

A photograph of a stream flowing over mossy rocks in a forest. The water is clear and cascades over several large, dark rocks covered in green moss. The background is filled with lush green foliage and trees, creating a serene natural setting. A semi-transparent text box is overlaid on the center of the image.

# Increasing State Biological Capabilities (Using Probabilistic Monitoring Strategies)



# Virginia Monitoring Strategy

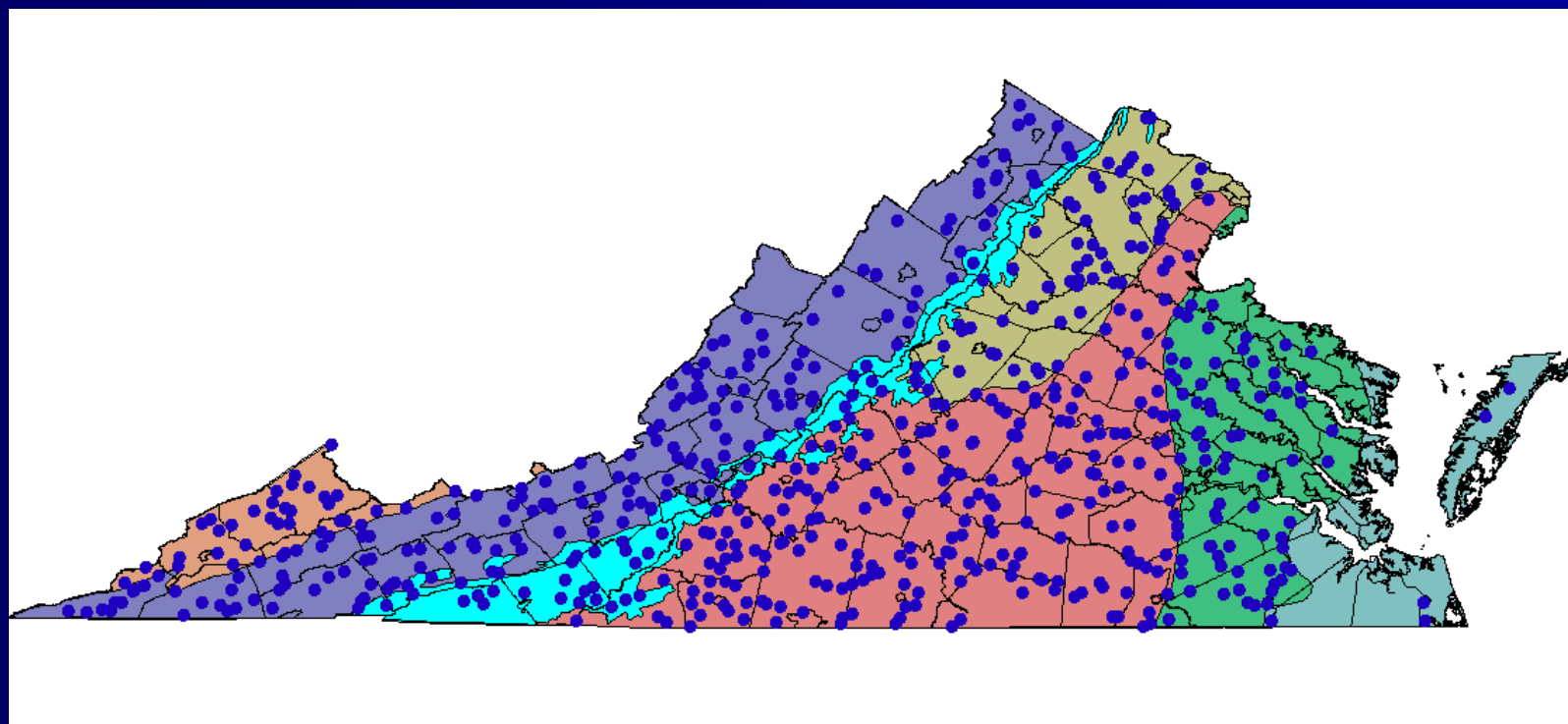
- Strategy online at (57.5 MB zipped, Yikes!):  
<http://www.deq.state.va.us/watermonitoring/monstrat.html>
- Watershed Monitoring Network (monitoring chemistry, field data, bacteria at 1247 NWDB subwatersheds)
- Trend Monitoring Network
- TMDL Support Program (development and implementation)
- Special Studies (Shenandoah / James fish kills or pollution response)
- Chesapeake Bay Program
- Lakes Monitoring Program (over 200 reservoirs monitored)
- Biological Monitoring Program
- Probabilistic Monitoring Programs (freshwater and estuarine)

# Accomplishments

- Collecting Habitat, Fish, Bugs, Algae, and Chemistry at same site
- Identified over 100 new biological reference sites
- Validated Virginia Stream Condition Index
- Probabilistic monitoring chapter in 2008, 2010, and 2012 IR
- Set baseline conditions for hundreds of environmental variables
- Identified top stressors to aquatic communities in VA



