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Wyoming Landscape Conservation Initiative Science and Management Workshop Proceedings, May 12–14, 2009, Laramie, Wyoming

Scientific Investigations Report 2010–5067

U.S. Department of the Interior
U.S. Geological Survey

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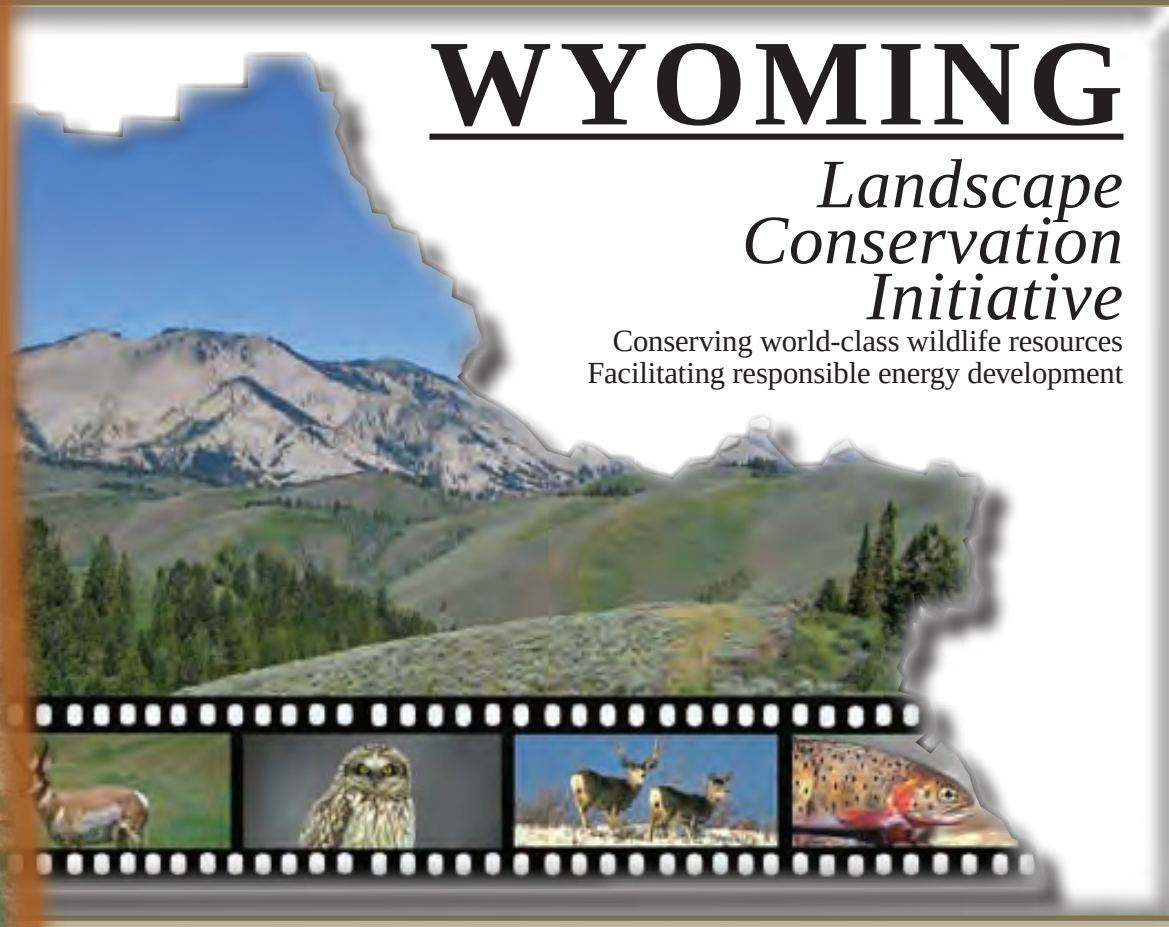
Edited by Vito F. Nuccio and Frank D'Erchia
Compiled by K. Parady and A. Mellinger



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U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia: 2010

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Preface

The Wyoming Landscape Conservation Initiative represents the U.S. Geological Survey partnership with other Department of the Interior bureaus, State and local agencies, industry, academia, and private landowners committed to maintaining healthy landscapes, sustaining wildlife, and preserving recreational and grazing uses while developing energy resources in southwest Wyoming.

Our Nation is involved in many endeavors to move toward energy independence. One landscape that has seen an accelerating increase in development is southwest Wyoming. This area contains an estimated 85 trillion cubic feet of recoverable natural gas, one of the largest concentrations in the United States. Southwest Wyoming also encompasses some of the highest quality terrestrial and aquatic wildlife habitats in the Intermountain West. To help ensure sustainability of these important habitats while facilitating responsible development, Federal, State, and local agencies have embarked on a partnership known as the Wyoming Landscape Conservation Initiative (WLCI). The U.S. Geological Survey (USGS) has become an active partner in the WLCI, providing important scientific data and information to decisionmakers and land managers through research and monitoring.

The USGS and the WLCI Science and Technical Advisory Committee sponsored the Science and Management Workshop in Laramie, Wyo., May 12–14, 2009. The workshop addressed the scientific findings that have yielded efficient management actions in the WLCI area, highlighting scientific and management activities since the preceding WLCI workshop in May 2007 (http://pubs.usgs.gov/sir/2008/5073). Many organizations are conducting science in southwest Wyoming, and the workshop provided an opportunity to hear from them about their activities.

The WLCI continues to be a positive force in the effort to assess, monitor, and enhance aquatic and terrestrial habitats at a landscape scale in southwest Wyoming. Perhaps most importantly, this initiative will also serve as the foundation for future efforts in other landscapes as the models, protocols, and technologies developed will be transferable to other areas where energy development is occurring or planned.

Participating Organizations

Principal Partners

Bureau of Land Management, Wyoming

County Commissioners representing Lincoln, Uinta, Sublette, Sweetwater, Carbon, and Fremont Counties

Conservation Districts representing Lincoln, Little Snake River, Popo Agie, Saratoga-Encampment-Rawlins, Star Valley, and Sublette County

U.S. Fish and Wildlife Service, Mountain-Prairie Region

U.S. Forest Service, Regions 2 and 4

U.S. Geological Survey

Wyoming Game and Fish Commission

Wyoming Department of Agriculture

Additional Cooperators Include

National Park Service, Intermountain Region

Natural Resources Conservation Service, Wyoming

U.S. Bureau of Reclamation, Upper Colorado Region

Wyoming Department of Environmental Quality

Wyoming State Land Board

This report summarizes discussions at the Wyoming Landscape Conservation Initiative (WLCI) Science and Management Workshop. This event was cosponsored by the U.S. Geological Survey (USGS) and the WLCI partners. Comments made by speakers not affiliated with the USGS do not necessarily reflect the positions of the USGS.

Contents

Acknowledgments

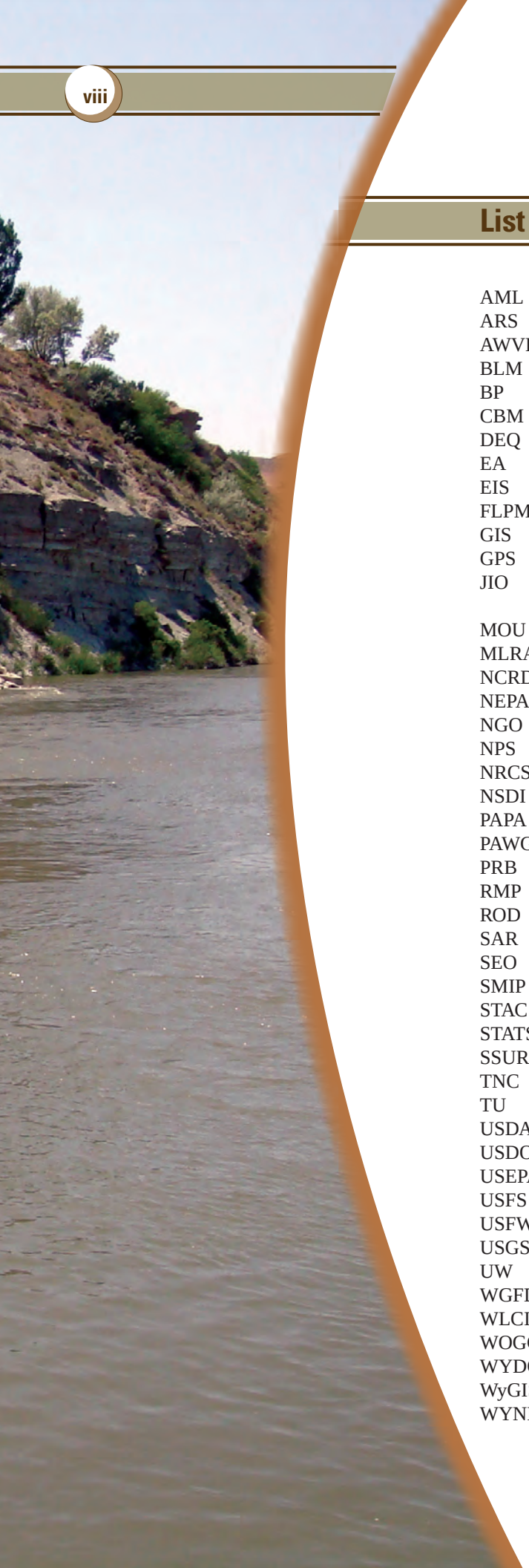
Many thanks to all of the partners who attended the WLCI Science and Management Workshop and actively participated throughout the sessions. Special appreciation is due to those who helped organize this critical stakeholder forum, facilitating the panels and breakout groups and assisting in writing sections of this report.

The WLCI Science and Technology Advisory Committee and the Coordination Team members (see app. 5 for names of members) spent many hours prior to and during the workshop to make it a success, and they deserve recognition for their efforts.

Thank you to Dave Ozman for arranging for the media briefings and to Reg Rothwell and our partners at the Wyoming Game and Fish Department for their generous financial support for the publication of this report. And thank you to the USGS Enterprise Publishing Network Publishing Service Center in Lafayette, La., for superb production support: Beth A. Vairin, Christina C. Boudreaux, and Victoria Chachere Jenkins.

Finally, a very special thank you to staff at the Ruckleshaus Institute of Environment and Natural Resources at the University of Wyoming, Laramie, especially Jill Lovato for moderating and leading the team. Ruckleshaus staff provided exemplary support in facilitating and recording the presentations and discussions at the workshop and did an excellent job preparing the draft summary workshop report. Thank you to Courtney Carlson (note-taking), Diana Hulme (facilitation), Abby Mellinger (note-taking), and Katelyn Parady (facilitation/note-taking/draft report).

Katelyn Parady, Abby Mellinger, Courtney Carlson, Jill Lovato, Diana Hulme, and Teal Wyckoff



List of Commonly Used Abbreviations

AML	Abandoned Mine Lands
ARS	American Range Society
AWVED	Assessment of Wildlife Vulnerability to Energy Development
BLM	Bureau of Land Management
BP	British Petroleum
CBM	Coal bed methane
DEQ	Department of Environmental Quality
EA	Environmental assessment
EIS	Environmental impact statement
FLPMA	Federal Land Policy and Management Act
GIS	Geographic information systems
GPS	Global Positioning System
JIO	Jonah Interagency Office (Jonah Interagency Mitigation and Reclamation Office)
MOU	Memorandum of understanding
MLRA	Major Land Resource Area
NCRDS	National Coal Resource Data Systems
NEPA	National Environmental Policy Act
NGO	Nongovernment organizations
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NSDI	National Spatial Data Infrastructure
PAPA	Pinedale Anticline Project Area
PAWG	Pinedale Anticline Working Group
PRB	Powder River Basin
RMP	Resource management plan
ROD	Record of decision
SAR	Sodium absorption ratio
SEO	State Engineer's Office
SMIP	Science management implementation plan
STAC	Science and Technical Advisory Committee
STATSGO	State Soil Geographic Database
SSURGO	Soil Survey Geographic Database
TNC	The Nature Conservancy
TU	Trout Unlimited
USDA	United States Department of Agriculture
USDOI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UW	University of Wyoming
WGFD	Wyoming Game and Fish Department
WLCI	Wyoming Landscape Conservation Initiative
WOGCC	Wyoming Oil and Gas Conservation Commission
WYDOA	Wyoming Department of Agriculture
WyGISC	Wyoming Geographic Information Science Center
WYNDD	Wyoming Natural Diversity Database

Wyoming Landscape Conservation Initiative Science and Management Workshop Proceedings, May 12–14, 2009, Laramie, Wyoming

Edited by Vito F. Nuccio[1] and Frank D'Erchia[1]
Compiled by K. Parady[2] and A. Mellinger[2]

Executive Summary

The U.S. Geological Survey (USGS) hosted the second Wyoming Landscape Conservation Initiative (WLCI) Science and Management Workshop at the University of Wyoming Conference Center and Hilton Garden Inn on May 12, 13, and 14, 2009, in Laramie, Wyo.

The workshop focused on six topics seen as relevant to ongoing WLCI science and management activities:

- mapping and modeling resources for decisionmaking;
- data information and management;
- fish and wildlife research;
- changing landscapes;
- monitoring; and
- reclamation and offsite mitigation.

Panelists gave presentations on ongoing research in these six areas during plenary sessions followed by audience discussions. Three breakout groups focused on discussing wildlife, reclamation, and monitoring.

Throughout the plenary sessions, audience discussions, and breakout groups, several needs were repeatedly emphasized by panelists and workshop participants:

- developing a conservation plan and identifying priority areas and species for conservation actions;
- gaining a deeper understanding of sagebrush ecology;
- identifying thresholds for wildlife that can be used to create an "early warning system" for managers;
- continuing to collect basic data across the landscape;
- facilitating even greater communication and partnership across agencies and between scientists and land managers; and
- engaging proactively in understanding new changes on the landscape such as wind energy development and climate change.

Detailed proceedings from the workshop are captured and summarized in this report.

Introduction

Now in its third year of funding, the Wyoming Landscape Conservation Initiative (WLCI) is a long-term, science-based initiative operating in southwest Wyoming. The WLCI's ultimate goal is to assess and enhance the aquatic and terrestrial habitats of southwest Wyoming on a landscape scale while facilitating responsible energy development and other anthropogenic drivers of change. Recently expanded, the boundaries of the WLCI encompass the entirety of Carbon, Lincoln, Sublette, Sweetwater, and Uinta Counties, as well as areas in Fremont County that are in the Great Divide and Green River Basins.

Within these areas, the WLCI's partners are focused on (1) collecting baseline science information to assess what is already known about southwest Wyoming's ecosystems, (2) conducting monitoring and research, and (3) developing methods for archiving and disseminating data to collaborators and the public. This landscape-level approach to science-based resource management and science-based decisionmaking is strongly supported by the U.S. Department of the Interior (USDOI).

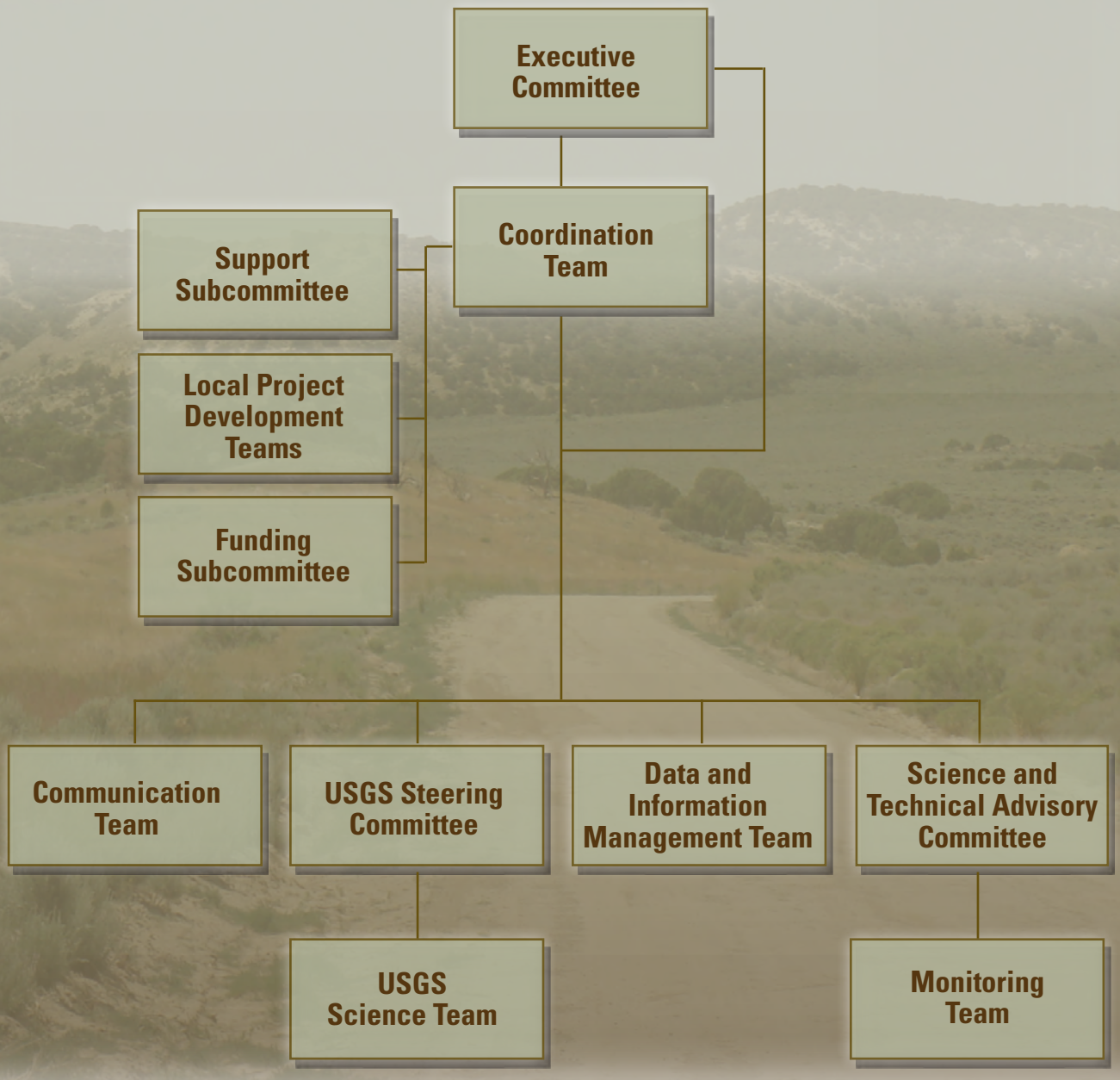
To further advance these objectives, the U.S. Geological Survey (USGS) hosted the WLCI's second Science and Management Workshop in Laramie, Wyo., in May 2009. Facilitated by the University of Wyoming's William D. Ruckelshaus Institute of Environment and Natural Resources, the workshop was attended by over 135 people. Participants gave and listened to plenary session presentations, engaged in dialogue about the presentations, and participated in breakout groups. Breakout group participants were tasked with identifying science and technology needs related to fish and wildlife, monitoring, and reclamation; science activities that could benefit on-the-ground management activities; ways to integrate science and management to benefit adaptive management; and the components of the WLCI that are the most valuable to scientists, managers, the public, and other stakeholders.

[1] U.S. Geological Survey, Denver, Colo.

[2] University of Wyoming, William D. Ruckelshaus Institute of Environment and Natural Resources, Laramie, Wyo.

Organization

With help from other WLCI collaborators, the USGS organized the 3-day workshop and oversaw the call for abstracts. Plenary session presentations were organized around six primary topics, with discussion following each panel of presenters. After listening to presentations and participating in discussions, participants chose to attend one of three breakout groups—reclamation, monitoring, or wildlife—or a demonstration session on data modeling. A representative from each breakout group reported back to a final plenary session, and workshop participants discussed the priorities emerging from breakout sessions.



Explanation and Disclaimer

These proceedings, which were developed from notes taken during the workshop, capture what the speakers said in their own words. Hence, it does not read like a typical written report. Effort was made to clarify some of the jargon and unclear points, but for the most part, the following represents the speakers' presentations and the audiences' questions and comments.

