ENVIRONMENTAL RESEARCH AT THE DEPARTMENT OF ENERGY

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

JUNE 9, 2009

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C O N T E N T S

June 9, 2009

Opening Statements

Witnesses:

Appendix 1: Answers to Post-Hearing Questions

Appendix 2: Additional Material for the Record

ENVIRONMENTAL RESEARCH AT THE DEPARTMENT OF ENERGY

TUESDAY, JUNE 9, 2009

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Brian Baird [Chair of the Subcommittee] presiding.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

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COMMITTEE ON SCIENCE AND TECHNOLOGY

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Hearing on

Environmental Research at the Department of Energy

Tuesday, June 9, 2009
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witness List

Dr. Paul Hanson
Group Leader, Ecosystem and Plant Sciences
Environmental Sciences Division
Oak Ridge National Laboratory

Dr. Dave Bader
Director
Program for Climate Model Diagnosis and Intercomparison

Dr. Nate McDowell
Earth and Environmental Sciences Division
Atmospheric, Climatic, and Environmental Dynamics Group
Los Alamos National Laboratory

Dr. J. Whitfield Gibbons
Professor of Ecology, University of Georgia
Savannah River Ecology Laboratory

HEARING CHARTER

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

Environmental Research at the Department of Energy

TUESDAY, JUNE 9, 2009
10:00 A.M.–12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On Tuesday, June 9, 2009 the House Committee on Science and Technology, Subcommittee on Energy and Environment will hold a hearing entitled *"Environmental Research at the Department of Energy."*

The Subcommittee's hearing will receive testimony on H.R. 2729, sponsored by Rep. Luján, to authorize the seven existing National Environmental Research Parks as permanent research reserves and provides guidance for research, education, and outreach activities to be conducted on or in collaboration with the Parks. The hearing will examine how the Parks have been used to study long-term trends in the development of ecosystems, develop methods to monitor and remediate contaminants, and conduct environmental education and outreach programs. The hearing will also examine other climate and environmental research programs conducted by the Department of Energy (DOE) Office of Science.

Witnesses

- **Dr. Paul Hanson** is the Ecosystem Science Group Leader at Oak Ridge National Laboratory. Dr. Hanson will testify on DOE's carbon cycle studies, with a focus on experimentation and measurement. He will also address the importance and utility of the Oak Ridge National Environmental Research Park.
- **Dr. David Bader** will testify on his role as the Director of the Program for Climate Model Diagnosis and Intercomparison, which conducts comparative computational modeling studies and synthesizes the U.S. contribution to research coordinated by the Intergovernmental Panel on Climate Change.
- **Dr. Nathan McDowell** is a lead researcher in the Atmospheric, Climate, and Environmental Dynamics Group at Los Alamos National Laboratory. Dr. McDowell will testify on research and educational activities conducted by the Los Alamos National Environmental Research Park.
- **Dr. Whit Gibbons** is Professor Emeritus of Ecology at the University of Georgia and Head of the Environmental Outreach and Education program at the Savannah River Ecology Laboratory (SREL). He has also been involved in collecting and managing several long-term sampling programs at the Savannah River National Environmental Research Park.

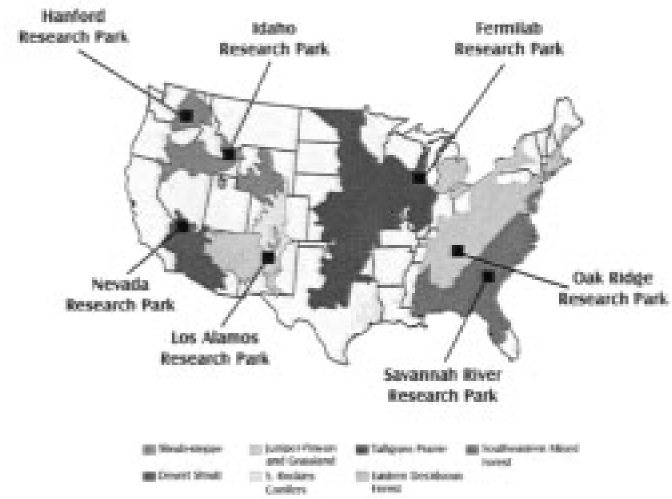

Figure 1: Department of Energy National Environmental Research Parks and Associated Ecoregions

Background

National Environmental Research Parks

The National Environmental Research Parks (NERPs) are unique outdoor laboratories that provide opportunities for environmental studies on protected lands around DOE facilities. They offer secure settings for long-term research on a broad range of subjects, including biomass production, environmental remediation, plant succession, population ecology, ecological restoration, and thermal effects on freshwater ecosystems. The Parks also provide rich environments for training researchers and introducing the public to ecological sciences.

Interest in the use of radionuclides in ecological research evolved after World War II. To ensure the security and safety of the Nation's work on nuclear weapons, the government established laboratories in isolated regions surrounded by large buffer zones of undeveloped land. DOE's predecessor, the Atomic Energy Commission (AEC), began to recognize the need to track both radioactive fallout from the testing of nuclear weapons and inadvertent radioactive releases from nuclear weapons production facilities into the environment. Out of the radionuclide research grew new technologies for quantifying the movement both of natural materials such as nutrients and fluids and of introduced pollutants through the ecosystem.

Site	Year Designated	Acres	Ecoregion
Savannah River	1972	198,000	Southern Mixed Forest
Los Alamos	1973	28,400	Juniper-Pinyon and Grassland
Idaho	1975	568,000	Shrub-steppe
Oak Ridge	1980	21,500	Eastern Deciduous Forest
Hanford	1983	366,000	Shrub-steppe
Fermilab	1989	6,800	Tallgrass Prairie
Nevada	1992	865,000	Desert Shrub

Table 1: Details on the seven National Environmental Research Parks

In 1970, the Office of Science and Technology Policy provided President Nixon with ten recommendations on the stewardship and use of federal lands. One of these was to utilize federal lands to conduct research on ecosystems and wildlife biology and preservation. In 1972 AEC established its first research park at the Savannah River Site in South Carolina. The plan for a research park emerged during a formal review of the environmental research activities at Savannah River. The review team consisted of scientists, representatives from other Federal agencies, and members of the newly formed President's Council on Environmental Quality. Four years later, DOE released a charter and directives for current and future research parks, initially shaped by the recommendations of this team.

The seven National Environmental Research Parks are located within six major ecological regions of the United States (Figure 1), covering more than half of the Nation. More information on each can be found in Table 1 above.

The mission of the research parks is to: conduct research and education activities to assess and document environmental effects associated with energy and weapons use; explore methods for eliminating or minimizing adverse effects of energy development and nuclear materials on the environment; train people in ecological and environmental sciences; and educate the public. The Parks maintain several long-term data sets that are available nowhere else in the U.S. or in the world on amphibian populations, bird populations, and soil moisture and plant water stress. This data is uniquely valuable for the detection of long-term shifts in climate.

	(dollars in thousands)		
	FY 2008	FY 2009	FY 2010
Climate and Environmental Sciences			
Atmospheric System Research	25,201	25,316	26,452
Environmental System Science	77,816	79,631	82,558
Climate and Earth System Modeling	35,141	72,029	69,775
Climate and Environmental Facilities and Infrastructure	88,944	94,450	99,479
SBIR/STTR	—	7,299	7,442
Total, Climate and Environmental Sciences	227,102	278,725	285,706

Table 2: Budget table for the DOE Office of Science's Climate and Environmental Sciences program. FY 2008 and FY 2009 are appropriated levels, and FY 2010 is the Administration's request level. This does not include funding from American Recovery and Reinvestment Act of 2009, which has not yet been allocated in further detail.

Over the years since their establishment, there have been thousands of scientific papers published on the environmental studies done at the NERPs. The research at these sites has been conducted by DOE scientists, scientists from other federal agencies, universities and private foundations.

The maintenance of the Parks by DOE meets the Department's statutory obligations to promote sound environmental stewardship of federal lands and to safeguard sites containing cultural and archaeological resources.

DOE Research in Climate and Environmental Sciences

Climate and Environmental Sciences is a major component of the DOE Office of Science's Biological and Environmental Research program. It focuses on developing a comprehensive understanding of the fundamental science associated with carbon cycling and climate change and developing monitoring and remediation methods to address the control and clean up of environmental contaminants on DOE facilities. Climate and Environmental Sciences supports three research activities and two national scientific user facilities. The Climate and Earth System Modeling activity focuses on development, evaluation, and use of large-scale computational models to determine the impacts and possible mitigation of climate change. Atmospheric System Research seeks to resolve two areas of uncertainty in climate change projections: the role of clouds and the effects of aerosol emissions on the atmospheric radiation (heat) balance of the Earth. The Environmental System Science program supports research to understand the effects of climate change on terrestrial ecosystems, the role of terrestrial ecosystems in global carbon cycling, and the role of subsurface biochemical processes on the transport and fate of contaminants, including heavy metals and radionuclides. Two scientific user facilities—the Atmospheric Radiation Measurement Climate Research Facility (ACRF) and the Environmental Molecular Sciences Laboratory (EMSL)—provide the scientific community with technical capabilities, scientific expertise, and unique information to facilitate research in the above-mentioned areas. Details on current and proposed funding for Climate and Environmental Sciences can be found in Table 2.

Atmospheric Science Program

The emphasis for the Atmospheric Science program is on understanding the effects of aerosols on climate. The program is focused on understanding atmospheric processes that influence transport, transformation, and fate of trace chemicals and particulate matter associated with energy use and that are generated through natural processes. This work is done as part of the U.S. Global Change Research Program in coordination with the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA). The Intergovernmental Panel on Climate Change (IPCC) fourth assessment report identified cloud simulation as a major source of uncertainty in climate models. Improvement in this area could reduce the range of projected increases in Earth's average surface temperature could be narrowed significantly. With regard to aerosols, the challenge is further complicated by the variety of compositions, shapes, and sizes of aerosol particles and the fact that they can act to either enhance or offset warming. This research seeks to increase the reliability of atmospheric process representations and interactions among processes that are needed inputs for the development of the next generation of climate models.

Environmental System Science

Environmental System Science covers three major research thrusts:

- The *Terrestrial Ecosystem Science* program focuses on determining the effects of climate change on the structure and functioning of terrestrial ecosystems, understanding the processes controlling the exchange rate of carbon dioxide (CO_2) between atmosphere and terrestrial biosphere, and improving the reliability of global carbon cycle models for predicting future atmospheric concentrations of CO_2. Experiments involving controlled manipulations of climate factors such as precipitation, temperature, and atmospheric CO_2 concentration are conducted to examine cause-and-effect relationships between climate changes and effects on ecosystems. This activity also supports AmeriFlux, the interagency network for directly measuring net sources and sinks of CO_2 by terrestrial ecosystems.
- The *Terrestrial Carbon Sequestration* program supports research to: identify the physical, biological, and chemical processes controlling soil carbon input, distribution, and longevity; develop models of these systems to project future scenarios of carbon storage or release in terrestrial systems; and seek ways

to exploit these processes to enhance carbon sequestration in terrestrial ecosystems. Current research focuses on switchgrass ecosystems associated with DOE's cellulosic ethanol R&D program.

- The *Subsurface Biogeochemical Research* program addresses fundamental science questions at the intersection of biology, geochemistry, and physics to determine the transport and fate of contaminants in subsurface environments. This research effort focuses in particular on processes that control the mobility of radionuclides in the environment, which will help address DOE strategic initiatives for cleanup and monitoring of the Department's nuclear energy-related and former nuclear weapons development sites. This activity currently supports field research sites in Colorado, Tennessee, and Washington to obtain samples for further evaluation in the laboratory and to test laboratory-derived hypotheses regarding subsurface transport at the field scale. These sites also are important for testing and evaluating computer models that describe contaminant mobility in the environment. In addition, this activity will assist DOE's research on using deep geological formations to store CO_2 taken from the atmosphere.

Climate and Earth System Modeling

The Climate and Earth System Modeling program covers several areas of large-scale computational research. It examines the processes needed to improve the coupled atmosphere, ocean, land, and sea ice models for simulating climate variability and change over decadal to centennial time scales with a current focus on incorporating advanced representations of cloud-aerosol and carbon-cycle interactions. It also supports climate model diagnosis and comparison, as well as the development and improvement of metrics and diagnostic tools for evaluating model performance. Over the next several years, analyses will be conducted on a suite of global climate modeling experiments that are currently being planned under the auspices of the World Climate Research Program which addresses the scientific priorities identified by the IPCC. DOE takes a lead role in coordinating the U.S. contribution to these international climate research activities with other federal agencies, in particular the National Science Foundation (NSF), NOAA, and NASA.

An important additional component supported under this program is the development of "integrated assessment models." These models provide advanced quantitative tools for exploring the implications of policy decisions and technological innovations on our energy, environmental, and economic futures. They integrate physical and social science research to inform decision-makers of the potential impacts of and uncertainties in their options. Understanding the role of present and possible future energy technologies and their implications for greenhouse gas emissions is also a major focus of this research.

Climate and Environmental Facilities and Infrastructure

DOE's Climate and Environmental Sciences subprogram supports two significant user facilities:

- The *Atmospheric Radiation Measurement Climate Research Facility* (ACRF) is unique in that it is a multi-platform facility, with stationary and mobile instruments at fixed and varying locations around the globe. ACRF provides continuous field measurements of climate data to improve our understanding of atmospheric processes and promote the advancement of climate models through observations of atmospheric phenomena. The stationary sites provide scientific testbeds in three different climate regions (mid-latitude, polar, and tropical). The two mobile facilities provide a capability to address high priority scientific questions in other regions. And the ACRF's aerial capability provides in situ cloud and radiation measurements that complement ground-based measurements.
- The *William R. Wiley Environmental Molecular Sciences Laboratory* (EMSL) at Pacific Northwest National Laboratory provides an integrated suite of resources that enable scientists to combine theory and computational modeling with experimental data to develop a molecular-level understanding of the physical, chemical, and biological processes that influence the movement, transformation and fate of contaminants. EMSL's users currently include 742 different institutions in 68 countries. All resources housed within EMSL are available at no cost to researchers if their research results are shared in the open literature, and access to these resources is awarded on a peer-reviewed basis. EMSL's capabilities include: a supercomputer designed specifically to solve large chemistry and biochemistry problems; a series of advanced spec-

trometers to examine biochemical processes as they occur; surface deposition instruments to study and design materials at the atomic and molecular scales; and high-precision subsurface flow and transport tools to measure, model, and predict the transport and fate of environmental contaminants.

Chair BAIRD. This hearing will come to order.

I thank everyone for joining us. This morning we will explore some of the environmental research programs and activities conducted by the Department of Energy and the facilities the Department offers for scientists who do this work. DOE's seven National Environmental Research Parks are extraordinary outdoor laboratories that provide opportunities for environmental studies on protected lands around DOE facilities in a variety of geographic and ecological regions. I am pleased that my colleague, Mr. Luján, has introduced H.R. 2729, a bill that would authorize these parks in law formally and provide the guidance and support they need to support critical work in research, education and public outreach. I should say parenthetically, I don't even know if Mr. Luján knows this, my father was in the final boys school class at Los Alamos when the U.S. Government tapped him on the shoulder and said "young man, it is time for you to leave, we have some work to do here at Los Alamos," and my brother was born in Albuquerque and some years later I made a pilgrimage to Los Alamos, and it is indeed remarkable, and we also near my District have Hanford, and one of the great, I think, wonderful paradoxes about this is that at the time those facilities were constructed, they were still in a rather primitive state. My father, when he was in the boys school, used to go on three-week-long mule packing trips out into the wilderness of New Mexico and with the establishment of Los Alamos, basically that stayed in its same state, and much is true of the area surrounding the Hanford lab. So some of the most high-tech, sophisticated labs in the world ironically have some of the most pristine environments, not in all cases, as we know at Hanford, but parts of Hanford are in remarkably original condition.

So I really commend Mr. Luján for his initiative in recognizing this unique resource and advocating on its behalf, and at this time it is my pleasure to recognize Mr. Luján for a brief statement on his legislation.

[The prepared statement of Chair Baird follows:]

PREPARED STATEMENT OF CHAIR BRIAN BAIRD

This morning we will explore some of the environmental research programs and activities conducted by the Department of Energy and the facilities the Department offers for scientists who do this work. DOE's seven National Environmental Research Parks are extraordinary outdoor laboratories that provide opportunities for environmental studies on protected lands around DOE facilities in a variety of geographic and ecological regions. I am pleased that my colleague Mr. Luján has introduced H.R. 2729, a bill that would authorize these parks in law, formally and provide the guidance and support they need to support critical work in research, education and public outreach.

