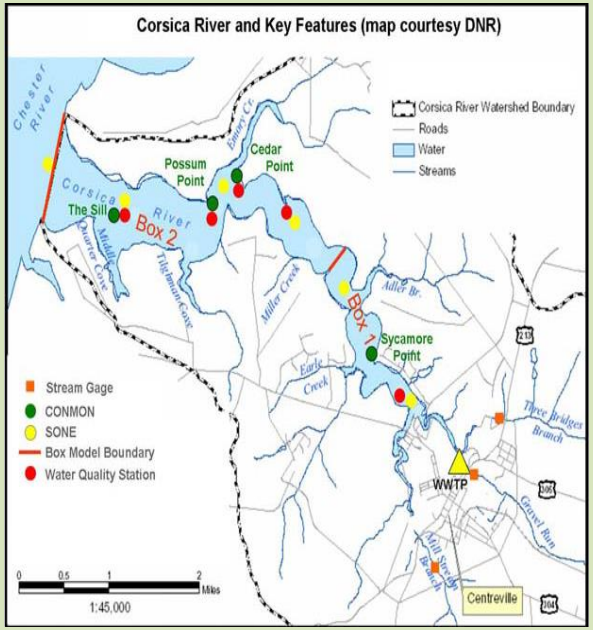
Triblet Characteristics & Responses

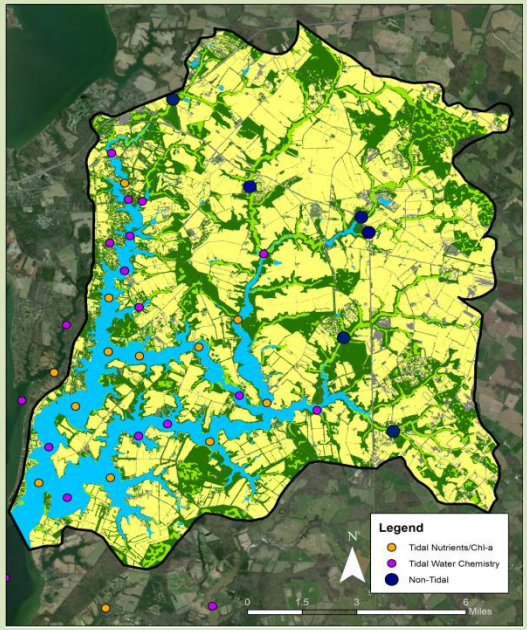
K.G. Sellner[1], W.R. Boynton[2], J. Testa[2], T. Rosen[3], R.J. Orth[4], D. Dauer[5], and J. Uphoff[6]

[1]Center for Coastal & Watershed Studies, Hood College
[2]UMCES-CBL
[3]ShoreSavers
[4]VIMS
[5]ODU
[6]MD DNR Fishing & Boating Services

Water Quality & Biogeochemistry

- River inputs
  - Urban Back: ~100 $gN/m^2/y$
  - Ag Corsica: ~10 $gN/m^2/y$
  - Ag Wye: ~0.08 $gN/m^2/y$

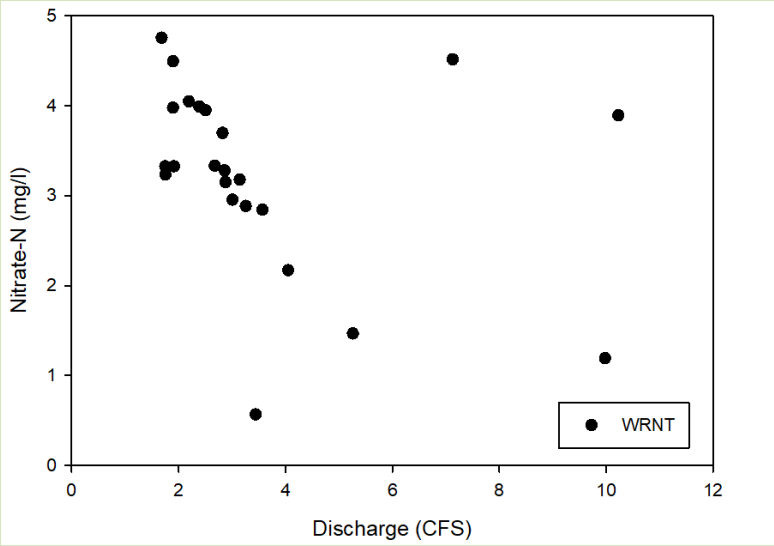




URBAN AG AG

Wye Subwatershed Characteristics

Site	Waterhsehd Area	Mean Discharge	NO_3^-	PO_4^{-3}	NH_4^+	NO_3^-	PO_4^{-3}	NH_4^+	NO_3^-	PO_4^{-3}	NH_4^+
	Acres	CFS	mg/l			lbs/yr			lbs/acre		
MNT-1	3,997	8.2	5.48	0.03	0.04	87,175	323	646	21.81	0.08	0.16
SHNT-1	5,651	10.0	3.74	0.06	0.06	67,921	1,024	1,260	12.02	0.18	0.22
SNT-1	2,926	3.9	1.93	0.08	0.07	13,744	553	545	4.70	0.19	0.19
WENT-2	3,318	5.4	4.20	0.03	0.26	42,524	298	2,732	12.82	0.09	0.82
WENT-3	1,678	2.7	6.50	0.07	0.04	32,956	361	186	19.64	0.22	0.11
WRNT-1	2,547	3.5	3.37	0.03	0.06	23,428	193	386	9.20	0.08	0.15
					Total	**267,748**	**2,751**	**5,755**			

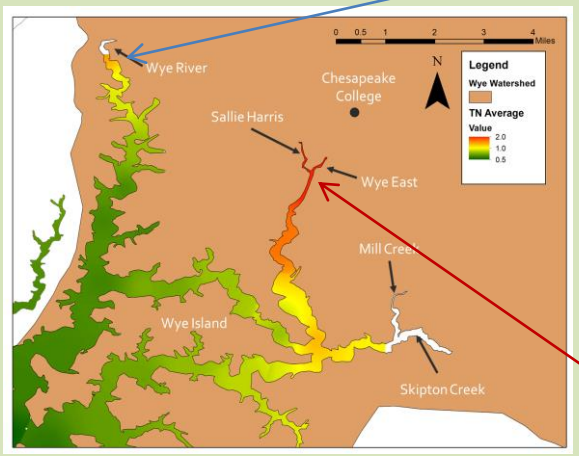


Nutrient pools rapidly diluted via increasing flow, little chance for in stream processing