Plenary Session 1

WLCI Background and Overview Presentations

Presenters

John Linn, Sublette County Commissioner

Max Ethridge, USGS

Brian Kelly, U.S. Fish and Wildlife Service (USFWS)

Panel Presentations

Southwest Wyoming is a nexus of critical wildlife habitat, vast energy resources, and agricultural operations. Panelists in the first plenary session reviewed the role of the WLCI and its collaborating partners in managing these resources.

The role of the USGS in the WLCI partnership is to provide science on which resource managers can base decisions. Originally funded through the Healthy Lands Initiative, WLCI projects in 2009 underwent a budget cut. The budget is expected to be restored in 2010 under the Sustainable Energy Development initiative, a renamed program which will continue to support the USGS partnership with State and Federal bureaus committed to maintaining healthy landscapes and preserving wildlife and grazing uses while developing natural gas in the Green River Basin.

The USGS is not alone in providing science information for the WLCI. The WLCI science vision emerged in 2006 from conversations between former director of the Wyoming Game and Fish Department (WGFD) Terry Cleveland and the late Bob Bennet, former State director of the Wyoming Bureau of Land Management (BLM). With the approval of the national directors of the BLM and the USFWS, the agencies embarked on a course to landscape-scale resource management in Wyoming.

The panelist from the USFWS urged WLCI collaborators to further that vision and think about strategic landscape conservation. By strategically picking priority species such as sage grouse—a species with broad ownership, local involvement, a State government strategy, an abundance of data, and an association with many sagebrush obligate species—and designing outcomes for those species, agencies will be able to conduct conservation on the landscape in a way that ensures conservation achievements.

New to the WLCI partnership are county commissions. Communities across southwest Wyoming are historically tied to energy development and related boom and bust cycles. Current energy activities—including conventional oil and gas, oil shale, and wind energy—can be disconcerting to people in the region who deal with the socioeconomic consequences of boom and bust economies. Like scientists, community members and local governments are urgently trying to react to these issues. Decisions based on unbiased and complete science will be significant to the lives of people living in southwest Wyoming.

Plenary Session 2

WLCI Foundations for Science-Based Conservation

Session Leads

Renee Dana, BLM

Pat Anderson, USGS

Presenters

Zack Bowen, USGS

Renee Dana, BLM

Dan Blake, USFWS

Cay Ogden, National Park Service (NPS)

Jay Hestbeck, USGS

Susan Patla, WGFD

The science research approach of the WLCI is built around the first Science and Management Workshop. The USGS used outcomes from that workshop to create a science strategy for the WLCI (available at www.wlci.gov). Panelists in the second plenary session emphasized the support offered by the Coordination Team, the Science and Technical Advisory Committee (STAC), the Monitoring Team, and various subcommittees of the WLCI for the science strategy.

Plenary Session 2

Panel Presentations

Working at a landscape scale includes building local collaborations and facilitating communication among partners, the public, and other stakeholders to help plan on-the-ground conservation actions that further the WLCI's science goals. The Coordination Team regularly works with Federal and State agencies, conservation groups, private landowners, the University of Wyoming (UW), and more recently members of industry. Local project development teams have been created to engage local biologists, range managers, conservation districts, landowners, and others in helping the WLCI with the conservation planning process. Working with these local partners, the Coordination Team is trying to identify high-priority areas and associated species, translate priorities into areas of habitat projects, and tie local projects into the larger context of the WLCI.

The STAC is also working to advance the WLCI's science goals, creating a science and management implementation plan (SMIP) to guide them and conducting periodic reviews of science and management to identify opportunities for better integration. STAC representatives emphasized the work that is being done to synthesize baseline data, conduct targeted research and monitoring, and integrate science into decisionmaking and evaluation. Progress has been made on WLCI science goals, including the development of conceptual ecologic models for southwest Wyoming, the development of methods for looking at landscape-level change, and assessments of how to prioritize wildlife needs in the context of energy development.

Long-term monitoring is also progressing through the use of effectiveness monitoring and mechanistic studies. Only a few months old, the Monitoring Team has draft plans for a monitoring framework that will occur at varying spatial and temporal scales, be a fundamental element in the integration of science and management, provide information on the status and trends of the environment (as well as the effectiveness of WLCI management and restoration efforts), and develop monitoring practices that are already in place.

Finally, conservation actions are ongoing. A prime example of an on-the-ground project is the WGFD Trumpeter Swan Green River Range Expansion Project. Beginning several decades before the WLCI, the project is an example of a long-term, science-based, landscape-level initiative that has seen great success.

Audience Discussion

Audience members expressed concern that panelists focused on narrow questions of habitat enhancement and preservation while ignoring the larger questions of oil and gas development. Panelists explained that the way the WLCI has evolved has led to an emphasis on habitat projects; however, efforts are ongoing to research and support a broader range of issues, such as human health concerns, in an oil and gas context. Workshop participants also questioned the degree to which WLCI projects have provided a counterbalance to habitat losses inside project areas. Responses from the panel emphasized that the WLCI is not a mitigation initiative and not an alternative to fulfilling resource management plans (RMPs). WLCI projects will provide offsets, but more time and resources are needed before direct benefits will be identifiable.

Finally, audience members suggested that developing a clear plan for how best to manage sagebrush habitat should be a priority for the WLCI. Work is ongoing to prioritize and fill in data gaps, and once the necessary science information is available, the WLCI will work to address this to some degree.

Plenary Session 3

Mapping and Modeling Resources for Decisionmaking

Session Lead

Jay Diffendorfer, USGS

Presenters

Doug Keinath, Wyoming Natural Diversity Database (WYNDD)

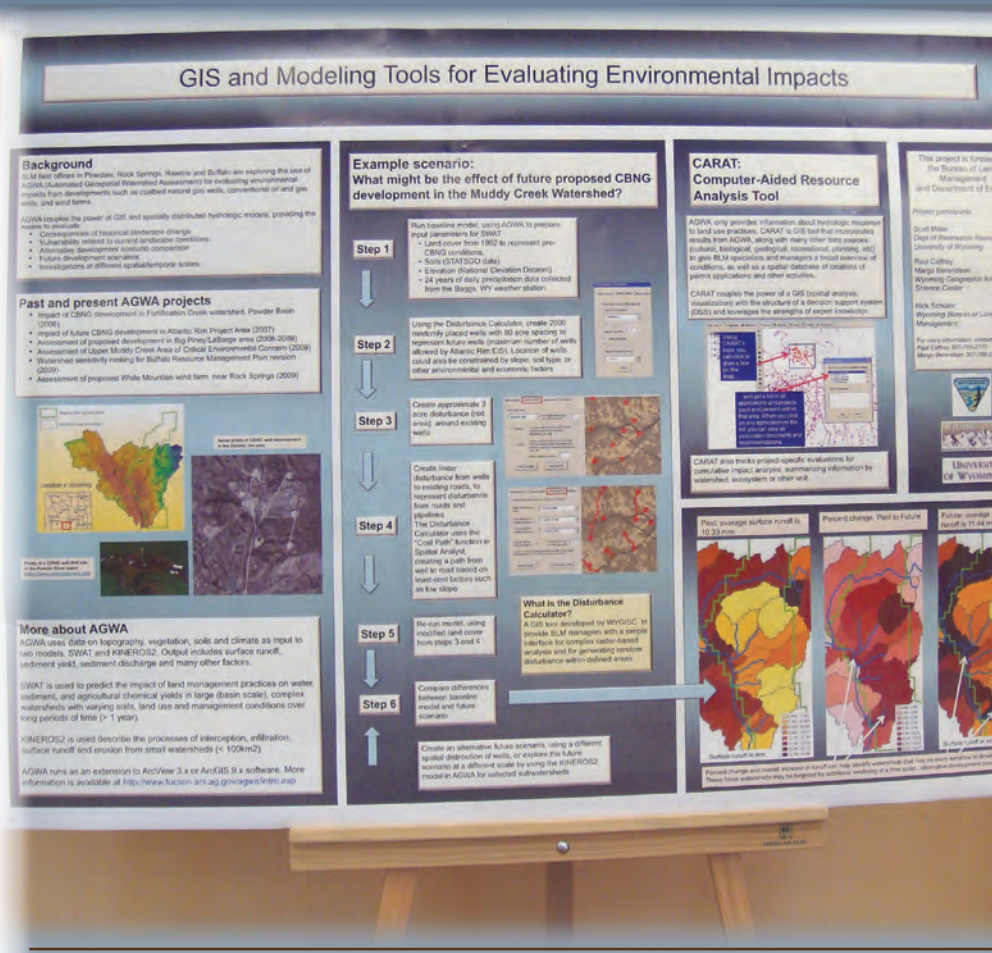
Steve Germaine, USGS

Collin Homer, USGS

Ramesh Sivanpillai, Wyoming Geographic Information Center (WyGISC)

Jessica Montag, USGS

Joe Kiesecker, The Nature Conservancy (TNC)



WLCI partners are finding innovative ways to portray spatially explicit information to aid decisionmaking. New data are being gathered to advance descriptions of the landscape, and existing data are being used in new ways to steer strategic landscape planning.

Plenary Session 3

Panel Presentations

USGS researchers are engaged in infrastructure mapping across southwest Wyoming. The ongoing research focuses on identifying optimal methodologies of identification and measurement for spatial data in each distribution class. Researchers are working to find accurate and efficient methodologies to eliminate three errors common in WLCI datasets: omission, lack of or erroneous attribution, and spatial measurement errors.

Other USGS scientists are focusing on sagebrush habitat, building mapping models, and conducting multiscale remote sensing. Mapping models are being created to assess the ability of continuous coverage maps to enhance our understanding of wildlife-habit relations. The goal is to identify and create map products that allow directed questioning about how sage grouse use sagebrush in different life stages. Multiscale remote sensing of sagebrush habitat is being conducted within a quantification and monitoring framework. Rigorous operational methods that quantify shrub, soil, and grass abundance in a repeatable way have been developed. Also, research has shown that regression tree classification, multiple images, improved ancillary data, and superior training data improve characterization, while component modeling creates rigorous objective baselines.

In partnership with the Wyoming Department of Agriculture (WYDOA), social scientists at the USGS are developing models to map human population data at a fine scale useful to biologists. Conducted at the census block level (to produce finer data than current county-level modeling attempts), dasymetric modeling will predict future population distributions and couple that information with population density estimates. The resulting data can then be overlaid onto migration corridors, sagebrush cover predictions, and so on.

Other organizations conducting mapping and modeling work include the WyGISC, the Assessment of Wildlife Vulnerability to Energy Development (AWVED) group from UW, and TNC.

WyGISC is involved in a lengthy list of remote sensing projects, including the Governor's Sagebrush Scope Project, site-level mapping (such as mapping peatlands in the Beartooth Mountains), project-level mapping for oil fields, and management-level mapping for the State Engineer's Office (SEO) involving consumptive water evaluations. All datasets are available through WyGISC.

Researchers and doctoral students with AWVED are creating models and indices to evaluate wildlife vulnerability to energy development. Using a two-part analysis, researchers are evaluating risk in a spatial context and then coupling that information with an analysis of a species' biological sensitivity. Finally, TNC is interested in using existing information to conduct strategic conservation planning. They are engaging in multitiered planning processes that involve coarse and fine data, viability goals, mitigation analysis, and larger landscape goals. The goal of conservation planning is to make decisions about the landscape for mitigation, avoidance, and restoration that will result in no net species or habitat losses on individual projects.

Audience Discussion

Questions were raised about how to keep up with remote sensing, mapping, and modeling in a rapidly changing development area. Panelists indicated that it would be easier to keep up with changing development in a more favorable funding climate; however, they are using the sensitivity of indicators to set priorities for reevaluating information.

Audience members also questioned the value of maximization and offsite mitigation. Panelists emphasized that in certain fields there are no opportunities for avoidance because conservation planning focuses on no net losses on individual project sites and on examining what could happen on a landscape in the future.

Plenary Session 4

Data and Information Management

Session Lead

Sky Bristol, USGS

Presenters

Jim Oakleaf, WyGISC

Sky Bristol, USGS

Tim Kern, USGS

At the inception of the WLCI, data coordination was identified as a high-priority need. Partners working in the State of Wyoming, including the USGS and WyGISC, are now working to identify, compile, maintain, and expand data from the best sources.

Suggestions and needs related to data and information management identified during plenary session 4 included the following:

- requiring all WLCI-funded projects to produce and publish metadata;
- increasing the availability of information about on-the-ground science work being done by the WLCI, including location and data outcomes; and
- developing a protocol to deal with questions of data ownership that may arise as data are increasingly shared by using WLCI applications.

Plenary Session 4

Panel Presentations

Presenters focused on explaining the data management tools available through the WLCI and WLCI collaborators, including the Wyoming GeoLibrary, the WLCI's projects database and mapping application, and the Jonah Infill Data Management System.

Developed and maintained by WyGISC, the Wyoming GeoLibrary is a centralized, searchable application that holds digital metadata. Users include private entities, universities, and Federal and State government organizations. Data providers include those publishers who create and maintain their own metadata, cooperators who work with WyGISC to create and maintain metadata, and contributors who maintain external records to which GeoLibrary users are directed.[1] WyGISC hopes to increase the number of data publishers, as well as develop automated maintenance routines for metadata. The WyGISC Technical Coordinator also suggested that the WLCI invest in the GeoLibrary by requiring all funded projects to produce metadata records and by using the WLCI's science catalog to publish metadata for site-level and value-added geospatial information.

The GeoLibrary is a prime source of metadata records for the WLCI science catalog, which holds over 650 metadata records. As part of the science catalog, the WLCI is maintaining and building a projects database mapping application that currently tracks habitat projects in which the Coordination Team is involved, representative points of where WLCI science work is occurring, and contact information and methods and objectives for science projects. Additional attribution data about habitat type and focus species are being collected. Next steps include collecting information on more projects and identifying information needs to incorporate into the mapping application.

A final example of progress towards data management is the Jonah Infill Data Management System, a Web application used to record, track, and analyze data submitted by operators on reclamation, air quality, and water issues. The application ties every piece of data to a point on the ground. Data recorded include spatial and quantitative data, as well as general observations, and are used for interactive mapping that identifies data voids. The data are being made available through the Council of Science Editors.

Audience Discussion

Audience members responded enthusiastically to the panel's request for ideas for the WLCI's projects database and its mapping application. Suggestions included mapping vegetation treatments being conducted by the WLCI, sharing information about mitigation management areas (designated by BLM officials), creating polygons that show projects' specific footprints instead of representational points, developing the capacity to overlay different kinds of projects occurring in the same area, and including detailed soil data. Concern arose over how to deal with data ownership when working to share data through a WLCI application.

[1] Data publishers include the SEO, the State Geological Survey, the WGFD, and the Wyoming Department of Environmental Quality (DEQ). Data cooperators include the BLM Buffalo Field Office, the Wyoming Travel & Tourism Board, and the WGFD. Finally, data contributors provide data on external sites which are linked to the GeoLibrary.

Plenary Session 5

Fish and Wildlife Research

Session Lead

Zack Bowen, USGS

Presenters

Cam Aldridge, USGS

Gary Beauvais, WYNDD

Anna Chalfoun, UW

Brad Fedy, USGS

Steve Germaine, USGS

Hall Sawyer, UW and Western EcoSystems Technology, Inc. (WEST)

Researchers working within the WLCI study area gave presentations that emphasized the relation among species and energy development, habitat use, priority species, nongame wildlife, and land use. In their presentations and their replies to an audience question about research priorities, panelists identified the following high-priority needs related to fish and wildlife research:

- proactively identifying what could happen on the landscape;
- developing future scenarios for energy development and climate change;
- understanding thresholds;
- understanding differences among how different levels and types of development will affect landscapes, habitats, and wildlife;
- improve the understanding of how species relate to one another across fragmented landscapes;
- paying attention to small-scale distinctions for management purposes;
- thinking about how to get ahead of listing situations—understanding species before they are listed and become a main driver of natural resources decisions; and
- developing a conservation management plan.

Panel Presentations

Scientists at UW's Wyoming Cooperative Fish and Wildlife Research Unit are working to understand ungulate migration routes at the individual and population levels. Using the Brownian bridge movement model in the Atlantic Rim project area, researchers are identifying population-level migration routes by using a sample of marked animals; distinguishing which route segments are used for forage, stopover, and rest and which are used for movement; and prioritizing routes on the basis of use received. Data analysis indicates that road placement in route segments used for rest and forage is more damaging to the route's ecological function than is road placement in route segments used for movement, indicating that foraging and resting areas should be managed to minimize disturbance and that movement corridors should be managed for connectivity.

Other research addressing land use includes a BLM-funded project to fill in gaps of previously conducted ecoregional assessments. Using human footprint assessments, data collection on species of concern, exotic and invasive species data, and habitat characteristics, 20 species models were created, and empirical predictions were used to predict and map biodiversity hotspots. The species models and hotspot identifications are tools that can be used to identify priority conservation areas, areas of conflict, and areas for mitigation in a conservation management plan; they can also be used to develop future scenario applications. The project's book completion is scheduled for fall 2009.

USGS researchers are refining and enhancing predictive habitat models for mountain plover and pygmy rabbits by working to improve on TNC and BLM distribution and habitat maps for plovers and on the WYNDD predictive range map for pygmy rabbits. The next step is to develop an energy development gradient documenting habitat suitability versus development density.

With assistance from a UW zoology lab and other groups, WYNDD researchers are working to clarify the taxonomy, distribution, and threatened status of Wyoming pocket gophers, a species that was virtually ignored until it was petitioned for listing under the Endangered Species Act (ESA). After using morphological and genetic analyses to determine that Wyoming pocket gophers are in fact a distinct species, researchers turned to trapping and multivariate statistical analyses to map and describe Wyoming pocket gopher habitat. It is clear that the gophers do not occupy dark, fine, deep, high-quality soils or areas of dense shrub stands (including sagebrush). They occur in a very small

global range and are sparsely distributed across a highly fragmented range. More field surveys, detailed genetic analysis, and new soil analysis and sand soil mapping studies will be conducted in the future.

Unlike Wyoming pocket gophers, an abundance of data have been collected on sage grouse in Wyoming over the last 40 years. USGS researchers are using that long-term dataset to build a population trend model for sage grouse in Wyoming.[2] The model can be applied to other sagebrush obligate species, and the model's capacity to identify change points may eventually be used to identify the beginning of an increase or decrease in population.

Other nongame wildlife research includes work out of UW's Department of Zoology and Physiology on songbird decline. Initial patterns of decline have been documented, and preliminary results indicate that energy development has affected songbirds. Data collection will continue to test hypotheses about fragmentation, shrub vigor, abundance and richness, increased nest predation, and behavioral avoidance. Ultimately, the goal of the study is to improve the understanding of the relation between species and energy development for management purposes.

[2] Trends in the Powder River Basin differ from trends detected in the rest of the State.

Audience Discussion

Questions from the audience indicated that the research presented will be useful on the ground, and the audience asked that it be shared with agency offices. Other audience members noted that the descriptions offered of future energy development, population densities, and hotspots for biodiversity showed that few areas will remain undeveloped, which led to the suggestion that the WLCI's attention should turn to learning how to make development less detrimental rather than focusing on avoidance.

In response to a question about research priorities, panelists said they would prioritize being proactive about understanding what is to come on the landscape; developing models for future scenarios with regards to development and climate change; understanding thresholds and how different levels and types of development affect landscapes, habitats, and wildlife; understanding how species relate to one another across fragmented landscapes; and managing species on the basis of distinct attributions (that is, avoiding "umbrella" managing on the basis of what is best for sage grouse).

Plenary Session 6

Changing Landscapes

Session Lead

Vito Nuccio, USGS

Presenters

Chris Potter, USGS

Mark Kirschbaum, USGS

Laura Biewick, USGS

Heather Nino, BLM

Stephen Gray, Wyoming Water Resources Data System (WRDS), Wyoming State Climatologist

Jessica Montag, USGS

Simultaneous changes are occurring on the southwest Wyoming landscape, including oil development, gas development, uranium and hard rock mining, wind energy development, and climate change. Panelists made several recommendations to deal with changing landscapes in southwest Wyoming:

- address the environmental implications of wind development;
- invest in scenario planning and climate monitoring to understand the possible range of futures with regards to climate change in southwest Wyoming; and
- expand social and economic research related to energy development and agriculture in southwest Wyoming.

