

# INSTREAM FLOWS RESEARCH AND VALIDATION METHODOLOGY FRAMEWORK AND BRAZOS ESTUARY CHARACTERIZATION

## BRAZOS RIVER AND ASSOCIATED BAY AND ESTUARY SYSTEM

OCTOBER 1, 2015  
BRAZOS BBASC



# OVERVIEW

- Project goals:
  - To enhance the understanding of flow-ecology relationships in the Brazos River basin
  - To better describe baseline ecological conditions in the Brazos estuary
  - To initiate the process for developing a methodology for testing established flow standards
- A key focus is how pulse flows affect the ecology in the rivers and estuary

# OVERVIEW

- Project Development Science Workshops
  - July and October 2014
  - Hypothesis development and Indicator selection
  - Site selection and methodologies
- Preliminary field work and observations
  - July through September 2014
- Environmental Flows Validation Project Study Methodologies Interim Report
  - Submitted to TWDB in November 2014

## ENVIRONMENTAL FLOWS VALIDATION PROJECT STUDY METHODOLOGIES INTERIM REPORT

November, 2014



**Prepared for:**

Texas Water Development Board  
1700 North Congress Avenue  
Austin, Texas 78711

**Prepared by:**

BIO-WEST, Inc.  
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Texas State University  
University of Houston – Clear Lake

# ECOLOGICAL COMPONENTS

- Aquatic
- Fish Recruitment
  - (Otoliths)
- Riparian
- Brazos Estuary



# ENVIRONMENTAL FLOWS VALIDATION METHODOLOGY

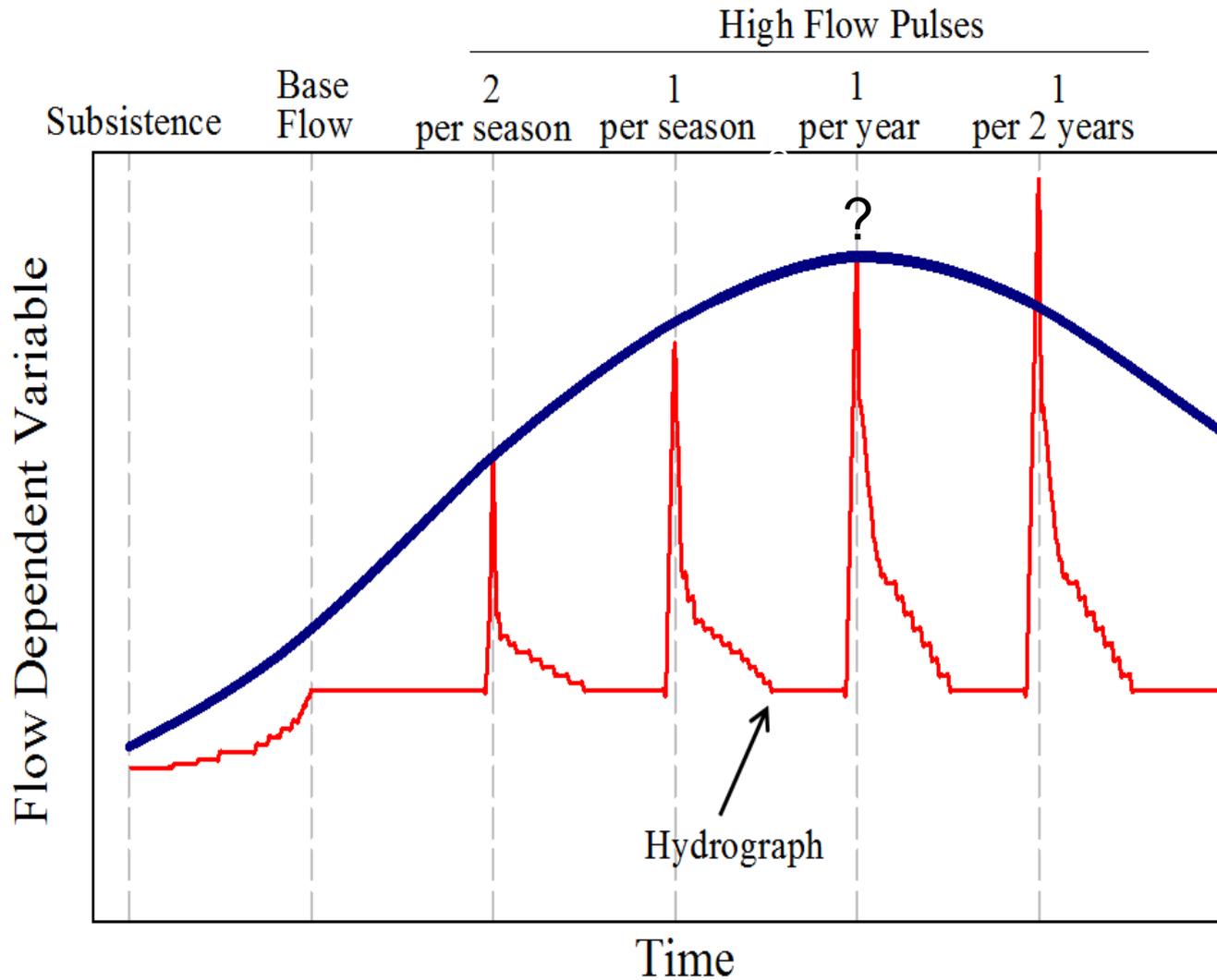
- Two main objectives
  - To inform and refine validation methodologies with the goal of having a scientifically defensible approach for testing TCEQ environmental flow standards.
  - To provide the Brazos BBASC with information on how application of these methodologies might validate or suggest refinement for existing TCEQ flow standards at select Brazos basin sites.

# **SAMPLING ACTIVITIES AND RESULTS**

## **AQUATICS**

- Timothy Bonner

# PREDICTIONS





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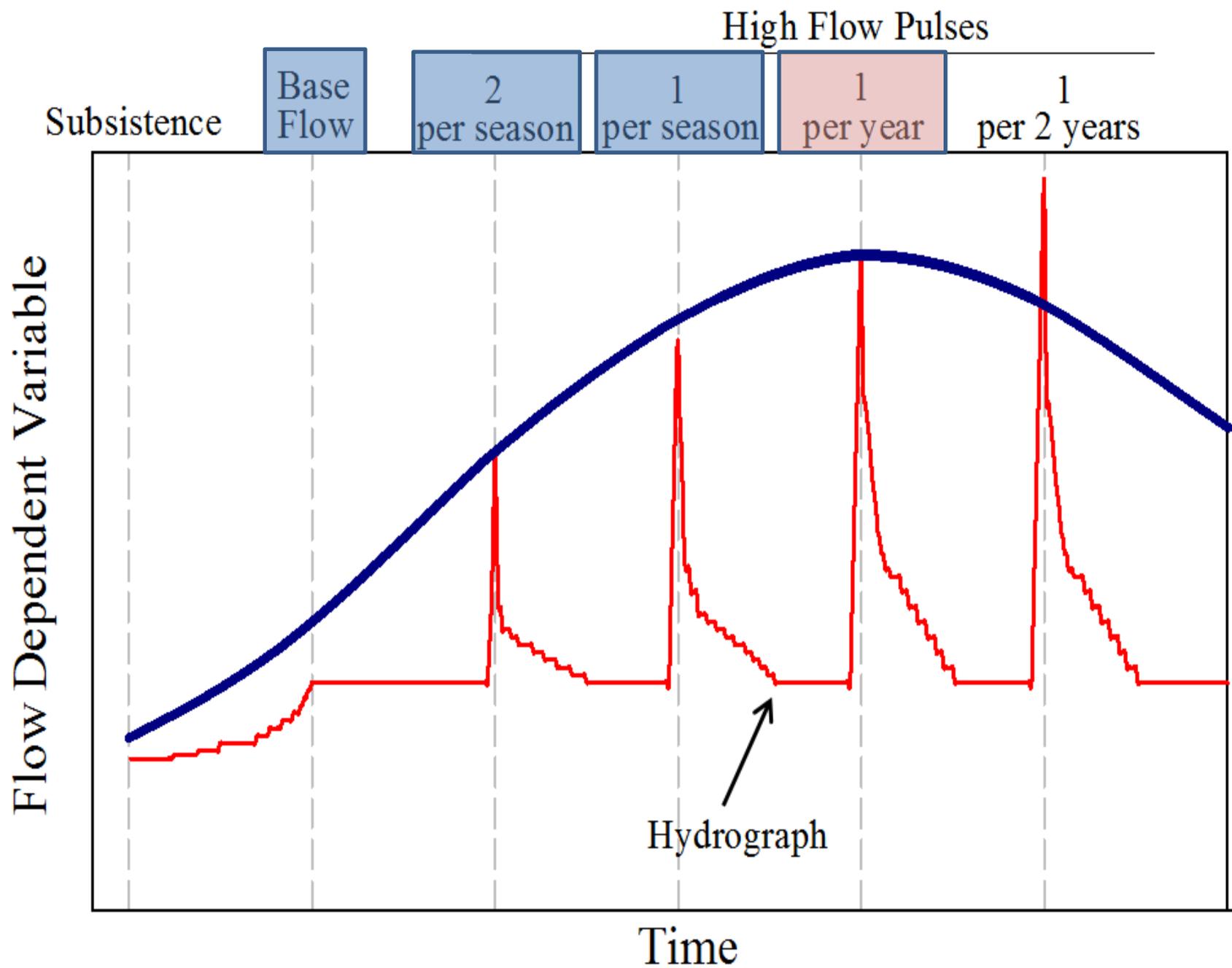


