Predicting Impacts of Stressors at the Land-Water Interface

Chesapeake Bay and
Delmarva Coastal Bays

NOAA Support

$4.8M for 5 Years

Starting September 2009

17 Principal Investigators, 8 Institutions, led by the Smithsonian Environmental Research Center (SERC)

From SERC:

- Thomas Jordan (lead)
- Denise Breitburg
- Charles Gallegos
- Eric Johnson
- Xuyong Li
- Melissa McCormick
- Patrick Neale
- Gerhardt Riedel
- Donald Weller
- Dennis Whigham

From other institutions:

- Karin Kettenring, Utah State
- Michael Erwin, USGS
- Lee Karrh, MD DNR
- Evamaria Koch, UMCES
- Rochelle Seitz, VIMS
- Timothy Targett, UDE
- Denice Wardrop, PSU

Collaborators:

NOAA Chesapeake Bay Office:

-Howard Townsend

-Steven Giordano

MD Department of Natural Resources:

-James Uphoff, Jr.

-Kevin Smith

Focus on:
Shallow (<2m deep) Estuarine Waters

- Biologically active land-sea interface

- Critical habitats for fisheries and migratory species

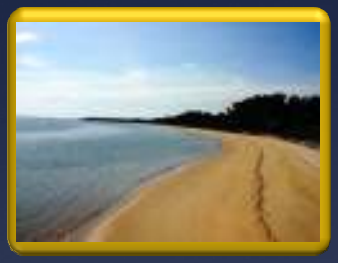
Major Components:

- **Water Quality**
  - Nutrients (in water)
  - Contaminants (in tissues)
- **Macro Fauna** (mesohaline)
  - Nekton
  - Benthic Invertebrates
  - Shorebirds
- **SAV** (oligo-, meso-, polyhaline)
- **Tidal Wetlands** (especially *Phragmites* invasions)

Factors:

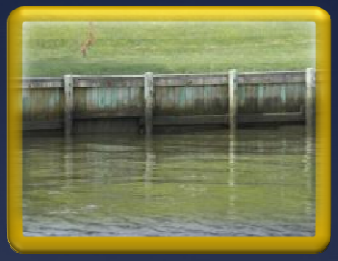
Shoreline Types

Natural Marsh



Beach

Rip-Rap



Bulkhead

Upland Usage

Forested

Residential and Urban Development

Agricultural

Experimental Design

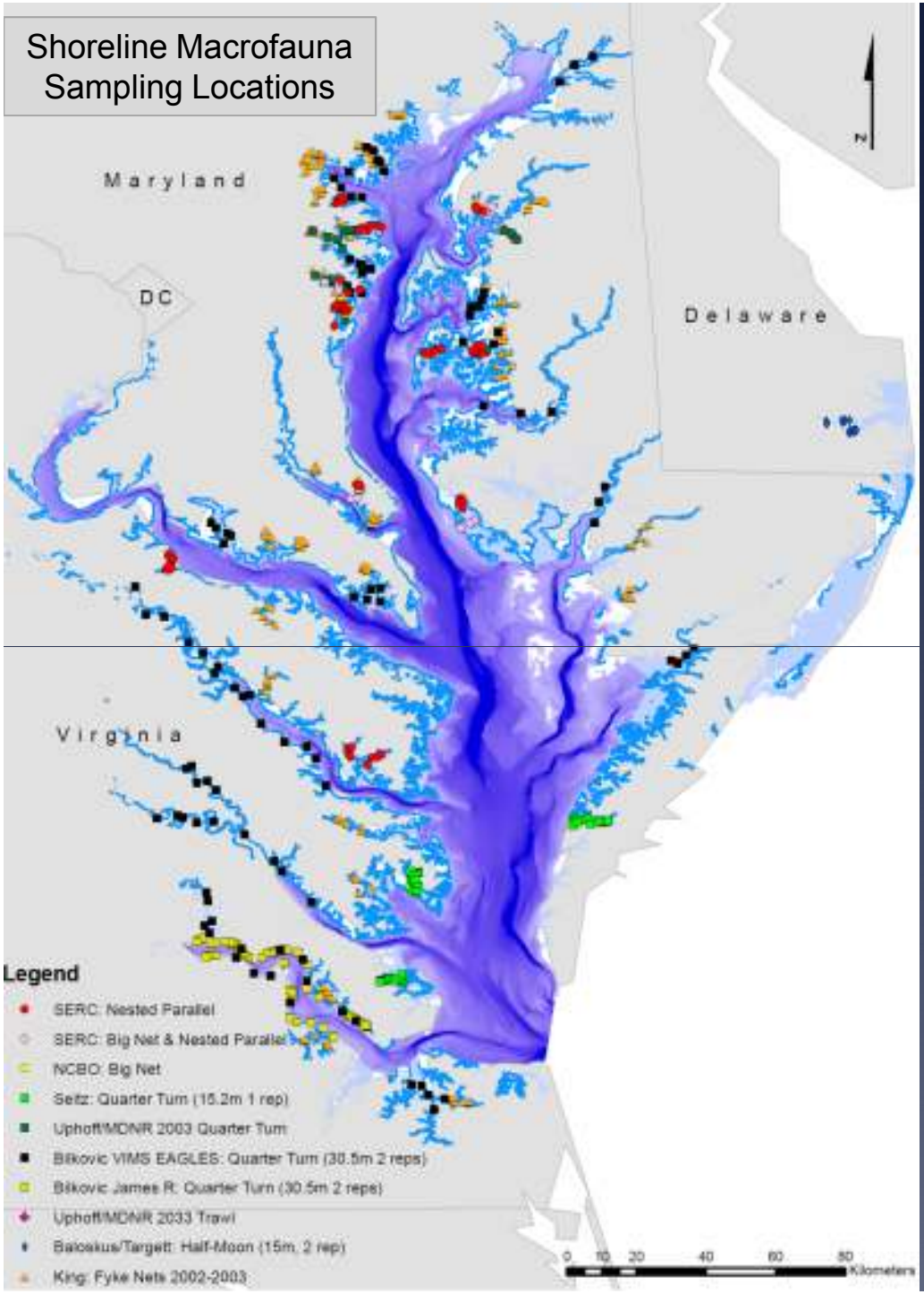
- 4 shoreline types
- 3 upland usage types
- 6 replicates of each (2 analyzed)

