Conservation Effects Assessment Project: Assessing Conservation Practice Effects on Grazing Lands

By Loretta J. Metz and Charles A. Rewa

On the Ground

- The USDA Natural Resources Conservation Service (NRCS) Conservation Effects Assessment Project (CEAP) is responsible for assessing and reporting on the effects of conservation practices provided through Farm Bill programs.
- Effects on resources, economics, and production capacity are assessed statistically through a combination of modeling, direct measurement, benefit transfer, and producer surveys.
- Results from CEAP-Grazing Land projects help guide NRCS conservation planning and policy, and provide grazing land managers with additional resources for successful management of their soil, water, air, plant, animal, and economic resources.
- A summary of projects and project status is provided.

Keywords: Conservation Effects Assessment Project, grazing land, Farm Bill, modeling, ecosystem services, rangeland.

Rangelands 41(5):227–232
doi 10.1016/j.rala.2019.07.005
© 2019 The Society for Range Management.

Background

In 2003, 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 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.[1]

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.[2] To effectively assess the benefits of conservation across the suite of natural resource concerns, CEAP is carried out through five national "components" focused on croplands, grazing lands, wetlands, wildlife, and special watersheds studies. The grazing lands component focuses on conservation assessments on noncropped agricultural production lands including rangeland, pastureland, and grazed forests.

By 2012, the grazing lands component of CEAP accomplished a milestone with two publications documenting the science behind 13 of NRCS's main conservation practices on rangeland[3] and pastureland.[4] These literature syntheses provided NRCS, ranchers, researchers, and partners a comprehensive assessment of the science, identified key knowledge gaps, and made recommendations for improving agency accountability, technology, and program policies.

Since those two seminal publications, the CEAP-Grazing Lands (CEAP-GL) component has been working with partners to more comprehensively determine the effects of grazing land conservation practices supported by NRCS. The following examples of CEAP-GL activities illustrate how these assessments contribute to outcome-based conservation efforts on grazing lands.

CEAP-GL Assessment Framework

Understanding the effects of various conservation treatments on grazing lands is necessary to inform suitable management actions. Effective conservation effects assessment considers both constraints and opportunities, people as well as places, and living and nonliving resources. Productive natural resource management often involves understanding

and balancing trade-offs associated with sustainable production of agricultural products while preserving ecosystem function and services provided by the land. Managers of grazing lands are called to make wise decisions to achieve a suitable and sustainable balance in those trade-offs. These decisions depend on and are informed by a range of reliable data. A primary focus of CEAP-GL is to provide the data needed by managers and agricultural producers to make wise land-use decisions on grazing lands.

Steven Levitt, coauthor of "Freakonomics," could have easily been speaking about the CEAP-GL conservation effects assessment framework when he stated, "Data, I think, is one of the most powerful mechanisms for telling stories. I take a huge pile of data and I try to get it to tell stories."[5] The heart of the CEAP-GL goal is to tell the story of using data to inform effective natural resource conservation and sustainable use of grazing lands in the United States.

Modeling Conservation Effects

Since 2004, the NRCS National Resources Inventory (NRI) Grazing Land On-site Data Study has been generating data on how patterns and distribution of land use, grazing land conditions, natural resource concerns, and environmental disturbances have changed over time. The dataset represents over 30,000 point locations on nonfederal lands spanning 17 western states and parts of Louisiana and Florida, and provides spatial and temporal snapshots of actual conditions that CEAP-GL uses as input data for computer simulation modeling of conservation effects. The results from the Agricultural Policy/Environmental eXtender (APEX) model are used by CEAP-GL to provide insight into conservation practice effectiveness based on degree of soil retention, water infiltration, plant growth, air quality, and carrying capacity for domestic and wild animals. These metrics will be used to develop a library of recommended conservation practice designs by region, soil, ecological site, and plant community that planners and land managers can use to help make adaptive grazing management choices that promote soil, water, air, plant, and animal health. APEX simulations of prairie growth[8] and the APEX grazing algorithm, which is used to replicate cattle dietary choices and environmental outcomes,[9] showcase its new ability to more finely represent plant growth and livestock selection.

