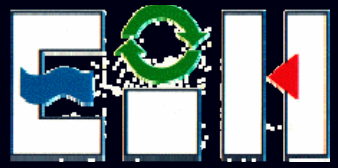
Fish, Shrimp, Crabs and Freshwater – Life in a Dynamic Estuary

George Guillen, Jenny Oakley, Mandi Moss and Cory Scanes and Tyler Swanson

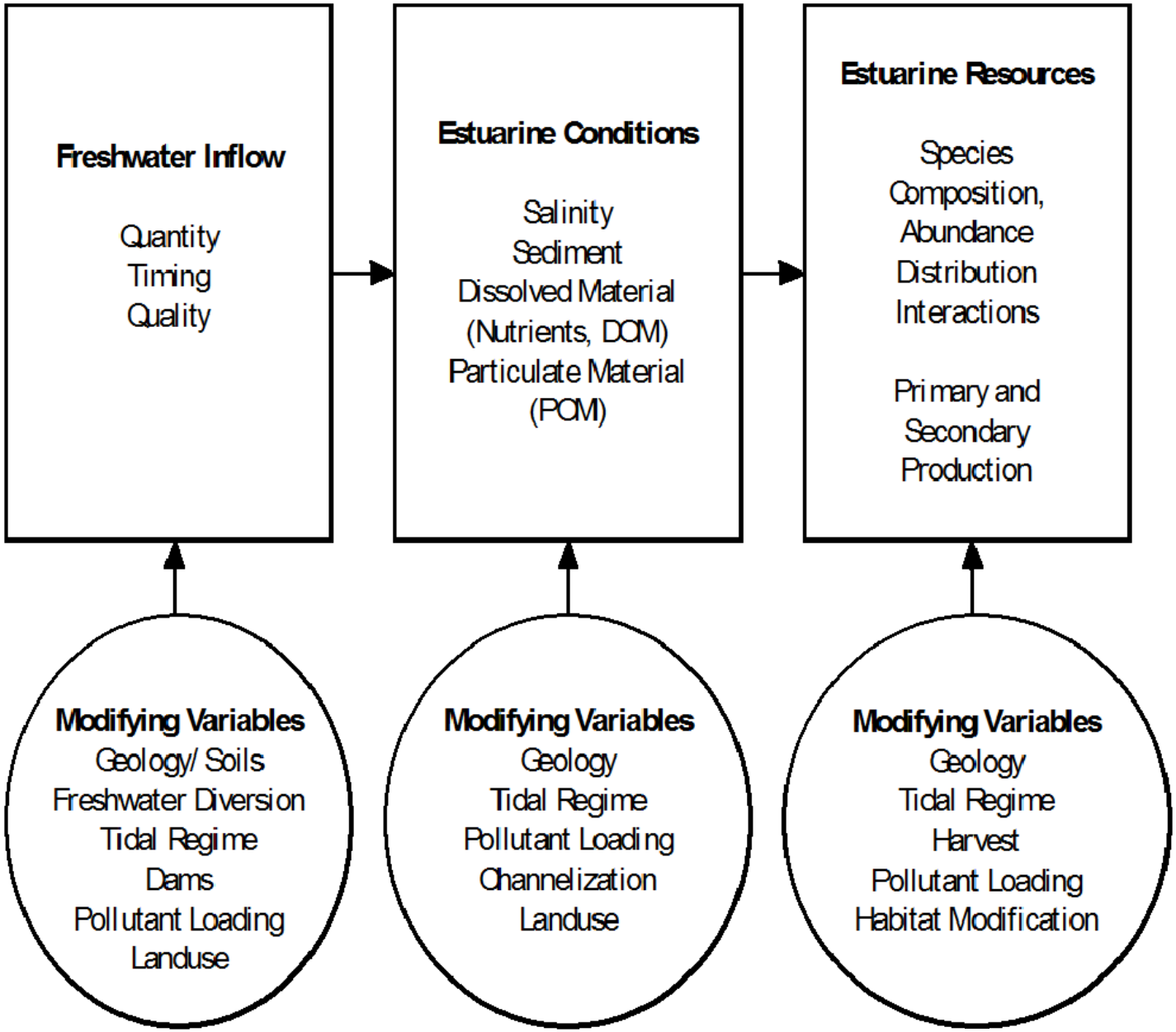
Environmental Institute of Houston: University of Clear Lake

H-GAC's Clean Waters Initiative Workshop

Houston, Texas 11-28-17

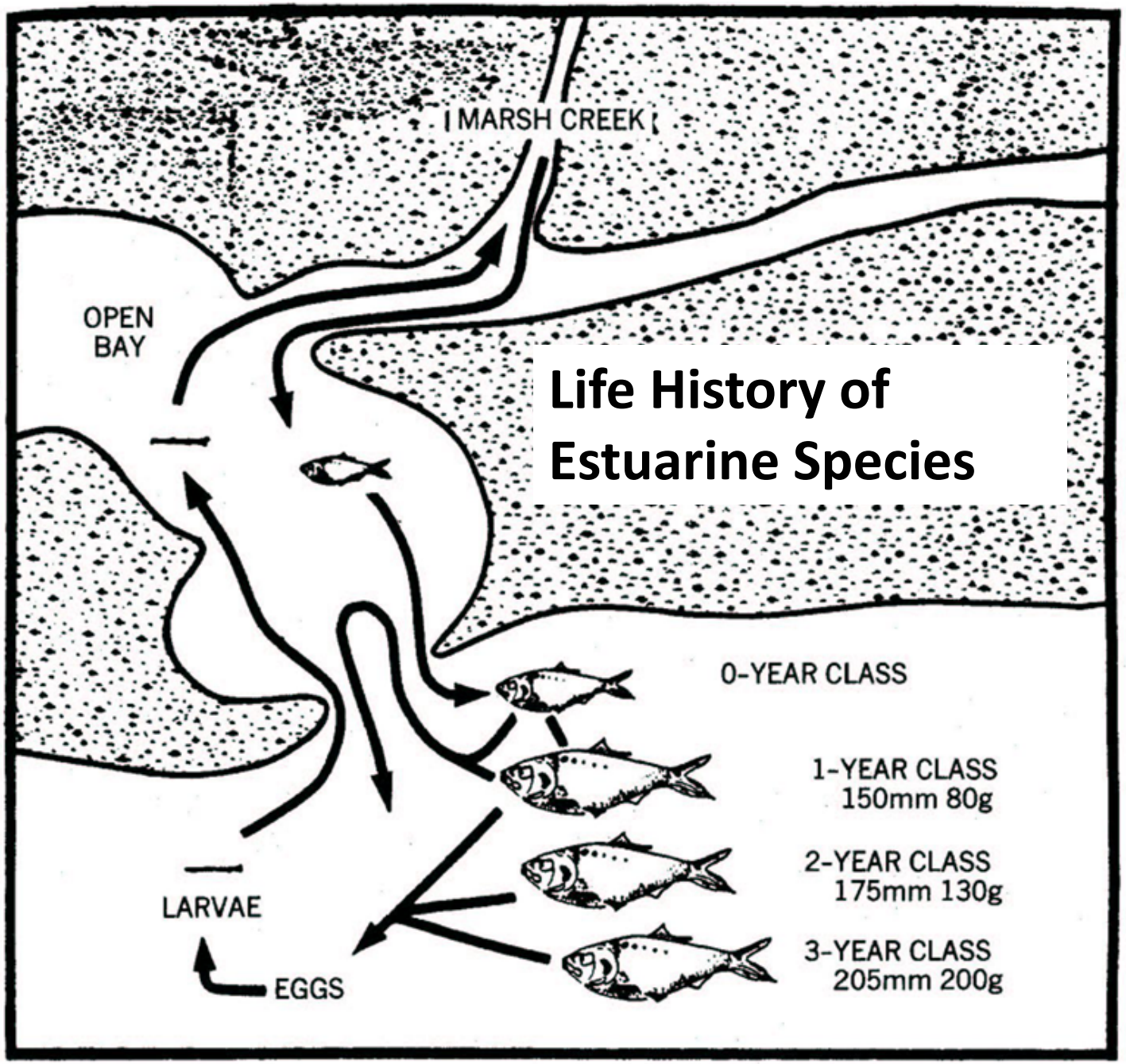


Freshwater Inflow Model

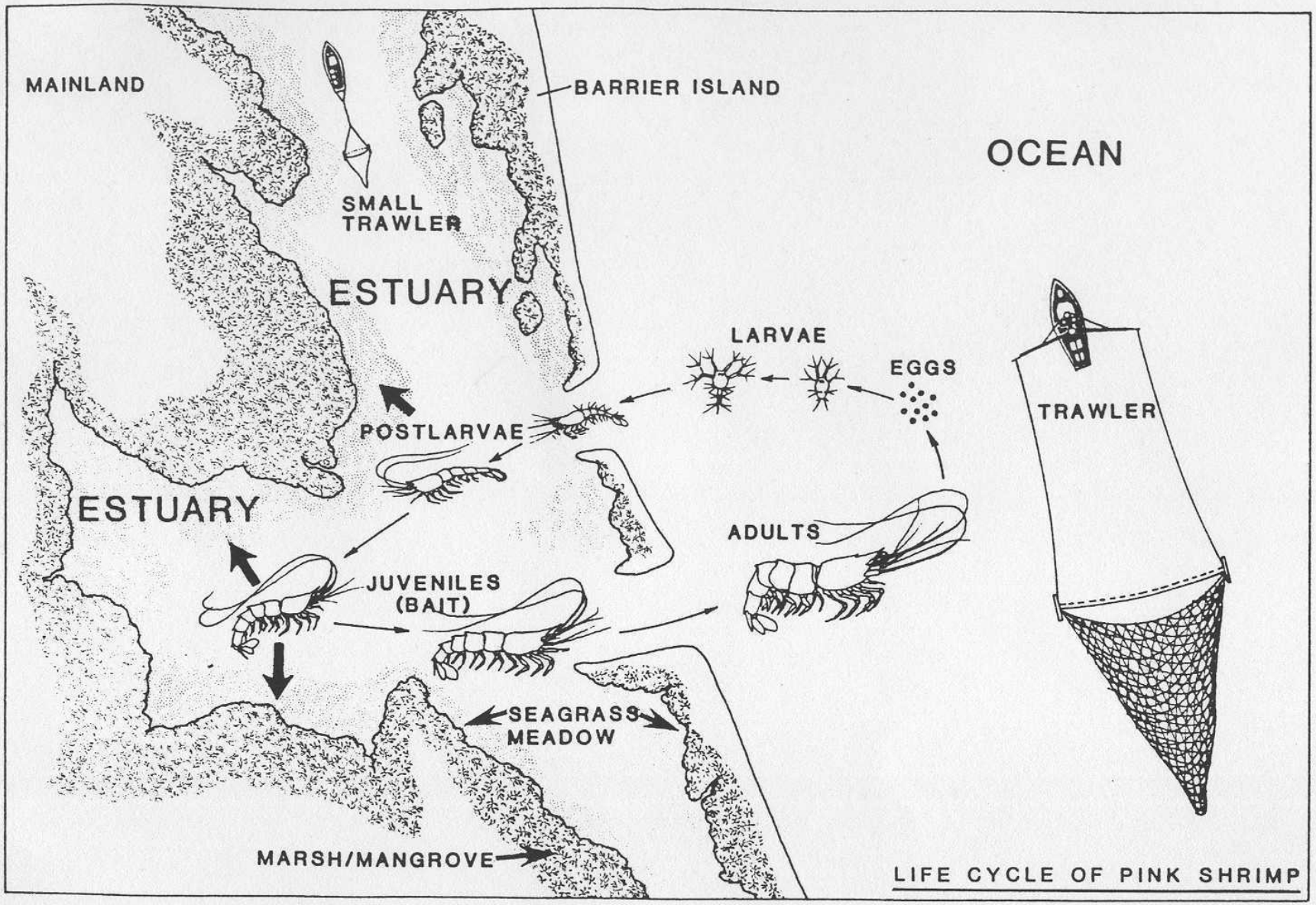


Alber (2002)

Many juvenile organisms require access to upstream tidal creeks and rivers.

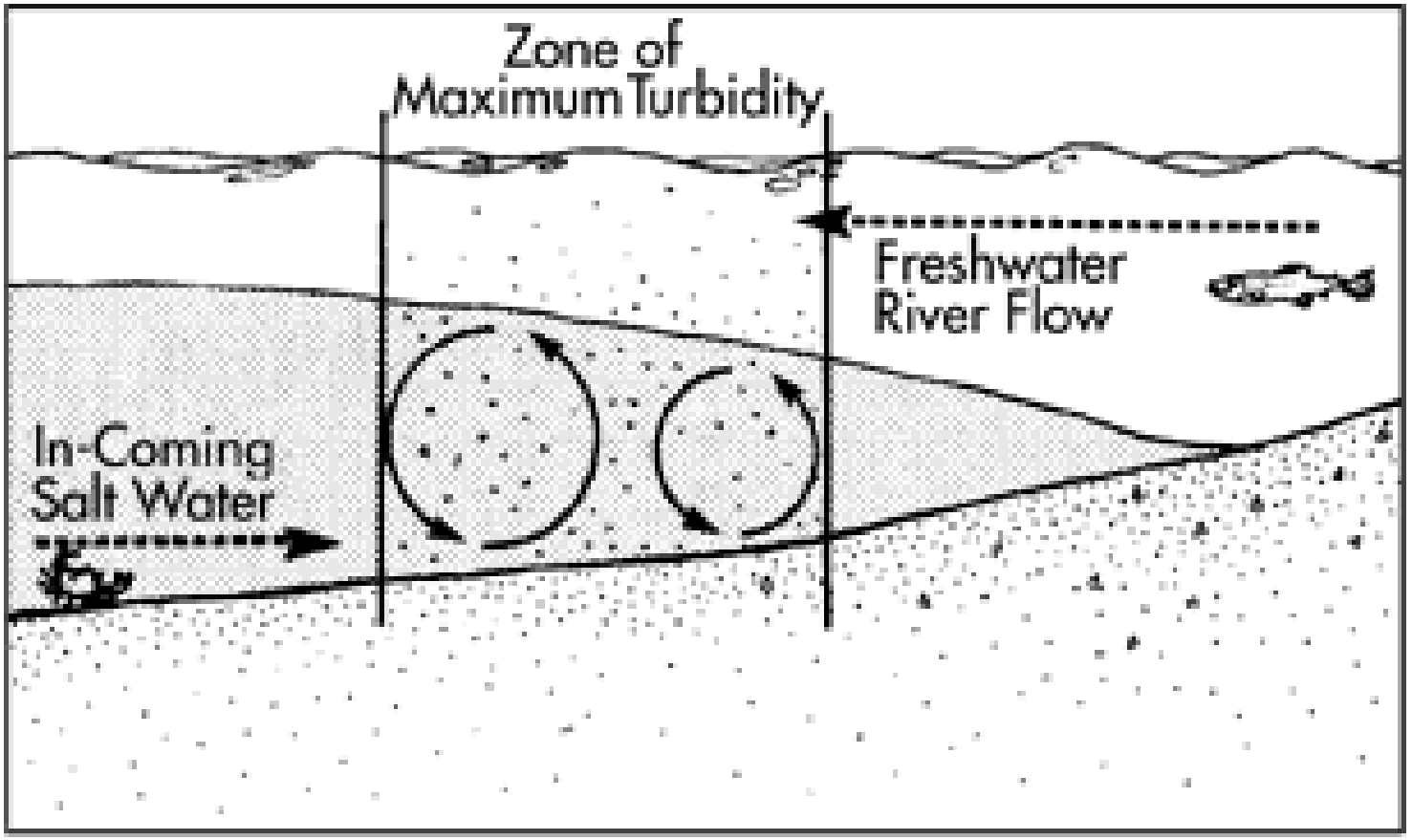


Deegan 1985



Artwork by Mangrove Systems Inc.

