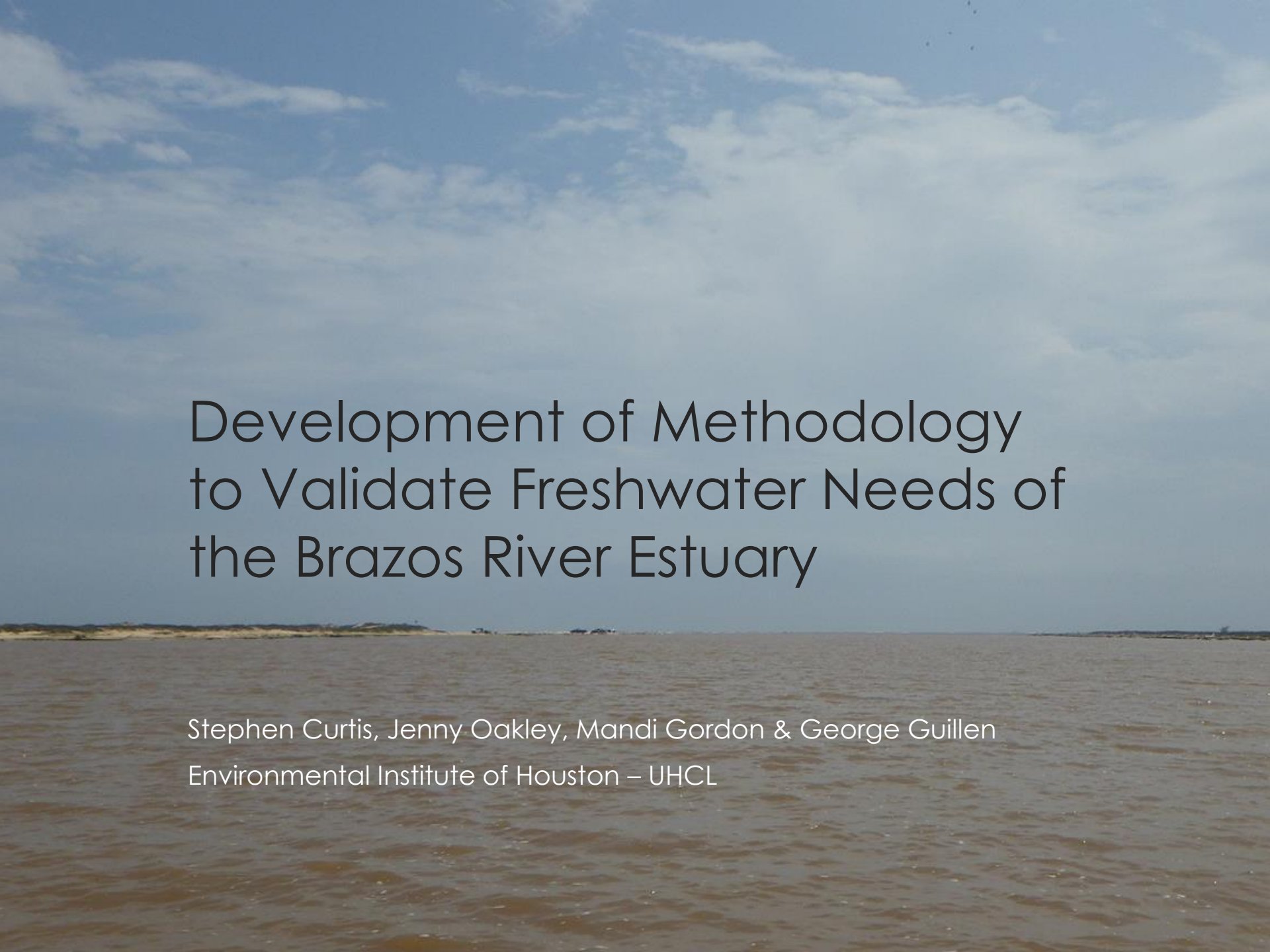
Reviewed: 7/27/2021

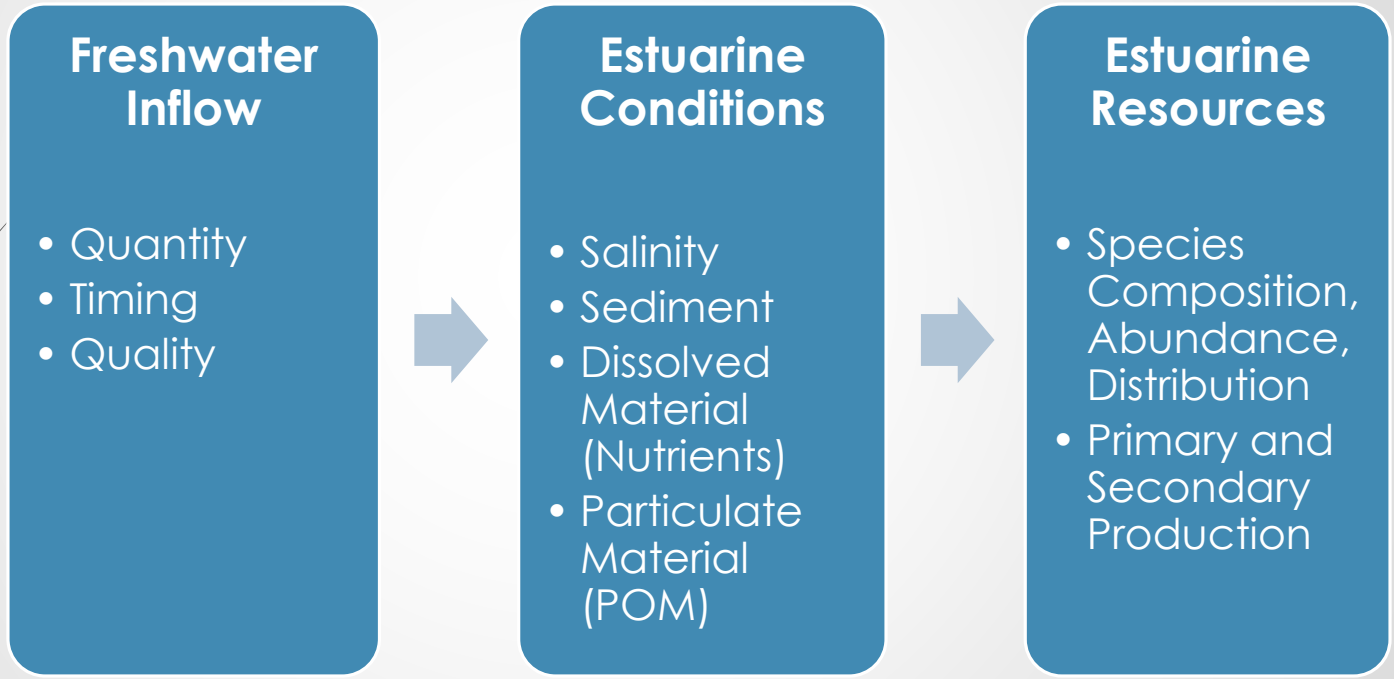


Development of Methodology to Validate Freshwater Needs of the Brazos River Estuary

Stephen Curtis, Jenny Oakley, Mandi Gordon & George Guillen

Environmental Institute of Houston – UHCL

Estuarine Conceptual Model



Alber 2002

Benefits of Freshwater Inflow

- **Salinity** – optimal conditions for estuarine residents & opportunists[1,2,3]
- **Sediment** – habitat creation; delta formation and maintenance[4,5]
- **Dissolved/Particulate Material** – nutrients contribute to productivity; supports bottom up systems[6,7,8]

[1]Drake et al. 2002; [2]Greenwood et al. 2007; [3]Stevens et al. 2013; [4]Alber 2002; [5]Rodriguez at al. 2000; [6]Grange at al. 2000; [7]Smith 2006; [8]Purtlebaugh & Allen 2010

Inflow Management in Texas

- SB2/SB3 Process[1]
- Texas estuaries managed by lowest USGS gage[2,3,4,5]

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[1]TIFP 2001; [2]Colorado & Lavaca BBEST 2011; [3]GSA BBEST 2011; [4]Nueces BBEST 2011; [5]Brazos BBEST 2012

Environmental Flow Recommendations

Overbank Events	Qp: 60,900 cfs with Average Frequency 1 per 2 years Regressed Volume is 1,463,000 Duration Bound is 42										
High Flow Pulses	Qp: 51,000 cfs with Average Frequency 1 per year Regressed Volume is 1,133,000 Duration Bound is 38										
	Qp: 25,700 cfs with Average Frequency 1 per season Regressed Volume is 415,000 Duration Bound is 23				Qp: 33,700 cfs with Average Frequency 1 per season Regressed Volume is 665,000 Duration Bound is 31				Qp: 13,300 cfs with Average Frequency 1 per season Regressed Volume is 153,000 Duration Bound is 16		
	Qp: 13,600 cfs with Average Frequency 2 per season Regressed Volume is 168,000 Duration Bound is 16				Qp: 14,200 cfs with Average Frequency 2 per season Regressed Volume is 184,000 Duration Bound is 18				Qp: 4,980 cfs with Average Frequency 2 per season Regressed Volume is 39,100 Duration Bound is 9		
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Base Flows (cfs)	4,700				4,740				2,630		
	2,090				2,570				1,420		
	1,140				1,250				930		
Subsistence Flows (cfs)	430				430				430		
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	Winter				Spring				Summer			

Base Flow Levels	
	High (75th %ile)
	Medium (50th %ile)
	Low (25th %ile)

Pulse volumes are in units of acre-feet and durations are in days.