Valuing Ecosystem Services

Alongside model results that quantify certain soil, water, plant, and air metrics resulting from various conservation scenarios, accounting the values of and effects on ecosystem services is necessary. Maresch et al.[10] noted that, "A cross-cutting focus throughout CEAP will be to work toward establishing a framework for measuring and reporting the full suite of ecosystem services provided by conservation practices."

Ecosystem goods are tangible, physical products of a natural process that can be quantified using flow, volume, weight, or quantity measures. Crop, livestock, and timber products are examples of ecosystem goods. Ecosystem services, on the other hand, are intangible benefits, defined as "the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life."[11] Furthermore, "Agricultural lands that produce market commodities also provide ecosystem services such as flood mitigation, pollination, wildlife habitat and biodiversity, carbon sequestration, nutrient cycling, aesthetics, and recreation. These ecosystem services are often under-priced or un-priced by the marketplace."[10]

With full acknowledgment that grazing lands provide far more benefits to society than merely their agricultural production capacity, CEAP-GL is currently working with a team of partners on a unique pilot study to account for and quantify nature's value in terms of ecosystem services on grazing lands in the central and southern Great Plains (Fig. 1). The approach uses findings from ecological, social, and economic literature plus economic valuation methods, primarily the benefit transfer method, to apply monetized and nonmonetized values to ecosystem services affected by conservation practices applied with NRCS assistance. Benefit transfer estimates the economic contribution of ecosystem services by applying the value identified in one primary research study to another location. Also known as value transfer, benefit transfer follows one of three methods: unit value transfer, function transfer, or meta-analysis[i]. Drawing on recommendations and processes from the Millennial Ecosystem Assessment: Ecosystems and Human Well-Being framework[12] and additional works by Costanza et al.,[13] de Groot et al.,[14,15] Earth Economics, and others, the pilot study is underway in the area shown in Figure 1.

By developing a standardized approach to ecosystem service valuation, CEAP-GL will be uniquely positioned to inform decision- and policy-makers with ways to relate conservation practice effects to the public's desire for nature to continue providing services such as open space, clean air, clean water, wildlife habitat, and disaster risk reduction from flood, fire, drought, or other sources.

Building Blocks for Modeling and Ecosystem Service Valuation

NRCS desires to use data, model results, and spatial layers to optimize conservation planning and program efforts. This should focus treatment of relevant resource concerns, thus producing the greatest benefits. In support of the ultimate goals of modeling conservation practice effects and determining ecosystem service values, CEAP-GL and partners have been actively building the science foundation for those end products. Some of this foundational work includes development of: ecological site groups for 8 Major Land Resource Areas (MLRA); conservation tools to spatially and temporally display woody and herbaceous vegetation extent and cover values on western rangelands; input data from universities and ARS long-term grazing land research studies; a standardized data system for field data entry to be used for modeling; and conservation optimization strategies for forest and grazing lands. More detail on some of this work is presented below.

