Update on BBEST Recommendations for Freshwater Inflow to Galveston Bay

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With contributions from Dave Buzan, George Guillen, Antonietta Quigg, Joe Trungale and Woody Woodrow.

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Tasks

- Identify best available science on relationship of freshwater inflow to ecological characteristics of GB
- Develop a methodology for quantifying relationship
- Use best professional judgment to decide on flow regime for sound ecological environment

This recommendation

- Meets SB3 legislative mandate and complies with SAC guidance.
- Uses best available science: thorough review and application of the current state of knowledge of salinity-ecology relationships in Galveston Bay and best professional judgment
- Protects a sound ecological environment using appropriate flows, variation between months and seasons and frequency of attainment.

Sound Ecological Environment

- All native species in perpetuity
- Key habitats
- Key features of flow regime
- Key ecosystem services

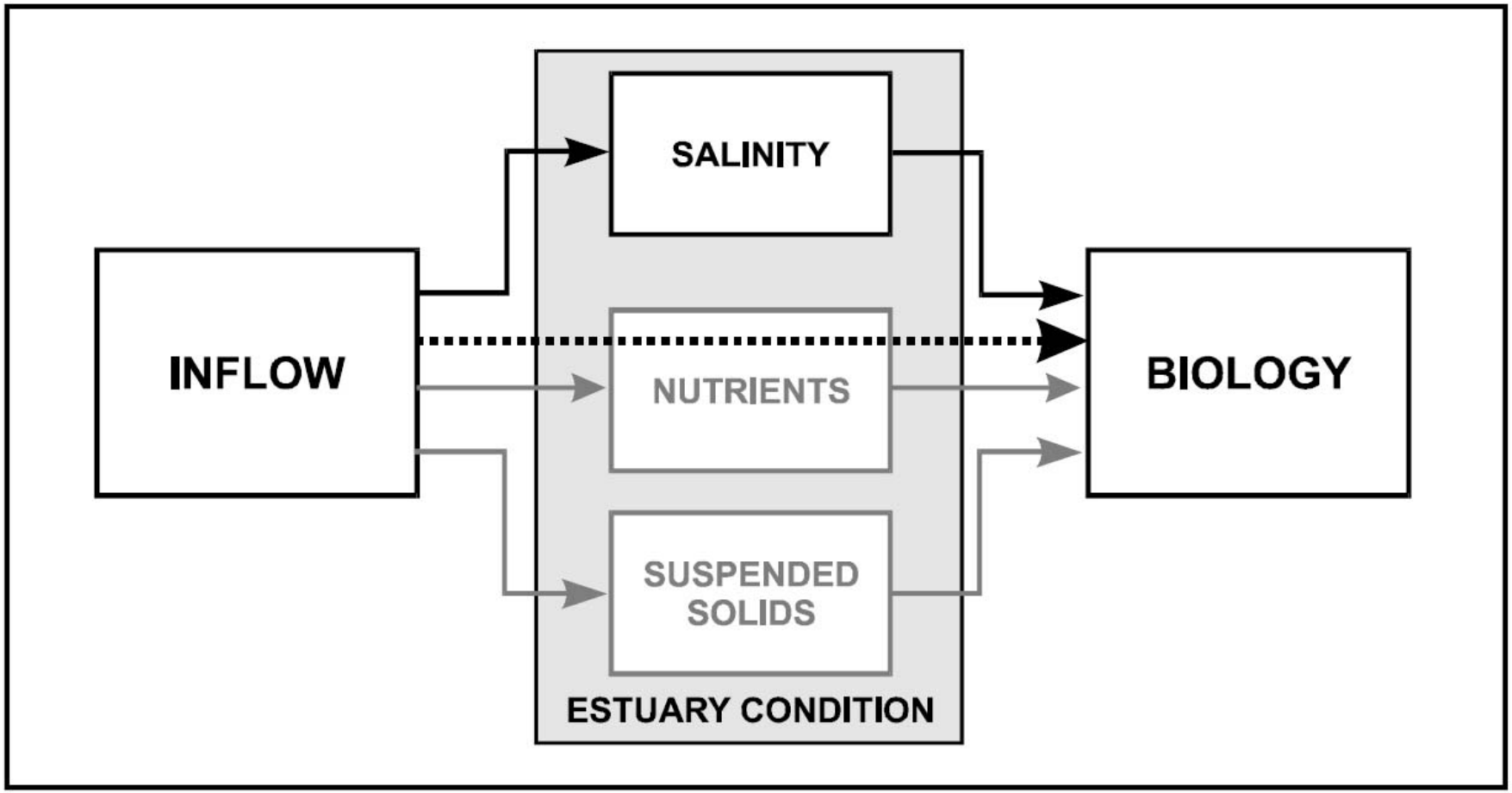
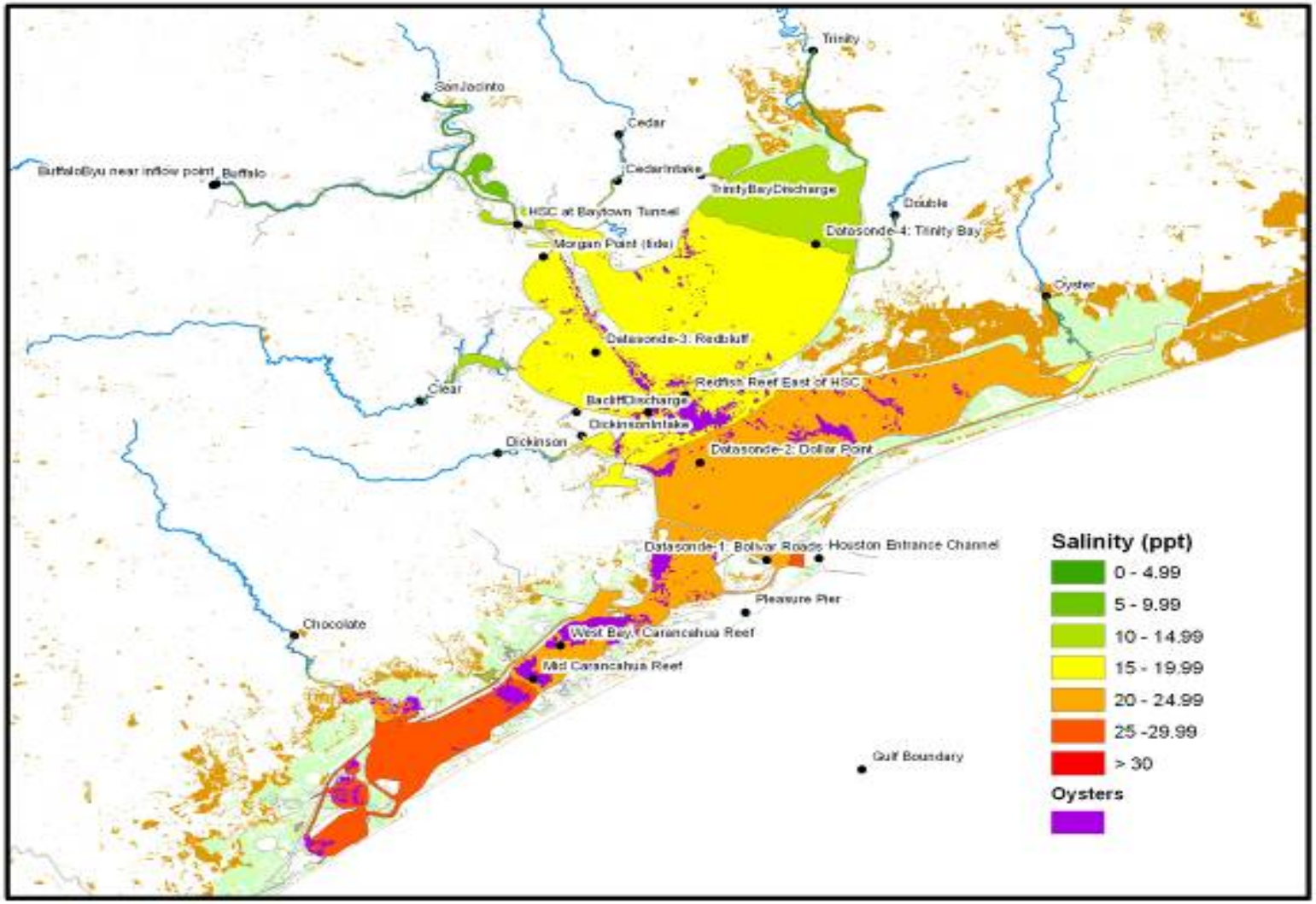


Figure 2.1-2 – Schematic of Relation of "Biology" to "Inflow"
(Compressed from Figure 2.2-1)

TXBlend Model of 5 psu salinity zones in Galveston Bay for the flow pattern of May 2000. (50th percentile of flows for the period of record used by TXBlend.)



