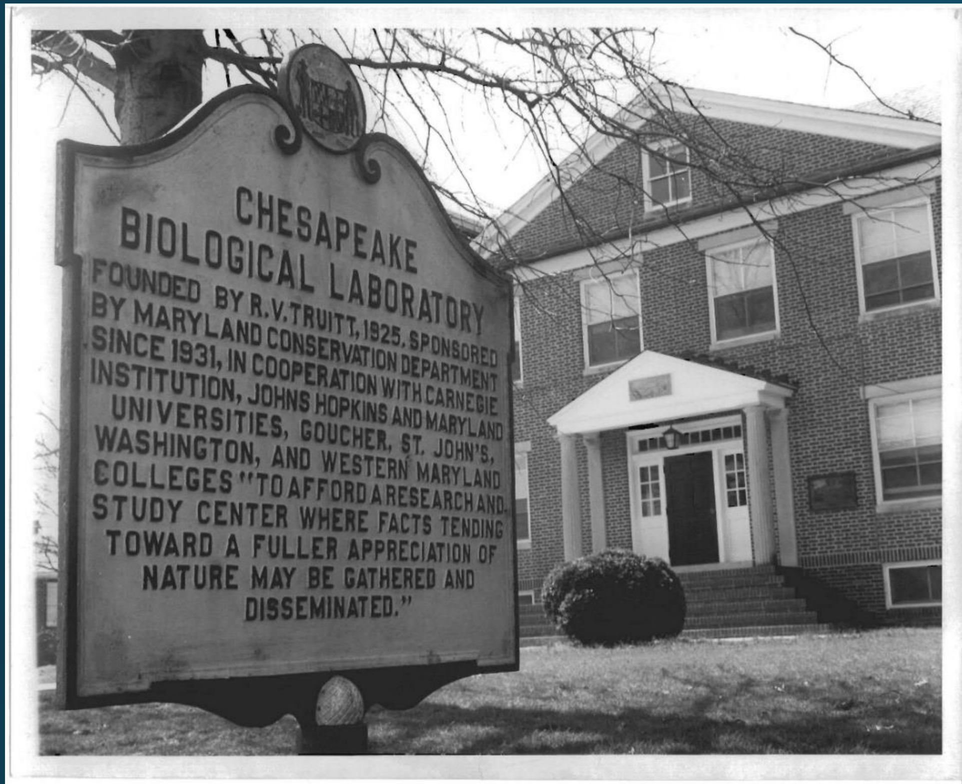
Case Studies from a Coastal Ecologist Working at the County Scale

Lora Harris

University of Maryland Center for Environmental Science

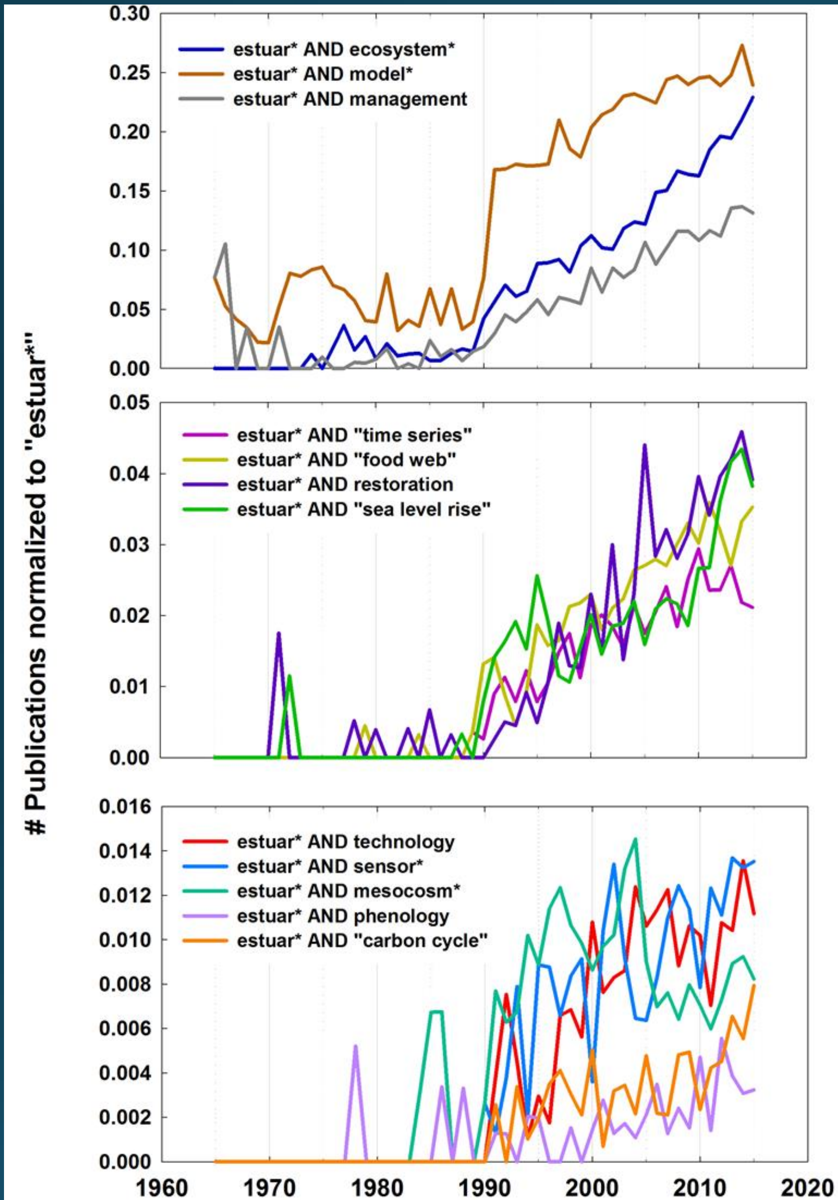
Chesapeake Biological Laboratory

Image from resilience.org



University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

UMCES contributes to meeting the **legislative mandates** of the University System of Maryland in numerous ways including: achieving national eminence as one of the world's premier research centers focused on ecosystem science; uniquely integrating research, public service, and education related to the **sustainability** of environment and natural resources of Maryland and the **Chesapeake Bay region**



Challenges and Directions for the Advancement of Estuarine Ecosystem Science

Jeremy M. Testa, W. Michael Kemp, Lora A. Harris, Ryan J. Woodland & Walter R. Boynton

"We argue that such an applied science framework constrains and defines many of the most important scientific questions in estuarine ecosystems, driving our field to greater clarity and more insightful research with greater potential for societal relevance."

"This science-management relationship needs to be elevated beyond "service-to-society," acknowledging the transformative ways in which applied research may spark creativity and inform theoretical advances in basic estuarine science."

Testa et al. 2016. Ecosystems

Access to Models

Local Water Quality Monitoring

Prioritization of Restoration

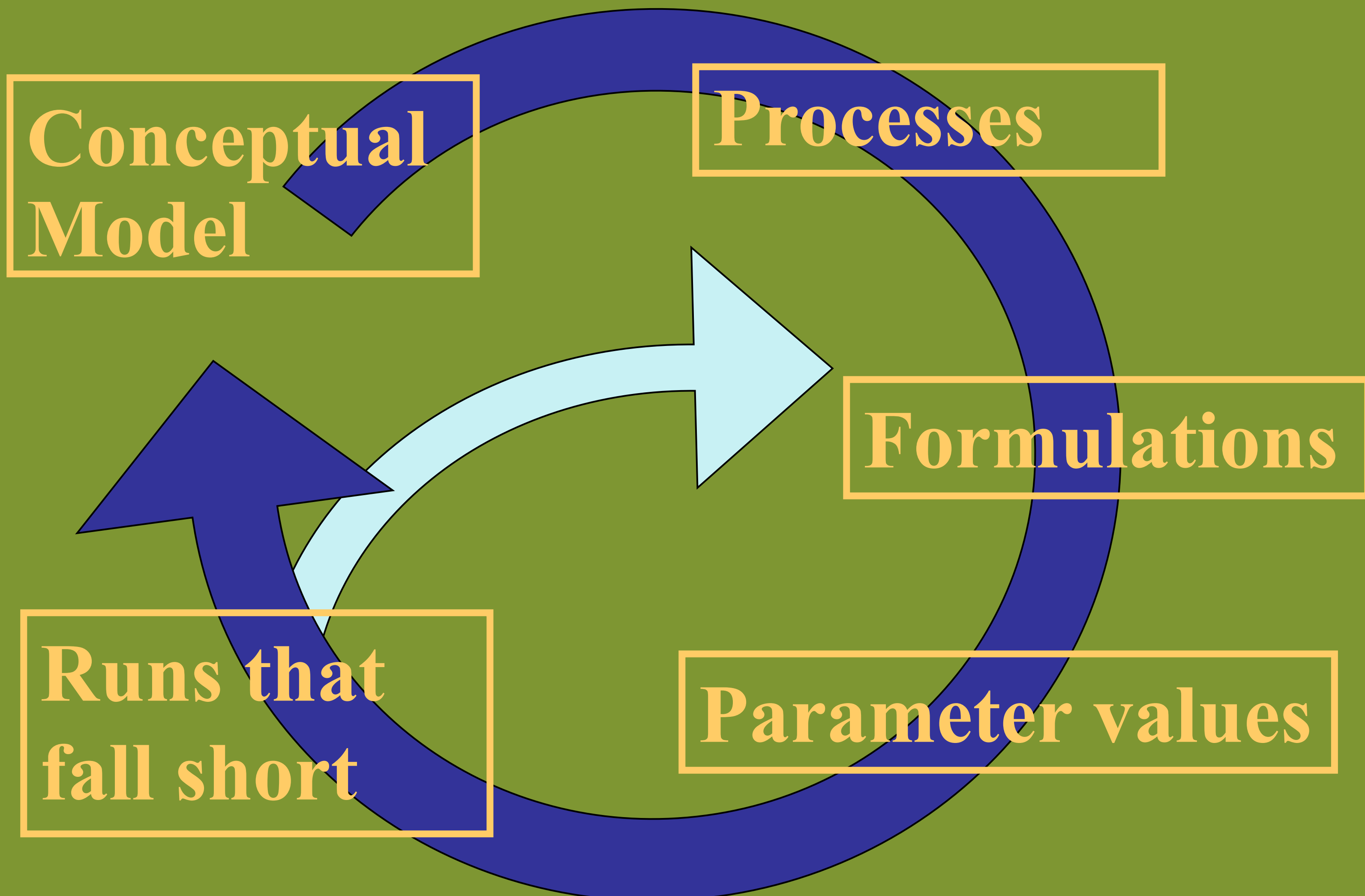
Sources of Pollution

Testa et al. 2016. Ecosystems

Photo courtesy Juan Alvarez

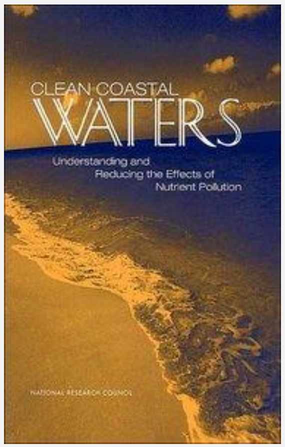
Delmarva Coastal Bays Model

NLM – LEM – VEM




Delmarva Coastal Bays Model
NLM – LEM – VEM
Image: Google Earth


Con
Mod
lations
Run
fall short
values



NRC (2000):

- A reasonably accurate model accessible to managers to predict nutrient loads
- Simple frameworks for characterizing estuarine response

Project Objectives

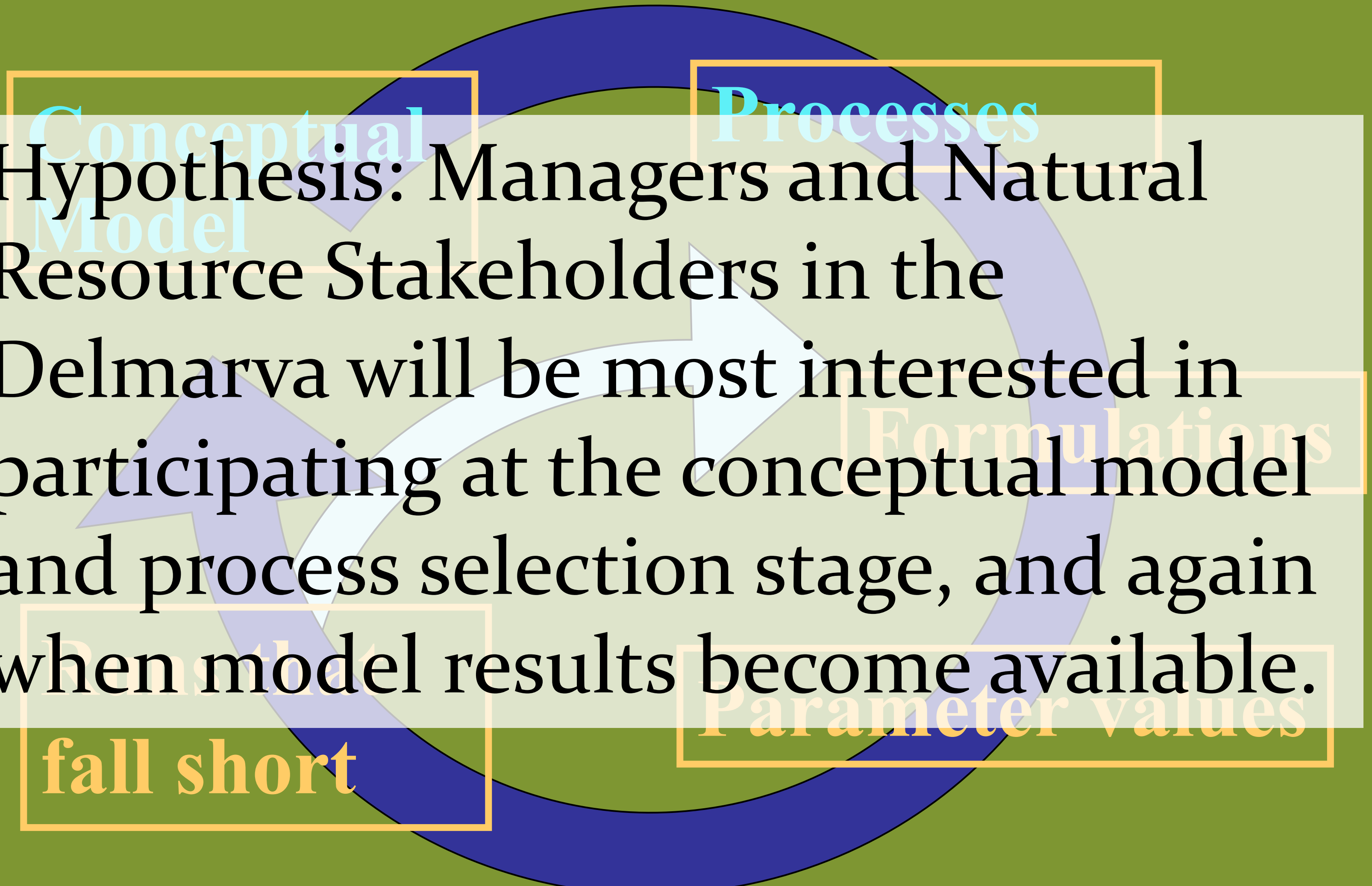
Develop novel, management-focused models:

- Watershed loading model (NLM)
- Lagoon ecosystem model (LEM)
- Virtual eelgrass meadow (VEM)

To …

- Quantify changes in TN loads under changing land use, population, agricultural activities, and BMPs.
- Model lagoon response to these loads coincident with climate change – focus on water quality and seagrass habitat.
- Provide the models for direct use by regional stakeholders.

With Mark Brush & Joanna York



Hypothesis: Managers and Natural Resource Stakeholders in the Delmarva will be most interested in participating at the conceptual model and process selection stage, and again when model results become available.

Regional Stakeholder Workshops

Workshop 1: Ocean City, MD
Workshop 2: Wachapreague, VA

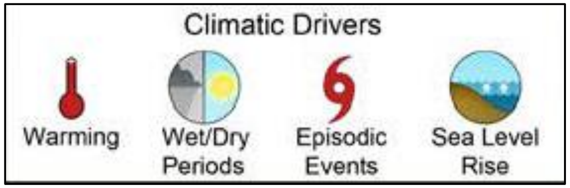
Participants:

DE:	DNREC, USGS UDel Extension
MD:	DNR, MCBP, NPS, TNC, Worcester Co.
VA:	ANPDC, Accomack Co., Northampton Co., Chincoteague, TNC
SG:	facilitators & leadership

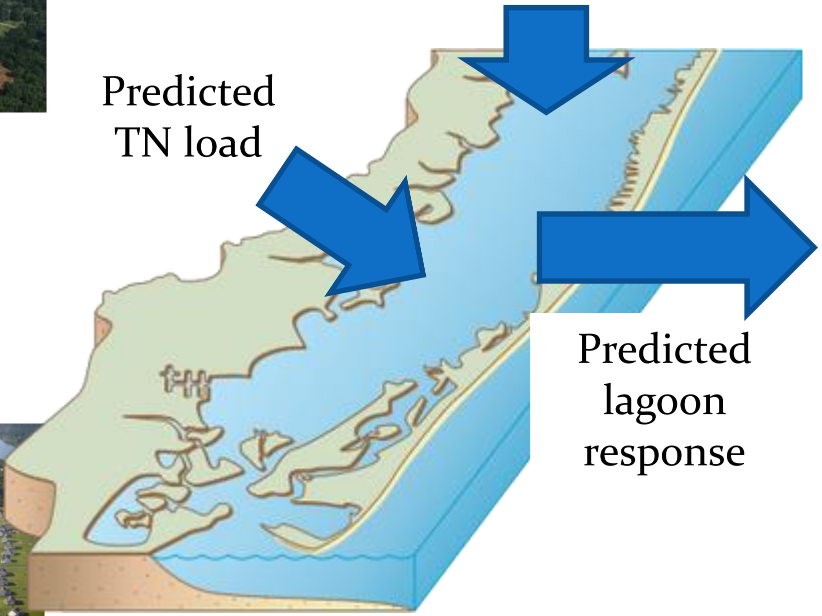
Images: IAN (UMCES), Virginian-Pilot, K. Reece (VIMS), VIMS, dcerp.rti.org

Project Objectives

Watershed land use:

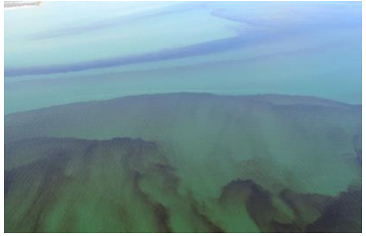


Predicted TN load



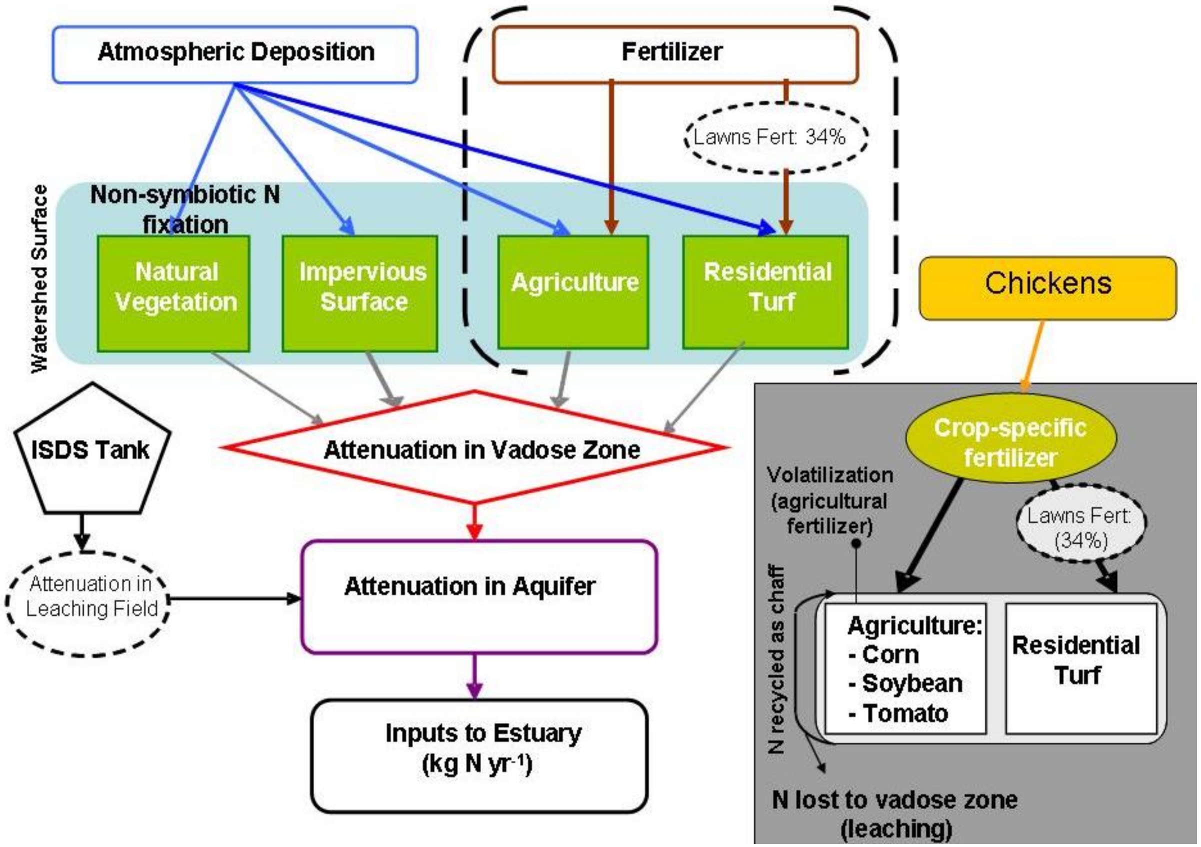
Predicted lagoon response

Lagoon water quality & habitat:



