United States Department of Agriculture
Natural Resources Conservation Service

Helping People Help the Land

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Conservation Effects Assessment Project

CEAP Highlights

CEAP Support in the Chesapeake Bay

The Chesapeake Bay is one of the most environmentally and economically important estuaries in the world. The drowned estuary of the Susquehanna River, the Bay extends about 200 miles from the mouth of the Susquehanna in northern Maryland to the Atlantic Ocean. It has more than 11,000 miles of shoreline and covers more than 4,000 square miles. The Bay's watershed covers more than 64,000 square miles in Washington, DC, and parts of Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia. It is home to significant agricultural production as well as millions of people.

Executive Order

On May 12, 2009, President Obama issued Executive Order 13508 on Chesapeake Bay Protection and Restoration. Section 202(b) of the order requires agencies to recommend ways to "target resources to better protect the Chesapeake Bay and its tributary waters, including resources under the Food Security Act of 1985 as amended, the Clean Water Act, and other laws."

Conservation Effects Assessment Project (CEAP) studies are helping to respond to the Executive Order and will be available for use by many agencies and organizations involved in Bay restoration. Following are highlights of some of the work now being done in the Bay watershed.

Cropland Assessment

The effectiveness of current conservation practices in the Chesapeake Bay Watershed will be assessed in the same manner as was done for the Upper Mississippi River Basin (UMRB). (See page 2 of these *Highlights.*) Conservation treatment of row crops should be generally similar, except that cover crop use is widespread in the Chesapeake Bay Watershed and rarely used in the UMRB. The Chesapeake Bay Watershed typically has a lower density of row crops on the landscape and a greater degree of development pressure than found in the UMRB.

In addition, other important findings are likely to emerge in the Chesapeake Bay Watershed assessment. For example, additional conservation practices not included in the UMRB simulations will be examined, such as construction of wetlands near interfaces with streams and cultivated cropland, or use of water control structures at drainage outlets to promote denitrification. Given the concentration of animal agriculture in the watershed, there will be special emphasis on conservation needs related to manure management. Although the influence of proximity of confined animal operations to streams was not possible in the UMRB assessment, it will be important in assessing potential vulnerabilities in the Chesapeake Bay Watershed. Analyses of soil vulnerability—a methodology developed through the CEAP-Cropland studies—will provide assessment of leaching and runoff and could guide future conservation planning from the field to the large watershed scale in all areas of the Nation. Completion of the CEAP-Cropland study on the Chesapeake Bay Watershed is expected in the spring of 2010.

> **Links**
>
> NRCS assistance in the Chesapeake Bay Watershed.
> www.nrcs.usda.gov/feature/chesapeakebay/chesapeakebay.html
>
> Choptank River NRCS Special Emphasis Watershed: Research Findings and Recommendations.
> www.nrcs.usda.gov/technical/nri/ceap/library

Cover Crops in the Choptank

The Agricultural Research Service (ARS) and the Maryland Department of Agriculture (MDA) are partnering to evaluate the effectiveness of cover crops in taking up excess nitrogen from the soil and thus reducing nitrogen delivery to downstream systems The ongoing partnership, developed over 4 years of research, is supported by NRCS and ARS funding and two grants administered by the National Fish and Wildlife Foundation.

Each fall, MDA provides a list of all fields enrolled in the Maryland Cover Crop Program within the Choptank River Watershed. ARS scientists sample a subset of these fields in December—at the time of satellite imagery acquisition—to measure nitrogen uptake prior to the onset of winter and in March to estimate springtime nutrient uptake prior to row-crop planting. From these data, the researchers correlate observed aboveground biomass measurements with satellite-derived reflectance data to develop biomass and nitrogen uptake estimates for all fields enrolled in the cover crop program. Researchers have found that cover crops planted before October 15 have the greatest effect on reducing nutrient loading.

