Southwest Florida Tidal Creeks Nutrient Study

Presentation to the
Tampa Bay Estuary Program
Technical Advisory Committee

SARASOTA BAY ESTUARY PROGRAM
Restoring Our Bays

Janicki Environmental, Inc.

MOTE MARINE LABORATORY

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

October 22, 2015

Project Partners

Pinellas County

Environmental Protection Commission Hillsborough County

Manatee County Florida

Sarasota County

Charlotte County Florida 1921

Lee County Southwest Florida

Tampa Bay National Estuary Program

Sarasota Bay Estuary Program
Restoring Our Bays

United States Environmental Protection Agency

Charlotte Harbor National Estuary Program

Janicki Environmental, Inc.

Mote Marine Laboratory

Florida Fish and Wildlife Conservation Commission

Project Goals

- Accelerate the research
  (Wetlands Grant)

- Develop management level nutrient targets and thresholds
(Estuary Programs/Stakeholders)

- Recommend targets and thresholds for consideration as NNC
(FDEP/EPA)

Hierarchical Approach

Hierarchy 1: (Site-specific)

Level II Water Quality-Based Effluent Limitations,
Nutrient Total Maximum Daily Loads,
Site Specific Alternative Criteria,
Reasonable Assurance Plans, and
Estuary-specific Criteria

Hierarchy 2: Lakes/Springs

Stressor-Response Relationships (lakes & springs)

Hierarchy 3: Streams

Reference-based thresholds (streams)
combined with biological data (flora and fauna)

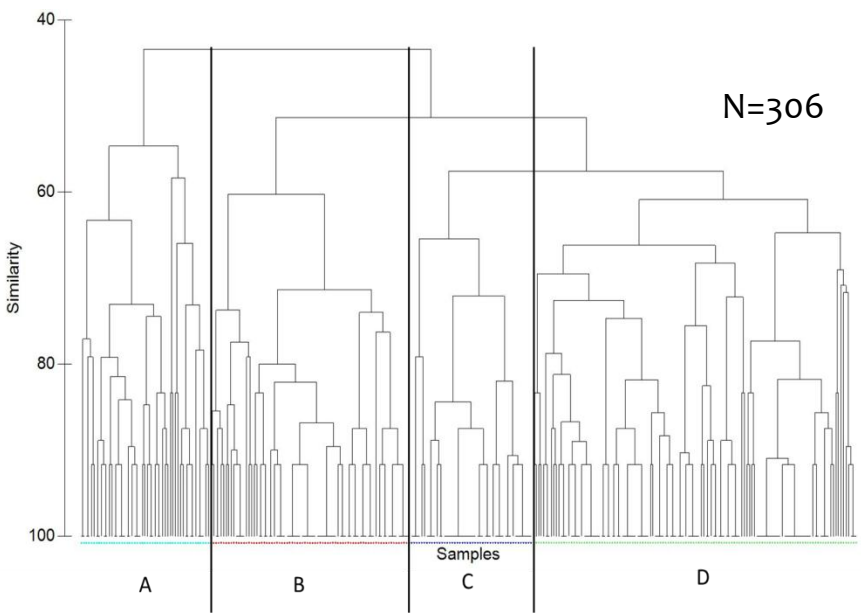
Hierarchy 4: Narrative

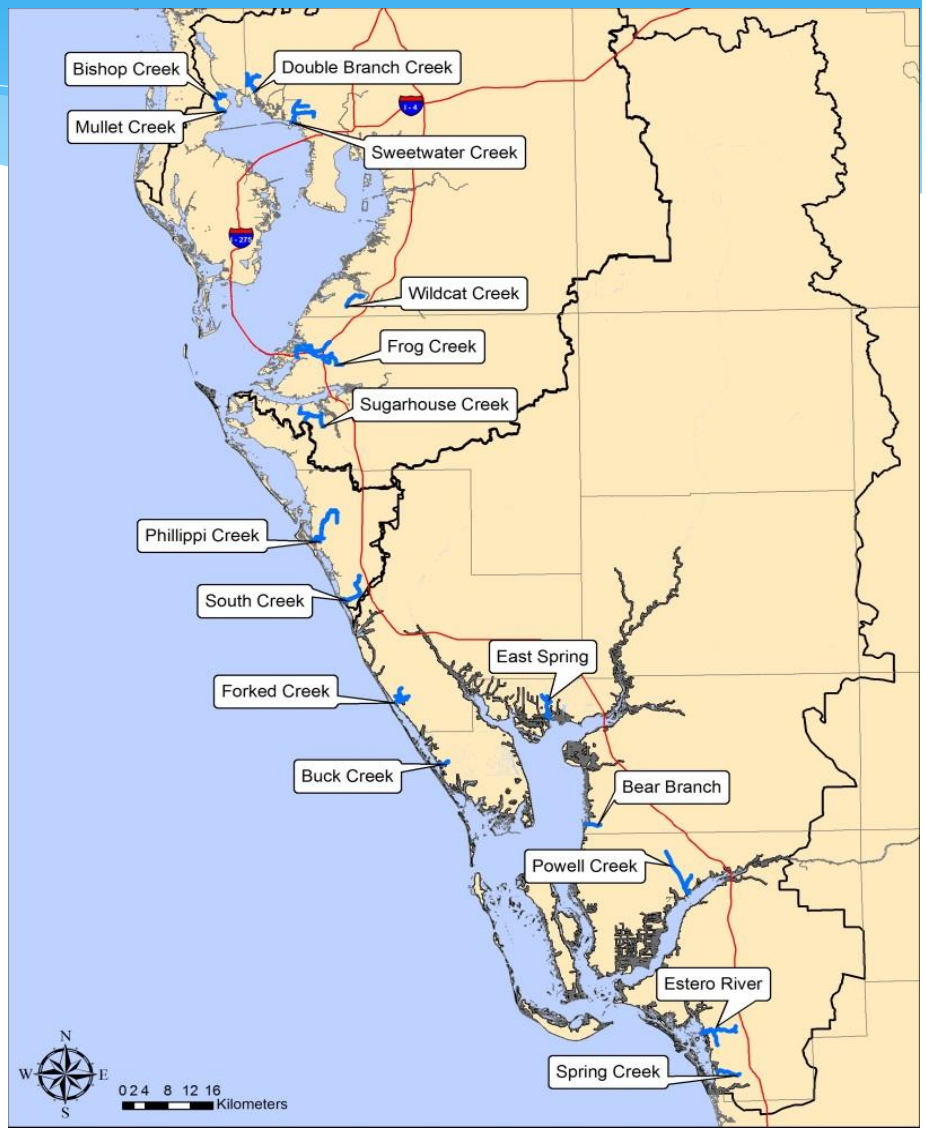
Ditches/canals used for water conveyance,
wetlands, non-perennial streams, tidally fluctuating areas, and
South Florida flowing waters

Project Goal

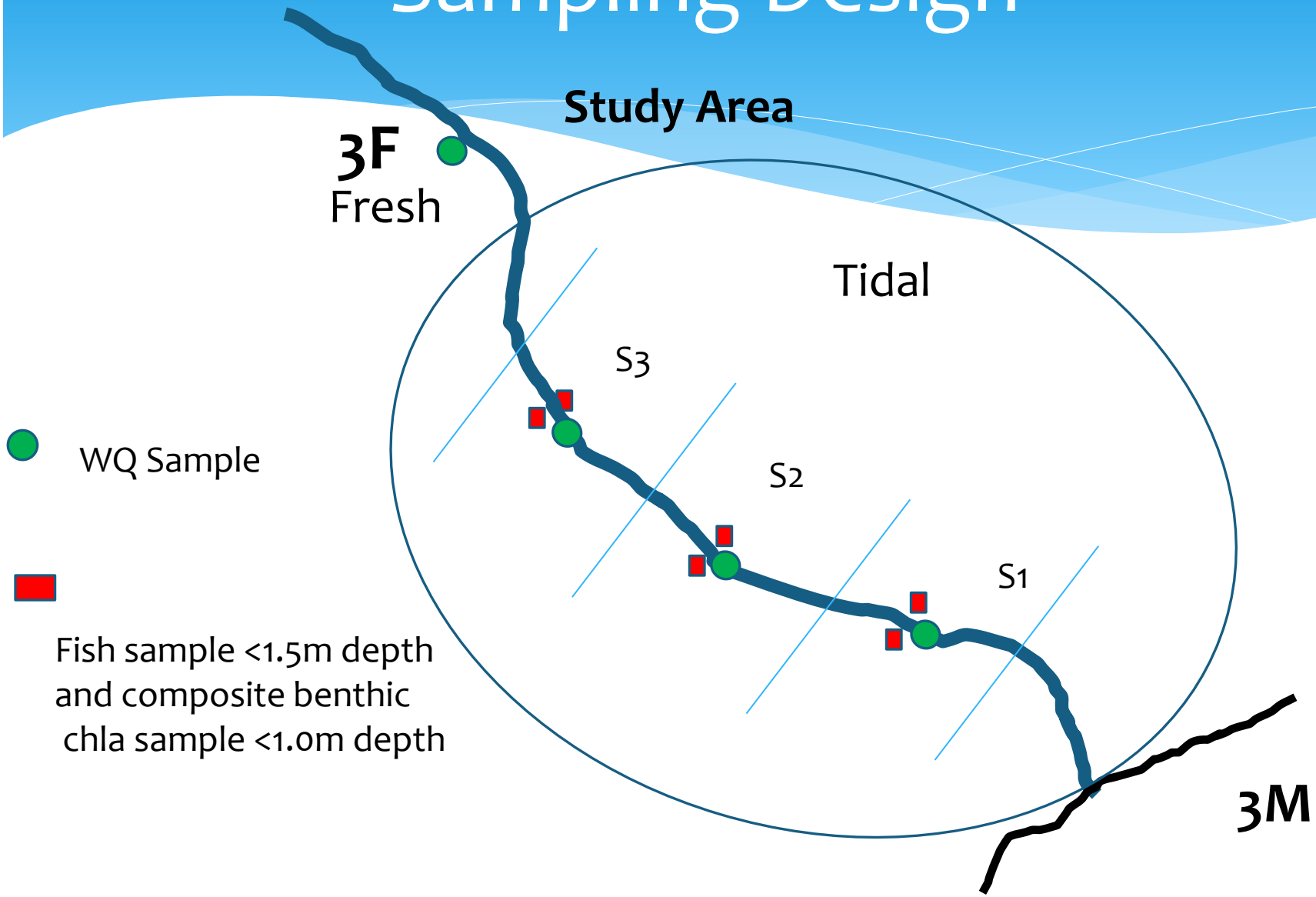
Final Selection (16 Creeks)

Creek Classification and Selection





Sampling Design



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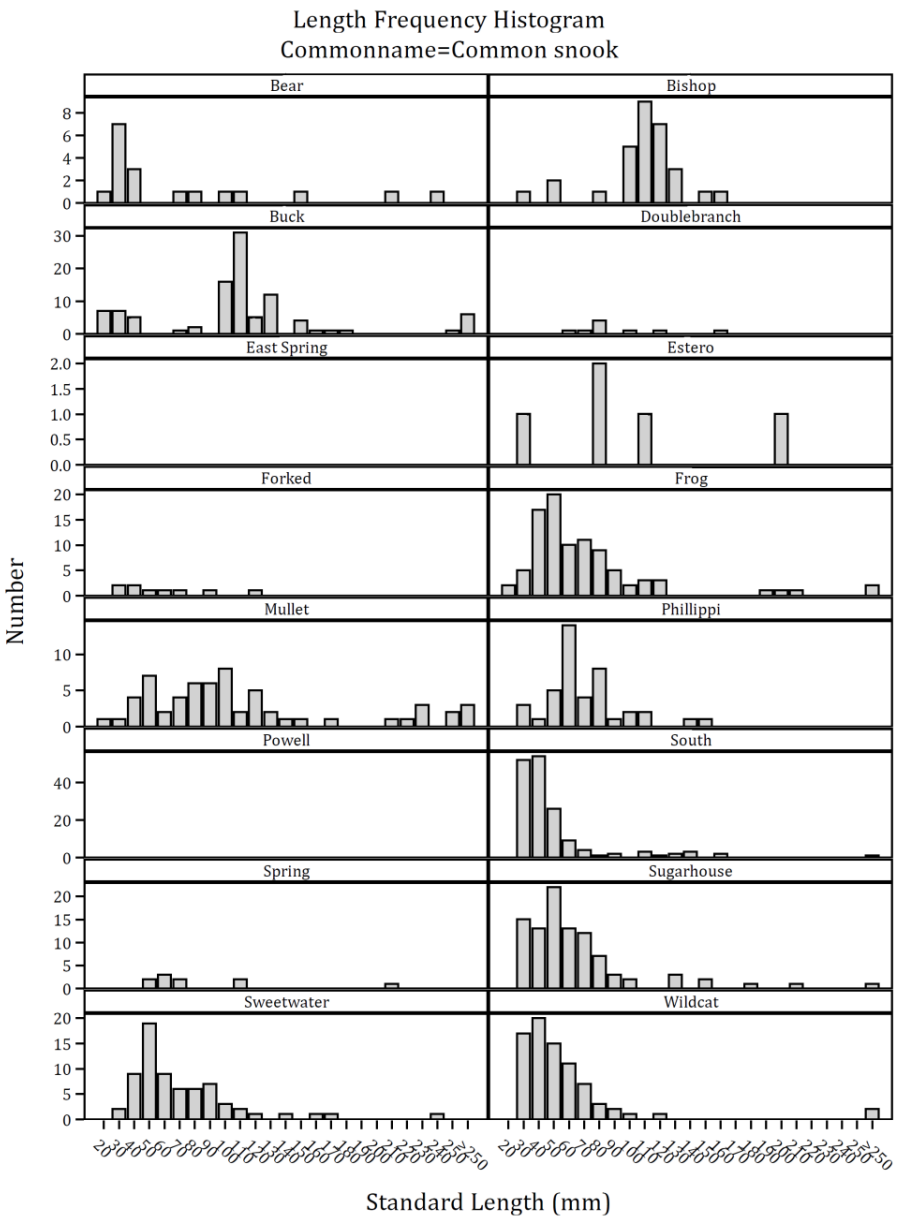
Fish Catch