Period of record used : 1/1/1972 to 12/31/2010.

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Brazos BBASC 2012; Brazos BBEST 2012; Opdyke et al. 2014

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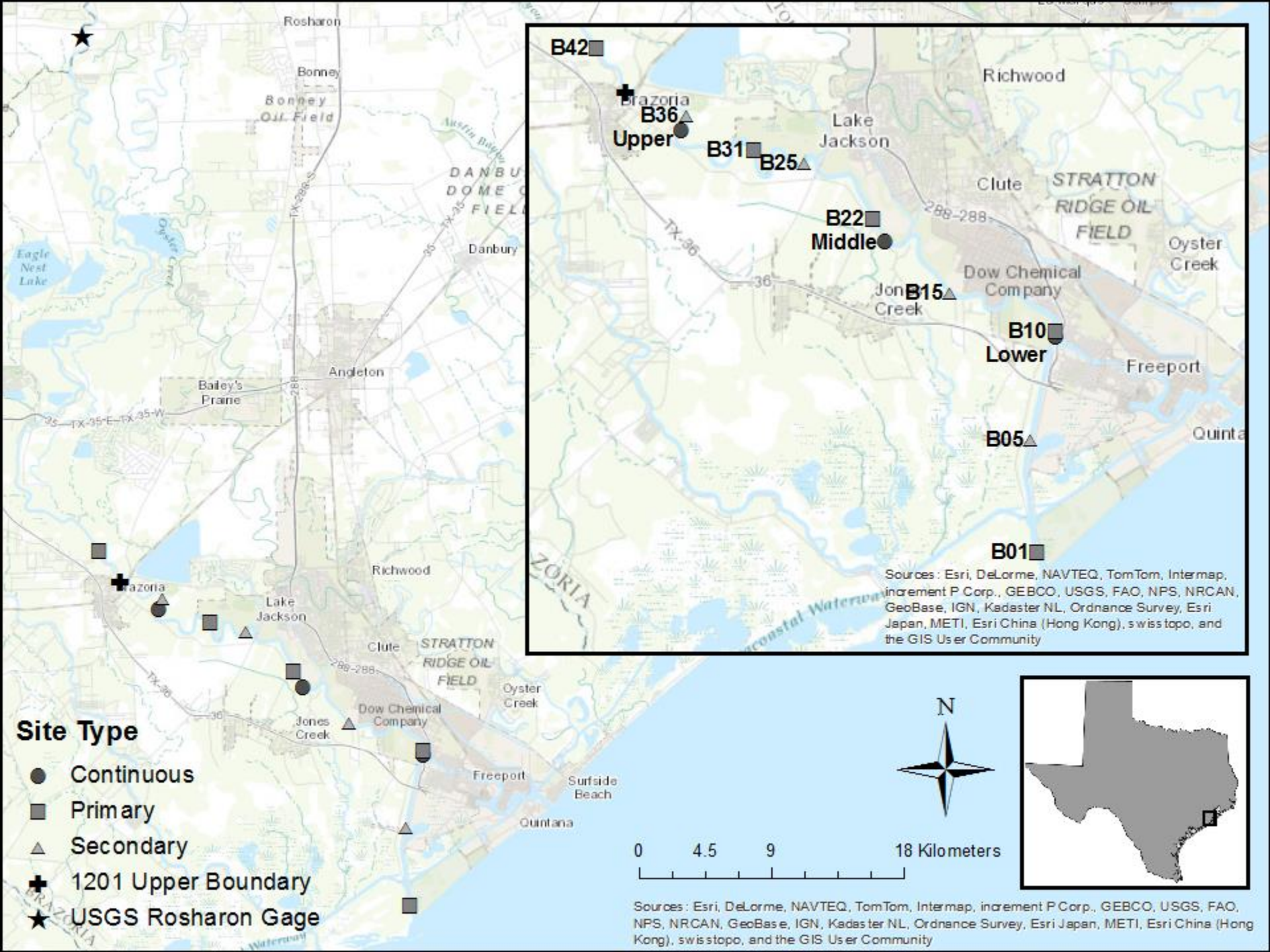
Rosharon
Bonney
Bonney Oil Field
DANBU
DOME
FIELD
Danbury
Eagle Nest Lake
Oyster Creek
Angleton
Bailey's Prairie
TX-35-E
TX-35-W
288
Richwood
Brazoria
Lake Jackson
Clute
STRATTON RIDGE OIL FIELD
Oyster Creek
Dow Chemical Company
Jones Creek
Freeport
Surfside Beach
Quintana
TX-36
36
B42
B36
Upper
B31
B25
B22
Middle
B15
B10
Lower
B05
B01
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community
Site Type
Continuous
Primary
Secondary
1201 Upper Boundary
USGS Rosharon Gage
N
0
4.5
9
18 Kilometers
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Objectives

1) Classify the flow regime of the lower Brazos River according to E-flow recommendations
2) Develop a lag time estimate to compare riverine flows at the Rosharon gage to real-time conditions
    a. Lag Time
    b. Characterize Response
3) Describe how responses in salinity & nutrients can be used to validate E-flow recommendations

Methods: Lag Time
(Objective 2)

- Continuous Data
  - Pressure Transducer: Water Level (Feb – Oct ‘15)
  - HOBOs: Salinity (Nov ‘14 – Oct ‘15)

Methods: E-flow Validation (Objective 3)

- Opportunistic Water Quality (Nov '14 – Aug '15)
  - In-Situ Profiles: Salinity
  - Grab Samples: RFU (Chl-a), TSS, Nitrate-Nitrite, TKN, TP

Methods: Lag Time Stats (Objective 2)

- Pressure Data (Physical Response)
  - Lag time estimate
  - Real-time conditions
    - Joinpoint analysis[1,2,3,4]
    - Spring & summer flows vs. water level
- HOBO Data (Chemical Response)[5]