[i] definitions provided at https://www.eartheconomics.org/glossary

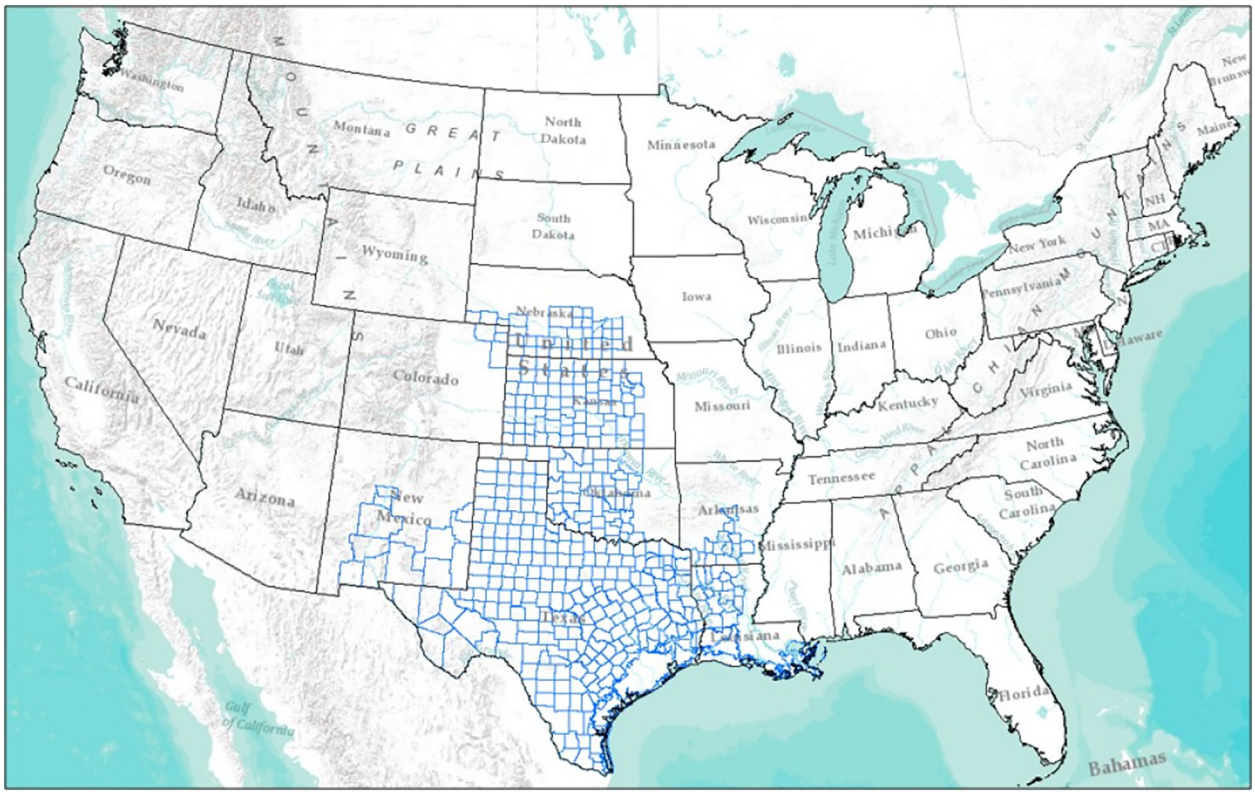

Figure 1. Conservation Effects Assessment Project (CEAP)-Grazing Lands Ecosystem Service Valuation Project Area (2018–2019). The counties within the project area are outlined in blue.

An ecological site group (ESG) is a collection of similar ecological sites that share a common state and transition model. The ecological sites that comprise an ESG respond similarly to disturbances and management, though performance of particular attributes varies.[16] The use of ESGs provides CEAP-GL an ecologically based way to scale-up practice effects to provide conservation design and management recommendations gleaned from modeling interpretations. Between 2015 and 2018, CEAP-GL partners worked closely with soil, rangeland, and wildlife experts and ranchers to develop ESG reports for selected MLRAs in Texas, Oklahoma, Kansas, Colorado, Wyoming, South Dakota, and North Dakota (Fig. 2). The reports are located on the CEAP-GL Publications Web site[ii] and are intended not only to aid in modeling efforts, but to contribute to the development of ecological site descriptions and conservation planning in those areas.

The Rangeland Brush Estimation Toolkit (RaBET) is a field-scale ArcGIS tool[iii] developed by ARS-Tucson that provides a spatial display of woody canopy cover from 1997 to the present.[17] The tool and supporting processed imagery were designed to be used by NRCS conservationists in the planning process. It allows the user to map areas of woody cover, with user-defined canopy classes and geolocations (polygons), to observe the change in woody canopy cover over time. As a planning tool, it aids in identifying the complexity and extent of treatment needs in specific areas. As a monitoring tool, it displays the change in cover post-treatment, enabling the land manager to decide if/when retreatment is necessary, and where. Figure 2 shows the MLRAs that are currently being completed for RaBET, and the MLRAs where ESGs have been completed.