Associated agronomic information can then be used to parse out the effects of cover crop management strategies. In addition, actual conservation program dollars spent per pound of nitrogen abatement can be calculated on a county, watershed, and regional basis. MDA is already using these results to guide cover crop program options.

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Cropland National Assessment

Upper Mississippi River Basin Study

Scientific peer review for the report on the Upper Mississippi River Basin study is complete. More than 100 reviewers submitted comments and suggestions. NRCS staff reviewed all comments carefully and are restructuring the report and updating model runs to address concerns and issues raised during the reviews.

Next steps are interagency clearance within USDA and then public release, now projected for early 2010. Meanwhile, model simulations have been completed for the Ohio-Tennessee River Basin, the Chesapeake Bay Watershed, and the Northeastern United States drainage. Reports on all of the major river basins and water resource regions in the lower 48 States are expected to be prepared over the next year.

The CEAP-Cropland river basin studies show the results of modeling simulations based on information gleaned from farmer surveys conducted at National Resources Inventory (NRI) sample points in each region. They compare simulations of the current conservation condition in each region with conditions that would be expected if conservation practices had not been applied. Following are some lessons learned from the UMRB study:

- Targeting initial conservation efforts to treat the most vulnerable acres would provide the quickest response at the watershed level. Preliminary estimates show that applying conservation to all under-treated acres of cropland (36 percent of the basin's cropland) would reduce sedimentation by over 55 percent, nitrogen in runoff by over 40 percent, and total phosphorous by almost 30 percent.

- Vulnerability assessments of soil runoff potential and leaching potential can be made using soil databases such as the Soil Survey Geographic (SSURGO) database.

- Full treatment of the most vulnerable acres would require a *suite* of conservation practices to (1) control overland and concentrated flow, (2) trap materials from leaving the field, and (3) avoid or limit the potential for loss by using strict nutrient management practices (appropriate rate, timing, and method).

- Acres with manure applied will require more intensive and comprehensive treatment than acres without manure applied to attain acceptable levels of nutrient loss.

Other conservation practices not included in the UMRB simulations can also be effective, such as drainage water management to promote denitrification, construction of wetlands near interfaces with streams and cultivated cropland,

Wildlife National Assessment

CCRP Buffers Promote Bobwhite Habitat Improvement

CP33, a practice of the Continuous Conservation Reserve Program (CCRP), is the first Federal conservation practice to target species-specific population recovery goals of a national wildlife conservation initiative (the Northern Bobwhite Conservation Initiative). Habitat buffers established at the margins of cropland fields under CP33 encourage significantly increased populations of bobwhite and many species of upland songbirds, according to a study summarized in a new CEAP *Conservation Insight*. Specific findings of the survey include the following:

- Over the 14 States of the study, breeding bobwhite densities were 70 to 75 percent greater around CP33 buffered fields than around unbuffered crop fields.

- Fall bobwhite covey densities were 50 to 110 percent greater around CP33 fields than around unbuffered crop fields, and this positive response to CP33 increased each subsequent year of the study.

- Several upland songbirds (dickcissel and field sparrow, for example) responded strongly to CP33 in the landscape.

- Area-sensitive species such as grasshopper sparrow, however, exhibited little response to CP33.

Conservation buffers such as CP33, which require relatively small changes to primary land use at little or no cost to landowners, can provide essential wildlife habitat in productive working agricultural landscapes. However, to accomplish regional recovery of bobwhite populations in agricultural landscapes this effective conservation practice must be much more broadly applied.

The *Insight* and the full report of the study—"Bobwhite and Upland Songbird Response to CCRP Practice CP33, Habitat Buffers for Upland Birds"—will be available on the NRCS Web site at www.nrcs.usda.gov/technical/nri/ceap/library. The primary investigators on this project were Wes Burger and Sam Riffell, Mississippi State University, with support from project coordinators Kristine Evans and Mark Smith.

For additional information, contact Charlie Rewa, RIAD, at 301-504-2303 or charles.rewa@wdc.usda.gov.