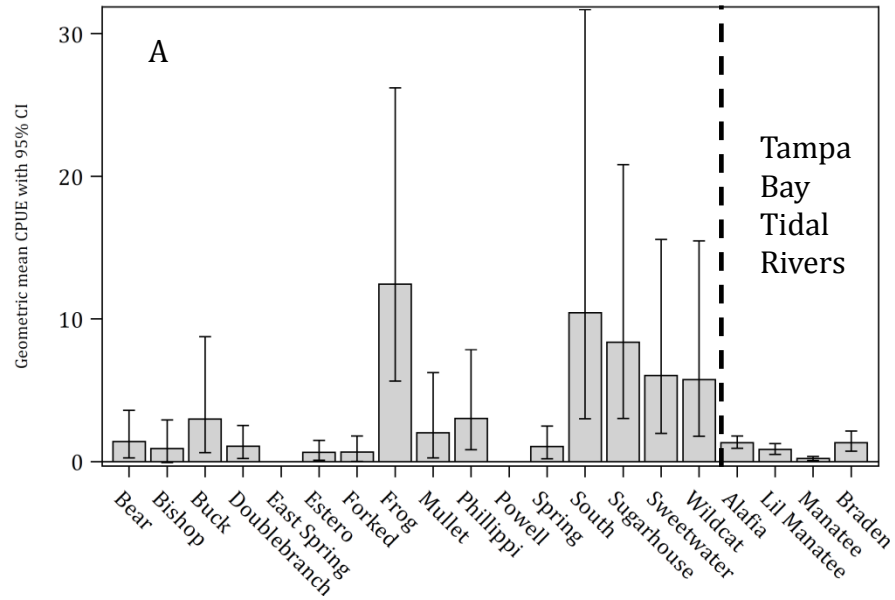
- Fish community structure includes important estuarine sportfish and their prey
- Catch rates for Snook suggest preferential habitat relative to larger rivers routinely monitored by FWC
- Size range for Snook important for population success and data Important for improving stock assessments

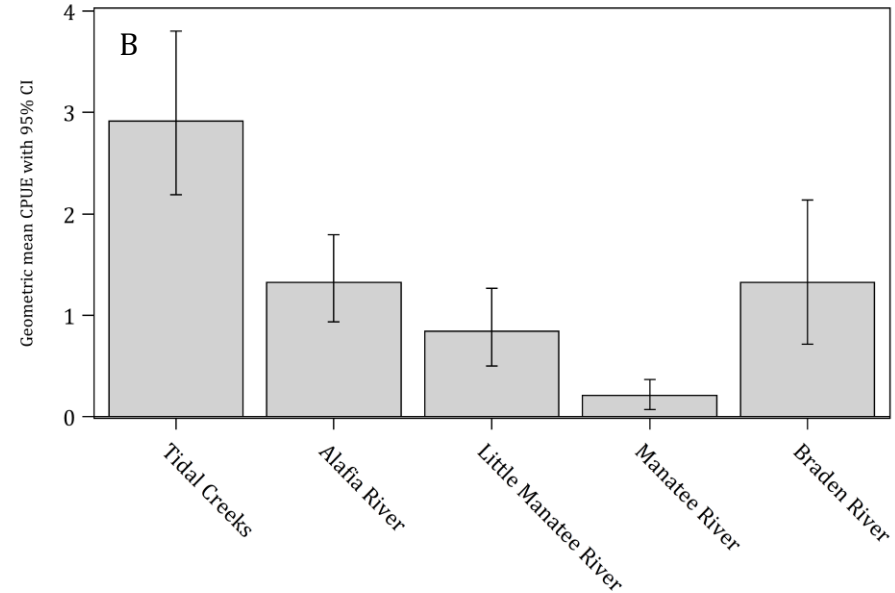
Table 1. Dominant fish and macro invertebrate taxa collected in 16 southwest Florida tidal creeks between November 2013 and September 2014.

Scientific Name	Common Name	Total Number Collected
Anchoa mitchilli	Bay Anchovy	15097
Eucinostomus spp.	Mojarra's < 40mm	11242
Palaemonetes pugio	Grass Shrimp	2837
Menidia spp.	Silversides	2555
Lucania parva	Rainwater Killifish	2086
Eucinostomus harengulus	Tidewater Mojarra	1921
Gambusia holbrooki	Eastern Mosquitofish	1125
Diapterus auratus	Irish Pompano	982
Centropomus undecimalis	**Common Snook**	**775**
Eugerres plumieri	Striped Mojarra	593
Trinectes maculatus	Hogchoker	561
Poecilia latipinna	Sailfin Molly	454
Lagodon rhomboides	Pinfish	412
Microgobius gulosus	Clown Goby	287
Sciaenops ocellatus	**Red Drum**	**271**
Leiostomus xanthurus	Spot	262
Brevoortia spp.	Menhaden	243
Clupeidae spp.	Unidentified Clupeids	204
Callinectes sapidus	**Blue Crab**	**191**
Oreochromis/Sarotherodon spp.	Tilapia	174
Gobiosoma spp.	Small gobies <20mm	147
Gobiosoma bosc	Naked Goby	141
Fundulus grandis	Gulf Killifish	101
Lophogobius cyprinoides	Crested Goby	85
Farfantepenaeus duorarum	**Pink Shrimp**	**84**
Mugil cephalus	**Striped Mullet**	**81**
Archosargus probatocephalus	**Sheepshead**	**74**

Snook Statistics







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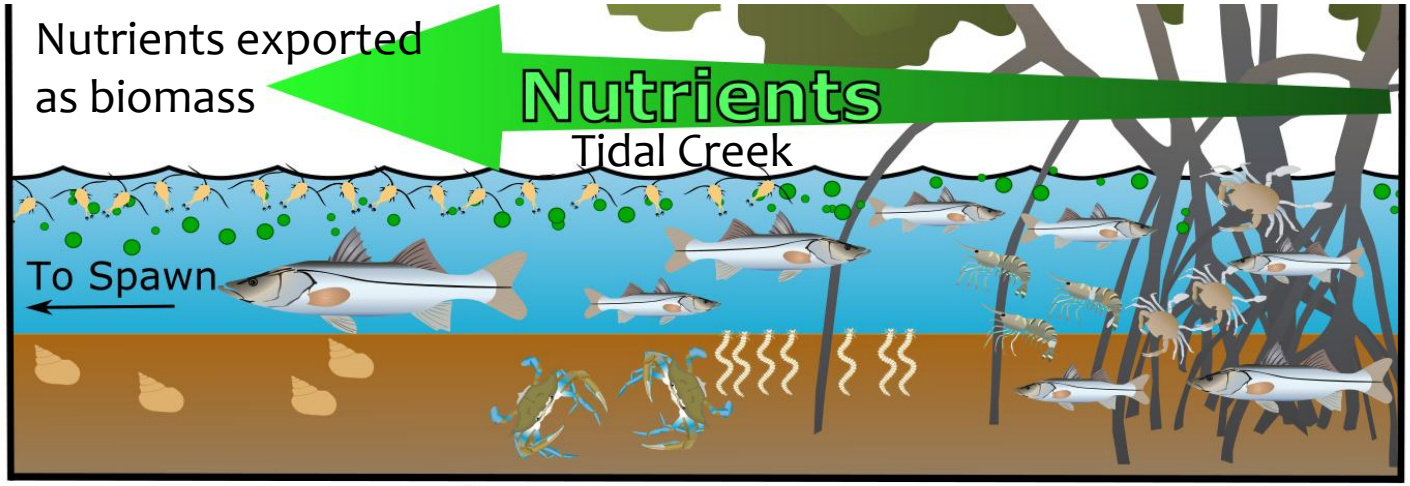
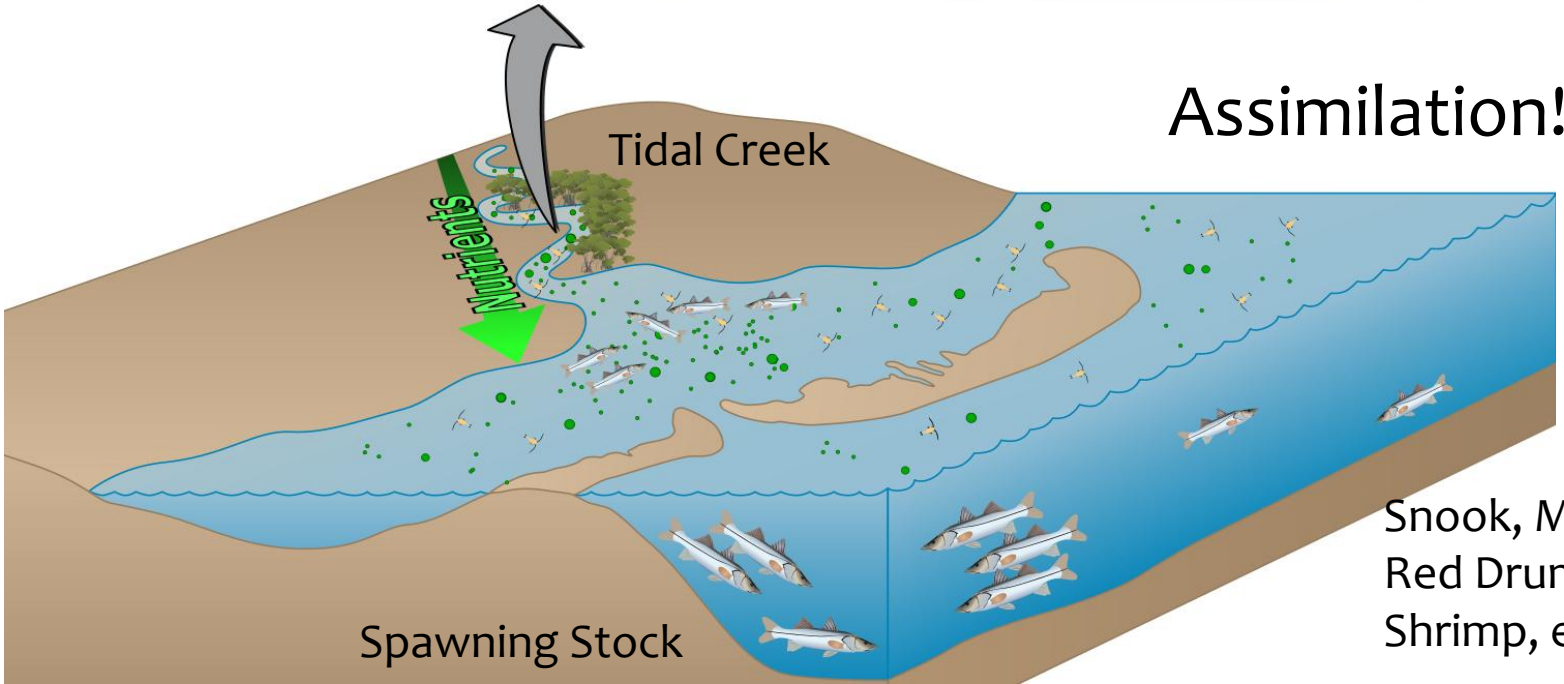
Tidal Creek Function





Assimilation!