Site selection

142 systems identified

- 128 Chesapeake Bay
- 14 Coastal & Inland Bays

Statistical modeling can consider all, but not sampling.

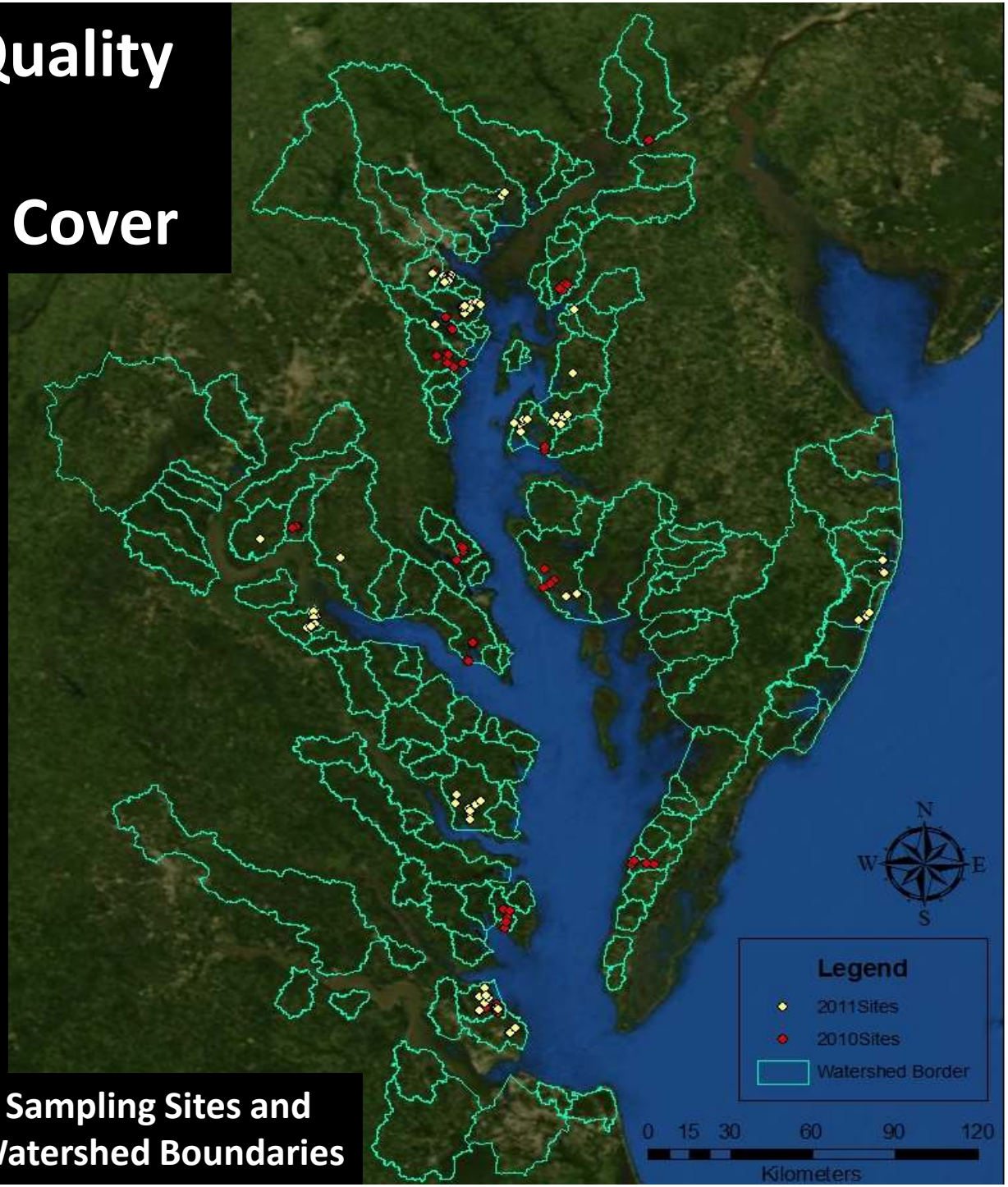


Patterns in Community Composition and Abundance

- Nearshore macrofauna data from several research groups (SERC, VIMS, U-Delaware, MDNR, NOAA CBO, and NOAA Oxford Lab)
- Over 500 sample locations spanning 31 subestuaries
- Multivariate statistics and models to understand how community composition and abundance relate to land use and shoreline habitat