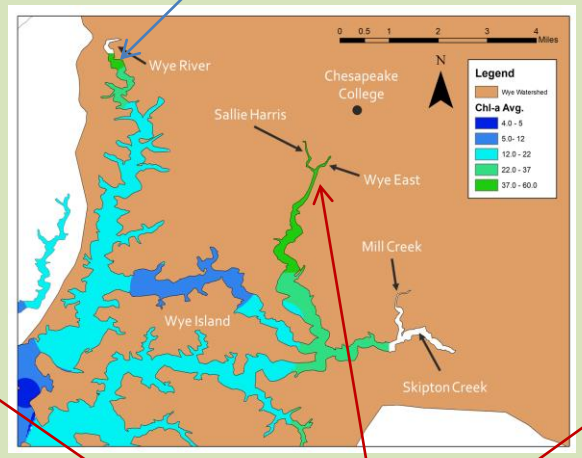
Wye Estuary Characteristics

Sub-estuaries below the triblets respond to the incoming triblet loads

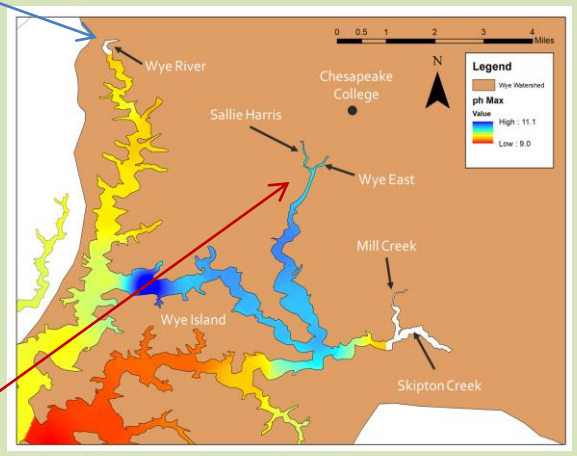
Marshes at triblet-estuary interface in the long residence Upper Wye River (left) remove triblet nutrients leading to lower sub-estuary responses