Basin	Season	Flow Tier	Science	Stakeholder	TCEQ
Brazos	Summer	S	X	X	X
	Winter	B	X	X	X
	Spring	4/S	X	X*	X**
		3/S	X	X	X
		2/S	X		
		1/S	X		
		1/Y	X		
		1/2Y	X		
		1/5Y	X		
Guadalupe	Summer	S	X	X	X
	Fall	B	X	X	X
	Winter	2/S	X	X	X
	Spring	1/S	X	X	X
		1/Y	X	X	
		1/2Y	X	X	
		1/5Y	X	X	
San Antonio	Summer	S	X	X	X
	Fall	B	X	X	X
	Winter	2/S	X	X*	X**
	Spring	1/S	X	X*	X**
		1/Y	X	X*	**
		1/2Y	X	X	
		1/5Y	X	X	

# SUMMARY STATS

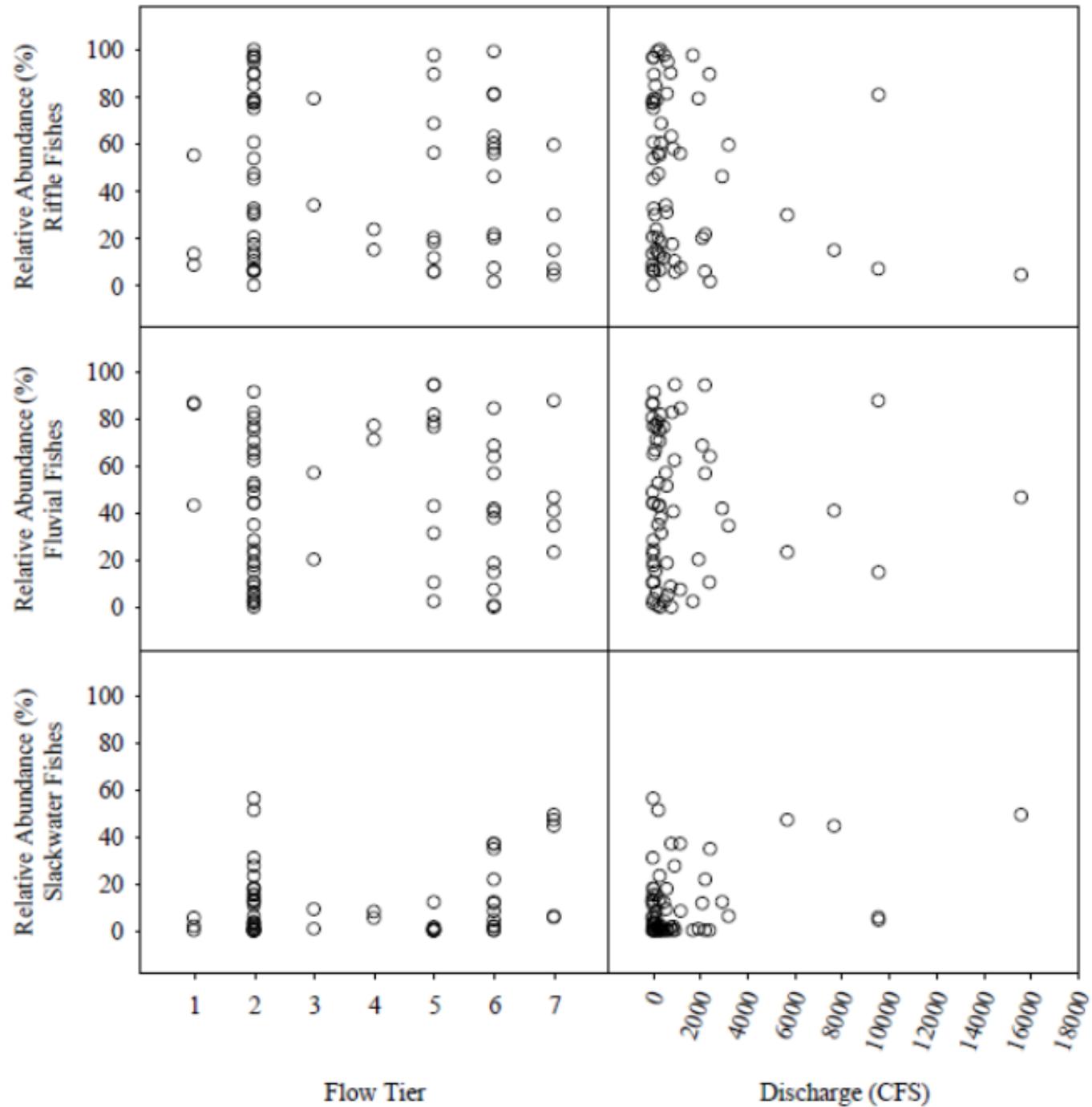
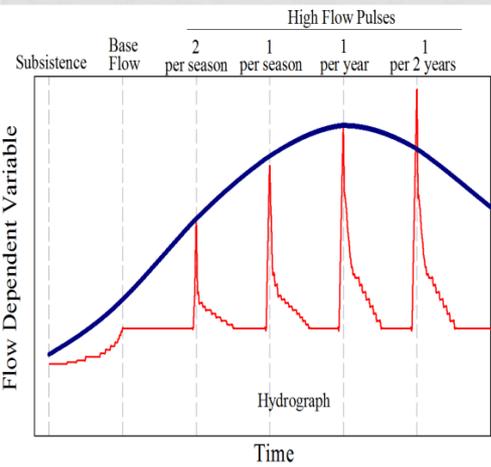
- 63 riffle habitats, 74 run habitats
- 51,000 macroinvertebrates
- 21,000 fishes

<u>Tier</u>	<u>N</u>
Subsistence	3
Base	30
4 / season	2
3 / season	2
2 / season	9
1 / season	12
1 / year	5

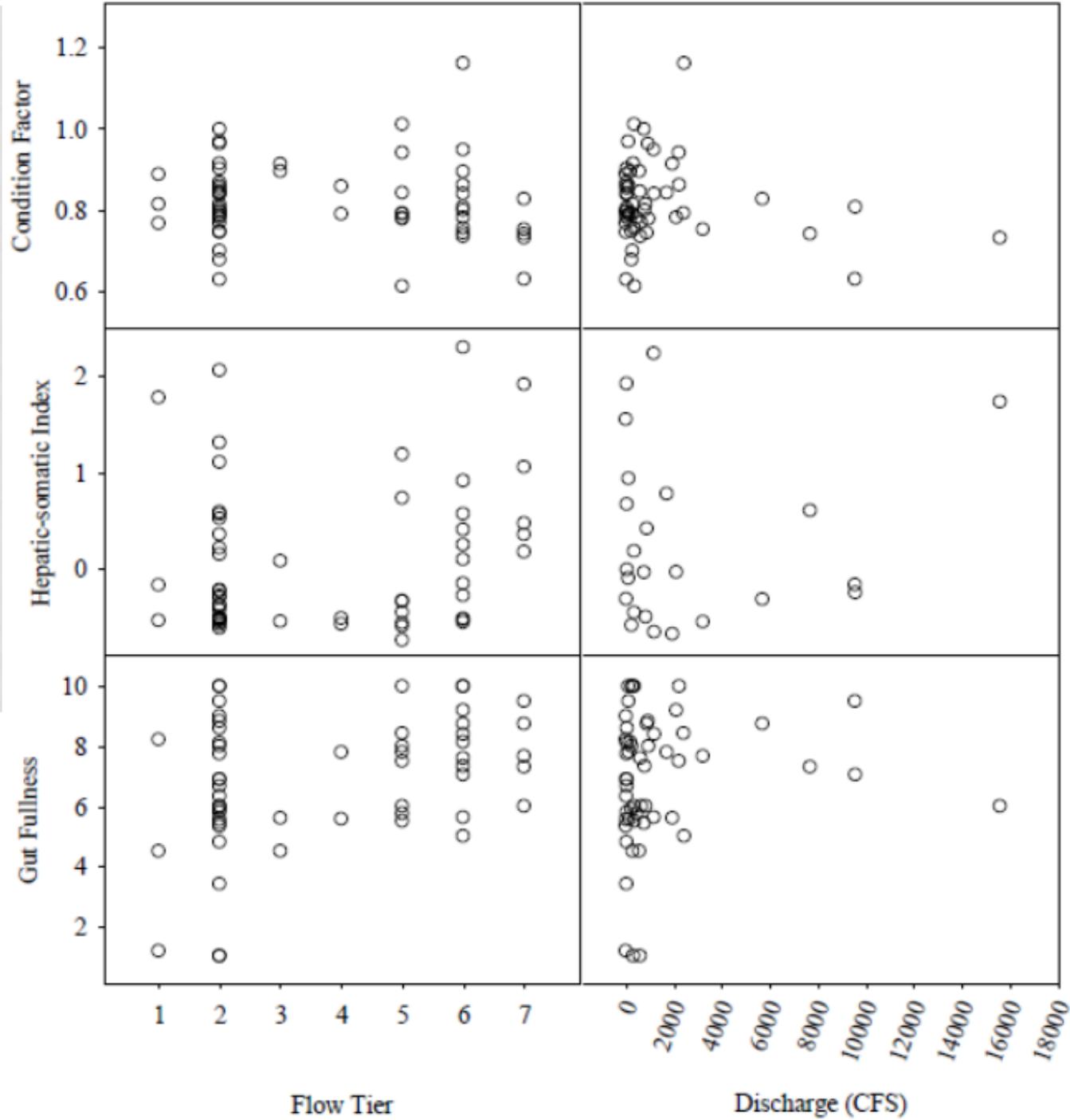
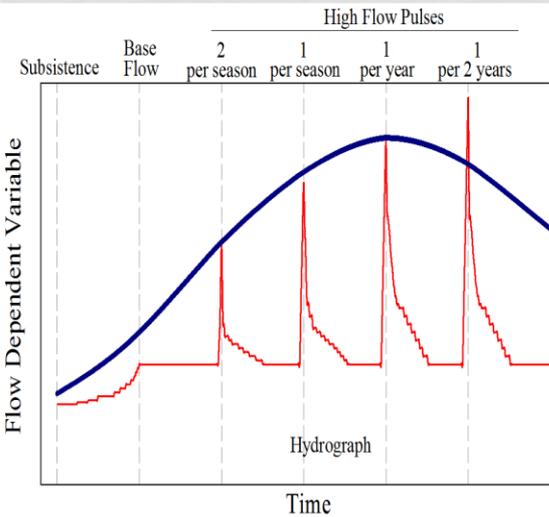