Relating Water Quality to Watershed Land Cover

28 Subestuaries Sampled 2010-2011

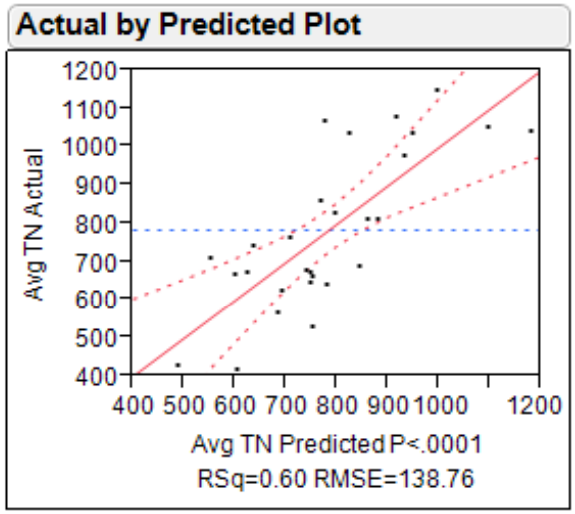


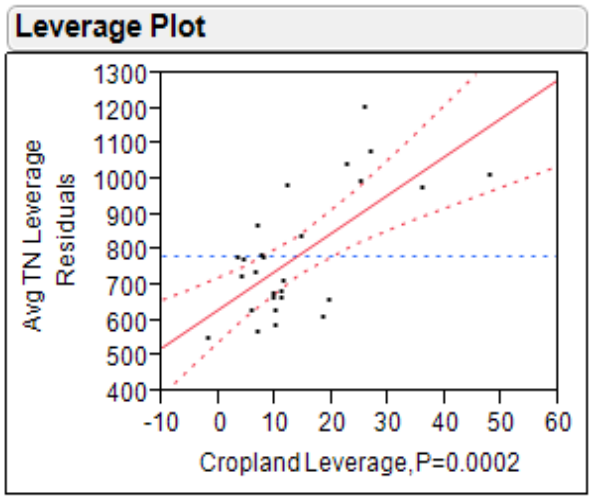
Sampling Sites and Watershed Boundaries

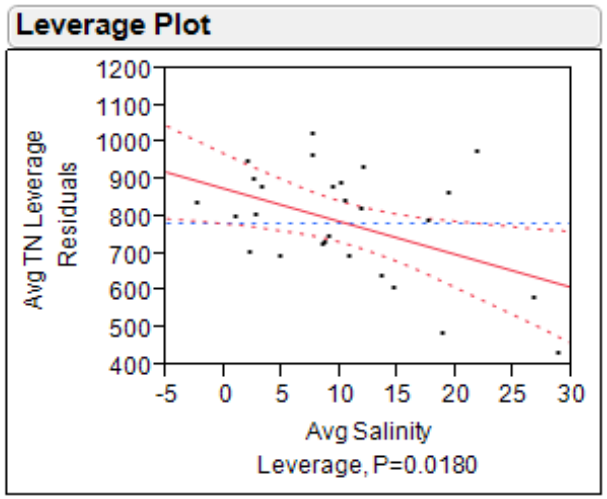
Stepwise Regression: Total N

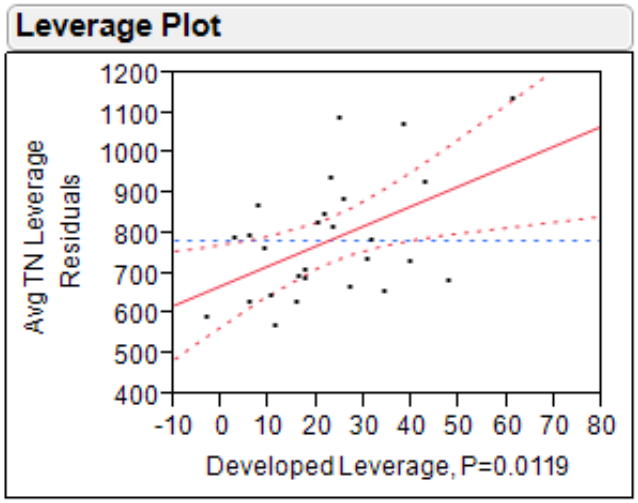
Parameter	R^2	AIC	Δ_i	w_i	# Parameters
% Developed Land	0.00	371	19	0.00	1
% Cropland	0.49	355	4	0.13	2
Average Salinity*	**0.60**	**352**	**0**	**0.79**	**3**
% Developed (Removed)	0.47	356	5	0.08	2

