An Alternative Approach to Addressing Freshwater Inflow Management

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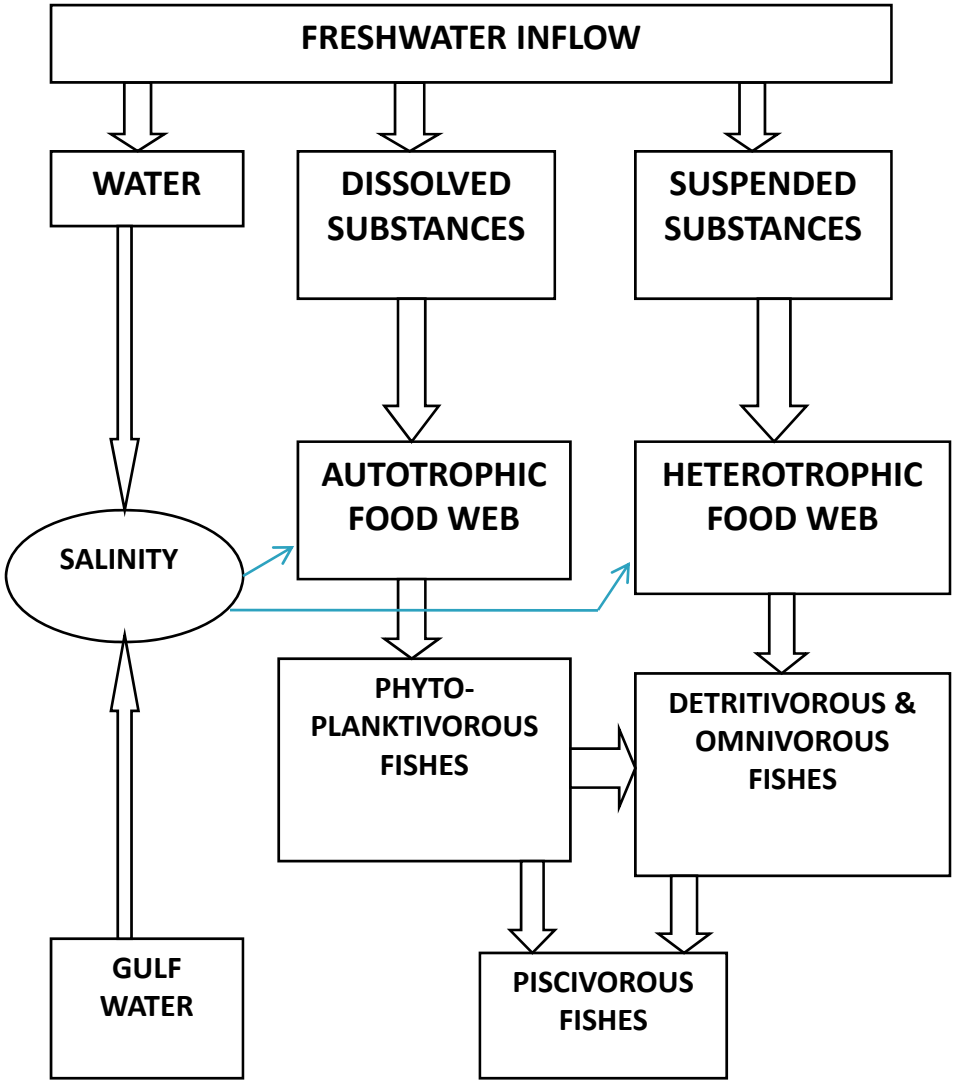
Texas Water Code Sec. 11.147 – Effects of Permit on Bays and Estuaries and Instream Uses

"Beneficial Inflows" means:

- a salinity, nutrient, and sediment loading regime adequate to maintain
- an ecologically sound environment that is necessary for
- 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.