The Rangeland Analysis Platform (RAP) is a landscape-scale tool for estimating spatial cover by plant functional groups over time. It was developed by the University of Montana in partnership with NRCS (CEAP-GL, CEAP-Wildlife, and Working Lands for Wildlife) and the Bureau of Land Management (BLM). The RAP uses on-site vegetation cover data from the Rangelands NRI and the BLM Assessment, Inventory, and Monitoring programs to train models capable of producing annual percent cover estimates of annual forbs and grasses, perennial forbs and grasses, shrubs, trees, and bare ground.[18] The estimates are produced by combining field plots with historical Landsat satellite records, gridded meteorology, and abiotic land surface data (e.g., elevation, soils). The RAP uses the computation power of Google Earth Engine to produce annual cover estimates (from 1984 to 2017) for rangelands in the western United States[iv].

Long-term grazing land research data has been made available to CEAP-GL from Kansas State University, Texas

[ii] https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/pub/?cid=stelprdb1186363

[iii] https://www.esri.com/en-us/home

[iv] https://rangelands.app/

Figure 2. Major Land Resource Areas of the western United States that have Ecological Site Groups completed (yellow) or are being developed for the Rangeland Brush Estimation Toolkit (RaBET) (brown).

A&M University, and several ARS locations: Mandan, North Dakota; University Park, Pennsylvania; Tifton, Georgia; and El Reno, Oklahoma. These datasets are essential to calibrating and validating the APEX model processes and outputs described above. In addition to these long-term research data, published studies that may be of shorter duration are also used for model calibration.

In addition to obtaining long-term datasets, CEAP-GL has partnered with ARS, BLM, and others to feed quality-checked data into a shared platform for researchers to use in other conservation assessment projects. ARS is leading the effort to develop this conservation data platform, known as Ag Data Commons[v], with the Jornada Experimental Range as our key data partner.

The Vegetation Data System (VGS), developed by the University of Arizona, is the CEAP-GL-supported data system for new field-based projects. Characterized by efficiency of data entry, streamlined reports, storage of

[v] https://ltar.ars.usda.gov/ag-data-commons/

PDFs and image files, active GPS, and multiple-format data downloads, VGS provides field data to CEAP-GL in the formats needed for modeling conservation effects. The partnership with the VGS team has given CEAP-GL, and potentially all of NRCS, a measure of efficiency that exceeds other data collection, management, and interpretation options[vi].

Enhancing existing data storehouses such as USDA PLANTS[vii] and the Ecological Dynamics Interpretation Tool (EDIT),[19] [viii] has become a natural extension of the CEAP-GL product line. Because CEAP manages vast datasets and seeks to improve the tools available to land managers and conservation planners, data are shared for use in complementary applications. For example, the NRI Grazing Land Onsite Data Study has greatly expanded our knowledge on where plants grow and the soils that support them. One key CEAP-GL data management and modeling requirement is the use of plant functional groups. CEAP-GL has developed a standardized list of plant functional groups, assigned approximately 48,000 plants to these functional groups, and has shared the functional group assignments, soil characteristics, and plant location data with the NRCS National Plants Data Team, NRCS ecological site developers, ARS researchers, and BLM partners. Making these data correlations available has the potential to improve our understanding of plant-soil-water dynamics, aid in plant material selection for revegetation efforts, and inform ecological site description development. Additionally, the ESG work conducted by CEAP-GL will be entered into the EDIT database for use by ecological site developers, land managers, and conservationists.

Conservation optimization strategies are being developed for forest land, rangeland, and pastureland. Through a CEAP-GL partnership with Colorado State University's Colorado Forest Restoration Institute, effectiveness and tradeoffs among conservation practices in a Colorado dry forest watershed are being explored using modeling and unique aggregation of landscape and climate features. A companion article (*see Cannon et al.* [24]) provides more detail. As the methodology develops further, applying it in other western forests will provide NRCS with spatial layers to aid in assessing watershed scale resource treatment needs designed to optimize Farm Bill conservation investments and outcomes.

Similar optimization strategies are underway for rangeland and pastureland, utilizing model results and soil, landscape, and NRI data. A common request from ranchers who have invested in long-term monitoring is a desire for NRCS to aggregate their point- and pasture-by-pasture data to the ranch scale. Ranchers make decisions at the ranch scale. Trends gleaned from the monitoring data that can be applied at a ranch scale are also solutions that CEAP-GL is exploring in order to optimize conservation efforts.

