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Bacterial Toxicity of Engineered Metal and Metal Oxide Nanoparticles

A.K. Suresh[1]* (sureshak@ornl.gov), D.A. Pelletier,[1] K. Giri,[1] S.D. Brown,[1] B. Gu,[2] W. Wang,[2] D.P. Allison,[1,3] D.C. Joy,[3,4] M. Ji-Won,[1] T.J. Phelps,[1] and **M.J. Doktycz**[1]

[1]Biosciences Division, [2]Environmental Sciences Division, and [4]Center for Nanophase Materials Sciences, Oak Ridge National Laboratory, Oak Ridge, Tenn.; and [3]University of Tennessee, Knoxville

Project Goals: (1) Synthesis and characterization of metal and metal oxide nanoparticles. Nanoparticles containing Au, Pd, and ZrO_2 will be prepared by wet-chemical precipitation techniques. The size and composition of these structures will be varied and characterized by techniques such as dynamic light scattering, XRD, AFM, SEM and high-resolution TEM. Well-defined nanoparticle structures are essential for drawing accurate conclusions on how physical and chemical characteristics influence microbial response. (2) Assessment of microbial growth and viability from metal and metal oxide nanoparticle exposure. The goal of this aim will be to assess how the size, composition, and concentration of engineered nanoparticles impact microbial growth and the microbe's molecular response to these exposures. We will focus on *Escherichia coli* K12, *Bacillus subtilis*, and the metal-reducing species *Shewanella oneidensis* MR1 as initial model organisms.

Nanomaterials are of tremendous interest to pursuits in biology, medicine, electronics, catalysis and energy storage because of their unique size and shape dependent properties. Characteristics such as high surface to volume ratios, quantum confinements and the ability to selectively mediate chemical transformations make them unique from their bulk counterparts. Besides size, composition, surface coat and surface charges are properties that affect nanomaterials performance and may affect their fate and transport in the environment. The transformation of such nanoparticle catalysts in the environment is likely to influenced through interactions with bacteria. Nanoparticle production, nanoparticle toxicity, nanoparticle binding and incorporation with bacteria have all been observed. However, basic knowledge that would allow prediction of the probable interaction between an engineered nanoparticle and bacteria is lacking. Our efforts seek to quantify and characterize interactions between engineered metal and metal oxide nanoparticles on selected microbial species. Initial efforts are focused on the effects of cerium oxide, zinc oxide and silver nanoparticles on the growth, viability, structural changes and genetic response of *E. coli* and *B. subtilis*. Well-characterized CeO_2, ZnO and Ag nanoparticles have been prepared and presented to bacterial cells in a dose dependent manner. Apart from basic routine techniques such as disc diffusion tests, minimum inhibitory concentrations, viability assays, and colony forming units, advanced imaging techniques like TEM and AFM are also being used to evaluate the binding and fate of the nanoparticles on the bacterial cell. From our studies it is evident that most nanoparticles cause toxicity to the bacteria by interacting with them and causing perforations and aberrations which is direct interaction in some (Ag) and reactive oxygen species mediated in others (ZnO). The results of these studies will provide a basis for understanding how nanoparticle size and composition influence their interactions with microorganisms, and how microorganisms may alter the fate and transformation of engineered nanoparticles in the environment.

Student Presentation

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Mechanisms for Transnational Coordination and Harmonization of Nanotechnology Governance

Gary E. Marchant (gary.marchant@asu.edu), Kenneth W. Abbott, Douglas J. Sylvester, Michaelyn Gulley,* Blair Moses, Vanessa Lancaster, and Keenan Whanamaker

Center for the Study of Law, Science, and Technology and the Sandra Day O'Connor College of Law, Arizona State University, Tempe

Project Goals: This project will analyze and explore the potential for transnational coordination and harmonization of regulatory and other oversight mechanisms for nanotechnology, focusing specifically on nanotechnology applications relating to bioenergy. The specific goals are to: (1) create and maintain a publicly available online database of proposed and enacted regulatory requirements and programs specific to nanotechnology at the international, national, and sub-national levels; (2) analyze proposed and enacted national and sub-national regulations for nanotechnology, including the consistency (or lack thereof) of regulatory requirements in different jurisdictions, using nanotechnology-related applications of bioenergy as the regulatory focus; and (3) prepare case studies of nine different transnational precedents or models for the regulation or oversight of various technologies, including an analysis of the strengths, weaknesses, and lessons of each model.