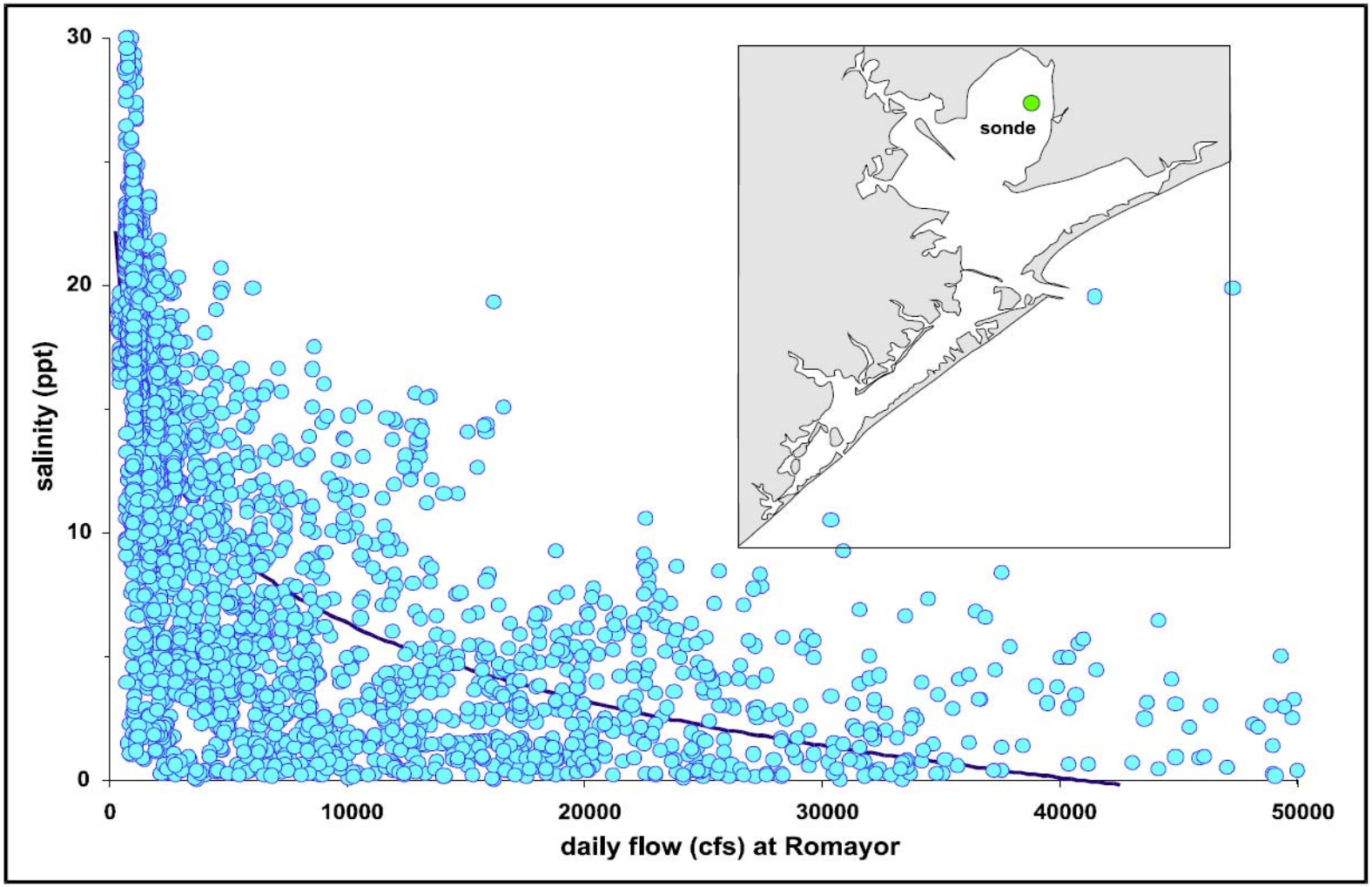
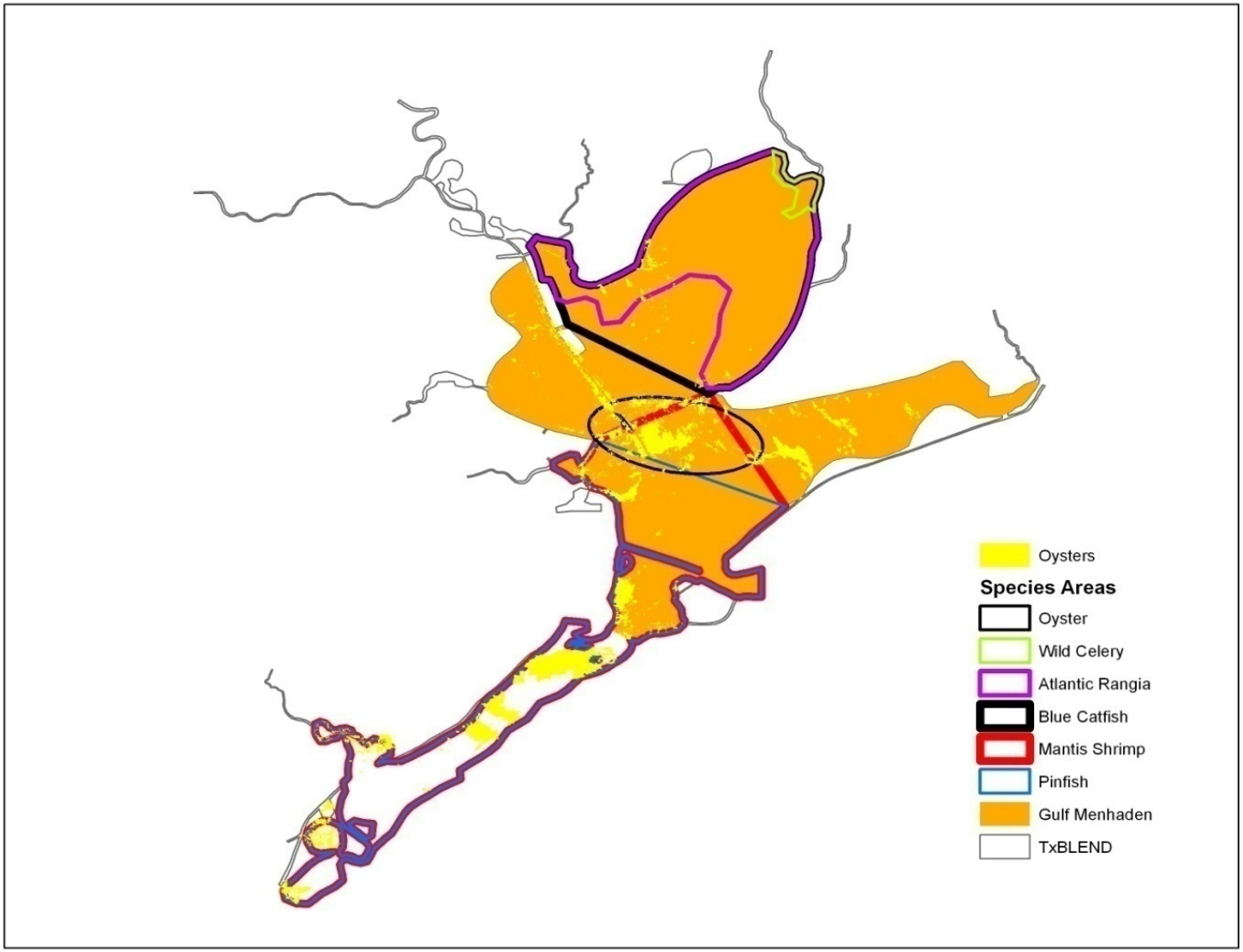


Figure 2.3-2 Surface Daily-Mean Salinity at Trinity Bay Sonde Versus Trinity River Flow at Romayor with 30-Day Lag of Salinity Behind Flow for 1986-2007
(from data files of Texas Water Development Board)