# 2001-2010 Sample Sites

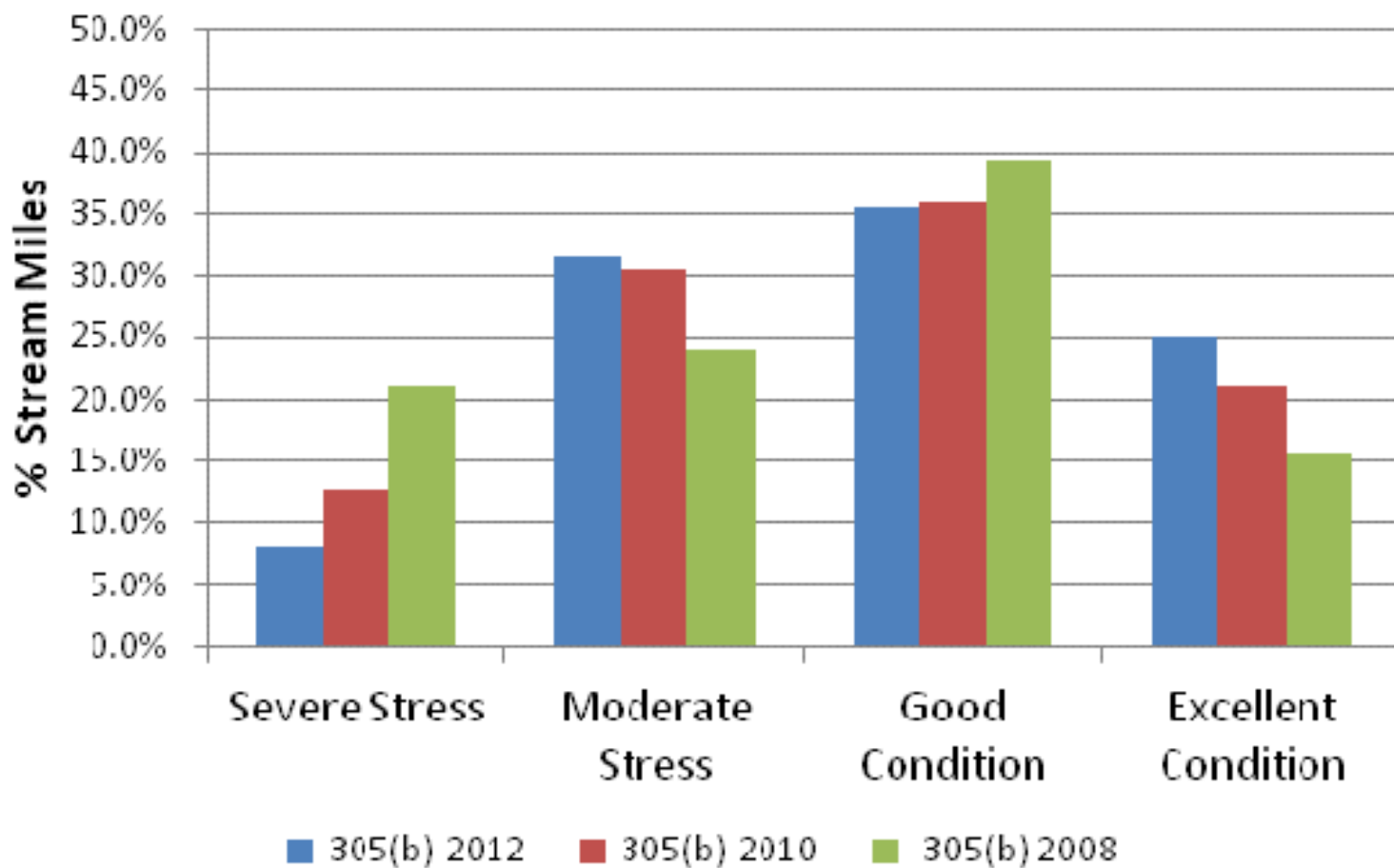


- 15% sample frame is non-perennial, tidal, or reservoir
- Chemistry data 41,557 miles; Biology data 35,680 miles

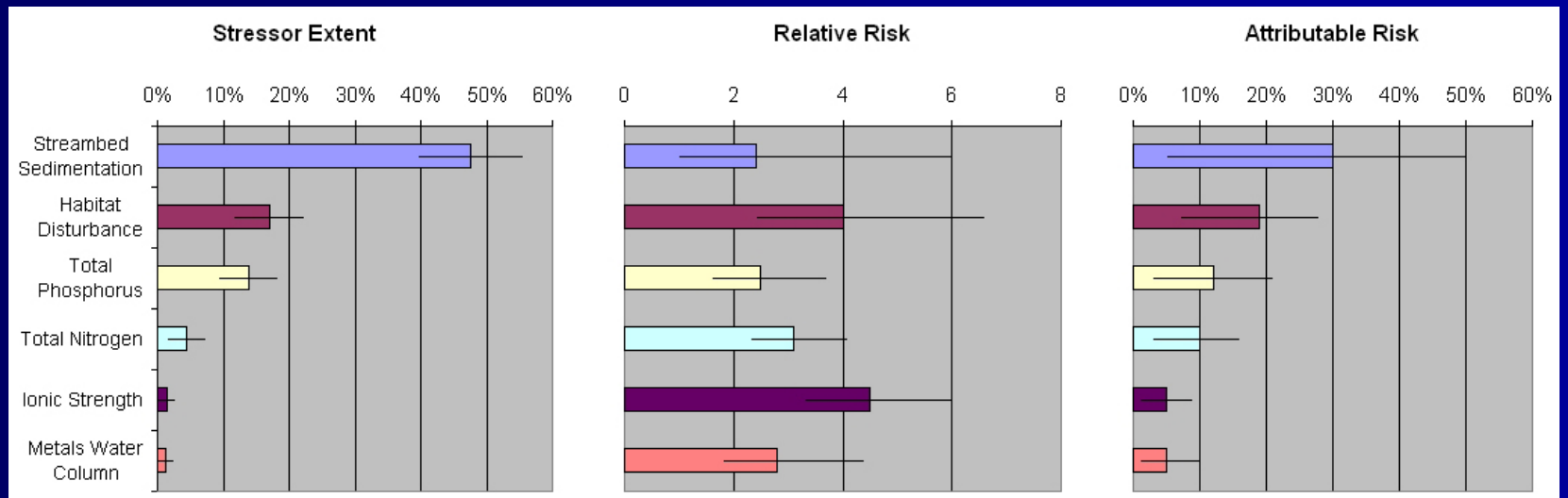
# Data Collected

- Field data
  - DO, Temp, pH, Specific Conductance
- Benthic community metrics
  - CPMI/VSCI
- Habitat Survey
  - RBP & RBS
- Bacteria Indicators
  - Fecal Coliform & E. Coli
- Chlorophyll (water column)
- Total Organic Carbon
- Land Cover Data (GIS)
- *Need Hydrology*
- *Need real time temp data*
- *Monthly Data*
- Nutrients (a bunch)
- Solids (a bunch)
- Hardness
- Alkalinity
- Turbidity
- Chlorides
- Sulfates
- ~~Heavy Metals & Pesticides (in sediment)~~
- Dissolved Metals (in water column)
- ~~SPMDs~~
- Fish and Algae community (2006-present)

