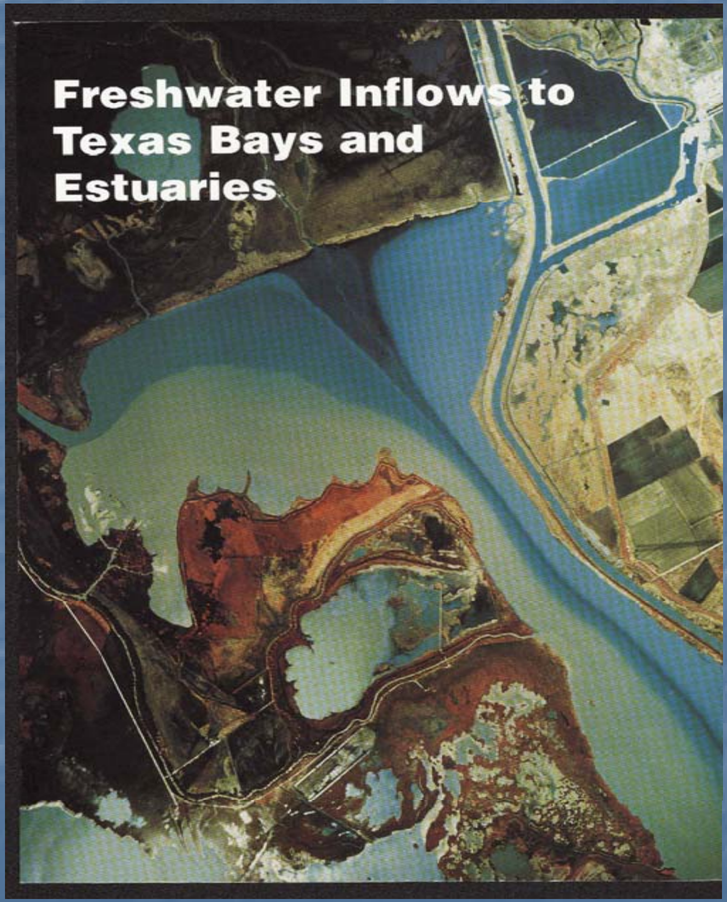
Policy Decisions Required for Application of the State Methodology

Presented to the

Texas Scientific Advisory Committee

November 5, 2008

State Methodology Report



Freshwater Inflow to Texas Bays and Estuaries: Ecological Relationships and Methods for Determination of Needs

Texas Water Development Board and Texas Parks and Wildlife Department, 1994.

http://midgewater.twdb.state.tx.us

Policy Decisions

this model to these dynamic constituents, however, data is needed on the rates of biological and chemical processes which affect these materials.

There may be a role for the optimization approach developed here to address future water quality concerns. There are trade-offs to the estuary in a future scenario of higher rates of nutrient loading which may come with increased urbanization of estuarine shores. Increased nutrient loading may bring positive increases in productivity to some estuaries. However, increased nutrient loading also may increase risks of the development of anoxic areas, red tide blooms, or other problems. How these risks weigh against the possible increased productivity depends on many factors, including rates of water exchange, seasonality, and factors which limit the biological community. The framework of the TXEMP Model is uniquely suited to incorporate in a quantitative way our knowledge of the interactions of these various factors. Water quality standards and productivity measures could also be included as targets or controlling parameters. Relationships between loading rates and predicted dissolved oxygen concentrations or other parameters could be used as constraints. It is possible to envision the application of this model to water quality concerns in this way. However, to make it work, more detailed knowledge is required of the best way to express relationships between nutrient loading, pollutant concentrations, and the behavior of the estuarine ecosystem.

Conclusion

The models and methods needed to use the analytical procedure to determine freshwater inflow requirements have been developed. Most of the information about the hydrology of inflowing waters and fishery equations is also available. The models of circulation and conservative transport for several estuaries need to be calibrated, and the nutrient budgets using cumulative flows from these models must still be prepared. Analyses of sediment requirements for the bay systems other than the Guadalupe Estuary will have to be done on a case-by-case basis, probably aimed at determining sediment requirements for maintaining delta wetlands.

Several enhancements to the method were discussed including improved primary productivity relationships and the addition of benthic productivity and water quality components. Because the analytical procedure is somewhat modular, incremental improvements to the analytical procedure as well as new features can be added easily at any time. Some of the techniques and analyses can be applied to other important problems such as the responses of ecosystems to unusual occurrences or deleterious changes from major pollutant spills, eutrophication, or toxic algae blooms. There may be concern over the length of time required for a bay to flush out a pollutant, or the question might be whether currents will sweep a red tide bloom into a bay. The morphometry of passes, the orientation of ship channels, and the volume of freshwater inflows all influence the exchange between major secondary and tertiary bays and the circulation of fresh and salty water within the bays. The models presented here provide a way of combining information on many aspects of estuary hydrodynamics, movements of materials, and ecological processes.