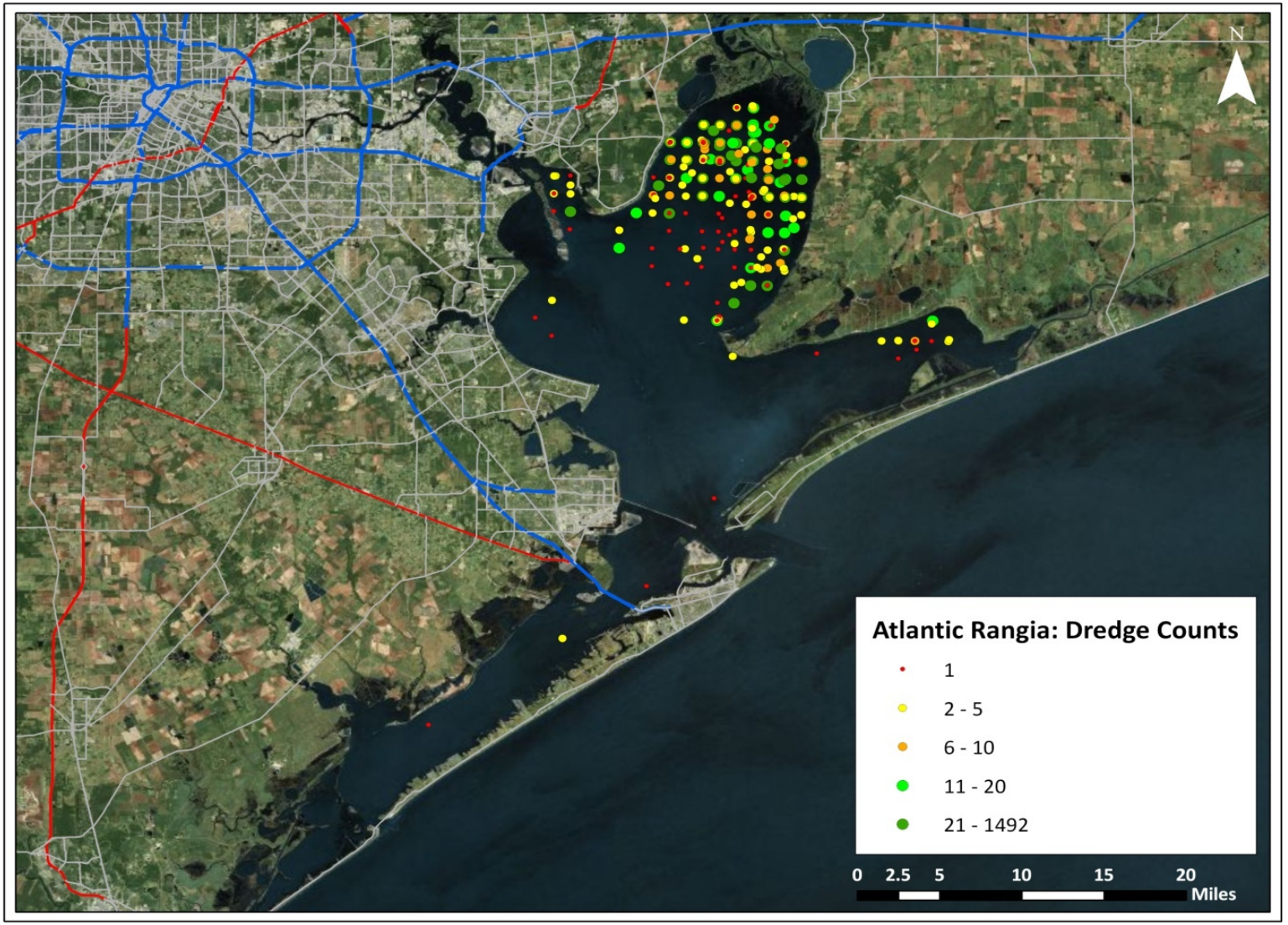
Identified Biological Indicators for Evaluating Freshwater Inflow Needs to Galveston Bay. Emphasis was placed on the sessile organisms: wild celery, Atlantic Rangia and oyster parasites and predators.

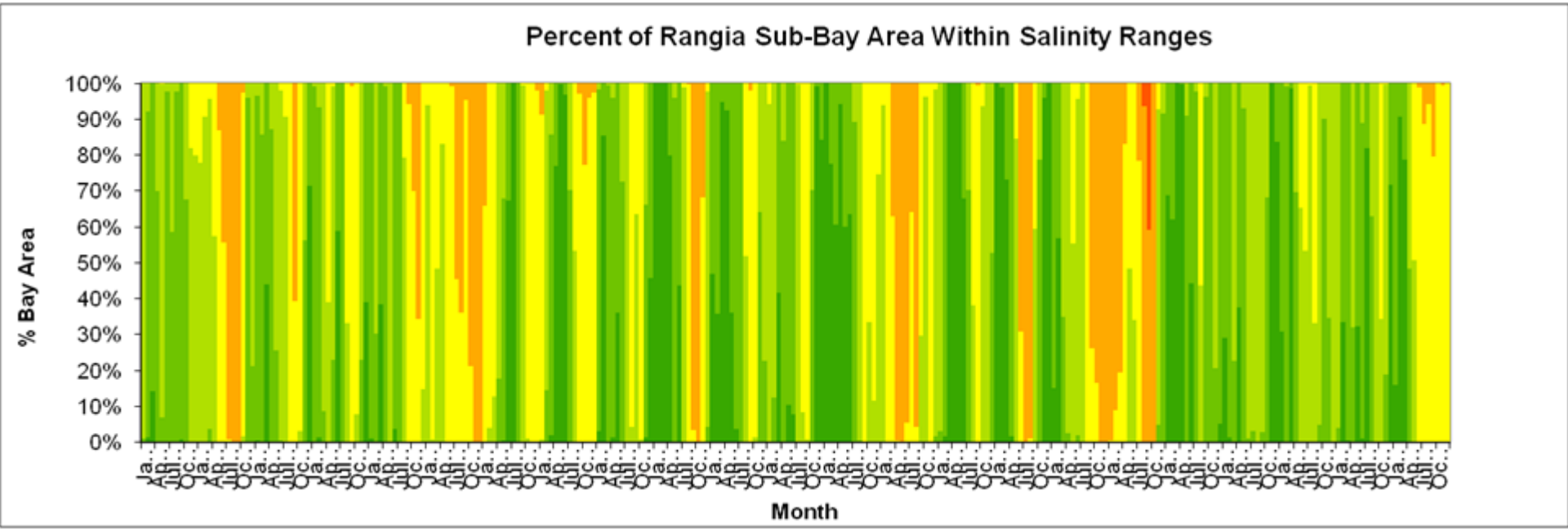
	Common Name	Scientific Name	Criterion	Period of Concern
Habitat Indicator	Wild Celery	*Vallisneria americana*	<5 psu for germination and establishment	Spring
	"	"	<10 psu for survival	Summer and Fall
Low Salinity Indicators	Atlantic Rangia	*Rangia cuneata*	2 – 10 psu for spawning and larval survival	Spring and Fall
	Gulf menhaden	*Brevoortia patronus*	5 – 15 psu for occurrence as forage fish	Winter and Spring
	Blue catfish	*Ictalurus furcatus*	<10 psu for occurrence as predator	Single pulse in winter or spring
High Salinity Indicators	Mantis shrimp	*Squilla empusa*	>25 psu for abundance	Summer - Fall
	Pinfish	*Lagodon rhomboides*	>25 psu for abundance	Summer - Fall
Oyster Health Indicators	Dermo and oyster drill impacts on oyster	Dermo= *Perkinsus marinus* Oyster drill= *Stramonita haemastoma* Oyster= *Crassostrea virginica*	10 – 20 psu to prevent excessive parasitism and predation	July - September
	"	"	<5 psu to remove parasite load from central reefs	2 weeks at 10 year intervals

