

# Discussion of Previous SAC Comments and Galveston Bay Technical Subcommittee Activities

Presented to the  
Texas Scientific Advisory Committee  
November 5, 2008



# 2006 SAC Comments Related to the State Methodology

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2006 – *Recommendations of the Science Advisory Committee for the Governor’s Environmental Flows Advisory Committee.*

## *Recommendation 4*

*“The **significant shortcomings** exhibited by the TWDB’s State Methodology and the TPWD’s “verification” process that are used to develop freshwater inflow recommendations for the state’s bays and estuaries **must be addressed ...**”*

# 2006 SAC Comments Related to the State Methodology

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- *The measure of abundance used is **commercial harvest**, which **has a poor relation to ecological soundness***
- *The various **statistical methods** employed are **questionable**, including regression forms and definition of independent variables*
- *The resulting “**optimum**” inflow regime is mainly **determined by constraints**, which are arbitrarily specified*
- *The **optimum solution bears no relation to actual harvests**, nor do the optimum patterns of inflow occur in the natural hydrology*
- *TPWD’s verification process is actually a comparative analysis between the **MinQ and maxH solutions**, and favors the optimal solution with greater inflow to the bay.*
- ***Under drought conditions, what inflows must a bay receive** to maintain its ecosystem over the long term?*

# 2006 SAC Comments Related to the State Methodology

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## *Recommendation 5*

*“The TCEQ, TWDB and the TPWD should engage as soon as possible the services of qualified professionals to review existing bay and estuary inflow assessment tools and available data and to develop one or more alternative or supplemental methodologies that could be employed with results from the State’s ongoing bay and estuary work as part of the overall process of establishing appropriate interim levels of freshwater inflow requirements for bays and estuaries.”*



# 2006 SAC Comments Related to the State Methodology

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- *...strong consideration should be given to examining the present State Methodology and TPWD's verification process and refining these procedures to the extent possible using available data to more effectively represent estuarine behavior.*

# Galveston Bay Technical Subcommittee (GBTS)

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- Formed by Galveston Bay Stakeholder Group in January 2005
- Tasked to “*Develop a statement of work (task list) to address technical concerns regarding the Galveston Bay freshwater inflow study and description of expected time and resources for the elements of the statement of work.*”

# GBTS Membership

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- TWDB, TCEQ, TPWD
  - Trinity River Authority
  - Galveston Bay Foundation
  - Espey Consultants
  - National Wildlife Federation
  - Houston Audubon
  - J. F. Trungale Engineering and Science
  - University of Texas
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# GBTS Identified Short-Term Tasks

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## Modifications of the State Methodology

- Task 1. Demonstrate validity of TPWD fisheries-independent dataset for developing new productivity-inflow regression equations.
- Task 2. Use recent harvest data to redevelop productivity-inflow regression equations for TxEMP analysis, for comparison to 2001 FWI recommendation.
- Task 3. If appropriate, Use TPWD fisheries-independent data to develop new productivity-inflow regression equations for TxEMP analysis.
- Task 4. Validate Texas Rainfall Runoff (TxRR) model and/or suggest suitable alternatives.
- Task 5. Explore and develop better statistical relationships between salinity at specific locations and FWIs.
- Task 6. Validate TxBLEND and/or suggest suitable alternatives.
- Task 7. Investigate alternatives to bi-monthly inflows for use in productivity-inflow regression equations and TxEMP analysis.

# GBTS Additional Short-Term Tasks

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## Additional Studies on the Effects of FWIs on Productivity

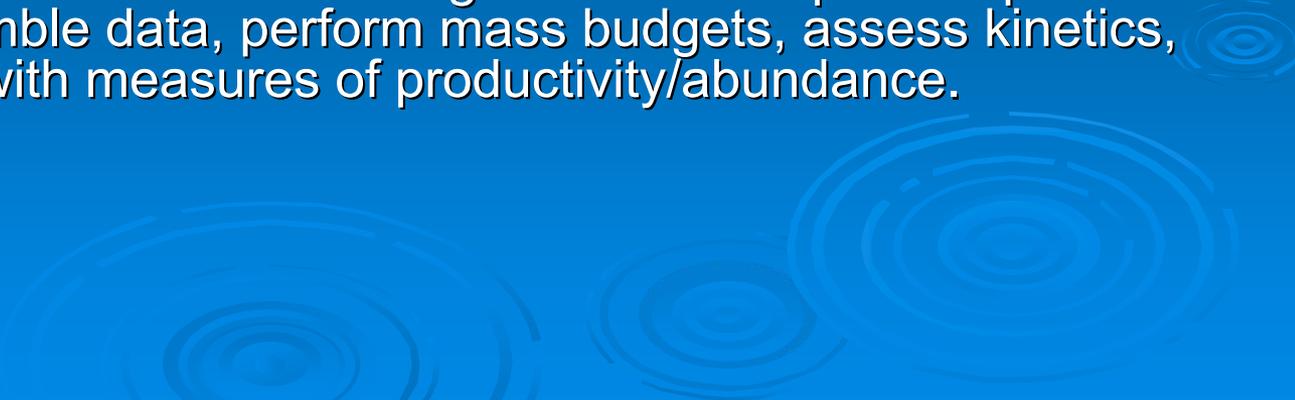
- Task 8. Investigate significance of key hydrological events upon measures of productivity/abundance – with special attention given to meteorological (e.g., El Niño) and geographic influences (e.g., multiple watershed input)
- Task 9. Investigate suitability of grouping species (by trophic group, guild, or other) as a measure of biological productivity and FWIs.
- Task 10. Investigate use of a different index or measure of estuarine biological productivity.
- Task 11. Describe the historical relationship between FWIs and biological productivity for the full range of flows for one or more Texas estuaries.

## Modifications of the State Methodology

- Task 12. Run TxEMP with modified and/or without the hydrological constraints to get an understanding of the effect of the constraint's on the model's output.
- Task 13. Run the model with modified biomass constraints to get an understanding of the effect of the constraints on the model's output.

