS FISHES

DETRITIVOROUS & OMNIVOROUS FISHES

GULF WATER

PISCIVOROUS FISHES
Key Assumptions

• CPUE fisheries data reflect true fish abundance

• Fish abundance is affected by salinity

• Salinity reflects nutrient content
Relationship between Atlantic Croaker Bag Seine vs. Trawl CPUE for Galveston Bay, 1982-2005

<table>
<thead>
<tr>
<th>Lag Time</th>
<th>Coef.Det R-Sq</th>
<th>Probability p</th>
<th>Samples n</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>0.03</td>
<td>0.003</td>
<td>288</td>
</tr>
<tr>
<td>1 month</td>
<td>0.0001</td>
<td>0.839</td>
<td>287</td>
</tr>
<tr>
<td>2 months</td>
<td>0.023</td>
<td>0.01</td>
<td>286</td>
</tr>
<tr>
<td>3 months</td>
<td>0.052</td>
<td>0.001</td>
<td>285</td>
</tr>
</tbody>
</table>
Atlantic Croaker
Galveston Bay trawl CPUE

No./Hr

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

Most TPW data are POINT COUNTS

- There are two probabilities involved with each sample, one with the fish, the other with the fisherman.

<table>
<thead>
<tr>
<th></th>
<th>PRESENT</th>
<th>ABSENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>DETECTION</td>
<td>True Positive</td>
<td>False Positive</td>
</tr>
<tr>
<td>NON-DETECTION</td>
<td>False Negative</td>
<td>True Negative</td>
</tr>
</tbody>
</table>
Indirect determination of salinity preference

Fig. 8

Spatial Correlation Between Salinity and Species Abundance
White Shrimp
Galveston Bay, Texas
July - December

Catch per 10 Minutes
- 0 - 7.326
- 7.327 - 14.653
- 14.654 - 379.826
- 379.827 - 745

Salinity (ppt)
- 0 - 4.99
- 5 - 9.99
- 10 - 14.99
- 15 - 19.99
- 20 - 24.99
- 25 - 29.99
- > 30

(Prepared by: Texas Parks & Wildlife COASTAL CONSERVATION BRANCH)
Relationship between Salinity and Trawl CPUE, Galveston Bay, 2004 (n=240)
### Relationship between Salinity and Trawl CPUE for Galveston Bay, 2004

<table>
<thead>
<tr>
<th>Species</th>
<th>Coef. Deter. R-Sq</th>
<th>Probability p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Crab</td>
<td>0.010</td>
<td>0.131</td>
</tr>
<tr>
<td>Brown Shrimp</td>
<td>0.017</td>
<td>0.046</td>
</tr>
<tr>
<td>White Shrimp</td>
<td>0.0004</td>
<td>0.749</td>
</tr>
<tr>
<td>Atlantic Croaker</td>
<td>0.007</td>
<td>0.203</td>
</tr>
<tr>
<td>Bay Anchovy</td>
<td>0.006</td>
<td>0.224</td>
</tr>
<tr>
<td>Gulf Menhaden</td>
<td>0.011</td>
<td>0.111</td>
</tr>
<tr>
<td>Spot</td>
<td>0.002</td>
<td>0.514</td>
</tr>
<tr>
<td>Striped Mullet</td>
<td>0.024</td>
<td>0.016</td>
</tr>
</tbody>
</table>
Figure 11. The connectivity of open-bay bottom habitat. The fungi and bacteria which comprise the benthic decomposers are vital at both ends of the food web. The benthic-pelagic coupling provides a vital link to the open-bay water habitat.
## Correlations with Salinity

\( R-Sq (p) \)

<table>
<thead>
<tr>
<th></th>
<th>Trinity Bay</th>
<th>UL Galveston Bay</th>
<th>West Bay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total-N</td>
<td>0.145 (0.131)</td>
<td>0.128 (0.111)</td>
<td>0.0002 (0.953)</td>
</tr>
<tr>
<td>NH3-N</td>
<td>0.084 (0.216)</td>
<td>0.0009 (0.899)</td>
<td>0.050 (0.328)</td>
</tr>
<tr>
<td>Total-P</td>
<td>0.050 (0.343)</td>
<td>0.046 (0.353)</td>
<td>0.018 (0.558)</td>
</tr>
<tr>
<td>Chl-Phr</td>
<td>0.002 (0.846)</td>
<td>0.003 (0.817)</td>
<td>0.011 (0.658)</td>
</tr>
</tbody>
</table>
Key Assumptions

• CPUE fisheries data reflect true fish abundance
  • Frequently FALSE
• Fish abundance is affected by salinity
  • FALSE
• Salinity reflects nutrient content
  • FALSE
The State Methodology

• Has not worked in the past, is not working now, and will not work in the future, because

• There is no theoretical basis for it to work, and

• It has been based on salinity but salinity has little, if anything, to do with it.

• It is sophisticated pseudoscience.
## Aquatic Zone Distribution of Fish Life Cycle Events

<table>
<thead>
<tr>
<th>Class</th>
<th>EGGS</th>
<th>LARVAE</th>
<th>JUVENILES</th>
<th>SUBADULTS</th>
<th>ADULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshwater</td>
<td>Freshwater</td>
<td>Freshwater</td>
<td>Freshwater</td>
<td>Freshwater/ Estuary</td>
<td>Freshwater/ Estuary</td>
</tr>
<tr>
<td>Estuarine</td>
<td>Estuary</td>
<td>Estuary</td>
<td>Estuary</td>
<td>Estuary</td>
<td>Estuary</td>
</tr>
<tr>
<td>Estuarine/Marine 1</td>
<td>Nearshore</td>
<td>Nearshore/ Estuary</td>
<td>Estuary/ Freshwater</td>
<td>Estuary/ Freshwater</td>
<td>Nearshore</td>
</tr>
<tr>
<td>Estuarine/Marine 2</td>
<td>Offshore</td>
<td>Nearshore</td>
<td>Estuary</td>
<td>Nearshore</td>
<td>Offshore</td>
</tr>
<tr>
<td>Marine</td>
<td>Offshore</td>
<td>Offshore</td>
<td>Offshore</td>
<td>Nearshore/ Estuary</td>
<td>Nearshore/ Estuary</td>
</tr>
</tbody>
</table>
Texas has a natural freshwater inflow and salinity gradient along its coast.

- Bay water turnover time ranges from days (Sabine) to years (Laguna Madre).
- None of the bay ecosystems are “unhealthy”.
- A solution must address all of the bays, not be done piecemeal, one bay at a time, as we are currently doing.

- Where is the tipping point, where the bay ecosystem flips and undergoes a regime change?