Plenary Session 6

Panel Presentations

Panelists provided the audience with a geologic context for understanding the Greater Green River Basin. Bounded on the western side by the Wyoming Thrust Belt and on the other sides by large uplifts, the oldest geologic units in the basin are exposed in the Rock Springs uplift. The basin evolved in Cretaceous and early Tertiary time, and USGS estimates indicate that today it holds 84 trillion cubic feet of technically recoverable natural gas.

Oil and gas resources are studied in the context of petroleum systems, constituted by the source rocks that generated oil and gas, geologically defined passageways through which oil and gas migrate, and the eventual accumulation within a geologic reservoir. Using this approach, USGS researchers are working to understand hydrocarbon potential in the WLCI area. Mandated by the Energy Policy and Conservation Act, their assessments predict potential areas of oil and gas resources, identify potential additions to reserves, and estimate quantities underlying federally administered lands. Recent assessments include the geologic provinces the Wyoming Thrust Belt Province and the Southwest Wyoming Province that cover the WLCI area.

Other resources in the Green River Basin and across southwest Wyoming include coal bed methane; oil shale, a very organically rich resource that has never been buried deeply enough to generate oil but potentially contains huge oil resources; uranium; and wind. There are currently 29 active uranium projects in the Great Divide Basin, and there is also a major USGS project underway to reassess the potential oil resources of oil shale. Wind development is intensifying, especially near Rawlins, and questions of aesthetic values and control, impacts to wildlife and cultural resources, and public access are arising.

Southwest Wyoming is also home to agricultural resources and ranching communities that are influenced by energy development. The USGS and the WYDOA have developed a survey instrument focused on quality of life issues to try to identify the ranching community's perception of all types of energy development. Analysis of survey results, which will be sent out in the WLCI area, will occur during the summer and fall of 2009.

Although it supports agriculture, southwest Wyoming receives less than 16 inches of average annual precipitation and depends on snowpack as a primary water source. These factors make the area very susceptible to any type of climate change. While specific predictions about coming changes in precipitation are difficult to make, it is likely that the West will be drier. It is predicted to be 3 degrees Fahrenheit warmer by midcentury, which will significantly change snowpack and hydrology. Changing temperature and precipitation regimes render the relation of the past to the present invalid and will require management flexibility and extensive planning.

Audience Discussion

Audience members focused their questions and comments on wind energy development and climate change. Questioners were specifically concerned with the influence of climate change on sagebrush in Wyoming and if distributions will change. Panelists suggested that it may be possible to do physiological modeling, but not until changes in precipitation amount and seasonality are evident. With regards to wind development, comments about potential avian impacts and aesthetic impacts were dominant.

Plenary Session 7

Monitoring

Session Leads

Jay Hestbeck, USGS

Pat Anderson, USGS

Presenters

Pat Anderson, USGS

Joe Bohne, WGFD

Kevin Gelwicks, WGFD

Dick Grauch, USGS

Dan Manier, USGS

Tim Morrison, Little Snake River Conservation District

Kathy Raper, Sublette County Conservation District

Mary Read, BLM

Ramesh Sivanpillai, WyGISC

Dave Smith, USGS

Kevin Spence, WGFD

The WLCI's Monitoring Team has been in action for only a few months. The Monitoring Team will report to the STAC. The team is guided by the framework below, stating that monitoring should do the following:

- occur at varying spatial and temporal scales for the life of the WLCI;
- be a fundamental element in the integration of science and management;
- provide information on the status and trends of the environment;
- provide information on the effectiveness of WLCI management and restoration efforts; and
- build on monitoring practices of all entities already in place.

Plenary Session 7

Panel Presentations

Monitoring can be thought of as repeated observations of the amount or condition of a defined target as it changes through time. Information gained through monitoring is vital for managers engaging in adaptive management, and especially in the WLCI, where changes are occurring rapidly on the landscape.

WLCI Monitoring Team collaborators and others are working to advance monitoring efforts on a broad spectrum. USGS scientists are examining the effectiveness of restorations for soil health, conducting range evaluations, and mapping invasive species and working with county weed and pest partners. The USGS is also involved with the WLCI's local project development teams, providing science to guide the conservation actions and monitoring plans the teams develop. The BLM's Rawlins Field Office is conducting focused amphibian monitoring by looking for the Wyoming toad, the Great Basin spadefoot toad, the northern leopard frog, the boreal toad, the tiger salamander, and the boreal chorus frog in key environmental impact statement (EIS) areas. The WGFD combines several types of monitoring with habitat evaluations. They commonly monitor aspen, riparian, sagebrush, aquatic, and tall forb habitats. The WGFD also monitors breeding birds, big game, and nongame mammals through extensive surveys and has a wildlife disease monitoring program. Finally, the agency is working to bolster monitoring of amphibian and reptile populations as part of their aquatic monitoring program.

State and Federal agencies are also working together through the Monitoring Without Borders program to avoid overlap and cover all important monitoring tasks. Participating organizations—including the BLM, the WGFD, the USFWS, and industry—meet twice a year. Together, they prioritize species and designate monitoring tasks and partnerships.

Conservation districts and county commissions are involved with monitoring efforts at a local level and are especially involved in water-monitoring efforts. Prime examples of these efforts are the Sublette County Surface Water Quality Monitoring Program and the monitoring conducted by the Little Snake River Conservation District on the Muddy Creek since 1954. These programs track water quality trends over time; consequently, these programs also ensure that data collection is locally led.

Finally, organizations at UW are working to involve students in monitoring efforts across the State. Through WyGISC's WyomingView program, scientists and managers with remote sensing monitoring needs have an opportunity to have students digitize their field data. Those interested should contact WyGISC.

Audience Discussion

Because of time limitations, plenary session 7 did not have an audience discussion component.

Plenary Session 8

Science Associated with Reclamation and Offsite Mitigation

Session Leads

Justin Caudill, WYDOA

Pat Anderson, USGS

Presenters

Karen Clause, Natural Resources Conservation Service (NRCS)

Peter Guernsey, Questar Corporation

Tim Kern, USGS

Dave Lockman, Wildlife Management Services of the Rockies

Dan Stroud, Jonah Interagency Office (JIO)

Steve Williams, Wyoming Reclamation and Restoration Center

Efforts to collect data about reclamation and to develop new tools for reclamation are ongoing across southwest Wyoming. Panelists emphasized the following reclamation needs:

- developing and identifying new forb species for reclamation purposes;
- continuing to conduct soil surveys while recognizing how to use the surveys correctly;
- sharing reclamation data to create reclamation guidance tools; and
- finishing ecological site descriptions.

Plenary Session 8

Panel Presentations

Several reclamation resources exist across the State, including the Wyoming Reclamation and Restoration Center at UW. Scientists with the center primarily study energy-related reclamation and disturbances and operate under the research philosophy that reclamation methodology should be based on the best available science. Treatments should be compared to controls, treatments and controls should be replicated, observations should be made across multiple seasons, and decisions should be made on the absence of doubt, not on the presence of proof. The director of the center also emphasized that most reclamation attempts in Wyoming are doomed to failure because of the nature of Wyoming's soils and precipitation rates and that everything is connected.

Reclamation experts from industry noted that there are limited sources of reclamation guidance for oil and gas, so evaluating existing reclamation and developing extensive tracking systems are important tools. A representative from Questar Corporation recommended that people working to reclaim in the oil and gas fields develop a series of references for each pad to allow for changing baseline conditions. He also discussed ongoing research being conducted in partnership with Federal, State, and county organizations, including a shrub-planting trial, a habitat inventory, and research on seed bed preparations, mulch applications, and sagebrush treatment.

Efforts to collect data on reclamation efforts include the previously discussed Jonah Infill Data Management System, an application that allows operators to collect field data for use by the JIO. The JIO is also finishing detailed ecological site descriptions. Efforts to collect data useful for reclamation include the NRCS' Web application that allows access to soil data from Major Land Resource Areas (MLRA) Explorer, the State Soil Geographic (STATSGO) Database, or the Soil Survey Geographic (SSURGO) Database. The application can be accessed at http://soildatamart.nrcs.usda.gov.

The NRCS is also actively conducting soil surveys across the WLCI area and continues to develop plant materials for conservation needs. Through its plant materials program, the NRCS and other cooperators have preliminarily identified top performing forbs, grasses, and shrubs.[3] They hope to continue working to develop forb species useful for reclamation efforts in Wyoming.

Audience Discussion

Audience members asked panelists to give a progress report about whether or not reclamation activities are meeting reclamation needs. Panelists responded that while reclamation efforts are quickly producing quality forage for livestock they have not been as successful at producing suitable nesting habitats for sage grouse. A discussion ensued as to whether or not having cultivars and varieties compete with native species is an issue of concern. There is an ongoing debate about whether varieties have caused more problems than they have solved or whether they are helpful to restoration efforts. Ultimately, panelists said, those issues should be considered on a site-by-site basis to facilitate a consideration as to whether an area has sensitive species issues.

[3] For complete lists, see transcript notes in appendix 1.

Plenary Session 9 and Breakout Groups

Discussion, Brainstorming Lists, and Report Outs

Reporters

Steve Williams, Wyoming Reclamation and Restoration Center

Cay Ogden, NPS

Matt Kauffman, UW Fish & Wildlife Cooperative Research Unit

Participants in three breakout groups were given the four objectives below and asked to prioritize the needs they identified:

- identify science and technology needs related to the topic at hand;
- identify science activities that would benefit on-the-ground management;
- identify ways to integrate science to benefit adaptive management; and
- identify the most valuable components of the WLCI.

Prioritized lists and complete brainstorming lists are below.

Breakout Group Reports

Reclamation Breakout Group

The reclamation breakout group identified finishing soil surveys and ecological site descriptions, gathering more and better data, creating a central location for data, and developing a standard assessment protocol for reclamation as priority science and technology needs. Activities that will benefit reclamation work on the ground include gathering accurate data at a finer scale, including data regarding human-caused impediments and other unmapped features; creating opportunities for communication between managers, agencies, and academics; conducting control trials for future climate scenarios; and developing climate-modeling expertise to identify future habitat scenarios. Science and management can be integrated to benefit adaptive management by applying lessons learned through science, creating a structure for adaptive management that allows managers to supply questions and scientists to shape answers, conducting more direct comparisons of management techniques, devoting formal attention to reclamation monitoring, and engaging in upfront planning with both scientists and managers at the inception of a program. Finally, the reclamation breakout group identified the increased level of access to detailed data, the integration of multiple scientific disciplines and organizations, and the opportunity for in-person communications as the most valuable aspects of the WLCI.

Wildlife Breakout Group

The wildlife breakout group concluded that landscape-scale prioritization of habitats and critical areas is an important science need. Along with gaining a deeper understanding of sagebrush system ecology and learning how to improve the habitat through treatment, research should be focused on mechanisms to understand what lessons can be transferred across species, facilitating interaction between agencies to leverage resources and integrating science into management and policy. The priority science activity with the potential to benefit on-the-ground management work was identified as developing a conservation plan with a map of critical areas to guide development. The plan would be based on newly gathered baseline data and would set goals for viability thresholds.

The wildlife breakout group chose not to prioritize ideas for how to benefit adaptive management by integrating science and management but instead listed several ideas. These included communicating that adaptive management is best understood as a clinical trial that will show how a treatment works; arranging for researchers and managers to work directly together and, perhaps, to be colocated; identifying management and political realities; and making a commitment to monitoring, not just to treatments. Finally, members of the wildlife breakout group agreed with the reclamation breakout group that the value of the WLCI is in the integration occurring among agencies and between scientists and managers.

Monitoring Breakout Group

The findings of the monitoring breakout group were presented in the context of to what the WLCI Monitoring Team should devote resources. Suggestions included creating an inventory of all monitoring efforts and reporting duplication back to the Executive Committee, developing a monitoring scheme that will indicate when a threshold is being approached and a population is going to crash, and understanding the need for more public outreach and involvement.

The monitoring breakout group also identified general science needs and activities that should be prioritized. These included conducting more fish and aquatic monitoring, more water quality and quantity monitoring, and more forage monitoring. Also prioritized was facilitating more coordination and participation between stakeholders and conducting effectiveness monitoring to understand if project objectives are being met.

The monitoring breakout group valued the cross-agency and cross-disciplinary opportunities afforded by the WLCI, but unlike in the other two breakout groups, participants identified the WLCI's single most valuable aspect as working towards ecosystem integrity at a large scale. The monitoring breakout group also valued the work being done through the WLCI to connect applied science and management. Finally, they suggested that the WLCI work to draw a larger pool of interested parties, noting that though Wyoming is a headwaters State these issues are important for numerous communities outside Wyoming.

Audience Discussion

After the breakout group reports, workshop participants discussed the appropriate relation of the WLCI to management and policymaking. Some attendees were uneasy with the language of using science to influence policymaking and management decisions, while others felt that this use was a natural extension of the WLCI's mission. The conversation reached no definite conclusion, leaving it an open subject for future dialogue. Participants did seem to agree, however, that scientists should work to make science more operational and accessible to managers, planners, and policymakers.

Breakout Group Brainstorming Lists

Breakout group reporters presented prioritized needs during the final plenary session. The complete lists of the needs identified during breakout group discussions are presented below.

Reclamation Breakout Group

Objective 1: Science and Technology Needs

- Increase automated and standardized collection of data.
- Use mobile applications.
- Create a central location for data.
- Conduct standardized assessments of reclamation.
- Create a template plan for how to meet reclamation standards.
- Do long-term planning from the beginning.
- Develop tools to address the long-term impacts of development (including economic tools).
- Utilize current remote sensing technologies.
- Document what exists now for future comparison purposes.
- Do groundtruthing.
- Evaluate structural and floristic characteristics of reclaimed sites.
- Finish soil surveys.
- Finish ecological site descriptions.
- Develop more and better seed, especially forb seed.
- Evaluate which historical mine sites need to be inventoried.
- Compile case studies of industry sites and sites where reclamation processes are known.
- Pull data on reclamation from ecological site descriptions into a database.
- Engage in a flexible dialogue about what is wanted across the landscape.

Objective 2: Benefitting On-the-Ground Management Activities Through Science

- Develop climate-modeling expertise.
- Identify long-term movement trends.
- Create a detailed description of what managers are responsible for.
- Gather more accurate and current data for all resources, especially on human impacts on the landscape (for example, fencing).
- Consistently update data.
- Create more opportunities for communication between managers and scientists.
- Research the ecological impacts of wind energy development.
- Utilize mobile soil-testing kits.

Objective 3: Integrating Science and Management for Adaptive Management

- Create working groups that are refined through specific parameters.
- Understand what management will respond to.
- Apply lessons learned from science.
- Create a structure where science responds to questions supplied by managers.
- Conduct more direct comparisons of management techniques.
- Turn more formal attention to monitoring reclamation efforts.
- Increase upfront interaction between scientists and managers at the beginning of projects.

Objective 4: Value of the WLCI

- Accessible, detailed data on existing landscape conditions
- Increased opportunity for dialogue between land managers and scientists
- Formula for shared communication, cooperation, and resource leveraging
- Examples of reclamation practices and successes
- Availability of detailed (GIS-ready) and accurate data from all science activities
- Availability of base data
- Integration of multiple scientific disciplines across a large area
- Increased amount of data sharing and transferring

Wildlife Breakout Group

Objective 1: Science and Technology Needs

- "Downscale" climate change to a finer spatial and temporal resolution.
- Manage and restore sagebrush habitat.
- Conduct vegetation treatments.
- Create priority wildlife listings.
- Prioritize core habitat linkage areas on a landscape scale.
- Generally identify core habitat areas.
- Facilitate better communication among agencies and better integration of work.
- Adopt mitigation strategies for more species.
- Better integrate science into policy and recognize when the science is complete "enough."
- Conduct a long-term evaluation of the short-term benefits of mitigation.
- Conduct a long-term cumulative analysis to determine "how much can be lost."
- Articulate a time scale for mitigation and reclamation.
- Gather more information on wildlife responses to wind energy development.
- Determine how many replications are needed in sagebrush habitat and across how many landscapes.

- Study mechanisms to understand causes.
- Understand natural vegetative ecology.

Objective 2: Benefitting On-the-Ground Management Activities Through Science

- Conduct vegetative studies to analyze vegetation's response to development and the link to wildlife.
- Understand how hydrology is affected by development.
- Create a conservation plan that identifies priority areas for conservation.
- Address wind development through rigorous studies, not just through monitoring.
- Synthesize what is known about sagebrush communities and use to develop new strategies.
- Create a detailed map of all infrastructure in the WLCI area.
- Continue to collect basic data across the landscape, especially about development.
- Collect targeted baseline data by site by using key indicators.
- Conduct a landscape-level connectivity analysis.
- Develop target goals for population numbers at a landscape scale.
- Expand aquatic research.

Objective 3: Integrating Science and Management for Adaptive Management

- Gain a solid understanding of the steps to implementing adaptive management to ensure a long-term commitment to the feedback loop.
- Establish goals for adaptive management.
- Design trials that link science directly to adaptive management, like clinical trials.
- Identify the limits of adaptive management and political realities.
- Reserve some monitoring for experimental use.
- Make a long-term commitment to monitoring.
- Colocate managers and researchers.
- Identify trigger points and goals.
- Do correlative science—make sure science is applied on the ground.

Monitoring Breakout Group

Objectives 1, 2, and 3: Science and Technology Needs, Benefiting On-the-Ground Management Activities Through Science, and Integrating Science and Management for Adaptive Management

- Increase coordination and participation between stakeholders.
- Conduct more fisheries and aquatics monitoring.
- Understand better the impacts of hydrofracking and gas production impacts.

- Conduct more water quality and quantity monitoring in the context of oil and gas and coal bed methane production.
- Conduct insect monitoring, particularly for indicator species and pollinators.
- Conduct an inventory on basic monitoring, and use to identify data gaps.
- Find indicators that have public appeal (megafauna), but continue to monitor other systems.
- Avoid duplication of efforts.
- Increase public outreach.
- Partner with universities outside Wyoming.
- Conduct more effectiveness monitoring.
- Monitor on private lands.
- Develop monitoring educational materials and protocols for landowners.
- Engage more landowners to help with monitoring access.
- Understand what degree of change should trigger mitigation.
- Identify thresholds to develop an early warning system.
- Have the ability to balance uncertainty.
- Monitor forage on public and private lands.

Objective 4: Value of the WLCI

- Attempts to maintain ecosystem integrity while accommodating various land uses
- On-the-ground education and interactions
- Bottom-up approach
- Sets good example for future large-scale studies
- Bridging the gap between monitoring projects
- Interdisciplinary and interagency cooperation
- Protection of water quality for downstream users

Closing Remarks

The WLCI has come a long way in the past 2 years, learning to connect with local communities and partners as a foundational method in understanding disturbed habitats and achieving some successes. There is still a lot of work ahead, and providing the best science possible and working to integrate that science into management cycles remain priorities. Concurrently, outreach and data sharing need to be enhanced, which is underpinned by people continuing to communicate proactively.

By the next meeting, the WLCI will have more data, more maps, and an improved Web site.