TN



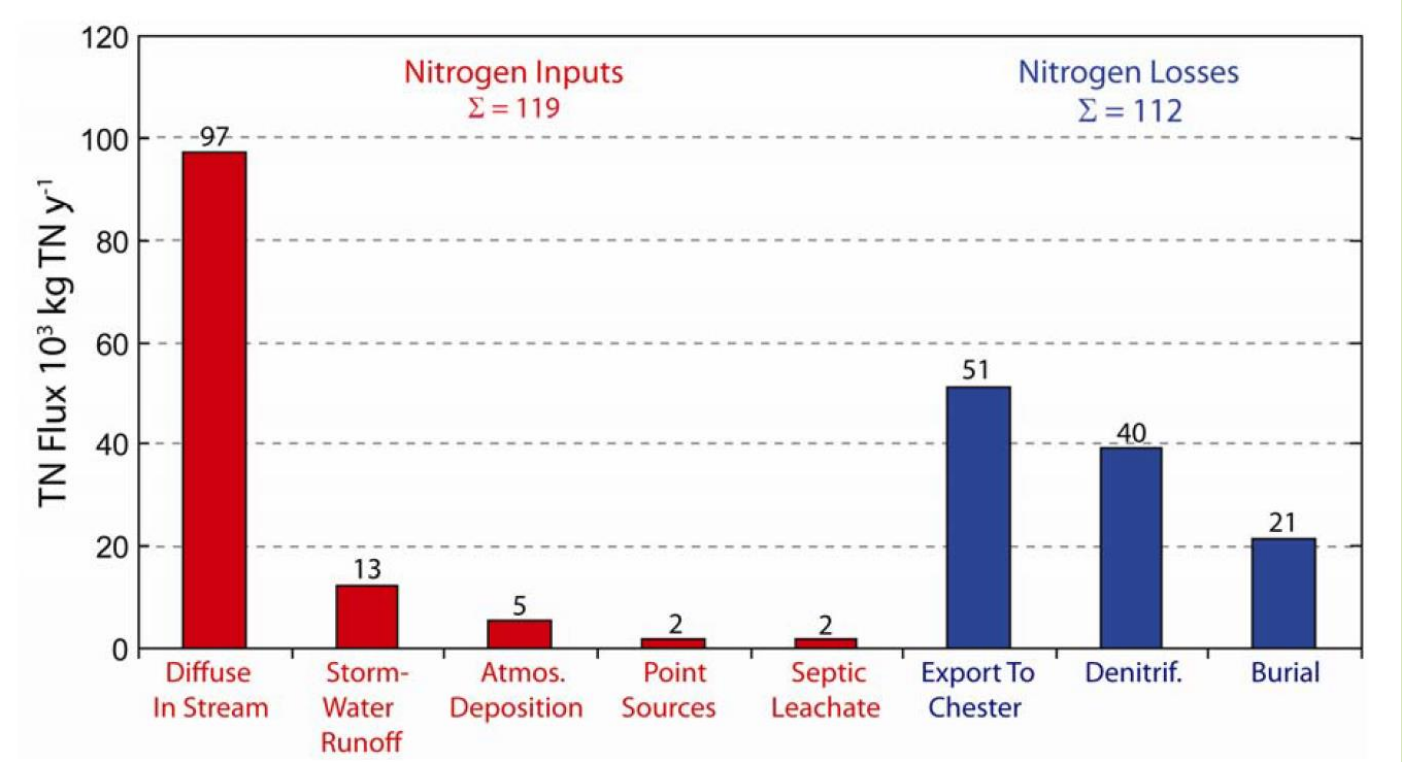
Chl a



pH

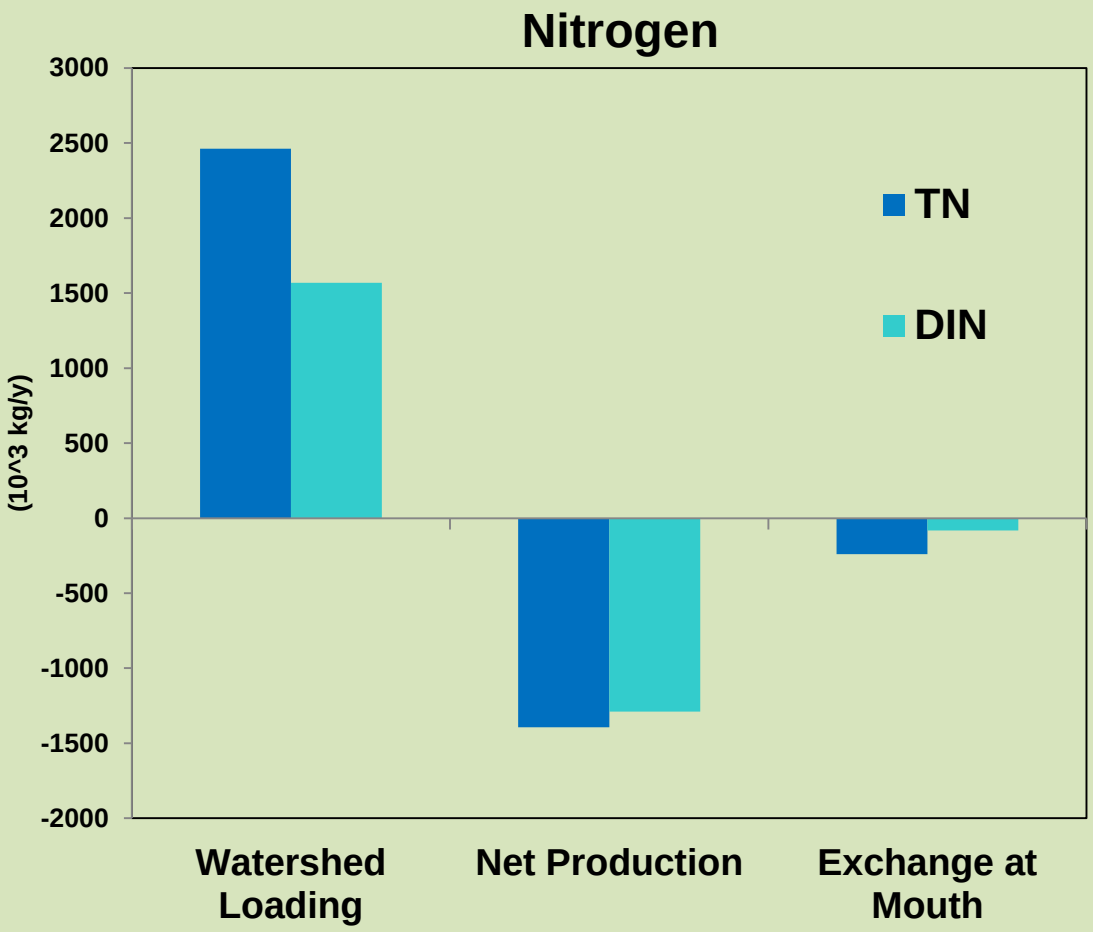
Rapid transit through the Sallie Harris & Wye East triblets (middle) limits processing so most of the nutrient enters the upper sub-estuary to support high TN and chlorophyll, low bottom DO, and elevated pH, the latter 2 characteristics yielding needed DIP for algal growth and accumulation

Corsica River TN Budget



(1) Input & losses nearly balance
(2) 50% retention

Is Back River nutrient enrichment a Local or Chesapeake Bay Issue…where does the enrichment come from?



A Simple Nutrient Budget

- Budget balances…

Inputs = Net Production + Exports

- Exports are to Chesapeake Bay
- The enrichment problem is LOCAL…don't blame the Bay for this pollution issue

NET EXPORT!

