Modeling Sediment and Nutrient Loads Input to Chesapeake Bay and Effects of Agricultural Conservation Practices on Water Quality

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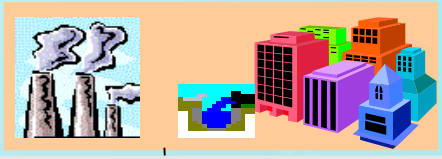
CEAP/SWAT/APEX National Modeling System

Watershed Configuration Details (Subbasins/Rivers/Routing/Reservoirs)

Weather (Precipitation, Temperature and others)

Dry and Wet Atmospheric Nitrogen Deposition



SWAT Watershed Model (Calibrated)

APEX Farm Scale Model (Calibrated)

Point Sources: Flow, TSS and nutrient loadings from Municipal and Industrial Plants

Uncultivated Land: Flow, sediment, nutrient and pesticide loadings from HRUs

Cultivated Cropland &CRP: Edge of field flow, sediment, nutrient & pesticide loadings from subareas with practices

Effects on Edge of Field Water Quality

INTEGRATE APEX OUTPUT

Instream Processes: Routing through reach, ponds, reservoirs to 8-digit watershed outlet & through main river reaches to basin outlet

SCENARIOS

1. Current Conservation Baseline: SWAT simulation using APEX output with current conservation practices
2. No Practice: SWAT simulation using APEX output without conservation practices
3. Additional Treatment Need: SWAT simulation using APEX output with ENMC and ENMA
4. Background: SWAT simulation with APEX output with background grass-tree mix condition

Conservation Scenarios

1. Current Conservation Baseline: APEX inputs with current conservation practices from CEAP survey
2. No Practice: APEX inputs without conservation practices
3. Additional Treatment Need: APEX inputs with different combinations of practices & practice acres (ENMC and ENMA)
4. Background: APEX inputs with grass-tree mix condition on cropland

RESULTS

Effects on Local/Instream Waters

1. Reductions in sediment, nutrients and pesticide yields and loads at 8-digit watersheds due to current conservation practices and additional treatment practices on cropland
2. Reductions in instream loads at river points due to current conservation and additional treatment scenarios

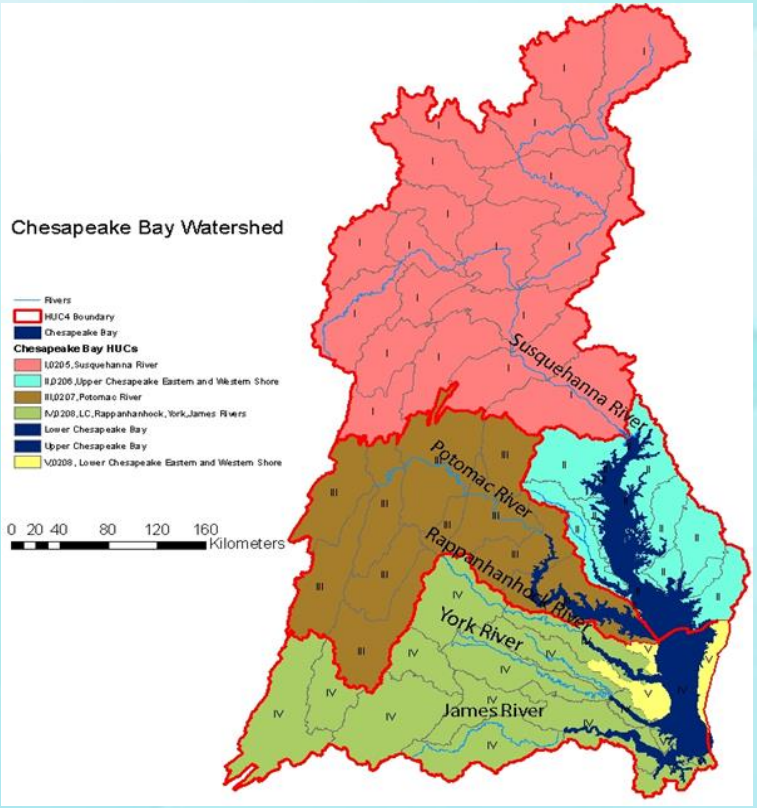
NRI/Survey/Conservation Practice Details

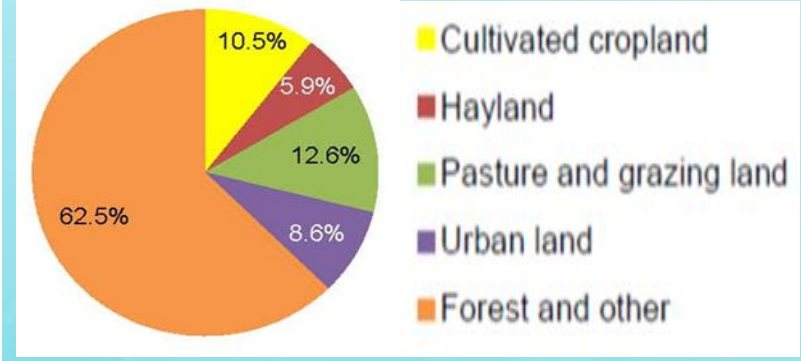
- Structural Practices
- Cultural Management Practices
- Practice Acres
- Farming Activities/Survey Database
- NRI

Presentation Overview

- Chesapeake Bay – Calibration and Validation
- Determine the Sediment and Nutrient Loads input to the Chesapeake Bay
- Determine the Major Sources of Sediment and Nutrients in the Chesapeake Bay Watershed
- Determine the Off-site Benefits of Agricultural Conservation Practice Scenarios on Water Quality in the Chesapeake Bay Watershed

Chesapeake Bay





Largest estuary system in the US.