We will also examine some of the broader research programs underway at the DOE Office of Science's Climate and Environmental Sciences Division. This division works to achieve a comprehensive understanding of climate change, ocean acidification, and remediation of environmental contaminants on land and in water.

Two of the programs are conducted as part of the U.S. contribution to international climate research activities. DOE with other federal agencies including NSF, NOAA, and NASA seek to resolve two remaining areas of uncertainty in our understanding of climate change: the role of clouds and the effects of aerosol emissions on the atmospheric radiation balance between the sun and the Earth.

DOE's Environmental System Science program supports research on carbon cycling in terrestrial ecosystems and its implications for climate change. This program also examines the crucial role of subsurface biochemical processes on the transport and fate of DOE-relevant contaminants, including radionuclides relevant to the cleanup of the Department's former weapons development sites. The persistent con-

tamination problems on these sites require on-going attention. Development of methods to contain and remediate these substances is very important to the people in my state.

We have an excellent panel of witnesses with us today. I appreciate each of them taking the time to come and share their expertise with the Subcommittee.

At this time, I recognize Mr. Luján for a brief statement on his legislation.

Mr. LUJÁN. Mr. Chairman, thank you very much, and we both know how beautiful New Mexico is and it would be an honor if we could have some of the Members of the Committee visit with us and we could show them around New Mexico a bit and hopefully be able to accomplish some great things and look at some of the science behind the work that is happening there.

Thank you very much, Mr. Chairman. And thank you very much, Mr. Chairman, for holding the hearings on the National Research Parks at the Department of Energy's facilities. As you have stated, these parks have been providing environmental scientists with unique, undisturbed environments for conducting research since they were first established in the 1970s. The ecosystems contained within these parks contain intact, undisturbed native vegetation and wildlife that represents some of the major ecosystems of the United States. The long-term data sets that have been collected by these sites are extremely valuable for understanding natural ecosystems and variability. In a number of cases, these data sets represent the world's longest continuous records.

For example, the scientists at Los Alamos have the world's longest running data sets on soil moisture and plant and water stress. The 2002 drought that killed off large areas of piñon pine in New Mexico could be understood because of the long-range data sets. This is the type of information we need to anticipate the impacts of severe weather and climate on natural systems and to develop strategies to manage the systems in the face of climate change.

H.R. 2729 will provide core funding for an organizational structure to support the important work of these parks. Again, I thank the Chairman for holding this hearing and I look forward to the testimony of our witnesses today.

[The prepared statement of Mr. Luján follows:]

PREPARED STATEMENT OF REPRESENTATIVE BEN R. LUJÁN

Thank you, Chairman Baird for holding this hearing on the National Research Parks at the Department of Energy's facilities.

As you have stated, these Parks have been providing environmental scientists with unique, undisturbed environments for conducting research since they were first established in the early 1970's.

The ecosystems contained within these Parks contain intact, undisturbed native vegetation and wildlife that represent some of the major ecosystems of the United States. The long-term data sets that have been collected from these sites are extremely valuable for understanding natural ecosystem development and variability. In a number of cases, these data sets represent the world's longest, continuous records.

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H.R. 2729 will provide core funding and an organizational structure to support the important work of these Parks. Again, I thank the Chairman for holding this hearing and I look forward to the testimony of our witnesses today.

Chair BAIRD. Thank you again, Mr. Luján. You know, one of the things that biologists talk about a lot is the changing baseline phenomenon that when you try to study something today relative to 10 years earlier, that 10 years earlier was different than what would have been 10 years earlier, and what we have in these facilities that you have so wisely identified with this legislation is a baseline that may be a pretty real baseline and so the data set is incredibly valuable.

Today we will also examine some of the broader research programs underway at the DOE Office of Science's Climate and Environmental Science Division. This division works to achieve a comprehensive understanding of climate change, ocean acidification and remediation of environmental contaminants on land and water.

Two of the programs are conducted as part of the U.S. contribution to international climate research activities. DOE along with other federal agencies including NSF, NOAA and NASA seeks to resolve two remaining areas of uncertainty in our understanding of climate change: the role of clouds and the effects of aerosol emissions on the atmospheric radiation balanced between the sun and the Earth.

DOE's Environmental System Science program supports research on carbon cycling and terrestrial ecosystems and its implications for climate change. This program also examines the crucial role of subsurface biochemical processes on the transport and fate of DOE relevant contaminants, including radionuclides relevant to the cleanup of the Department's former weapons development sites. The persistent contamination problems on these sites require ongoing attention. Development of methods to contain and remediate these substances is very important to the people of my state, particularly if you look at the issues surrounding Hanford.

We have an excellent panel of witnesses today. I appreciate each of them taking time to come and share their expertise with the Subcommittee, and with that, I would be happy to recognize our distinguished Ranking Member, Mr. Inglis.

Mr. INGLIS. Thank you, Mr. Chairman, and thank you for holding this hearing.

It has been 37 years since the first Environmental Research Park was established at the Savannah River site in Aiken, South Carolina. Now nearly four decades later, we profit from seven such research parks, each contributing a unique piece to our national environment and ecological research portfolio.

I wonder how many blind spots we would have had in our understanding of various ecosystems within this country were it not for the commitment and vision of those who first established these parks. The research education outreach gains we have made through these institutions highlight our need to continue supporting such efforts in the future. I appreciate Representative Luján's leadership to introduce H.R. 2979, a bill to authorize these research parks permanently, and I look forward to hearing the witnesses' comments and suggestions for improving the bill.

In today's hearing, we will also discuss the work being done in the climate and environment sciences through the Department of Energy's Office of Science. Environmental remediation and cleanup, climate modeling, atmospheric and environmental system

science are the major priorities of this program. Each of these research areas presents significant challenges that require substantial financial commitments, but they are challenges that we must meet and I am interested to hear from our witnesses on the strengths and weaknesses of these research efforts.

Mr. Chairman, I should also point out that this is the last time that my senior LA, Philip Van Steenburgh, will be with us in Science. I think this really is the last time he is going to be with us. He left once before and came back, so we are hoping that—I keep doing this. Once a year maybe I will have this farewell to Philip from the Science Committee and then he will come back. But this time he may be going away for good to work at Capitol Hill Baptist Church and then off to seminary after that, but who knows. Maybe he will decide that the ministry of the Science Committee is a good thing to commit to. We will see if we can get him back. What do you think, Mr. Chairman?

Chair BAIRD. Philip, I want to thank you for your service. I hope you have more success with your next flock than you have had with this one. We are a much more recalcitrant bunch, I am afraid, but we are all deeply indebted to the work of staff on both sides of the aisle and I thank Mr. Inglis for acknowledging your contribution. I wish you all the best in your future role.

Mr. INGLIS. Thank you, Mr. Chairman. I yield back.

[The prepared statement of Mr. Inglis follows:]

PREPARED STATEMENT OF REPRESENTATIVE BOB INGLIS

Good morning, and thank you for holding this hearing, Mr. Chairman.

It has been thirty-seven years since the first environmental research park was established at the Savannah River Site in Aiken, South Carolina. Now, nearly four decades later, we profit from seven such research parks, each contributing a unique piece to our national environmental and ecological research portfolio.

I wonder how many blind spots we would have in our understanding of our various ecosystems within this country, were it not for the commitment and vision of those who first established these parks? The research, education, and outreach gains we've made through these institutions highlight our need to continue supporting such efforts in the future. I appreciate Representative Luján's leadership to introduce H.R. 2729, a bill to authorize these research parks permanently, and I look forward to hearing the witnesses' comments and suggestions for improving the bill.

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Thank you again for holding this hearing, Mr. Chairman.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Good Morning. Thank you, Mr. Chairman, for holding today's hearing to examine Department of Energy (DOE) programs in environmental research and to receive testimony on legislation H.R. 2729, *To authorize the designation of National Environmental Research Parks (NERP) by the Secretary of Energy.*

As this committee's passage of the *National Climate Service Act of 2009* indicated, measuring and predicting the impact of climate variation will be central to a sustainable energy policy. The experiments and observations conducted at DOE-sponsored research facilities will help scientists and policy makers protect our ecosystems, resources, and infrastructure from the effects of a changing climate. At the center of these research efforts are the seven NERP facilities. Located in six distinct

ecosystems, including the prairies of Illinois, these cutting edge facilities conduct research and provide information regarding the impact of energy and nuclear policy on the environment.

Though the NERPs play a unique and important role in DOE environmental research, they are not officially authorized by Congress and do not receive a dedicated funding stream through the appropriations process. My colleague, the gentleman from New Mexico, Mr. Luján, has introduced legislation to officially authorize and fund the NERPs. I am interested to hear from our witnesses today how this authorization would impact their work, and what recommendations they have for this committee as we consider this legislation.

I am also interested to hear from Dr. Bader regarding his work with the Intergovernmental Panel on Climate Change. As my colleagues and I have recognized on this committee, climate change is an international problem. I would like to hear from Dr. Bader how research is coordinated at the international level and how this committee can support the DOE Office of Science in its efforts to remain at the forefront of environmental research.

I welcome our panel of witnesses, and I look forward to their testimony. Thank you again, Mr. Chairman.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Good morning, Mr. Chairman.

Our environment has been subjected to great contamination over the past century.

The Department of Energy has specific research programs to measure, model, and predict the transport and fate of environmental contaminants.

It is very important to be able to determine where contaminants travel in the environment.

As our nation invests more in nuclear power and other alternative energy sources, these power plants will become old. They will need to be modified or decommissioned.

An understanding of how to appropriately dismantle a nuclear power plant is a key question that research at the Department of Energy helps to fund.

In cases such as radiation spills or leaks, this research is also of great importance.

Texas Tech has a strong research program in this area. Researchers there study the impacts of some of the world's worst radioactive accidents.

Teams of experts investigate radiological, genetic, and biological impacts in settings contaminated with radiation.

Activities such as drilling for natural gas can lead to accidental environmental contamination.

In Texas, radioactive elements rose to the surface, along with the Barnett Shale's natural gas, at drilling sites.

Once above ground, the chemicals may remain suspended in the water produced from the well. Otherwise, they fall from their own weight and accumulate.

Statewide, 140 such "hot" sites were decontaminated from January 2005 to the 2007, according to documents from the Texas Department of State Health Services, which oversees disposal of the state's hottest radioactive waste.

Moreover, 25 of those decontamination sites were in Denton, Tarrant and Wise counties, the core counties of the Barnett Shale. These areas are near my Congressional District.

It is clear that more research should be done to determine the relative risk of various human activities, whether it is drilling or energy and radiation research.

We must do all that we can do understand the impacts of these activities on human health.

Mr. Chairman, you may know that I chair the Transportation Subcommittee on Water Resources and Environment.

Recently, I traveled to Tennessee to see, first-hand, the effects of the environmental disaster caused by the coal ash spill in Kingston.

Many people's lives will forever be impacted by that spill.

We need good information on how to safeguard the public from chemical and radiological impacts. We also need better oversight to see that safety standards are being followed.

It is far better to prevent environmental disasters of this nature than to clean up afterwards.

There is untold damage that is likely to become apparent years later in the long-term health of the people living in that area.

The National Environmental Research Parks are well-positioned to continue to provide research leadership and expertise in this area.

Whether the topic is carbon dioxide, radiation, or some other chemical, the research parks study the movement and impacts of these.

I want to welcome today's witnesses. We have a varied set of perspectives today, and I look forward to your views on environmental research supported by the Department of Energy.

Chair BAIRD. Thank you, Mr. Inglis.

It is my pleasure to introduce our witnesses at this time. Dr. Paul Hanson is the Ecosystem Science Group Leader at Oak Ridge National Laboratory. Dr. David Bader will testify on his role as Director of the Program for Climate Model Diagnosis and Intercomparison. Dr. Whit Gibbons is Professor Emeritus of Ecology at the University of Georgia and Head of the Environmental Outreach and Education Program at the Savannah River Ecology Laboratory. At this time I will yield again to Mr. Luján to introduce our other witness.

Mr. LUJÁN. Thank you very much, Mr. Chairman, for allowing me to introduce our witness from Los Alamos National Laboratory. I am happy to welcome Dr. Nate McDowell to share his expertise on these important issues with us today. Dr. McDowell is the Director of the Los Alamos Environmental Research Park and a Lead Researcher in the Earth and Environmental Sciences Division at Los Alamos National Laboratory. Today Dr. McDowell will testify on research and educational activities conducted by the Los Alamos National Research Park. Dr. McDowell brings extensive experience and insight to us, especially in the areas of physiological and ecosystem ecology. Dr. McDowell, thank you very much for being with us today.

Chair BAIRD. Thank you, Mr. Luján. As the witnesses can tell, you have a very interested group here. All of us have both personal and professional interest in your work and we are grateful for your remarks today. I want to acknowledge the presence of Ms. Giffords from Arizona. Thank you, Ms. Giffords.

With that, I would begin with our first witness, Dr. Hanson.

STATEMENT OF DR. PAUL J. HANSON, DISTINGUISHED RESEARCH AND DEVELOPMENT SCIENTIST, OAK RIDGE NATIONAL LABORATORY; CHIEF SCIENTIST, PROGRAM FOR ECOSYSTEM RESEARCH, U.S. DEPARTMENT OF ENERGY

Dr. HANSON. Good morning, Mr. Chairman and other Members of the Committee. I am Dr. Paul J. Hanson. I hold the position of Distinguished Research and Development Scientist at Oak Ridge National Laboratory. I appreciate the opportunity to discuss the Department of Energy Office of Science's support for environmental research.

My comments will highlight advances in climate change science gained through past and current support of terrestrial ecosystem research, summarize conclusions of the scientific community about the need for next-generation experiments and measurements, and describe the importance of the DOE National Environmental Research Parks as a protected land resource.

The Office of Science is an essential supporter of fundamental research for understanding of environmental effects associated with the application and use of energy technologies. The Office of

Science Research has clarified and quantified the dominant role of the terrestrial carbon cycle in moderating atmospheric greenhouse gas concentrations. This achievement has been accomplished through sustained support of landscape-scale carbon, water and energy exchange measurements in important global biomes.

The Office of Science also encourages and enables large-scale innovative experiments operating over multiple years. Long-term support of elevated carbon dioxide exposure studies in a range of ecosystems is one example. Those studies have demonstrated enhanced terrestrial carbon uptake into both plant biomass and soil carbon pools. The uptake capacity is reduced, however, when nutrient limitations or water stress become key constraints.

Long-term and large-scale precipitation manipulations designed to induce severe drought have revealed a tremendous contrast between the resilience of trees in wet eastern ecosystems and the vulnerability of trees in dry western environments.

Warming studies, both completed and ongoing, demonstrate a complex mixture of responses including extended growth periods and enhanced plant growth. Such arguably beneficial responses are contrasted with warming-induced losses of important greenhouse gases to the atmosphere and the acceleration of drought occurrences.

Notwithstanding progress to date, new and more complex research is still needed to improve our understanding of fundamental mechanisms surrounding carbon release from long-term biological storage pools and the vulnerability of species in the face of rapid climate change. The absence of such mechanisms within ecological models undermines our current ability to provide policy-relevant predictions of both climate change impacts and future greenhouse gas trajectories from those ecosystems.

Long-lived organisms and virtually all ecological communities that we recognize today will experience unique climates in the future. Therefore, controlled experiments which allow us to manipulate a wide range of environmental conditions are the preferred method for characterizing ecosystem responses and feedbacks.

Important environmental drivers to be studied in new combinations and at multiple treatment levels include temperature, water availability, atmospheric CO_2 concentration and rising sea level in the case of low relief coastal ecosystems.

The DOE National Environmental Research Parks are distributed across the United States in a wide variety of ecosystems from deciduous and pine forests in the East to arid ecosystems in the West. These research parks provide protected land areas appropriate for conducting climate change manipulations and for measuring ecosystem functions under changing environmental conditions.

Several globally extensive biomes associated with priority carbon cycle feedback questions are not, however, represented within DOE's National Environmental Research Park network. In those cases, it will be necessary for DOE to partner with other landowners to develop and conduct the necessary experiments and measurements to advance the science of climate change.

By funding multi-disciplinary science at national laboratories and universities, the DOE Office of Science plays a dominant role

in the support of terrestrial ecosystem studies to understand the fate and function of global land surfaces and their role in the Earth system. Only through the development of an integrated understanding of multiple interacting environmental effects can the scientific community generate appropriate prognostic models to inform Congress and the public about the capacity of our ecosystems to provide goods and services for society under projected rapid rates of climate change.

