

Oral Presentation Abstracts

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A Review of the Remediation Techniques used for Soils Contaminated with Pesticides

Teresa Castelo-Grande^{1, 2, 3}, 1- Departamento de Engenharia Química, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal. 2-Departamento de Engenharia, Universidade Lusófona do Porto, Rua Augusto Rosa, 24, 4000-098 Porto, Portugal. 3-Departamento de Ingeniería Química y Textil, Facultad de Ciencias Químicas, Universidad de Salamanca, Plaza de los Caños, 1-5, 37008 Salamanca, Spain.

1) Paulo A Augusto^{1,3}, 1-Departamento de Engenharia Química, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal. 3-Departamento de Ingeniería Química y Textil, Facultad de Ciencias Químicas, Universidad de Salamanca, Plaza de los Caños, 1-5, 37008 Salamanca, Spain. , pauloaugusto@usal.es

2) Paulo Monteiro⁴, 4-Departamento de Engenharia Civil, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal., psm@fe.up.pt

3) Angel M Estevez ³, 3-Departamento de Ingeniería Química y Textil, Facultad de Ciencias Químicas, Universidad de Salamanca, Plaza de los Caños, 1-5, 37008 Salamanca, Spain. , estevez@usal.es

4) Domingos Barbosa ¹, 1-Departamento de Engenharia Química, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal., dbarbosa@fe.up.pt

Nowadays, there is the knowledge that water and soil contamination must be taken into account with the same degree of concern, as soil is not only the support of life, but also the support for clean water resource, and as contaminated water also contaminates the soil.

The aim of this work is to address the problem of soil contamination with pesticides and present a review of the existing techniques for remediation of these types of soils.

A brief discussion of the soil structure and complexity, and the impact of its contamination by pesticides will be examined. Then, the main existing and emerging techniques for soil remediation, particularly for the elimination of pesticides, are discussed, and their relative advantages and disadvantages presented. In order to choose the best remediation technology, the characteristics of the soil and of the site, the suitability of the technique, the costs and environmental footprint must be taken in consideration. This comparison of existing technologies will be a helpful tool for preliminary selection of the most promising techniques to use for a particular soil decontamination problem. The advantages of using some of these technologies in terms of ecosystem services will also be addressed.

Soil Resource Management and Conservation

Agricultural BMPs and Ecosystem Services in Beasley Lake, a CEAP Watershed

Richard E. Lizotte, Jr., USDA Agricultural Research Service

1) Scott S. Knight, USDA ARS, scott.knight@ars.usda.gov

2) Martin A. Locke, USDA ARS, martin.locke@ars.usda.gov

3) Charles T. Bryant, USDA ARS, charles.bryant@ars.usda.gov

Aquatic ecosystems such as oxbow lakes found throughout the Lower Mississippi Alluvial Plain (i.e. the Mississippi Delta) can provide valuable goods and services such as water supply, fisheries, wildlife habitat and aesthetic value. Agriculture occurring intensively in the same region also provides valuable goods and services such as pollination, food and fiber. However agriculture can also produce disservices such as water pollution, habitat loss and decreased biodiversity. Attempting to balance desired services and undesired disservices between agriculture and aquatic ecosystems could include judicious use of agricultural best management practices (BMPs). The current study examined Beasley Lake ecosystem services such as water quality, fisheries and aquatic invertebrate biodiversity during a 14 year period in which various BMPs were implemented. Lake responses included improved water quality and fisheries and, to a lesser extent, improved aquatic invertebrate biodiversity without significant reductions to agricultural services in the watershed. Results show the use of agricultural BMPs can assist in providing a balance between aquatic ecosystem services and agricultural services.

Conservation Tools and Technologies

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Agricultural Nonpoint Source Pollution: Agenda for the Future

Katie Flahive, U.S. EPA

1) Joe Piotrowski, U.S. EPA, piotrowski.joe@epa.gov

Nonpoint source pollution remains the Nation's largest source of water quality problems. It is the main reason that roughly 52% percent of our nationally surveyed rivers, lakes, and estuaries are not clean enough to meet basic uses such as fishing or swimming and are thus labeled impaired. Reducing nonpoint source pollution, particularly nutrients, and their impacts to water quality, has become a top priority for USEPA. Agriculture, both animal and row crop operations, is the leading nonpoint source, causing lakes, rivers, and streams across the U.S. to consequently be impaired. The most common agricultural pollutants are nutrients and sediment. A variety of data sources show that the current voluntary approaches alone have not been sufficient to deal with the nutrient problems. USEPA must look to the full suite of tools available and expand the use of the Clean Water Act tools to better address this increasing problem.

Conservation and Environmental Policy and Program Design

AGWA Application to Assess Surface Water Availability of the San Pedro Watershed

Wenming Nie, USEPA, ORD, NERL-ESD-Landscape Ecology Branch

1) Yongping Yuan, USEPA, ORD, NERL-ESD-Landscape Ecology Branch, Yuan.Yongping@epamail.epa.gov

2) William Kepner, USEPA, ORD, NERL-ESD-Landscape Ecology Branch, Kepner.William@epamail.epa.gov

3) Nita Tallent-Halsell, USEPA, ORD, NERL-ESD-Landscape Ecology Branch, tallent-halsell.nita@epa.gov

4) Caroline Erickson, USEPA, ORD, NERL-ESD-Landscape Ecology Branch, Erickson.caroline@epa.gov

The Southwest Ecosystem Service Project (SwESP) is part of the U.S. Environmental Protection Agency's new Ecosystem Services Research Program, undertaken to examine the variety of ways in which the landscapes including crop lands, conservation areas, wetlands, lakes, streams, and other land cover types contribute to wildlife and human well-being. The primary goal of the SwESP is to examine landscape of the Southwestern US and quantify the current magnitude of such contributions, and to examine how ecosystem services in the Southwest have changed in the past decades and/or could change over the next decades. Given the growing demand for water and the likely decreasing precipitation due to climate change, water availability has become a dominant issue in arid and semi-arid ecosystems. Therefore, the overall objective of this study is to assess the amount of current available surface water and how it has changed during the past decades in the San Pedro watershed. To achieve this objective, the Automated Geospatial Watershed Assessment Tool (AGWA), jointly developed by the U.S. Environmental Protection Agency, the U.S. Department of Agriculture Agricultural Research Service, and the University of Arizona, will be applied to evaluate amount of runoff generated from the San Pedro watershed. AGWA is a GIS interface developed to automate the parameterization and execution of the Soil Water Assessment Tool (SWAT) and KINematic Runoff and EROsion (KINEROS2) hydrologic models. The application of these two models allows AGWA to conduct hydrologic modeling and watershed assessments at multiple temporal and spatial scales.

Water Resources and Management

APEX Model Simulation of Runoff and Sediment Losses from Grazed Pasture Watersheds with Agroforestry Buffers

S.H. Anderson, University of Missouri ; Sandeep Kumar, University of Missouri

1) S.H. Anderson, University of Missouri, AndersonS@missouri.edu

2) R.P. Udawatta, University of Missouri, UdawattaR@missouri.edu

3) A. Mudgal, University of Missouri, amudgal@mail.mizzou.edu

Buffers have been found to reduce non-point source pollution from watersheds. Hydrologic simulation models assist in predicting buffer effects on runoff and sediment losses from small watersheds. The objective of this study was to calibrate and validate a model to simulate runoff and sediment losses from small grazed watersheds with agroforestry buffers (AgB) and no buffers (control watersheds, CW). Experimental design consisted of four watersheds (two AgB and two CW) under pasture management monitored from 2002 through 2008. Pasture areas included fescue (*Festuca arundinacea* Schreb.) while AgB included Eastern cottonwood trees (*Populus deltoids* Bortr. ex Marsh.) planted into fescue. Measured runoff was 57% higher for CW watersheds compared to AgB watersheds. Measured sediment loss was 95% higher for CW watersheds compared to AgB watersheds. The r^2 and NSE values for calibration and validation periods of the runoff varied from 0.52 to 0.78 and 0.50 to 0.74,

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respectively. The model did not predict sediment loss well probably due to low measured sediment loss. After calibration and validation, the model was run for scenario analyses. Buffer width had an influence on runoff; simulated runoff decreased 24% when buffer width was doubled compared to losses associated with the measured width. Simulated runoff from CW watersheds was 11% higher with double cattle stocking density (relative to measured density) compared to AgB watersheds with double stocking density. With half stocking density, AgB watersheds had 18% lower runoff compared to CW. Results imply that establishment of agroforestry buffers for grazed pastures reduce runoff and sediment losses.

Conservation Tools and Technologies

APEX Simulations of Productivity for 9 Cropping Systems over 19 Years in 3 Claypan Landscape Positions

Edward John Sadler

Baffaut, C., USDA-ARS, claire.baffaut@ars.usda.gov

Kitchen, N.R., USDA-ARS, newell.kitchen@ars.usda.gov

Sudduth, K.A., USDA-ARS, ken.sudduth@ars.usda.gov

Mudgal, A., University of Missouri, AMudgal@mail.missouri.edu

Prior research has shown that conventional corn-soybean cropping systems are economically riskier in the claypan MLRA, caused by variable rain and limited water holding capacity above the low-permeability claypan. These observations prompted research into alternative cropping systems that offer more stable yields and thus profitability. A replicated experiment with 10 treatments was established for this purpose in 1991. In each of three replications, 0.85-acre (0.34-ha) plots were subjected to all phases of mulch-till corn-soybean and no-till corn-soybean for the entire period of record. Other treatments were modified during the period of record, leaving 5 years of mulch-till corn-soybean-wheat-cover crop, 14 years of no-till corn-soybean-wheat-cover crop, 3 years of ridge-till corn-soybean, 9 years of no-till corn-soybean with variable-rate fertilization, 7 years of no-till corn-soybean-switchgrass, 19 years of cool-season grass (to CRP standards), and 9 years of both warm-season grass/legume CRP and warm-season grass hay. The treatments involving CRP were split (making 20x620' [6x189 m] plots within one original 60x620' [18x189 m] plot). After calibration and validation of the APEX model on 12 plots, all plot-years were simulated using plot-specific soil parameters, year- and cropping-system-specific management parameters, and on-site weather. Landscape position (summit, sideslope, and footslope) and whole-plot yields were compared with measured values. From these results, confidence in the APEX model in the claypan context will be increased, and productivity of these cropping systems will be documented. Scientists, action agencies, and conservation interests will benefit from the research.

Soil Resource Management and Conservation

Applications of Ecosystem Services Payments in Forest Conservation Outreach

Colin M Donohue, Executive Director, NNFP

In many regions limited resource landowners have low rates of participation in conservation programs. In forestry, income-generating sales happen very infrequently and landowners often are not motivated to invest in forest management plans. The advent of carbon offset payments offers an annual income for landowners, and incentive for forest management planning, but significant barriers exist, including up-front expenses of inventories and plans, and low offset prices.

This presentation will provide case studies of local projects using payments for forest carbon sequestration as an incentive for forest management planning.

In 2009 the prices for offsets had collapsed but innovative local groups found "direct to customer" markets and provided financing and other supports for early adopters, allowing them to serve limited resource landowners and demonstrate the use of this incentive. This presentation will provide several examples, with emphasis on two. The Appalachian Carbon Partnership (ACP) works in the Central Appalachian region, an area with chronic poverty. Most landowners do not have forest management plans, and levels of implementation of conservation cost-share programs are low.

The Partnership uses the annual payment for carbon sequestration as an incentive for landowners to develop forest management plans.

The Limited Resource Landowner Education and Assistance Network (LRLEAN) in Alabama brings together partners Alabama A&M, National Wildlife Federation and others to make carbon payments and forest certification accessible to limited-resource African American landowners in Alabama.

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The projects are nascent but in its pilot the ACP enrolled over 10,000 acres of land, with significant acreages newly developing management plans.

Conservation Outreach and Education

Assessing Direct Seed Adoption in the Pacific Northwest

Hans Kok, Washington State University and University of Idaho

R. Dennis Roe, WSU

Ty Meyer, Spokane County Conservation District

Russ Evans, Pacific Northwest Direct Seed Association

Paul Carter, WSU, Columbia County Extension

Ken Hart, UI, Nez Perce County Extension

Carrie Ulschmid, NRCS

Jim Armstrong, SCCD

Ann Swannack, NRCS

Diana Roberts, WSU Extension

Soil erosion is a serious problem in the Inland Pacific Northwest. Direct seed is a proven method to dramatically reduce soil erosion. Reliable information on the current adoption of direct seed practices in the Pacific Northwest is not available. The latest information from CTIC predates 2004. Adoption information is crucial to target educational programs and to develop adoption promotion strategies.

GPS guided roadside surveys were conducted in 2007, 2008, and 2009, in eastern Washington and northern Idaho, to assess direct seed adoption and crop residue cover. CTIC procedures were adjusted to account for the unique PNW topography and cropping systems.

As the data are georeferenced, we hope cost and time can be saved in future surveys by using remote sensing information.

Conservation Outreach and Education

Assessing Ecosystem Services Using the National Resources Inventory (NRI)

J. Jeffery Goebel, U.S. Department of Agriculture, Natural Resources Conservation Service, Resources Inventory and Assessment Division, Beltsville, MD 20705

Findings from the 2007 National Resources Inventory (NRI) are now available for the conterminous 48 States to help improve understanding of natural resource status, conditions, and trends on the Nation's non-Federal land. Conducted by the USDA Natural Resources Conservation Service in cooperation with the Iowa State University Center for Survey Statistics and Methodology, the NRI is a statistical survey whose primary purpose is to support agricultural and environmental policy development and program implementation. The NRI provides nationally consistent statistical data that support analysis of resource trends on rural and developed land over all regions of the United States since 1982. It provides information for addressing a broad range of natural resource issues, including land use and development, soil erosion, and wetlands. Linkages to NRCS soils data provide a unique capability for spatial as well as temporal analyses.

Data from the 2007 NRI show trends in land use, including use and extent of agricultural land and development of rural non-Federal land. The data show the dynamics of land-use change within agricultural uses and between agricultural and nonagricultural uses. Also presented are trends in soil erosion both by water (sheet and rill erosion) and wind, including erosion in relation to soil loss tolerance (T), as well as trends in the extent of wetlands.

NRI data show not only the current condition of natural resources on agricultural landscapes but also changes over time and place. These data are thus valuable sources of information that can help describe current and historical conditions and recent (25-year) trends in changes to, and assess ecosystem services provided by, agricultural landscapes.

Soil Resource Assessment

Assessing Stormwater and Agricultural Best Management Practices in Suburban Watershed Restoration

Zeyuan Qiu, New Jersey Institute of Technology

1) Lizhong Wang, New Jersey Institute of Technology, lwang@adm.njit.edu

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Restoring an impaired watershed in a suburban setting could be much more difficult and complicated than in an agricultural setting because stormwater runoff from residential and other urban development compounds the water quality impacts of traditional agricultural runoff. Separate policies and regulations are being adopted to deal with stormwater and agricultural runoff. There is also a great debate among the suburban communities who should be responsible to watershed restoration. The presentation will use Neshanic River watershed, a 31 mi² headwater watershed in Hunterdon County, New Jersey, as an example to discuss the complicated social, economic and political conflicts in restoring water quality in suburban watersheds. The Neshanic River is impaired for total suspended solid, phosphorus and fecal coliform due to nonpoint source pollution from agricultural lands as well as urban areas. The Soil and Water Assessment Tool (SWAT) model was developed to simulate streamflow, sediment, phosphorus and bacteria loads to streams. The model was calibrated and validated using the streamflow and water quality data during the 1997-2008 period. A suit of agricultural and stormwater best management practices (BMPs) were developed in collaboration with a local farmer group, residents and municipalities. The implementation and maintenance costs of BMPs were estimated. And their water quality impacts were estimated using SWAT and/or from literature. A comprehensive mathematical programming model will be developed to integrate all the BMP information to delineate the impacts of stormwater and agricultural BMPs and evaluate the tradeoffs between the watershed restoration goals and costs.

Water Resources and Management

Assessment of Herbicide Transport in Central Missouri Watersheds Using a Process-Based Index Model

Robert Lerch, USDA-ARS

- 1) C.D. Willett, University of Missouri, drostc@missouri.edu
- 2) M. Milner, University of Nebraska, mmilner1@unl.edu
- 3) M. L. Bernards, University of Nebraska, mbernards2@unl.edu
- 4) P. J. Shea, , University of Nebraska, pshea1@unl.edu

Identification of areas at risk for pesticide loss is a necessary requirement for targeting best management practices (BMPs) to the most vulnerable areas within watersheds. To work toward that goal, a process-based index model was developed to assess relative landscape vulnerability to hydrologic losses of pesticides. The model applies mathematical functions to assign scores (i.e., degree of risk) on the basis of pesticide, soil, and landscape properties relevant to the environmental fate of pesticides. The model uses the NRCS county SSURGO database as the input source of soils data. The risk of pesticide transport is considered for three hydrologic pathways, or scenarios: leaching, solution runoff, and particle adsorbed runoff. The model is used to compute the relative risk of pesticide transport for a given pesticide for each hydrologic pathway, providing the spatial and temporal risk of transport. The model is being applied to the Youngs Creek watershed in the Central Claypan Region of Missouri, a watershed with known herbicide contamination problems. The risk of herbicide loss for each hydrologic pathway was determined for each of four corn herbicides (atrazine, metolachlor, isoxaflutole, and glyphosate). By computing area-weighted scores at the watershed scale, a score for each herbicide and hydrologic pathway scenario combination was determined. Area-weighted scores were used to evaluate the potential spatial and temporal risk of applying these herbicides in the Youngs Creek watershed. This information can then be used to make recommendations regarding the choice of herbicides that minimize the risk of hydrologic transport for this watershed.

