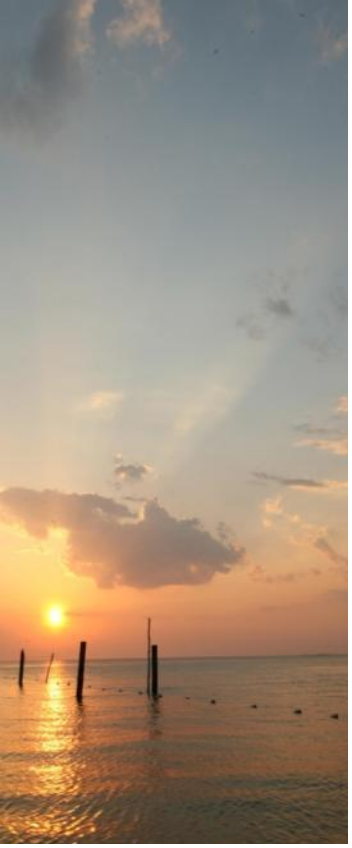
Photo Credit: H. Stevens http://ian.umces.edu/imagelibrary/

The Nature Conservancy
Protecting nature. Preserving life.™

Chesapeake Bay Restoration: Prioritizing Wetland Restoration & BMP Opportunities in the Pocomoke River Watershed

The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

The Nature Conservancy
Protecting nature. Preserving life.™



TNC in the Chesapeake Bay Watershed

- *Priority Bay wetlands and benthic habitats are restored* and resilient to climate change by 2030.

- ***Water Quality in the Bay and its tributaries is improved by 2025* – specifically reductions in nutrients and sediment – to support healthy fisheries, freshwater and estuarine habitats, drinking water, and recreation.**

- *Healthy and viable Bay fisheries* – including oysters, blue crabs, menhaden, striped bass, American eel and shad – *are restored by 2030* and sustained thereafter.

The Nature Conservancy
Protecting nature. Preserving life.™

Designing Sustainable Habitats in the Face of Human Development, Climate Change, and Sea Level Rise

Discussion Overview:

1) Key issues and trending conditions: **Water quality and wetland habitat enhancement in the Pocomoke River Watershed**

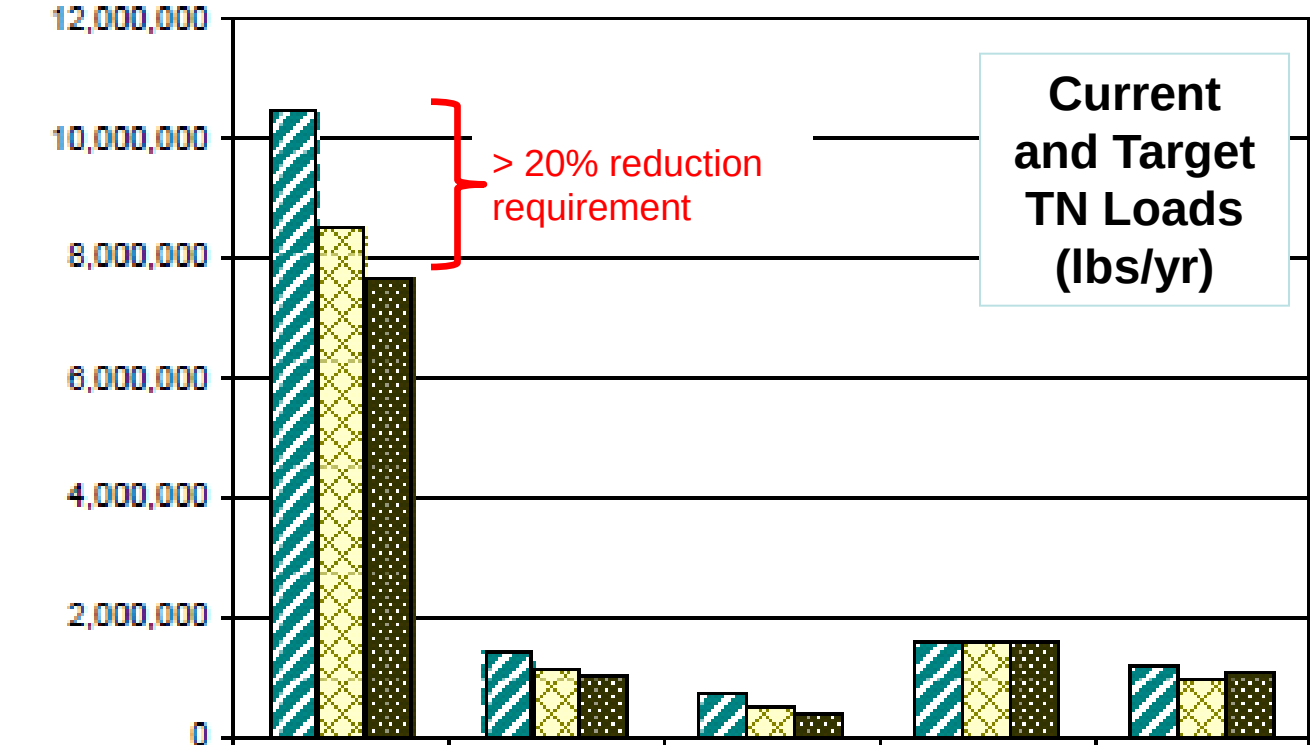
2) Assessing Vulnerabilities and Opportunities: **Science-based decision tools to optimize restoration investments**

3) Identifying critical knowledge gaps and research needs: **Decision tool assessments**

5) **Key challenges over the next decade**

6) **Recommendations**

Chesapeake Bay TMDLs: Lower Eastern Shore TN Targets



	Agriculture	Urban	Septic	Forest	Wastewater
2009	10,450,365	1,449,911	761,172	1,612,904	1,215,831
2017 Target	8,515,194	1,157,435	531,973	1,624,126	954,921
2020 Target	7,685,835	1,032,088	433,744	1,628,936	1,090,187

http://www.chesapeakebay.net/maps/map/delivered_yield_of_total_nitrogen_agricultural_sources

Ag Targeting Concerns:

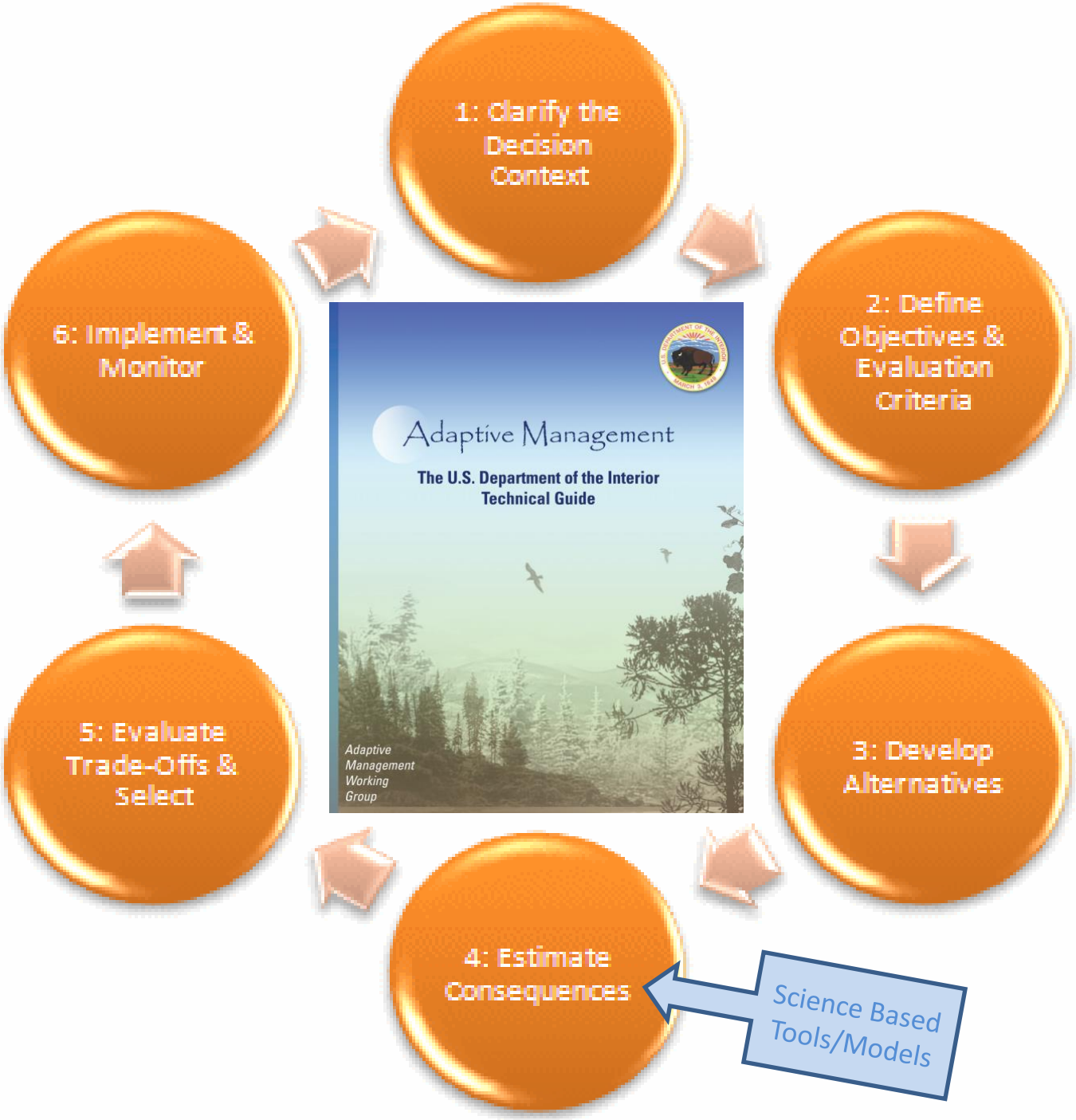
- Improve water quality
- Maximize crop yields (i.e., mitigate not eliminate stressors)
- Improve habitat quality
- Maximize cost effectiveness
- *Overtime*, improve capacity to manage resources

Photo Credit: H. Stevens http://ian.umces.edu/imagelibrary/

The Nature Conservancy
Protecting nature. Preserving life.™

Chesapeake Bay Watershed Restoration Project

Adaptive Management



The Nature Conservancy
Protecting nature. Preserving life.™

Management Alternatives:

Filter Strips

Floodplain Reconnection

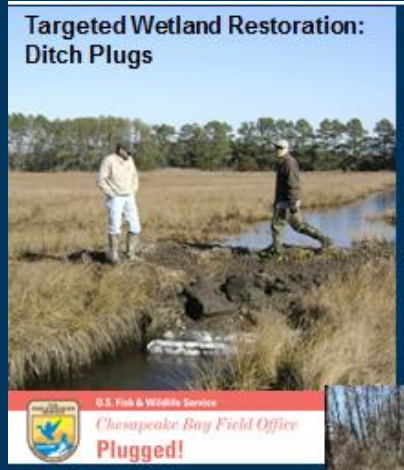
Riparian Buffers

Targeted Wetland Construction/Restoration

Pre-construction - 1993 During Construction - Summer 1994 Post Construction - Fall 1994

The Nature Conservancy
Protecting nature. Preserving life.™

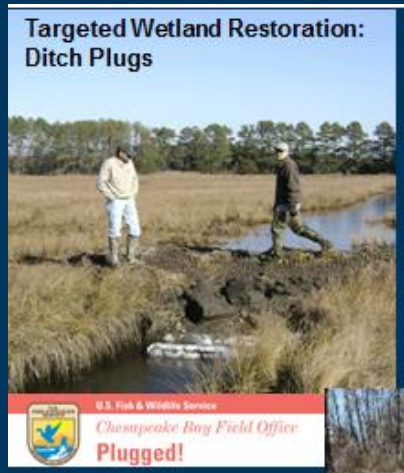
Adaptive Watershed Management



	Mass TN removed	Mass TP removed	Mass TSS removed	Farm Acres Lost	?Habitat Acres?	Cost
Target Wetland Restoration						
Floodplain Reconnection						
Buffers						
Combination						