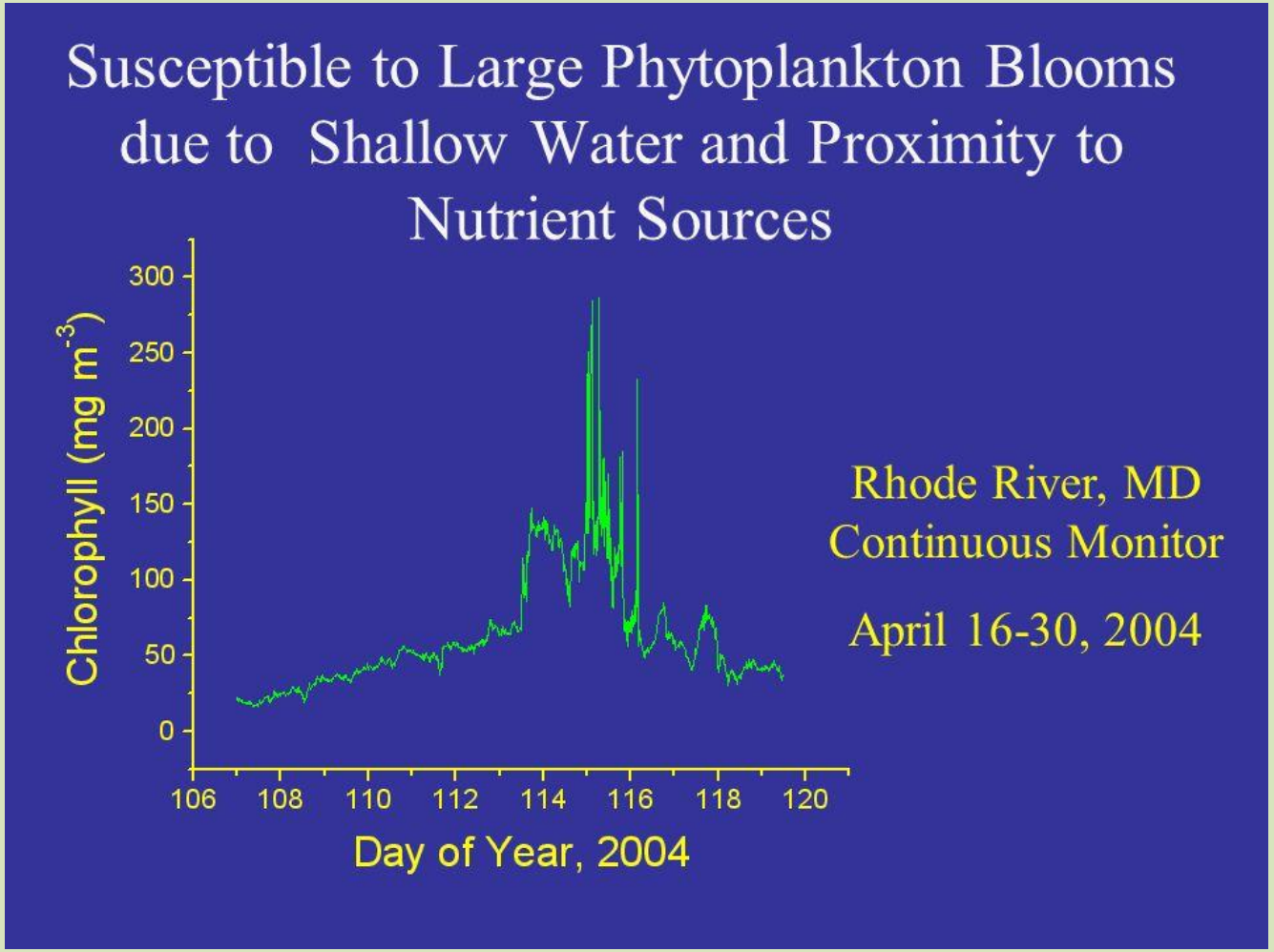
Autotroph Response

- Phytoplankton: Dependent on flow-residence time, tidal 'seeding', & turbidity
  - FW community?
  - Cyst beds?
  - Export? Importance of bottom substrate & benthic suspension feeding
- Case studies: Upper Sassafras, Chester, Corsica, Back, Rhode, Lafayette

J. Vail, Sassafras River Association

S. Earley, The Virginian-Pilot

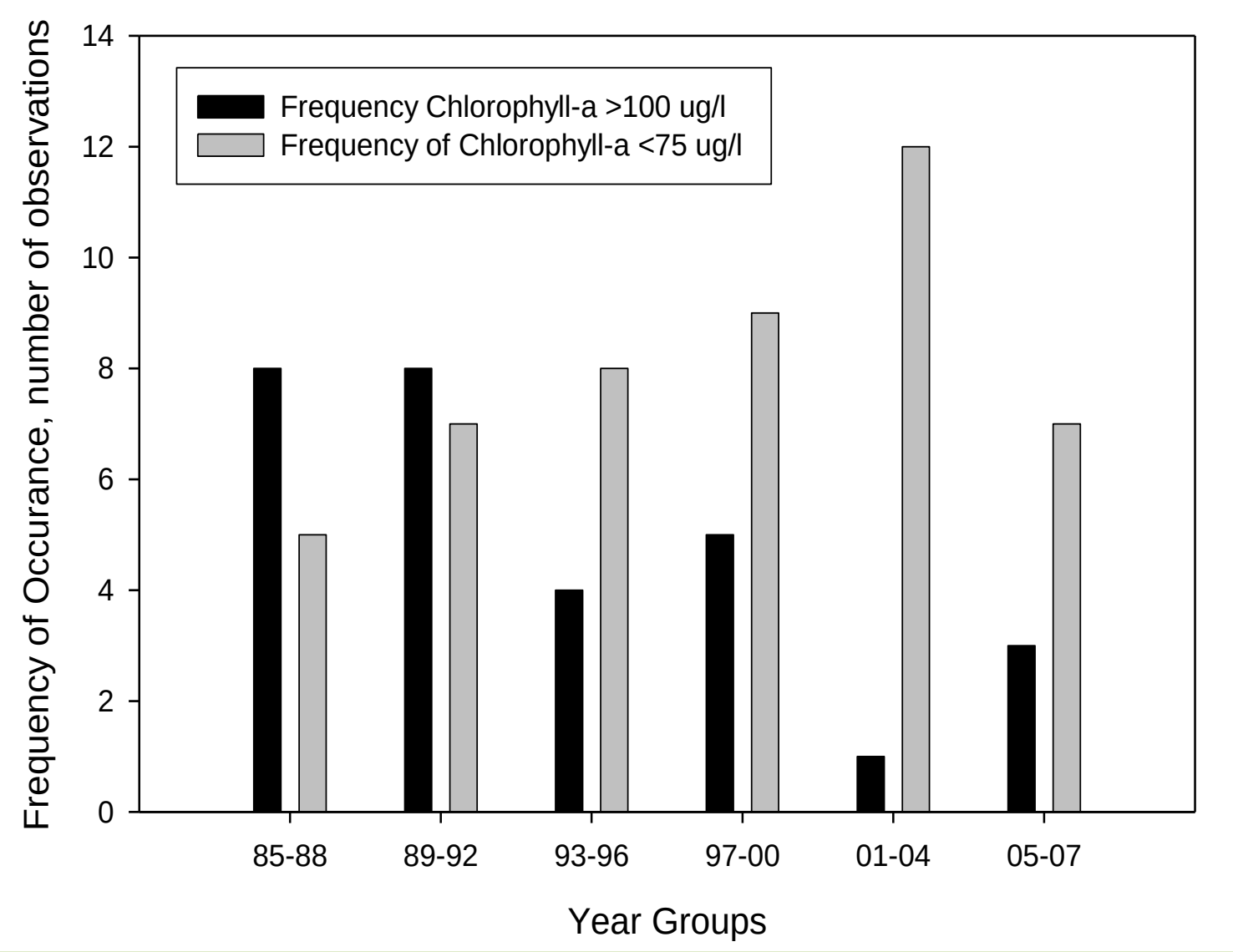
Bay Influx: Rhode River *Prorocentrum* bloom