*best fit model





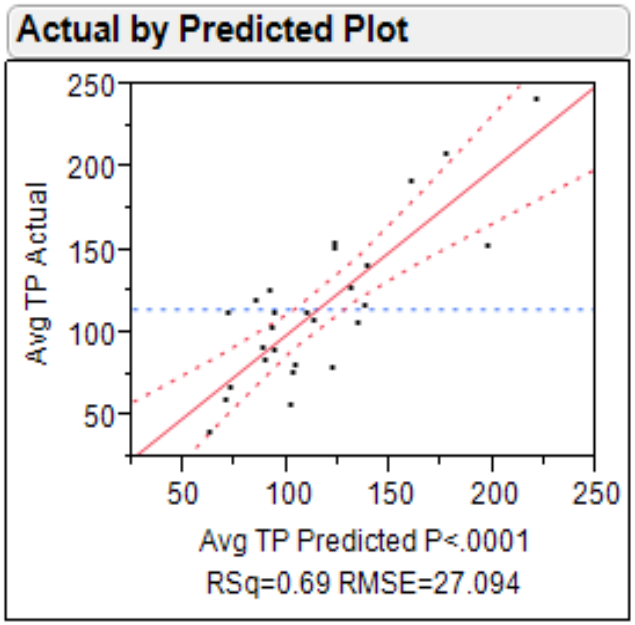


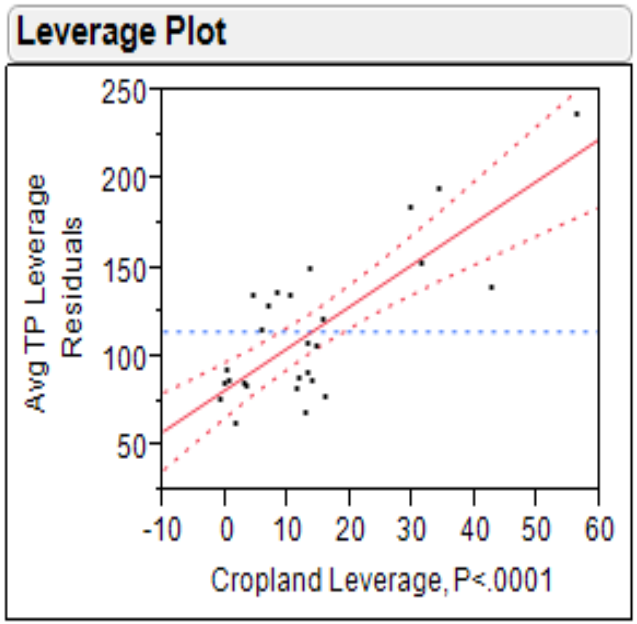


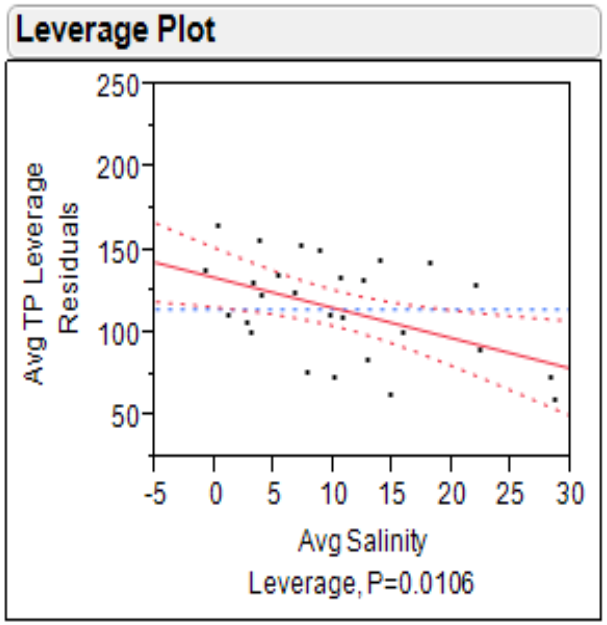
Stepwise Regression: Total P

Parameter	R^2	AIC	Δ_i	w_i	# Parameters
Average Salinity	0.19	284	23	0.00	1
% Developed Land	0.40	279	18	0.00	2
% Cropland	0.69	264	3	0.18	3
% Developed Land (Removed)*	**0.69**	**261**	**0**	**0.82**	**2**

