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

Robert W. McFarlane
McFarlane & Associates

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

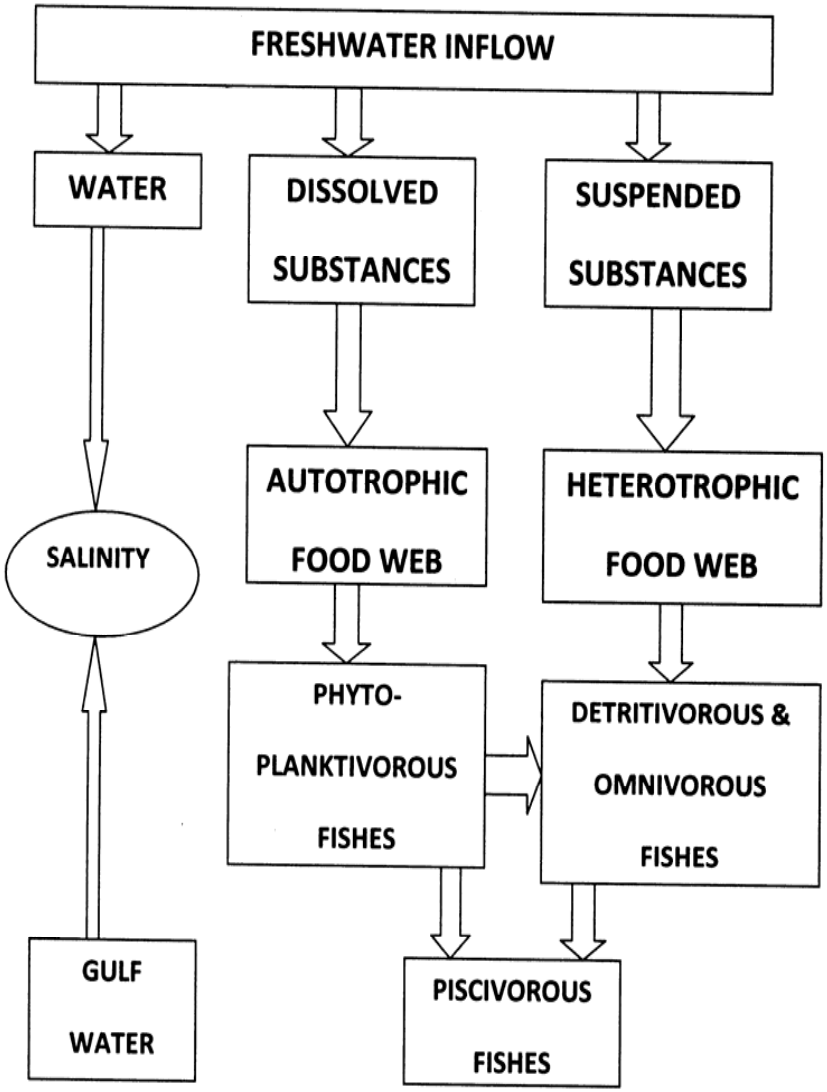
FOLLOW THE DATA !!!

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?