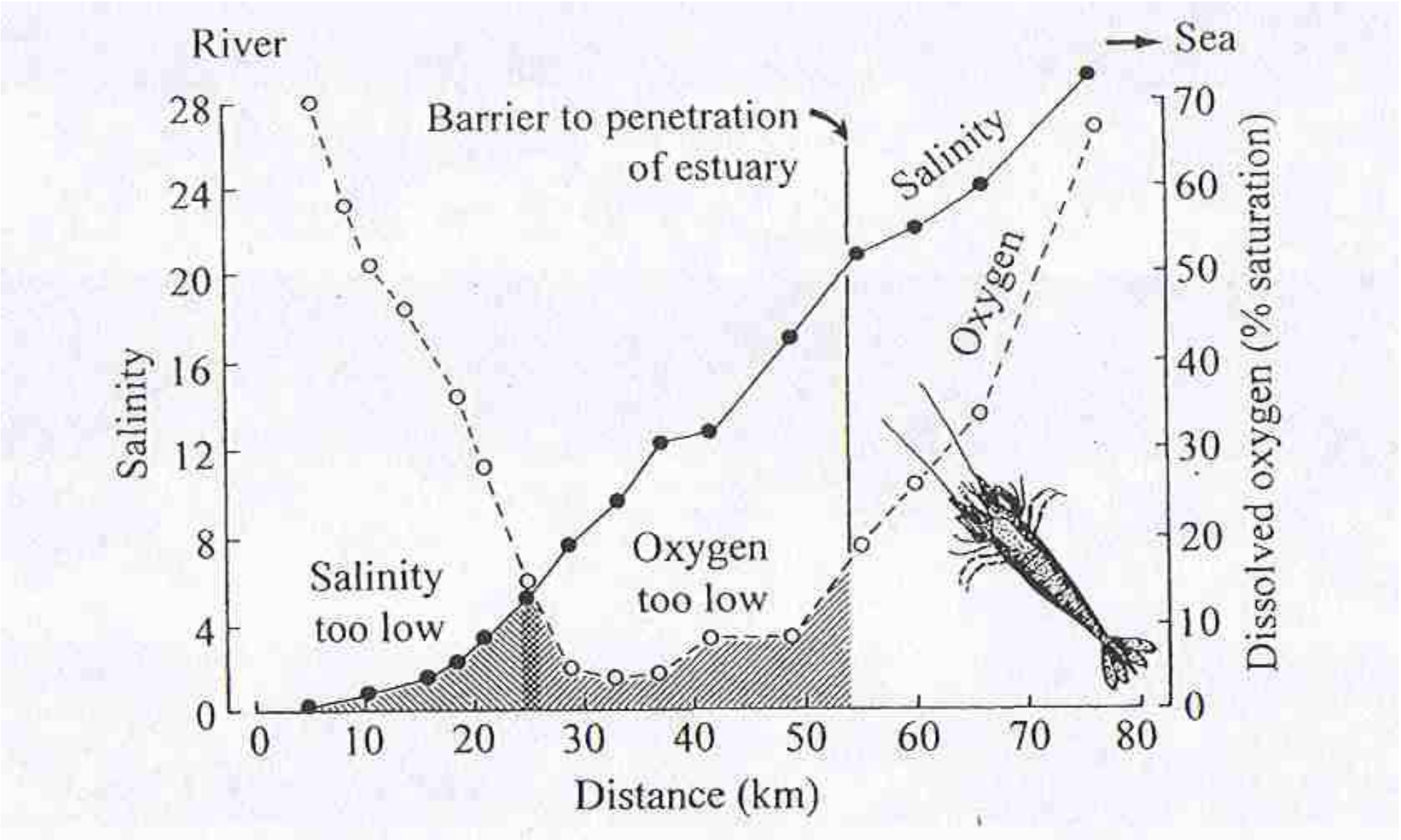
Salt-Wedge and Turbidity Maxima



Salt-wedge and Turbidity Maxima – another effect of the salt wedge and freshwater mixing

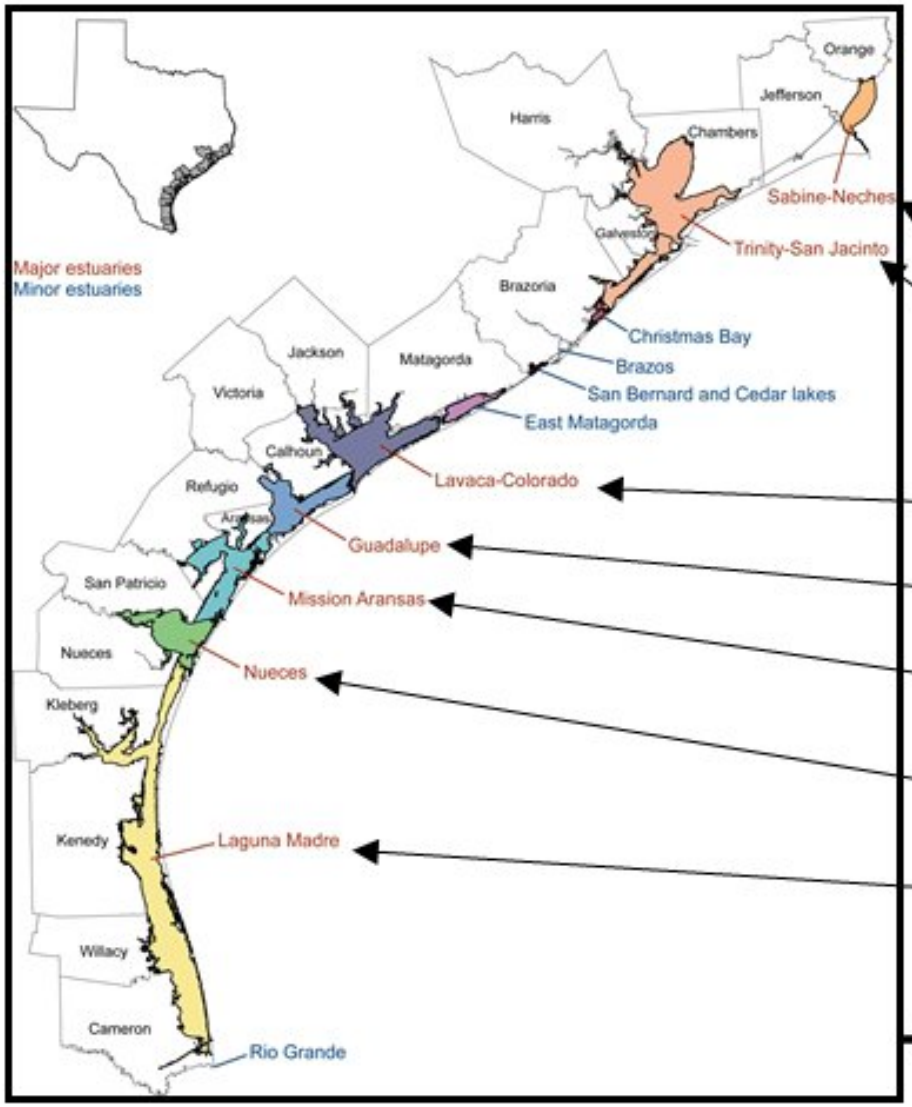
science.kennesaw.edu

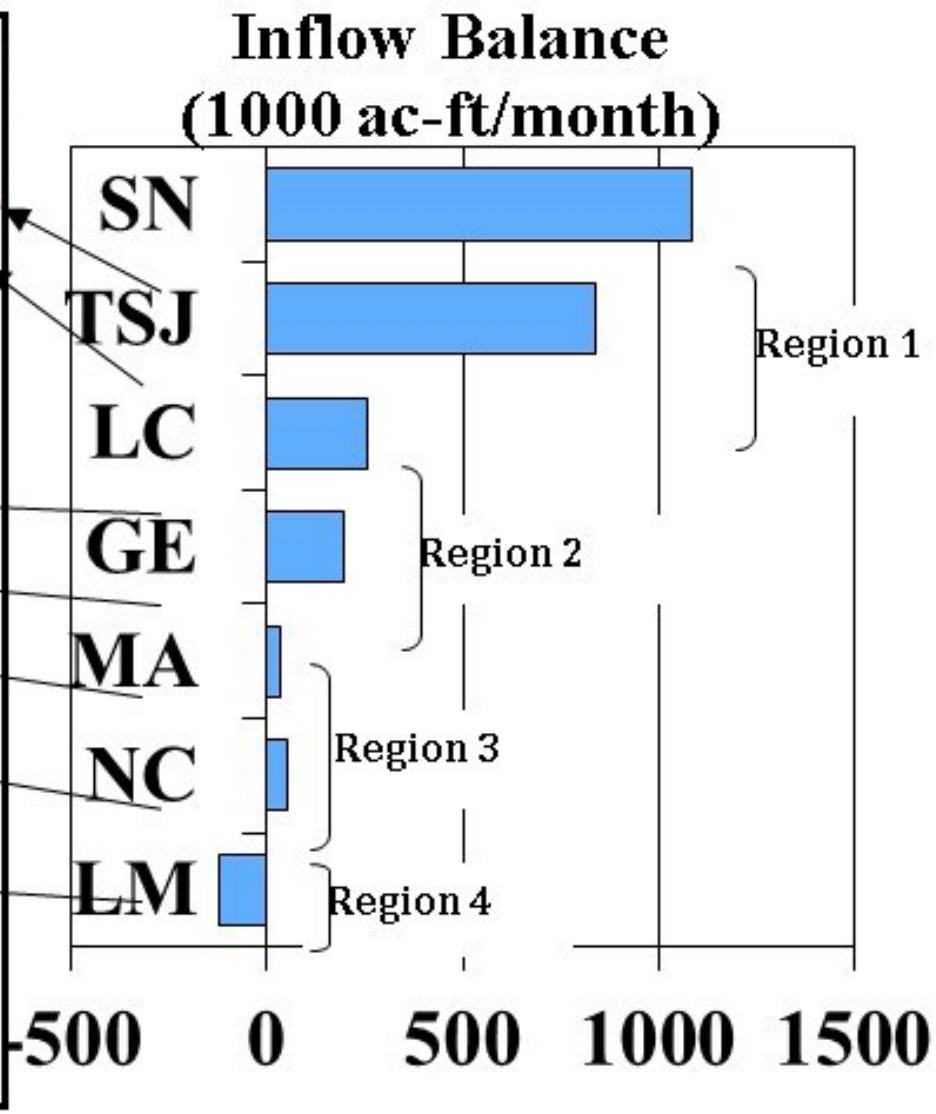
Freshwater Inflow → Salinity → Dissolved Oxygen → Biota



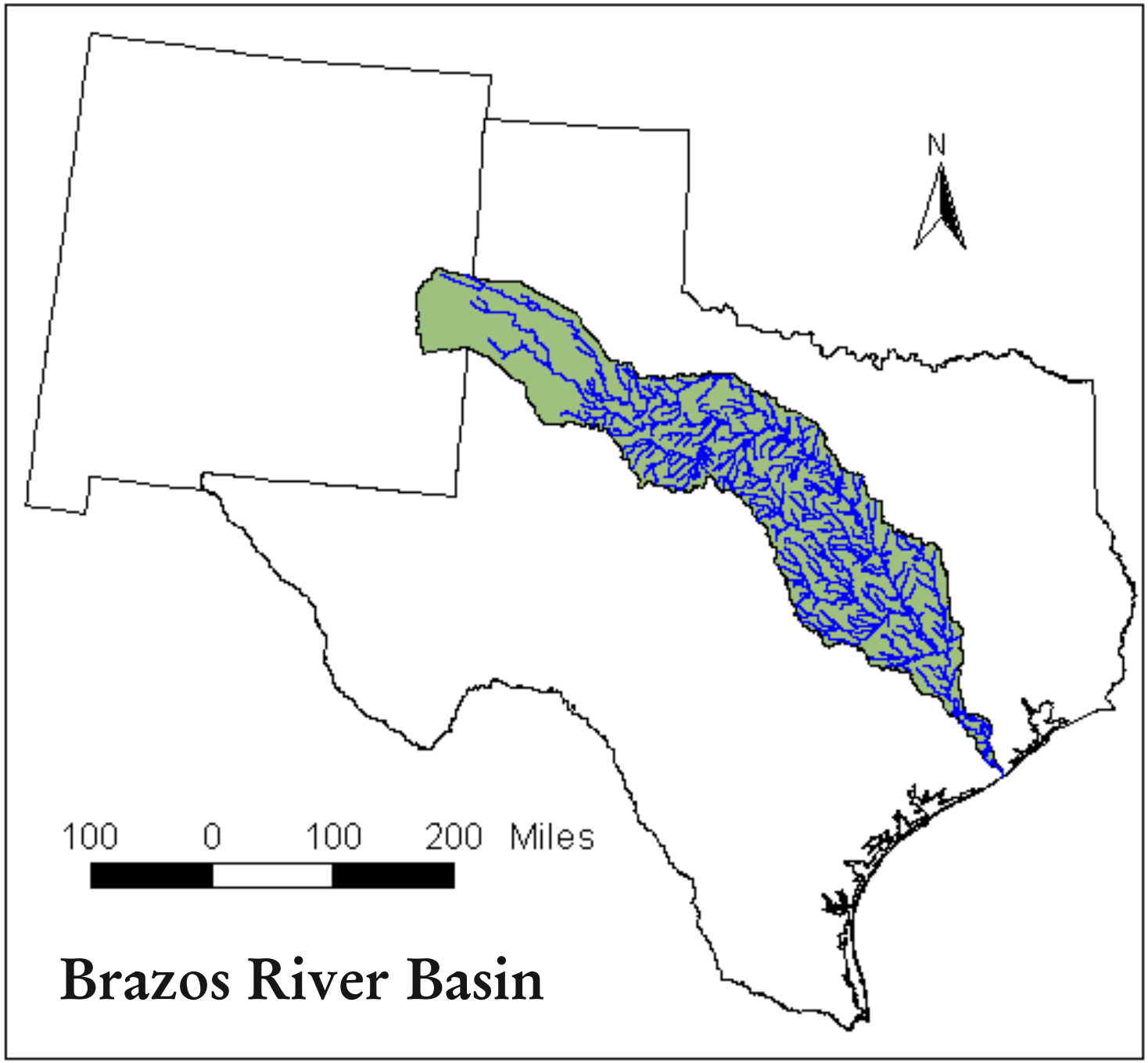
Day et al. 1989

High rainfall





Arid


N
100 0 100 200 Miles
Brazos River Basin


3.72 km
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2017 Google

United States Geological Survey Gage 08116650, Brazos River near Rosharon

Season	Subsistence	Hydrologic Condition	Base	Dry Condition Seasonal Pulse	Average Condition Seasonal Pulse	Wet Condition Seasonal Pulse
Winter	430 cfs	Dry	1,140 cfs	1 per season Trigger: 9,090 cfs Volume: 94,700 af Duration: 12 days	3 per season Trigger: 9,090 cfs Volume: 94,700 af Duration: 12 days	2 per season Trigger: 13,600 cfs Volume: 168,000 af Duration: 16 days
		Average	2,090 cfs			
		Wet	4,700 cfs			
Spring	430 cfs	Dry	1,250 cfs	1 per season Trigger: 6,580 cfs Volume: 58,500 af Duration: 10 days	3 per season Trigger: 6,580 cfs Volume: 58,500 af Duration: 10 days	2 per season Trigger: 14,200 cfs Volume: 184,000 af Duration: 18 days
		Average	2,570 cfs			
		Wet	4,740 cfs			
Summer	430 cfs	Dry	930 cfs	1 per season Trigger: 2,490 cfs Volume: 14,900 af Duration: 6 days	3 per season Trigger: 2,490 cfs Volume: 14,900 af Duration: 6 days	2 per season Trigger: 4,980 cfs Volume: 39,100 af Duration: 9 days
		Average	1,420 cfs			
		Wet	2,630 cfs			