Thank you for the opportunity to provide testimony. I would be happy to answer questions.

[The prepared statement of Dr. Hanson follows:]

PREPARED STATEMENT OF PAUL J. HANSON

Good morning Mr. Chairman and other Members of the Committee. I am Dr. Paul J. Hanson. I hold the position of Distinguished Research and Development Scientist at Oak Ridge National Laboratory. I also serve as the Chief Scientist for the Department of Energy's Program for Ecosystem Research. I appreciate the opportunity to discuss the Department of Energy, Office of Science's support for environmental research.

My comments will (1) highlight advances in climate change science gained through past and current support of terrestrial ecosystem research, (2) summarize conclusions of the scientific community about the need for next-generation experiments and measurements, and (3) describe the importance of the DOE National Environmental Research Parks as a protected land resource.

The Office of Science is an essential supporter of fundamental research for understanding environmental effects associated with the application and use of energy technologies. Recent research in this area has focused on developing an understanding of how climatic and atmospheric changes can modify the form and function of terrestrial ecosystems.

Office of Science research has clarified and quantified the dominant role of the terrestrial carbon cycle in moderating atmospheric greenhouse gas concentrations. This achievement has been accomplished through sustained support of landscape-scale carbon, water, and energy exchange measurements in important global biomes.

The Office of Science also encourages and enables large-scale innovative experiments operating over multiple years. Long-term support of elevated carbon dioxide (CO_2) exposure studies in a range of ecosystems is one example. Those studies have demonstrated enhanced terrestrial carbon uptake into both plant biomass and soil carbon pools. The uptake capacity is reduced, however, when nutrient limitations or water stress become key constraints. Terrestrial components of the global carbon cycle must be known to calculate fossil fuel use impacts on global greenhouse gas accumulation in the atmosphere.

Long-term and large-scale precipitation manipulations designed to induce severe drought have revealed a tremendous contrast between the resilience of trees in wet eastern ecosystems and the vulnerability of trees in dry western environments.

Warming studies, both completed and ongoing, demonstrate a complex mixture of responses, including extended annual growth periods and enhanced nutrient mineralization resulting in increased plant growth. Such arguably beneficial responses are contrasted with warming-induced losses of important greenhouse gases to the atmosphere (CO_2 and methane) and the acceleration of drought conditions.

The Office of Science has also pioneered studies to apply state-of-the-science technologies, molecular analyses, and genetic methods to the evaluation of ecosystem-scale responses to climatic and atmospheric changes.

Notwithstanding progress to date, new and more complex research is still needed to improve our understanding of fundamental mechanisms surrounding carbon release from long-term biological storage pools and the vulnerability of species in the face of rapid climate change. The absence of such mechanisms within ecological models undermines our current ability to provide policy-relevant predictions of both climate change impacts and future greenhouse gas trajectories from those ecosystems.

Long-lived organisms and virtually all ecological communities that we recognize today will experience unique climates in the future. Therefore, controlled experiments, which allow us to manipulate a wide range of environmental conditions, are the preferred method for characterizing ecosystem responses and feedbacks.

Recent scientific committees and workshops concluded that available experimental data are insufficient to address the complexity of climate change impacts and feedbacks associated with terrestrial ecosystems (e.g., Dickinson et al., 2008; Ehleringer et al., 2006; Hanson et al., 2008; NRC, 2007). Existing studies have not used a sufficiently wide range of temperatures and CO_2 concentrations, nor have multi-factor manipulations been attempted in key ecosystems.

Important environmental drivers to be studied in new combinations and at multiple treatment levels include temperature, water availability, atmospheric CO_2 concentration, and rising sea level in the case of low relief, coastal ecosystems. The scientific community has concluded that future experiments will be most realistic and useful if they are (1) conducted at ecosystem scales; (2) address multi-factor environmental changes; (3) include multi-level treatments; and (4) integrate with process modeling during conceptualization, operation, and following the completion of experiments.

New research to understand climate change *impacts* must be conceptually relevant to many ecosystems, and therefore provide mechanistic outputs translatable across ecosystems. New research on carbon cycle *feedbacks* from ecosystems should prioritize spatially extensive high-latitude ecosystems and tropical forested regions with a correspondingly large potential to impact the Earth's climate (e.g., boreal and arctic biomes, and wet tropical forests of Latin and South America, Africa, and southeast Asia).

The DOE National Environmental Research Parks are distributed across the United States in a wide variety of ecosystems, from deciduous and pine forests in the east to arid ecosystems in the west. These research parks provide protected land areas appropriate for conducting climate change manipulations and for measuring ecosystem functions under changing environmental conditions. DOE-managed federal lands represent an important resource for research. For example, the National Ecological Observation Network of the National Science Foundation has identified the Oak Ridge Reservation as a core wild land site for their planned long-term measurements of environmental change. Long-term observations of pine mortality on the Los Alamos Reservation have also provided insights into plausible climate change implications (i.e., drought exacerbated under climate change may force mortality of important species).

Several globally extensive biomes associated with priority carbon cycle feedback questions (defined above) are not, however, represented within DOE's NERP network. In those cases, it will be necessary for DOE to partner with other land owners (such as other federal agencies, states, and private landholders) to develop and conduct the necessary experiments and measurements to advance the science of climate change.

To conclude:

By funding multi-disciplinary science at national laboratories and universities, the DOE Office of Science plays a dominant role in the support of terrestrial ecosystem studies to understand the fate and function of global land surfaces and their role in the Earth system. The scientific community looks to the Office of Science for guidance and necessary support to enable complex next-generation experiments and measurement systems.

Only through the development of an integrated understanding of multiple, interacting environmental effects can the scientific community generate appropriate prognostic models to inform Congress and the public about the capacity of our ecosystems to provide goods and services for society under projected rapid rates of climate change.

Thank you for the opportunity to provide testimony. I am pleased to answer any questions.

References:

Dickinson RE, Meehl GA, et al. (2008) *Identifying Outstanding Grand Challenges in Climate Change Research: Guiding DOE's Strategic Planning.* A report of the DOE/BERAC Workshop, 25–27 March 2008, Crystal City, Virginia available at *http://www.sc.doe.gov/ober/berac/Grand_Challenges_Report.pdf*

Ehleringer J, Birdsey R, Ceulemans R, Melillo J, Nosberger J, Oechel W, Trumbore SE (2006) *Report of the BERAC Subcommittee Reviewing the FACE and OTC Elevated CO_2* Projects in DOE. White paper report submitted to the U.S. Department of Energy, 16 October 2006, 23 p. available at *http://www.sc.doe.gov/ober/berac/FACE_2006_report.pdf*

Hanson PJ, Classen A, Kueppers L, Luo Y, McDowell NG, Morris J, Rogers A, Thornton P, Ceulemans R, Dukes J, Goulden M, Jackson R, Knapp A, Kirschbaum M, Lewin K, MacCracken M, Melillo J, Ringler T, and Workshop

Participants (2008) *Ecosystem Experiments: Understanding Climate Change Impacts on Ecosystems and Feedbacks to the Physical Climate.* A community white paper workshop report available at *http://per.ornl.gov/Experiment_Workshop_Report_16June08.pdf* or *http://www.sc.doe.gov/ober/Ecosystem%20Experiments.pdf*

National Research Council of the National Academies (NRC) (2007) *Understanding Multiple Environmental Stresses: Report of a Workshop.* Committee on Earth-Atmosphere Interactions: Understanding and Responding to Multiple Environmental Stresses, Board on Atmospheric Sciences and Climate, Division on Earth and Life Studies, The National Academies Press, Washington, D.C., 142 p.

DOE WWW Resources:

DOE, Office of Science
http://www.sc.doe.gov

Climate and Environmental Sciences Division
http://www.sc.doe.gov/ober/CCRD_top.html

Program for Ecosystem Research (PER)
http://www.sc.doe.gov/ober/CCRD/per.html

Terrestrial Carbon Processes (TCP) program
http://www.sc.doe.gov/ober/CCRD/tcp.html

National Environmental Research Parks
http://www.nerp.ornl.gov/index.html

National Ecological Observatory Network (NEON)
http://www.neoninc.org/domains/appalachians

BIOGRAPHY FOR PAUL J. HANSON

Dr. Paul J. Hanson is a Distinguished Research and Development Staff Member of the Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee. He graduated *summa cum laude* with a B.A. degree in biology from St. Cloud State University, St. Cloud, Minnesota, in 1981. Dr. Hanson also received M.S. and Ph.D. degrees from the University of Minnesota, St. Paul in the fields of plant and forest tree physiology, in 1983 and 1986, respectively. Dr. Hanson's current research focuses on the impacts of climatic change on the physiology, growth, and biogeochemical cycles of eastern deciduous forest ecosystems. Dr. Hanson has also conducted research on the impacts of air pollutant oxidants on forest plant physiology and growth (ozone and hydrogen peroxide), the deposition of gaseous nitrogen compounds to plant surfaces, and the exchange of mercury vapor between terrestrial surfaces and the atmosphere. He has authored or co-authored over 100 journal articles and book chapters, and has co-edited (and authored) a book titled *"North American Temperate Deciduous Forest Responses to Changing Precipitation Regimes"* published in 2003 as volume 166 of the Springer Ecological Studies series. Dr. Hanson is actively serving as an Editor of *Global Change Biology,* and in the advisory position of Chief Scientist for the U.S. Department of Energy's Program for Ecosystem Research. Dr. Hanson previously served as an Associate Editor of the *Journal of Environmental Quality* (1995–2000), and was a member of the Editorial Review Board of *Tree Physiology* from 1994 to 2004. He was a member of the U.S. Department of Energy's National Technical Advisory Committee for the National Institute of Global Environmental Change (NIGEC) from 2002 to 2004, and has served on a number of peer-review panels for the evaluation of scientific proposals. Dr. Hanson received the 1995 Distinguished Scientific Achievement Award from the Environmental Sciences Division, Oak Ridge National Laboratory, and was elected a Fellow of the American Association for the Advancement of Science in 2008.

Chair BAIRD. Thank you, Dr. Hanson.
Dr. Bader.

STATEMENT OF DR. DAVID C. BADER, PROGRAM MANAGER FOR CLIMATE CHANGE RESEARCH, OAK RIDGE NATIONAL LABORATORY

Dr. BADER. Mr. Chairman, Congressman Inglis and Members of the Committee, thank you for inviting me to address the Committee and provide my perspective on the Department of Energy Office of Science's Climate Change Research Program. My name is

David Bader, and I am the newly appointed Manager for Climate Change Research at Oak Ridge National Laboratory, supported by the Office of Science. From June 2003 until last Friday, I was the Director of the Program for Climate Model Diagnosis and Intercomparison at Lawrence Livermore National Laboratory.

The PCMDI is part of the Department of Energy's Climate Change Prediction Program and it pioneered the concept of standardized climate model experiments which have been a major factor in the scientific advancement of climate models over the last 20 years. Most recently, PCMDI established and maintained the international global climate model output archive for the Fourth Assessment Report for the Intergovernmental Panel on Climate Change published in 2007.

In the past, only researchers with access to modeling centers were able to utilize climate model results in their work. Now, several thousand users are able to download and analyze the output from all the world's major modeling groups from a single location in a standardized format.

Prior to joining Lawrence Livermore, I spent over 12 years in various roles helping to plan, organize and manage climate modeling programs for the Office of Science, coincidentally as a member of Pacific Northwest Laboratory in Richland, Washington. In addition, I worked with leaders of the modeling programs in other federal agencies, particularly NASA, NOAA and NSF to develop a national climate modeling strategy as part of the Climate Change Science Program Strategic Plan published in 2003. From these experiences, I gained valuable perspectives on the importance of climate modeling, simulation and prediction in preparing the Nation and the world for the future. Furthermore, I developed an appreciation for the critical roles in national and international modeling enterprise at the Office of Science Program and the national laboratory system plays.

Climate models have successfully answered many questions regarding the role of human activities in climate change. Recent simulations of the observed climate over the 20th century are far superior to those of just a few years ago. Although imperfect, climate models offer the only tools to quantitatively estimate future climate variability and change. There is unanimous agreement among all the models that significant further global warming is likely over the next several decades through the end of the century under all reasonable greenhouse gas emission scenarios. The amount of projected warming, however, varies substantially among models. Moreover, there is considerable disagreement among the models as to how global-scale temperature changes will be manifested as changes in precipitation on regional and local scales where most impacts are experienced that must be dealt with.

The demands for new information from climate simulations and predictions far exceed the skill of the current generation of models. Climate simulation and prediction is required by the Department of Energy as it evaluates alternative energy technology options to mitigate climate change many decades into the future. The science community must quantify, understand and reduce these uncertainties so that both near-term and long-term decisions can be guided with confidence.

We are on the verge of transformational changes in climate simulation and prediction which we realize by a combination of enhanced understanding of how the climate system operates and the advent of Exascale Computing. This requires not only investment of dollars but also a rethinking of the organizational paradigms that develop and apply climate models. Vast knowledge and understanding has been and continues to be gained from investments in observational programs, particularly ARM and the carbon cycle programs at the Department of Energy. Tremendous potential exists to improve prediction capabilities through the integration of this knowledge with increasing computer power such as the current and future systems at the Oak Ridge National Laboratory Leadership Computing Facility supported by the Office of Science.

Several key elements are needed to continue a vibrant climate modeling enterprise in the Office of Science. First, climate modeling is one of the most complex simulation problems in science. It requires a correct representation of highly interactive processes across a broad range of time and space scales. Future models must be developed by multi-disciplinary teams of climate researchers and computational scientists supported to achieve a common purpose. They will construct new models to be run on tomorrow's computers.

Second, it must be recognized that climate model development, evaluation and application occurs simultaneously. While a new generation of models typically appears every five years, some aspects take much longer to complete.

Finally, as it was demonstrated in the IPCC assessment, no single model is best in all respects and the community continues to need the results of multiple modeling groups to best understand climate changes, particularly at local and regional scales. As it turns out, the best representation is the average of all the models. The Nation benefits from having multiple groups, including those supported by the Office of Science.

Thank you for this opportunity. I am willing to take any questions that you have.

[The prepared statement of Dr. Bader follows:]

PREPARED STATEMENT OF DAVID C. BADER

Mr. Chairman, Ranking Member Inglis, and Members of the Committee: Thank you for inviting me to address the Committee and provide my perspective Department of Energy, Office of Science's Climate Change Research Program.

My name is David Bader and I am the newly-appointed manager for the Climate Change Research Program supported at Oak Ridge National Laboratory by the DOE Office of Science.

From June 2003 until June 5 of this year, I was the Director of the Program for Climate Model Diagnosis and Intercomparison (PCMDI) at Lawrence Livermore National Laboratory. The PCMDI is part of the Department of Energy's Climate Change Prediction Program. Program for Climate Model Diagnosis and Intercomparison pioneered the concept of standardized climate model experiments, which has been a major factor in the scientific advancement of climate models over the last 20 years.

Most recently, PCMDI established and maintained the international global climate model output archive for the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) published in 2007. Through the definition of standardized experiments and imposition of data standards, this archive revolutionized the use of climate model results by the international climate research community. Whereas in the past, only the researchers with access to the modeling centers were able to utilize climate model results in their work, several thousand users

now are able to download and analyze the output from all of the world's major modeling groups from a single location in a standardized format. The IPCC has recognized the significance of this transformational activity by stating in its most recent Assessment, "In particular we wish to acknowledge the enormous commitment by the individuals and agencies of 14 climate modeling groups from around the world, as well as the archiving and distribution of an unprecedented amount (over 30 Terabytes) of climate model output by the Program for Climate Model Diagnosis and Intercomparison (PCMDI). This has enabled a more detailed comparison among current climate models and a more comprehensive assessment of the potential nature of long term climate change than ever before."

Prior to joining Lawrence Livermore, I spent over 12 years in various roles helping to plan, organize and manage climate modeling programs for the Office of Science. In addition, I worked with leaders of modeling programs in other federal agencies, particularly NASA, NOAA and NSF, to develop a national climate modeling strategy as part of the *Climate Change Science Program Strategic Plan* published in 2003. From these experiences, I gained valuable perspectives on the importance of climate modeling, simulation and prediction, in preparing the Nation and the world for the future. Furthermore, I developed an appreciation for the critical roles in the national and international modeling enterprise that the Office of Science program and the national laboratory system play.

