ASSESSING THE NATIONAL EFFECTS OF CONSERVATION—FOR THE FIRST TIME (CEAP)

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INTRODUCTION

The Conservation Effects Assessment Project (CEAP) began in 2003 as a multi-agency effort to quantify the environmental benefits of conservation practices used by private landowners participating in U.S. Department of Agriculture (USDA) conservation programs. The project consists of three components:

- National Assessment - Providing national summary estimates of conservation practice benefits and assessing the potential for USDA conservation programs to meet the nation's environmental and conservation goals. Cropland, wetlands, wildlife and grazing lands will be assessed.
- Watershed Assessment Studies - Basic research on conservation practices in selected watersheds nationwide to provide a framework for evaluating and improving performance of national assessment models.
- Bibliographies and Literature Reviews - Current literature on conservation programs. Two literature reviews in progress will document what is known and not known about the environmental benefits of conservation practices and programs for cropland and wildlife.

The purpose of this paper is to briefly review the activities underway as part of the CEAP National Assessment. More information about CEAP can be found at www.nrcs.usda.gov/technical/NRI/ceap.

The National Assessment component of the Conservation Effects Assessment Project (CEAP) will provide scientifically credible estimates of the environmental benefits obtained from USDA conservation programs. The National Assessment component has two goals:

- Provide NRCS and the conservation community with quantitative estimates of the benefits of conservation practices for national and regional reporting.
- Assess the potential for existing conservation programs and future alternatives to meet the Nation's environmental and conservation goals.

Currently, there are four active components within the National Assessment:

- Wildlife component
- Wetlands component
- Grazing lands (pastureland and rangeland) component
- Cropland component

WETLANDS

The Wetlands Component of the Conservation Effects Assessment Project (CEAP) National Assessment quantifies the environmental, biological and ecological effects of wetland conservation practices and systems on agricultural landscapes. On-site and off-site conservation effects will be derived from collaborative regional assessments in the conterminous United States. Each assessment will focus on one or more wetland hydrogeomorphic classes dominant on agricultural landscapes in that region. Regional conservation effects will be interpreted by quantifying ecosystem services provided by each regional wetland class. The following wetland ecosystem services will be quantified, depending on the regional wetland class of interest:

- Biological conservation and sustainability
- Habitat quality
- Sediment and nutrient reduction
- Pesticide reduction
- Carbon sequestration in soils and vegetation
- Floodwater storage, reduction and attenuation
- Greenhouse gas emissions reduction
- Groundwater recharge

Regional assessments are developed in collaboration with researchers involved in ongoing or previous investigations complementary to the CEAP wetlands effort. Data gaps are identified, and new data are collected or measured at site and landscape scales using sampling designs developed for each regional class. A "reference-based" approach is used to quantify wetland ecosystem services and interpret conservation effects. USDA program wetlands and non-program wetlands that lie along an 'alteration gradient' are sampled in each region. Measures of conservation effects (i.e., the type of information to be quantified) and the specific variables to be collected or measured are identified for each regional wetland class ecosystem service. Data is collected or measured through field sampling, and using remote sensing data and Geographic Information Systems (GIS).

The regional assessments will provide the following types of products:

- Regional quantifiable estimates of wetland ecosystem services before conservation practice/system implementation (i.e., "baseline" conditions) and after practice/system implementation (i.e., "conservation" conditions) and the quantitative difference between the two conditions (i.e., "conservation effect");
- Regional predictive functional condition indicator models to identify site and landscape factors (i.e., variables) that influence wetland ecosystem service estimates;
- Estimates of modeled (i.e., simulated or predictive) conservation effects under varying environmental conditions or program scenarios;
- Analytical tools/models for selected ecosystem services.