# Biological Status (VSCI/CPMI)



# 2010 ProbMon 305(b) Results



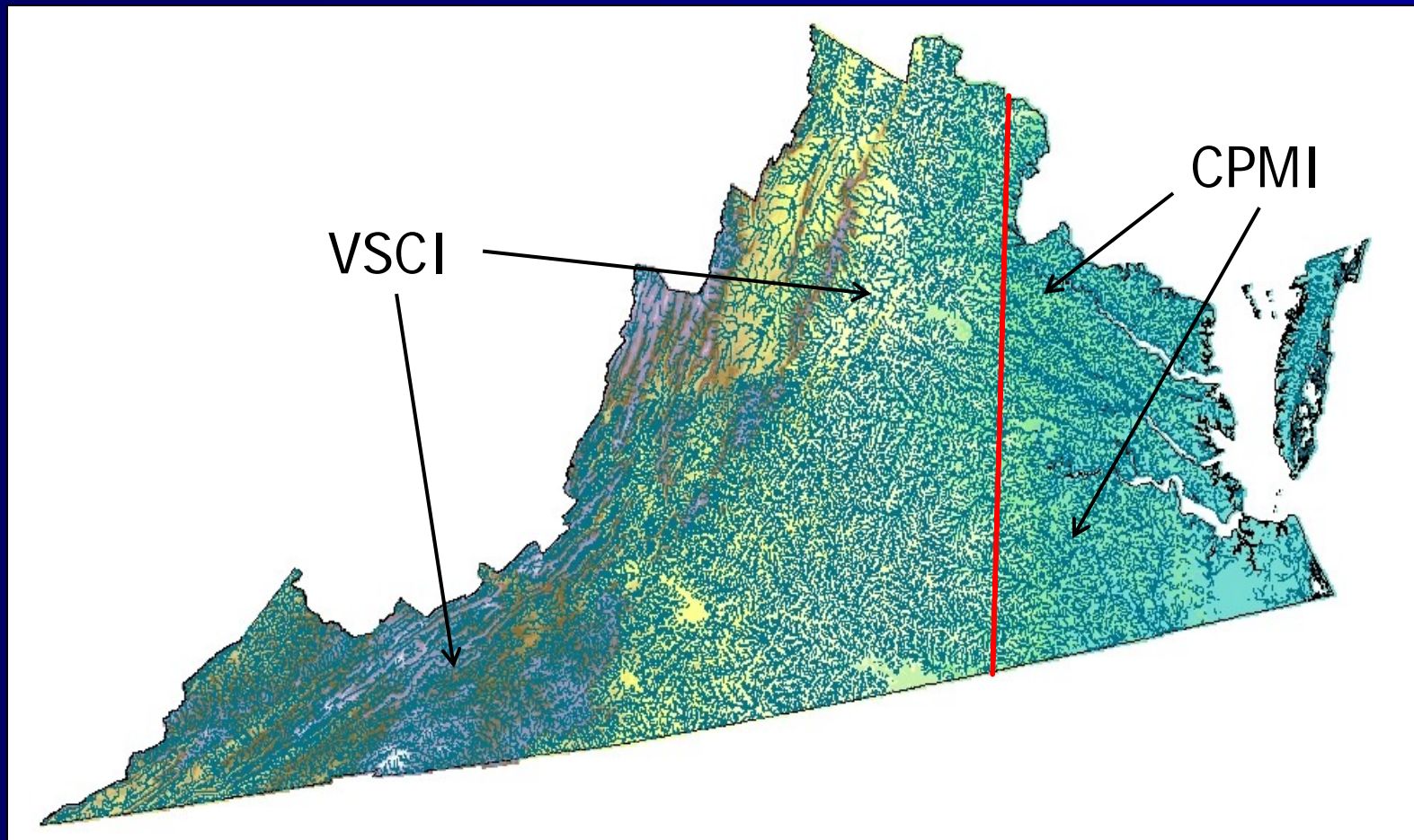
Stressor Parameters	Optimal	Suboptimal	Classification Reference
Total Nitrogen (mg/L)	<1	>2	(VDEQa 2006)
Total Phosphorus (mg/L)	<0.02	>0.05	(VDEQa 2006)
Habitat Degradation (unitless)	>150	<120	(USEPA 1999)
Streambed Sedimentation (unitless)	>-0.5	<-1.0	(Kaufmann 1999)
Ionic Strength (TDS mg/L)	<100	>350	(VDEQb 2006b)
Metals Water Column (unitless)	<1	>2	(Clements 2000)

# Biological Self-Assessment

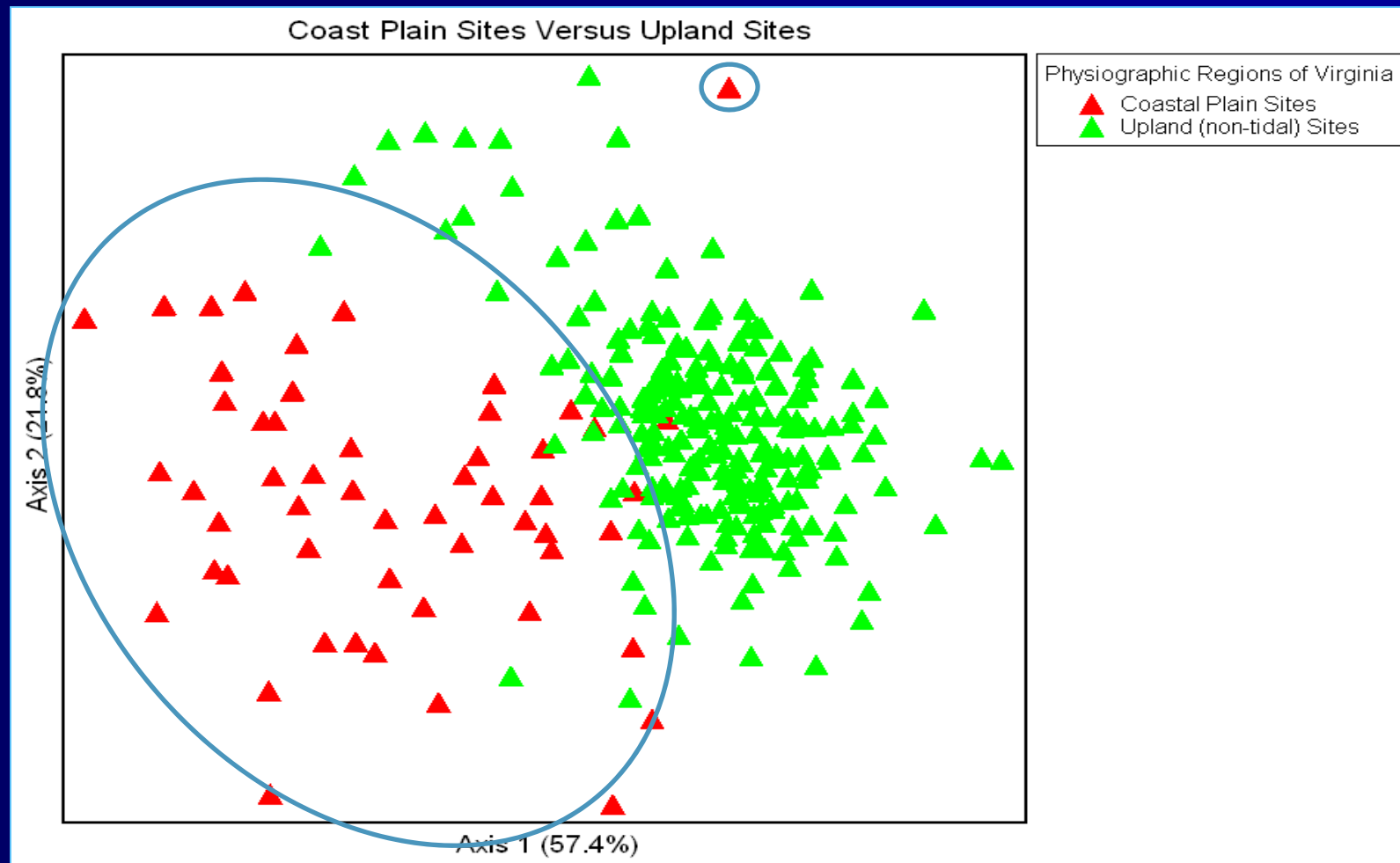
- *Coastal Plain Macroinvertebrate Index (CPMI) validation*
  - Genus Level certification and Genus Level VSCI/CPMI (Congrats Biologists!)
  - *TMDL/Biology Workgroup creating Benthic TMDL development guidance*
  - Biological Condition Gradient (BCG)
  - *Virginia Fish Index of Biotic Integrity (FIBI)*
  - Virginia Algae Index of Biotic Integrity
  - Boatable Biological Assessment Tools
- The major data set for all of these initiatives are Freshwater ProbMon!*