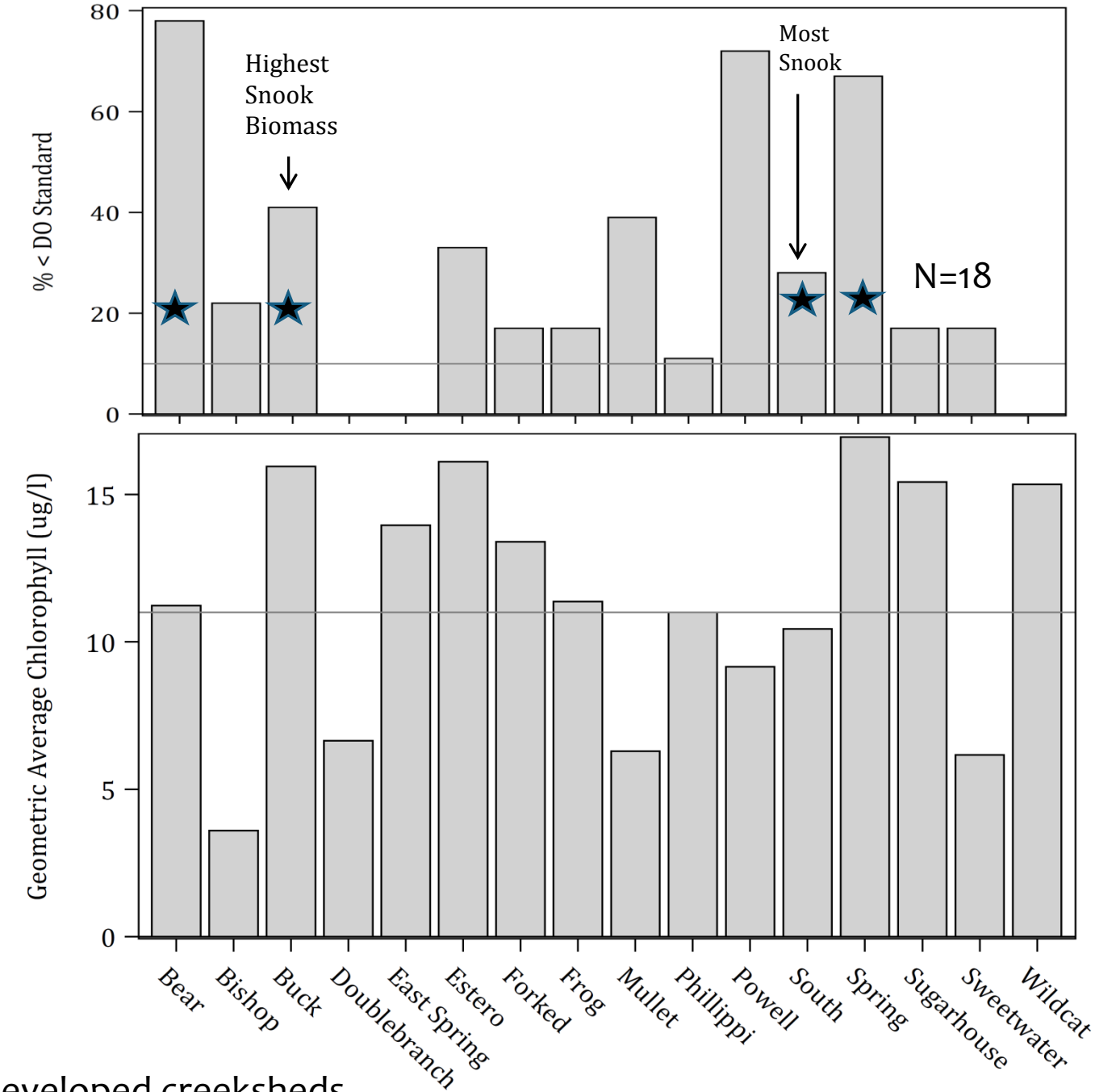
Snook, Mullet
Red Drum, Pinfish,
Shrimp, etc..