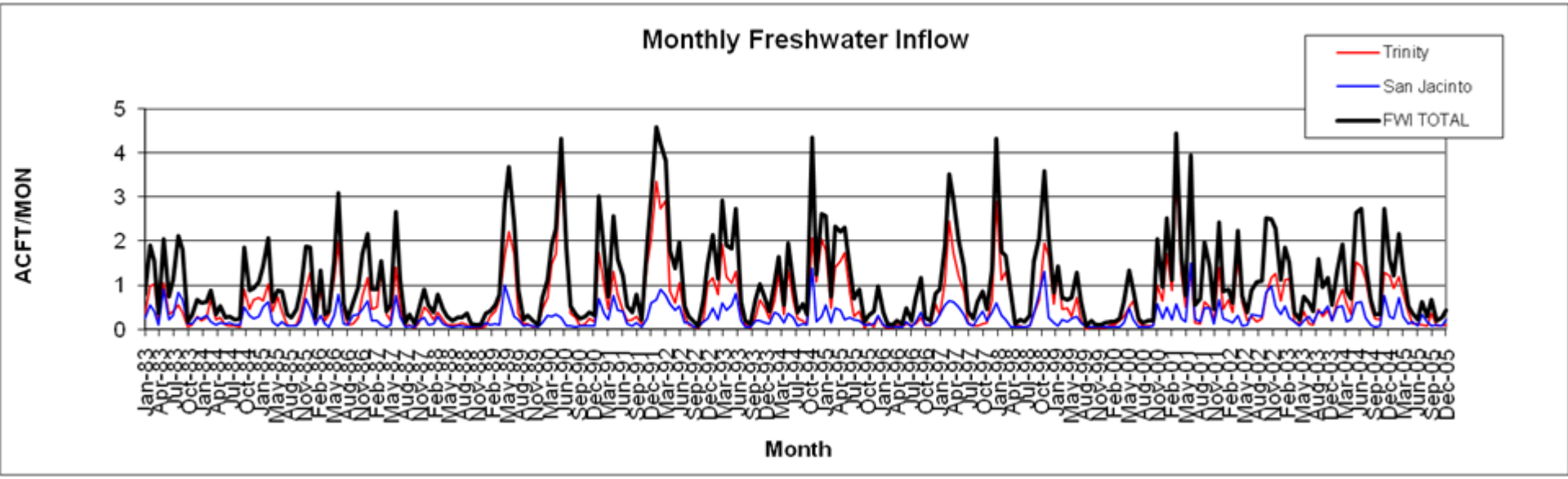
Areas assigned to each biological indicator for evaluation of flow effects on the salinity criteria.



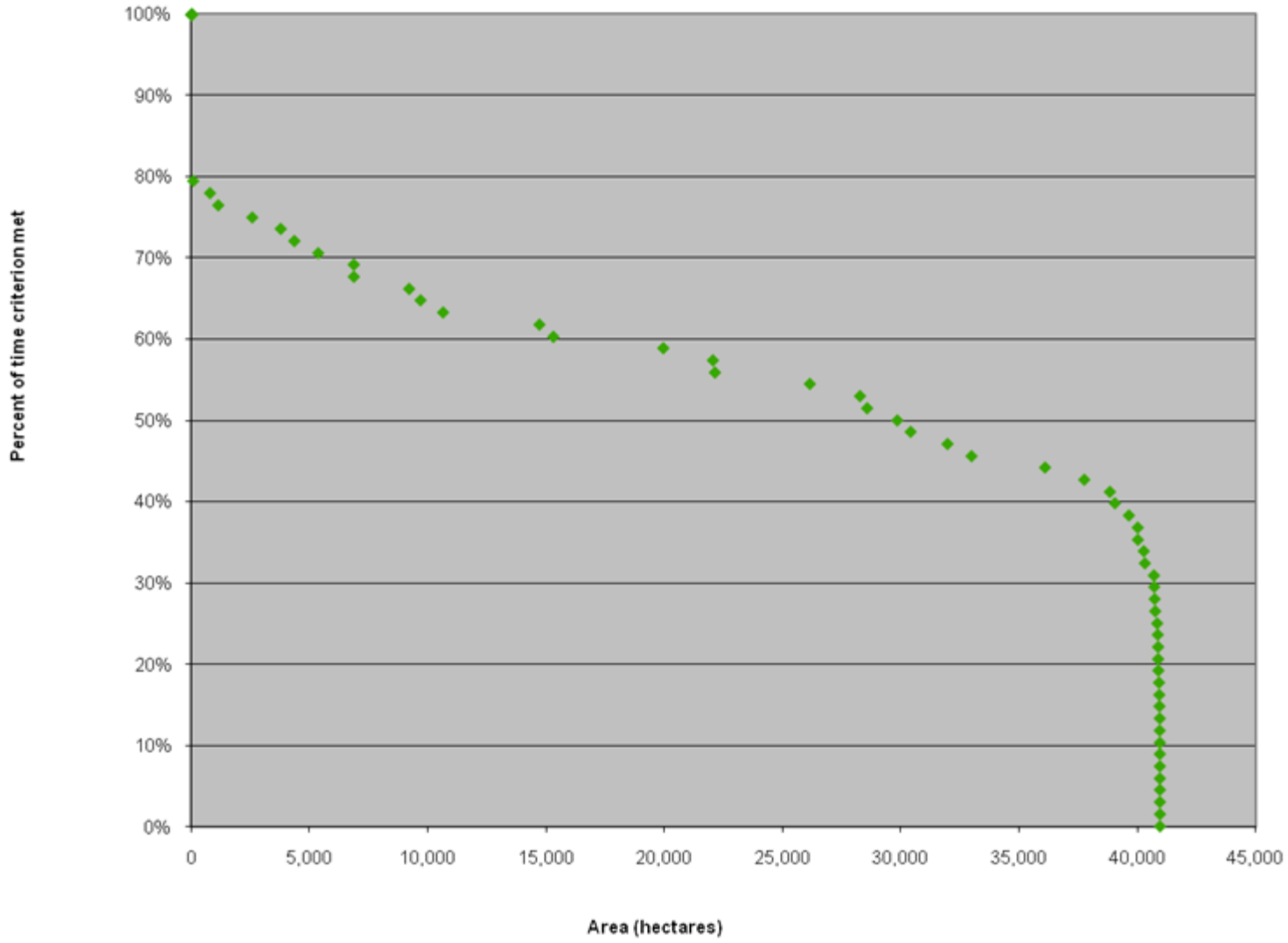
Map of the collections of Atlantic Rangia by TPWD in dredge samples and the abundance of clams in each collection.



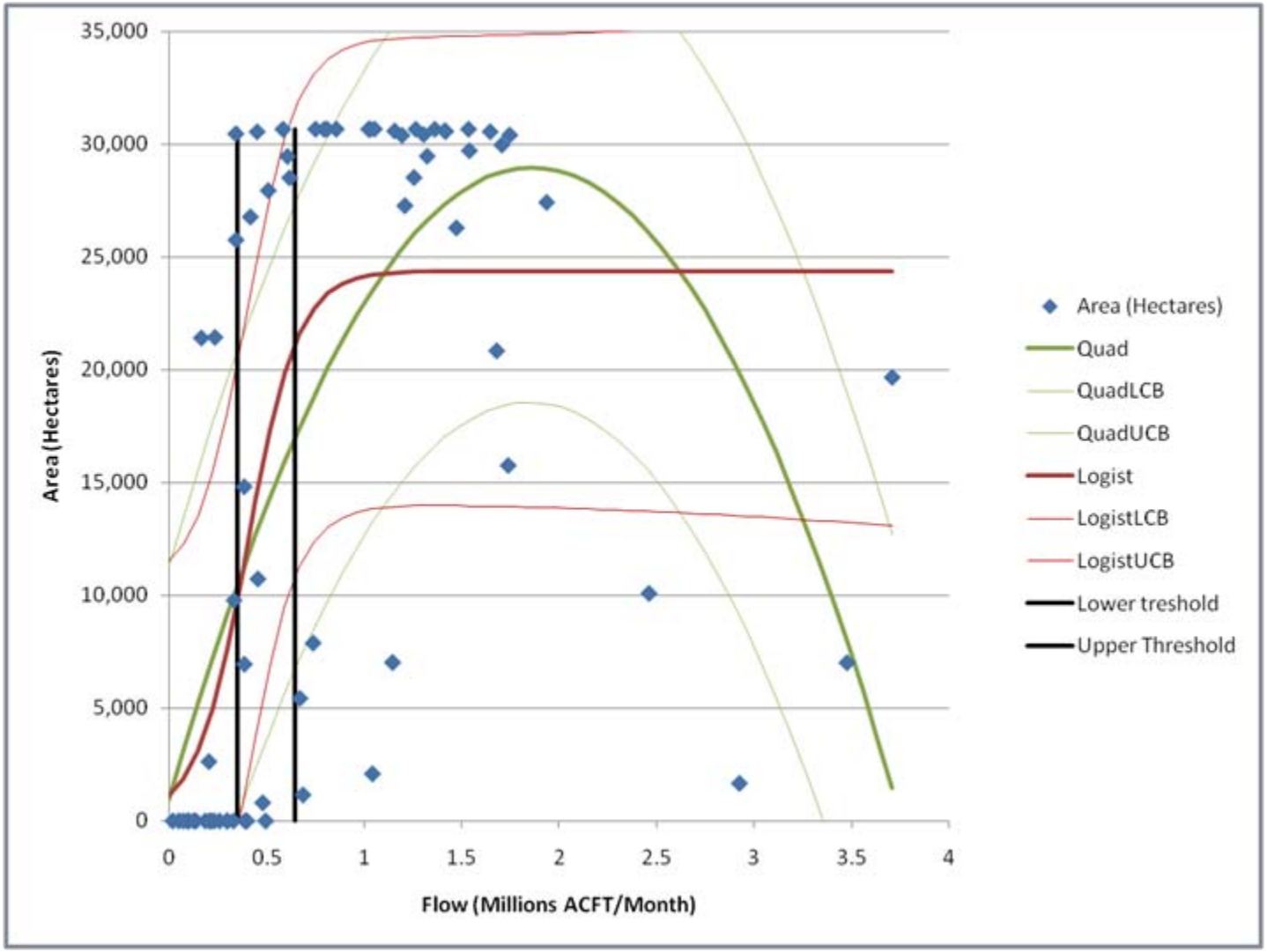

Percent of Rangia Sub-Bay Area Within Salinity Ranges
% Bay Area
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Month