cfs = cubic feet per second
af = acre-feet
N/A = not applicable

*** Default Freshwater Inflow Standards for Brazos River Estuary is the freshwater inflow standard for this gage site**

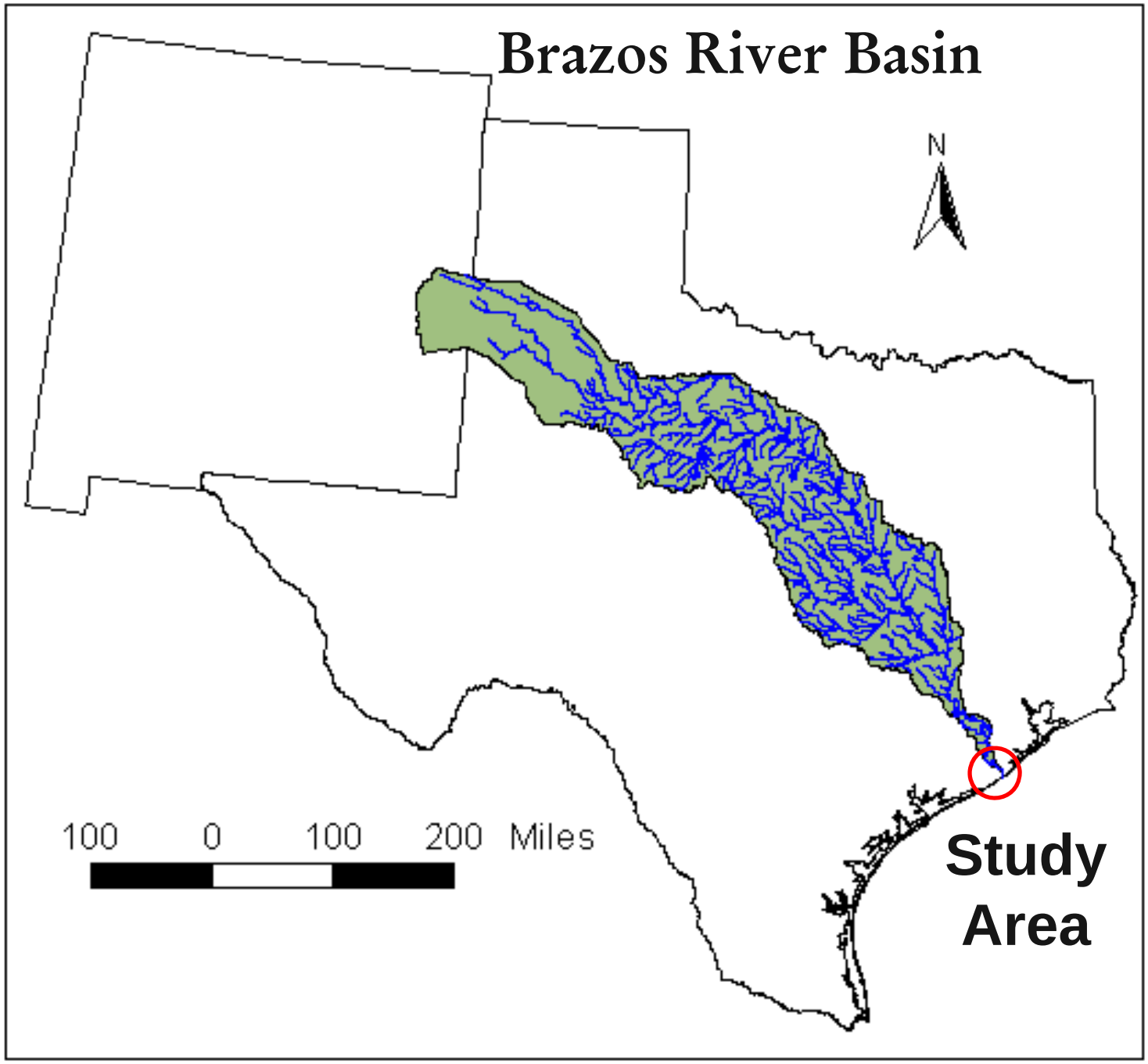
Study Objectives

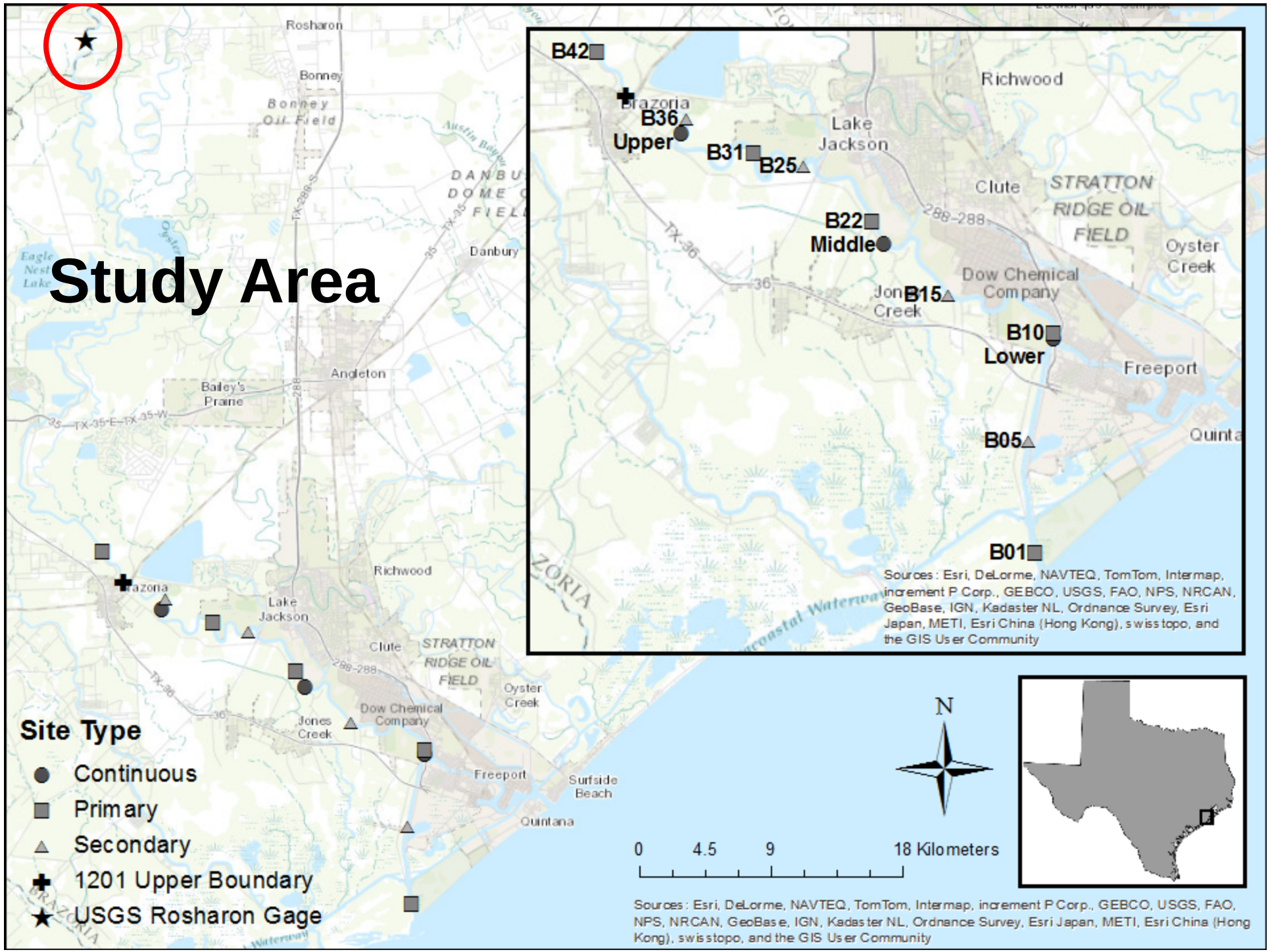
1. Describe the freshwater inflow regime, and water quality (salinity, dissolved oxygen) of the tidal portion of the Brazos River

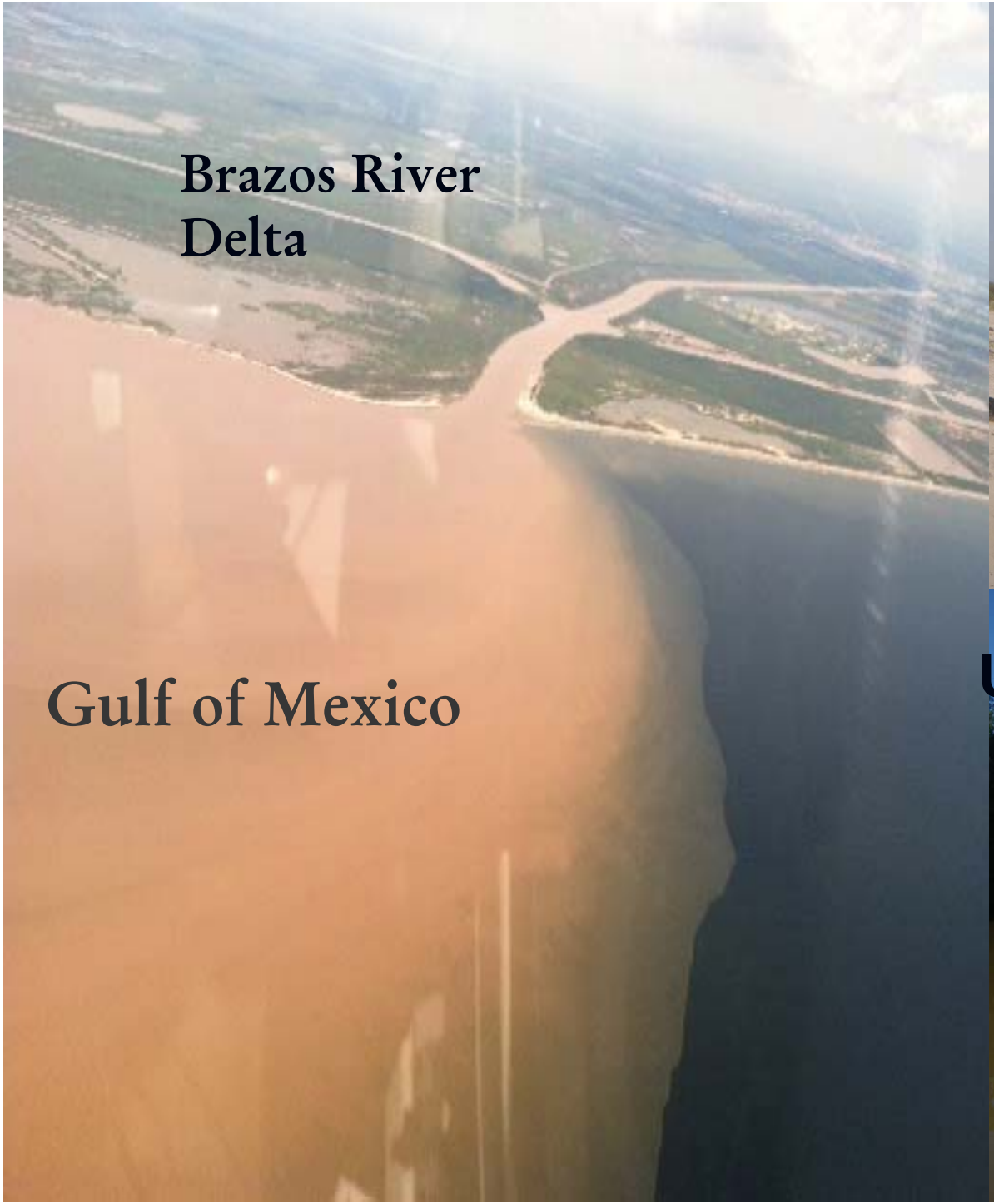
2. Characterize and describe the response of nekton community including density, composition and metrics to various flow regimes

Data Collection

- Miller 2014 (Jan-Dec 2012 nekton data) – 12 events.
- Phase 1: (Nov. ‘14 – May ’15) – 10 events
- Phase 2: (Dec. ‘16-May ’17) - 6 events (some additional ongoing work)