With Mark Brush & Joanna York

Nitrogen Loading Model (NLM)



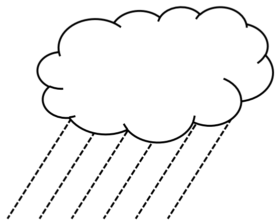
Brush et al. (2010)
Giordano et al. (2011)

With Mark Brush & Joanna York

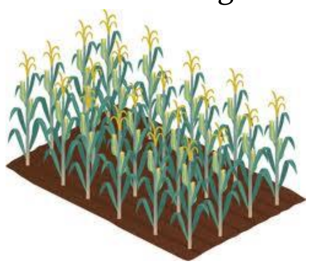
Photos: ian.umces.edu, Chesapeake Bay Program, Virginian-Pilot

NLM: Inputs

Atmospheric deposition – NADPP, CastNet



Crop distributions – USDA, state, & county agricultural statistics

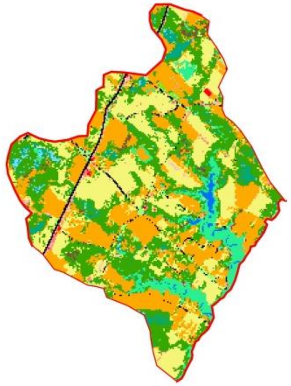


2-yr corn-soy-wheat rotation

(from aerial photos)

Residential development (septic tanks, lawns) – TIGER & county sources

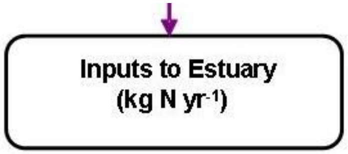
Land use – NLDC, RESAC



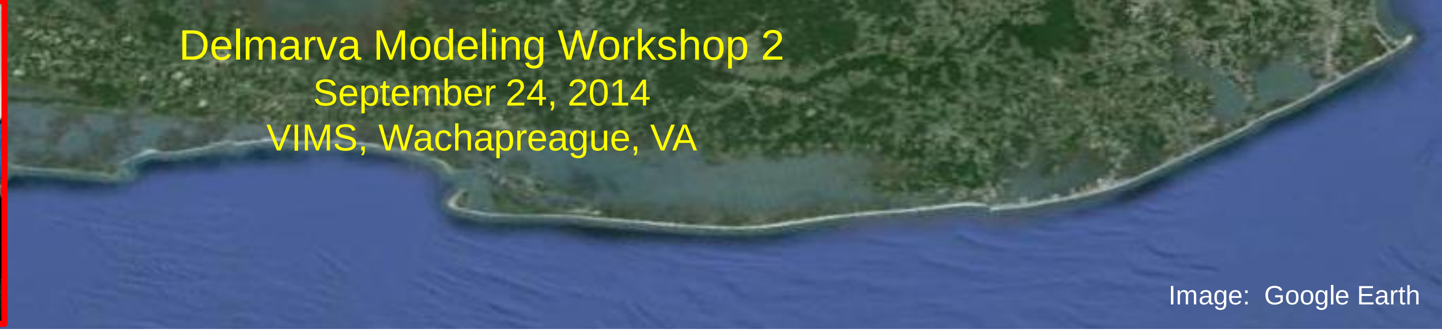
Poultry operations – local grow-out schedule & density

Point sources – EPA

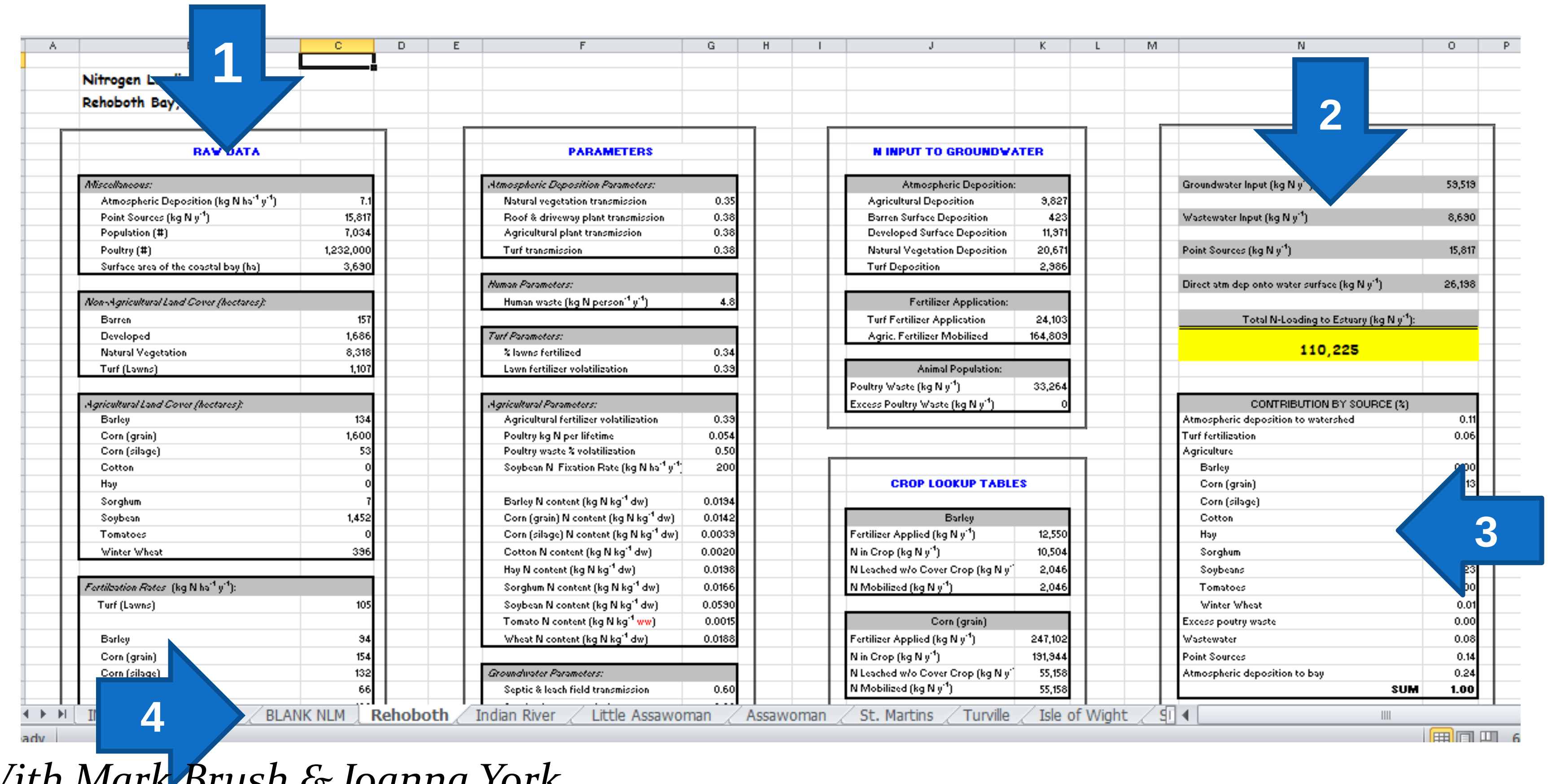
Output



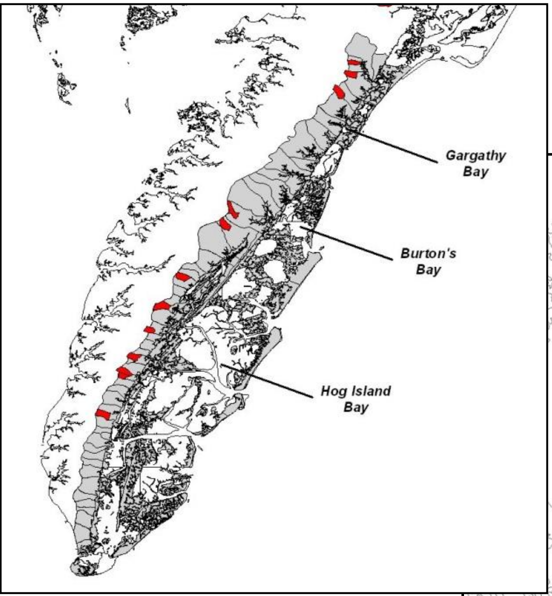
With Mark Brush & Joanna York



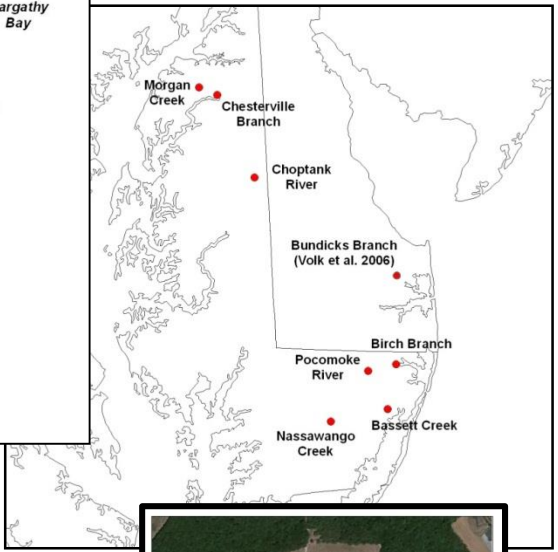
NLM: Spreadsheet Version

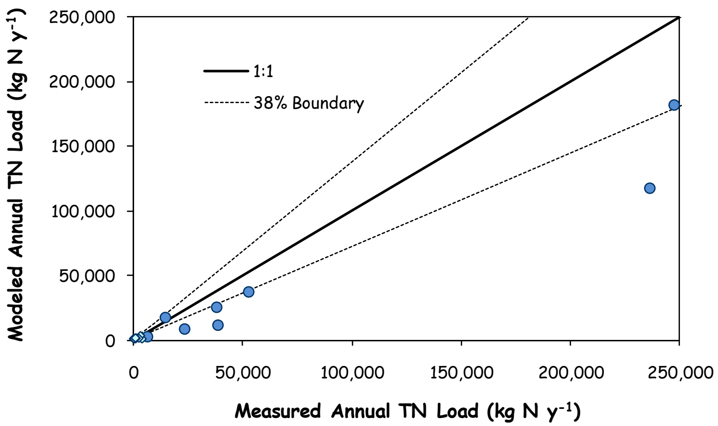


With Mark Brush & Joanna York

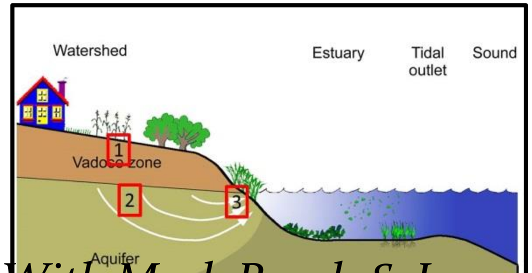


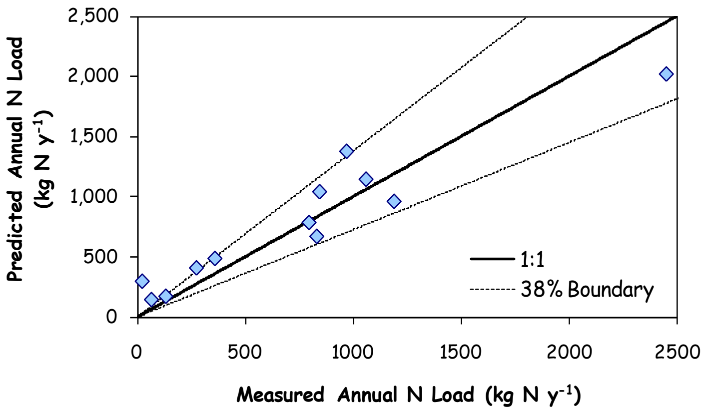
NLM: Initial Model Calibration





Field measurements to constrain the NLM (J. York & K. Kroeger):

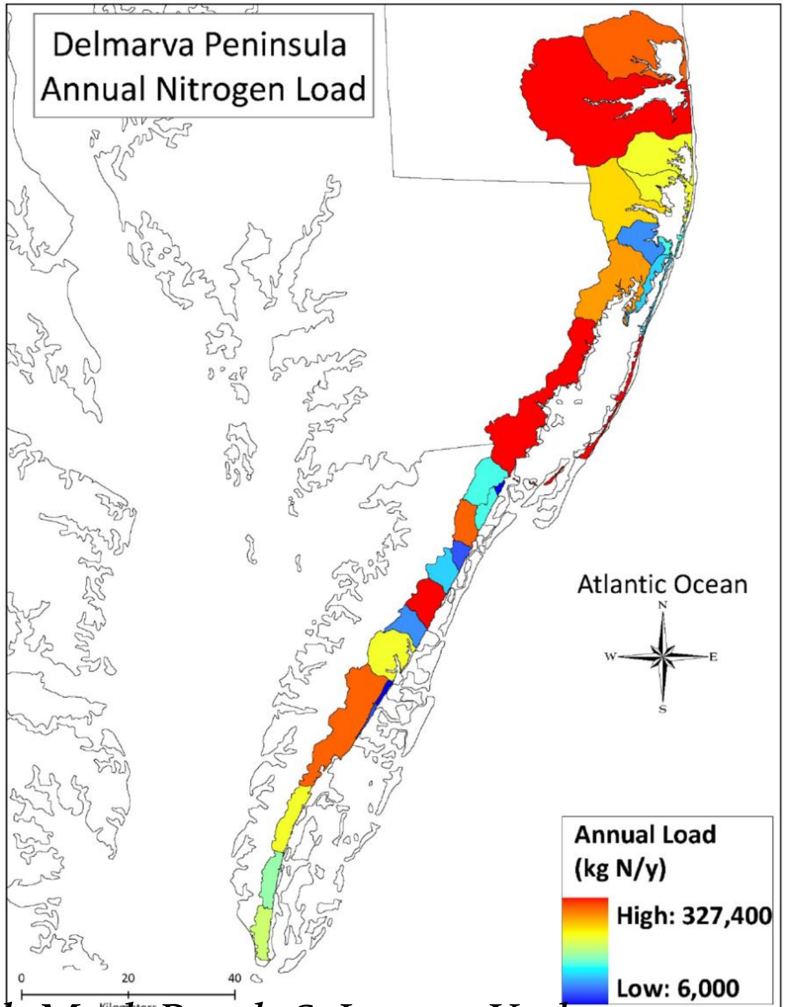


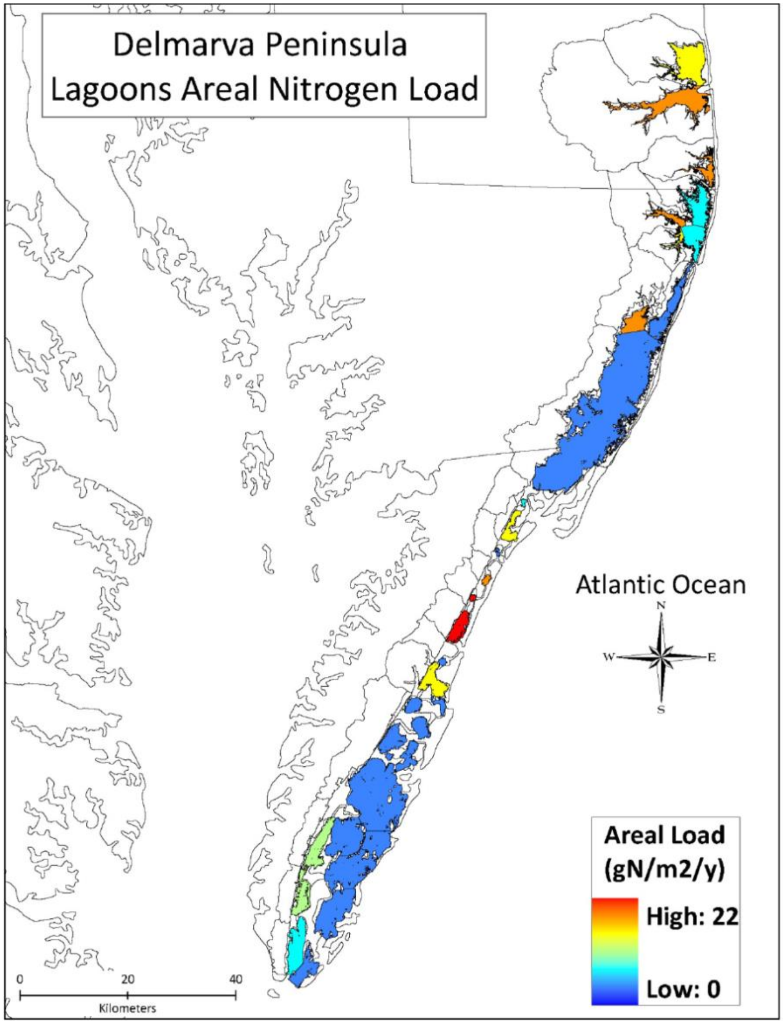


With Mark Brush & Joanna York

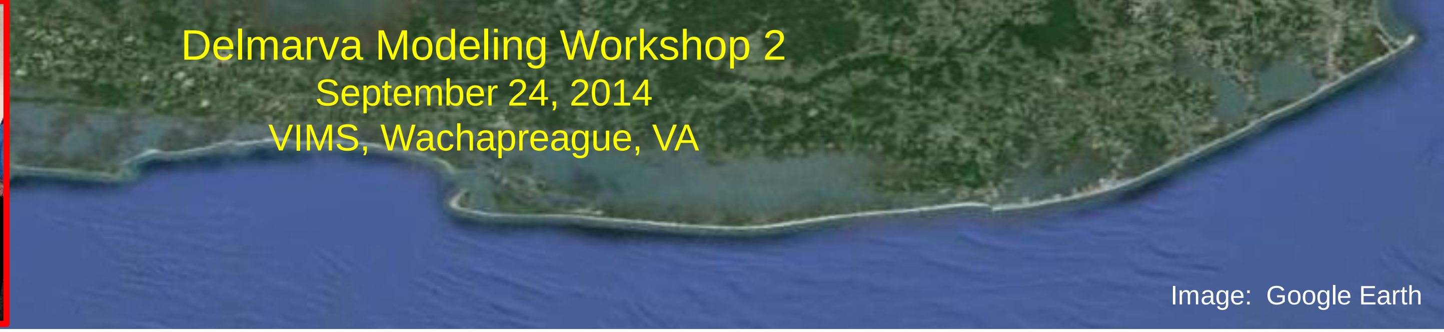
Delmarva Coastal Bays Model

NLM – LEM – VEM

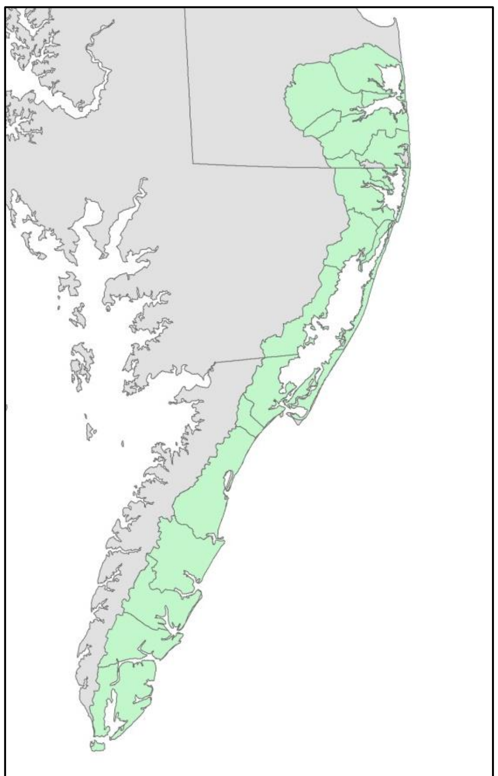




With Mark Brush & Joanna York



NLM: Converting to P loads



Phase V load ratios:

