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FEATURE

The first five years of the Conservation Effects Assessment Project

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The Conservation Effects Assessment Project (CEAP) was initiated by the USDA Natural Resources Conservation Service (NRCS), Agricultural Research Service (ARS), and Cooperative State Research, Education, and Extension Service (CSREES) in response to a general call for better accountability of how society would benefit from the 2002 farm bill's substantial increase in conservation program funding (Mausbach and Dedrick 2004). The original goals of CEAP were to establish the scientific understanding of the effects of conservation practices at the watershed scale and to estimate conservation impacts and benefits for reporting at the national and regional levels. Other federal agencies and nongovernmental organizations with conservation and natural resource interests are currently partners in various CEAP activities, often through jointly funded research projects.

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CEAP activities are organized into three interconnected efforts:

1. *Bibliographies, literature reviews, and a scientific workshop* to establish what is known about the environmental effects of conservation practices at field and watershed scales, and what kinds of research and data collection are needed to assess conservation practice benefits.
2. *Watershed assessment studies* to provide in-depth quantification of water quality and soil quality impacts of conservation practices at the local level and to provide insight on what practices are needed and where they are needed within a watershed to meet environmental goals.
3. *National and regional assessments* to estimate the environmental effects and benefits of conservation practices on the landscape and to estimate remaining conservation treatment needs.

During its first five years, CEAP established research and assessment efforts designed to estimate the effects and benefits of conservation practices through a combination of research, data collection, model development, and model application. This article provides an overview of CEAP efforts at the end of the first five years, summarizes accomplishments to date, and presents plans for completing current activities. A vision for how CEAP can contribute to better and more effective delivery of conservation programs in the years ahead is addressed in a companion paper (Maresch et al. 2008).

BIBLIOGRAPHIES, LITERATURE REVIEWS, AND A SCIENTIFIC WORKSHOP

A science-based approach to conservation requires an understanding of the current state of knowledge on the effects of conservation practices. As a first step, the USDA National Agricultural Library (NAL) Water Quality Information Center prepared six bibliographies of existing scientific literature on the effects of conservation practices and programs (USDA NAL 2004a, 2004b, 2004c, 2004d, 2006a, 2006b). A seventh bibliography is in preparation.

In addition, subject area specialists reviewed the existing literature and prepared syntheses of the current state of knowledge on the effects of conservation practices, including identification of critical knowledge gaps that require additional research. Three of these literature reviews have been completed:

1. *Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge* (Schnepf and Cox 2006)
2. *Fish and Wildlife Benefits of Farm Bill Conservation Programs: 2000–2005 Update* (Haufler 2005)
3. *Fish and Wildlife Response to Farm Bill Conservation Practices* (Haufler 2007)

Two additional literature syntheses are currently in preparation: (1) a synthesis of the effects of conservation practices on rangeland and pastureland and (2) a synthesis of the effects of conservation practices on ecosystem services provided by wetlands in agroecosystems.

In 2005, USDA engaged the Soil and Water Conservation Society (SWCS) to assemble a review panel of academic and conservation leaders to recommend ways of making CEAP more useful, responsive, and credible, and to ensure that CEAP products will have wide utility for program

managers, policy makers, and the conservation community. The SWCS Blue Ribbon Panel strongly endorsed the goal of CEAP and recommended that the CEAP plan be expanded and adjusted: "CEAP must change direction to become the coherent, science-based assessment and evaluation system … needed" (SWCS 2006).

In October 2006, a CEAP workshop, "Managing Agricultural Landscapes for Environmental Quality: Strengthening the Science Base," was held on how to strengthen the science to account for the offsite environmental benefits of conservation efforts at landscape and watershed scales (Schnepf and Cox 2007). Four themes provided the framework for the workshop:

1. What should be measured, and how, to account for environmental effects at landscape and watershed scales?
2. Methods for environmental management research at landscape and watershed scales
3. The science of targeting within landscapes and watersheds to improve conservation effectiveness
4. Realistic expectations about the timing between conservation implementation and environmental effects

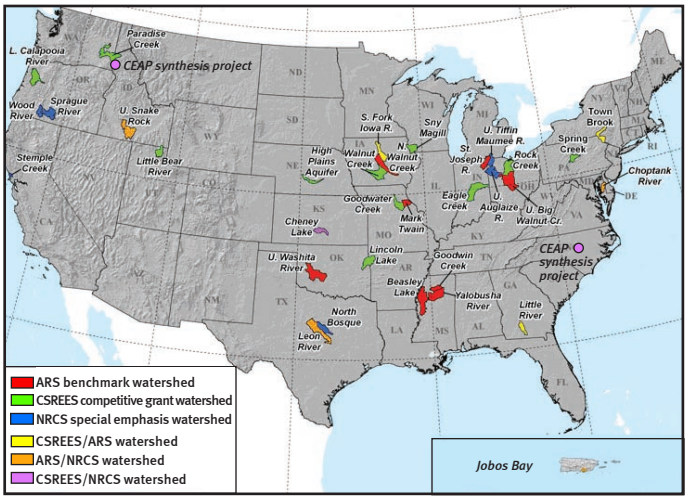
The workshop and resulting book advance our understanding of the linkages between individual efforts on farms and ranches and meaningful results at the watershed and landscape scales.

WATERSHED ASSESSMENT STUDIES

When CEAP was initiated, an extensive body of literature already existed that described plot- or field-scale conservation practices designed to protect water quality, water quantity, and soil quality (Schnepf and Cox 2006; USDA NAL 2004a, 2004b, 2004c, 2004d). However, research results from these studies often failed to capture the complexities and interactions of conservation practices, biophysical settings, and land uses within a watershed. CEAP watershed studies were established to quantify the effects of conservation practices at the watershed scale.

Figure 1

Locations of the CEAP watershed assessment studies.