Population: 17 Million

Drainage Area: 177,346.5 km^2

Cropland and CRP : 10%

U.S. Crop Sale and Corn: 2%

Agriculture Production,

Metropolitan Cities, Industries,

Tourism, Fisheries

Source of sediment and nutrients to the Bay

Eutrophication–Low DO-Fish Kill

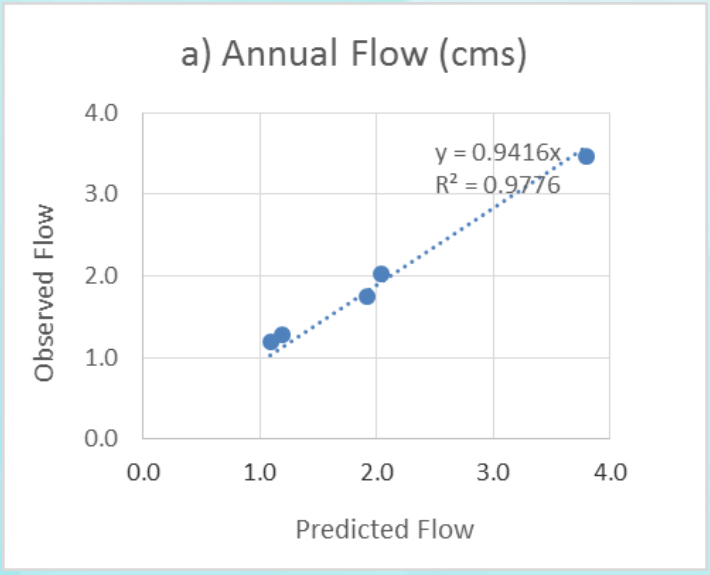
Specific Objectives

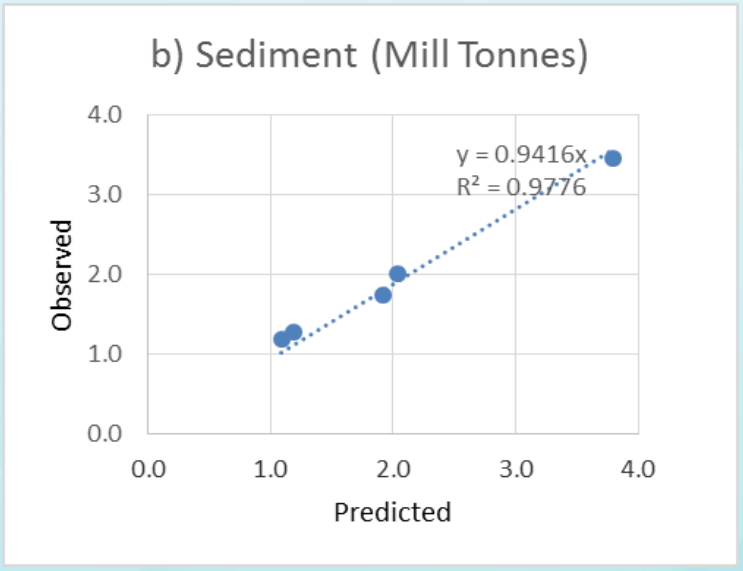
1) Estimate the sediment and nutrient loads discharged to the Chesapeake Bay,
2) Determine the major sources of sediment and nutrients delivered to local waters in the Chesapeake Bay, and
3) Evaluate the effects of the current agricultural conservation and future conservation needs on water quality in the Chesapeake Bay.