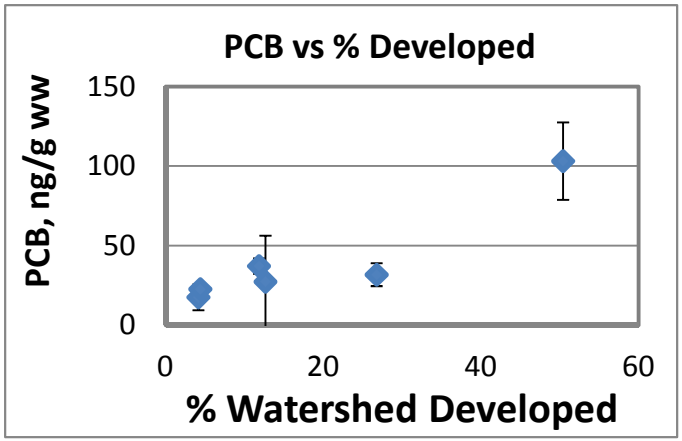
*best fit model

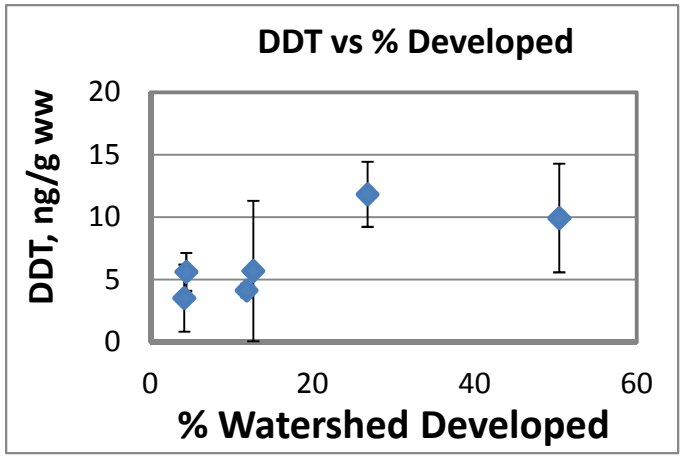


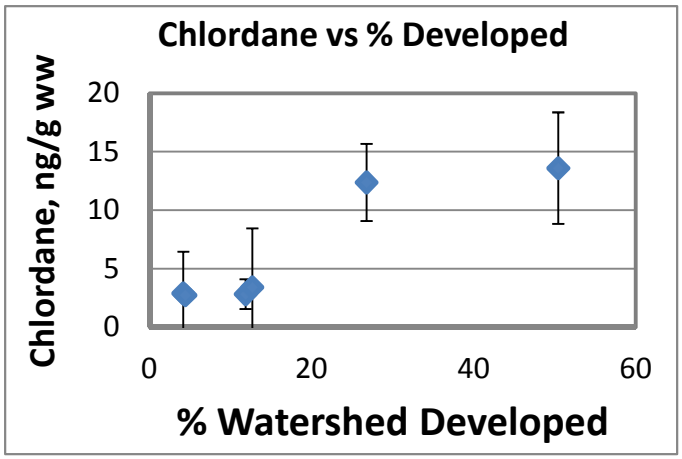


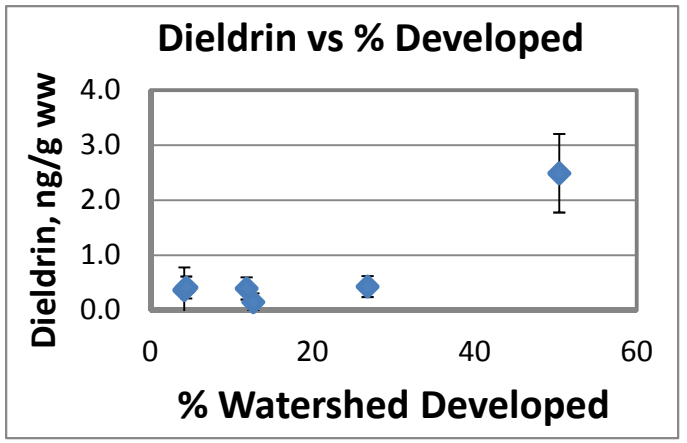


Persistent Organic Pollutants in Silversides vs. % Developed





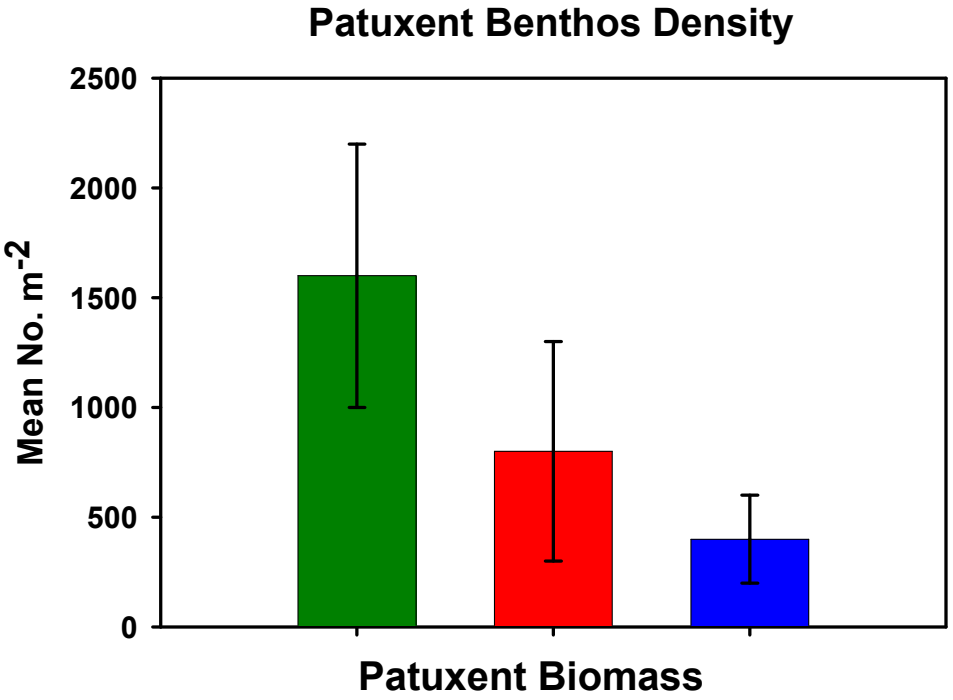