Monthly Freshwater Inflow
Trinity
San Jacinto
FWI TOTAL
ACFT/MON
5
4
3
2
1
0
Month

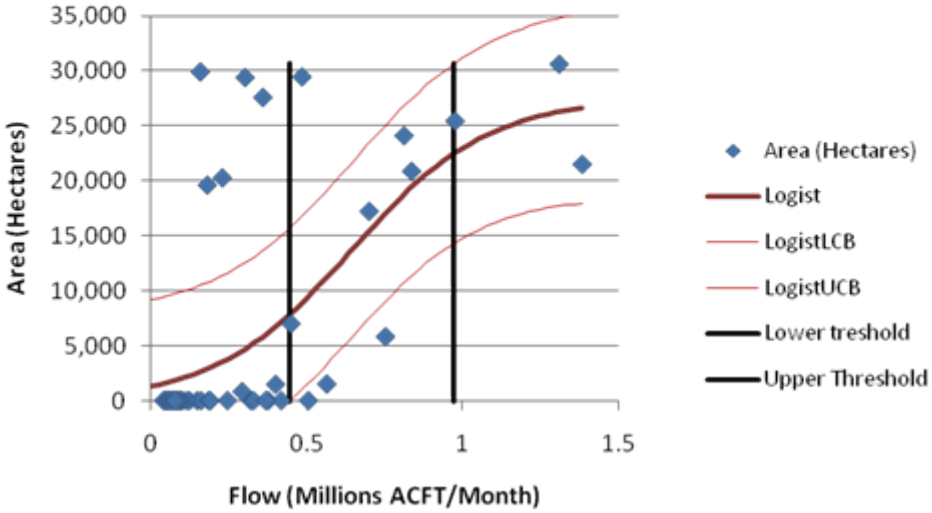
Plot of the percent of spring months in the TXBlend record in which a given portion of Atlantic Rangia habitat in Galveston Bay meets the salinity criterion (2 – 10 psu)



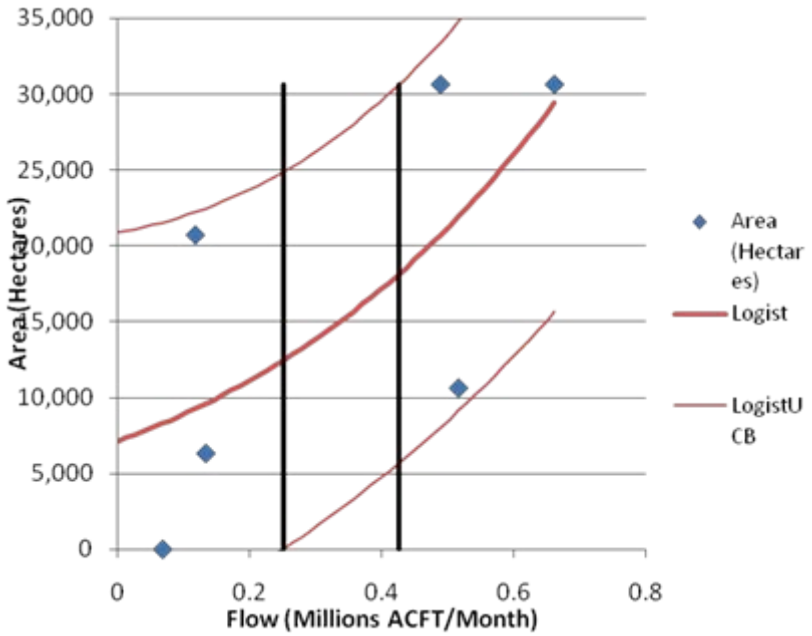
Plot of spring flow from the Trinity River and the hectares of habitat assigned to Atlantic *Rangia* with suitable salinity values for survival of larvae. Quadratic and logistic regression analyses are shown. Logistic provides a better fit.



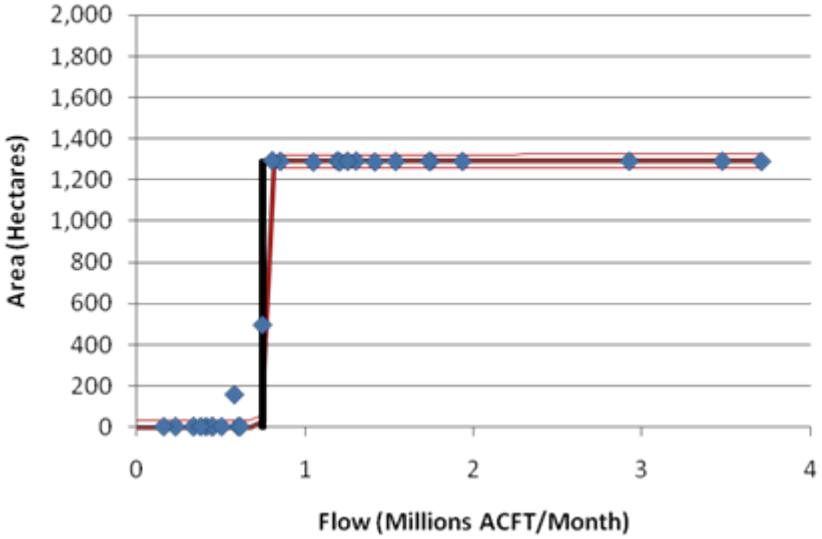
Regression of San Jacinto flow for Rangia spawning criterion in fall if preceding month is salty. (446,000 ac-ft)

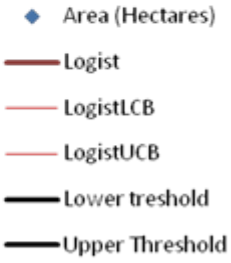


Regression of flow for Rangia spawning criterion in fall if preceding month is suitable. (250,000 ac-ft)

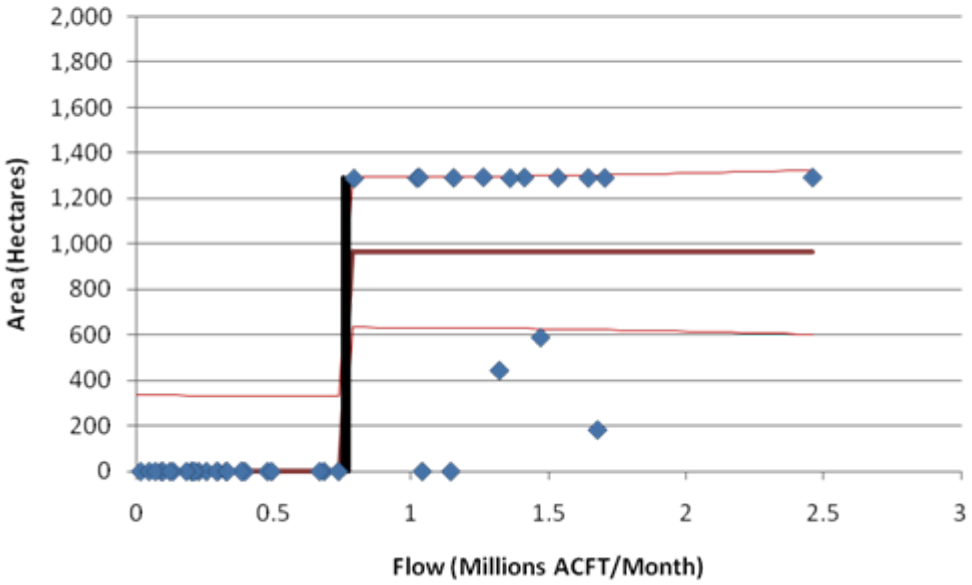


Flow to obtain salinity criteria for Vallisneria in Spring with preceding Good Conditions = 742,000 ac-ft