Thirty-eight watershed assessment studies were established during the first five years of CEAP (figure 1). There are three groups of these CEAP watershed studies:

1. *ARS benchmark watershed studies.* Fourteen watersheds where long-term research is being conducted on water and soil quality effects of conservation practices in rain-fed croplands and on improving and validating models.
2. *CSREES competitive grant watershed studies.* Thirteen three-year retrospective studies initiated to quantify relationships among suites of conservation practices in watersheds on water quality and quantity, evaluate the timing and location of practices, and explore socioeconomic factors related to adoption and maintenance of conservation practices.
3. *NRCS special emphasis watershed studies.* Eleven three-year studies that address specific issues or resource concerns, such as land application of animal waste, soil erosion, drainage management, and water conservation, and also document conservation practice effects on water resources.

CEAP watershed assessment studies address most of the conservation practices implemented through the Environmental Quality Incentives Program (EQIP), Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Wildlife Habitat Incentives Program (WHIP), and NRCS conservation technical assistance. Conservation practices or best management practices (BMPs) that were emphasized include the NRCS Core 4 practices (conservation buffers, nutrient management, pest management, and tillage management) plus irrigation management practices, manure management practices, grazing management practices, establishment of wildlife habitat, and wetland protection and restoration.

Environmental effects and benefits are currently being estimated for each of the following resource concerns that conservation programs are designed to address:

- Water quality (nutrient, pesticide, and sediment delivery to lakes, rivers, streams, and groundwater)
- Soil quality (including soil erosion and carbon storage)
- Water conservation (including flood and drought prevention or mitigation)
- Wildlife habitat (including aquatic and terrestrial habitats or species)

Watershed studies have been funded collaboratively and are led by ARS, CSREES, and NRCS. Funded watersheds were carefully selected based on availability of long-term geo-referenced spatial data (including data on water quality, water quantity, soils, and conservation practice implementation), ability to analyze measurable effects of conservation, and quality of modeling approaches. Several joint symposia were held over the past four years to enhance collaboration and information sharing across the watershed projects.

ARS Benchmark Watershed Studies. As part of its CEAP-related activities during the first five years, ARS established 14 benchmark watershed studies (figure 1). Land use in all 14 ARS watersheds is primarily rain-fed cropland. Most watersheds were selected in 2003 and became operational as CEAP watershed studies in 2004.

ARS scientists are conducting long-term research to measure watershed-specific effects of conservation practices on environmental quality, and to improve and validate models used by NRCS in the national/regional assessments (Richardson et al. 2008).

All 14 ARS benchmark watersheds monitor water quantity (streamflow, precipitation, drainage, irrigation, and groundwater) and water quality (plant nutrients, pesticides, pathogens, dissolved oxygen). Soil quality is being assessed at 13 of the 14 watersheds. Selected watersheds are also measuring biotic (ecosystem—e.g., species richness and diversity, habitat quality, and native vegetation cover) and/or economic (profit, program efficiency, and optimum placement) system components. The development of regional watershed models is associated primarily with these research watersheds.

A number of specific products have resulted from this research effort (Richardson et al. 2008):

- ARS scientists developed a data storage and management system, Sustaining the Earth's Watersheds–Agricultural Research Data System (STEWARDS). When fully populated, STEWARDS will provide ready access to the ARS benchmark watershed network and other data sets and will facilitate research synthesis and cross-site comparisons.
- Data from many of the watersheds have been used to validate ARS watershed models (e.g., Soil and Water Assessment Tool [SWAT], Riparian Ecosystem Management Model [REMM], Agricultural Policy Environmental Extender [APEX], and Annualized Agricultural Non-Point Source [AnnAGNPS] model). Through this validation process, these models have been shown to be valuable tools for extrapolating regional findings to accomplish the national assessment effort. For some watershed studies, the physical process models were combined with economic models to provide decision support systems to optimize tradeoffs between environmental and economic objectives of conservation practices.
- A prototype of a new modular modeling system called the Object Modeling System has been developed that should provide a more powerful modeling tool for future studies.

CSREES Competitive Grant Watershed Studies. Between 2004 and 2006, CSREES and NRCS jointly funded 13 watershed-scale projects to determine the measurable effects of agricultural conservation practices on surface water and/or groundwater quality at the watershed scale. These projects are unique among the watershed-scale investigations because they concurrently address social and economic factors influencing adoption of conservation practices as well as the physical and chemical impacts of practices on water quality. These projects also evaluated the optimization of conservation within a watershed to address water quality impairments and water resource goals. The predominant land use in these 13 watersheds was cropland, with some grazing land.

Each of the CSREES studies focuses on the following four sets of questions:

1. Within the hydrologic and geomorphic setting of a watershed, how do the timing, location, and suite of implemented agricultural conservation practices affect surface water and/or groundwater quality at the watershed scale?
2. What are the relationships among conservation practices implemented in a given watershed with respect to their impact on water quality? Are the effects of conservation practices additive, contradictory, or independent?
3. What social and economic factors within the study watershed either facilitate or impede implementation or proper maintenance of conservation practices?
4. What is the optimal set or suite of conservation practices and what is their optimal placement within the watershed in order to achieve water quality goals or to provide acceptable reductions in water quality impairments?

The 13 watershed projects also were required to implement an extension-outreach activity. Through this extension effort, agricultural producers, key stakeholders, and citizens in these watersheds are engaged in the implementation of the projects. These extension efforts address factors encouraging or inhibiting adoption of conservation practices as well as

those factors affecting maintenance of implemented practices.

In 2007, CSREES and NRCS jointly funded two additional projects with the aim of synthesizing the results of the 13 previously funded watershed case studies. The two synthesis projects will build a knowledge base that can be used to evaluate impacts of conservation practices and programs on water resources, improve the management of agricultural landscapes to achieve environmental goals, and inform conservation policy. The two projects will also provide outreach to key stakeholder groups within the conservation community.

NRCS Special Emphasis Watershed Studies. The special emphasis watershed studies address the effects of conservation practices on water quality and quantity for specific issues or resource concerns. Initiated in 2004, these studies include a mixture of research, monitoring, and modeling activities. A total of 11 three-year special emphasis watershed studies were selected to address specific issues such as land application of animal waste, soil erosion, drainage management, or water conservation and use on irrigated land (figure 1).