# Parameter vs. Flow Tier And Discharge



# Parameter vs. Flow Tier And Discharge

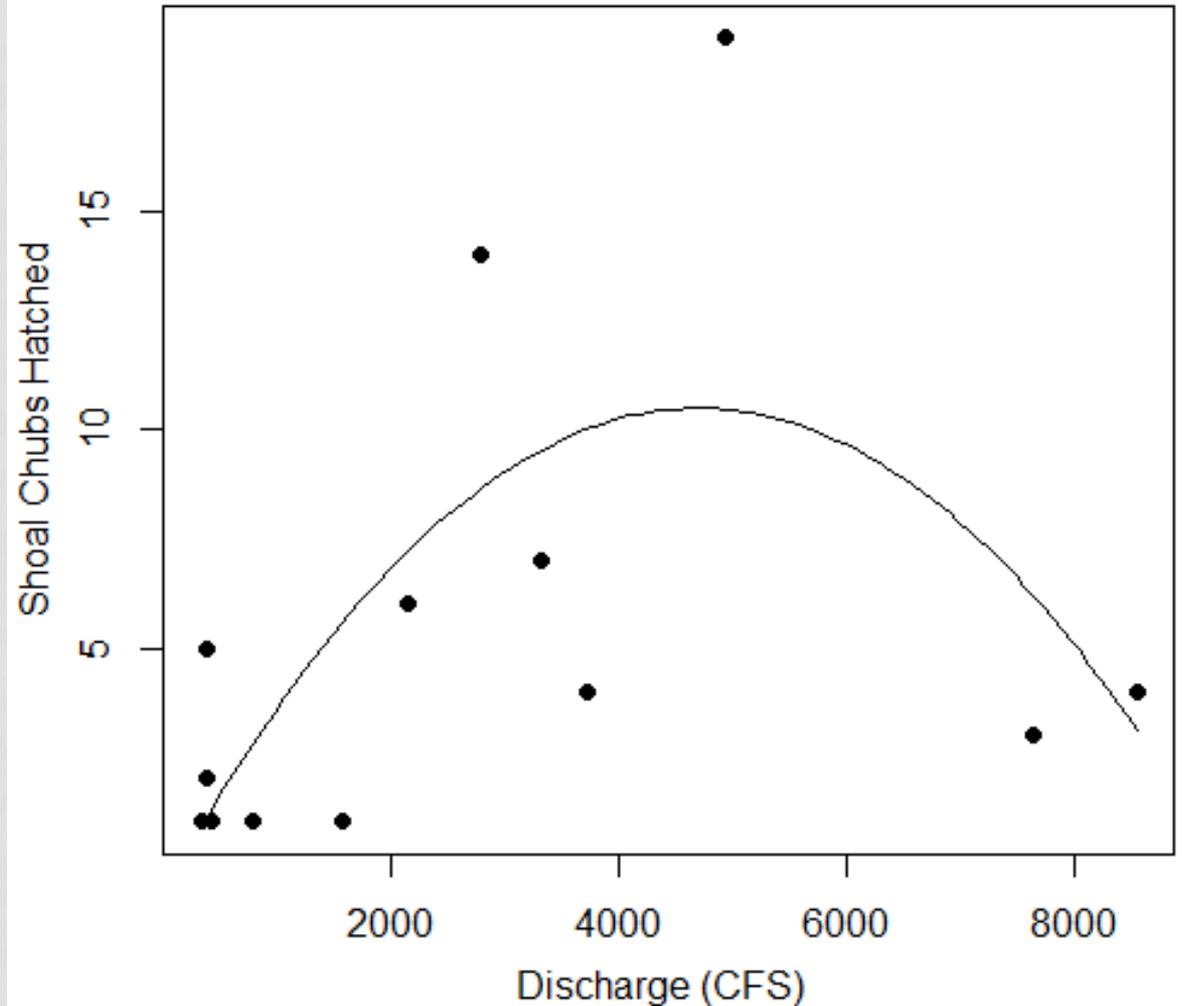


# CONCLUSIONS SO FAR...

- Among base, 2/season, 1/season, and 1/year events...
- Among 58 abiotic and biotic predictions tested...
  - ↑ Flow tiers    ↑ slackwater fishes
    - Opposite of predicted, but not too surprising
  - ↑ Flow tiers    ↓ N of darters
    - Opposite of predicted, surprising
- “Failure to detect a difference doesn’t mean a difference doesn’t exist” - MORE LATER

# DAILY OTOLITH AGING

- Our best current assessment is that flow pulses of moderate magnitude promote highest recruitment of Shoal Chubs in the lower Brazos River.



# **SAMPLING ACTIVITIES AND RESULTS**

## **RIPARIAN**

- Jacquelyn Duke

# RIPARIAN STUDY HYPOTHESES

## Riparian responses to flow:

- Seedlings

- Distributions correlate with TCEQ /BBEST flows
- Distributions correlate with *actual* flows
- Survival correlates with flows

- Saplings

- Distributions correlate with TCEQ /BBEST flows
- Distributions correlate with *actual* flows
- Survival correlates with flows

- Mature trees

- Distributions reflect TCEQ/BBEST flow coverage (80% or more)

- Community

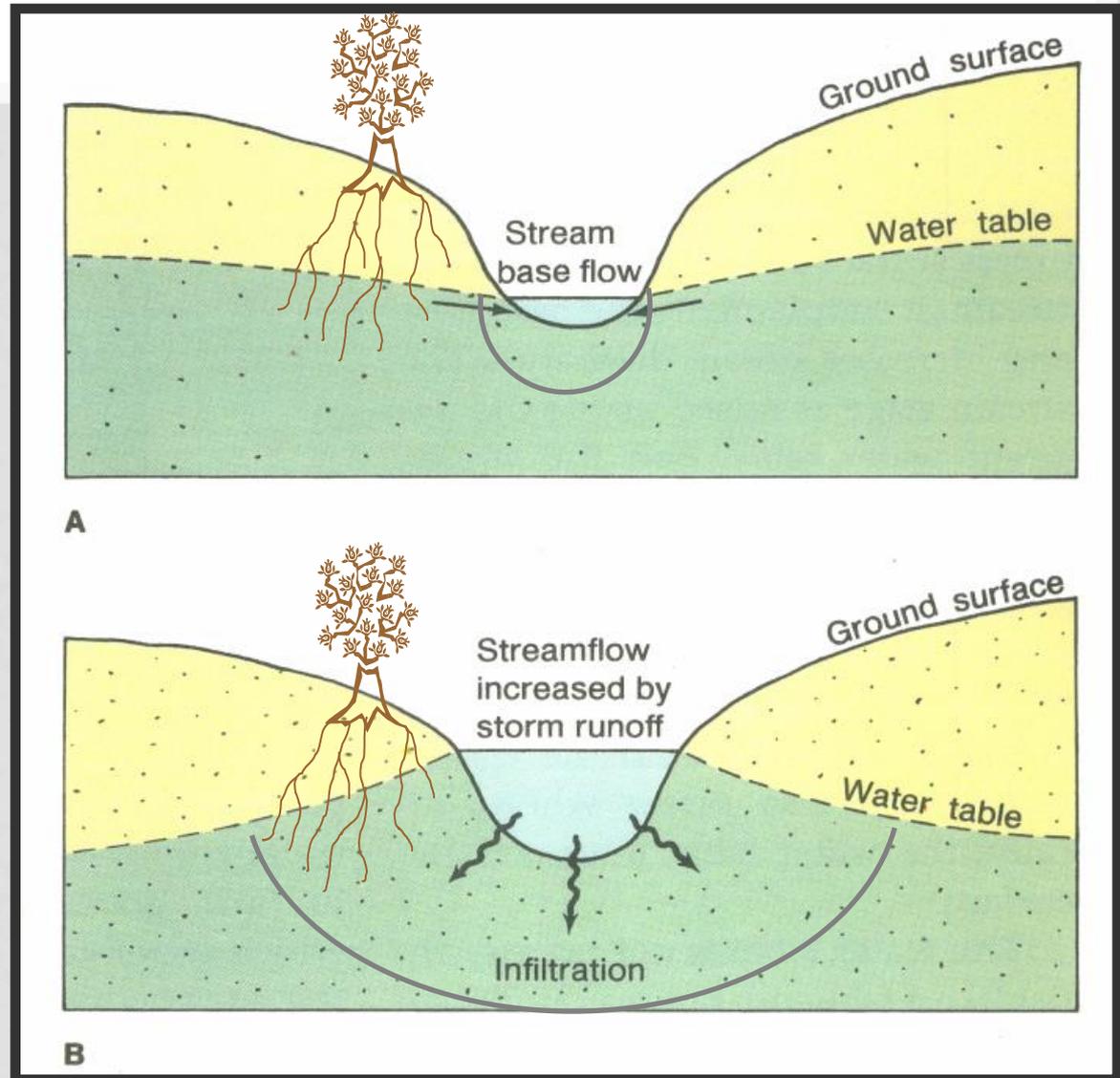
- Relative abundance reflects riparian dominance
- Age distributions detect the effect of major anomalies in flow



# HYPORRHEIC ZONE

- A – Low-flow conditions, little discharge to hyporheic zone
- B – Increased flow, expansion of hyporheic zone