Choptank Study Advances Understanding of Wetlands

Results are emerging from the CEAP-Wetlands study in the Choptank River Watershed (Maryland-Delaware), a major tributary to the Chesapeake Bay. The study, an interdisciplinary collaboration led by ARS, is designed to quantify pollutant regulation services provided by depressional wetlands in the headwaters of the watershed. Drained wetlands (prior-converted cropland), wetlands established through the Wetland Restoration and Shallow-Water Development and Management practices (referred to here as *restored* wetlands because wetland ecosystem services are re-established, or restored, via these practices), and native wetlands make up the sample population. The study was initiated in 2007 and is scheduled to wrap up next year.

Following are brief summaries adapted from the 2009 Society of Wetland Scientists meeting abstract. Complete abstracts and other papers from this meeting are available at www.sws.org/2009_meeting/docs/SWS0021.pdf.

Effects of wetland conservation on nutrient regulation in the Choptank River Watershed. USDA has implemented several different conservation programs—the Wetlands Reserve Program, for example—with the aim of enhancing the delivery of key wetland ecosystem services such as pollution control and habitat provision. The interdisciplinary CEAP study of the Choptank Watershed, which has high nutrient and sediment loads originating from agriculture, is assessing the ability of natural, restored, and prior-converted wetlands on cropland to improve water quality in the river.

Data collection is ongoing but trends in water quality, quantity, and transport are emerging. Field-scale measurements are being combined with remotely sensed and other geospatial data to extrapolate findings across the watershed.

Project results will be used to assess and improve the effectiveness of conservation practices and Farm Bill programs affecting wetlands and associated lands. This project encourages future interagency cooperation and is an important step toward producing a national landscape analysis tool that will support adaptive management of wetland restoration and enhancement programs.

Groundwater movement impacts the effectiveness of wetland conservation practices. Untested assumptions about groundwater hydrology can contribute to misunderstandings regarding the importance of wetlands to water quality in nearby streams. Shallow groundwater flow paths can be critical vectors for nitrogen movement near wetlands and must be sufficiently understood in investigations of nitrogen fate and transport. The effectiveness of natural, restored, and prior-converted (drained and used for agriculture) wetlands for mitigating agricultural impacts on local streams is under investigation at nine sites in the Upper Choptank Watershed.

Hydrologic and geochemical observations at some sites challenge common initial assumptions based on local topography. At one site, for example, groundwater flow is controlled by a distant drainage feature and often is in the opposite direction of initial assumed flow paths. At another site, relatively low nitrate concentrations in shallow groundwater beneath a grass buffer adjacent to a restored wetland might be assumed to reflect reduction of much higher nitrate in groundwater recharged through uphill cropland. Geochemical data indicate, however, that sampled water beneath the buffer likely recharged through the buffer or the wetland. Ground water containing higher nitrate from beneath the cropland may pass beneath the buffer toward the wetland.

Understanding gained from the Choptank and similar local studies is being used to construct a conceptual model for predicting the effects of wetlands on water quality in the wider Mid-Atlantic Coastal Plain.

Transformation of agricultural source nitrogen by wetlands across an alteration gradient. Fertilizer and manure applications on crop fields are significant sources of nitrate (NO_3), and groundwater NO_3 frequently reaches 500 to 1,000 µM. In the Choptank Watershed, groundwater transport of agricultural NO_3 results in denitrification in adjacent wetlands. Natural, restored, and even some prior-converted wetlands near agricultural fields appear to be effective as a mitigation strategy for removing agricultural NO_3 from groundwater. The extent of NO_3 removal depends on local hydrogeologic conditions and varies considerably in space. Also, since the greenhouse gases N_2O and CH_4 can be generated under conditions of NO_3 depletion, there may be optimal ratios of crop field to wetland to ensure adequate NO_3 removal without production of greenhouse gases.