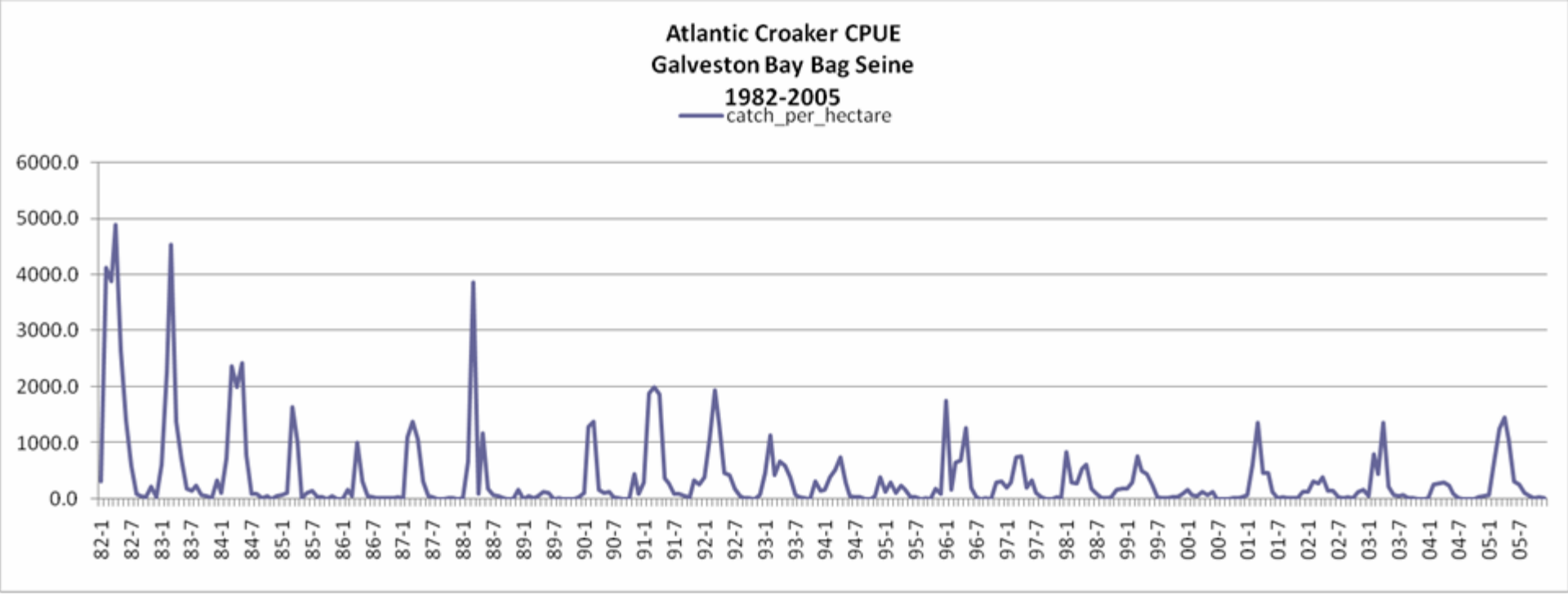
Freshwater Inflow Requirements

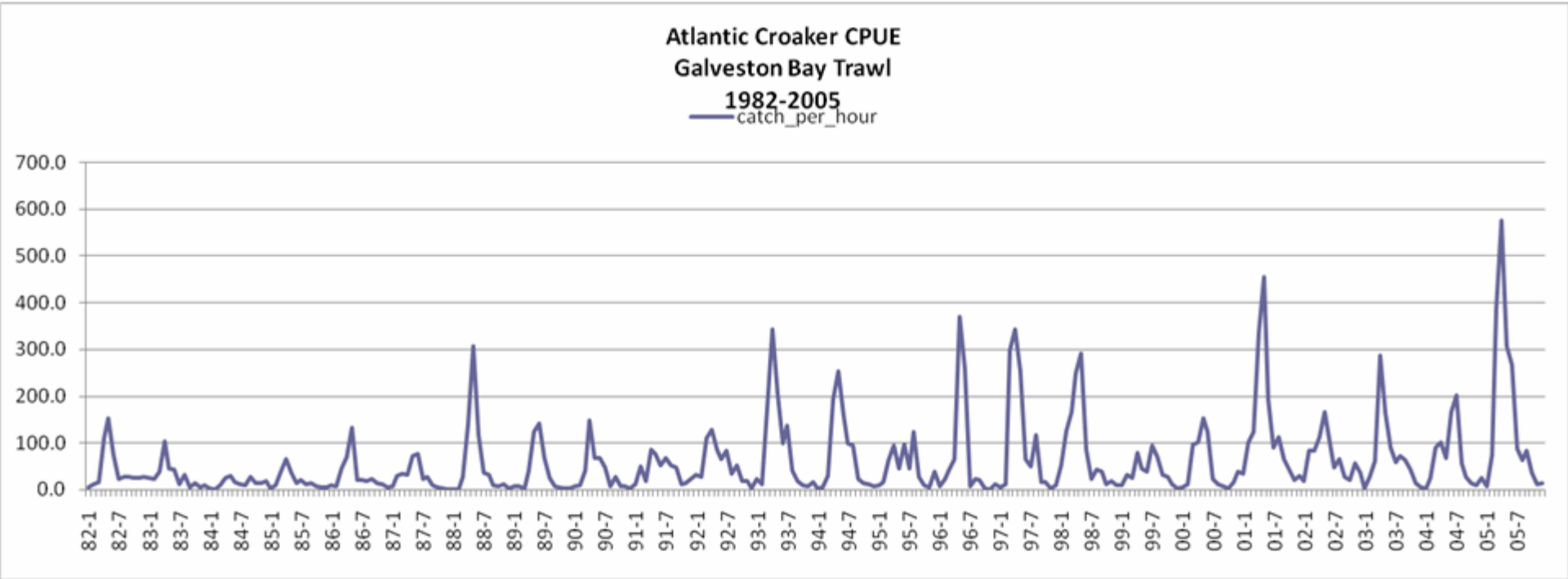
- TxRR – Rainfall Runoff model for ungaged flows
- TxEMP – Estuarine Mathematical Programming model to determine optimal annual inflows and estuarine fisheries harvests.
- Species Spatial Distribution models for a number of finfishes and shellfishes.
- TxBLEND – hydrodynamic circulation model to evaluate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