Gallegos et al. 2004

Severe Algal Blooms

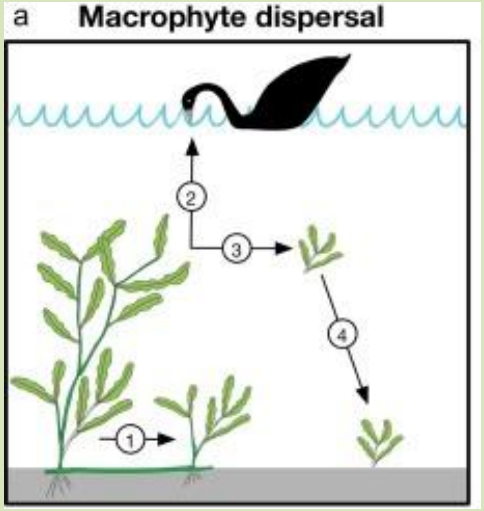
- Severe algal bloom frequency decreased following N load reductions
- N loads increased again (05-07) with rapid response in bloom frequency



Autotroph Response

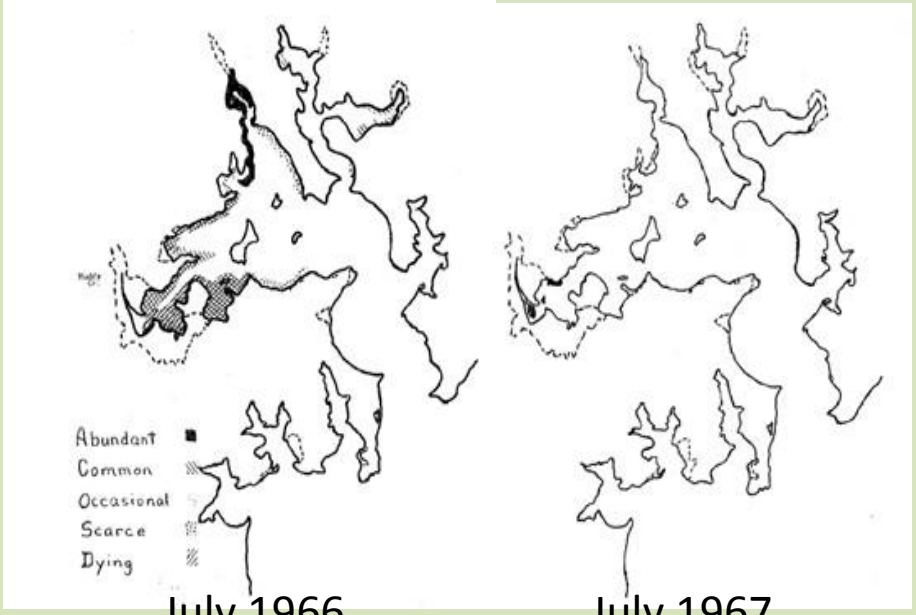
- SAV: Dependent on nutrients, bottom substrate, turbidity
  - Nutrients & epiphytes
  - Easily resuspended bottom-light limitation