As documented in the U.S. Climate Change Science Program Synthesis and Assessment Report 3.1, *"Climate Models: An Assessment of Strengths and Limitations,"* (for which I was convening lead author) models have successfully answered many questions regarding the role of human activities in global climate change. Recent simulations of the observed climate over the twentieth century are far superior to those of just a few years ago.

Although imperfect, climate models offer the only tools to quantitatively estimate future climate variability and change. Figure 1 below was taken from the most recent IPCC Assessment. It shows unanimous agreement among all models that significant further global warming is likely over the next several decades through the end of the century under all reasonable greenhouse gas emission scenarios. The amount of projected warming, however, varies substantially among models. Moreover, there is considerable disagreement among models as to how global scale temperature changes will be manifested as changes in precipitation on regional and local scales, where most impacts will be experienced and must be addressed (Fig. 2).

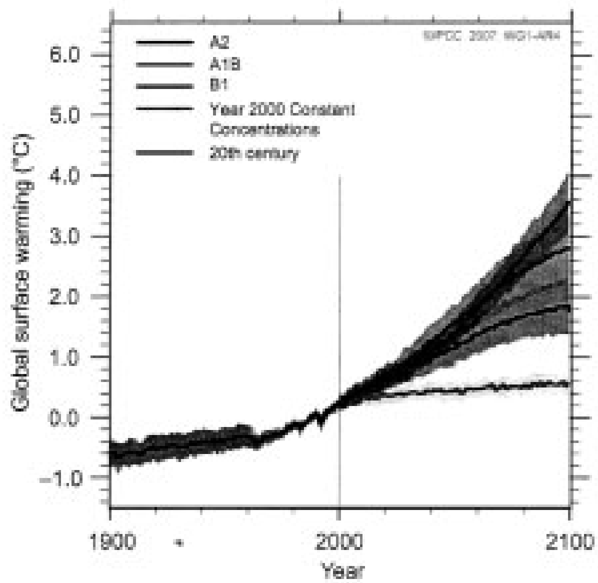

Figure 1: *Solid lines are multi-model global averages of surface warming (relative to 1980–1999) for the scenarios A2 (831 ppm CO_2 at year 2100), A1B (703 ppm CO_2 at year 2100) and B1 (540 ppm CO_2 at year 2100), shown as continuations of the 20th century simulations. Shading denotes the ±1 standard deviation range of individual model annual averages. The orange line is for the experiment where concentrations were held constant at year 2000 values (From 2007 IPCC Working Group I Report).*

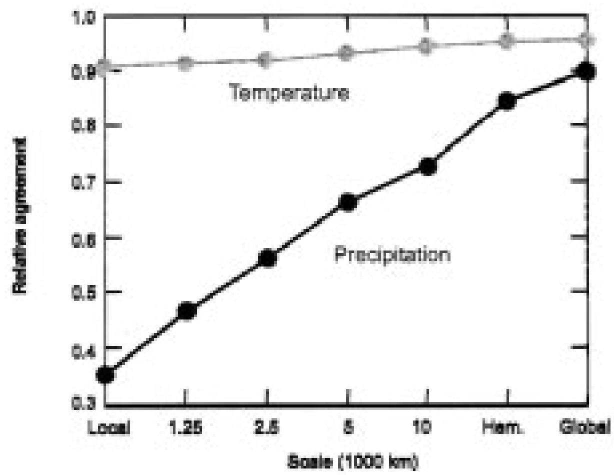

Figure 2: Statistics of annual mean responses to the A1B scenario, for years 2080 to 2099 relative to 1980 to 1999, calculated from 21 model runs from the IPCC AR4 multi-model archive. Results are expressed as a function of horizontal scale on the x axis ('Loc,' is about 200 km; 'Hem': hemispheric scale; 'Glob': global mean) plotted against the y axis showing the relative agreement among individual model runs. This result shows general agreement on temperature changes at all scales, but little agreement among models for changes in precipitation for regions smaller than 2500 km (From 2007 IPCC Working Group I Report).

The demands for new information from climate simulations and predictions far exceed the skill of the current generation of models. Climate simulation and prediction is required by DOE as it evaluates alternative technology options to mitigate climate change many decades into the future. The science community must quantify, understand, and reduce these uncertainties so that both near-term and long-term decisions can be guided with confidence.

We are on the verge of transformational changes in climate simulation and prediction, which will be realized by the combination of enhanced understanding of how the climate system operates and the advent of Exascale computing capability. This requires not only the investment of dollars, but also a rethinking of the organizational paradigms that develop and apply climate models. Vast knowledge and understanding has been and continues to be gained from investments in observational programs and research studies. Tremendous potential exists to improve the prediction capabilities of models through the integration of this knowledge with increasing computational power, such as the current and future systems at the ORNL Leadership Computing Facility supported by the Office of Science.

Major advancements will come from increasing the spatial resolution of models so that they more accurately simulate small scale atmospheric and oceanic phenomena, such as tropical cyclones and mesoscale convective complexes, that are critical to predicting not only changes in mean climate, but also to correctly predicting the probability of damaging events like floods and hurricanes. Unlike current climate models, the coming generation of models include explicit biogeochemical cycles to examine feedbacks between climate change and carbon sources and sinks. The Office of Science continues to invest in the Atmospheric Radiation Measurement (ARM) program and carbon cycle observational and experimental programs necessary to inform the development of these Earth System models. The challenge for the Office of Science is to accelerate the translation of knowledge gained in these programs

into more realistic and accurate global models capable of projecting changes over many decades and centuries.

Transforming climate prediction by integrating knowledge with computational power cannot be achieved through reductionist approaches. In an unprecedented multi-institutional and multi-disciplinary partnership, DOE laboratory computational scientists, in collaboration with Warren Washington at the National Center for Atmospheric Research, pioneered the use of massively parallel computing systems for climate simulation in the 1990s to produce the DOE Parallel Computing Model. The legacy of the collaboration continues today. The DOE Climate Change Prediction Program supports an interagency partnership to develop and apply the Community Climate System Model (CCSM), one of the three U.S. modeling groups contributing to the last IPCC Assessment. Department of Energy laboratory scientists are integral to the development of key pieces of the modeling system, including the ocean, sea ice and terrestrial carbon cycle components. Major climate change simulations using the CCSM are run on the Office of Science computing facilities at Oak Ridge and Berkeley. The emphasis today, however, has devolved to improvement of the pieces, and the vision for the next generations of climate models has been somewhat lost.

Several key elements are needed to continue a vibrant climate modeling enterprise in the Office of Science. First, climate modeling is one of the most complex simulation problems in science. It requires the correct representation of highly interactive processes across a broad range of time and space scales. Future models will be developed by multi-disciplinary teams of climate researchers and computational scientists supported to achieve a common purpose. They will construct new models that can be run on tomorrow's Exascale computers. This computational power additionally will allow us to employ advanced mathematical and statistical techniques for uncertainty quantification practiced in other fields to better understand predictability limits of models.

Second, it must be recognized that climate model development, evaluation and application all occur simultaneously. While a new generation of models typically appears every five years, some aspects of model development take much longer to complete. This puts a tremendous strain on all of the elements of the modeling community. The long-term commitment to maintain a core infrastructure of people and computational capabilities is needed to support such an enterprise. The resources and capabilities of the national laboratory system meet those needs, but cooperation among the laboratories requires a common direction and purpose articulated by the Office of Science program management.

Last, as was demonstrated in the IPCC Assessment, no single model is the best in all respects and the community continues to need the results of multiple modeling groups to best understand potential climate changes, particularly at local and regional scales. As it turns out, the best representation of current climate is achieved by averaging the results from all of the models participating in the coordinated experiments. The Nation benefits from having multiple groups, including the CCSM partnership supported by the Office of Science.

In the past, the Office of Science executed a successful climate modeling strategy by providing long-term support for teams of researchers from its national laboratories and academic stable of investigators. Continued support will lead to even greater success.

Mr. Chairman, I want to thank you and Members of the Committee for the opportunity to appear today. I would be pleased to answer any questions you may have.

BIOGRAPHY FOR DAVID C. BADER

EDUCATION

1985 Ph.D., Atmospheric Science, Colorado State University

1981 MS, Atmospheric Science, Colorado State University

1979 BS (with Distinction), Engineering Science, Colorado State University

POSITIONS

2009–present, Program Manager, Oak Ridge National Laboratory

2003–2009, Scientist, Lawrence Livermore National Laboratory

1992–2003, Project Manager at Pacific Northwest National Laboratory (PNNL)

1985–1992, Research Scientist/Senior Research Scientist at PNNL

PROFESSIONAL EXPERIENCE

David C. Bader is the Manager for the DOE Office of Biological and Environmental Research's climate research programs at Oak Ridge National Laboratory. From June 2003 until June 2009, he was the Director, Program for Climate Model Diagnosis and Intercomparison, which coordinates major international climate model evaluation and intercomparison activities for the World Climate Research Program. He is also Chief Scientist for the U.S. Department of Energy's Climate Change Prediction Program. From 1990 to 2002, he developed and managed climate modeling and computational research programs for DOE's Office of Science, and was the agency's principal representative for climate research and climate modeling to interagency working groups and committees. He was a lead author of the interagency U.S. Climate Change Science Program Strategic Plan Chapter 10 on Modeling Strategy, and in 2001 was Chairman of the interagency Climate Change Research Initiative (CCRI) Working Group on Climate Modeling. He was the U.S. Government review coordinator of the climate model evaluation chapters in the Working Group I contributions to the IPCC Second Assessment Report and Third Assessment Report.

SYNERGISTIC ACTIVITIES

2008–present—Member of CCSM Scientific Steering Committee

2008–present—Member of the AMS Committee on Applied Climatology

2006–2008—Convening Lead Author Climate Change Science Program Synthesis and Assessment Report 3.1 *Climate Models: An Assessment of Strengths and Limitations for User Applications*

2007—Joint Subcommittee, DOE Office of Biological and Environmental Research and Office of Advanced Scientific Computing Research Advisory Committees

2005–2007—NRC Committee on Archiving Environmental and Geospatial Data at NOAA

2004–2005—NASA Advanced Modeling and Simulation Capability Roadmap Committee

2004—Global Change Subcommittee, DOE Office of Science Biological and Environmental Research Advisory Committee

2003—NSF Steering Committee for Cyberinfrastructure Research and Development in the Atmospheric Sciences

2000—Member of the White House Office of Science and Technology Policy Ad Hoc Working Group on Climate Modeling, which prepared the report *High-end Climate Science: Development of Modeling and Related Computing Capabilities* for the U.S. Global Change Research Program.

RECENT PUBLICATIONS

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Chair BAIRD. Thank you, Dr. Bader.
Dr. McDowell.

STATEMENT OF DR. NATHAN G. MCDOWELL, STAFF SCIENTIST AND DIRECTOR OF THE LOAS ALAMOS ENVIRONMENTAL RESEARCH PARK, LOS ALAMOS NATIONAL LABORATORY

Dr. MCDOWELL. Good morning, Chairman Baird, Ranking Member Inglis and Members of the Subcommittee. My name is Nate McDowell and I am a Staff Member at Los Alamos National Laboratory and Director of our Environmental Research Park. I am honored to join my colleagues to speak with you today regarding the strategic value of these parks to the Department of Energy and to the Nation. Although I have only been a staff member at Los Alamos since 2004, I have published over 40 papers, approximately one-third of which were derived directly from research done at the Environmental Research Park at Los Alamos.

There are three points I would like to highlight for the Subcommittee today. First, what are the Environmental Research Parks? You have already summarized it but I will briefly go over it. They were established between 1972 and 1992 across the DOE complex. The charter of the parks is to assess, monitor and predict the environmental impact of human energy use and other human activities. Research at the parks includes measuring terrestrial ecosystem processes such as carbon and water cycling, testing ecosystem management options, monitoring of endangered species, virus threats, pollution and hydrology, just to name a few.

Second, why are these research parks important today? I would like to highlight this with an example from Los Alamos. When I first arrived in Los Alamos, the view outside of my office window was of a landscape full of dead and dying pine trees. In fact, we observed 97 percent mortality rate at the Los Alamos Research Park following a drought that has been labeled as a climate change-type drought because it was a particularly warm drought, a particularly wet and warm drought. Though everyone knows that drought and beetles combine to kill trees, no one could actually explain to me which trees will die and which ones won't, and no one could predict when this will happen again in the future or where it will happen. This challenge remains true today, particularly because there are an increasing number of observations throughout the world of increasing mortality rates of forests and there is increasing concern that the mortality will be exacerbated by climate change such as warming and drying.

Though the mortality event was depressing for people throughout the Southwest, we were fortunate at Los Alamos that the scientists had maintained measurements of the impact of climate on pine trees for over a decade preceding the mortality event, allowing rapid detection of the onset of the mortality and the first ever documentation of how trees die. These globally novel observations spawned new research supported by DOE's Office of Biological and Environmental Research. This new research is devoted ultimately to improving models of climate change. If those long-term measurements had not existed, we would be far behind our current understanding of tree death.

Third, why are the National Environmental Research Parks the right place for research regarding greenhouse gases and the impacts of climate on ecosystems? There is a multitude of reasons. To name a few, they are located throughout the United States in regions that are representative of large areas of the world. This can allow the results to be meaningful and policy relevant. Due to our already strong collaborations, the research parks complement existing efforts throughout America such as those at NOAA, AmeriFlux and DOE's climate change programs. They have the rare combination of protected landscapes and existing infrastructure for continuous observations and for large-scale experiments such as manipulations of rainfall to simulate drought. The parks have enabled extremely long-term data sets that allow us to capture extreme events and to detect long-term trends versus short-term variability, the baseline you referenced earlier. And finally, the parks already have educational programs in place for students of all ages, K to 12 to graduate school, enabling us to educate the next generation of scientists and the public as well.

In conclusion, the National Environmental Research Parks are a valuable yet underutilized network of sites that can be used as part of an early warning network for ecological impacts. The parks can also be applied to develop techniques to detect greenhouse gas emissions and to conduct fundamental research in line with the original research parks charter.

I applaud the Subcommittee's efforts to establish a mechanism for sustained funding for the parks. I would be pleased to answer any questions you have. Thank you.

[The prepared statement of Dr. McDowell follows:]

PREPARED STATEMENT OF NATHAN G. MCDOWELL

Introduction:

Good morning Chairman Baird, Ranking Member Inglis, and Members of the Subcommittee. I am honored to speak with you today regarding the strategic value of the Department of Energy's (DOE) National Environmental Research Parks (NERP). I am Nate McDowell, a staff scientist at Los Alamos National Laboratory (LANL) and Director of the Los Alamos Environmental Research Park. To date, LANL has produced 130 peer-reviewed scientific publications based on research conducted at the Los Alamos Environmental Research Park, including many that were high impact largely because they included long-term data sets that captured extreme climatic events.

I obtained my Ph.D. in Tree Physiology from Oregon State University's College of Forestry in 2002, my M.Sc. in Ecosystem Processes from the University of Idaho's College of Natural Resources in 1998, and my B.Sc. in Biology from the University of Michigan in 1994. During these formative years, I learned to think critically about the fundamental regulation of ecosystem function in response to management methods and climate. In the five years that I have been a staff scientist at LANL, my research focus has grown to consider ecosystems from the perspective of national security, in which sustained ecosystem productivity is a critical resource.

A key piece of my research deals with the theory, instrumentation and models needed to monitor and understand how CO_2 moves in and out of an ecosystem. I created and am also the Director of the Los Alamos Tunable Diode Laser Facility located within our Environmental Research Park. This unique Facility is devoted to monitoring and understanding the exchange of carbon dioxide between terrestrial ecosystems and the atmosphere in response to climate variability. The laser measures the isotopic composition of CO_2 exchanged by the plants (Bickford et al., 2009), animals (Engle et al., 2009) and ecosystems we study (McDowell et al., 2008a), allowing us to trace the source and cause of shifts in carbon storage. For example, if an ecosystem undergoes a large emission of CO_2, we can determine why this has occurred. Likewise, we employ our laser facility to determine if specific CO_2 emissions come from biological or from fossil fuel sources; this application may help ad-

dress a huge technological challenge that lies ahead for any global cap and trade verification system. My team has built strong collaborations with others studying climate impacts, including over 20 academic institutions, other National Laboratories, the Environmental Protection Agency, the Forest Service and the Agricultural Research Service. Our rate and quality of publications is currently undergoing a dramatic rise due to support from DOE's Office of Science–Office of Biological and Environmental Research and to the growing societal urgency associated with understanding and predicting climate impacts on terrestrial ecosystems.