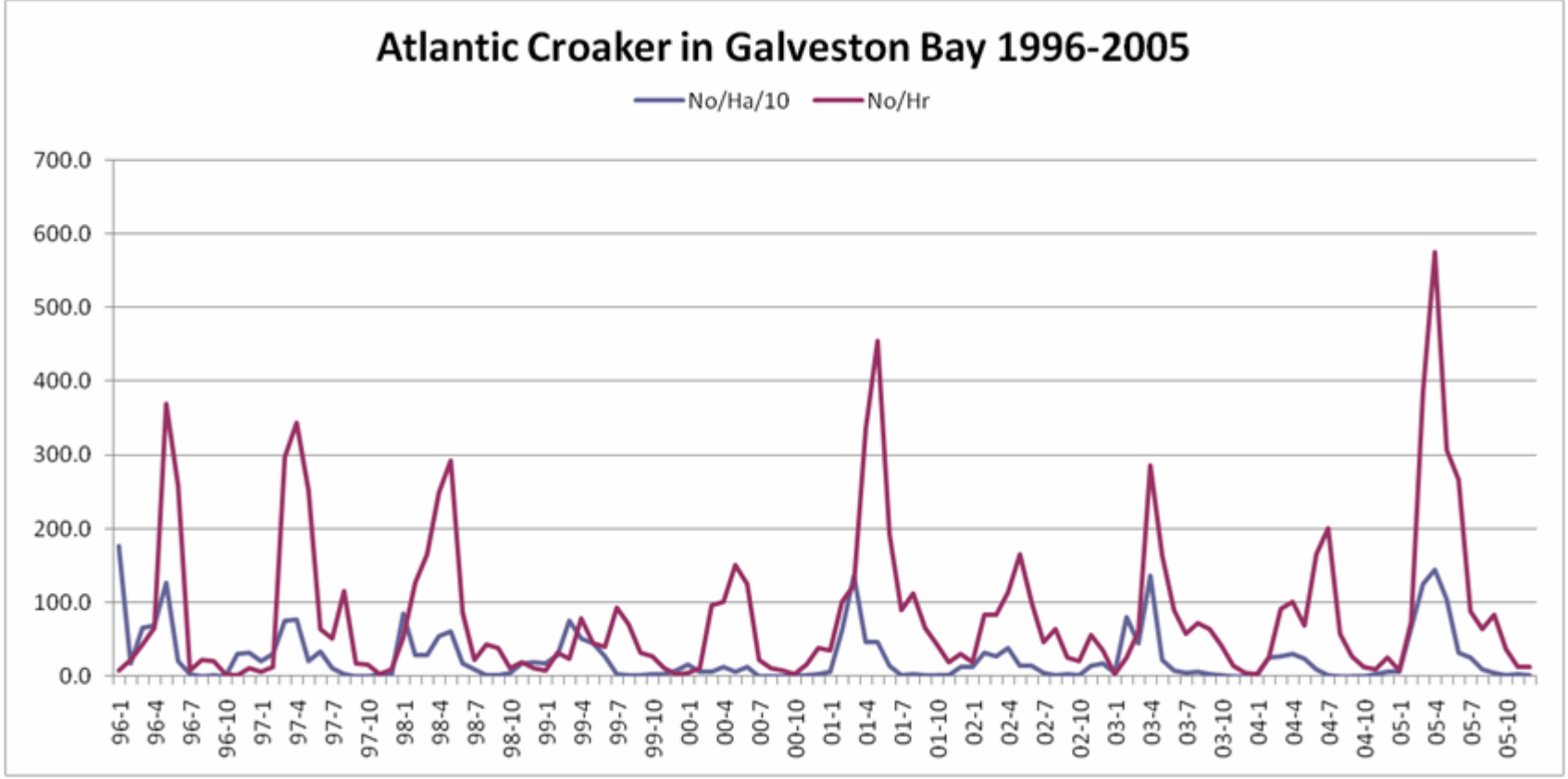

FRESHWATER INFLOW
WATER
DISSOLVED SUBSTANCES
SUSPENDED SUBSTANCES
SALINITY
AUTOTROPHIC FOOD WEB
HETEROTROPHIC FOOD WEB
PHYTO-PLANKTIVOROUS FISHES
DETRITIVOROUS & OMNIVOROUS FISHES
GULF WATER
PISCIVOROUS FISHES

Key Assumptions

- CPUE fisheries data reflect true fish abundance
- Fish abundance is affected by salinity
- Salinity reflects nutrient content