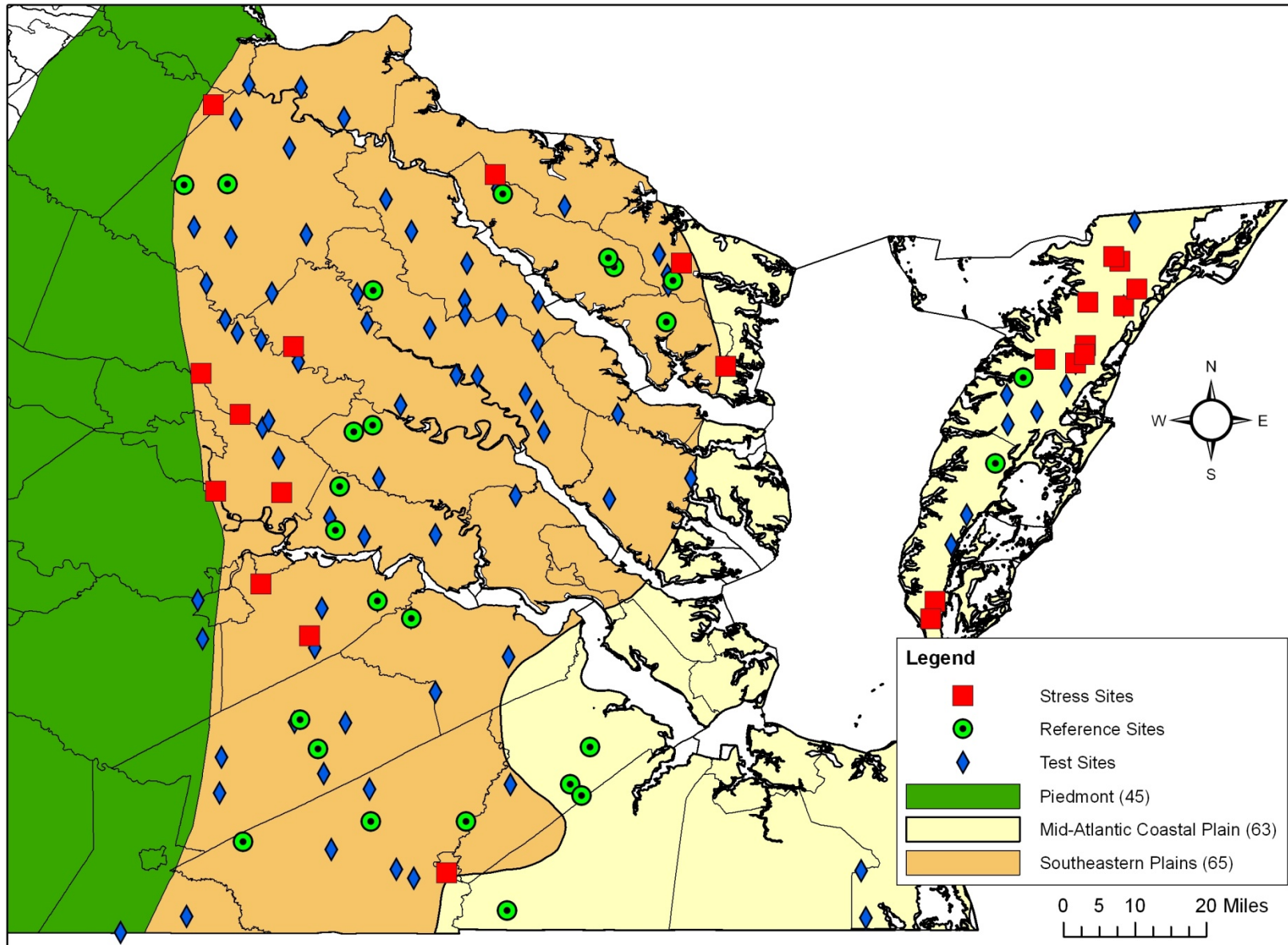
# Biological Assessment



# Why do we need a coastal plain macroinvertebrate index in VA?



# CPMI Study: map of stations



# CPMI study

## MACP (63) Best standard values

### BSV 63S (Maxted et al. 2000)

Percentile	TotTaxa	HBI	EPTTax	%Ephem	% Clingers
95th Percentile	33.0	8.0	6.0	48.1	42.3
5th Percentile	11.0	3.7	0.0	0.0	0.0

### BSV MACP + Chowan

Percentile	TotTaxa	mHBI	EPTTax	%Ephem	%PT - H	%5Dom	%Clingers -H&S
95th Percentile	21.0	7.4	8.0	25.4	8.2	100.0	18.7
5th Percentile	6.1	4.9	0.0	0.0	0.0	69.2	0.0



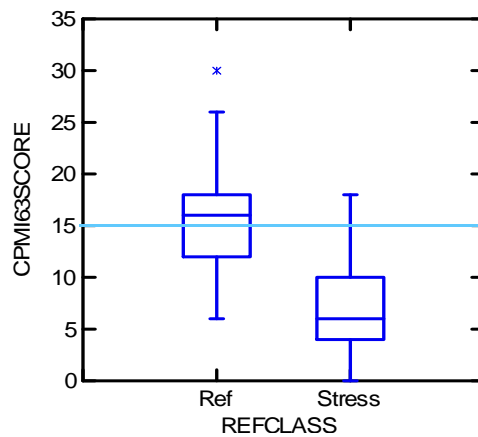
# CPMI study

## "Old" CPMI vs. "new" CPMI

### "Old" CPMI

### "New" CPMI

MACP (63)



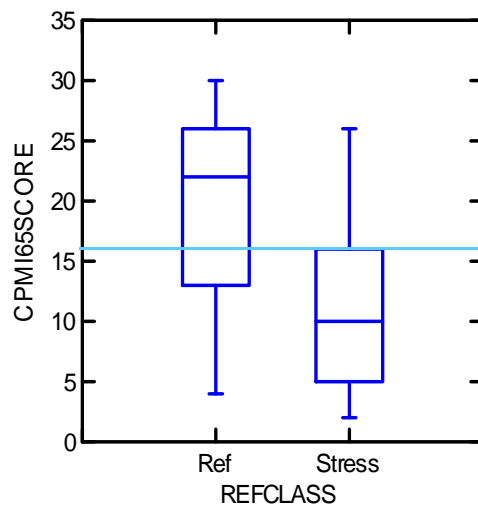
n=21 ref  
n=35 str

MACP (63)  
+ Chowan



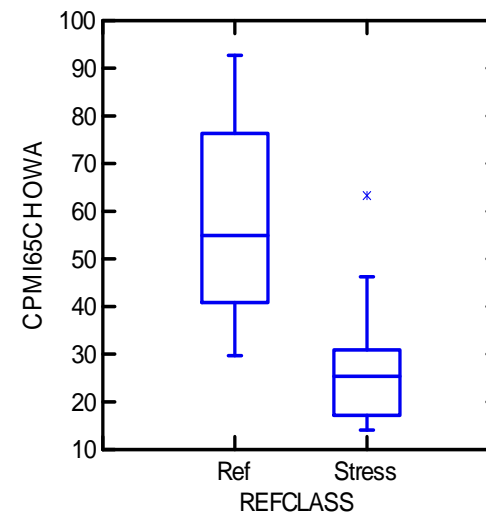
n=27 ref  
n=42 str

SEP (65)