# GBTS Identified Long-Term Tasks

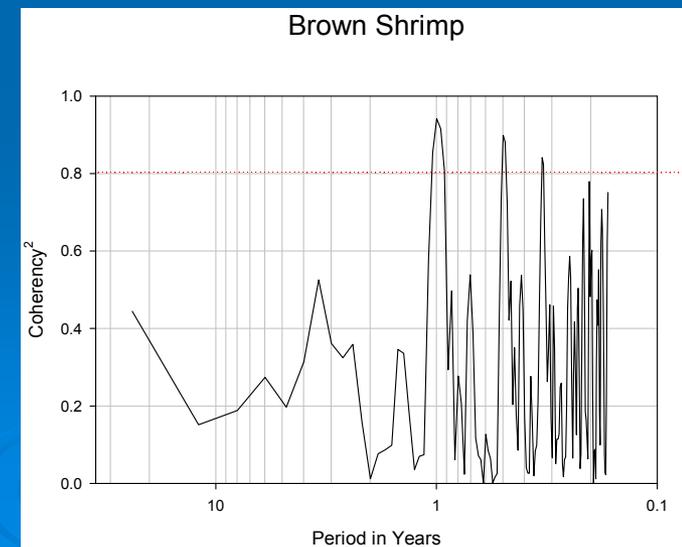
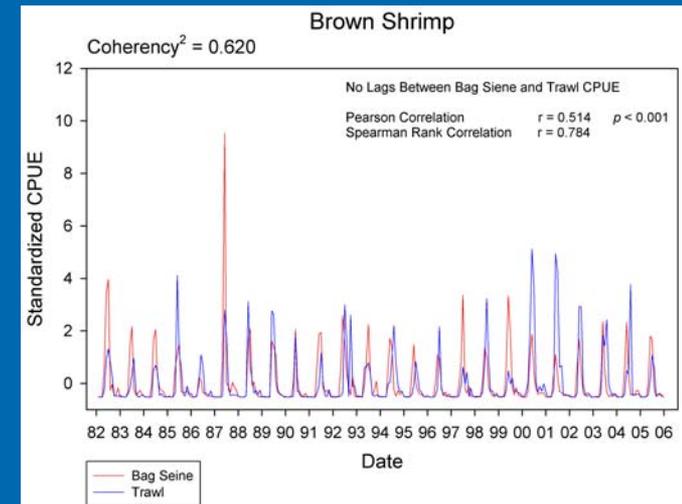
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- Task 14. Assess availability and/or need for vegetation, primary production, turbidity, substrate, *etc.* data in order to define bay health in terms of habitat variables.
- Task 15. Examine effect of other factors (such as ship channel changes) on the circulation of the bay. Such factors may complicate understanding the impacts of FWI changes.
- Task 16. Evaluate alternative measures of ecological health (such as in Task 14).
- Task 17. For analysis of nutrient and organic carbon input components of FWIs, assemble data, perform mass budgets, assess kinetics, and compare with measures of productivity/abundance.
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# GBTS Task 1. Demonstrate validity of TPWD fisheries-independent dataset for developing new productivity-inflow regression equations. [TPWD]

## Approach

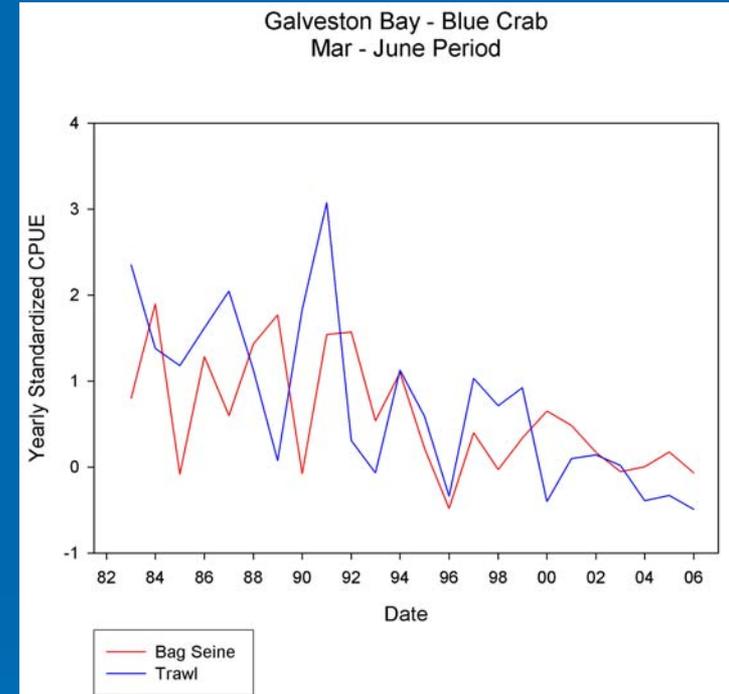
- 1) Look at coherency of signals
- 2) Look at correlation of signals
- 3) Look at consistency of annual signals
- 4) Species – brown shrimp, white shrimp, blue crab, Atlantic croaker  
Gear types – bag seine, trawl, gill net



# GBTS Task 1. Demonstrate validity of TPWD fisheries-independent dataset ... [TPWD]

## Conclusions

- 1) Different gear types showed coherence in their time signals
- 2) Abundance measured by different gear types showed significant correlations
- 3) Annual signals showed consistency



# GBTS Task 2. Use recent harvest data to redevelop productivity-inflow regression equations for TxEMP analysis, for comparison to 2001 FWI recommendation. [TWDB]

## Commercial Harvest Data

Original Study (1959 – 1987) compared to Current Study (1959 – 2004)

Year	Original Study		Current study		
	6 species	shrimp	6 species	shrimp	
1959					<i>Early Years</i>
1962	Original Data		Original Data		
1972			Recent Data		
1988					<i>Later Years</i>
2004					

- Blue Crab
- Eastern Oyster
- Brown Shrimp
- White Shrimp
- Black Drum
- Southern Flounder
- Red Drum
- Spotted Seatrout