Appendixes

Appendix 1. Compilation of Workshop Notes

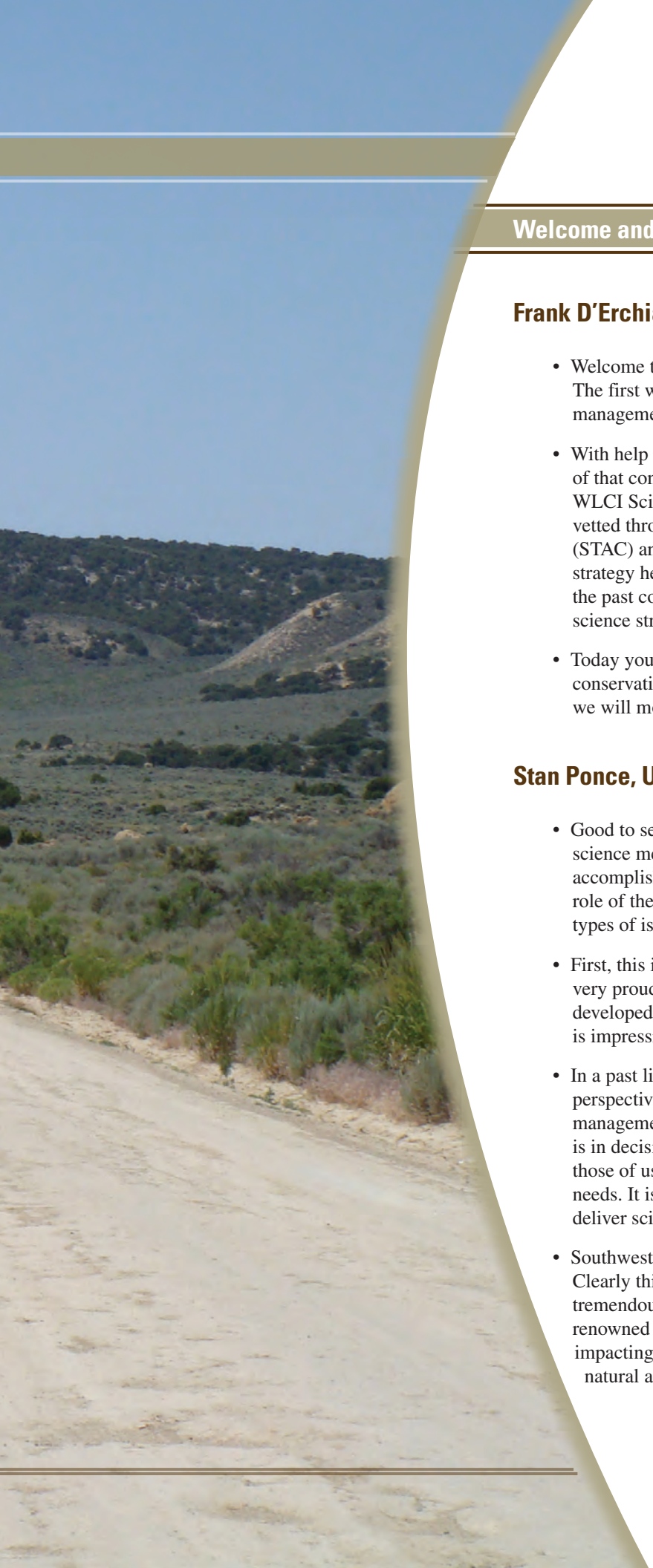
Wyoming Landscape Conservation Initiative (WLCI) Science and Management Workshop

U.S. Geological Survey (USGS)

University of Wyoming, Laramie, Wyo.

May 12–14, 2009

The following notes are a general transcript of panelist presentations and audience discussion during the plenary sessions of the May 2009 WLCI Science and Management Workshop. The names listed reflect presenters and are not intended to imply sole authorship of the work discussed.



Welcome and Opening Remarks

Frank D'Erchia, USGS

- Welcome to the second WLCI Science and Management Workshop. The first was 2 years ago here in Laramie and focused on identifying management needs and issues.
- With help from the Ruckelshaus Institute, we put together a summary of that conference. From that document, the USGS worked with the WLCI Science Team to put together a science strategy, which was vetted through the WLCI Science and Technical Advisory Committee (STAC) and approved by the Executive Committee. The science strategy helped direct the science initiatives that have taken place the past couple of years. (Both the conference proceedings and the science strategy are available at www.wlci.gov.)
- Today you will hear from the STAC on some of the science and conservation issues and how science is being used by managers. Then we will move into plenary sessions.

Stan Ponce, USGS

- Good to see such a great turnout for this second stakeholder science meeting. In preparation for this meeting, I reviewed the accomplishments of our agency, as well as those of others. Clearly the role of the USGS is to provide unbiased science and support for these types of issues.
- First, this is truly a partnership and one that all of you should be very proud of. Second, the data management capacity that has been developed here is very impressive. Third, the data integration element is impressive.
- In a past life, I worked with a lot of different land agencies. I bring a perspective to my current position from having worked on the land management side of the fence. I know how important quality science is in decisionmaking, but I also understand how important it is for those of us on the science side to work with you to understand your needs. It is important for us as scientists to listen to your needs and deliver science that helps you address the questions you have.
- Southwest Wyoming is really the nexus of many critical needs. Clearly this is one of the central areas of energy development, a tremendous source of energy for our country. It also has some world-renowned species that we are trying to protect. Climate change is impacting the area as well. It is a dynamic system that integrates both natural and anthropogenic forces.

- Looking at outcomes, this collaboration has led to the prioritization of proposed conservation actions, has helped identify indicator species and monitoring systems, has led to the development of Web use for sharing data, and also has provided data used in choosing offsite mitigation activities.
- This is really a partnership held up by the Department of the Interior (DOI) as successful. Recently Frank D'Erchia, Zack Bowen, and others went to Washington, D.C., to help sensitize folks on the hill about how important this is—and there really was broad support for that.
- Another thing that speaks to the success of this program is imitation. What you have done here is being imitated in other areas, like in the Ozarks. The model we are using there in terms of developing a government structure and a science support entity is the WLCI. Others are imitating what you have done—you have broken some interesting territory.
- My hope is that this partnership will continue to grow and flourish, that our science contributions will benefit all parties. I wish you a good meeting.
- [Introduction of Sue Haseltine, the Associate Director of Biology with the USGS] Sue is a real proponent of science in biological needs. She has led a lot of the efforts to support critical species across the country and has been a real supporter. Sue is a real friend to this program and to biology in general.

Sue Haseltine, USGS

- Glad to be here to learn the latest and greatest about the partnership going on here. Frank asked me to make some remarks about the new administration and how their priorities might mesh with your work here.
- One of the most oft-quoted remarks of the new President is "We will restore science to its rightful place…" Science-based resource management and science-based decisionmaking are on the forefront and are what Secretary Salazar is talking about. The new Secretary has invited USGS to the table to get a science perspective on what we really know and what we can do to improve our factual base for decisionmaking before making policy. That is a pattern that is going to continue with this administration, and partnerships like what you have here are going to be very influential.
- When you look at the priorities our new Secretary has rolled out, the first is climate impacts—how is climate impacting the landscapes we live and work on, and how is it impacting our lives?
- The second is sustainable energy resources. The emphasis is on carbon-based resources but also on alternatives that are not adding to the carbon loading in the atmosphere. "Sustainable energy resources" is now where the Healthy Lands Initiative and the WLCI sit in the budget. Last year Congress gave us a budget cut, but the Secretary has restored it.

- His third priority is national treasures—some of the icons in our country. He reopened the top of the Statue of Liberty and has an emphasis on Yosemite and Yellowstone; however, most people's backyards are iconic to them. That is the approach being taken in supporting initiatives like the WLCI. Working landscapes that people love and value need to move forward and support our human endeavors and our natural resources in the future. So far, we have gotten a lot of support for that perspective.
- Fourth initiative is youth—youth involvement in the great places in North America. That ranges from engaging school kids in sustaining our treasures to, for the USGS, the cooperative research units which he [Secretary Salazar] has been supportive of fully funding so we can train the Ph.D. scientists of the next generation.
- Secretary Salazar is very supportive of the types of partnerships that you all are developing.
- One of the other efforts our partners have asked the USGS to develop is the National Climate Change and Wildlife Science Center. USGS wants to provide data to help forecast biological responses to climate change so decisions can be made on the basis of what our landscapes will look like 20–50 years from now and not what they look like today. We have left an era of stability in terms of what our landscapes look like and have entered an era of rapid change. We would like people to be able to take that into account. Partnerships like the WLCI that are already looking at tradeoffs at a landscape scale are going to be way ahead. I hope you all will use the information from this center and be one of our pilot programs in looking at what climate may impact and then use that in decisionmaking. I think we will be able to give you output that can affect decisionmaking.

Frank D'Erchia, USGS

- [Introduction of the William D. Ruckelshaus Institute of Environment and Natural Resources and its staff] I have seen their work in many places and have been very impressed. They helped facilitate the workshop 2 years ago and provided tremendous support on all levels, especially in helping us provide the report you see out there. We have here with us their director Indy Burke and the whole staff of the institute with us to do various things. And especially, we have Jill Lovato, who has over 150 hours of facilitation and mediation experience.

Plenary Session 1

John Linn, Sublette County Commissioner

- I am a Sublette County resident born in Pinedale, raised on the Green River on my grandfather's ranch. The spring pasture where our cattle went is now the Jonah Field. As a young kid, I traveled the Mesa to get to school. Have seen a few changes!
- Sublette County has been home to active drilling and production, and with that comes boom and bust. In the 1980s, it had a full man camp and by 1985 a developed ridge project.
- Many energy activities are happening in southwest Wyoming—oil shale, wind energy, even hydro, with a pipeline being talked about to take water to Colorado. All of these things are pretty disconcerting to people in the region who are just trying to make a living. The boom and bust cycle is hard on families, and these communities are dealing with socioeconomic issues. These folks are trying to react just as urgently as the science folks are.
- As you can imagine, our plates are full—highways are getting busier, our roads need regrading, we have issues with dust. With all the things happening in southwest Wyoming, a coalition of local governments has been formed. I think I represent a typical commissioner in these five counties. The things happening to and for our counties are pretty dramatic.
- In 2007 the county commissions and conservation districts were not a part of the WLCI. This marks a big difference with this science workshop.
- I appreciate that county commissions have been included in the WLCI. The commissions in these counties have been in the react mode for so many years, and the science community and the land managers have been in the react mode as well. In the mid-1980s, winter drilling restrictions were being contested, and the land managers were using data from Idaho. The same thing was happening in all the other counties. The neat thing happening here with WLCI are the opportunities to get the studies done in the area being affected.
- Issues in Sublette County:
  - We have exceeded the ozone threshold for 3 years in a row, and we will be considered a nonattainment area. Sublette County has witnessed a huge public outcry about air quality and water quality.
  - Sublette County in its proactive approach has funded a hazardous air pollutant study and has put $3 million in reserve for resource monitoring. Would like to see air monitoring beefed up in southwest Wyoming, especially upwind source monitoring.
  - Sublette County has been really supportive of conservation districts and efforts to monitor our water situation. We have disposal pits on private riparian areas to which the water generated in the arid Jonah Field is being moved. We are struggling with Bureau of Land Management's (BLM) decision to not have disposal pits onsite, but we have had to deal with that.
- Finally, agriculture has been going on in these counties for well over 100 years and has made a contribution to habitat and those irreplaceable type habitats. Agriculture is a primary reason we have the big game numbers that we have. Credit must be given to family-run generational agricultural operations' contribution to what the wildlife use for habitat. There is much pressure on them to be pushed out. If science proves grazing is a detriment to the sage grouse, then that is one thing. But if it is just hype because somebody does not want to go out and see a cow, that is wrong. The science has to be complete and pure. The unintended consequences from half studies are not good for the country or the economy.
- My overall perspective on the WLCI is limited because I have only been involved for a year. I know it takes a lot of planning, drafting, gathering of memorandums of understanding (MOUs), and so on. Fortunately that is all done, and there were 29 projects in 2008. One of the biggest accomplishments is this coalescing of all sorts of people here.
- We need clean air, clean water, lots of fish, but we need an economy. The decisions made can make a big difference to the lives of people that live here. I hope we keep all this in mind when we bring these scientific studies together. We have world-class scenery, world-class wildlife, and a world-class gas drilling area all in the same place.

Max Ethridge, USGS

- With the USGS, as a Regional Executive for the North Central Area, which includes Wyoming. Had the good fortune when assigned to the job to have good things already in place, one of the best being the WLCI. I had a great group of partners working together from the Federal level, the State level, the county level, academia, and the private sector, and there was money!
- John Linn did a great job portraying southwest Wyoming—pristine landscapes, energy needs, the country's need for energy, and the need to preserve the landscape for our youth.
- People do need science, which is the purpose of this workshop. This is your opportunity to tell us what you have learned and what additional things you need to work on.
- The USGS's role is an unbiased science organization. We do not handle any resources, so we do not need reports to come out any way. We support resource managers; in southwest Wyoming that is primarily the BLM and the U.S. Fish and Wildlife Service (USFWS). The State is also heavily involved, and at the county level there is involvement also.
- All decisions should be based on sound science. That is part of Secretary Salazar's mission and the President's mission.
- The USGS became involved in the WLCI in 2007 at the request of the Wyoming Governor's office. The greatness of the WLCI is that it bubbled up from the bottom, came up from the State level and the county level and Federal agencies that are local here. That was the genesis of USGS involvement.
- The Healthy Lands Initiative was funded, and the BLM did the heavy lifting in getting the funding approved through Congress, and the WLCI was nested under that. In 2008 funding came over for the USGS, the BLM, and the USFWS. In 2008 the USGS received $1.8 million to do WLCI work. We developed projects under biology, geology, water resources, and information management.
- In fiscal year 2009 we expected to receive another $1.5 million. When the new Congress passed the new 2009 year we received $750,000 in 2009. That was a great shock to us, and we are struggling to bridge the gap for the remaining part of 2009. We are making good progress because of sympathetic folks like Sue Haseltine.
- For 2010, though, it has been approved that we can request to have our money restored. A budget increase was put forth just last week, and the Secretary supports that. In the budget increase request, the title is Sustainable Energy Development +$750,000. This program represents USGS's partnership with State and Federal bureaus committed to maintaining healthy landscapes, preserving wildlife and grazing uses, and developing natural gas in the Green River Basin. The role of the USGS is to provide science.
- This increase will allow USGS to support fieldwork needed to maintain current data and monitor specific species such as sage grouse, songbirds, and pygmy rabbits. Landscapes and habitats important for fish and wildlife sustainability are undergoing rapid change while we are relying on aged datasets and outdated models.
- Again, this is an increase that is a part of the DOI 2010 budget initiative delivered last week. We would certainly appreciate any support for this from our partners.
- We are no longer using the Healthy Lands name because of the new administration. Notice the description of the work is virtually the same, but we do have the new name Sustainable Energy Development. I think some of our other Federal partners will have adopted different names as well.
- Our focus is actively applying science on the ground for WLCI science projects. We have done this for 2 years; the purpose of this workshop is to present our findings and hear from you if our results are meeting your needs. We are also looking to expand the application of this science to a larger area to understand, mitigate, and manage the changes in a broader area.
- We have science projects focused on ground habitat modeling and monitoring; evaluating various habitat treatments; mapping and modeling resource use for decisionmaking; and learning how to manage, store, and retrieve data generated. We have great information management tools and an active and available Web site. We also have studies dealing with the effects of changes on the landscapes.
- The key to the WLCI success has been our Coordination Team, which has been active and engaged and has representation from all areas. I would like to recognize Pat Anderson, who is very visible and very active. One thing done recently was hosting a series of open public meetings where they discussed what local concerns are and what science locals think they need. We used the information from those meetings in the process the Executive Committee uses to evaluate projects and assign money.

Brian Kelly, USFWS

- One of the things that attracted me to Wyoming 6 years ago is that Wyoming is unique in the West. We do not have a lot of listed species, just a few big ones. The State has a lot of intact habitats. We have a really good opportunity to keep what is good good in this State instead of fixing what is not.
- Although the perception of the WLCI was that it was a top-down initiative, the real kernel for this came from local communities through feedback to the BLM and the Wyoming Game and Fish Department (WGFD).
- In 2006, the late Bob Bennet (director, Wyoming BLM) and Terry Cleveland (director, WGFD) sat down with Kathleen Clarke (Director, BLM) and Dale Hall (Director, USFWS) and asked if they embarked on a different route to management in Wyoming would their agencies be supportive. Dale and Kathleen said, "Absolutely." The vision Bob and Terry had was if we build a good thing the money will come—there was no talk of funding at that point.
- Bob and Terry called me and said, "We want to understand projects on a landscape scale." We did not know why they wanted us to be involved because we had no listed species, but they saw that we had a lot of species ready to go.
- Want to focus on that: to have the WLCI think about priority species and strategic landscape conservation—or, in our terms, strategic habitat conservation. Our approach differs from that of the WLCI because we pick priority species, but the fundamentals of local communities and science are already embedded in the WLCI. What we do in this landscape approach is define outcomes for species—how many do we want, what is the metric, and so on. We should design our conservation on a landscape scale in a way that ensures we achieve that outcome.
- I want to encourage us to collectively think about what species we might want to focus on. Sage grouse is an excellent one because there is broad ownership, local involvement, a State government strategy, we know a lot about it, and it is a huntable species. If we conserve the greater sage grouse (sage grouse) we are conserving 21 other sagebrush obligates. Be thinking about that. That is strategic.
- To end, we are doing good things and have made huge progress. When you take the time to look at our poster, we give an example of the work we have been doing on this conservation approach for 21 years. We are way down that road in just 2 years of this initiative.
- I also want to compliment the Coordination Team. It is those folks that do the work for this with partners on the ground. The way they have run with this is amazing. Finally, we have a huge opportunity, and let us not lose it.

Plenary Session 2

WLCI Foundations for Science-Based Conservation

Session Leads

Renee Dana, BLM

Pat Anderson, USGS

Zack Bowen, USGS

- [Began with John Wesley Powell's statement] "Research cannot be controlled by some central authority, as an army by its general, from the fact that scientific men, competent to pursue original research, are peculiarly averse to dictation and official management."
- There are a lot of good people working on the WLCI. The presentations today are the work of different people who represent the disciplines of the USGS—biology, geography, water; however, the USGS is not the only game in town when it comes to research in southwest Wyoming.
- There are three big things in Wyoming. The first is agriculture, which has been here for generations and helps maintain open spaces. The second is wildlife, and last but not least is energy development. Wyoming has some of the most productive gas fields in North America. It also has uranium, and some of the best wind in the United States.
- John Linn also mentioned land ownership. Seventy-two percent of WLCI land is public. The WLCI and its partnerships constitute a "long-term science-based effort to assess and enhance aquatic and terrestrial habitats at a landscape scale while facilitating responsible energy development."
- So, with 15 million acres of public land, there is concern about balancing agriculture, recreation, wildlife habitat, and energy. The core of the WLCI is enhancing habitat. There were 29 projects done in 2008 by working groups to benefit many species.
- The role of the USGS is really about the questions we are helping people address. For example, where are the best places to think about restoration versus conservation? What is the best treatment for each habitat type, and is it working? The USGS tries to address management needs by advancing science for predicting what is going to happen. Ultimately, we want to take what we have learned here and apply it in Utah, Colorado, and so on.
- The whole science research approach of the WLCI is built around the May 2007 Science Workshop. Outcomes from that workshop were used to develop a science strategy. The science strategy document provides background issues and identifies objectives.
- There is already a lot of work done with baseline syntheses, so to avoid duplication we are trying to collect all information available for southwest Wyoming. That information will be used to develop the right products and help people make decisions now. That information is an analytical backbone. One hundred and seventy-five datasets have been collected.
- A lot of other things have also been done, including the development of methods for looking at landscape change, looking at the database for economic minerals and updating those, conducting assessments of how to prioritize wildlife needs in regards to energy development, developing conceptual models of how ecology works in southwest Wyoming, and asking how climate might play into decisionmaking. We have developed quite a few products to help the WLCI Coordination Team.
- One challenge is that you cannot find a piece of ground that is not important to somebody. The big challenge, though, is translating priorities into areas of habitat projects and tying those local projects back into the WLCI's bigger context.
- Targeted research and monitoring need to be done through long-term effectiveness and mechanistic studies. Effectiveness studies look at treatments themselves and ask if they are accomplishing the objective set out. Mechanistic studies should be used to address specific questions about wildlife, selecting conservation areas, management practices, and so on. Finally, to do long-term monitoring, a framework must be developed, and pilot data must be collected.
    - One example of long-term monitoring is sagebrush. Continuous coverage maps of sagebrush in southwest Wyoming can be used to look at sage grouse habitat and develop long-term management tools on the basis of how habitats are changing. Continuous coverage maps allow you to look at more specific questions with regards to wildlife.

- With regards to effectiveness monitoring, we are looking back in time at past treatments and embedding monitoring into new treatments. Herbicide treatments of sagebrush in Pinedale reveal differences in vegetation in and out of spray areas. This long-term effect of treatments can be used to analyze what treatments might be applied now and how they might bear out in the future. This is also being done with plots of conifers where we can see how effective past treatments were.

- Mechanistic studies of wildlife are being conducted on pygmy rabbits, sage grouse, mule deer, and sagebrush obligate songbirds. For example, with mule deer, a question being looked at is how energy development is going to affect migration. Migration routes have been mapped through the Atlantic Rim and Baggs area, and polygons show existing or proposed developments and where deer are moving between ranges. The potential for crossovers is clear, which allows us to think about needed projects and how development should occur. Funding for these projects comes from the University of Wyoming (UW), Anadarko Petroleum Corporation, and the WLCI.