The Nature Conservancy
Protecting nature. Preserving life.™

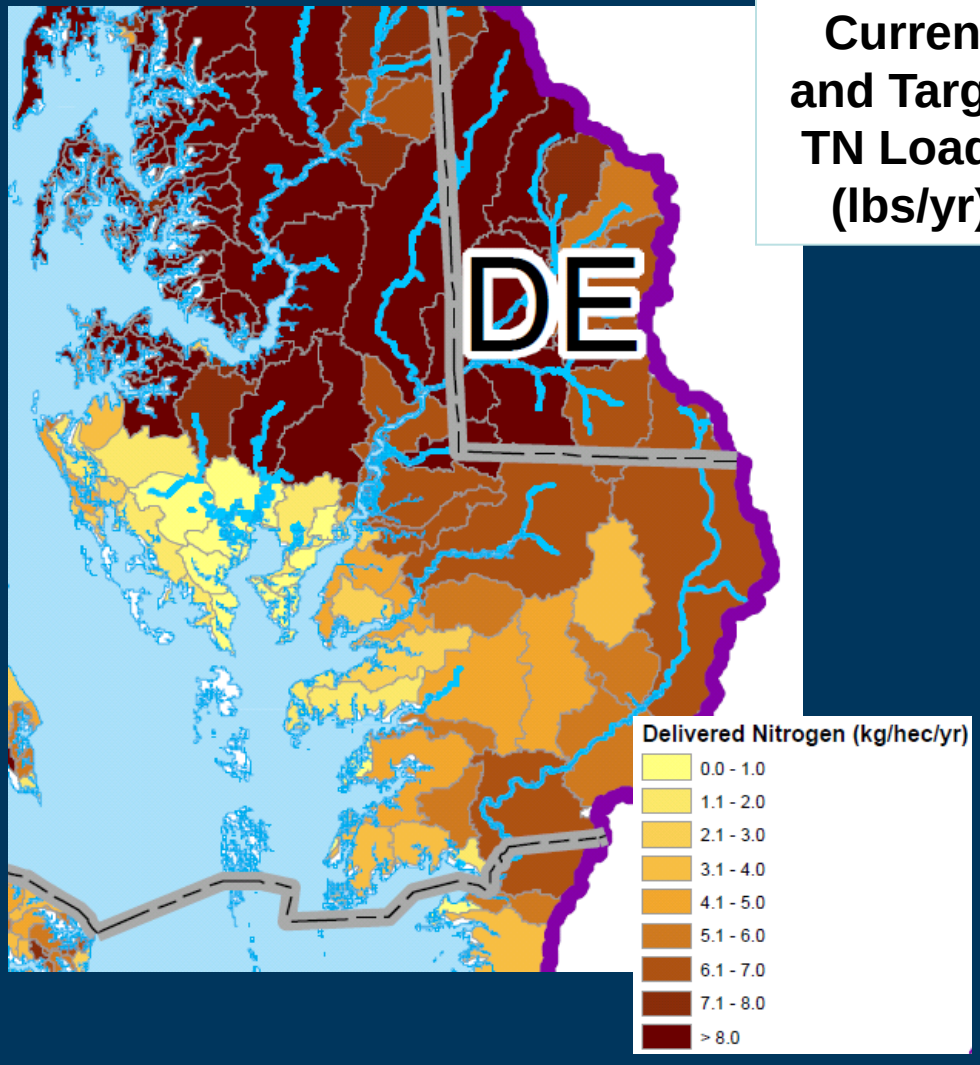
BMP Targeting and Prioritization



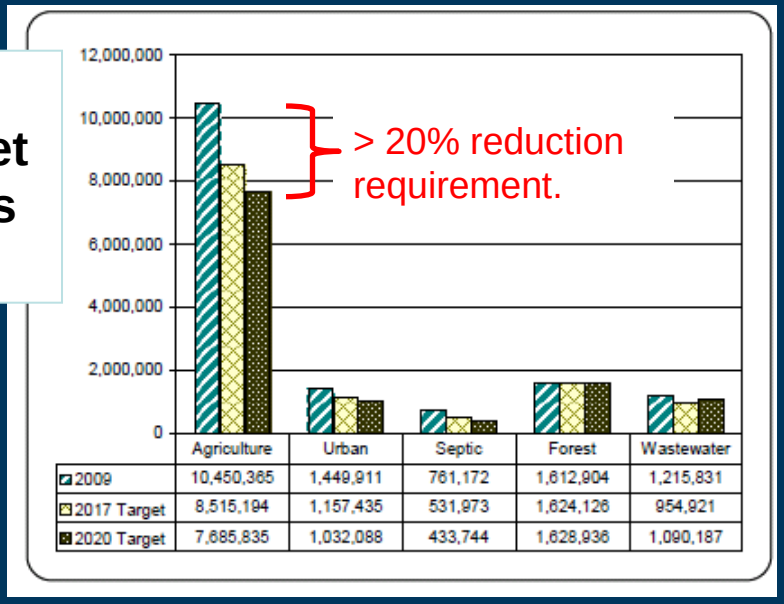
Reach	Subbasin	Reach Length (ft)	Watershed Area (acres)	Retention Area (acres)	Restoration Type	Number of Owners	EOS TN (lbs/yr)	TN captured (lbs/yr)	EOS TP (lbs/yr)	TP captured (lbs/yr)	EOS TSS (lbs/yr)	TSS captured (lbs/yr)	Cost	C
6297	Nass	266	749.64	19.36	buffer	1	212,264	39,177	32,779	11,318	144,877	3,449	$104,544	
6588	Nass	1043	28.88	5.58	plug	1	78,430	61,379	12,501	11,975	6,187	717	$3,232	
6592	Nass	1260	292.3	6.31	buffer	1	193,895	30,415	30,546	9,111	47,800	662	$34,074	
7232	Nass	492	85.19	2.82	buffer	1	140,458	32,306	22,332	9,352	15,881	285	$15,228	
10123	Nass	1053	79.63	7.53	buffer	1	53,676	28,240	8,463	6,667	7,860	952	$40,662	
6621	Nass	541	16.91	2.69	plug	1	45,920	32,842	7,319	6,779	3,622	346	$2,076	
6685	Nass	669	213.19	3.91	buffer	1	187,775	25,308	29,688	7,706	27,376	398	$21,114	
6796	Nass	164	10.99	10.91	plug	2	29,836	29,825	4,756	4,756	2,354	1,402	$5,364	
6853	Nass	371	64.17	10.99	plug	1	35,353	26,218	5,550	5,216	10,176	1,180	$5,396	
7521	Nass	285	211.73	57.31	buffer	3	2,573	2,270	79	78	49,722	6,616	$309,474	

The Nature Conservancy
Protecting nature. Preserving life.™

Science Challenge: Provide science-based tools (which can be tested and improved) to guide bmp placement and design.



Current and Target TN Loads (lbs/yr)



	Agriculture	Urban	Septic	Forest	Wastewater
2009	10,450,365	1,449,911	761,172	1,612,904	1,215,831
2017 Target	8,515,194	1,157,435	531,973	1,624,126	954,921
2020 Target	7,685,835	1,032,088	433,744	1,628,936	1,090,187

Additional Model Needs:

- Simple (Enhances landowner buy-in)
- Compliments or links to CBP-HSPF Model

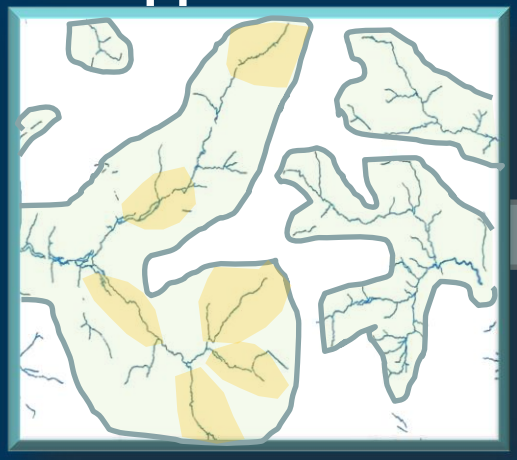
http://www.chesapeakebay.net/maps/map/delivered_yield_of_total_nitrogen_agricultural_sources

The Nature Conservancy
Protecting nature. Preserving life.™

BMP Implementation Challenge:
Where, What, How Much?

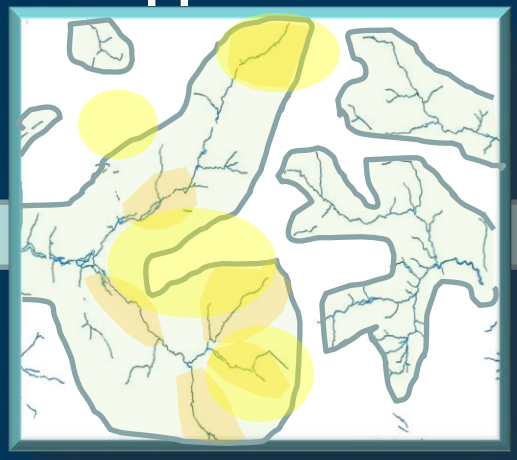
Conceptual Approach:

I. Identify Opportunities



Restorable Ecohydrological Active Areas

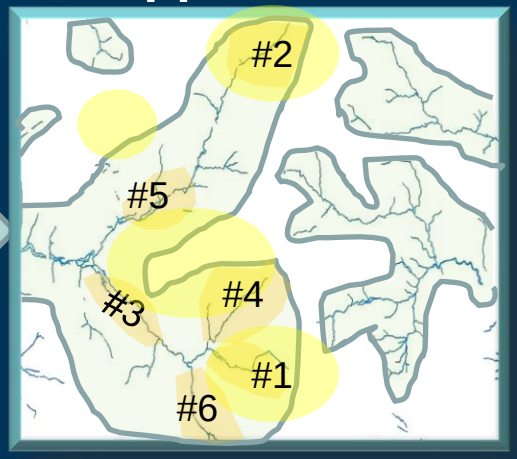
II. Compare Opportunities



Potential Priority Criteria:

- Nutrient Sources
- Sediment Sources
- Habitat Quality
- County Access
- Landowner Cooperation
- Soil Fertility
- Cost

III. Rank Opportunities



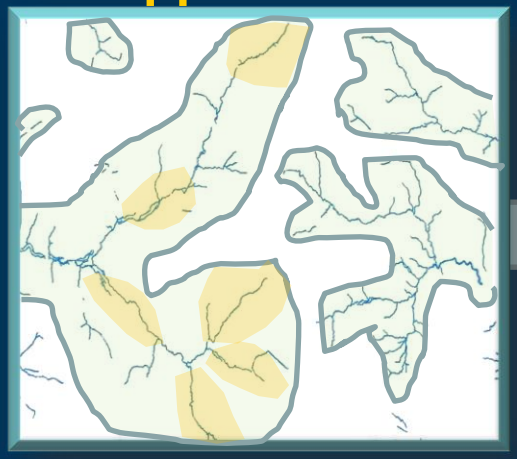
Results:
Ranked/Summed opportunities to maximize return on $$ invested to install bmp's and provide services.

The Nature Conservancy
Protecting nature. Preserving life.™

BMP Implementation Challenge:
Where, What, How Much?

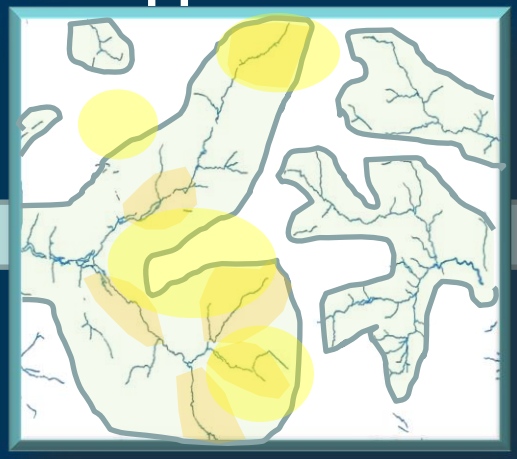
Conceptual Approach:

I. Identify Opportunities



Restorable Ecohydrological Active Areas

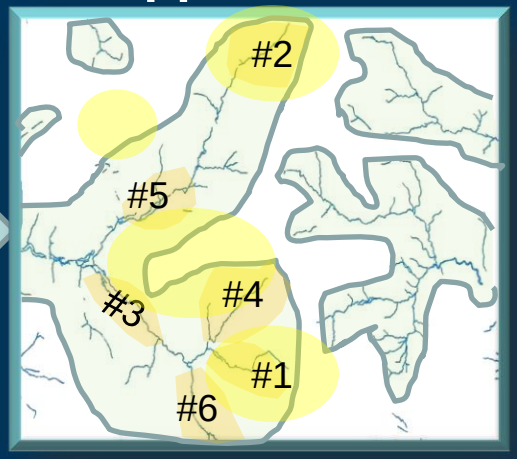
II. Compare Opportunities



Potential Priority Criteria:

- Nutrient Sources
- Sediment Sources
- Habitat Quality
- County Access
- Landowner Cooperation
- Soil Fertility
- Cost

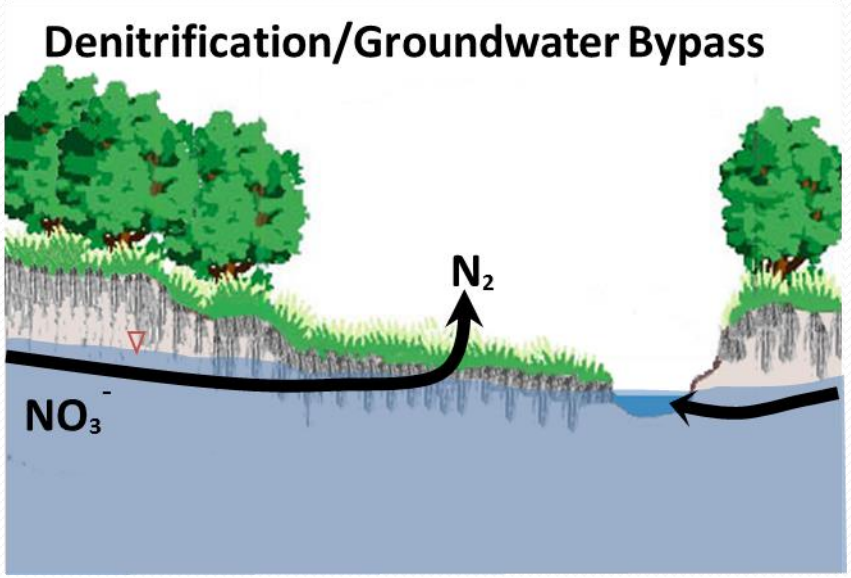
III. Rank Opportunities



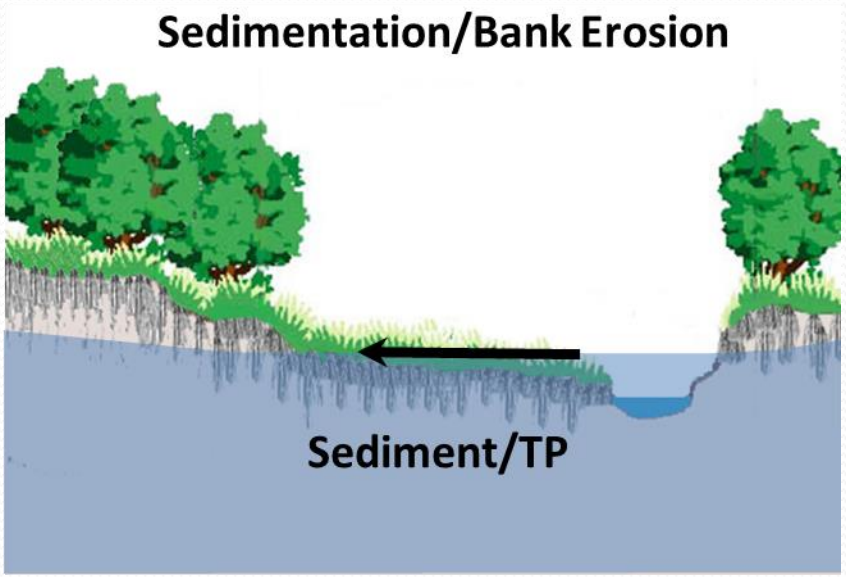
Results:
Ranked/Summed opportunities to maximize return on $$ invested to install bmp's and provide services.

Wetlands (and BMP alternatives):

Nutrient/Sediment Sink, Source, or Transformer?