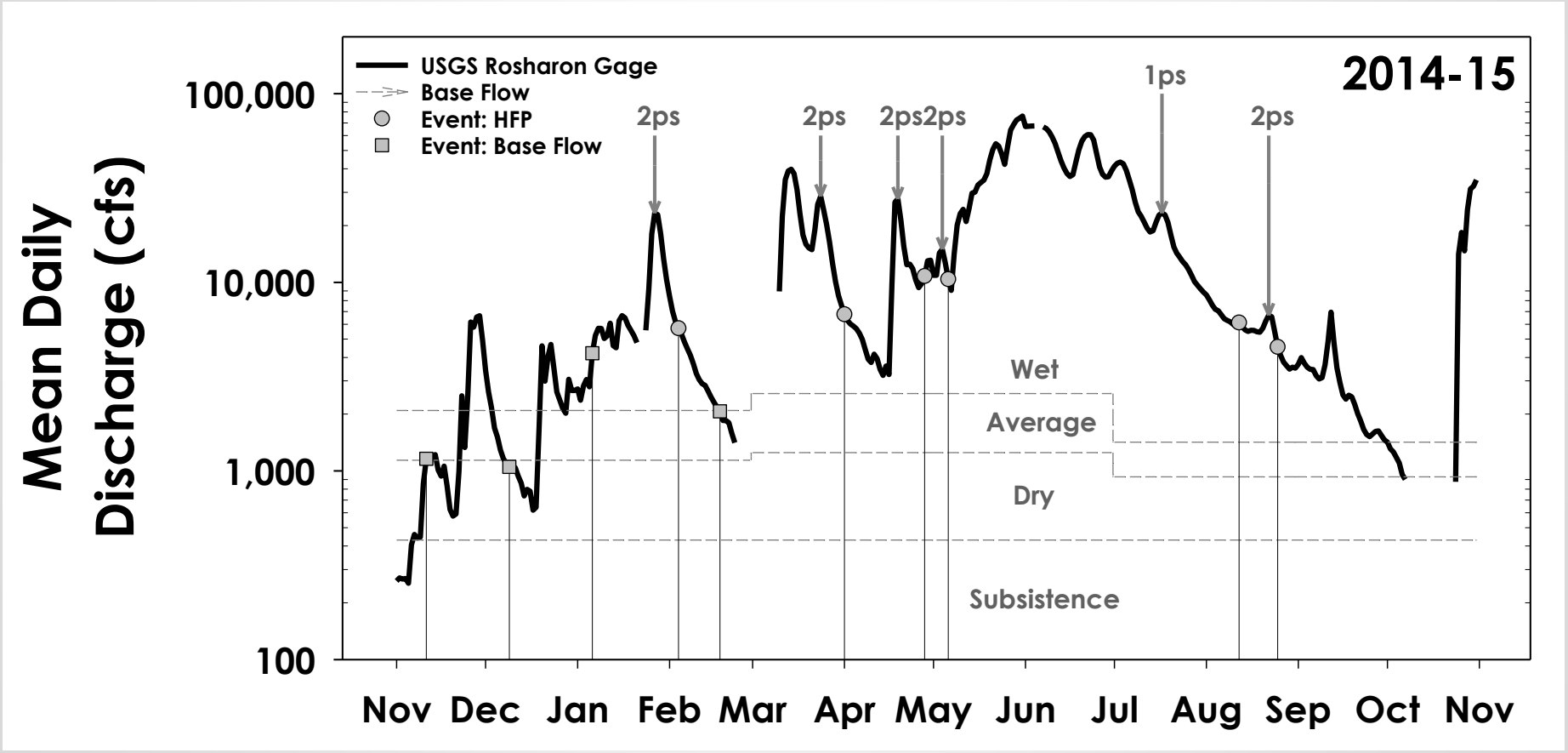
[1]Joinpoint; [2]Kim et al. 2000; [3]Maceina 2008; [4]Perkin & Bonner 2011; [5]HOBOware

Methods: E-flow Stats (Objective 3)

- In-Situ Profiles & Grab Samples
  - 2-Factor ANOVA: Flow Tier x Site[1]
    - Interaction → Flow Tier within site
    - No Interaction → Flow Tier
  - Fisher's LSD

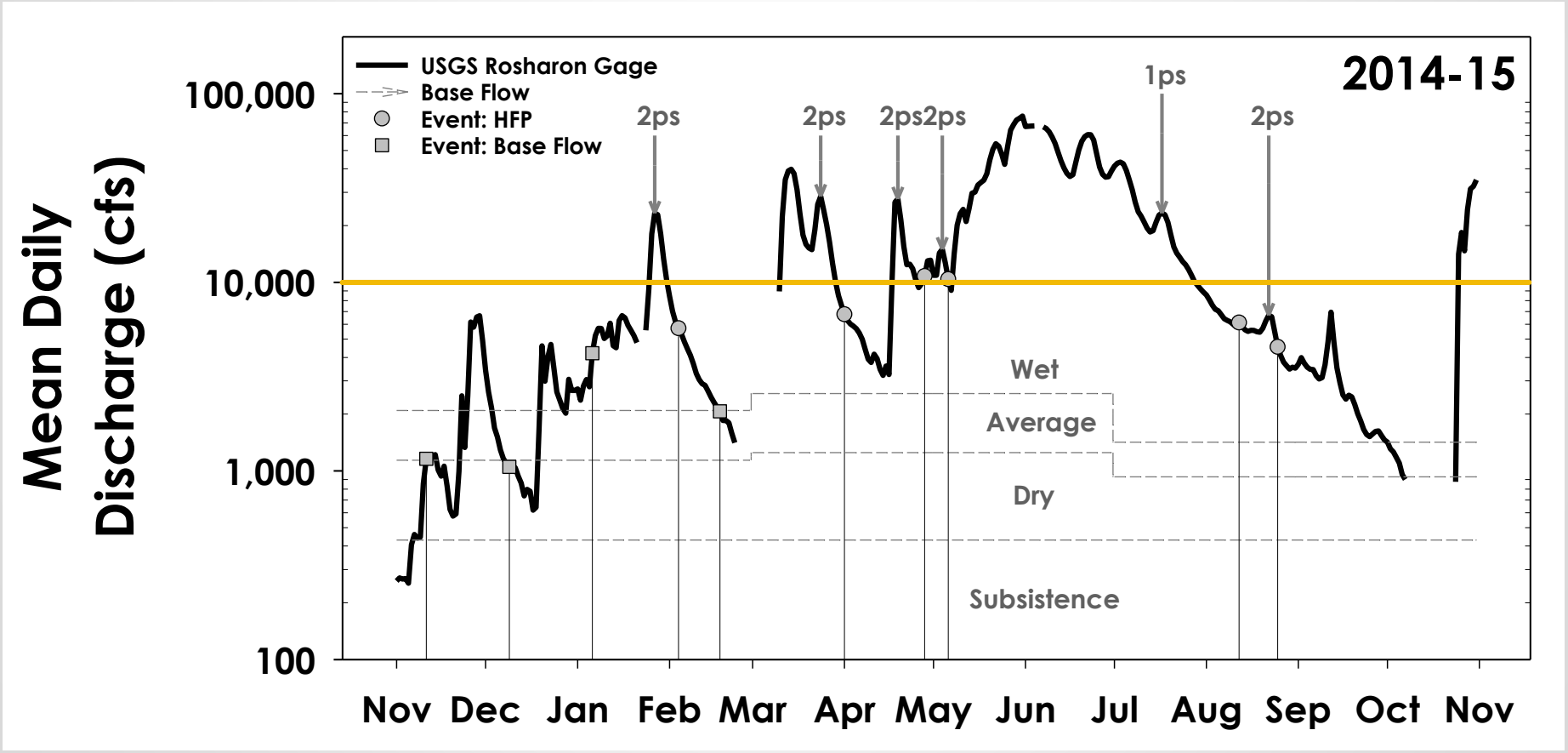
[1]R

Results: Flow Classification
(Objective 1)



- 1/season = 1; 2/season = 5; Wet = 1, Avg = 2, Dry = 1

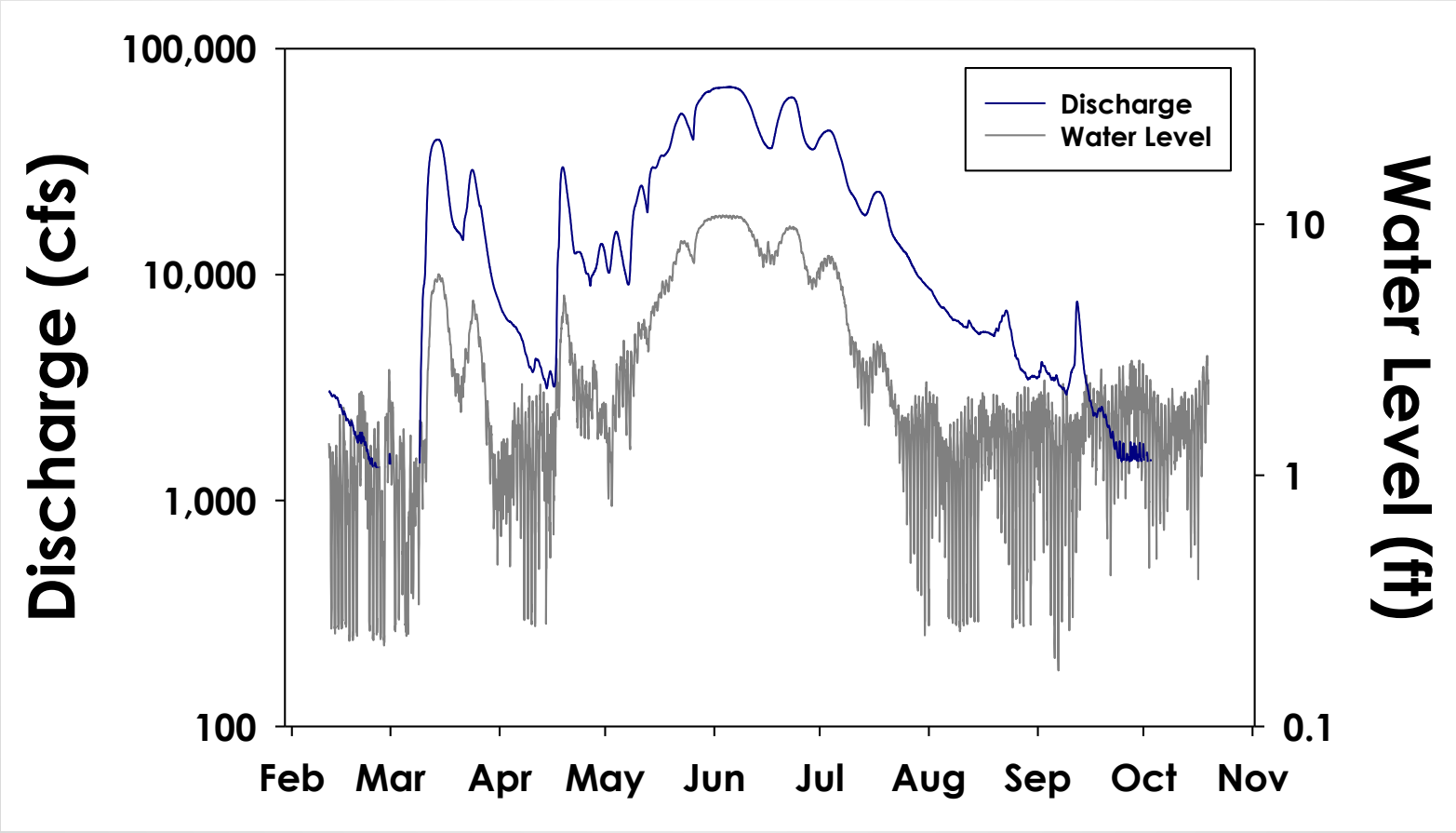
Results: Flow Classification
(Objective 1)