- In terms of integration and coordination, the role of the Science Team is to provide direct technical assistance and to connect WLCI teams with people who can help. A lot of documents have been developed that show who is doing what. A framework has also been developed for doing strategic conservation. Finally, we helped develop criteria for selecting conservation projects, and projects have been funded.

- With regards to information management, everything we are doing we want to be made available. It takes an incredible effort to support 175 different datasets. Go to the WLCI Web site (www.wlci.gov) to see the accomplishments, to see the data clearinghouse, and to see where habitat projects are for 2009.

- We also want to do the best we can integrating what we do for science into decisionmaking and evaluation. With adaptive management, you have an objective—to do something, see how it worked, and if it did not work, figure out why it did not work, and then do something different! We want to do adaptive science, to constantly ask if it is working and what we should be doing. We want to get feedback from people using this information. It boils down to somebody making a decision with lots of information. They need to have the right information.

- Probably one of the biggest aspects of this initiative is relationships. People need to be aware of others and what they are doing, and coordination needs to exist among scientists, managers, and government. Our role is to make sure we are giving people the best information we have and that we are developing our technology in a way that provides for the future. We want to predict better so there is better information for planning.

Renee Dana, BLM

- Purpose of our session is to talk about how science is integrated into what the Coordination Team does.

- Our landscape scale is southwest Wyoming. A big part of what we do is local collaborations and partnerships. We have a number of wonderful partnerships not just with agencies and local governments but also with other entities.

- One thing we have been talking about a lot is landscape-level effects of change. What are those effects, and how do we identify them? We know changes are occurring, we know that somehow we have to address them, and we have to provide for landscape-scale conservation. The WLCI has a number of processes that help with strategic planning. We have a charter MOU that provides the foundation and umbrella for what we are and what we do. Strategic planning, science planning, and an operating plan help the Coordination Team plan on-the-ground conservation actions.

- The Coordination Team has developed a strategic plan, with six goals:

  - To manage, conserve, restore, or enhance the sagebrush, mountain shrub, aspen, riparian, and aquatic focus communities to ensure sustainability of fish and wildlife populations in the WLCI area.

  - To support opportunities for sustainable agriculture.

  - To improve the understanding of ecological processes across southwest Wyoming.

  - To synthesize information and facilitate communication to inform and encourage responsible development and sustain healthy landscapes. We are not a mitigation program, but we do complement it, and we share information and activities with all of our partners.

  - To ensure effective relationships exist among partners, stakeholders, and the public through internal and external partnerships. When we first started outreach, we held some meetings, and one of the common themes was to make a ground-up initiative and provide input at a local level for what

activities would take place. We have been building on that to recognize those partnerships.

- To provide mechanisms to ensure effective data and information exchange. Our Web site is a reflection of this, and we are looking for opportunities to get our information out to folks.

- Our objectives are to identify high-priority areas. That information comes from a number of sources, including individuals, nongovernmental organizations (NGOs), and agencies. They all provide information for the WLCI to build on in identifying priority areas and species associated with those habitat types.

- The Coordination Team has great support in the WLCI Executive Committee and in the support subcommittees. They help us with project design, National Environmental Policy Act (NEPA), partnering, and general outreach. The Funding Subcommittee represents the folks we can call on how to share dollars, leverage more dollars, and make things work on the ground. The Steering Subcommittee and the USGS Science Team were addressed earlier by Zack Bowen. The Data and Information Management Team helps get the information out. The Communications Team helps us and all these entities with outreach and provide the who and what of the WLCI.

- Focus communities are identified in the MOU, including aspen, sage, riparian, aquatic, and mountain shrub. A priority is to summarize further into categories which are helpful for developing actions and identifying projects. Examples of these categories are fragmented habitats, migration corridors, obstructions, and invasive species.

- All of the guiding documents are available on the WLCI Web site, as are other documents.

Dan Blake, USFWS

- Fitting into all of these plans, we needed an operation plan to figure out what types of work needed to be done and how best to do that. This operational plan talks about partnerships and the conservation planning process that we have developed with partners.

- Partners are the key to making things happen for the WLCI. The organizations represented in the Executive Committee include the WGFD, the Wyoming Department of Agriculture (WYDOA), the conservation districts, the county commissions, the USFWS, the USGS, and the U.S. Forest Service (USFS). We have a variety of other partners as well, including conservation groups like The Nature Conservancy (TNC) and Trout Unlimited (TU). We have worked with industry as well and recently had a workshop to get them more involved with both science and conservation. We work regularly with private landowners, the JIO, and the UW. When we talk about partners it means different things. We use the word "partner" in a broad sense to just mean people we are trying to work with.

- One approach we have come up with to leverage support is local project development teams. We have local project development teams across four different parts of southwest Wyoming to help facilitate planning work across political and administrative boundaries. Local biologists, range managers, conservation districts, and landowners have attended the local project development meetings.

- We want these teams to be involved in looking at priorities of the WLCI initiative and to help with project design and generally be very involved. A lot of them have been doing projects in the past, but they were not communicating at the same level.

- Also with these teams, we hope to implement monitoring and evaluate the effectiveness of their projects.

- We also have a support subcommittee formed by local managers that commit resources to a project if they know there is a lengthy NEPA process, for example. This support subcommittee helps us keep local managers aware of WLCI activities.

- A key part of working with partners is outreach and communication. Our Web site has a variety of information, and we are trying to get as much publicly available as possible. We published a newsletter twice last year and had a social event with industry and NGOs to understand how they would best like to work with the WLCI. We have worked with the media as well.

- In the conservation planning process, we recognize partners, missions, and priorities. We want to integrate and work together at the landscape scale. We have defined the process as "a strategic approach to incorporate science into landscape-scale conservation planning with measurable outcomes or improvements to ecosystem functions."

- A key part of this is being strategic with measurable outcomes. Conservation strategies are based on broad courses of action for specific objectives. Proposed

projects are reviewed and prioritized by using the criteria we have laid out. We want objectives with quantitative results and metrics to make sure a project works at its own level but also at the landscape level.

- There are five steps for the conservation planning process.
  - Resource assessment: WLCI partners and local project development teams identify conservation issues and priorities and select and evaluate ecological indicators. Utilize local knowledge and comprehensive assessment databases. Address species and habitat recommendations.
  - Conservation priorities: Use available information to establish priorities and objectives. Identify appropriate quantitative benchmarks to support measurable outcomes.
  - Design and development: Select appropriate conservation tools. Address management issues as needed. Final approval and ranking of projects; finalize funding. Complete project checklist including the NEPA process.
  - Implementation: Implement project; conduct implementation and compliance monitoring.
  - Evaluation and adaptive management: Apply monitoring objectives, monitoring design, and protocols. Use feedback to develop best management practices (BMPs), recommendations, and guidelines.
- Planning principles are as follows:
  - be strategic;
  - measure outcomes;
  - integrate science;
  - work with partners;
  - use data;
  - conduct program- and project-level evaluations;
  - work at local and landscape scales;
  - be flexible by working outside of traditional borders; and
  - use the adaptive management process.
- Partners are key to all steps of these processes. Each of our WLCI teams and partners has different strengths and tools to contribute to the process to make it more effective.
- The map of WLCI community areas of interest (fig. 1–1) gives you a feel of what is important on the landscape. The colors aren't important—the point is that we all have items of interest (as partners) that we bring to the table. This shows geographic items of interest. There are other areas of interest as well that we need to become aware of and figure out how to proceed.
- Conservation tools and approaches are being developed. Examples of this are the USFWS "candidate conservation agreements." Landowners commit to certain measures. Other partners have their own conservation tools.
- Types of projects we've been planning are thinning conifers from aspen, forage reserves, new wetlands, invasive weed treatments, improving fish passages, fixing problem fences, creating mosaic habitats, and conservation agreements.
- We are working to become more strategic in applying these conservation planning processes. To date a lot of work has by necessity been opportunistic.

Cay Ogden, National Park Service (NPS)

- The WLCI's STAC is led by Reg Rothwell of the WGFD. Other members include Matt Kaufmann, USGS; Catherine Willard, USFS; Jessica Crowder, WYDOA; Adrienne Pilmanis, BLM; Pat Deibert, USFWS; and me. The agencies have put forward some of their best and brightest staff to help us work on these big-scale issues.
- The STAC was chartered by the Executive Committee to provide science expertise and technical advice to the overall WLCI and the Executive Committee. We ensure that research, monitoring, and conservation projects are well integrated. We give guidance on research needs and implementation and assist in keeping an eye on the money to avoid duplication of efforts.
- After the first workshop, the USGS developed proposals for what work needed to be done to move the WLCI forward. The STAC reviewed these and gave advice to the Executive Committee on where those might take the WLCI.
- In late 2007 and early 2008 the STAC developed a science management implementation plan (SMIP), which provided overall structure and integration for the USGS science plan and the Coordination Team's developing strategic and operations plan.
  - The objectives in the SMIP process are to review new studies and assess their importance, promote an exchange of information, use adaptive management

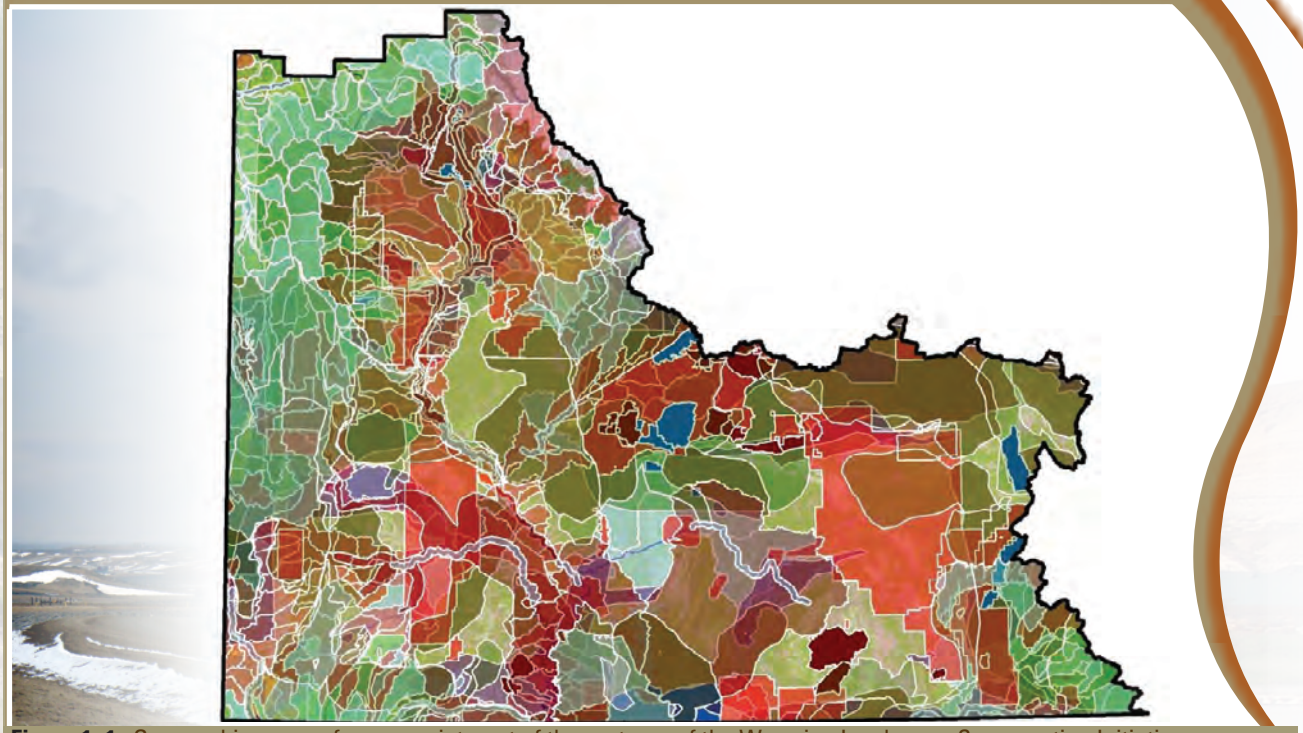


Figure 1–1. Geographic areas of common interest of the partners of the Wyoming Landscape Conservation Initiative (WLCI). Partners have an interest in essentially all of the WLCI area.

to assess impacts of projects and mitigations, implement monitoring to feed adaptive management, standardize methods and data, promote research where appropriate, fill in knowledge gaps, and ensure that projects and mitigations are all brought together to design better conservation projects in the future.

- In the next year or so the STAC will conduct periodic reviews of science and management to identify opportunities for better integration. It will also document the science proceedings from this workshop to help the Executive Committee.

Jay Hestbeck, USGS

- The monitoring tasks come out of Objective 4 in the SMIP:
  - Identify, evaluate, and make recommendations associated with monitoring and other science activities that are pertinent to the goals of the WLCI.
  - Ensure that monitoring is occurring at appropriate scales to inform WLCI actions and compile information to facilitate adaptive management and cumulative effects analyses.
- Each WLCI partner has one member on the Monitoring Team.
- The Monitoring Team has only met for several months, but the next steps are for draft plans for a monitoring framework that will occur at varying spatial and temporal scales, be a fundamental element in the integration of science and management, provide information on the status and trends of the environment and on the effectiveness of WLCI management and restoration efforts, and build on monitoring practices that are already in place. The Monitoring Team will report to the STAC.
- There are several short-term goals, including the following:
  - Identify monitoring and related science activities already occurring in the WLCI area.
  - Identify information needed to inform the adaptive management process.
  - Recommend indicator and surrogate species and approaches.
  - Stay informed about useful monitoring methods.
- Midterm goals have also been developed:

- Identify monitoring protocols that are consistent with WLCI data management standards, suitable for inclusion into adaptive management and adequate to create performance measures.
- Recommend minimum standards for monitoring species and habitats.
- Disseminate information and encourage the use of standardized protocols.
- Ensure that monitoring data provide information at the landscape scale that can be used for model validation.

- Finally, there are also the following long-term goals:
  - Synthesize information to inform the adaptive management process.
  - Coordinate with USGS Science Team and STAC to ensure that new information is available to update the science plan measures and priorities.
  - Develop new monitoring protocols when necessary.
  - Provide recommendations to assess the potential effects of development.

Sue Patla, WGFD

- We have talked about teams, planning processes, and some accomplishments. We want to present some of the conservation actions that have been ongoing.
- The WGFD Green River Basin Trumpeter Swan Range Expansion Project started many decades before the WLCI and provides an example of a long-term, science-based, landscape-level initiative.
- Conservation planning requires perseverance, patience, and partnerships. You also have to understand your species and limiting factors. The trumpeter swan is the largest waterfowl in North America, and it is a specialist that needs highly productive shallow wetland habitat, which is one of the rarest habitats in Wyoming. The young stay with adults year round and learn habitats and movements through the adults, not through genetics. The trumpeter swan is also a species of concern in Wyoming.
- People thought the bird would go the way of the passenger pigeon, but some persisted in the Yellowstone region because of its thermal features. All others in the country were killed off through commercial hunting.
  - In 1935 there were only 60 resident nests known, all in a small area near Yellowstone Lake. The management strategy at the time was to keep the birds concentrated in that area by using winter feeding.
  - By 1950 there were 500 resident birds. Then, resident bird numbers stagnated and decreased, while migrants shifted exponentially. The management strategy shifted dramatically towards expanding the range.
  - In Wyoming, only a few places made sense for range expansion, including the Green River. The goal was to keep populations connected.
  - Good summer and winter habitat existed along the Green River corridor, with 20–30 miles that could stay open in the winter.
  - The first project was to establish nesting pairs. Over a 9-year period we put out 75 swans and did tracking to see if they survived. Eventually, we got nice growth in resident birds and were attracting even more in the winter.
  - The program was a success, so much so that we now have as many birds in the Green River area as we did in the Snake River area. The distribution is pleasing, with nest sites from the Upper Green down to the Seedskadee National Wildlife Refuge.
- Working with private landowners takes tremendous time and commitment. We had lots of data and were fortunate enough to hire Dave Lockman to contact landowners and work with them to develop 22 different management plans. We then developed prescriptions and a "cookbook" to show landowners how to create habitat for swans.
- In 2006 there was some Federal funding available, and the Wyoming Wildlife and Natural Resource Trust and the WLCI provided matching funds.
- Construction work was done on three wetlands in 2008—one near Pinedale, one at Friendly Pond, and one at Big Piney. Rimfire Ranch is the largest project to date, with 20-plus acres of wetlands created. All the ponds were created and are full. But it is a process. It takes 2–3 years for vegetation to develop to support the swans.
- Planning two other projects on the Swift and Lazy River Ranches on the New Fork.
- These are not just single species projects. It is amazing the number of wildlife, birds, and mammals that use these ponds.
- These are not just single species projects. It is amazing the number of wildlife, birds and mammals that use these ponds.

Plenary Session 2

Discussion

- This morning we heard from the commissioner who talked about concerns about ozone and organics in the water and how much the landscape had changed with the drilling of the anticline near Pinedale. As I listen to our planning group here, I did not see one picture of an oil well. It is almost like the whole gas aspect was forgotten. Seems that the same problems that are affecting people should be a big part of the planning for the wildlife species. This is like the polar bear. It is good to study the polar bear, but it is good to study why the ice is going away. It seems that you are forgetting the big picture of what the effect of this oil and gas development is going to be.
  - Things are evolving. Originally, we picked up on habitat projects through the NEPA process and built the science to support those projects. At the same time we are trying to think about these bigger issues like human health concerns. Expect in the future that you will see more emphasis from the research community on these topics. They are not being ignored.
  - Someone from the Wyoming Department of Environmental Quality (DEQ) is now on the Monitoring Team as well, and talks later in the day will address issues surrounding gas development.
  - There are interrelated priorities and issues. Energy development and other types of development such as urban expansion come up in meetings, and the teams are looking at those other issues as well.
- One of the original ideas of the WLCI was that the money invested in these projects would be an alternative for the oil and gas projects in the WLCI area that were not going to maintain wildlife populations. To what degree have projects provided a counterbalance and to what extent are they compensating losses outside project areas for those inside project areas?
  - Not yet able to identify direct benefits. The WLCI is not a mitigation initiative. We do work jointly with industry, but we do not provide an alternate source for company-committed mitigation.
  - Two years is not enough time to see wildlife responses to these projects. This is a long-term effort.

  - The work of the WLCI is to enhance habitat, but it is not an alternative to things required in resource management plans (RMPs). There are stipulations and requirements for reclamation in those RMPs; the WLCI does not replace that.
  - The original funding request was for $5 million, and only $1.5 million was received, so projects were scaled back. There is a lot to be done, but the initiative is very constrained by the available funding. To do more of the necessary science we need to build up our funding resources.
- Appears one of the biggest information gaps is how best to manage sagebrush habitats. We have a certain dogma in the WGFD on how to approach habitats. If you look across the spectrum of people involved, there are some that believe in disturbance regimes, others that view mature sagebrush as able to sustain itself over time if not subjected to things like livestock. Are the USGS and the WLCI going to tackle this management issue? Managers need to know basic ecology, the endpoint we want to reach, and if what we are doing for mitigation is benefiting sage grouse and other species. Who is going to write the mitigation plan for oil and gas development? Will it be the WLCI?
  - We use the science and information that we have and want to proceed carefully while recognizing that doing nothing and waiting for science has its own hazards.

- Some of these points have been brought up by WLCI partner agencies, local government folks, and individuals. Questions like what is a healthy sagebrush community, what is needed to maintain that community, and how to go about that are still being worked on. To some degree we will address this, our partners want to address this, and things are being done to assess that community and make recommendations, as will be heard later in this conference. USGS folks have looked at background treatments to see what they can tell us about what can be done in the future.

- Those were not rhetorical questions—they were about serious data gaps that we need to look into.

  - We are working to fill some of those data gaps and prioritizing which data gaps need filling with some emphasis on soils data and other activities. Certain parts are being addressed but not as much as you have indicated.

- It makes sense that the WLCI has a proactive approach towards acquiring and providing this science. Before this, almost every wildlife study has come from an environmental assessment (EA) or an RMP with broad, vague brush strokes. Science has never been accomplished on a broad scale like this. The WLCI is producing the science that will make this work on a landscape level. Other perspectives say to just lock up everything—the economy does not matter, effects do not matter. The WLCI is going a long way towards getting the necessary science figured out.