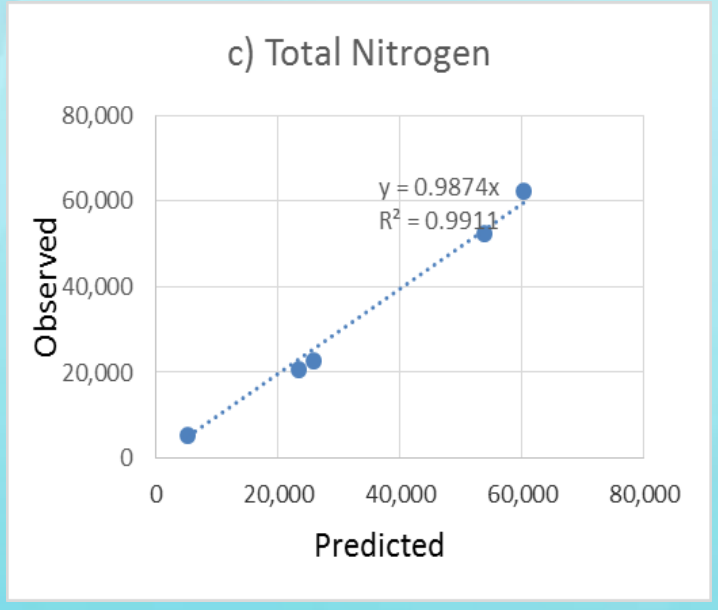
Calibration Gages

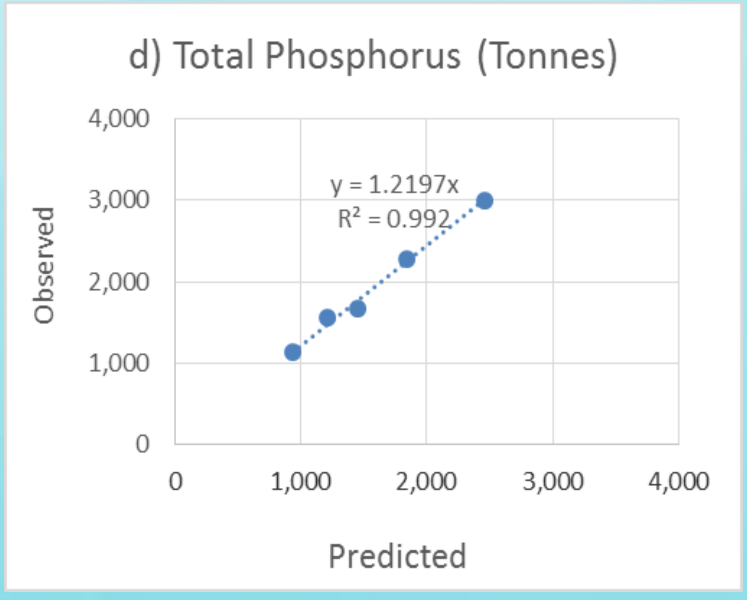
Gauging Station Name	Gage ID on Map	Hydrologic Unit Code	Drainage Area (km^2)
Susquehanna R. at Danville	S1	02050107	29,060
Susquehanna R. at Harrisburg	S2	02050305	62,419
Susquehanna R. at Conowingo	S3	02070008	70,189
Potomac R at Little Falls	S4	02080205	29,940
James R at Catersville, VA	S5	02080205	16,193