Toward a Scientific and Social Assessment Framework

Conservation practice implementation and land management decisions have both ecological and economic implications, with the opportunity to produce significant natural resource benefits and financial return. But there are social factors as well.

Some key social factors identified by Nowak et al.,[20] Andrews et al.,[21] and Maresch et al.[10] include how conservation behaviors manifest themselves in individuals and social groups; how education contributes to a person's willingness or ability to apply conservation practices and a conservation "ethic"; how the cost of conservation practice adoption influences decision making; how the use of incentives influence the adoption of conservation practices; and, the socioeconomic factors that influence those decisions.

In 2016, CEAP embarked on a project to improve our understanding of the social aspects of conservation adoption, continuance, and/or expansion. Guidance from works by Roche,[22] Lubell,[23] and others have added to our understanding, but we also sought direct feedback from producers. Regional meetings with landowners across the country are beginning to shed some light on the social barriers to implementing conservation. Coalescing the social aspects of conservation adoption with the application of ecological modeling and ecosystem service valuation will enhance NRCS's ability to help producers optimize benefits of conservation practices and programs while sustaining agricultural productivity. CEAP-GL and other components of CEAP are contributing to this movement toward an outcomes-based approach to conservation delivery. Success of this approach will rely on continued use of specific datasets such as the NRI and field-based research studies, plus sound science and productive partnerships.

Acknowledgments

The authors would like to thank the following individuals for their commitment to the CEAP-Grazing Land vision and framework: Leonard Jolley; Jay Angerer; Brandon Bestelmeyer; Steve Barker; Pat Shaver; Angela Fletcher; Matt Chadsey; Chandra Holifield-Collins; Daniel Mullarkey; Kevin Ingram; Lee Norfleet; Patrick Flanagan. For more information on the CEAP-Grazing Land efforts, activities, and products, please visit our Web site (https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/nra/ceap/na/?cid=nrcs143_014159).

References

1. Mausbach, M.J., and A.R. Dedrick. 2004. The length we go: measuring environmental effects of conservation practices. *Journal of Soil and Water Conservation* 59(5):96A-103A.
2. Duriancik, L.F., D. Bucks, J.P. Dobrowolski, T. Drewes, S. D. Eckles, L. Jolley, R.L. Kellogg, D. Lund, J.R. Makuch,

[vi] https://vgs.arizona.edu/user; undergoing name change from Vegetation GIS/Data System to Vegetation Data System

[vii] https://plants.sc.egov.usda.gov/java/

[viii] https://edit.jornada.nmsu.edu/page?content=about

M.P. O'Neill, C.A. Rewa, M.R. Walbridge, R. Parry, and M.A. Weltz. 2008. The first five years of the Conservation Effects Assessment Project. *Journal of Soil and Water Conservation* 63(6):185A-197A.