Nanotechnologies are a rapidly developing set of emerging technologies being pursued by industry and governments

around the world. While these technologies promise many benefits, they will also inevitably create some risks, and regulatory agencies in numerous countries are now considering regulatory oversight approaches for nanotechnology. This project is investigating models and approaches for coordinating or harmonizing international regulation of nanotechnology. The first step in the project is to create a publicly-accessible online database of transnational, national, and sub-national regulatory activities specific to nanotechnology. This part of the project will go "live" as a publicly-available and searchable online database in July 2009. The second part of the project is to identify and analyze nine different regulatory models for transitional oversight of nanotechnologies.

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Linking Ethical, Legal, and Societal Implications (ELSI) Analyses to Nanoscale Science and Technology

Amy K. Wolfe[1]* (wolfeak@ornl.gov), Stephanie Wang,[2] David J. Bjornstad,[1] W. Christopher Lenhardt,[1] and Mitchel Doktycz[1]

[1]Oak Ridge National Laboratory, Oak Ridge, Tenn. and [2]Grinnell College, Grinnell, Iowa

Project Goals: Oak Ridge National Laboratory's Ethical, Legal, and Social Issues (ELSI) Scientific Focus Area (SFA) is a DOE-SC focused research activity that analyzes systematically the dynamic and evolving societal implications of emerging bioenergy and nanotechnology S&T.

One tenet of Oak Ridge National Laboratory's (ORNL's) Ethical, Legal, and Societal Implications (ELSI) research associated with DOE's nanoscale science user centers is that analyses should add value to the nanoscale science research and development (R&D) community. By "add value," we mean providing information and insights that are useful in framing R&D questions, managing the flow of information and intellectual property within and outside of the DOE nanoscale science user centers, and aiding scientists who engage in forums with other audiences. By "adding value," we do *not* aim to contribute to or alter any specific experiment or research; advocate for or against any technology, facility, or population; or in any way "manage" or affect perceptions and opinions.

In what ways might ELSI analyses be salient to the nanoscale science community? While the answer to this question is not immediately obvious, we suggest that the following elements are key: (1) strong, explicit links to nanoscale science and technology (S&T); (2) attention to nano product- and application-type; and (3) consideration of phase along the R&D life cycle (e.g., research vs. deployment vs. decommissioning). Before embarking on investigations whose design specifies these elements, we conducted an analysis to learn the extent to which existing nano-related ELSI publications do so. This poster presents results from that screening analysis and suggests potential implications with regard to nanoscale science and, by extension, genomics science communities.

We screened 68 nano-ELSI publications. There was considerable variation in the primary issues addressed in these documents, with the highest concentrations on ELSI, perception, equity, and governance issues. Most authors emphasized various portions of the research through deployment portion of the R&D life cycle, with very few addressing disposal, decommissioning, or the full life cycle. Perhaps most significantly, the vast majority of publications did not link their analyses either to particular nanoscale materials or processes or to specific nano-products or applications. Thus, there is a large gap in the nano-ELSI literature that our investigations will start to fill.

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Implications of Alternative Intellectual Property Rights Management Approaches

David J. Bjornstad* (bjornstaddj@ornl.gov)

Oak Ridge National Laboratory, Oak Ridge, Tenn

Project Goals: This project is part of Oak Ridge National Laboratory's (ORNL's) Ethical, Legal, and Social Issues (ELSI) Scientific Focus Area (SFA), which seeks to estab¬lish a unique ELSI resource for the U.S. Department of Energy (DOE) and its Office of Science (SC).