Current Regulatory Thresholds

Dissolved Oxygen and Chlorophyll *a*

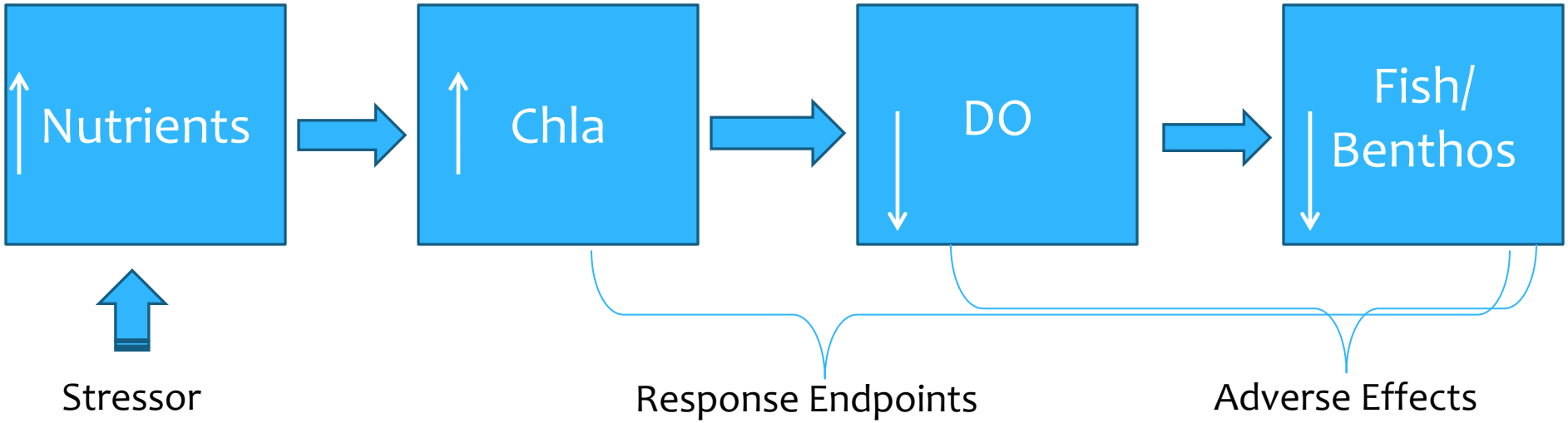
Estuarine DO Evaluation

Estuarine Chla Evaluation

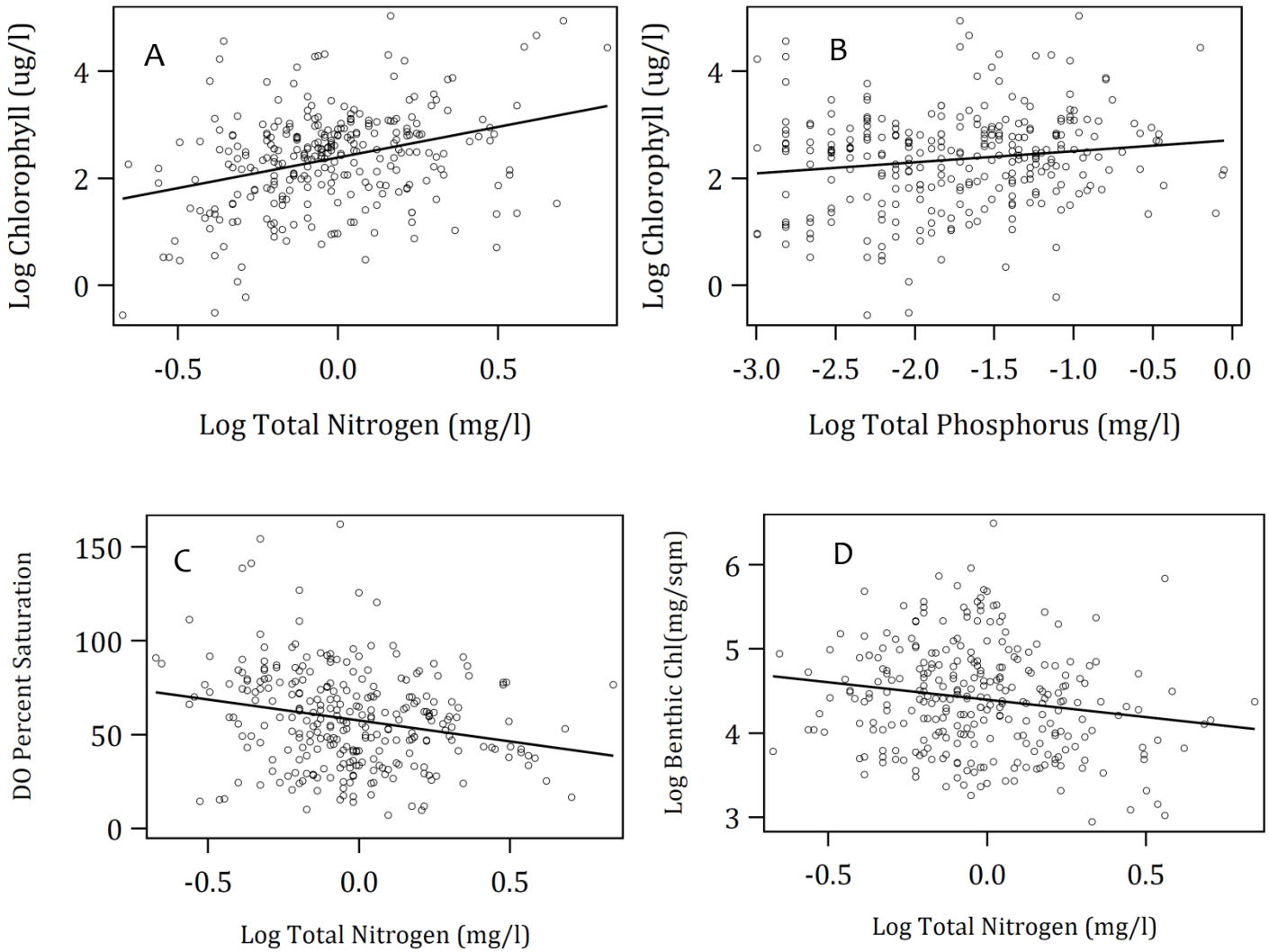


★ = Class C : most undeveloped creeksheds

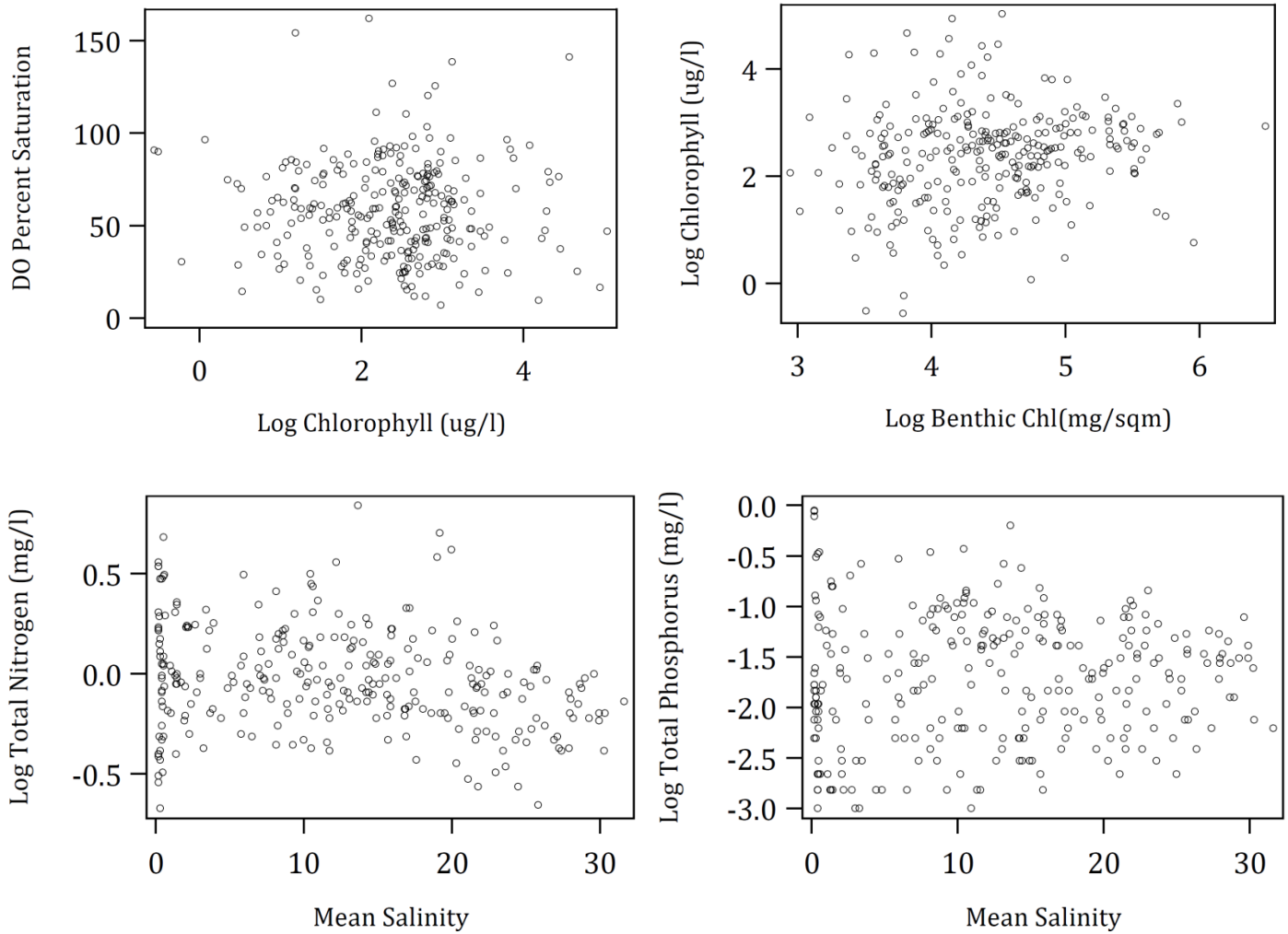
General Nutrient Management Model



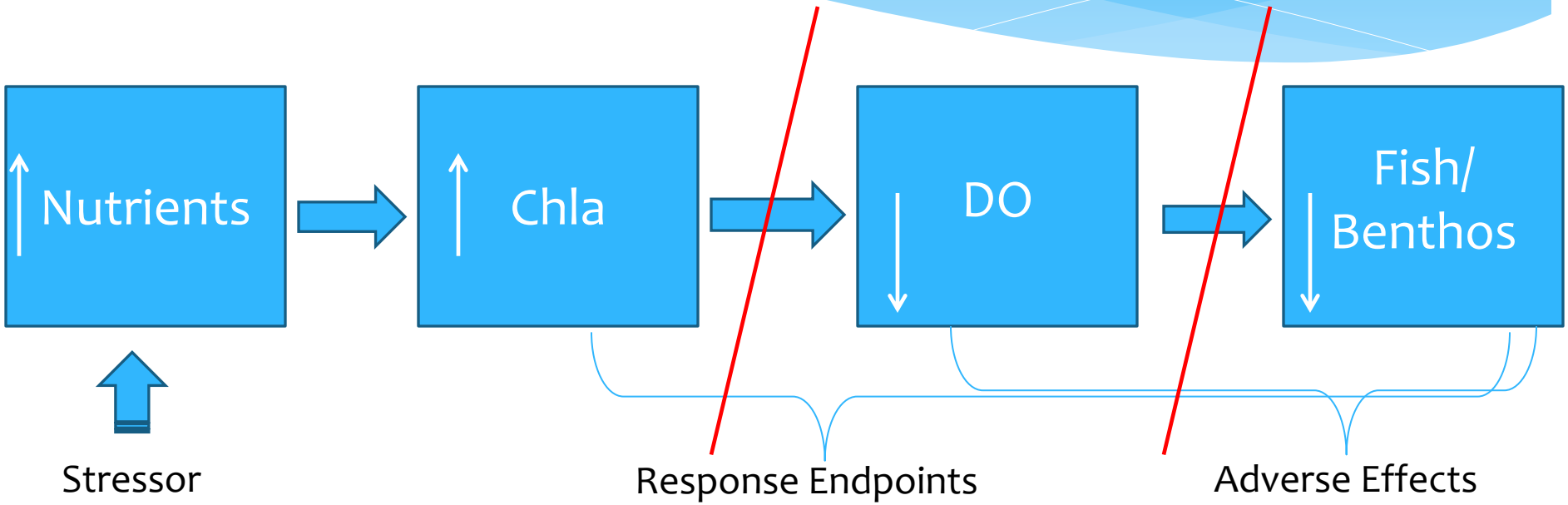
Conform to Management Model



Did Not Conform to Management Model



General Nutrient Management Model



Conditional Probability Analysis

Conditional Inference

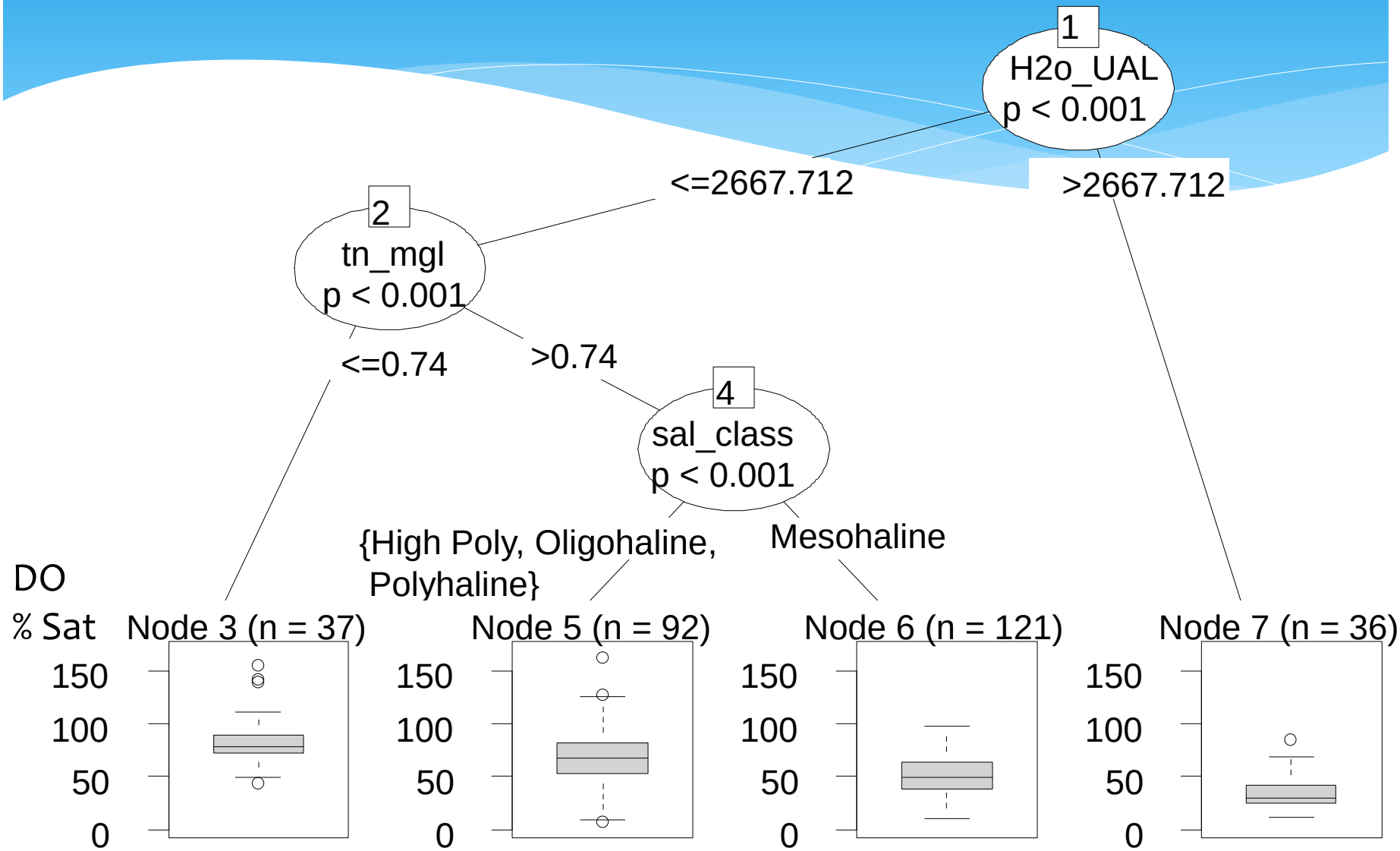
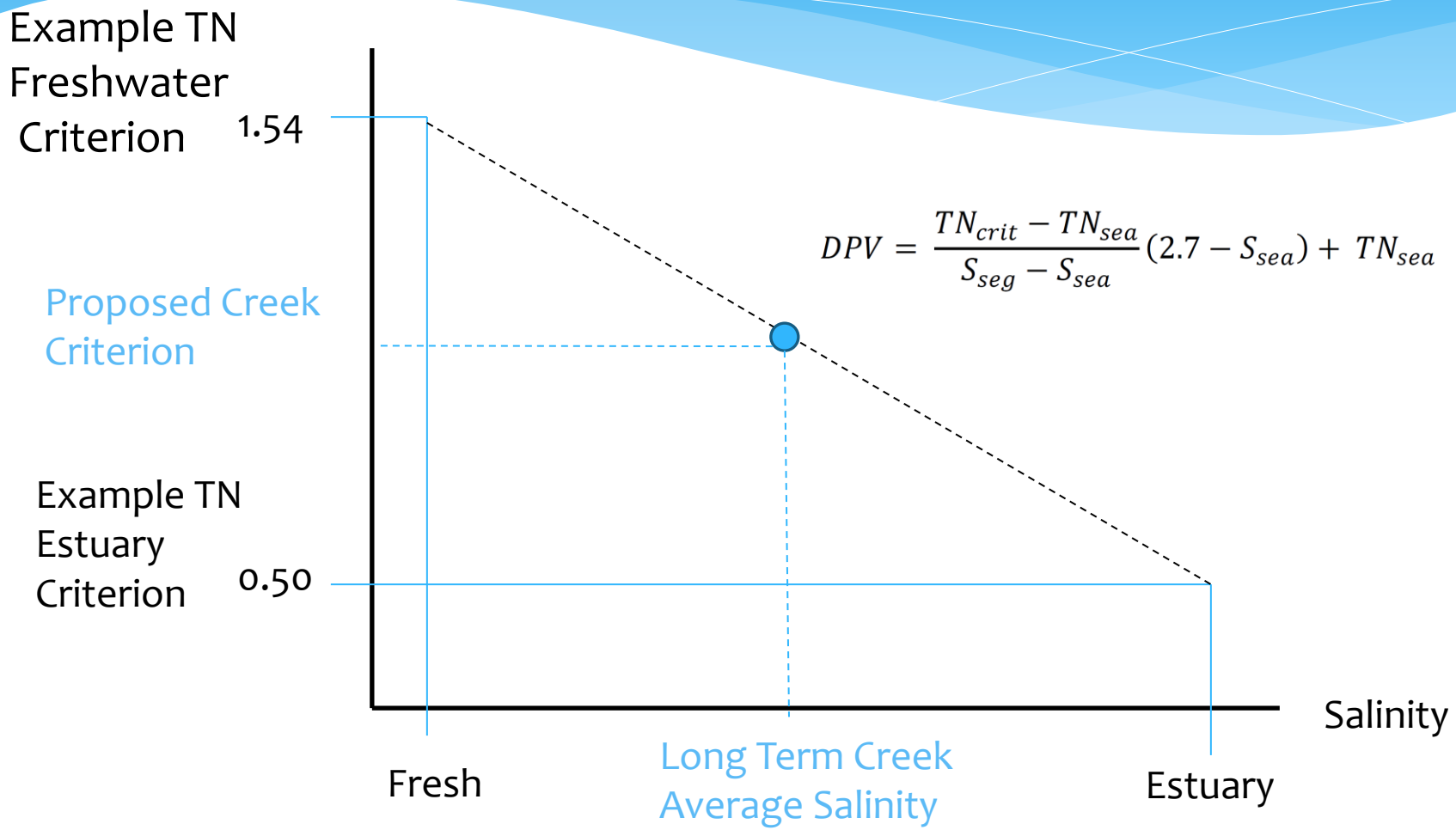


Table 4. Results of random forest bootstrap implementation of conditional inference tree. Analysis related the response variable to a set of water quality and habitat metrics in the sampled creeks.