R. Orth & C. Gurbisz, pers. comm.



Vilas et al. 2017. Ecol. Mod. 363

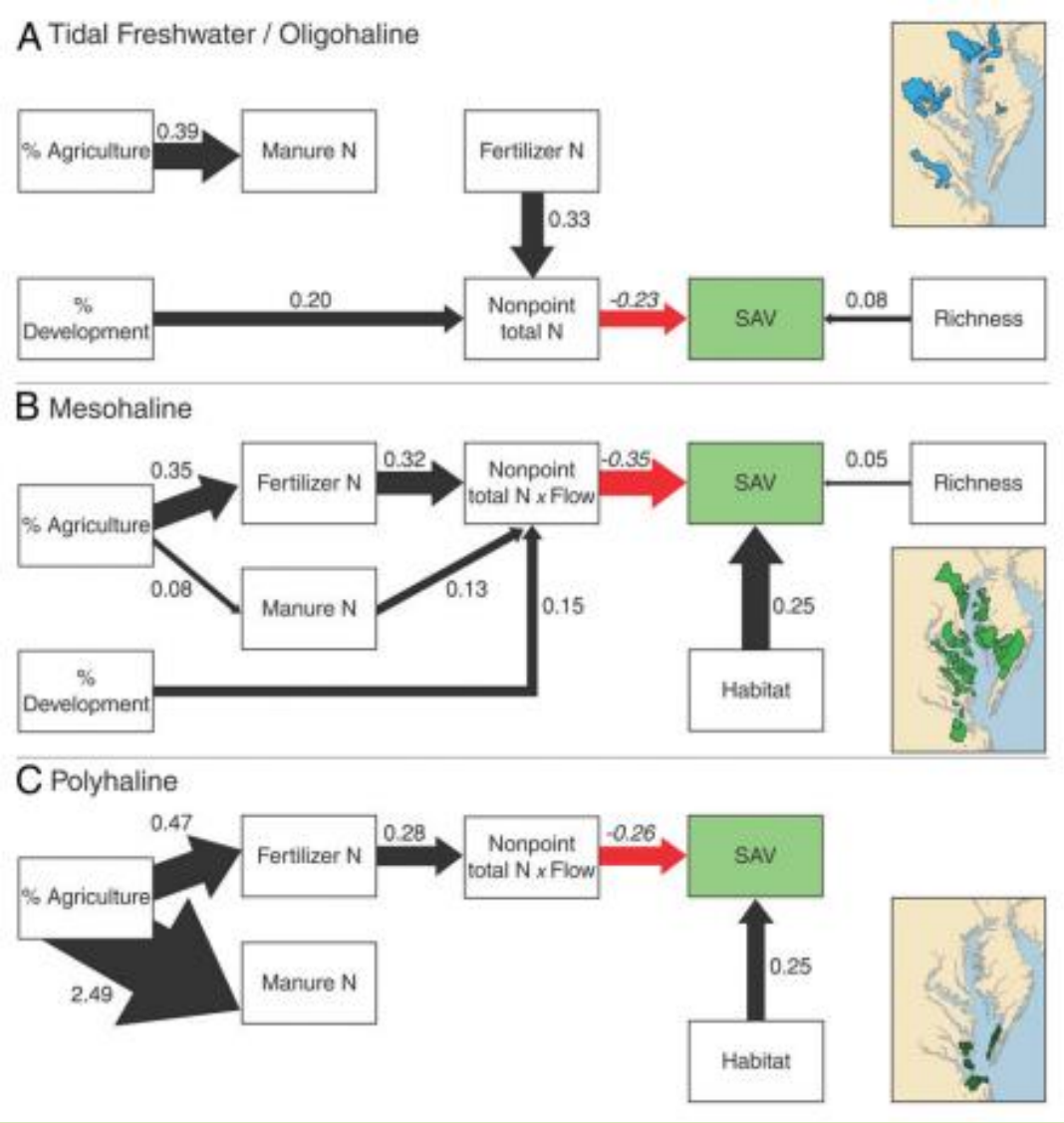
Shafer & Bergstrom 2008



Bayley et al. 1968 in Gallegos et al. 2004

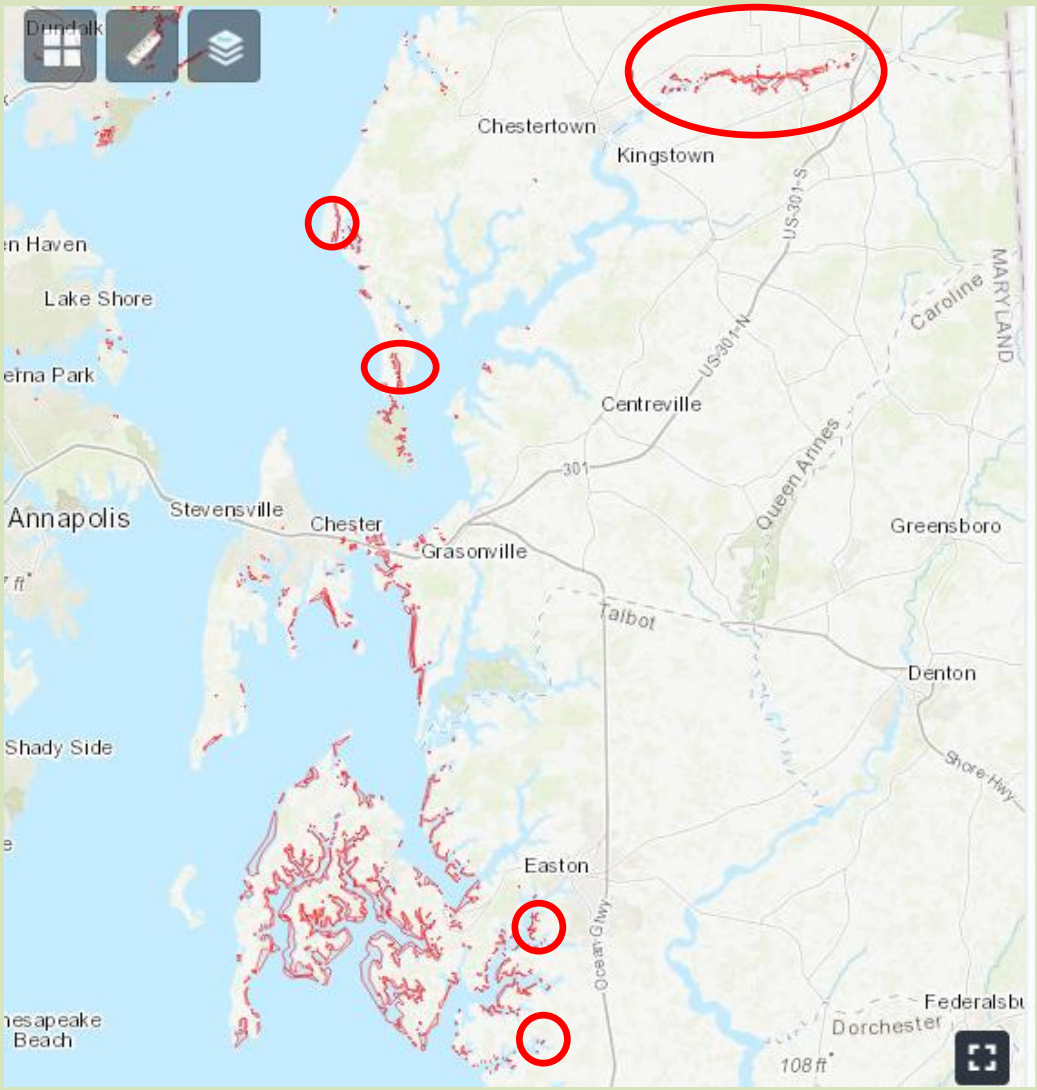
Likely SAV Response

- Lefcheck et al. (2018) indicate importance of N & P loads as detriments to SAV growth in the Bay & its tributaries
- Hence, reducing these loads in triblet watersheds should increase probability of SAV



Triblet SAV Area in the CB

- Many small triblet watersheds throughout the CB & its tributaries
- Hence, opportunity for assessing SAV response to extensive BMP implementation in small watersheds