Three of the special emphasis watersheds are now also designated as ARS benchmark watersheds. These are the Upper Snake River/Rock Creek watershed, Idaho; the Choptank River watershed in the Chesapeake Bay watershed, Delaware and Maryland; and the Leon River watershed, Texas. The Cheney Lake special emphasis watershed in Kansas transitioned into a CSREES competitive grant watershed in 2006.

The most recent special emphasis watershed was initiated in 2007 in Jobos Bay, Puerto Rico. This watershed study is a partnership among NRCS, ARS, and the National Oceanic and Atmospheric Administration. The main objective of the Jobos Bay special emphasis watershed is to determine the environmental effects that agricultural conservation practices implemented on the landscape may have on coastal waters and associated habitats in a tropical ecosystem.

Many different models are being studied in the special emphasis watersheds. Most watersheds are using either SWAT or AnnAGNPS to assess conservation effects, but other models to be evaluated include Spatially Referenced Regressions on Watershed Attributes (SPARROW), REMM, APEX, MIKE SHE, and Conservational Channel Evolution and Pollutant Transport Systems (CONCEPTS) models. Most of the special emphasis watersheds address cropland issues, but five include a high proportion of grazing lands (pasture or range) in the watersheds. These five are the Leon River and North Bosque River watersheds in Texas; Wood River and Sprague River watersheds, both in the Upper Klamath Lake basin, Oregon; and the Stemple Creek watershed in California. The Sprague River project also includes aquatic species studies and economic analyses.

Final reports for the original 10 special emphasis watershed studies are scheduled for completion at the end of 2008. A few special emphasis watershed studies will continue beyond 2008, including Jobos Bay, which was started in 2007. The four special emphasis watershed studies that are now either ARS benchmark watershed studies or CSREES competitive grant watershed studies will continue their research activities as well.

NATIONAL AND REGIONAL ASSESSMENTS

CEAP national and regional assessments include (1) Cropland, (2) Wetlands, (3) Wildlife, and (4) Grazing Lands Components. During the first five years, the CEAP national and regional assessments were focused primarily on quantifying the effects and benefits of existing conservation practices on water quality and soil quality on cropland. The scope was broadened over the five years to include the ecosystem services derived from wetland restoration and protection in agroecosystems, the benefits of conservation practices to wildlife, and the effects of conservation practices on grazing lands (rangeland, pastureland, and grazed forest land).

The four components were initiated at different times, and so are in different stages of development. The Cropland Component was initiated in 2003, and regional assessments are scheduled for completion in 2008 and 2009. The first regional assessment for the Wetlands Component was initiated in 2004, and data collection has since been initiated in four additional regions. The Wildlife Component initiated several special studies beginning in 2005. The Grazing Lands Component was established in 2006, and data collection efforts have only recently been initiated. All components are taking a regional approach and will be aggregated at the national level as appropriate. In some cases, regional differences in resource concerns, practices used, and available data require analytical approaches tailored to specific regions. The following pages describe the general analytical approach and the status of activities currently underway for each component:

- CEAP Cropland Component
- CEAP Wetlands Component
- CEAP Wildlife Component
- CEAP Grazing Lands Component

CEAP Cropland Component

The three goals for the CEAP Cropland assessment are (1) to estimate the benefits of conservation practices currently present on the landscape, (2) to estimate the need for conservation practices and the benefits that could be realized under full conservation treatment of the land, and (3) to simulate alternative options for implementing conservation programs on cropland.

Cropland Assessment Overview. About 1.25×10^8 ha (3.10×10^8 ac) of cultivated cropland exists in the United States. Different systems of conservation practices are needed to protect the soil and other resources on cultivated cropland in different parts of the country. Soils, climate, and topography vary from region to region; resource concerns vary with regional variations in this resource base.

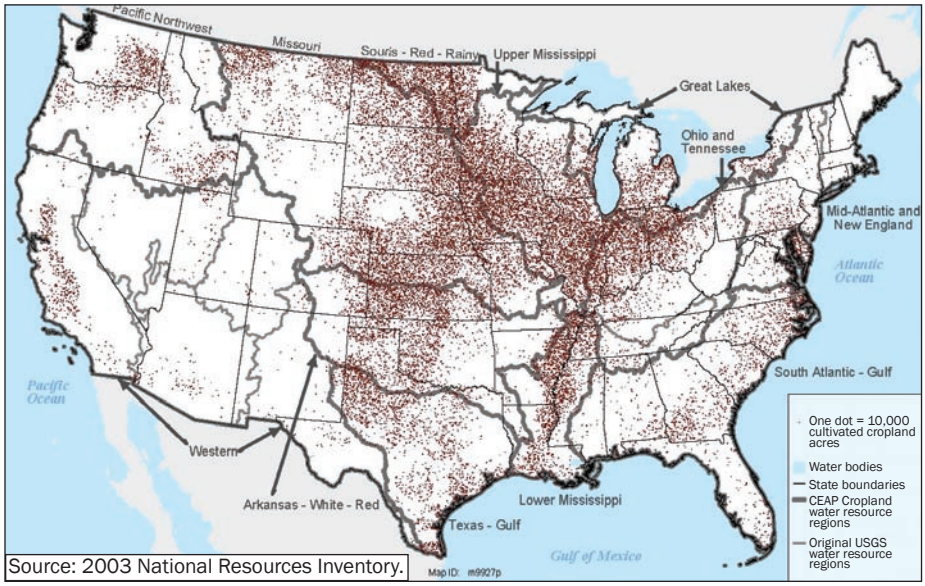
Even in areas with relatively consistent cropping systems, farming practices can be substantially different from one field to another. Moreover, the effects of conservation practices on cropland will change from year to year at any given point depending on weather conditions.