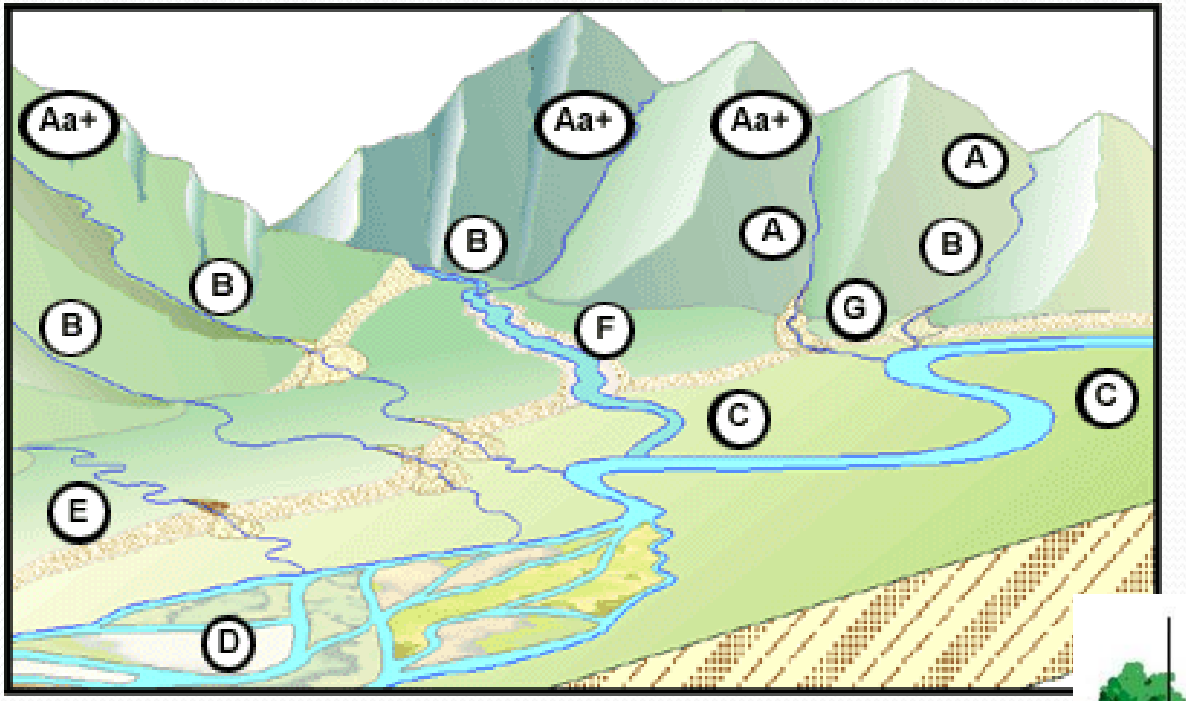


Nitrogen

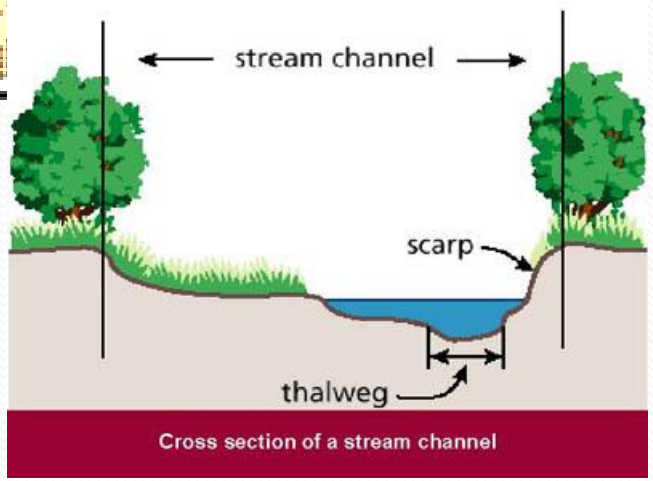


Sediment / Phosphorus

A fluvial geomorphologist's persective:

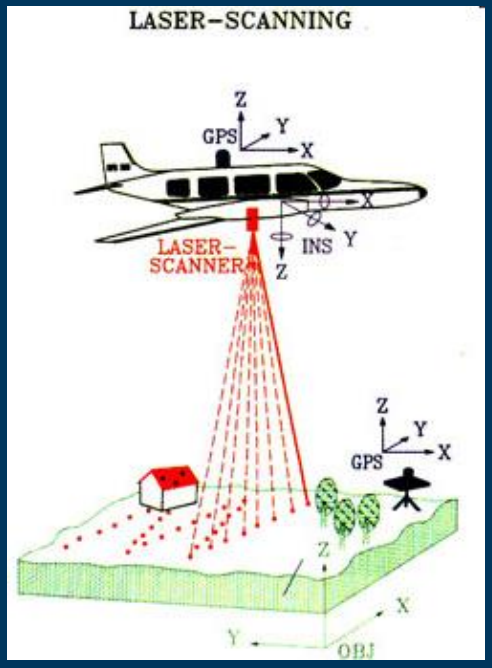


e.g., Rosgen's Stream Scheme (1996).

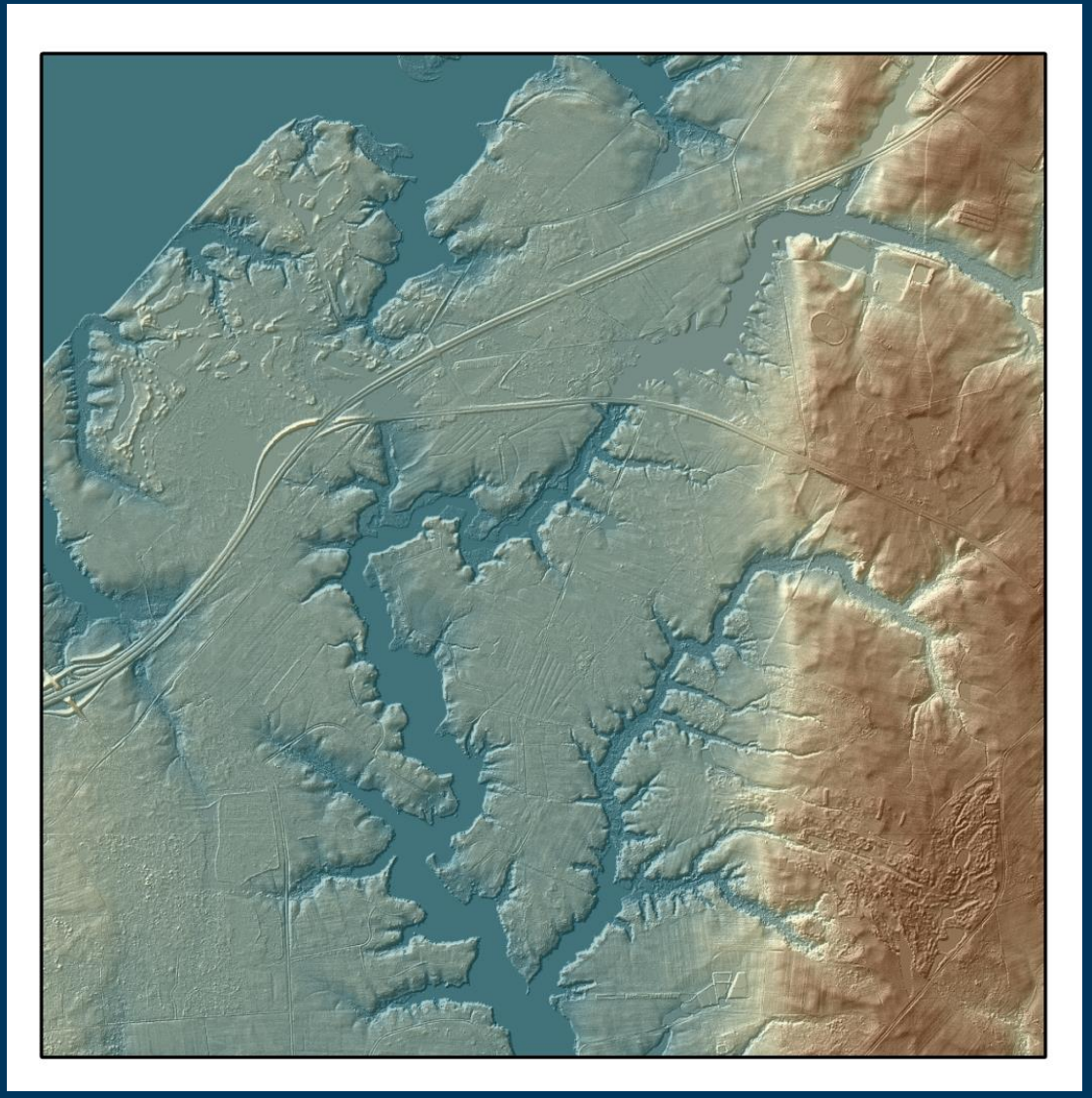


The Nature Conservancy
Protecting nature. Preserving life.™

High Resolution Topography Data Derived from Light Detection And Ranging (LIDAR) Remote Sensing Data



Flood and Gutelius 1997
J. of Photogrammetry &
Remote Sensing

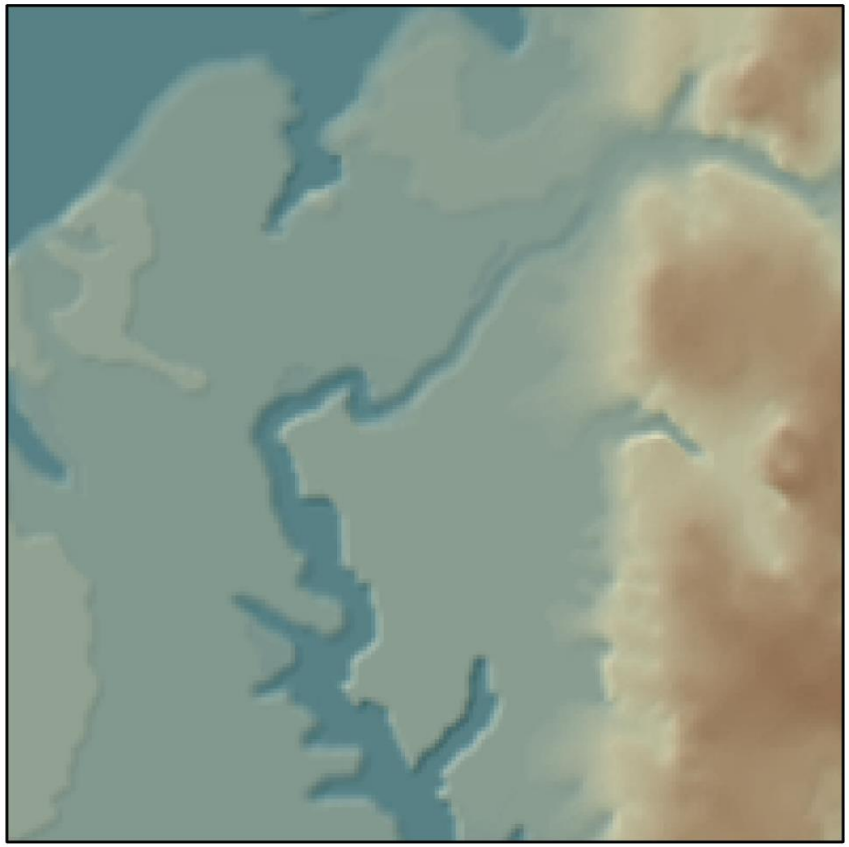


The Nature Conservancy
Protecting nature. Preserving life.™

High Resolution Topography Data Derived from Light Detection And Ranging (LIDAR) Remote Sensing Data

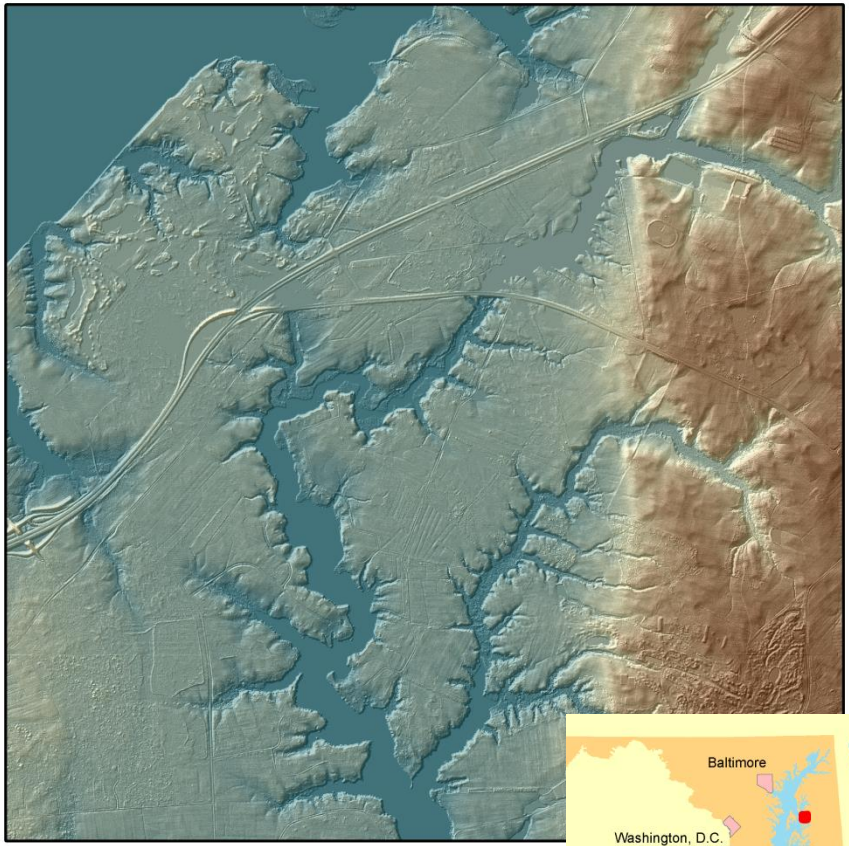
USGS 30 m DEM

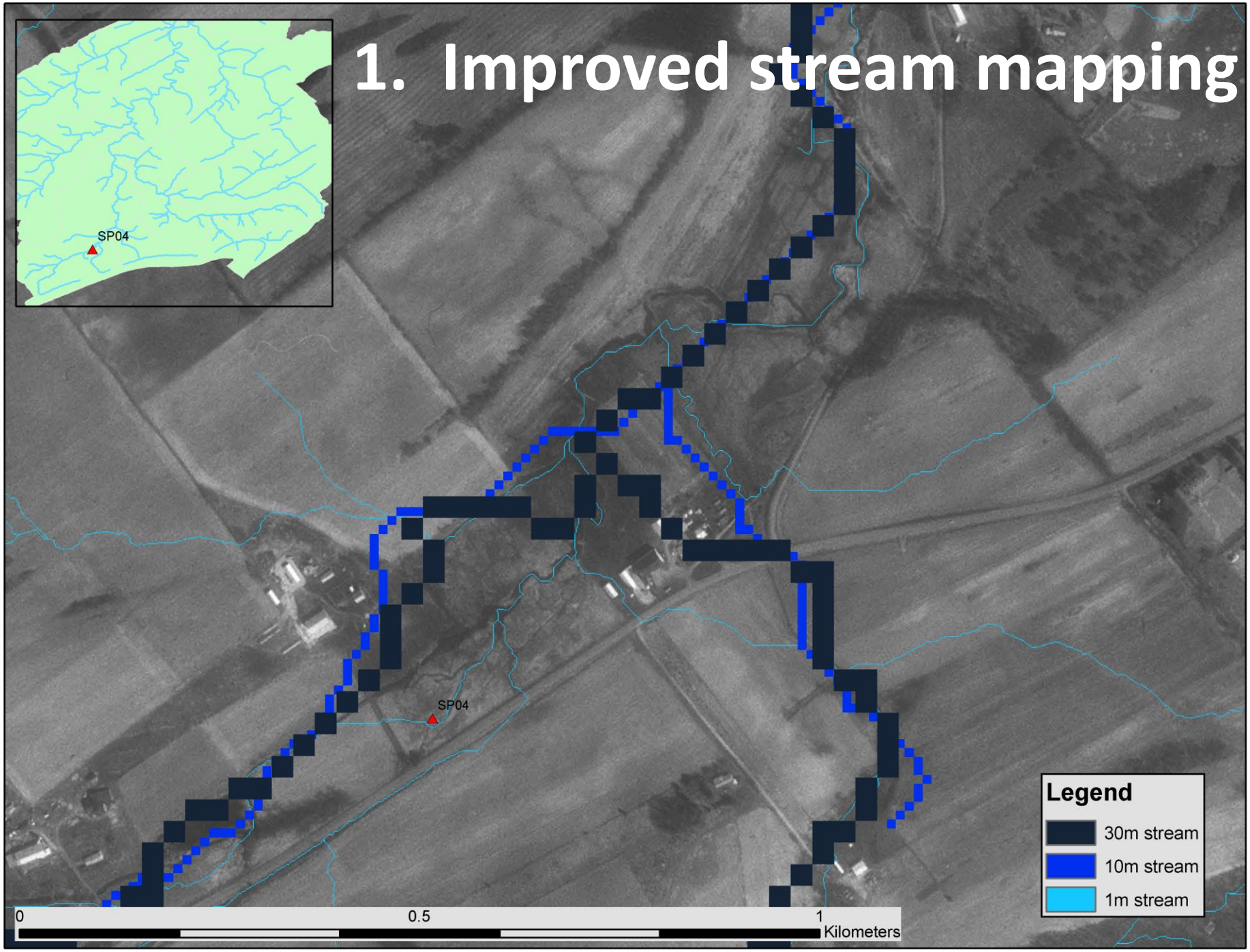
(7 to 10 m vertical accuracy)