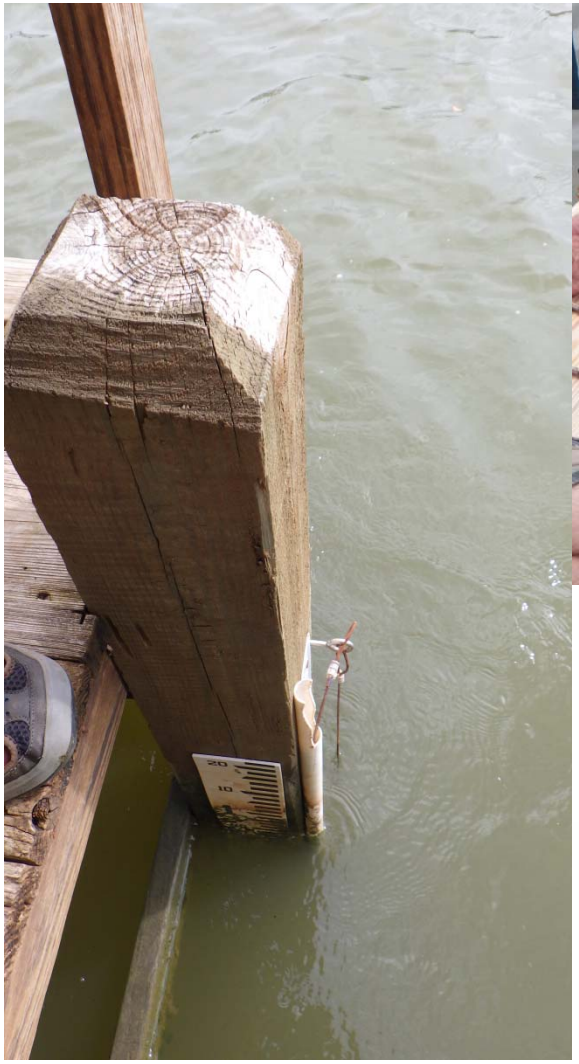

Brazos River Basin
N
100 0 100 200 Miles
Study Area

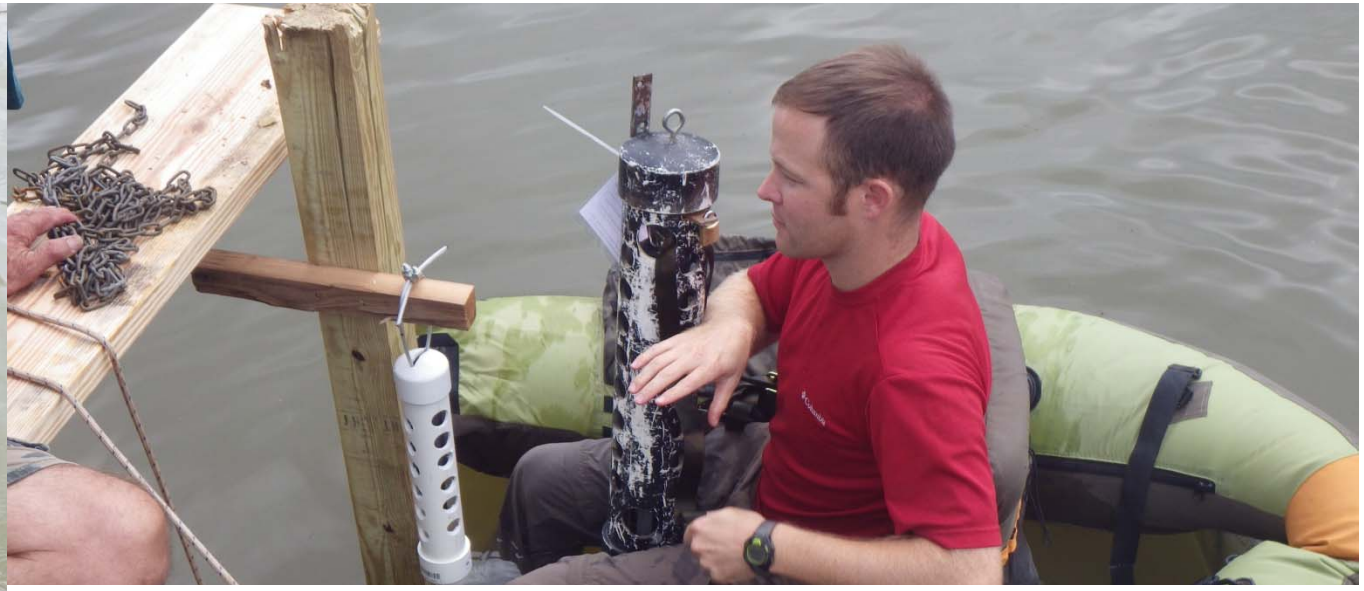

Study Area
B42
B36
Upper
B31
B25
B22
Middle
B15
B10
Lower
B05
B01
Richwood
Lake Jackson
Clute
STRATTON RIDGE OIL FIELD
Oyster Creek
Dow Chemical Company
Freeport
Quintana
Angleton
Danbury
Rosharon
Bonney
Bonney Oil Field
Bailey's Prairie
Jones Creek
Surfside Beach
Site Type
Continuous
Primary
Secondary
1201 Upper Boundary
USGS Rosharon Gage
N
0
4.5
9
18 Kilometers
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


Brazos River
Delta
Gulf of Mexico


Downstream site
1 km from mouth.


Upstream Site 42 km



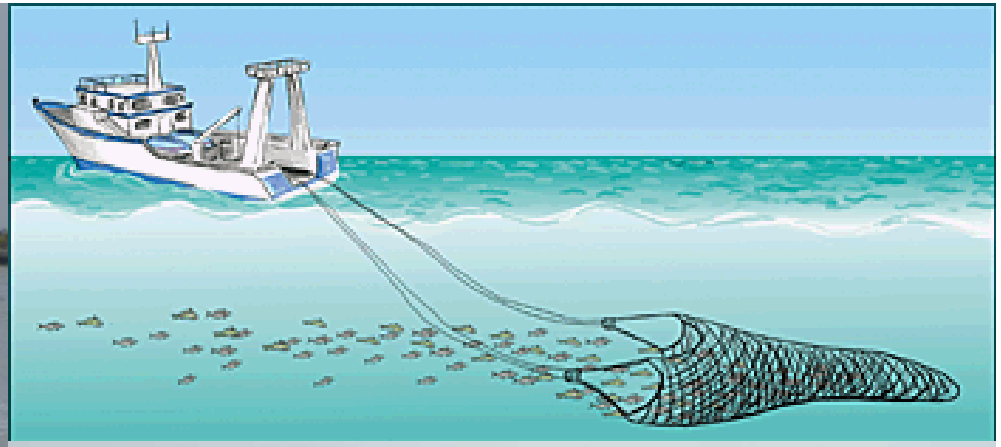


Water Level Recorder

Water Temp, Salinity, Dissolved Oxygen

Otter Trawl


Environmental Institute of Houston




Environmental Institute of Houston
Twin Vee
EVINRUDE

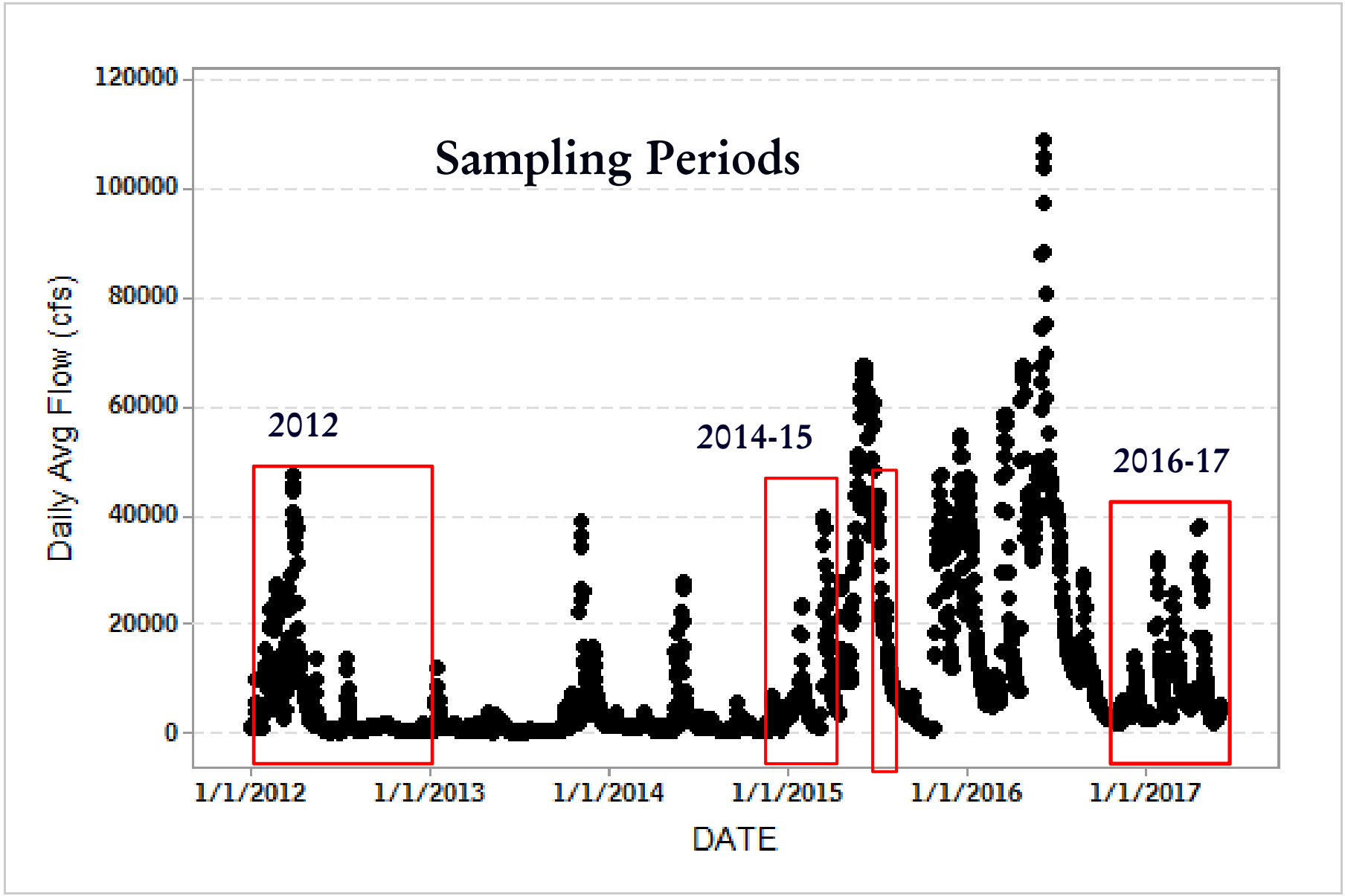

12/20/2016 09:31

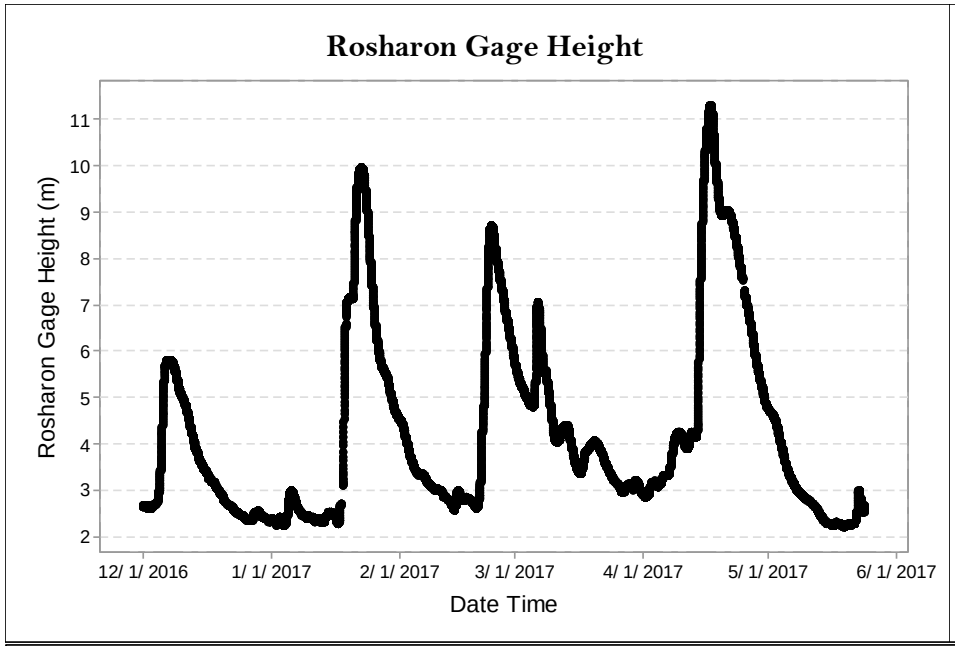
Data Analysis

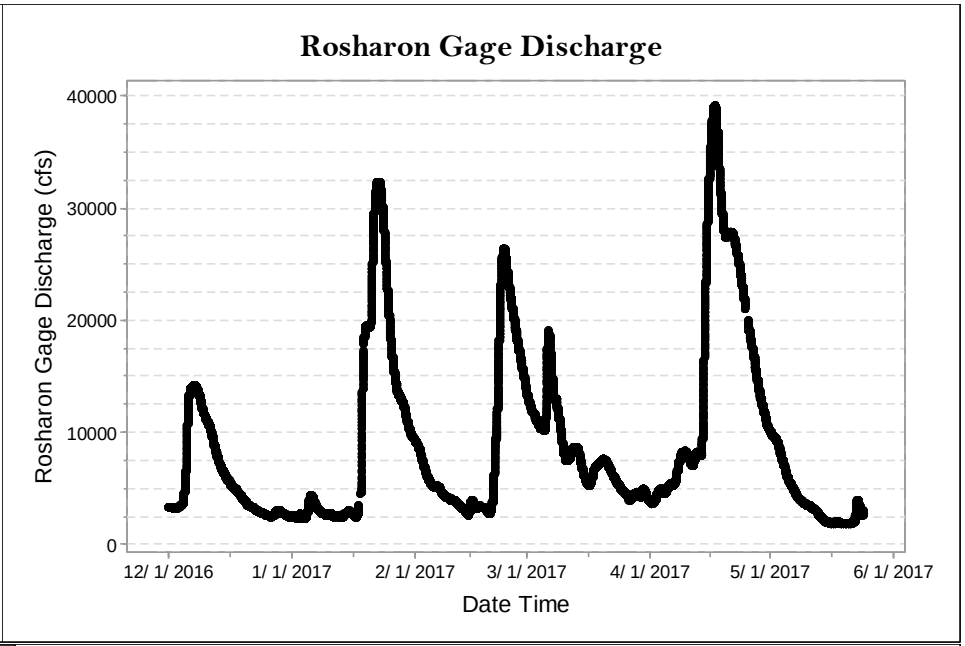
- Describe bottom water salinity, dissolved oxygen and nekton community versus flow regime
- PRIMER - Cluster analysis with SIMPROF, and nMDS
- ANOSIM – compare collection similarity