- 1/season = 1; 2/season = 5; Wet = 1, Avg = 2, Dry = 1

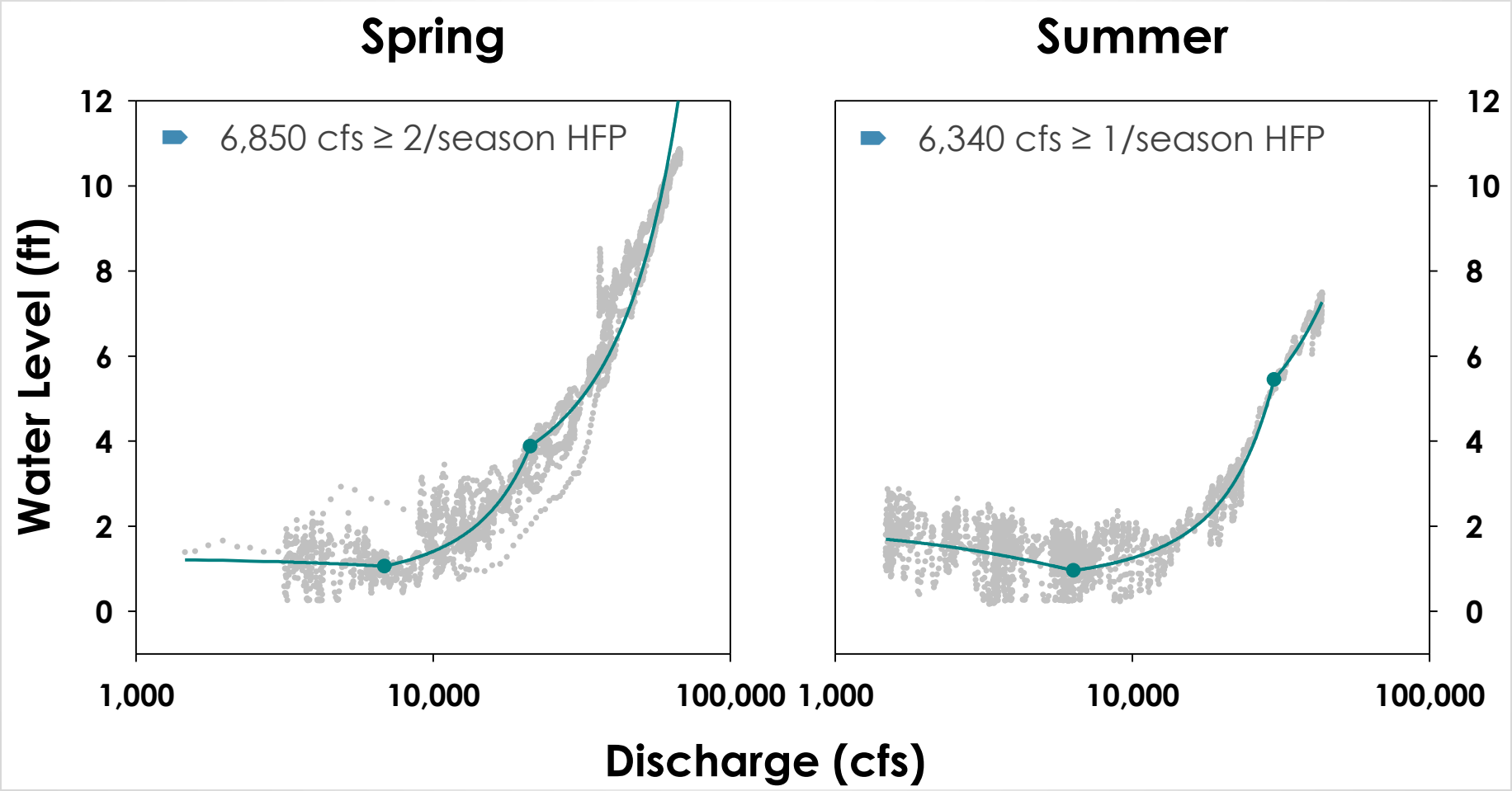
Results: Lag Time
(Objective 2)

- Physical Response
  - 5-10 hour delay



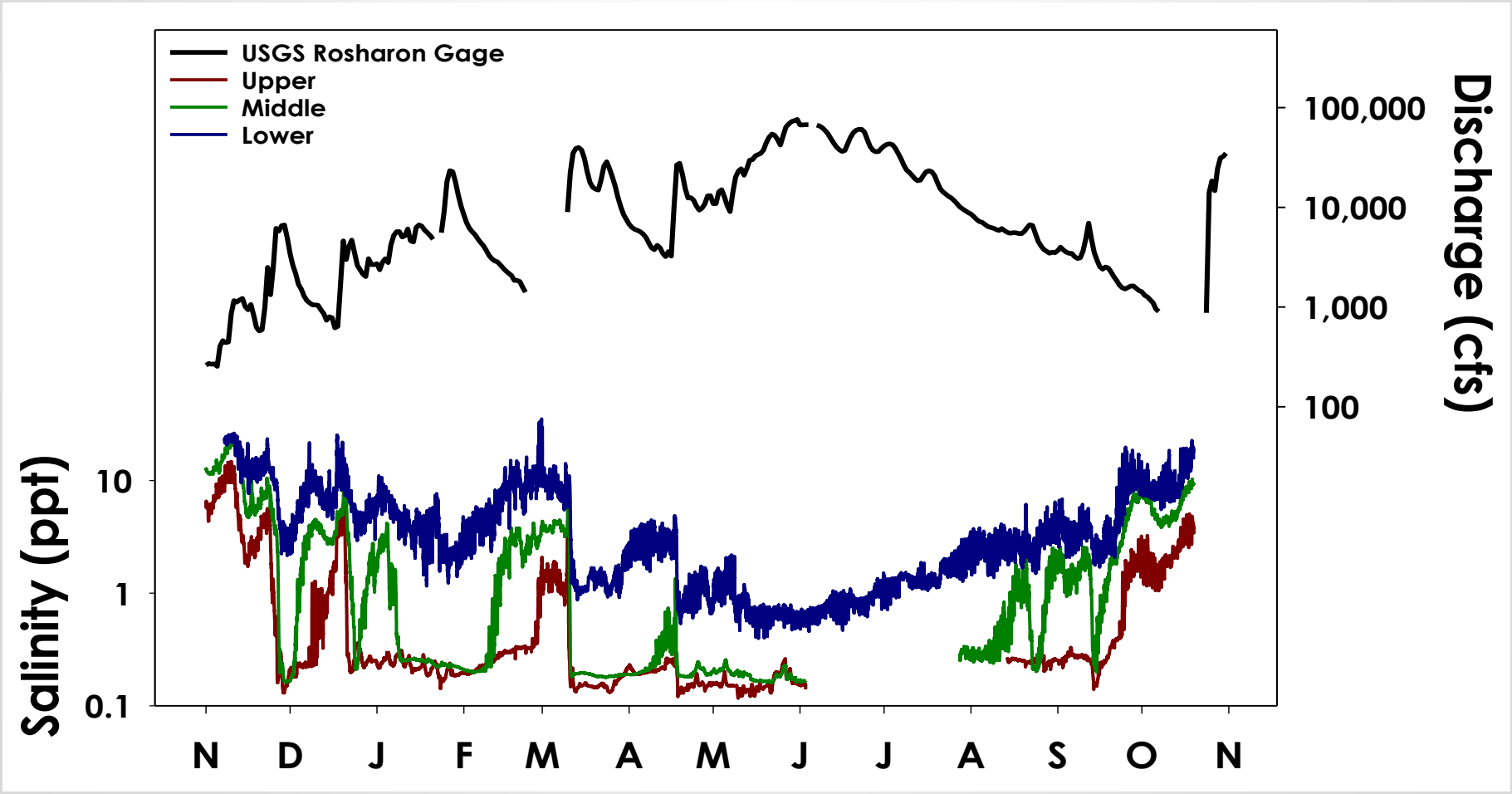
Results: Real-time Conditions (Objective 2)