Calibration Results at the Gages

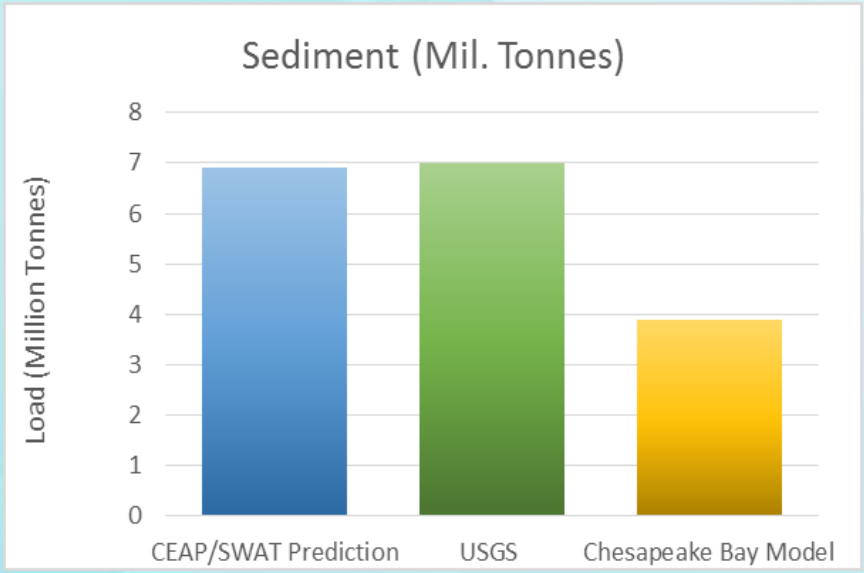


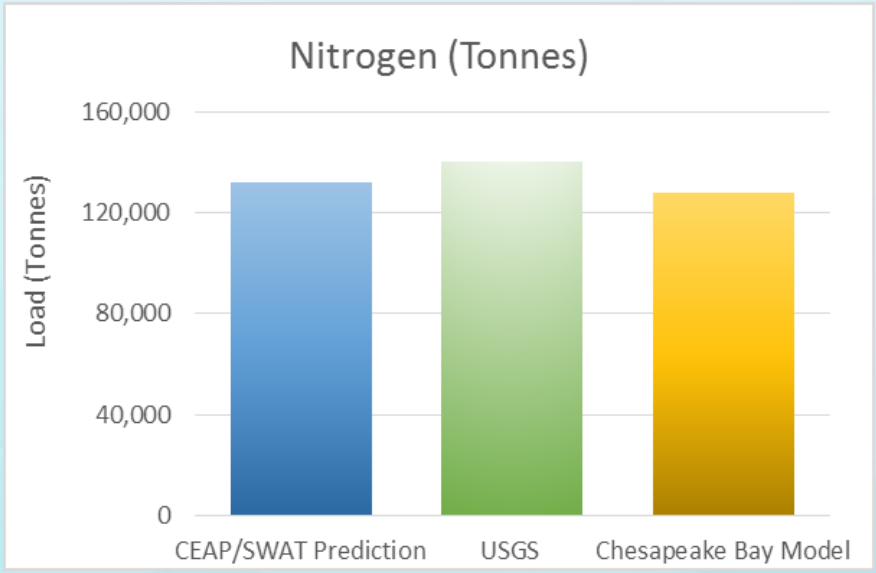


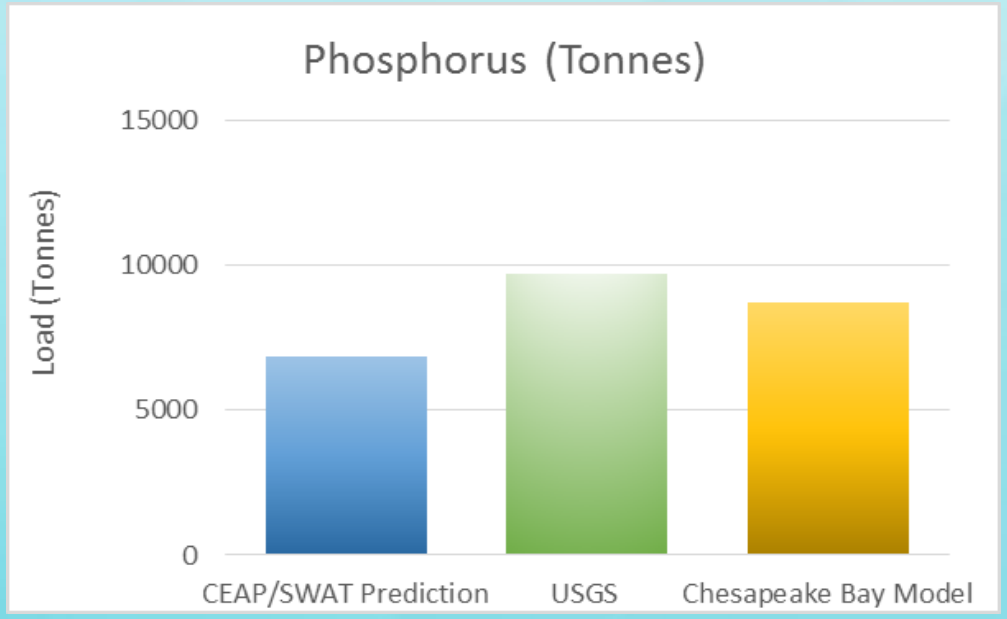




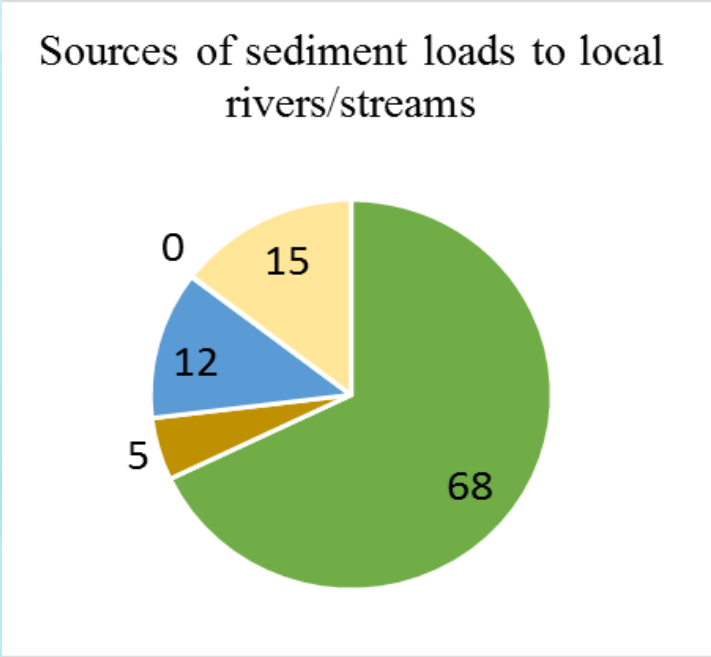
Loads Discharged from Chesapeake Bay Watershed to the Bay: Prediction and Validation