9.3 POLICY DECISIONS THAT MUST BE MADE TO APPLY THE METHODOLOGY

Introduction

In response to statute directives for studies on the effects of freshwater inflows, state scientists and engineers have developed a comprehensive database and methodology for estimating the freshwater inflow needs of Texas bays and estuaries. Since freshwater inflows affect our estuarine (tidal) systems at all basic levels of interaction—physical, chemical, and biological effects—the new method was designed to include at least the minimum needs for each functional level. It also incorporates a technique for optimizing the freshwater inflow needs across all levels of interaction to maintain the ecological integrity of these valuable coastal environments.

The TXEMP Model. The TXEMP Model was cooperatively developed and tested with the Center for Research in Water Resources at The University of Texas at Austin. It allows use of a multiobjective approach to solving the inflow problem and incorporates the statistical uncertainty of correlated relationships between freshwater inflows and resulting bay salinities and fisheries harvests. This is a real advancement in this type of solution technique. Model results are displayed as "performance curves" like the illustrative examples shown in Figure 9.3.1. From these performance curves, decision-makers can select the point that best balances the needs of man and the environment for the benefit of all Texans. As a final check, the freshwater inflow needs calculated by the TXEMP Model are incorporated into the TXBLEND hydrodynamic model to evaluate the overall effects on bay circulation and salinity patterns.

Policy decisions and management objectives. While the logic and equations of the optimization model are built on scientific and engineering analyses, application of the model requires the mathematical expression of all operative constraints, limits, and state resource management objectives. Decisions about these objectives are in the realm of public policy, more than science and engineering. They are

Policy Decisions

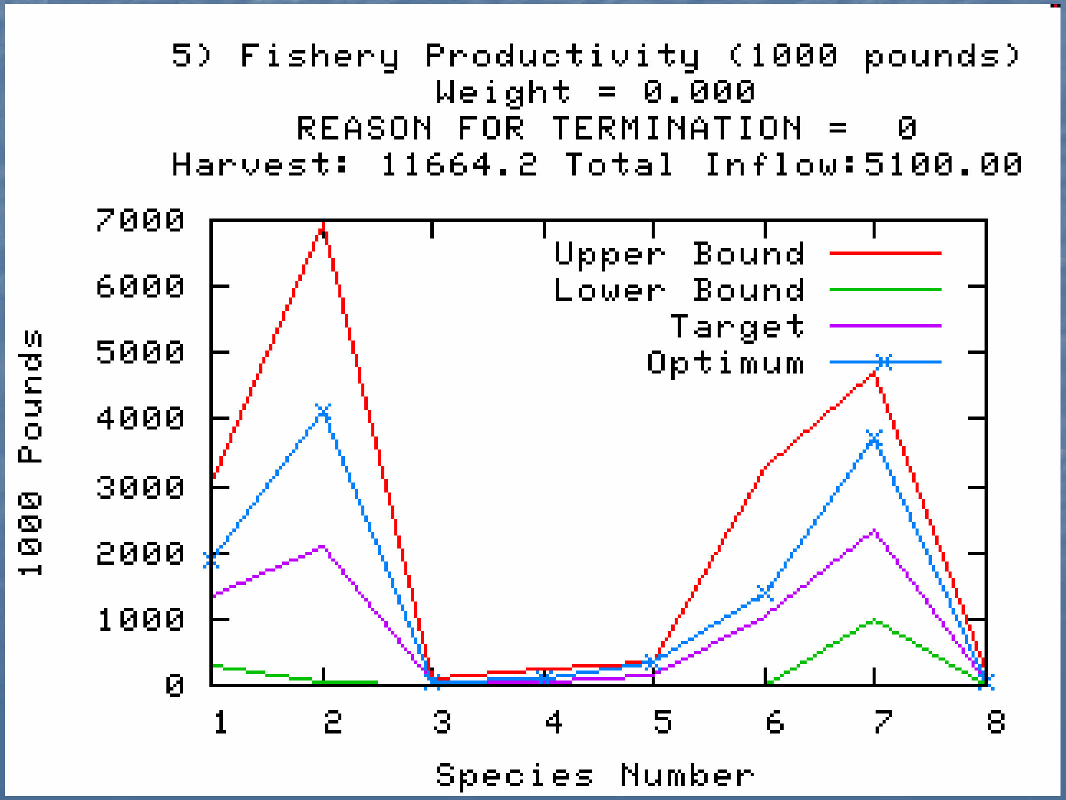
- Species to be included
- Relative weighting of species
- Selection of inflow-response equations
- Inflow constraints
- Area-specific salinity limits by month
- Nutrient loading constraint
- Sediment loading constraint
- Chance constraint for salinity and harvest
- Harvest targets
- Objective function for optimization