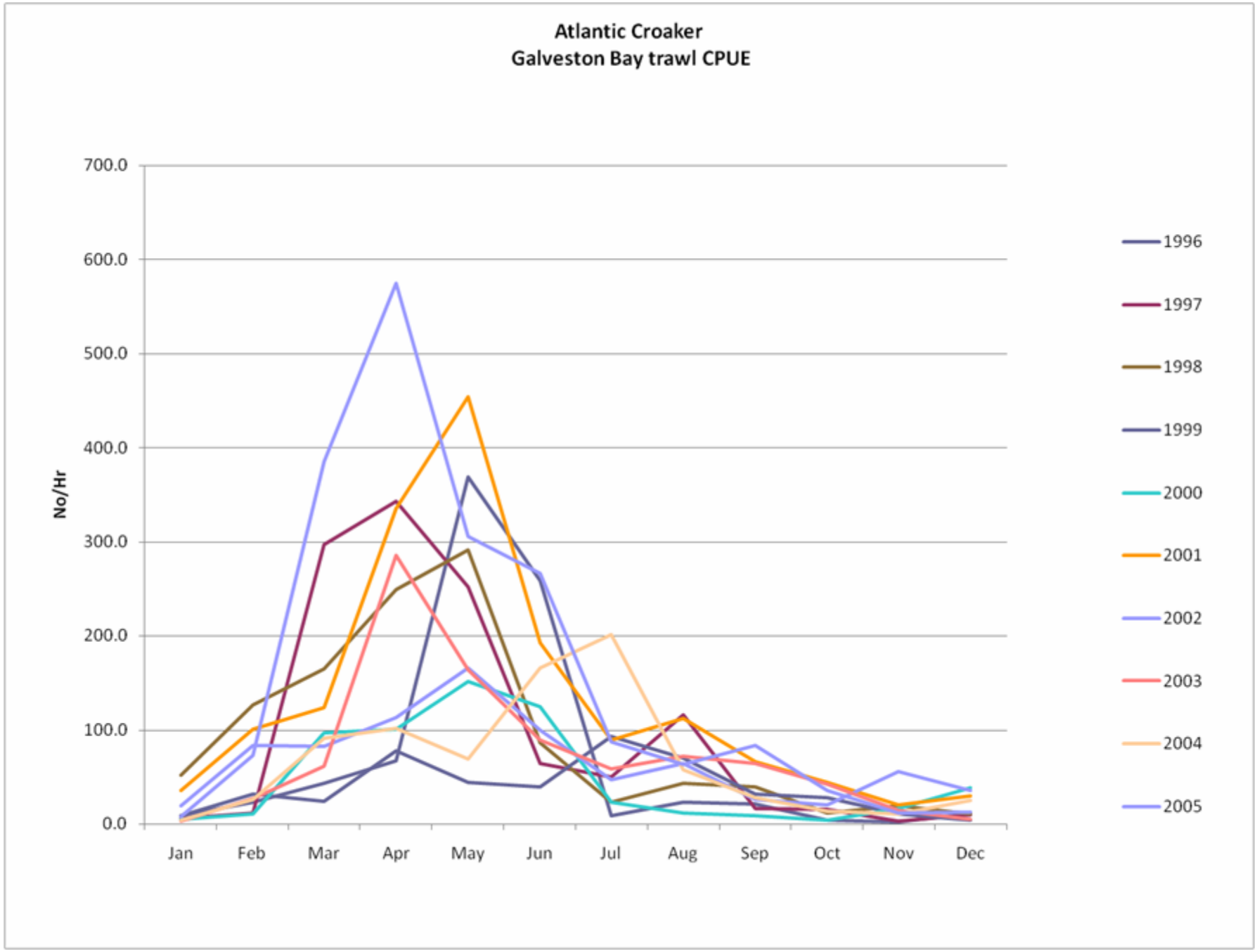

Atlantic Croaker CPUE
Galveston Bay Bag Seine
1982-2005
catch_per_hectare
6000.0
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
82-1 82-7 83-1 83-7 84-1 84-7 85-1 85-7 86-1 86-7 87-1 87-7 88-1 88-7 89-1 89-7 90-1 90-7 91-1 91-7 92-1 92-7 93-1 93-7 94-1 94-7 95-1 95-7 96-1 96-7 97-1 97-7 98-1 98-7 99-1 99-7 00-1 00-7 01-1 01-7 02-1 02-7 03-1 03-7 04-1 04-7 05-1 05-7


Atlantic Croaker CPUE
Galveston Bay Trawl
1982-2005
catch_per_hour
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
82-1 82-7 83-1 83-7 84-1 84-7 85-1 85-7 86-1 86-7 87-1 87-7 88-1 88-7 89-1 89-7 90-1 90-7 91-1 91-7 92-1 92-7 93-1 93-7 94-1 94-7 95-1 95-7 96-1 96-7 97-1 97-7 98-1 98-7 99-1 99-7 00-1 00-7 01-1 01-7 02-1 02-7 03-1 03-7 04-1 04-7 05-1 05-7



Relationship between Atlantic Croaker Bag Seine vs. Trawl CPUE for Galveston Bay, 1982-2005

Lag Time	Coef.Det R-Sq	Probability p	Samples n
none	0.03	0.003	288
1 month	0.0001	0.839	287
2 months	0.023	0.01	286
3 months	0.052	0.001	285