Benthos

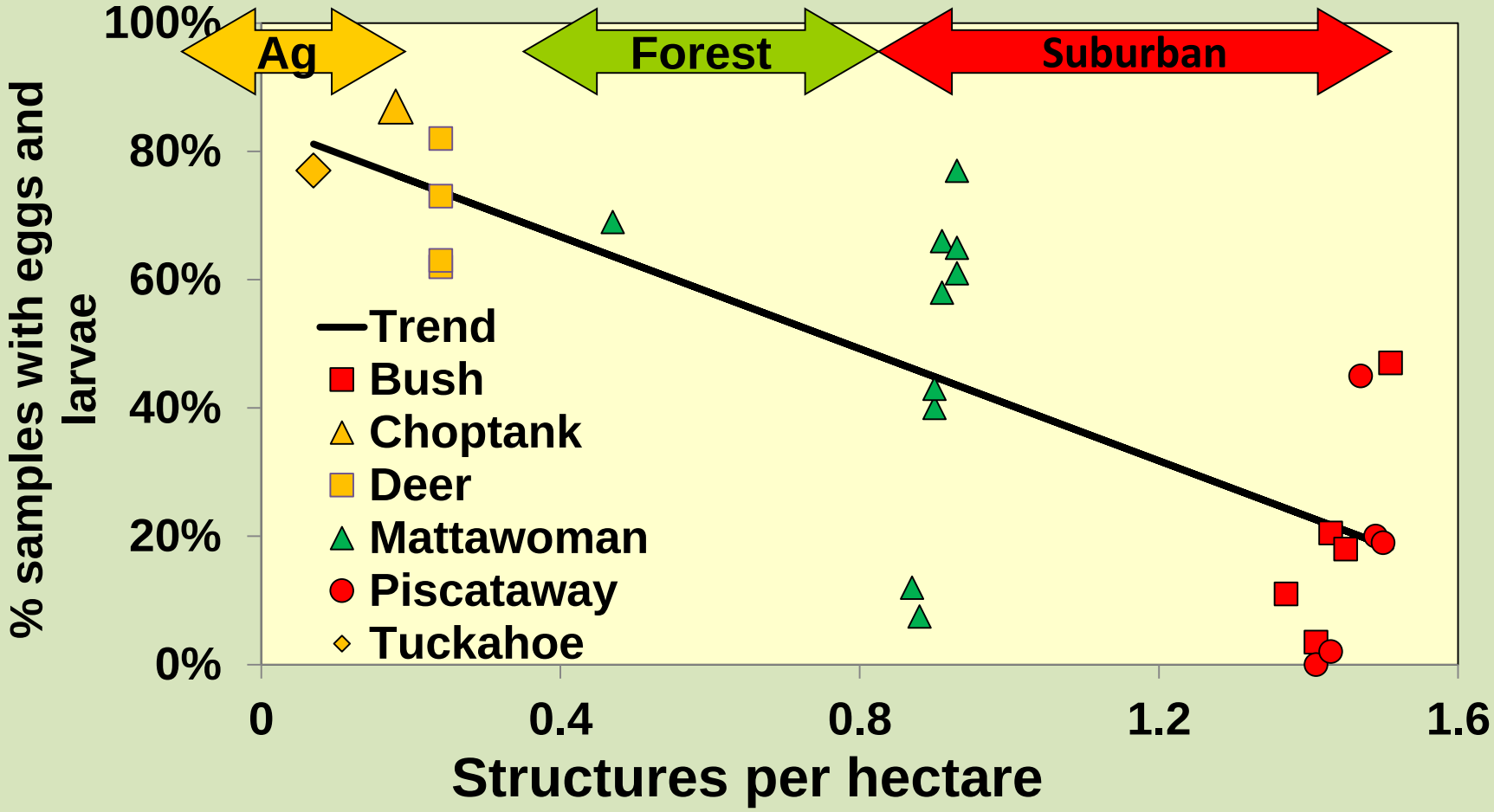
- Incoming sediment
  - load
  - grain size
  - bottom substrate
  - DO
- Dauer & colleagues (de la Ossa Carretero et al. 2016) indicate that benthic IBIs show a stronger relationship to small watersheds vs. larger systems; hence, these small systems should be good candidates to detect triblet macrobenthic responsiveness to mass BMP implementation
- For modeling triblett responses, Nixon (2002) may have said it all: As long as there is DO, "…the weight of benthic animals per unit area above the halocline in the Baltic is now up to 10 or 20 times greater than it was in the early 1920s… Cross-system comparisons have also shown that there are strong correlations between primary production and the … standing crop and production of benthic macrofauna in phytoplankton-dominated marine ecosystems"`

Fish

Watershed land use critical

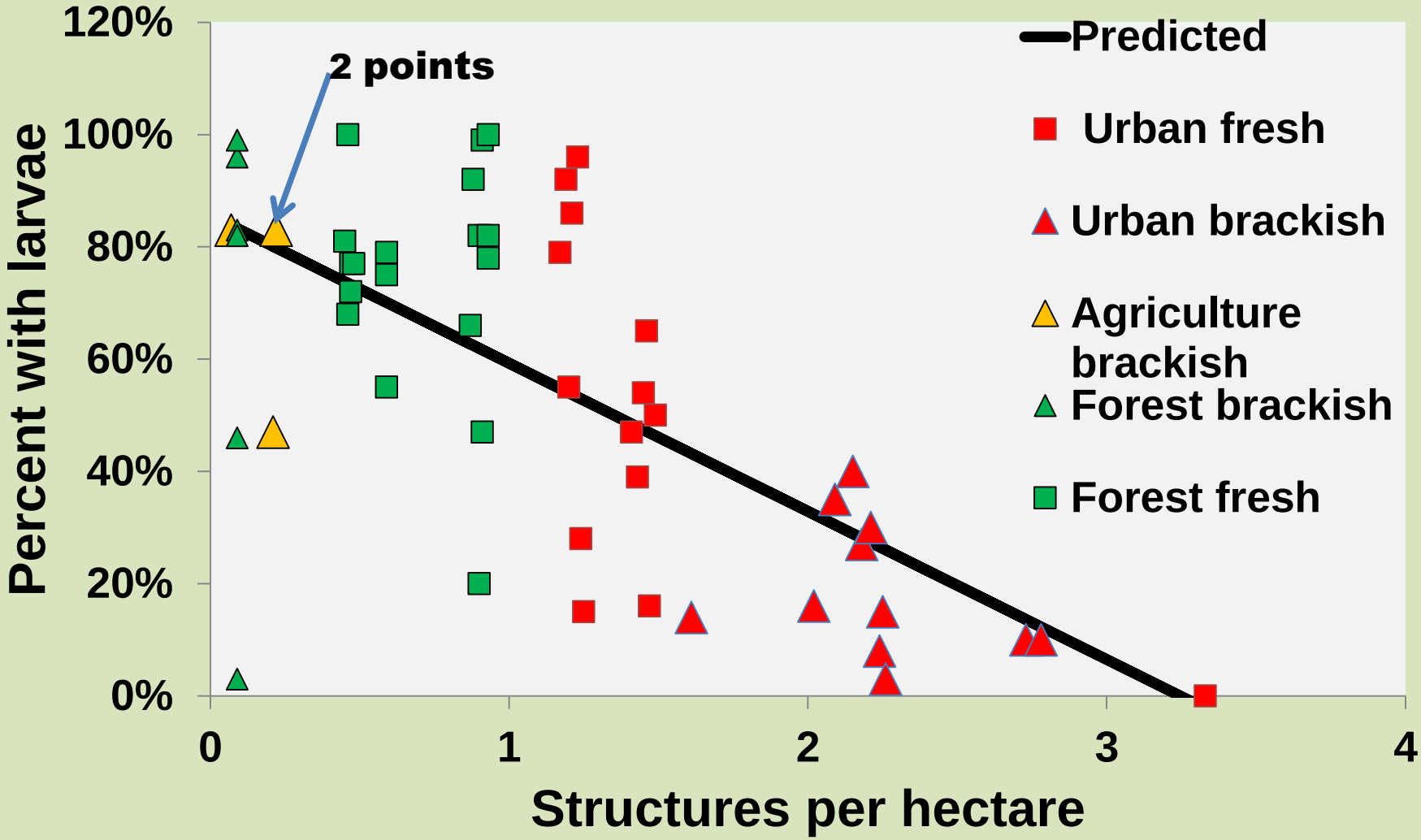
- Agriculture enhances fish eggs & larvae
  - Ag+BMPs = even greater enhancement
- Suburbanization (impervious surface) reduces larvae