Using radar and LiDAR to monitor wetlands. Wetlands must be routinely monitored to regulate the loss, preservation, and/or restoration of wetlands and to judge how effective these efforts are in preserving associated ecosystem services. Wetland hydrology is the most important non-biologic factor controlling wetland extent and function, and should be a vital part of any wetland mapping or monitoring program.

The hydrology of watershed-scale forested wetlands has been difficult to study with conventional remote sensing methods, and the collection of this information on the ground is cost prohibitive. The ability of optical data such as aerial photographs to detect hydrology is limited, especially in forested ecosystems. Two types of active systems, radar and LiDAR, have the potential to significantly improve our ability to map and monitor forested wetlands. Both have been used to monitor hydrology in a series of wetland depressions and flats in the headwaters of the watershed.

Remotely derived results have been compared with field data, existing wetland maps, and one another. Results are very encouraging. Improved estimates of forested wetland extent and hydrology should allow for the estimation of key biogeochemical transformations (e.g., denitrification) and the provision of water quality services across the landscape.

Progress continues on the CEAP-Grazing Lands literature syntheses, currently projected for publication in early 2010 (rangeland) and early 2011 (pastureland). Both efforts were front and center at the Grazing Lands Conservation Initiative Fourth National Conference on Grazing Lands, December 13–16, 2009, in Sparks, NV. Following are summaries of accepted presentations at the meeting.

Rangeland CEAP literature synthesis: Conclusions and recommendations. *—David Briske, Texas A&M University, and Leonard Jolley, NRCS*
The rangeland CEAP literature synthesis was formally initiated in June 2007 with the goals of evaluating the effectiveness of NRCS rangeland conservation practices, providing recommendations, and identifying knowledge gaps on the basis of previously published experimental data. Experimental data show that stocking rate is the single most important management variable influencing production and sustainability of grazed ecosystems.

Fire negatively affects some herbaceous species the year of the fire, but within 2 to 3 years most species recover regardless of season. This finding suggests that the use of prescribed burning to control undesirable plants is justifiable and sustainable. These conclusions were surprisingly consistent among rangeland regions of the western United States. A major deficiency in fire research and management is the failure to consider reoccurring fire as a critical part of long-term ecosystem management.

Restoration of invasive plant-infested rangeland is successful only about 20 percent of the time when non-native plant material is seeded and less often when native species are seeded. Major recommendations for more effective invasive plant management include standardizing data collection and risk analysis, developing science-based management strategies, and implementing a comprehensive education and technology transfer program.

Recent experimental data addressing rangeland planting support most previous interpretations, but are insufficiently replicated for general inferences. Seedbed preparation, planting depth, and planting season and seeding rate recommendations are irrelevant in very dry and perhaps very wet years, but seeds incorporated into a firm seedbed consistently outperform broadcast and seedbed control treatments across multiple studies. Application of mulch consistently improves establishment success, but economic considerations generally preclude use of surface amendments.

It was consistently recommended that monitoring be implemented to more effectively determine the ecological benefits realized from these conservation practices and to provide feedback to optimize practices for greatest efficiency. Efforts are underway to incorporate these findings into NRCS conservation planning standards and related USDA initiatives to improve rangeland management and conservation.

Progress and implications from the pastureland CEAP project. *—C. Jerry Nelson, University of Missouri-Columbia*
The CEAP pastureland literature synthesis is designed to evaluate the scientific evidence for conservation practice standards. The U.S. public is expecting more and more ecosystem services from forage and pasture lands, but the complexity of these environments makes it difficult to develop generalizations.

The synthesis authors are analyzing the literature and developing insights on managing forage and pasture lands, including planting, fertilization, pesticide use, and other operations; management of grazing; wildlife habitat considerations; and the effects of management on environmental quality.

Pastureland research and assessment supporting CEAP objectives. *—Matt Sanderson, Penn State University*
Early grazing land conservation practices focused on eliminating overgrazing on pasture and rangeland. Despite several decades of improving management on pasture and haylands through conservation practices, significant conservation issues remain. An estimated 75 million acres of pasture and hayland need some form of conservation treatment.