Water stress is limiting factor to tree growth (Spurr and Barnes, 1980)



# INDICATOR SPECIES

- Black Willow (*Salix nigra*)
  - Seed deposition early spring through summer
- Box Elder (*Acer negundo*)
  - Fall/overwinter
- Green Ash (*Fraxinus pennsylvanica*)
  - Spring and Fall/overwinter



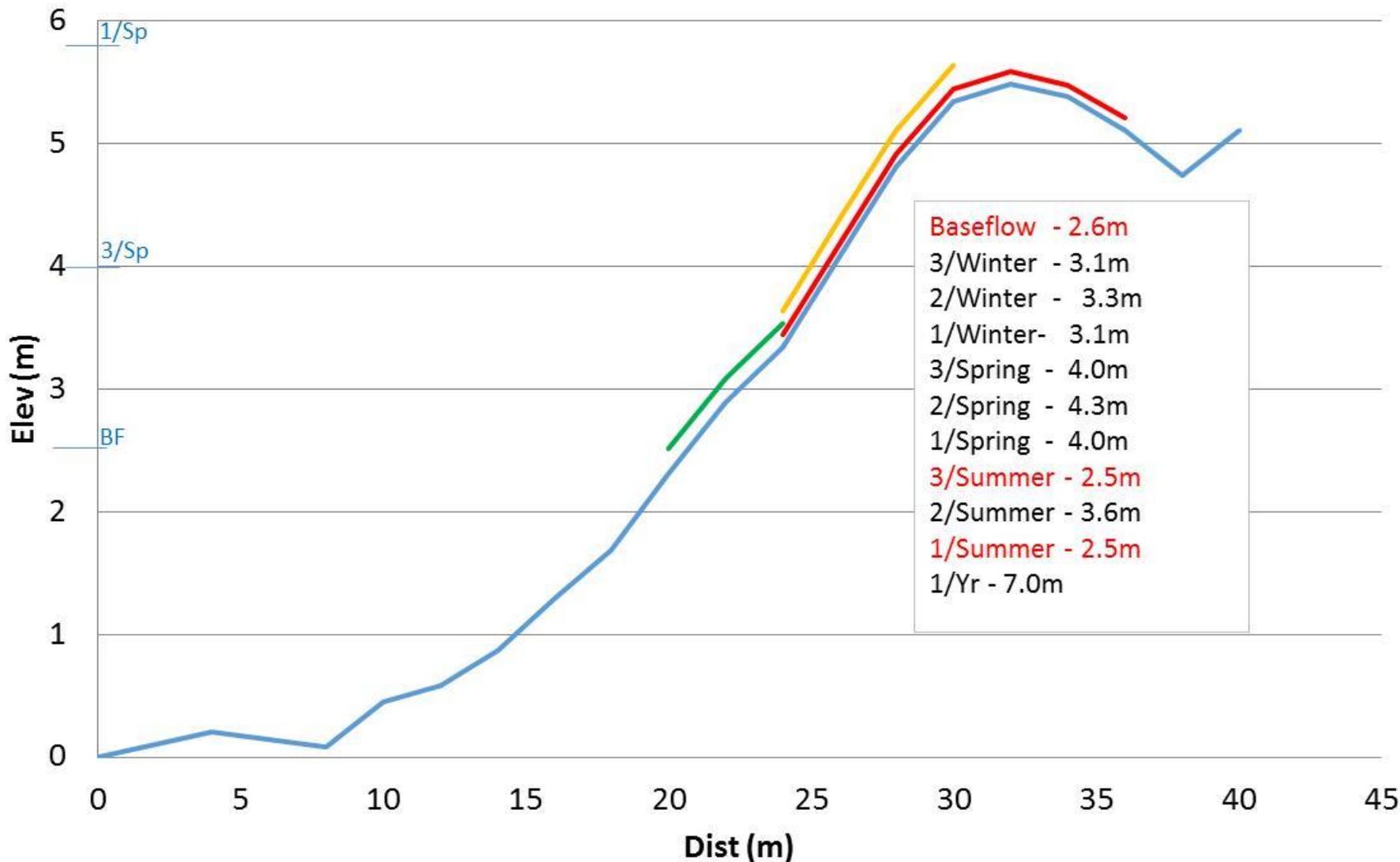
Credit: ncwildlife.org

# SAMPLING EVENTS

- Summer 2014
  - Scouting, establishment, equipment installation, first counts taken, sapling collections, community characterization
- Fall 2014
  - Counts, download data, sapling collections, tree coring
- (Winter 2014)
  - Download data, map elevations
- Spring 2015
  - Counts, download data, tree coring, sapling collections
- Summer 2015
  - Counts, download data, community characterization, equipment removal