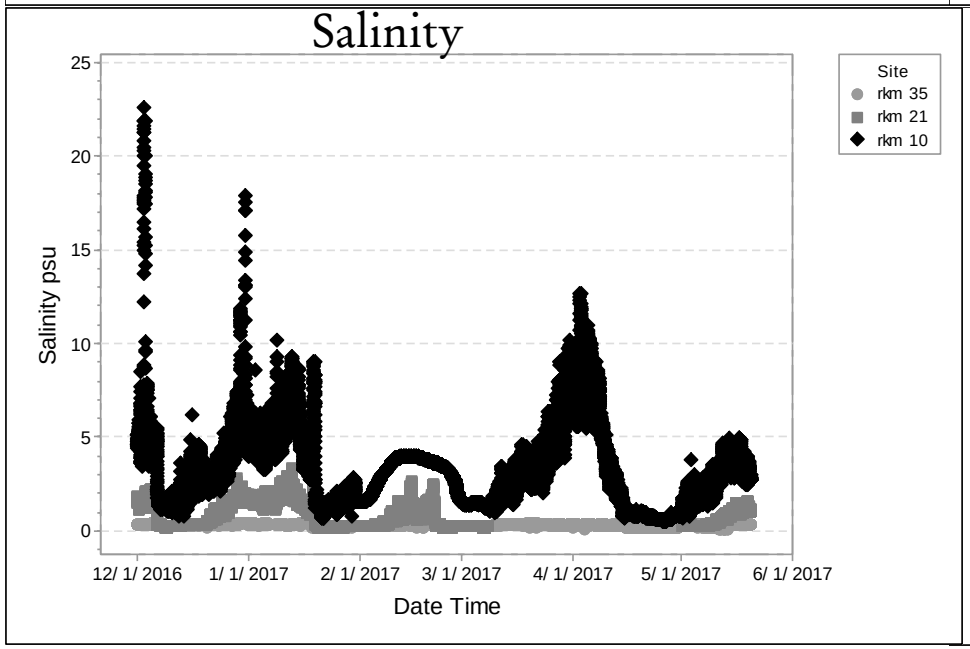
Results

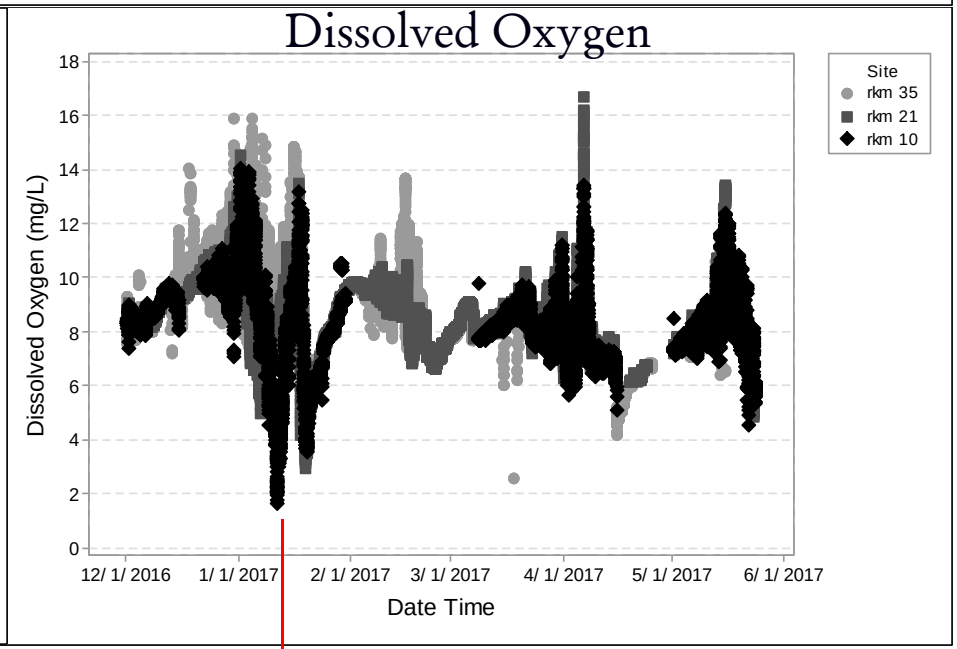
Hydrology vs. Salinity and Dissolved Oxygen


Sampling Periods
2012
2014-15
2016-17
Daily Avg Flow (cfs)
120000
100000
80000
60000
40000
20000
0
1/1/2012
1/1/2013
1/1/2014
1/1/2015
1/1/2016
1/1/2017
DATE


Rosharon Gage Height
Rosharon Gage Height (m)
11
10
9
8
7
6
5
4
3
2
12/ 1/ 2016
1/ 1/ 2017
2/ 1/ 2017
3/ 1/ 2017
4/ 1/ 2017
5/ 1/ 2017
6/ 1/ 2017
Date Time


Rosharon Gage Discharge
Rosharon Gage Discharge (cfs)
40000
30000
20000
10000
0
12/ 1/ 2016
1/ 1/ 2017
2/ 1/ 2017
3/ 1/ 2017
4/ 1/ 2017
5/ 1/ 2017
6/ 1/ 2017
Date Time

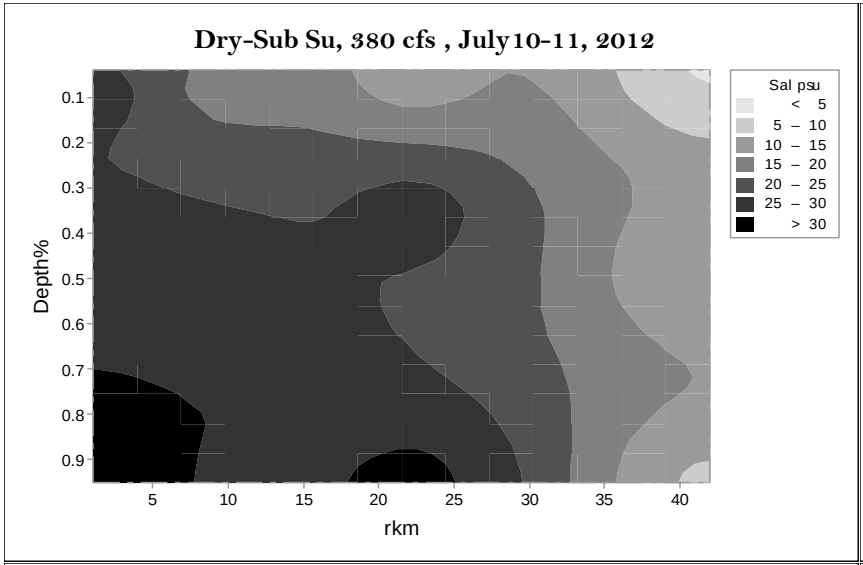

Salinity
Salinity psu
25
20
15
10
5
0
Site
rkm 35
rkm 21
rkm 10
12/ 1/ 2016
1/ 1/ 2017
2/ 1/ 2017
3/ 1/ 2017
4/ 1/ 2017
5/ 1/ 2017
6/ 1/ 2017
Date Time

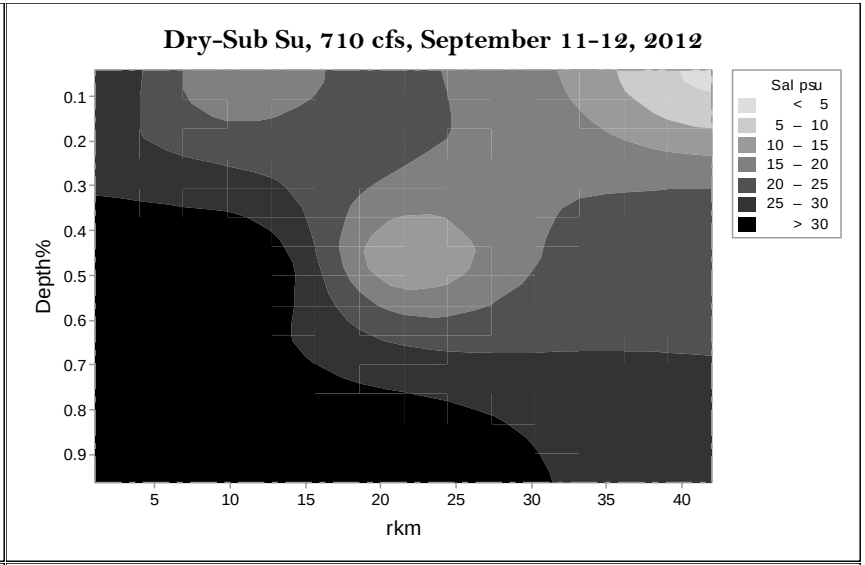

Dissolved Oxygen
Dissolved Oxygen (mg/L)
18
16
14
12
10
8
6
4
2
0
Site
rkm 35
rkm 21
rkm 10
12/ 1/ 2016
1/ 1/ 2017
2/ 1/ 2017
3/ 1/ 2017
4/ 1/ 2017
5/ 1/ 2017
6/ 1/ 2017
Date Time