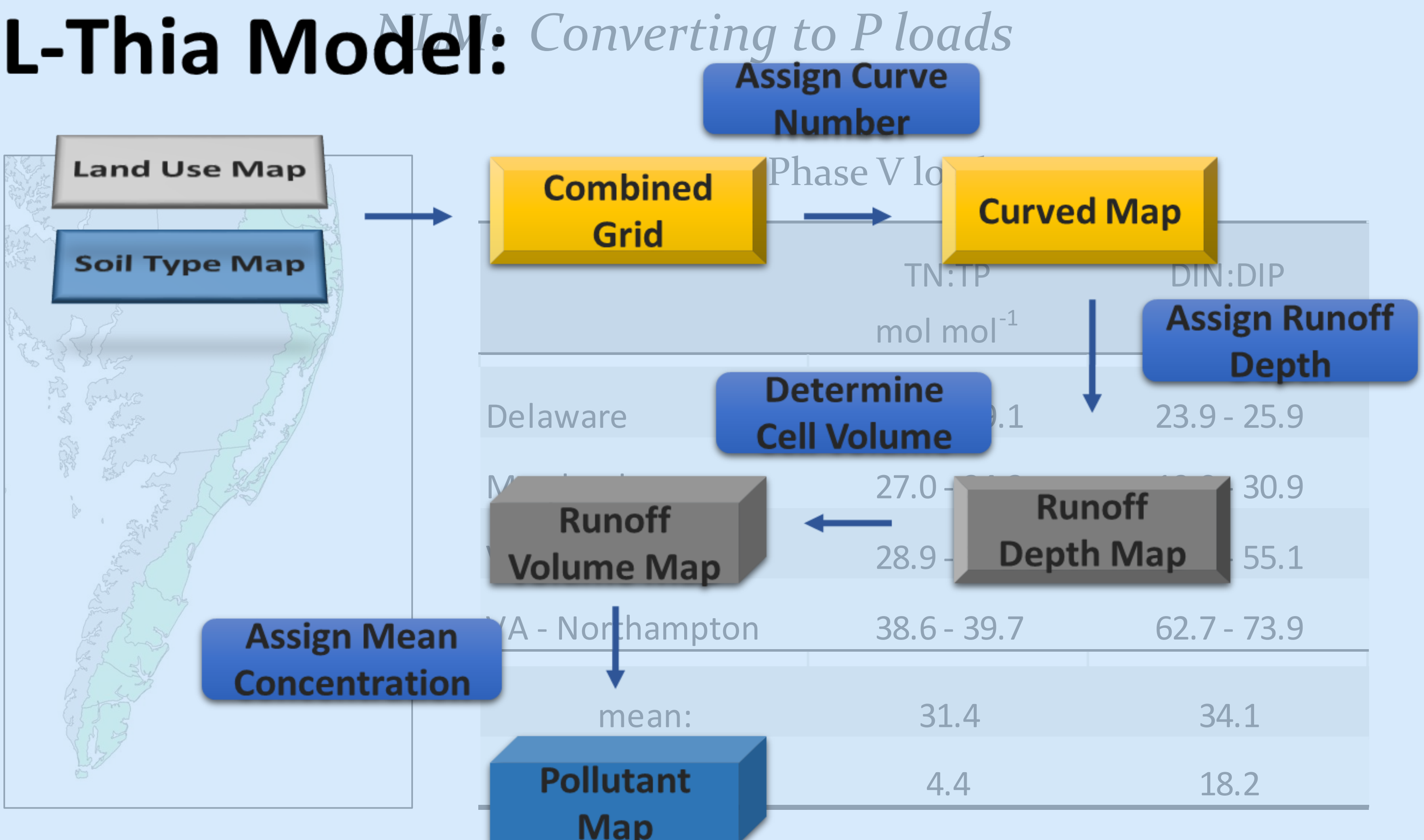
	TN:TP mol mol^{-1}	DIN:DIP mol mol^{-1}
Delaware	27.1 - 29.1	23.9 - 25.9
Maryland	27.0 - 34.3	19.0 - 30.9
VA - Accomack	28.9 - 36.4	22.4 - 55.1
VA - Northampton	38.6 - 39.7	62.7 - 73.9
mean:	31.4	34.1
st. dev.:	4.4	18.2

With Mark Brush & Joanna York

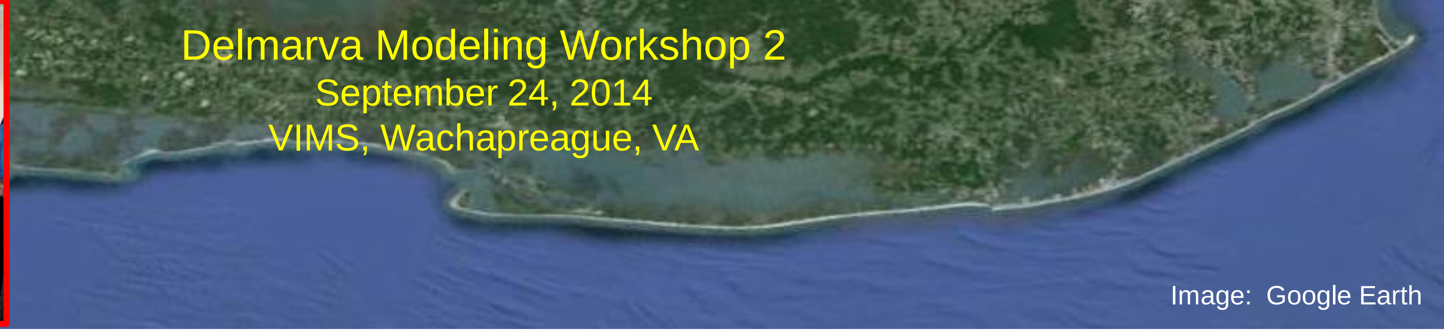
Delmarva Modeling Workshop 2
September 24, 2014
VIMS, Wachapreague, VA

Image: Google Earth

L-Thia Model:



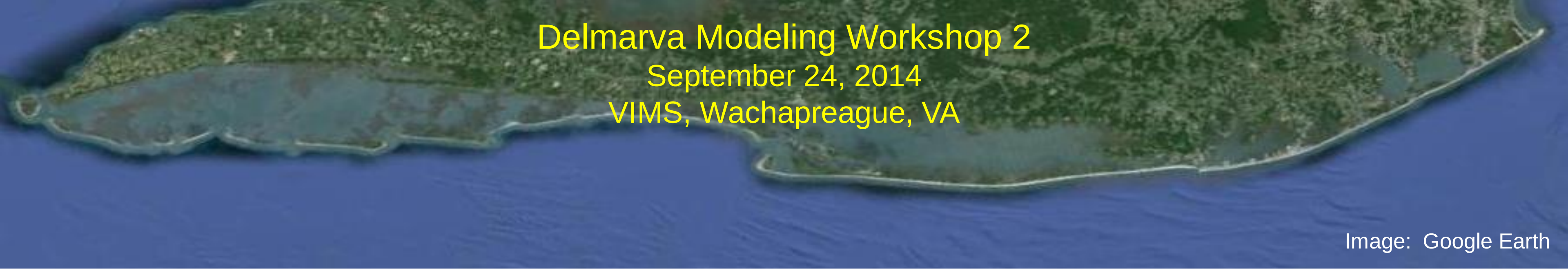
With Mark Brush & Joanna York



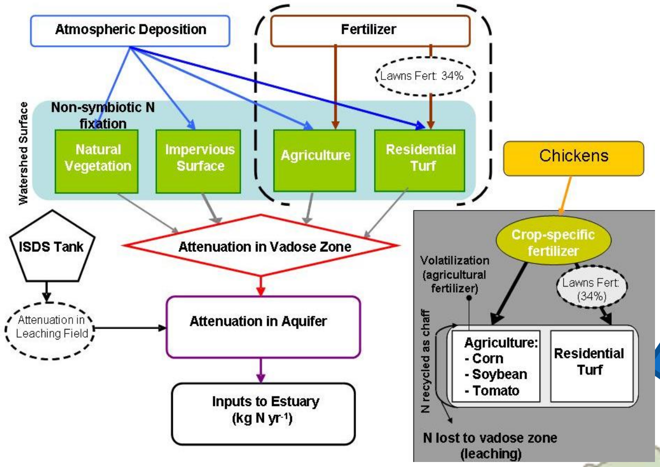
NLM: BMP removal efficiencies

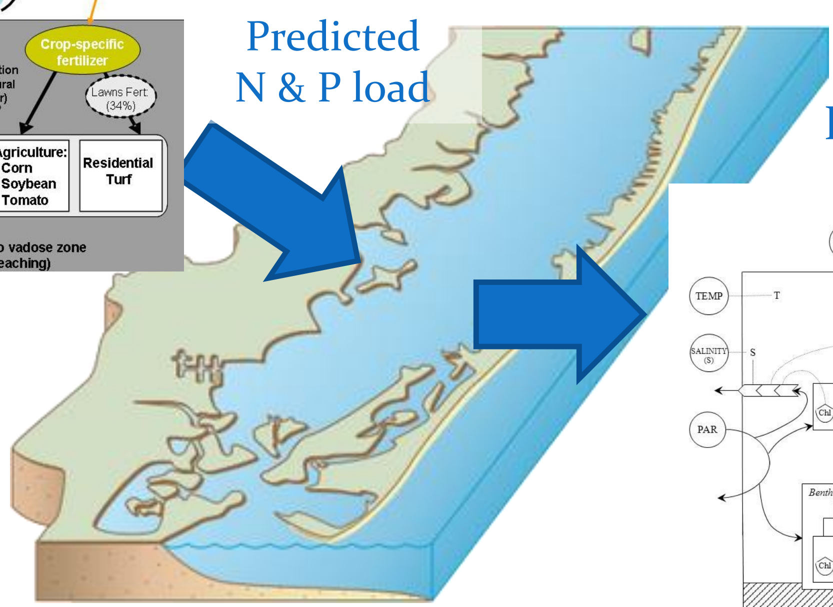
BMP	Minimum %N Removal	Maximum %N Removal	Average (if reported)
Advanced Septic	40	90	
LID techniques (green roofs, bioretention cells, permeable pavement)	0	96	68
Permeable Reactive Barriers	90	90	90
Treatment wetlands	0	100	44
Riparian Zones	40	100	
Artificial lakes and reservoirs	10	100	
Stream Restoration	5	40	24

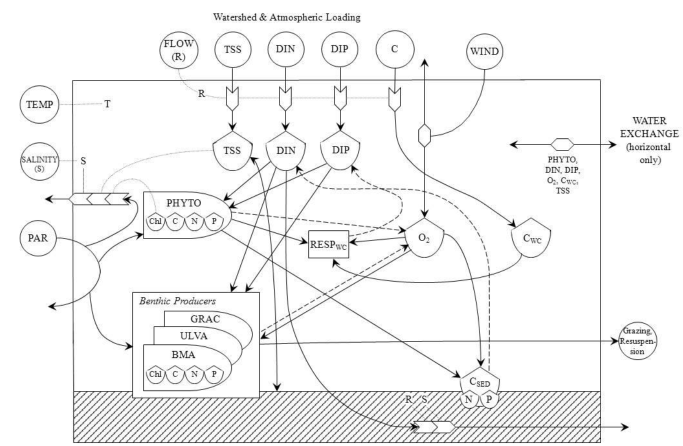
With Mark Brush & Joanna York

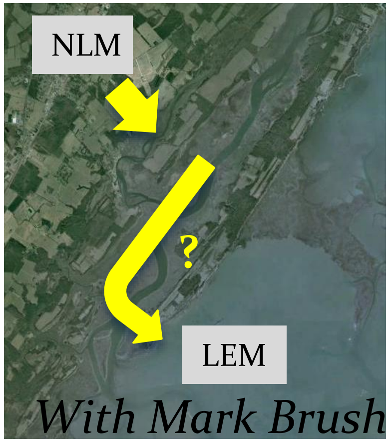


NLM: Full Coupling to the LEM







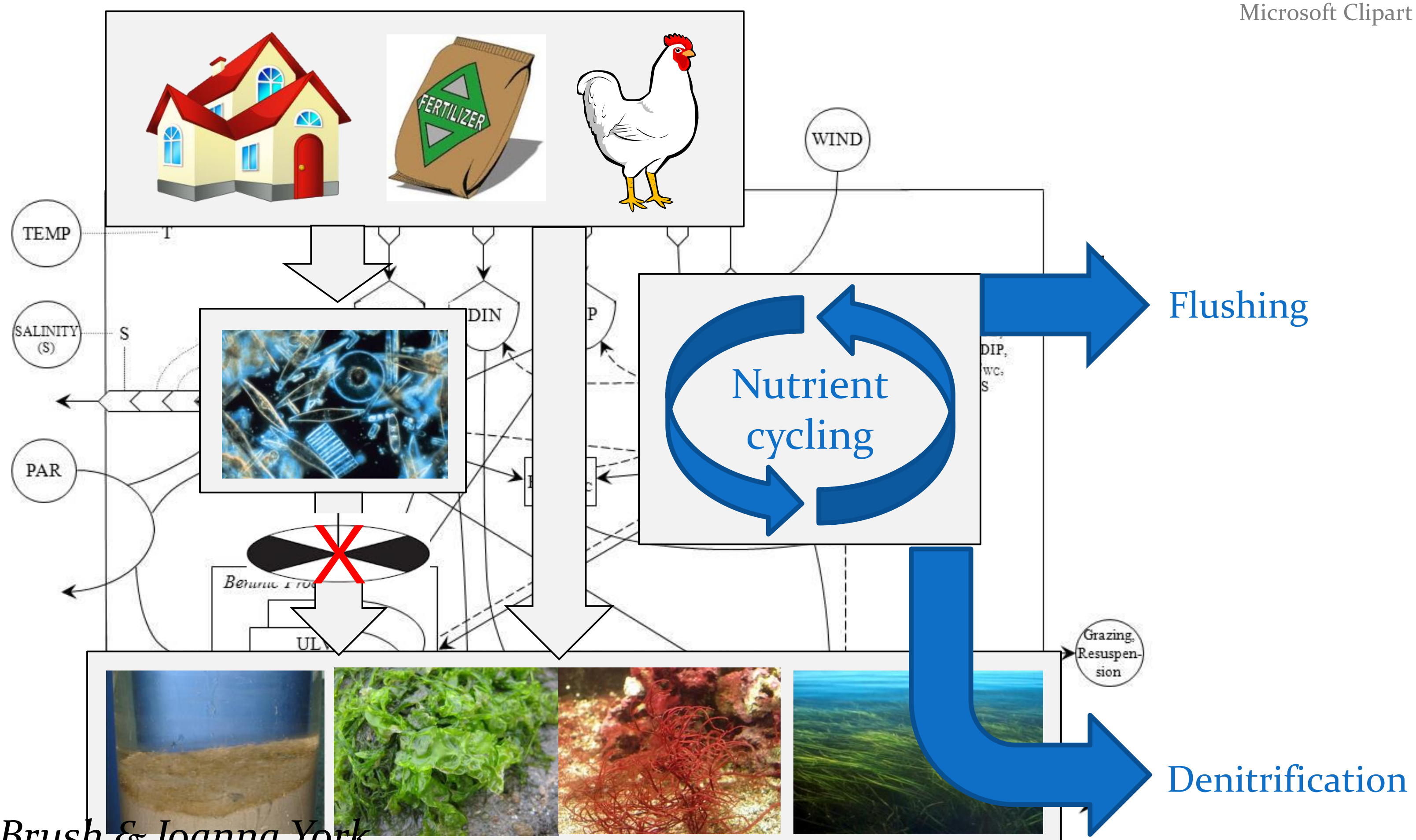


Modulation of loads by tidal creeks: B. Dean, M.S. student, VIMS

With Mark Brush & Joanna York

Lagoon Ecosystem Model (LEM)