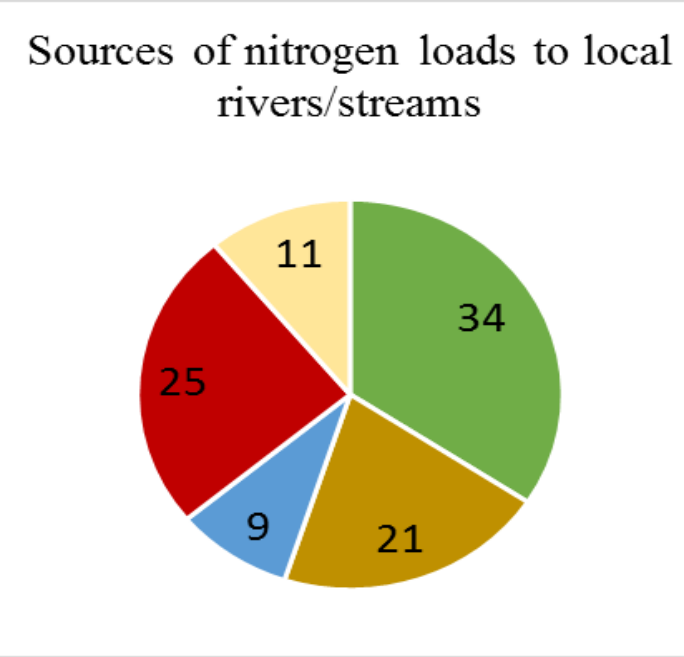


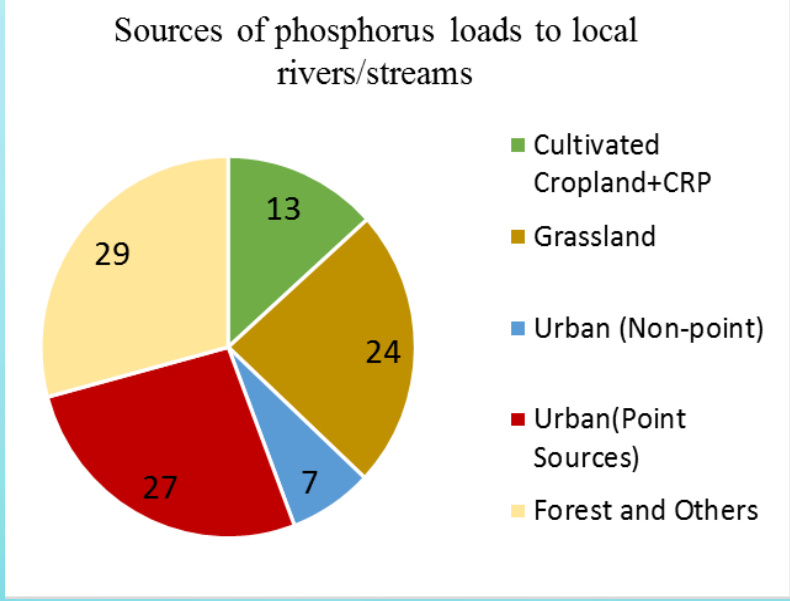




Major Sources of sediment and nutrients to local waters







Practices Simulated Within APEX

a) Structural Practices

In-field Practices for erosion control

- Contour Farming
- Strip Cropping
- Contour Buffer Strips
- Terraces
- Grass Terraces
- Tile Drain
- Grade Stabilization Structures
- Grassed Waterways
- Diversion

Edge of Field Practices for buffering

- Filter Strips
- Riparian Forest Buffers
- Riparian Herb. Cover
- Field Borders
- Vegetative Barrier

Wind Erosion Control Practices

- Windbreak / Shelterbelt
- Herbaceous Wind Barrier
- Hedgerow planting
- Cross Wind Practices

b) Cultural/Agronomical Management Practices

Residue, tillage, nutrient, pesticide and irrigation management practices and cover crops