n=35 ref  
n=15 str

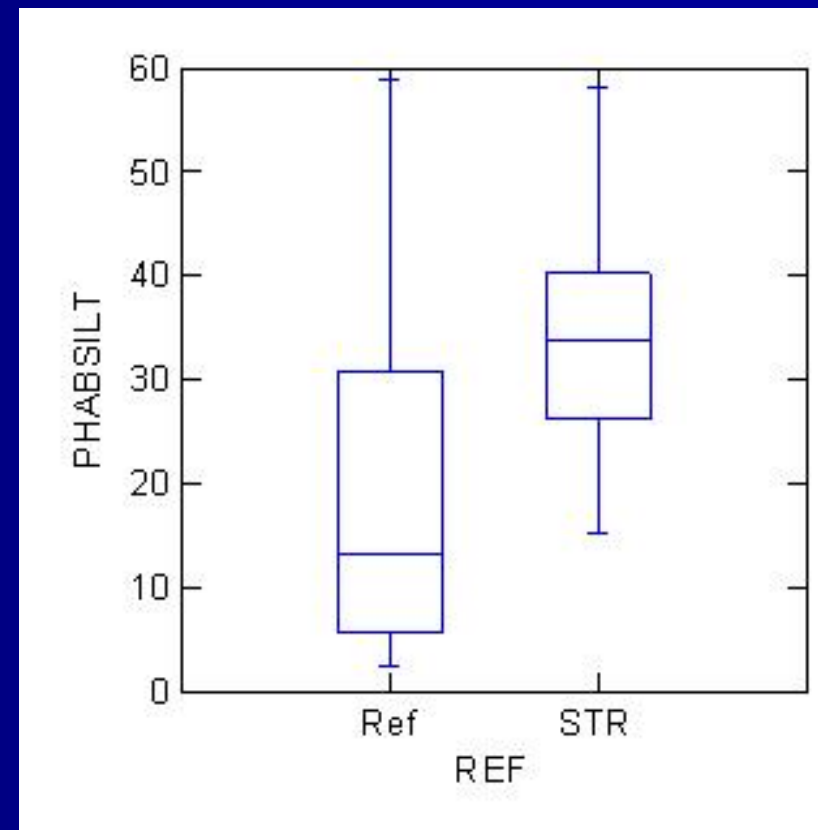
SEP (65)  
- Chowan



n=26 ref  
n=11 str

# TMDL Screening Tools

Metrics that increase with stress	Best standard value (X5)	Xmax	Standardization equation. X=metric value
NoFNBRembed	12.6	100	score=100 x [(100-x)/100-12.6]
SA+FN	8.7	100	score=100 x [(100-x)/100-8.7]
Metrics that decrease with stress	Best standard value (X95)	Xmin	Standardization equation. X=metric value
tLRBS (converted to 0-100 scale) using $y=16.667x+66.667$	75.7	0	score = 100 x (x/75.7)
TOTHABSC	176.2	0	score = 100 x (x/176.2)



# TMDL Screening Tools

Figure 7. Box plot of Motile Diatom metric and PHAB siltation index. Category 1 = Motile diatom  $\leq 20\%$  (n=95), Category 2 = Motile diatom between 20% and 40% (n=60), Category 3 = Motile diatom  $\geq 40\%$  (n=60).

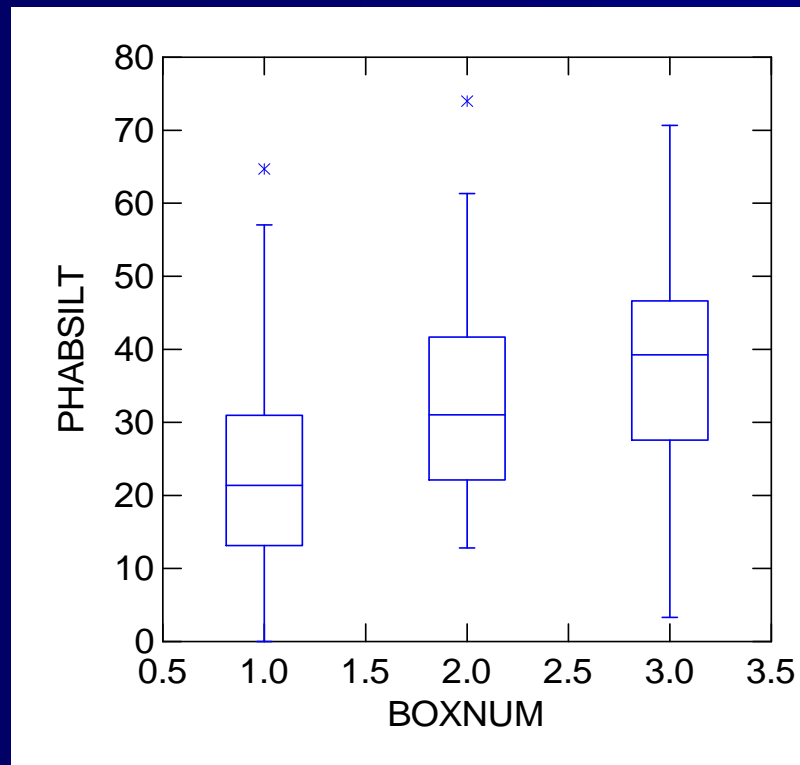
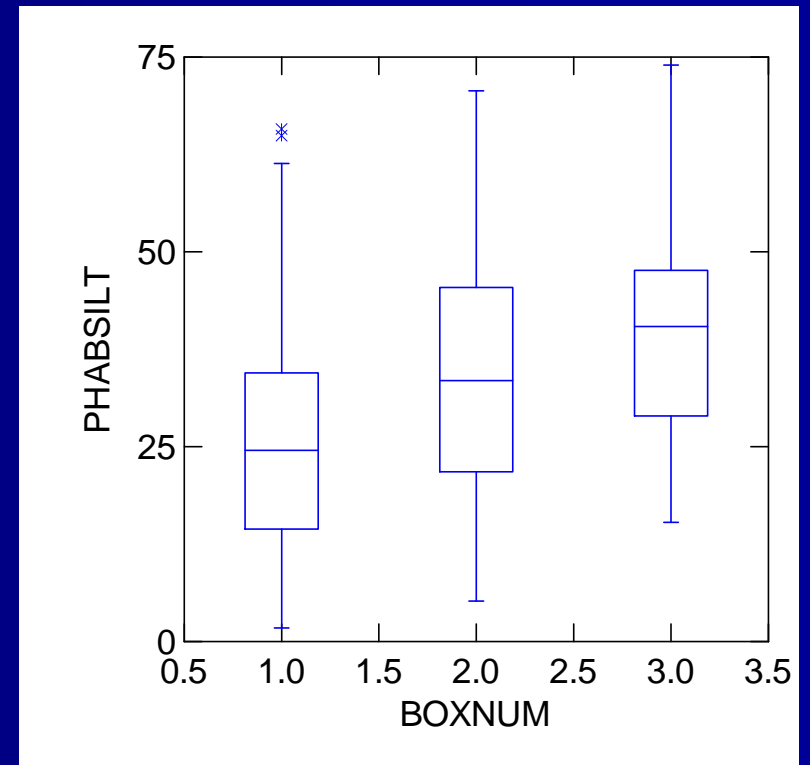
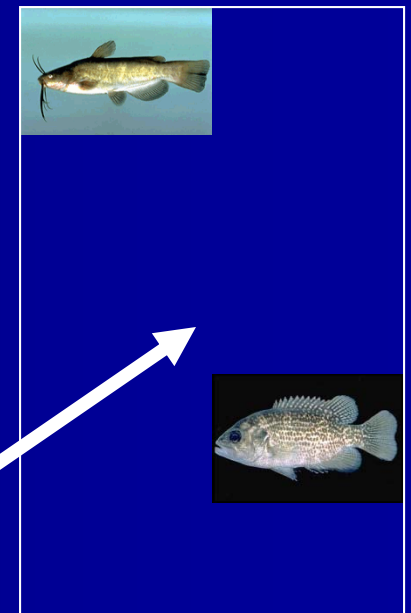
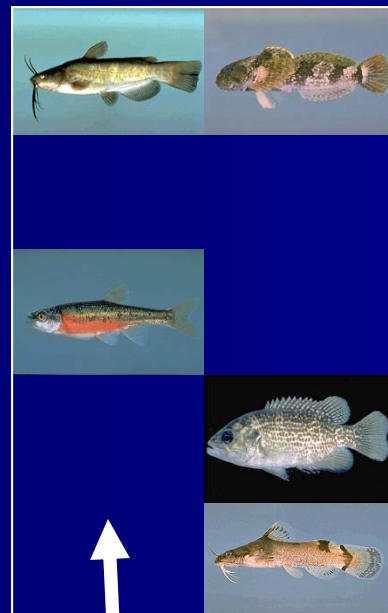
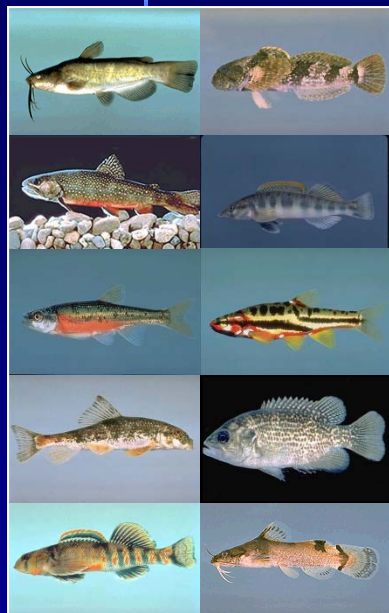