Percent of stream samples with herring eggs and larvae declines with development. Color indicates primary land use.

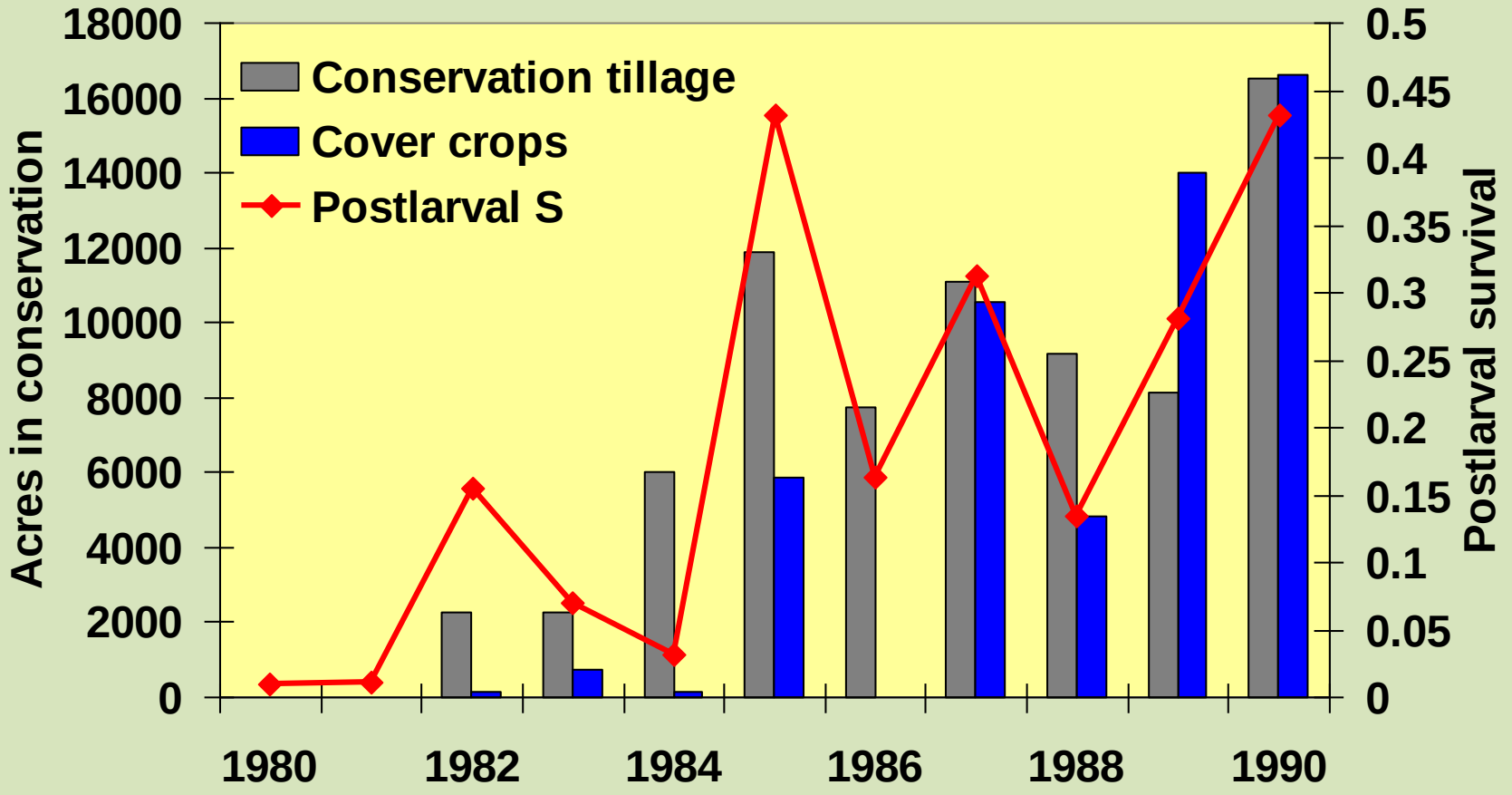


Uphoff et al. 2017. Agriculture, development, and local fish habitat conditions in Chesapeake Bay.

Size matters? Small sub-estuaries (<73,000 ha): Percent with Yellow Perch larvae vs development; dominant land use & salinity indicated (2003-2016)



Blast from Uphoff past!
Striped Bass recovery: Choptank River post-larval survival rose with Ag BMPs in Caroline County (good records & borders most of nursery)



Fish Summary

- **Small and large sub-estuaries with agricultural watersheds support viable fish habitat**
- **Development has a negative impact on sub-estuary fish habitat**
- **Small sub-estuary watersheds may be more vulnerable to development than large**

Bottom Line: Small watersheds* and their triblets offer the best opportunity to detect impacts of BMPs

- Watershed land use obviously critical
- Residence time in non-tidal loading areas needs to be determined (modeling?)
  - Long residence time: Triblet nutrient processing reduces input into sub-estuary perhaps facilitating 'healthy' estuarine conditions
  - Short residence time implies transport into sub-estuary & imported bay phytoplankton response with associated eutrophic system attributes
- Triblet 'memory' matters, inducing lags in responses
- Phytoplankton, SAV, macrobenthos, & early fish life stages appear to be good indicators of triblet processing

*as suggested in a previous 2010 STAC Workshop