CEAP Cropland Approach. In order to capture this diversity in both resource condition and natural resource management, NRCS implemented a statistical sampling and modeling approach for CEAP. There are four basic steps to the approach:

1. Select a sample that is statistically representative of cultivated cropland at the national and large regional levels, such as major river basins. The National Resources Inventory (NRI) provided the sample frame. The NRI CEAP sample consists of about 20,000 NRI sample points on cultivated cropland and represents about 98% of the nation's cultivated cropland (figure 2). Because the sample is drawn statistically, each sample point can be assigned an acreage weight that is used to aggregate the physical process model results.
2. Conduct a farmer survey—the NRI CEAP Cropland Survey—in cooperation with the USDA National Agricultural Statistics Service (NASS) to obtain information needed for modeling at each sample point. Farmers provided information on farming activities (e.g., field operations, nutrient applications, pesticide applications, and manure applications) for three consecutive years. Farmers, local NRCS field offices, and the NRI database provided information on the conservation practices associated with each sample point (USDA NRCS 2006).
3. Use a field-scale physical process model—APEX—to simulate erosion, sediment loss, nutrient loss, pesticide loss, and changes in organic carbon at the field level for each sample point (Gassman et al. 2004).
4. Integrate these field-scale model results with a national water quality model—SWAT/HUMUS—that assesses offsite

Figure 2

Distribution of cultivated cropland and water resource regions.



Source: 2003 National Resources Inventory.

Figure 3

Modeling strategy used to simulate the effects of conservation practices on cultivated cropland.

1. Estimate a CEAP baseline using farmer survey information at National Resources Inventory sample points.

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2. Construct an alternative scenario assuming "no practices."

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3. Difference between these two scenarios represents the benefits of the accumulation of conservation practices currently in place on the landscape.

estimates of water quality benefits. This model is a combination of the SWAT model (Neitsch et al. 2002) and the Hydrologic Unit Modeling for the United States (HUMUS) databases required to run SWAT at the eight-digit hydrologic unit code watershed scale for all watersheds in the United States (Srinivasan et al. 1993; Arnold et al. 1999). It simulates the transport of water, sediment, pesticides, and nutrients from the land to receiving streams and routes the flow downstream to the next watershed and ultimately to the estuaries and oceans. For noncropland and noncultivated cropland, the SWAT model simulates loadings into streams and rivers.

Two model scenarios are produced for each NRI CEAP sample point: (1) The "current conservation condition" scenario provides model simulations that account for current cropping patterns, farming activities, and conservation practices on cultivated cropland. (2) The "no-practices" scenario simulates model outputs as if no conservation practices were in use but holds all other model inputs and parameters the same as in the current conservation condition scenario. The effects of conservation practices are obtained by calculating the difference in model outputs between the two scenarios (figure 3).

For onsite (field-level) effects, the national and regional average per-acre reductions are calculated for model outputs on surface water and percolation volumes, sediment delivery, wind erosion rate, nutrient losses for various pathways, pesticide leaching, and runoff losses. For offsite water quality effects, reductions in sediment, nutrient, and pesticide loadings and concentrations attributable to conservation practices in the watershed or basin are reported.

Status of CEAP Cropland. Data collection was completed in 2007, and construction of model input databases by region is currently in process. Field-level results will be summarized and reported for major river basins and at the national level, and offsite water quality results will be reported by major river basin and selected four-digit watersheds where sample sizes are adequate for reporting. Plans are to complete the assessment for the Upper Mississippi River Basin by fall 2008, followed by assessments of the four other basins in the Mississippi drainage (Ohio-Tennessee, Missouri, Lower Mississippi, and Arkansas-White-Red) by early 2009. Six remaining basins where sample size allows estimation will be completed in 2009 (Mid-Atlantic, South Atlantic-Gulf, Great Lakes, Souris-Red-Rainy, Pacific Northwest, and Texas-Gulf). A final report summarizing onsite effects of practices at the national level is scheduled for the end of 2009.

CEAP Cropland is a collaborative effort involving scientists and modelers from NRCS; ARS; Texas Agricultural Experiment Station, Temple, Texas; University of Massachusetts, Amherst, Massachusetts; and the Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa.

CEAP Wetlands Component

The CEAP Wetlands Component has two goals: (1) to routinely provide science-based data, results, and information to inform conservation decisions affecting wetland ecosystems and the services they provide, and (2) to develop a broad collaborative foundation that facilitates the production and delivery of scientific data, results, and information.

Wetlands Assessment Overview. CEAP Wetlands uses a regional approach to quantify the effects of conservation practices and programs on ecosystem services—for example, sediment, nutrient, and pesticide reduction; flood mitigation; and water quality sustainability and water partitioning—provided by wetlands and associated ecosystems in agricultural landscapes.

The following five objectives guide the Wetlands Component:

1. Conduct collaborative regional investigations.
2. Build science alliances as the foundation of CEAP Wetlands.
3. Document the scientific knowledge base and gaps in knowledge to understand the effects of conservation practices and programs on wetland ecosystem services.
4. Analyze NRCS conservation practice and program data to support CEAP Wetlands research and assessment activities.
5. Develop a national wetlands monitoring process to improve decisions affecting wetlands conservation.

CEAP Wetlands Approach. The regional focus of CEAP Wetlands was developed to capture the diversity of wetlands, conservation practices and programs, and types of natural and anthropogenic gradients affecting wetlands. In addition, the Wetlands Component was designed to address ecosystem services provided by wetlands in agro-ecosystems (i.e., benefits provided by wetlands to people (Millennium Ecosystem Assessment 2003).

Collaborative regional investigations (objective 1) provide the foundation for the following activities of the Wetlands Component:

1. Collect biophysical data on wetlands in a variety of conditions ranging from relatively unaltered to highly altered and quantify the ecosystem services provided.
2. Estimate the effects of conservation practices and programs based on where the wetland falls on the wetland alteration gradient, compared to where it would be without conservation practices.
3. Develop predictive models of wetland condition that are functions of observable factors that influence the capacity

for a wetland to provide an ecosystem service.

4. Develop integrated landscape modeling capability to account for the temporal and spatial variability that influences a point-in-time estimate of ecosystem services, such as natural disturbances (fire, drought, floods) and human actions (conservation actions, land use change).