DOE maintains a vigorous technology transfer program as a key element of its intellectual property (IP) activities. As part of the management strategy for administering its Bioenergy Research Centers, DOE has issued a set of Principles to guide IP practices for new findings emanating from the Centers. The Bioenergy Research Centers, in turn, responded with Management Plans for implementing the Principles. The Principles and Plans are innovative, far-reaching and represent a departure from past practice. If successful, DOE might consider them for other similar partnered research ventures. For these reasons, and because they are "zero- based," that is, instituted from the initiation of the Bioenergy Research Centers Program, the Plans offer a unique opportunity to document how they are implemented, how the incentives they embody influence research partners and potential licensees, and the extent to which they could be adjusted for application to other situations. This poster presents findings from our investigation of the implications of evolving and differing implementation of the Principles and Plans for the conduct of science at the three Bioenergy Research Centers and the flow of information and IP from the Centers.

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CGE Approach to Estimating Employment, Income, and Revenue Impacts of Biofuel Mandates in Pacific Northwest Regions

Olga V. Livingston* (olga.livingston@pnl.gov), **David M. Anderson** (dma@pnl.gov), and Ryan S. Butner (Ryan.Butner@pnl.gov)

Pacific Northwest National Laboratory, Richland, Wash.

Project Goals: Quantifying economic and social impacts of biofuel mandates.

Biofuel mandates in the Pacific Northwest are expected to have a significant influence on agriculture with direct impacts on land use. One of the primary economic factors driving land allocation among crops is expected to be land rent. There are multiple economic forces at play that jointly determine returns on land. With prices and demand for various land classes being endogenous to the model, Computable General Equilibrium (CGE) has been chosen as the methodology to analyze effects of biofuel mandates in the Pacific Northwest.

The larger project of quantifying economic and social impacts of biofuel mandates consists of two essential parts. The first part utilizes CGE model to determine demand and price changes for crops, which would result from the increased demand for biofuel due to the mandated mixing ratio. This model also accounts for the changes in underlying production functions as a result of boost in yields driven by latest genomic research. The second part uses the results of regional CGE analysis as an input to determine patterns of the land use due to changes in the returns on land, based on various allocation scenarios.

This discussion covers the first part of the analysis outlined above. Primary study areas include the following economic regions in Idaho, Oregon, and Washington: The Palouse, Middle Columbia, Umatilla/Walla Walla, Willamette Valley, and the Rogue Valley. Calibration of Social Accounting Matrix (SAM) tables is developed from the IMPLAN database (MIG 2009). The model assumes producers maximize profits with output being sold either to the domestic (regional) market or on the export market. Analogously, domestic supply comes from both regional production and imports. Households also consume a mix of goods from both sources. Producers are modeled by a combination of Constant Elasticity of Substitution and Leontief production functions. Results of the GTL research impact the production side of the model the form of possible scenarios with increased crop yields. Each scenario enters as a modified production function at the level of intermediate inputs. The solution for each scenario is a unique set of equilibrium prices that determines the direction and magnitude of changes in employment, income, taxes and overall welfare.

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Meeting the Demand for Biofuels: Impact on Land Use and Carbon Mitigation

Madhu Khanna* (khanna1@illinois.edu), Atul Jain, Hayri Onal, Haixiao Huang, Seungmo Kang, Xiaoguang Chen, and Matthew Erickson

University of Illinois, Urbana-Champaign

Project Goals: This integrated, interdisciplinary research project investigates the impact of meeting the biofuel mandates on land use, crop production, social welfare and the environment in the U.S. over a 15 year horizon. To this end, we conduct a variety of research activities including: (1) examination of the optimal allocation of existing cropland for feedstock production, the mix of feedstocks that should be produced, and the spatial pattern of land use in the U.S. to meet specified levels of renewable fuel production under a variety of policy scenarios; (2) determination of the productivity in terms of yield and greenhouse gas mitigation benefits for each type of feedstock both in the form of soil carbon sequestration and displacement of carbon emissions from gasoline; and (3) identification of the optimal size and location of biorefineries and the transportation network that is consistent with regional feedstock production patterns and the location of demand for ethanol.