Conservation Tools and Technologies

Assessment of soil conservation strategies in upland agriculture: Interdisciplinary case study in Tat hamlet, Da Bac district, Hoa Binh province, Northern Vietnam

Thanh Thi Nguyen, Hohenheim University

- 1) Yohannes Zergaw Ayanu, Hohenheim University, yohanneszer@yahoo.com
- 2) Eko Nugruho, Hohenheim University, eko_nug@yahoo.com
- 3) Simon Ikenoue, Hohenheim University, simon.ikenoue@gmail.com
- 4) Carsten Marohn, Hohenheim University, Carsten.Marohn@uni-hohenheim.de
- 5) Georg Cadisch, Hohenheim University, cadisch@uni-hohenheim.de

Due to the rapid economic growth and the demographic pressure in Northern Mountainous Region (NMR) of Vietnam, traditional swidden farming has been replaced by more profitable land use systems. This has increasingly led to problems of soil degradation and hydrological processes. The implementation of soil conservation measures

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(SCMs) is becoming an important issue for sustainable agriculture. Considering that implementation of SCMs has rarely been a long-term success, so in this study, two models were used in order to suggest the suitable SCMs in the NMR. The data used to parameterise the models were derived from previous studies in Tat Hamlet, Northern Vietnam. After calibrating, WaNuLCAS (Water, Nutrient, Light Capture in Agroforestry Systems) was used to assess biophysical outputs (soil erosion, runoff) and financial profitability of four scenarios. The Land Use Change Impact Assessment (LUCIA) model was used to see the consequence of land use change at the watershed level including runoff and water balance. The results from LUCIA showed that land use in the upland changed runoff and hydrological processes in the lowlands. At landscape level, effect of increased rainfall variability under a scenario of climate change exceeded that of land use change. WaNuLCAS could, to a certain extent, predict the consequence of the different scenarios. A no-tillage system seemed to be the most appropriate strategy, however, farmers' perception towards this system could become a barrier. In order to come to a successful adoption of SCMs, all aspects of the implementation (environment, financial profitability and suitability) have to be considered

Soil Resource Management and Conservation

Biological Diversity on Working Lands, Implications for the Conservation of Ecosystem Processes

Stephen Brady, NRCS CNTSC

Ecosystem services include a range of functional attributes applicable at multiple scales. Some of those attributes directly benefit the landowner while the benefits of some other attributes are more difficult to capture, or may manifest only to the public. Reducing environmental complexity down to short lists of resources (e.g., soil, water, animals, plants, and air) misses many of the functional attributes of ecosystems that only result from the interaction of resources at multiple scales. In intensively farmed ecosystems the resources that are linked to provide synergistic effects may become uncoupled unless decision-makers actively include holistic considerations. Conservation technical assistance delivered through public agencies, including NRCS, should advocate for broader approaches where both the individual landowner and the public derive benefits. Residual attributes of the landscape, such as drainage ways, riparian areas, and odd, non-farmable areas do more than just hold the land together, they provide reservoirs of biodiversity that in turn support processes necessary for the healthy functioning of ecosystems. Increasing evidence that land cover/use changes may also be major factors contributing to climate change has prompted the National Research Council to recommend the inclusion of land cover/use change as an important climate forcing. Pollination services, pest management, nutrient cycling, water quality, and biodiversity are also directly linked to land cover/use. The interaction of these resources is reviewed in light of recent developments that more fully contribute to sustainability and call for a more inclusive definition of conservation.

Fish, Wildlife, and Biodiversity Conservation

Cellulosic feedstock production in fields of complex topography

Kurtis Reitsma, South Dakota State University

- 1) Tom Schumacher, SDSU, Thomas.schumacher@sdstate.edu
- 2) David Clay, SDSU, david.clay@sdstate.edu
- 3) Chang Oh Hong, SDSU, Chang.oh.Hong@sdstate.edu
- 4) C. Gregg Carlson, SDSU, Gregg.Carlson@SDSTATE.EDU
- 5) Douglas Malo, SDSU, Douglas.Malo@SDSTATE.EDU
- 6) Todd Trooien, SDSU, Todd.Trooien@SDSTATE.EDU
- 7) Larry Janssen, SDSU, Larry.Janssen@SDSTATE.EDU
- 8) Gerald Warman, SDSU, Gerald.Warmann@sdstate.edu
- 9) Arvid Boe, SDSU, Arvid.Boe@SDSTATE.EDU
- 10) Vance Owens, SDSU, Vance.Owens@SDSTATE.EDU
- 11) Paul O. Johnson, SDSU Ext, PaulO.Johnson@sdstate.edu
- 12) Gary Erickson, SDSU Ext (ret), gary.erickson@sdwg.com
- 13) Irene Graves, SDSU Ext, Irene.Graves@sdstate.edu

Many land managers are reconsidering enrollment of land in programs such as the Conservation Reserve Program (CRP) due to increased land values, rental rates, and higher commodity prices. The northern great plains biofuels industry depends on corn (grain) for ethanol. Currently, livestock can be fed a blend of cellulosic materials and distillers grain; a byproduct of corn ethanol production. In the future the use of cellulosic materials for biofuel

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feedstocks is likely to increase, improving the productivity potential of marginal lands. Selected management strategies will highly influence the sustainability of these systems. This project was designed to demonstrate practices used in producing multiple feedstocks within fields of complex topographies. Four locations were selected in three differing climate regimes. Each site had unique soil and landscape characteristics. Three sites were managed within a no-tillage system, the remaining site was tilled in the spring prior to planting. Total above ground biomass production was measured at the crest, back-slope, and toe-slope, replicated four times across the field. Crop establishment, development, and productivity were found to be highly dependent on variations of residue management, topography, climate, and soil. Precision conservation and management strategies for cellulosic feedstock production are likely to be site specific.

**CIG Abstracts (Conservation Innovation Grant Program)*

Chesapeake Bay Executive Order Section 502 Guidance

Katie Flahive, U.S. EPA

Some of the measures and practices to be included in the new guidance are advanced from those included in previously published management measures guidance documents, to reflect both (1) the special need to implement the most advanced and effective measures available to restore the Chesapeake Bay, and (2) advances in the state of the art for managing some of the critical sources of nonpoint source pollution in the Bay watershed. EPA intends that the 502 guidance will reflect the "next generation of tools and actions" report that is being developed under EPA's leadership under Section 202(a). Thus, there will be tools and practices from previous publications that will not be included in the 502 guidance that are considered "out-dated" or provide poor treatment or removal efficiencies compared to the state of the art.

EPA intends to write the document in a manner such that it could apply to all sources in the Chesapeake Bay watershed, regardless of whether they are on Federal land or otherwise within the control of Federal agencies. From a pollution control perspective, the same measures and practices that apply to Federal land management are equally applicable to private land management. It is EPA's expectation that writing this single technical guidance as applicable to all landowners and land managers in the Chesapeake Bay watershed, and that is consistent with the "next generation of tools and actions" report, will provide an excellent framework for implementation throughout the Bay to meet the reductions in nutrients and sediments needed.

Conservation Tools and Technologies

Conservation Marketplace of Minnesota: A Transferable Market Infrastructure for Ecosystem Services

Susan Carlin, Minnesota River Board

Susan Carlin, Minnesota River Board, susan.carlin@mnsu.edu

Jim Klang, Kieser & Associates, jklang@kieser-associates.com

Brian Brandt, American Farmland Trust, bbrandt@farmland.org

Shannon Fisher, Minnesota River Board, shannon.fisher@mnsu.edu

Dennis Fuchs, Stearns County (MN) SWCD, dennis.fuchs@mn.nacdnet.net

Tom Green, Agflex Inc., tom.green@agflex.com

Brooke Hacker, Greater Blue Earth River Basin Alliance, brooke.hacker@mnsu.edu

Holly Kavorik, Sauk River Watershed District, holly@srwdmn.org

Linda Meschke, Rural Advantage, linda@ruraladvantage.org

Carrie Raber, Stearns County (MN) SWCD, carrie.raber@mn.nacdnet.net

Market-based programs for ecosystem services can bring economically efficient implementation alternatives to land managers and producers, encouraging them to generate credits that are saleable in local, regional or national markets. Conservation Marketplace of Minnesota is creating three ecosystem service markets in Minnesota. To increase the sustainability of production agriculture, the project proposes stacking credit payments from multiple ecosystem service buyers. Thus, a single BMP will receive credits for each service it provides-water quality, carbon sequestration, habitat, etc. Stacking credit payments creates a cost-effective method for promoting and sustaining desired land uses. The Greater Blue Earth River, Lower/Middle Minnesota River, and Sauk River watersheds were selected for their diversity in land use, geomorphology, political settings, and market interests. These watersheds are creating independent frameworks that leverage the existing strengths of each area. The Sauk River Watershed will feature a joint powers agreement between the Stearns SWCD and the Sauk River Watershed District to implement and generate credits for targeted BMPs. The Greater Blue Earth Watershed will develop a standardized

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process to allow any trained local governmental unit to participate in market transactions. The Lower/Middle Minnesota Watersheds will develop a third model, demonstrating how a private organization can participate in ecosystem service markets. These locally developed market structures are transferable throughout the Upper Mississippi River Watershed and one goal is to openly share successes and challenges. CMM illustrates that science and policy decisions can be combined to improve the implementation of nutrient management practices and land conservation in the Mississippi River Watershed.

**CIG Abstracts (Conservation Innovation Grant Program)*

Conservation Marketplace of Minnesota: Addressing Critical Questions in the Development of a Strong Ecosystem Services Market Framework

Susan Carlin, Minnesota River Board

Brian Brandt, American Farmland Trust, bbrandt@farmland.org

Susan Carlin, Minnesota River Board, susan.carlin@mnsu.edu

Shannon Fisher, Minnesota River Board, shannon.fisher@mnsu.edu

Dennis Fuchs, Stearns County (MN) SWCD, dennis.fuchs@mn.nacdnet.net

Tom Green, Agflex Inc., tom.green@agflex.com

Brooke Hacker, Greater Blue Earth River Basin Alliance, brooke.hacker@mnsu.edu

Holly Kavorik, Sauk River Watershed District, holly@srwdmn.org

Jim Klang, Kieser & Associates, jklang@kieser-associates.com

Linda Meschke, Rural Advantage, linda@ruraladvantage.org

Carrie Raber, Stearns County (MN) SWCD, carrie.raber@mn.nacdnet.net

Conservation Marketplace of Minnesota (CMM) is developing and institutionalizing a market infrastructure with locally-led service providers and designing the tools necessary to provide simple and easy access to ecosystem service markets. This presentation will describe the ecosystem services targeted by CMM's three watershed partners. We will describe the diversity among the three settings regarding socio-political attributes and geomorphology, and also how that diversity will uniquely shape the organizational framework for each area's facilitation of ecosystem services. Each watershed's unique implementation goals and their priority Best Management Practices (BMPs) will be highlighted. In addition, CMM will identify and pose a series of questions that each project area is individually addressing. The questions are based on the CMM National Advisory Committee's topics of concern:

- What crediting mechanisms are under development and how will they address uncertainty, equivalence, and location for services such as habitat, water quality and greenhouse gases?
- What innovative processes for selecting and implementing BMP projects were benchmarked and implemented in each area's ecosystem services framework?
- What conceptual and policy considerations were used in development of the ecosystem services framework?

Some examples include:

- o What program attributes address the "stacking" of ecosystem service payments?
- o Are payments awarded for the implementation of a BMP or are they awarded for attaining a performance standard related to measurable improvements in ecosystem quality?
- o How is the use of public funding factored into crediting?

Conservation and Environmental Policy and Program Design

Conservation Transaction Plug-in for NRCS Conservation Delivery

Eduardo DiPolina-GeoAgro Inc., Ken W. Rojas-USDA-NRCS, Arlen Ricke-USDA-NRCS

Anthony DiPolina-GeoAgro

Frank Geter-USDA-NRCS

Jon Vrana-USDA-NRCS

The USDA Natural Resources Conservation Service (NRCS) is the lead agency administering Federal natural resources conservation programs, coordinating the drafting of natural resources conservation regulations, working with land owners and operators to develop and implement conservation plans, and visiting a sample of the 1.6 million plan sites each year to verify conservation plan implementation. NRCS currently manages over 1,000,000 conservation plans contained in the National Conservation Planning (NCP) database, servicing between 5,000 and 35,000 customer folders daily.

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Typically this conservation delivery is provided by NRCS employees; however, there is a new effort to extend delivery externally using Technical Service Providers (TSP). As part of facilitating this new vision, NRCS has a partnership with a commercial partner to provide access to corporate data sources and enable land users and Conservation partners outside the USDA to access the NCP Database over the Internet.

This presentation will focus on the deployment of GeoAgro Cplanner, a product that integrates access to the NCP database, document exchange features, GIS management, field data collection and standard models through a simple web-enabled tool. We will review how technologies were applied for efficient collaboration between NRCS staff and external parties.

This innovative approach has been field tested in several locations during 2008 and 2009, and will be available for Technical Service Providers starting January 2010.

The expected benefits of this effort are many, including time savings for NRCS staff and partners, improving timeliness and quality of plan information, timely tracking of accomplishments, and streamlining conservation program delivery.

Conservation Tools and Technologies

Conservation Videos - Animation showing real problems

John Klein, Missouri and Mississippi Divide RC&D

ABSTRACT for an ORAL Presentation at the 2010 SWCS Annual Conference

Over the course of the past several years, the M&M Divide RC&D has developed seven short conservation education videos for Best Management Practices (BMP) education. Video development has been a learning experience, and the process of topic selection, script writing, animation storyboard development, and editing is new to most conservationists.

In this presentation, I will outline the process we went through to select a BMP or conservation topic, draft an outline, and work with professional animators to create a video for wide-scale disc and internet distribution. Number seven video, "What is a Watershed, and why should you care?" is currently in the final stages of production. It is nearly all animation. I plan to show this 4-minute video in my presentation as an example of how animation can be used to show concepts that live video and still photography cannot show.

I will discuss costs of video production, and NRCS Conservation Innovation Grants (CIG) assistance in funding our first six videos.

Finally, I will discuss our distribution process in DVD disks statewide to NRCS Field Offices, Extension Offices, and Vocational Agriculture programs in high schools and community colleges. I will cover the internet distribution of these videos to the world-wide web on our RC&D website, and how that site is linked to the more widely used Iowa NRCS and Iowa State University Learning Farm websites.

Learning about conservation practices and issues does not have to be boring. Animation can enhance the interest, hold the attention, and teach a lesson.

Conservation Outreach and Education

Crossing Jurisdictional Boundaries: Getting Consensus on an Integrated Ecosystem Credit Accounting System and a Standard Credit Issuance Process

David Primozich, Willamette Partnership

1) Bobby Cochran, Clean Water Services, cochranb@cleanwaterservices.org

2) Bartholomew Martin, Willamette Partnership, martinm@cleanwaterservices.org

As ecosystem services markets emerge around the world, demand is growing for standard crediting methods to ensure markets achieve ecological goals. Current markets have grown from existing regulations and institutions that split the environment into its constituent parts (water, land, species) rather than treating it as an integrated whole. As a result, it is difficult for landowners to access multiple markets for the full suite of ecological services their restoration actions produce.

In 2008 the Willamette Partnership convened 25 federal, state, and local resource agencies, conservation organizations, and other leaders to develop an integrated ecosystem credit accounting system. Instead of using separate methodologies and indicators to assess wetland, water quality, or species conditions, this diverse group worked toward agreement on a method and set of indicators to calculate both a site's specific ecological functions and its contextual value to the surrounding ecosystem. Late in 2009 this group secured written agreement from regulatory agencies to use the first-of-its-kind accounting system that gives landowners access to credit markets

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across multiple regulatory jurisdictions using a single calculation methodology and standardized credit issuance process.

This innovation enables landowners to quantify benefits from restoration actions and enables others to quantify the impacts of development actions. These debits and credits form the basis of marketable currencies in an ecosystem services marketplace. With this system in place, farmers, foresters, and ranchers will be able to assess emerging market potential for the benefits generated by management practices on their land.

Conservation and Environmental Policy and Program Design

CSREES-CEAP Synthesis: Preliminary Lessons on Protecting Water Quality

Deanna Osmond, NC State University

Don Meals, Ice.Nine Environmental Consulting, dmeals@burlingtontelecom.net

Mazdak Arabi, Colorado State University, Mazdak.Arab@ColoState.EDU

Dana Hoag, Colorado State University, dana.hoag@ColoState.EDU

Al Luloff, Penn State University, aelluloff@psu.edu

Greg Jennings, NC State University, greg_jennings@ncsu.edu

Andrew Sharpley, Univ of Arkansas, sharpley@uark.edu

Mark McFarland, Texas A&M, ml-mcfarland@tamu.edu

Jean Spooner, NC State University, jean_spooner@ncsu.edu

Dan Line, NC State University, dan_line@ncsu.edu

The 13 CSREES-CEAP watershed projects were designed to evaluate the impacts of interactions among conservation practices and their biophysical setting on water quality at a watershed scale, while simultaneously evaluating social and economic factors that influence implementation and maintenance of practices. These CSREES-CEAP projects have finished or are finishing and the results and lessons learned are being currently being synthesized. This science-based evaluation (synthesis) is focusing on the effectiveness of suites of conservation and land management practices, as influenced by timing and the spatial distribution throughout a watershed, and with respect to their cumulative influence on water quality. To date, 9 of the 13 projects have been completed or are almost complete. Based on information developed by these projects and site visits, about one-third of the projects have been able to demonstrate water quality changes relative to conservation practice implementation. There are multiple reasons why not all projects have been able to demonstrate the effectiveness of conservation practices ranging from difficulty with water quality monitoring designs to insufficient land treatment. Preliminary lessons learned will be explored.