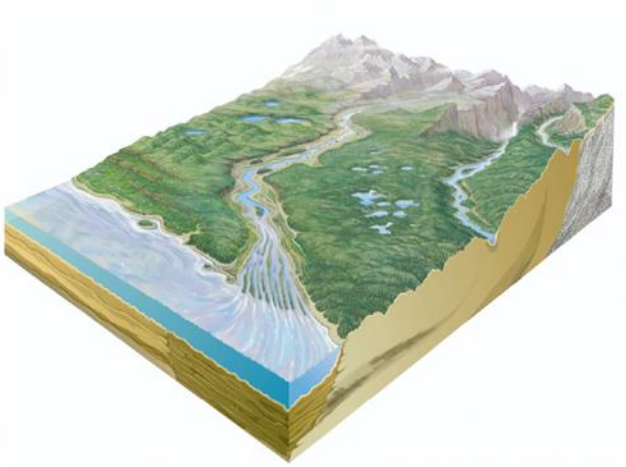
LiDAR 2m DEM

(15 cm vertical accuracy)

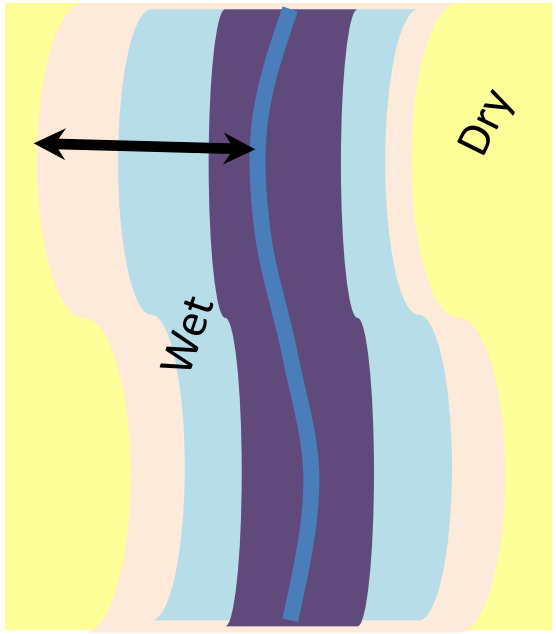



1. Improved stream mapping
SP04
SP04
Legend
30m stream
10m stream
1m stream
0
0.5
1
Kilometers

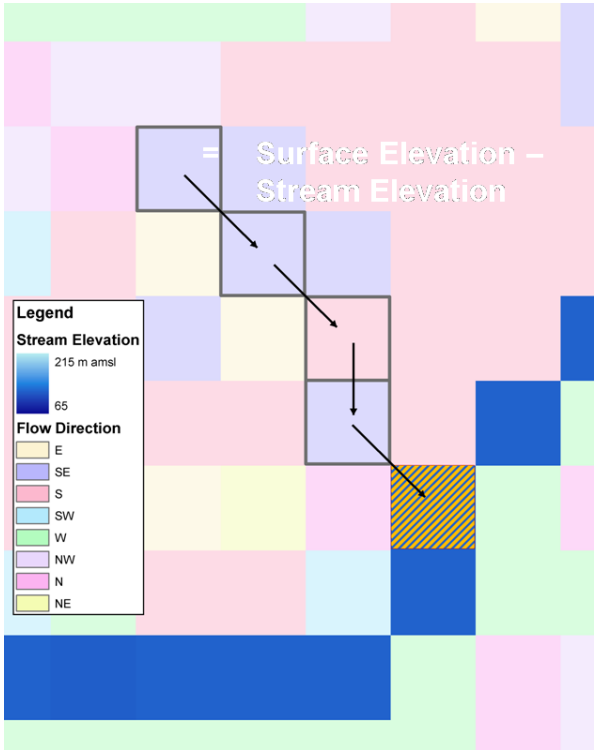
2. Mapping soil wetness



If surface waters considered watertable outcrops (e.g., Winter 1999)…

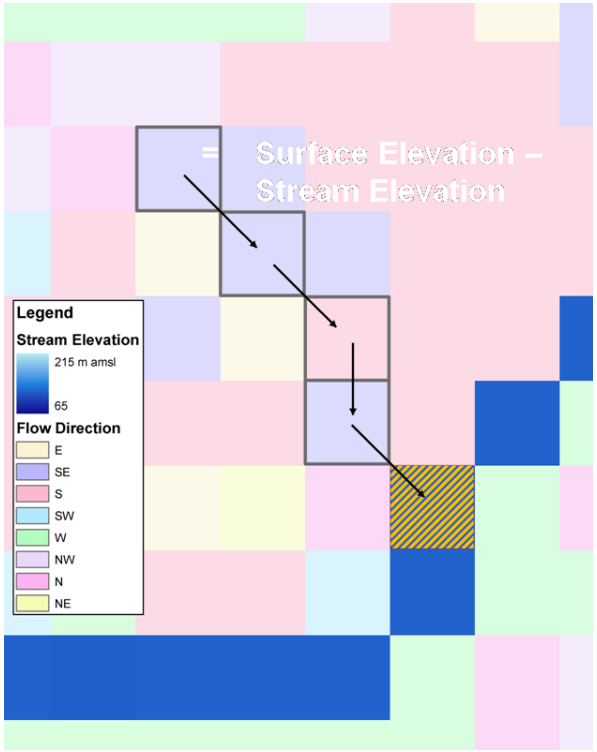


… then land areas within 1.5m elevation of surface water more likely wet.

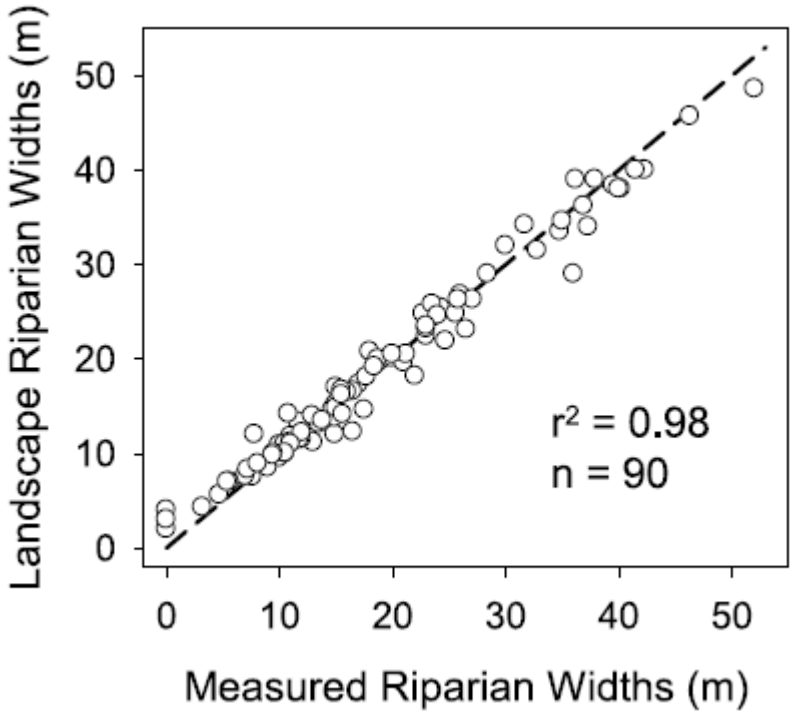


→ Map land surface relative to surface water

2. Mapping soil wetness



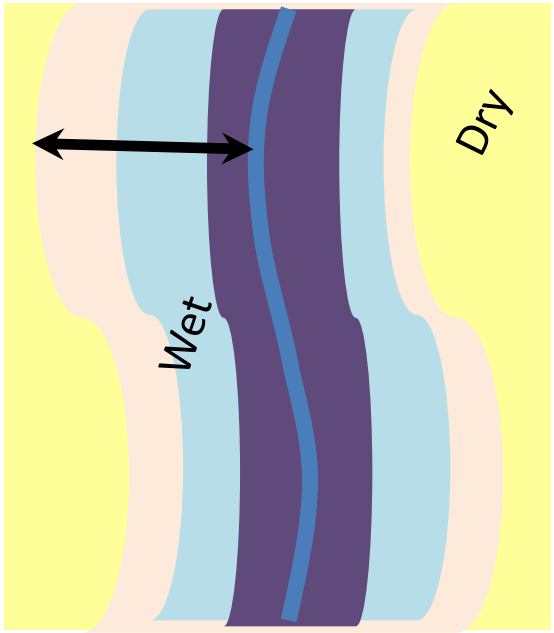
→ Land surface relative to surface water

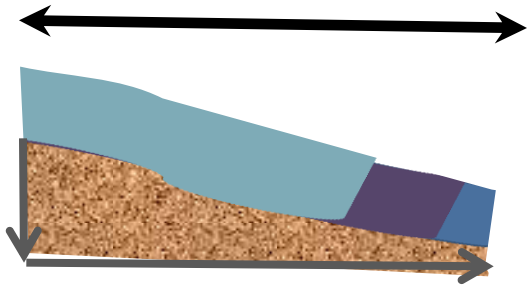


Jensco et al. 2009;
Also Murphy et al. 2007

3. Riparian/Floodplain Slope…because local topographic relief reflects hydrologic controls

(Vidon and Hill 2004)





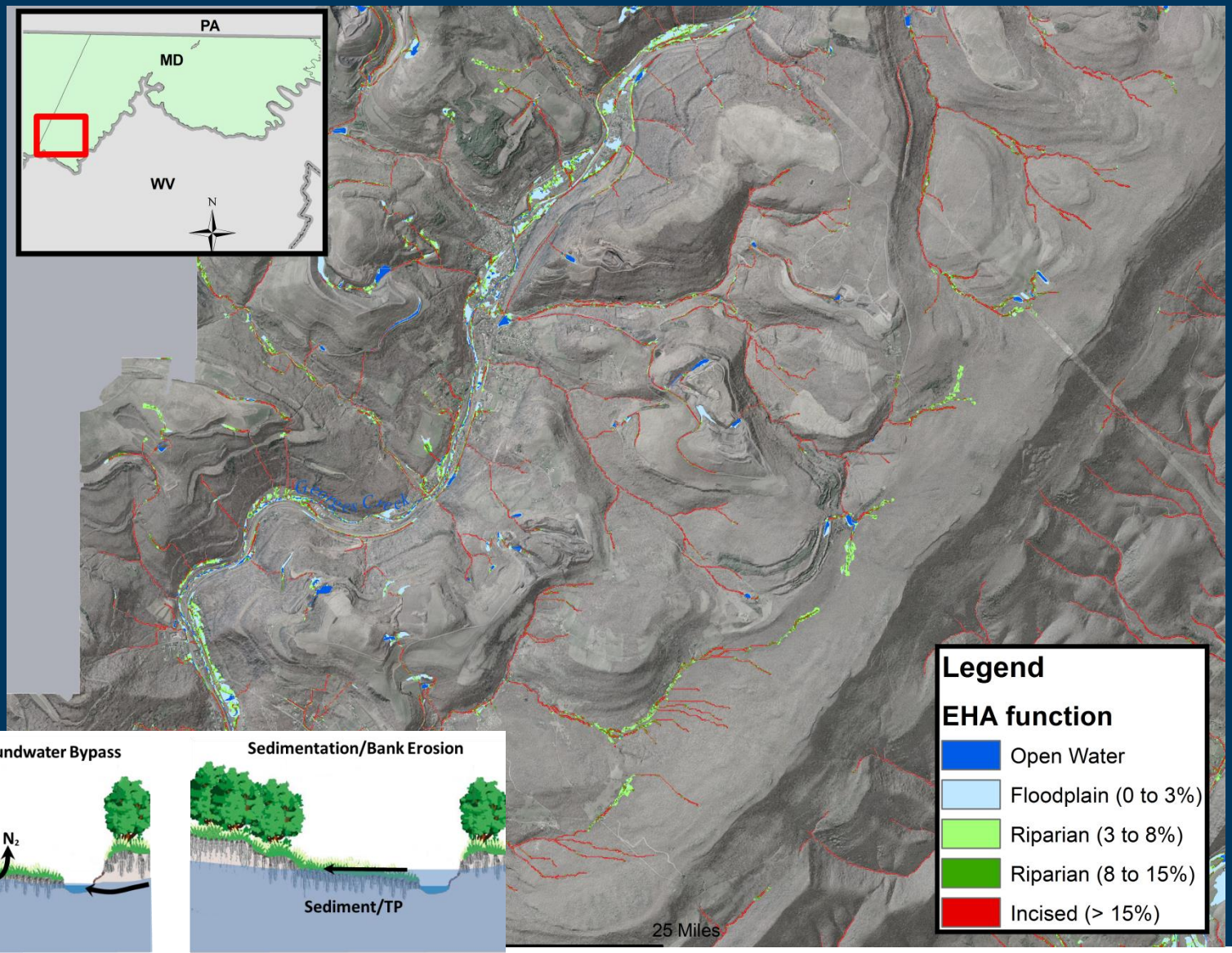
Slope = ΔElevation/ΔDistance

Legend

- **Open Water**
- **Floodplain Area (0 to 3° slope)**
- **Riparian Area (3 to 15° slope)**
- **Incised Area (> 15° slope)**