3. USDA Natural Resources Conservation Service, 2011. Conservation benefits of rangeland practices: assessment, recommendations. and knowledge gaps. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?cid=stelprdb10458112011 Accessed 11 July 2019.
4. USDA Natural Resources Conservation Service, 2012. Conservation outcomes from pastureland and hayland practices: assessment, recommendations, and knowledge gaps. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?cid=stelprdb108058120122012 Accessed 11 July 2019.
5. Levitt, S.D., and S.J. Dubner. 2005. Freakonomics: a rogue economist explores the hidden side of everything. New York, NY, USA: William Morrow. 315 p.
8. Zilverberg, C., J. Williams, C. Jones, K. Harmoney, J. Angerer, L.J. Metz, and W. Fox. 2017. Process-based simulation of prairie growth. *Ecological Modelling* 351:24-25.
9. Zilverberg, C.J., J. Angerer, J. Williams, L.J. Metz, and K. Harmoney. 2018. Sensitivity of diet choices and environmental outcomes to a selective grazing algorithm. *Ecological Modelling* 390:10-22.
10. Maresch, W., M. Walbridge, and D. Kugler. 2008. Enhancing conservation on agricultural landscapes: a new direction for the Conservation Effects Assessment Project. *Journal of Soil and Water Conservation* 63(6):198A-203A.
11. Daily, G. 1997. Nature's services: societal dependence on natural ecosystems. Washington, DC, USA: Island Press.
12. Alcamo, J., and E.M. Bennett. 2003. Millennium Ecosystem Assessment (Program). Ecosystems and human well-being: a framework for assessment. Washington, DC, USA: Island Press.
13. Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruelo, R.G. Raskin, P. Sutton, and M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387:253-260.
14. De Groot, R. 2006. Function analysis and valuation as a tool to assess land use conflicts and planning for sustainable, multi-functional landscapes. *Landscape and Urban Planning* 75:175-186.
15. De Groot, R., L. Brander, S. van der Ploeg, R. Costanza, F. Bernard, L. Braat, M. Christie, N. Crossman, A. Ghermandi, L. Hein, S. Hussain, P. Kumar, A. McVittie, R. Portela, L.C. Rodriguez, P. ten Brink, and P. van Beurkering. 2012. Global Estimates of the value of ecosystems and their services in monetary units. *Ecosystem Services* 1:50-61.
16. USDA Natural Resources Conservation Service, 2017. National Ecological Site Handbook. Proposed changes to Part 631. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcseprd12912322017.
17. Holifield Collins, C., M. Kautz, G. Ponce-Campos, J. Hottenstein, and L. Metz. 2015. Development of an integrated multi-platform approach for assessing brush management conservation efforts in semiarid rangelands. *Journal of Applied Remote Sensing* 9:1-15.
18. Jones, M.O., B.W. Allred, D.E. Naugle, J.D. Maestas, P. Donnelly, L.J. Metz, J. Karl, R. Smith, B. Bestelmeyer, C. Boyd, J.D. Kerby, and J.D. McIver. 2018. Innovation in rangeland monitoring: annual, 30 m, plant functional type percent cover maps for U.S. rangelands, 1984–2017. *Ecosphere* 9 (9)e02430.
19. Bestelmeyer, B., J. Williamson, C. Talbot, G. Cates, M.C. Duniway, and J. Brown. 2016. Improving the effectiveness of ecological site descriptions: General state-and-transition models and the Ecosystem Dynamics Interpretive Tool (EDIT). *Rangelands* 38:329-335.
20. Nowak, P., S. Bowen, and P.E. Cabot. 2006. Disproportionality as a framework for linking social and biophysical systems. *Society and Natural Resources* 19:153-173.
21. Andrews, E., M. Stevens, and G. Wise. 2002. A model of community-based environmental education. In: Dietz T, & Stern PC, editors. New tools for environmental protection: education, information, and voluntary measures. Washington, DC, USA: Committee on the Human Dimensions of Global Change, National Research Council. p. 161-182.
22. Roche, L.M., T.K. Schohr, J.D. Derner, M.N. Lubell, B.B. Cutts, E. Kachergis, V.T. Eviner, and K.W. Tate. 2015. Sustaining working rangelands: insights from rancher decision-making. *Rangeland Ecology & Management* 68:383-389.
23. Lubell, M., B. Cutts, L.M. Roche, J.D. Derner, M. Hamilton, E. Kachergis, and K.W. Tate. 2013. Conservation program participation and adaptive rangeland decision-making. *Rangeland Ecology & Management* 66:609-620.
24. Cannon, J.B., B.M. Gannon, J.A. Feinstein, and B.H. Wolk. 2019. An Effects Assessment Framework for Dry Forest Conservation. *Rangelands* 41:205-210.

Authors are Grazing Land Component Leader, Resource Inventory and Assessment Division, Conservation Effects Assessment Project, Natural Resources Conservation Service, Tucson, AZ 85721, USA, Loretta.Metz@usda.gov (Metz); and Wildlife Component Leader, Resource Inventory and Assessment Division, Conservation Effects Assessment Project, Natural Resources Conservation Service, Beltsville, MD 20705, USA (Rewa).