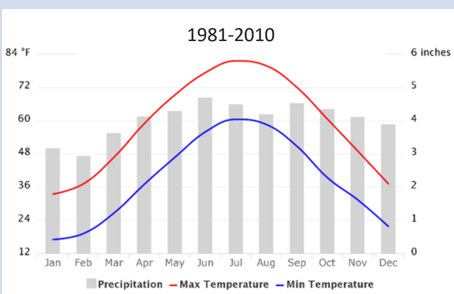
Mahantango Creek Watershed

A Conservation Effects Assessment Project (CEAP) Watershed Assessment Study: A collaboration between the Agricultural Research Service and the Natural Resources Conservation Service

Location

The 420-km^2 Mahantango Creek Watershed (MCW) lies in the Appalachian Valley and Ridge Physiographic Province of the Upper Chesapeake Bay Watershed. Long-term monitoring is focused in WE-38, a 7.3-km^2 subbasin of Mahantango Creek.

Temperature and Precipitation



Major land uses

Cropland: Corn, Soybean, Small Grains.
Grassland: Pasture and Hay.
Woodland: Mixed hardwood.

Data collection

Flow from WE-38 is continuously monitored via tandem broad-crested and v-notched weirs established in 1968. Since 1981, water quality samples have been collected thrice weekly. Recently, Mahantango Creek joined other CEAP partners in testing real-time sensors for high-frequency water quality monitoring. NRCS-SCAN and ARS weather stations are located at the Mahantango Creek field station. Also, three rain gauges are dispersed across WE-38 (two since 1968, and a third since 1978). WE-38 farmers share management information annually, aiding interpretation of monitored data.

Concerns

Concerns over the health of the Chesapeake Bay have guided most conservation priorities in recent decades, with an emphasis on mitigating nitrogen, phosphorus, and sediment losses from the 166,000 km^2 Watershed to the Bay.

Given concerns over water quality, nutrient runoff via surface and subsurface hydrological flow pathways has been the primary resource concern. Improved mapping of soil layers that restrict downward water movement is key to identifying soils where excessive soil moisture can promote surface runoff.

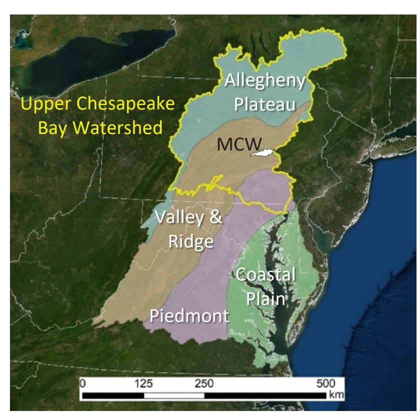
Increasingly, there is an association between emergent groundwater flows from seeps in lower landscape positions and nitrate-nitrogen losses to headwater streams.

These resource concerns converge in the riparian area, intersecting with riparian and aquatic ecosystem health. Grazing options for the riparian area are seen as a priority for livestock farmers in the region and conservation practices that restrict grazing are a barrier to their adoption.

Main conservation practices used

The main practices advocated for agriculture are no-till, winter cover crops, and 4R nutrient stewardship. The Chesapeake Bay TMDL identifies many other practices, all of which are vetted by the Chesapeake Bay model and prescribed by the State Watershed Implementation Plan. Farmer field days, hosted by NRCS, educate and problem solve locally.

Strategies to target and prioritize conservation practices include critical source area identification with the Phosphorus Index, and watershed planning under the Agricultural Conservation Planning Framework.



Location of Mahantango Creek Watershed (MCW) in the Upper Chesapeake Bay Watershed.

Mahantango Creek Watershed

Outcomes/Findings

Plot and field scale

- Manure applied to no-till soil exacerbates dissolved phosphorus (P) losses in runoff, increasing losses from critical source areas.
- In sloping landscapes, saturation excess runoff processes tend to override management factors in P mobilization and transport from agriculture to headwater streams.
- Added to soils high in P, gypsum decreases P solubility, improves infiltration, and reduces dissolved P losses in runoff.
- When simulated on historic, local crop rotations, the BMPs shown below reduced N, P, and sediment losses by 3 to 120, 4 to 22, and 9,300 to 17,400 lb/ac, respectively.

	N	P	Sed.
Cover crop*	15.8	15.8	3.2
Grass buffer	1.5	2.9	4.3
Land retirement	7.0	13.9	23.1
Manure injection	0.8	5.5	
No-till	0.1	0.5	0.8
Wetland restoration	9.5	19.9	35.7

* does not include benefit from residual N, forage use, or weed prevention.