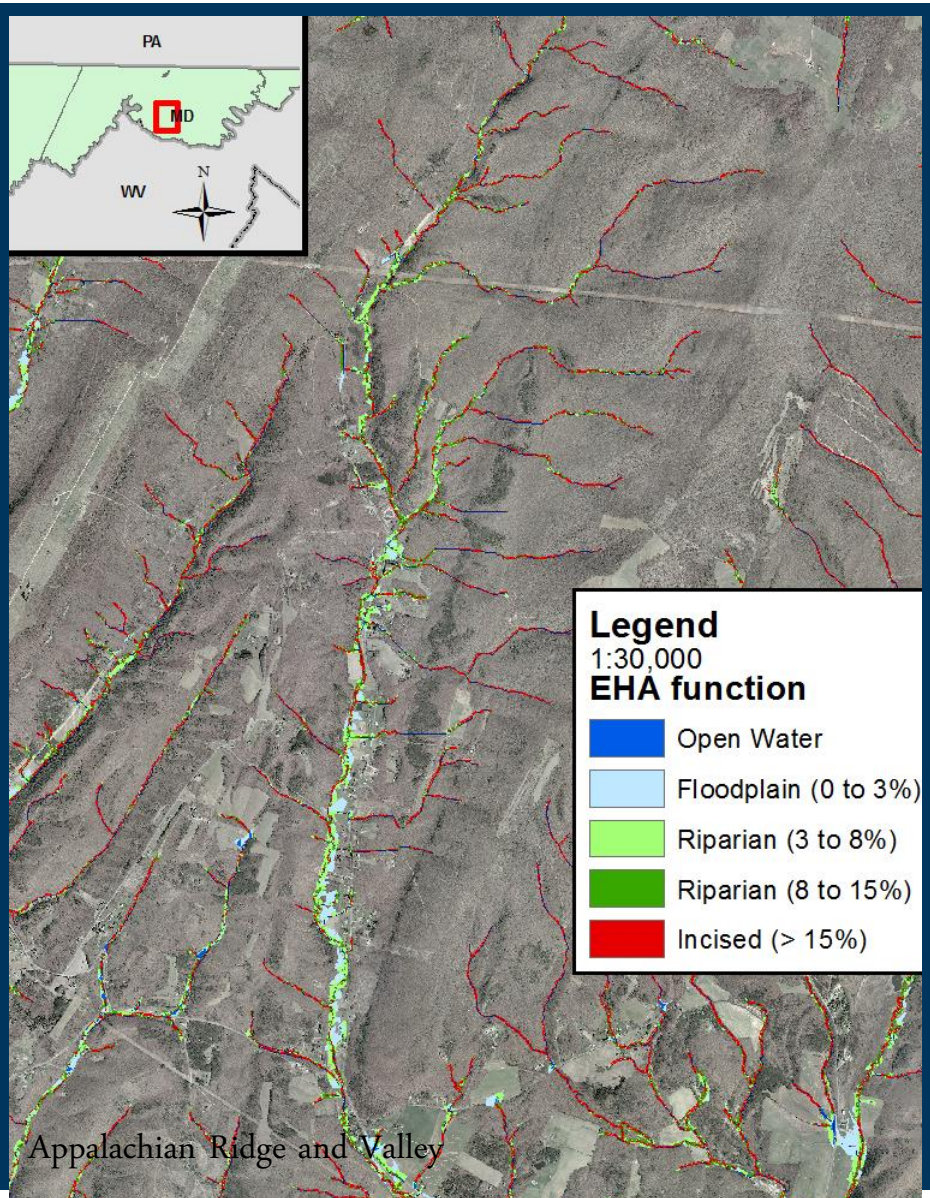
The Nature Conservancy
Protecting nature. Preserving life.™

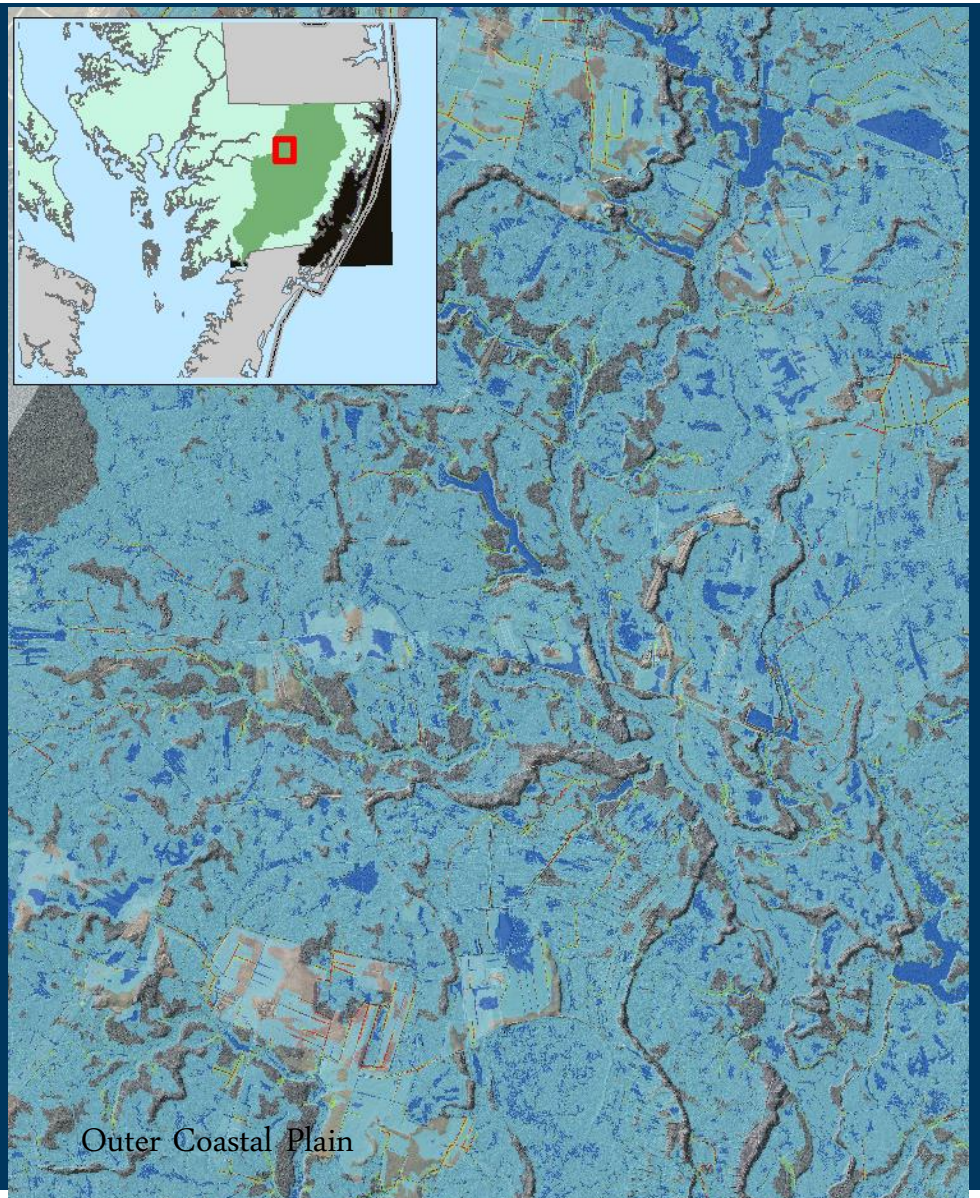
3. Predicted wetland hydrologic function



The Nature Conservancy
Protecting nature. Preserving life.™

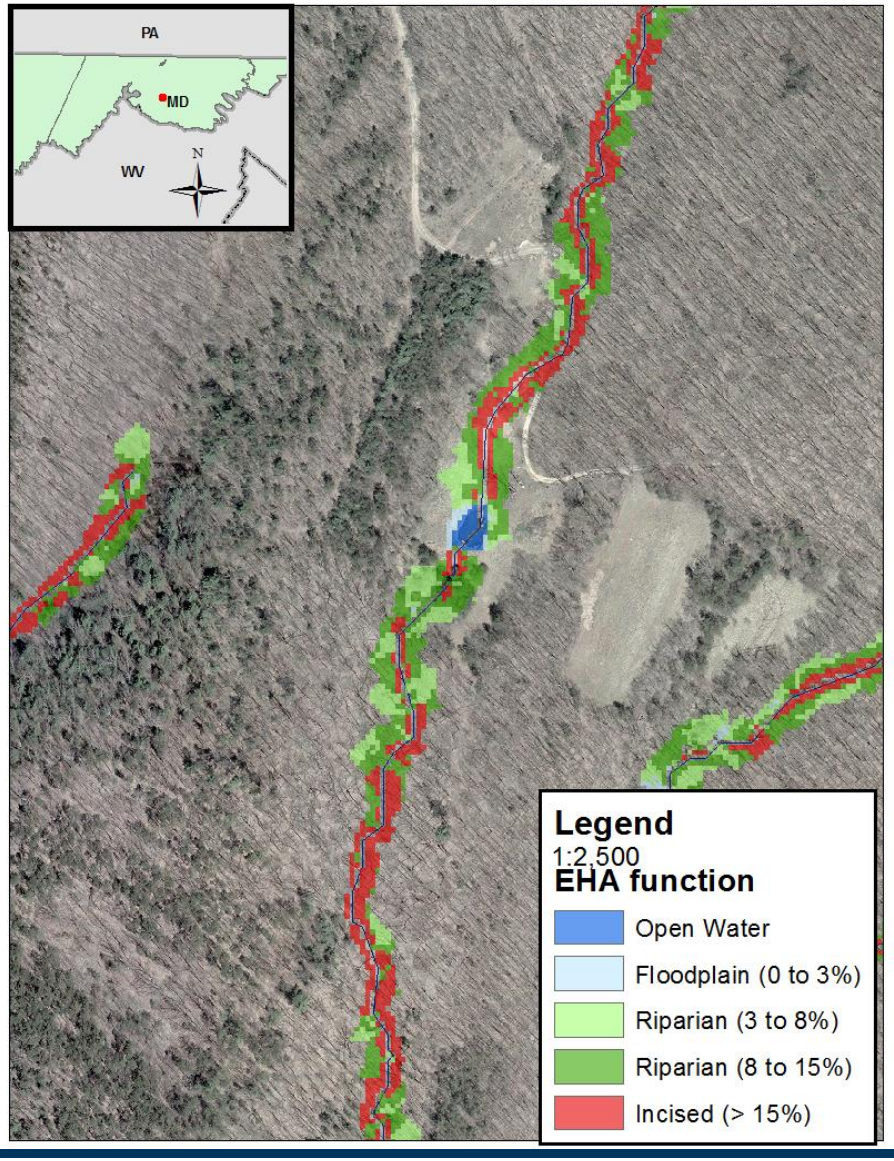
Variation in stream corridor function depends on physiographic province

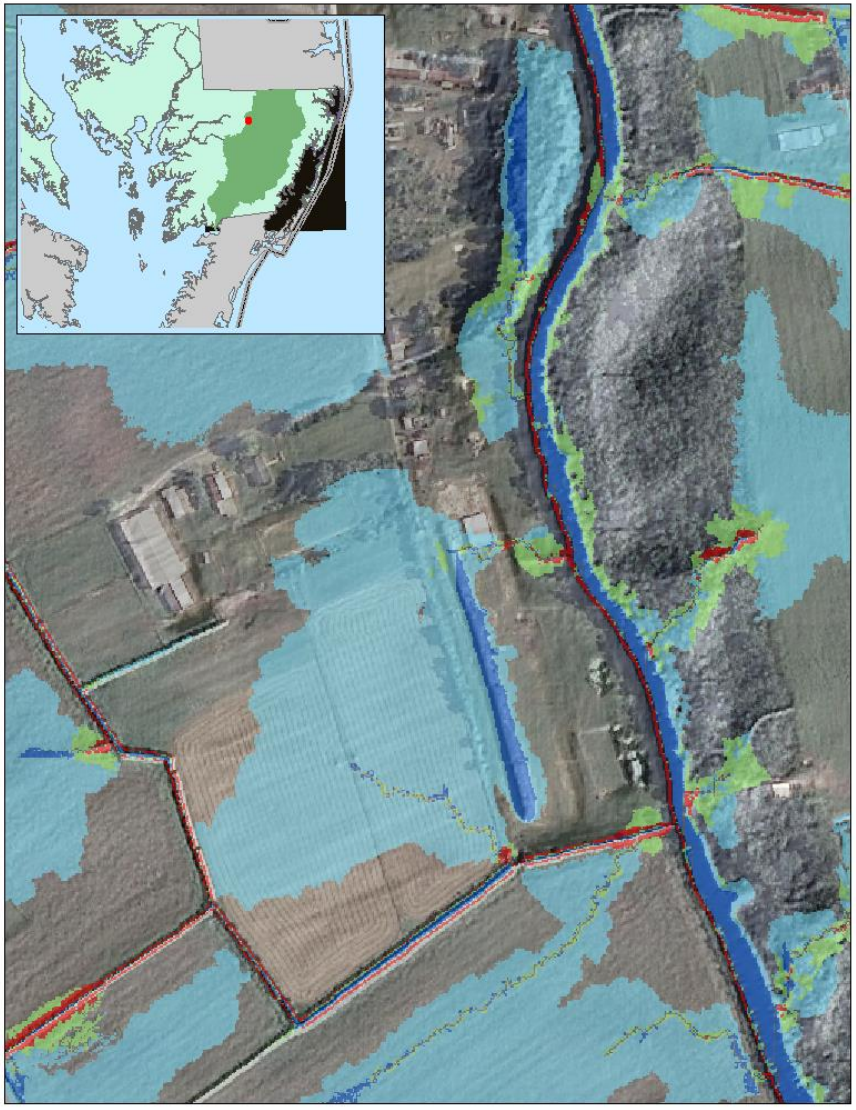




The Nature Conservancy
Protecting nature. Preserving life.™

Variation in hydrologic alterations depends on physiographic province.



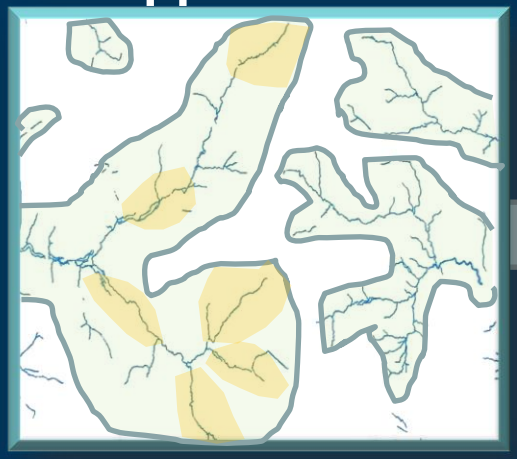


The Nature Conservancy
Protecting nature. Preserving life.™

BMP Implementation Challenge:
Where, What, How Much?