This integrated, interdisciplinary research project investigates the impact of meeting the biofuel mandates on land use, crop production, social welfare and the environment in the U.S. over a 15 year horizon. To this end, we conduct a variety of research activities including: (1) examination of the optimal allocation of existing cropland for feedstock production, the mix of feedstocks that should be produced, and the spatial pattern of land use in the U.S. to meet specified levels of renewable fuel production under a variety of policy scenarios; (2) determination of the productivity in terms of yield and greenhouse gas mitigation benefits for each type of feedstock both in the form of soil carbon sequestration and displacement of carbon emissions from gasoline; and (3) identification of the optimal size and location of biorefineries and the transportation network that is consistent with regional feedstock production patterns and the location of demand for ethanol.

Wide-scale economic analysis of biofuel production is heavily dependent on development of crop growth models capable of accurately simulating cellulosic feedstock growth at a wide scale. We have developed a continental-United States scale biophysical crop growth model based on the ALMANAC model to produce fine resolution (0.1˚ grid scale) estimates of growth for various cultivars of switchgrass and *Miscanthus ×giganteus*, along with corn and soybeans for comparison. We integrate the spatially variable simulated yields of energy crops from this biophysical model with a dynamic, multi-market Biofuel and Environmental Policy Analysis Model (BEPAM) which includes markets for fuel, biofuel, food/feed crops and livestock for the period

2007-2022. We consider biofuels produced not only from corn but also from corn stover, wheat straw, switchgrass and *miscanthus* as well as the potential for imports of sugarcane ethanol from Brazil. Spatial heterogeneity in yields, costs of production and land availability is incorporated by using Crop Reporting Districts (CRD) as our decision making unit for economic analysis. A rolling horizon model is used in which crop producers form price expectations based on lagged prices and make crop choice and land use decisions for the next ten years. Food and fuel prices are endogenously determined annually and used to update price expectations and land use choices for decision-making. We incorporate temporal changes in yields and costs of production of perennial energy crops, switchgrass and *miscanthus*. Econometrically estimated acreage and yield functions are used to update land availability and yields in response to changes in crop prices and time trends. Life cycle analysis is used to estimate the greenhouse gas intensity of alternative fuels and the emissions due to changes in cropping patterns at the CRD level. Using the BEPAM model, we examine the impact of various biofuel policies such as biofuel mandates and subsidies and carbon taxes on U.S. agricultural land use, carbon mitigation and social welfare.

Finally, we have developed a mathematical modeling framework (specifically a linear mixed integer program) to identify the optimal transportation network and the location and capacity of biorefineries for a given spatial supply pattern of different bioenergy crops generated by the BEPAM model. The transportation/facility location model includes the transportation cost of biomass delivered from farms to refineries, the transportation cost of biofuel delivered from biorefineries to demand centers and the processing cost at biorefineries for a multi-year planning horizon. The model is applied to examine potential refinery location and transportation modes and networks at a county level within the Midwest given demand for ethanol and livestock feed throughout the U.S.

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The Biofuels Revolution: Understanding the Social, Cultural, and Economic Impacts of Biofuels Development on Rural Communities

Theresa Selfa[1]* (tselfa@ksu.edu), Richard Goe,[1] Laszlo Kulcsar,[1] Gerad Middendorf,[1] and Carmen Bain[2]

[1]Dept. of Sociology, Kansas State University, Manhattan; and [2]Dept. of Sociology, Iowa State University, Ames

Project Goals: The goal of this project is to provide a better understanding of the socio-economic costs and benefits of biofuels development for rural communities in the Midwest, and to examine how different environmental and socio-economic factors contribute to the outcomes.

A new wave of economic growth is currently sweeping across rural communities in the Midwest region of the U.S., fueled by the construction and expansion of ethanol biorefineries and the expansion of biofuel crop production. While the expansion of the biofuels industry promises to bring jobs and economic vitality to rural communities, it is also creating dilemmas for farmers and rural communities in weighing the benefits of income growth and job growth against safety risks, increased pollution, and the potential of overextending water supplies. Presently, there is little empirical knowledge about the social and economic impacts of biofuels development on rural communities. This research is intended to help fill these lacunae through an in-depth analysis of the social and economic impacts of ethanol biorefinery industry on six rural communities in the Midwestern states of Kansas and Iowa. The goal of this project is to provide a better understanding of the socio-economic and cultural implications of biofuels development for rural communities, and to contribute to more informed policy development regarding bioenergy.