- Physical Response



Results: Real-time Conditions (Objective 2)

- Chemical Response: All HFP & Wet Base Flow



Results: Real-time Conditions (Objective 2)

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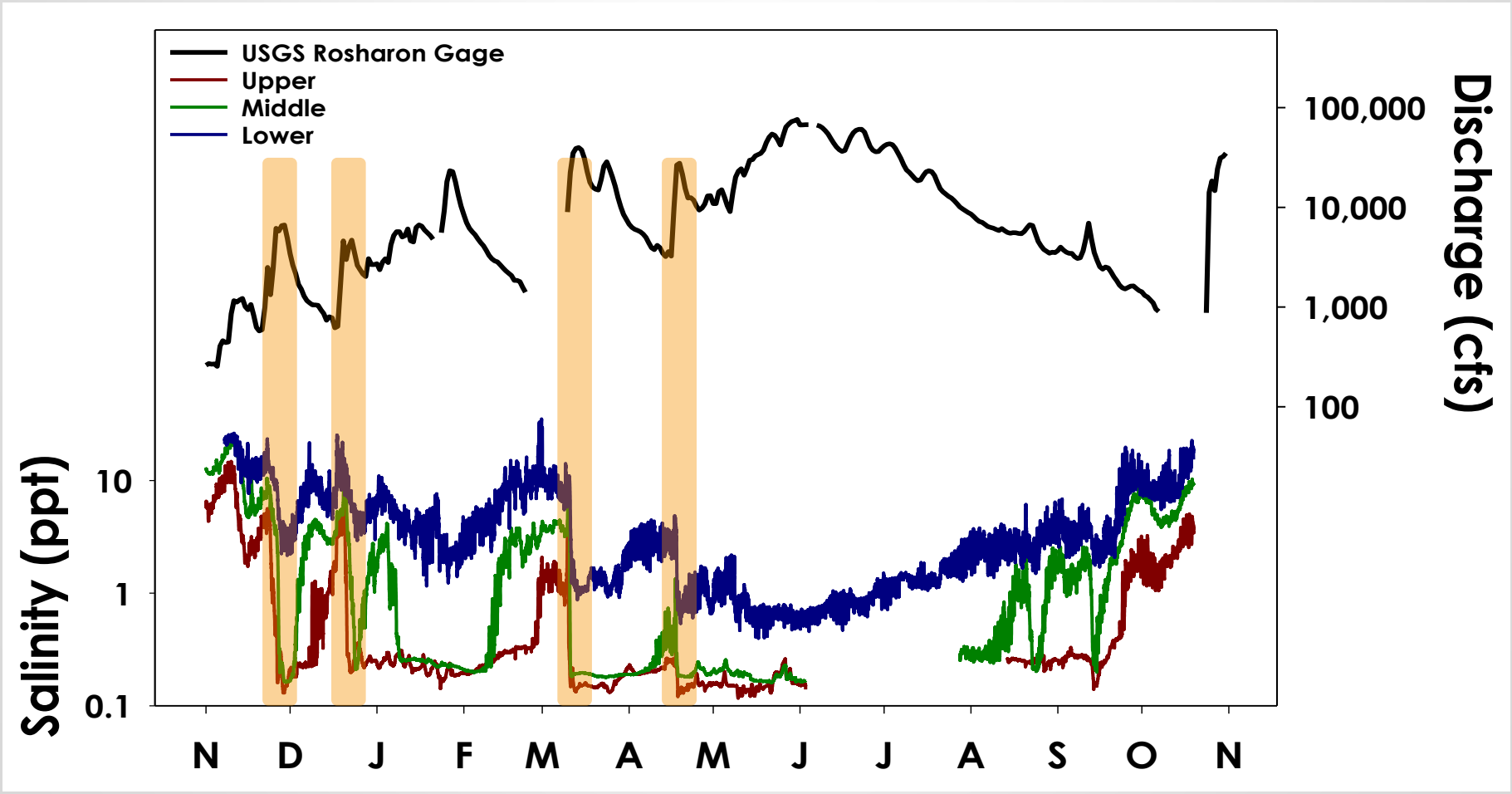