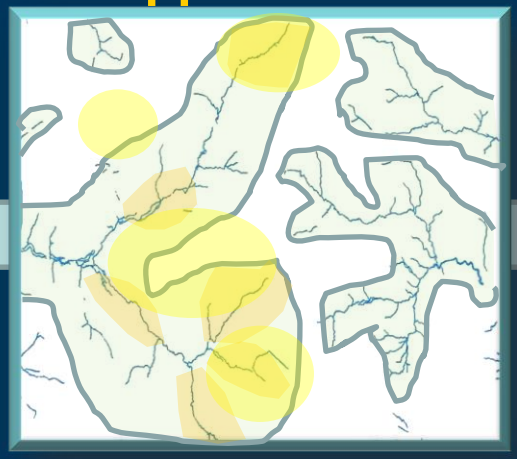
Conceptual Approach:

I. Identify Opportunities



Restorable Ecohydrological Active Areas

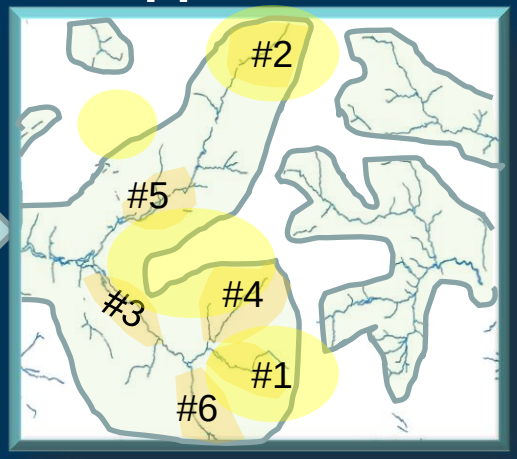
II. Compare Opportunities



Potential Priority Criteria:

- Nutrient Sources
- Sediment Sources
- Habitat Quality
- Access
- Landowner Cooperation
- Soil Fertility
- Cost

III. Rank Opportunities

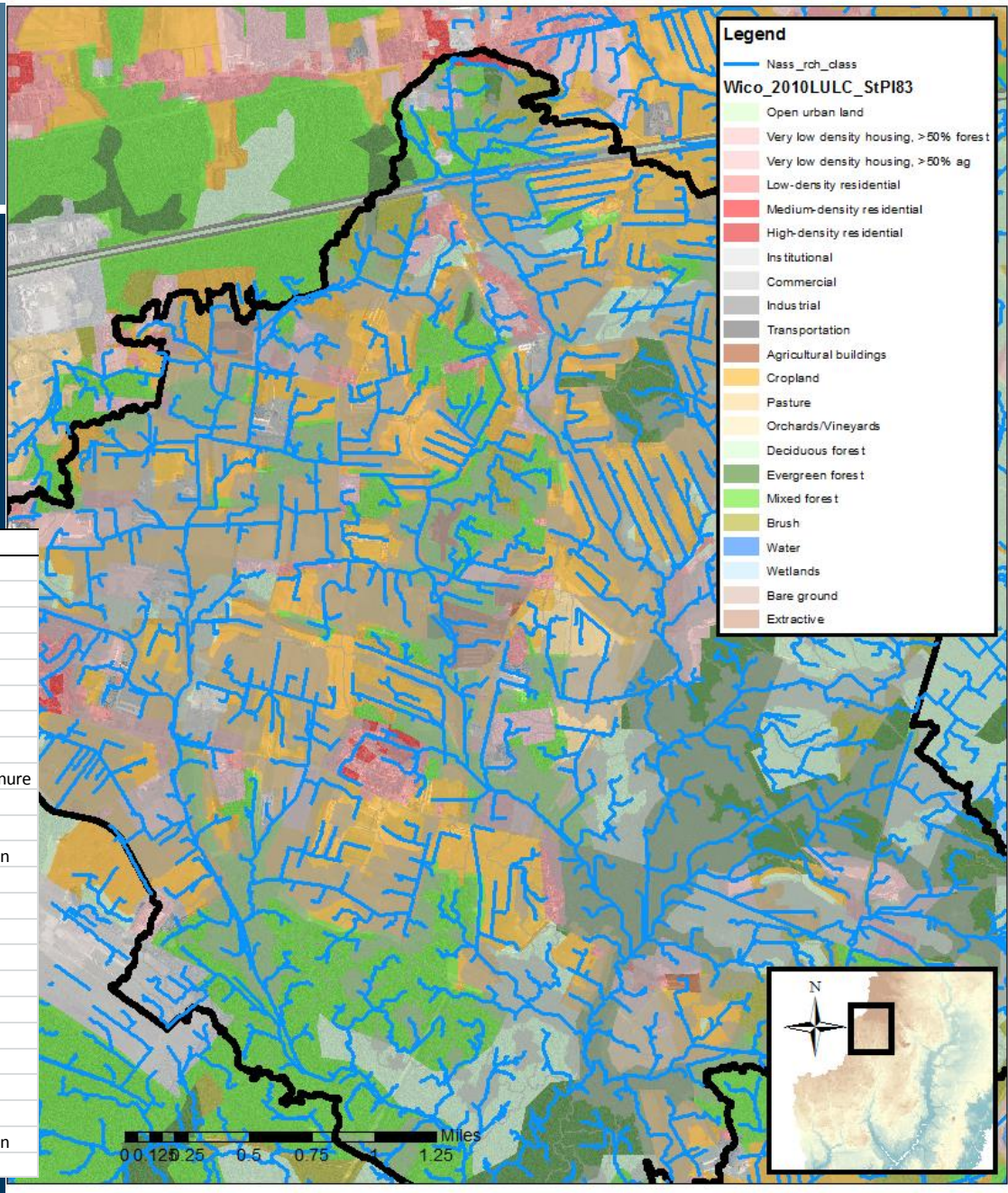


Results:
Ranked/Summed opportunities to maximize return on $$ invested to install bmp's and provide services.

The Nature Conservancy
Protecting nature. Preserving life.™

BMP Targeting:
Impact Assessment (Source Strength)

MDP LULC	MDP LULC Description	CBP_LULC
11	Low-density residential	Urban Reg - impervious developed
12	Medium-density residential	Urban Reg - impervious developed
13	High-density residential	Urban Reg - impervious developed
14	Commercial	Urban Reg - impervious developed
15	Industrial	Urban Reg - impervious developed
16	Institutional	Urban Reg - impervious developed
17	Urban extractive	Urban NonReg - extractive
18	Open urban land	Urban Reg - pervious developed
21	Cropland	Agriculture - nutrient management hightill with manure
22	Pasture	Agriculture - pasture
23	Nurseries	Agriculture - nursery
25	Feeding operations	Agriculture - concentrated animal feeding operation
41	Decidous forest	Forest - harvested forest
42	Evergreen forest	Forest - harvested forest
43	Mixed forest	Forest - harvested forest
44	Brush	Forest - harvested forest
50	Water	Non-tidal atmospheric
60	Wetlands	Forest - harvested forest
73	Bare ground	Urban Reg - construction
80	Transportation	Urban Reg - impervious developed
191	Low-density residential x ag	Urban NonReg - impervious developed
192	Low-density residential x for	Urban NonReg - impervious developed
241	Feeding operations	Agriculture - concentrated animal feeding operation
242	Ag buildings	Urban Reg - impervious developed

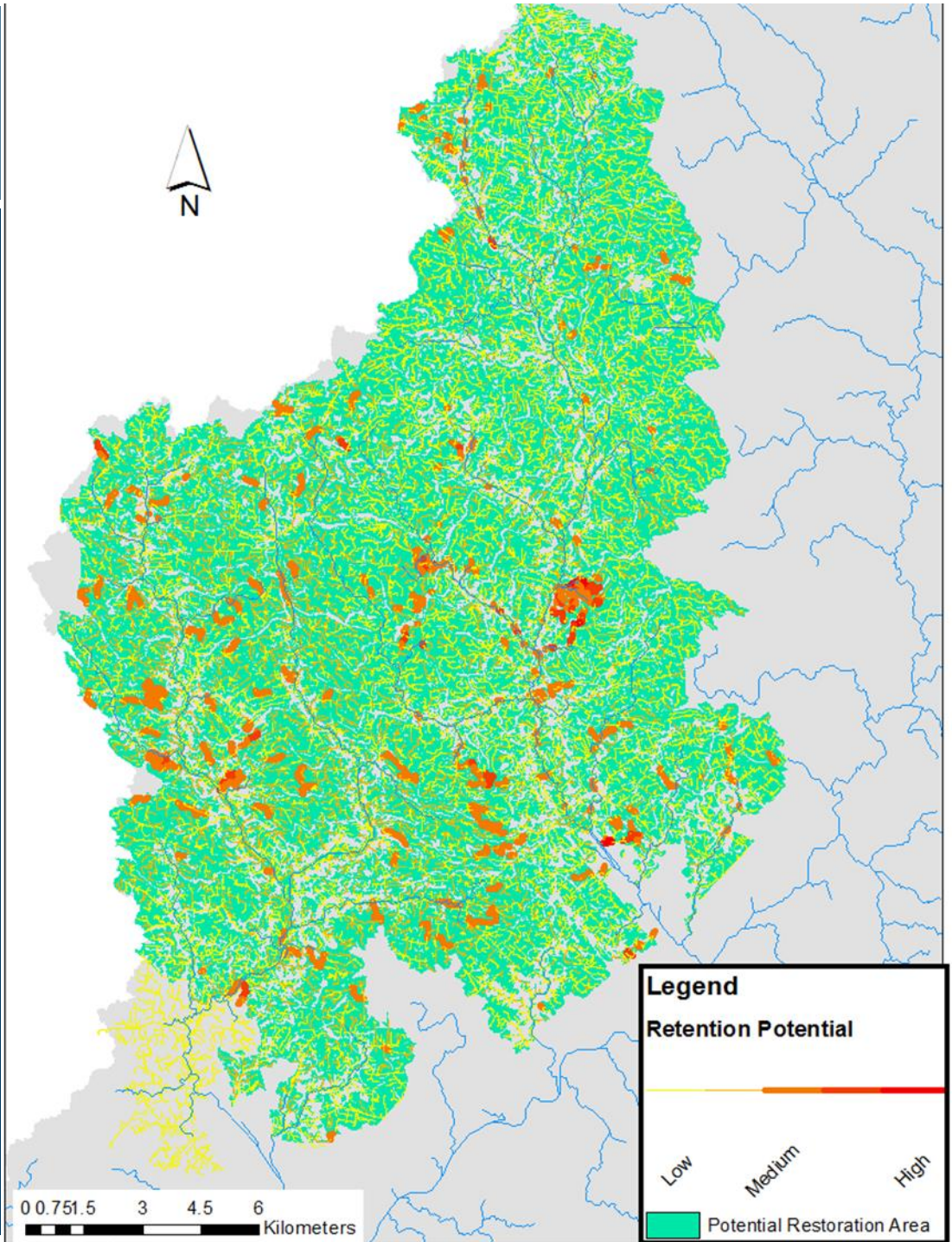


Nassawango River Watershed BMP Prioritization:
Potential Nutrient and Sediment Sources

The Nature Conservancy
Protecting nature. Preserving life.™

BMP Targeting: Load Assessment

∑(MDP LULC acres
* EOS loading rate)



The Nature Conservancy
Protecting nature. Preserving life.™

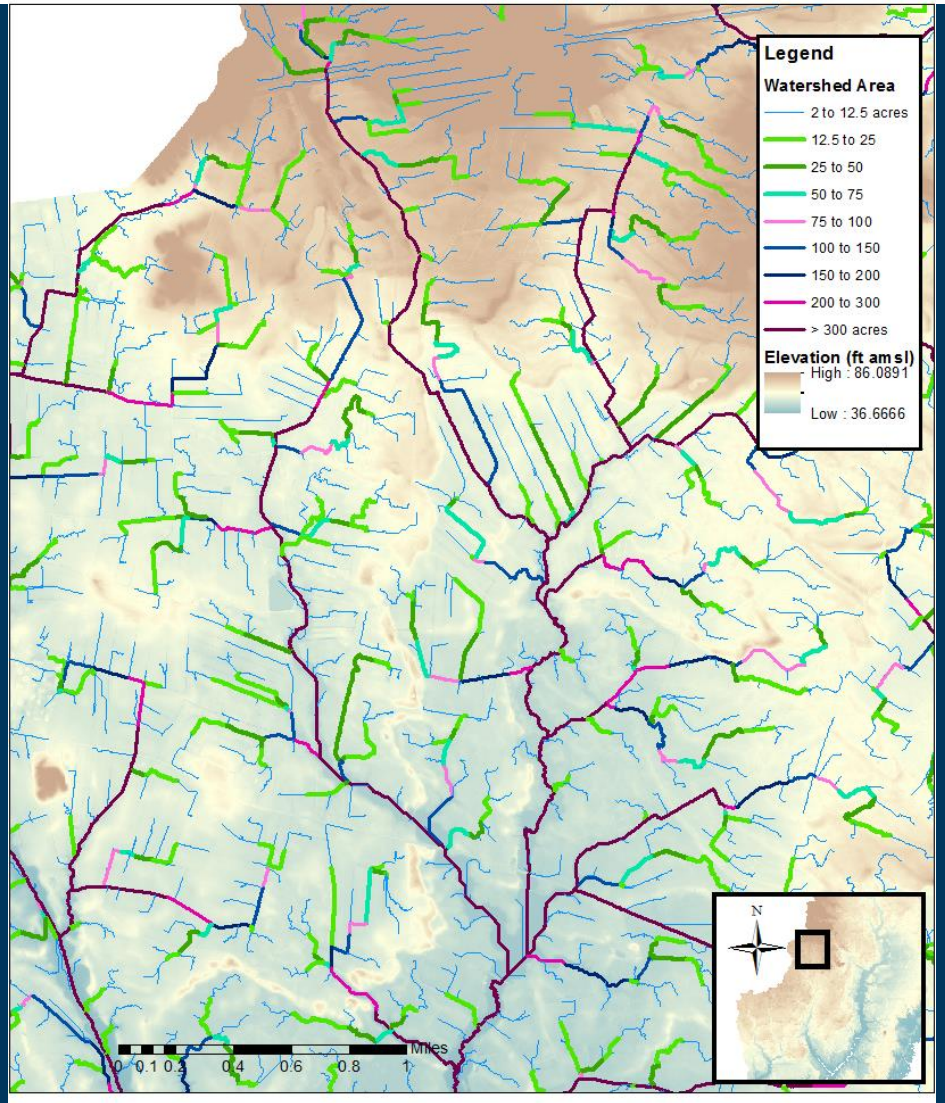
BMP Targeting and Restoration

BMP Targeting:
Size / Design

< 75 acres: headwater restoration

Riparian restoration

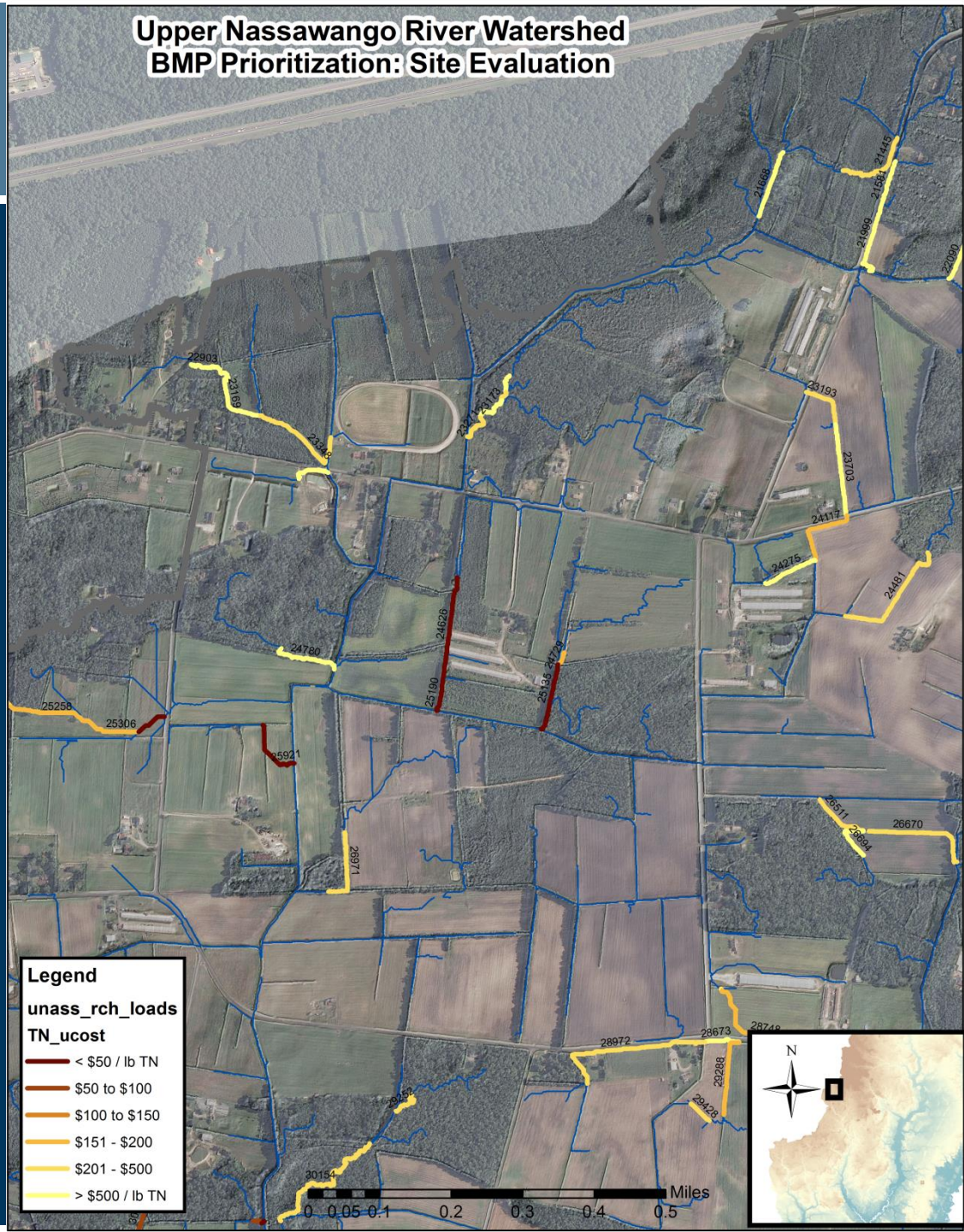
> 300 acres: floodplain reconnection



Stream Reach Classfication for BMP Prioritization:
Watershed Contributing Area

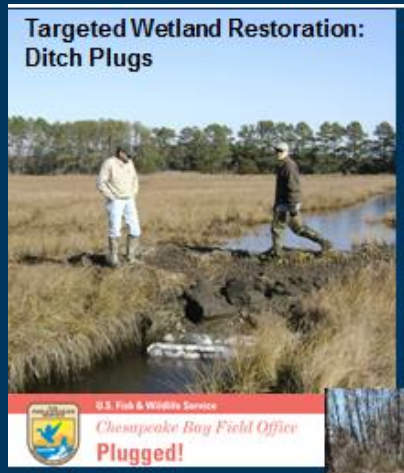
The Nature Conservancy
Protecting nature. Preserving life.™