Figure 6. Box plot of VSCI and PHAB siltation index. Category 1 = VSCI  $\geq 65$  (n=82), Category 2 = VSCI between 65 and 50 (n=64), Category 3 = VSCI  $\leq 50$  (n=33).



# Stream fishes provide indicators of environmental quality



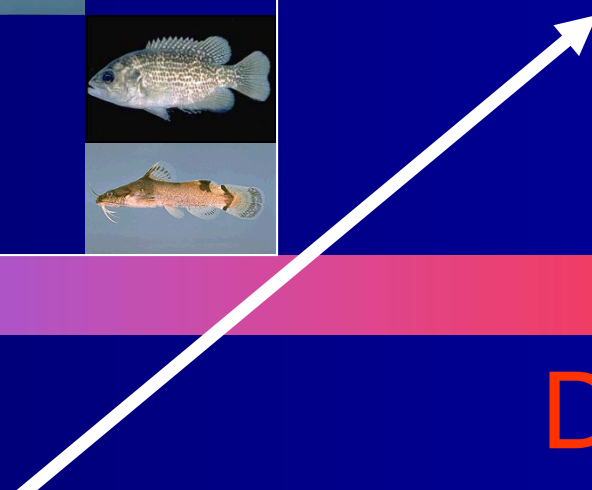
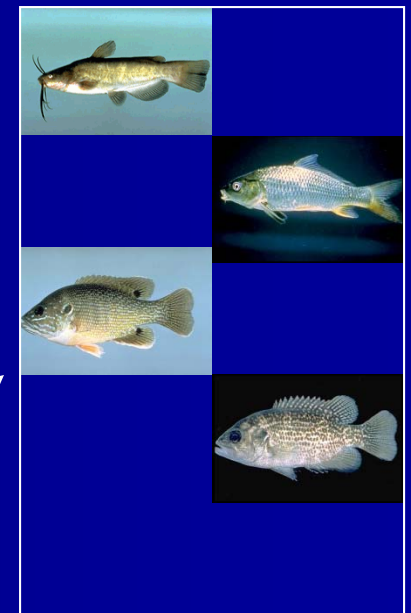
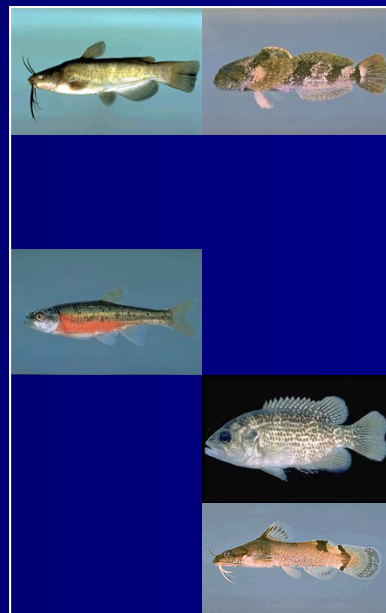
Pristine