Response Variable	Predictor	Percent of Variance explained
Water column average (DO % sat)	CDOM 345, TN , OPO4, H2O_UAL, natural buffer proportion, salinity class	42.03%
Water Column Chlorophyll	TKN, TN, NH3, OrgP, Turbidity, natural buffer proportion	46.84%
Total Nitrogen	Creek Length, TP, CDOM, Turbidity, OPO4, OrgP, proportion of agriculture in the buffer, acreage of golf course in the watershed, natural buffer proportion, and the number of outfalls in the surveyed portion of the creek	69.97%
Total Phosphorus	Creek Length, TN, Proportion of agriculture in the buffer, TKN, acreage of golf course in the watershed, natural buffer proportion, and the number of outfalls in the surveyed portion of the creek	84.24%
Benthic Chlorophyll (BMAC)	Salinity, OPO4, CDOM, natural buffer proportion, creek length, TP, and Nh3	20.27%
Chlorophyll Ratio	TKN, TN, Nh3, NO23, turbidity, natural buffer proportion, OPO4, TP, and CDOM	34.05%

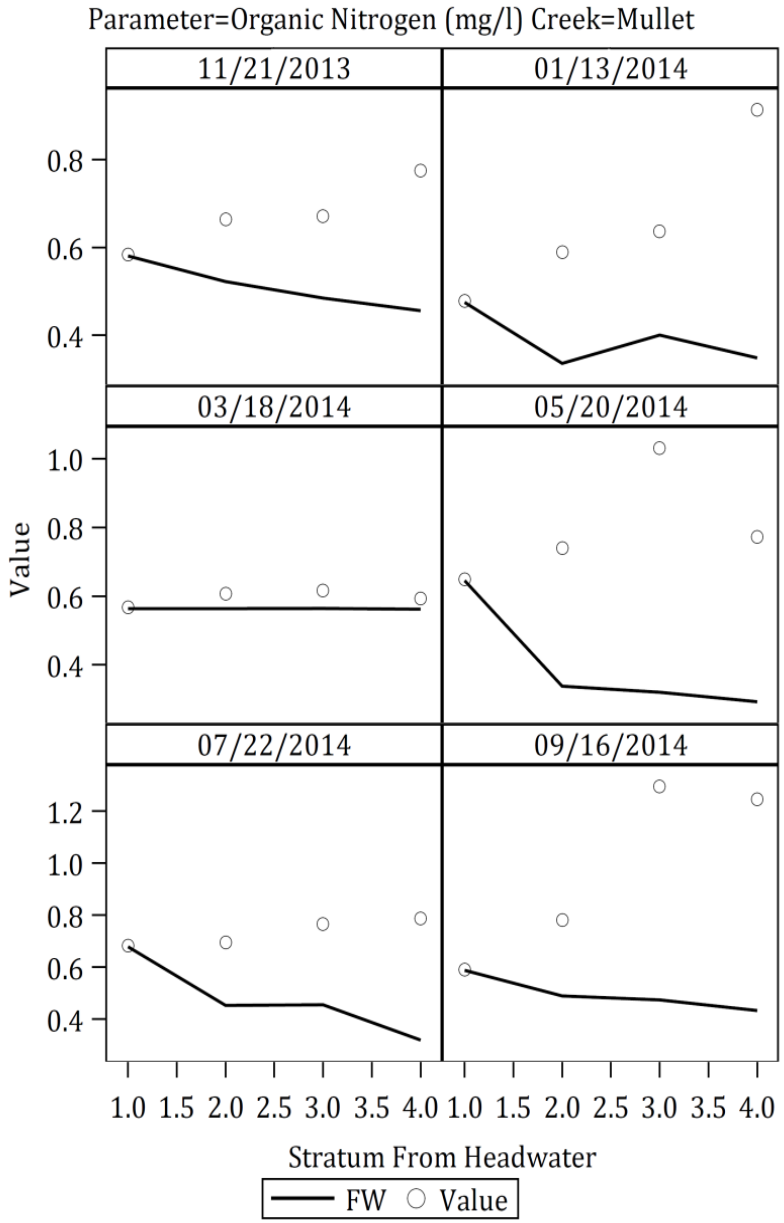
EPA/DEP Proposed Dilution Method

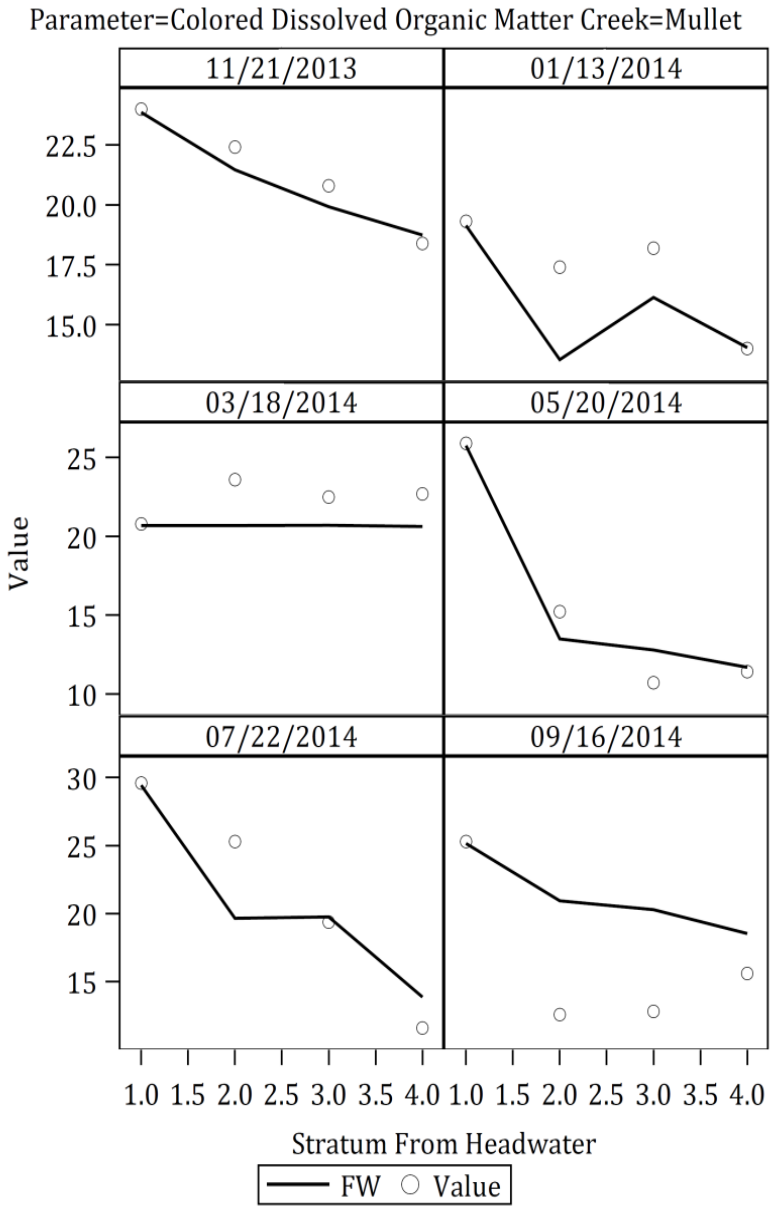
EPA/DEP Considered Approach

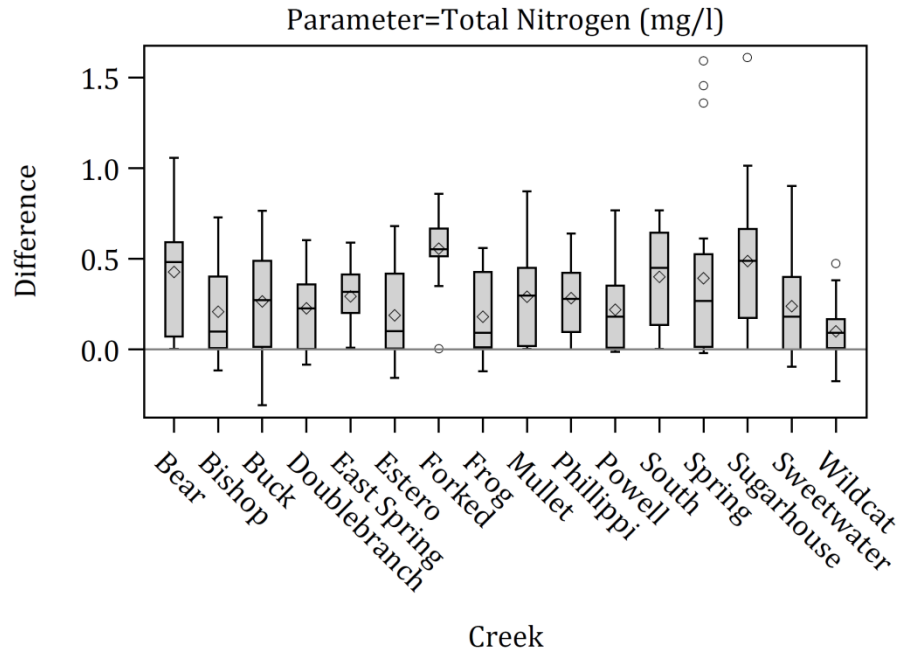


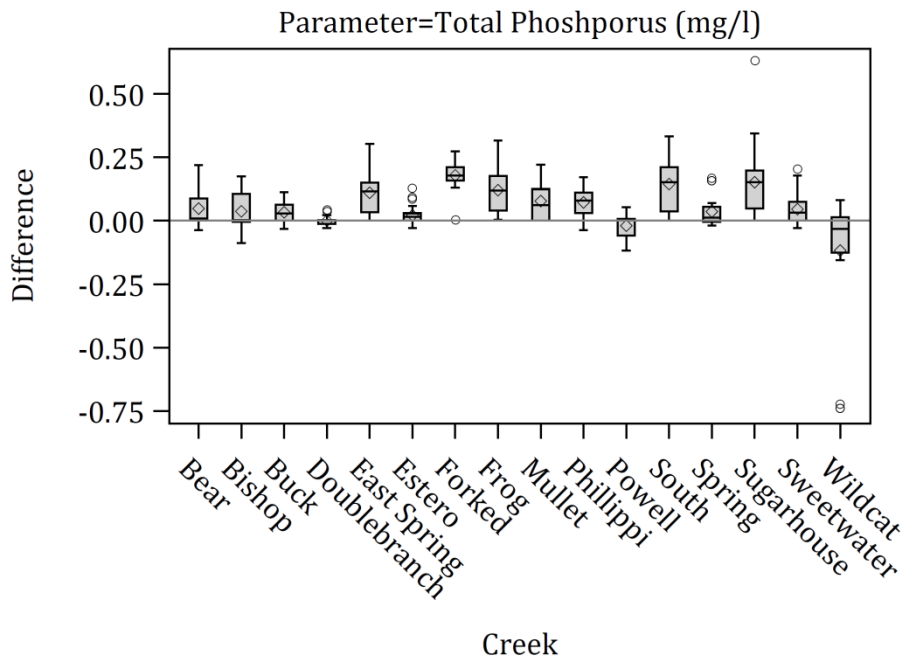
$$DPV = \frac{TN_{crit} - TN_{sea}}{S_{seg} - S_{sea}}(2.7 - S_{sea}) + TN_{sea}$$

Based on EPA 2012


Parameter=Organic Nitrogen (mg/l) Creek=Mullet
11/21/2013
01/13/2014
03/18/2014
05/20/2014
07/22/2014
09/16/2014
Value
Stratum From Headwater
FW
Value


Parameter=Colored Dissolved Organic Matter Creek=Mullet
11/21/2013
01/13/2014
03/18/2014
05/20/2014
07/22/2014
09/16/2014
Value
Stratum From Headwater
FW
Value

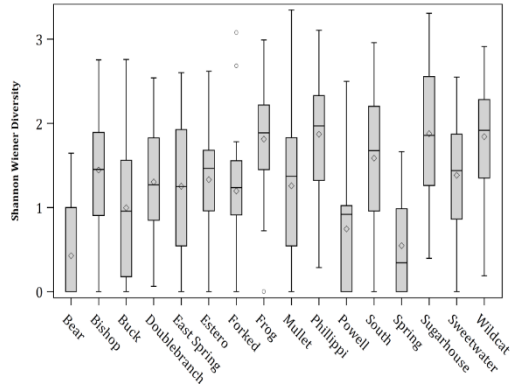

Parameter=Total Nitrogen (mg/l)
Difference
1.5
1.0
0.5
0.0
Bear
Bishop
Buck
Doublebranch
East Spring
Estero
Forked
Frog
Mullet
Phillippi
Powell
South
Spring
Sugarhouse
Sweetwater
Wildcat
Creek