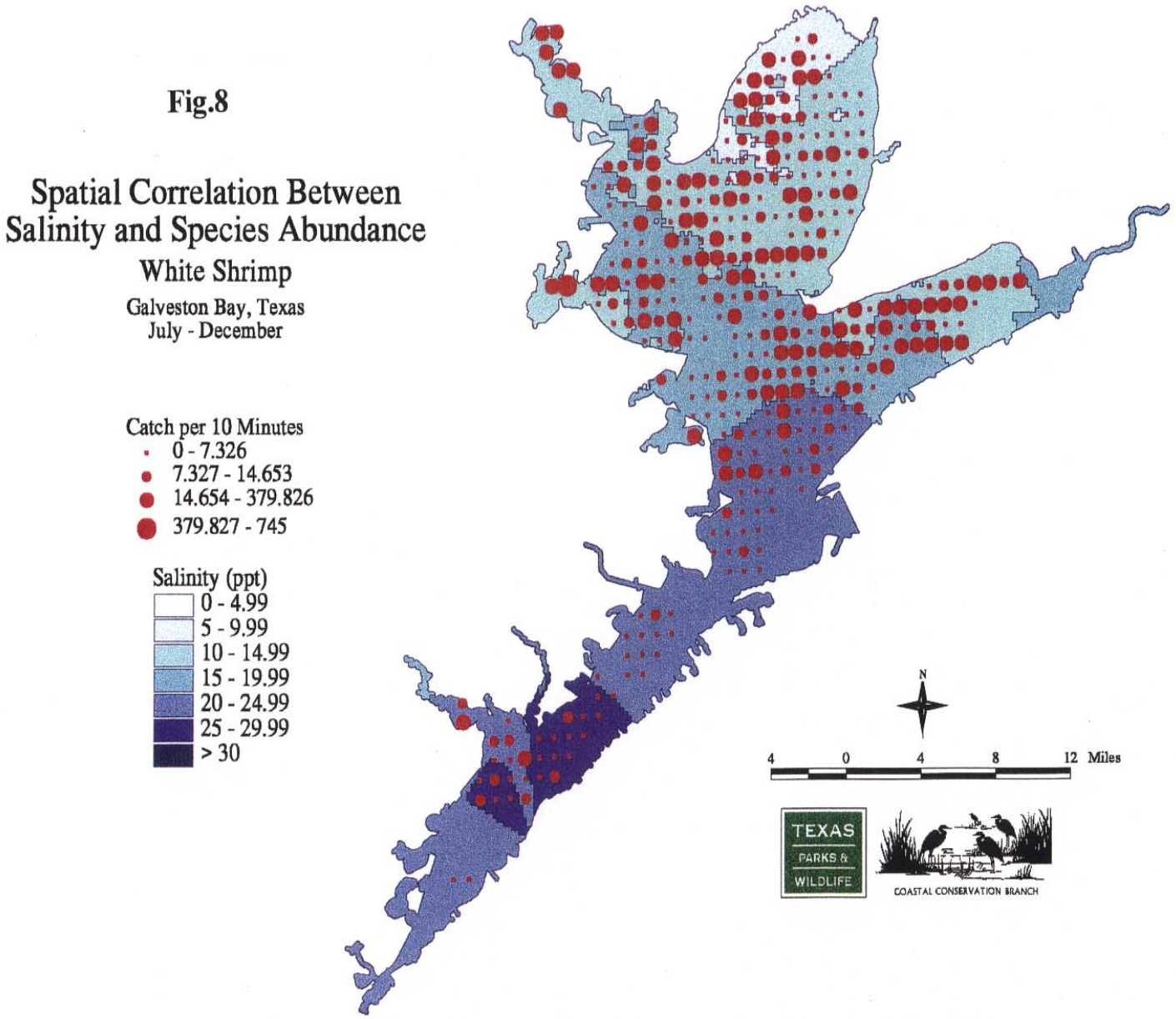

Atlantic Croaker
Galveston Bay trawl CPUE
No/Hr
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

Most TPW data are POINT COUNTS

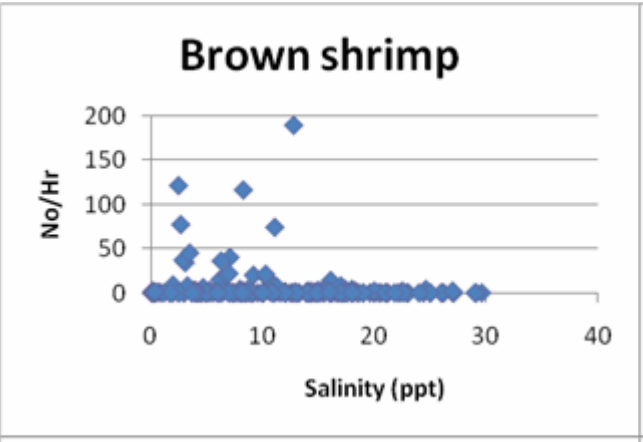
- There are two probabilities involved with each sample, one with the fish, the other with the fisherman.

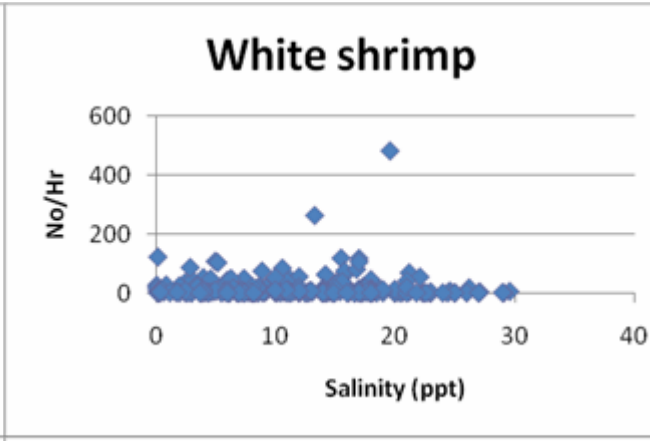
	PRESENT	ABSENT
DETECTION	True Positive	False Positive
NON-DETECTION	False Negative	True Negative

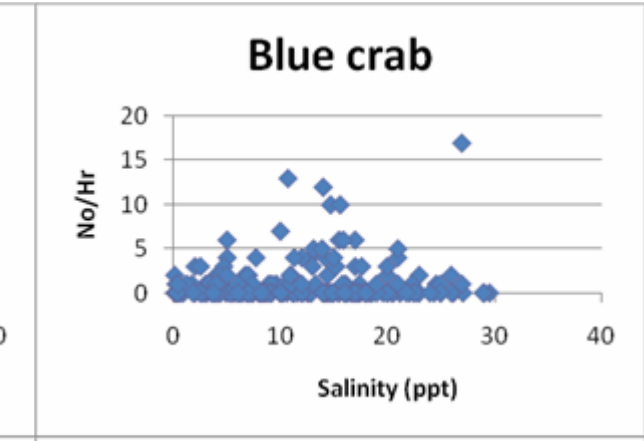
Indirect determination of salinity preference