Degraded

Loss of intolerant species



# Stream fishes provide indicators of environmental quality



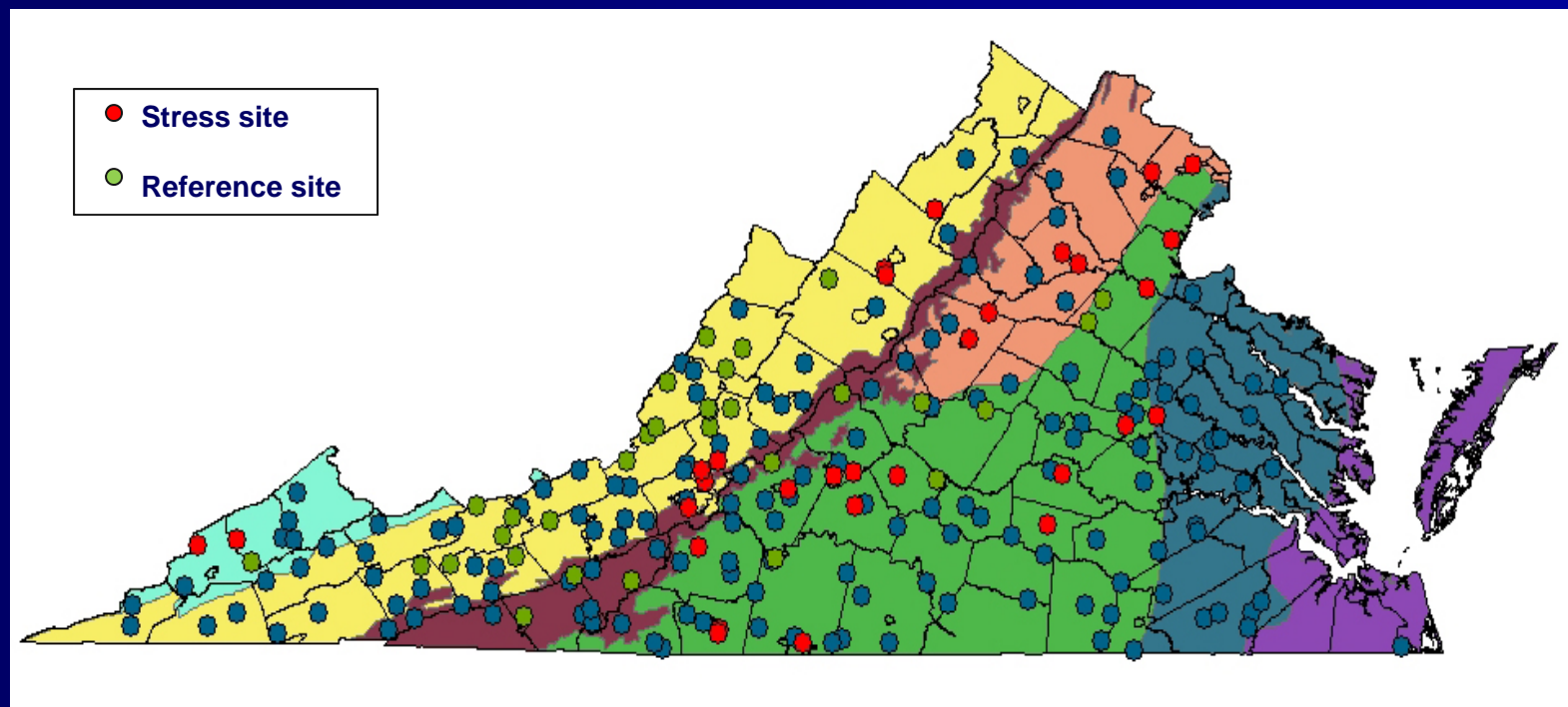
Pristine

Degraded

Addition of tolerant species

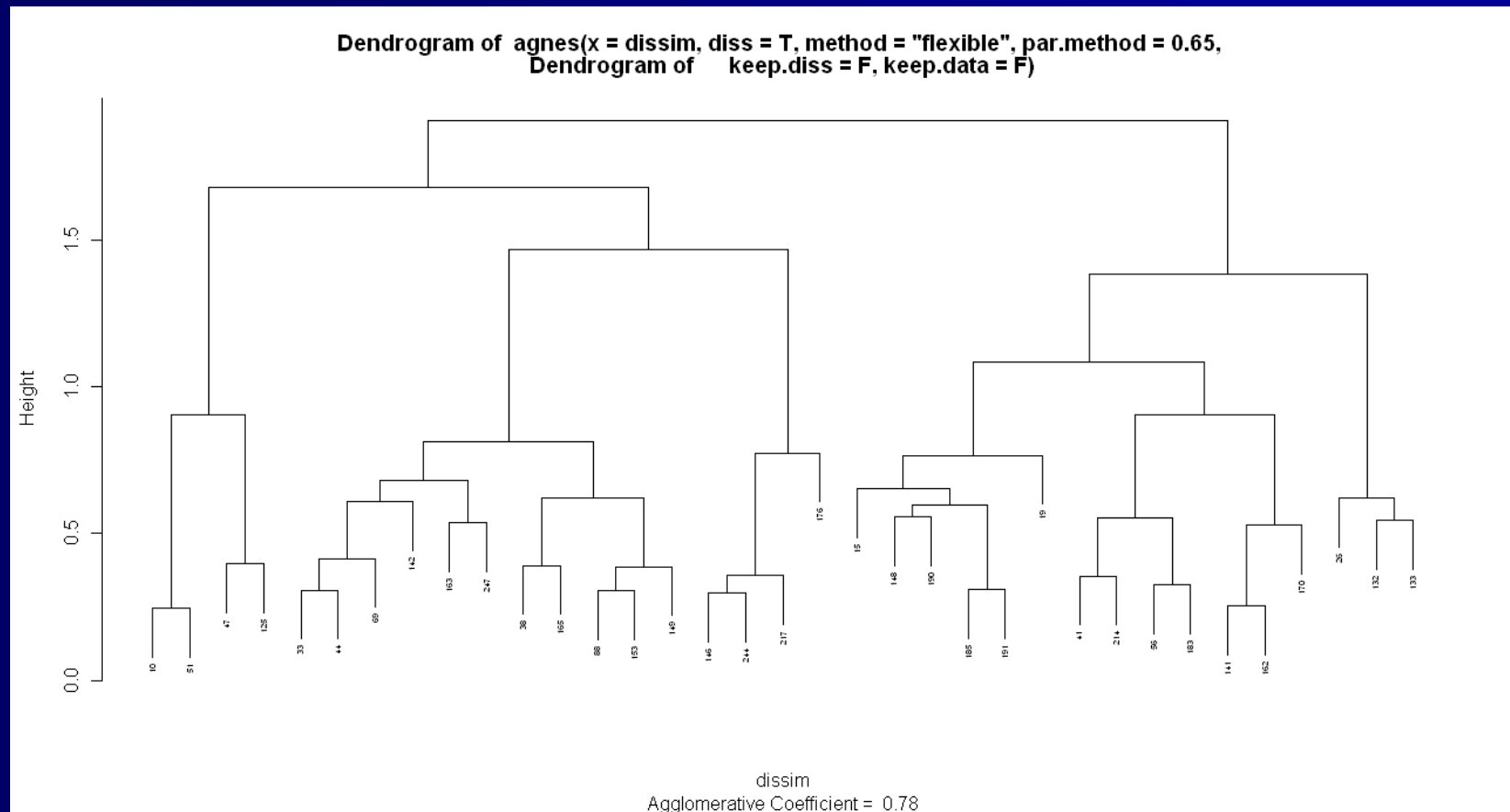
# Map of Fish Sites

All VA ProbMon Fish Sample Sites 2006-2009 (n=227)