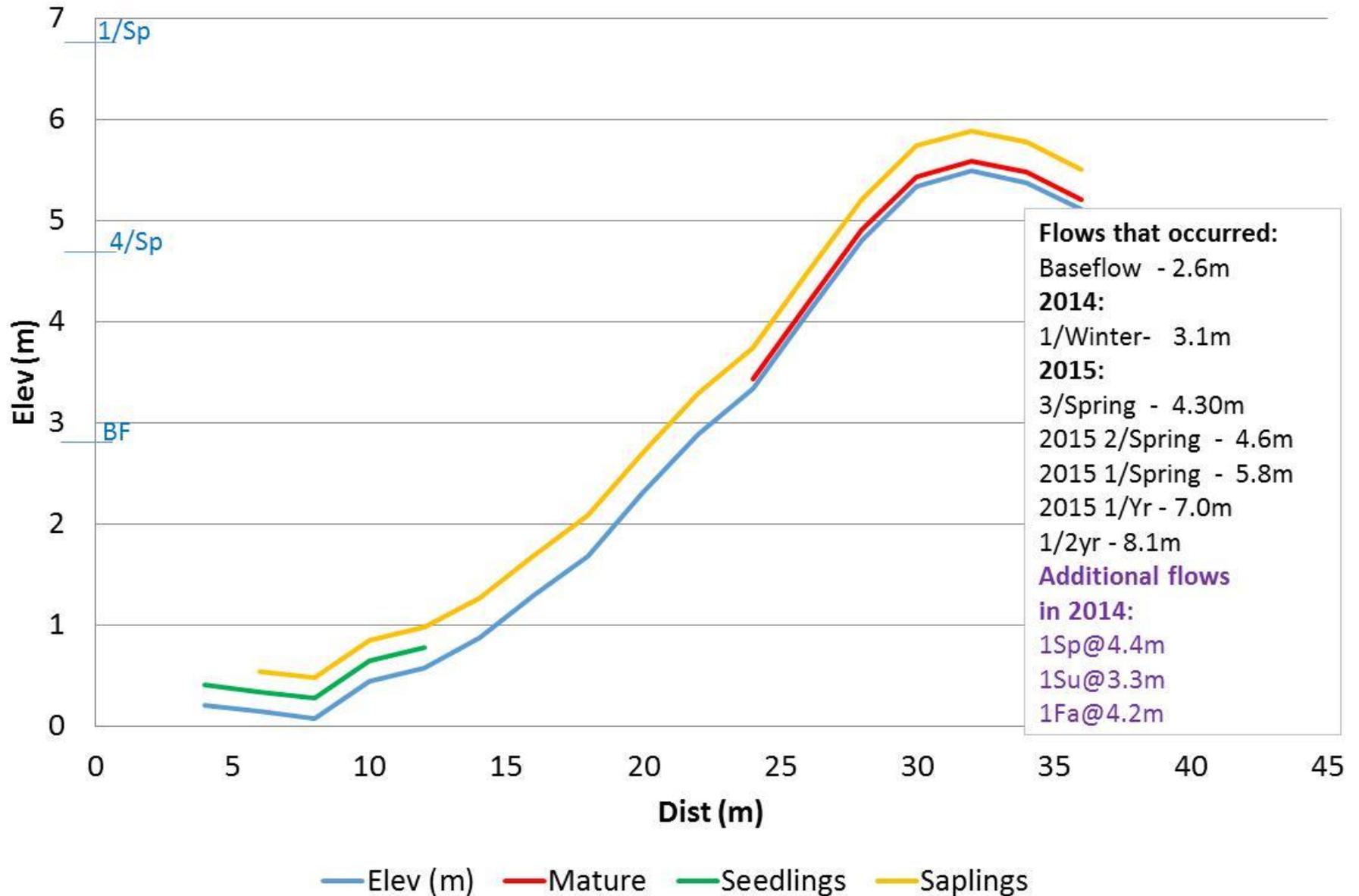


# Hearne (BR at Bryan)

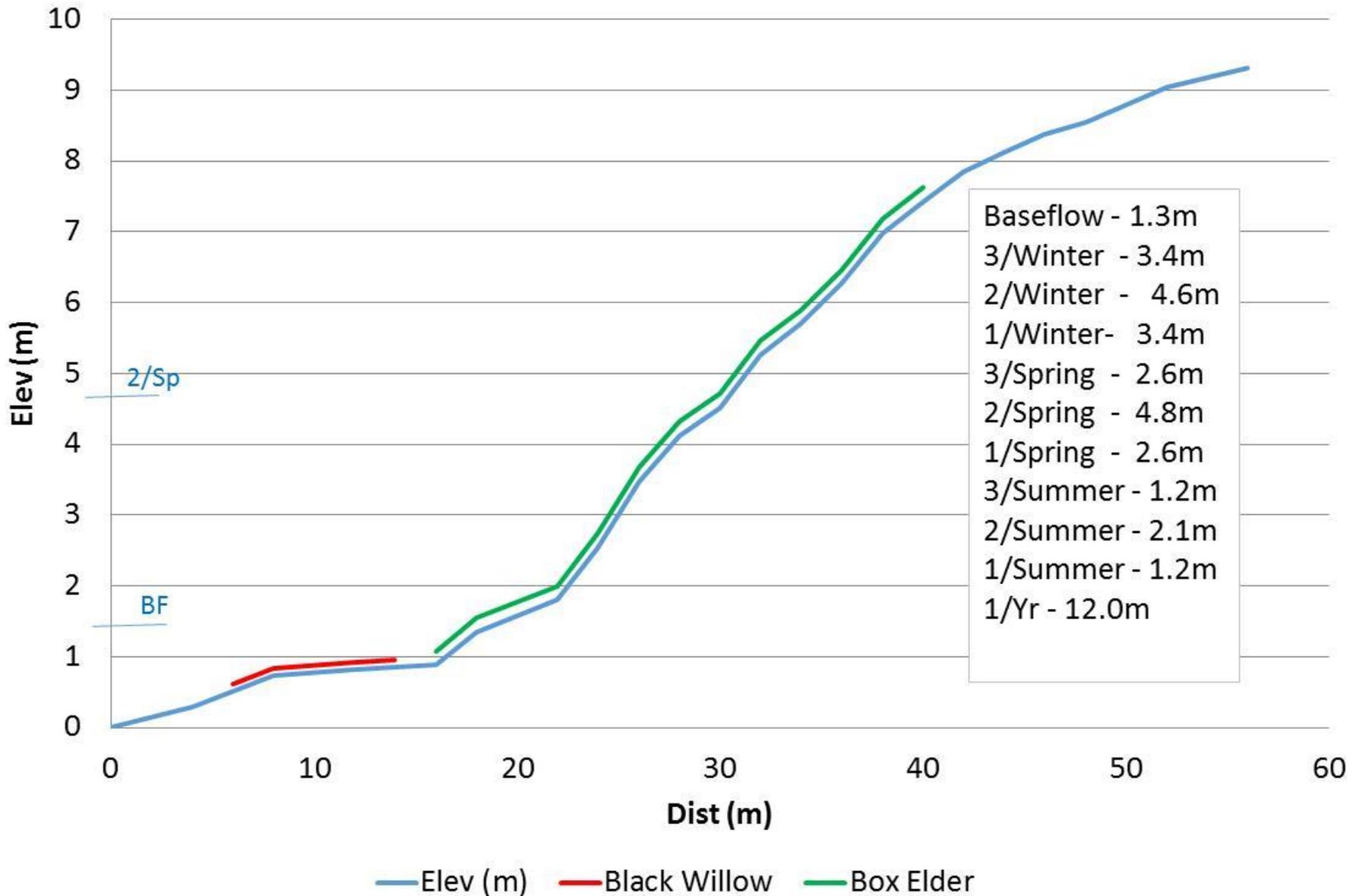


— Elev (m)    — Black Willow    — Box Elder    — Green Ash

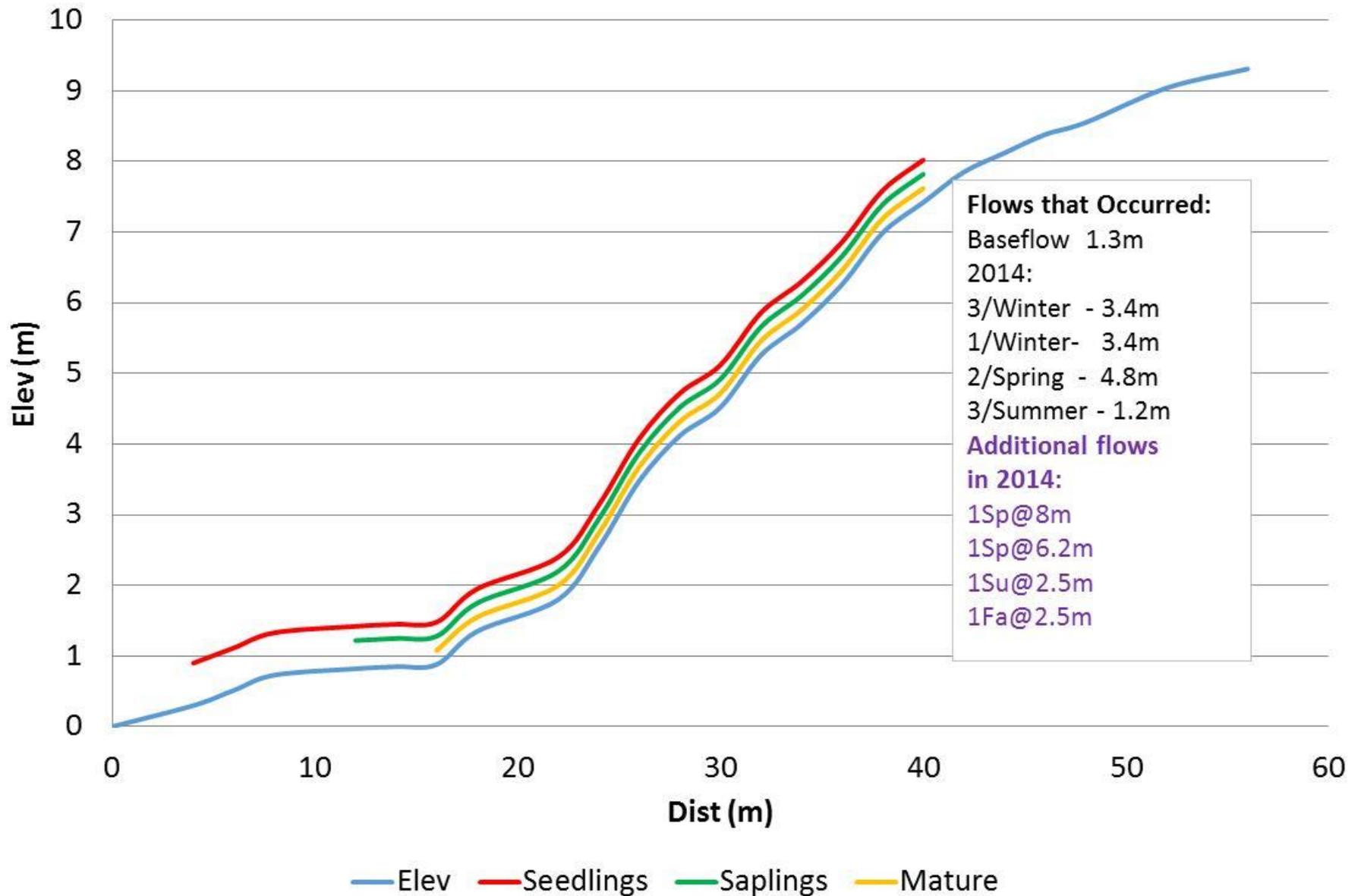
# Hearne Black Willow Seedlings and Saplings



# Brazos Bend (BR near Rosharon)



## Box Elder Seedling and Sapling Distribution



# SUMMARY OF RESULTS

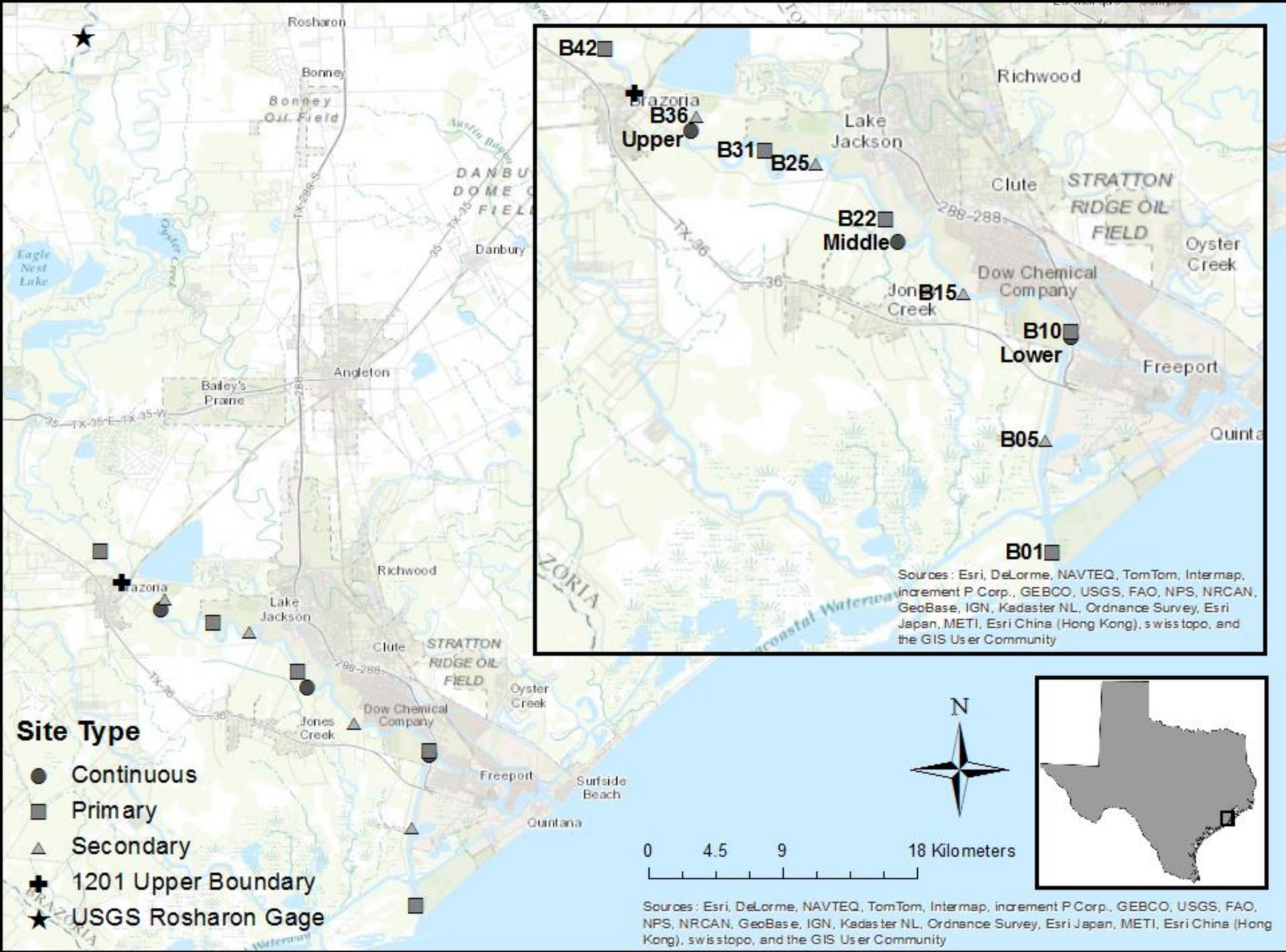
<b>Flow Tiers</b>	<b>Number of All Species Covered* by</b>	<b>Number of Species at the Highest Elev Covered* by</b>	<b>Number That Occurred in 2014</b>
BF	1/13	0/5	5/5
3/W	1/13	0/5	2/5
2/W	2/13	0/5	3/5
1/W	1/13	0/5	2/5
3/Sp	2/13	0/5	3/5
2/Sp	4/13	0/5	1/5
1/Sp	2/13	0/5	1/5
3Su	1/13	0/5	1/5
2/Su	2/13	0/5	1/5
1/Su	1/13	0/5	0/5
1/Yr	13/13	5/5	0/5