Species Used in Analyses

	Estuary						
Species	Sabine-Neches	Trinity-San Jacinto	Lavaca-Colorado	Guadalupe	Mission-Aransas	Nueces	Laguna Madre
Brown Shrimp	X	X	X	X	X	X	X
White Shrimp	X	X	X	X	X	X	X
Blue Crab	X	X	X	X	X	X	X
Red Drum	X	X	X	X	X	X	X
Atlantic Croaker	X						
Gulf Menhaden	X		X				
Spot	X						
Spotted Seatrout	X	X		X		X	X
Eastern Oyster		X	X	X	X		
Black Drum		X		X	X	X	X
Southern Flounder		X			X	X	X
Striped Mullet			X				
Speckled Trout					X		
Pink Shrimp							X

Relative Weighting of Species

- Based on historical harvest/abundance weighting



<u>Species Number</u>

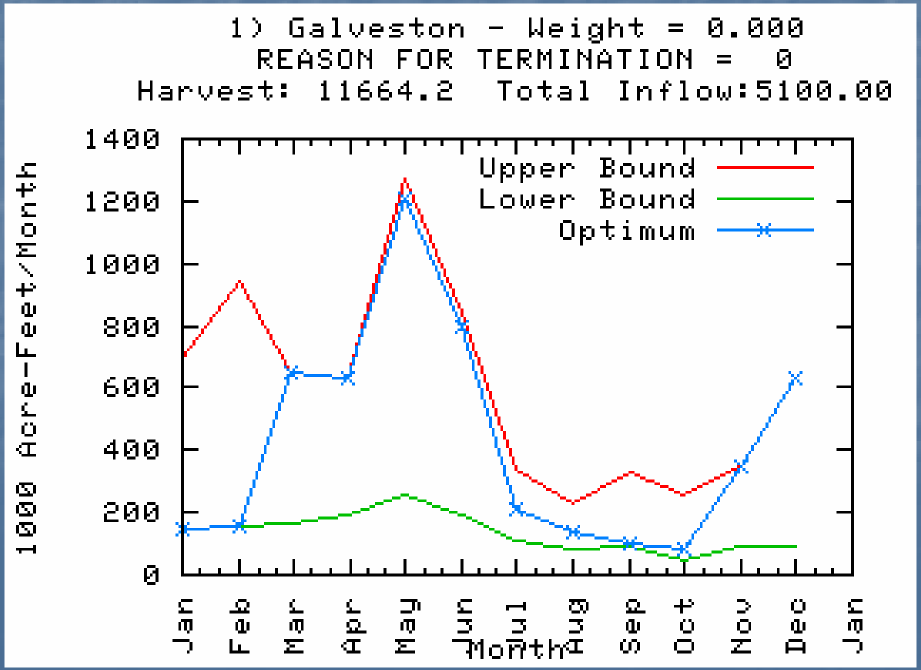
1 Blue Crab
2 Eastern Oyster
3 Red Drum
4 Black Drum
5 Spotted Seatrout
6 Brown Shrimp
7 White Shrimp
8 Flounder

Selection of Inflow-Response Equations

- Statistically derived
- Must decide on appropriate flow variable (month, lagging, ...)
- Must choose between similarly good candidate equations