Images: ian.umces.edu, wikipedia.org, Microsoft Clipart

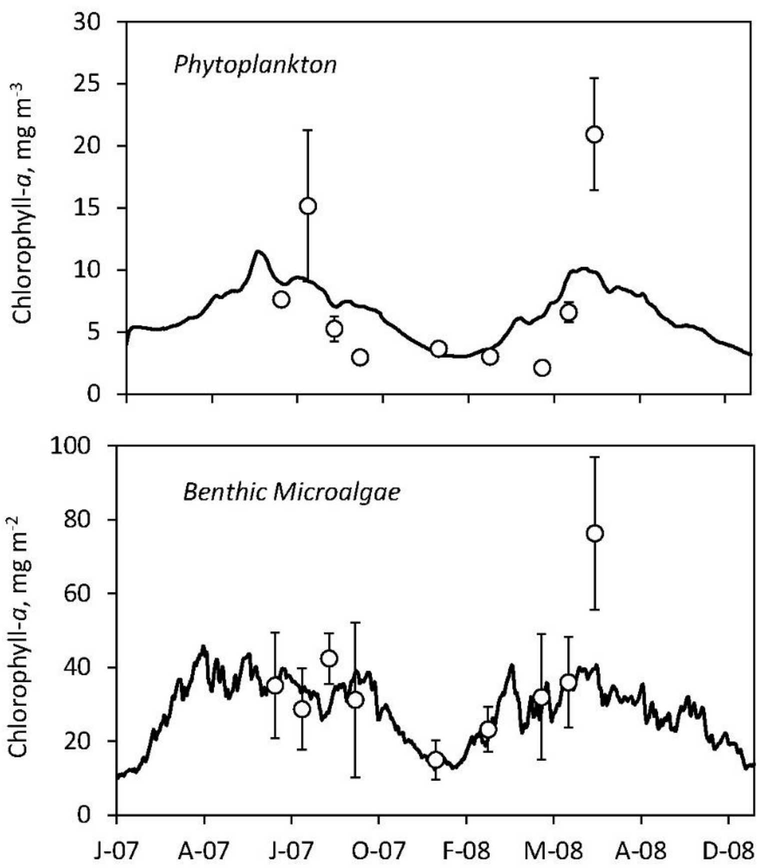


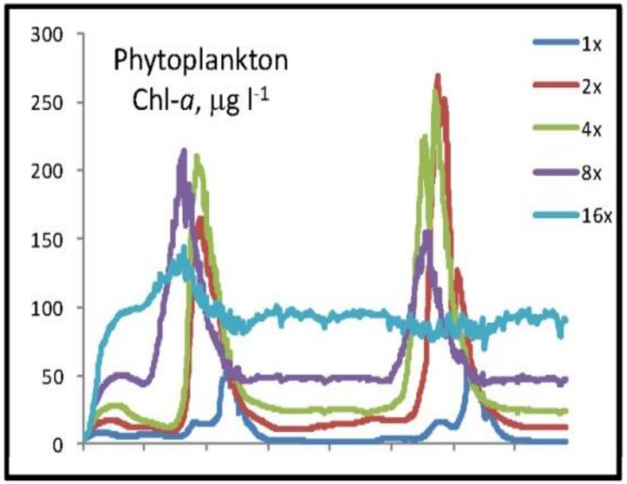
With Mark Brush & Joanna York

Delmarva Coastal Bays Model

NLM – LEM – VEM

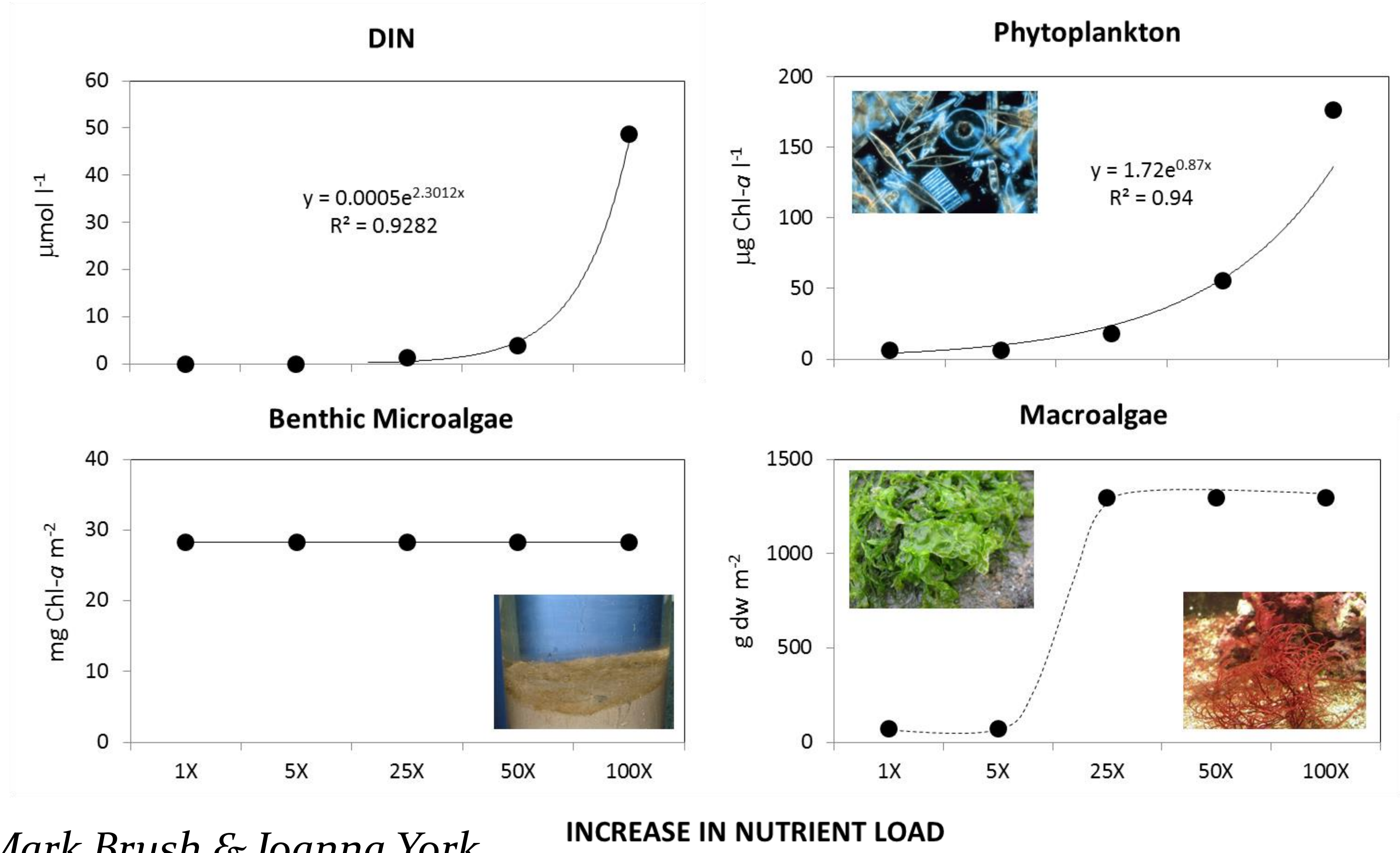
LEM Calibration: Hog Island Bay, VA



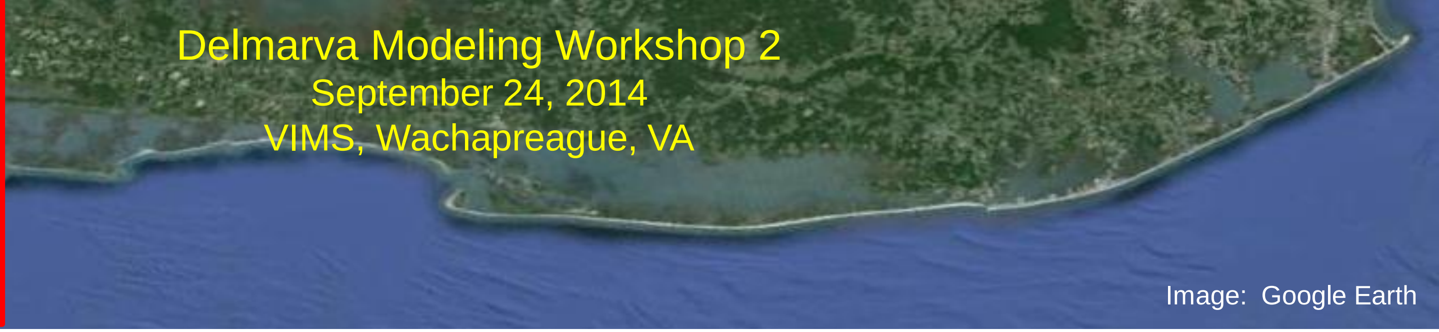


With Mark Brush & Joanna York

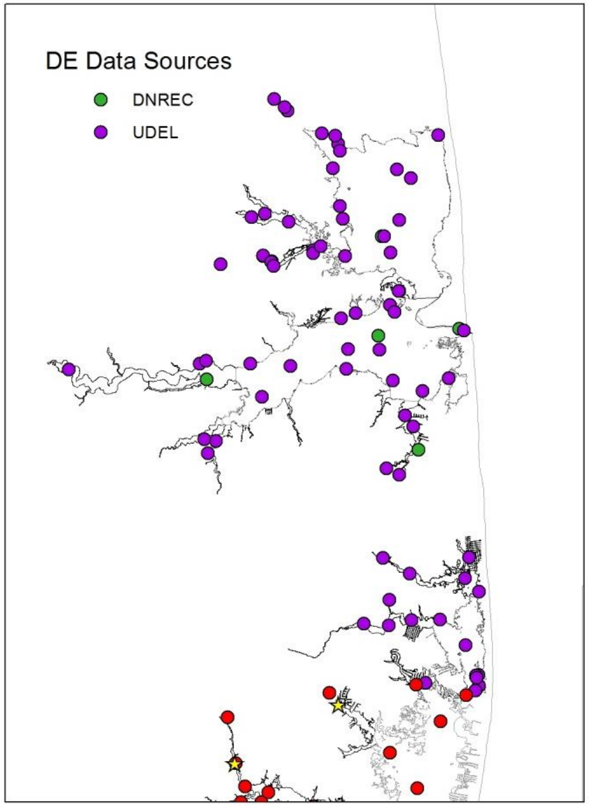
LEM: Example Nutrient Loading Scenarios

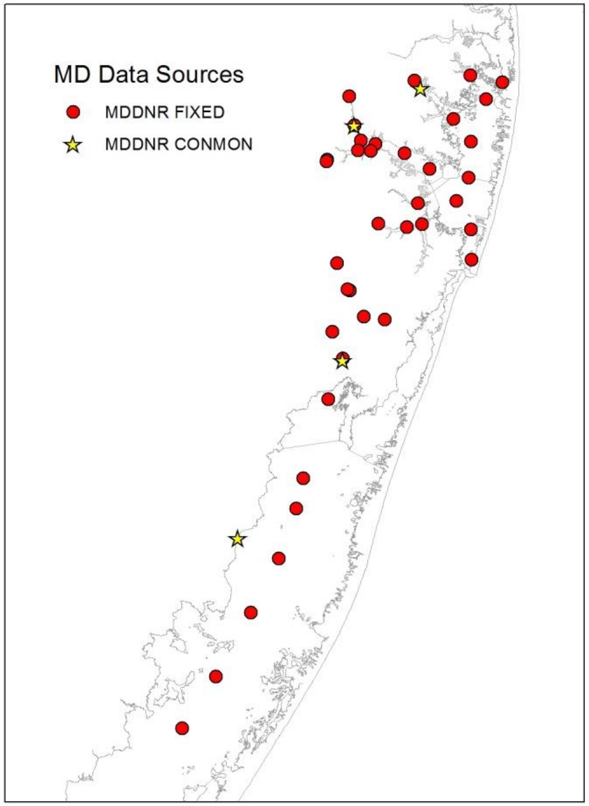


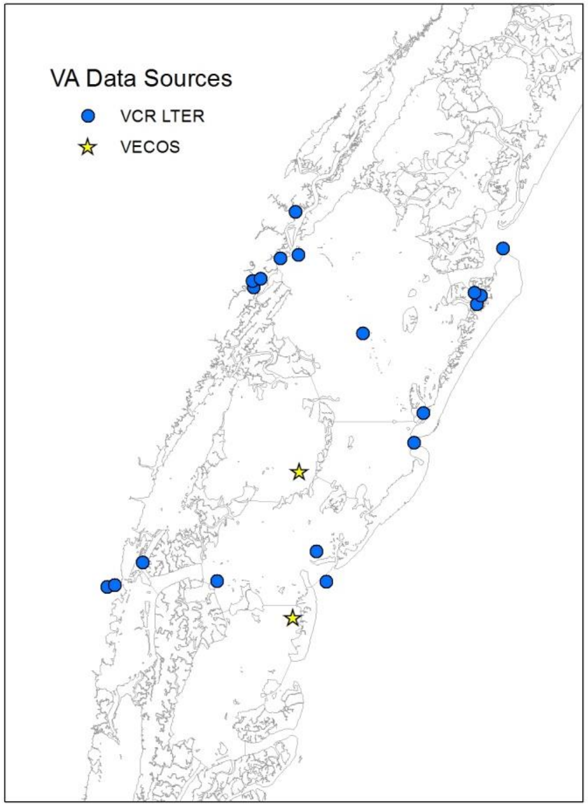
With Mark Brush & Joanna York



LEM Calibration: Monitoring Data

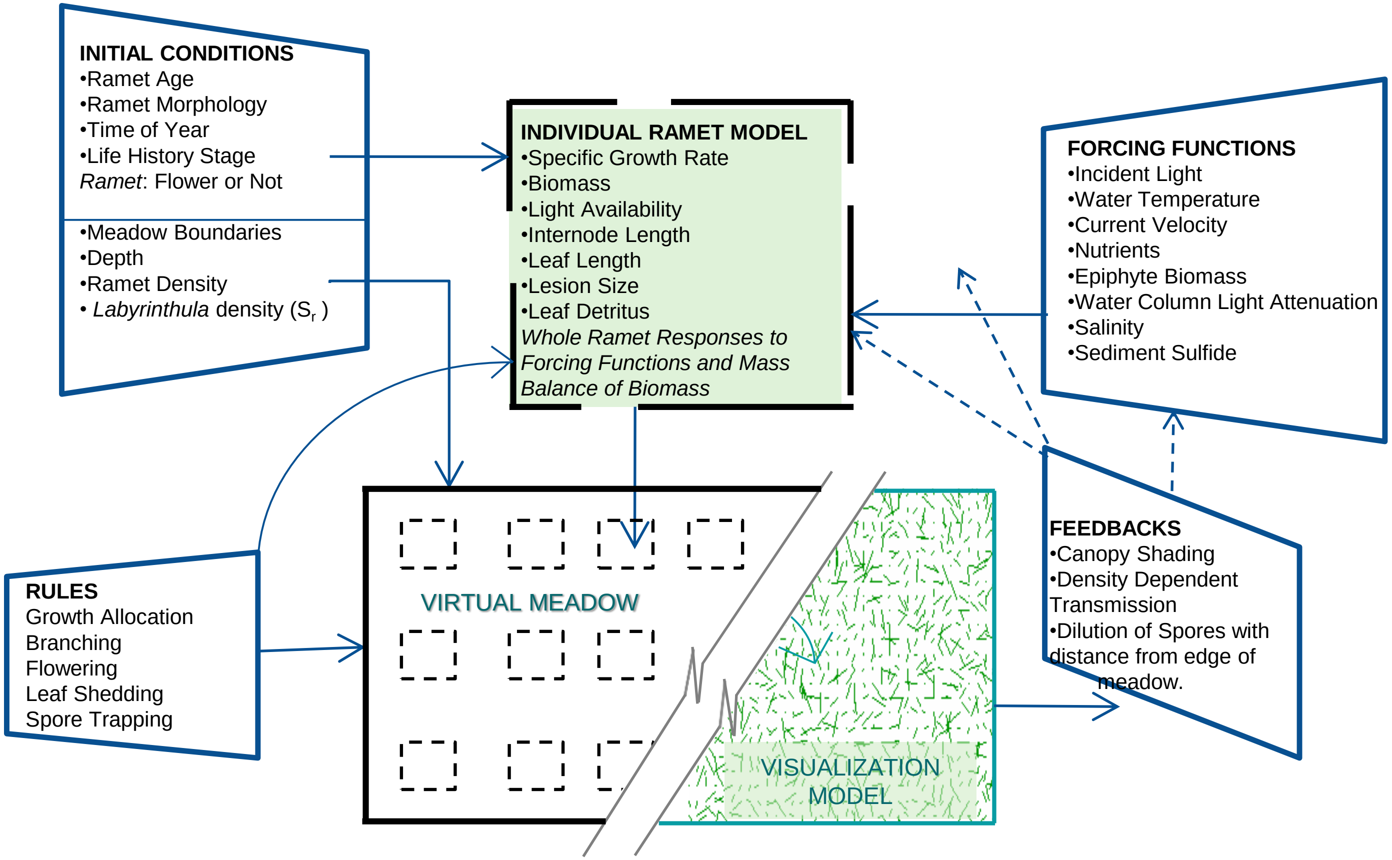




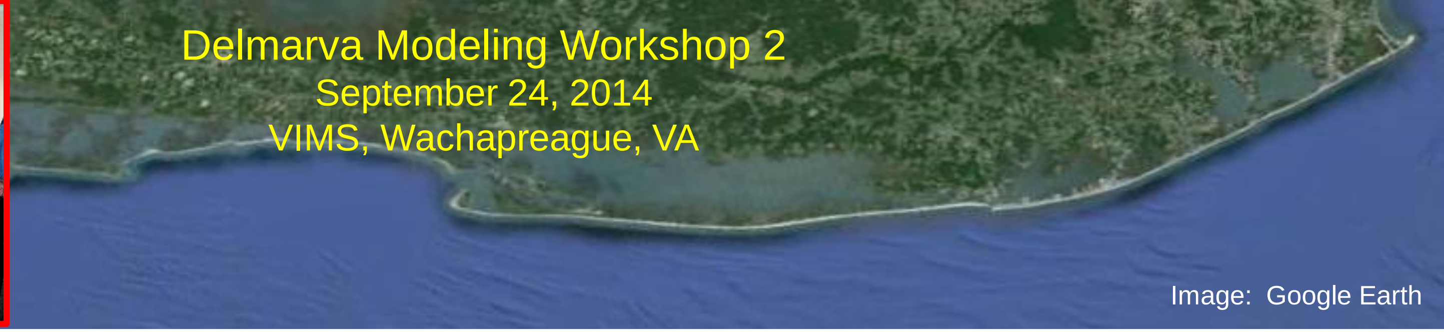


With Mark Brush & Joanna York

Virtual Eelgrass Meadow (VEM)



With Mark Brush & Joanna York



Delmarva Modeling Workshop 2
September 24, 2014
VIMS, Wachapreague, VA

Image: Google Earth

Coupled NLM-LEM: New Online Interface

Delmarva Coastal Bays Model
beta version 1.1

Dr. Mark J. Brush
Virginia Institute of Marine Science

September 2014

Image: Google Earth

Next Page

Skip to Model Scenarios

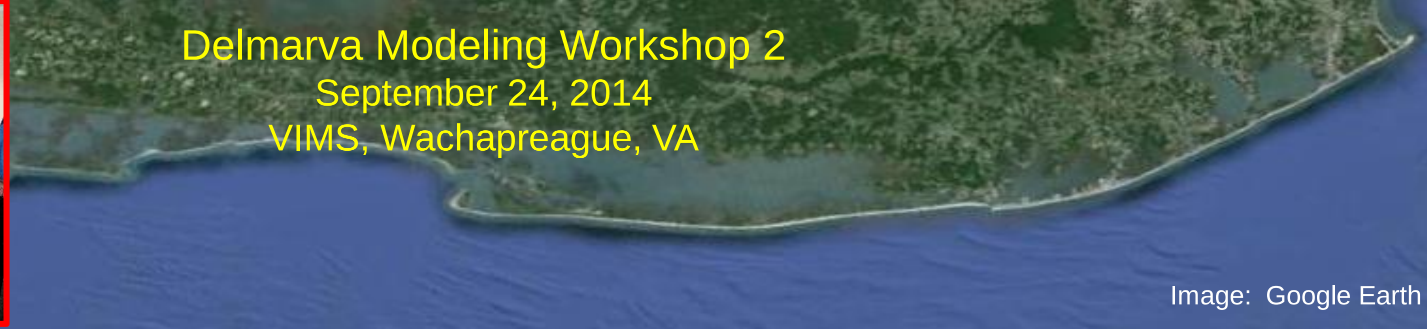
Introduction

Welcome to the demonstration website for the VIMS Delmarva Coastal Bays Model. This demonstration version of the model is provided for illustration only; the model and online interface are currently undergoing revision with expected completion in Jan 2015.

Model output is to be regarded as preliminary at this point as this tool is under ongoing development and should not yet be used to inform management. Use the navigation buttons to the right to move through the tool. The following pages provide background on the model and allow the user to perform simulations related to nutrient loading.

Contact for questions:
Dr. Mark J. Brush
VIMS, PO Box 1346
Gloucester Point, VA 23062
Tel: 804-684-7402
Email: brush@vims.edu

With Mark Brush & Joanna York



Coupled NLM-LEM: New Online Interface

Previous Page

Delmarva Coastal Bays Model
beta version

<u>Scenario Simulations (Page 1 of 3):</u>

This model allows the user to manipulate watershed characteristics and resulting nutrient loading by either (1) using the slider below to directly change loads of N and P (as a multiplier of the current loads), or (2) proceeding to the next two pages to alter watershed characterisitics (e.g., population size, land use).

You may also increase/decrease water temperature using the second slider below (as an additive change to current temperatures. Click the "U" in the upper left corner of the sliders to restore default values.

When finished making changes, return to this page and press "Run". The model will take a few minutes to run. When finished, computed watershed TN loads (including direct atmospheric deposition to each coastal bay) will be shown in the table below. Click the Export button to copy the loads to your clipboard for pasting into a spreadsheet program. Lagoon model output will be displayed on the following pages.

Watershed Load Multiplier: 0.00 — 10.00 (1.00)

Temperature Change: -5.0 — 5.0 (0.0)

Run | Pause | Stop | Resume | Restore

Modeled TN Loads (kg/y):

1:15 AM 9/23/2014 T...s) ?

Days	
TN Load[Rehoboth]	
TN Load[Indian River]	
TN Load[Little Assawoman]	
TN Load[Assawoman]	
TN Load[St Martins]	
TN Load[Turville]	
TN Load[Isle of Wight]	
TN Load[Sinepuxent]	
TN Load[Newport]	

Click to Modify Watershed Charactersitcs

Export TN Loads to Clipboard

Next Page

With Mark Brush & Joanna York

Delmarva Coastal Bays Model

NLM – LEM – VEM

Hypoth[illegible]is: Managers and N[illegible]ural Resou[illegible]older[illegible] Delmarva w[illegible]erested in participati[illegible]al model and pr[illegible]ection st[illegible] again when m[illegible]del results become available.