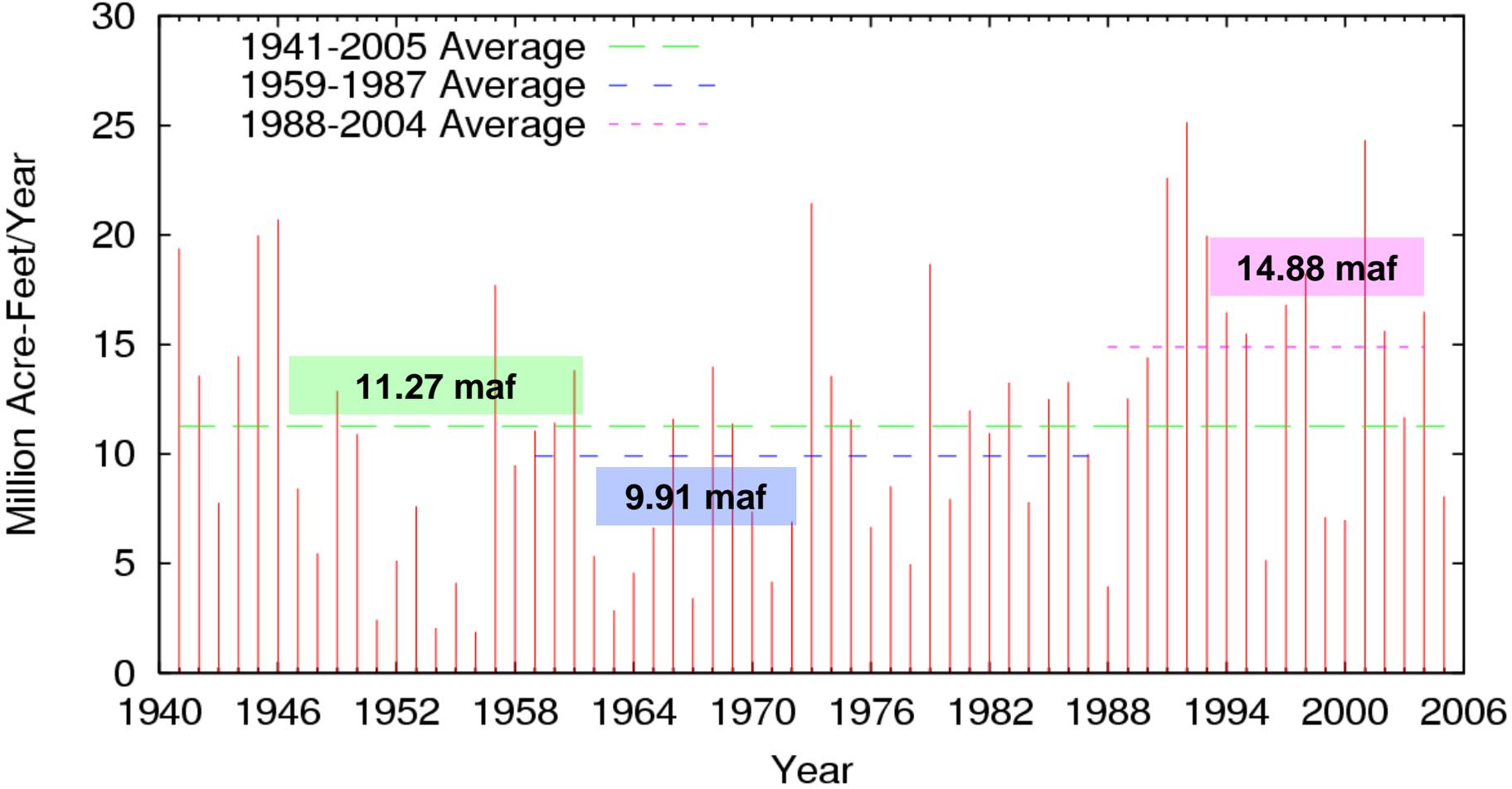
\* Note: Minor changes of harvest and FWIs in the extended data sets. Red drum and spotted seatrout listed as game species after 1981 – no longer commercially harvested.

## GBTS Task 2. Use recent harvest data to redevelop productivity-inflow regression equations ... [TWDB]

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- Re-analysis of original dataset (1959-1987, early years) with conservative outlier and model selection.
  - 7 of 8 equations significant with similar bi-monthly inflow terms, but somewhat lower  $r^2$  than in the original equations
- Analysis of extended dataset (1959-2004)
  - 6 equations developed (omitting 2 game species); 3 were significant, but FWI explained little of variation and equations had *very* low  $r^2$
- Why the poor results?

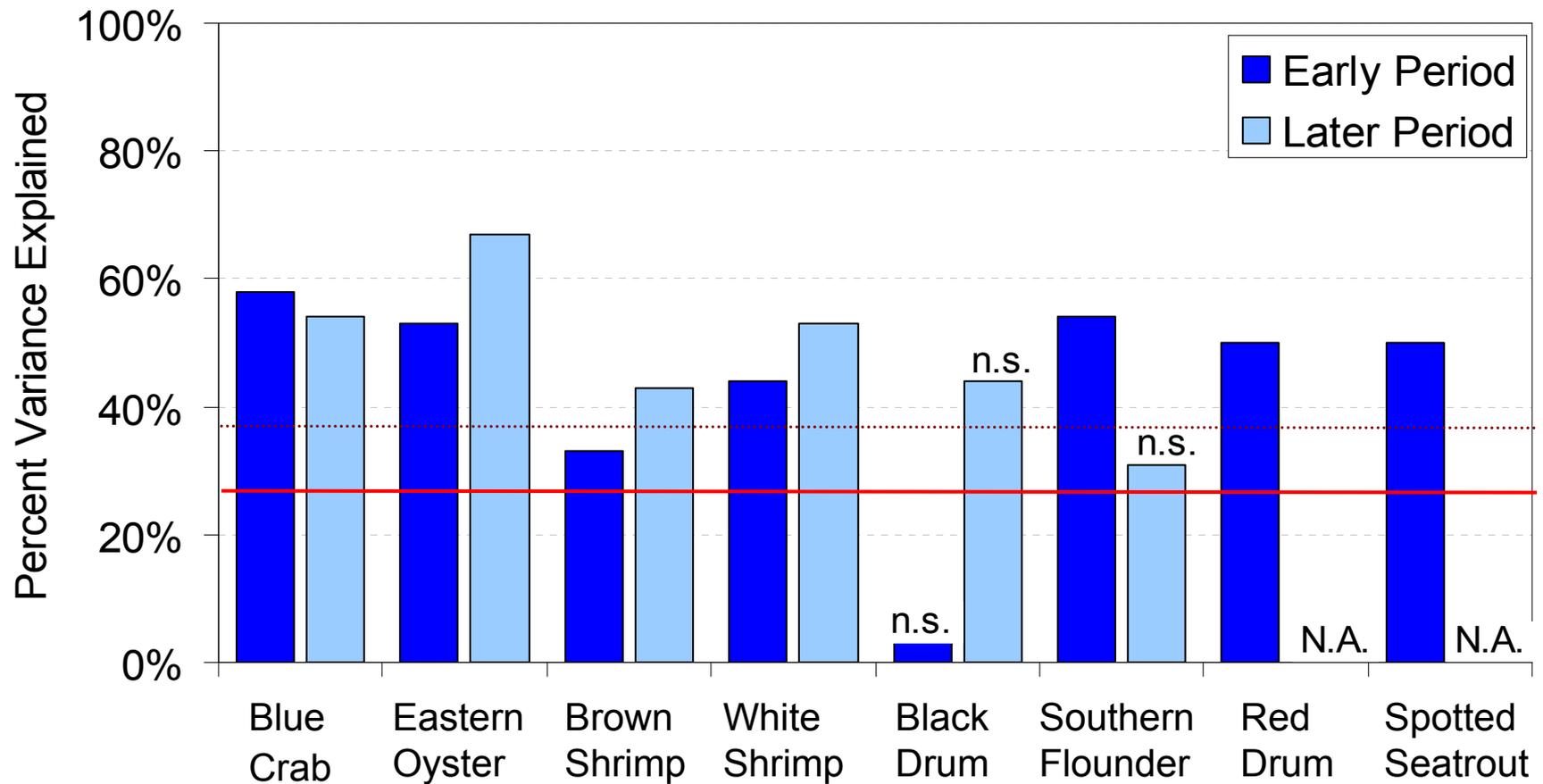
# Recent Changes in Total Annual FWI to Galveston Bay