Research Questions:

1. To understand how the growth of biofuel production has affected and will affect Midwestern farmers and rural communities in terms of economic, demographic, and socio-cultural impacts.
2. To determine how state agencies, groundwater management districts, local governments and policy makers evaluate or manage bioenergy development in relation to competing demands for economic growth, diminishing water resources, and social considerations.
3. To determine the factors that influence the water management practices of agricultural producers in Kansas and Iowa (e.g. geographic setting, water management institutions, competing water-use demands as well as producers' attitudes, beliefs, and values) and how these influences relate to bioenergy feedstock production and biofuel processing.
4. To determine the relative importance of social-cultural, environmental and/or economic factors in the promotion of biofuels development and expansion in rural communities.

Research Methodology

We have analyzed data gathered for the first three case study communities. The comprehensive methodology includes: demographic analysis; in-depth key informant interviews, three focus groups with farmers, ethanol plant workers, and community leaders; a general population opinion survey of community residents; and a content analysis of local newspapers and print media. In the winter of 2010 we will be completing data collection for our final three case studies.

Preliminary Findings

Data from community level surveys, individual and focus group interviews in three case study communities in Iowa and Kansas in the Midwestern region of the United States are utilized to explore community perceptions about the biofuels industry. Results show that community members believe that ethanol plants have brought modest economic benefits to their community. Increased traffic and water competition were two areas of concern identified by

residents with respect to local ethanol plant, while other environmental impacts were not strongly identified. Widespread concerns were expressed about the future viability of the industry and the devastating impacts that future declines in the ethanol industry would have on communities. This research highlights the social vulnerabilities that communities where ethanol plants are located are experiencing.

For Additional Information:
Project information and research findings will be available at: http://www.ksu.edu/sasw/kpc/biofuels/project_doe.htm

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Land Use Impacts of Second Generation Biofuel Mandates in the Pacific Northwest

J.S. LaRiviere* (jlarivie@ucsd.edu), D.M. Anderson, and V.L. Bailey

Pacific Northwest National Laboratory, Richland, Wash.

Project Goals: Biofuel mandates can have a significant effect on agricultural land use decisions (Bento and Landry 2009). This paper exploits a unique data set to analyze the impacts of changes in state and national biofuel mandates on agricultural land use decisions in the Pacific Northwest. This paper examines the effect of mandates on cellulosic biofuels, such as those derived from switchgrasses, on a farmer's discrete choice between type of crop and on the decision to convert "marginal" land into active farmland. Changes in land use decisions are found to be heavily dependent on three factors: yields in switchgrass production, variation in transportation costs to cellulosic biofuel processing plants, and changing biofuel prices due to different government mandates.

Biofuel mandates can have a significant effect on agricultural land use decisions (Bento and Landry 2009). Mandates influence prices, which in turn influences the relative profitability of different crop and land use decisions. While changes in relative prices drive land use decisions, idiosyncratic agricultural characteristics of individual parcels of land, such as access to irrigation, composition of soil nutrients, and tillage history, are critical to each individual farmer's crop decisions. The uniformity of land's agricultural characteristics across regions necessitates accounting for them in any study of the regional impacts of state or national biofuel mandates. This paper exploits a unique data set consisting of various agricultural characteristics of land in the inland Pacific Northwest to analyze the effect of mandates on second generation cellulosic biofuels, such as those derived from switchgrasses, on agricultural land use decisions.