Conceptual Model

Processes

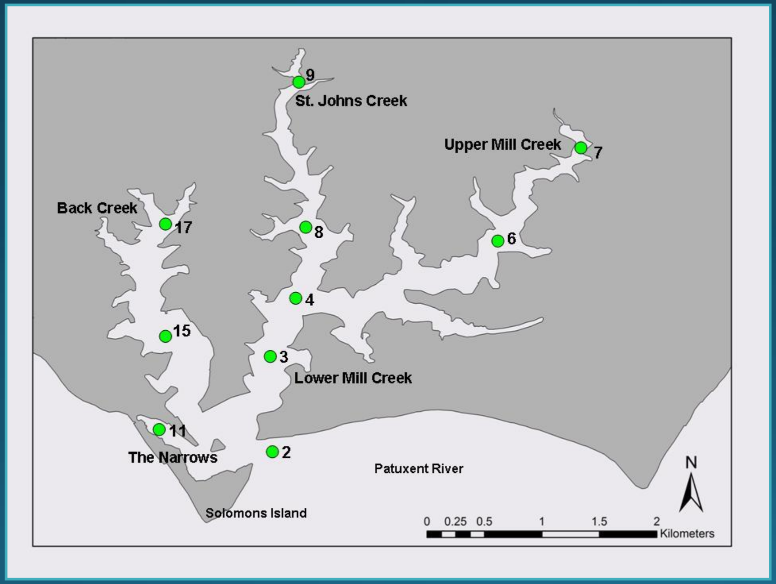
Formulations

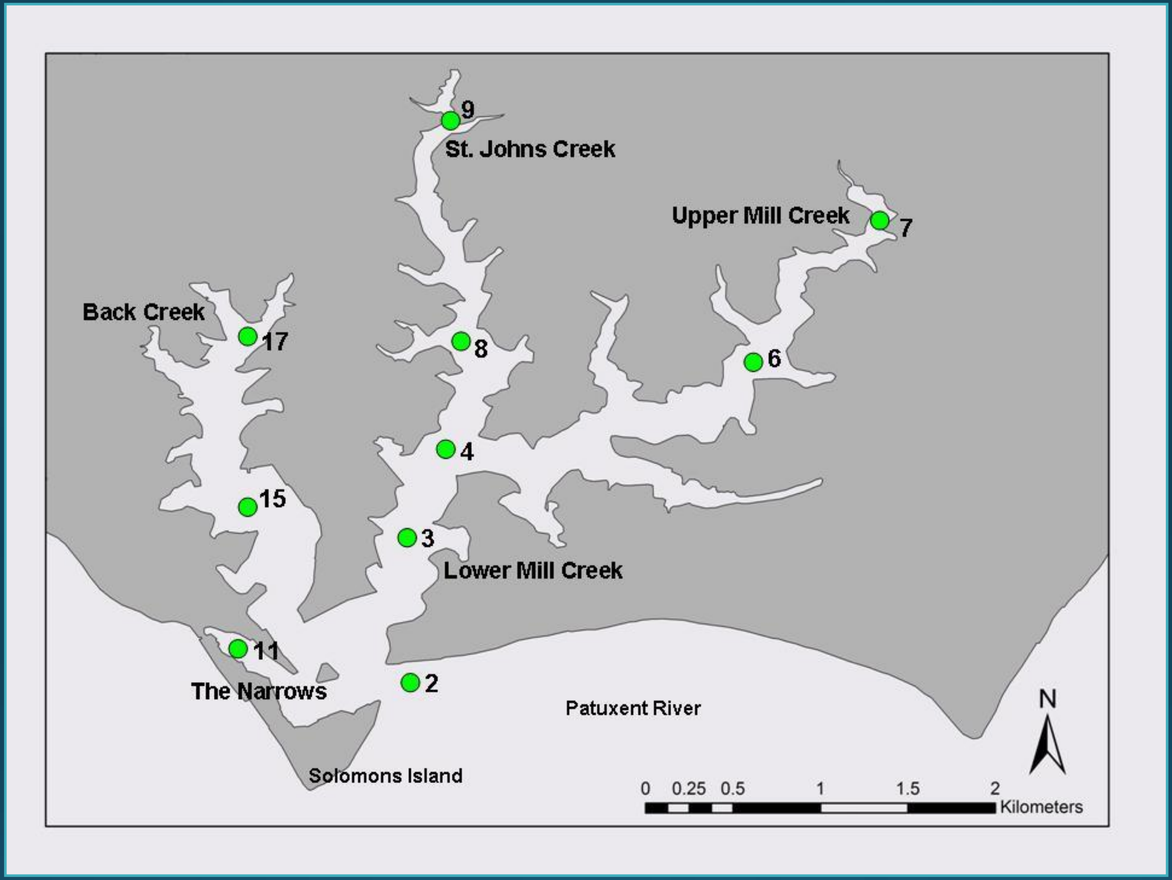
Parameter values

fall short

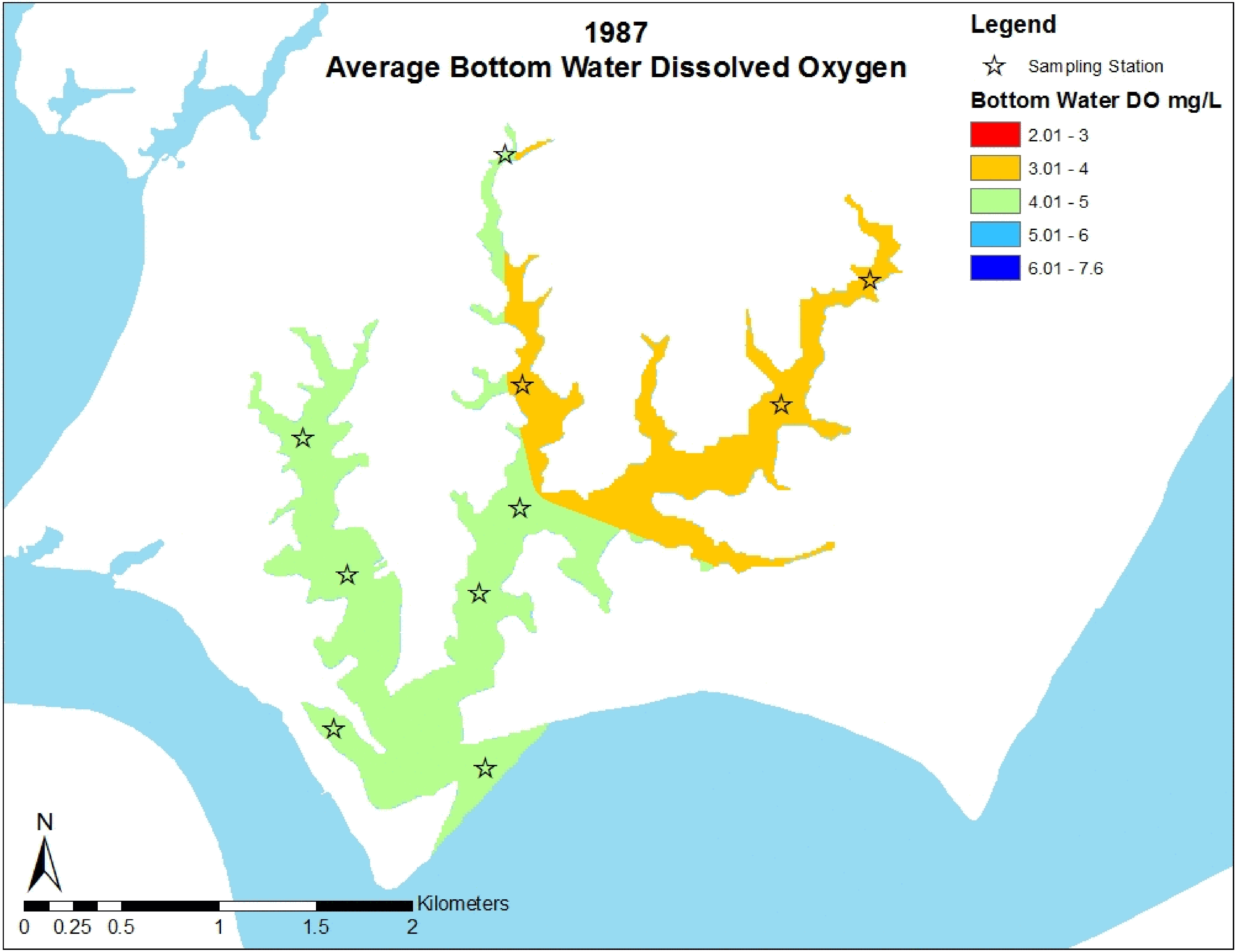
Managers and Stakeholders in the Delmarva were interested in participating at multiple levels of model development, parameterization, and testing. They were keen proponents of simple, accessible models that met their needs!


Application
Discovery


9
St. Johns Creek
Upper Mill Creek
7
Back Creek
17
8
6
4
15
3
Lower Mill Creek
11
The Narrows
2
Patuxent River
N
Solomons Island
0 0.25 0.5 1 1.5 2
Kilometers



2017 BOCC Presentation - Calvert County



1987
Average Bottom Water Dissolved Oxygen
Legend
Sampling Station
Bottom Water DO mg/L
2.01 - 3
3.01 - 4
4.01 - 5
5.01 - 6
6.01 - 7.6
N
Kilometers
0
0.25
0.5
1
1.5
2

Recommendations

- Continue to monitor tidal creeks in Calvert County
  - *Negative and positive trends in water quality can be clearly documented*
  - *Measure effectiveness of implementing the Calvert Watershed Implementation Plan.*

- Encourage high frequency monitoring and other forms of assessments when the opportunity arises.
  - *We continue to look for useful collaborations in conducting this monitoring program*

- Implement the Calvert WIP to the maximum extent practicable
  - *Focus on practices and locations where the effectiveness will be greatest.*

- Continue to support planning and eventual implementation of:
  - *Sewer upgrades, BMPs, installation of enhanced nutrient removal (ENR) septic systems, riparian buffer zones, and encourage the use of pump-out facilities by boaters*

- Continue to support the local county and state environmental educational programs so the public can make informed decisions at the personal, local and regional levels.

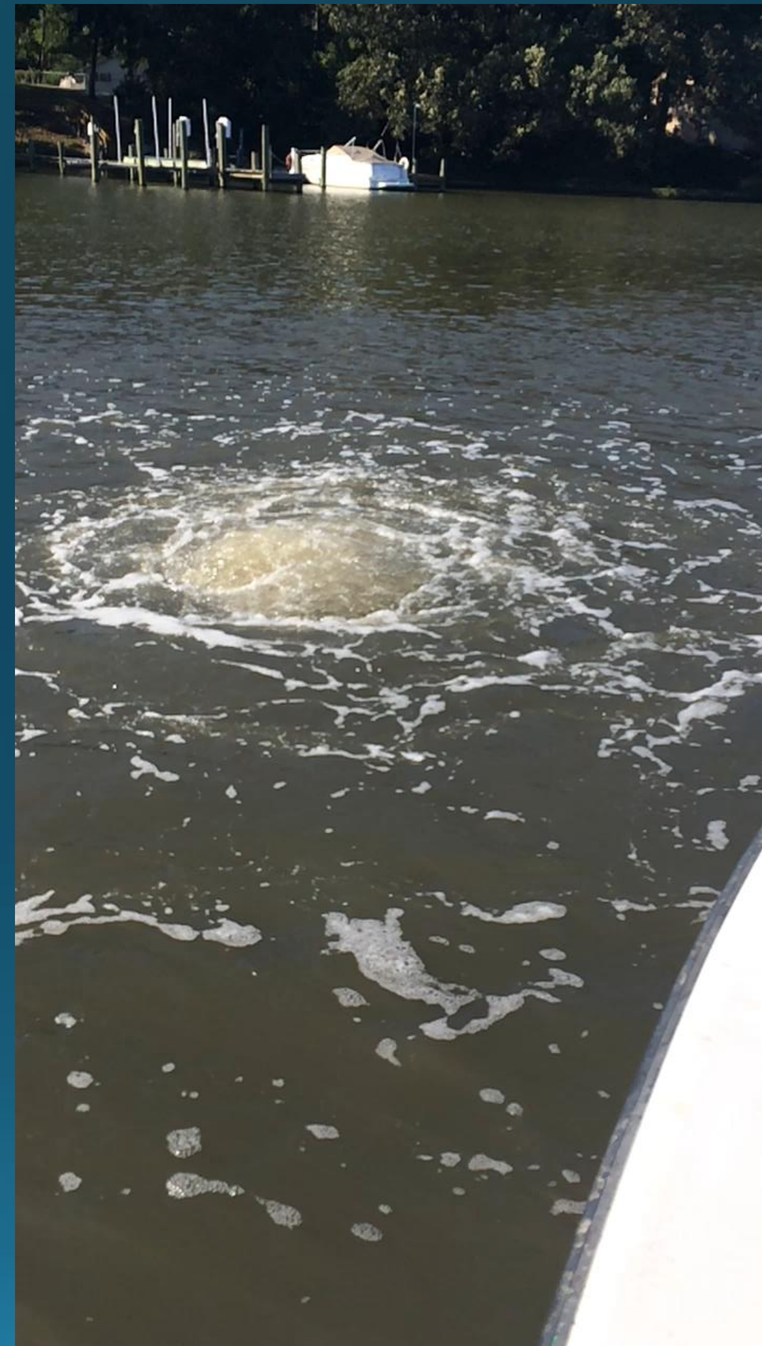
Application

Discovery

Contents lists available at ScienceDirect
Ecological Engineering
journal homepage: www.elsevier.com/locate/ecoleng

Optimizing recovery of eutrophic estuaries: Impact of destratification and re-aeration on nutrient and dissolved oxygen dynamics

L.A. Harris [a,*], C.L.S. Hodgkins [a], M.C. Day [a], D. Austin [b], J.M. Testa [a], W. Boynton [a], L. Van Der Tak [b], N.W. Chen [c]



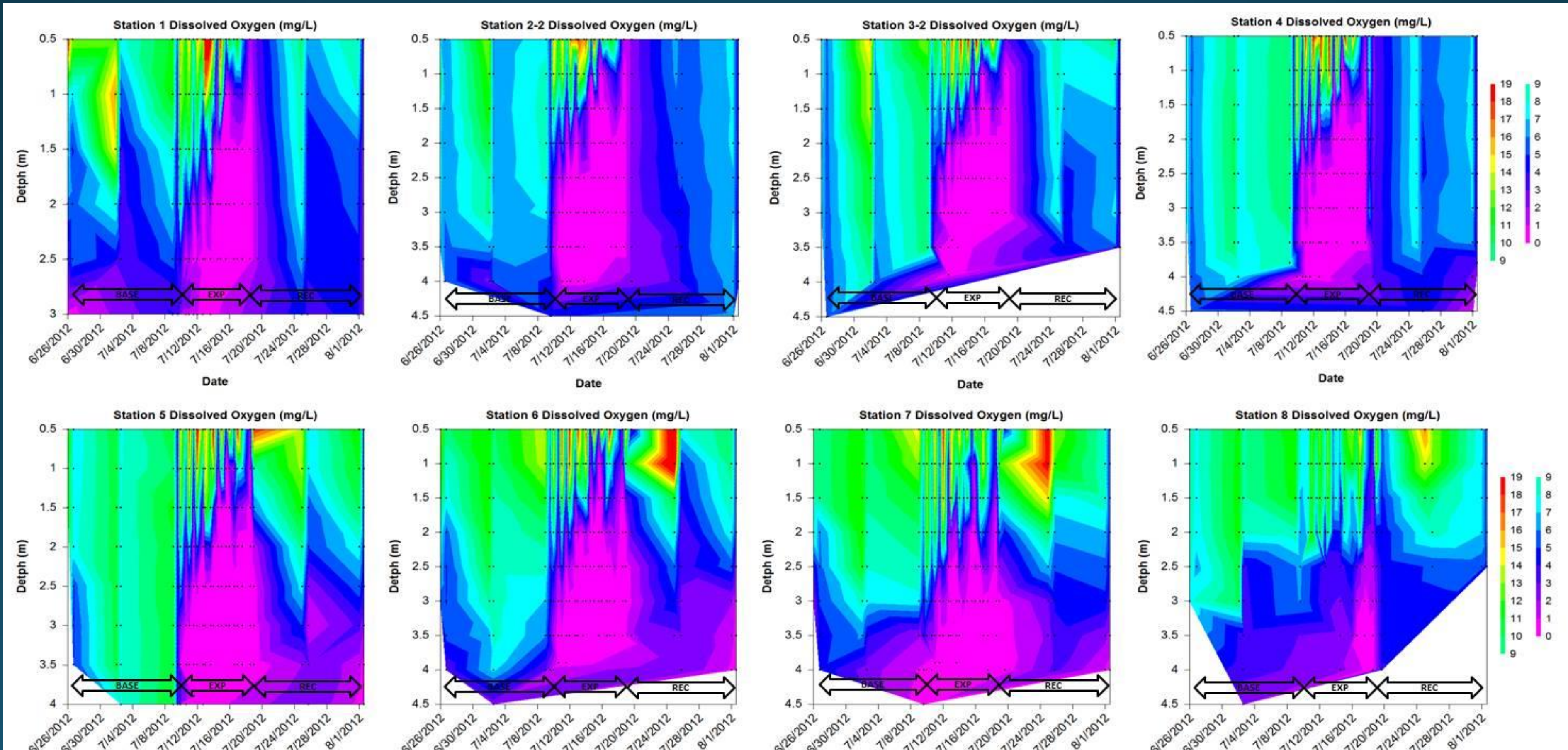
Contents lists available at ScienceDirect

Ecological Engineering

journal homepage: www.elsevier.com/locate/ecoleng

Optimizing recovery of eutrophic estuaries: Impact of destratification and re-aeration on nutrient and dissolved oxygen dynamics

L.A. Harris [a,*], C.L.S. Hodgkins [a], M.C. Day [a], D. Austin [b], J.M. Testa [a], W. Boynton [a], L. Van Der Tak [b], N.W. Chen [c]