Plenary Session 3

Mapping and Modeling Resources for Decision Making

Session Lead

Jay Diffendorfer, USGS

Doug Keinath, Wyoming Natural Diversity Database (WYNDD)

- Assessment of Wildlife Vulnerability to Energy Development (AWVED) has been with the WLCI since the beginning. The WLCI had to come up with plans right off the bat, even before projects got going, because there was a need for short-term planning around critical species habitat and corridors and also a need to move quickly into long-term planning.
- The coarse approach to all of this is good, but you need a fine filter approach to go along with it. There are about 15 species listed; however, many species not on our radar could qualify for critical species status, and we need to know which species those are. So the goal of the AWVED project is to assess which species are most likely to be impacted by development so that management can be adapted to prevent their endangerment.
- There are two components of the project. The first is risk, which is very spatially oriented. Is there road or highway or energy development spatially that would put this species at risk?
- The second component is assessing if that species is biologically sensitive to development. Combining spatial risk and biological sensitivity gets at which species are most vulnerable to a particular development.
- Using this approach, a runthrough of species that represents the gamut of issues we might be concerned with was conducted. In this runthrough were a lot of sagebrush-sensitive species. The results we have now are only preliminary—the data maps are in draft and need to be reviewed. Once reviewed, they will be folded into WLCI projects to improve models.
- To begin the risk assessment, classic range maps and species distribution maps are used in a simple overlay. The next step of the analysis is refining where, within a species' range, the sensitive habitat is. Also, predictive distribution modeling can show where within the range a species is most likely to occur. On the development side, the same type of overlays are conducted to determine what percentage of active surface development overlaps with a species' habitat or what percentage of a species' habitat is within the range of pending leases.
- Looking at these nine species ranked from the most overlap of habitat with pending leases to the least, it is evident that all of the sagebrush obligate species are at the top of the list (table 1–1). But, even within those species there is a range of percentage of overlay.

Table 1–1. Ranking of nine selected species from most to least habitat overlap with pending oil and gas leases.

[Note that all of the sagebrush obligate species are at the top of the list]

Species	Percent of range in lease	Percent of range in producing lease	Rank (most to least at risk)
Wyoming pocket gopher	44.9	14.7	1
Pygmy rabbit	36.1	10.9	2
Northern sagebrush lizard	27.4	8.2	3
Sage thrasher	27.1	8.0	4
Greater sage grouse	24.8	7.4	5
Northern leopard frog	24.6	7.3	6
Ferruginous hawk	24.0	7.1	7
Northern goshawk	21.9	5.9	8
Hoary bat	11.4	2.2	9

- Looking at the same nine species ranked from the most overlap of habitat with active oil and gas development (including roads) to the least, all sagebrush obligate species are again right next to each other (table 1–2). This is because sagebrush is where development happens and sagebrush obligates have similar habitat needs.
- Again, this shows which species are most likely to be impacted and where they are most likely to be impacted. It gives a complete spatial distribution, and weighted distributions can be conducted on the basis of proximity to development and even high probability of proximity to development.
- The next step is the biological sensitivity analysis. Some species are more sensitive to development than are others. Some respond differently to development, and oftentimes the reason for those different responses is known. So, a sensitivity distribution index can be developed.
- The goal is to develop as much baseline data as possible for species and development. We know that reproductive effort and the density of a species affect how sensitive it is to disturbance. Species that occur at lower densities are more likely to be affected by disturbance.
- An advantage of this project is that it is very defensible on the basis of conservation biology. There are a lot of data. The drawback is that it is limited by the availability of information on species and taxonomic variation that occurs within species.
- The goal is to focus on species that are at the greatest risk on the bases of spatial distribution and biologic sensitivity before they are listed. The project is not just general indexing. There are a lot of studies that are going to be evaluated, and if the predictions from the indices are not matching, they will have to be reassessed.
- This approach will be done for the whole WLCI area and also for all of Wyoming for other forms of development.

Steve Germaine, USGS

Infrastructure Mapping in Southwest Wyoming: Acquiring the Best Information To Support Wildlife Management Decisions

- Focused on infrastructure and what is happening in southwest Wyoming. Would like to recognize coauthors Bob Waltermire, Mike O'Donnell, Robert McDougal, Lori Baer, Jamie McBeth, Tammy Fancher, Cam Aldridge, Steve Garman, Zack Bowen, and Jay Diffendorfer.
- Document published in 2003 that argues 80 percent of land in the contiguous United States falls within 1 kilometer of a road.
- The WLCI area represents one of the places in the contiguous United States that is relatively pristine; however, here is what we have in western Wyoming shown in fig. 1–2). Although some roads are omitted, this does represent secondary and tertiary roads and some energy development.
- The map was created by using different sources and databases because, depending on the data source used, road densities can vary by over 200 percent. That allows for a tremendous potential for error when associating road density with species.

Table 1–2. Proportion of habitat overlap distribution within 500 meters of oil- and gas- related development of the same selected nine species in table 1–1.

Species	Percentage distribution within 500 meters of development
Northern leopard frog	64.5
Pygmy rabbit	64.1
Greater sage grouse	63.8
Ferruginous hawk	63.7
Sage thrasher	63.3
Wyoming pocket gopher	62.6
Northern sagebrush lizard	55.4
Hoary bat	46.7
Northern goshawk	45.4

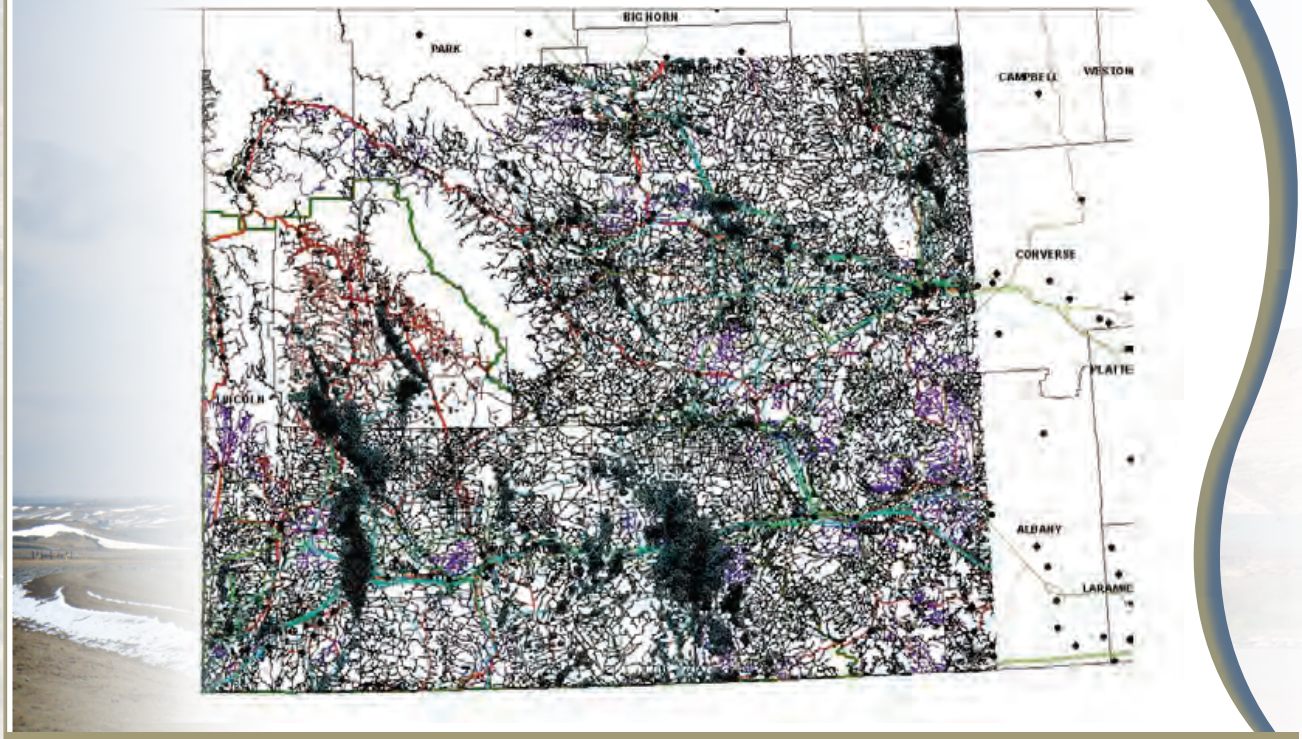


Figure 1–2. Map of western Wyoming showing primary, secondary, and tertiary roads and some surface disturbance related to the energy industry.

- There are three common sources of digital data errors:
  - The first relates to detail and missing elements—omission. You may have imagery that is not of a high enough resolution. Or, regardless of the quality, things may have just been missed. Mapping and GIS digitizing are tedious work!
  - The second source of error is attribution. In many cases, attribution is scarce or not accurate. Even if elements are labeled, how many are labeled, and how many are labeled correctly? And at what level of classification?
  - Finally, spatial measurement errors. For example, when measuring well pads, minute errors on a per-pad basis can translate to tremendous total error.
- Do not have to hunt for examples of these errors. They are common among WLCI data.
  - The first example was pulled up from WLCI data about Patrick Draw. There are 104 wells present, but 12 of them are not digitized. Of the 92 that were digitized, 65 percent of those did not have digitized roads leading to them. Again, if using this to model the relation between a dataset and species, a tremendous amount of error will occur.
  - The second example comes from a hand graphic of a 64-square-kilometer section of Jonah Field in the BLM database. Several different data sources were used for roads in the area, but there are no attributes. On this graphic from the Jonah Field, it shows a road that is not a road.
  - The Pinedale Field Office's dataset is pretty good, with 50 percent attribution. Other field offices show that 50 percent seems to be about typical of what is being tracked, but if one were trying to do a large field-scale analysis, there would be trouble. This is not critical—we appreciate what they are doing and that things are changing on the landscape quickly.
- Essentially, small errors on the local scale lead to big errors on the landscape scale.
- Progress will require ambitious and rigorous work that needs to be coordinated among field offices. Because

of the WLCI, there is now a fairly high level of data sharing among different agencies, which is helpful.

- There is also a point about the infrastructure mapping being done. The goal is to identify optimal methodologies of identification and to document development across the WLCI area. This will be done through a combination of 12 different methodologies and results comparison. Objectives are to best identify and attribute disturbance features into meaningful classes and most accurately measure spatial area in each disturbance class.
- Would like to work with existing data, complete attribution in areas where mapping is complete and current, identify areas where information is lacking, and get the attribution done.
- Anticipate publishing a technical report by the end of the year. See this work as providing the foundation for changes over time. It will allow forecasting and hindcasting. Finally, the data will be freely shared and distributed.

Questions

- Did not mention how to keep up in a rapidly changing development area.
  - How often information will be updated depends on rapidity of change and sensitivity of indicators. Until we are in a more favorable funding scenario, it will be difficult to keep up.
- Results showed were current results after editing.

Collin Homer, USGS

Implementing and Applying a Multiscale Remote Sensing Sagebrush Habitat Quantification and Monitoring Framework Across Wyoming

- The WLCI area is a challenging remote sensing environment: there is a lot of disturbance, not a lot of chlorophyll, a low commodity return, and not a lot of science going on. Poor financing.
- This has resulted in either specific local classifications that are unusable for large area analyses or large area efforts that are very generalized and not usable locally. Working on database data gap analysis. We need datasets that are accurate not only on a local level but also system wide.
- Sagebrush ecosystem issues need consistent data over large areas that still can be locally relevant.
- Sagebrush monitoring needs rigorous operational methods that objectively quantify shrub, soil, and grass abundance from remote sensing in a way that is repeatable enough to enable monitoring.
- Sagebrush methods need to support multiple spatial scales and time periods. Methods should provide a foundation for habitat analysis, disturbance trends, and other monitoring issues. Methods need to be affordable enough to complete over a large area and sustain for long periods.
- In our work, eight rangeland components were modeled across Wyoming. There are eight targets that were estimated: bare ground percentage, shrub percentage, herbaceous percentage, litter percentage, sagebrush percentage, the percentage of sagebrush that is big sage, Wyomingensis sagebrush percentage, and sage height.
- We start with 1-meter frames and 14 frames per plot. We then walk that up to different raster cell resolutions (2.4 meters, 30 meters, and 56 meters) by using regression tree models at 1-percent increments.
- So, the field plot protocol begins with 1-meter frames, with 14 frames per plot, and then to frames averaged by plot, to 65 plots per QuickBird scene, to 845 plots for the WLCI, to 1,950 plots for the State, or 27,300 frames.
- The nice thing about a regression tree is that it outputs a continuous estimate on 1-percent scales and provides for very effective data mining, too. It also provides a classification engine for component modeling.
- Larger area predictions confine the model. It is designed to be effective in lower threshold lands. No modeling above 7,900 feet and on nonrange areas.
- Thirty QuickBird scenes were used to train predictions. We used a minimum of four Quick Bird satellite scenes per Landsat footprint. Scenes in the overlap zone were used to train two Landsat footprints.
- Wyoming component predictions have been validated through a rigorous independent accuracy assessment across 300 plots. The results tend to overpredict very low occurrences and underpredict at high occurrences, but now that we have a baseline we can actually measure and quantify these results.
- It is also very cost effective across an entire ecosystem. If you look at the Jonah Field and model at 56-meter plots, the cost is only 1/10 of a cent per acre.

- Take-home messages:
  - Regression tree classification, multiple image dates, improved ancillary data, and superior training data offer new improvements in sagebrush characterization, and component modeling creates rigorous objective baselines to characterize sagebrush landscapes at multiple scales for multiple applications.
  - Seasonal and annual change are being measured and monitored across scales by using the same protocol.
  - We have a repeatable way to monitor the landscape now even if we are looking on a grass or bare ground landscape. It is independent of any sensor, and we are doing a lot of work to gain efficiencies.

Cam Aldridge, USGS

Wildlife Habitat Applications Using Sagebrush Map Products

- Intended to show applications of this work for wildlife, but did not quite get there.
- The work allows directed questioning about how sage grouse use the landscape. All sagebrush is not equal. The grouse use different components of the ecosystem at different life stages differently. For example, nesting habitat requires a certain amount of cover, which sometimes indicates whether or not nests will be successful.
- Focusing on the WLCI area in southwest Wyoming where we have cover products that were available over the last 11 years to assess sage grouse-habitat relations.
- The idea is to take each individual study (Lander, Pinedale, Kemmerer, and Ryegrass) and try to develop a model in each of the four study areas by using the following products:
  - Wyoming ReGap, 2001, cover type
  - National Land Cover Dataset, 2001, cover type
  - Landfire, 2001, cover type
  - Wyoming Geographic Information Science Center (WyGISC), 1985–2005, cover maps
  - USGS, 2005–6, sagebrush habitat continuous cover maps
- Each of the models will be tested and used to make predictions.
- This analysis will be done in the rest of the southwest Wyoming area and ultimately across the State.
- We will assess the ability of continuous cover maps to enhance the understanding of wildlife-habitat relations. The goal is to ultimately get statewide models for sage grouse to try to identify nesting habitat, brood-rearing habitat, and winter habitat. The key is that until today we have not had uniformly developed models. This is the first attempt.

Ramesh Sivanpillai, WyGISC

WyGISC Remote Sensing Projects

- Giving this talk for Eli Rodemaker.
- The following list of projects close to the WLCI area gives an idea of the types of projects being done at WyGISC, which was established in 1996 as a spatial data center.
  - We are currently providing imagery and manpower for a USGS pilot project to test if remote sensing will work.
  - We are currently conducting site-level mapping such as mapping peatlands in the Beartooth Mountains.
  - We are currently conducting project-level mapping such as oil fields.
  - We also conduct management-level mapping, like the work we have done for the State Engineer's Office (SEO) to help them evaluate consumptive water. It is a consumptive water use estimation project for the SEO-Colorado River Coordinator, which includes using our models to show the evapotranspiration rate per hour (which is 0.514 millimeters per hour for the pixel).
  - At the Rawlins Field Office level, textured information was added to images to improve accuracy, and now 90 percent or more of the oil field is done.
  - A sagebrush closure map was also generated for the Rawlins area.
  - The WGFD was interested in a snow cover map. Looking at the archive, they were able to get images of high snow cover and average snow cover, from which a snow index was produced.

- The Governor's Sagebrush Scope Project tasked us with creating a statewide map and database of sagebrush for characterizing sagebrush habitat, within a 1-year timeframe and within our existing resources. Field data was collected as part of this project. It is the first time such a comprehensive effort to collect data occurred at such a statewide scale. This dataset will be used for categorizing sage grouse habitat. We are currently taking the USGS model and sagebrush cover to create a predictive species model.

- All datasets are uploaded at WyGISC. Once you have permission you will be able to access the entire geographic information system (GIS) on the Internet site. We are working on refining classification by identifying the classes that can be separated.

Jessica Montag, USGS

Utilizing Dasymetric Modeling of Human Population Growth: Scenario-Building Tool for Wildlife Habitat and Migration Corridor Research

- Trying to show how to map human population in a way that provides valuable information for biologists on a fine scale. This is the first pilot case study, and it hopefully will be built upon.

- Understanding human population in the development areas is critical to predicting where future growth and development might happen and to see where habitat fragmentation might occur in the future.

- Sublette County's population is a little over 8,000, which may seem insignificant; however, from 2000 to 2008, the growth rate was 40 percent.

- Such an intense growth rate in a very short amount of time places stress on the area's ecology and on the community as whole.

- Documenting growth rate data gives a baseline from which to calculate trends. In terms of projecting Sublette County's population, the Wyoming Department of Administration and Information's Economic Analysis Division projects that there will be almost 17,000 people by 2030. The increased needs of this population will cause a change on the landscape.

- In the WLCI area, they are looking at population level by county to describe what is occurring. Having something at this scale shows the range of the human species, but it does not give a good sense of density or distribution.

- So, we conducted a review of census block information. Because census blocks encapsulate areas of 100 people, in rural areas they were very large. The value is at a much finer scale than are county data, and the distribution of the population becomes much clearer.

- Barriers to using the data exist, however. There are 1,700 census blocks for the entire county to contend with, and to put in some sort of mapping feature becomes unwieldy for the social scientist. Additionally, all habitat and landscape information is not necessarily available. There is landscape that is not inhabited, so it does not get included with land ownership. These barriers lead to dasymetric modeling.

- Dasymetric modeling incorporates topography, land cover, and modeling. It was first used in 1936 and went out of fashion, but it is now coming back for urban planning because it provides a lot of information about communities on a much larger scale. It has been used in San Francisco.

- They are trying to use this method for a rural landscape, which has not been previously done. It is challenging at times. Essentially, census block information is entered at the beginning, then a filter is entered in, and a new map is created. Filters are things like landownership and land cover. For example, you can enter the census block data and see that there are 100 people across a wide area. Then, a reduction occurs, and on a fine level it shows the smaller area that is actually populated. Eventually this leads to a prediction about future population distributions that can be coupled with population density estimates.

- By 2030, a lot of places are going to have much higher human population densities. There is going to be real concern over decreasing habitat and habitat fragmentation. This information can help biologists think ahead to try to balance human and wildlife needs.

- If migration corridors are overlaid with this data, you can see there is going to be considerable overlap between corridors and human populations. That is critical to understand.

- We want to put the projected population growth into areas that have not had growth yet and determine where the population is going to go in terms of what features are in an area.

- This could be placed on top of a sagebrush continuum map.

Questions

- How did you determine viable areas?
  - Any parts of the landscape that are publicly owned or cannot sustain population (for example, because of water features like glacial lakes or because of a slope of greater than 15 percent) were removed. If there was not a population but the area met all of the other factors of being able to have a population, it was included because populations will move outside of areas where they currently exist.
- Have you gone back and used maps that show population growth in the past to determine known population growth centers and see if the modeling works?
  - Looking back will help refine the model to make it more specific and accurate.
- Is there any way to model the secondary effects of human population growth as well?
  - That has been considered and talked about for the future and is somewhere we want to go.