Water Resources and Management

Delineation of Critical Areas and Developing Best Management Scenarios for a Field Using Simulation Model

APEX

Ashish Mudgal, University of Missouri, Columbia

1) C. Baffaut, USDA-ARS, claire.baffaut@ars.usda.gov

2) S.H. Anderson, University of Missouri, AndersonS@missouri.edu

3) E.J. Sadler, USDA-ARS, John.sadler@ars.usda.gov

4) N.R. Kitchen, USDA-ARS, Newell.Kitchen@ars.usda.gov

Targeting critical management areas (CMAs) within fields is essential to maximize cultivation area while implementing management practices to minimize impacts on water quality. The objective of this study was to develop a physically-based index to identify CMAs in a 32-ha field. The field was characterized by a claypan, a restrictive clay layer occurring within the upper 30 to 50 cm. The field was under a corn -soybean crop rotation since 1991 with a V-notch weir installed at the outlet for measurement of runoff, sediment and atrazine transport. Thirty-five subareas were defined based on slope, depth to claypan, and soil mapping units. The Agricultural Policy Environmental Extender (APEX) model was calibrated and validated from 1993 to 2002 for runoff, sediment and atrazine loads. Simulated output by subarea was correlated with physical parameters including depth to claypan (CD), surface saturated hydraulic conductivity (Ksat) and subarea slope (SL). Two indices were developed, $CD \cdot Ksat / SL$, and CD / SL , which correlated with runoff ($r = -0.77$), and atrazine and sediment loads ($r = -0.55$), respectively. These indices captured 100 % of CMAs due to runoff and sediment yield and 75 % of CMAs due to atrazine load, as predicted by APEX. These critical areas were also areas with lower productivity. Management scenarios were simulated that differentiated the management of the CMAs from the rest of the field. Indices such as those for

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identifying and managing areas of higher environmental risk and lower productivity could prove beneficial for effective implementation of best management practices.

Conservation Tools and Technologies

DEVELOPMENT AND APPLICATION OF A MODIFIED NTT TOOL FOR WATER QUALITY ASSESSMENT AND TRADING

Ali Saleh, Texas Institute for Applied Environmental Research (TIAER), Tarleton State University

- 1) ALI SALEH, SALEH@TIAER.TARLETON.EDU
- 2) OSCAR GALLEGU, GALLEGU@TIAER.TARLETON.EDU
- 3) EDWARD OSEI, OSEI@TIAER.TARLETON.EDU

The Nutrient Trading Tool (NTT) is a web-based computer tool that enables users to determine the impacts that alternative practices or management options have on crop yields, and sediment and nutrient losses from individual fields. Impacts of alternative practices on sediment and nutrient losses can be readily converted to water quality credits for use in a water quality trading program. Based on recent enhancements, air quality credits can also be estimated from NTT output for use in trading.

NTT was initially developed as a Nitrogen Trading Tool by Natural Resource Conservation Service (USDA-NRCS) and Agricultural Research Service (USDA-ARS). Recently, through a national Conservation Innovation Grants (CIG) the Texas Institute for Applied Environmental Research (TIAER), TIAER researchers have linked USDA-ARS's Agricultural Policy Environmental eXtender (APEX; Williams et al., 2000) model to the NTT interface. The result is a tool that in addition to nitrogen estimates sediment and phosphorus losses, crop yields, and other indicators. The new version of the tool is called Nutrient Trading Tool, since it is no longer focused on just nitrogen.

This project was funded by National Conservation Grants (CIG).

**CIG Abstracts (Conservation Innovation Grant Program)*

Development of A Methodology to Quantify Ecosystem Services using Landscape Models

Indrajeet Chaubey, Purdue University

- 1) R. Logsdon, Purdue University, rlogsdo@purdue.edu
- 2) B. Gramig, Purdue University, bgramig@purdue.edu

Even though agroecosystems provide critical ecosystem services for direct human benefits, very rarely ecosystem service values are included in product or service prices or in making land management decisions. Although the importance of ecosystem services for human well-being is widely recognized, the main setback for including ecosystem service values in land management decisions is due to the lack of a standard method for quantifying specific ecosystem service values. The unpredictable and dynamic nature of ecosystems and their processes is the main reason that ecosystem services have yet to have a method of quantification established. We will present a methodology for quantifying ecosystem services using the Soil and Water Assessment Tool (SWAT) and the Century Carbon Content models. Specifically, we will discuss methods to quantify provisioning and regulating services using these landscape models. The models will be applied to quantify various ecosystem services in Wildcat Creek Watershed, a predominantly agricultural watershed located in central Indiana. We will discuss how these models can be used to evaluate changes in ecosystem services related to land use or land management forcings in the watershed. We will present how economic models can be used with the watershed models to provide specific market valuations for each ecosystem service.

Water Resources and Management

Development of a National Air Quality Self Assessment Tool

Wendy Powers, Michigan State University

The National Air Quality Site Assessment Tool (NAQSAT) was developed by researchers, Extension specialists, industry representatives and producers in 14 states to provide assistance to livestock and poultry producers and their advisors in assessing a producer's performance in minimizing air emissions and in determining where there are opportunities to reduce air emissions. NAQSAT considers the influence of diet and feed management; animal housing and management; manure handling, storage and application practices; mortality management; and internal and nearby road management practices on air emissions based upon the most credible information available when the tool was developed. Upon completion of the on-line tool, NAQSAT users are shown a report that summarizes percentage scores for six emissions of primary interest (ammonia, methane, volatile organic compounds, hydrogen sulfide, particulates, and odor). The scores apply for the given facility and associated

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infrastructure and reflect the degree to which an operation has incorporated all of the feasible practices that would effectively minimize air emissions from use of the facility. For example, a high score for odor indicates that a producer is employing a relatively high degree of management and incorporating most of the best practices currently available for controlling odor from his/her operation. A low score indicates that there are additional measures or improvements in management that the producer should consider. An overview of NAQSAT will be presented along with example output and a demonstration.

**CIG Abstracts (Conservation Innovation Grant Program)*

Digital storytelling and targeted marketing to educate and engage absentee landowners in Swan Valley, Montana

Leslie Horner, National Network of Forest Practitioners

- 1) Leslie Horner, National Network of Forest Practitioners, leslieahorner@gmail.com
- 2) Colin Donohue, National Network of Forest Practitioners, colin@nnfp.org
- 3) Anne Dahl, Swan Ecosystem Center, swanec@blackfoot.net

The Swan Valley region in Montana is facing significant change in ecological, ownership, and market conditions. Many new landowners in the Swan Valley are seasonal residents from other regions of the country, which disrupts the potential for neighbor-to-neighbor learning. Given the context of sparse home distribution and absentee landownership, the concept of "neighbors" can and must be broadened, particularly through use of web-based outreach tools accessible anywhere. We developed a strategy to connect with, inform, and engage new landowners in the Swan Valley region, using a suite of outreach tools targeted to new and absentee landowners, including a series of multimedia videos. Multimedia pieces can be significant tools for effective outreach as storytelling has a much greater impact in 1) attracting attention, 2) achieving retention, and 3) affecting behavior than simply telling an audience what they should be doing. A range of landowners were interviewed about their experiences, and interview questions were crafted so that a "story" of owning and managing land would naturally emerge in the interviews. Footage from the interviews was reviewed for management themes and resulted in 6 multimedia pieces (5-7 minutes), with themes such as learning from and working with neighbors, taking the first steps toward active forest management, hopes and fears for the future of the Swan Valley, and profiles of a range of stewardship projects completed by landowners. The coordinated outreach series-including postcards, a new landowners' welcome pamphlet, and web-based handbook-is expected to lead to increased understanding and adoption of management practices.

**CIG Abstracts (Conservation Innovation Grant Program)*

Driving Conservation Innovation and Sustainable Winegrowing Adoption through Performance Benchmarking, Tools, and Resources

Joe Browde, California Sustainable Winegrowing Alliance, mjbrowde@pacbell.net; and Andrew Arnold, SureHarvest, andrew1arnold@yahoo.com (split presentation)

- 1) Allison Jordan, California Sustainable Winegrowing Alliance, ajordan@wineinstitute.org

The California Sustainable Winegrowing Program is a statewide initiative by the winegrowing community to promote, adopt, and certify "ground to bottle" sustainable practices and measure associated performance-based outcomes for producing grapes and wine. The program relies on an extensive partnership network to implement its "cycle of continuous improvement," consisting of voluntary grower and vintner self-assessment, the interpretation of performance, action planning, and the implementation of change. National CIG funds have been and continue to be used to evolve key program elements including its Sustainable Winegrowing Practices Workbook, online assessment and reporting software, and educational and outreach activities for conserving natural resources. Current funds are supporting the development and customization of metrics and educational and user-friendly online accounting tools, enabling winegrowers to understand and calculate impacts of practices on specific environmental outcomes such as energy and water use efficiency and greenhouse gas footprints. Tools are being linked to existing program software so users can confidentially measure and track progress and the industry can collectively benchmark performance and set targets for and report improvement. Online grower workshops are used to convey the benefits for tracking metrics and to facilitate data collection. Processes and elements of the California Sustainable Winegrowing Program have served as and will continue to be positioned as a model for other commodities pursuing sustainable agriculture.

**CIG Abstracts (Conservation Innovation Grant Program)*

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Economic And Efficacy Analysis Of Brush And Weed Management Practices In Texas And New Mexico Using The Pestman Decision Support System.

R. Loren Naylor, Center for Natural Resource Information Technology

- 1) Krystal T. Lair, Center for Natural Research Information Technology, klair@cnrit.tamu.edu
- 2) Courtney Chambers, Center for Natural Research Information Technology, softballcatcher5@hotmail.com
- 3) Edward C. Rhodes, Center for Natural Research Information Technology, erhodes@cnrit.tamu.edu
- 4) Tim Brown, Center for Natural Research Information Technology
- 5) David Kwiatkowski, Jr., Center for Natural Research Information Technology, davidk@cnrit.tamu.edu
- 6) Wayne Hamilton, Texas Agrilife Research, wthamilton@ag.tamu.edu
- 7) J. Richard Conner, Texas Agrilife Research, jrc@tamu.edu
- 8) Allan McGinty, Texas Agrilife Extension, a-mcginty@tamu.edu
- 9) Kirk McDaniel, New Mexico State University, kmcdaniel@nmsu.edu

Landowners, resource managers and livestock producers in Texas and New Mexico continually manage against the encroachment of unwanted brush and weedy species. Often times these pest plants have a negative impact on agricultural and rangeland resources such as soil loss from reduced herbaceous cover. Recommendations for chemical and mechanical treatments are readily available through each states' extension publications; however the long-term economic impacts of those treatments are difficult and time-consuming to ascertain using existing methods. PestMan, Pest Management decision support system, was developed as a free, web-based decision support system which provides existing treatment recommendations in a readily accessible format, and help the user decide, as simply and efficiently as possible, which treatment is the most economically beneficial.

PestMan combines Texas and New Mexico extension publications with the Expert System for Brush and Weed Control Technology, EXSEL, decision support system and the economic tool, Grazingland Alternative Analysis Tool, GAAT. The decision support system accounts for differences between Texas and New Mexico in control practices and valuation of land and livestock. The user chooses a treatment recommendation provided for their problem species and provides specific information about their property, and PestMan returns reports detailing economic indicators such as cost/benefit ratio, internal rate of return, years to break even, and change in stocking rate. Resource managers can save the reports and use PestMan to evaluate the economic benefits and efficacy of differing brush and weed management practices and choose the most suitable of these when building land and resource management plans.

Conservation Tools and Technologies

ECoPayPack: A Tool for Advancing Conservation

Linda Meschke, Rural Advantage

- 1) Linda Meschke, Rural Advantage linda@ruraladvantage.org

Rural Advantage is developing a tool, called ECoPayPack - Ecological Commodity Payment Package, to reward landowners who provide one or more ecosystem services through management changes on land they own or operate. While our interests are around supplying native prairie mixes for a new bio-refinery to be built at Madelia, MN, this concept is readily transferable to other productive conservation on working lands crops across the Midwest. This concept compliments the biomass production payment, from the energy facility, with an Ecological Commodity Payment Package [ECoPayPack] that supplies a payment to the landowner based on the ecological service values or public benefit provided when you convert from an annual crop to a perennial crop that is managed in a sustainable way. ECoPayPack is a market based approach for an aggregator to "package" together payments for various ecological services and then pay out a single payment to the landowner. Ecological services that there are currently markets for include carbon, greenhouse gas emission reductions, nitrogen and phosphorous reductions, habitat improvement, sustainability standards, green space and aquifer recharge/ water storage. While these programs are not developed in Minnesota, they all exist now in other places in the world.

Conservation Tools and Technologies

Estimates of the Wildlife Value of Rice Fields in Southwestern Louisiana

William L. Hohman, USDA-NRCS

- 1) Wayne Norling, USGS National Wetlands Research Center, norlingw@usgs.gov
- 2) John Pitre, USDA-NRCS, john.pitre@la.usda.gov

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3) Michael E. Salassi, Louisiana State University (LSU) Agricultural Center, msalassi@agcenter.lsu.edu

4) William Waits, USDA-NRCS, bill.waits@la.usda.gov

5) John V. Westra, LSU Center for Natural Resource Economics and Policy, jwestra@lsu.edu

The 1-1.5 million acres of farmland in southwestern Louisiana operated on a 2-year rice-crayfish-fallow or rice-fallow rotational scheme simulate wet, early successional habitats that are highly attractive to wetland-associated wildlife. In recognition of the increasing importance of these "working wetlands" for resident and migratory waterbirds, a coalition of agricultural and wildlife interests seeks to develop a stewardship program that would provide financial compensation to rice-crawfish producers in southwestern Louisiana for additional ecosystem services (i.e., waterbird habitat) provided by their operations. In support of this initiative, we sought to estimate the value of these services. Traditional methods used to estimate the worth of wildlife habitat based on recreational uses underestimate the full value of areas because they do not account for use by nongame. If the value for nongame is assumed to be equal to that for game (i.e., value of waterfowl hunting leases), then an estimated habitat value of Louisiana rice fields for waterbirds would be \$26/acre (range, \$15-50/acre). Previous research has estimated residents' willingness-to-pay for coastal wetlands at \$250-300/acre. Combining Louisiana Department of Wildlife and Fisheries' restitution values with estimates of waterbird density yields an average value of \$27/acre for all species and \$6/acre for nongame species during the non-growing season and \$6/acre for all species during the growing season. Estimates of cumulative value of rice fields over the entire year are \$217/acre for all waterbirds and \$69/acre for nongame waterbirds. Based on this estimate, the annual value of southwestern Louisiana rice fields for waterbirds may exceed \$300 million.

Fish, Wildlife, and Biodiversity Conservation

Evaluating the economic benefits of interstate nutrient trading in the Chesapeake Bay

Cy Jones, World Resources Institute

1) Craig Hansen, World Resources Institute, chansen@wri.org

2) Mindy Selman, World Resources Institute, mselman@wri.org

3) Evan Branosky, World Resources Institute, ebranosky@wri.org

4) Sara Walker, World Resources Institute, swalker@wri.org

5) John Talberth, World Resources Institute, jtalberth@wri.org

6) Michelle Perez, World Resources Institute, mperez@wri.org

The Chesapeake Bay will become the nation's largest water body to receive a Total Maximum Daily Load (TMDL) cap on nitrogen and phosphorus pollution in December 2010. The nutrient reductions needed to achieve the TMDL will involve costly upgrades to waste water treatment plants (WWTPs), municipal stormwater jurisdictions, and reductions from agricultural sources. Analyses pursuant to proposed Congressional legislation that establishes an interstate nutrient trading program in the Bay watershed are on-going.

Methods employed include net present valuation of nutrient credits purchased by WWTPs and stormwater systems (entities with relatively high costs to reduce nutrients) from crop and livestock farmers (entities with lower reduction costs). Project data sources include World Resources Institute's web-based tool NutrientNet, the EPA's Chesapeake Bay water quality and watershed models, and state and federal agricultural cost-share programs. Results thus far have demonstrated potential cost savings at real-world WWTPs from the conceptual purchase of nitrogen credits to meet a portion of their upgrade obligations. Potential net profits at hypothetical farms have also been calculated. Trading thus appears economically feasible.

Anticipated contributions of these analyses to science and society include laying the analytical and technical framework for the creation of a robust and stable market of nutrient credits. Such a market would stimulate technology innovation, foster market competition, provide better price discovery, and lower risk. Establishment of an interstate trading program will likely offer the political benefit of lowering resistance to the TMDL and the environmental benefit of accelerating achievement of the TMDL to restore Bay water quality.

Conservation and Environmental Policy and Program Design

Evaluating the feasibility of interstate nutrient trading in the Mississippi River Basin to Reduce Hypoxia in the Gulf of Mexico

Michelle Perez, World Resources Institute

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- 1) Cy Jones, World Resources Institute, cjones@wri.org
- 2) Sara Walker, World Resources Institute, swalker@wri.org
- 3) Brandon Koltz, Symbiont, Brandon.Koltz@symbiontonline.com
- 4) Andrew Sharples, University of Arkansas, sharples@uark.edu

Options for reducing hypoxia in the Gulf of Mexico have included establishing nutrient reduction targets from various sources in the Mississippi River Basin. Achieving such future goals will likely involve costly upgrades to point sources such as waste water treatment plants (WWTPs) and include nutrient reduction expectations for agricultural sources. Market-based mechanisms, such as nutrient trading, should be evaluated for their feasibility to help lower the cost of compliance to WWTPs, generate new revenue sources for farmers, and make progress towards achieving water quality goals.

To determine the economic feasibility of point-nonpoint source nutrient trading in the Mississippi River Basin, conceptual pollutant suitability and economic suitability analyses are being conducted. The potential demand for nitrogen and phosphorus credits from selected WWTPs in Illinois and Kentucky will be estimated while the potential supply of credits from livestock, poultry, and crop producers in selected watersheds in Arkansas and Mississippi will be also estimated. Trading potential will be evaluated under two scenarios: with and without in-stream nutrient criteria in receiving waters of the WWTPs.

The anticipated results of this project and the potential contributions to science and society include: an estimate of the potential price, supply, and demand for nutrient credits from the project's buyers and sellers and methodologies for establishing pollution reduction targets for WWTPs and "baseline" requirements for farmers to meet potential future obligations to reduce nutrient pollution to the Gulf.