Problems with FW Inflow – Productivity Relationship

- Ecosystem productivity (biomass/area/time) determined by limiting nutrients and limiting resources
- Water cannot be limiting variable in aquatic ecosystem
- FW inflow affects salinity: a stressor, not a limiting resource
  - Stressed species yield resource space to non-stressed species
- TWPD dataset shows species substitution effect
- Relationship of FWI – salinity – community composition can be modeled



Model by Dr. Robert McFarlane, 2008
Modified by Lester and Gonzalez, 2009

Analysis of FW Inflow Effects on Ecosystem Composition (2006)

- Used Species Reported in TPWD Coastal Fisheries Independent Monitoring Database
- Gear included: shrimp trawl, bag seine (no useful results), and gill net deployed in Galveston Bay 1982 to 2004
- Analyzed 101 species of finfish and invertebrates with actual catch numbers

Relative Abundance

- Samples from Trinity Bay, Upper Galveston Bay, Lower Galveston Bay, West Bay
- Number of individuals of one species divided by the total number of all species captured in a given sample
- If a taxon was not captured, it was assigned a relative abundance of zero
- Samples with fewer than five individuals captured were not analyzed
- Discriminant function analysis

Relationship of RA and FW Inflow (Years Classified Based on Flow)

- Years from 1982 to 2004 classified into high flow and low flow years
- 3 medium flow years omitted
- Flows measured by USGS gage at Romayor on the Trinity River
- Low flow < 3,000,000 ac-ft/yr
- High flow > 4,500,000 ac-ft/year

High Flow Years	Low Flow Years
1990	1982
1991	1983
1992	1984
1993	1985
1994	1987
1997	1988
1998	1996
2001	1999
2003	2000
2004	2002

Trinity Bay Trawl Samples (n=904)
Species with RA Differences High vs. Low Flow

Species	High Flow Mean RA	Low Flow Mean RA	F (p<0.005, *) (p<0.001, **)
Atlantic Brief Squid	0.004	**0.031**	36.78**
Atlantic Croaker	**0.251**	0.194	12.98**
Bay Anchovy	**0.082**	0.046	11.95**
Blue Catfish	**0.073**	0.015	40.43**
Blue Crab	0.057	**0.093**	15.28**
Brown Shrimp	0.043	**0.078**	13.82**
Sand Seatrout	**0.023**	0.011	17.82**
White Shrimp	0.128	**0.175**	9.19*

Galveston and West Bay Trawl Samples (n=751, 826, 120) Species with RA Differences High vs. Low Flow