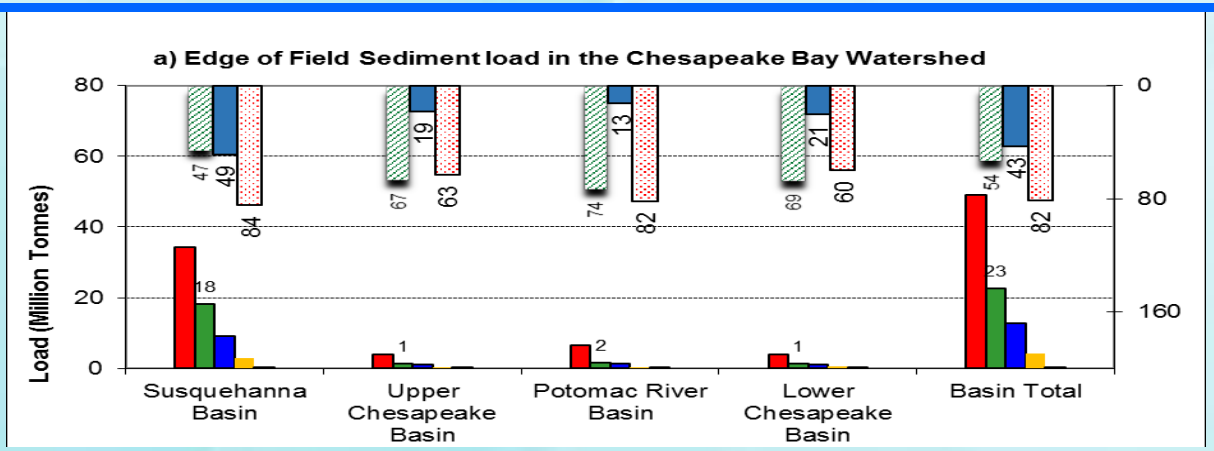
c) Long-term conservation cover

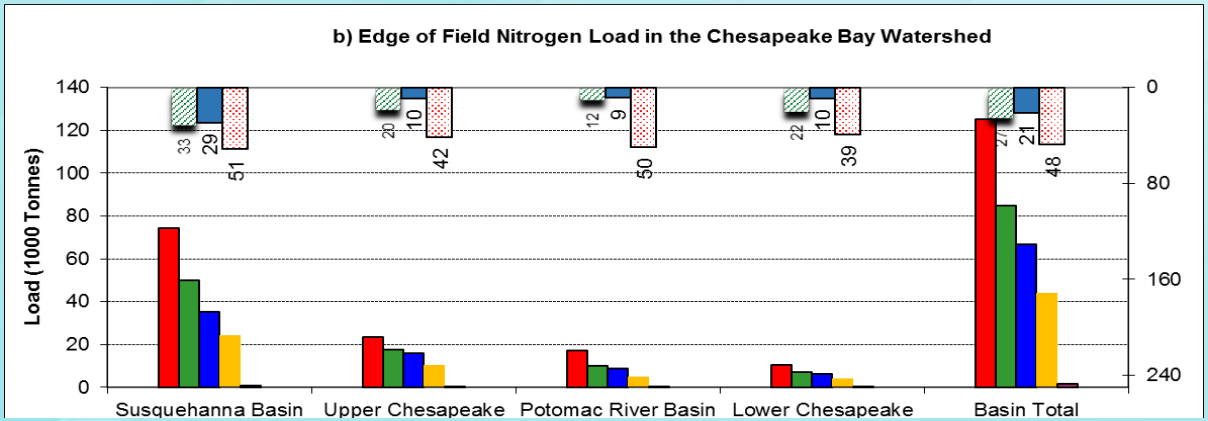
Conservation Practice Scenarios

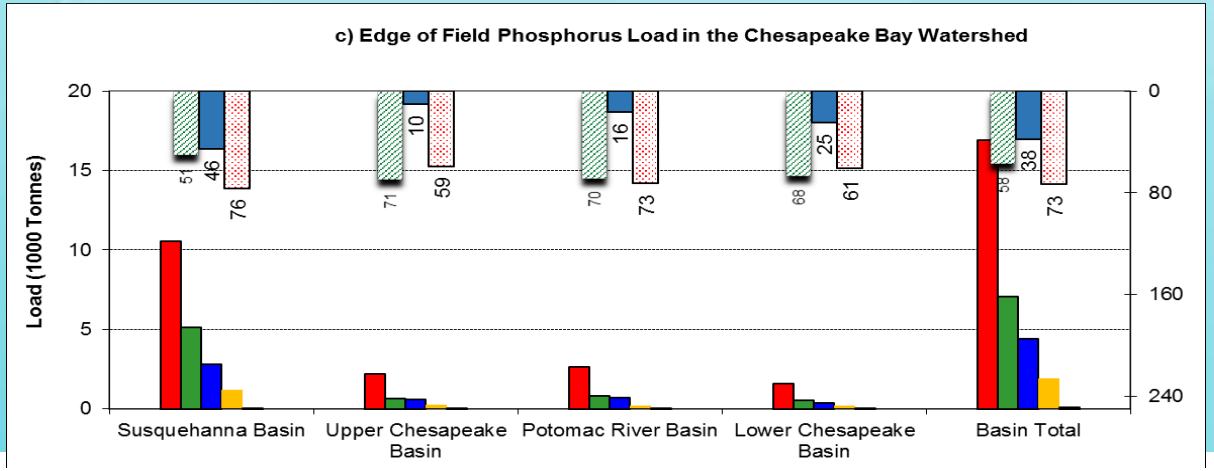
Scenarios	Practice Details
No Practice	No conservation practices on cropland
Current Conservation Condition (Baseline)	Currently existing conservation practices on cropland
Enhanced Nutrient Management on all under-treated cropland (ENMA)	Combinations of erosion control and nutrient management practices on under-treated cropland area; These areas have losses more than acceptable level.
Background	Grass-Tree mix grown on cropland in stead of crops. No fertilizer or manure. No cultivated cropland contribution

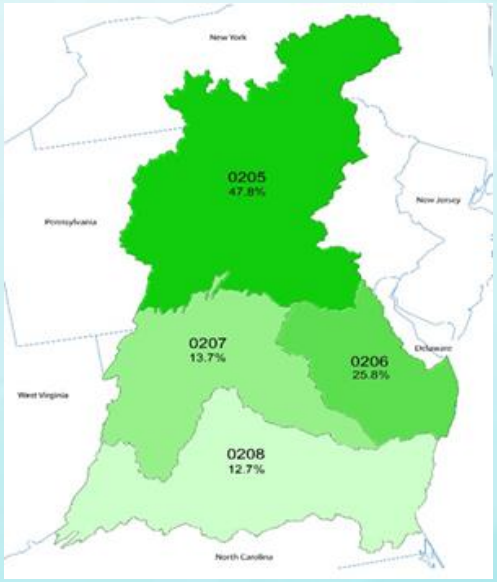
Chesapeake Bay Area	177,347 km^2
Cropland & CRP Area	10 % 180,57 km^2