\* Inundation of 80% or more of the species' distribution

# **SAMPLING ACTIVITIES AND RESULTS**

## **BRAZOS ESTUARY**

- George Guillen



# WATER QUALITY (INSTANTANEOUS)

## In-situ Profiles

- Temperature
- Dissolved Oxygen
- Salinity
- pH
- Turbidity (NTU)



## Water Chemistry

- Chlorophyll-a
- Total Suspended Solids - TSS
- Total K Nitrogen - TKN
- Nitrate-Nitrite – N-NO<sub>2+3</sub>
- Total Phosphorous - TP



# WATER QUALITY (CONTINUOUS)

- Temperature
- Salinity
- Dissolved Oxygen

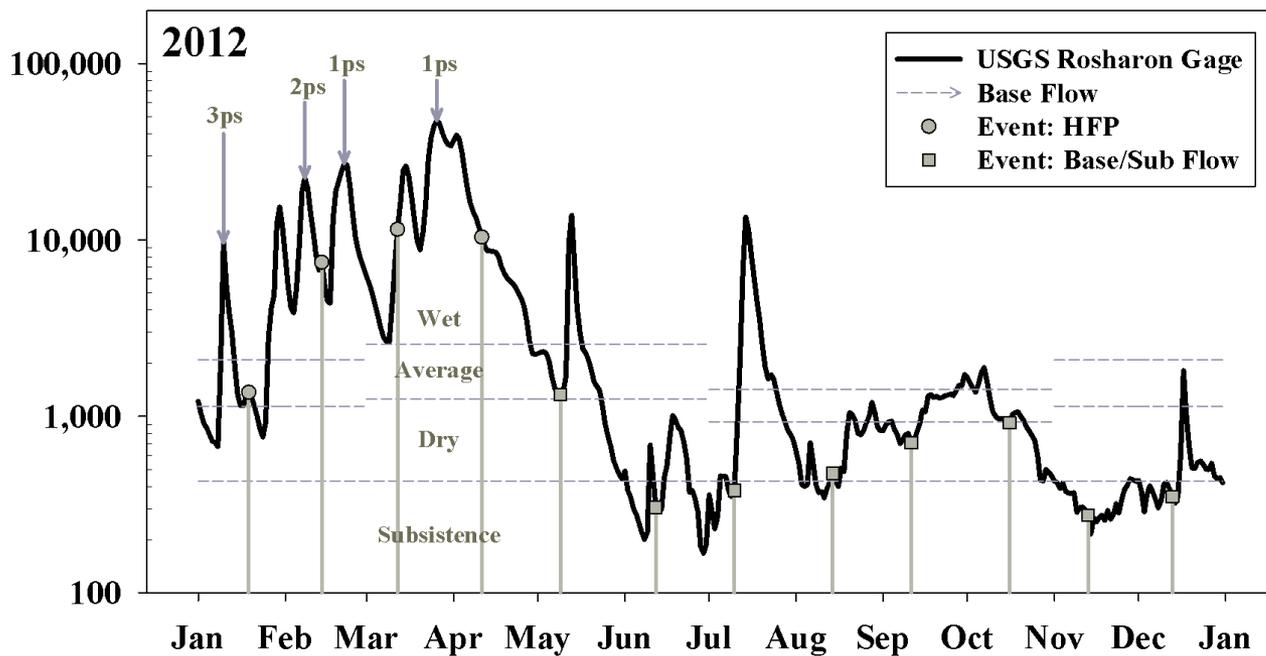
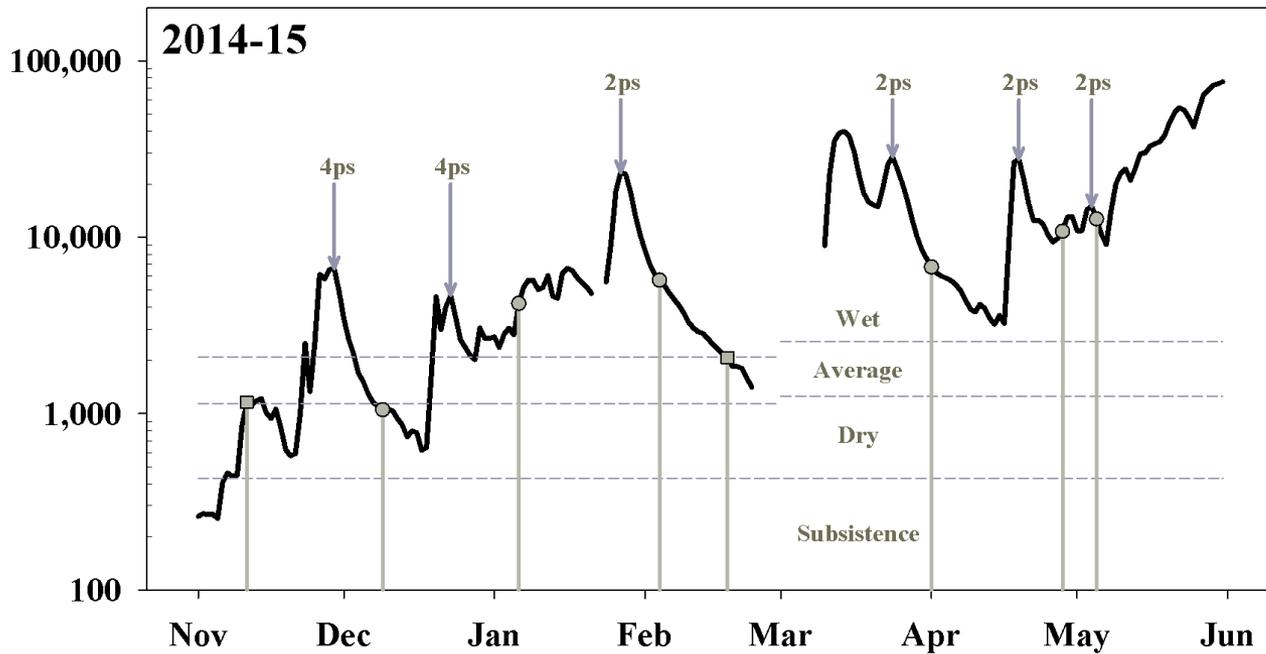


# NEKTON

- Otter Trawl
- Beam Trawl
- Electroshocking



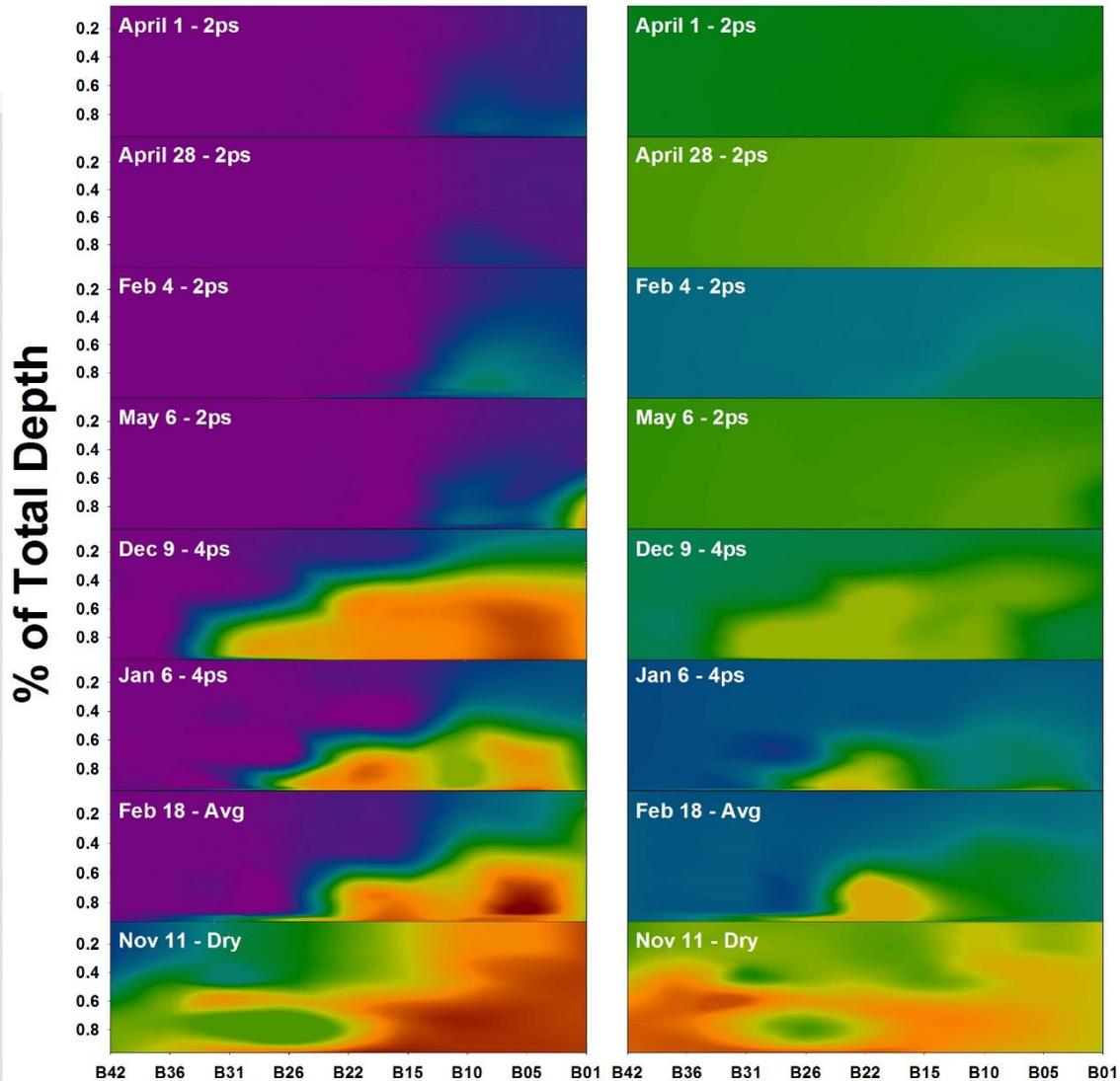
# Mean Daily Discharge (cfs)