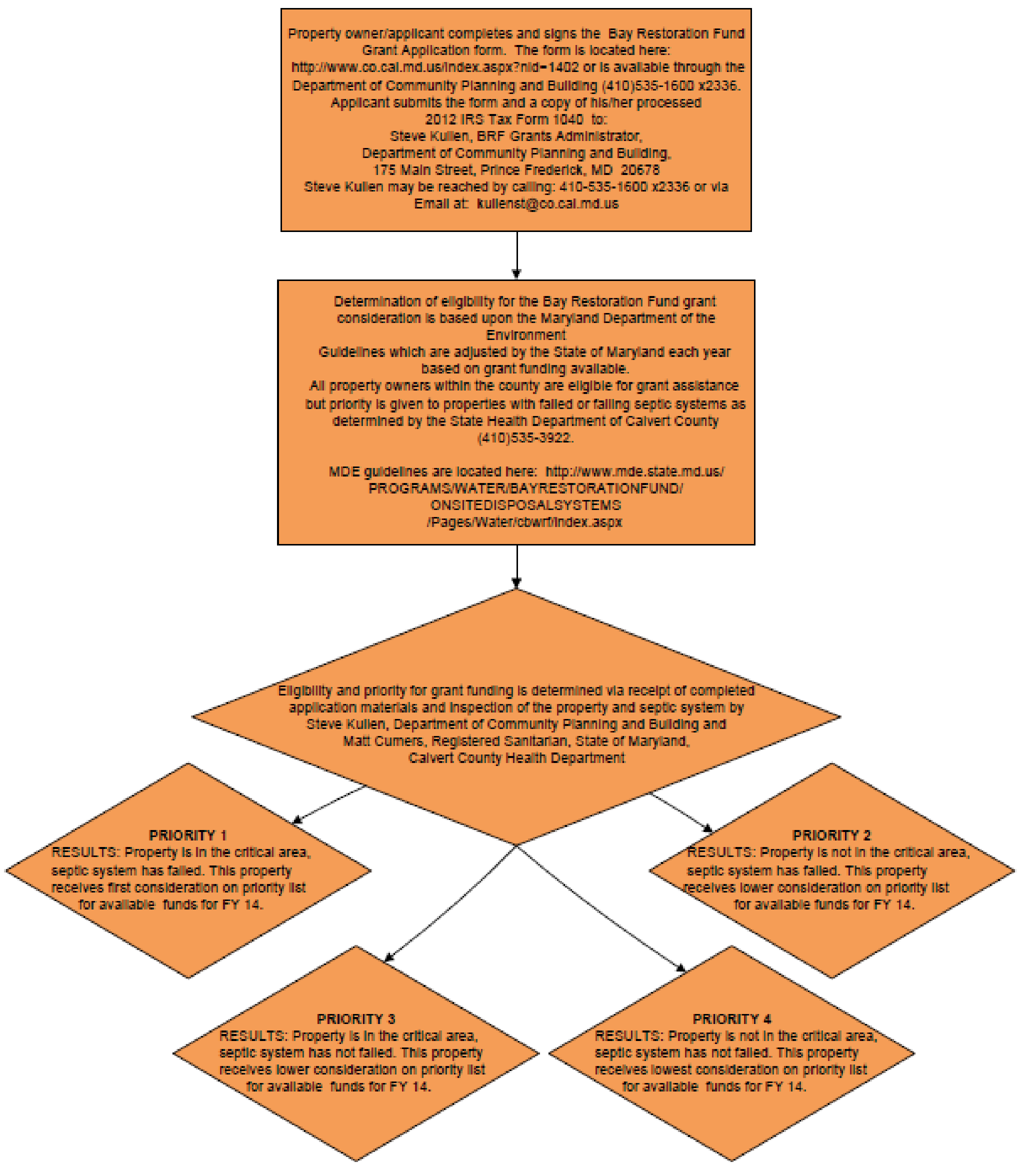


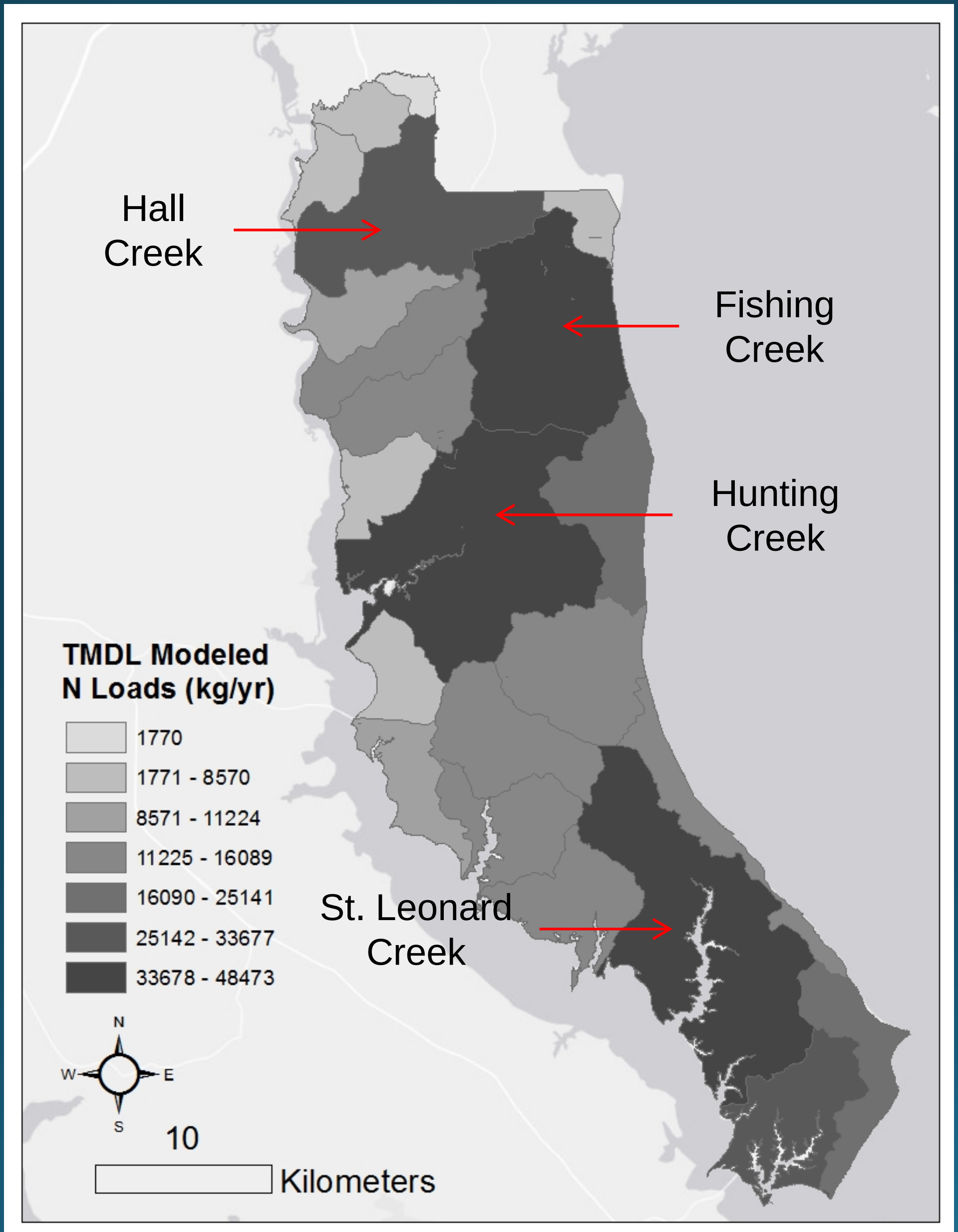

Application
Discovery

CALVERT COUNTY HEALTH DEPARTMENT

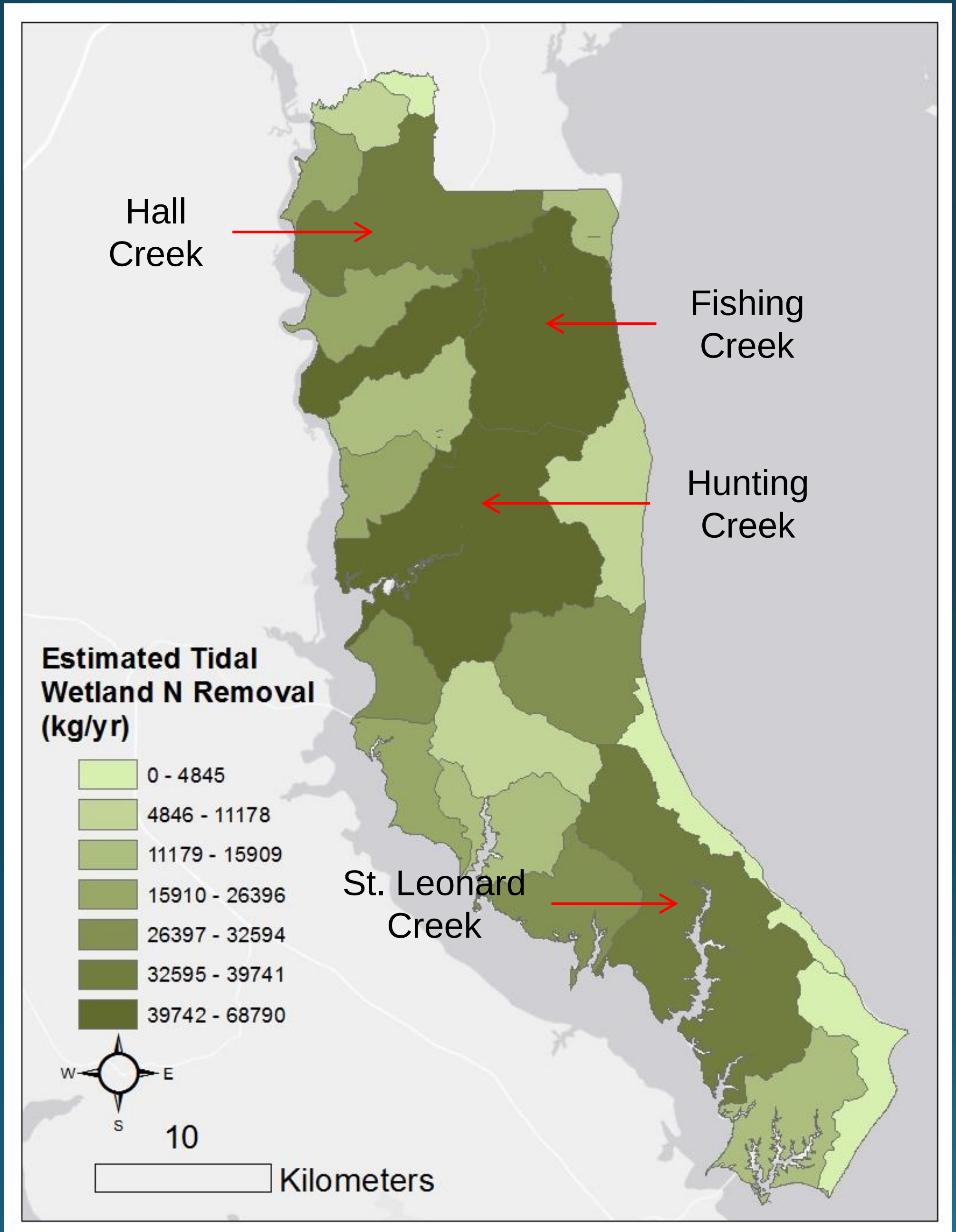
Flow Diagram from Calvert County

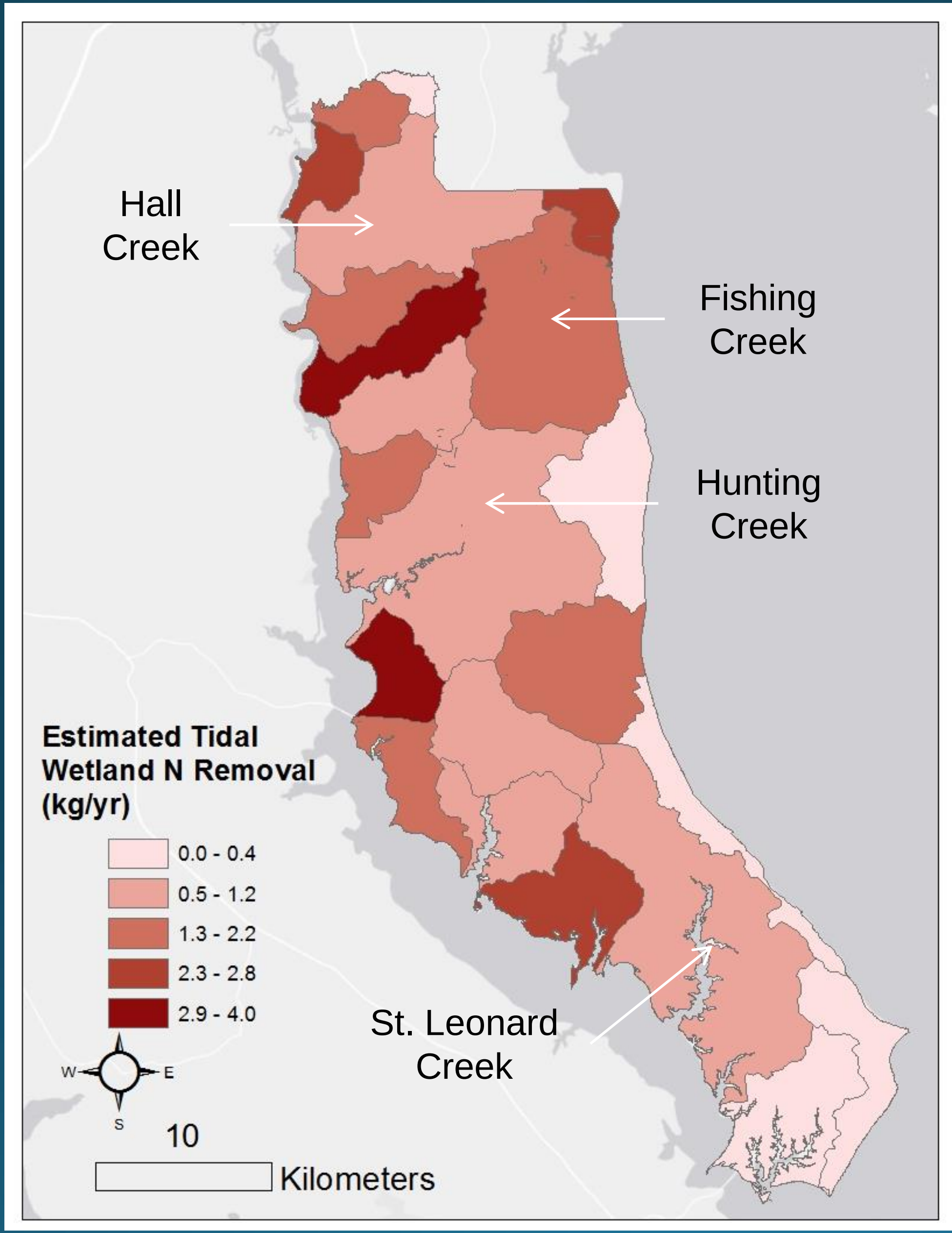
Bay Restoration Grant Fund – FY 14 Calvert County Process

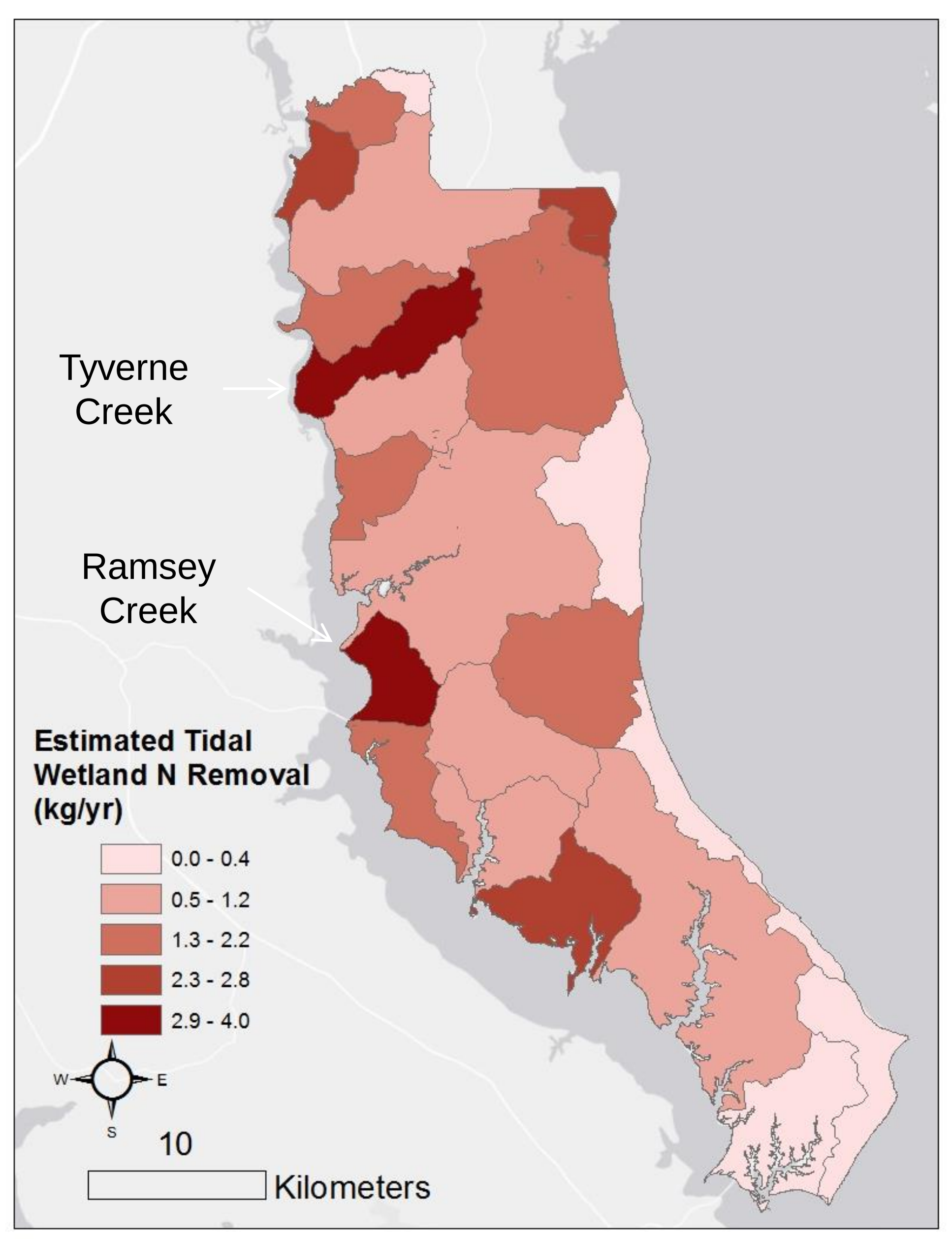



Hall Creek
Fishing Creek
Hunting Creek
St. Leonard Creek
TMDL Modeled N Loads (kg/yr)
1770
1771 - 8570
8571 - 11224
11225 - 16089
16090 - 25141
25142 - 33677
33678 - 48473
N
W
E
S
10
Kilometers

Wetland Category	Nitrogen Removal Services	Source
	Denitrification ($g\ N\ m^{-2}\ yr^{-1}$)	
Tidal Fresh	14.7	Greene 2005
Brackish	7.4	Kemp 2006
Salt	0.6	Thomas & Christian 2001
	Nitrogen Burial ($g\ N\ m^{-2}\ yr^{-1}$)	
Tidal Fresh	23.4	Merrill & Cornwell 2000
Brackish	13.6	Merrill & Cornwell 2000
Salt	4.3	Thomas & Christian 2001

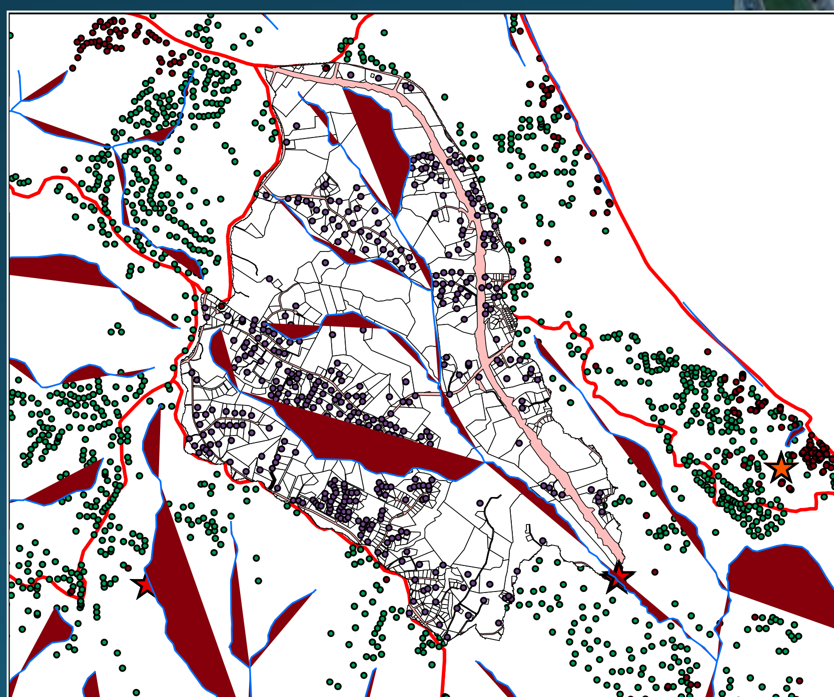

Hall
Creek
Fishing
Creek
Hunting
Creek
St. Leonard
Creek
Estimated Tidal
Wetland N Removal
(kg/yr)
0 - 4845
4846 - 11178
11179 - 15909
15910 - 26396
26397 - 32594
32595 - 39741
39742 - 68790
W
E
S
10
Kilometers

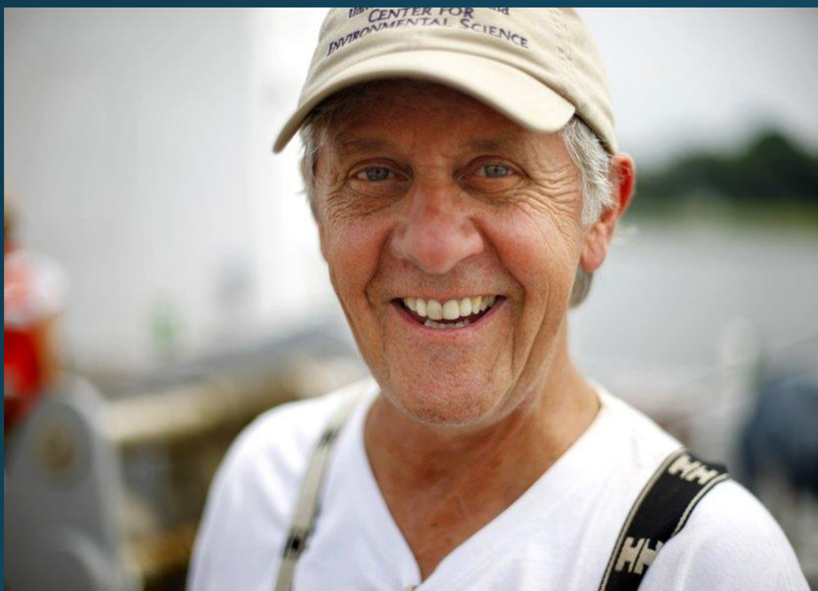

Hall Creek
Fishing Creek
Hunting Creek
St. Leonard Creek
Estimated Tidal Wetland N Removal (kg/yr)
0.0 - 0.4
0.5 - 1.2
1.3 - 2.2
2.3 - 2.8
2.9 - 4.0
W
E
S
10
Kilometers

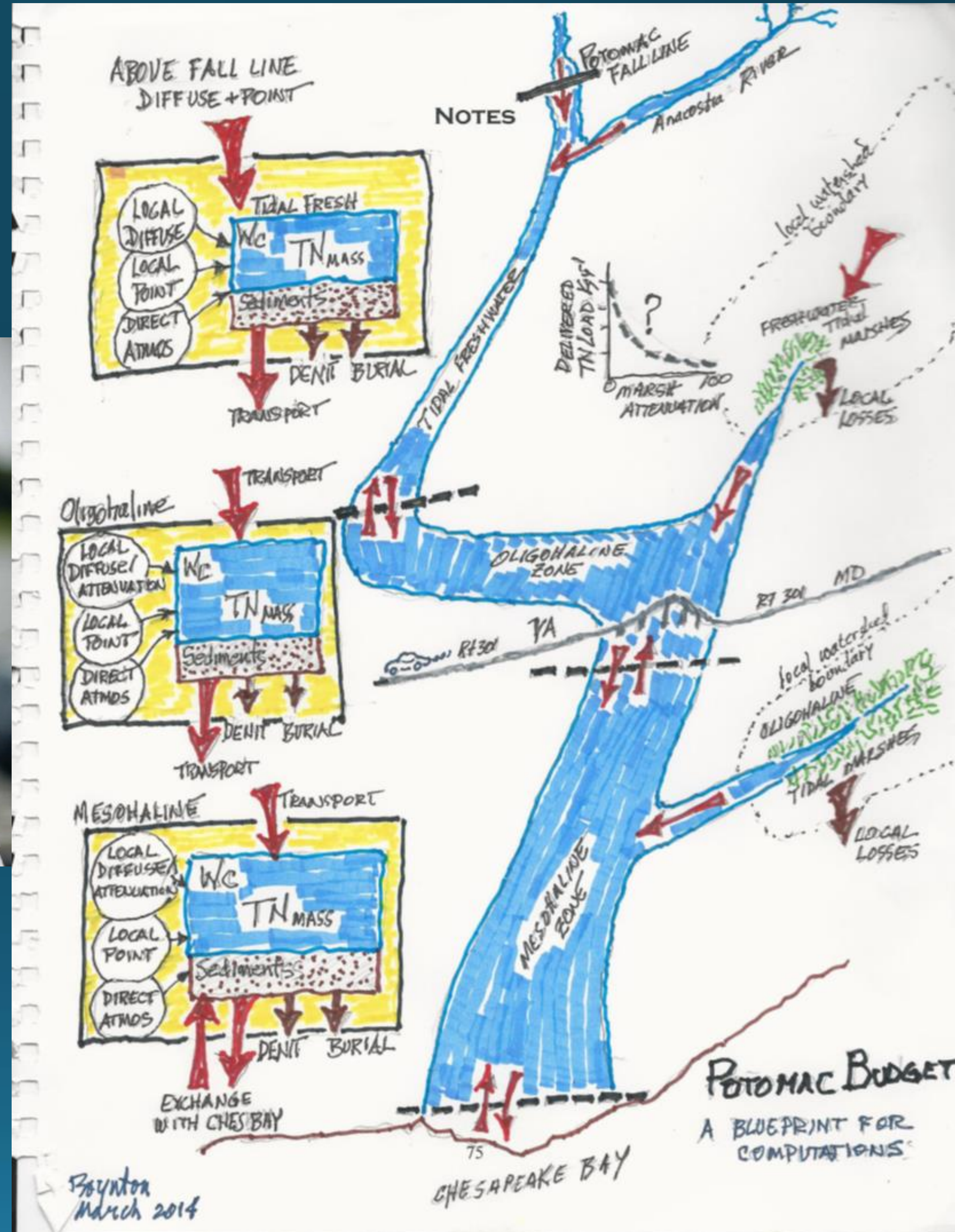

Tyverne
Creek
Ramsey
Creek
Estimated Tidal
Wetland N Removal
(kg/yr)
0.0 - 0.4
0.5 - 1.2
1.3 - 2.2
2.3 - 2.8
2.9 - 4.0
W
E
S
10
Kilometers