Conservation and Environmental Policy and Program Design

Examining Trends and Influences in Adoption of Best Nitrogen Management Practices to Improve Nitrogen Fertilizer Use Efficiency in the United States

Wen-yuan Huang, Economic Research Service, USDA

Robert Ebel, Economic Research Service, USDA

Rebel@ers.usda.gov

Nitrogen is an essential plant nutrient for producing food and fiber for human consumption. Current intensive agricultural production practices in the United States require a large flow of nitrogen fertilizers for crop production annually. When nitrogen fertilizers are applied in excess of crop need, the excess nitrogen can cause environmental problems, especially if a large quantity of applied nitrogen is lost from soil/crop system into water or the air. There is increasing interest in examining agricultural practices that not only can reduce nitrogen losses to surface and ground water, but also can reduce greenhouse gas (GHG) emissions to combat climate change. Adoption of best nitrogen management practices (BNMPs) can improve N use efficiency to increase crop's N uptake and reduce N losses. BNMP adoption is to apply right fertilizer at the right rate at right time and at right place, and to practice right crop management systems. The objective of this paper is to examine trends of adoption of best nitrogen management practices as well as to analyze influence of BNMP adoption on N fertilizer use efficiency in corn production. Trends of nitrogen fertilizer materials selection, soil testing, N application timing, N field application method, and crop rotation practices will be examined. Correlation analyses will be employed to examine the influence of use of BNMPs on N fertilizer use efficiency. The efficacy of BNMP adoptions on reducing GHG emission will be discussed. The primary data source is USDA's Agricultural Resource Management Survey conducted from 1990 to 2008.

Conservation Tools and Technologies

Facilitating Family Forest Access to Carbon Offset Markets: A Pilot Project

George McKinley

Non-industrial private and family forests cover a significant portion of the forested landscape and provide a broad spectrum of market goods and ecosystem services. At the same time, such forests are prone to land use conversion and a lack of focused forest planning and management. These factors increase risk to forest health, particularly in light of ongoing demographic and ownership shifts, expected climate change impacts, and, particularly in drier forest types, an increase in the risk of catastrophic wildland fire. Emerging offset markets that purchase forest sequestered carbon could play an important role in helping keep non-industrial and family forests well managed, healthy, and productive by generating funds to enhance forest restoration and management

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capacity and practice.

A Conservation Innovation Grant has helped create a site-specific pilot project on Greenwood Forest, a 600-acre diverse, mixed-conifer family forest in Southwest Oregon. The presentation discusses findings from this pilot project, including the creation of a conservation mechanism (tool) to document quantifiable carbon, and test the logistic and economic feasibility of carbon offset market access for individual forest owners. Â

The presentation will address:

1. Creating a management plan for both adaptation (primary) and mitigation (opportunity?);
2. Using a plot-based inventory and FVS modeling for measurement, baseline and additionality;
3. Challenges related to verification and permanence;
4. Best value/best option markets for family forest owners; andÂ
5. Additional ecosystem benefits and services from project implementation.

**CIG Abstracts (Conservation Innovation Grant Program)*

Factors Affecting Adoption of BMPs for Animal Manure Management

Laura McCann, University of Missouri

- 1) Haluk Gedikoglu, Univ. of Wisconsin-LaCrosse, gedikogl.halu@uwlax.edu
- 2) Bob Broz, Univ. of Missouri, brozr@missouri.edu
- 3) John Lory, Univ. of Missouri, loryj@missouri.edu
- 4) Ray Massey, Univ. of Missouri, masseyr@missouri.edu

Voluntary adoption of appropriate manure management practices by animal feeding operations (AFO's) is necessary in order to reduce water quality problems associated with excess nutrients and pathogens. A randomized mail survey of 3000 livestock farmers in Missouri and Iowa was conducted in the spring of 2006 in order to determine adoption rates of various practices and the factors affecting adoption.

Overall adoption rates were: Injection of manure (19%), Grass filters near water sources (63%), Soil testing (every 3 years, 73%), Record keeping on manure applications (29%), Manure testing (every year, 22%), Calibrating manure spreaders (19%), and Maintaining 100 foot setbacks (61%). Results of probit analysis indicated that perceived profitability was the only factor that significantly (and positively) affected adoption of all practices. If the practice was not perceived to be complicated, farmers were more likely to adopt manure testing, calibration, injecting manure, grass filters and soil testing. Farmers who disagreed that record-keeping was time-consuming were more likely to do it. Perceived improvement in water quality was positively related to only injecting manure and was somewhat negatively related to soil testing.

Those with more animal units were significantly more likely to adopt manure testing, soil testing, and record-keeping. Larger farmers, measured as gross farm sales, were also more likely to adopt some practices. Other factors that impacted adoption of some practices were age, education, manure management system, species, and off-farm income. The results indicate that additional educational efforts, or simplified practices, may be needed for smaller and part-time farmers.

Conservation Outreach and Education

Forest Cooperatives: Community-based Partners for Increasing Participation in Forest Conservation

Scott Bagley, National Network of Forest Practitioners

- 1) Colin Donohue, National Network of Forest Practitioners, colin@nnfp.org

While much was made of the 2003 closure of the Sustainable Woods Cooperative in southwest Wisconsin, many other forest cooperatives are still in business or have become established in the meantime, growing steadily and providing a suite of services for hundreds of member and tens of thousands of acres of family forest lands across the US.

In addition to providing stewardship planning services and administering conservation projects, forest cooperatives are also showing promise as tools for maintaining stewardship continuity across generations. As they grow and re-weave forested landscapes parcel by parcel, they are also becoming important partners in protecting ecosystem services.

This presentation will provide an overview and examples of the ways cooperatives are bringing more landowners into forestry and coordinating cross-boundary projects to enable treatment of small-acreage parcels. Additionally, the authors will describe how cooperatives are developing local workforces that are tailored to meet the challenges of parcelized landscapes and the evolving demands of the growing number of new landowners. They

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will also provide examples of cooperatives facilitating peer-to-peer learning between landowners, gearing up to assist forest owners in adapting in the face of climate change, and exploring ways to aggregate biomass and ensure sustainability for community-scale bioenergy applications.

Finally, they will describe the growing network of forest cooperative leaders who are working together to share lessons learned and compare notes of their progress, while developing a policy voice for small-scale forestry at local, regional, and national levels.

Conservation Outreach and Education

Future Corn Belt Landscape Scenarios: Perennials, People, and Policy

Ryan Atwell, AAAS Science and Technology Policy Fellow, USDA Office of Environmental Markets

Lisa Schulte, Iowa State University, lschulte@iastate.edu

Lynne Westphal, U.S. Forest Service, lwestphal@fs.fed.us

Emerging biofuel markets in the U.S. Corn Belt are leading to more row crop production and less land in perennial cover. Simultaneously, ecosystem services and societal goods provided by multifunctional agriculture are increasingly valued by society. We conducted 33 in-depth interviews with farmers and other rural stakeholders and engaged regional leaders in the state of Iowa (USA) in a participatory workshop to develop future policy scenarios that could guide Corn Belt land use and conservation in the midst of the emerging bioeconomy. Analysis of workshop data, in conjunction with the results of regional social and ecological research, was used to develop a heuristic model outlining interactions between key drivers and outcomes of regional landscape change. Three policy scenarios, also based on workshop data, were built on this framework and included the following approaches: tweak, adapt, and transform. These scenarios demonstrate that, if top-down factors such as markets, technologies, and federal farm policy are allowed to be the overriding drivers of farm owner and operator decision making, Corn Belt landscapes will become highly efficient at rowcrop production at the cost of ecosystem services and other societal goods. Other desired outcomes will only come about if mechanisms to understand and bolster multifunctionality are directly constructed as central components of Corn Belt systems. Although the future is uncertain, perspectives of regional scientists, stakeholders, and leaders suggest that adaptive or transformative landscape change to achieve desired multi-objective outcomes is possible if a coordinated strategy of change is implemented across multiple levels of the system.

Conservation and Environmental Policy and Program Design

Geospatial evaluation of riparian buffer effectiveness for watershed management

Colin Brooks, Michigan Tech Research Institute

Michael Billmire - MTRI, michael.billmire@mtu.edu

Ben Koziol - MTRI, bkoziol@mtu.edu

Nancy H.F. French, PhD - MTRI, nancy.french@mtu.edu

Non-point source pollution from diffuse sources such as agriculture and storm water is a significant source of water quality degradation. This overland hydrological flow pollution can be offset effectively by the presence of natural vegetation buffers in riparian areas. We have developed ecologically relevant, easily implementable, flexible, and adaptable methods to evaluate watershed water quality via geospatial analysis of riparian buffers. We developed and tested our watershed buffer evaluation system for the Tittabawassee watershed in northeast Michigan using Coastal Change Analysis Program (C-CAP) land cover products. Two methods have been developed to prioritize catchments (1-10km² watersheds) of concern: (1) a drainage pattern summarization process and (2) a geospatial analysis of the filtration effectiveness of riparian vegetation. A third method, using a traversability algorithm for precision buffer placement, has been developed as a more intensive assessment for targeted catchments.

Parameters in the analysis include soil conductivity, water capacity, slope, hydraulic flow, stream location, and drainage basin land cover composition. Topography and land cover were effectively combined providing information on the position of the natural riparian buffers within a watershed and their potential influence on water quality.

This research will aid watershed management in numerous ways:

- Targets for restoration can be prioritized to maximize management effectiveness.
- Conservation target selection can be geospatially driven.
- The traversability algorithm can identify areas along river, stream, and lake perimeters where buffers should be

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placed and how wide buffers should be to maximize filtration effectiveness and minimize cost.
Conservation Tools and Technologies

Great Lakes Restoration and Sustainable Biomass Project

Dan Clarahan, EcoCombustion Energy Systems Corp

1) Brett Hulseay, Better Environmental Solutions, Brett@BetterEnviro.Com

2) Paul Schneider, EcoCombustion Energy Systems, paul@burnmanure.com

Project Location: Lake Michigan and Lower Fox River Basins

Problem Statement: The GLRSB Project will identify and restore stream buffer habitat and wetlands to native vegetation to grow biomass for energy to address the greatest challenges facing the Great Lakes to restore habitat, reduce polluted runoff, and achieve TMDL reductions. We will also fund a region biomass and manure treatment and energy facility to convert biomass and manure to at least 600 kW of energy and remove phosphorous and nitrogen from animal waste and biomass.

Proposed Work and Project Description: To grow biomass sustainably, we will research and test the Biomass Buffer™ concept along streams and floodplains to grow and harvest biomass to restore native prairies and forests, reduce flooding and water pollution of our drinking water sources, beaches, streams and rivers, restore fish and wildlife habitat, reduce carbon emissions through offsets and sequestration, and control invasive species.

The outcomes and deliverables resulting from this project will to restore 500 acres of stream buffer habitat for biomass production, study the impacts of that conversion, and create at least a 600 kW biomass and manure handling facility to reduce the phosphorous from at least a 2000 cow dairy farm to ash fertilizer.

This project will target restoring critical habitat, reducing polluted runoff and promoting sustainable development.

We will transfer knowledge or process outcomes to other State, local governments, or other entities by creating successful Biomass Buffer™ models and a full scale Elimanure® plant to reduce phosphorous from dairy manure and biomass.

**CIG Abstracts (Conservation Innovation Grant Program)*

Groundwater Protection: Sustainability in the Face of Development

Cassandra McKinney, McHenry County Government

Over the past two decades, McHenry County, Illinois has been one of the fastest growing counties in the State. In addition, the County is solely dependent on groundwater for its drinking water resource, with no other options available. From 2000 to 2030, McHenry County's population (current population 310,000) is expected to grow by 190,000. In the year 2000, water use in the county amounted to an annual average of 34.6 million gallons per day (mgd). By 2030, average annual water use is estimated to almost double to 67.5 mgd. With this tremendous growth, water shortages are forecasted as early as 2020.

In addition to groundwater being the only viable drinking water resource for McHenry County, groundwater protection is a challenge because the State of Illinois follows the doctrine of reasonable use. With the absence of statutory authority, counties are unable to enforce groundwater ordinances in areas other than the unincorporated. The impending water shortages and the lack of statutory authority prompted the creation of a Water Resource Manager position to utilize a cooperative planning process to coordinate the development of a multi-faceted, inter-governmental Groundwater Protection Program. This program uniquely seeks to address quantity and quality in one comprehensive program with the underlying goal "to provide a sustainable and safe water supply for current and future generations, including the built and natural environments." The Groundwater Protection Program was completed in October 2009 and will assist in assuring our growing population an adequate, sustainable supply of safe water in the future.

Water Resources and Management

Hedgeapple Biotech

Alan Gravett MD MPH

1) Brent Tisserat PhD USDA/ARS NCAUR Peoria Illinois tisseratbh@ncaur.usda.gov

Generating enthusiasm from political or business entities to promote conservation requires economic viability in times of economic downturn. Massive reforestation is being considered by our government to address the climate crisis thus creating enormous opportunity. Rapidly growing species with significant "value added product" offer significant potential for successful economic development. Moraceae ssp. harbor unique potential for

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further development due to high concentrations of bioactive and chemically useful compounds. Previous work done internationally on related species facilitates development of Osage Orange and Red Mulberry. Bioactives include hydroxystilbenes, flavanoids, triterpenes, xanthenes, lectins, tannins and alkaloids. Many of these substances are in as high of concentrations as exists in nature facilitating extraction. All these are useful variably as anti-infectives, anticancer, antidiabetic, anticardiovascular and neurologic disease agents. Wood preservatives, food additives, dyes, polymers, preservatives, enzyme inhibitors, 3rd generation solar cells components (xanthenes) are additional products in addition to fuels. Large number of preexisting trees offers potential for rural cooperative development prior to plantation establishment. Non-outsourcable jobs in tree establishment, harvest, bioprocessing, product development and distribution are an undeniable "economic stimulus". Existing research has built a significant foundation for the replacement of many petro-chemicals and fuels with biobased materials. Construction of viable biorefineries is an important start on that pathway as is appropriate feedstock development. Building on existing research and capitalizing on existing biomass sources we are constructing a model system adaptable to the spectrum of woody biomass species. The best hope for "saving the planet and the country" is economically viable green industry.

**CIG Abstracts (Conservation Innovation Grant Program)*

How Farmers Adapt to Structural and Regional Shifts Induced by Climate Change:

Richard Nehring, ERS

Seth Wechsler, Univ of Md SWechs1@Umd.edu

Ken Erikson, ERS Erikson@ers.usda.gov

Charles Hallahan, ERS Hallahan@ers.usda.gov

Art Grube USEPa, Grube.Arthur@epamail.epa.gov

Project Description:

Have recent ethanol mandates (in tandem with changes in temperature and precipitation) affected corn farmers' input choices, tillage practices, and crop rotation decisions?

This study examines how economic and climatic changes (caused by global warming) affect farmers' input choices, tillage practices, and crop rotation decisions. Secondary questions address environmental consequences, whether the use of genetically modified seed strains, particularly corn because of its genetic adaptability, can mitigate these consequences, and the role of region-specific factors.

Underlying Data and Modeling Framework:

We use county and state-level data in order to examine how farmers adapt to structural and regional shifts induced by climate change. First, fertilizer and pesticide prices are quality adjusted using hedonic techniques to derive quality-adjusted quantity series. Second, a simultaneous system of equations is econometrically estimated in order to examine how various drivers—including the ethanol mandate and climatic trends—affect corn farmers' crop rotation decisions, tillage practices, and demand for fertilizer and pesticide products. Data compiled from the Agricultural Census, ARMS, NASS, DOANES, and the National Oceanic and Atmospheric Administration datasets are used in both the first and second stages of the analysis.

Expected Outcome:

Rotational shifts leading to crop rotations emphasizing corn (from soybeans and hay in the central Corn Belt and spring wheat in the northern areas now suitable for corn, e.g. North Dakota) are expected to: 1) increase acres of corn planted, 2) increase in aggregate demand for fertilizers and pesticides, and 3) encourage less environmentally friendly tillage and crop rotation.

Adaptive Management of Conservation Efforts

Hugh Hammond Bennett and the Creation of the Soil Conservation Service

Douglas Helms, Natural Resources Conservation Service

Douglas Helms, Natural Resources Conservation Service, douglas.helms@wdc.usda.gov

Hugh Hammond Bennett arrived at the Department of the Interior as head the Soil Erosion Service with a mission and a dream. The mission was to demonstrate the practicability of using coordinated soil conservation practices on farms. The dream was to establish a permanent agency which could continue the work beyond the economic emergency of the Great Depression. During the 19 months from September 19, 1933, to April 27, 1935, Bennett succeeded with the passage of the law that created the Soil Conservation Service. The outcome was by no means assured. This presentation will illuminate both the hurdles and advantages the economic crisis presented to

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Bennett.

President Franklin Roosevelt and Secretary of the Interior Harold Ickes generally supported Bennett but were uneasy with the appearance of spending public money on private lands. Congressmen generally liked the reception of the Bennett program in the countryside and requested additional projects and offered to support permanent legislation. At the same time some established agricultural institutions tried to frustrate the effort.

The administration fervently hoped for an early end to the economic crisis, but embraced an enlarged "work relief" program, as the depression deepened. An enlarged soil conservation program would provide employment. Finally, Bennett deftly used the dust storms of 1934 and 1935 that swept up from the Great Plains to the Atlantic Coast to demonstrate the national interest in soil conservation.

Conservation and Environmental Policy and Program Design

Identification and management of critical fields for a claypan watershed

Claire Baffaut, USDA-ARS-CSWQRU

- 1) A. Mudgal, University of Missouri, am4db@mail.mizzou.edu
- 2) S.H. Anderson, University of Missouri, AndersonS@missouri.edu
- 3) E.J. Sadler, USDA-ARS-CSWQRU, john.sadler@ars.usda.gov

Identifying fields that need conservation to minimize impacts on stream water quality is critical to ensure effectiveness of conservation programs at the watershed scale. This study was located in the 72 km² Goodwater Creek Watershed, in northeast Missouri. Most soils in this watershed are characterized by a clay layer of extremely low permeability, which can be visible at the surface in eroded sideslope areas or up to one meter deep in footslope areas. Field scale data and simulation results showed that a field's critical areas can be identified based on surface layer hydraulic conductivity, slope, and depth to claypan. Our objective was to extend these results to the watershed scale. Using criteria developed with field data, critical fields of the watershed were identified. The SWAT model was utilized to simulate runoff, crop yields, and pollutants yields from these areas and compare them to outputs from non-critical areas. Subsequently, alternative management including grasses, specific crop rotations and appropriate tillage practices were simulated on these critical fields to reduce pollutant loadings to the stream. Results include the fraction of cropland in the watershed classified as critical as well as a comparison of runoff and pollutant loadings generated from these fields and other non-critical fields. The effect that implementation of practices may have on stream loadings will be presented. The identification and specific management of these critical areas is important for producers and regulators as it allows better use of cost-share dollars and greater flexibility for producers on the rest of their land.