Prioritizing Wetland Restoration Projects in the Pocomoke River Watershed



The Nature Conservancy
Protecting nature. Preserving life.™

BMP Targeting and Prioritization



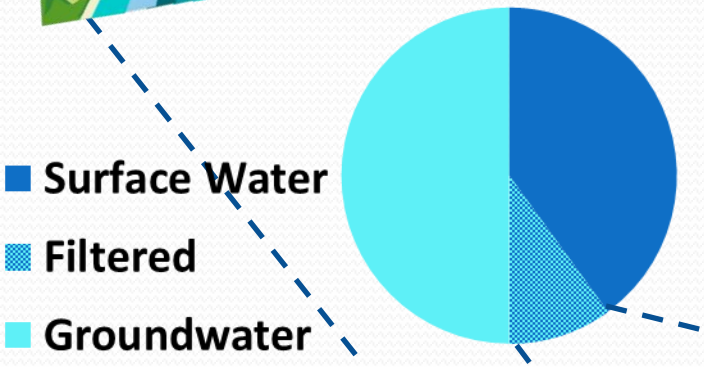
Reach	Subbasin	Reach Length (ft)	Watershed Area (acres)	Retention Area (acres)	Restoration Type	Number of Owners	EOS TN (lbs/yr)	TN captured (lbs/yr)	EOS TP (lbs/yr)	TP captured (lbs/yr)	EOS TSS (lbs/yr)	TSS captured (lbs/yr)	Cost	C
6297	Nass	266	749.64	19.36	buffer	1	212,264	39,177	32,779	11,318	144,877	3,449	$104,544	
6588	Nass	1043	28.88	5.58	plug	1	78,430	61,379	12,501	11,975	6,187	717	$3,232	
6592	Nass	1260	292.3	6.31	buffer	1	193,895	30,415	30,546	9,111	47,800	662	$34,074	
7232	Nass	492	85.19	2.82	buffer	1	140,458	32,306	22,332	9,352	15,881	285	$15,228	
10123	Nass	1053	79.63	7.53	buffer	1	53,676	28,240	8,463	6,667	7,860	952	$40,662	
6621	Nass	541	16.91	2.69	plug	1	45,920	32,842	7,319	6,779	3,622	346	$2,076	
6685	Nass	669	213.19	3.91	buffer	1	187,775	25,308	29,688	7,706	27,376	398	$21,114	
6796	Nass	164	10.99	10.91	plug	2	29,836	29,825	4,756	4,756	2,354	1,402	$5,364	
6853	Nass	371	64.17	10.99	plug	1	35,353	26,218	5,550	5,216	10,176	1,180	$5,396	
7521	Nass	285	211.73	57.31	buffer	3	2,573	2,270	79	78	49,722	6,616	$309,474	

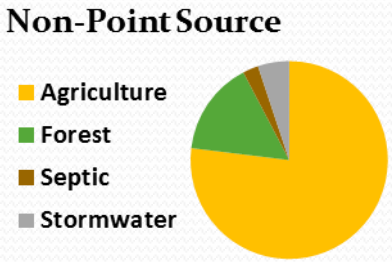
Critical Knowledge Gaps & Research Needs:

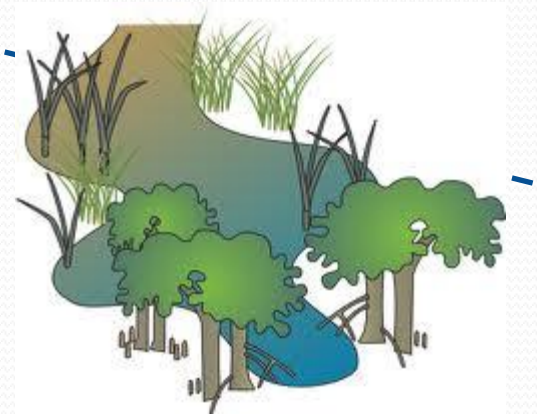
Model Performance Evaluation

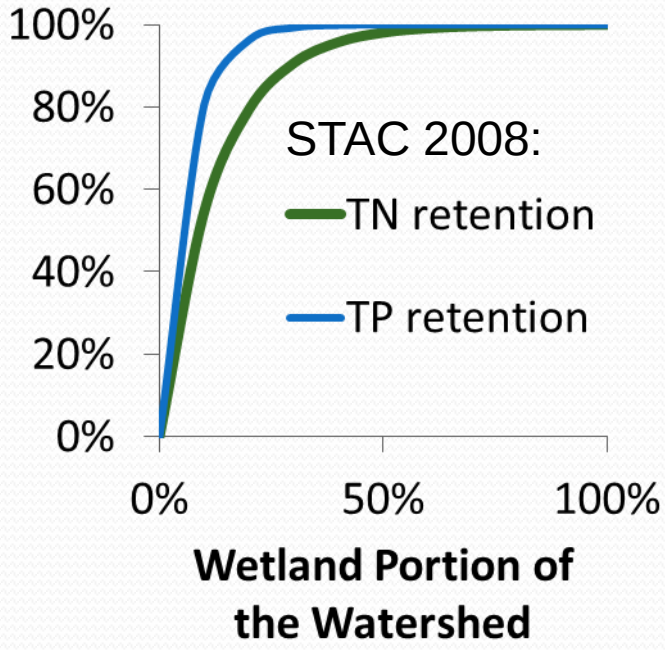
CBP-HSPF Watershed Model

Predicted Stream Water Budget







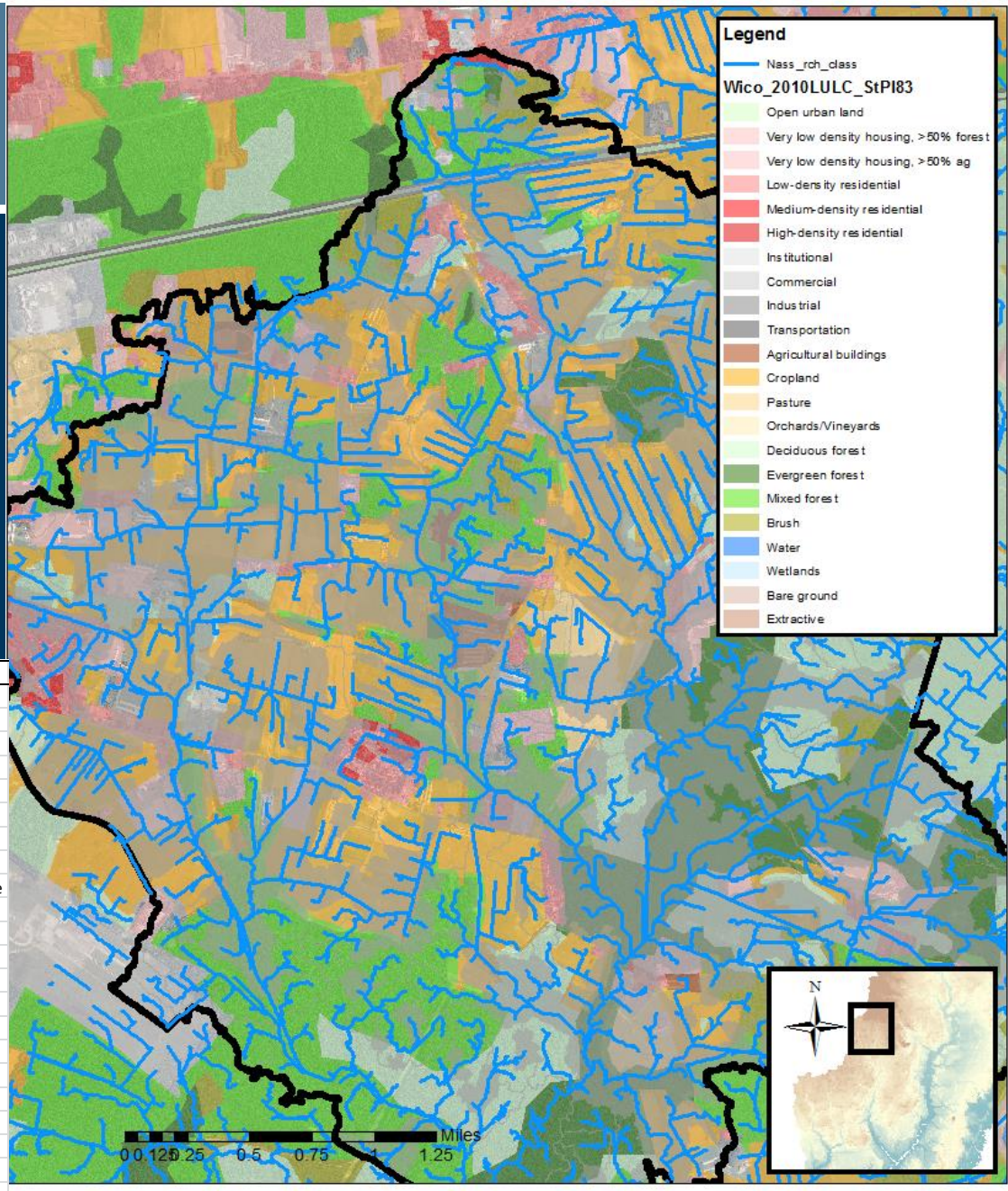


The Nature Conservancy
Protecting nature. Preserving life.™

Critical Knowledge Gaps & Research Needs:

Improve Nutrient & Sediment Source Assessments

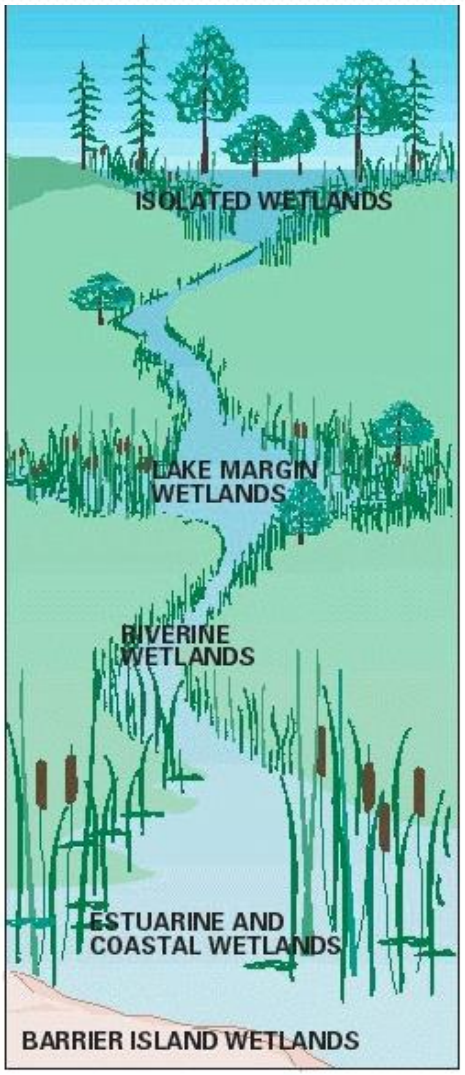
MDP LULC	MDP LULC Description	CBP_LULC
11	Low-density residential	Urban Reg - impervious developed
12	Medium-density residential	Urban Reg - impervious developed
13	High-density residential	Urban Reg - impervious developed
14	Commercial	Urban Reg - impervious developed
15	Industrial	Urban Reg - impervious developed
16	Institutional	Urban Reg - impervious developed
17	Urban extractive	Urban NonReg - extractive
18	Open urban land	Urban Reg - pervious developed
21	Cropland	Agriculture - nutrient management hightill with manure
22	Pasture	Agriculture - pasture
23	Nurseries	Agriculture - nursery
25	Feeding operations	Agriculture - concentrated animal feeding operation
41	Decidous forest	Forest - harvested forest
42	Evergreen forest	Forest - harvested forest
43	Mixed forest	Forest - harvested forest
44	Brush	Forest - harvested forest
50	Water	Non-tidal atmospheric
60	Wetlands	Forest - harvested forest
73	Bare ground	Urban Reg - construction
80	Transportation	Urban Reg - impervious developed
191	Low-density residential x ag	Urban NonReg - impervious developed
192	Low-density residential x for	Urban NonReg - impervious developed
241	Feeding operations	Agriculture - concentrated animal feeding operation
242	Ag buildings	Urban Reg - impervious developed



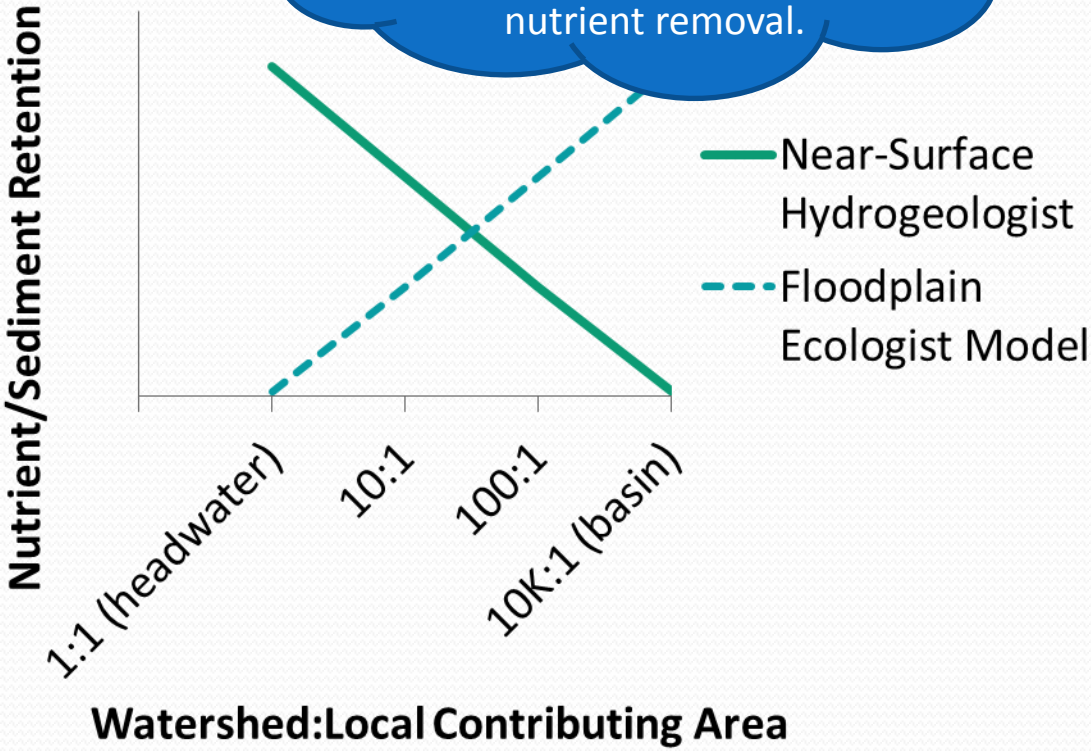
Nassawango River Watershed BMP Prioritization:
Potential Nutrient and Sediment Sources

Critical Knowledge Gaps & Research Needs:

Determine Linkages between Wetland Function & Landscape Position



STAC 2008: Removal efficiencies decrease with increased variability of water flow, but floodplains offer best opportunities for nutrient removal.