# GBTS Task 2. Use recent harvest data to redevelop productivity-inflow regression equations ... [TWDB]

## Commercial Harvest – Inflow Equations

Early Period (1959 – 1987) compared to Later Period (1988 – 2004)



Early Period,  $r^2_{exp} = 0.21$  to  $0.25$

Later Period,  $r^2_{exp} = 0.38$

# GBTS Task 3. Use TPWD fisheries-independent data to develop new productivity-inflow regression equations for TxEMP analysis, if appropriate. [TWDB]

## TPWD Fisheries - Independent Dataset (1978 - 2004)

Gear Type	Species	Lagging Period
<b>Bag Seine</b> (CPUE standardized to 0.03ha)	Blue Crab	1 water year (S & LM FWI)
	Brown Shrimp	1 water year (S & LM FWI)
	White Shrimp	1 calendar year (S FWI)
	Black Drum	1 water year (LM FWI)
	Southern Flounder	1 water year (LM FWI)
	Red Drum	1 calendar year (S & LM FWI)
	Spotted Seatrout	1 water year
<b>Oyster Dredge</b> (CPUE)	Eastern Oyster	2 water year (Harvest)

\*S & LM FWI refer to Sabine Lake Freshwater Inflow Study (2005) and Laguna-Madre Freshwater Inflow Study (2004).

# GBTS Task 3. Use TPWD fisheries-independent data to develop new productivity-inflow regression equations .... [TWDB]

## Whole Bay and Sub-Bay Designations

**Whole Bay**

(segment 0)

**Trinity Bay**

(segment 330)

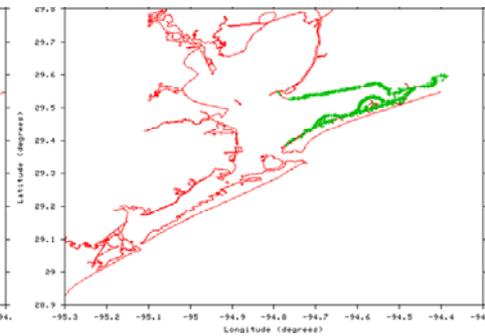
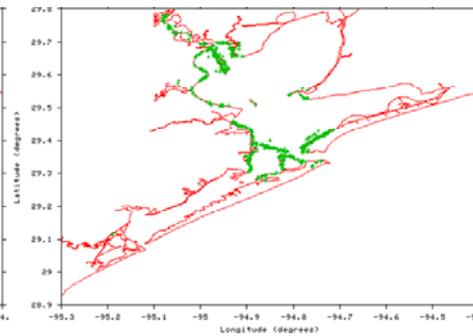
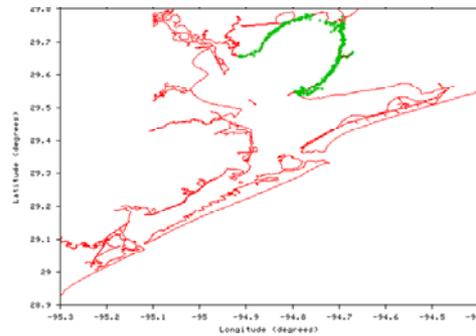
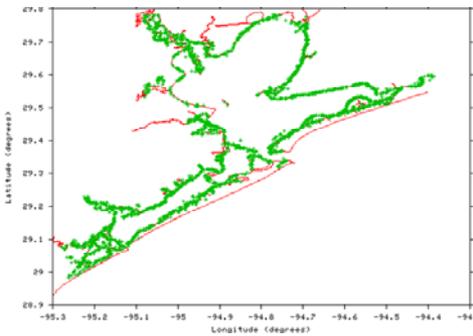
**Middle Bay**

(segment 180)

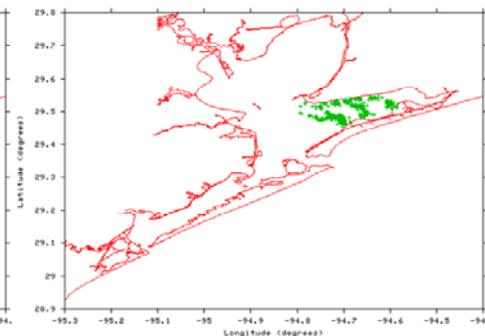
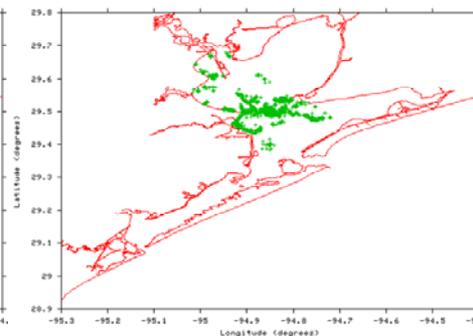
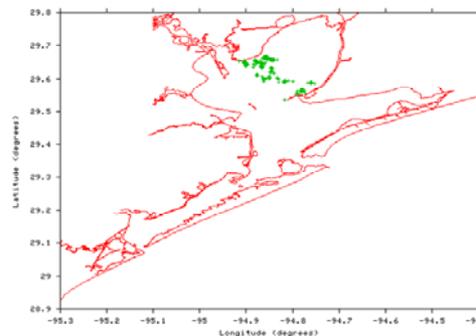
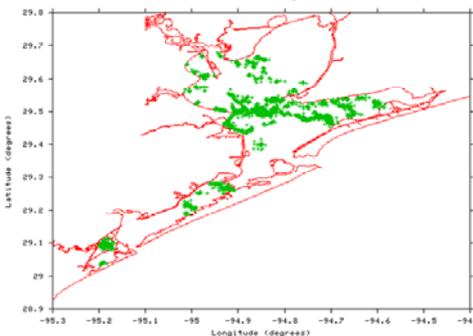
**East Bay**

(segment 150)