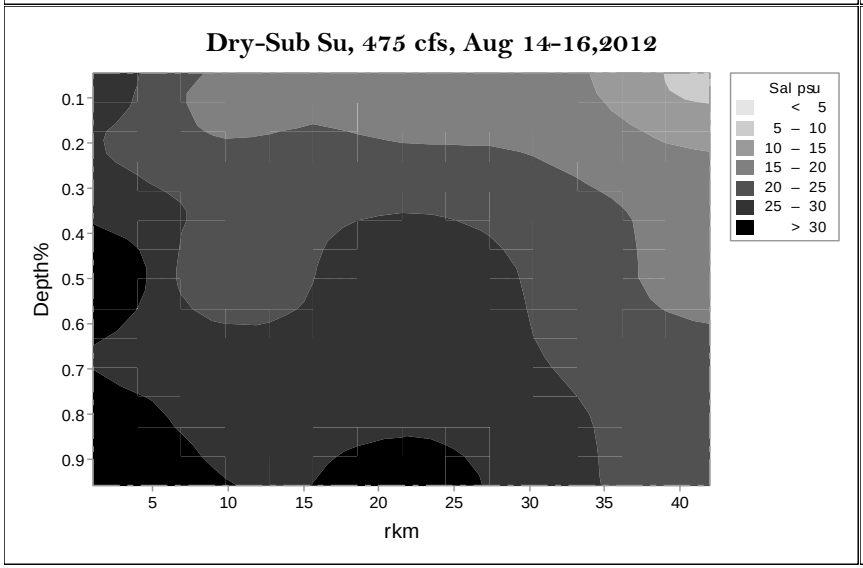
Winter 17

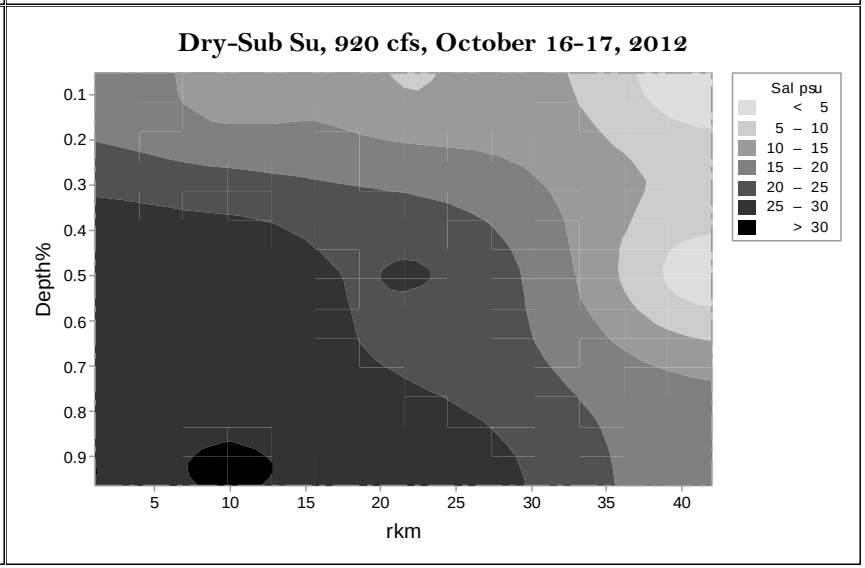
Salinity

Salinity – Dry, Subsistence Flow, Summer 2012

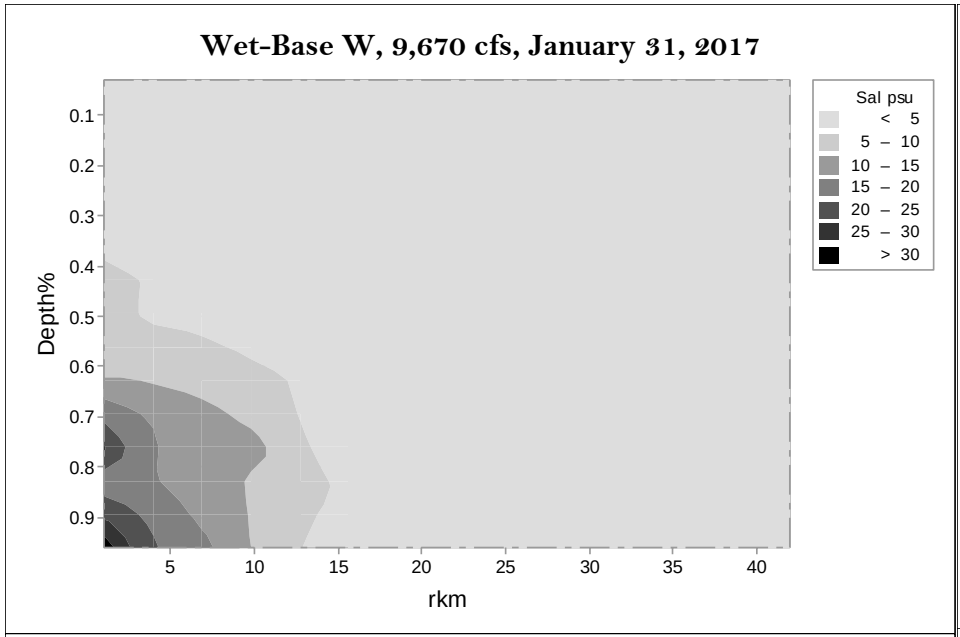


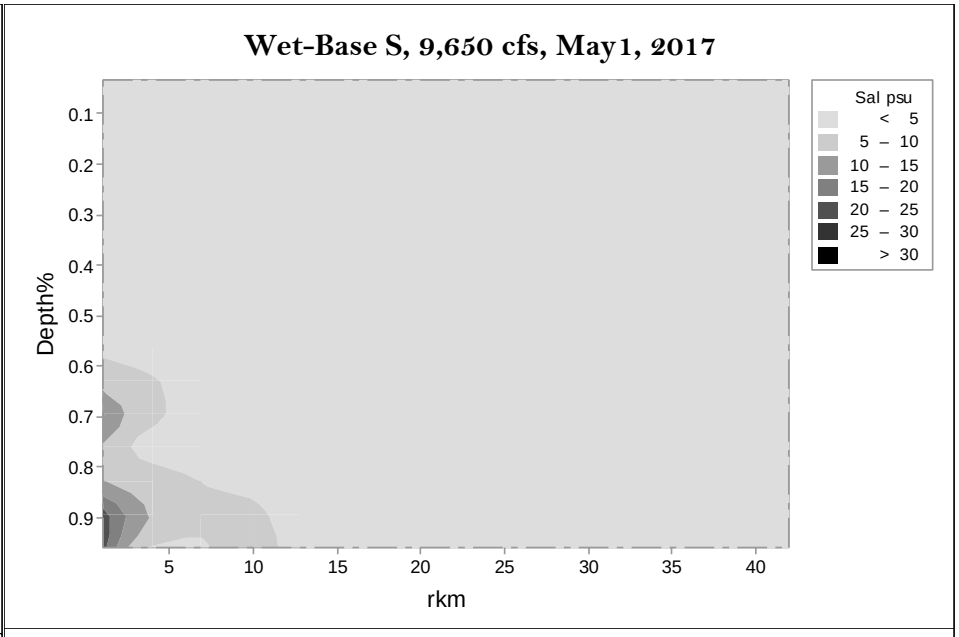


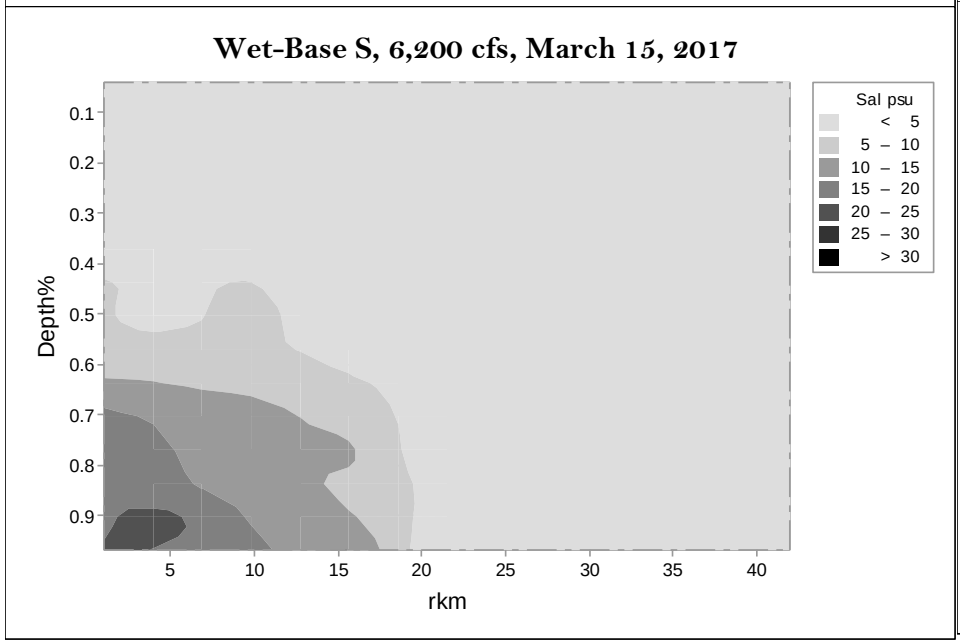


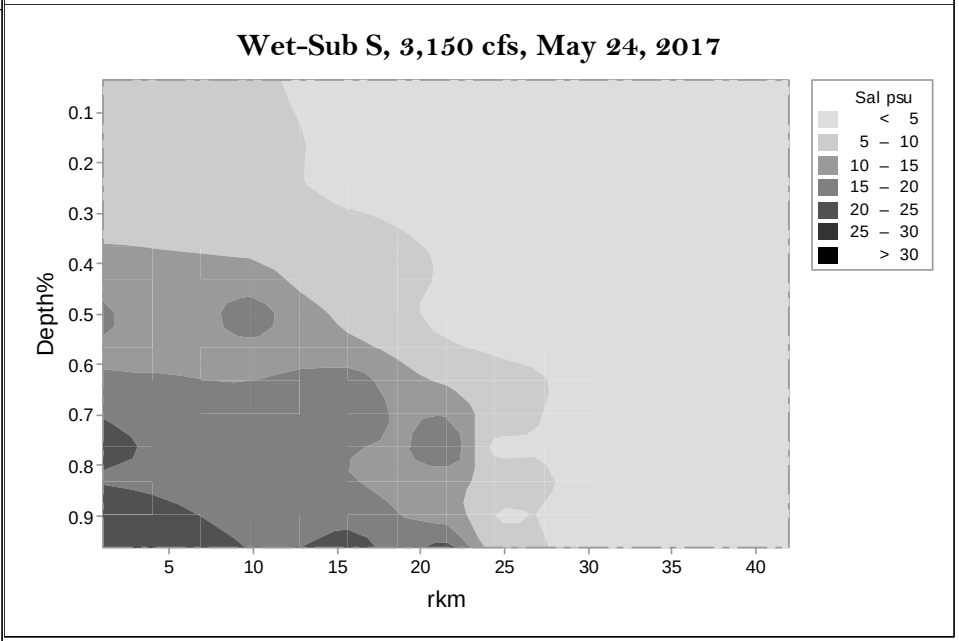


Salinity Wet Base, Wet and Subsistence Flow, Winter/Spring



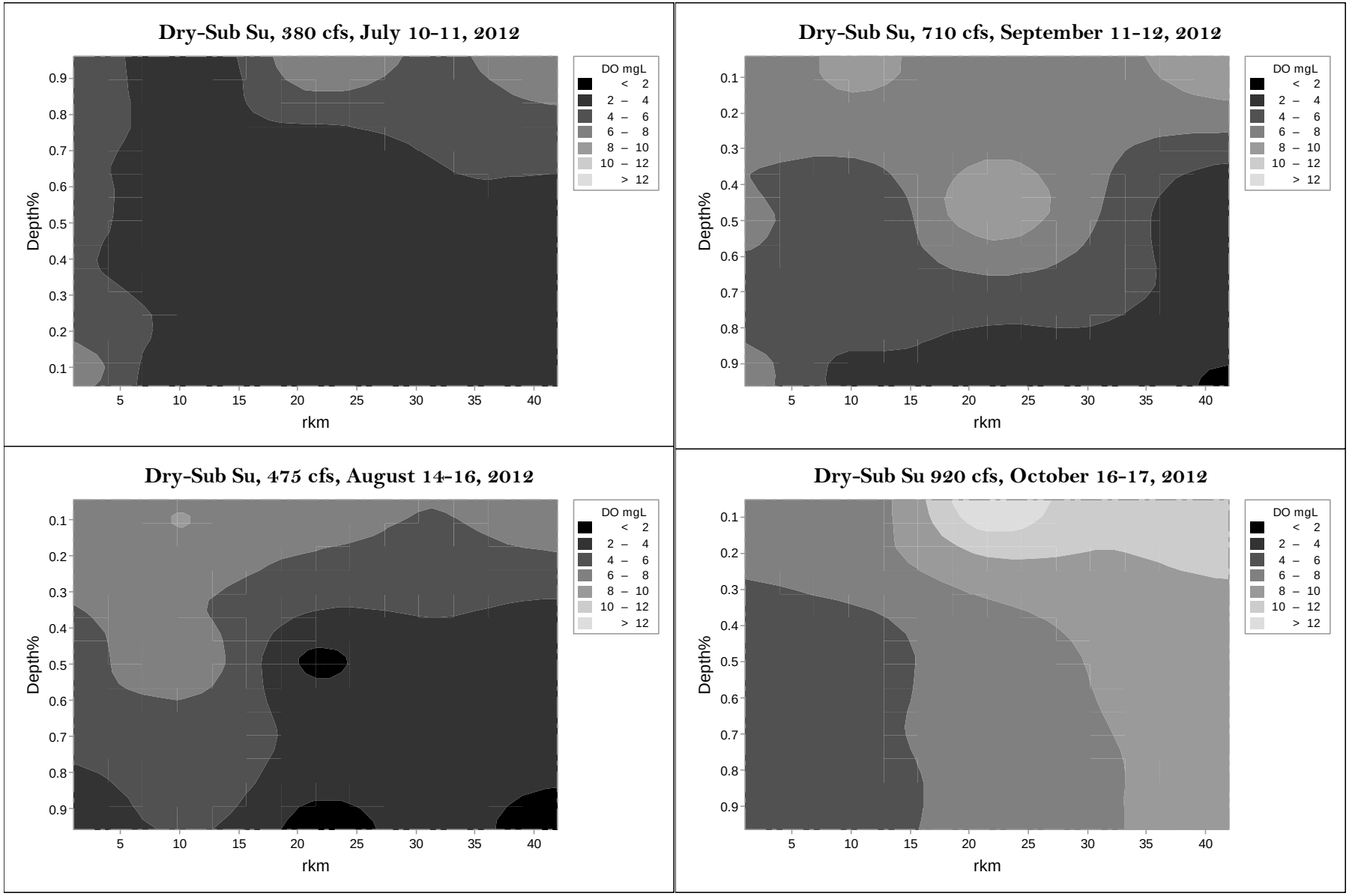




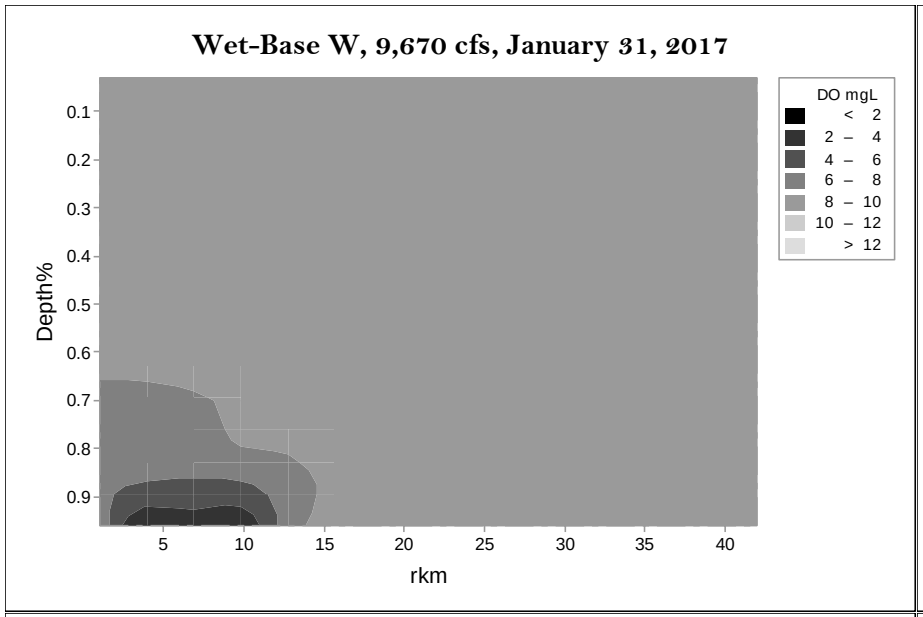


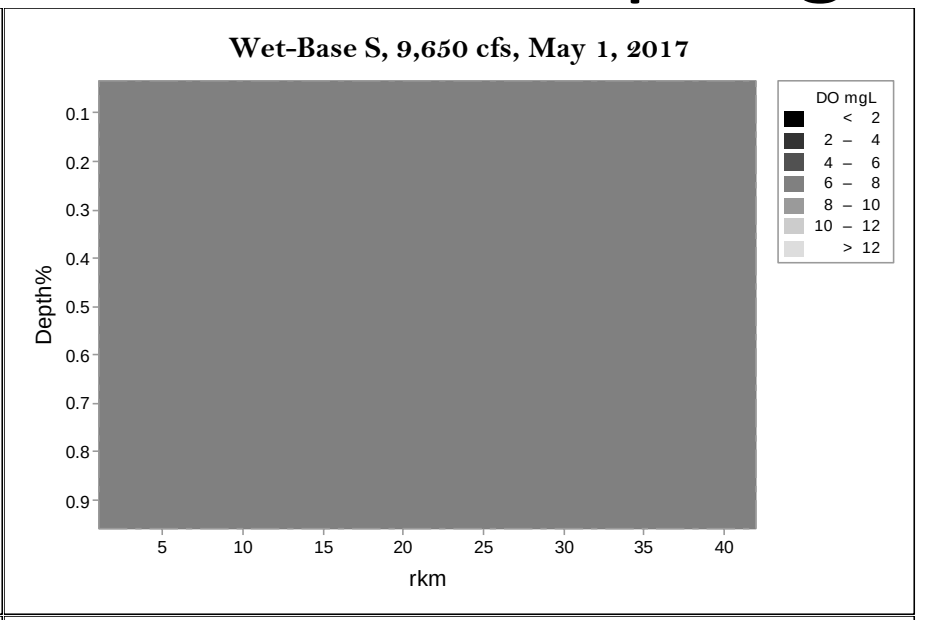
Dissolved Oxygen

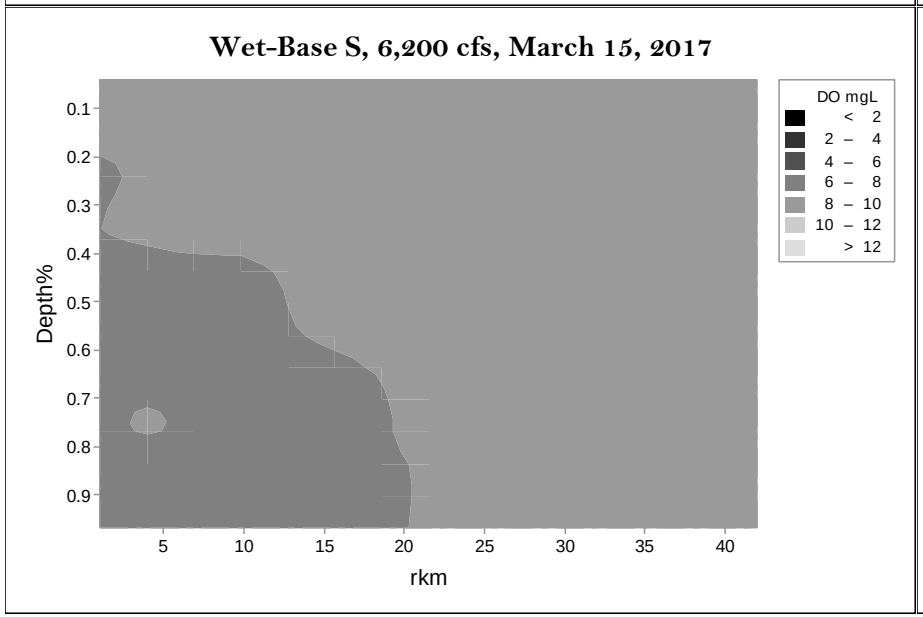
D.O. Dry Subsistence Flow - Summer

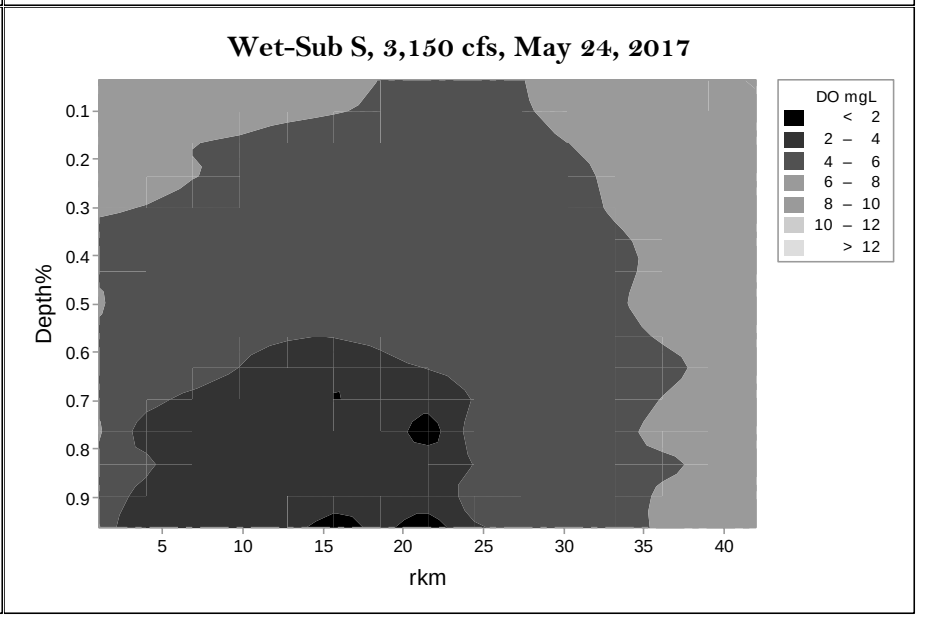


D.O. Wet Base/Sub Flow Winter, Spring



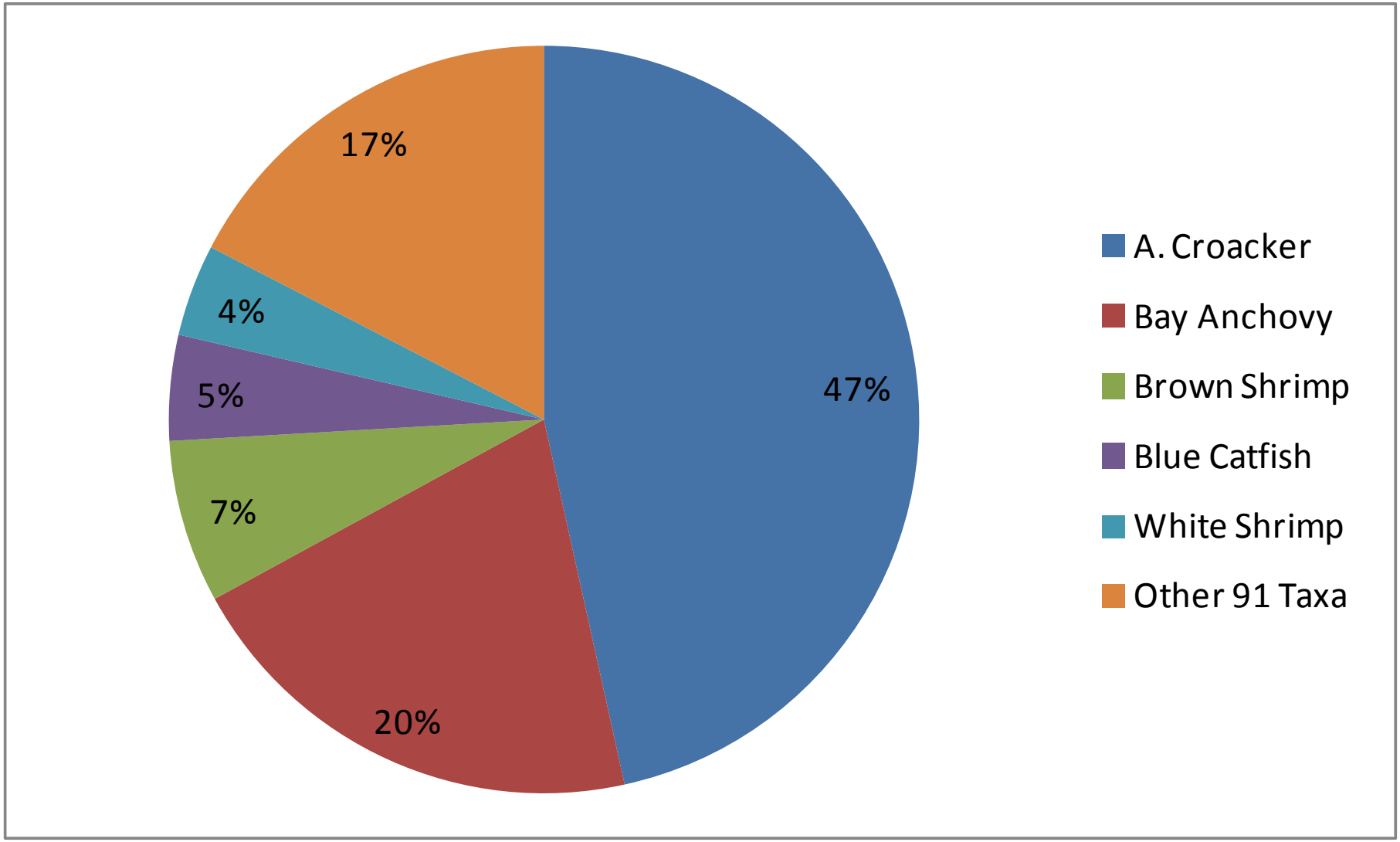






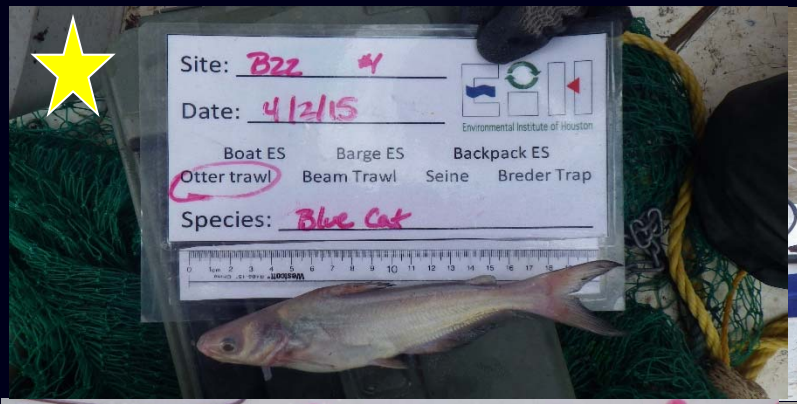
Biological Response

N=32,081 96 Taxa

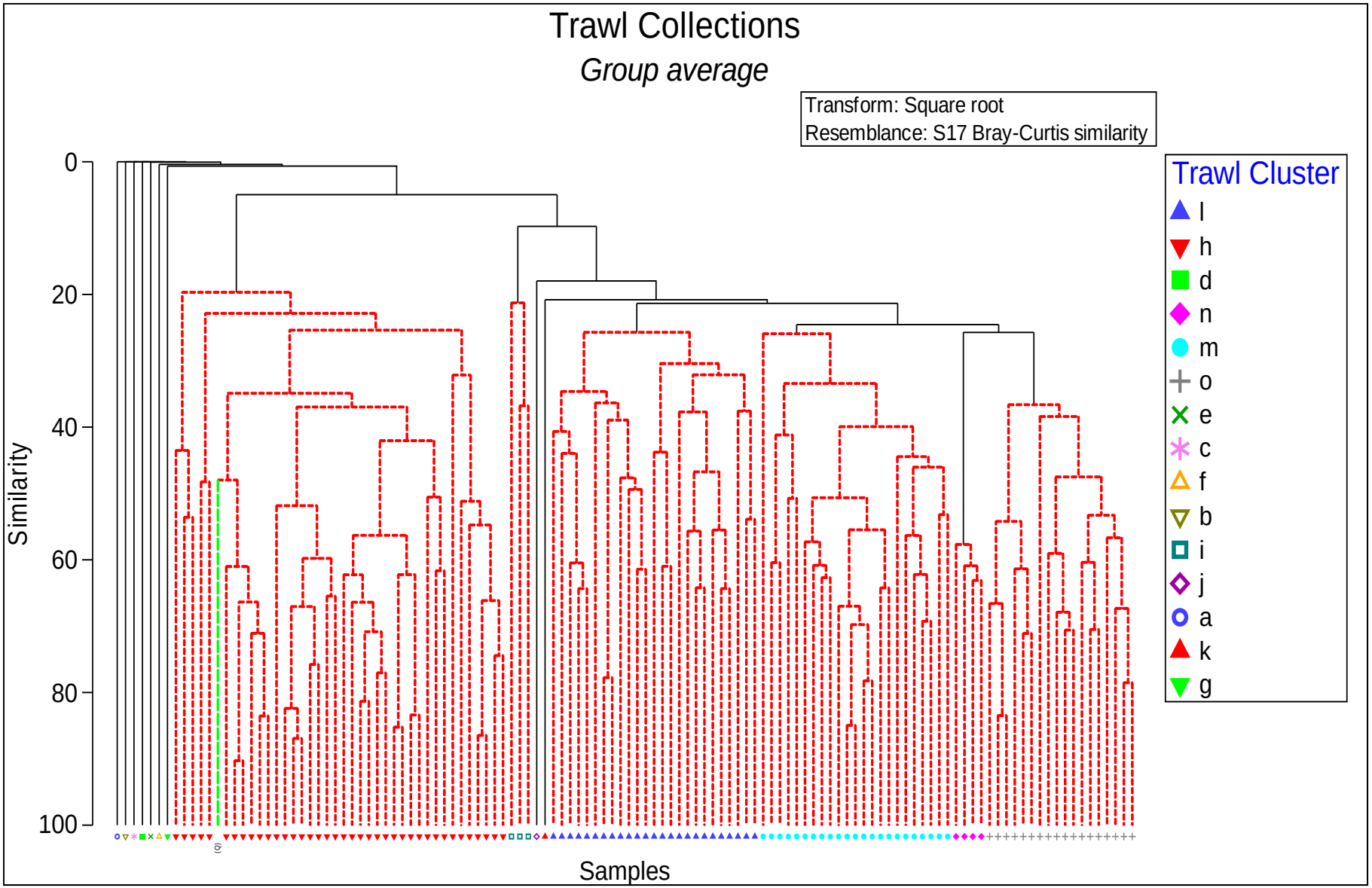


Marine and Estuarine Nekton

Freshwater Nekton



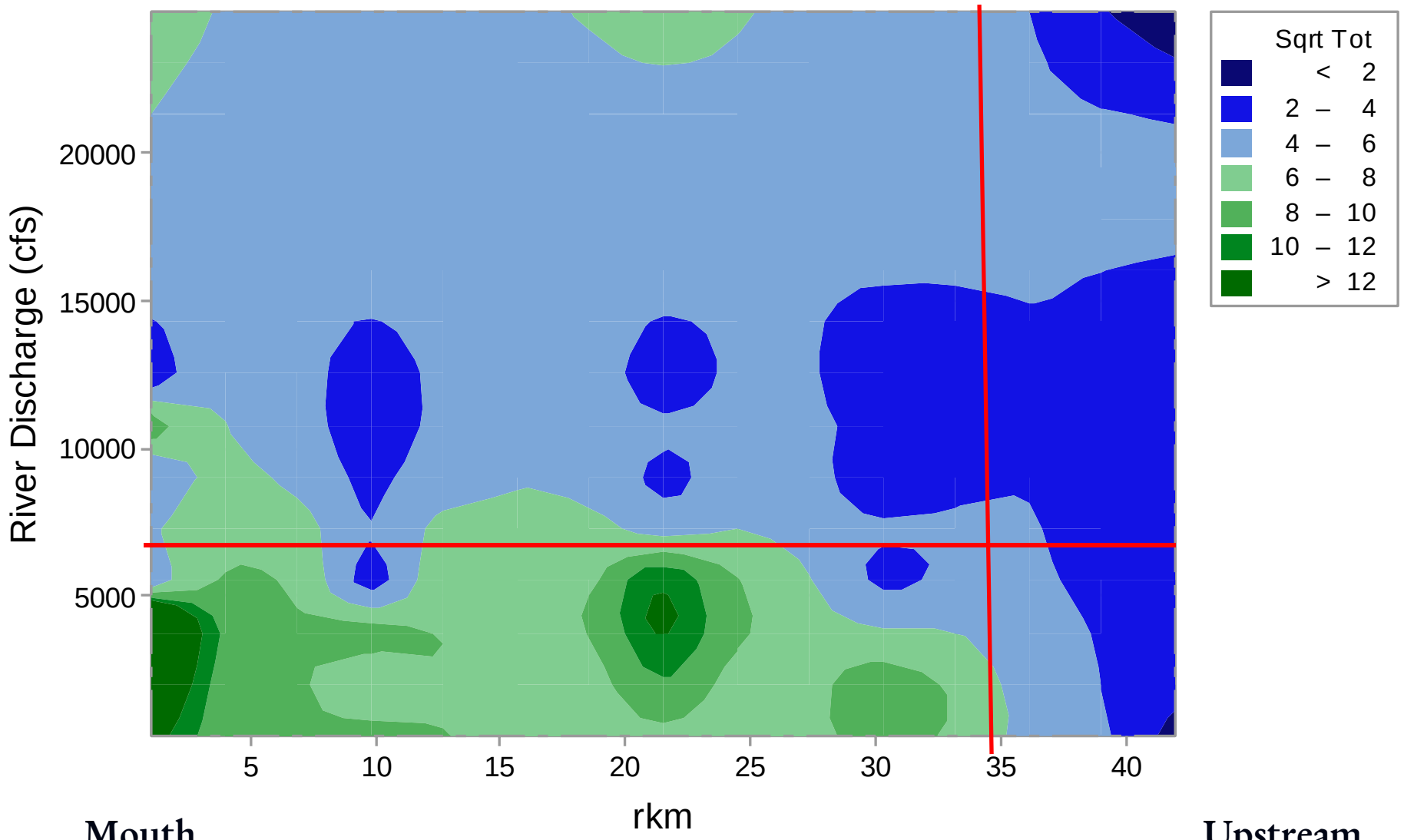
15 Groups of Collections Identified

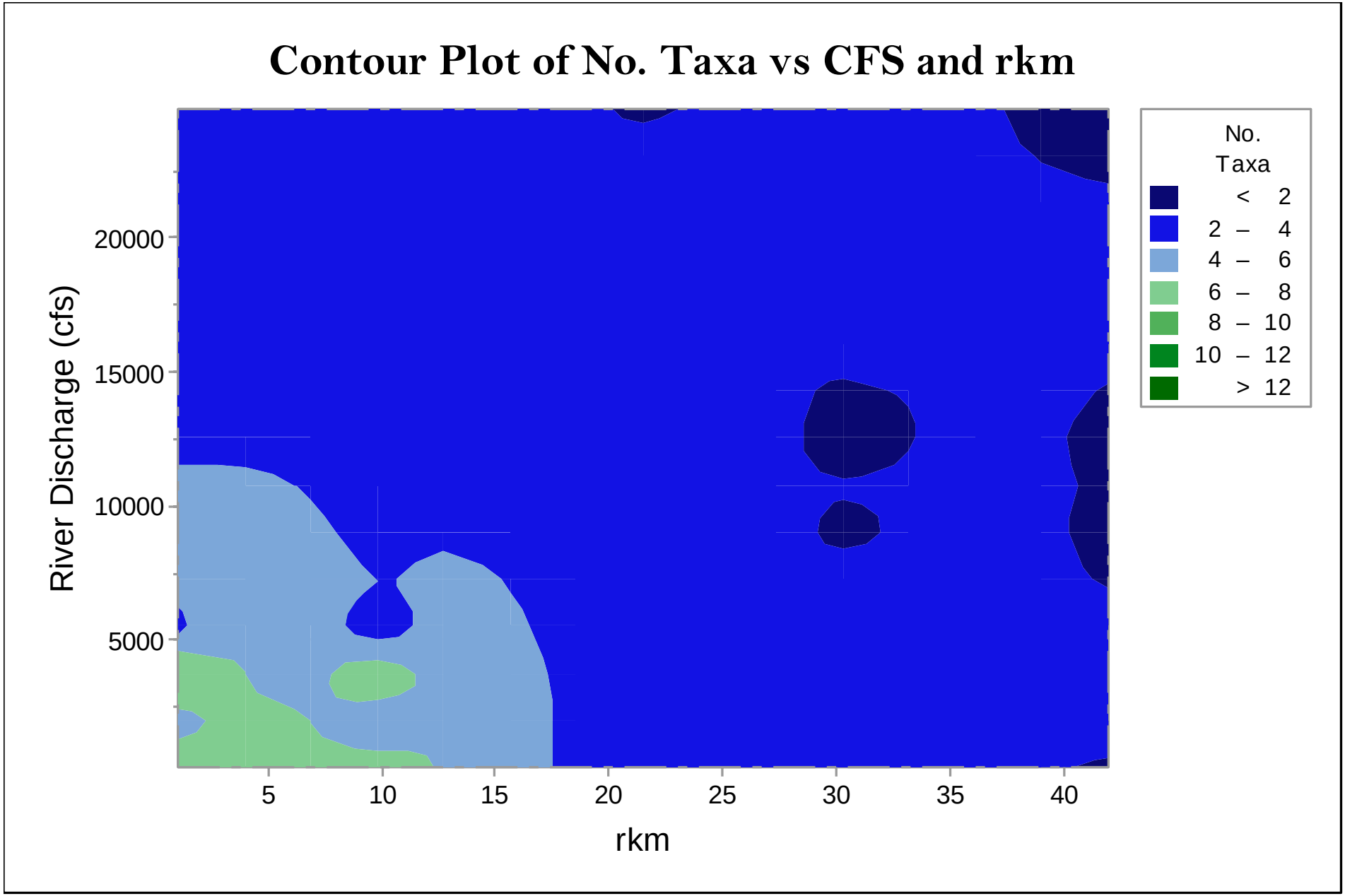


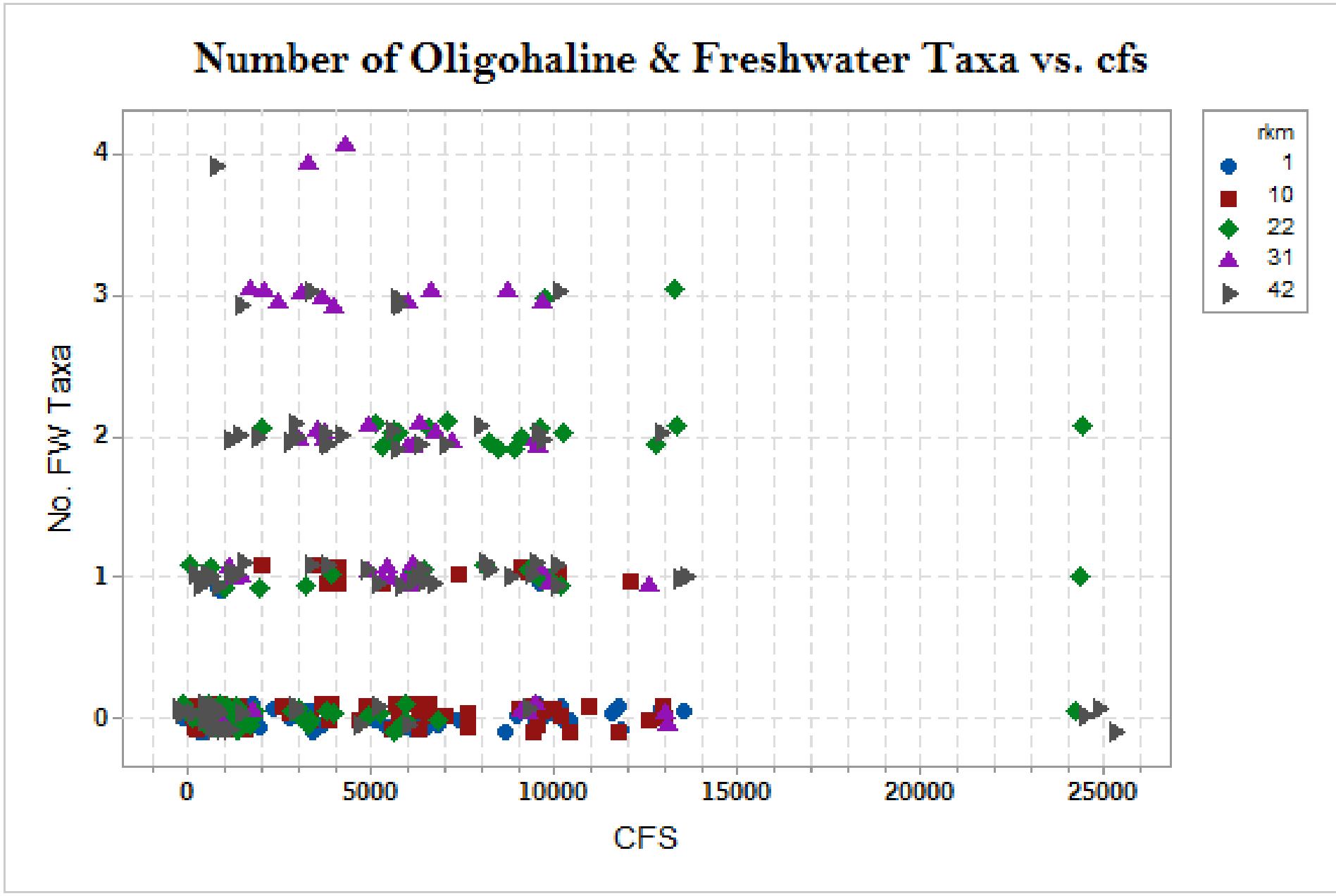
Most Significant Differences in Community Composition occurred between Dry (subsistence) and Wet or Peak (1, 2, 3ps) Flows