NRCS and the Agricultural Research Service (ARS) conducted pilot projects in 2007, 2008, and 2009 to develop an improved sampling protocol to enhance the data collection and pasture assessment when the full NRI sampling effort is implemented. Pilot projects in 5 States in 2007, 13 States in 2008, and 15 States in 2009 tested new protocols, estimated the cost and time required, and provided a realistic test of implementation within a State.

U.S. grazing lands include rangelands in the West (Utah, left photo) and pasture in the Northeast (Vermont, right photo) as well as grazed forest.

Little River Experimental Watershed: Conservation Tillage Impacts on Water Yield. *—David Bosch, ARS Southeast Watershed Research Laboratory, Tifton, Georgia*
Considerable acreage across the Southeastern Coastal Plain has been converted from conventional tillage systems into some form of conservation tillage. Strip tillage, a practice of tilling a narrow strip for planting, has been the dominant form of conservation tillage implemented across the region.

Field observations indicate that surface runoff can be reduced by as much as 61 percent by converting from conventional tillage to conservation tillage within the Coastal Plain. As a result of reduced porosity within the root zone of soils under strip tillage, however, the increased infiltration can lead to a 90-percent increase in subsurface water losses. Although the annual water balance appears to remain largely unaffected by conversion to conservation tillage systems, increased subsurface losses in the winter and reduced surface losses in the summer can be expected.

In watersheds where shallow subsurface flow and groundwater flow contribute directly to streamflow, this shift in water dynamics could significantly affect streamflow. Data on farming practices across the Little River Experimental Watershed (LREW) in South-Central Georgia indicate that strip tillage has been implemented on 55 percent of the cropped area—15 percent of the total land area in the watershed. Hydrologic data from the LREW were examined to evaluate streamflow characteristics that may be related to trends in conservation tillage adoption over the past 15 to 20 years.

Examination of precipitation and flow data indicate that anticipated changes in water balance have been cancelled out by decreasing wintertime precipitation. While the anticipated winter increases in streamflow have not been observed, conversion to conservation tillage may be responsible for maintaining streamflow at historical levels despite decreasing wintertime precipitation.

South Fork Iowa River Watershed: Impacts of historical sediment accretion and channel straightening on the South Fork Iowa River. *—Mark Tomer, ARS National Soil Tilth Laboratory, Ames Iowa*
Soil erosion from historic clearing of agricultural land produced sediment that accumulated in river valleys and continues to influence rivers and be a source of streambank sediment loads today.

Researchers found that recent sediment along the South Fork Iowa River—an Iowa watershed with low relief and limited settlement history (160 years)—averaged 2.6 feet in thickness out to a distance of 260 feet from the channel. This equates to 69.8 tons per acre of soil that was eroded from uplands across this 158,000-acre watershed.

The volume of this sediment has reduced the capacity of the flood plain to store floodwater by an estimated 4,123 acre-feet after discounting for the sediment's volume of pore space. In addition, channel straightening of the South Fork and its tributaries has reduced channel length by up to 15 percent, hastening routing of water to the Iowa River.

River restoration projects need to be conducted recognizing that bank erosion and exacerbated flooding may result from historical legacies within our river valleys. This is of particular interest to water resource managers and aquatic ecologists who are developing and implementing river restoration and watershed management plans.

Four watersheds in the Midwest: Hydrologic changes in the Midwest result more from shifts in climate than land use. *—Mark Tomer, ARS National Soil Tilth Laboratory, Ames Iowa*
Hydrologic shifts towards greater discharge have been observed in the Midwest, but it is not certain whether this trend results from changes in agricultural land use or changes in climate.