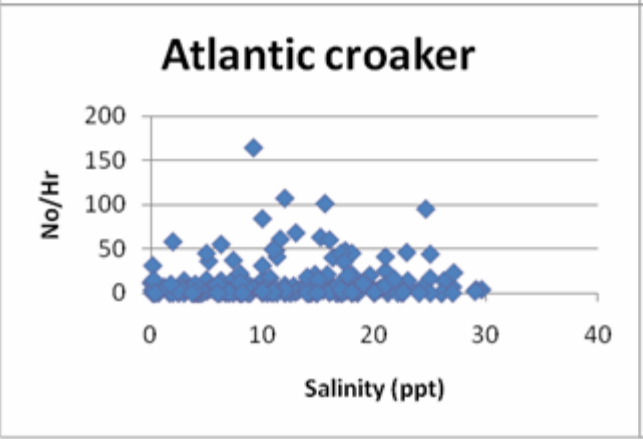


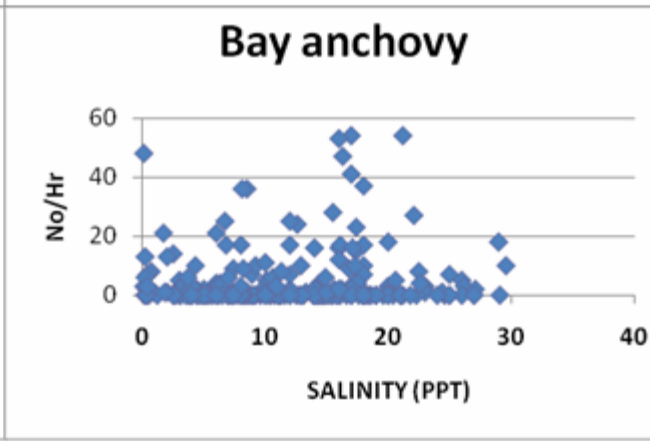
Relationship between Salinity and Trawl CPUE, Galveston Bay, 2004 (n=240)