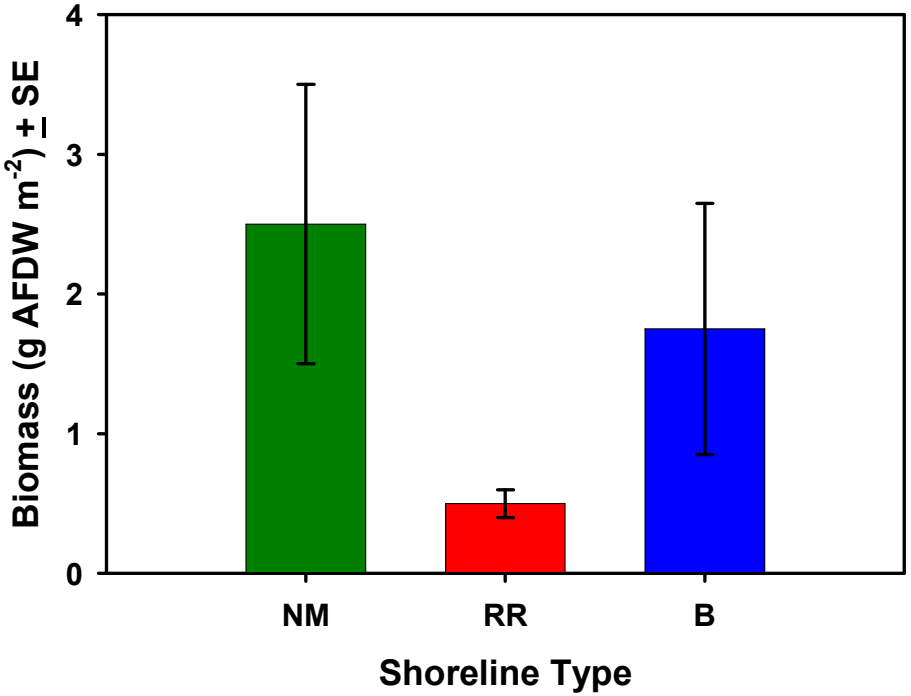


Macro Fauna Results for Patuxent River

Patuxent (Dev): Density & Biomass

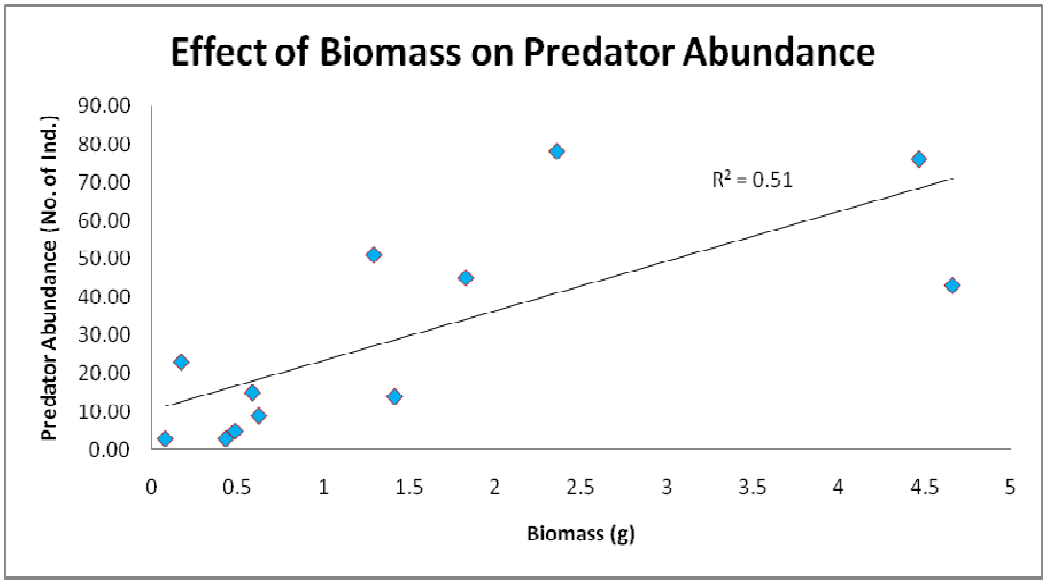
- Shoreline type influences benthic density
- "Developed" system shows deleterious effects on rip-rap habitats
- Shoreline top predictor in AIC stats