Environmental Law Institute 1983; Brinson 1993

The Nature Conservancy
Protecting nature. Preserving life.™

Critical Knowledge Gaps & Research Needs:

Linkages between Wetland Function & Landscape Position

Interactions with Climate & Physiography

Dryer Climates, Steeper, Less Permeable Soils, Landscapes:

Wetter Climates, More Permeable Soils, Flatter Landscapes:

Designing Sustainable Coastal Habitats

Scientific and Technical Advisory Committee

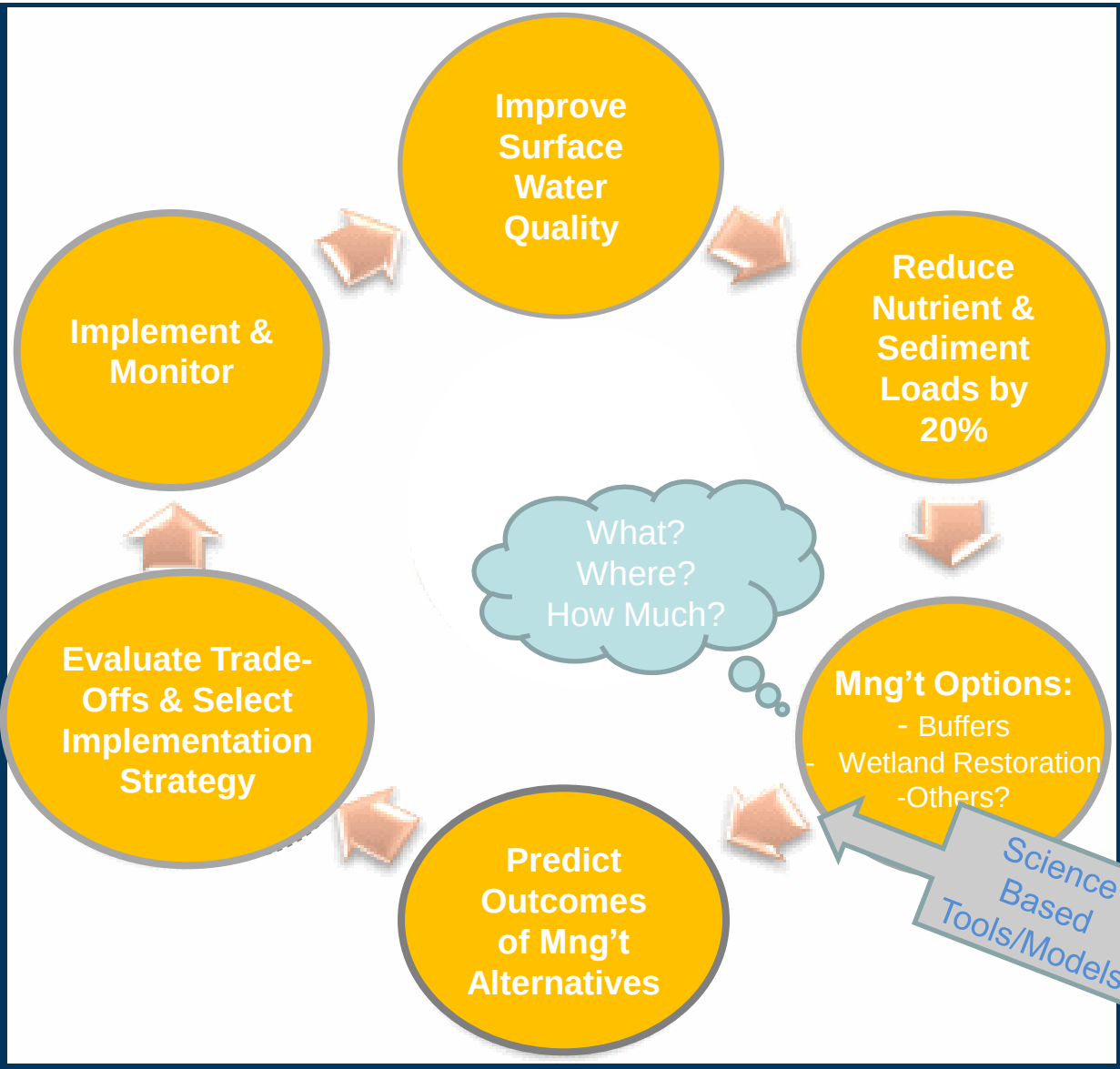
Workshop Goal: *Design Sustainable Approaches and Initiatives for Coastal Wetland Habitat Restoration and Protection within the Chesapeake Bay Watershed*

The Nature Conservancy
Protecting nature. Preserving life.™

Recommendation: Use Structured Decision-Making to Identify Key Decision Tools and to Guide Monitoring/Research Programs

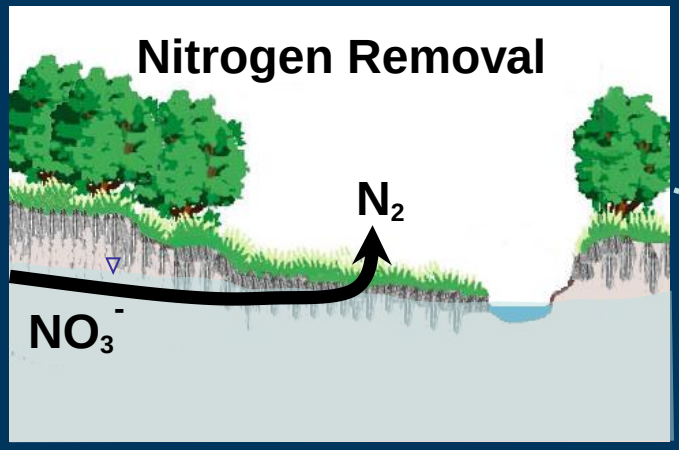
BMP Decision Framework:

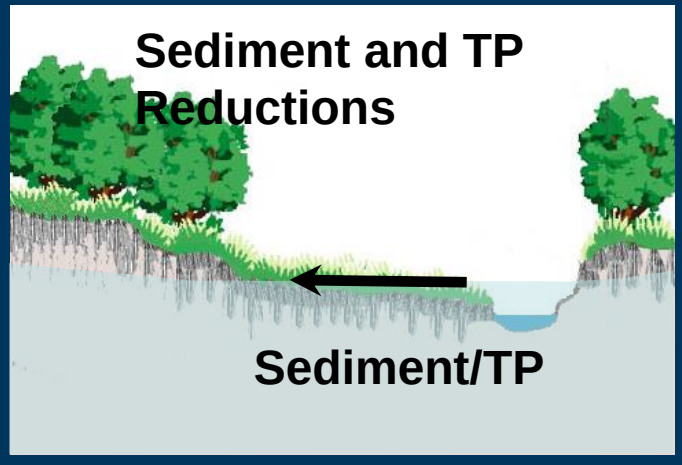
	TN removed	TP removed	TSS removed	Cost
Stream Restoration				
Wetland Restoration				
50/50 Combination				
Buffers				

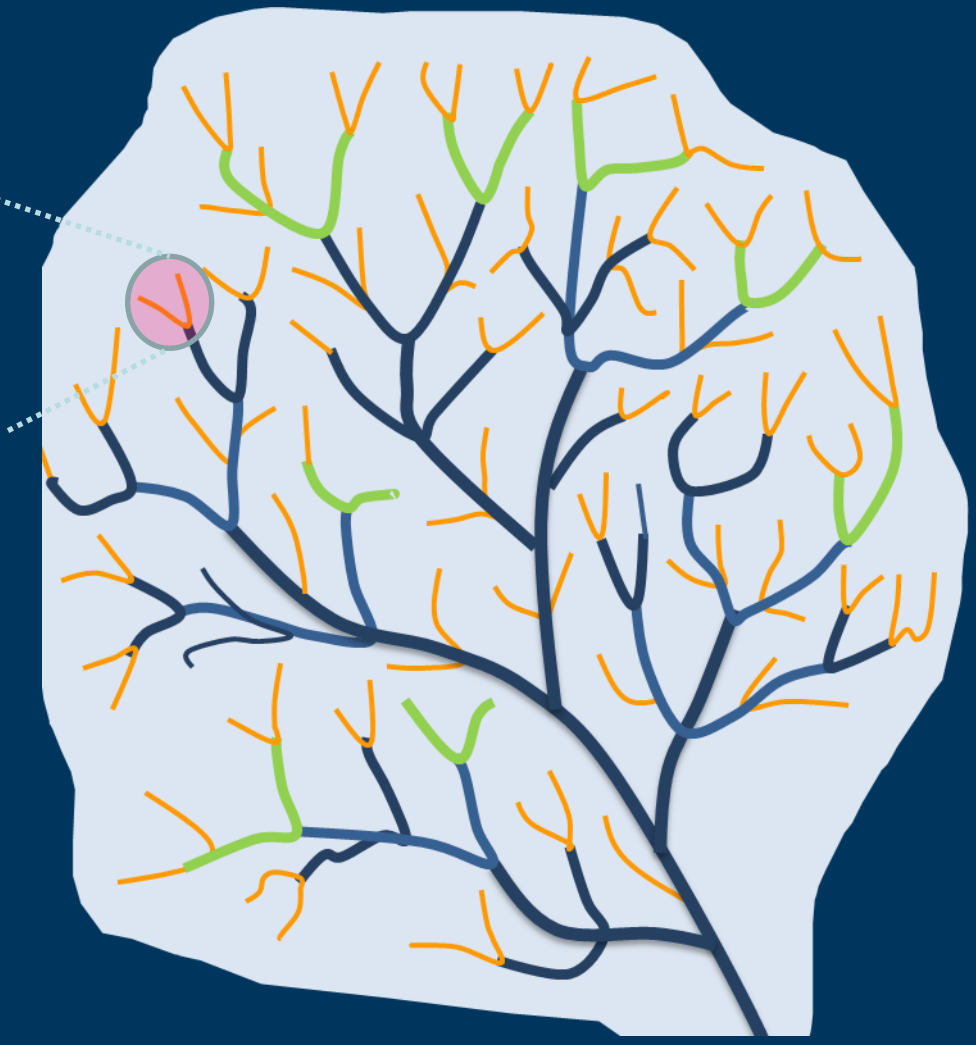


The Nature Conservancy
Protecting nature. Preserving life.™

Recommendation: Link Spatial Scales by Regional Modeling of Local Processes

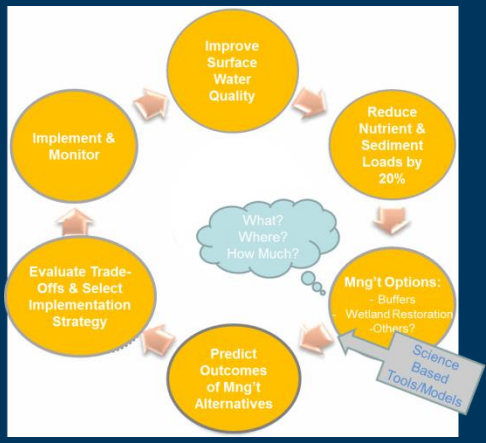






The Nature Conservancy
Protecting nature. Preserving life.™

Recommendation: Shift STAC Research Priorities



- ✖ Before-After Control Impact studies
- ✖ Paired watershed studies
- ✖ Empirical watershed studies
- **Integrated Field Studies**
  - Provides opportunity to test model predictions
  - No more complicated than other study designs
  - Facilitates collaborations
  - Local Scale: Opportunity to generate local ‘credibility’
- **Monitoring = Research Opportunity**

The Nature Conservancy
Protecting nature. Preserving life.™

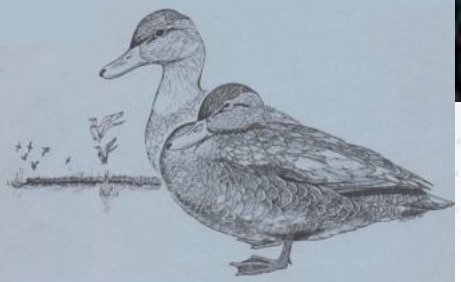
Recommendation: Evaluate Trends in Habitat Suitability Related to Hydrogeologic Setting

A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area

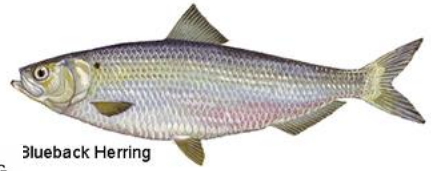
June 2000

FWS/OBS-82/10.66
SEPTEMBER 1984

HABITAT SUITABILITY INDEX MODELS: AMERICAN BLACK DUCK (WINTERING)



Fish and Wildlife Service
U.S. Department of the Interior



ALEWIFE AND BLUEBACK HERRING
Alosa pseudoharengus and *Alosa aestivalis*

Ronald J. Klauda[1], Steven A. Fischer
Lenwood W. Hall, Jr. and John A. Sullivan
University of Maryland
Agricultural Experiment Station
Wye Research and Education Center
Queenstown, Maryland

The Nature Conservancy
Protecting nature. Preserving life.™

Summary of Recommendations

- Promote Adaptive Watershed Management
- Prioritize research & monitoring to support AWM
  - Evaluate model predictions and embedded scientific hypotheses (e.g., source assessment, wetland function as a function of landscape position)
  - Evaluate effects of climate change & human impacts on regional water table dynamics.
- Integrate water quality and habitat goals
  - Environmental Flow Requirements

The Nature Conservancy
Protecting nature. Preserving life.™

Chesapeake Bay Whole System Conservation