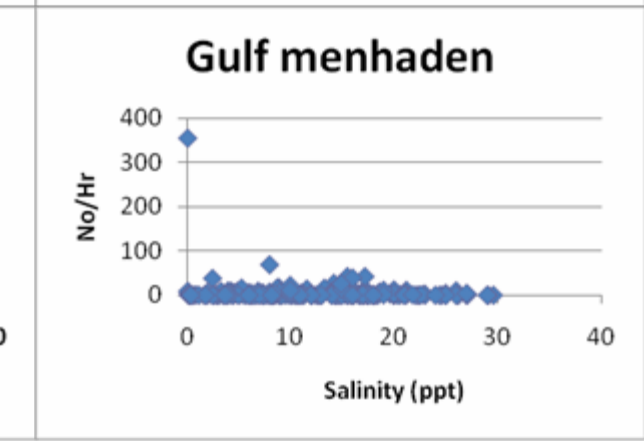


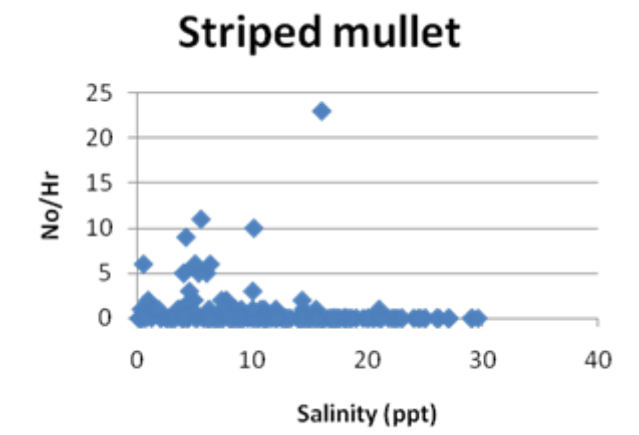


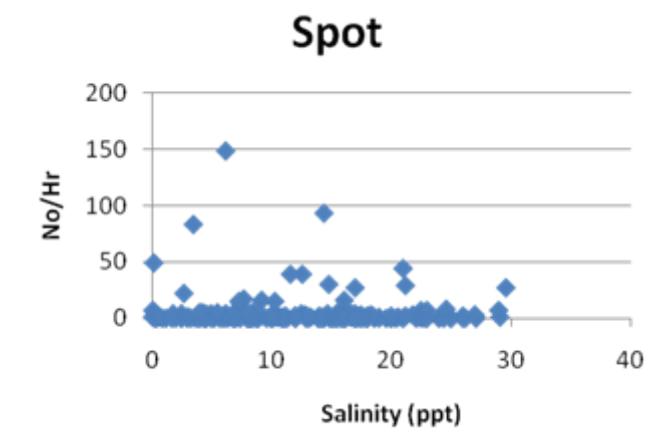








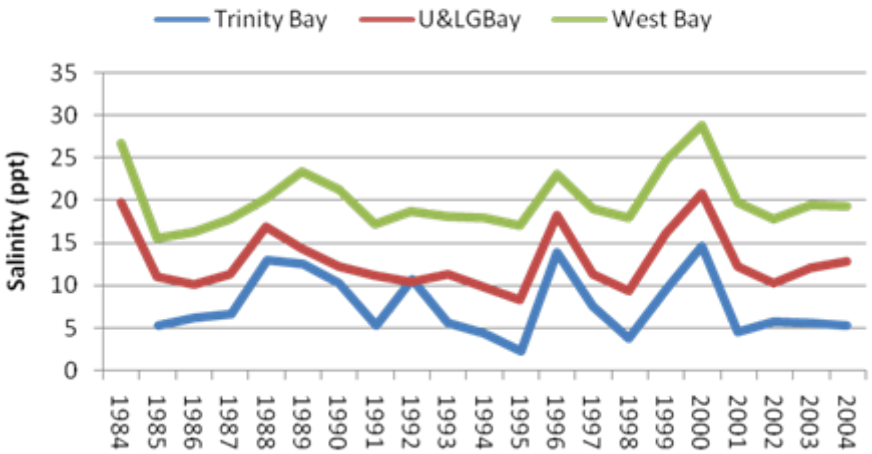




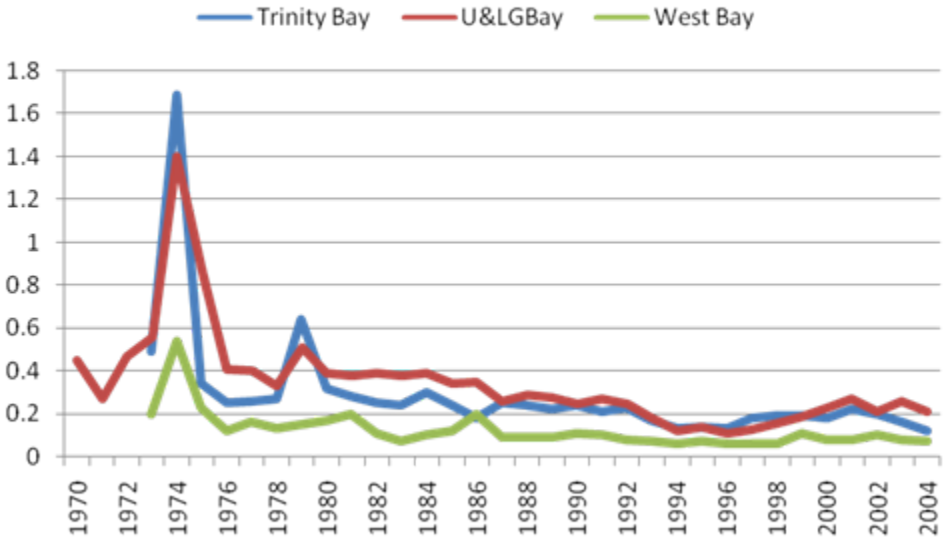
Relationship between Salinity and Trawl CPUE for Galveston Bay, 2004

	Coef. Deter. R-Sq	Probability p
Blue Crab	0.010	0.131
Brown Shrimp	0.017	0.046
White Shrimp	0.0004	0.749
Atlantic Croaker	0.007	0.203
Bay Anchovy	0.006	0.224
Gulf Menhaden	0.011	0.111
Spot	0.002	0.514
Striped Mullet	0.024	0.016