Vallisneria Spring Salty Conditions = 754,000 ac-ft

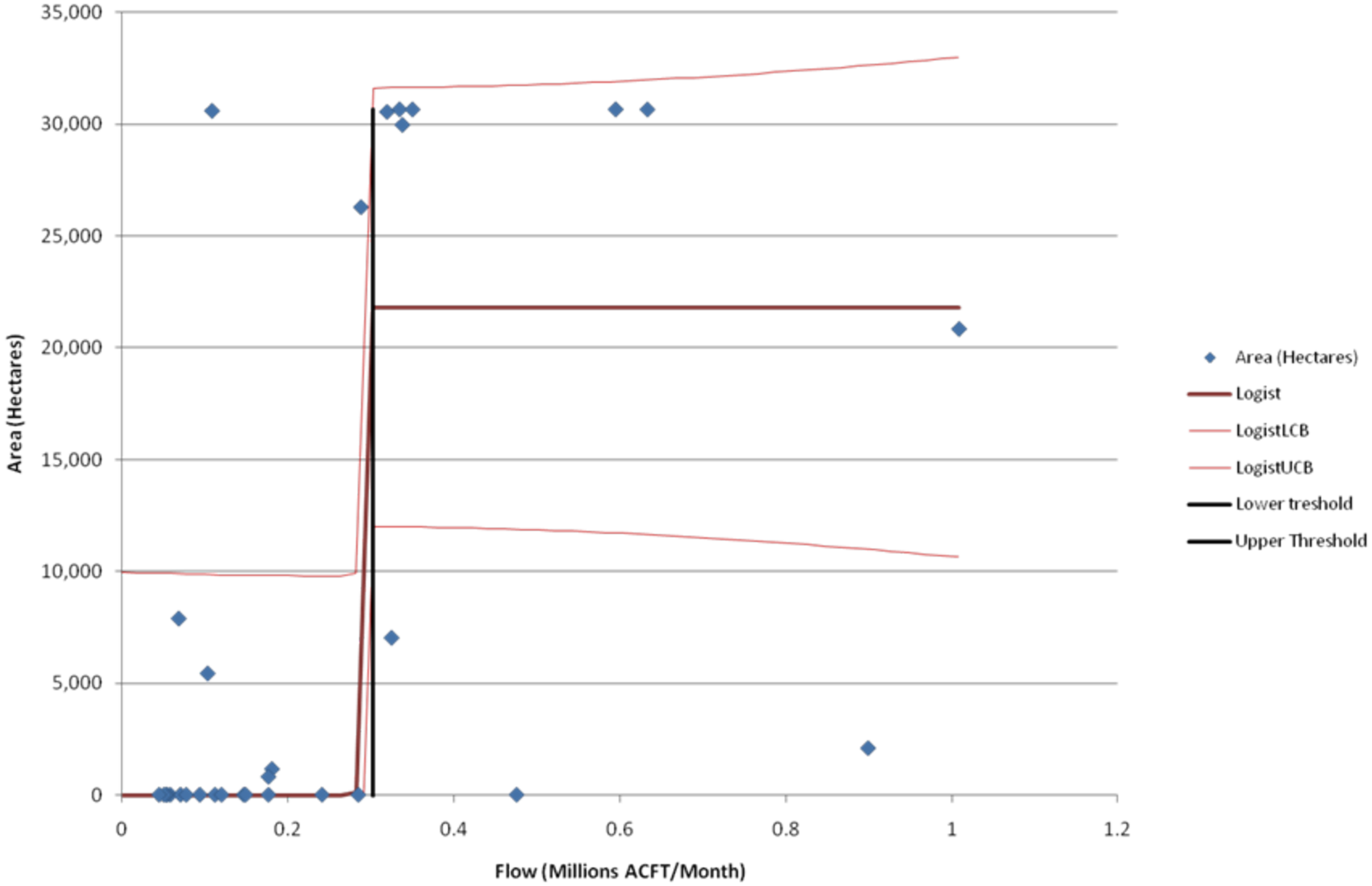


Recommendations for monthly seasonal flows and periodicities from the Trinity River.

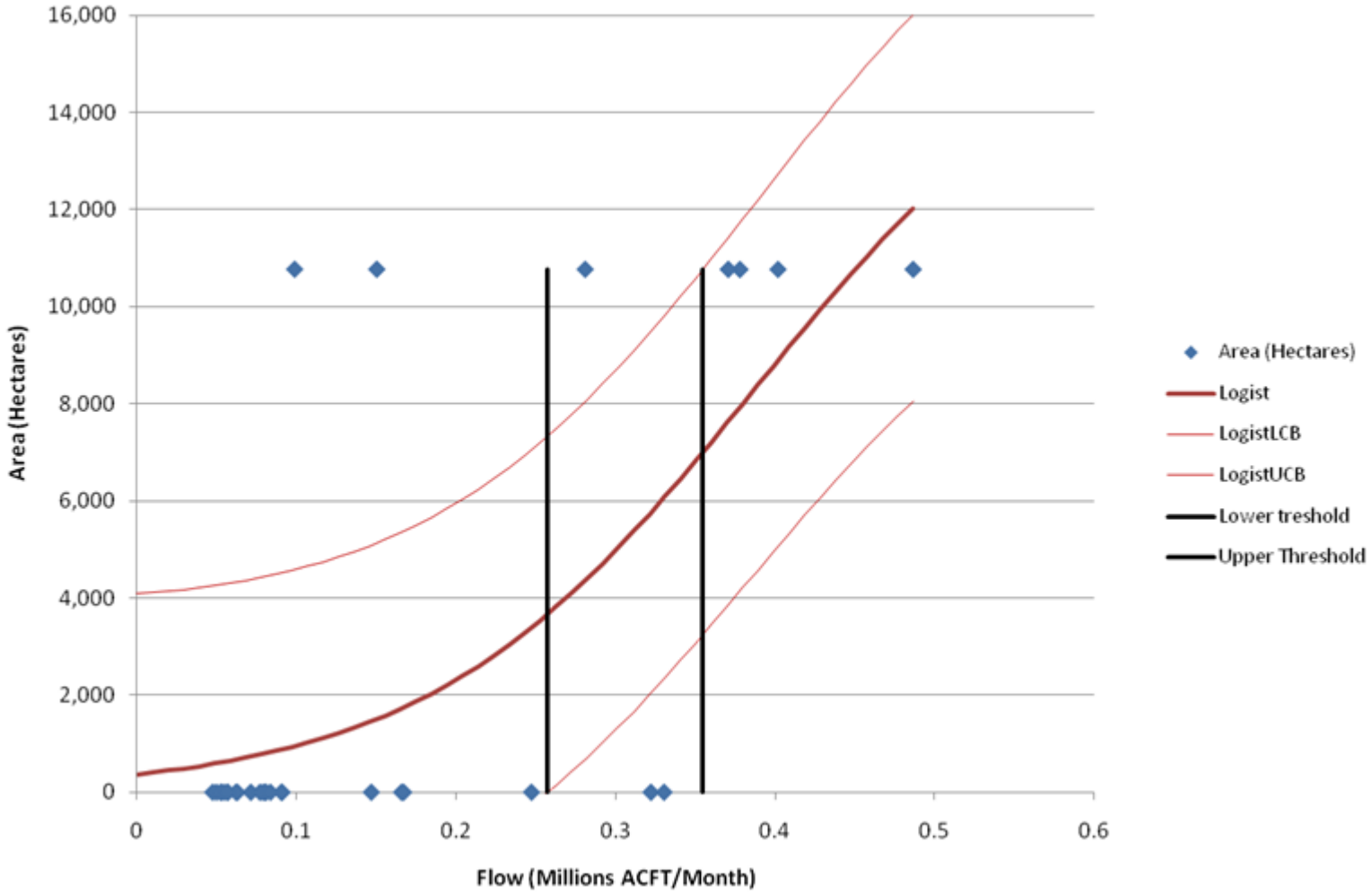
Criterion	Spring	Summer	Fall	Winter
Flow (ac-ft)	742,000	205,000	141,000	
Periodicity	1 of 3 months	2 of 3 months	2 of 3 months	
Historical Annual Occurrence	18 of 23 years	12 of 23 years	11 of 23 years	
Recommended Annual Frequency	1 in 2 years	1 in 2 years	1 in 3 years	

Criteria: Spring- germination of Vallisneria <5 psu; Summer and Fall- survival of Vallisneria <10 psu.