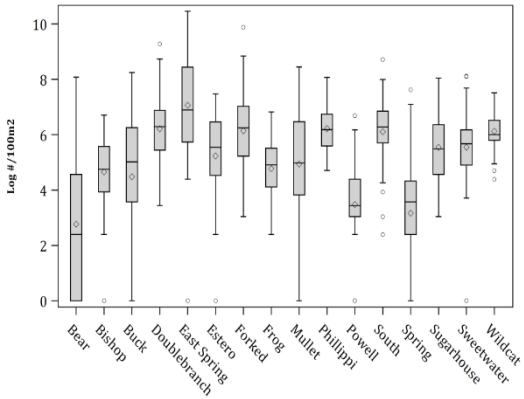

Parameter=Total Phoshporus (mg/l)
Difference
0.50
0.25
0.00
-0.25
-0.50
-0.75
Bear
Bishop
Buck
Doublebranch
East Spring
Estero
Forked
Frog
Mullet
Phillippi
Powell
South
Spring
Sugarhouse
Sweetwater
Wildcat
Creek

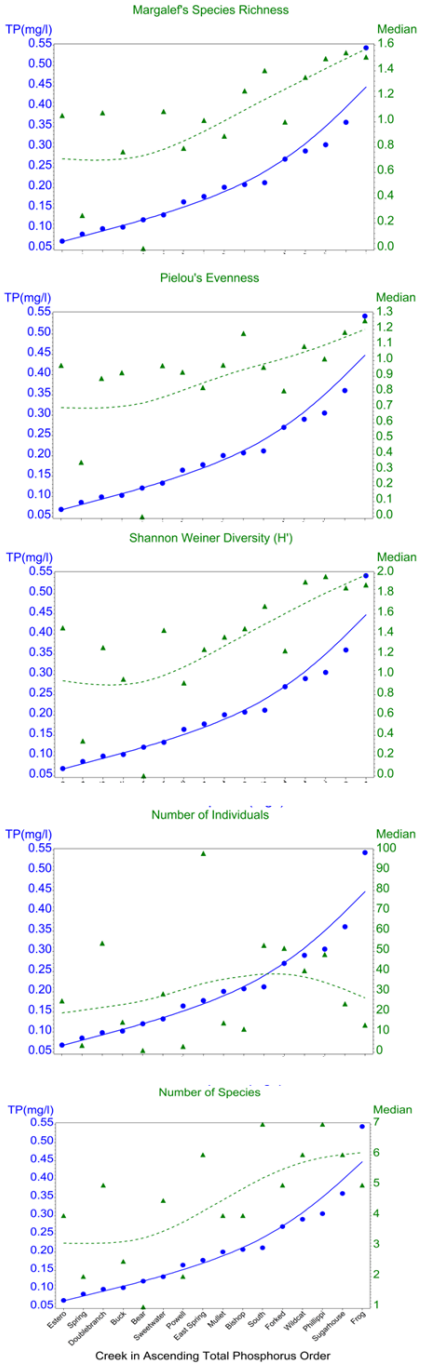
Fish and Nutrients

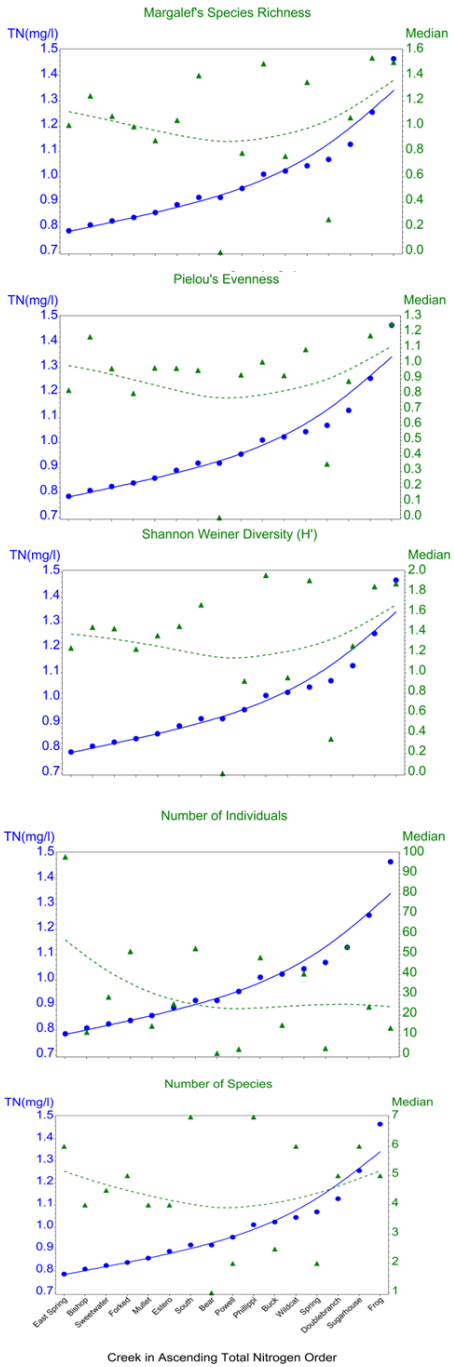
Nutrients and Fish Diversity Indices

No observed adverse effects of nutrients on fish diversity metrics based on our sampling.

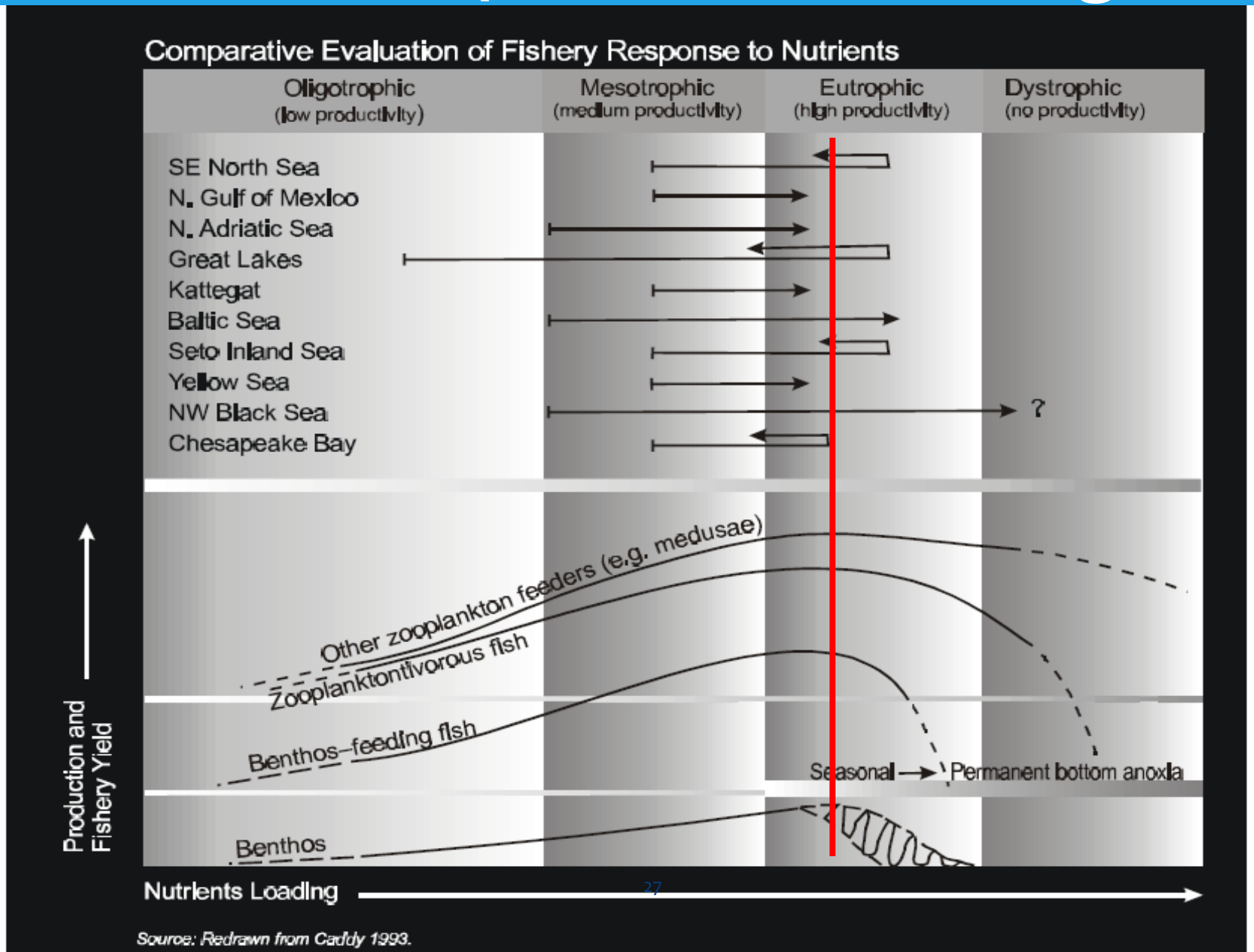








The Eutrophication Paradigm



Source: Redrawn from Caddy 1993.

Review of Findings

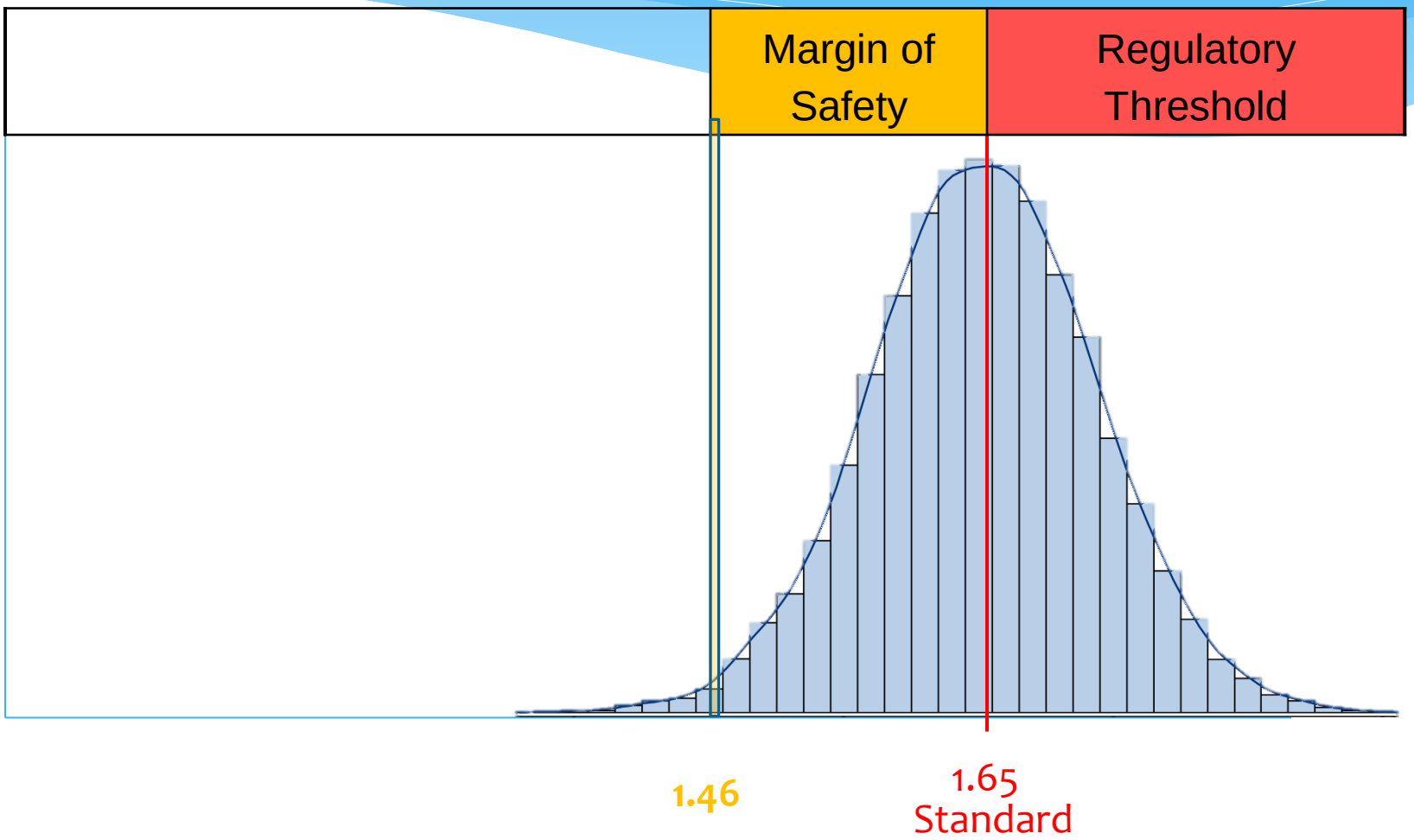
* Critical habitat for estuarine dependent fish.
* The water quality was characteristic of wetland environments.
* Existing DO and Chlorophyll criteria not reliable indicator of adverse effects in southwest Florida tidal creeks.
* Tidal portion can contribute nutrients to the system.
* Dilution curve method not appropriate for tidal creeks.
* Observed nutrient levels have not yet resulted in highly eutrophic or dystrophic conditions in sampled creeks.
* Lack observed response threshold indicative of adverse effects that could be used in a stressor response approach.