WILDLIFE

The Wildlife Component of the Conservation Effects Assessment Project (CEAP) is an effort to quantify the effects of USDA conservation practices and programs on fish and wildlife in landscapes influenced by agriculture in the United States. The Wildlife Component links to and complements the CEAP Cropland Component by addressing fish and wildlife population responses and habitat issues that are not obtainable through its sampling and modeling framework. Because fish and wildlife are affected by conservation actions taken on a variety of landscapes, the Wildlife Component also links to the Wetlands Component and Grazing Lands Component to the extent possible.

Since 1985, the wildlife conservation community -- state and federal agencies and non-governmental organizations (NGOs) -- viewed USDA conservation programs as a key element in effective fish and wildlife habitat management. These entities have spent considerable effort to help deliver these programs and to evaluate their effectiveness. The primary approach of the CEAP Wildlife Component is to engage these groups, apply information already collected on wildlife effects, and solicit their assistance in initiating additional work to fill remaining data gaps and develop modeling and other approaches to quantify conservation practice effects. A task force consisting of a diverse mix of agency and NGO representatives has developed an approach and a framework for developing a detailed work plan. This approach includes incorporation of numerous ongoing activities that can be used to explain conservation practice effects on fish and wildlife, as well as additional actions that will contribute to the effort.

GRAZING LANDS

The grazing lands component of the CEAP National Assessment will quantify the environmental effects of conservation practices used on pastureland and rangeland. A group of grazing lands scientists and conservation experts met in 2004 to discuss how best to proceed. A report was prepared that included the overall objectives, data availability, complimentary ARS research endeavors, and a possible analytical framework. The group suggested that the national assessment be based on the National Resources Inventory (NRI) and modeling (such as use of WEPP/SPUR to estimate erosion reductions), and that the first step should be a comprehensive literature review and synthesis of what is currently known about the effects of conservation practices on pastureland and rangeland. It is anticipated that the comprehensive literature review will be conducted in 2006. The literature review will be conducted in a manner similar to those currently underway for cropland and wildlife, and thus serve as the third in a series of CEAP literature reviews.

A research project has been initiated to determine how Sustainable Rangeland Roundtable (SSR) criteria and indicators could be used in conjunction with the NRI Rangeland Field Study data (collected during 2003-2005) to estimate the effects of conservation practices on grazing lands. This will include an investigation of the indicators to see which will be appropriate to include when addressing the effectiveness of conservation applied on grazing lands. Investigators will focus attention on about five conservation practices and five resource issues.

CROPLAND

The purpose of the national assessment for cropland is to estimate the environmental effects of conservation practices applied to cropland. The assessment has four specific goals:

- Estimate the benefits of conservation practices currently present on the landscape.

- Estimate the need for conservation practices and the benefits that could be realized if appropriate conservation practices were implemented on all cropland.
- Simulate alternative options for implementing conservation programs on cropland in the future.
- Incorporate science-based estimates of practice benefits into NRCS's Performance Reporting System (PRS) to provide annual estimates of benefits for each program.

A sampling and modeling approach is used to estimate the benefits of conservation practices. First, a subset of National Resources Inventory (NRI) sample points has been selected to serve as "representative fields." NRI sample points provide the statistical framework for the model as well as information on soils, climate, and topography.

Second, USDA developed and implemented a new farmer survey to collect the information needed at the selected NRI sample points to run field-level process models and assess the effects of conservation practices. The National Agricultural Statistics Service (NASS) interviews cooperating farmers to obtain current information on farming practices (crops grown, tillage practices, nutrient and pesticide application, conservation practices, etc.)

Third, the physical process model called APEX (Agricultural Policy Environmental Extender) is used to estimate field-level benefits. APEX is a variant of the EPIC (Erosion Productivity Impact Calculator) model that allows us to estimate the effects of buffers, grassed waterways, and other erosion control practices. APEX allows estimation of the reductions in soil loss, reductions in nitrogen loss, reductions in phosphorus loss, and reductions in pesticide loss from farm fields. Pesticide loss will be expressed as reductions in pesticide risk. APEX will also allow soil quality enhancement to be evaluated.