Economic factors determine the relative profitability of farmers land use decisions. Most generally, crop yields depend on costly inputs, such as water. Lack of access to irrigation restricts the set of feasible crops and alters farming practices over crops that remain economically feasible, such as affecting rotations and tillage practices. Similarly, soil attributes affect the amount of fertilizer input needed in crop production. Further, past crop and tillage decisions influence current soil quality, and therefore influence land-use decisions. Biofuel mandates affect the supply of biofuel feedstocks by increasing the price which farmers receive for feedstocks in the marketplace. Additionally, the distance to biofuel processing plants influences the costs for biofuel feedstock production. Because agricultural characteristics like soil quality and access to water affect the relative profitability of second generation biofuel feedstocks, they must be accounted for in assessing the regional land use impacts of biofuel mandates.

The effect of second generation biofuel mandates on land-use decisions is subject to large amounts of uncertainty because feedstocks, like switchgrasses, have not been commercially produced and mandates have yet to influence prices. As a result this study simulates land use changes which would result from a range of potential outcomes informed by scientific study of switchgrass yields. We use a unique data set to account for regional agricultural attributes present in the inland Pacific Northwest. This paper examines on a farmer's discrete choice between type of crop and on the decision to covert "marginal" land into active farmland. Changes in land use decisions are found to be heavily dependent on three factors: yields in switchgrass production, variation in transportation costs to cellulosic biofuel processing plants, and changing biofuel prices due to different government mandates.

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Science Literacy Training for Public Radio Journalists

Bari Scott* (Bariscot@aol.com)

SoundVision Productions, Berkeley, Calif.

Project Goals: The purpose of the weeklong workshops is to teach public radio reporters, producers, editors and news directors about science, science journalism, and the creative use of radio and online technologies so that they can produce clear, accurate and engaging science stories.

To help journalists explain accelerating scientific advances and their profound social implications, SoundVision is offering another series of Science Literacy Training workshops. Our goal is to shrink the widening knowledge gap between the scientific community and the general public by increasing the number and quality of science stories on radio and the web. During the project's weeklong workshops experts teach public radio reporters about science, science journalism, and the creative use of radio and online technologies to produce clear, accurate and engaging science stories.

This project is timely. Broadcasters' growing commitment to report on science is reflected in our changing applicant pool—most of our applicants now work as science, environmental, health or technology reporters. As journalists become acutely aware of the need to tell science stories in a changing media landscape, more and more of them are looking to the Science Literacy Training project to teach them how. As a result, the challenge and scope of this project has had to change on every level. To remain relevant, we've had to evolve from teaching radio science reporting to mid-career radio journalists with similar skills to teaching a group of public radio and online journalists with diverse skills and specialties to communicate science on a variety of broadcast and multi-platforms.

We've outgrown our original project. Because the demand for this training will only increase, we must decide how the project should expand to meet it.

SoundVision selects up to twelve journalists to attend each workshop. As more people seek admission, it's becoming harder to choose from the growing pool of impressive candidates that includes journalists from all areas of public radio. Our applicants work on national programs including *The World*, *Studio 360, Living on Earth, Radio Lab,* and *Marketplace*. They come from NPR, statewide networks and major market and rural stations in the United States. We're also attracting a growing number of international applicants.

The variety in our workshop participants is striking. We've had a large influx of young Internet-savvy news people applying to the program, some of whom work exclusively in their stations' online departments, and we've broadened the curriculum to include more Internet reporting and production techniques. More of our candidates have advanced science and medical degrees than ever before, and we're attracting journalists who are new to radio but have extensive print experience; although they may have impressive journalism skills and scientific expertise, they may still be learning how to write for radio, use a microphone or handle recording equipment in the field.

SoundVision's challenge is to fill the gaps in each journalist's knowledge and provide all participants with an educational experience tailored to their individual requirements. To do that, we build the workshops around core content that everyone studies while designing additional courses to meet their individual needs and levels of expertise. We determine these needs through extensive pre-workshop questionnaires.

Major stations around the country are eager to host the workshops, and a number of universities, including Princeton, Santa Clara University, the University of Texas at Austin and University of California, Berkeley, have asked to hold the workshops and offered to help us identify and secure presenters from their own and other campuses. A workshop was held in the San Francisco Bay Area in April 2009 and another is scheduled there in April 2010.