*Bag Seine Localities*

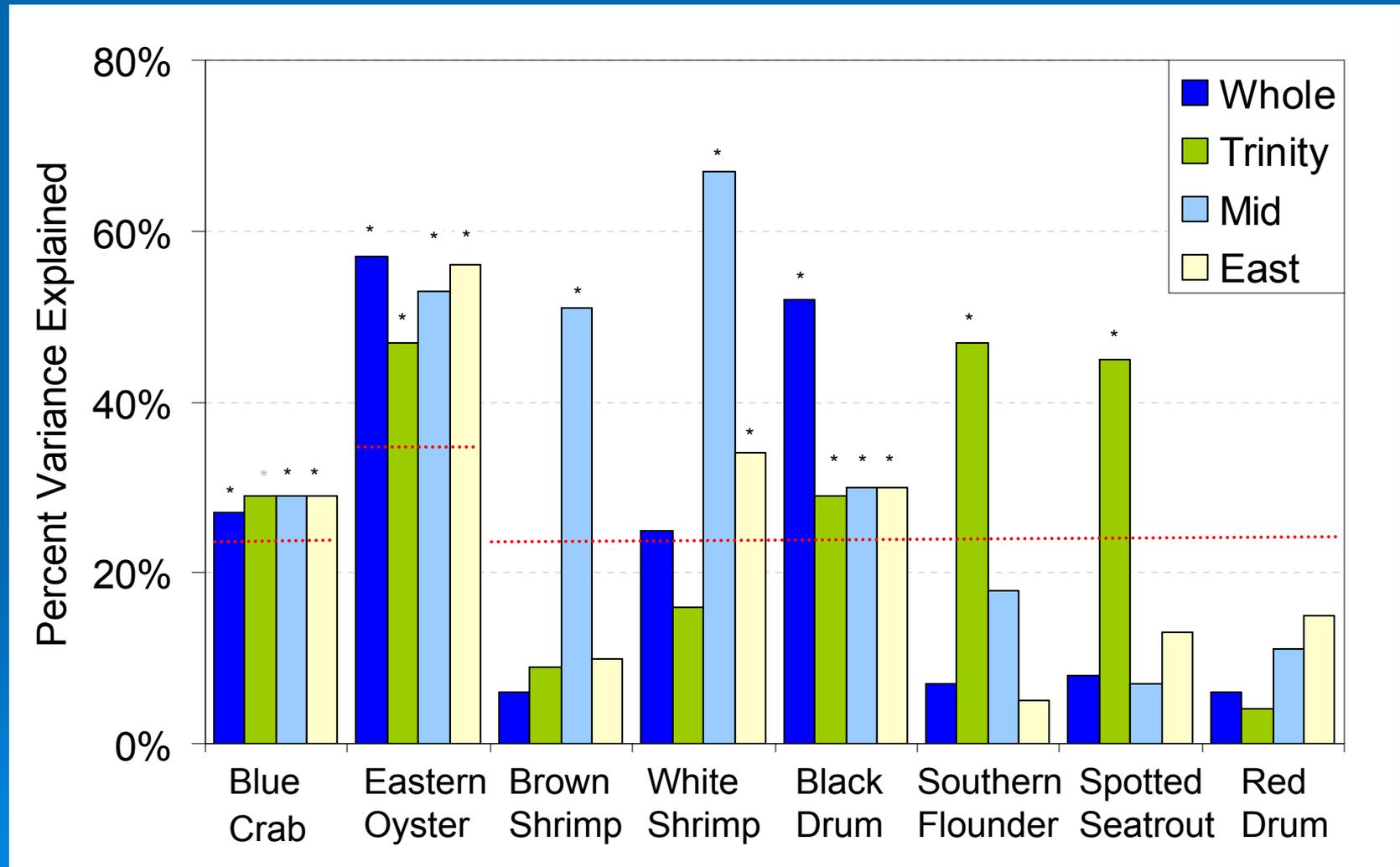


*Oyster Dredge Localities*



# GBTS Task 3. Use TPWD fisheries-independent data to develop new productivity-inflow regression equations .... [TWDB]

## Catch-Inflow Analysis of Whole & Sub-Bays



Weighted least squares regression analysis

# Harvest versus Coastal Fisheries Data

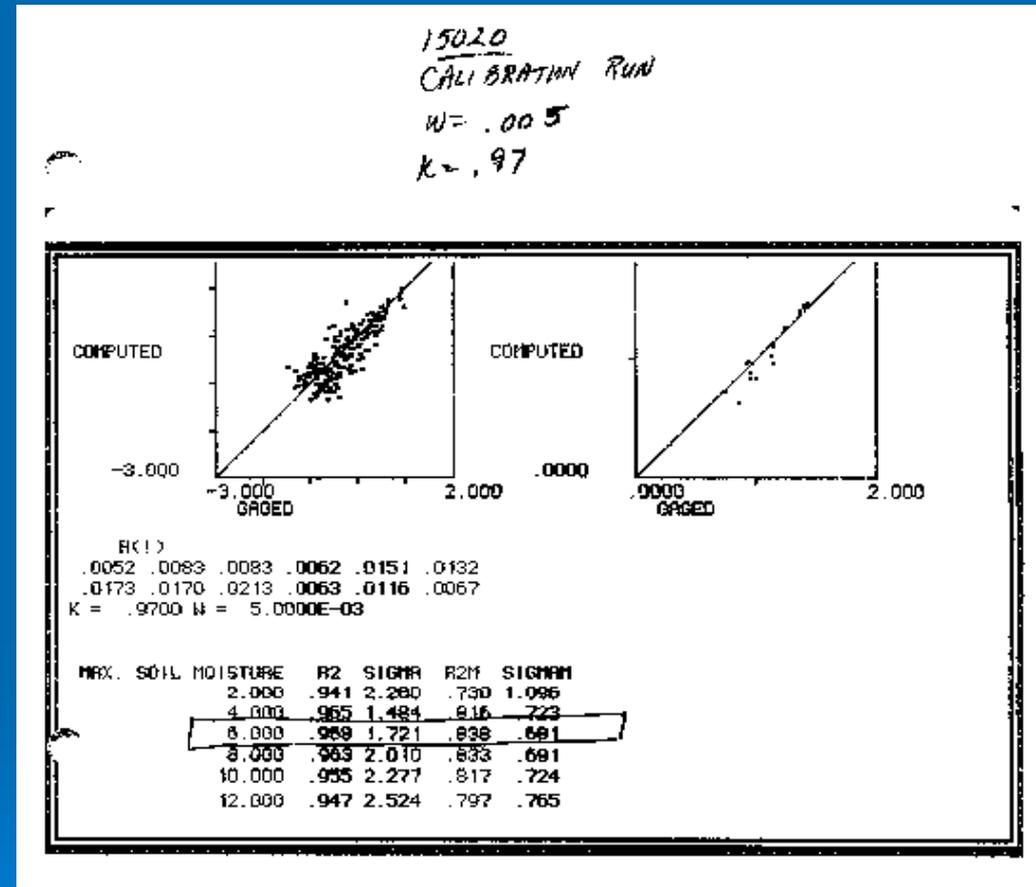
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- Harvest has longer period of record, but is a limited dataset.
- CF Data is more recent, but dataset for some bays is large enough to begin using in analysis.
- CF regression equations are more robust than the harvest regression equations.
  - CF dataset allows for greater flexibility for further refinements to the analysis (*i.e.*, species, spatial analysis, etc.)