Joe Kiesecker, TNC Wyoming

- The presentations so far have been about trying to move the ball in some really amazing ways in how we describe the landscape. What I am going to talk about is using existing information in ways that can steer how we view conservation.
- Our goal is to get gains for biodiversity conservation from development, on a project-by-project basis, which has been a dismal failure.
- Conservation planning tools are an early warning system. They can help identify potential conflict areas and are a way to maximize returns. We can provide conservation planning tools through avoidance, early warning, and offsets.
- Mitigation efforts have common problems. They are reactive. They are motivated by a permit process that began before any thinking about mitigation began. They are cost prohibitive. Other key problems include identifying suitable offset sites, which are often just random. Then, making sure that offsets account for ecological concepts of loss and for broader landscape goals. And the last and most problematic and important issue, developing the capacity to ensure that you have adhered to mitigation.
- TNC looks at this as a multitiered planning process. The first step is called ecoregional planning. Ecoregional planning has been done for all ecoregions in North America, most of the Western Hemisphere, China, Australia, and other places.
- At the ecoregional scale, planning is done at a coarse filter level and a fine filter level. Viability goals are set for each ecoregion, often by using optimization technology.
- The Wyoming Basin Ecological Assessment is not a perfect representative of this type of process, but it does show the general framework. We are in the process of redoing this assessment. We built a predictive model in-house by using producing and nonproducing wells. The model is used as a way to look at different development scenarios. You could do the same for the Wind River Basin and for different Wyoming basins.
- Some conflicts could be avoided by redesigning portfolios. Imagine a development proposal in a pristine site that conflicts with targets that are highly irreplaceable. We would recommend that development leaves little if any impact—avoidance. Contrast that with Jonah, where you have more flexibility. If an area is already degraded it does not contribute to larger landscape goals, so offsets can be used as a tool.
- After the decision was made about creating offsite mitigations for the Jonah Field, British Petroleum (BP) and the BLM created a mitigation fund. BP invited TNC to design a mitigation plan (an offset plan) and convinced TNC they could provide additional value. What we have now done is taken a systematic approach to how we design mitigation analysis. We are not burdened with having to be experts on all species because a team of experts is relied on to help with identification.
- One of first steps in mitigation analysis is compiling critical species from all of the lists and then gathering the spatial data about habitat these species rely on. It would be nice to also have a refinement of how sensitive (or not sensitive) these species are.
- In Jonah, the assumption was that potentially everything would be impacted. The goal was not to set an amount for funding but to determine how mitigation dollars might be used.

- We looked at data from different scales because the offsets create the tension of wanting to keep close to the impact site. We were not able to meet those goals for all of our targets, so we had to go to a larger scale.
- One of the rules built into site selection is the cost-surface rule, which is essentially a footprint analysis. We also built a predictive oil and gas model into this so that it would not select sites of high oil and gas potential. Some of those sites, though, have a high biological value also, so in that instance the rule was relaxed some.
- We worked to meet a one-to-one goal. You cannot value an acre of offset equally with an acre of impact.
- This is not a conservation plan for the WLCI. This is only a series of places that could serve as a series of potential offset sites.
- Something being done retroactively is a review of all completed projects.
- We are trying to keep relatively good habitat in good shape by abating or averting future loss. Restoration, on the other hand, means a lot of different things. You have to consider the expected background, areas of greatest population growth, and areas with the highest probability of success. Our effectiveness is very high.
- Finding good data on restoration is critical to calculating what your actual offset benefit is.

Questions

- You walked us through the kind of hierarchy, so avoidance was not in the picture. The oil and gas industry has chosen not to minimize but to kind of maximize. Given that, the probability of success goes down, yet TNC appears to be endorsing maximization?
  - In Jonah, there was no opportunity for us to discuss avoidance. For other fields that is not the case, and the opportunity to affect avoidance does exist. You can assess the degree of impact and the need and pretty quickly come up with the ability to say, "There will not be the opportunity to avoid that impact," or "There will be." They can make informed decisions about whether or not it will work. It makes it clear that for some of our targets and target species it is very difficult. It becomes increasingly difficult to get a return after the fact; however, our role at TNC is not to make that decision.
- When mitigation for a project is a conservation easement somewhere else, you have only prevented further loss, and nothing has been gained for the sage grouse. Are you just assured that there will be less loss for the grouse in the future?
  - The goal is not "no net loss" from the landscape as a whole. The goal is no net loss for that individual project. What would have happened on that landscape in the future? In 30 years, how did the conservation easement help the impact of human population growth, for example? Those impacts are being valued within the context of 30 years.

Plenary Session 4

Data and Information Management

Session Lead

Sky Bristol, Science Information Services, USGS

- When the WLCI began, almost everyone involved said data coordination was needed. The Geospatial Information Office at the USGS is trying to use the WLCI activity as a way to spearhead methods for how to programmatically identify and build up the best available data sources.

Jim Oakleaf, WyGISC

- At WyGISC, we really believe in helping decisionmakers make more informed decisions, and most of the applications we develop are tailored toward that objective.
- I am going to talk about the Wyoming GeoLibrary and how it supports the WLCI science catalog, the issues with the database, and possible recommendations.
- Recognition of folks in this room for helping develop the Wyoming GeoLibrary. The Ruckelshaus Institute obtained a Department of Energy Office of Science grant which directly funded the library. Continuous funding has come from the BLM Buffalo Field Office and Reservoir Management Group. The seed grant came from USGS National Spatial Data Infrastructure (NSDI) Partnership Office. Also, the Wyoming Travel & Tourism Board and the WGFD help with the addition of metadata records on a project-by-project basis.
- The Wyoming GeoLibrary application is a centralized and searchable digital metadata library providing access to geospatial information distributed among a network of Wyoming providers.
- Metadata are basically a description of the data—what they are describing, who created the data, why it was created, when, and how it can be accessed. Geospatial information is not just downloading data for your GIS software. This has developed into a lot more data, which includes research documents, environmental assessments, geographic activities, geographic services, static map images, applications, clearinghouses, databases, live data and maps, and more.
- The GeoLibrary is a searchable database of over 800 geospatial metadata records that has information for access or direct access for all geospatial information.
- For data consumers, the GeoLibrary is a Web page that provides the ability to search for geospatial information. User information has been gathered since 1997, and the majority of users are private entities. UW and other universities make up the next largest component, then the Federal government, and then the State government.
  - Private/other
  - UW
  - Higher education
  - Consultants
  - Energy and mineral industry
  - BLM
  - WGFD
- For data providers, the GeoLibrary is a metadata database that allows direct access and editing access to metadata records. There are three different types of data providers.
  - The first type of data provider is the data publisher. These folks actually publish metadata inside the database and maintain the data and links to their data. This is who we want everyone to become. To do this, you have to create your own metadata and then obtain a GeoLibrary account and use the tools we provide to edit and maintain your records. WyGISC's costs with data publishers are very low, the currency of the data is very high, and the accuracy of the metadata record is high because the person maintaining the data is also creating the data. Finally, the accessibility of the data is high because most of the time there is a direct link or good description. Current data publishers include the SEO, the State Geological Survey, the WGFD, the DEQ, and a recent local program in Cheyenne.
  - The next type of data provider is the data cooperator. Data cooperators are groups that WyGISC has worked with to create and maintain metadata within the GeoLibrary. The cost to WyGISC is medium, the currency of the data is medium after the project is finished because data are not always maintained, and access is high. The groups that have filled this role are the BLM Buffalo Field Office, the Wyoming Travel & Tourism Board, and the WGFD.

- The last level of data provider is the data contributor. Contributors may not know that they are a part of the GeoLibrary. WyGISC is maintaining and publishing metadata records that point to their relevant geospatial data for Wyoming. The cost of this to WyGISC is quite high, the currency and accuracy of the metadata record is variable, and often the accessibility is low because users or consumers are directed to a new, often unfamiliar, site. Unfortunately, over 60 percent of WyGISC's current metadata records fall into this category.

- WyGISC's role has included the development and maintenance of the application. We provide user support for publishers and administer the GeoLibrary. We add and maintain metadata records for nonpublishing data providers, we educate Wyoming data consumers, and we provide first-line technical support for data users. Many times we receive calls from folks asking questions about your data, and we answer them. That often prevents them from having to be redirected to you.

- Future GeoLibrary goals include increasing the number of data publishers and the metadata record count, automating metadata maintenance routines, creating Web-based metadata publishing and editing tools, enhancing Web site functionality, enhancing ease of use, increasing recognition for data publishers, and understanding better who the data consumers are.

- Currently, 65 percent of the metadata records found in the WLCI science catalog have been directly harvested from the GeoLibrary. So, the issues are similar in both databases.

  - Limited data publishers result from the perceived issue of additional work required by data publishers, a lack of knowledge of existence of the tools, and a lack of understanding in regards to who manages the data.

  - Few "local" Federal agencies are participating, even though they are producing a lot of data.

  - Limited funding exists for maintenance and support. Metadata maintenance is performed only yearly instead of quarterly, and newer Web technologies are utilized very slowly.

- The connection between these issues, the GeoLibrary, and the WLCI comes because data currency issues are propagated back into the WLCI science catalog. The science catalog is not incorporated back into the GeoLibrary, so we have not resolved who will reconcile updates in both databases. Also, there are no local entities within the WLCI as publishers.

- Recommendations to the WLCI are to do the following:

  - Invest in the GeoLibrary, not only through funding but also by becoming publishers to produce metadata records.

  - Have the WLCI science catalog focus on publishing metadata for site-level and value-added geospatial information like we saw this afternoon.

  - Require all funded projects to produce metadata and publish that metadata in either one of these applications.

Questions

- If I were to search the Wyoming Geological Survey's database for geospatial data, would I come up with a list similar to what I would come up with by using the GeoLibrary?

  - Tried to incorporate the Wyoming Geological Survey's database as much as we could by having them as a publisher, but we would like for that to be the case.

- Do you have a feeling for what they use to determine what they give you?

  - You will not find everything you find at the Geological Survey in the GeoLibrary. We will keep adding to it, but it is not all there.

- So is the idea to have a bunch of Wyoming data focused so you do not have to plow through multistate data?

  - That is exactly the idea.

Sky Bristol, Science Information Services, USGS

WLCI Projects Database and Mapping Application

- We now have 651 metadata records of some kind or another, from Web sites to geospatial services to geospatial data layers. A good portion of that comes from the GeoLibrary. Much of it also comes from the comprehensive assessment work out of the USGS Fort Collins Science Center. Some of the data are bigger than the WLCI area but can be understood in a way that we can use them.

- There was a story we heard loud and clear from the Executive Committee, which is essentially "I want to draw a box around an area and see where we are doing habitat conservation work. Where are things happening? Where are projects planned next, and what are those projects?" The deeper story behind this is "I need to decide if I want to call someone up about that and offer

my two cents," and "I want to find out what made them decide to do that work there instead of here," and "I want to know if that project has produced any data that might help me in some way," and "I really want to find out how many acres of a certain type of habitat are going to be impacted or improved in this particular area."

- Here is what we have today, which can all be found on the WLCI Web site (http://wlci.gov).
- We have a map that shows habitat projects and science projects. On the map, the current habitat projects that the WLCI Coordination Team is involved in are in red. The blue points are representative points of where we have scientific work going on. Any of these can be clicked on to see title and description for the habitat projects. For the science projects you get a lead contact and then can follow another link and see the information tracked in the project system, such as methods and objectives. Right now, this project system is rudimentary. We want to do a whole lot of other things with it.
- We have collected additional attribution about these projects, like habitat being dealt with, focus species, and what overall type of project it is.
- We have thrown together some ideas thus far. We know we have projects dealing with aspen and sagebrush, for instance, and that we have species focus areas, long-term monitoring efforts, wildlife studies, landscape change studies, mapping and technology development, and data development. Soon you will be able to click a filter and sort projects by some of these categories.
- Another major next step is to collect information on other projects (share your projects!). We heard about 22 projects developed related to trumpeter swans today, and we would like information on that. So we will put a form on the Web site open to everybody, and anyone can go and give a title, description, and contact information. We will work with the WLCI Coordination Team to review those before we put them online.
- So, the next question is "What do you want on your map?"
- We have thought about the following:
  - Where people are located, or who is involved where.
  - Other types of projects. What other project information do we want to have?
  - Where to find data on a certain topic. Right now you can browse to the data clearinghouse page and see the last five postings or browse and search the clearinghouse.

Ideas from the Audience

- Vegetation treatments. Our field office does a fair amount of chemical and mechanical treatments and prescribed burns, some in the WLCI area. It happened a couple of times last year where we went to recon and there were USGS employees working on things, and we did not know they would be there or exactly why they were there. If a BLM field person could click on an area and see what treatments you are doing, as well as a listing for a contact person, it would help.
- At the BLM, if we are going to do a prescribed burn, we have to come up with a mitigation management area. The person whose area it is is the one who comes up with the mitigation management area and the trigger points. Then a fuel specialist comes in and says "OK to achieve" and "This needs to be a spring burn," "This should be a fall burn," and so on. All the information is just on the person's own U drive so to say. It should be shared here.
- That is a really typical user story. Back when I was in the USFWS I had the same issue all the time. I would always wonder if USGS was doing work upstream that I could use. But one of the problems we have is "Who owns those data?" We could probably create a very robust outfall for all of this. But who owns those data? It is not USGS data. Is there a way to create a capacity for the BLM to house those data? It is a conundrum.
  - We are trying to figure out how, as a part of the WLCI, can we deal with data ownership? Can we take action for a while to prove how useful the data are and then transfer the data later to the agency that manages them?
- Mentioned earlier that you have representational points. Can we get past balloon bubbles and get polygons on a map?
  - Yes, we have two projects trying to deal with footprints. The idea is that if you click around you can find another map with the very explicit footprint for a specific project.
- But right now you cannot have several different kinds of projects show up in overlays? What kinds of projects would you overlay?

- Areas where the BLM is doing vegetation treatments and where the USGS has experimental sites.

- If you bring up a project form, can I have the different project maps right on top of each other to see exactly where they intersect?

  - To a certain extent, sure. Right now it is very simple; the projects page does not let you turn on and off certain types of projects. But as we get more information in here, that is the kind of overlay we could do. The other thing we will do is provide the data to you in a way that you can download into your own GIS. We want to provide the data as much as possible to let folks deal with the unanticipated things while we just deal with the anticipated things. Right now, the map only lets you look at representational points for USGS science projects and WLCI habitat conservation projects.

- What is the timeline?

  - The full projects mapper that will give you the basic functionality that you are after (such as where the USGS has sampling sites) should come along later this summer (2009).

- Would like to see a lot more fundamental data than are in the database. For example, soil surveys. Cannot tell what is happening with treatment projects unless you know the fundamentals about the soils there. Detailed soil data are missing from most of the maps, especially in southwest Wyoming.

  - That is where the data clearinghouse itself comes in. We have 651 records in there today, and we are probably missing things even from the basic data element, not to mention value-added GIS datasets that are providing a rich source of interpretative information. It is here today, you can search for data, and we are looking to the Wyoming GeoLibrary to handle most of these things. At the same time we are bringing in all of our USGS data. Another thing coming over the next year will be the ability to have you all and a lot of other folks contribute and say, "Look you missed this; I do not know the metadata, but here is contact information."

- We are dealing with a lot of the same issues as is Jim (Oakleaf), but we are working together to overcome that. Browse through; use the contact forms we have online to tell us about what we are missing.

Tim Kearn, USGS

Jonah Infill Data Management System

- Part one of two presentations. This is talking about the actual data integration components of the Jonah Infill Data Management System. Thursday's presentation will be about how we can actually use this system.

- Would like to thank David Mack for developing this.

- The JIO has been collecting data for years (as dictated by the record of decision, or ROD). These data are not self-organizing—they sprawl. We ended up with about 2,400 different files. The challenge was to figure out what this office had and to put it in context and make sure it could be used in trend studies and analysis.

- The system we built is a Web application. If you are with the JIO you are going to get a dashboard full of a variety of options to work with. The system

allows users to work with any operator data, service reclamation data on an operator-by-operator basis, look at air emissions data, and so on.

- The different data types dictate the way you can work with the data. There is interactive mapping that goes on, data downloads, spatial data uploads, quantitative data, general observations, and also a portable data input option to what are a mobile Web version and a runtime version.
- The system itself is workflow oriented, from extremely simple workflows such as the mitigation data the office is working with. We tie a wire to every data element in the system. Every piece of data has to be tied to a point on the ground that puts the system in context.
- We also have some fairly complex tools. One of the take-home messages is that when dealing with spatial data, when you treat the data, there are different ways to get it back to the users.
- You never get what you need—you just get what your data developers know how to do. We try to work with a variety of technologies. Depending on what the problem domain is, we use GeoTools, JTS Topology Suite, Hibernate Spatial, and ESRI products (ArcGIS server and ArcSDE).
- So, in the case of the JIO and this system, you can generate a report that has a number of spatially oriented components that the system grabs and then form the map rendered with ArcGIS to the summary chart of acreage generated by GeoTools. You can piece these technologies together to get reports out that will make sense to the users. In this case, EnCana Corporation is a primary operator in the area, and thanks to this tool the JIO discovered a number of data voids showing that EnCana and the office have missed a number of reports. This way of generating data can tell us what is missing and where that is happening.
- When you start working with a system like this, the centroid ends up outside the area. Real life gets in the way of what you expect. In the case of the JIO, we found a lot of that. This is pretty typical—you are going to find errors. Tracking down these errors got to be a pretty big project. The system now double-checks the feature they have uploaded and verifies that it is not overlapping.
- These are things you learn as you go along, and the JIO is great in working with us to get the data and get it out. We ended up with a system where if someone uploads an erred polygon we can tell them what the error is. We use this throughout the site, so we know inputs are legitimate and so we know they finally get in the system. It uncovers an early error, which is going to be extremely valuable going forward. The automation will provide the office with an email alert or a report on when there is an issue going forward. And in case anyone wants to take a look at the system it is operational now.
- The bottom line is that it is functional. It tracks reclamation, air, and water problems. It is built to work around data at their core. We are making the data available with the Council of Science Editors.

Plenary Session 5

Fish and Wildlife Research

Session Leads

Zack Bowen, USGS
Reg Rothwell, USGS

- The idea of this session is to look at groups of species, how they use habitat, and how they are affected by development.