Curriculum: Workshop leaders train participants in several key areas: science, including basic biology, chemistry, physics, statistics and nanotechnology, with a strong focus on energy-related issues; science journalism, including how to interview scientists, how to handle controversy and the standards and ethics of science reporting; radio craft, from story telling to audio and production tools, and web techniques and podcasting. Participants also go on field trips, attend informal gatherings with scientists and learn creative ways to deal with the unique limitations and advantages of radio and web production. Session leaders also teach participants how scientific methods differ from journalistic practices and show them how to explore new research and fact check stories on tight deadlines. In addition, online librarians show journalists how to make the best use of the Internet for research and identify reliable sources online. Finally, each participant's work is critiqued by expert radio producers and science editors.

To prepare participants to make the most of their experience while building a sense of community and excitement, SoundVision has also created a Google Group which is used in the weeks before the conference to send them weekly homework assignments and links to valuable articles and other resources. We also mail participants books and magazine articles to read. The homework and reading are designed to give all participants a baseline foundation in science, the scientific method and science journalism before they arrive.

The project also includes a web site that provides online resources, "tip sheets," and transcripts and selected audio from the training sessions. (For sample Tip Sheets, see www.scienceliteracyproject.org.) In response to requests, SoundVision schedules follow-up teleconferences and possibly a webinar with participants.

Evaluation: The Science Literacy Training workshops are evaluated by Rockman *ET AL*, a well-established San Francisco firm with expertise in assessing media projects and the impact of training on journalistic practice. Pre-workshop evaluations help us tailor presentations to participants' needs. During the workshops, we conduct daily evaluations in which we ask participants to list the key scientific concepts they have just learned to gauge their retention of the material. Approximately two months after the workshop, Rockman also conducts follow-up evaluation interviews with all the participants to see how much they've retained.

Rockman reported that the April 2009 workshops had achieved the right balance of sessions on science, science journalism and radio techniques. In their enthusiasm everyone wanted more time for Q&A with the science presenters. While they appreciated the depth and breadth of the material, some felt the schedule was packed too tightly because they wanted more time to digest the information and reflect on the experience and what they were learning. Their only criticism of scientists who made powerpoint presentations was that some of them read those presentations verbatim. Overall, Rockman concluded that the workshops had had a lasting impact on participants.

We've learned that the workshops have a ripple effect. Many radio reporters return to their stations and give their own workshops using some of our handouts. They also produce

stories using the tools and techniques they acquired in the workshops, and a large number keep in touch with each other, sharing editorial advice and support. Most important, at the end of the Science Literacy Training workshops, participants feel confident that they can handle complex scientific stories well.

An assistant news director who took the workshop ten years ago wrote recently, "I feel it has helped immeasurably with my reporting, my interactions with scientists, and my ability to weigh scientific information, studies and reports."

Another participant called the workshop a "transformative experience" while a third said, "I am a better reporter because of what I learned at that workshop…I use what I learned there almost every day."

The Department of Energy's funding has helped make this important work possible. As one applicant wrote, "science pervades every aspect of our lives and there is now a need like never before for people to better understand the world around them. The work of the Science Literacy Project, in bringing together and training radio science journalists from around the country, is an invaluable service."

We thank DOE for having the foresight to support this project.

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Biological and Environmental Research Information System: A Multifaceted Approach to DOE Systems Biology Research Communication

Anita J. Alton, Shirley H. Andrews, Jennifer L. Bownas, Christopher E. Caldwell, Kris S. Christen, Holly L. Haun, Sheryl A. Martin, Marissa D. Mills, Judy M. Wyrick, and **Betty K. Mansfield*** (mansfieldbk@ornl.gov)

Biosciences Division, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Project Goals: Provide programmatic information via printed and online materials to help build the critical multidisciplinary community needed to advance systems biology research for DOE energy and environmental missions. The Biological and Environmental Research Information System group works with Genomic Science program managers to help develop and communicate key scientific and technical concepts to the research community and the public. Ideas are welcome to extend and improve communications and program integration and thus represent Genomic Science program research more comprehensively.