# GBTS Task 4. Validate TxRR and/or suggest suitable alternatives. [TWDB]

## Validate TxRR

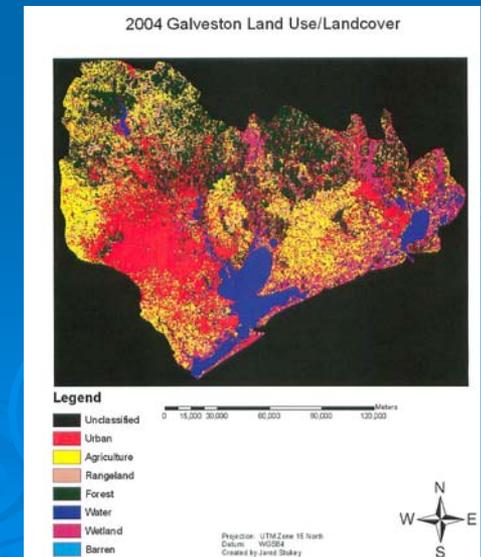
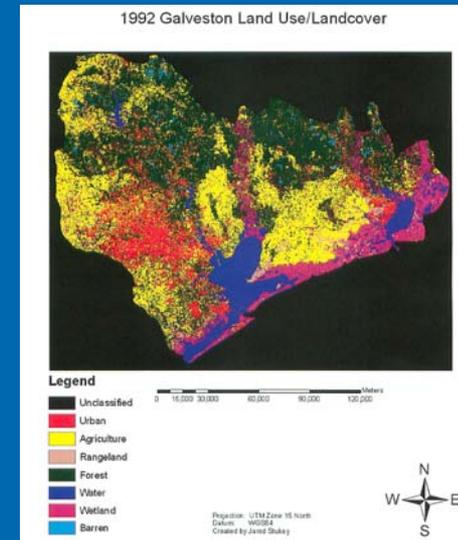
- Calibrated to USGS monthly streamflow data
- Multiple parameter adjustments
- Select model parameters to achieve best monthly and annual model fit



# GBTS Task 4. Validate TxRR and/or suggest suitable alternatives. [TWDB]

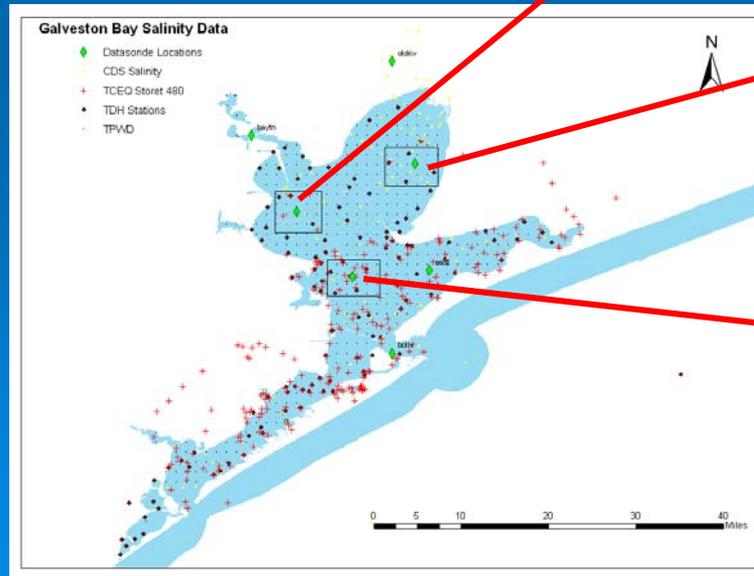
## Possible Alternatives

- TWDB has funded research on evaluation of use of NEXRAD data
- TWDB has funded analyses of changes in watershed use
- TWDB is currently funding research into alternative R/R models (SWAT) by TAMU

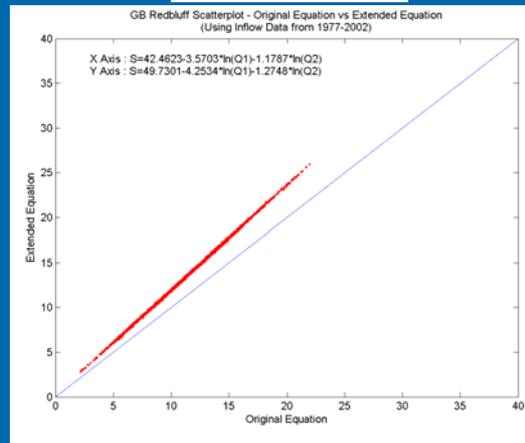


# GBTS Task 5. Explore and develop better statistical relationships between salinity at specific locations and inflows. [TWDB]

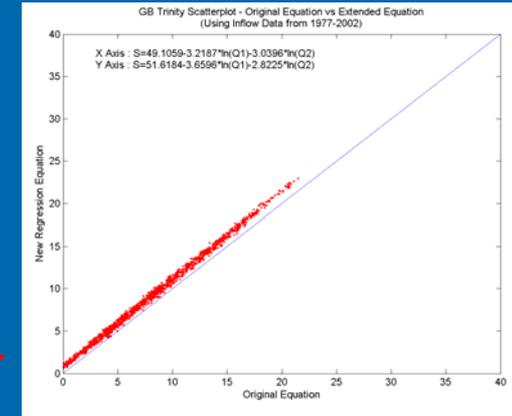
TWDB reanalysis of salinity-inflow regressions using extended TWDB, TCEQ, TPWD, and TDH salinity data