Edge of Field Water Quality Benefits: Conservation Scenarios



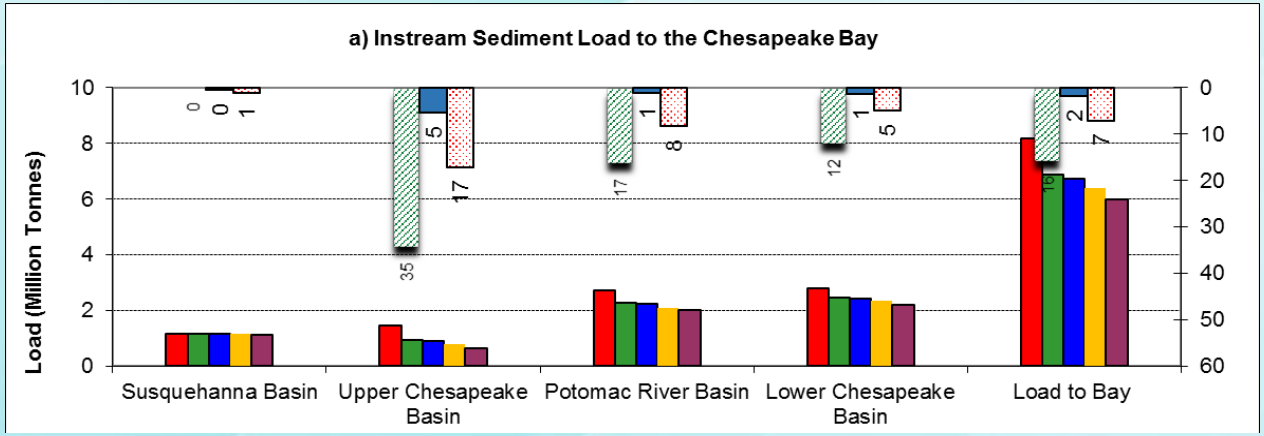


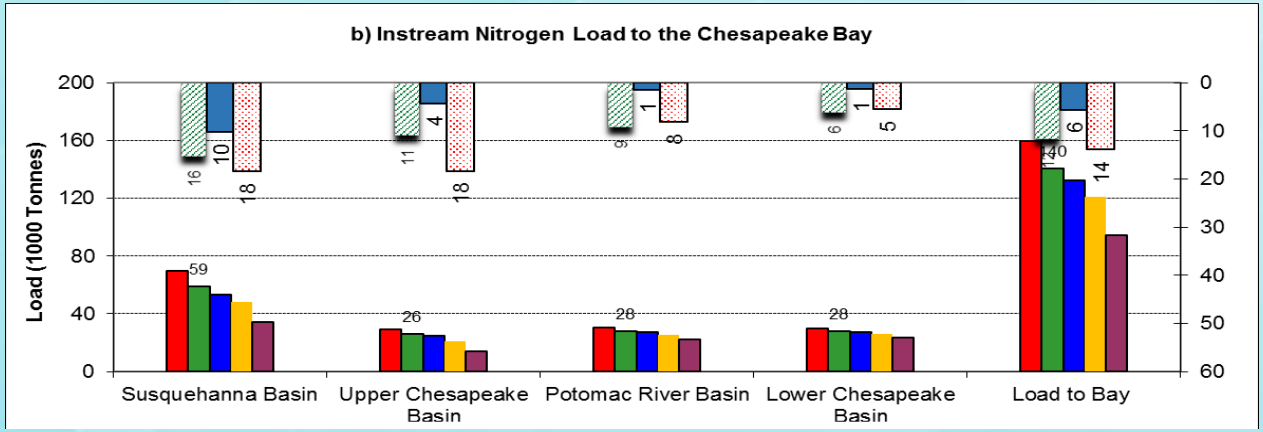


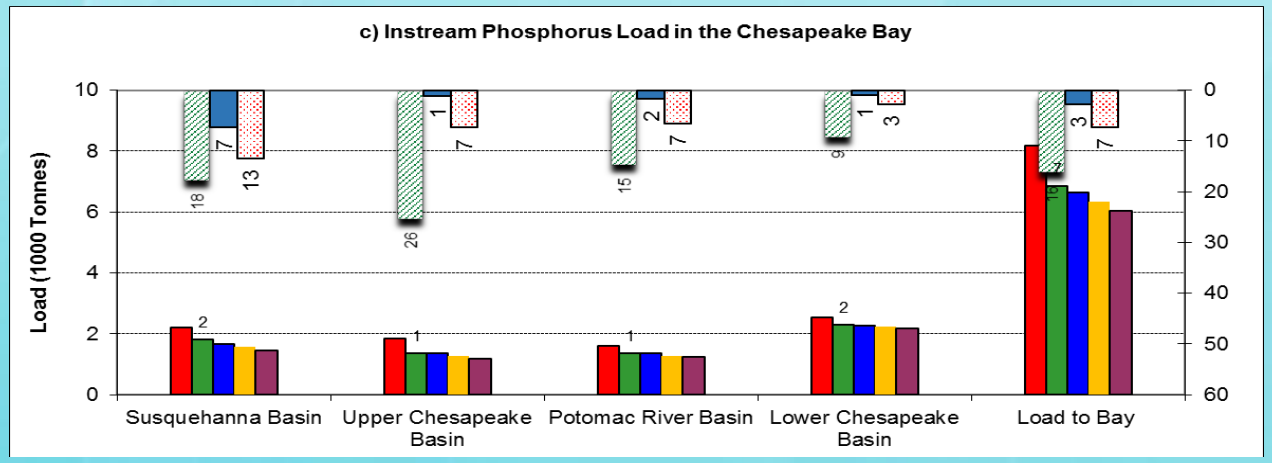


- No Practice
- Current Conservation Condition
- ENM C
- Current Conservation Reduction
- ENMA Reduction
- ENMA
- Background