My testimony will focus on the pressing need to quantify, understand, predict, and manage the response of terrestrial ecosystems to climate, and on the value of the National Environmental Research Parks as an essential American resource for understanding these impacts.

What are the National Environmental Research Parks? The National Environmental Research Parks were formally created in the 1970's following passage of the *National Environmental Policy Act* (1969). As specified by the Department of Energy in 1976, the charter of the Environmental Research Parks is to assess, monitor and predict the environmental impact of energy use and other human activities. Scientists within the Research Parks are expected to develop methods for observation, experimentation, and prediction of environmental impacts, to inform the public of their results, and to train future environmental scientists. Lastly, the Parks are intended to improve access to non-federal researchers while capitalizing on the protected nature of the DOE land holdings. Current and past research at the Parks includes not only measuring terrestrial ecosystem processes such as carbon and water cycling, but also determining ecosystem management options, and monitoring of endangered species, animal dynamics, virus threats, pollution and hydrology (Dale and Parr, 1998).

Fig. 1. Distribution of the National Environmental Research Parks

Nearly all of the Parks have formal educational components. At Los Alamos, there are numerous K–12, undergraduate and graduate programs that capitalize on the Research Park for exposing students to environmental science, such as geology, carbon cycling, and climate. There are specific programs directed towards undergraduates, high school students, minorities and Native Americans. Los Alamos staff sci-

entists frequently donate their time to these programs. Additionally, numerous student interns conduct research within the Park under staff supervision each year.

The Research Parks are located in six major vegetative zones, representative of over half of the American landscape (Figure 1). The Research Parks contain large swaths of land—they are five times larger than the National Science Foundation's Long-Term Ecological Research sites (NSF–LTER)—making replication and large scale experiments possible to ensure that the results are meaningful to larger areas. Their large size and broad coverage of both vegetation and climate types allow experimental results to be extrapolated, with care, to much larger areas of the Earth, as might be necessary for monitoring of greenhouse gases and carbon offsets associated with verification of carbon trading and international treaties. Their value as test beds for sensing and prediction of greenhouse gas emissions and terrestrial impacts cannot be over-stated: their lands are protected, they have long-term data sets that capture climate impacts, and they are flexible to experimental manipulations similar to those conducted by DOE's Program for Ecosystem Research and Terrestrial Carbon Process Program (e.g., altering climate change factors such as precipitation, temperature, atmospheric CO_2 to determine the ecosystem impacts, or conducting mitigation experiments such as sustainable forest thinning). It is rare that such protected, yet scientifically important land areas, are available for testing monitoring tools for use in denied or hostile territories, or for testing new theories for climate modeling.

The National Environmental Research Parks have long-term records that are unprecedented in length. These include stream hydrology, soil carbon, and vegetation dynamics records at Oak Ridge; avian virus, isotopic CO_2 exchange, and vegetation water stress and mortality at Los Alamos; grassland rehabilitation studies at Fermi; and numerous other long-term data streams at the four other parks. Notably, the Parks have unique access to skilled scientists with state-of-the-art instrumentation and analysis tools, providing a technical advantage in gathering data and knowledge not available in most countries.

The current threat: The terrestrial impacts of our changing climate are occurring across the Earth in novel, dramatic, and often irreversible ways. These impacts include regional-scale vegetation mortality, changing carbon storage and water availability, and reduced lumber and food production. Human impacts are already widespread and are expected to become both more common and severe globally. Our understanding of these threats has increased dramatically in the last decade due in part to the leadership of DOE's Office of Science–Office of Biological and Environmental Research scientific programs.

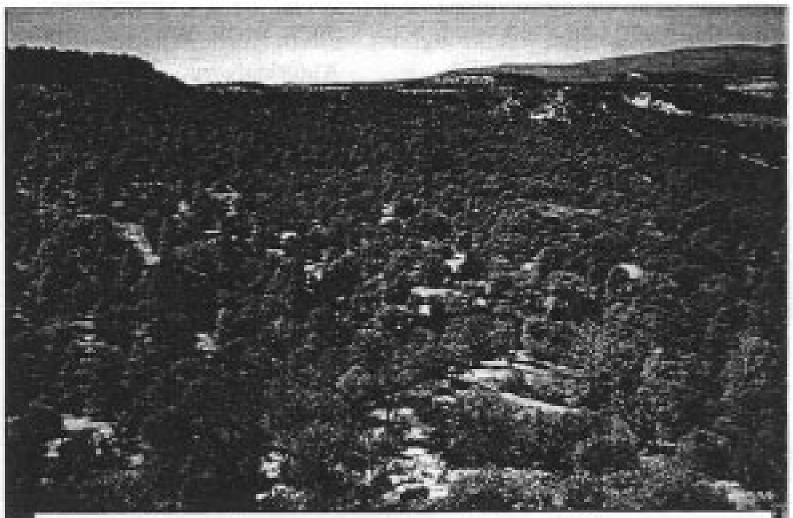

Fig. 2. Piñon pine mortality in Los Alamos during a severe drought event, autumn 2002. *Courtesy* C. Allen, USGS

A drastic example of climate impacts on terrestrial ecosystems can be seen by looking no further than outside my office window at the semi-arid woodland that covers much of the Los Alamos Environmental Research Park. In 2002, piñon pine trees died throughout the southwestern United States following a 12-month drought that was considered unusually warm as is consistent with global warming (Breshears et al., 2005). At the Los Alamos Park, the mortality rate exceeded 97 percent (Figure 2). The rash of dead trees drew significant attention within the region, as many of my neighbors lamented the loss of their favorite trees from their yards, not to mention the economic impacts on commodity production and tourism.

From a scientific perspective, we were fortunate that scientists at the Los Alamos Environmental Research Park had sustained long term water stress and hydrology observations for over a decade proceeding the mortality event, allowing us the first-ever documentation of how trees die (Breshears et al., 2009). In short, trees were unable to photosynthesize for 12 continuous months because of severe water stress, forcing them to starve for carbon. Subsequently they had no resources left for defense against beetle attack. This is similar to starving humans who are often unable to fight off a simple cold virus. This research is critical because during the period of carbon starvation the forests are not absorbing carbon and thus are no longer functioning as a carbon sink. In addition, once trees die they begin releasing carbon back into the atmosphere through the decomposition process.

From the long-term data at Los Alamos we developed the first testable theory regarding the exact causes of tree mortality (McDowell et al., 2008b). We are now testing this theory via a large scale drought manipulation experiment supported by DOE's Program for Ecosystem Research and are examining the consequence of mortality on carbon storage and water yield via DOE's Experimental Program to Stimulate Experimental Research (EPSCoR) as part of the AmeriFlux program. We are also testing the new theory for integration into the Community Climate System Model (a joint project funded by DOE and the National Science Foundation, *www.ccsm.ucar.edu*) for global climate prediction.

But the southwestern piñon pine mortality was only the proverbial canary in the coal mine: catastrophic mortality events are now being observed throughout western North America (Allen et al., *in review*). These regional die-off's are now altering some of America's most cherished places, such as the Colorado Rockies and Yellowstone National Park, where entire mountainsides of pine trees are turning brown. Perhaps even more disturbing is the subtle but insidious doubling of mortality from

one to two percent in apparently healthy forests over the last three decades (van Mentegm et al., 2009). Though less graphic than the catastrophic die-off's, this doubling of mortality in apparently healthy forests may be a precursor of worse things to come. Notably, increased mortality has also been revealed in wetter areas that are expected to be more resilient, such as at the Oak Ridge Research Park in the Appalachian Mountains (Kardol et al., *in review*). Again, the increase in forest mortality rates reduces the amount of atmospheric carbon that can be absorbed and stored by forests over the long-term.

The challenge: The science challenges are clear: we must understand the changing climate and its impacts on terrestrial systems well enough that we can predict over the next decades what will happen to terrestrial resources such as crop yields, carbon storage, productivity, and water quality. Importantly, this understanding and prediction must be done at regional scales relevant to policy-makers. Furthermore, the United States needs a regionally distributed early-warning network of climate impacts. For example, we can presently anticipate weather with near-realtime predictions based on a network of weather measurements that feed data into predictive models. Modelers are also making great advances in predicting weather and climate in the upcoming weeks to seasons, which may allow society to plan for events such as heat waves and droughts. We have no such early warning system for climate impacts on ecosystems. The scientists and their associated technology, models, and research sites at both the National Environmental Research Parks and elsewhere, are already available and amenable to development of just this early-warning network for terrestrial impacts.

The Environmental Research Parks are an ideal, yet underutilized network of sites located throughout America that can be used as part of an early warning network, for testing remote techniques for detecting impacts and greenhouse gas emissions, and for conducting fundamental research in line with the original Research Park charter. Unfortunately, they have no formalized funding source, and thus they have only really been used when individual investigators have been able to obtain grants to support work on the Park lands. Thus, there are only rare data sets that have been maintained over sufficiently long time periods to capture extreme climate events and to differentiate short-term variability from long-term trends. Likewise, no integration across parks has occurred, preventing us from determining how ecosystems and their inhabitants respond to climate variation across regions.

Recommendations: It is essential that we have a network of sites for early detection of climate impacts on ecosystems and for testing tools that monitor greenhouse gas emissions and terrestrial impacts. If the National Environmental Research Parks were employed with this charge, they could become a leading entity in the new generation of science in which we not only learn more fundamental science, but also develop and apply tools for verifying international treaties, for predicting consequences on our own soil, and for developing mitigation options. Such a network should be used to build upon existing efforts such as NSF–LTER sites, the AmeriFlux network, which monitors CO_2, water and energy exchanges, NOAA's Cooperative Air Sampling Network, USDA's Forest Inventory Analyses and Natural Resources Inventory, which monitor biomass and soil carbon throughout the United States, as well as with existing and future remote sensing tools supported by NASA and the Jet Propulsion Lab. Likewise, capitalizing on existing data management networks, for example, with the North American Carbon Program, is essential.

Support of the Research Parks should be a long-term priority. Decadal-length monitoring is essential for capturing extreme climate events as well as chronic warming. Like fine wines, the few long-term data sets that exist globally have all increased in value with each passing year as they reveal climate change impacts that were not detectable in only three years, the normal proposal funding cycle.

The long-term efforts must include experimental manipulations, such as those supported by DOE–Office of Science. Altering CO_2, rainfall, and temperature over entire ecosystems allows us to see ecosystem response to climate changes that will occur in the future. The manipulations are essential for predicting the response of ecosystems to changes we expect to occur in the next 20 to 50 years. Like long-term observations, these experiments must be decadal in length. For example, in my Office of Science funded study, we are altering rainfall to simulate climate change and determine why trees die and what happens to the ecosystem afterwards, and have found that trees are just starting to die after three years, which is the end of a typical funding cycle. Three years is not sufficient for most ecosystem scale observational or experimental studies of climate change impacts.

Ideally, this research must be integrated spatially and across disciplines. The challenge is complex and exists at multiple scales. Rising air temperature impacts plants at the cellular level, yet it manifests at the tree, landscape, and global scales that affect humans. Observations and experimentation must be integrated with

models, such as the Community Climate System Model, if we are to advance our understanding and our forecast accuracy. Only then will our effort be relevant to the American public.

We are at a critical turning point. We know that climate is changing, and we know that terrestrial ecosystems are being impacted. We now have the theory, tools and models to make rapid advances in our ability to forecast impacts that are relevant to human populations. We simply need to integrate these tools and apply them within and beyond the Research Parks.

Thank you for this opportunity to appear before the Subcommittee.

Relevant websites

McDowell Lab at Los Alamos National Laboratory:
http://climateresearch.lanl.gov/

DOE EPSCoR Program:
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DOE Program for Ecosystem Research:
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BIOGRAPHY FOR NATHAN G. MCDOWELL

McDowell is a staff scientist within the Earth and Environmental Sciences Division at Los Alamos National Laboratory (LANL), where he serves as the Director of LANL's Tunable Diode Laser Facility and Director of LANL's National Environmental Research Park. McDowell received his B.Sc. in Biology from the University of Michigan in 1994, M.Sc. in Ecosystem Processes from the University of Idaho's College of Natural Resources in 1998, and Ph.D. in Tree Physiology from Oregon State University's College of Forestry in 2002. His interests are focused on understanding the fundamental physiological regulation of plant carbon and water balance in response to the environment. To achieve this goal McDowell employs many techniques and develops collaborations across many disciplines, including empirical observations, experimentation, and modeling. His team's current research is focused on two main areas 1) the mechanisms and consequences of vegetation mortality in response to drought, and 2) the fundamental regulation of the terrestrial carbon and water cycles in response to climate and management.

Chair BAIRD. Thank you, Dr. McDowell.

Dr. Gibbons.

STATEMENT OF DR. J. WHITFIELD GIBBONS, PROFESSOR EMERITUS OF ECOLOGY; HEAD OF THE SAVANNAH RIVER ECOLOGY LABORATORY ENVIRONMENTAL EDUCATION AND OUTREACH PROGRAM, UNIVERSITY OF GEORGIA

Dr. GIBBONS. Chairman Baird, Ranking Member Inglis and Members of the Subcommittee, good morning and thank you for inviting me to address the Subcommittee and provide a perspective on the Department of Energy's National Environmental Research Parks. I am Whit Gibbons, Professor Emeritus of Ecology from the University of Georgia and Head of the Environmental Education and Outreach Program at the Savannah River Ecology Laboratory, which we call SREL, on DOE'S Savannah River site in South Carolina. I have provided more written material to you than I will have time to read so I will summarize the high points by using SREL and the Savannah River site as examples of how the designations of these parks across the Nation will be in the public interest. Please remember that any of the other DOE sites can provide excellent examples as well.

SREL has been operated by the University of Georgia since 1951 with a mission to provide an independent evaluation of the environmental effects of Savannah River site operations through a program of ecological research, education and public outreach. SREL has been recognized internationally by Encyclopedia Britannica as the outstanding laboratory of the year and awarded a Guinness World Record certificate for the longest running amphibian field research program in the world. Both of these were made possible by DOE operating the site as a National Environmental Research Park. SREL research contributions include more than 3,000 publications in the peer-reviewed scientific literature and more than 25 books on ecology and environment. Most of the research could not have been conducted without the protected areas that have allowed these long-term studies.

As far as education, SREL has provided training for more than 1,000 future scientists as undergraduate research participants or graduate students, the latter producing more than 400 theses and doctoral dissertations. Students have come from 275 universities and colleges and from every state and Puerto Rico. Most came to SREL because of research opportunities offered by the protected land area.

In public outreach programs, SREL reaches more than 50,000 students, teachers, civic leaders and other members of the general public each year through talks, tours, exhibits, workshops and other presentations about the Savannah River site and its activities and environmental stewardship. All are focused on the protected land area and what it provides for ecological research and wildlife conservation.

The environmental research themes possible that are currently undertaken on the site and that will be enhanced by legislative recognition of the parks are environmental characterization. This will be true for any of the parks on all of the natural habitats, which is a necessary first step in determining environmental and health risks, research on ecological risk and effects, which helps to ensure that good decisions are made by reducing uncertainties associated with complex environmental processes, and studies on remediation and restoration of natural habitats can be conducted on the Savannah River site where large land areas are contaminated with relatively low levels of metals, organics and radionuclides.

All parts of the DOE complex can also serve as reference landscapes for the patchwork of commercial and private land areas that exist outside of their borders as well as representing a landscape with biological communities that can be used as a reference for climate change without the impact of typical economic development. Long-term ecological studies can be conducted on the parks that would be impossible to carry out without official protection. Protecting these areas in perpetuity will be in the best interest of all Americans. The establishment of the Savannah River site and other DOE sites as National Environmental Research Parks will assure a legacy that DOE can be proud of.

Mr. Chairman, thank you and Members of the Subcommittee for the opportunity to provide testimony in support of the National Research Park concept and to present the SREL model for ecological research and for environmental education and public outreach. The contributions to field research relating to energy technologies that can be accomplished at these DOE sites are unsurpassed as outdoor laboratories and their boundless opportunities. The opportunities to achieve public trust through transparent presentation of ecological research findings and advancements in environmental stewardship through education and public outreach programs are limitless, and remember to remind your colleagues in the House and Senate that National Environmental Research Parks are different from national parks or wildlife refuges or national forests because they not only allow, but welcome environmental disturbances resulting from energy technologies where they can be studied and reported on in the national interest. I urge you to continue the process of formalizing the DOE lands as National Environmental Research Parks.