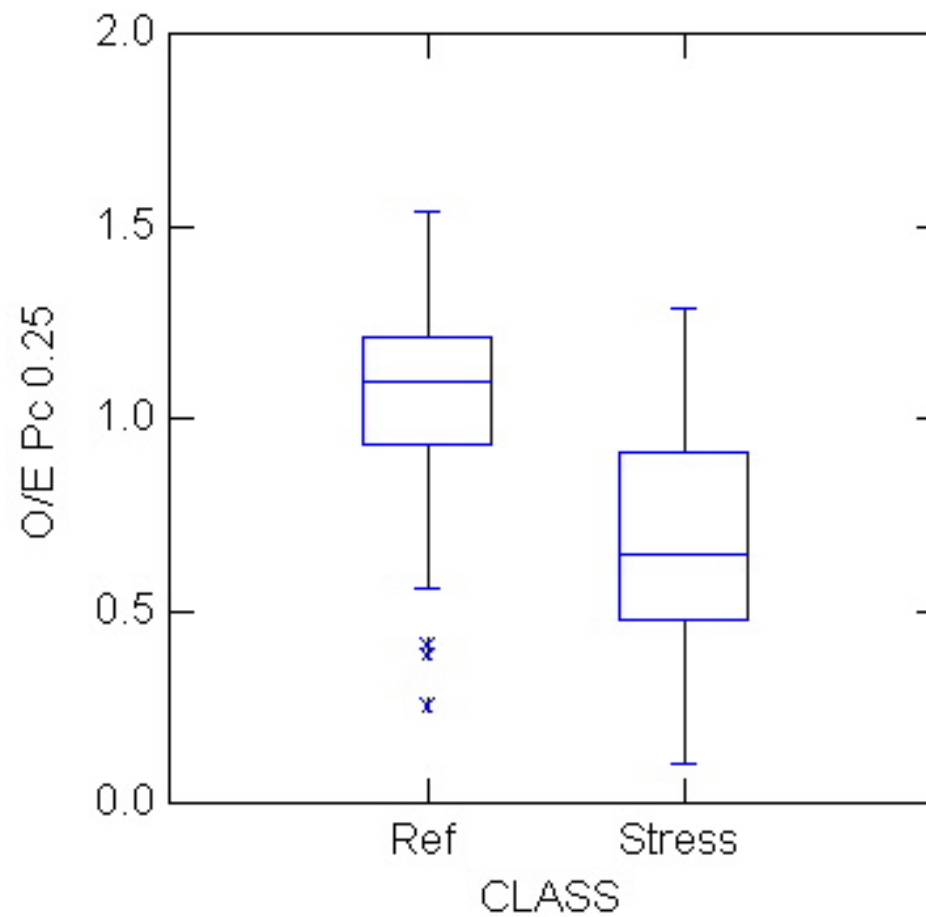


# RIVPACS for Fish (ref = 35, str = 48)

RMSE around 0.260 for all models

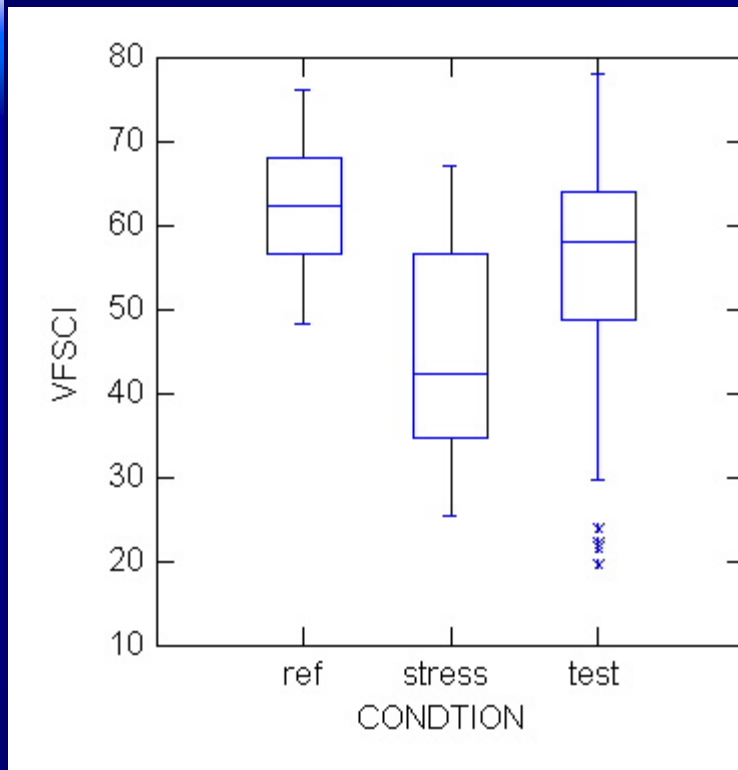


$P_c = 0.25$ , model used Area, BioRegion, Atlantic Slope Basin, good separation of ref/str and small amount of 'outlier'





# Draft Fish IBI for Mountainous Water (Class 4)



Category	Most consistent metrics across all stressors
Richness	<b># of Species (RIVPAC) (class 3/4 metric)</b>
Richness	<b>% Sculpin (class 4 metric)</b>
Richness	% Sunfish (class 3 metric)
Trophic	<b>% Macro-omnivore (class 3/4 metric)</b>
Trophic	% Insectovore (class 3 metric)
Trophic	<b>% Benthic Feeder (class 3/4 metric)</b>
Habitat	% General Habitat (class 3 metric)
Habitat	<b>% Simple Lithophil (R-G) (class 4 metric)</b>
Tolerance	<b>% Tolerant (class 3/4 metric)</b>



# Acknowledgements

## WE NEED A NEW PICTURE!



**Tony Olsen, Greg Pond, Lou Reynolds, Frank Borsuk, Maggie Passmore**, for assistance, training, and support

**Private Landowners** across the state of Virginia for allowing DEQ field staff to access ProbMon sites



*M. Scanlan, L. Willis, W. Brown, R. Dabb, D. Schmidt, W. Shanabruch, M. Aling, J. Brooks, A. Cario, C. Chamberlain, C. Cook, C. French, B. Harrison, G. Holland, L. Seivard, S. Torbeck, D. Smith, R. Stewart, M. Shaver, C. Staten, K. Wills, R. Johnson, N. Heagy, E. Cumbow, L. Sparks, A. Silvia, W. Harlan, C. Davey, D. Wolfram, J. Howell, A. Wazlak, W. Van Wart, M. Titman, R. Turner, M. Richardson, R. Anderson, A. Barron, D. Lazarus, M. Hutchison, S. Woody, G. Anderson, J. Wunningham, M. McLeod, T. Liptak, J. Harris, R. Bodkin, T. Frazier, J. Palmore, B. Thomas, A. McKee, S. Cioccia, W. Smigo*



# Questions? Stream Yeti? Greek God?

VDEQ

Jason Hill

3019 Peters Creek Rd

Roanoke, VA 24019

phone: 540.562.6724

email: [jason.hill@deq.virginia.gov](mailto:jason.hill@deq.virginia.gov)

<http://www.deq.virginia.gov/probmon/> (old)

<http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/ProbabilisticMonitoring.aspx>