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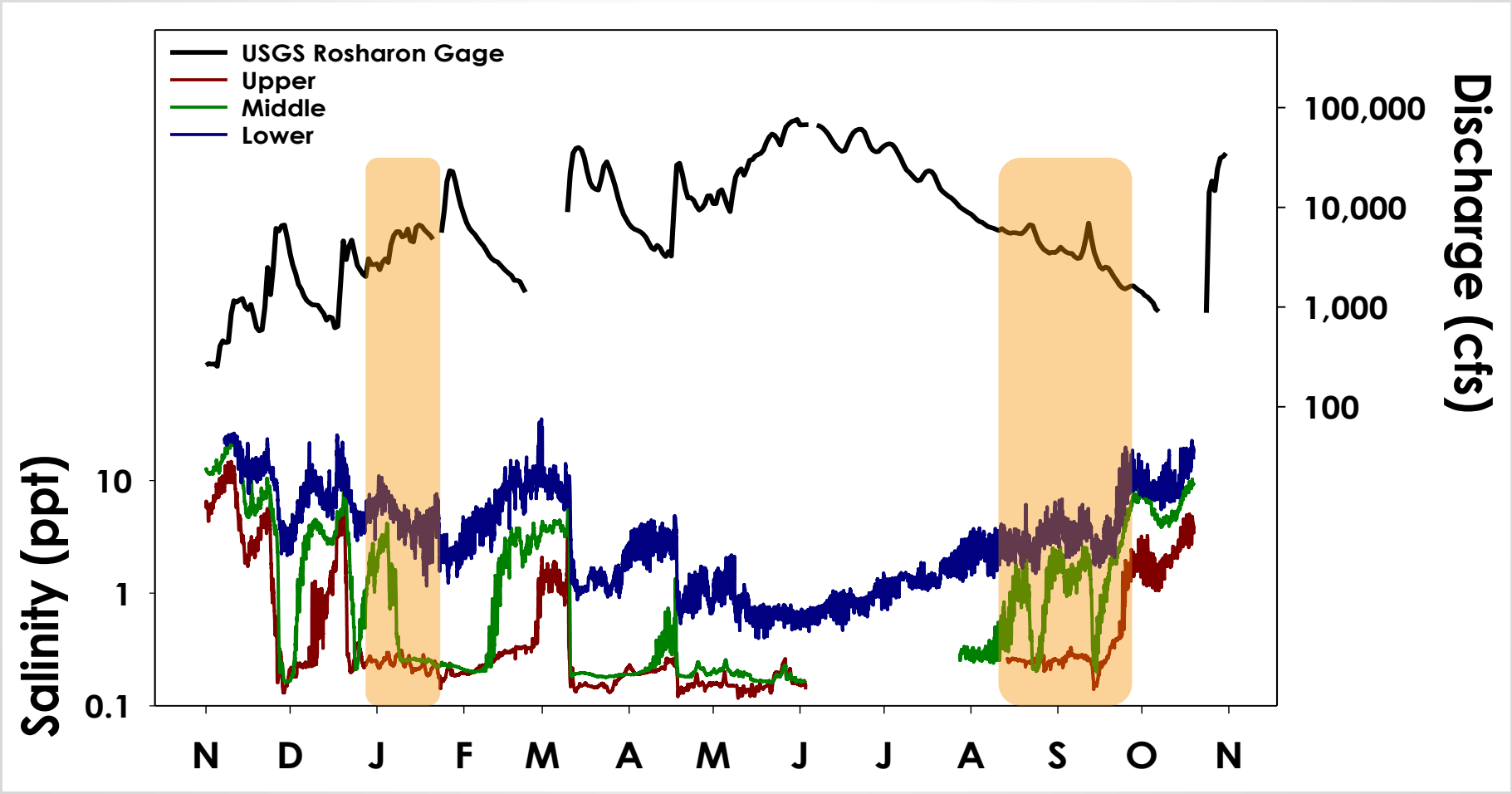
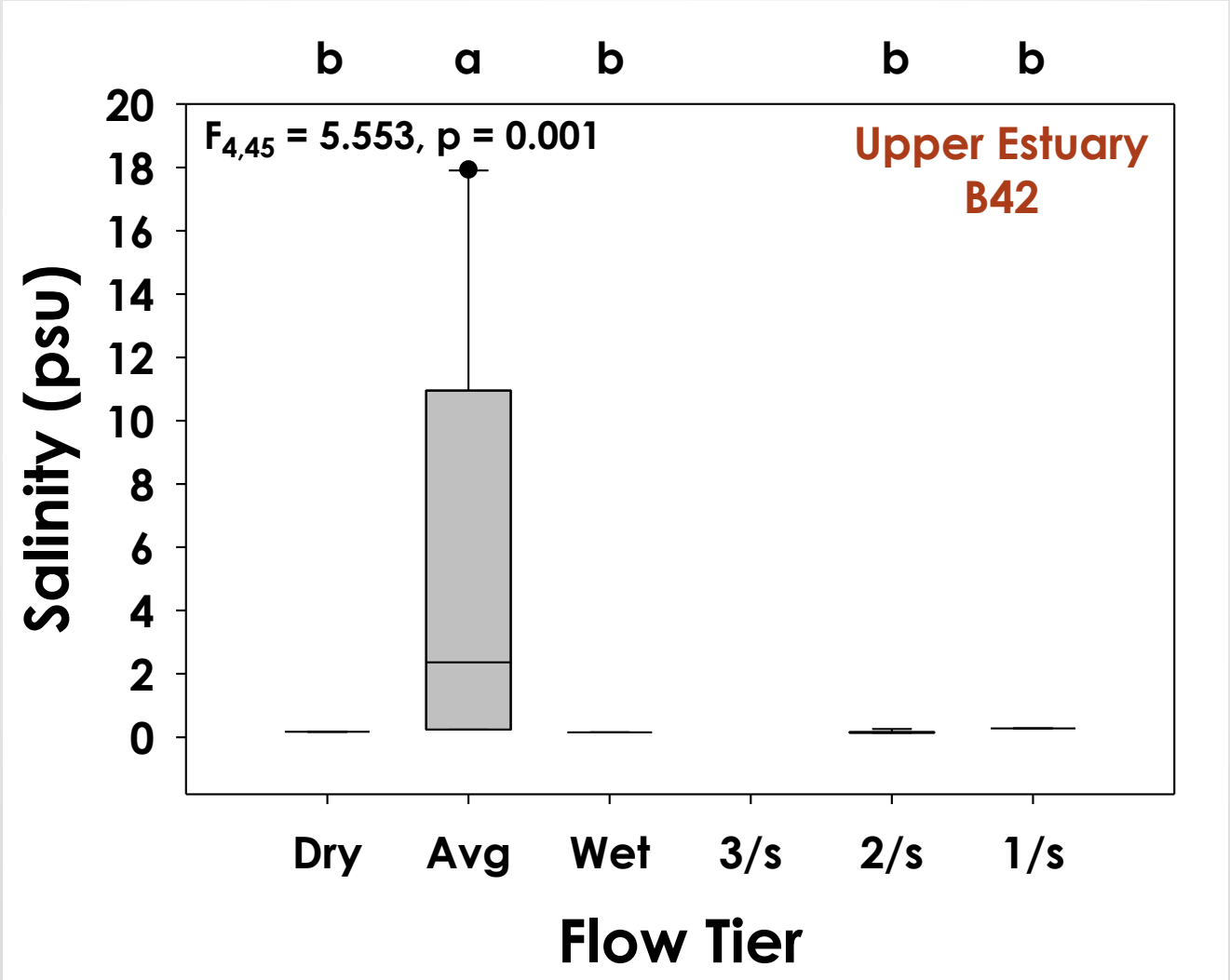