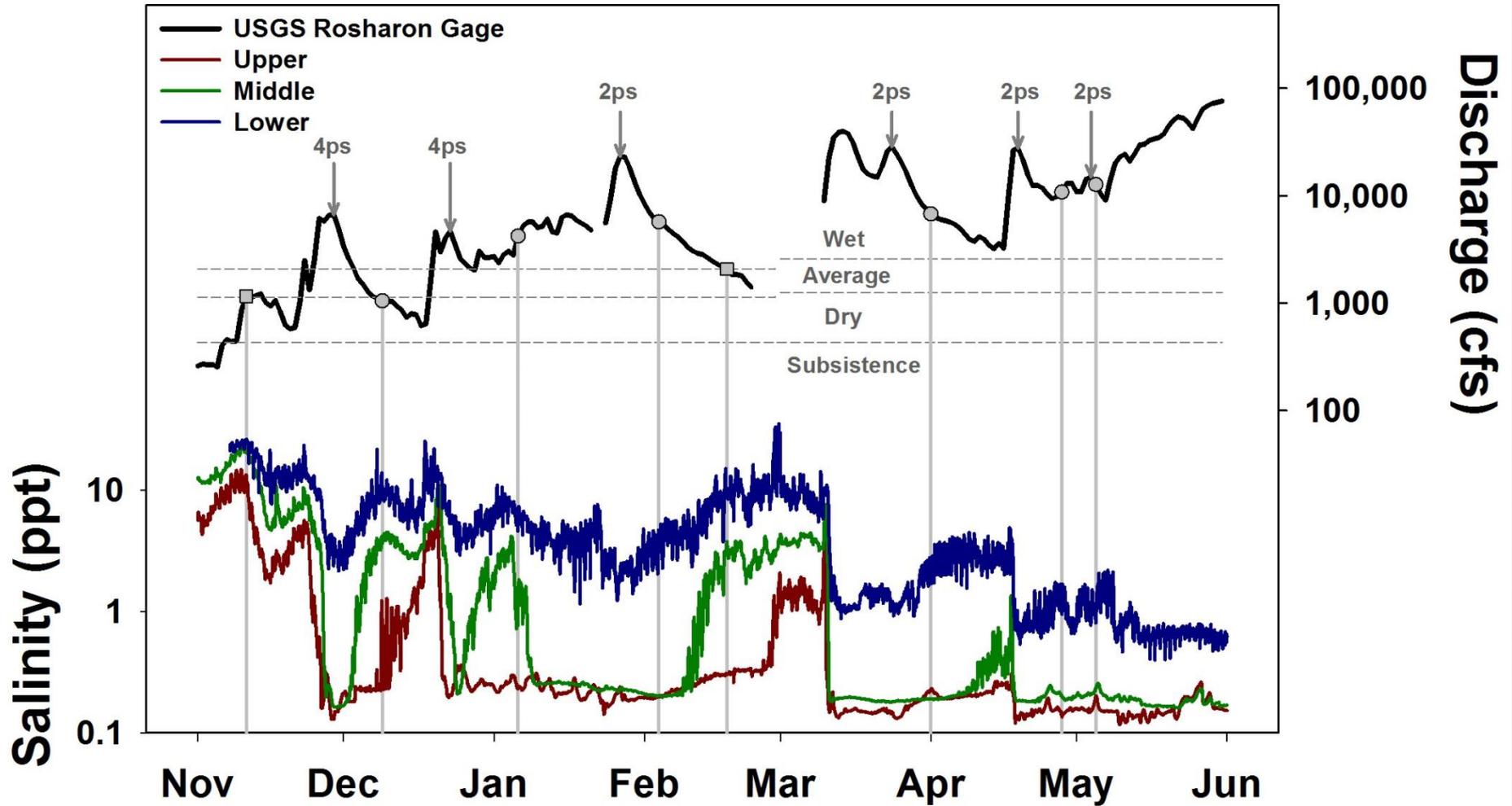
# WATER QUALITY

## Salinity (psu)

## Dissolved Oxygen (mg/L)



# WATER QUALITY (CONTINUOUS)



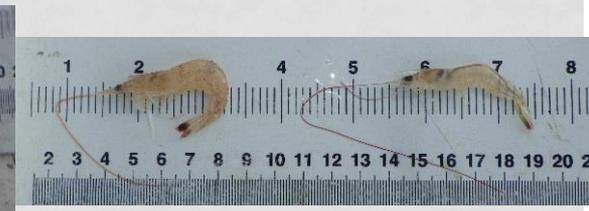
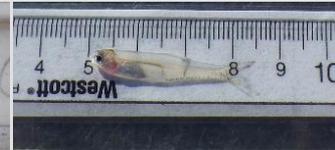
# NEKTON COMMUNITY COMPOSITION

## Upper Estuary

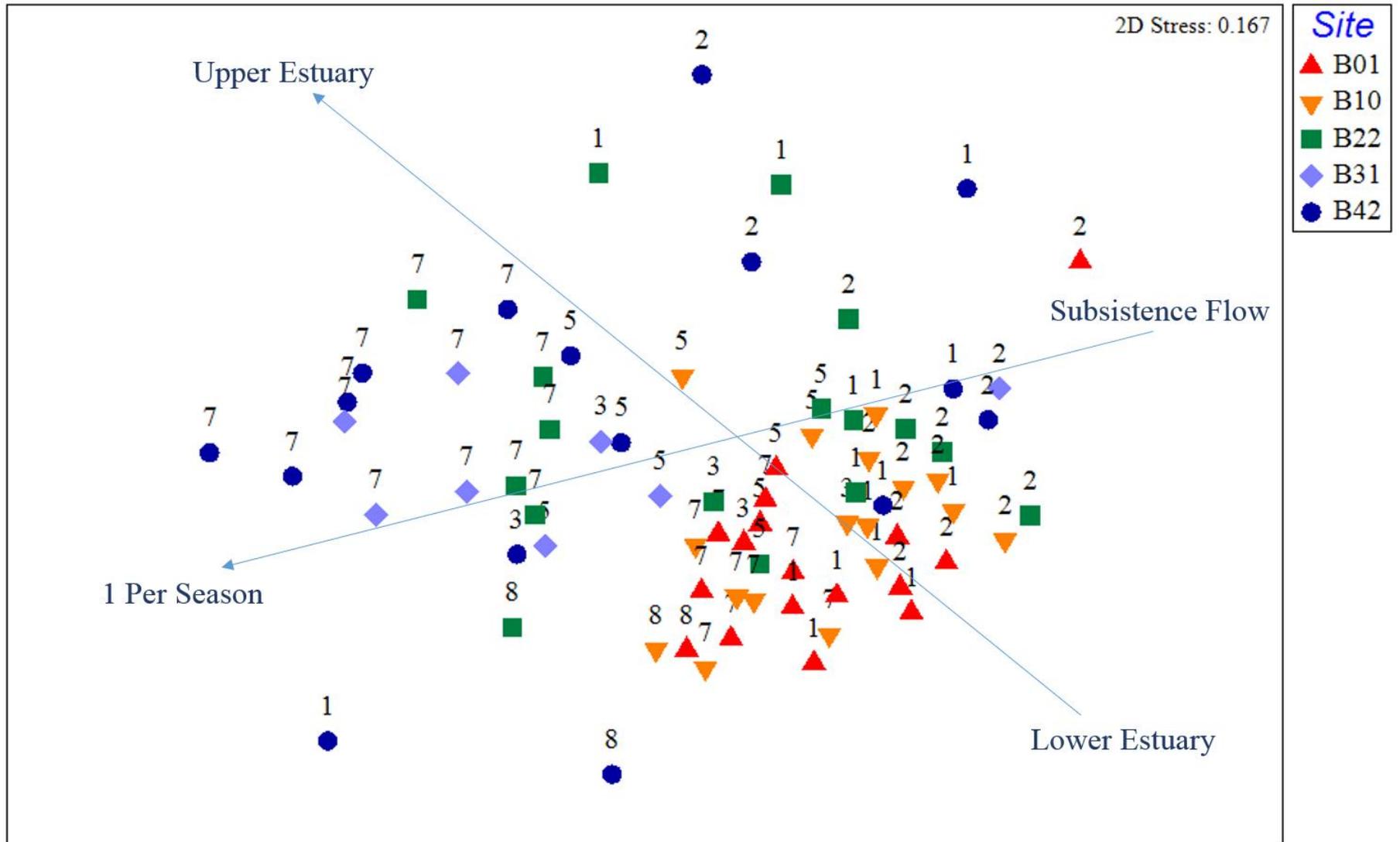
- Striped Mullet
- Atlantic Croaker
- Blue Catfish
- Ohio River Shrimp
- Bay Anchovy