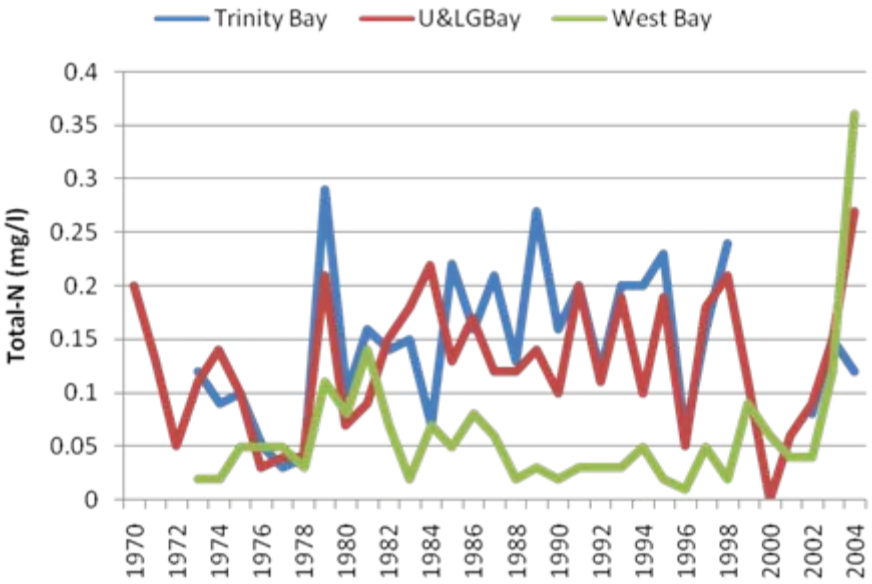
Salinity in the Galveston Bay Ecosystem



Total-P in the Galveston Bay Ecosystem



Total-N in the Galveston Bay Ecosystem



Total-P in Galveston Bay Ecosystem

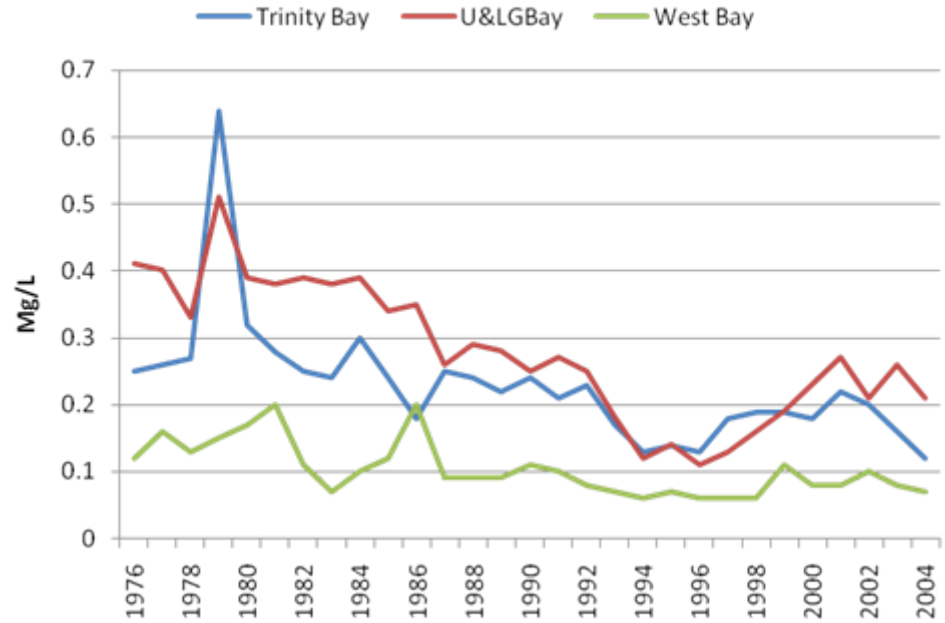
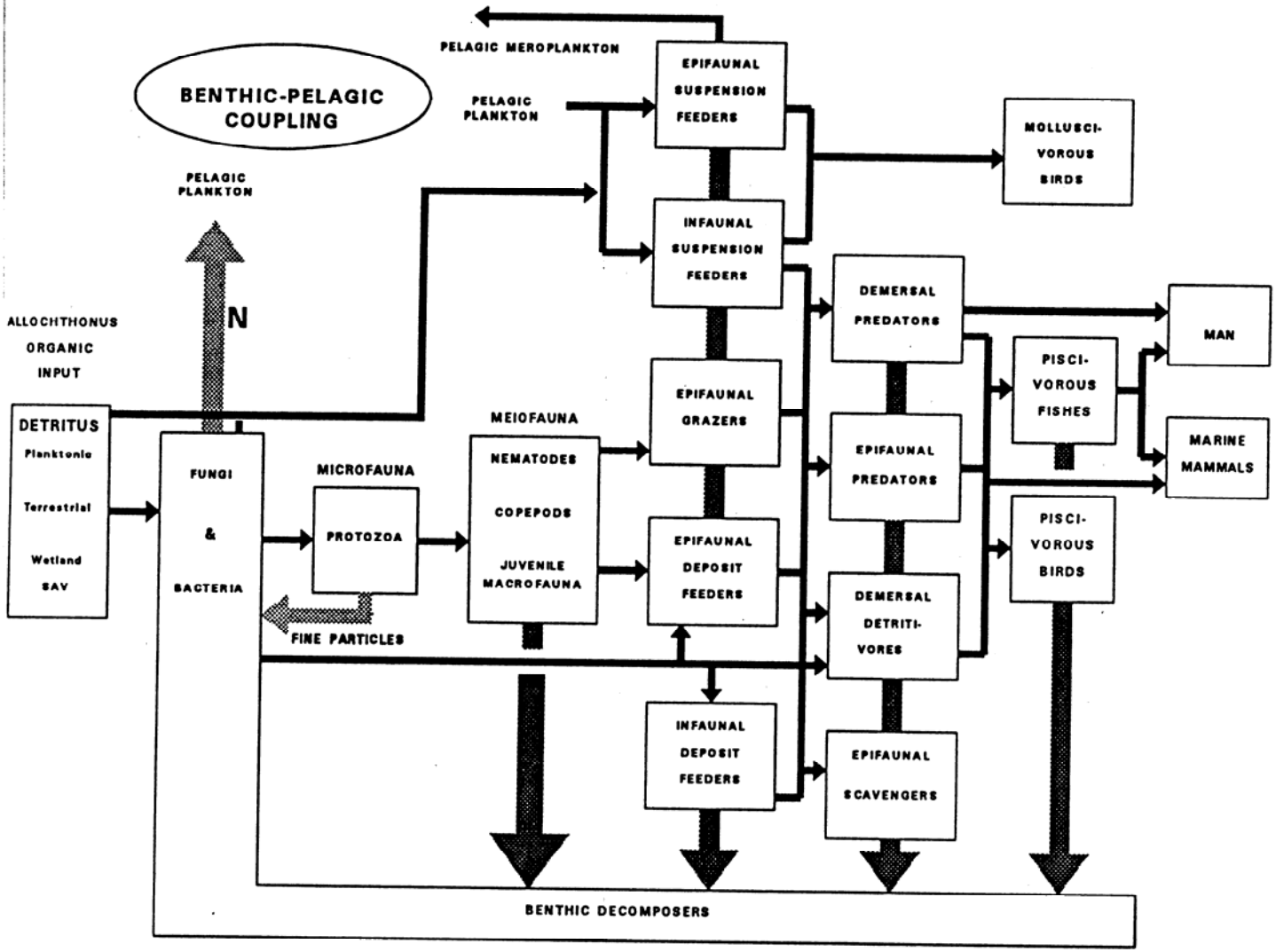


Figure 11. The connectivity of open-bay bottom habitat. The fungi and bacteria which comprise the benthic decomposers are vital at both ends of the food web. The benthic-pelagic coupling provides a vital link to the open-bay water habitat.



Correlations with Salinity
R-Sq (p)

	Trinity Bay	UL Galveston Bay	West Bay
Total-N	0.145 (0.131)	0.128 (0.111)	0.0002 (0.953)
NH3-N	0.084 (0.216)	0.0009 (0.899)	0.050 (0.328)
Total-P	0.050 (0.343)	0.046 (0.353)	0.018 (0.558)
Chl-Phr	0.002 (0.846)	0.003 (0.817)	0.011 (0.658)

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

Class	EGGS	LARVAE	JUVENILES	SUBADULTS	ADULTS
Freshwater	Freshwater	Freshwater	Freshwater	Freshwater/ Estuary	Freshwater/ Estuary
Estuarine	Estuary	Estuary	Estuary	Estuary	Estuary
Estuarine/ Marine 1	Nearshore	Nearshore/ Estuary	Estuary/ Freshwater	Estuary/ Freshwater	Nearshore
Estuarine/ Marine 2	Offshore	Nearshore	Estuary	Nearshore	Offshore
Marine	Offshore	Offshore	Offshore	Nearshore/ Estuary	Nearshore/ Estuary

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?