Preliminary information from the regional investigations, particularly those conducted early in CEAP Wetlands, are point-in-time estimates. That is, they are temporally and spatially constrained estimates of ecosystem services resulting from implementation of conservation practices and programs to establish or manage wetlands in agro-ecosystems. The regional investigations also provide multiple-scale data to identify factors that influence the capacity for a wetland to provide an ecosystem service within a predicted range of estimates. This information will be developed into regionally specific predictive wetland condition indicator models.

Efforts to quantify wetland ecosystem services to interpret conservation effects under existing or future conditions are challenged by the lack of modeling and data collection mechanisms that capture the temporal and spatial variability of wetland ecosystems. Such mechanisms would routinely provide information to improve decisions affecting wetlands conservation and provisioning of services. Research collaborations with the US Geological Survey (USGS) Northern Prairie Wildlife Research Center and the USGS National Wetlands Research Center are currently underway to investigate the development of a temporally robust, spatially explicit integrated landscape model and remote-data-capture technologies.

A complementary research study, led by the ARS Hydrology and Remote Sensing Lab, Beltsville, Maryland, was initiated in 2007. This study is investigating the application of several remote sensing tools to capture data that ultimately can be used to predict ecosystem services within a geographic information system (GIS) framework. The GIS-based landscape tool developed from the ARS study will be merged with the USGS integrated landscape model developed to produce a prototype for operational testing that will ultimately lead to GIS-based landscape modeling capability.

Eleven geographic areas of the conterminous United States have been identified (figure 4) to focus regional investigations. The regions represent areas with significant wetland losses caused by agricultural activities, and where significant USDA conservation resources have been invested to reestablish, manage, or otherwise conserve wetland ecosystems and the services they provide.

The regional studies are collaborations with numerous federal, academic, and nongovernmental organization scientists. In addition, NRCS, local conservation districts, and the USDA Farm Service Agency contributed to the regional studies by providing conservation practice information, assisting in site selection for sampling, and supplementing financial resources.

Status of CEAP Wetlands. Preliminary findings are available for the Prairie Pothole Region (Gleason et al 2008) and Mississippi Alluvial Valley (Faulkner et al. 2008). Each study focused on the dominant wetland type associated with agriculture in that region. The Prairie Pothole regional study emphasized the effects of enrollment in the CRP and WRP on prairie pothole wetlands. Preliminary predictive wetland condition models will be developed for selected ecosystem services. A companion study focuses on factors affecting occupancy of amphibian species inhabiting seasonal wetlands across the alteration gradient.

Preliminary findings from the Mississippi Alluvial Valley were derived from two sources: (1) data collection on bottomland hardwood wetlands in the Lower White/Cache River Basins, Arkansas, and the Tensas River Basin, Louisiana, and (2) geospatial analyses for the entire Lower Mississippi Valley relative to metrics associated with habitat suitability and biological sustainability ecosystem services. Sampling in the Yazoo River Basin, Mississippi, is underway.

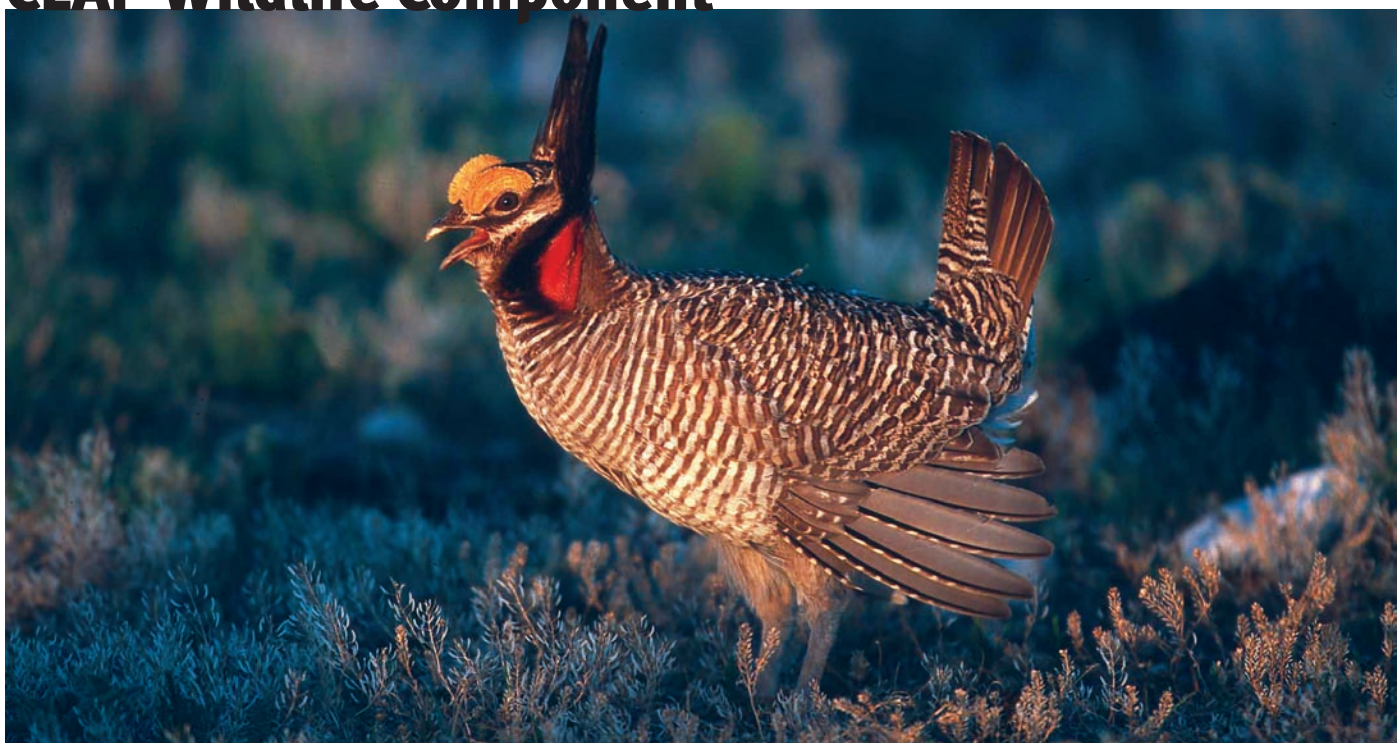
Point-in-time estimates and other information will be produced from the High Plains region, California Central Valley/California-Oregon Intermountain region, and Mid-Atlantic Rolling Coastal Plain and Coastal Flats region beginning in 2008.