Establishing Nutrient Criteria in the Absence of an Identified Response Threshold

The Reference Based Approach

Computer Simulation

Stewardship Goals Management Thresholds



Proposed Tidal Creek Nutrient Management and Regulatory Thresholds with Allowable Exceedence Frequency

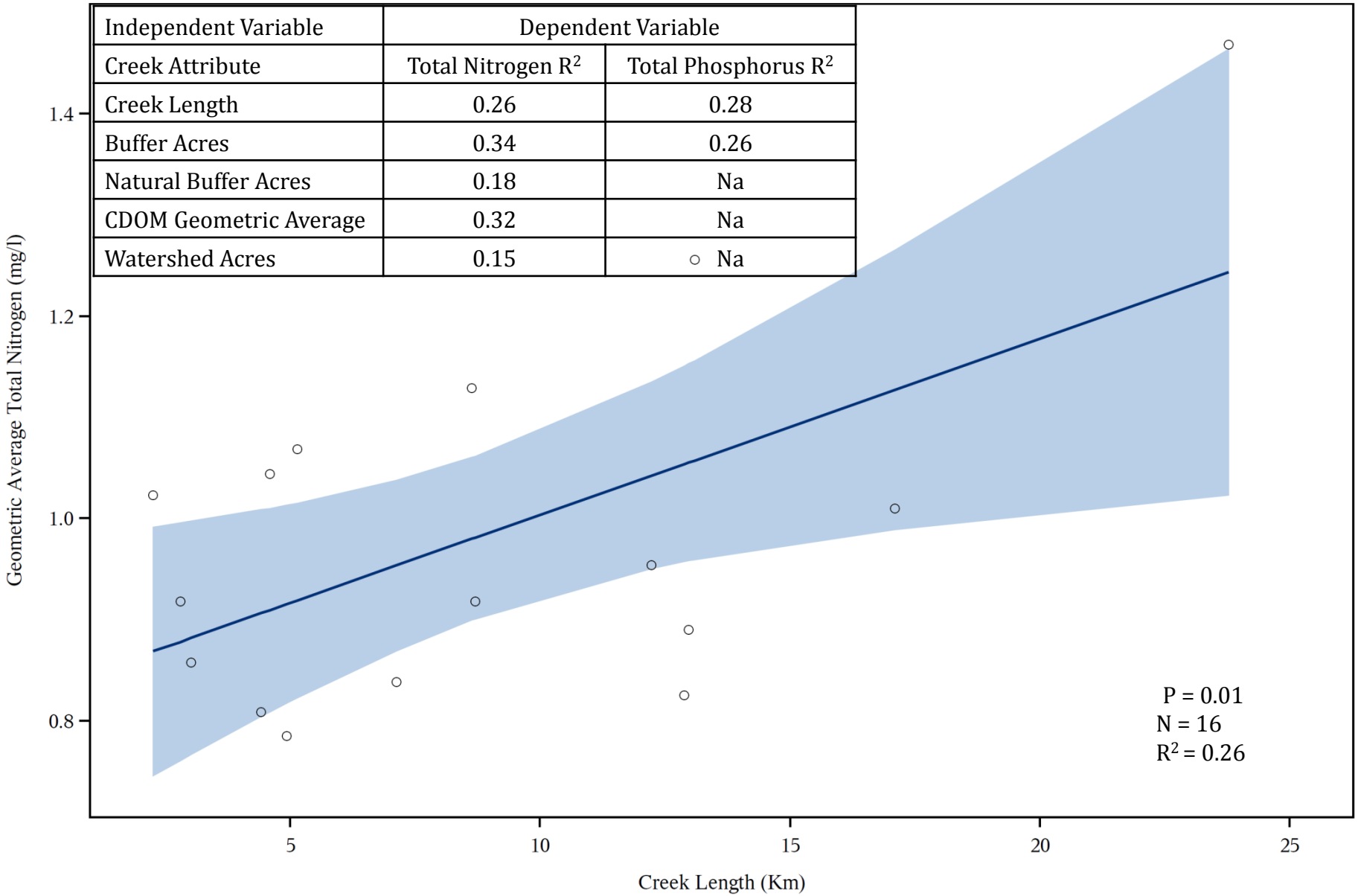
Nutrient	Region	Management Geometric Average	Management Exceedence Frequency	Regulatory Geometric Average	Regulatory Exceedence Frequency
Total Nitrogen	West Central	1.46 mg/l	No more than 2:5	1.65 mg/l	No more than 1:3
	Peninsula	1.36 mg/l	No more than 2:5	1.54 mg/l	No more than 1:3
Total Phosphorus	West Central	0.40 mg/l	No more than 2:5	0.49 mg/l	No more than 1:3
	Peninsula	??	No more than 2:5	??	No more than 1:3

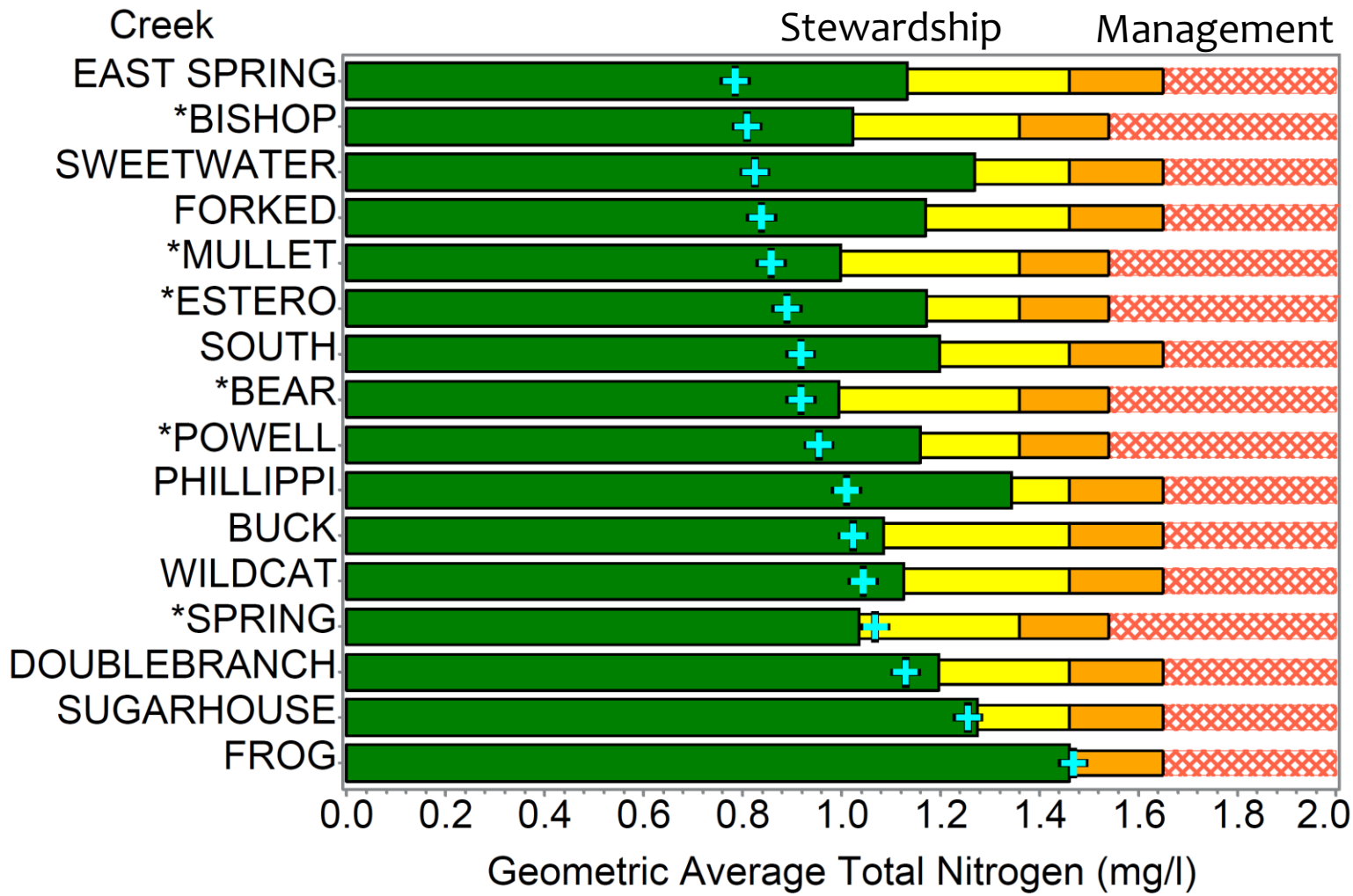
Importance of Stewardship Goals

* As a stewardship goal, the one size fits all approach is underwhelming.
* The proper stewardship of these creeks is to recognize that each creek has its own optimum and the stewardship goal should be to achieve that optimum.
* All three Estuary Programs have stewardship goals for tidal creeks in their CCMPs
* Need for a method to generalize to entire population (i.e. 306 creek).

Robust Fit for Total Nitrogen

Independent Variable	Dependent Variable	
Creek Attribute	Total Nitrogen R^2	Total Phosphorus R^2
Creek Length	0.26	0.28
Buffer Acres	0.34	0.26
Natural Buffer Acres	0.18	Na
CDOM Geometric Average	0.32	Na
Watershed Acres	0.15	Na





*= Peninusla Region

Observed | Target | Caution | Action | Regulatory

Target	Caution Level	Management Action Plan	Regulatory (NNC)
Running geometric average	Running geometric average	2:5	1:3

Benefits of Management Strategy

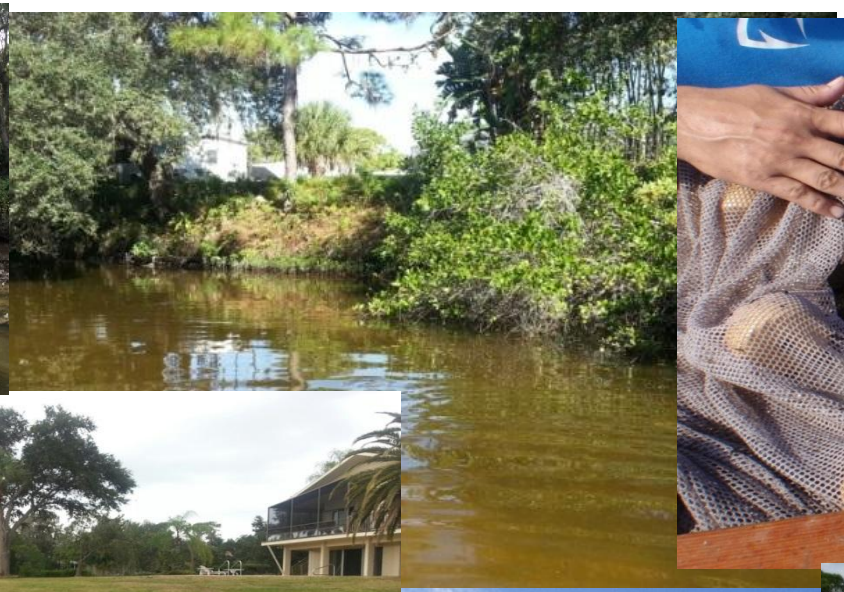
* Unified Framework – not piecemeal
* More comprehensive – not binary (pass/fail)
* Site specific components – not just “one size fits all”
* More effective use of resources – not chasing the DO TMDL
* More responsive – not reliant on cycles / listing / TMDLs

Benefits of Management Strategy

* Includes Regulatory, Management, and Stewardship components.
* Based on observed, locally derived data.
* Includes nutrients, not just assumptions between DO/Chla and nutrients.
* Provides additional layers of protection and early detection mechanism.
* Encourages more science as basis for improving site specific targets.
* Encourages more local control, local stewardship.