When evaluating simultaneous shifts in how energy (evaporative demand) and water (precipitation) was partitioned during a long-term, small-watershed experiment, effects of land use (watershed treatment) and climate trend (time) became readily distinguished. Applying the technique to four larger watersheds across the Midwest, increasing discharge was shown to be more attributable to climate change than land-use change. Changes in land use, in particular increased soybean acreage, did show a shift towards increasing discharge that could be attributed to decreased crop water use. But since 1975 and after this change in cropping occurred, changing climate in the form of increased precipitation and decreased evaporative demand has been the dominant influence on watershed hydrology.

The trend impacts issues such as Gulf of Mexico hypoxia, which expands as both nutrient losses and discharge increase. Results are of interest to all groups interested in conservation effectiveness in the Midwest (i.e., conservation groups, policy developers, environmental and commodity groups), because increased discharge from agricultural watersheds, due to climate change, inherently increases the challenges of retaining agricultural nutrients within soils.

Restored wetland in the South Fork Iowa River watershed

Upcoming Meetings with CEAP Connections

February 21–25, 2010
2010 Land Grant and Sea Grant National Water Conference. Hilton Head, SC
Contact Mike O'Neill, NIFA

April 28–30, 2010
Managing Agricultural Landscapes for Environmental Quality (MAL II): Achieving More Effective Conservation. Denver, CO
Contact Dewayne Johnson, SWCS

June 27–July 1, 2010
Joint 9th Federal Interagency Sedimentation Conference and 4th Federal Interagency Hydrologic Modeling Conference. Las Vegas, NV.
Contact Jerry Bernard, NRCS

The Conservation Effects Assessment Project Translating Science into Practice

CEAP is a multi-agency effort to quantify the environmental benefits of conservation practices and develop the science base for managing the agricultural landscape for environmental quality. Project findings will guide USDA conservation policy and program development and help farmers and ranchers make informed conservation choices.

The three principal constituents of CEAP—the national assessments, the watershed assessment studies, and the bibliographies and literature reviews—contribute to the evolving process of building the science base for conservation. That process includes research, monitoring and data collection, modeling, assessment, and outreach.

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Currently, the project is in a technology transfer phase and will focus research on overcoming obstacles associated with scaling up applications from the Choptank River study area to the core states of the watershed (Maryland, Pennsylvania, and Virginia). In the coming year, a pilot project will be implemented in Talbot County, Maryland, to program a geospatial data capture tool that will streamline the collection of agronomic data on cover crops during the cost-share program enrollment period.

See page 3 for more information on research in the Choptank Watershed. The work in this and other projects in the Bay will inform conservation decision-making throughout the Bay watershed.

Assessing BMPs in Spring Creek Watershed

Another CEAP project within the Bay watershed is Spring Creek, in central Pennsylvania. Spring Creek drains into the Susquehanna River, the main northern tributary of the Bay. This project, supported by the National Institute of Food and Agriculture (NIFA), is conducted jointly by the Penn State Cooperative Wetlands Center and the Pennsylvania Cooperative Fish and Wildlife Research Unit and supported by NIFA.

The researchers are organizing data collected by a variety of methods for streams, fish, macroinvertebrates, and landscapes to assess Best Management Practice (BMP) performance systematically and document impacts from agricultural activities. By combining ground-based measurements with fine-resolution LiDAR data, the researchers can more precisely map topographically and hydrologically distinct reaches that vary in their response to BMPs.

Because a necessary criterion for BMPs to be effective is adoption and implementation by farmers, the research team is examining the factors that have affected BMP implementation, performance, and maintenance throughout the watershed. The team has pioneered ways to integrate ecological and socio-economic data in assessing the condition of watersheds.

Preliminary findings from monitoring water quality in Cedar Run, a tributary of Spring Creek, show that between 1992 (pre-treatment) and 2007 (post-treatment)—

- sedimentation declined more than 50 percent after riparian restoration and fencing;
- brown trout populations increased significantly—more than double in some sampling locations—after BMP implementation; and
- macroinvertibrate densities increased downstream from treatment areas by up to 500 percent in some areas.

Modeling and geospatial analyses will provide more information on practice performance. Results are forthcoming.