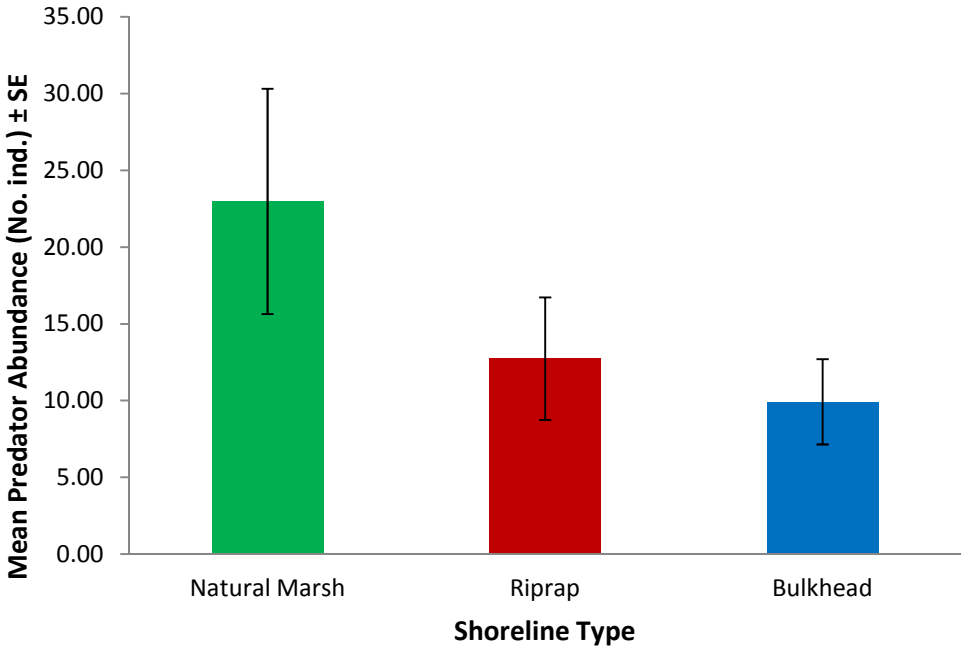




Patuxent (Dev): Predators

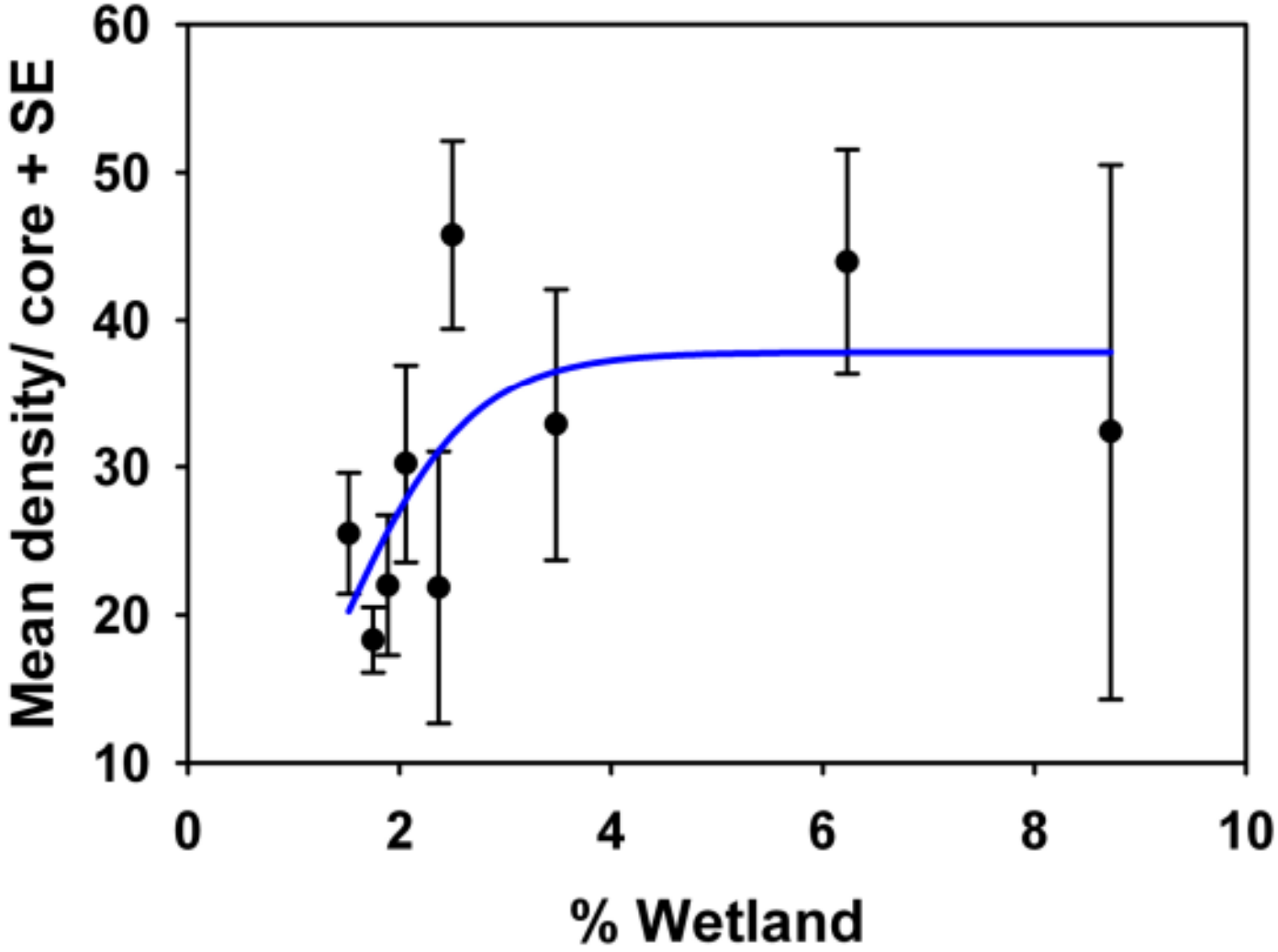
- Positive relationship between benthic biomass and predators:
  - bottom-up control
- Deleterious effects in rip-rap habitats in "developed" systems





Density by % Wetland

$R^2 = 0.58$



Summary: Patuxent River Results

- Natural marsh has highest density and diversity; Rip Rap and Bulkhead shorelines show negative effects
- Rip rap may be poor habitat when in degraded system –cumulative effects (e.g., Patuxent)
- Predators may be adversely affected by shoreline development and are more abundant in marshes where prey are abundant
- Habitat degradation may be linked with loss of higher trophic levels
- There is a crucial link between natural marshes, benthic infaunal prey, and predator abundance; therefore, protection and restoration of marsh habitats may be essential to the maintenance of high benthic production and consumer biomass in Chesapeake Bay and similar estuarine systems