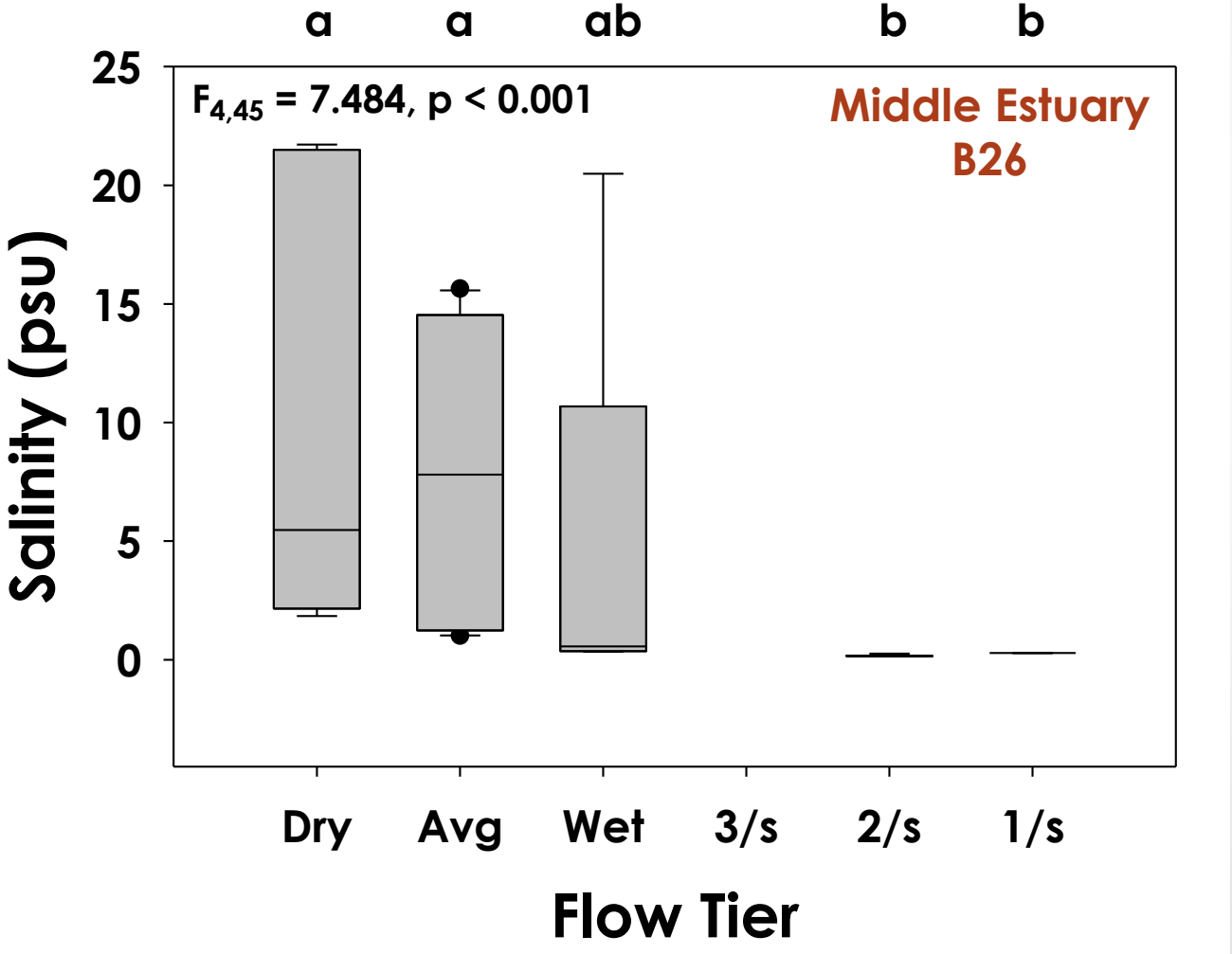
Results: E-flow Validation

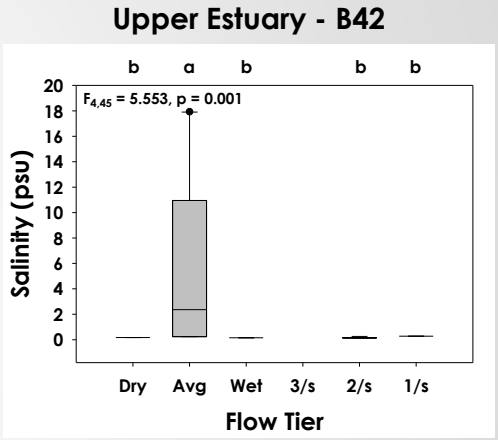
(Objective 3) – Salinity



Results: E-flow Validation

(Objective 3) – Salinity





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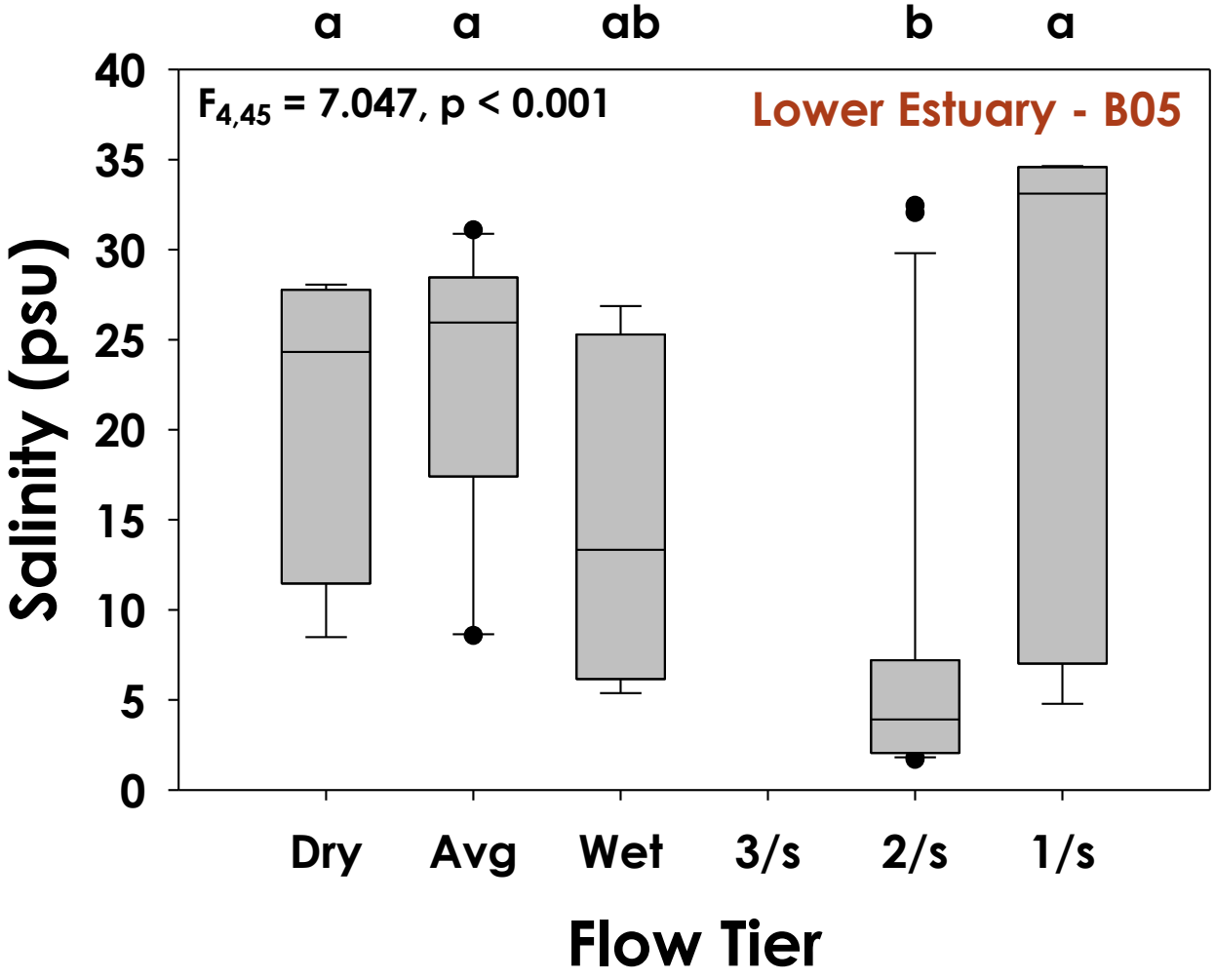
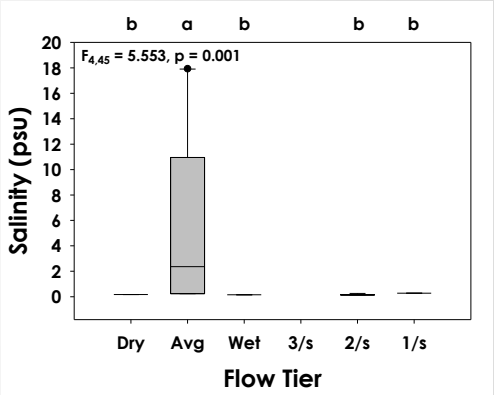
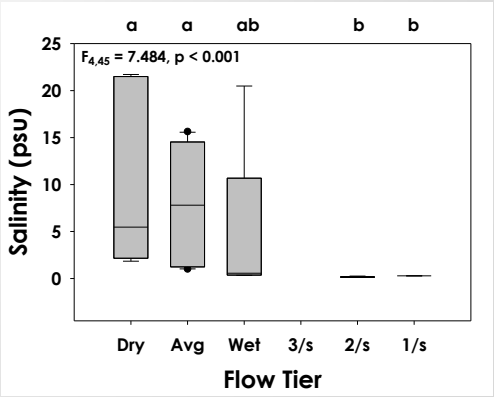
(Objective 3) – Salinity