Figure 4

Regions identified for CEAP Wetlands regional assessments.

Source: USDA Natural Resources Conservation Service and US Geological Survey digital elevation model data.

CEAP Wildlife Component



The CEAP Wildlife component seeks to quantify the effects of USDA conservation programs and practices on select fish and wildlife species—including the lesser prairie-chicken, an important resident of portions of the southern Great Plains—and their habitats.

Wildlife Assessment Overview. The myriad effects of the many conservation practices on innumerable fish and wildlife species and communities are difficult to comprehend, let alone quantify. Individual practices are typically applied in concert with many other practices within conservation systems. Many practices benefit some species while harming others. For example, planting trees for windbreaks and shelterbelts can attract species that thrive in diverse habitats but degrade habitat quality of species that require open grasslands.

CEAP Wildlife Approach. CEAP Wildlife is an effort to quantify the effects of USDA conservation programs and practices on fish and wildlife and their habitats. Unlike other components of the national/regional assessments, which focus on specific land use/land cover categories, the wildlife component focuses on fish and wildlife habitat concerns, regardless of land use or land cover. Therefore, the Wildlife Component also links to the Cropland, Wetlands, and Grazing Lands components to the extent possible.

NRCS is leading CEAP Wildlife. Numerous other organizations, including other federal agencies, nongovernmental organizations, universities and other academic institutions, and state fish and wildlife agencies have provided input to and assistance with planning and conducting CEAP Wildlife assessments.

The effects of conservation programs and practices on fish and wildlife are quantified by documenting the following attributes:

1. Habitat use by target species or groups associated with conservation actions
2. Changes in habitat quality for target species or groups attributable to conservation actions
3. Measured target species population response to conservation actions

The most reliable predictor of conservation effects may be the quantification of the change in habitat quality or suitability for target species. A focus on habitat quality is useful in predicting the potential for habitats to provide the conditions necessary for target species to survive and reproduce. The CEAP Wildlife approach attempts to compile documentation from all three categories of effect (habitat use, habitat quality, and population response), wherever feasible and to the extent possible, with an emphasis on measures relating to habitat quality and availability.

The effort focuses mostly on quantifying effects of common practices and conservation systems on particular fish and wildlife species or species groups for which documentation is available or obtainable in the near future. Much of the effort to assess wildlife response is focused at the regional level to match the diversity of fish and wildlife resources, agricultural landscapes, and conservation programs and practices applied across the country. Broad geographic regions were identified to correspond loosely to regional associations of fish and wildlife agencies: Midwest, Southeastern, Northeastern, and Western.

Input from state fish and wildlife agencies and other conservation interests was obtained through workshops, surveys, and meetings conducted in partnership with the Association of Fish and Wildlife Agencies. Through this process, prominent fish and wildlife species or groups in each region likely affected by USDA conservation activities were identified along with relevant conservation programs and practices. Interaction with the fish and wildlife conservation community has also helped to identify data sources and assessment approaches for meeting assessment needs.

Table 1
CEAP Wildlife assessment projects (as of January 2008).

Project lead	Year initiated	Practice type(s) addressed	Region	Wildlife focus	Assessment topic	Status
Wildlife Society	2004	All	National	All	Literature synthesis of documented effects of conservation programs and practices on fish and wildlife	Program-based synthesis complete 2005; practice-based synthesis complete 2007
NatureServe	2005	All practice types, with emphasis on pasture and hay planting	Midwest	At-risk terrestrial and aquatic species	Using NatureServe information to assess conservation practice effects on at-risk species (Missouri pilot)	Final report complete 2007; CEAP science note complete 2007
University of Northern Colorado	2005	Conservation cover, CRP enrollments	Midwest, South, East	Grassland nesting birds	Grassland bird response to CRP-related land use changes (using NRI and Breeding Bird Survey data to assess landscape-level bird response)	Final report complete 2007; CEAP science note in development
University of Missouri	2006	Wetland restoration, WRP enrollments	Midwest	Wetland birds, amphibians	Assessing wildlife habitat value on restored wetlands in Missouri through analysis of WRP ecological monitoring data	Interim report complete 2007; CEAP conservation insight complete 2008
Playa Lakes Joint Venture	2006	Conservation cover, wetland restoration, CRP, WRP	Great Plains	Grassland-dependent birds, wetland birds	Estimated contributions of CRP and WRP habitats toward conservation goals of priority grassland and wetland birds in the mixed-grass prairie region	Final report complete 2007; conservation insight in development
Mississippi State University	2006	Upland buffers	Southeast, Midwest	Northern bobwhite, songbirds	National evaluation of wildlife benefits of CRP practice CP33 (Habitat Buffers for Upland Birds)	Interim reports complete 2006 and 2007; final report expected 2009
University of Massachusetts–Amherst	2006	Early successional habitats	Northeast	Scrub-shrub birds	Assessing the benefits of conservation practices for scrub-shrub birds in New England	Literature review complete 2007; final report expected 2009
Nature Conservancy	2007	Soil and water practices applied to cropland	Upper Midwest	Freshwater aquatic biota	Development of a freshwater aquatic health indicator for use with CEAP Cropland modeling output in the Upper Mississippi Basin	Final report expected 2008
USDA National Agricultural Library	2007	All	North America	All	Literature bibliography on the effects of conservation practices on fish and wildlife	Final bibliography expected 2008
Missouri Resource Assessment Partnership, University of Missouri	2007	Upland, riparian, and in-stream practices	Midwest	Freshwater aquatic biota	Use of Aquatic GAP stream fish survey and practice application data to assess practice effects on aquatic biota in the Missouri River Basin	Missouri River Aquatic GAP and human stressor analysis report expected 2008
University of Nebraska–Lincoln	2007	Conservation cover, CRP enrollments	Midwest	Northern bobwhite, ring-necked pheasant	Use of rural mail carrier wildlife surveys to assess benefits of farm bill programs in the Great Plains	Final report expected 2009
Pennsylvania State University	2007	Fish passage, dam removal	Northeast	Freshwater aquatics	Evaluating biological effects of dam removal on streams in Pennsylvania	Final report expected 2009
National Wetlands Research Center, US Geological Survey	2007	Wetland restoration	West	Waterfowl, shorebirds	Use of Doppler weather radar to determine bird use of WRP restored wetlands in California	Final report expected 2010

Notes: CRP = Conservation Reserve Program. NRI = National Resources Inventory. WRP = Wetlands Reserve Program.