T4-1
T4-2
T3-1
T3-2
T3-3
T2-1
T2-2
T2-3
T1-1
T1-2
T1-3

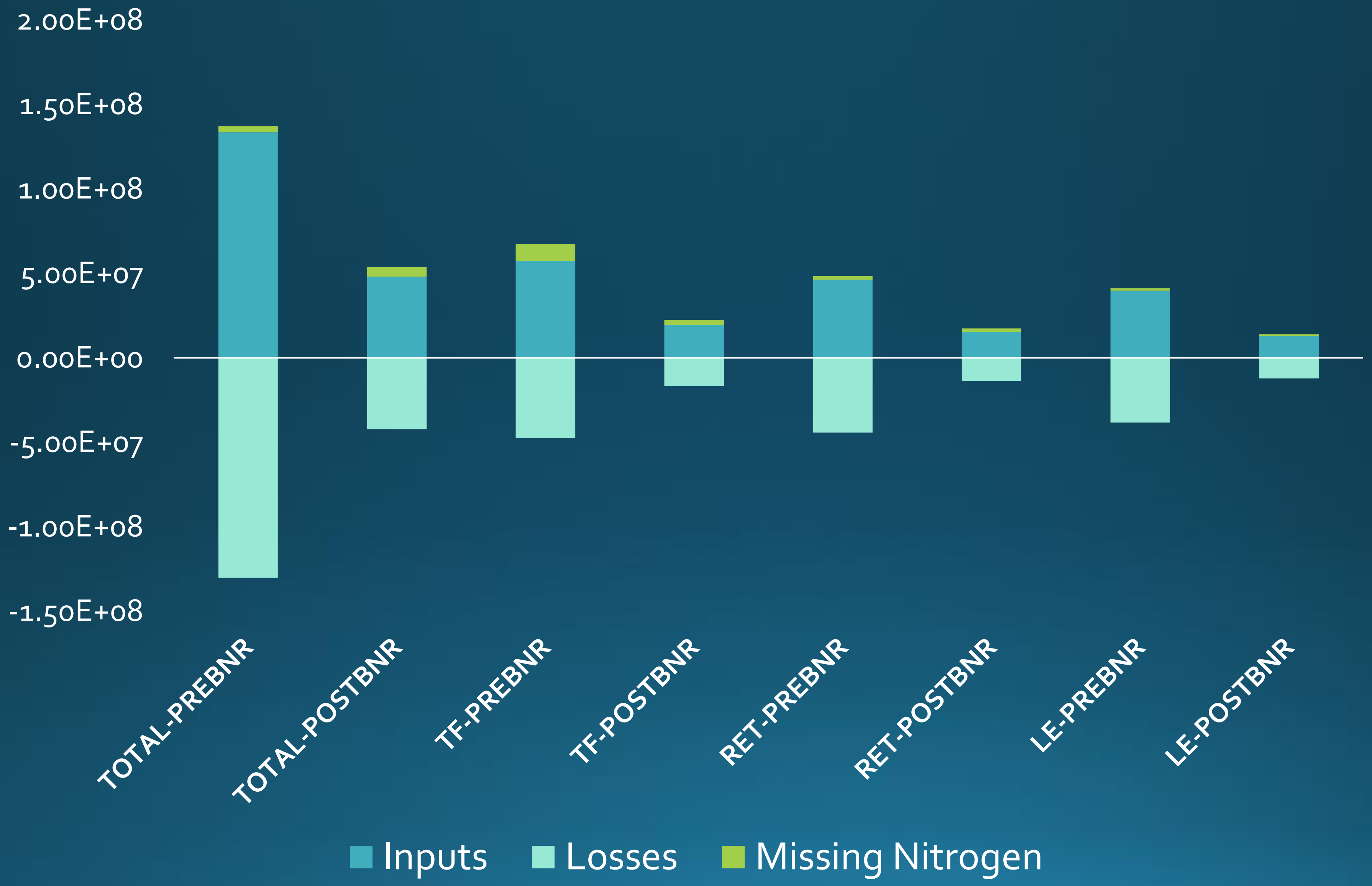

Application
Discovery




CENTER FOR
ENVIRONMENTAL SCIENCE


ABOVE FALL LINE
DIFFUSE + POINT
NOTES
POTOMAC FALL LINE
Anacostia River
TIDAL FRESH
LOCAL DIFFUSE
LOCAL POINT
DIRECT ATMOS
WC
TN MASS
Sediments
DENIT
BURIAL
TRANSPORT
TIDAL FRESHWATER
local watershed boundary
DELIVERED TN LOAD kg/
?
0
MARSH ATTENUATION
100
FRESHWATER TIDAL MARSHES
LOCAL LOSSES
TRANSPORT
Oligohaline
LOCAL DIFFUSE/ ATTENUATION
LOCAL POINT
DIRECT ATMOS
WC
TN MASS
Sediments
DENIT
BURIAL
TRANSPORT
OLIGOHALINE ZONE
MD
RT 301
VA
Rt 301
local watershed boundary
OLIGOHALINE TIDAL MARSHES
LOCAL LOSSES
MESOHALINE
TRANSPORT
LOCAL DIFFUSE/ ATTENUATION
LOCAL POINT
DIRECT ATMOS
WC
TN MASS
Sediments
DENIT
BURIAL
EXCHANGE WITH CHES BAY
MESOHALINE ZONE
POTOMAC BUDGET
A BLUEPRINT FOR COMPUTATIONS
75
CHESAPEAKE BAY
Boynton
March 2014

Inputs, Losses, and Mass Balance



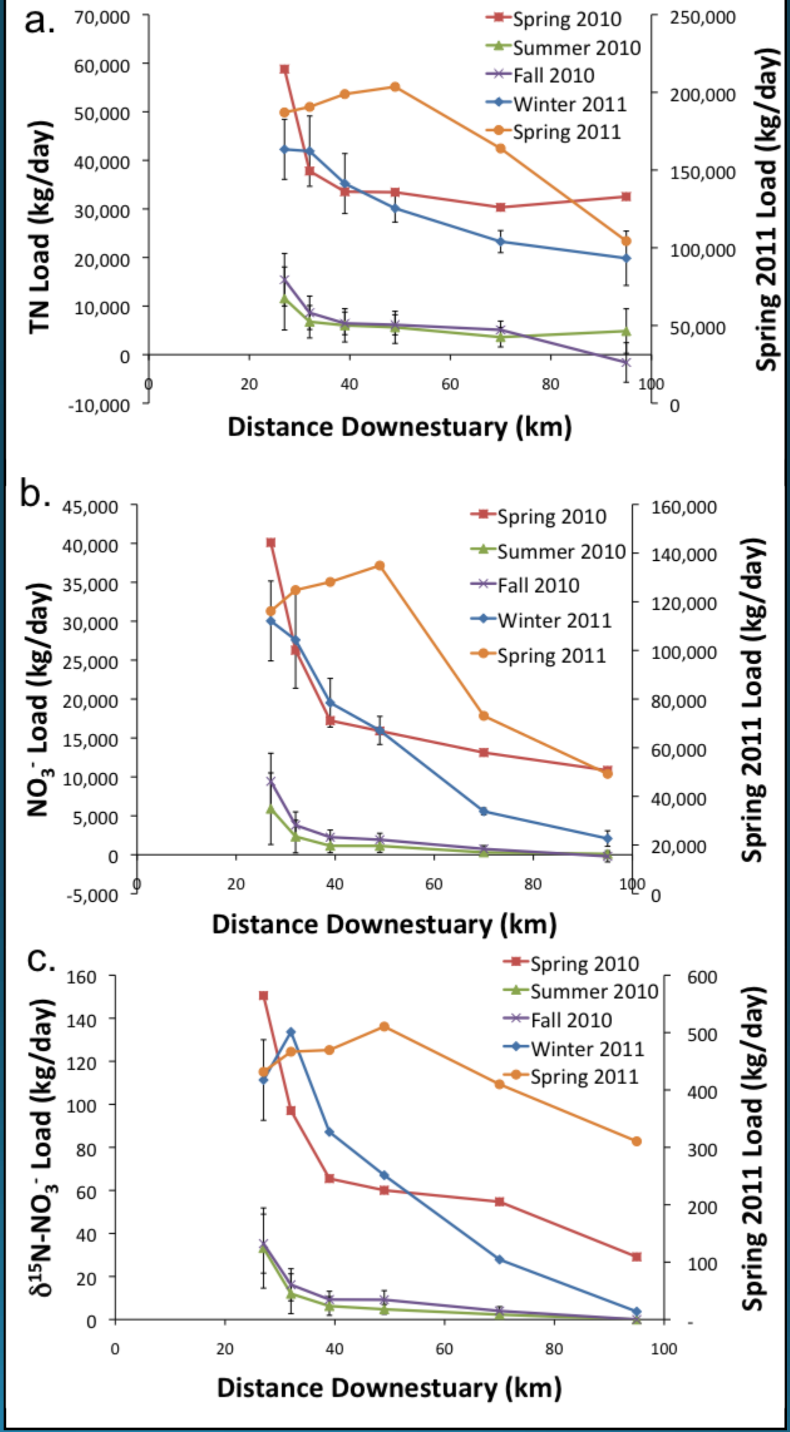
Source Tracking

Modeled N loads decreased down estuary.

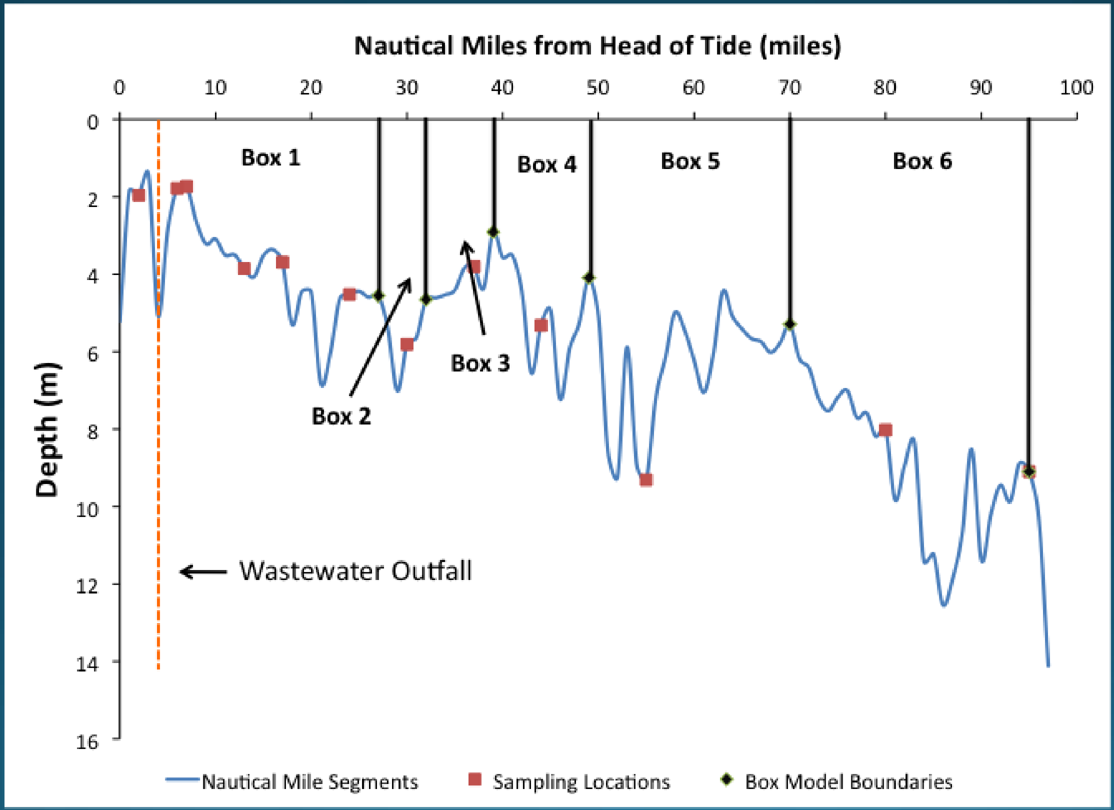
Depending on the season, export of wastewater effluent to the Chesapeake Bay main stem characteristic of the Blue Plains treatment plant ranged from 1-30% of inputs.

Remineralization of N inputs was evident in changed ratio of *δN15 and δO18* isotopes of nitrate.

Values estimated using this approach similar to direct flux measurements.



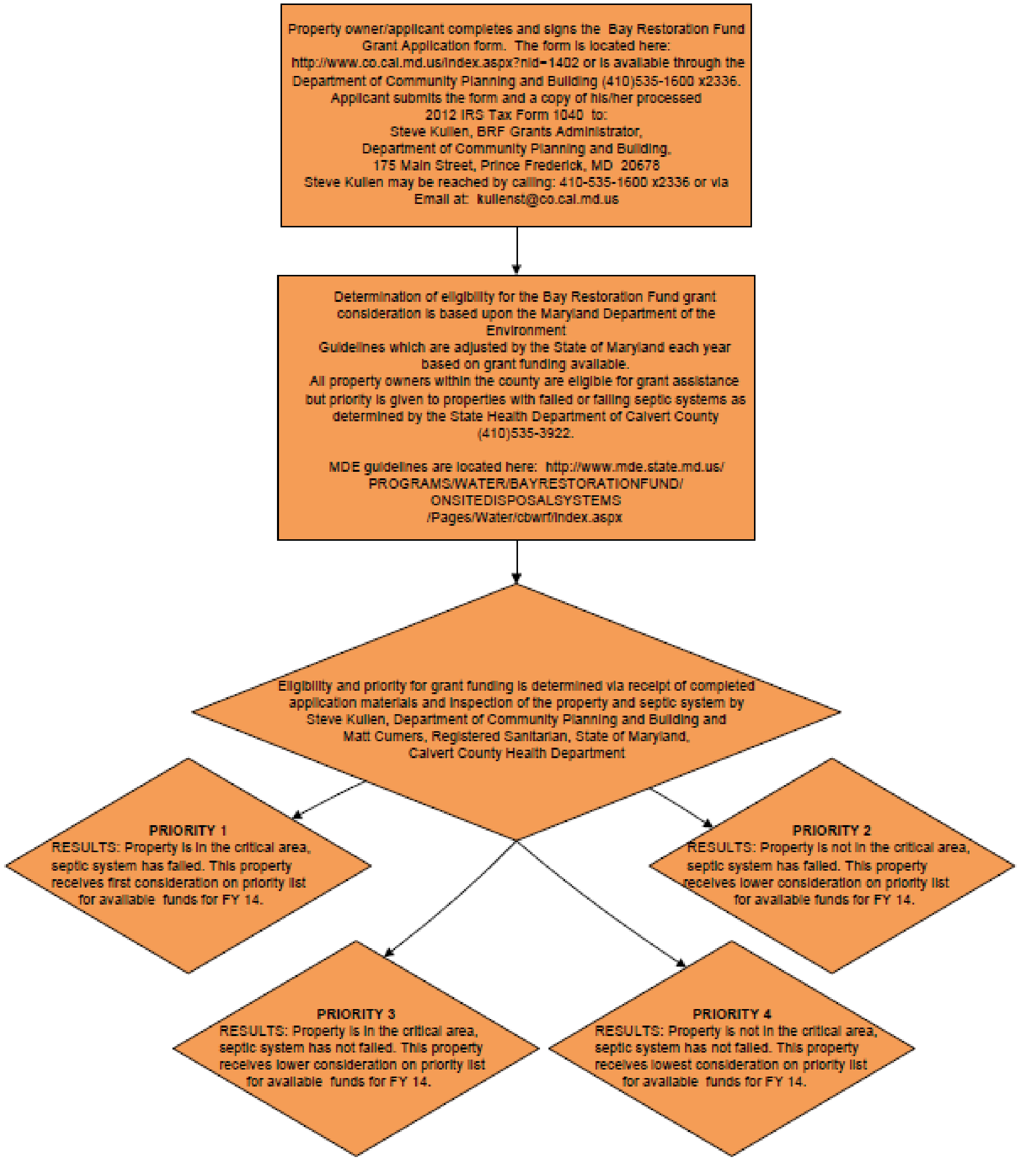
	Total Inputs (kg/day)	% of Inputs from Blue Plains*	Net Export (kg/day)	% of Blue Plains Inputs Exported
Winter	49,150 ± 30,323	10 ± 13	19,844 ± 13,728	3.7 ± NA
Spring	13,5317 ± 14,614	8 ± 0.8	68,431 ± 48,060	71 ± 20
Summer	13,888 ± 596	38 ± 3	4,853 ± 8,326	19 ± 11
Fall	15,334 ± 3,700	47 ± 13	-1,613 ± 12,124	18 ± 10



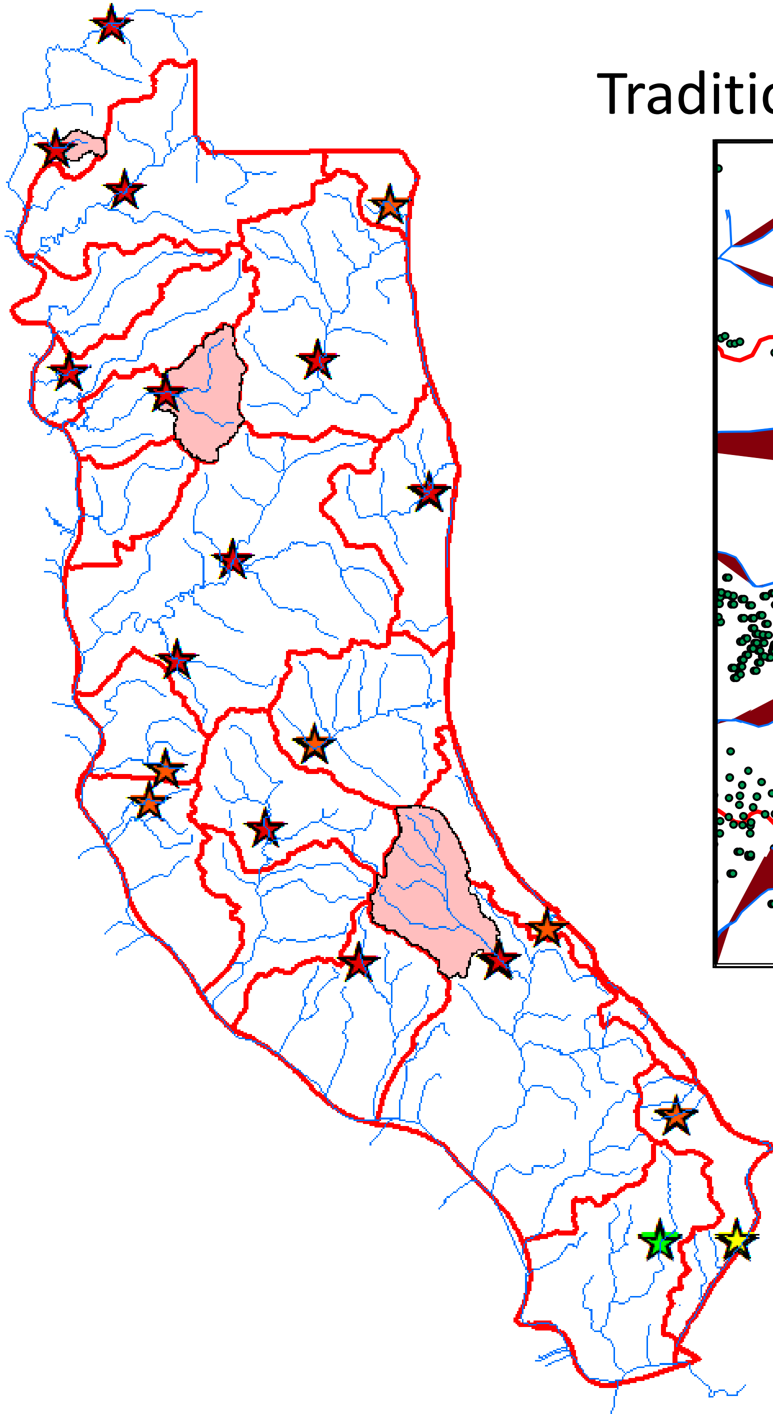
Pennino et al. 2016. Biogeosciences 13:6211-6228.