Conservation Tools and Technologies

Illustrating soil and water conservation to undergraduate students by building a water quality structure-arain garden

Dr. Warren Anderson, Middle Tennessee State University

- 1) Mr Larry Sizemore, MTSU
- 2) E. Garrett and other MTSU undergraduate students enrolled in ABAS 3370 and ABAS 4370 from fall 2005 through spring 2009

Drainage ditches can be essential management strategy for rural and urban land use. Surface ditches conduct excess water from crop production land or from an impermeable surface (parking lot) to a drain basin or waterway. Rain gardens can be used as bio-filter to remove soluble ions, petrochemical and trap sediments from runoff water before the water pools in a drain basin or enters a waterways. MTSU has built three gardens on campus since 2005. The rain gardens on the campus filter storm runoff water from some of the 20,000 + parking stalls before it pools in a drain basin. This presentation will present insight learned about building and maintaining rain gardens.

(1), Professor, School of Agribusiness and Agriscience, Campus Box 5, Middle Tennessee State University, Murfreesboro TN 37132; voice 615-898-2408, Fax 615-898-5169; email: wanderso@mtsu.edu

(2), Greenhouse Manager, Middle Tennessee State University

Conservation Outreach and Education

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In a market-based crop rotation, teff will maximize the use of soil moisture and increase the annual income for dry land farmers in Kansas

Josh Coltrain, Solomon Valley RC&D Area, Inc.

1) Josh Coltrain, Solomon Valley RC&D Area, Inc., darla.juhl@ks.usda.gov

2) Teresa Webb, Solomon Valley RC&D Area, Inc., teresa.webb@ks.nacdnet.net

Title: In a market-based crop rotation, teff will maximize the use of soil moisture and increase the annual income for dry land farmers in Kansas

Author(s): Josh Coltrain (1), Teresa Webb (2)

Affiliation(s): (1) Solomon Valley RC&D Area, Inc. (2) Solomon Valley RC&D Area, Inc.

A three year national Conservation Innovation Grant for \$119,300 was awarded to the Solomon Valley RC&D in 2007. The Solomon Valley RC&D, in cooperation with the Kansas Black Farmers Association have taken a market-based approach with objectives to: 1) expand teff, a drought tolerant cereal grain and forage crop, from test plots to marketable sized fields; 2) provide farmers in Graham County and north central Kansas with the knowledge, guidance and equipment to plant, grow, harvest, and market teff; 3) increase annual income for dry land farmers in north central Kansas; and 4) increase depth of soil moisture in cropping rotation. During the 2008 crop year fifty five acres of teff was drilled in three different Kansas Counties. In crop year 2009 the planted acres expanded to ninety five in four Counties. The acres planted to teff, a gluten free grain native to Ethiopia, is expected to expand in 2010, the final year of the grant. Teff, a grain one hundred and fiftieth the size of a wheat grain has proved to be difficult to plant, harvest, and clean. The majority of the acres have been planted using a Truax Flex grass drill. In 2008 all the harvested crop was taken for grain using a Flail Vac Harvester; however in year two all but twenty acres was taken for forage. The grain is cleaned by the Clipper Cleaner prior to shipping.

**CIG Abstracts (Conservation Innovation Grant Program)*

Incorporating the Ecosystems Services Concept into On-Farm Decision-Making Processes

Dennis Busch, UW-Platteville Pioneer Farm

1) Jeff Huebschman, UW-Platteville, huebschj@uwplatt.edu

2) Philip Younger, Consultant, philip.younger@googlemail.com

Narrow base terraces are permanently vegetated earthen berms constructed perpendicular to the slope to prevent rapid runoff of rainfall and control erosion of topsoil. Unfortunately, spacing between terraces is fixed, and as a result, terraces installed twenty years ago are not compatible with today's larger farming implements. The University of Wisconsin Platteville's Pioneer Farm installed narrow base terraces in 1982 and 1985, and is now considering removing the terraces, or replacing them with an alternative conservation system. The farm has organized a diverse stakeholder group that includes producers, scientists, and agency personnel, and is using the ecosystem services concept to explore and evaluate both the current system and potential alternatives. The goal is to consider agricultural lands not only in terms of economic benefits, but also ecosystem services-including sustaining biodiversity. This approach may represent a significant paradigm shift within the agricultural community. However, the potential benefits that may arise from finding best practices in these areas will result in positive ramifications for not only agricultural producers and consumers, but for the environment as a whole. The presentation will discuss multidisciplinary data collected to date for the project, such as: surface-water runoff quality, surface and groundwater modeling results, and results of surveys of nesting birds, small mammals, and vegetation. In addition, we will discuss producer response and attitude toward the ecosystem services concept as a decision making tool.

Conservation Tools and Technologies

Information Centric Natural Resource Management

Brian Gelder, Iowa State University

Richard Cruse, Iowa State Univ., rmc@iastate.edu

Robert Anex, Iowa State Univ., rpanex@iastate.edu

Ecosystem services provided at watershed and global levels are the aggregate result of field level management choices and site specific environmental conditions. Current databases of production practices are inadequate, describing crop acreages and tillage in terms of large administrative units (i.e. counties) or confidential survey locations. Creation of open access, field level, databases of land management practices could remedy these shortcomings and increase the effectiveness and efficiency of conservation effort by allowing coordinated

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ecosystem service planning and streamlined reporting of conservation activities. It will also enable research into areas of critical importance that are currently too costly or difficult to tackle. To realize these goals, methods for determining rotations, residue cover, and some permanent practices have already been developed by members of our group. We are currently refining techniques to map land cover from USDA Cropland Data Layer and Common Land Units with greater than 95% accuracy, tillage and residue harvest practices from optical and radar imagery, permanent practices such as buffers, terraces, and ponds from LiDAR topography, precipitation intensity and storm totals from NEXRAD radar and NCEP rainfall totals, tile drainage status from topography, hydrology, and tile maps, and high resolution organic matter within 1% from aerial photography/topography and SSURGO soil surveys. These data, when combined with information on site specific properties, such as topography, soils, and climate, will enable precision conservation management and modeling to be realized.

Conservation Tools and Technologies

Innovative Approach for Restoring Native Grasslands, Wildlife and Other Natural Resources

Jim Willis, Wildlife Habitat Federation

Habitat fragmentation or loss of native grasslands is the primary cause for the decline in upland wildlife and a primary reason for the destruction of natural resources on the Texas Coastal Prairie. To combat this problem the Wildlife Habitat Federation or WHF is building a 7-mile native grassland corridor, which links several ranches to the Attwater Prairie Chicken National Wildlife Refuge. By constructing cross-fencing on this tract, grazing can be deferred indefinitely and other innovative approaches or traditional tools for restoring habitat can be applied. The prototype being developed for reviving upland wildlife, like bobwhite quail, is revealing benefits which are encouraging more participation by landowners and other conservation groups. These include the repopulation by numerous wildlife species, reduced costs and increased net profits for livestock producers and the potential to market native grass seed and hay.

Data collected are being used to develop a user-friendly guide for restoring native grasslands. This guide provides insight on the more exact use of herbicides, alternative planting techniques and how to measure and monitor impact. A website is also being developed to help landowners locate technical and financial resources. The CIG has allowed WHF to provide a one-stop, on-line service center for most state-wide native grass restoration needs.

**CIG Abstracts (Conservation Innovation Grant Program)*

Invasive Plant Species Control through a CWMA

Bob Eddleman - Hoosier Heartland RC & D Council

- 1) Bob Eddleman, Hoosier Heartland RC&D, bobedleman@sbcglobal.net
- 2) Rebecca Fletcher, USDA - NRCS. rebecca.fletcher@in.usda.gov
- 3) Mike Warner, Arbor Terra Consulting, mwarner@arborterra.com

Ecosystems in Central Indiana and across the nation are being seriously threatened by non-native invasive plant species. Some estimates state that the current economic damages cause by invasive species to be over 100 billion dollars annually. Invasive species overwhelm the reproduction of desirable timber species as woodlands are harvested and sunlight reaches the forest floor. In addition to current economic costs, invasives are taking the place of native plants and threatening the habitat for native mammals and wildlife by depriving them of their natural food sources. Another major concern is the steady loss of native pollinating insects as their natural habitats are being replaced by invasive plants. Urban recreation areas are especially damaged by invading plants reducing their value for recreation and natural resources education activities.

Now is the time to take action to reduce this threat. Three RC & D Councils and twenty five Soil and Water Conservation Districts in West Central Indiana are joining forces with other public and private entities to establish a Cooperative Weed Management Area (CWMA). The CWMA will focus on educating the public about invasive plants and helping individuals and groups control their rapid spread.

This presentation will provide background on invasive plant damage to the ecosystem and the process of organizing CWMA's and how CWMA efforts can impact the health and well-being of natural ecosystems. Participants will be able to take this information home with them and help their constituents attack the fast moving spread of invasive plants in their home area.

Conservation Outreach and Education

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Linking Ecosystem Services to State and Transition Models on Western Rangelands

Sapana Lohani, University of Arizona

1) Philip Heilman, USDA-ARS Southwest Watershed Research Center, Phil.Heilman@ars.usda.gov

2) D. Phillip Guertin, University of Arizona, phil@snr.arizona.edu

Ecosystem services are a relatively new concept that puts additional focus on the benefits provided by ecosystems to humans. Those services do not pass through a market for valuation, though often the cost would be very high if, through mismanagement, the ecosystem is no longer capable of providing those services. A significant portion of western rangelands is publicly owned, so to the extent that ecosystem services are identified and values estimated, those ecosystem services could be incorporated into land management decision making, depending on the land management agency's charter and its ability to frame the information in a decision making context. We propose that estimates of the values of ecosystem services on rangelands can be linked to vegetation composition and condition, and applied in the context of state and transition models. Ecological sites are defined as areas with the potential to produce vegetation communities of distinct kinds, amounts, and proportions. Within ecological sites, there are often a number of states, with some natural variability, that are very difficult to get out of without significant additional inputs. We identified six different ecosystem services - forage production (animal unit months), water supply (mm of runoff), soil stabilization / protection (kg of soil loss), water quality regulation (kg of sediment), climate regulation (kg of carbon sequestered), and recreation (days). We will present preliminary results from evaluating ecosystem services based on values in the literature for three study areas in southeastern Arizona: the Walnut Gulch Experimental Watershed (150 km²); Las Cienegas NCA (170 km²); and the Santa Rita Experimental Range (200 km²). We will discuss the practical difficulties, as well as the potential benefits, of linking the concepts of ecosystem services and state and transition models on western rangelands.

Water Resources and Management

Multiple Criteria Evaluation of Conservation Buffer Placement Strategies in Watersheds

Zeyuan Qiu, New Jersey Institute of Technology

Conservation buffers are a widely used best management practice for reducing agricultural nonpoint source pollution. There are two comprehensive watershed planning approaches being developed to prioritize the conservation buffer placement in watersheds in addition to conventional riparian buffer placement strategy. Terrain analysis evaluates topographic attributes in relation to agricultural source areas to identify locations where runoff loadings would be relatively greater for conservation buffer placement. Alternatively, soil surveys are evaluated to identify soil map units where slope, soil, and water table attributes present relatively better conditions for trapping pollutants in runoff from agricultural areas. Although conservation buffers provides multiple ecosystems in watersheds, the current conservation buffer planning strategies tend to use a single criterion, most frequently a hydrological or soil condition indicator, to guide conservation buffer placement. This study will evaluate those planning approaches that prioritize agricultural lands for conservation buffers using multiple criteria. These criteria include soil erodibility, hydrological sensitivity, wildlife habitat, and impervious surface that are derived from different data sources and capture the conservation buffers' benefits in reducing soil erosion, controlling runoff generation, enhancing wildlife habitat, and mitigating stormwater impacts, respectively. A multidisciplinary panel is organized to assign weights to these criteria for prioritizing agricultural lands. This study also compares the total program cost of converting prioritized agricultural lands to conservation buffers under different strategies. The study area is the Neshanic River watershed, which has serious water quality issues and the highest percentage of agricultural land in North-Central New Jersey.

Conservation Tools and Technologies

Nitrates in Groundwater, A Forty Year Northwest Missouri Assessment

Ming Hung, Northwest Missouri State University

1) Jamie Patton, Northwest Missouri State University, jamiejp@nwmissouri.edu

2) Yi-Hwa (Eva) Wu, Northwest Missouri State University, ywu@nwmissouri.edu

3) Dennis Hoffman, Blackland Research & Extension Center, Texas AgriLife Research, Texas A&M University System, d-hoffman@tamu.edu

4) June Wolfe, Blackland Research & Extension Center, Texas AgriLife Research, Texas A&M University System, jwolfe@brc.tamus.edu

The objective of this project was to quantify the effects of land use change and the implementation of Best

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Management Practices (BMPs) on ground and surface water nitrate contamination in Nodaway County, Missouri. During the spring of 1970, a Northwest Missouri State University (Northwest) study collected water samples from 93 locations (89 wells and 4 farm ponds) across the county to evaluate the extent of nitrate contamination of local waters. During the spring of 2010, a team of Northwest scientists used the 1970 mapping records to resample the remaining original sites to determine the current nitrate status of these wells and ponds. Spatial technologies, such as Global Positioning System (GPS), remote sensing, and geographic information system (GIS) were used to record sampling locations, evaluate local land use/cover data from aerial photos and satellite images and interpolate local ground and surface contamination with land use/management practices and soil/geologic features, respectively. All derivatives were used to track and evaluate BMPs installed to reduce nitrate contamination concerns. The results of study will be utilized by Northwest for education and extension activities and will serve as a basis for future research projects. Correlations between water nitrate levels and land use and/or soil/geologic features will serve as potential guides for land owners seeking to locate quality surface and ground waters for human and livestock use.

Water Resources and Management

Nitrogen and Phosphorus Saved by NRCS Conservation Practices

Shaun P. McKinney

- 1) Harbans Lal, NRCS, harbans.lal@por.usda.gov
- 2) Joe Bagdon, NRCS, joe.bagdon@ma.usda.gov
- 3) Chris Gross, NRCS, chris.gross@wdc.usda.gov

A national assessment was completed calculating the nitrogen and phosphorus conservation savings attributed to NRCS conservation practices. For each major conservation practice a nutrient savings efficiency was assigned and associated with the acres of the practice. Total acre equivalents were calculated per practice for the years 2003 and 2007. These relationships provided a basis for predicting nitrogen and phosphorus savings in the years 2012 and 2020. In conjunction with the national Conservation Effects Assessment Project (CEAP) results this analysis provides a national perspective into nutrient savings attributed to installed conservation practices.

Conservation Tools and Technologies

Northern Forest Watershed Services Incentives Project

Todd Gartner, American Forest Foundation

- 1) John Gunn, Manomet Center for Conservation Sciences, jgunn@manomet.org
- 2) David Sleeper, Hubbard Brook Research Foundation, dsleeper@hbresearchfoundation.org
- 3) Lee Dasler, Western Foothills Land Trust, wflt@megalink.net
- 4) Mary Russ, White River Partnership, mary@whiteriverpartnership.org

The American Forest Foundation and its partners are developing an innovative and replicable market-based model to incentivize private forest landowners to restore, enhance, and protect aquatic resources in two critical watersheds in the Northern Forest region: the Upper Connecticut River watershed in Vermont and New Hampshire, and the Crooked River watershed in Maine. Both areas provide vital watershed services that face an array of pressures from development pressures leading to fragmentation of landscapes; pollution from aging municipal water treatment plants or overflow during storm events; sedimentation in tributaries; nonpoint source water pollution from land management activities; proposed dam construction; noxious species; loss of biodiversity; and additional adverse effects related to climate change.

Clean reliable water is becoming increasingly scarce in many parts of the country as climate change and development pressures affect water quantity, quality, timing, and distribution. Market-based approaches are proven to provide effective incentives for sustainable forest management and have emerged as alternative financing mechanisms to ensure water quality and the protection of other important watershed services. As part of this project, partners will compile and synthesize existing information on watershed services; conduct extensive education and outreach activities to landowners, policymakers, and the public; develop a market-based framework for watershed services; create resource guides and other publications; implement best management practices on private forestlands; and demonstrate payment for ecosystem services transactions.

**CIG Abstracts (Conservation Innovation Grant Program)*

Patch Burn Grazing: A Quail-friendly Approach to Managing Cacti-infested in the Rolling Plains of Texas

Kurt Huffman, Texas A&M University/Rolling Plains Quail Research Ranch

1) Dale Rollins, Texas A&M University/Rolling Plains Quail Research Ranch, d-rollins@tamu.edu

2) Merwyn Kothmann, Texas A&M University, m-kothmann@tamu.edu

Millions of hectares of Texas rangeland are infested by prickly pear (*Opuntia* spp.). Dense stands of prickly pear decrease forage production, interfere with livestock movement, and reduce huntability of Northern Bobwhite (*Colinus virginianus*). Prickly pear can be controlled effectively with a combination of prescribed fire followed by an application of picloram, but at the cost of suppressing desirable woody plants (e.g., *Celtis reticulata*) and forbs that are valuable to wildlife. We propose that a combination of prescribed fire and grazing by cattle can reduce prickly pear densities to an acceptable level without negatively affecting desirable forbs and woody plants. In addition, we propose that patch burn grazing will benefit bobwhite and other wildlife species by promoting floral heterogeneity at the pasture scale. We implemented patch-burn grazing regimes in 2 pastures (126 ha and 256 ha). Each pasture is stocked lightly with cattle. Patches within each pasture are burned between November and March. Cattle are allowed to graze freely within the pasture. We fitted two animals in each pasture with GPS data-logging collars to quantify temporal use of burned and unburned patches. We are measuring prickly pear density, frequency of key forbs, and visual obstruction (vegetation structure) in burned and unburned patches. We use radio-telemetry and nest site locations to quantify bobwhite use of burned and unburned patches. Preliminary findings suggest that patch burn grazing is an effective means of managing prickly pear as well as enhancing bobwhite habitat.