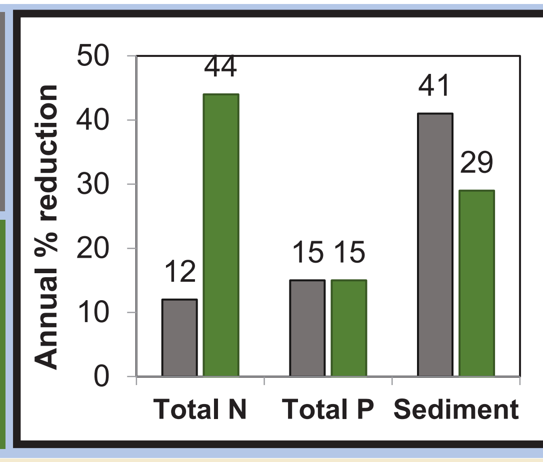
BMP cost-effectiveness ($/lb)

Watershed scale

- CRP-funded riparian buffers across the region have reduced N and P levels in surface runoff by about 12 and 35%, respectively.
- Since the late 1900s, increasing focus on conservation tillage and on-contour strip cropping of row crops with grasses has reduced annual overland losses of N, P and sediment by up to 26 kg/ha, 4.3 kg/ha, and 3.6 t/ha, respectively.
- Implementation of critical source area management strategies can achieve nutrient management objectives of the Chesapeake Bay TMDL at less cost than can strategies not prioritizing location.

TMDL Watershed Plan Scenario
BMPs (e.g., nutrient management, land retirement, stream buffers, wetland restoration) placed randomly by field to meet area allocation of Plan, **without** attention to critical source areas.

Cost-effective Targeting Scenario
BMPs highly cost-effective in reducing losses (e.g., 4R nutrient stewardship, cover crops) placed preferentially by field-level critical source areas to meet N and P reduction levels of TMDL Watershed Plan Scenario.



Two BMP placement scenarios of Mahantango Creek Watershed, simulated with the Soil & Water Assessment Tool, demonstrate environmental and economic watershed-level trade-off impacts in management decision-making. For 30% of the cost of the *TMDL Watershed Plan Scenario*, the *Cost-effective Scenario* reduced three times more nitrogen (N) and similar levels of phosphorus (P) annually from the watershed, leaving money for focusing on sediment control practices. (Methods described in: Amin, M.G.M., Veith, T.L., Shortle, J.S., Karsten, H.D., and Kleinman, P.J.A. 2020. Addressing the spatial disconnect between national-scale total maximum daily loads and localized land management decisions. *J. Environ. Qual.* 2020:1–15)

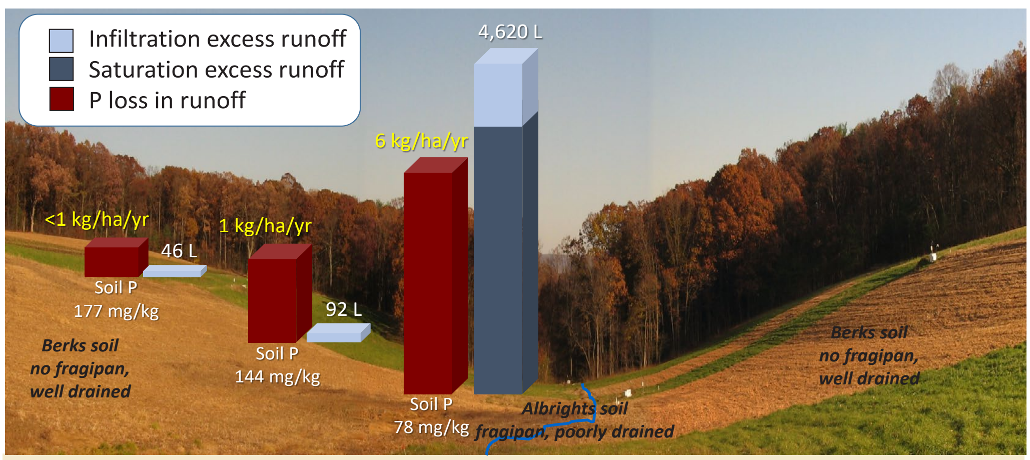


Illustration of the critical source area concept in the Mattern experimental watershed, part of CEAP's Mahantango Creek Watershed. Columns emphasize the contribution dissimilarities of well-drained and somewhat poorly drained soils to surface runoff and total phosphorus (P) loss in surface runoff over 2.5 years of monitoring. Soils above restrictive fragipan layers have the highest runoff potentials and, thus, contribute overwhelmingly to P loads. (Source: Buda, A.R., Kleinman, P.J.A., Srinivasan, M.S., Bryant, R.B. and Feyereisen, G.W. 2009. Factors influencing surface runoff generation from two agricultural hillslopes in central Pennsylvania. *Hydrol. Process.* 23:1295-1312)

Collaborators and Stakeholders

USGS science for a changing world
PennState

More Information

CEAP Site Lead: Tamie Veith, tamie.veith@usda.gov
ARS website: ars.usda.gov NRCS website: nrcs.usda.gov
CEAP website: nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/ceap/