And finally, CEAP is integrating the model output from APEX with another model called SWAT/HUMUS (Soil and Water Assessment Tool / Hydrologic Unit Model of the U.S.) to assess off-site benefits for water quality. HUMUS includes databases on land use and sources of non-point and point source pollutants that are used with the SWAT model to simulate the transport of water and potential pollutants from the land to receiving streams, and routes the flow downstream to the next watershed and ultimately to the estuaries and oceans. SWAT/HUMUS allows estimation of the reduction in in-stream concentrations of sediment, nutrients, and pesticides attributable to implementation of conservation practices.

OVERVIEW OF THE MODELING APPROACH

A microsimulation model built on the National Resources Inventory (NRI) will provide the basis for estimating reductions in sediment, nutrients, and pesticides from farm fields, increased water use efficiency, and enhancement of soil quality. While the NRI is designed to provide statistical information on the natural resources on private lands, it can also be used as an analytical framework for simulation modeling. Data on field management activities are obtained from farmer surveys and integrated with the information on land use, climate, and soil characteristics at each NRI sample point. This information is then used in conjunction with a field-level fate and transport process model to estimate the loss of materials from farm fields and other outcomes such as accumulation of soil carbon. The statistical sample weight associated with each sample point is used to aggregate the modeling results to the national or regional scale. The resulting simulation model captures the diversity of land use, soils, climate, and topography from the NRI, estimates the loss of materials from farm fields at the field scale where the science is best developed, and provides a statistical basis for aggregating results to the national and regional levels.

The CEAP Sample and Data Collection: A subset of about 30,000 NRI cropland and CRP sample points will be used to construct the simulation model for the national assessment on cropland, representing about 10 percent of the full NRI cropland sample. This sample constitutes the CEAP Farm Survey Database, and consists of a cropped subset and a CRP subset. Approximately 20 percent of the CEAP sample points will be fields enrolled in the CRP. In order to estimate the on-site effects of conservation practices, it is necessary to obtain information on farming practices (crops grown, tillage, nutrients and pesticides applied, conservation practices applied, etc.) at the selected NRI sample points. A farmer survey is being conducted to collect the needed information at CEAP sample points for the cropped subset. For the subset of points enrolled in the CRP, a link will be established to FSA's CRP database to obtain information on practices implemented. Since it is not possible to administer the survey for the full sample in a single year, survey data are collected over four years--2003 through 2006. The data are pooled for construction of the microsimulation model.

Field-Level Modeling: Field-level modeling will be conducted for the CEAP sample using the physical process model called APEX (Agricultural Policy/Environmental eXtender). APEX allows multiple land uses within a field to be simulated and includes a hydrologic component to route runoff from one land use to another. The EPIC routines are used in APEX to model outcomes for each land use within the field. EPIC is a continuous simulation model that has been widely used to determine the effects of management strategies on agricultural production and soil and water resources. For CEAP modeling, APEX will allow estimation of the effects of buffer strips and other conservation practices involving portions of the field that are not cropped. APEX simulates processes important in agricultural management as well as fate and transport of potential pollutants such as nitrogen, phosphorous, eroded soil, and pesticides. Recent versions of APEX and EPIC include carbon cycle routines from the Century model and pesticide fate and transport routines from GLEAMS. APEX operates on a daily time step, integrating daily weather data, soil characteristics, farming operations such as planting, tillage, and nutrient applications, and a plant growth model to simulate the growth and harvest of a crop. All farming operations that take place on the field throughout the year are taken into account. On a daily basis, APEX tracks the movement of water, soil erosion, the cycling of nitrogen, phosphorus, carbon, and pesticide loss. Model outputs represent pollutant and water movement to the bottom of the root zone and edge of the field. A wide variety of soil, weather, and cropping practice data input options allow simulation of most crops on virtually any soil and climate combination.