**CIG Abstracts (Conservation Innovation Grant Program)*

Payments for Ecosystem Services and Agroecology in Brazil's Subtropical Atlantic Forest

*Abdon L. Schmitt F., Silvopastoral Grazing Group, Federal University of Santa Catarina - Brazil
abdonfilho@hotmail.com*

1) Felipe Francisco, Silvopastoral Grazing Group, Federal University of Santa Catarina - Brazil,

The Brazilian Atlantic forest is a biodiversity hotspot harboring more threatened and endangered species than any other Brazilian ecosystem. The remaining forest patches are small, isolated and unprotected. Most of remaining 7% of the forest is located in private areas owned by small farmers. Payments for ecosystem services (PES) for restoration activities might facilitate restoration while keeping small farms viable. However, it is very difficult to ensure continued funding for PES schemes, threatening their sustainability. Another option is for small farmers to adopt agroecology practices ranging from silvopastoral Voisin grazing systems to agroforestry in riparian zones, which can help protect and restore critical natural capital while enhancing farmers' income. However, high initial investments may be prohibitive when interest rates in Brazil average over 40% annually. We are currently developing a PES scheme to finance adoption of agroecology practices that comply with Brazilian laws for forest reserves and permanent protection areas. Our initial results suggest that farmers are eager to participate in PES schemes, but payments for any single service are unlikely to entice farmers to adopt agroecological practices and restore forests. An effective PES scheme will require payments for various services from the relevant beneficiaries. We explain how appropriate payment mechanisms depend on the physical and institutional characteristics of specific services, including their spatial distribution. Some services are amenable to market institutions, while others require public provision. We propose separate mechanisms for financing water provision, water regulation, carbon sequestration and biodiversity habitat, which together could finance adoption of appropriate agroecology practices with net benefits for both producers and consumers.

Conservation and Environmental Policy and Program Design

Phosphorus and Solids Removal from Anaerobic Digestion Effluent through Electrochemical Technology

Quanbao Zhao, Washington State university

1) Shulin Chen, Washington State University, chens@wsu.edu

2) Joe Harrison, Washington State University, jhharrison@wsu.edu

Potential air and water pollution caused by waste generated from concentrated animal feeding operations has been a major environmental concern. Anaerobic digestion (AD) is effective to control odor and convert organic components of the waste to biogas as an alternative fuel. AD however, cannot remove nutrients (N and P) from the waste. Traditional nutrient removal technology such as flocculation with polymers is not economical for treating manure that has high ion strength and high suspended solids concentration. Furthermore, the fertilizer resulted from such processes is not able to be used on organic farm due to the polymer added. Electrocoagulation

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(EC) technology can meet this technical gap because of its following advantages: (1) no additional chemicals are needed; (2) low maintenance costs; and (3) EC units can even be powered by solar panels, which has the potential to further reduce operational costs. In this project, EC is evaluated for phosphorus recovery and solids removal from anaerobically digested manure. A pilot EC system was tested at various amperages (3A-6A), electrolysis time (30 min-60 min) and settling time (30 min-60 min). The operating parameters of EC tests were optimized to obtain best phosphorus removal efficiency. The fertilizer produced from EC experiments was evaluated (1 % P and 2.5% N dry weight) and compared with commercial fertilizer with greenhouse test. The mechanism of solids and P removal by EC process was discussed. The economic feasibility for the application of EC process to animal waste management was analyzed. The performance of the process was documented in terms of P recovery. A longer-term outcome of the project will be attaining the goal of a more sustainable animal production system that is environmentally compatible.

**CIG Abstracts (Conservation Innovation Grant Program)*

Power from the Prairie - Demonstration and Evaluation of Burning Agricultural Waste Streams in a Small-scale Gasifier

George Swentik, Giziibii Resource Conservation and Development Association

Giziibii Resource Conservation and Development Association was awarded a USDA Conservation Innovation Grant to assist Northern Excellence LLC, a producer/owner cooperative located in Williams, Minnesota, develop and test the conversion of biomass to electricity beginning October 2007 with completion scheduled for January 2010. The project has two primary components: 1.) Installation of a gasification system in Williams, and 2.) Conduct field studies to evaluate technical, environmental, and financial assessments of perennial crop residues and other biomass sources in the conversion of plant material into energy (electricity, syngas).

Farmers who raise perennial grass seed crops assisted in the field portion of this project. During the 2008 and 2009 seasons, sixteen farmer cooperators baled bluegrass and ryegrass straw. Plant material was dropped from the combine and baled with commercial baling equipment. The bales gave an estimate of the tons of plant material available to be utilized for biomass.

Information collected in this field study included: cost and returns of perennial grass seed production, biomass quantity (ton/acre) produced, biomass quality (BTU's/acre) produced, costs and returns of the biomass produced, and a complete financial analysis to determine a value for various sources of biomass.

**CIG Abstracts (Conservation Innovation Grant Program)*

Practice Standard Development using Co-Grazing with Small Ruminants

Tom Basden, West Virginia University

The benefits of using Goats to biologically control woody invasive species in pasture systems have been well documented but adoption by cattle and sheep producers in West Virginia has been limited. Research has also clearly demonstrated that adding sheep to a cattle operations increases livestock producer income through greater output of livestock products per acre, better utilization of grassland resources and positive soil effects including macro-nutrient cycling and buffering of pH. Profitability of multi species grazing is well documented, but the practice has declined steadily throughout the last century. Two Conservation Innovation Grants have been funded in the last 3 years to address these two resource concerns. The first project was initiated in 2006 to evaluate the adoption of electric net fence with goats to control invasive weeds in pastures. 18 livestock producers have agreed to cooperate for a 3 year period to determine the suitability of this management system. The agreement includes a cost share requirement. The project supplies the fence system and the farmer agrees to purchase a goat herd of equal or greater value of the fence system. The 18 cooperators have successfully adopted this brush control method. In 2008 a second CIG was funded to evaluate the suitability of using sheep and cattle for improved ecological soil conditions. This project uses the same cost share method used in the Goat GIG. 20 livestock producers have been recruited to this second CIG and will add a flock of sheep to the livestock operation.

Conservation Tools and Technologies

Principles for Stacking Payments for Ecosystem Services

Nicholas Bianco, World Resources Institute

Payments for ecosystem services are becoming an increasingly important part of the U.S. business and regulatory landscape. Used properly, these payments can efficiently mitigate greenhouse gases, filter pollution from runoff,

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protect wildlife habitat, and prevent soil erosion. Recognizing this, the American Clean Energy Security Act establishes a cap-and-trade program that allows firms to "offset" their greenhouse gas emissions through practices that reduce or sequester greenhouse gas emissions elsewhere. Some state governments are also expanding water quality trading programs that allow facilities that discharge water pollutants to avoid expensive facility upgrades by, for example, paying farmers to improve land management practices. There are also long-standing federal programs that pay farmers and forest landowners for providing a range of ecosystem services, such as protection of wildlife habitat and prevention of erosion.

As programs that provide payments for ecosystem services grow, policy makers will need to determine how these various payments should interact with each other. This interaction presents an opportunity to expand the suite of services for which an ecosystem is managed. However, it also creates the risk that multiple payments will be made for the same ecosystem services, possibly reducing the efficiency of payments or diminishing the environmental benefits they were intended to provide. This presentation will reflect on ongoing research at the World Resources Institute to address these risks.

Conservation and Environmental Policy and Program Design

Prioritization of Locations for BMPs to Maximize Water Quantity and Quality Benefits in the Paw Paw River Watershed, Michigan.

John Legge, The Nature Conservancy

- 1) Patrick Doran, The Nature Conservancy, pdoran@tnc.org
- 2) Matthew Herbert, The Nature Conservancy, mherbert@tnc.org
- 3) Jeremiah Asher, Michigan State University, asherjer@msu.edu
- 4) Glenn O'Neil, Michigan State University, oneilg@msu.edu

Some industrial water users are anticipating a future need to offset their water consumption by sponsoring activities that improve water quantity and quality in their host watershed(s). In Michigan's heavily agricultural Paw Paw River watershed, conservationists had developed plans for watershed management and conservation, which prioritized BMP strategies including application of conservation tillage and other practices. An industrial user with a large, local packaging facility was interested in sponsoring offsets for its water use. However, conservationists lacked the ability to calculate water quantity and quality benefits, nor could they specify where to locate BMPs for maximum benefit. To address this, we used modeling to prioritize BMP locations from three perspectives:

1. High-risk erosion areas, using High Impact Targeting system (HIT) modeling
2. Groundwater recharge change potential, using Soil Water and Assessment Tool (SWAT) modeling
3. Groundwater withdrawal susceptibility, using Michigan's Water Withdrawal Assessment Tool calculating when additional groundwater withdrawal will have a detrimental biotic impact.

The combination of these assessments produced a map identifying priority locations for conservation tillage and other BMPs to produce maximum water quantity and quality benefits. We further focused these areas by selecting three sub-basins in the watershed where concentrated BMP activity will maximize benefits. Starting in 2010, we are partnering with the county conservation district to enroll farmers on these key properties in EQIP and other USDA programs to adopt priority BMPs. TNC will use this technique in other Great Lakes watersheds facing similar issues.

Water Resources and Management

Public preferences for watershed management programs in Blackstone River Watershed, Rhode Island, USA: An application of Contingent Choice Method

Achyut Kafle, University of Rhode Island, Department of Environmental and Natural Resource Economics

- 1) Stephen K. Swallow, University of Rhode Island, Department of Environmental and Natural Resource Economics, swallow@uri.edu
- 2) Elizabeth C. Smith, University of Rhode Island, Department of Environmental and Natural Resource Economics, lizcsmith@gmail.com

The Natural Resource Conservation Service (NRCS) is working to implement a Rapid Watershed Assessment (RWA) approach to initial management planning and is striving to identify the differences in public preferences for allocation of public funds to better manage natural resources in a watershed. This study is an attempt to employ alternative indicators to account for preference heterogeneity as part of a watershed assessment approach that takes into account public preferences for watershed management programs.

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This study measures public preferences using stated preference methodology in Blackstone River Watershed. The net response rate was about 18% from the paper mail survey, with the internet survey producing a response of about 8% based on initial, one-time email contact to 1852 members from cooperating watershed associations to assess differences in these administration approaches to reach watershed stakeholders. Preliminary results indicate that open space preservation and water quality improvement are more important areas for action among major attributes included in the study, suggesting that people preferred watershed management plans that place a main focus on water quality improvement and open space preservation. The study design also allows an exploration of the role that the availability of federal funds as matching grants might play in attracting public support, including local taxpayer support, to execute alternative watershed management actions. While the case study concerns the Blackstone, the study should illustrate ways to incorporate preferential heterogeneity for watershed management programs across a population dispersed geographically within a single watershed.

Water Resources and Management

Pumping Plant Energy Audit and Reporting System

Dennis K. Carman, P.E. White River Irrigation District

Our CIG project objective was to develop, package, demonstrate, install and transfer technology that will perform continuous pumping plant evaluations and provide continuous pumping plant performance information in-the-field and on-line to the irrigator in a "dashboard" display format. We have accomplished the major goals and are now in the demonstration and technology transfer mode. The technology permits the measurement of the necessary water depths, operating pressures, flow rates and volumes for both water and fuel. Affordable technology has been developed that communicates this information from remote in-field locations to the office, in the field or in your truck and provides for remote control of the motors and engines to start or stop pumping based on continuously reported data. Electronic "alerts" are provided to irrigators for immediate attention when the engine performance problems occur or energy used to water pumped ratio is outside of established norms. In addition to fuel and water pumped and irrigation efficiency reports, we provide engine performance factors at near real-time for oil pressure, temperature, engine RPM, fuel tank levels, and similar pump and engine performance factors. We will provide detailed information on the technology utilized, lessons learned, equipment and sensors utilized, and system performance. We will also present the results of about 100 pumping plant evaluations utilizing both diesel engines and electric motors. This CIG grant was funded by NRCS and administered by the National Fish and Wildlife Foundation, and implemented by the White River Irrigation District in Cooperation with the Arkansas Natural Resources Conservation Commission.

**CIG Abstracts (Conservation Innovation Grant Program)*

Quantifying Wildlife Mitigation Benefits in Sagebrush Ecosystems Using Ecological Sites

Thomas Esgate, Cooperative Sagebrush Initiative

1) Jonathan Haufler, Ecosystem Management Research Institute, Jon Haufler, Jon_Haufler@emri.org

The Cooperative Sagebrush Initiative is implementing a Conservation Innovation Grant to evaluate a metric system for use in a potential credit trading system for off-site mitigation in sagebrush ecosystems. As a basis for such a system, we have developed and are testing a metric system based on a combination of NRCS Ecological Sites, existing sagebrush vegetation conditions, and a broader landscape habitat assessment for sagebrush-associated wildlife species to quantify impact losses and mitigation benefits. The metric system is being evaluated on demonstration projects in California, Idaho, Utah, and Wyoming. Vegetation responses produced by development impacts and by on-the-ground mitigation treatments are quantified based on a comparison to a reference standard developed from Ecological Site Descriptions for the specific sagebrush plant communities associated with either the mitigation or impact site. Wildlife benefits are evaluated at a landscape scales using models that quantify the gains or losses in habitat quality associated with the mitigation or development activities. Initial results show that a modifier based on the level of exotic species can significantly change the level of benefits produced, so that the equation used for this calculation must be carefully selected. Wildlife benefits calculated from analysis of the broader landscape are sensitive to the scale being used. For wide ranging species, benefits produced from relative small treatment areas result in few mitigation gains, but for species with small home ranges, dramatic increases in benefits can be documented. The challenges of incorporating site and landscape considerations into a possible credit trading system are discussed.

**CIG Abstracts (Conservation Innovation Grant Program)*

Rangeland Monitoring for Management and Market Development of Carbon and Water Sequestration

Gregg Simonds and Eric Sant, Open Range Consulting

1) Eric Sant eric@openrangeconsulting.com

Grasslands and shrublands, often called rangelands, are extensive and diverse, ranging from coastal meadows to prairies, shrublands, bushland, deserts and tundra. They account for nearly 50% of the earth's surface and of the United States. They are generally lands in the arid and semi-arid climates that are not suitable for cultivation. Despite these varied resources, the historical and nearly universal value of rangeland is forage for wild and domestic animals. Forage value is very low in comparison to other resources, i.e. crops, water and minerals. However, culture and stage of societal development determines the local value of rangelands. For instance, primitive societies rely on the food and wildlife from rangeland, it is the primary resource of pastoral economies. In highly developed economies rangeland's effect on water and recreation supply is more valueable than forage. Currently with global warming affecting the world economy, rangeland's ability to sequester carbon is likely its greatest value.

Rangeland management and value development has been impaired by the lack of our ability to monitor its condition and trend. The highly variable production of rangeland vegetation both spatially and temporally, has kept historical method from having adequate inferential value at the watershed level. Enriching sampling of the historical methods to add clarity is not economically feasible. Thus, rangeland management and developing markets for its ecological services has been serverely limited.

We have developed a method to assess rangeland watersheds that has high inferential value. It is low cost and timely, so that incentive systems can be developed for proper grazing, water and carbon sequestration. Developing this market will give rangeland ecological services a "voice" in the market place, allow pastoralists to make a living from these lands, and give an incentive to manage their ecological value.

Conservation Tools and Technologies

Reducing Leachate Pollutants and Solids by a Membrane Bioreactor and Nano-Magnetic Separation Process

Paulo A Augusto^{1,3}, 1-Departamento de Engenharia QuÃmica, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal. 3-Departamento de IngenierÃa QuÃmica y Textil, Facultad de Ciencias QuÃmicas, Universidad de Salamanca, Plaza de los CaÃdos, 1-5, 37008 Salamanca, Spain. , pauloaugusto@usal.es

1) Teresa Castelo-Grande^{1, 2, 3}, 1 Departamento de Engenharia QuÃmica, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal. 2 Departamento de Engenharia, Universidade LusÃfona do Porto, Rua Augusto Rosa, 24, 4000-098 Porto, Portugal. 3 Departamento de IngenierÃa QuÃmica y Textil, Facultad de Ciencias QuÃmicas, Universidad de Salamanca, Plaza de los CaÃdos, 1-5, 37008 Salamanca, Spain.

2) Paulo Monteiro⁴, . 4-Departamento de Engenharia Civil, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal., psm@fe.up.pt

3) Angel M Estevez³, 3-Departamento de IngenierÃa QuÃmica y Textil, Facultad de Ciencias QuÃmicas, Universidad de Salamanca, Plaza de los CaÃdos, 1-5, 37008 Salamanca, Spain. , estevez@usal.es

4) Domingos Barbosa¹, 1-Departamento de Engenharia QuÃmica, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal., dbarbosa@fe.up.pt

The main goal of this research is to study the possible applicability of MBR's allied with magnetic separation techniques in the treatment of leachate resultant from urban sanitary landfills (Lustosa landfill at Lousado Municipality and Lipor II landfill at Porto Region), in order to establish the potential of the alliance of these techniques to reduce solids and contaminants present in the above-mentioned leachates, and also to achieve a reduction of the presence of the activated sludge in the final permeate.

Magnetic separation by its own will also be tested.

We have already applied as a first stage, a laboratory scale MBR unit- Zenon model ZW-1, and have performed some permeation experiments. From these preliminary results, we may conclude that MBR alone presents the potential of obtaining partially some of the desired results, but an alliance with another technique will improve the treatment into the desired levels.

These second step will consist on a magnetic separating device allied with a pre-step of magnetic tagging that will

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allow the reduction of activated sludge. We are currently selecting the magnetic tags to be used.

Water Resources and Management

Reducing Nitrogen at a River Basin Scale: The Neuse Experience

Deanna Osmond, NC State University

Since 1997, regulations in the Neuse River Basin of North Carolina (NC) have required a 30% nitrogen reduction from the point sources and the urban and agricultural nonpoint sources of pollution. North Carolina Cooperative Extension, along with USDA-NRCS, NC Soil and Water, NC Division of Water Quality, and the NC Department of Agriculture have worked collaboratively with the agricultural community to reduce nitrogen loading by 30%. According to the agricultural accounting tool used to track nitrogen reductions, the 30% reduction has not only been met but exceeded. There has been, however, no change in nitrogen reduction in the Neuse Estuary. Causes for the lack of reduction and changes in conservation strategy will be discussed.