This concludes my testimony, and I thank you very much. I would be pleased to answer any questions.

[The prepared statement of Dr. Gibbons follows:]

PREPARED STATEMENT OF J. WHITFIELD GIBBONS

Chairman Baird, Ranking Member Inglis, and Members of the Committee: good morning and thank you for inviting me to address the Committee and provide the University of Georgia's Savannah River Ecology Laboratory perspective on the Department of Energy's designation of National Environmental Research Parks.

I am Whit Gibbons, Professor Emeritus of Ecology from the University of Georgia and Head of the Environmental Education and Outreach Program of the Savannah River Ecology Laboratory on DOE's Savannah River Site in South Carolina.

Because of my own background and experience I will use the Savannah River Ecology Laboratory (SREL) as an example of how the designation of National Environment Research Parks across the Nation will be in the public interest. Please remember that SREL and the SRS are only examples and that any of the DOE sites can serve as excellent examples as well.

SREL was founded in 1951 by the late Dr. Eugene P. Odum of the University of Georgia and throughout its history SREL has been operated by the University of Georgia with collaboration from other academic units regionally and nationally. The laboratory is located on the Department of Energy's (DOE) Savannah River Site near Aiken, SC; it has been recognized internationally by *Encyclopedia Britannica* as the Outstanding Laboratory of the Year and also was recognized by a Guinness World Record Certificate for the longest running amphibian field research program in the world.

SREL's mission, as defined in its Cooperative Agreement with the Department of Energy, is to provide an independent evaluation of the ecological effects of Savannah River Site operations through a program of ecological research, education, and public outreach.

The program involves basic and applied environmental research, with emphasis upon expanding the understanding of ecological processes and principles, and upon evaluating the impacts of industrial and land use activities on the environment. Dissemination of this knowledge to the scientific community, land managers, government officials, and the general public is a key goal of SREL.

During its 58-year history, SREL has had a significant impact on the Savannah River Site, the scientific community, and the general public by actively contributing to environmental remediation, restoration efforts, and environmental stewardship on the SRS and elsewhere, all within the spirit of a what a system of National Environment Research Parks proposes to be in regard to research, education, and outreach.

1. RESEARCH—The environmental research themes that are currently undertaken and that will be enhanced by the National Environmental Research Park designation are:

(1) Environmental characterization,
(2) Ecological risks and effects, and
(3) Remediation and restoration of natural habitats.

SREL contributions to research include the publication of more than 3,000 publications in the peer-reviewed scientific literature and more than 25 books on ecology and the environment.

Environmental Characterization

Characterization is a necessary first step in determining environmental and health risks and in devising appropriate remediation and restoration strategies. Environmental information is also needed to make informed decisions about long-term stewardship and land management, and it is also a critical component of NEPA reports, Records of Decision (ROD), and other regulatory documents. Environmental characterization is more than simply measuring contaminant concentrations in biota or other media, or reporting the presence of organisms at various locations. It includes developing an understanding of the processes that control distributions of contaminants, chemical forms, and their bioavailability. Characterization is also necessary to construct models of how natural and engineered systems function, both in the presence and absence of environmental contamination.

Ecological Risks and Effects

Estimated risks and effects determine the need for remediation and restoration efforts, while perceived risks and effects determine the public's acceptance and support of DOE policies and actions. Estimating ecological risks and effects on the basis of sound science helps to ensure that good decisions are made by reducing uncertainties associated with complex environmental processes. A 1999 report from the National Academy of Sciences stated that *"Ecological risks are better characterized at the Savannah River Site than at any other DOE installation, due in part to the designation of the site as a National Environmental Research Park and the presence of the Savannah River Ecology Laboratory."*

Remediation and Restoration

The SRS National Environmental Research Park coupled with the knowledge and expertise based at SREL are ideally suited to address the remediation and restoration of large land areas contaminated with relatively low levels of metals, organics, and radionuclides. SREL conducts multi-disciplinary research designed to assist in the development, evaluation and stakeholder acceptance of remediation and restoration efforts that protect human and ecosystem health. Fundamental to the success of various bioremediation, natural attenuation, and *in situ* remediation applications is an understanding of the underlying scientific principles on which they are based.

The SRS and other National Environmental Research Parks in the DOE complex can also serve as reference landscapes for the patchwork landscapes that exist outside of their borders as well as representing a landscape with biological communities that can serve as a reference for climate change, without the impact of "normal" economic development. In addition, long-term ecological studies can be conducted on National Environmental Research Parks that would be impossible to carry out without the protected nature of the DOE sites.

2. EDUCATION—For more than a half century, SREL has provided training for future scientists and engineers, having had more than 600 undergraduate research participants, including representatives from 275 universities and colleges in every state and Puerto Rico. More than 200 of these students have continued careers in science. Graduate students have produced more than 400 Master's theses and doctoral dissertations based on research conducted.

3. OUTREACH—In environmental outreach programs, SREL reaches as many as 50,000 members of the general public each year through talks, tours, exhibits, workshops, and other presentations about SRS activities and environmental stewardship.

Reasons for SREL's success in accomplishing these goals include the facts that the SRS has the largest tract of fenced-off, environmentally protected land east of the Mississippi River and therefore minimally affected by impacts from agricultural, urban, or industrial activities. Paradoxically, because five formerly active nuclear production reactors were guarded and protected for defense security purposes for more than a half century, we now have what is arguably the most biologically diverse suite of regional habitats in the Atlantic and Gulf Coastal Plain. For these reasons, the SRS was proposed as the first National Environmental Research Park. The other DOE complexes have comparable uniqueness for environmental stewardship and ecological research.

Testaments to the biodiversity and abundance of wildlife on the SRS are:

1. Upper Three Runs Creek, which travels more than 20 miles across the site to the Savannah River, has the highest documented diversity of aquatic invertebrates, including clams, crawfish, freshwater shrimp, and countless fascinating insects, than any other stream in North America.
2. More ruddy ducks winter on SRS reservoirs each year than in the rest of South Carolina put together.
3. Much of the 10,000-acre river swamp and floodplain have been virtually untouched by on-site human activities for a minimum of 50 years. Recently, one of the cypress trees was aged using tree rings and found to be more than 600 years old.
4. More species of reptiles and amphibians, over 100 species, have been documented from the SRS than have been found on any other public land area in the United States, including the Everglades or Great Smoky Mountains National Park, and more than are found in most of the 50 states. Approximately 1,000 species of plants exist on the SRS.
5. Another environmental record is that the SRS has more intact and permanently protected Carolina bay wetlands, the natural wetlands of this region, than the remainder of the State of South Carolina.

These are but a few of the impressive features of this protected land area that speak to the ecological richness and environmental health of the region and to its perpetuation and stability. The establishment of the SRS and other DOE sites as National Environmental Research Parks will assure a legacy that DOE can be proud of.

Mr. Chairman, I thank you and Members of the Committee for the opportunity to provide testimony in support of the National Environmental Research Park concept. The contributions to field research relating to energy technologies that can be accomplished at these DOE sites, which are unsurpassed as outdoor laboratories, are boundless. The opportunities to achieve public trust through transparent presentation of ecological research findings and advancements in ecological stewardship through environmental education and outreach programs are limitless. We have prepared a model at SREL both for ecological research and for environmental education and outreach. We hope to continue our efforts at SREL under the umbrella of the National Environmental Research Park program at the Savannah River Site and hope that the six National Environmental Research Parks located in other major ecological and climatic regions of the United States will be afforded the same opportunities. This concludes my testimony. I will be pleased to answer any questions.

BIOGRAPHY FOR J. WHITFIELD GIBBONS

Whit Gibbons is Professor Emeritus of Ecology, University of Georgia, and Head of the Environmental Outreach and Education program at the Savannah River Ecology Laboratory (SREL). He received degrees in biology from the University of Alabama (B.S., 1961; M.S., 1963) and in zoology from Michigan State University (Ph.D., 1967).

Whit is author or editor of twelve books on herpetology and ecology, including:

Lizards and Crocodilians of the Southeast. 2009. (With Judy Greene and Tony Mills.) UGA Press.

Frogs and Toads of the Southeast. 2008. (With Mike Dorcas.) UGA Press.

Turtles of the Southeast. 2008. (With K. Buhlmann and T. Tuberville.) UGA Press.

Snakes of the Southeast. 2005. (With Mike Dorcas.) UGA Press. Winner of National Outdoor Book Award

North American Watersnakes: A Natural History. 2004. (With Mike Dorcas.) University of Oklahoma Press.

Ecoviews: Snakes, Snails, and Environmental Tales. 1998. (With Anne Gibbons.) University of Alabama Press. Choice Outstanding Academic Book award.

Life History and Ecology of the Slider Turtle. 1990. Smithsonian Institution Press.

Their Blood Runs Cold: Adventures with Reptiles and Amphibians. 1983. U. of Alabama Press.

Whit has published more than 250 articles in scientific journals, has had commentaries on National Public Radio (Living on Earth, Science Friday, and others), and has had more than 1,000 popular articles on ecology published in magazines and newspapers, including a weekly environmental column distributed by the *New York Times Regional Newspaper Group.* His encyclopedia articles have appeared in *World Book, Compton's,* and for the past 25 years have included the annual summary of Zoology for the *Encyclopaedia Britannica Year Book.* He wrote the latest edition of *Reptile and Amphibian Study,* the merit badge booklet for the Boy Scouts of America.

Whit Gibbons received the Henry Fitch Distinguished Herpetologist Award at the National Joint Meeting of Ichthyologists and Herpetologists for long-term excellence in the study of amphibian and reptile biology. He was awarded the IUCN Behler Turtle Conservation Award in recognition of long-term turtle research and conservation nationally and internationally. Other awards include the Southeastern Outdoor Press Association's First Place Award for the Best Radio Program, the South Carolina Governor's Award for Environmental Education, the Meritorious Teaching Award presented by the Association of Southeastern Biologists (ASB), and the ASB Senior Research Award.

Whit is a frequent speaker at meetings, both civic and scientific, and gives talks each year to college and pre-college school groups. Many of the talks use live animals, particularly reptiles and amphibians, in discussions of ecological research and environmental awareness.

Discussion

Chair BAIRD. Dr. Gibbons, thank you, and thanks to all the witnesses. We have been joined by Dr. Ehlers and also by Mr. Tonko. I thank them for being here, and I will recognize Mr. Luján first for five minutes as the author of H.R. 2729. Mr. Luján is recognized.

Mr. LUJÁN. Mr. Chairman, thank you very much for your indulgence there and Ranking Member Inglis as well.

I have been extremely impressed with the research that has been taking place with NERPs around the country despite not having the full support that they potentially could have in the past. The research compiled has been remarkable. From your standpoint, what type of research could be enhanced, could grow, could be developed with additional support or funding? And I would pose that question to the entire panel. Dr. Hanson.

Dr. HANSON. Recent community studies have highlighted all terrestrial ecosystems as being important for fuel, fiber, recreational areas, for everyone's backyard, so the key six or seven ecosystems represented by the National Environmental Research Parks represent a real opportunity to understand how vulnerable those systems might be to climate change as an issue or other environmental issues.

Mr. LUJÁN. Dr. McDowell.

Dr. MCDOWELL. Let me make sure I understand the question. You are curious what the future research applications could be if there was support for them?

Mr. LUJÁN. Sure.

Dr. MCDOWELL. Yeah, I think what Dr. Hanson said was absolutely true, and in addition what we could really capitalize on, which is already a huge interest to American scientists from any agency or academic institution, is to have a network of sites such as those done by AmeriFlux, which you guys may have heard of earlier this year, that are monitoring climate impacts continuously over long time periods but that has done so in a coordinated way, and that is one of the great values of this network is, it can be coordinated. We can actually work together to make sure that we are documenting those changes. Likewise, the type of experiments that Dr. Hanson emphasized in his presentation could be done in a coordinated fashion throughout the park to allow us to actually provide the necessary understanding for future models of climate impacts as well as climate change models such as those that Dr. Bader referenced. And I am sure, I just want to also say that there are a lot of other things other scientists with other interests might also, you know, add to that list.

Mr. LUJÁN. Dr. Gibbons.

Dr. GIBBONS. Yes. In the area of biodiversity, I think habitat fragmentation is one of the major concerns of impacts on wildlife across the country, across the world, and the advantage of the National Environmental Research Parks is, these are contained units, very little disruption within them. I mean, the Savannah River site, 300 square miles, 80 percent of it is forestlands and wetlands and so we can determine there what is—what should the natural world be like compared to what it is in the surrounding areas and

the rest of the country. It is an excellent opportunity to do that kind of research.

Mr. LUJÁN. And along those lines, Dr. Gibbons and Dr. McDowell, you mentioned in your opening remarks the importance of public outreach and how there can be coordination within the community. I would, you know, point out the youthfulness of Dr. McDowell but the rather extensive knowledge that he also brings in the research that has been done. In both working with public schools or surrounding universities in the community where our laboratories or the parks reside, what can be done to be able to continue to work with them and with the surrounding community as well as providing an opportunity to be able to continue to recruit young scientists, to encourage them to get into this field as well?

Dr. GIBBONS. Our program involves bringing what we call ecologists for a day and bring students out every week twice a week to the site from different regional schools, spend all day measuring the environment the way ecologists do and in fact, the program fills up immediately the first day after Labor Day because all the schools want to come to this. That is one thing, and I think what it does, it gives the public in an area more confidence that they know what is going on out on this site, that children are out there, that programs are developed so they can visit, they can see the natural areas. Of course, they don't get around some of the areas, but the natural areas—it is an opportunity to teach children. Then, the next step up of course, it is for college students who have undergraduate programs and the other sites do as well where research opportunities for undergraduates to come in for internships and then of course the programs with graduate students that are available on most of the sites too.

Mr. LUJÁN. Thank you very much, Dr. Gibbons.

And Mr. Chairman, if I may ask Dr. McDowell, what I would ask is if on the next round of questions I can come back and get Dr. McDowell to respond to that question.

Chair BAIRD. Absolutely.

Mr. LUJÁN. Thank you, sir.

Chair BAIRD. We have been joined by Mr. Davis. Thank you, Mr. Davis, for your presence today. With that, I recognize Mr. Inglis for five minutes.

LAND REMEDIATION

Mr. INGLIS. Thank you, Mr. Chairman.

Dr. Gibbons, I am excited about the work that is going on at Savannah River and really it is quite a site. Three hundred square miles is a lot of area to do work in, and it is also a place where I guess we are taking the lemons that we have been given and turning them into lemonade. There is some trouble there in 300 square miles, and I wonder if you could elaborate on that. There is research on how to remediate, right, that is important work that is going on there that may have great contributions to really the whole world?

Dr. GIBBONS. I think remediation and restoration of areas like that are particularly important. Obviously the community wants to be assured that it is a safe place to live around, and there is admittedly low-level radionuclides, there are metal contaminations, other

contaminants on the Savannah River site. I think the important part is, most of them are localized and people on the site know where they are. The next step is, how do you contain them in terms of groundwater? And certainly there are people—some of the scientists at the site are involved in addressing that question. I think an important feature of a National Environmental Research Park like Savannah River is when you do have contaminated areas, you have next door to them on the same site uncontaminated areas that you can use as reference sites or controls to compare what should the habitat be like. This is what it is perhaps in a sense of contamination. This is what it should be like. And so that is one of the real advantages that research can be done to make those comparisons. I think there is a suite of scientists of different areas, Savannah River Ecology Lab, Savannah River National Laboratory, Forest Service, there are people in various categories that are examining different aspects of the habitats, of the problems, and I think one of the things we think is important is the public education. We want to let the public know what are we finding out, what is really happening out there, and that seems to be a very—that is the educational component I think a lot of people are very interested in.

Mr. INGLIS. For the benefit of my colleagues, I think we should mention that, I think it is, what, 35 million gallons of high-level liquid radioactive waste that we have had at the Savannah River site that we have got to deal with. We are dealing with it, vitrifying it in the plant there, right?

Dr. GIBBONS. That is absolutely right.

Mr. INGLIS. So 35 million gallons is going down every year but it is a serious matter.

Dr. GIBBONS. It is a major problem that is being dealt with, I think by people there as well as it can be.

Mr. INGLIS. Right, and it is also—you mentioned in your testimony that the Savannah River Ecology Lab may help us with the development of energy technologies. I wonder if you could elaborate on that?