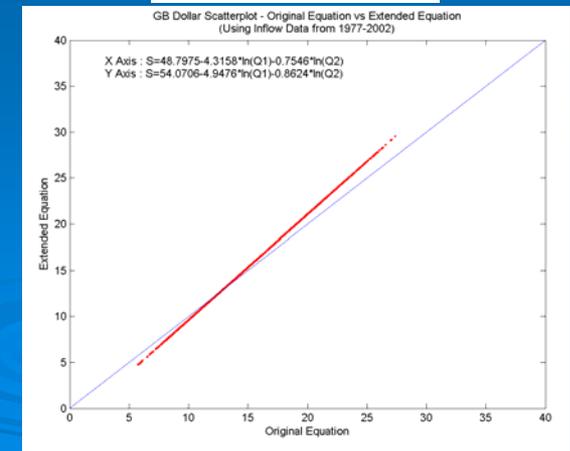
### Red Bluff



### Trinity Bay

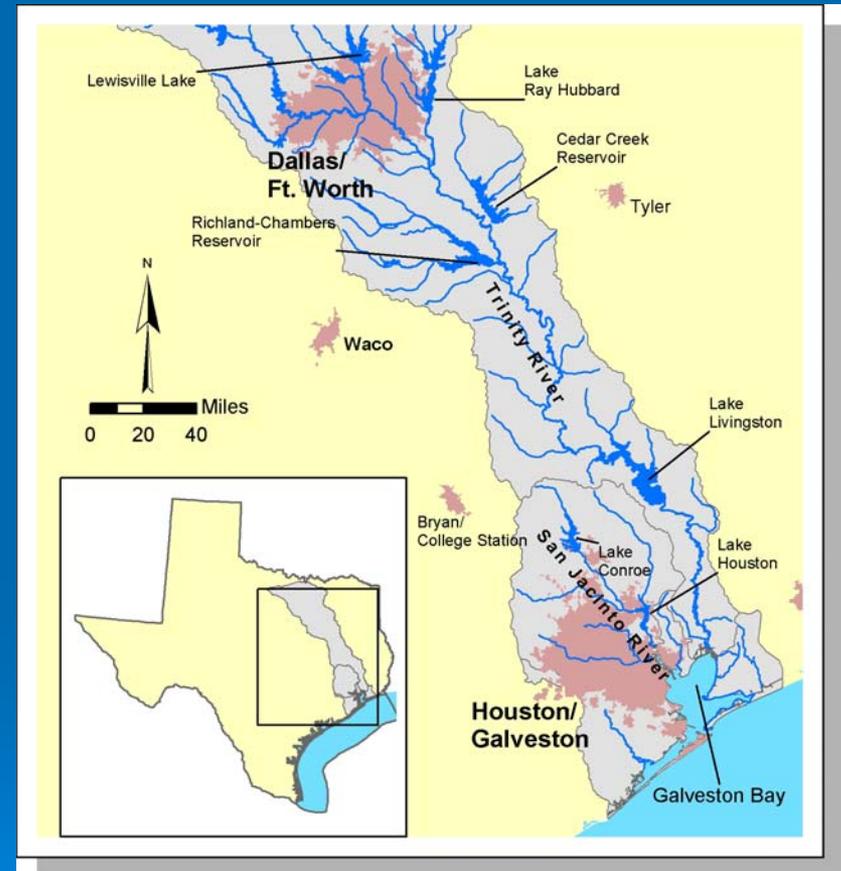


### Dollar Point



# GBTS Task 5. Explore and develop better statistical relationships between salinity at specific locations and inflows. [NWF]

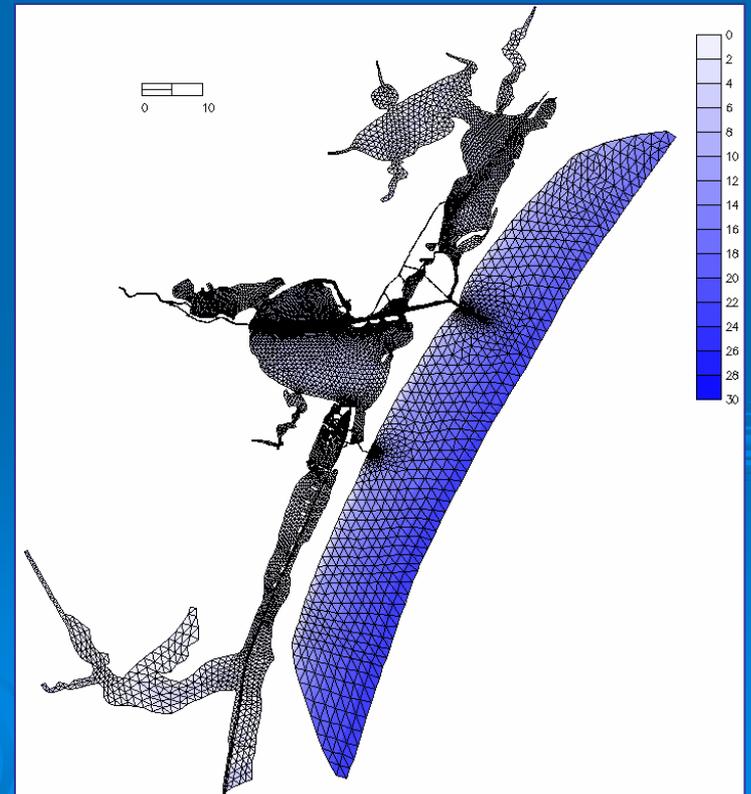
## *Refining the Inflow – Salinity Relationships for Upper Galveston Bay.*



Norman D. Johns

## GBTS Task 6. Validate TxBLEND and/or suggest suitable alternatives. [TWDB]

- TWDB is currently funding studies comparing four hydrodynamic models TxBLEND, SELFE, FVCOM, and UTBEST
- Results expected in 2009