CEAP Wildlife Status. CEAP Wildlife has initiated assessment projects intended to quantify the effects of various types of conservation practices on fish and wildlife in response to needs identified at the regional level (table 1). Two recently completed wildlife literature reviews reveal that whereas many studies have been conducted that document the benefits of conservation programs and practices to fish and wildlife, large gaps remain in our understanding of how various conservation practices affect the many fish and wildlife resources associated with agricultural landscapes. Most of the scientific literature relates to the field-scale effects of CRP enrollments on habitat quantity and quality for birds.

CEAP Wildlife assessments use this baseline knowledge as a starting point for fostering innovative approaches to quantifying effects while building the science base necessary for future assessments, particularly for non-avian and aquatic species and for landscape-level assessments. These projects involve cooperative agreements or other partnership arrangements to engage experts in the field of fish and wildlife biology and management to help quantify the effects of practices and to use existing natural resource and conservation practice information wherever possible.

Other CEAP national assessment components (e.g., Wetlands and Grazing Lands) are also addressing the effects of land use and land cover on fish and wildlife habitat. Several of the CEAP watershed studies include elements that assess effects of some practices on biodiversity and habitat at the watershed scale. In addition, contributions to our understanding of the effects of conservation practices or programs are being made by others, including assessments of the effects of CRP on select bird populations sponsored by Farm Service Agency (Nielson et al. 2006; Schroeder and Vander Haegen 2006; Niemuth et al. 2007; Reynolds et al. 2007; Riffell et al. 2007) and various studies supported by the NRCS Agricultural Wildlife Conservation Center. CEAP Wildlife is also working with these entities to link relevant findings to CEAP.

CEAP Grazing Lands Component

CEAP Grazing Lands is designed to quantify the environmental effects of conservation practices on nonfederal grazing lands—rangeland, pastureland, and grazed forest land—in the United States.

Grazing Lands Assessment Overview. Established in 2006, the grazing lands component is in the early stages of development. CEAP Grazing Lands will quantify the environmental effects of conservation practices on nonfederal rangeland, pastureland, and grazed forest land. There are currently about 2.33×10^8 ha (5.76×10^8 ac) of nonfederal grazing lands in the conterminous United States (1.64×10^8 ha [4.05×10^8 ac] of rangeland, 4.7×10^7 ha [1.17×10^8 ac] of pastureland, and 2.2×10^7 ha [5.4×10^7 ac] of grazed forest land) (figure 5).

Estimating the effects of conservation practices on grazing lands is more challenging than it is on cropland because of highly diverse landscapes, soils, climate, land use, and management. The grazing lands environment in the western United States is especially challenging. There, the ecology and use of rangelands are intertwined for nonfederal and federal lands related to invasive species, wildlife habitat, grazing enterprises, water quality, and water quantity. The interplay of climate, topography, organisms, soil parent material, and land management yield a succession of plant communities over time, further influenced by episodic disturbances such as fire and flood. The environment for pastureland and grazed forest land in the eastern United States and elsewhere is a complicated mosaic of interdependent landscape patterns interwoven with cropland, and with variable land-use histories.

CEAP Grazing Lands Approach. The objectives of CEAP Grazing Lands are (1) to document the scientific knowledge base and gaps in knowledge related to the effects of conservation practices and programs on grazing land ecosystem services and (2) to estimate the effects of conservation practices on grazing lands at the regional and national levels using a combination of data collection and modeling. This knowledge will support estimation of conservation benefits at multiple spatial scales.

There are three scales of investigation for CEAP Grazing Lands:

1. A national assessment to provide estimates of conservation benefits at the national scale for annual reporting
2. Watershed-scale assessments to provide more detailed, landscape-specific information about grazing land conservation practices and environmental benefits
3. A field-scale assessment to provide on-site science-based benefits

Grazing lands include rangeland, pastureland, and grazed forest land.

NRCS rangeland NRI data, which includes a comprehensive, detailed set of rangeland protocols, will be used as an analytical framework for statistical analyses and simulation modeling. The current NRCS rangeland NRI includes an array of indicators of rangeland health; species composition, productivity, and canopy; existing conservation practices; and several other factors.

The current, strengthened NRI rangeland data collection effort will provide the following:

Table 2

CEAP Grazing Lands projects (as of June 2008).