Instream Water Quality Benefits: Conservation Scenarios

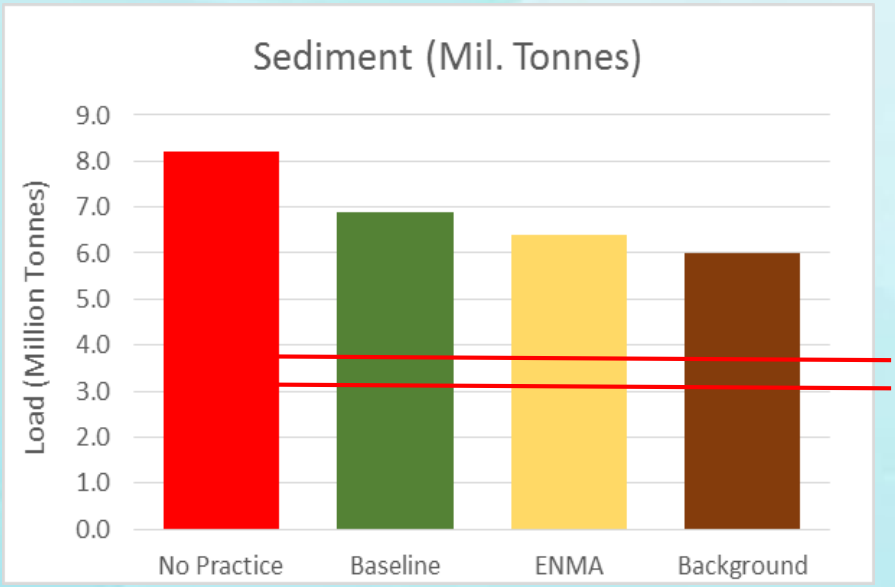


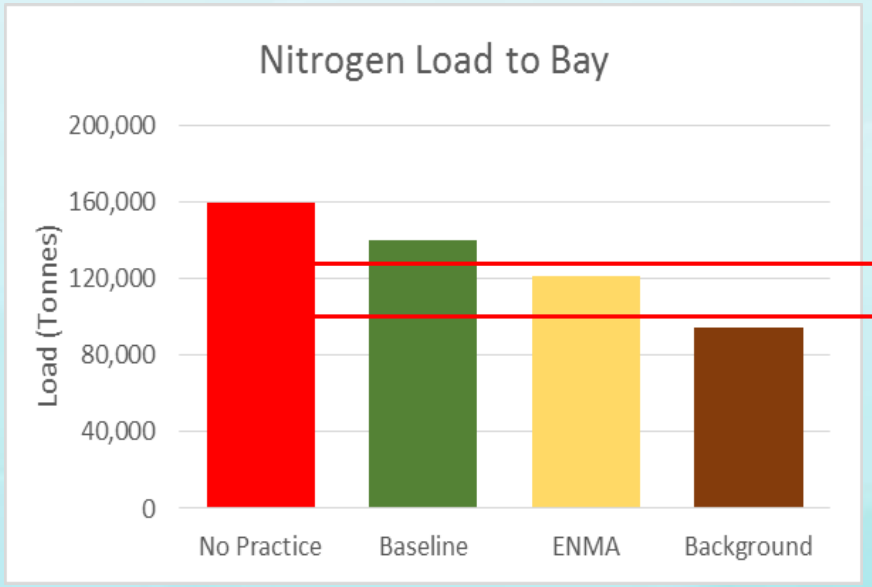


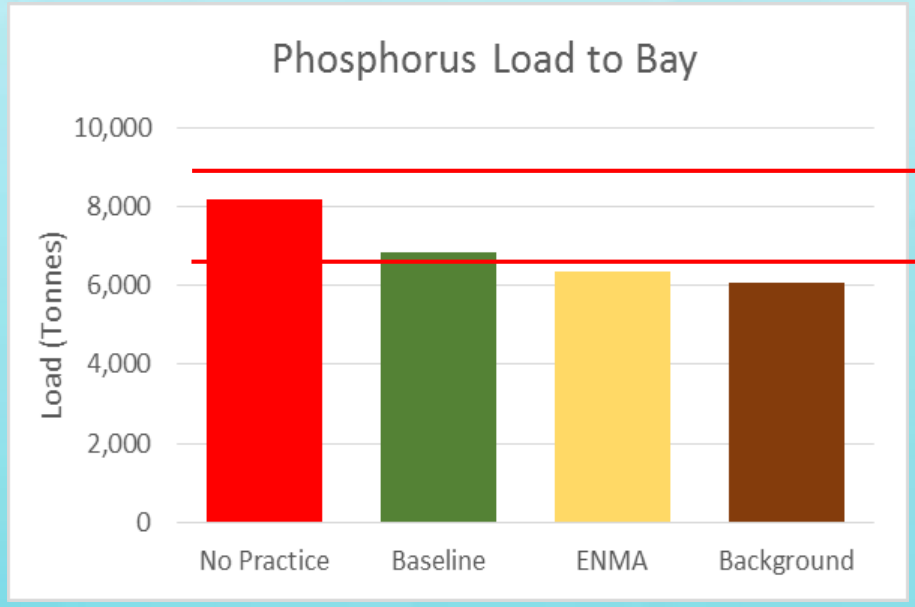


- No Practice
- Current Conservation Condition
- ENMA
- Current Conservation Reduction
- ENMA Reduction
- ENMA
- Background

Loads Discharged to Chesapeake Bay: SWAT Prediction and Proposed TMDL Targets







2009 Target

2013 Target

Conclusions

- About 6.9 million tonnes of sediment, 140, 500 metric tonnes of nitrogen and 6,850 metric tonnes of phosphorus loads were predicted to enter the Bay as per baseline conservation condition.

- Currently established practices on cropland reduced the sediment, nitrogen and phosphorus losses from edge of field by 54%, 27% and 58%, respectively.

- These practices also reduced the sediment, nitrogen and phosphorus loads entering the Chesapeake Bay by 16%, 12%, and 16%, respectively.

- Additional conservation treatment can help to further reduce the loads to the Bay and move towards meeting the proposed sediment and nutrient targets.

Conclusions

- A research methodology is developed for regional/large scale assessment using models and large databases. Researchers and modelers can adopt this.

- Tools available to study other emerging issues on eutrophication, hypoxia, algae blooms, climate change, future conservation programs, and restoration efforts.


Thank you !!!