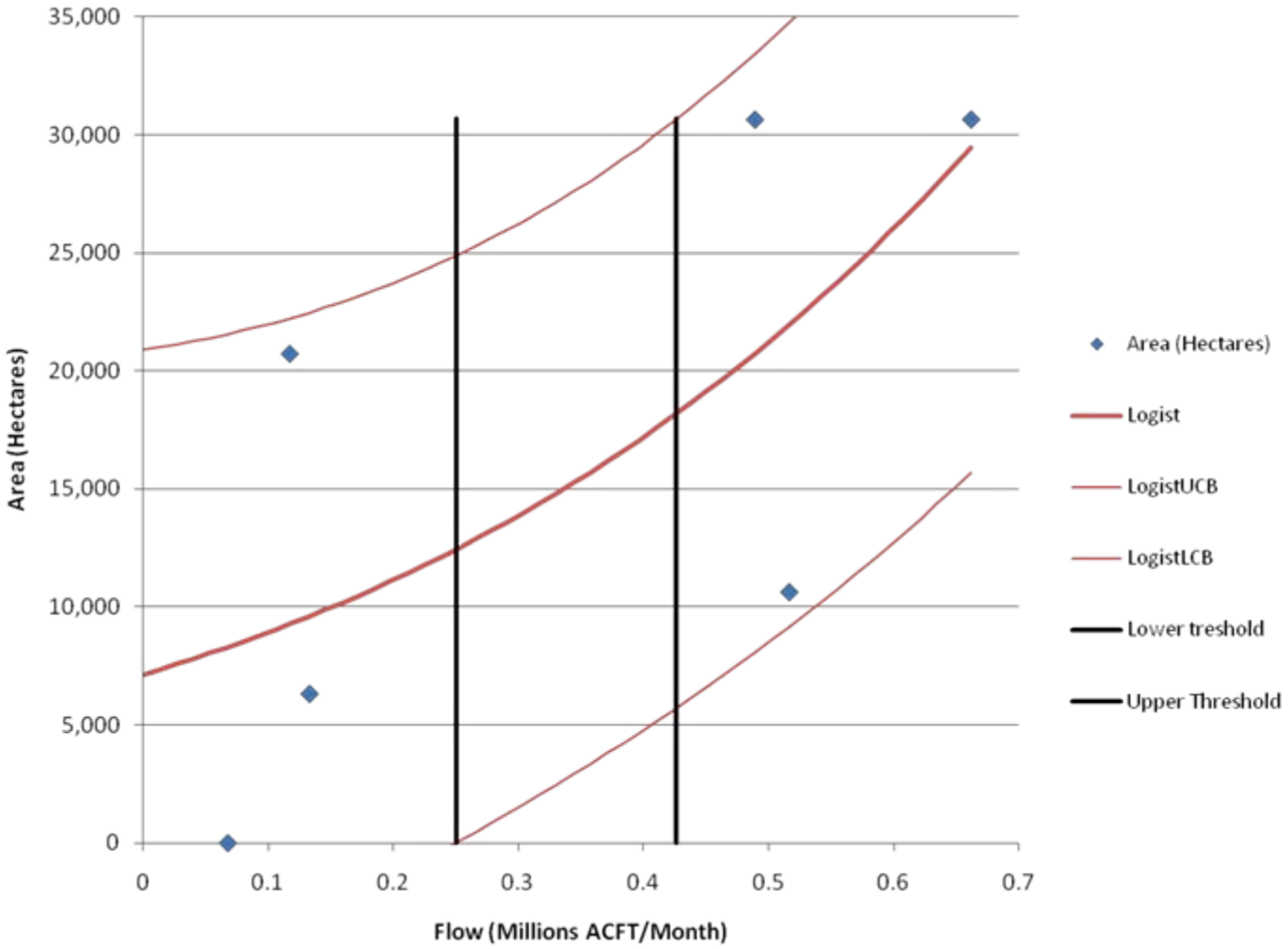
Plot of logistic regression showing flow required to obtain criterion salinity conditions for Rangia spawning in spring when preceding conditions are salty. (302,000 ac-ft)



Plot of logistic regressions based on summer flows from the San Jacinto River and the salinity in the area of the bay assigned to the oyster health indicator (10 – 20 psu).



Plot of logistic regression showing flow required to obtain criterion salinity conditions for Rangia spawning in fall when preceding conditions are good. (250,000 ac-ft)

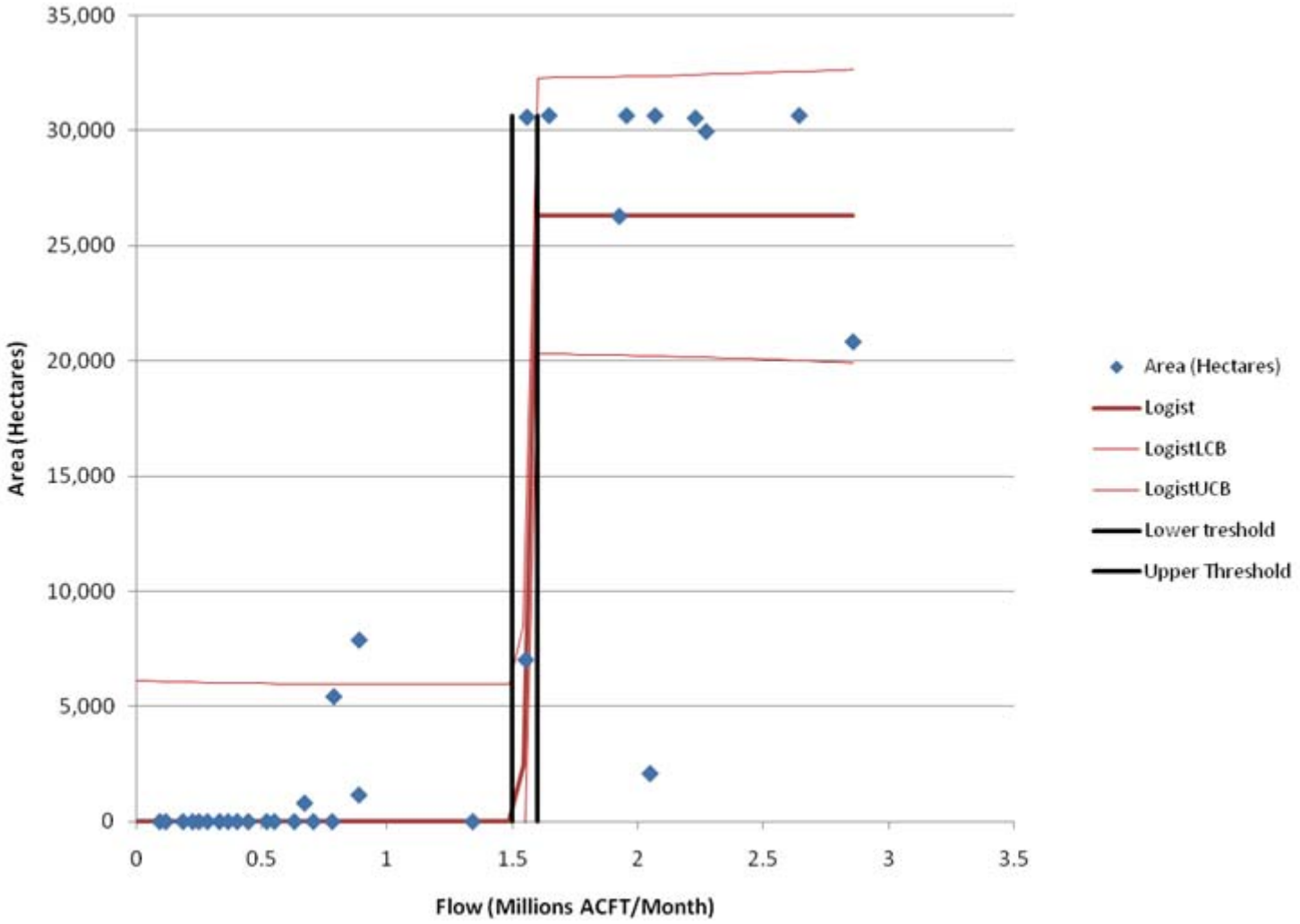


Recommended seasonal monthly flows and periodicities for the San Jacinto River.

Season	Spring	Summer	Fall	Winter
Flow	302,000	257,000	250,000	
Periodicity	1 of 3 months	2 of 3	1 of 3	
Historical Annual Occurrence	15 of 23 years	5 of 23	13 of 23	
Recommended Annual Frequency	1 in 2 years	1 in 5 years	1 in 2 years	

Criteria: Spring and Fall- spawning of Rangia, 2 – 10 psu; Summer- reduced predation and parasitism of oysters, 10 – 20 psu.

Plot of logistic regression of Rangia habitat meeting salinity criterion with spring flows for the entire bay when the preceding salinity has been high (recommended flow = 1,500,000 ac-ft).