Adaptive Management of Conservation Efforts

Regulating farmers: A three-state case study of nutrient management laws on the Delmarva Peninsula

Michelle Perez, University of Maryland

A series of fishkills in 1997 on the eastern shore of the Chesapeake Bay were associated with the toxic microorganism, *Pfiesteria piscicida*, and linked to nutrient pollution from agricultural sources. These fishkills served as a focusing event for policy makers in Maryland, Virginia, and Delaware to promulgate agricultural nutrient management regulations.

Over a decade later, a PhD dissertation using comparative political and policy analysis and a case study method has estimated how well farmers in the three states on the Delmarva Peninsula may be complying with their state's nutrient management plan requirements. Data sources included information gathered from interviews with 60 corn farmers on the Peninsula that use chicken litter as fertilizers, interviews with 45 policy stakeholders, and primary and secondary documents.

Results indicate that the state's policy development process in reaction to the *Pfiesteria* events did result in different compliance rates. Overall, farmers across all three states do appear to have improved their nutrient management practices. However, adoption of many practices that remained voluntary is low and very few farmers accept the "new" science that concludes phosphorus can runoff without soil erosion.

The contributions from this dissertation to science and society include the following conclusions: Agricultural regulations that rely on nutrient management plans are in reality voluntary; Regulatory policy processes that gain buy-in from the regulated community likely have better environmental outcomes; Regulations that tap into farmer culture and the mechanics of farming likely have better outcomes; Focusing events that are weak can undermine the justification for regulations.

Conservation and Environmental Policy and Program Design

Relationships between Sorption of Pesticides in Tropical Soils and their Physicochemical Properties after Soil Vinasse Amendment

Renato Fraguas de Carvalho, Federal University of Lavras

- 1) Jose M. Lima, Federal University of Lavras-Brazil, jmlima@ufla.br.
- 2) Rene L. O. Rigitano, Federal University of Lavras-Brazil, rigitano@den.ufla.br.
- 3) Richard H. Bromilow, Rothamsted Research-UK, richard.bromilow@bbsrc.ac.uk.

The sorption of 19 non-ionized pesticides, chosen to span a wide range of physicochemical properties ($-0.13 < \log K_{ow} < 4.96$), in the dystrophic Red-Yellow Latosol (LVAd), distroferric Red Latosol (LVdf), and Red-Yellow Argisol (PVA), was measured through batch sorption experiments after incubation of the soils with vinasse from the sugar cane ethanol industry. Quantification of the pesticides was done by HPLC. Linear free energy relationships (LFER) were calculated between the sorption of the compounds in the soils (as measured by their $\log K_{oc}$) and their lipophilicity (as measured by their $\log K_{ow}$), as well as their solvation descriptors - E (excess molar refraction), V (McGowan's volume), S (dipolarity/polarisability), A (hydrogen bond acidity) and B (hydrogen bond basicity) - which were measured using seven HPLC systems. There were no significant differences among the K_{oc} values for the three soils, which had about the same organic carbon content (1.84%). The modelling of the pesticide soil sorption using the solvation descriptors gave not only a better correlation but fit the sorption of the polar compounds much better than the $\log K_{ow}$ model. The solvation approach shown that dispersion force interactions, which are related

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to the descriptor E, are very important and not well reflected when using log Kow as an estimate for pesticide sorption in these amended soils. The application of vinasse changed the physicochemical nature of the soil resulting in lower sorption of the polar compounds. Such changes were reflected in the solvation model coefficients. Chlorpyrifos was concentrated more than 3840-fold.

Soil Resource Assessment

Relative Soil Improvement Index: A Promising Estimator for Effects of Land Uses On Soil Chemical Properties in Highly Populated Agricultural Landscapes

Lalisa Alemayehu Duguma, University of Natural Resources and Applied Life Sciences Vienna Austria

1) Lalisa Alemayehu Duguma, PhD student, University of Natural Resources and Applied Life Sciences Vienna Austria, lalisa222@yahoo.com

Today, time and situation are forcing the study of land uses to shift towards looking for practices which improve the soil properties at the same time providing the services demanded by the society dwelling on it. This demands the availability of appropriate methods of evaluation applicable to the prevailing local situation. In developing countries-especially those having high human and livestock population in the agricultural landscapes-the speed of degradation of the natural ecosystems like natural forests is very high. In some places like central highlands of Ethiopia, the woodlands cover less than 5% of the land area. Hence, it is less likely to use the estimator Soil Deterioration Index (SDI) which compares the effects of other land uses on soil properties relative to adjacent woodlands. This paper tries to present an alternative method called Relative Soil Improvement Index (RSII) which is applicable in areas with severe disturbances of the landscape structures because of human and livestock overpopulation, mechanized farming and other interfering investments that challenge the existence of adjacent 'ideal' land use to be used as a reference. In RSII, comparison is made against the dominantly practiced land use type rather than using the undisturbed 'ideal' land use like woodlands as in SDI. RSII requires three basic procedures: 1) proper identification of the dominant land use type; 2) appropriate soil sampling; 3) similar soil sample analysis methods. This paper tries to demonstrate the application of RSII using land use evaluation study conducted in central highland Ethiopia.

Conservation Tools and Technologies

Restoring Grassland Ecosystems Using Ecological Site Descriptors and Innovative Treatments

Jonathan Haufler, Ecosystem Management Research Institute

The Ecosystem Management Research Institute (EMRI) working with the states of South Dakota and Nebraska along with many other partners is conducting a National Conservation Innovation Grant project to implement restoration of grassland ecosystems based on ecological site descriptions and using innovative management treatments. Implementation is based on a coordinated and collaborative grassland restoration program that addresses restoration objectives identified in South Dakota and Nebraska Wildlife Action Plans as well as the Grassland Conservation Plan for Prairie Grouse adopted by the Association of Fish and Wildlife Agencies. On the lands of selected producers, specifically identified native grassland ecosystems as described using NRCS ecological sites will be restored using innovative combinations of practices and grazing management. Initial practices that are being used include brush management, seeding with site specific seed mixtures, prescribed burning, weed control, and grazing adjustments. Pre and post-treatment monitoring will document benefits produced. This project will serve as a pilot to attract significant and diverse additional funding support in an expanded program to restore native grassland ecosystems.

**CIG Abstracts (Conservation Innovation Grant Program)*

Saturated Hydraulic Conductivity of Surface Seals Estimated from CT-measured Porosity

Clark J. Gantzer, University of Missouri

- 1) Sang Soo Lee, University of Missouri, slwtb@mail.missouri.edu
- 2) Stephen H. Anderson, University of Missouri, AndersonS@missouri.edu
- 3) Allen L. Thompson, University of Missouri, ThompsonA@missouri.edu

Relationships between saturated hydraulic conductivity (K_s) and porosity ($\hat{\theta}_1$) have been developed with prior research. However, assessment of relationships between K_s and $\hat{\theta}_1$ are often limited because of difficulties estimating $\hat{\theta}_1$ distributions in seals. In addition, theoretical approaches for estimating K_s using numerical methods or empirical data produce significant variability in K_s within surface seal layers. The objectives of this study were to

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evaluate Ks in seals of different thickness determined using a High-Resolution-Computed-Tomography (HRCT) scanner and to investigate relationships between Ks and total macro-porosity ($\hat{\theta}_m$) of soil having an equivalent diameter $\hat{d}_m \approx 15 \hat{\theta}_m$, within developing seals. A Mexico silt loam soil was packed to a bulk density of 1.1 Mg m⁻³ in cylinders 160-mm i.d. by 160-mm high, and subjected to 61-mm h⁻¹ simulated rainfall for 0-, 7.5-, 15-, 30-, and 60-min to create a range in seal formation. Different thicknesses of the seal layer were determined using analysis of HRCT images. The Ks values in and below the seals were estimated using a measured effective saturated hydraulic conductivity (Ks-eff). The Ks relationship with $\hat{\theta}_m$ was described with the "Kozeny and Carmen" equation where B and n are empirical constants. Seal layers were characterized with "Kozeny and Carmen" n values of 33 for seal layers, and 24 for 0-120 mm soil below the seals. This approach successfully characterized the spatial distribution of Ks with $\hat{\theta}_m$ in and below the seals (r² values were 0.96 for seal layers and 0.69 for soil below the seals).

Soil Resource Assessment

Selling Ecosystem Services as Public Goods to Consumer-Beneficiaries: An Auction Experiment on Restoration of Sea Grass and Bird Habitat in Virginia Coastal Reserve

Stephen K Swallow, University of Rhode Island

1) Elizabeth C. Smith, University of Rhode Island, Dept. of Environmental and Natural Resource Economics, lizcsmith@gmail.com

2) Stephen K. Swallow, University of Rhode Island, Dept. of Environmental and Natural Resource Economics, swallow@uri.edu

Many ecosystem services provide public goods, such that improvements in services benefit many people simultaneously and providers cannot exclude beneficiaries who fail to pay toward delivery cost. Examples include scenic landscapes, habitat for aesthetically pleasing birds, or sea grass providing habitat, stabilizing sediments or buffering storm erosion. This study concerns an experiment to test a new method for translating peoples' values for ecosystems into revenues that support restoration. For economists, the experiment tests a practical approach to implementing individualized ("Lindahl") prices. For practitioners, the study reports on an auction-like approach that elicits individualized prices (bids) from many people and uses the sum of these prices to cover the cost of a marginal acre of restoration. Experiments involved approximately 85 residents of Virginia's Eastern Shore. Participants chose to allocate \$90 to \$150 each between ecosystem restoration and additions to their household income. Preliminary results suggest that the typical participant offered between \$26 and \$65 per half-acre of bird or sea grass restoration, with higher bids per acre offered for the first half-acre. These offers bracket an estimate of \$34 to \$42 per half-acre as the maximum marginal willingness to pay of typical participants, suggesting the auction process may generate revenues near the full marginal value of ecosystem restoration. The presentation will discuss auction processes as a market-based complement to government programs or philanthropic efforts that currently form society's approach to conservation of ecosystems. Funded by NSF/LTER at VCR, RI AES, NMFS/Sea Grant Marine Resource Economics Fellowship.

Conservation and Environmental Policy and Program Design

Soil and Water Quality with Tall Fescue Management in the Southern Piedmont

Alan J. Franzluebbers, USDA Agricultural Research Service, Watkinsville GA

Richard L. Haney, USDA-ARS, Temple TX

Dinku M. Endale, USDA-ARS, Watkinsville GA

Jeffrey S. Buyer, USDA-ARS, Beltsville MD

Dorcas H. Franklin, USDA-ARS, Watkinsville GA

David A. Zuberer, Texas A&M University, College Station TX

Pasture management not only affects plant and animal productivity, but also soil quality, carbon sequestration, water quality, etc. These additional ecosystem services need to be evaluated under a diversity of management approaches, including how nutrients are supplied (inorganic vs. broiler litter application), how forage is harvested (grazed by cattle vs. hay removal), and the type of forage (tall fescue without endophyte or with wild or novel endophyte). A long-term study in 2.5-acre paddocks was evaluated to determine these factors on soil quality (bulk density, penetration resistance, nutrient contents, soil organic matter fractions, and microbial community structure and function), soil organic carbon sequestration (rate of carbon accumulation in surface soil and litter), and water runoff volume and quality. Forage harvest by grazing enhanced soil organic matter accumulation

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compared with haying, but also led to redistribution of nutrients in a non-uniform manner, which could alter future pasture utilization and associated water quality. These results will help improve recommendations to farmers, professional practitioners, and policy makers for obtaining balanced ecosystem services from grassland-based agricultural systems in the southeastern USA.

Conservation Tools and Technologies

Soil nutrient management on grazed dairy farms

Sharon R. Aarons, Future Farming Systems Research Division, Department of Primary Industries, Ellinbank, 1301 Hazeldean Road, Ellinbank, Victoria, Australia 3820, sharon.aarons@dpi.vic.gov.au

1) Cameron J. P. Gourley, Future Farming Systems Research Division, Department of Primary Industries, Ellinbank, 1301 Hazeldean Road, Ellinbank, Victoria, Australia 3820, cameron.gourley@dpi.vic.gov.au

Within pasture-based dairy systems, cows spend the majority of their time grazing in the landscape, where feed nutrients are returned and recycled for pasture growth. Increasing intensification of these systems as well as below average rainfall in the last decade has required a greater reliance on brought-in feeds, greater inputs of fertiliser, particularly nitrogen, and an increase in conservation of fodder as silage and hay. Consequently more nutrients are imported in feed and fertiliser leading to nutrient surpluses on grazed dairy farms. We quantified the nutrients consumed and excreted by grazing dairy herds on 10 contrasting dairy farms around Australia. In conjunction with records of cow locations, we estimated nutrient returns to different management units (paddocks, laneways, milking parlour, holding yards, feedpads). Dairy cows spend the smallest proportion of their time in areas (2% - milking parlour and 9% - holding yards) where dung and urine are likely to be collected and stored for re-use, and over 72% of their time grazing paddocks. Based on dietary intake and milk production, the nitrogen (N), phosphorus (P) and potassium (K) returned to pastures on one of these farms in a year was calculated to be 26, 5 and 39 t respectively, amounting to applications of N and P of 90 and 20 kg/ha/year. The nutrients returned by animals are seldom deposited uniformly across the grazing areas of dairy farms and consequently pose a risk to the environment if they accumulate in parts of the landscape where pathways for nutrient movement occur.

Soil Resource Management and Conservation

Soil Physical Properties at Penn State's Living Filter - Lessons Learned from 40 Years of Wastewater Irrigation

Zachary Larson, Penn State University

1) Charles Walker, Penn State Univ., cww118@psu.edu

2) John Watson, Penn State Univ., jew21@psu.edu

Opportunities to reuse wastewater for agriculture have been demonstrated at Penn State's Living Filter, which for over 40 years has irrigated up to 250 cm of secondary treated wastewater per year on crop and forest land. The removal of nutrients has been well demonstrated but the impact on soil physical properties and indicators of soil quality have become a concern.

In 2008 and 2009, infiltration rates of the Ap and Bt horizons of irrigated and non-irrigated areas within the site were analyzed with a tension infiltrometer at 4 pressure heads to determine hydraulic conductivity. In addition, clay and organic matter content and bulk density was determined along 8 transects radiating from sprinkler heads. Soil profile cores were also sampled for TOC, SAR, EC and pH.

Results show that Ap horizon hydraulic conductivity did not differ between irrigated and non-irrigated areas, although the mean saturated hydraulic conductivity was relatively high for both areas at approximately 21 cm/hr. Bulk densities were approximately 1.4 g/cm³ in the irrigated area, compared to 1.5 g/cm³ in the non-irrigated area. Ap horizon clay content in the irrigated area ranged from 14-16% to 17-21% in the non-irrigated area, suggesting possible translocation of clays from excessive application rates. Soil pH throughout the soil profile increased by approximately 1 unit in the irrigated area but organic carbon content did not differ, with both measurements reflecting irrigation water characteristics. Both SAR and EC were greater in the irrigated areas of the Living Filter, with both measures increasing with profile depth.

Water Resources and Management

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Soybean Economic Opportunity and Cost Incentives for Environmental Management Adjustments to Herbicide Programs

C. Robert Stark, Jr., University of Arkansas at Monticello/UA Southeast Research & Extension Center

- 1) Ken Smith, UAM-SEREC, smithken@uamont.edu
- 2) Kelly J. Bryant, UAM-SEREC, bryantk@uamont.edu

Soybean producers throughout the nation currently use transgenic seed on 97% of the U.S. acreage, primarily to facilitate weed control utilizing glyphosate. Producers, especially across the South, are facing an increasing challenge from weeds showing resistance to glyphosate and other commonly used spectrums of herbicides. While LibertyLink production systems and alternative herbicides offer some hope, a complete production program review is needed to identify producer options and the associated opportunities and costs. Management adjustments being considered and implemented to combat this situation, including non-transgenic production, may have significant environmental effects. These effects should be fully considered as producers develop a weed control strategy.

Market elevator surveys will be conducted to estimate market price premiums available and special marketing program requirements for non-transgenic soybeans. The survey results will be combined with enterprise budgets by herbicide production system to compare estimated opportunities and costs. Current budgets will be updated to reflect anticipated 2010 prices.

Results are expected to suggest that producer costs of production will increase for labor and equipment outlays as more seasonal applications are required. Expanded overall herbicide use may also be necessary with associated potential environmental impacts on soil, wildlife, and selected plant species. Comprehensive production systems including specific crop rotations may be necessary in areas of extreme resistance.

The November 2009 U.S. soybean production forecast was 3.32 billion bushels with a 43.3 bushel per acre yield, both records. Maintaining soybean production in an environmentally responsible manner will require innovative team approaches to develop viable, sustainable production systems.

Conservation and Environmental Policy and Program Design

Speculative Benefits: The Role of Ecological Services in Public Policy Debates, The Case of the USDA Small Watershed Program

Sam Stalcup, USDA NRCS

The Watershed Protection and Flood Prevention Act of 1954 (P.L. 566) empowered the United States Department of Agriculture (USDA) to supply technical and financial assistance to state and local governments to construct earthen dams on small streams and apply soil conservation measures to land in surrounding watersheds. Since 1954, the USDA, acting under the authority of P.L. 566, has, by one estimate, constructed nearly 11,000 such dams on some 2,000 small watershed projects in 47 states. These projects are important examples of federally engineered landscapes, designed to provide a broad range of ecological services from flood control and erosion prevention to water supplies and recreation. My paper explores the role of ecological services in the origins and development of the USDA small watershed program. In particular, it examines the way advocates for a federal small watershed program framed their arguments in terms of the speculative benefits such projects would provide, and how these arguments changed over time to reflect changing rationales for the program. The conclusions it draws are applicable to contemporary debates in which ecological services are invoked to support specific public policy positions.