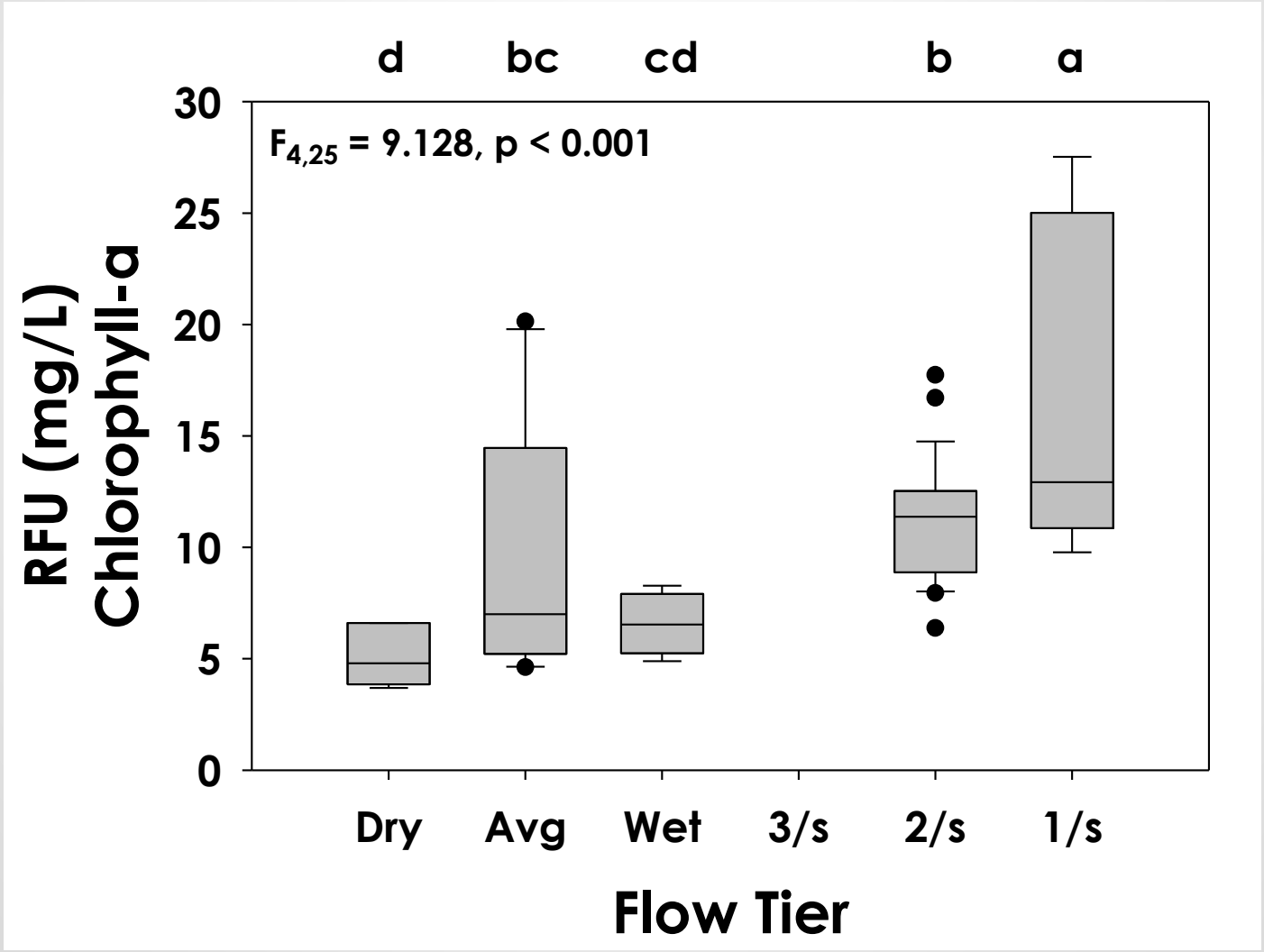
Upper Estuary - B42



Middle Estuary – B26



Results: E-flow Validation
(Objective 3) – Nutrients



Summary
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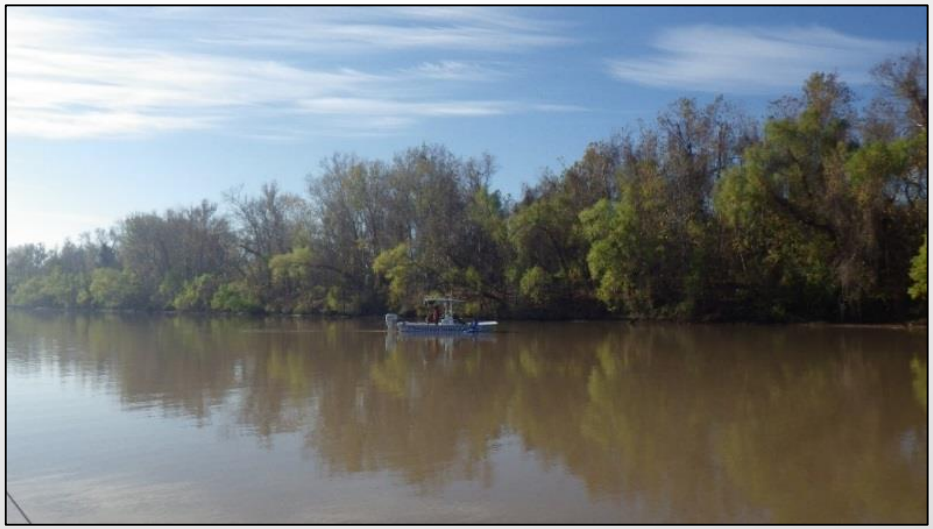
Brazos BBEST 2012; Brazos BBASC 2012

Summary
(Objective 2 & 3)

- Rosharon gage serves as a good indicator of instream flows to estuary
- **Salinity** – Wet base flows and HFP maintain gradient in middle and lower estuary
- **Sediment/Nutrients** – 1/season HFP increased chlorophyll-a levels



Lessons Learned/Difficulties

- Most valuable data obtained when sampling as close to the high flow pulse as possible
- Data collection of this magnitude takes longer than expected
- Mother nature will always win: ~5 months of 10,000+ cfs

Moving Forward

- Current study allows refinement of sampling methodology & variables
- Increase n to populate the models

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High Flow Pulses	Qp: 51,000 cfs with Average Frequency 1 per year Regressed Volume is 1,13[illegible]00 Duration Bound is [illegible]											
	Qp: 25,700 cfs with Average Frequency 1 per season Regressed Volume is 415,000 Duration Bound is 23				Qp: 33,700 cfs with Average Frequency 1 per season Regressed Volume is 665,000 Duration Bound is 31				Qp: 13,300 cfs with Average Frequency 1 per season Regressed Volume is 153,000 Duration Bound is 16			
	Qp: 13,600 cfs with Average Frequency 2 per season Regressed Volume is 168,000 Duration Bound is 16				Qp: 14,200 cfs with Average Frequency 2 per season Regressed Volume is 184,000 Duration Bound is 18				Qp: 4,980 cfs with Average Frequency 2 per season Regressed Volume is 39,100 Duration Bound is 9			
	Qp: 9,090 cfs with Average Frequency 3 per season Regressed Volume is 94,700 Duration Bound is 12				Qp: 6,580 cfs with Average Frequency 3 per season Regressed Volume is 58,500 Duration Bound is 10				Qp: 2,490 cfs with Average Frequency 3 per season Regressed Volume is 14,900 Duration Bound is 6			
Base Flows (cfs)	4,700				4,740				2,630			
	2,090				2,570				1,420			
	1,140				1,250				930			
Subsistence Flows (cfs)	430				430				430			
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
	Winter				Spring				Summer			

Base Flow Levels
High (75th %ile)
Medium (50th %ile)
Low (25th %ile)

Pulse volumes are in units of acre-feet and durations are in days.

Period of record used : 1/1/1972 to 12/31/2010.

Episodic events are terminated when the volume or duration criteria are met, or when the flow drops below 1310 cfs, or when the flow is below 9850 cfs and the flow drops from one day to the next by less than 5%.

Acknowledgments

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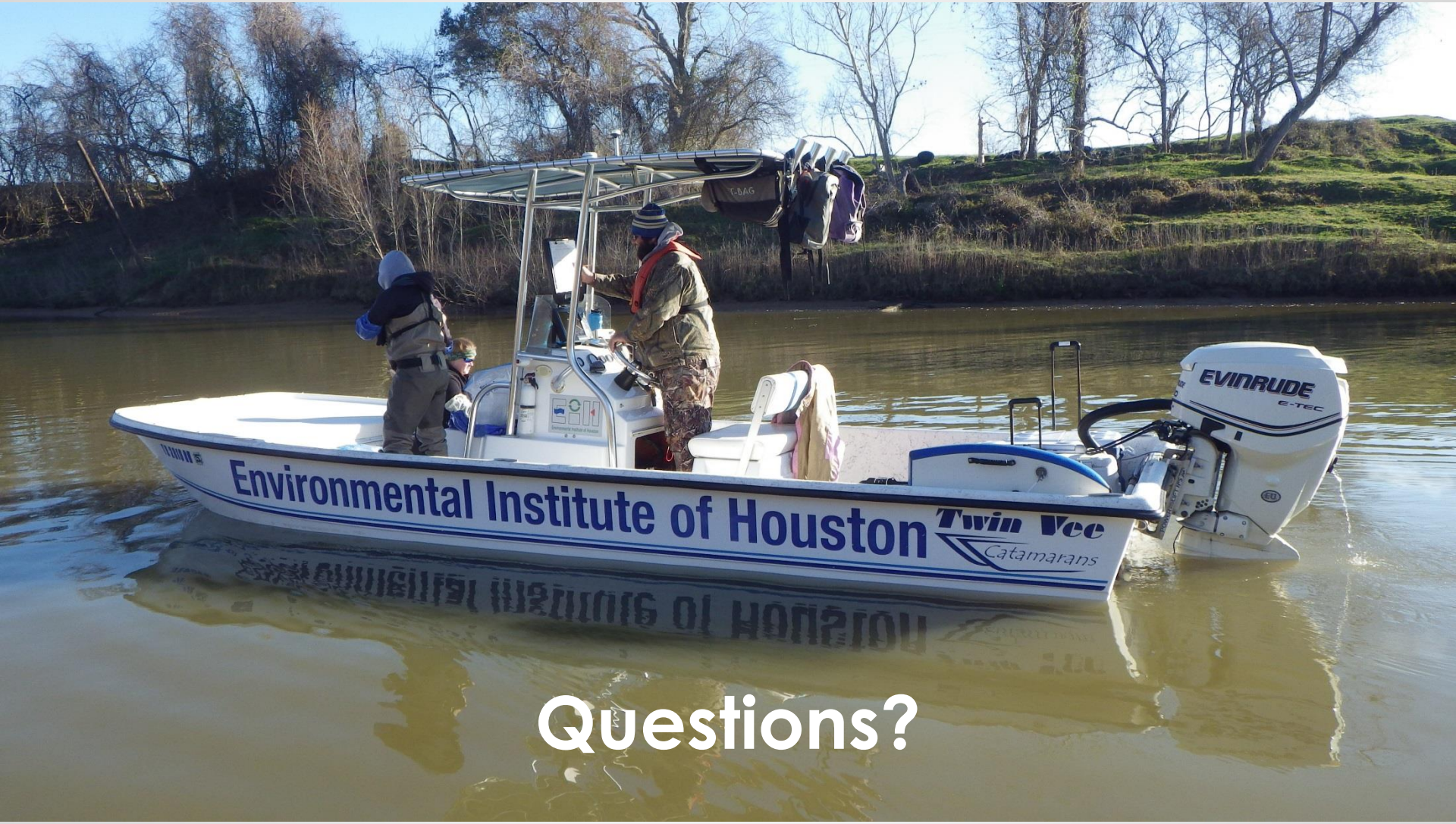
Texas Water Development Board

Environmental Institute of Houston

University of Houston Clear Lake


Environmental Institute of Houston
Twin Vee
Catamarans
EVINRUDE
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Questions?