APEX model results will be obtained for each of the NRI sample points comprising the CEAP sample. Annual model output will include: volume of runoff, volume of percolate, soil erosion rate, sediment loss, nutrient loss, pesticide loss and an indicator of environmental pesticide risk, accumulation of carbon and phosphorus, and other related measures. Results will be aggregated to provide national and regional estimates of baseline conditions reflecting farming activities on cropland for the time period 2003-2006, corresponding to the years of farm survey data collection.

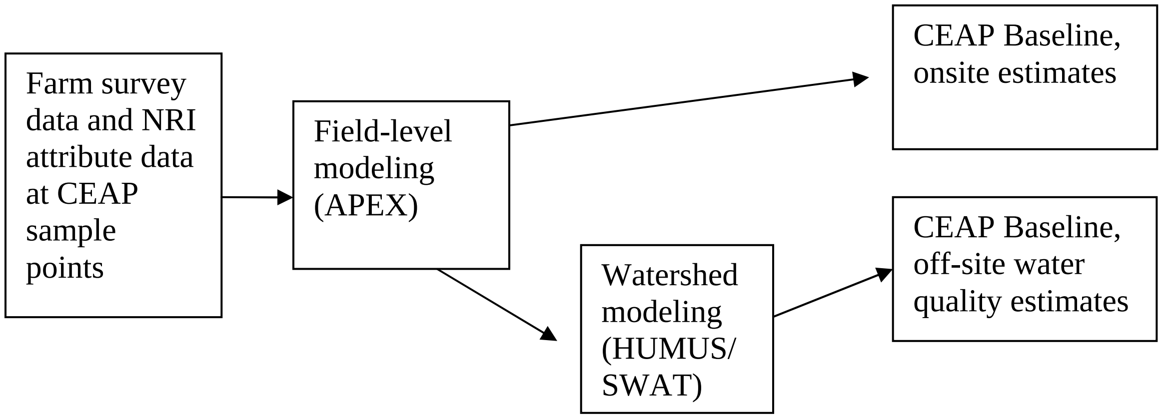

Figure 1. Flow Chart of Activities for Construction of the CEAP Baseline

Watershed-Level Modeling: Offsite estimates of water quality benefits will be assessed at the 8-digit hydrologic unit code watershed scale using a combination of models and databases called HUMUS (Hydrologic Unit Modeling for the United States). There are 2,263 8-digit watersheds in the U.S. The average size is about 10,000 square miles (or about 1.1 million acres). About two-thirds of these have significant cropland acreage. HUMUS includes databases on land use and sources of non-point and point source pollutants that are used with the SWAT model (Soil and Water Assessment Tool) to assess water quantity and water quality issues. SWAT 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. Outputs from the APEX model runs will be used to represent cultivated cropland in HUMUS. HUMUS/SWAT provides estimates of in-stream concentrations of potential pollutants at the outlet of each 8-digit watershed in agricultural regions.

Outcomes will be measured in terms of reductions in in-stream loadings and concentrations of nutrients, pesticides, and sediment attributable to implementation of conservation practices. The following outcome measures also will be estimated: 1) reductions in the number of days during the year that in-stream nitrogen concentrations exceed the drinking water standard, and 2) reductions in the number of days during the warm summer months that in-stream nitrogen and phosphorus concentrations exceed critical thresholds related to algal blooms and eutrophication.

Estimating Benefits of Conservation Practices: The CEAP Farm Survey Database, APEX, and HUMUS will be used to derive estimates of the CEAP Baseline Scenario as shown in figure 1. The CEAP Baseline represents the loss of potential pollutants from farm fields as represented by the farming practices reported in the CEAP Survey, including the presence or absence of conservation practices, and the instream concentrations associated with those farming activities.

In addition to the baseline, an alternative scenario will be constructed by assuming that no conservation practices were in use. For example, if a field associated with a sample point includes grassed waterways and a riparian buffer strip, the APEX model will be run for that sample point as if the grassed waterways and buffer strip were absent. By comparing this scenario to the CEAP baseline, the benefits of the conservation practices currently present on the landscape can be estimated.