Concerted communication is key to progress in cutting-edge science and public accountability. For the past 20 years, our group, the Biological and Environmental Research Information System (formerly Genome Management Information System), has focused on presenting all facets of genomics research for the Department of Energy's (DOE) Office of Science. The materials we produce have helped ensure that scientists can participate in and reap the bounty of the genome revolution, that new generations of students can be trained in genomics and systems biology, and that the public can make informed decisions regarding genetics issues. Our goals focus on three objectives: (1) facilitate Genomic Science planning, research, and communication; (2) respond to outreach and information exchange needs of related DOE projects; and (3) inform a broader audience about DOE genomics research projects, progress, and significance to science and society.

This past year, our scope was extended to all programs within the Office of Biological and Environmental Research (BER), which conducts frontier research in climate, subsurface biogeochemistry, and genome science within the Office of Science. These programs explore scientific complexity at scales requiring contributions from teams of interdisciplinary scientists, thereby necessitating an unprecedented integrative approach both to the science and to science communication strategies. Because each scientific discipline has multiple perspectives and languages, effective communication to help foster achievement and translation of scientific discovery into appropriate DOE mission areas is critical to BER's success. We work with DOE staff and the research community to produce and disseminate information in various formats: technical reports, roadmaps, websites, brochures, databases, technical compilations, presentations, exhibits for scientific meetings, text, graphics, and posters. When appropriate, we also work with DOE grantees and members of the extended DOE BER community, especially the BioEnergy Research Centers and the Joint Genome Institute, to help increase their reach and visibility.

For BER's Biological Systems Science Division (BSSD), our recent Genomic Science program accomplishments include research plans and reports produced with the scientific community:

- *New Frontiers in Characterizing Biological Systems* (October 2009)
- *Systems Biology Knowledgebase for a New Era in Biology* (March 2009)
- *Sustainability of Biofuels: Future Research Opportunities* (March 2009)
- *Genomics:GTL 2008 Strategic Plan* (February 2009)
- *Carbon Cycling and Biosequestration: Integrating Biology and Climate Through Systems Science* (December 2008)

BER BSSD booklets and brochures include:

- *DOE Genomic Science Program Overview* (November 2009)
- *DOE Systems Biology Knowledgebase: Community-Driven Cyber Infrastructure for Sharing and Integrating Data and Analytical Tools* (November 2009)
- *Bioenergy Research Centers: An Overview of the Science* (a revision, July 2009)

- *Executive Summary – Systems Biology Knowledgebase for a New Era in Biology* (April 2009)
- *Report Overview – Carbon Cycling and Biosequestration: Integrating Biology and Climate Through Systems Science* (January 2009)

Other recently produced BER BSSD materials include the abstracts books for the *Fourth Annual U.S. DOE Joint Genome Institute User Meeting* (March 2009) and the *DOE Genomics:GTL Awardee Workshop VII and USDA-DOE Plant Feedstock Genomics for Bioenergy Awardee Workshop* (February 2009), and an exhibit created for the DOE Office of Science Genomic Science Program (October 2009).

BER BSSD works in progress include this abstracts book and several brochures: *Executive Summary – Sustainability of Biofuels: Future Research Opportunities; Overview – DOE BER Biological Systems Science Division;* and *Overview – DOE BER Joint Genome Institute*.

We also continuously update and enhance numerous websites including the Genomic Science website (*genomicscience.energy.gov*) and public image gallery (*genomics.energy.gov/gallery/*). A major redesign of the Genomic Science website is under way. The updated site will streamline content and design, while improving navigation and increasing functionality and accessibility. A Flickr image gallery will be among the new features.

BER-wide projects completed and in progress include the creation, marketing, and dissemination of:

- *Overview – DOE Office of Science Biological and Environmental Research* (July 2009)
- DOE BER poster
- Public BER Research Highlights database (*public.ornl.gov/hgmis/bernews/*)

Related works in progress in BER's Climate and Environmental Sciences Division include:

- *Overview – DOE BER Climate and Environmental Sciences Division*
- *Overview – DOE BER Environmental Molecular Sciences Laboratory*
- *Overview – DOE BER ARM Climate Research Facility*

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