## Lower Estuary

- Gulf Menhaden
- Atlantic Croaker
- Striped Mullet
- White Shrimp
- Bay Anchovy

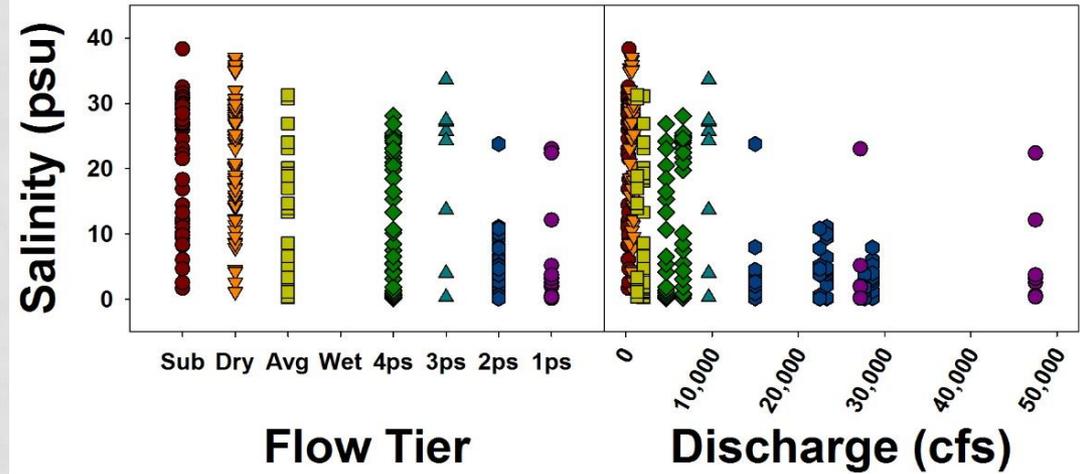
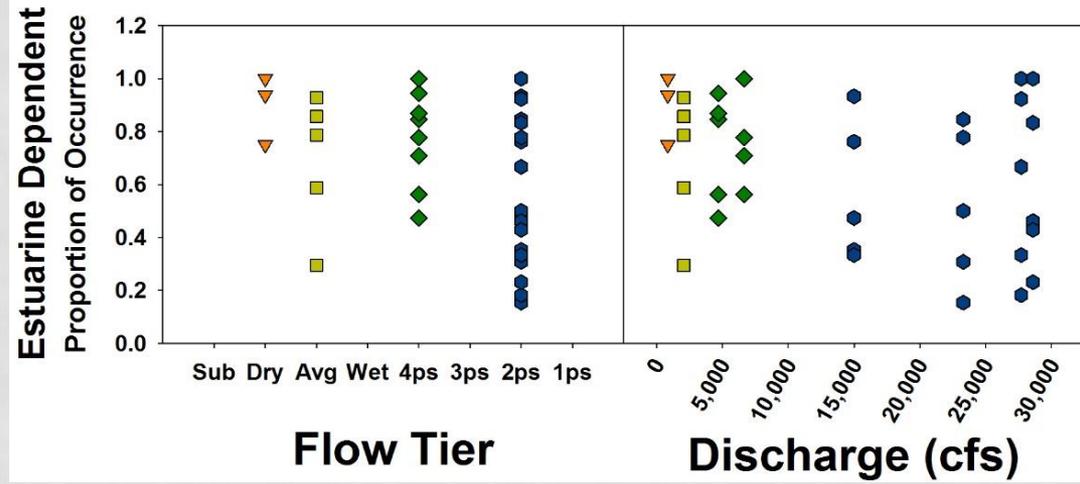
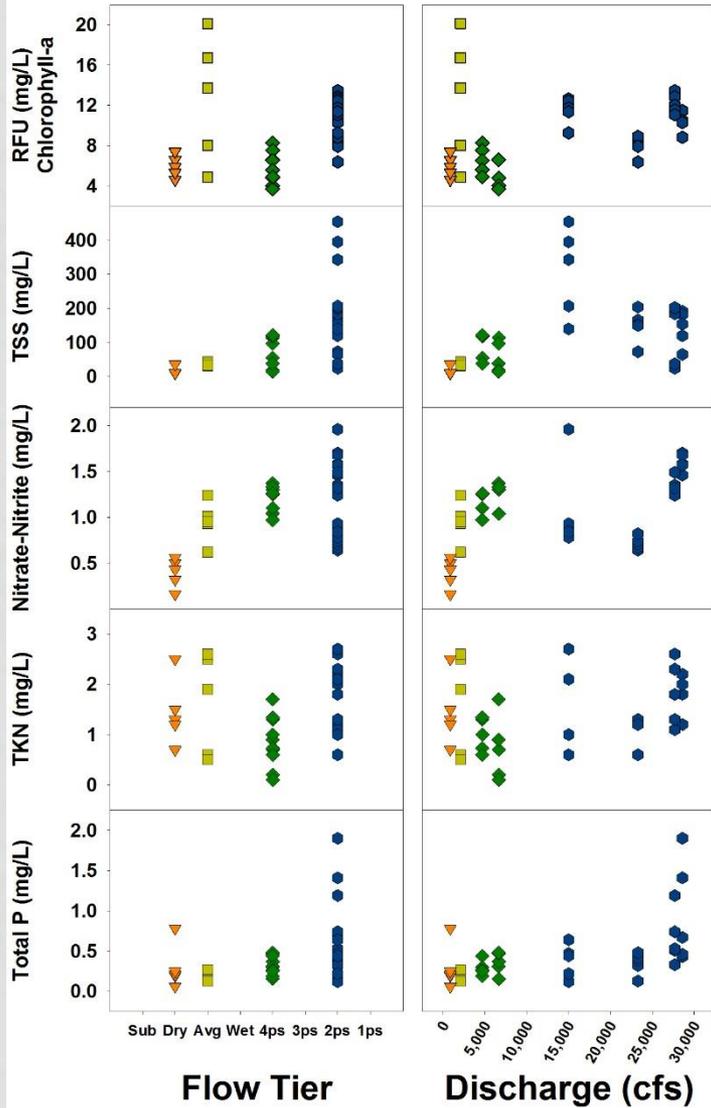


# NEKTON COMMUNITY COMPOSITION



# COMPARISON TO INSTREAM FLOW RECOMMENDATIONS

## Nutrients



# ESTUARY SUMMARY/CONCLUSIONS

- Broad-scale patterns in water quality and nekton responded predictably to instream flows.
- Maximum concentrations of TSS, nitrate-nitrite & TP occurred during 2/season flow pulses.
- Salinity levels primarily below 10 ppt around 15,000 cfs or 2/season.
- During Dry flow conditions maximum vertical stratification of salinity and dissolved oxygen occurred.
- Lowest (3.0 mg/L) bottom dissolved oxygen conditions occurred between river kilometer 42 and 22 during Dry Flow conditions.

# ESTUARY LESSONS LEARNED/DIFFICULTIES



- Most valuable data obtained when sampling as soon after the high flow pulse as possible
- Mother nature will always win: 3 months of 10,000+ cfs
- Data collection of this magnitude takes longer than expected
- Current study allows refinement of techniques and type of data collected



# PRELIMINARY STUDY CONCLUSIONS

- Aquatics

- Most aquatic hypotheses were “largely unsupported”
- “Failure to detect a difference doesn’t mean a difference doesn’t exist” - More data needed
- Daily otolith data suggests moderate pulses important for fluvial specialists

- Riparian

- Larger pulses are generally needed to support the existing riparian communities
- Timing also important

- Brazos Estuary

- Excellent first step of characterization
- Relationship to flow at Rosharon gage inconclusive due to limited sample sizes caused by Mother Nature

# ENVIRONMENTAL FLOWS

## PROPOSED VALIDATION METHODOLOGY

- Standardized approach
- Incorporates multiple ecological components
- Agreed upon upfront – BBASC and TCEQ
- Simplified field and desktop activities
- Tiered approach
  - Tier I – Floodplain Connectivity
  - Tier II – Riparian Assessment
  - Tier III – Aquatic Assessment
  - Tier IV - ???

# ENVIRONMENTAL FLOWS

## PROPOSED VALIDATION METHODOLOGY

- POTENTIAL APPLICATION
  - Tier I (based on literature) and Tier II can be conducted right now
    - Examples provided in Section 4.3
  - Tier III – premature to evaluate
  - Additional Tiers – to be developed via additional studies and expert workshops

# ENVIRONMENTAL FLOWS

## FUTURE RESEARCH AND MONITORING RECOMMENDATIONS – SECTION 5

- Applied Research
  - Each component with different focus
    - Instream
      - Aquatics – major emphasis
      - Riparian and Oxbows – more site specific as needed
      - New ecological instream components?
    - Brazos estuary
- Long-term Monitoring
  - Limited initiation for each component
- Expert Panel Workshops
  - To refine methodology

# QUESTIONS / COMMENTS?

- Acknowledgements
  - Landowners
  - BBASC
  - TWDB
  - TPWD and TCEQ
  - BBEST
  - Volunteers