Conservation and Environmental Policy and Program Design

Stacking Ecosystem Services in Reconnected Floodplains: Linking Socioeconomic and Biophysical Analysis to Improve Floodplain Management

Silvia Secchi, Southern Illinois University

- 1) Joe Fargione, The Nature Conservancy, jfargione@tnc.org
- 2) Mohamud Esmail, Southern Illinois University, mhemail@siu.edu
- 3) Steven E. Kraft, Southern Illinois University, sekraft@siu.edu
- 4) Bob Moseley, The Nature Conservancy, rmoseley@tnc.org
- 5) Jonathan Remo, Southern Illinois University, diamict@siu.edu
- 6) Todd Strole, The Nature Conservancy, tstrole@tnc.org

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River and floodplain management must meet multiple goals, including agricultural production, flood control, water quality, and wildlife habitat. In the Mississippi River Basin, increasing costs of structural flood control and flood damage and the hypoxic zone in the Gulf of Mexico illustrate the challenges and shortcomings of current approaches. Such approaches are unlikely to maximize benefit to society because they generally ignore the non-market value of ecosystem service provision of the river and its floodplain, they do not take into account linkages between economic and biophysical systems, and ignore the positive and negative externalities associated with agricultural land use. As an alternative to current approaches, reconnecting floodplains could provide both flood control and improved ecosystem services.

This study tests the hypothesis that combinations of novel funding mechanisms may be able to overcome the opportunity costs and cultural barriers to changes in floodplain management using payments for ecosystem services (carbon offsets, water quality, and flood reduction) combined with new markets for biomass from flood-tolerant crops (e.g. switchgrass or willow). We quantify the minimum level of ecosystem service payments necessary to induce farmers in levee districts across the Mississippi River watershed to participate in reconnection projects and value the greenhouse gas and water quality benefits of floodplain reconnection in levee districts to assess the feasibility and benefits of extensive floodplain reconnection strategies that maintain land in productive agricultural uses.

This integrated analysis identifies floodplain management strategies that increase societal benefit compared to approaches that only maximize market value of agricultural production.

Conservation and Environmental Policy and Program Design

Streambank Erosion Rates In Two Watersheds of the Central Claypan Region

C. C. Willett, University of Missouri

- 1) R. N. Lerch, USDA-ARS, bob.lerch@ars.usda.gov
- 2) R. Peacher, Iowa State University, rpeacher@iastate.edu
- 3) R.C. Schultz, Iowa State University, rschultz@iastate.edu

Sedimentation of surface waters in the United States is a significant environmental concern. The objective of this research was to determine the effect of stream order, adjacent land use, and season on stream bank erosion rates. Study sites were established in 2007 and 2008 within Crooked and Otter Creek watersheds, two claypan watersheds located in northeast Missouri. A factorial experimental design was implemented with four land uses (cropped, forest, pasture, and riparian forest) and three stream orders (1st, 2nd, 3rd). Each treatment was replicated three times for each stream order. Erosion pins were installed based on bank height and length at each site to measure bank erosion/deposition rates. The effect of different seasons was assessed by measuring the length of the exposed pins three times per year. Statistical analyses were performed to determine the effect of stream order, land use, and season on erosion rates. Using data from the National Hydrography Dataset, measured bank erosion rates were combined with the bank length for each stream order to estimate the sediment contribution from stream banks at the watershed scale. Overland erosion rates were also estimated. The results showed that the seasonal effect was highly significant, with much greater erosion rates in the winter compared to other seasons. Land use and stream order did not significantly affected bank erosion rates. Based on estimates of the total mass of eroded stream banks and overland erosion, bank erosion accounted for about 11% of the total eroded sediment annually in these two watersheds.

Soil Resource Assessment

Surface Mine Reclamation using Excess Poultry Manure for the Production of Biomass Energy Crops

Scott Van de Mark, Pennsylvania Environmental Council

- 1) Dr. Richard Stehouwer, Pennsylvania State University, rcs15@psu.edu
- Presenters: Dr. Rick Stehouwer, Associate Professor, Environmental Soil Science, Department of Crop and Soil Sciences, Penn State University; Scott Van de Mark, Director, Special Projects, Pennsylvania Environmental Economics

The Chesapeake Bay Watershed in Pennsylvania is impaired by excess nutrient loading due to multiple sources including agricultural. Pennsylvania has 180,000 acres of abandoned mine lands and annually approximately 5,500 acres of active coal mines require reclamation. Restoration of soil quality and productivity on these degraded lands requires large nutrient and carbon inputs and thus a potential use for excess manure. Since 2005, The Pennsylvania Environmental Council in partnership with Penn State University have been developing a mine

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reclamation technique using poultry manure stabilized with paper mill residuals or by composting to sequester nutrients and allow sustained production of biomass energy crops. If applied on a broad scale in PA this technique can reduce poultry manure land application in the Bay Watershed while simultaneously restoring mined lands. With the support of a NRCS CIG grant the project partners implemented a 30-acre demonstration project in Clearfield County, PA.

The demonstration project will address several topics:

- Nutrient and carbon inputs, fluxes, and sequestration from manure application and switchgrass growth in a field research project in Schuylkill County.
- Production of three warm season grass species in mono and mixed culture on mined land reclaimed with poultry manure mixed with paper mill sludge or composted manure.
- Economics of commercial-scale mine reclamation using poultry manure and paper mill sludge versus conventional mine reclamation.
- Economics of warm season grass harvest and sale as biomass to local markets in mining regions.
- Potential of PA nutrient trading program to offset poultry manure transportation costs to mine reclamation sites.

Soil Resource Management and Conservation

Sustainability of Payment for Watershed Service Implementation: Case Study of Cidanau Watershed, Banten Indonesia

Gun Gun Hidayat, GS of Agriculture Hokkaido University

1) Hiroaki KAKIZAWA, GS of Agriculture Hokkaido University, kaki@for.agr.hokudai.ac.jp

Payment for Watershed Service (PWS) mechanism of Cidanau watershed binding farmers at upstream as service seller with PT. KTI water company as service buyer, with watershed partnership (FKDC) as intermediary body, to secure water supply from watershed through protection of trees compensated with sum of cash payment. This study found some determinant factors considered as social capital which facilitate the mechanism to sustain while economic and technical-based fulfillments of the mechanism considered as insufficient. Commitment of PT. KTI is supported by belief on intangible benefit to secure the business, transparent and accountable management of transaction, and recognition from stakeholders at regional and national level for its pioneering and success story of implementation. Commitment of farmers might be sustained by good condition of social capital on relationship between farmers and partner, and among farmers themselves. Beside written contract as rule of implementation, provision of non-contract based arrangement and non-contract based assistance from FKDC is important to create comfort situation as compensation of limited payment. At most, collegial history of farmer or already existing farmer group, rather than the instant one, is important aspect to create well organized group and trustworthy leadership to drive farmers collectively maintain the agreement and comply with contract.

Conservation and Environmental Policy and Program Design

SWAT Model Application to Assess Nitrogen loadings from the Kaskaskia River Basin in Illinois

Li-Chi Chiang, Student Service Contractor, US EPA- Office of Research and Development, NERL-ESD-Landscape Ecology Branch, Las Vegas, Nevada

1) Yongping Yuan, Research Hydrologist, US EPA- Office of Research and Development, NERL-ESD-Landscape Ecology Branch, Las Vegas, Nevada, Yuan.Yongping@epamail.epa.gov

2) Megan Mehaffey, Ecologist, US EPA- Office of Research and Development, NERL-ESD-Landscape Ecology Branch, Las Vegas, Nevada, Mehaffey.Megan@epamail.epa.gov

3) Indrajeet Chaubey, Associate Professor, Department of Agricultural and Biological Engineering, Purdue University, West Lafayette, Indiana, ichaubey@purdue.edu

The Future Midwest Landscape (FML) project is part of the U.S. Environmental Protection Agency's new Ecosystem Services Research Program, undertaken to examine the variety of ways in which landscapes that include crop lands, conservation areas, wetlands, lakes and streams affect human well-being. The goal of the FML project is to quantify current and future ecosystem services across the region and to examine changes expected to occur as a result of the growing demand for biofuels. Increased anthropogenic inputs of nitrogen from fertilizer application and fossil fuel combustion can lead to eutrophication, hypoxia and contamination of drinking water. Eco-hydrologic models can be employed to simulate how future conditions may affect nitrogen turnover and transport. In this study, Soil and Water Assessment Tool (SWAT) model was used to assess the impacts of land use change and management practices have on nitrogen loadings to streams within the Kaskaskia River Basin (071402) in

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Illinois, a 6-digit HUC watershed of the Upper Mississippi River Basin. A base land use map for 2001 was developed by incorporating different sources, and maps for 2005, 2010, 2015 and 2020 were generated by using crop yield estimates. Several scenarios of management practices, such as tillage and fertilizer application, were created to simulate their influences on crop production and nitrogen loadings in the watershed. The results showed that nitrogen loadings increased due to larger crop areas and greater fertilizer application. This study also provided several suites of management practices for reducing nitrogen loadings from the Kaskaskia River Basin.

Keywords: Future Midwest Landscape study, SWAT model, watershed modeling, conservation practices, ecosystem services, nitrogen.

Water Resources and Management

Targeting watershed work at multiple scales: From Lake Itasca to the Gulf, by way of Iowa's Boone River

Jennifer Filipiak, The Nature Conservancy

- 1) Todd Sutphin, Iowa Soybean Association, tsutphin@iasoybeans.com
- 2) Eileen Bader, The Nature Conservancy, ebader@tnc.org
- 3) Anthony Seeman, Iowa Soybean Association, aseeman@iasoybeans.com

Working with regional experts and the best available data, NatureServe and The Nature Conservancy completed the Upper Mississippi River Basin plan identifying areas of freshwater biodiversity significance that represent the full array of biodiversity in the UMR. The plan further refined the list to identify fifty priority areas in the basin where terrestrial and aquatic biodiversity priorities intersect. The Boone River in Iowa was one of the fifty targeted basins due to its relatively intact stream ecosystem. The Boone supports excellent in-stream and riparian habitat in one of the most agriculturally productive regions of Iowa - the Des Moines lobe. Row crop covers 85% of the watershed and unfortunately the Boone faces a high likelihood of future degradation. The Conservancy began work in the Boone with an EPA watershed grant in 2003, completing a detailed ecological assessment and engaging two major partners: The Iowa Soybean Association and Iowa State University's Center for Agriculture and Rural Development. This initial partnership has grown to involve a variety of local, state and federal government partners, and other watershed stakeholders. We have engaged producers in a watershed group, initiated and are maintaining watershed-wide water quality monitoring, and are working with over 60 growers. We have used the data to target specific HUC12 subwatersheds and are now uniquely poised to fully engage with the Mississippi River Basin Healthy Watersheds Initiative to further our efforts toward the protection of healthy ecosystems and clean water in the basin while maintaining agricultural livelihoods. We will discuss the lessons we have learned to date regarding targeting resources and working within unique partnerships, and the initiation of the Boone River MRBI project.

Conservation and Environmental Policy and Program Design

The Effect of Anaerobically Digested Dairy Effluent and Method of Application on Yield and Nitrogen Uptake of Grass

Elizabeth Whitefield, Washington State University

- 1) J. Harrison, Washington State University, jhharrison@wsu.edu
- 2) A. Bary, Washington State University, bary@wsu.edu
- 3) A. Fortuna, Washington State University, afortuna@wsu.edu
- 4) O. Saunders, Washington State University, osaunders@wsu.edu
- 5) C. Cogger, Washington State University, cogger@wsu.edu

Different forms of manure: Anaerobically digested (AD) effluent (AD Ef after liquid -solids separation post AD) and raw manure (non-AD) were land applied to grass to determine nitrogen (N) uptake and yield. The AD Ef (2% solids) resulted from the anaerobic digestion of dairy manure (4% solids; 80% of total input) and varying feedstocks (whey, ruminant blood, chicken daff, egg waste; 20% of total input). The ammonia-N content in the pre AD manure was 37% of the total nitrogen, while 63% of the total nitrogen content in the AD Ef was ammonia-N. Manure was applied by surface broadcast (SB) or subsurface deposition (SSD) to replicated plots (4) in a complete randomized block design. Specific treatments were: control (no added nutrients), urea (at a rate of 97 kg N/year/ha), non-AD + SB, non-AD SSD, AD Ef-SB, and AD Ef-SSD. The data shown are for the 1st year of application. The total N applied to manure plots was: AD Ef 103 kg/year/ha and 64 kg/year/ha of ammonia; non-AD - 97 kg/year/ha of total N and 49 kg of ammonia/year/ha. There were no significant differences through the 6th cutting in forage yield due to application method or manure type. The plots treated with urea had a significantly higher cumulative average N

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uptake (58 kg N/ha) compared with the AD (49 kg N/ha) and non-AD (48 kg/ha) manure. Preliminary results of this 3 year study suggest that AD Ef and non-AD manure support equal grass production when applied at equal amounts of total N.

**CIG Abstracts (Conservation Innovation Grant Program)*

Understanding water and nutrient processing to guide restoration and management of a highly diverse floodplain savanna remnant in Iowa's Lower Cedar River Valley

Matt Fisher, The Nature Conservancy

- 1) Keith Schilling, Iowa Geological and Water Survey, kschilling@igsb.uiowa.edu
- 2) Peter Jacobson, Grinnell College, JACOBSOP@Grinnell.EDU
- 3) Jennifer Filipiak, The Nature Conservancy, jfilipiak@tnc.org

Lowland floodplain savannas are rare today but may have been common historically in Midwestern river valleys. The Nature Conservancy's Swamp White Oak (SWO) Preserve located on the floodplain of the Cedar River in Muscatine County, Iowa, is a 150 ha swamp white oak (*Quercus bicolor*) woodland savanna that is considered a G1 community (five or fewer exist globally). Developing a clearer understanding of ecosystem services is essential to guide current and future management and restoration efforts at the SWO Preserve and within the entire Upper Mississippi River Basin.

Hydrologic investigation via ground- and surface-water sampling was initiated at the site in 2004 to characterize spatial and temporal patterns of water and nutrient processing in shallow groundwater beneath the lowland oak savanna. Continuous water quality monitoring along with intermittent sampling during sustained flood conditions in 2008 were used to evaluate how the floodplain ecosystem processed excess water and nutrients delivered with a flood pulse. During non-flood periods, the water table was observed to range approximately two to four feet below ground surface and it fluctuated in response to stream stage, plant water demand and rainfall inputs. Diurnal water table fluctuations were observed from May to September in response to plant transpiration and analysis suggested that the oak savanna has a daily plant water demand of about 4-7 mm day⁻¹ during the growing season. Water quality results indicated that the shallow groundwater beneath the preserve is of higher quality compared to the adjacent Cedar River. Within the preserve, significant variation in groundwater quality was also evident among sampling wells. Using high resolution topographic information (LiDAR), preliminary analysis suggests that the complex microtopography of the floodplain influences the spatial and temporal dynamics of surface water inundation, sediment deposition and groundwater biogeochemistry. Variation in patterns of flood inundation appear to have a pronounced influence on soil and groundwater processes (e.g., biogeochemical cycling) and the structure of the associated biotic community. The implications of this research on management of a high quality savanna remnant community that is dependent on fire and flood disturbance will be discussed.

Fish, Wildlife, and Biodiversity Conservation

Using GIS Models to Identify Relative Nitrogen Attenuation by Riparian Buffers in the Coastal Plain of North Carolina

Jay Christensen, US EPA Landscape Ecology Branch

- 1) Anne C. Neale, US EPA Landscape Ecology Branch, neale.anne@epa.gov

Riparian areas have demonstrated the ability to attenuate nutrients and provide water quality services at the field scale, but services of riparian buffers for downstream users should be assessed at watershed scales. GIS-based riparian models have been developed to connect riparian buffers to agriculture at the watershed scale but the influence of sub-surface flows and variations in agricultural practices were not considered. In the Coastal Plain of North Carolina, flows often include a significant sub-surface component which can influence riparian buffer effectiveness. Artificial drainage also reduces nitrogen attenuation by effectively bypassing existing buffers. Spatial variation in nutrient loads influence the relative degree of water quality service provided by riparian buffers. We present the development of a simple GIS-based watershed riparian model that connects various agricultural nitrogen sources with natural buffers via surface and sub-surface flows. The model broadly assesses the relative nitrogen attenuation for the North Carolina Coastal Plain. To better account for sub-surface flows in the model, we include GIS-derived data layers of landform and baseflow. In addition, we use existing stream networks, digital elevation models, soils, and landcover data to estimate the influence of artificial drainage layer on relative nitrogen attenuation. When combined in the GIS riparian model, these additional data layers produce maps that highlight the relative nitrogen attenuation by riparian buffers in the Coastal Plain of North Carolina. Such maps can then be

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used to inform conservation and restoration plans. Although reviewed and approved by EPA, this work may not necessarily reflect official Agency policy.

Conservation Tools and Technologies

Voluntary Gopher Tortoise Habitat Credit Trading System

Todd Gartner, American Forest Foundation

1) Rhett Johnson, Longleaf Alliance, johnsee@auburn.edu

Fire-maintained longleaf pine stands once occupied 90 million acres in the Southeast, but today have declined to roughly 3 million acres as a result of habitat conversion and fire suppression. Lack of fire on the landscape has resulted in limited habitat for a variety of species. Consequently, many species have experienced population declines including the gopher tortoise. With over 80% of land in private ownership in the Southeast, the greatest potential for conservation, restoration and management of habitat for declining species lies in the hands of family forest owners

To address these issues, the American Forest Foundation is developing a market-based habitat credit trading system for the gopher tortoise and associated species in portions of Georgia and Alabama. The incentive-based framework will complement other efforts in the region to help preclude the need to federally list the eastern population of the gopher tortoise.

Under the program, interested family forest owners become eligible for habitat management assistance and conservation credit payments through a reverse auction process that considers the potential habitat contribution of the property in combination with the landowner's bid requirements. Landowners selected to participate will be issued credits for verifiable gopher tortoise habitat and agreed upon management activities. These credits can be voluntarily purchased by federal, state or county governments, or private companies to offset impacts on habitat and gopher tortoise populations. These credits may also assist the credit holders in meeting their regulatory obligations should the eastern population of the gopher tortoise become federally listed in the future.

**CIG Abstracts (Conservation Innovation Grant Program)*

Water Conservation Techniques and Technology

Patricia Watson NASA

Water conservation is not new nor is it unique to the United States. In this paper we take a look at water conservation techniques and technology over time and around the world.

Conservation Tools and Technologies