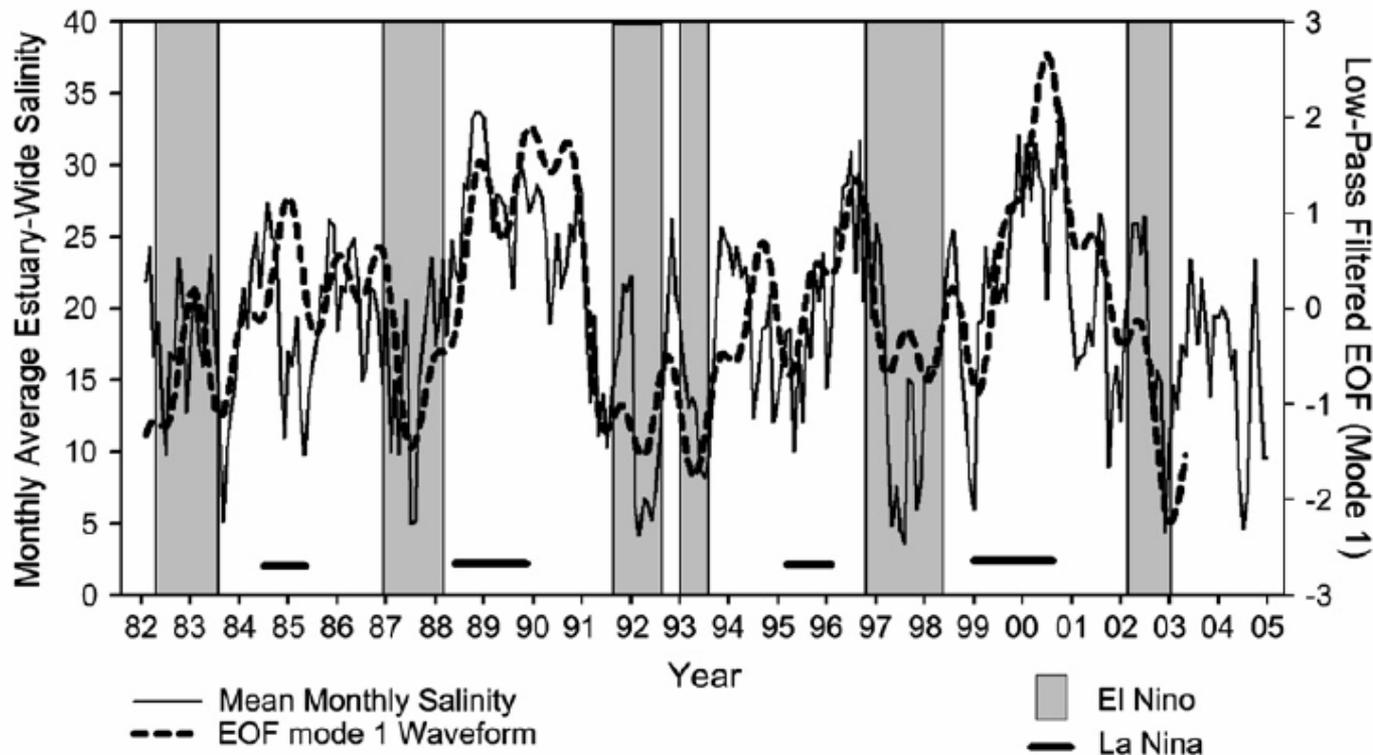


## GBTS Task 7. Investigate alternatives to bi-monthly inflows for use in productivity-inflow regression equations and TxEMP analysis. [ESPEY]

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- Espey Consultants/UT (G. Ward) – Freshet Analysis

GBTS Task 8. Investigate significance of key hydrological events upon measures of productivity/abundance – with special attention given to meteorological (e.g., El Niño) and geographic influences (e.g., multiple watershed input).  
[TPWD]



Tolan, J.M. 2007. *El Niño-Southern Oscillation impacts translated to the watershed scale: Estuarine salinity patterns along the Texas Gulf Coast, 1982-2004*. Estuarine, Coastal and Shelf Science 72:247-260.

GBTS Task 9. Investigate suitability of grouping species (by trophic group, guild, or other) as a measure of biological productivity and FWIs. [HARC – J. Lester]

GBTS Task 10. Investigate use of a different index or measure of estuarine biological productivity. [HARC – J. Lester]

- Work is based on statute language which includes the effect of salinity on estuarine ecology.
- This approach is based on *ecosystem management*, Previous approach based on fisheries management.
- Goal is the definition and maintenance of an ecologically characteristic fish and shellfish community within each bay.
- Utilized 1982 to 2004 TPWD CF dataset (trawl and gill net) from Galveston Bay to define ecologically characteristic communities and detect salinity related shifts in species composition.

## GBTS Task 9 & 10 continued..... [HARC – J. Lester]

FWI affects salinity which is a stressor. Stressors affect the abundance and distribution of sensitive species.

### Results of Study

TWPD CF data show a species substitution effect when salinity changes occurred within a region of the bay (Trinity Bay, Upper Galveston Bay, Lower Galveston Bay, and West Bay).

Decreasing flow (increasing salinity) is associated with significant changes in the composition of trawl catches

Lower flow from the Trinity River results in lower relative abundance of freshwater fish species and higher relative abundance of squid, shrimp and crab

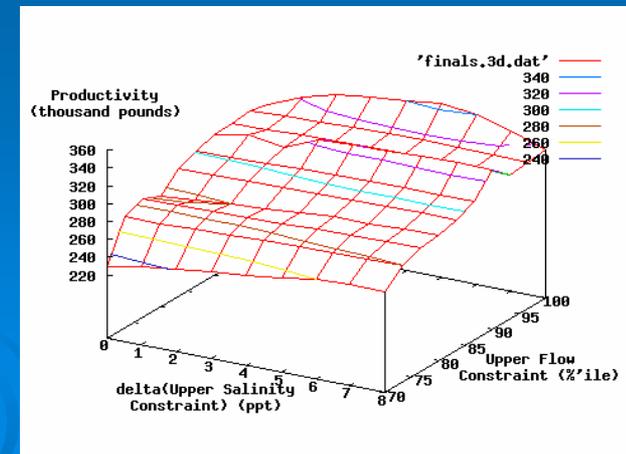
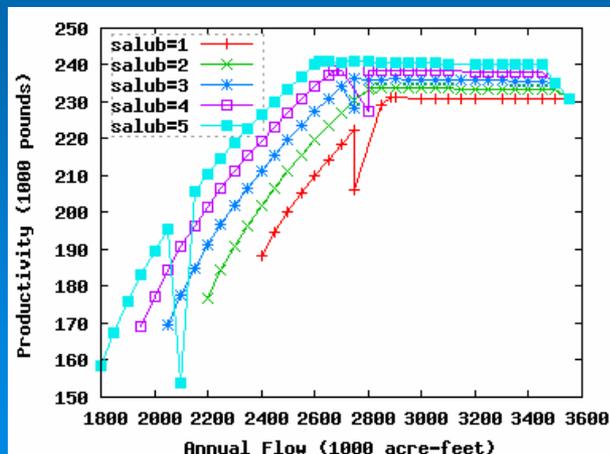
Effect of river flow decreases from Trinity Bay to Lower Galveston Bay to West Bay

# GBTS – Remaining Short-Term Tasks

Task 11. Describe the historical relationship between FWIs and biological productivity for the full range of flows for one or more Texas estuaries.

Task 12. Run TxEMP with modified and/or without the hydrological constraints to get an understanding of the effect of the constraint's on the model's output.

Task 13. Run the model with modified biomass constraints to get an understanding of the effect of the constraints on the model's output.



# GBTS Long-Term Tasks

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Task 14. Assess availability and/or need for vegetation, primary production, turbidity, substrate, *etc.* data in order to define bay health in terms of habitat variables.

Task 16. Evaluate alternative measures of ecological health (such as in Task 14).

GBTS Task 15. Examine effect of other factors (such as ship channel changes) on the circulation of the bay. Such factors may complicate understanding the impacts of FWI changes.  
[TWDB]

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### Model Scenarios:

- 1 – Effect of Trinity diversions to SJ basin
- 2 – Effect of use of bay water for power plant cooling
- 3 – Effect of Texas City Dike on circulation
- 4 – Effect of Houston Ship Channel on circulation and salinity
- 5 – Natural condition

Effects of Structures and Practices on the Circulation and Salinity Patterns of Galveston Bay, Texas

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Principal Investigator

Gary L. Powell  
David A. Brock  
Christopher Paternostro

Texas Water Development Board  
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Austin, Texas 78711-3231

February 2005

GBTS Task 17. For analysis of nutrient and organic carbon input components of FWIs, assemble data, perform mass budgets, assess kinetics, and compare with measures of productivity/abundance. [TWDB]

TWDB is funding collection of nutrient data in Galveston Bay (TAMU) and on the Trinity River (USGS) and has funded investigations on the use of satellite imagery for nutrient detection and measurement (UT).