Dr. GIBBONS. I think we are all interested in energy technologies, or most of us, and developing energy technologies, but I think many people these days also want to know that the environment is safe while we are doing it. I think what Savannah River Ecology Laboratory scientists do is, we look at the environment, look at impacts on the environment by different activities and can come up with recommendations for how can it be done better or is it being done properly. Can we do a better job environmentally as well as technologically?

Mr. INGLIS. Thank you.

Thank you, Mr. Chairman.

FUNDING SOURCES AND PARK ACTIVITY

Chair BAIRD. I will recognize myself for five minutes.

Talk to us a little bit about how it is determined what research gets done and where the funding is. You have each got jurisdiction over a different park or are involved with this. Who decides what studies are done and where does the funding come from? Is it at

NSF or is it out of the DOE budget, a combination? How does it work out? Dr. Hanson?

Dr. HANSON. Most of our research is funded through the federal good graces, of course. The Department of Energy provides the vast majority of research funds on the National Environmental Research Parks but NSF, USDA and EPA in times past, or for specific projects, have also provided funds. The National Science Foundation through their National Ecology Observation Network is targeting a wildland site on the Oak Ridge Reservation for long-term monitoring that would benefit from the legislation that is on the table. Specific projects have been funded and developed through initiatives sponsored by the agencies and the Program for Ecosystem Research, the Terrestrial Carbon Processes program, both within the Office of Science, and they have been very good at identifying what kind of projects scientists might deploy in the protected and available lands of the research parks.

Chair BAIRD. Thank you.

Dr. McDowell.

Dr. MCDOWELL. I would just like to add to Dr. Hanson's comment, which I fully agree with and it is very similar for Los Alamos what he said. I would just like to add that in terms of who decides what is actually done, that is both a strength and a weakness of the current system because the creativity of the principal investigator such as Paul or myself is what drives what decides gets done to a large degree. That is great, because we are creative, but that is bad because there is no formalized integration between us that we would like to have, so it is like having a lot of smart people not necessarily working together in a scenario.

Chair BAIRD. That actually raises a related line that I wanted to ask. Dr. Bader, you have talked about the need to improve climate models, and one of my questions would be, do you see a role for these parks, and how does your modeling work relate to the kind of research that might be done at these parks?

Dr. BADER. Well, the modeling is going through a transformation right now. We documented that there is climate change and now we have to understand what the impacts of that climate change are, so the questions for the models became a lot harder, and one of the reasons I moved from Livermore to Oak Ridge is because we are trying to do the other scenario. We are trying to understand what is going on at these scales and then bring them up to the models, so they perform two roles. They are laboratories for us to understand at the process level what needs to be included into the models, and at the other end they, as both my colleagues to the left and right have pointed out, they are validators of impacts of what the models produce and their results to see if they can get it right, so they serve both those purposes.

Chair BAIRD. Thank you. You know, we marked up last week in this committee a National Climate Service bill and it strikes me that the kind of research you are doing and the kind of modeling you are doing is synergistic and should interact very closely with the National Climate Service in a very constructive feedback loop as they seek questions of the specificity that you are referring to, Dr. Bader, and as they have laboratories such as we have in these parks. This is a stupid question because I think I pre-know the an-

swer but what is the funding situation for the parks as part of the DOE budget? Is it a—if I say is it adequate, let me guess the answer. But talk a little bit about funding and where it resides within DOE.

Dr. MCDOWELL. To my knowledge, there is none.

Dr. GIBBONS. I would say there is no funding now.

Chair BAIRD. So how do you run the parks?

Dr. GIBBONS. Well, the parks run themselves as long as they stay there. I think the parks are used as places to study and to develop energy technologies.

Chair BAIRD. One of the strange virtues of this is—they were created sort of incidentally as buffer zones for the labs and then protected by security for that purpose, and in so doing we inadvertently but quite happily have created a natural laboratory which is at virtually no cost. One could imagine if someone came and said we want the Congress to authorize a 300-square-mile research park. People would be up in arms. But here we have done that and we are able to benefit from the results. It is a happy side effect and I am fortunate that people like Mr. Luján and you gentlemen have recognized its merit.

I will recognize Ms. Giffords for five minutes.

Ms. GIFFORDS. Thank you, Mr. Chairman. Mr. Davis, an appropriator, has a meeting in 10 minutes so I am going to yield my time to him.

Chair BAIRD. Always wise to yield to appropriators.

ENVIRONMENTAL DEGRADATION AND WATER STUDIES

Mr. DAVIS. I will be very brief and not use the allotted time and will yield back my time, and Ms. Giffords, thanks very much, and Mr. Chairman and Ranking Member, thank you all for having this hearing today. I welcome Dr. Hanson. I just came from a meeting with several folks from Oak Ridge at the NEI conference here in D.C. I live in an area in the northern part of the plateau which you are very familiar with, and as I engage in dialogue with folks at the Big South Fork National River and Recreation area, about a 125,000-acre park, oftentimes I am reminded that the ecological system of the entire eastern United States has been totally disrupted as a result of the harvesting of timber, farming operations and others. Obviously mankind has to survive, but when I look at some of the photographs in places like Sterns, Kentucky, Huntsville, Tennessee, Jamestown over the years and see the huge piling of timber as they were basically cut down and then used for the expansion of American industry, the expansion of American growth, the home building, the factories and others—but I know the research you are doing dealt a lot with radiation and the area around the Oak Ridge Lab, but also you are doing some research on the impact on our sustainable forests in the area. I am just making a comment rather than a question. I am pleased to see these seven different locations where we are seriously looking at the impact of mankind on our environment. I applaud your work and hope that we can continue to fund at the level that is necessary to see that at least we know what we do as mankind on this Earth can have an impact on the future for our children. Thanks

for being here today and thanks for letting me just make a few brief comments. I yield back.

Chair BAIRD. Thank you, Mr. Davis, for your interest in this.

Ms. Giffords.

Ms. GIFFORDS. Thank you, Mr. Chairman. I applaud you for bringing these panelists together, a very interesting presentation. I come from southern Arizona. I notice in the map that unfortunately I am not in one of the NERPs. I am not sure how that happened because I have got the best District in the whole country with great environmental resources. But that being said, I would like to comment on being in the Colorado Rocky area last year where, driving for over an hour, I mean the horror of looking across the thousands and thousands of miles of acres of these beautiful pine trees that are now turning red and turning ashen gray and are dying, and I think about the fact that in Arizona we are suffering from a very prolonged drought. I think it is estimated that we have lost about a fifth of our forests due to infestation of bark beetles and these mega fires that are happening and what is happening with climate change in general. So I am curious if someone can talk specifically about the effects of climate and water. I know that there is the Los Alamos and also the southern Nevada NERP that exist, but I am wondering whether or not any of these facilities are specifically focused on the understanding of the hydrological cycle in the areas. And also, if someone could also tie in whether or not there is coordination. For example, at the University of Arizona, we have many eminent climate scientists specifically at the College of Science and whether or not there is that coordination and collaboration taking place.

Dr. MCDOWELL. Yeah, the Los Alamos Environmental Research Park originally was a hydrology study and it became from original funding to study radionuclide passage and they were worried about groundwater contamination, so that was the origin and that is why we—and then they happened to move into studying trees and that is why they just happened to document the water stress and the water aspects of tree mortality. I agree with you about Colorado. Skiing there is not quite what it used to be with all the dead trees, but—and that is happening all over the place right now. As for Arizona, you have—you indeed have some of the world's leading experts at the University of Arizona on this subject, and in fact, I talked about climate change-type drought. Well, that label came from Professor Bashirs at the University of Arizona. He actually used to sit in my office at Los Alamos before he came to Arizona. So there is a good collaboration. We don't have current funding to do that. You know, again, it is PI-driven-type research but there is a lot of dialogue. I mean, Dave and I e-mailed together last night about that. Paul?

Dr. HANSON. I just want to comment that the Nevada test site has hosted in the past precipitation studies in the arid system that is there along with elevated CO_2 studies complementary and specifically coordinated but also funded by the Department of Energy elevated CO_2 and precipitation studies on the Oak Ridge Reservation and similar observational work goes on at the Argonne National Lab. The point being that the Office of Science has funded a lot of these studies taking advantage of the NERP lands.

Chair BAIRD. I am going to let the gentlelady continue for two more minutes if she likes.

Ms. GIFFORDS. Thank you, Mr. Chairman.

THE STUDY OF RENEWABLE ENERGY SOURCES

I noticed from the testimony that a major focus of the NERPs seem to be to look at the traditional sources of energy, specifically fossil fuels, on the environment. We spent a lot of time in this committee talking about renewables. I am dedicated to particularly solar energy because of where I come from in Arizona and the potential that solar has for the desert Southwest. I know that there is a minimal environmental impact even on renewables that are supposed to be, you know, "clean." So I am curious whether or not there is any research happening at the National Environmental Parks on understanding and mitigating the environmental impacts of renewables as well, fossil fuels.

Dr. MCDOWELL. To my knowledge, that is not being done. I don't know if the other—my colleagues——

Dr. HANSON. No active on-the-ground research in the Oak Ridge Reservation, but a number of analyses have been looked at to determine what could be done with the National Environmental Research Park to provide some component of the energy needs of the Oak Ridge National Lab and surrounding DOE facilities. But I could look up more information on that if you would like.

Ms. GIFFORDS. No, I appreciate that.

Mr. Chairman, as we all know, as states and the country move towards a national renewable energy standard, we are going to be seeing a rapid increase, a ramping up of renewables and we don't quite understand them in this committee. In the Full Committee, I think during the markup, I wanted to include the studying of photovoltaics when it comes to recycling on a bill that we heard earlier. Unfortunately, it didn't get included but we need to know more about how these renewables are affecting our environment as well, so thank you.

Chair BAIRD. We do indeed, and Ms. Giffords, one of the interesting things about the die-off of trees in the Rocky Mountains is paradoxically, the legislation to prevent climate change does not currently allow most of those trees to be used as a renewable resource for energy production. Well, it allows it but there is no tax benefit. The mature, dead and diseased trees are excluded from the renewable energy and renewable fuels standards in the current bill moving before this Congress. I think it is a grave mistake and many of us are working to correct that. We have not been successful, however, instead we are going to let these dead trees turn into methane or carbon through forest fires rather than using them to heat homes and then replace them through reforestation, which to me is bad energy and environmental policy, but I thank the gentlelady.

Mr. Tonko is recognized for five minutes.

Mr. TONKO. Thank you, Mr. Chairman.

CLIMATE MODELING

Just rather quickly, some of you focused on the efforts to create the next generation of climate models, and just how is that being developed? Is it relying on that interagency climate change science program or are there ways that we can cultivate these new generations of models so as to take into account the dynamics that we need to?

Dr. BADER. The interagency climate change science program, you know, each—I worked at the Office of Science during the transition from the first Bush Administration to the Clinton Administration and from Clinton to the second Bush Administration, and that whole—as you know, that whole interagency activity kind of reshuffles at each of those and right now there is nothing to replace it that I am aware of, a reconfiguration of the interagency activity. Climate modeling is one of the true interagency parts of the U.S. climate change research program or the climate change science program, whatever incarnation you have, and does require cooperation. There has been several studies both National Research Council and then an OSTP-sponsored study that I was talking about, and I alluded to it in my testimony, the organization of the agencies to actually benefit—to produce climate models that really make use of all the capabilities, because it is a big problem and there is more than enough work for everybody to do. None of those recommendations seem to ever get past agency boundaries, you know, that kind of problem, even though at the level the technical workers were all cooperating very closely. So this is one of those things that you can't fault anybody for but it is the result of a lot of inertia in the system where you really need something different and there is lots of capabilities, there are lots of computer power but organizing that and structuring it and managing it is something that I feel and always will feel probably could be improved.

Mr. TONKO. When we talk about a next generation of climate models, is there an item or two that is most neglected or most ignored in that——

Dr. BADER. Two specific things that would be in the next generation. One is increasing resolution. Our climate models don't operate at the same resolution our weather prediction models operate now. We would like to get our climate models to be at high resolution, spatial resolution, resolve things like hurricanes and big thunderstorms. They don't do that now. That is one aspect. Or boundary currents in the oceans. The second thing is, we want to include the interactive carbon cycle which our colleagues are working on here so that we can drive the models not just with concentration scenarios but actual emission scenarios, so energy mitigation options being considered. So those are the two big areas, the incorporation of biogeochemical cycles and the increase in spatial resolution in both the atmosphere and the ocean and on land as well.

Mr. TONKO. And in terms of the value added to all that is done at your centers, how is any of the info or the assistance that is able to be provided to perhaps other situations across the country that, you know, gets extrapolated into that network? How does that happen? Is there a proactive quality to it or—I mean, there might be

great things that you are doing that might be useful to other applications.

Dr. BADER. Right. I mean, I think a good example of that is the organization I just left, PCMDI. We made the output available from the world's major climate modeling centers to thousands of people. High school kids actually would call me up because they couldn't figure out how to work with that amount of data but it is available to anybody who wants to access and use it, and at Oak Ridge one of the things that attracted me there, we are developing an information delivery system so when we run the models, that information can be first to the researchers but then to people who do impact analysis and things like that to make that information. The idea is for an end-to-end system, not just for the people doing the modeling but to deliver predictions and projections out to the broad range of users.

Mr. TONKO. And is there some sort of improvement that we can do from the Congressional perspective in order to make that more fluid, more effective?

Dr. BADER. I think that there are some pieces that require an infrastructure to do a lot of this work that don't lend themselves well to the traditional science research activities and you have to realize that there is—they talked about in many cases observational systems they call the Valley of Death between research to operations. A research paradigm doesn't work for operations but getting from one to the other requires a rethinking of the organizational paradigms on how you do this.

Mr. TONKO. Doesn't that seem to be the common overriding theme that we get caught in the prototype or whatever, the beginning stages, and it doesn't get followed through?

Dr. BADER. Right.

Mr. TONKO. And much of the R&D.

Dr. BADER. I think that is a problem. The Office of Science is a research-supporting agency, so taking that into the next step, there is nobody to pick it up in the ways it needs.

Mr. TONKO. So is it a structure or is it more a function of resources?

Dr. BADER. Both, but resources are needed but resources alone won't solve the problem.

Mr. TONKO. Thank you.

Chair BAIRD. The gentleman's time is expired, but I would just address that to some degree I think our climate service legislation, which we passed, has the potential to address this. As you may know, the mandate is for OSTP to convene the various agencies doing this relevant work and will have overriding entity to coordinate and perhaps address some of these questions, so I would invite Members of the Committee if they have a chance to offer suggestions regarding how that climate service should be structured, we would certainly welcome that input and I think Mr. Tonko has highlighted precisely one of the issues that we were trying to get at with that, and I think it has been affirmed by the panelists today, so excellent line of questioning, Mr. Tonko. Thank you.

Mr. Luján has asked for a second round. I am going to recognize myself for two quick questions, if I may. I want to clarify, whenever someone here in the Congress hears "establish a new park," a quite

understandable reaction is, we don't have enough money to pay for our existing parks. I think one of the points we want to make is, these are existing parks. We are just formalizing their existence. Is that a fair portrayal, Mr. Luján and to the witnesses? We are not asking for a bunch of new folks in Smoky Bear hats to go out. We are basically formalizing something that already exists.

Mr. LUJÁN. Mr. Chairman, that is absolutely correct and I think we heard from our witnesses today not only the importance of the parks but the established research, the establishment of the parks and how we can fully utilize them going forward to truly understand what can be done in remediation and research and ecology and environmental studies that will be critical into the future to help us better understand what is occurring today.

EVIDENCE OF CLIMATE CHANGE

Chair BAIRD. Thank you. I just wanted to clarify that so if it comes up and our colleagues ask, we have got that in the record.

Secondly, I just want to, for the benefit of the record also, is it— and I will ask each panelist just a very simple yes or no. It is your professional judgment that there is evidence, A, of climate change, and that B, that anthropogenic CO_2 and other greenhouse gas emissions are contributing to that?

Dr. HANSON. Yes.

Dr. BADER. Absolutely.

Dr. MCDOWELL. Yes.

Dr. GIBBONS. Yes.

Chair BAIRD. I thank that. I appreciate that. We periodically have Members of our committee who express some skepticism of that but, your combined professional—how many years have you been at this, Dr. Hanson?

Dr. HANSON. Twenty-three.

Chair BAIRD. Dr. Bader.

Dr. BADER. Twenty-four.

Chair BAIRD. Dr. McDowell.

Dr. MCDOWELL. Can I include my graduate school years to bump it up?