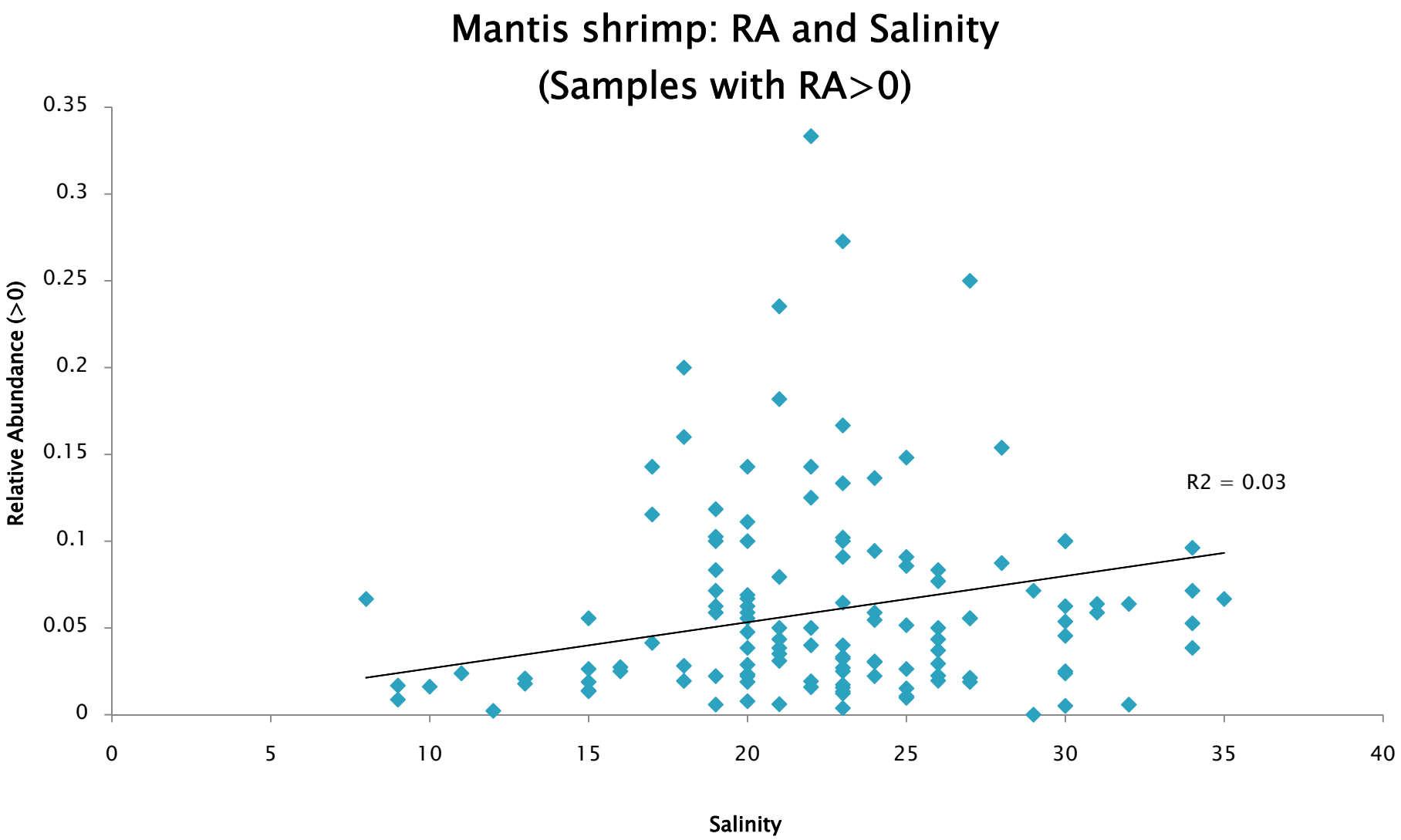
Bay	Species	High Flow Mean RA	Low Flow Mean RA	F (p<0.005, *) (p<0.001, **)
Upper GB	A. Brief Squid	0.014	**0.061**	45.27**
Upper GB	A. Croaker	**0.241**	0.161	22.55**
Upper GB	Blue Catfish	**0.008**	0	9.99*
Upper GB	Sand Seatrout	**0.021**	0.013	10.51*
Lower GB	A. Brief Squid	0.055	**0.105**	21.34**
Lower GB	A. Croaker	**0.210**	0.138	24.26**
Lower GB	Blue Crab	0.057	**0.087**	10.62*
West	A. Brief Squid	0.089	**0.207**	12.33*

Relationship of RA with Salinity

- Collate all Upper & Lower GB shrimp trawl samples with salinity conditions from 1982 – 2007 (N = 2802)
- Calculate the relative abundances of 101 species for each trawl sample
- Classify trawls into low 0–10 psu (n=800) and high salinity 20–36 psu (n=872)
- Run discriminant function on 50 species with >3 trawls of RA>0
- 16 species show significant differences in RA between high and low salinity regimes

High vs Low Salinity Relative Abundances of Selected Species in Trawl Samples (n=2801) from Upper/Lower Galveston Bay

Species	# Samples >0	Low Salinity	High Salinity
Atlantic brief squid	739	0.001	0.131
Atlantic croaker	1997	0.253	0.137
Blue catfish	57	0.007	0.000
Gulf butterfish	351	0.006	0.019
Gulf menhaden	1391	0.110	0.067
Lesser blue crab	325	0.001	0.019
Mantis shrimp	129	0.000	0.007


Mantis shrimp: RA and Salinity
(Samples with RA>0)
Relative Abundance (>0)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
30
35
40
R2 = 0.03
Salinity

Recommendations

- Consider common species with salinity preferences part of “ecologically characteristic” community
- Develop quantitative description of “ecologically characteristic” community
- Establish quantitative model of salinity effects on community composition
- Use salinity – community composition relationships to design FW inflow management regimes