Otter Trawl Flow Tier Pair wise tests - ANOSIM					
Flow Tier	Flow Tier	Sig %	Flow Tier	Flow Tier	Sig %
Dry-1ps S	Avg-3ps S	0.10	Dry-Sub Su	Avg-3ps S	0.10
Dry-Base W	Avg-3ps S	0.30	Avg-Sub W	Avg-3ps S	0.10
Dry-Base W	Dry-Sub W	1.11	Dry-Sub W	Avg-3ps S	0.20
Dry-Sub S	Avg-3ps S	1.17	Avg-3ps S	Wet-2ps Su	0.40
Dry-Base S	Wet-Sub W	1.23	Avg-3ps S	Wet-Sub W	0.40
Dry-Sub S	Wet-Sub W	1.23	Avg-Sub W	Wet-Base S	1.10
Dry-Sub S	Avg-Sub W	2.34	Wet-Sub W	Wet-Base S	1.23
Dry-Base W	Wet-Sub W	2.47	Dry-Sub Su	Wet-Base S	1.30
Dry-Base S	Avg-Sub W	3.13	Dry-Sub W	Wet-Sub W	1.48

Contour Plot of Square Root (Abundance) vs. CFS and Rkm

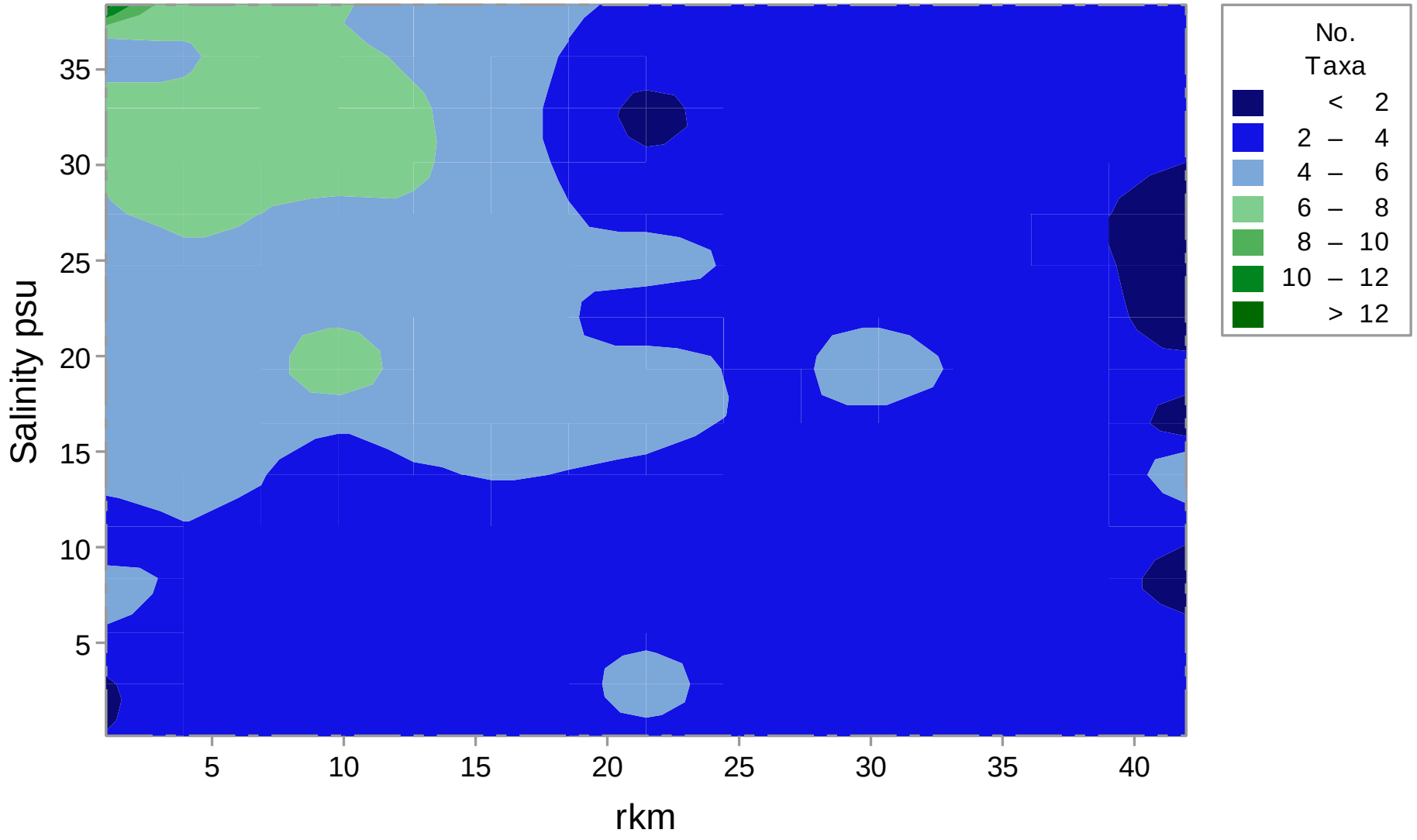


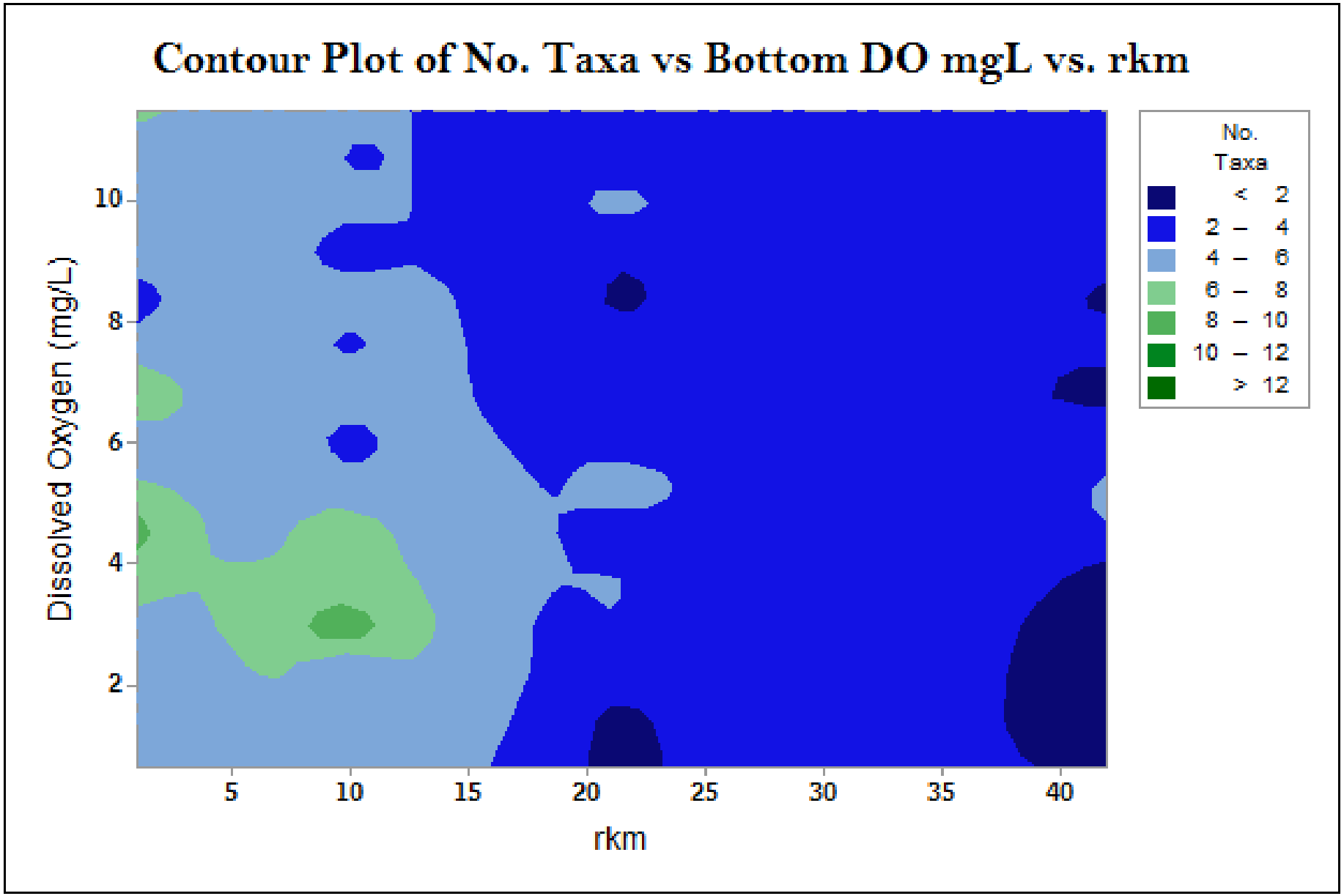

Contour Plot of No. Taxa vs CFS and rkm
River Discharge (cfs)
20000
15000
10000
5000
5
10
15
20
25
30
35
40
rkm
No. Taxa
< 2
2 – 4
4 – 6
6 – 8
8 – 10
10 – 12
> 12



< 2,000 cfs = 22-42 km; 2,000-15,000 cfs # taxa increases; 0 FW taxa @ rkm 42

Contour Plot of No. Taxa vs Bottom Sal vs. rkm




Contour Plot of No. Taxa vs Bottom DO mgL vs. rkm
Dissolved Oxygen (mg/L)
10
8
6
4
2
5
10
15
20
25
30
35
40
rkm
No. Taxa
< 2
2 – 4
4 – 6
6 – 8
8 – 10
10 – 12
> 12

Conclusions

- Salinity and dissolved oxygen responds rapidly to changes in freshwater inflow.
- *P*(hypoxia) lower when flow is high and salt wedge is reduced or pushed downstream
- Species composition sensitive to salinity change but some species exhibit strong seasonal response
- Spatial gradients related to salinity and dissolved oxygen are likely interacting with strong seasonal pulses of juvenile fish.

Future Work

- Targeted investigation of flow tiers during summer /early fall months currently lacking; critical period for dissolved oxygen
- Mark/recapture, length freq, otolith aging to evaluate growth of immigrating YOY fish vs. flow regime
- Stable isotope analysis – assess contribution of upstream nutrients to estuarine juvenile fauna
- Telemetry of larger fauna (alligator, juvenile bull shark)

Future Work

- Need to investigate role of discharge on nutrient and sediment transport and influence on nearshore GOM productivity and biological community and delta formation

Acknowledgments

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Questions?

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