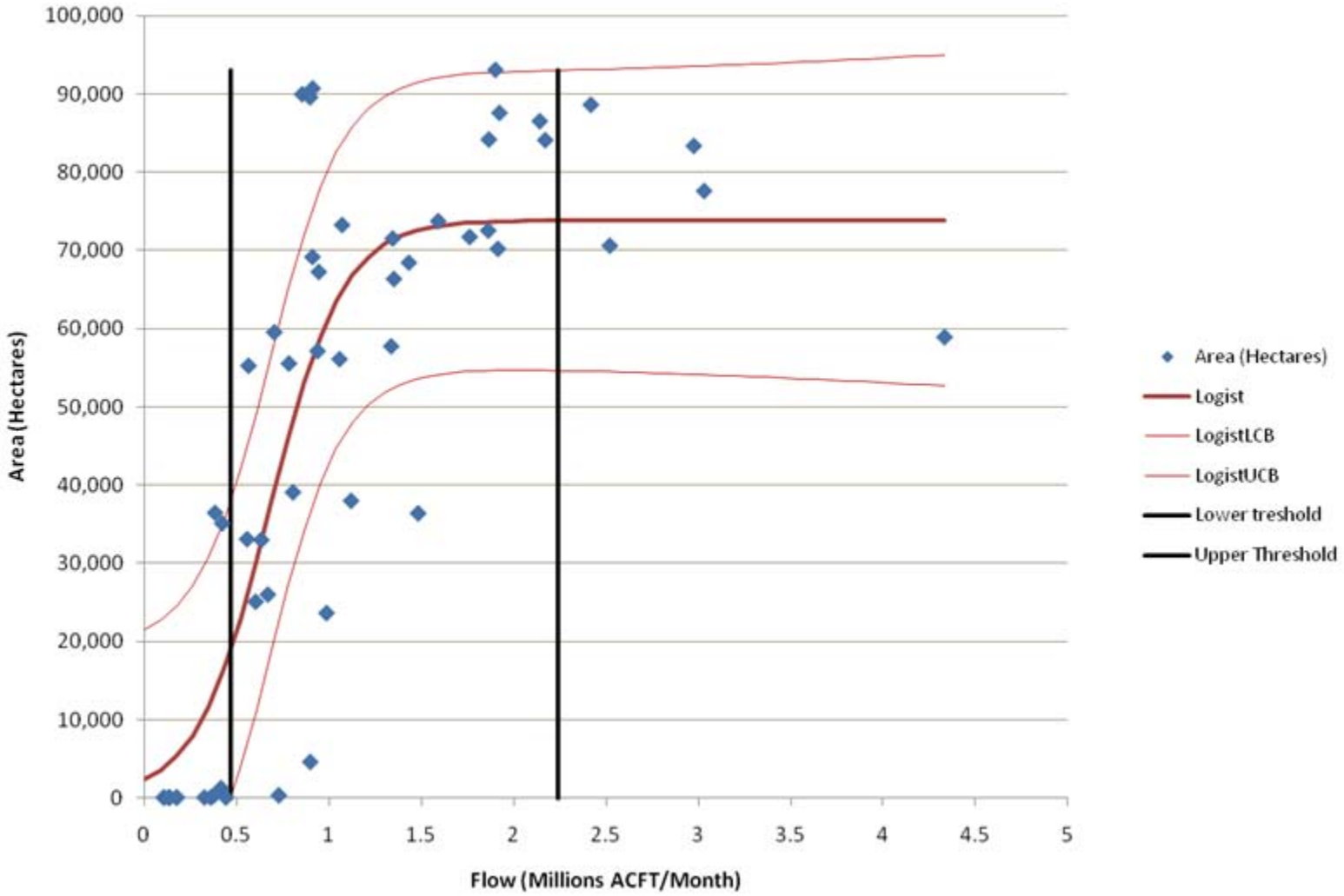


Recommendations of seasonal monthly flows and periodicities for the coastal streams.

Season	Spring	Summer	Fall	Winter
Flow (ac-ft/mo)	455,000	196,000	244,000	
Periodicity	1 of 3 months	2 of 3	1 of 3	
Historical Annual Occurrence	17 of 23	7 of 23	6 of 23	
Recommended Annual Frequency	1 in 2	1 in 4	1 in 4	

Criteria: Spring and Fall- Rangia larval survival, 2 =- 10 psu; Summer- oyster predation and parasitism, 10 – 20 psu.

Regression analysis of winter flows following high salinity conditions and the area of Gulf menhaden habitat in suitable salinity conditions (5 - 15 psu).
Recommended flow from all sources is 469,000 ac-ft in one winter month.



Flood Flow Recommendation

- The health of the oyster population can be enhanced by periodic flood events.
  - Two week period
  - Salinity below 5 psu
- Significantly reduce the level of infection by *Perkinsus* (Dermo) (LaPeyrie et al 2009).
- High flow event should occur at least once per decade.

Trinity

Season	Spring	Summer	Fall	Winter
Flow	742000	205000	141000	253000
Periodicity within season	1 of 3 mo.	2 of 3 mo.	2 of 3 mo.	1 of 3 mo.
Periodicity among seasons	1 in 2 yrs.	1 in 2 yrs.	1 in 3 yrs.	1 in 2 yrs.

San Jacinto

Season	Spring	Summer	Fall	Winter
Flow	302000	257000	250000	131000
Periodicity within season	1 of 3 mo.	2 of 3 mo.	1 of 3 mo.	1 of 3 mo.
Periodicity among seasons	1 in 2 yrs.	1 in 5 yrs.	1 in 2 yrs.	1 in 2 yrs.

Coastal Streams

Season	Spring	Summer	Fall	Winter
Flow	455000	196000	244000	84000
Periodicity within season	1 of 3 mo.	2 of 3 mo.	1 of 3 mo.	1 of 3 mo.
Periodicity among seasons	1 in 2 yrs.	1 in 4 yrs.	1 in 4 yrs.	1 in 2 yrs.

Plus Decadal Flood

BBEST Members Endorsing Recommendations

- L. James Lester, Ph.D.
- Dave Buzan
- George Guillen, Ph.D.
- Robert McFarlane, Ph.D.
- Antonietta Quigg, Ph.D.
- Sammy Ray, Ph.D.
- Joe Trungale, P.E.
- Jarrett (Woody) O. Woodrow, Jr.

BBEST Members Not Endorsing Recommendations

- William H. Espey, Jr. Ph.D., P.E., D.WRE.
- Richard Browning, Ph.D.
- Alan Plummer, P.E.
- Woody Frossard
- Tony L. Smith, P.E.
- Mike Reedy, P.E.

Consolidated Comments on Freshwater Inflow Recommendations for Galveston Bay (Chapter 3)
These Comments Endorsed by: William H. Espey, Jr. Ph.D., P.E., D.WRE.; Richard Browning, Ph.D.; Alan Plummer, P.E.; Woody Frossard; Tony L. Smith, P.E.; Mike Reedy, P.E.

While the salinity - zonation approach holds a potentially viable method, the salinity - zonation approach as utilized in Chapter 3 has many limitations that unfortunately do not allow for the identification of freshwater inflow requirements that can be shown to be necessary to support a sound ecological environment for Galveston Bay in its entirety.
Answer: Best professional judgment of ecologists familiar with GB

discussion is warranted on the scientific rationale behind *vallisneria's identification as the single indicator of estuarine health for the Trinity River flows to Galveston Bay.*
Answer: Indicator organisms are representative of a larger community

While sessile organisms were preliminarily selected for their utility in identifying freshwater inflow targets, the Trinity - San Jacinto BBEST B&E Subcommittee indicated it is necessary to ensure these results work within the context of the needs of the remaining indicator organisms identified by the subcommittee. As no such work has been performed, the assertion that the flows incorporated within the proposed recommendation are necessary for a sound ecological environment should be limited to only those organisms studied (i.e. *vallisneria, Rangia, and oyster), and not suggested as representing a healthy Galveston Bay ecosystem in its entirety.*

Answer: Best professional judgment of ecologists is that characteristic ecology will be maintained by recommended flows.

GBFIG has recommended a schedule of targets, shown in Table 4, which includes meeting the maximum productivity target in at least 50% of future years. The RHWPG has endorsed GBFIG's recommendation

Answer: GBFIG recommendations are a possible alternative, but they are not "best available science." The salinity – ecology relationships are flawed and not supported by the TPWD monitoring database.

Conclusions

- Better data and analyses should be developed in the future for this decision process, but they are not currently available.
- The recommendations in the BBEST report are based on the best professional judgment of scientists with extensive knowledge of Galveston Bay ecology.
- The resultant flow regime should maintain the current ecological status of Galveston Bay and meet the mandate of SB3.