Chair BAIRD. Absolutely.

Dr. MCDOWELL. About 10.

Dr. GIBBONS. Forty-two.

Chair BAIRD. So we have got well over 100 years of experience. And one last part of this, have you examined the so-called skeptical arguments? Have you taken some time to look at these or are you only looking at the confirmatory evidence? Have you looked at some of the arguments of the skeptics? Dr. Hanson.

Dr. HANSON. I think the perspective is one of how science works. Projections of climate change today are what they are. Science will proceed. New findings will develop and they may shift the projections of what climate change might be in the future, but that is the nature of climate change. A shift in direction of a projection is not a reason to disbelieve what we believe is the current condition. It is simply a recognition of new understanding.

Chair BAIRD. Thank you.

Dr. Bader.

Dr. BADER. Yeah, I was the lead author for the CCSP Climate Modeling Report 3.1 and we actually had to take on—one of our committee oversight members was Dick Lindzen from Massachusetts[1] and we had to go toe to toe with him for about three months in the process. So, yeah, I do know their arguments. Most of them try to develop a greater uncertainty than actually exists and they exploit those uncertainties to a large degree to make their argument and try to present it as a balanced argument where really, even if you exploit those uncertainties, the evidence on the other side is overwhelming.

Chair BAIRD. So when one hears various points, well, what about this, solar flares, what about heating of Mars, what about blah, blah, blah, in most cases those questions have actually been answered satisfactorily?

Dr. BADER. Oh, yes. I mean, the simplest way to look at this is, you can't violate the first law of thermodynamics, and increasing greenhouse gases cause more energy to be trapped into the climate system, and when you trap more energy, you will increase its temperature. It is that simple, and a sophomore class in thermodynamics in college teaches everybody that.

Chair BAIRD. Dr. McDowell or Dr. Gibbons care to comment?

Dr. MCDOWELL. I would say yes, I have considered the alternative viewpoints certainly, but the bulk of the evidence that exists, perhaps you could—you know, anyone can look at the IPCC report of 2007—concludes quite strongly that there is a real anthropogenic effect on the climate which these guys have nicely summarized.

Chair BAIRD. Dr. Gibbons.

Dr. GIBBONS. I would agree with what Dr. McDowell says, and yes, I agree that all the evidence, all the objective evidence I have seen supports the anthropogenic effects.

Chair BAIRD. Thank you, gentlemen.

I recognize Mr. Inglis for five minutes.

Mr. INGLIS. Thank you, Mr. Chairman.

Dr. McDowell, in your testimony, following up on the Chairman's line of questioning, you pointed out that you are using your laser facility to determine if specific CO_2 emissions come from biological or from fossil fuel sources. I wonder if you can describe how you differentiate the two. It may go to helping some of those folks that are skeptical in the matter.

Dr. MCDOWELL. Yes, certainly I can do that. In our particular case, we have a laser facility which measures the isotopic composition of atmospheric CO_2. The isotopic composition of atmospheric CO_2 is controlled by a number of factors. The two biggest factors we can say right now globally as well as locally at my site are the biology of the terrestrial ecosystems, which has a major effect on that isotopic composition, and fossil fuels. So fossil fuels are simply dead plants from a long, long time ago and so they have an isotopic composition characteristic of plants. Now, natural gas in particular has a very distinct isotopic composition. It is very different than the ecosystems that exist today over most of the Earth. A natural gas-burning plant slightly—it is about six kilometers away from

[1] Massachusetts Institute of Technology

my facility, just slightly uphill, so at night as CO_2 drains down the landscape, we can actually see that signal. So in the winter when there is very high fossil fuel emissions, we almost only see the signature of fossil fuels. In the summer when the gas plant is virtually turned off, it is a very low level, we only see signatures that are characteristic of the ecosystems. This same sort of technology is actually applied at the global scale, particularly by NOAA, who makes these measurements around the world. Does that help?

Mr. INGLIS. That is very interesting, yes. You really can tell the difference. And the signature is—and I am not a scientist so you are going to have dumb this down to get it where I can understand it. What does the signature look like that is different? It reflects light differently or something when it is hit with the laser?

Dr. MCDOWELL. Yeah, that would be correct. It is an absorption process and so the laser has different peaks it can shift to, and there is absorption of the different isotopologs, we would call them, C1202 or C1302, these different isotopes, isotopologs, and it does pick them up, yeah.

Mr. INGLIS. Interesting.

Dr. MCDOWELL. Yeah. This technology is fairly unique at Los Alamos because it is very rapid. We have a very fast system that is very accurate. However, slower but just as accurate systems are run by NOAA and other organizations to allow us to do this around the world.

Mr. INGLIS. I would be happy to yield to the Chairman.

Chair BAIRD. So what you are saying to us is that you have technology that allows us to tell where the carbon in the atmosphere came from, whether it was anthropogenic, through burning of fossil fuels or whether it was a natural mechanism of respiration from ground, for example, release from agriculture or some other source?

Dr. MCDOWELL. That is correct. I would only add that I am not the only one, but yeah.

Chair BAIRD. But this technology exists so that——

Dr. MCDOWELL. Yes.

Chair BAIRD.—when people say "yes, I understand that the climate may be changing, I just don't think anthropogenic factors are the cause of that," you have a mechanism to say what percentage of the greenhouse gases, at least CO_2 in this case, are from anthropogenic and what may be from natural processes?

Dr. MCDOWELL. Our society does have that capability.

Mr. INGLIS. Dr. Bader, do you want to add something to that?

Dr. BADER. Yeah, at Lawrence Livermore there is—the Center for Accelerator Mass Spectrometry does similar type measurements on samples taken from the air and from water that can then do the isotopic analysis on the source of carbon, so besides the lidar-type measurements, there is other instruments that can differentiate natural versus fossil fuel carbon.

Mr. INGLIS. Dr. Bader, it is interesting, when you mentioned the second law of thermodynamics being applicable here, is that just—maybe—I am trying to think, when people are skeptical about that and they say that maybe it is not caused—it is a natural effect and therefore it is just—it can't be controlled in any way by human intervention, in other words, you can't change it, it is just what it is is what it is. How would you respond to that?

Dr. BADER. Well, I mean, so the theory of greenhouse gas warming is well over 100 years old. It was first presented at the London society meeting. You know, nobody debates the fact that if you put more carbon dioxide into the air, that you will trap more infrared energy. So that is where the first law of thermodynamics comes in. So while you are increasing your concentrations of carbon dioxide, you are putting in something that will decrease the amount of infrared radiation emitted and you are still getting the same amount of solar coming in. So for a while, you are going to have more energy coming into the Earth than going out, and that is where the first law of thermodynamics applies. When you add more energy than you emit, then you are going to heat up and eventually the planet will heat up to the point, if the concentrations stay constant, that it will start emitting infrared energy at the level it needs to be balanced and it will stop warming. That takes several hundred years if you stopped changing concentrations today. The science behind this is irrefutable. The theory behind it has never been assaulted. What they try to do is obfuscate the basic theory with a bunch of other things that don't matter.

Mr. INGLIS. And I guess the models can be poked at, right? I mean, you can—it is an enormously complex system, the Earth's climate system, so you can poke at various points on those models, right?

Dr. BADER. You can, but I mean, so what we try to do, though, the first thing we try to do is make sure the global model does the right things globally, and up until a few years ago these models used to what we call "drift." You will put a model together, a very complex, highly, what we call nonlinear so there are lots of feedbacks and it wouldn't look like the Earth's climate, but they have gotten good enough. That is what I referred to. We are able to do very good simulations of the 20th century climate. We are only able to do those if we add anthropogenic greenhouse gases to the time history of concentrations in the atmosphere. If we don't do that, the planet does not warm as observed and so the models are complex, but in some ways the system itself works as you would expect it to.

Mr. INGLIS. Thank you.

Thank you, Mr. Chairman.

Chair BAIRD. Thank you, Mr. Inglis.

Mr. Luján.

MORE ON REMEDIATION

Mr. LUJÁN. Thank you, Mr. Chairman, and again, Ranking Member Inglis. Again, what a great line of questioning. You know, I almost wanted to yield more time, Mr. Chairman, but I know you can allow yourself as much time as we may need.

I want to get back to the line of questioning around remediation and the work and the research that is specifically taking place within each of our parks which can help us better understand how we can do better on the true need for support for restoration or remediation around our national laboratories and anywhere else in the country or, for that matter, the world that may need some help. Dr. Gibbons, if we could start with you and then maybe Dr. McDowell.

Dr. GIBBONS. Okay, the question being, what do we need to do in terms of remediation or why do we need remediation?

Mr. LUJÁN. How do the designations of the national parks allow us to better understand this going forward to be able to make progress in this area? And then the follow-up question I would have is, you know, is the remediation program within DOE adequately supported today? That would be my follow-up but we can address those together.

Dr. GIBBONS. Yeah. Well, the remediation program in DOE is supported in a variety of different ways to different organizations who do different parts. I think the important part from the National Environmental Research Park designation is that you keep these lands intact so that there is no loss of these lands, for instance, the periphery, until the remediation is complete or at least underway or identified what needs to be done where, and do we have the reference area control sites in comparative areas to make sure the remediation has been accomplished, and the remediation covers a host of different aspects, as you would know. One is, do you get rid of radionuclides that are in a habitat or do you manage to contain them and live with them there? There are just many different components and I think the important thing is to keep the land intact at all these areas that have contaminants to be sure that—that is one reason for, I think, keeping the integrity of the sites. As far as the funding, I can't—it varies so much. I am sure you would have to talk to different people about—most people will tell you they never have enough funding.

Mr. LUJÁN. And Dr. Gibbons, can you also touch upon how this can assist us with remediation or restoration of areas where we may have abandoned uranium mines throughout the country? I know that we have some in my District around the Navajo Nation.

Dr. GIBBONS. Well, I am not sure I can—well, I guess you can—by doing remediation at one site, you can certainly learn what to do at other sites. It can be applicable to other areas. I am not—my uranium background is pretty sparse, so I would probably have to defer to someone else about that, specifically.

Mr. LUJÁN. Thank you, Dr. Gibbons.

Dr. MCDOWELL. Congressman Luján, I can—I am in a similar situation as my colleague but I can say that—I will say that for the record the part about the funding in particular and get back to you. Regarding the quality of—I mean, I do—I can say this, that I have colleagues and friends at Los Alamos who study environmental remediation and who have done very, very high-impact work that has done a lot for Los Alamos and for their individual careers and for their groups at the lab, both in terms of bringing in additional funding for pure science as well as applied science, and I know that they have—universally when I speak with them, they say that they couldn't do it without the preservation of the landscape and the ability to make the measurements that they need to make on the landscape, so they are very dependent on the National Environmental Research Park. Regarding the funding, I would like to respond to you for the record later.

Mr. LUJÁN. Thank you, Mr. Chairman. I yield back my time.

Chair BAIRD. I thank you, Mr. Luján. Again, I want to thank Mr. Luján for recognizing the importance of this marvelous resource

that we have. I thank the witnesses for their insightful testimony and for their ongoing scientific research. With that, I would also indicate that the record will remain open for two weeks for additional statements for the Members and for answers to any follow-up questions the Subcommittee may ask of the witnesses. I thank the witnesses. It has been a most insightful round of testimony and I hope we have the opportunity to share the transcript with some of our colleagues who I think will find some of the testimony very enlightening.

Again, I thank the witnesses for their experience, and with that, the hearing stands adjourned. Thank you very much.

[Whereupon, at 11:20 a.m., the Subcommittee was adjourned.]

Appendix 1:

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Nathan G. McDowell, Staff Scientist and Director of the Los Alamos Environmental Research Park, Los Alamos National Laboratory

Question submitted by Representative Ben R. Luján

Q1. In your opinion, is DOE's environmental remediation program adequately supported, and are there any ways you believe this program could be improved?

A1. I appreciate the importance of environmental remediation at LANL and throughout the DOE complex. LANL's environmental remediation work is funded by DOE Environmental Management. There have rarely been sufficient funds to meet the goals of environmental remediation because environmental remediation is extremely challenging and the cleanup goals are hard to achieve. Environmental remediation at LANL has received $1.4 Billion since 1991, however, which contrasts with ecological impacts of climate change, which has received $0.

Appendix 2:

Additional Material for the Record

I

111TH CONGRESS
1ST SESSION

H. R. 2729

To authorize the designation of National Environmental Research Parks by the Secretary of Energy, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

JUNE 4, 2009

Mr. LUJÁN introduced the following bill; which was referred to the Committee on Science and Technology

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A BILL

To authorize the designation of National Environmental Research Parks by the Secretary of Energy, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. FINDINGS.

Congress finds the following:

(1) The National Environmental Research Parks are unique outdoor laboratories that provide opportunities for environmental studies on protected lands around Department of Energy facilities.

(2) In 1972, the Atomic Energy Commission established its first official environmental research park at the Savannah River site in South Carolina.

(3) In 1976, the Department of Energy defined the mission for the research parks in accordance with the recommendations of the multiagency review team for environmental research activities at the Savannah River site.

(4) The mission of the research parks is to—

(A) conduct research and education activities to assess and document environmental effects associated with energy and weapons use;

(B) explore methods for eliminating or minimizing adverse effects of energy development and nuclear materials on the environment;

(C) train people in ecological and environmental sciences; and

(D) educate the public.

(5) The seven National Environmental Research Parks are located within six major ecological regions of the United States, covering more than half of the Nation.

(6) The parks are especially valuable research sites because within their borders they provide se-

cure settings for scientists to conduct long-term research on a broad range of subjects including—

(A) plant succession;

(B) biomass production;

(C) population ecology;

(D) radioecology;

(E) ecological restoration; and

(F) thermal effects on freshwater ecosystems.

(7) The parks maintain several long-term data sets that are available nowhere else in the United States or in the world on amphibian populations, bird populations, and soil moisture and plant water stress. These data sets are uniquely valuable for the detection of long-term shifts in climate.

(8) The maintenance of these parks by the Department of Energy is consistent with statutory obligations to promote sound environmental stewardship of Federal lands and to safeguard sites containing cultural and archeological resources.

(9) Public education and outreach activities carried out on these sites provide unique learning opportunities, promote a stronger connection between these Federal facilities and the surrounding communities, and enhance public confidence that the De-

partment of Energy is fulfilling its environmental stewardship responsibilities.

SEC. 2. NATIONAL ENVIRONMENTAL RESEARCH PARKS.

(a) DESIGNATION.—The Secretary of Energy shall designate the seven National Environmental Research Parks located on Department of Energy sites, including—

(1) the Savannah River National Environmental Research Park;

(2) the Idaho National Environmental Research Park;

(3) the Los Alamos National Environmental Research Park;

(4) the Fermi Lab National Environmental Research Park;

(5) the Hanford National Environmental Research Park;

(6) the Oak Ridge National Environmental Research Park; and

(7) the Nevada National Environmental Research Park,

as permanent protected outdoor research reserves for the purposes of conducting long-term environmental research on the impacts of human activities on the natural environment.

(b) PURPOSES.—Each site shall support environmental research and monitoring activities as well as public outreach and education activities to characterize and monitor present and future site conditions, and serve as control areas for comparison with environmental impacts of Department of Energy land management, energy technology development, remediation, and other site activities outside the National Environmental Research Park areas. Areas of research and monitoring on the sites shall include—

(1) ecology of the site and the region;

(2) population biology and ecology;

(3) radioecology;

(4) ecosystem science;

(5) pollution fate and transport research;

(6) surface and groundwater modeling; and

(7) undergraduate and graduate student training.

(c) COOPERATIVE AGREEMENT.—To ensure the independence of the research, monitoring, public education, and outreach activities conducted on each site, the Secretary shall enter into a cooperative agreement with a university or consortium of universities with expertise in ecology and environmental science of the region in which the National Environmental Research Park is located.

(d) ENVIRONMENTAL EDUCATION AND OUTREACH.—Each site shall support an outreach program to inform the public of the diverse ecological activities conducted at the park and to educate students at various levels in environmental science. Program activities shall include—

(1) on-site and in-classroom education programs for elementary and secondary students;

(2) presentations to school, civic, and professional groups;

(3) exhibits at local and regional events;

(4) development of educational projects and materials for students at all levels;

(5) undergraduate internship and graduate research opportunities; and

(6) regularly scheduled public tours.

(e) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary of Energy for carrying out this section $35,000,000, including $5,000,000 for each National Environmental Research Park, for each of the fiscal years 2010 through 2014.

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