Activity	Pacific	Inter-Mountain	Great Plains	East
CEAP project	Multi-model support, ARS, Reno, Nevada	RHEM model support, ARS, Boise, Idaho	Colorado State University CEAP pilot, Fort Collins, Colorado	Pasture biodiversity, ARS, University Park, Pennsylvania
Literature synthesis: rangeland	Plant physiology & modeling, NASA-Ames, California	Multi-model support, ARS, Tucson, Arizona	Functional Plant Groups study, Texas A&M University, College Station, Texas	Pasture modeling, ARS, Coshocton, Ohio
Literature synthesis: pastureland		CEAP National Resources Inventory integration testing, ARS, Jornada Range, New Mexico		

- Estimates of reductions in soil loss from rangeland
- Correlations of field-scale soil loss and runoff reductions with NRCS rangeland conservation practices
- Estimates of surface runoff from rangeland with and without conservation practices
- Evaluations of the effect of past and present conservation practices
- Evaluations of grazing land conservation practices for plant productivity and quality of vegetation
- Analysis of relationships between conservation practices and biotic integrity, apparent rangeland trend, and other variables

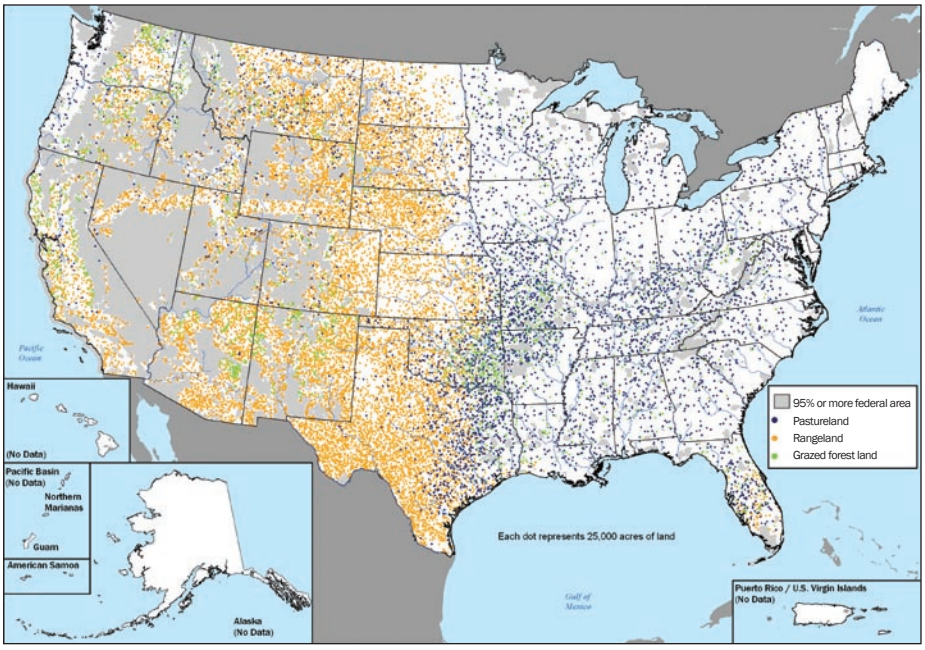
Pastureland is generally more agronomically managed than rangeland. Draft pastureland NRI protocols have been developed and need to be implemented in a similar fashion as described above for the rangeland NRI. These protocols will provide more detailed data than currently exist to increase our understanding of the national condition of agronomically managed grazing lands.

Status of CEAP Grazing Lands. The following investigations are planned:

- Estimates of the effects of grazing lands conservation practices on water quality for reporting at the regional and national levels will be made using a modeling approach similar to that used for CEAP Cropland. Physical process models will assess factors such as erosion and nutrient export that affect water quality at the field level, using a subset of NRI sample points. These model simulations will be integrated into the same national water quality model used in the Cropland Component—SWAT/HUMUS—to assess reductions in in-stream loadings of sediment and nutrients due to current grazing lands conservation practices.
- Case studies will be established to conduct research on practice effects at the field and landscape scale and to provide validation data for the national and regional assessments. Development and testing of modeling approaches and techniques will be a primary focus.
- CEAP Grazing Lands will examine a variety of environmental variables to determine, among other things, the impacts of conservation practices on water quality and quantity; effects of spatial and temporal distribution of conservation practices; appropriate time scale to observe benefits; risks and uncertainties associated with estimating benefits; interactive effects among environmental variables; and optimal spatial distribution of practices to achieve benefits.

Figure 5

Distribution of nonfederal grazing lands in the United States.



Source: 2003 National Resources Inventory.

The basic research—performed by ARS, CSREES, universities, and other entities—that will provide the quantitative information to make these assessments is highly dependent on site-specific characterization. The mathematical models that predict environmental performance also depend on site-specific characterization, and much of the research effort is dedicated to properly defining the background conditions against which management practices are evaluated. These models require detailed characterization and calibration (table 2).

The most effective tool for calibrating local conditions to improve model performance is the ecological site description, which integrates soil, vegetation, and landscape position factors to alter process rates and magnitudes and get a reasonable output at a relevant scale.

SUMMARY AND CONCLUSIONS

CEAP defined and initiated a research and assessment agenda for estimating the effects and benefits of conservation practices and programs. CEAP accomplishments during the first five years include the following:

- USDA established 38 research sites—ARS benchmark watersheds, CSREES competitive grant watersheds, and NRCS special emphasis watersheds—to quantify the measurable effects of conservation practices on the quality or quantity of water and soils.
- CEAP Cropland developed and implemented a new environmental and conservation farmer survey for cultivated cropland. Survey information was combined with natural resource information at NRI sample points to provide preliminary estimates of reductions in soil loss, nutrient loss, pesticide loss, and enhancement of soil quality that are attributable to conservation practices.
- CEAP Wetlands initiated studies in five regions to quantify wetland ecosystem services affected by conservation practices. Preliminary findings have been produced for the Prairie Pothole and Mississippi Alluvial Valley regions.
- CEAP Wildlife initiated regional assessment studies focused on documenting important wildlife species habitat associations with conservation activities.
- CEAP Grazing Lands developed a plan for assessing the effects of conservation practices for rangelands, pastureland, and grazed forest land.
- The NAL provided researchers and the public with extensive bibliographies of research findings on the effects of conservation practices.
- ARS and the SWCS completed a synthesis of the scientific literature on the effects of conservation practices on cropland.
- The Wildlife Society completed two literature reviews of the effects of conservation practices and programs on wildlife.
- NRCS engaged SWCS to review CEAP and recommend enhancements to the program, and followed the recommendations of the SWCS Blue Ribbon Panel to expand the scope of CEAP to include program enhancements.
- An international workshop was held—"Managing Agricultural Landscapes for Environmental Quality"—to enhance the understanding of how individual efforts on farms and ranches add up to real and meaningful results at the watershed or landscape scale.

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