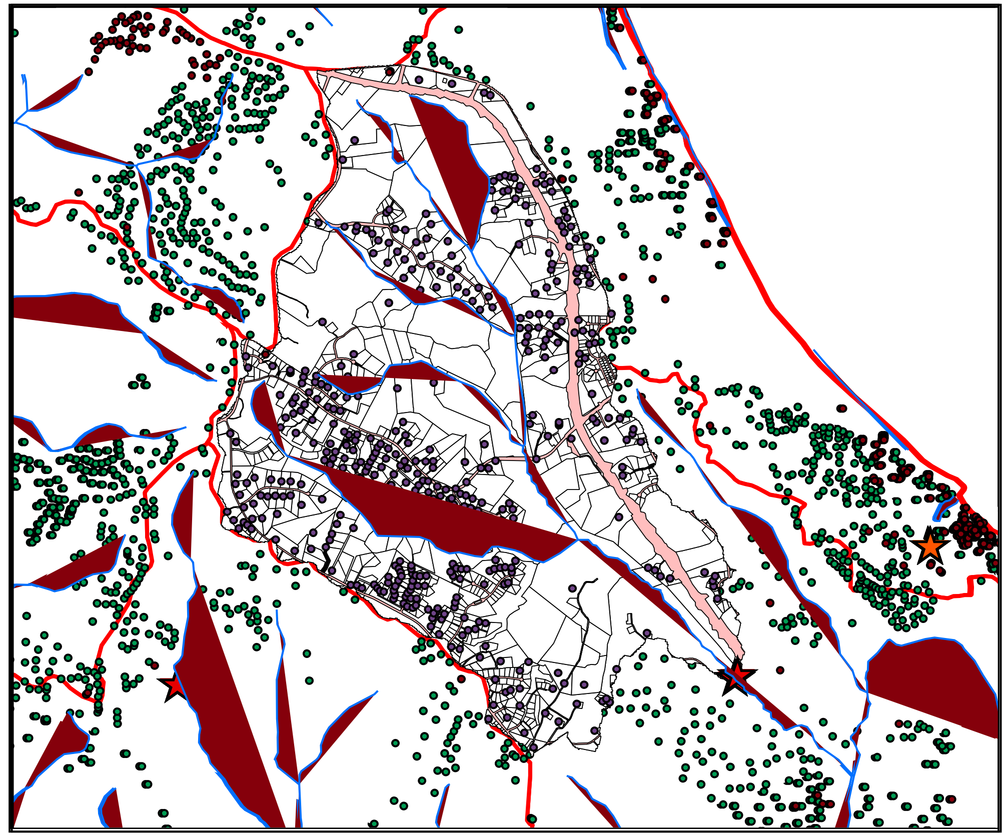
Flow Diagram from Calvert County

Bay Restoration Grant Fund – FY 14
Calvert County Process



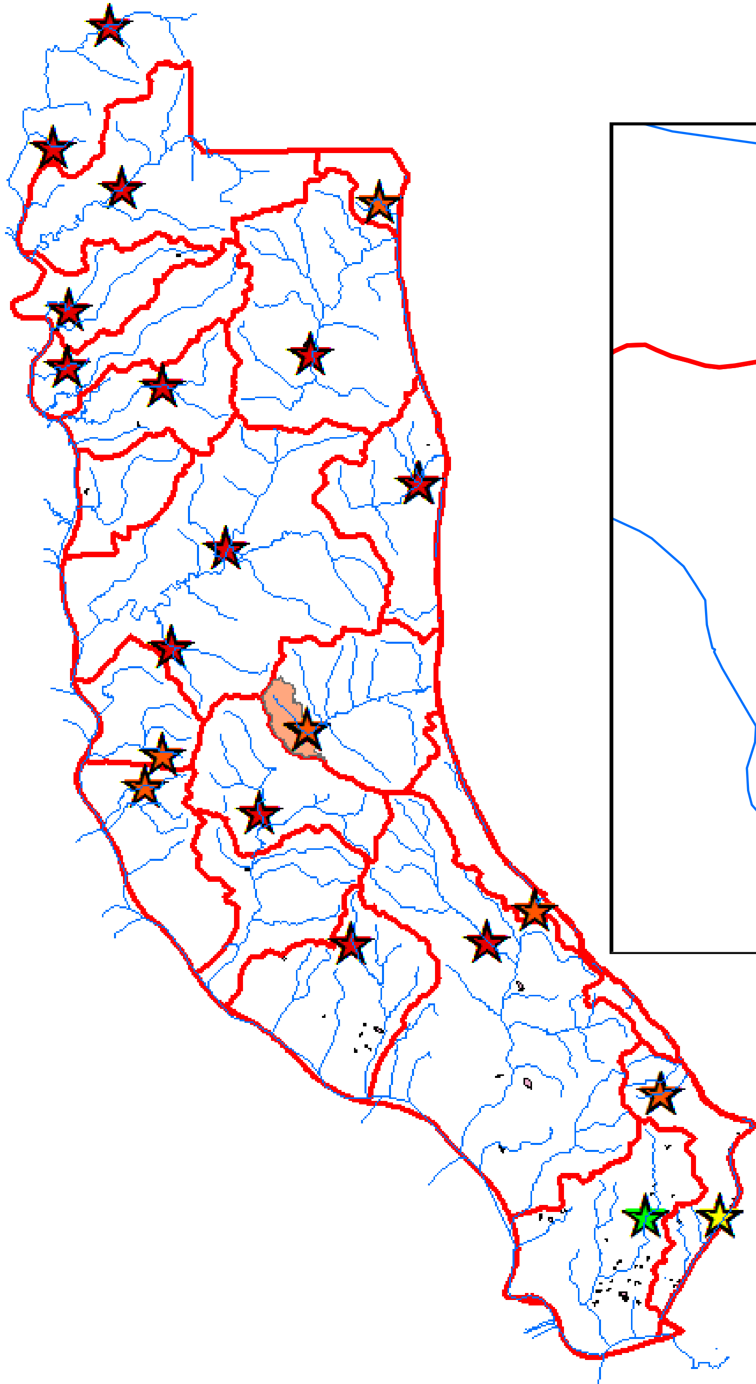
Traditional Septic Site 1: St. Leonard Creek

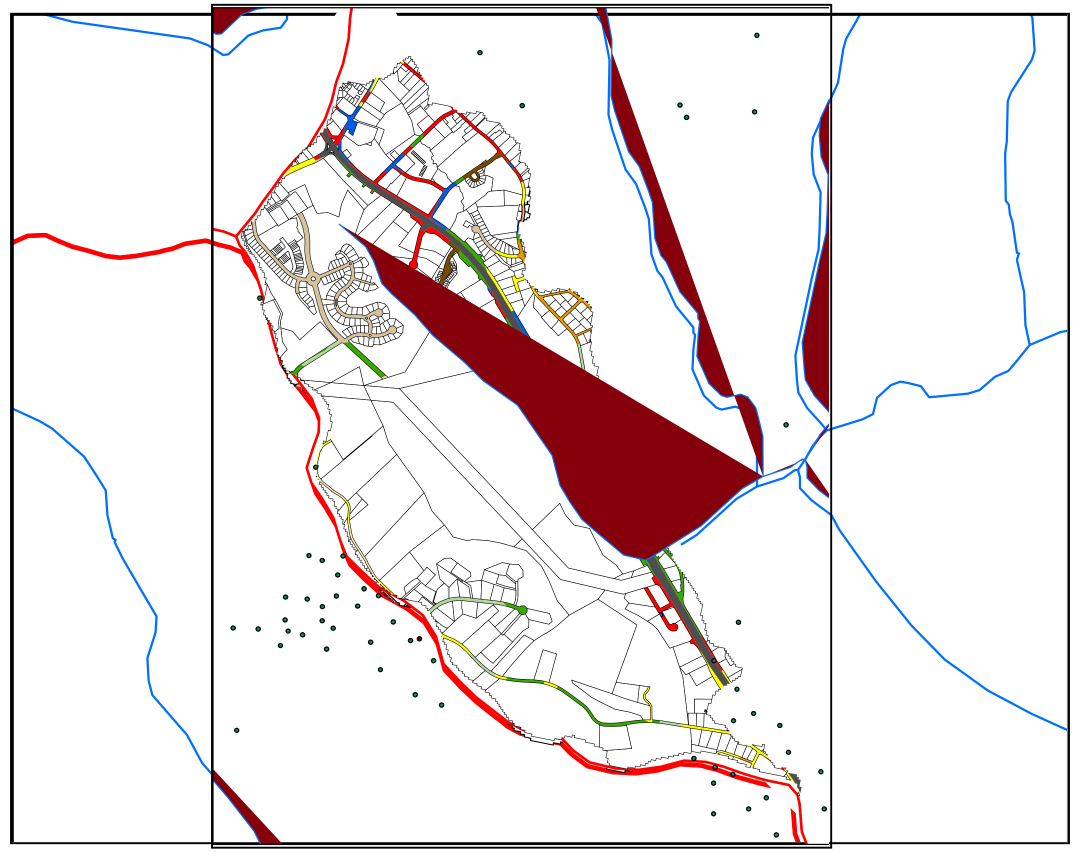




- 452 traditional septics
- 2 BRF BAT systems
- 6.81 sq mi

Reference Site 2: Parkers Creek





- 25 traditional septics
- No BAT systems
- 1.38 sq mi

Septic Tracers….

4:44

+ Queue

Download

Embed

Transcript

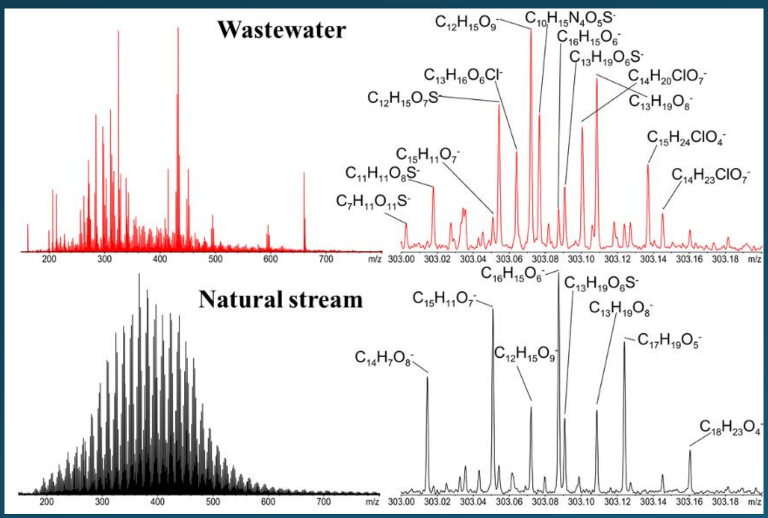
SCIENCE

Trump's Budget Would Eliminate A Key Funder Of Research On Coastal Pollution

May 8, 2017 · 2:30 PM ET

Heard on All Things Considered

CHRISTOPHER JOYCE



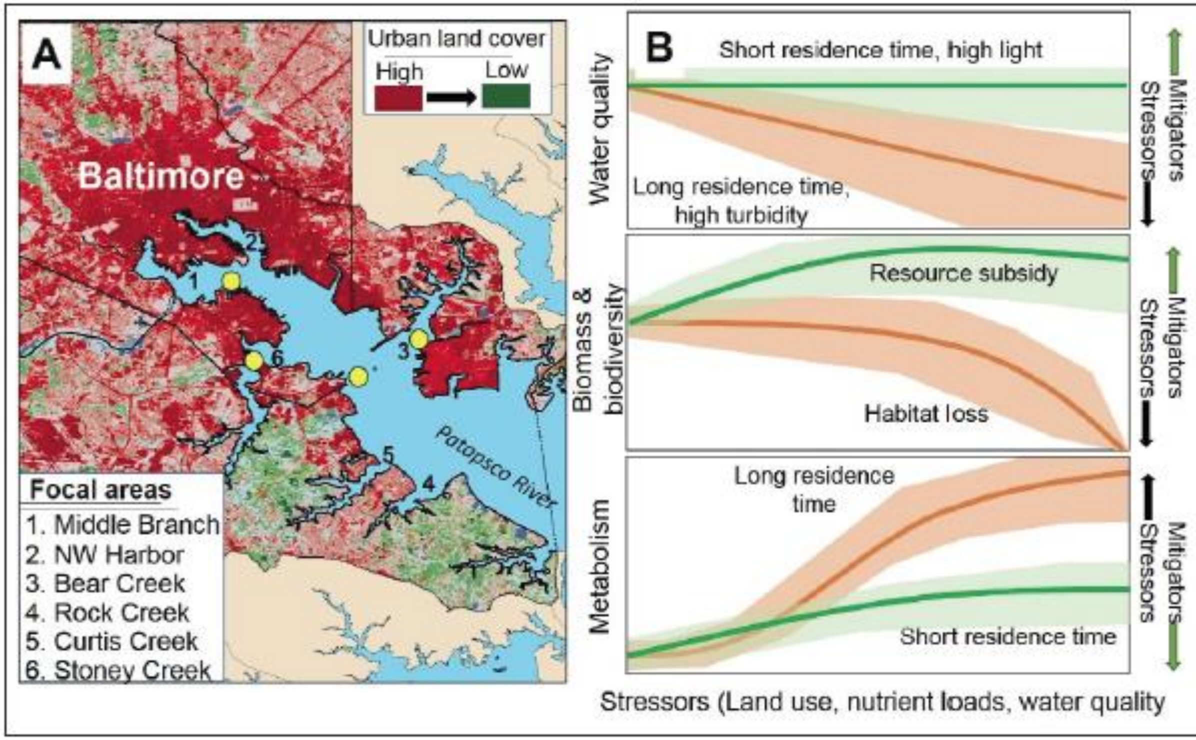


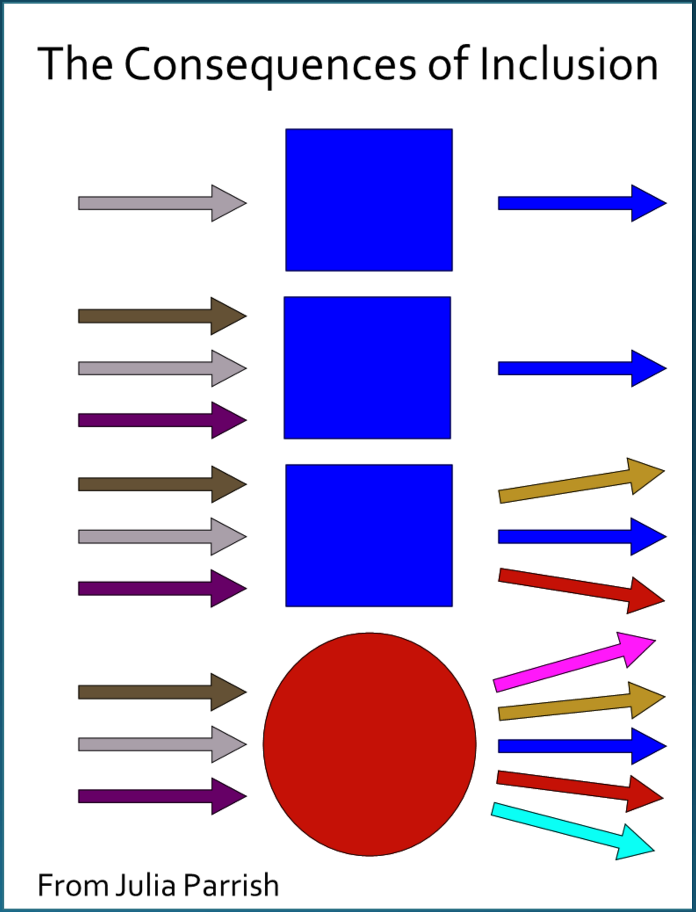
Figure 2. Proposed sampling zones (Focal areas 1-6) with watershed land cover differences in catchments and CBay Program monitoring sites (yellow symbols; A); hypothesized response of variables (left axes) over predicted stressor gradients (bottom axis) in the presence of stressors (orange line) and mitigators (green line; B).

ASPIRe

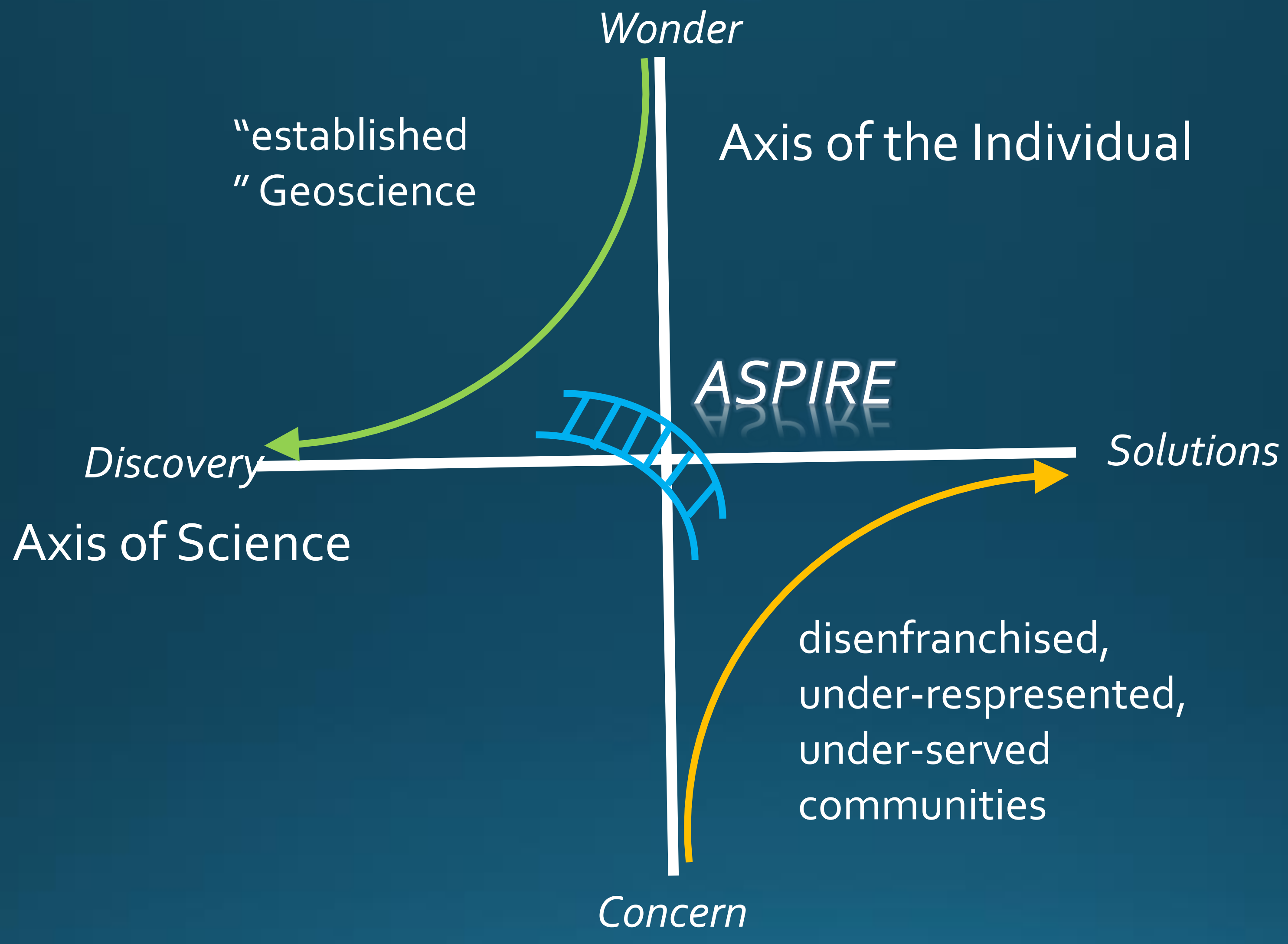
Active Societal Participation In Research And Education

- Corey Garza - California State University Monterey Bay
- Lora Harris - University of Maryland CES
- Julia Parrish - University of Washington
- Julie Posselt - University of Southern California

ASPIRE aims to cultivate a generation of geoscientists with the leadership knowledge and skills, scholarship, and material support to reframe and rebrand the geosciences (Atmospheric, Earth, Ocean and Polar Science) as socially relevant and, thereby, to broaden participation in these fields.



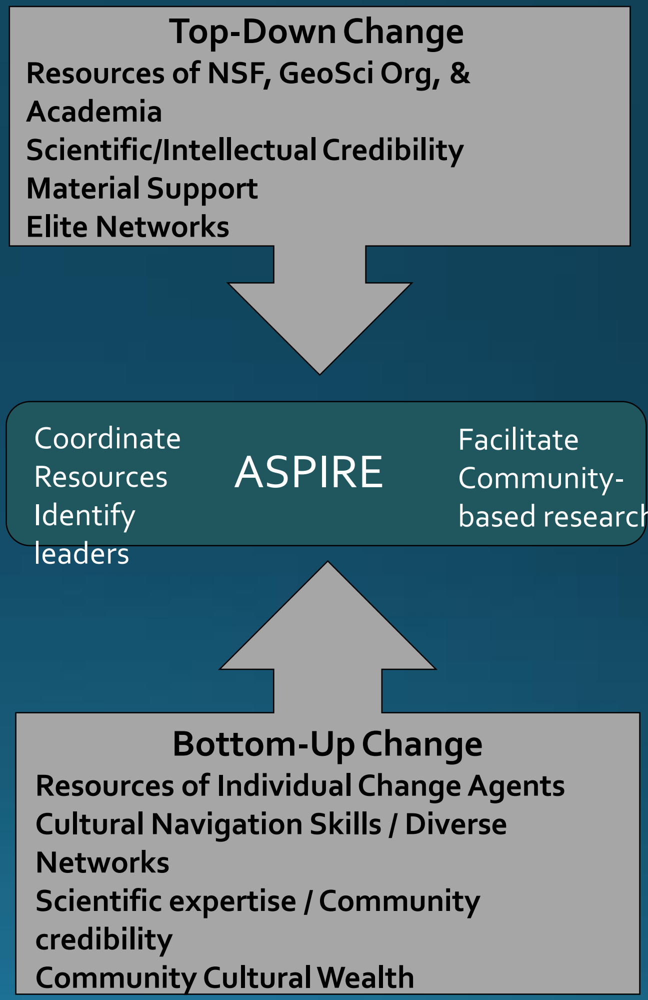
Julia Parrish, Corey Garza, Julie Posselt, L Harris



Julia Parrish, Corey Garza, Julie Posselt, L Harris

ASPIRE

- NCEAS working group model examines place based/participatory science as a vehicle for increasing diversity and leadership in the Geosciences.
- Examines how “gate openers” can bridge basic and applied science, characterizing leadership qualities.
- Employs mobile working groups, pilot effort focuses on developing best practices.
- Parallel workshops planned to develop leadership profiles and best practices



Julia Parrish, Corey Garza, Julie Posselt, L Harris

Anne Arundel County
WATERSHED
Protection & Restoration
PROGRAM

restore
ROCK CREEK

http://www.ceem.cbl.umces.edu/

Acknowledgements

Jeremy Testa
Casey Hodgkins
Mindy Forsyth
Zachary Gotthardt
Jeff Cornwell
Walter Boynton
Cindy Palinkas
Michael Pennino
Michael Kemp
Julia Parrish
Julie Posselt

Michael Gonsior
Katie Martin
Andrew Heyes
Steve Kullen
Dave Brownlee
Janis Markusic
Eric Schott
Ryan Woodland
Jen Bryan
Walter Boynton
Corey Garza

David Austin
Laurens vanderTak
Matt Cummers