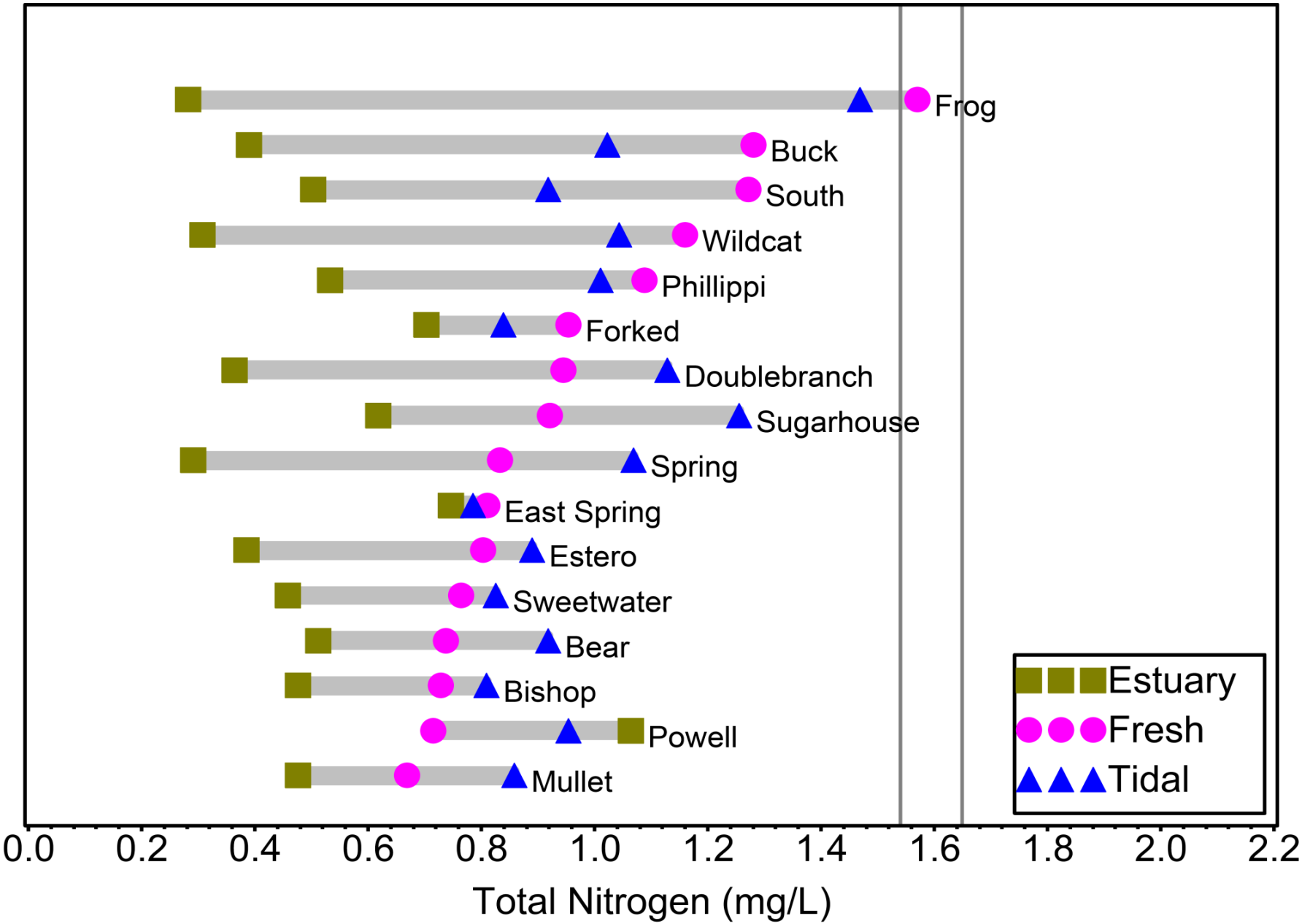
Future Efforts

* Recognize that tidal creeks are wetland environments.
* Recognize the role of creeks as an economic driver (fish production) in southwest Florida.
* Select a subset of creeks for continued water quality (and fish) monitoring (one creek in each County?).
* Data from larger tidal rivers should be analyzed to understand effects on larger systems with longer time series of data.
* The interaction between nutrient concentrations, wetland vegetation, and decomposition should be further investigated.

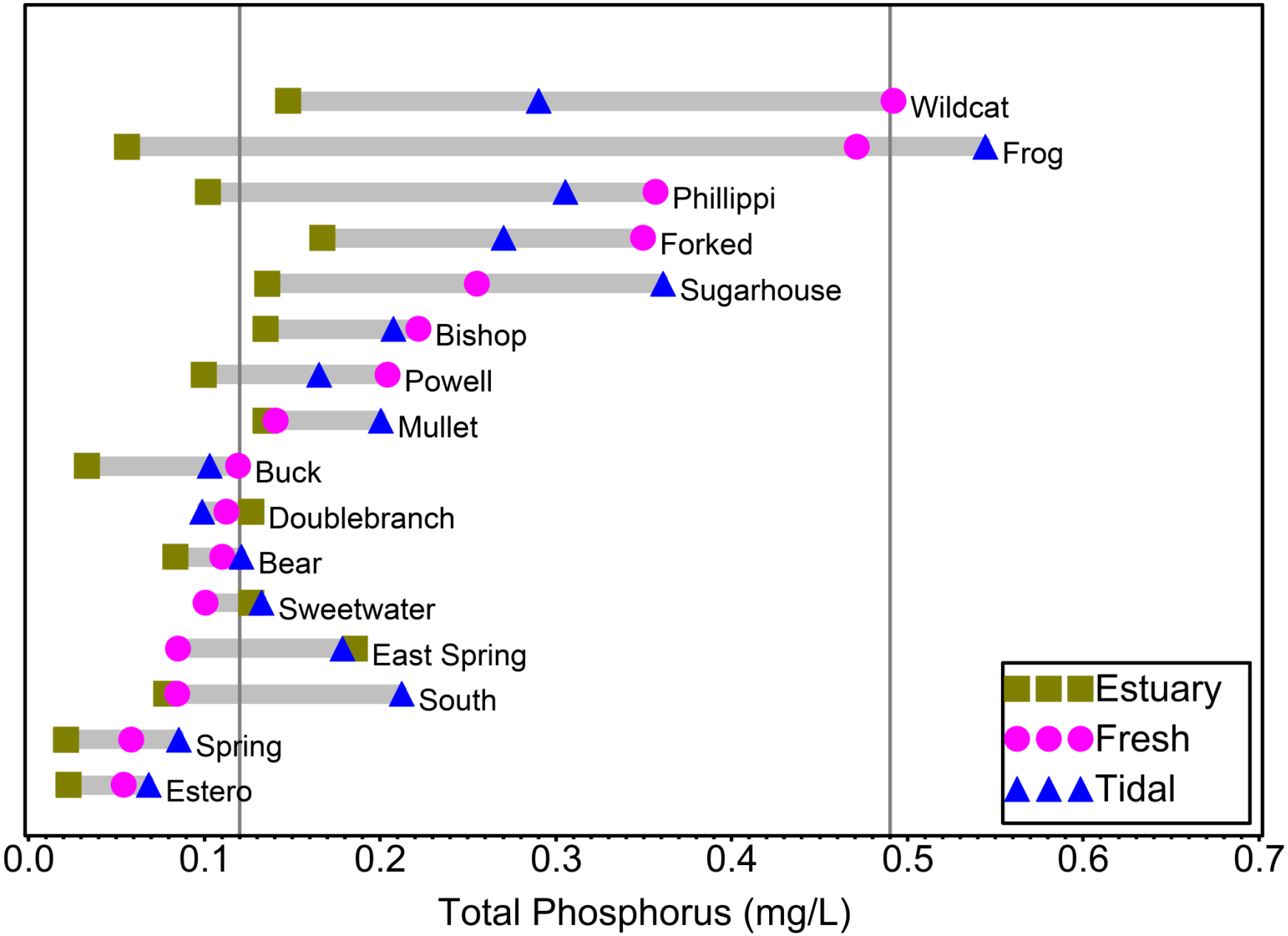
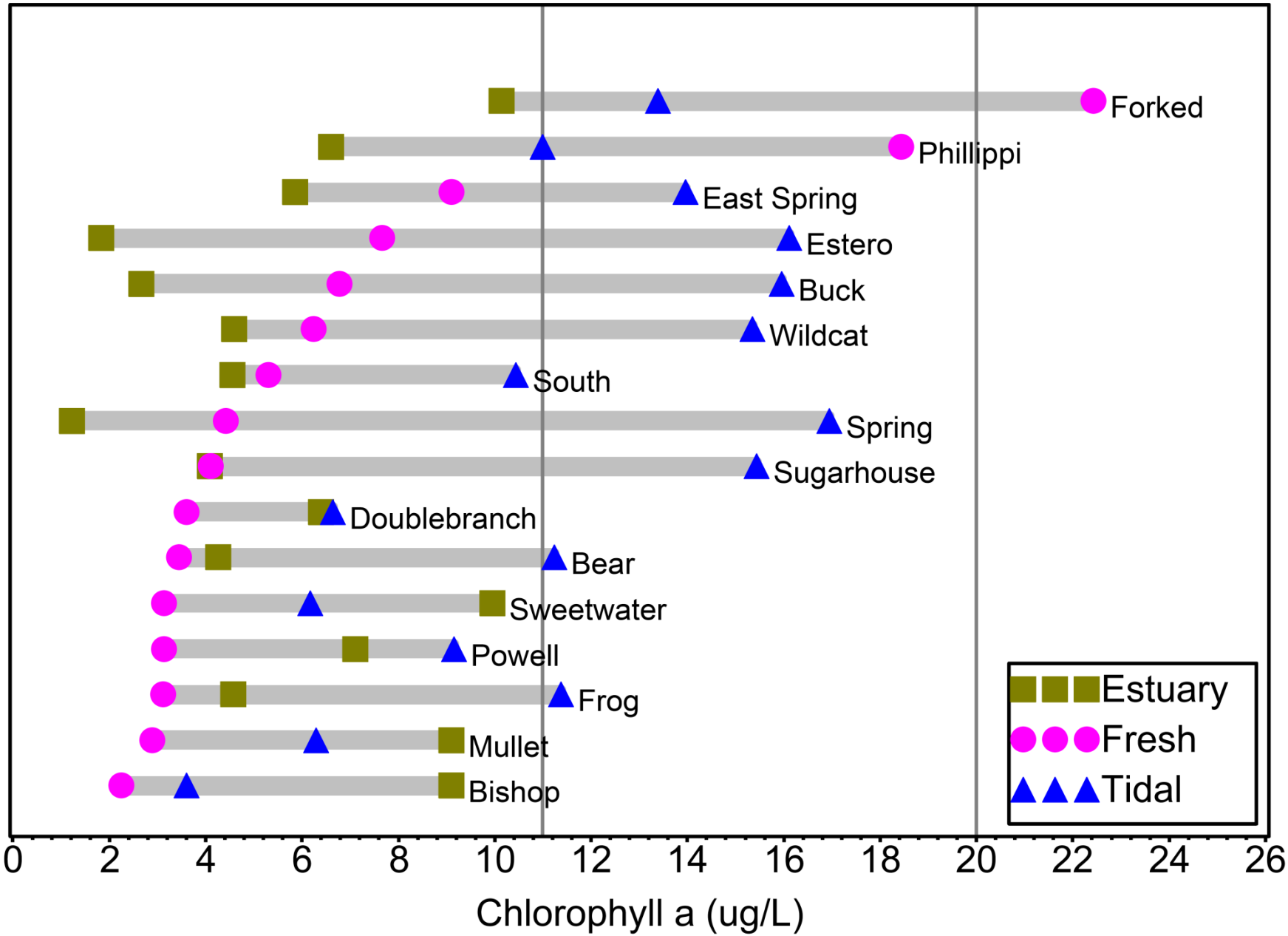


Thanks!

Distribution of Total Nitrogen by Creek



Distribution of Total Phosphorus by Creek



Distribution of Chlorophyll a by Creek