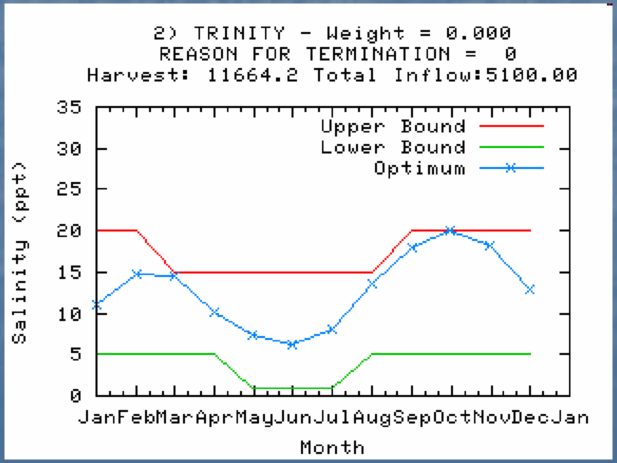
Inflow Constraints

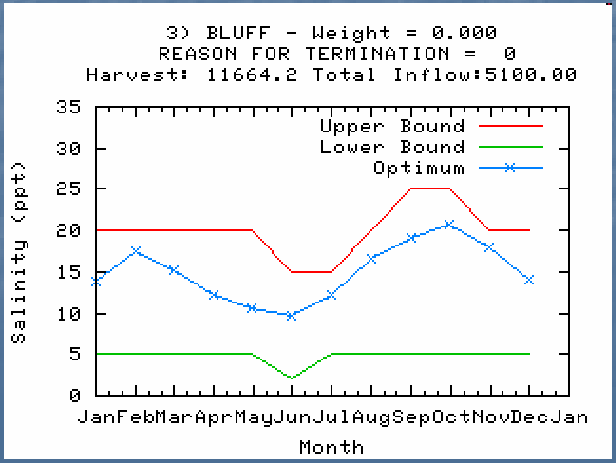
- 10%'ile monthly flow as lower constraint
- Median upper constraint
- Biological and "management" considerations

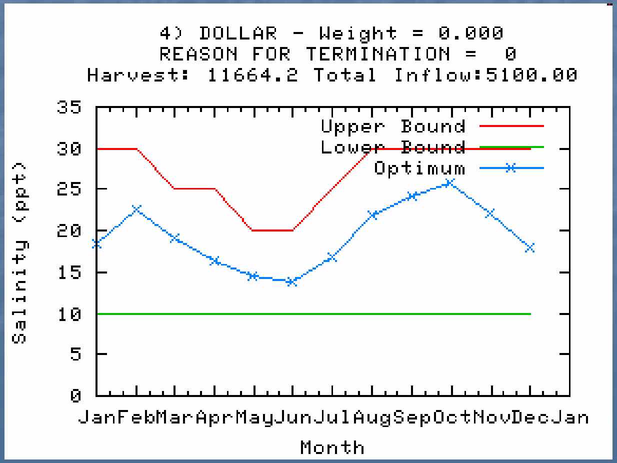


Area-Specific Salinity Limits by Month

- Goal of providing salinity regimes favorable for species survival, growth, and reproduction throughout the year
- Goal of protecting important habitat
- Based on historical data







Nutrient and Sediment Loading Constraints

- Limited data on both nutrients and sediment
- Goal to provide sufficient nutrients to maintain productivity
- Goal to provide sufficient sediments to maintain habitat
- Represented as lower constraints on annual inflow

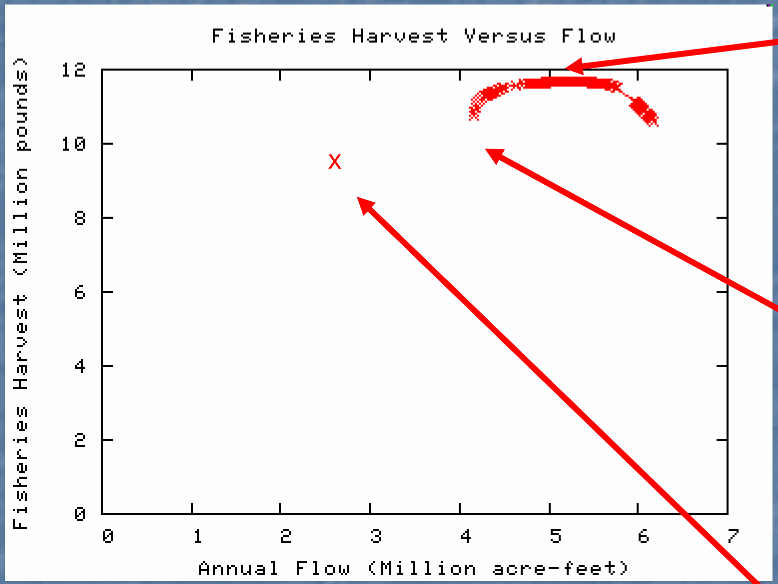
Chance Constraint for Salinity and Harvest

- Applied to inflow-response equations and inflow-salinity equations
- Sets the probability that harvest will be achieved and that salinities will not violate constraints

Harvest Targets

- 70% - 80% of combined annual historical harvest
- Policy decision
- Combined with other constraints, this is equivalent to identifying a “desired future condition” for the estuary

Objective Function for Optimization



- Fisheries Harvest Enhancement – MaxH
- Fisheries Harvest Maintenance – MinQ
- Subsistence – MinQSal

Conclusion

"The policy-level decisions that must be made by state policy makers and regulators to apply this assessment method involve choices about state management objectives, species analyzed, freshwater inflow records, salinity limits, nutrient and sediment loading requirements, fishery harvest targets, and chance constraints on the statistical uncertainties. Some of the decisions are straightforward; several will require interaction with knowledgeable biological or hydrological experts, or specialists operating the model. A few of the policy decisions involve the overall management objectives for an estuary and raise issues of importance to many citizens. It seems appropriate that some guidelines should be established before regulatory use of the model occurs."