Hall Sawyer, Western Ecosystems Technology, Inc., and UW Cooperative Game and Fish Unit

Identifying and Prioritizing Migration Routes for Landscape Level Conservation

- [Recognition of coauthors Matt Kauffman, Ryan Nielson, and Jon Horne]
- Conservation of ungulate migration routes has received a considerable amount of attention across the globe. To sustain the populations, functional migration routes must remain intact.
- Western Wyoming is excellent example. It supports more than 100,000 mule deer, 90 percent of which are migratory. At the same time the region supports intensive gas development that is converting native rangelands to gas fields. This presents a significant conservation challenge.
- In recent years Global Positioning System (GPS) advances have improved our ability to study animal movements. Identifying migration routes remains problematic; it is difficult to account for uncertainty associated with GPS locations and even more difficult to account for how animals move between these locations.
- Typically we just connect the dots between these GPS locations, but that results in a migration route with no area associated with it. Is it 10 meters or 1 kilometer wide? Trying to incorporate that route with no area into a land use plan is problematic.
- The second problem is we have no means to combine individual migration routes and look at population-level migration routes.
- A few years ago Jon Horne developed the Brownian bridge movement model, which accounts for both of these problems. The model uses correlated locations to estimate a utilization distribution (UD).
- The goal of our work was to take this new methodology and apply it to a gas field in southwest Wyoming so we could identify and prioritize migration routes for landscape-level conservation.
- Working in the Atlantic Rim project area, a 400-square-mile area with 2,000 coal bed methane wells approved by the BLM with 1,000 miles of road and pipeline construction. There are two major winter ranges (the DAD and Wild Horse winter ranges) in the area. Mule deer summer on opposite sides of the project area. A lot of the development will occur between the seasonal ranges of this major deer herd, so it is important to identify migration routes beforehand.
- Goals are to develop a framework that can do the following:
  - identify migration routes used by a sample of marked animals to identify population-level migration;
  - distinguish which segments of routes are used for stopover for forage and rest as opposed to being used for movement; and
  - prioritize routes on the basis of the portion of the population that uses them—those that receive the most use may have the most conservation value.
- Captured 47 mule deer, and collected locations with GPS collars every 2.5 hours. Of our 47 deer, 44 were considered migratory. From those 44 we collected movement data associated with 80 migrations. We estimated a UD for each migration route. We averaged UDs for each winter range so we had a population-level migration route for each winter range. We categorized on the basis of high use to low use.
- In the Wild Horse winter range, the largest winter range in the region, routes characterized by a network of foraging and resting are connected by movement corridors (see fig. 1–3).
- Near the south end of the project area two pods overlap with both types of habitat within migration routes.
- It is important to distinguish between the two types of habitats within migration routes. Foraging and resting areas, also known as transition ranges, are important

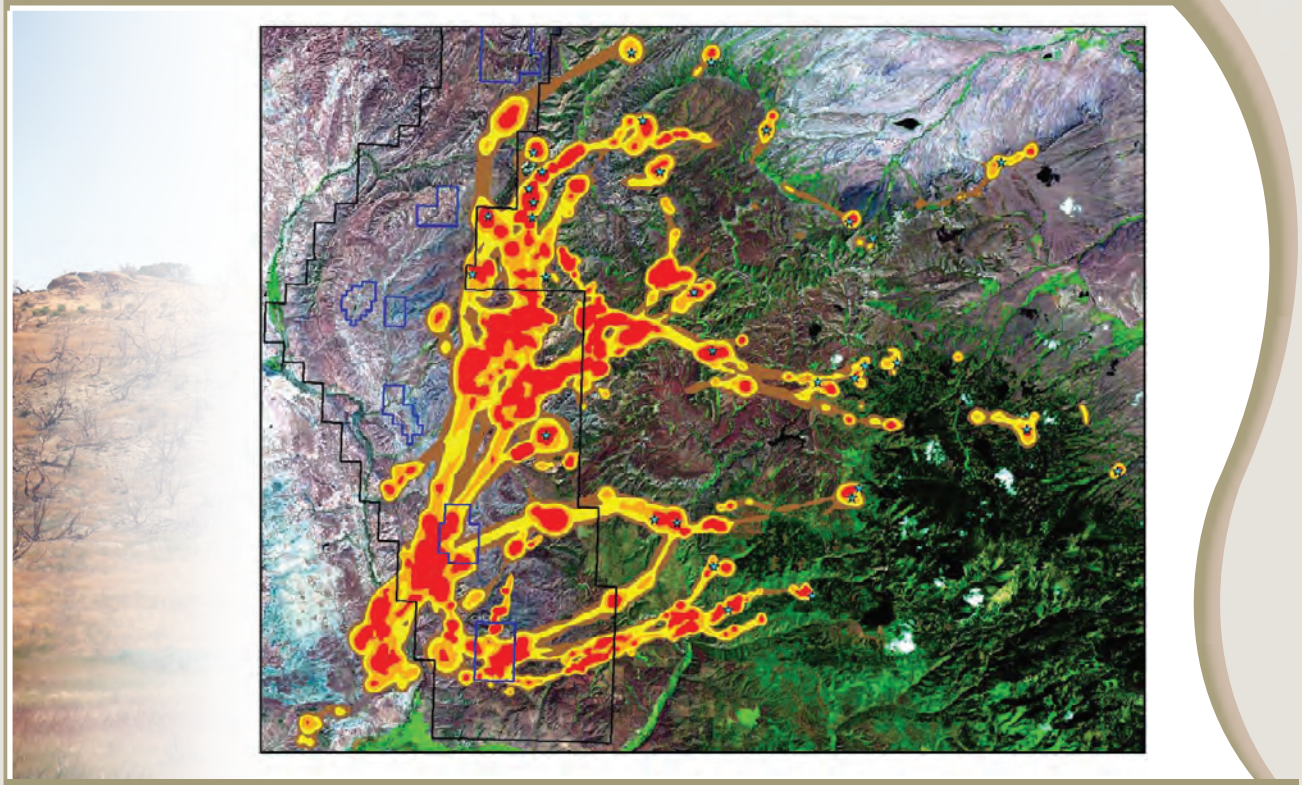


Figure 1–3. Wild Horse winter range in southwest Wyoming, the largest winter range in the region. Routes characterized by a network of foraging and resting (shown in red) are connected by movement corridors (shown in yellow and orange).

because they allow ungulates to recover body condition earlier in spring and maintain body condition later in fall before entering winter. They are analogous to the stopover sites talked about in the migratory bird literature. Same is true for migratory ungulates as more range is converted.

- From a management and land use planning perspective, the questions are "Are these areas affected by development differently than movement corridors are affected? And "Should we manage the two types separately? Do we put the road through the movement corridor or through the foraging and resting area?"
- We contend that if the purpose is to maintain the ecological function of routes then a road or other obstacle is less likely to affect migration if it crosses a movement corridor. If we put the same road in a foraging and resting area, we know from the literature that area will not be as effective for foraging and resting. We suggest that these foraging and resting areas be managed to minimize disturbance whereas movement corridors be managed for connectivity. This does not mean no development; they just need to be able to move through the area.
- Lots of work still needs to be done to identify thresholds for movement.
- Going back to population-level routes, it is not one well-defined, easy to manage route. Population-level routes are complex, with five or six major migration routes. From a conservation perspective, it useful to know which of these migration routes receives the most use.
- We identified those routes used by at least 10 percent of the population. If we go back to the overlap with oil and gas, we had routes heading east that went through the pods and then these routes to the north. We can tell after prioritization that routes to the north receive a lot more use. We envision these maps combined with stopover and movement corridors as a nice tool to prioritize areas and better manage in the face of oil and gas development.
- We have quantitatively identified migration routes and can distinguish between stopover sites and movement corridors, recognize segments of routes that do not function the same, and finally can prioritize routes on the basis of use received.

- This example is with mule deer and energy development, but methods could be applied to a wide range of species. We need to evaluate thresholds of development and the plasticity of migration routes. We would like to identify the vegetation characteristics of forage and stopover sites. If we know what makes them special, it opens up doors for habitat improvements and mitigation efforts.
- Most of the funding for this came from Anadarko, with subsequent support from the BLM, WGFD, WLCI, and the Wildlife Heritage Foundation. A publication will be coming this summer. For more information contact hsawyer@west-inc.com.

Questions

- What is the chance the relative use of these routes varies across years? (High-frequency routes may be low-frequency routes under different conditions.)
  - Comfortable that there is consistency because of the strong fidelity mule deer show to routes year after year after year. Across years and across seasons deer tend to use the same routes. Over 100 years I do not know, but in recent history we are confident of consistent use.
- Given such strong fidelity, if a route is blocked, will the deer just move over?
  - That is the million dollar question. And how much development does it take until they move over, or do they fly on through? We have an experiment in the making—there has been development that overlaps with our GPS-collared deer's routes—so a year from now we should have some insight.
- How built out are the southern pods the deer are crossing?
  - The one on the very south end is not developed at all. The second one that is developed had around 12 well pads built at the time of the study. Most of the development so far is on the north end of project area.

Steve Germaine, USGS

- This morning I will talk about two species we are conducting research on out of the Fort Collins Science Center: mountain plovers, by the Rawlins Field Office, and pygmy rabbits, across the entire WLCI area. Tasha Carr is doing mountain plover work.
- Both species are WGFD species of greatest conservation need, both are BLM priority species, and both are on the USFWS list, too.
- With mountain plovers we have three objectives:
  - To evaluate mountain plover response to energy gradient
  - To quantify habitat characteristics in shrub steppe (they are relatively well studied in short grass systems, but much less is understood about them in shrub steppe vegetative types)
  - To develop predictive habitat maps for planning activities
- Methodology for the mountain plover study included point count surveys. Data were measured by abundance per unit area. The data are the average over multiple visits to each point. Although it is not statistically significant, there is a slight negative relation between plover density and increasing gas well density.
- Plovers are present across the entire density of gas wells. We are interpreting this as demonstrating that the BLM has done a good job setting the densities they set here. At this built-out density of wells there is a minimal or negative effect of plover densities in the area. The negative trend line indicates that if more wells were permitted we could potentially see more dramatic negative effects on plover density.
- Now to the other objective, to refine and enhance existing predictive habitat models. TNC has a distribution map for mountain plovers. It is a good first start but is a coarse-scale map. To address management at some level of detail, we need this map to be more refined. Tasha's doing work to try to do some refinements there.
- The Rawlins Field Office has also produced a map with polygons that represent suitable habitat and areas where it is predicted that plovers do not occur. A nice start for trying to make decisions fast, but what they have found in their surveys is that plovers fall outside both of their predicted areas. That is part of the reason they have Tasha working up in their area.
- She is moving to using remotely sensed imagery to develop these predictive habitat maps for plovers. Plovers seem to be selecting on the basis of vegetation density.
- In 2008 she did surveys for abundance and density. In 2009, because some of the associations had a high level of variability, she has decided to focus on nesting

success where the data may be more sensitive and the parameters may be tighter or closer to statistical significance. She will be telemetering adults of breeding pairs, tracking, and using them to keep a close eye on habitat use and survival of fledglings through the first several weeks of life. She will also use observation data through telemetry work to test and refine a habitat model that she has been developing.

- Would like to talk briefly about some of the pygmy rabbit work I began last year. Pygmy rabbits are sagebrush obligates, and status review suggests strongly that the currently occupied range is only 5 to 10 percent of that historically occupied because of fragmentation and loss of habitat. The USFWS has just completed a 12-month status review. Their decision has not been announced yet.
- When I began this work I was aware that Gary Beauvais and Doug Keinath and one other WYNDD coauthor had generated a predictive range map for pygmy rabbits by using heritage data. It is a good model, and they statistically validated it, but they never had a chance to groundtruth it.
- Doug gave us the model segmented into four probability classes. We chose 50 random sites in each probability class, and then we began surveying. We limited our surveys to 600- by 600-meter survey boxes. For logistical reasons we began working on the south end of the WLCI area and slowly moved northward.
- Last year, we completed one round of surveys at each of 153 survey sites. We looked for relatively fresh pellets or burrows or rabbits themselves.
- Let me emphasize that the results we have now are preliminary; we have only 1 year of surveys completed. We have a second year to do surveys, and then Doug and Mike and I have to sort it all out. Right now, however, it looks like the model is overpredicting occupancy in the high-probability class areas and missing a little in the low-probability class areas. This is not unexpected.
- In 2009 the remaining sites will be surveyed. We will work with Doug to see what refinements we might make to the model. Interested in using presence and absence data to develop a new classification model.
- Two other habitat predictive models exist, GAP and WBEA (USGS Wyoming Basin Ecological Assessment). We want to and plan to work with those folks and use these data to validate their maps as well.
- Finally, we intend to move over into some sort of energy development gradient ranging from undeveloped suitable habitat to high-density development and model density along that gradient as a function of development intensity.
- We also want to improve predictive habitat models of both species, especially as it pertains to energy development. Want to share with managers to help make management conservation decisions.

Questions

- How confident were you in identifying signs of pygmy rabbits versus juvenile cottontails?
  - We collected scat every time we found a sign of a pygmy, and we need to have genetic analysis done. We generated two models with our data, a conservative estimate and a liberal estimate of occupancy. Conservative required at least two signs of pygmy; liberal required only one unless it was visual.
- For the future assessment of energy intensity, will you use the same plots or new samples?
  - A new sample scheme. The current distribution only marginally falls across energy areas. My desire is to make sure we have a good predictive model so that when we take it to the next stage and are evaluating road density, for example, we have high confidence that all our sites are selected within highly suitable habitat sites.

Gary Beauvais, WYNDD

Wyoming Pocket Gopher: State of Knowledge, Species Status, and Ongoing Research

- As is typical with a talk like this, I am a presenter but most of the credit goes to Doug Keinath and also Hannah Griscom and several other groups.
- The Wyoming pocket gopher is a species that has grabbed some headlines lately and has the potential to grab more in next few months. The species has a long and confusing history. From 1857 (the earliest mention) to 100 years after that nobody really knew for certain what a Wyoming pocket gopher was or where they might be found.

- In 1979 Charles Thaeler published a packet that established the Wyoming pocket gopher as a full species that was restricted to a small area of south-central Wyoming. Then the species was ignored for 30 years until 2006, when the Rocky Mountain Region of the USFS sponsored a full species assessment to draw all the information about the Wyoming pocket gopher into one source. The main conclusion was that there was not much known.
- In 2007 the species was petitioned for listing under the Endangered Species Act (ESA). The final decision is due this year or early in 2010. Suddenly, a lot of people are interested in the pocket gopher.
- One of first questions was "What is the Wyoming pocket gopher?" Or maybe, "Is it an actual valid species, or is it a subspecies or a variety?"
- The original description in 1979 relied on morphological characteristics to distinguish it, such as small body size, pale fur with a yellow color, an ear fringed with white hair, and the lack of a dark patch of fur around the ear. Critically, Thaeler recognized that Wyoming pocket gophers consistently have 46 chromosomes, which differs from Idaho pocket gophers and northern pocket gophers.
- One of the first things we did was reassess all of these characteristics by using museum specimens and recently caught field specimens. It is true that Wyoming pocket gophers are generally smaller than northern pocket gophers, although there can be overlap in size. Their fur is lighter, and it is definitely yellower. Also, those important morphological characteristics of the ears are present—Wyoming pocket gophers' ears are fringed with light hair and lack the dark patch of fur around ears seen in the northern pocket gophers. So we can use that to identify specimens and species in the field.
- In 2009 Dave McDonald was able to put together a solid genetic analysis of pocket gophers. His lab connected tissue specimens from several subspecies of northern pocket gopher and other species. Several samples came from purported Wyoming pocket gophers. His group created an amplified fragment length polymorphism (AFLP) genetic analysis and built a tree of genetic similarity between all of the pocket gophers in this region.
- The main conclusion is that the purported Wyoming pocket gophers formed a single and distinct group. Not only is it one genetic group, but it is also very distinct from all other pocket gophers, surprisingly distinct at the species level from all other pocket gophers in the study. Idaho pocket gophers, which occur in western Wyoming, also form a single and distinct species group.
- Additionally we brought two live field specimens in, they did a karyotype analysis, and each specimen had 46 chromosomes. The weight of morphological and fine- and coarse-scale genetics suggests the Wyoming pocket gopher is a valid species.
- Then the question turned to "Where is it?" The original map in 1979 had 22 confirmed specimens of all types of pocket gophers in 13 unique public land survey sections (roughly Sweetwater County). The Wyoming pocket gopher was thought to be completely restricted to two counties in Wyoming: Sweetwater and Carbon.
- Some trapping was supported by WYNDD, Dr. McDonald's lab, and Hayden-Wing Associates. The work combined for a total of 80 person-weeks of field trapping in 2007 to 2008. We documented 12 new specimens of Wyoming pocket gopher and added eight new public survey sections to the known range of species. We used historical locations and new locations in predictive distribution models to get a better idea of where the Wyoming pocket gopher might occur across southwest Wyoming.
- We built multivariate statistical models of the environment at all points of known occurrence and extrapolated across the State to identify environments similar to those. In Uinta County we may have a situation where all three species occur—although there are no known occurrences of Wyoming pocket gophers there, it is an interesting biogeographic situation.
- At a finer scale, it appears that Wyoming pocket gophers are occurring in islands of barren vegetation that occur within more general matrices of shrub-dominated landscapes. None have been found in shrub-dominated areas, just in barren patches dominated by cushion plants and bare ground and gravel.
- The description of the Wyoming pocket gopher's occupied environment then is patches of low vegetation within the sagebrush matrix on soil that allows the gophers to dig and tunnel. They also appear to occur on ridge slopes; we are not finding them on ridgetops or in the bottom of drainages.
- The Wyoming pocket gophers do not occur in dense sagebrush or other shrub stands. They do not occupy dark, fine, deep, high-quality soils. It may be that the larger northern pocket gophers occupy them and exclude the Wyoming pocket gophers to gravelly ridge slopes, although that is just a hypothesis at this point.

- So, we know about taxonomy and distribution, so question turns to "Is it threatened?"
- What we suspect is that this species has a very small global range and is distributed sparsely and fragmented within that range. Those factors suggest endangerment, but in terms of land use there is just no information. They do live underground, which suggests that any activity that disturbs or impacts topsoil may threaten populations, but we just do not know much at all.
- This year we will conduct additional field surveys. The BLM is likely going to do the same out of the Rock Springs Field Office, focusing on Wyoming pocket gophers and Idaho pocket gophers to better delineate range and distribution questions. Dr. McDonald is going to add context to his genetic conclusions. There is the possibility of soil analysis and a sand soil mapping study through the Wyoming Reclamation and Restoration Center. We would like to perhaps generate maps to more definitely predict occurrence.
- We are working hard to coordinate fieldwork and information exchange and development. We are using a special link on the Web to post maps and habitat descriptions so that people getting out in the field can get up to speed quickly on where to go and what to do.
- One final point, stepping back. This is a species that has been known for a long time but was ignored by everyone until it was petitioned for listing. Obviously when a species is petitioned it becomes a main driver of natural resource related decisions. We need to spend a lot of time thinking about how we might be able to get out ahead of these situations.

Questions

- Are there other taxa in the region with the same potential (for listing) such that we need to develop information on how to avoid management headaches later?
  - The case can be made that, yes, there are, but these do not have backbones, in contrast to WLCI-interested species. There are dozens of rare and endemic and poorly known invertebrates in Wyoming that are legitimate targets for listing petitions or have some level of conservation concern. Just yesterday I came up with 80. We have been working hard to develop information on rare invertebrates and trying to use lessons from the Wyoming pocket gopher to steer that.
- Does the model end at the State line?
  - Our model runs into northwestern Colorado. So far no one has turned up a Wyoming pocket gopher, but no one has specifically looked for it there.
- Has anyone looked at habitat differences or interactions or interbreeding between the pocket gophers?
  - It does not look like they interbreed—the difference in chromosome numbers prevents that. They are dividing up habitat somewhere—you get a foothills signal from Idaho pocket gophers; they may use habitat similar to Wyoming pocket gophers—but really it is an open question. The northern pocket gopher and Wyoming pocket gopher have been caught within 100 meters of each other.
- You said there were 22 confirmed locations in 1979 all throughout State, but your distribution model showed only southwest Wyoming.
  - No, the dots on that map were all of the pocket gophers; just the gray pocket in southwest Wyoming was Wyoming pocket gophers.
- So they have always been restricted?
  - Exactly. The Wyoming pocket gopher has only been in that one small area.

Brad Fedy, USGS

Population Monitoring: Within-Year Repeated Counts and Scale

- Cameron Aldridge coauthor.
- There is an incredible collection of data on sage grouse in Wyoming that has been gathered over the last 40 years.
- People interested in wildlife are interested in knowing how many animals there are in a given space and time. There are a lot of people and organizations tasked with this, and it is very challenging.
- Species counting is a cornerstone in wildlife management. We need to know what time period is appropriate. If counting more than once in season, you end up with more precision. But you have tradeoffs with time and money for precision. This relates to our goals.
- The question is "Are we thinking of counts?" Sage grouse is an excellent species to address

this issue because it is a hot species right now and because we have significant long-term data. Wyoming is great because the State contains a significant portion of the sage grouse range.

- Males arrive at leks in the spring, and this gives us an opportunity to monitor populations—leks in the springtime are a central place. It has been argued that you need a minimum of three to four counts per line for accurate counts at leks.
- Unfortunately, time and money constraints did not allow for three to four counts. So how useful are the data that were taken before we knew it was useful to count three to four times?
- We have a huge long-term Wyoming dataset and took only observations that were counted three to four times in each year. Then we built a trend model based on this best data and resampled it 50 times, randomly drawing on any number of these observations. For each climate division, I had one dataset.
- Data that were sampled only once were always in the 95 percent confidence interval, while 88 percent of those resampled fell within the 95 percent confidence interval. This tells us that one observation in a year at a lek site does not need to be discounted.
- Based on lek counts of males, sage grouse are cycling at 6–9 year intervals. This is important because if there is an upslope in population and you do not realize it and you put in a wind farm and the count goes up, you think the wind farm is good. If you do not know where you are, the truth of the count may be eroded.
- This model applied to these data translated into a percent detectable change. If you want to predict 15 percent change, you need to include 75 or more lek sites. You need to count those more than once per year. If asking on State or rangewide level, one count per year is close enough to not throw out.
- The conclusion is that interpretation does not change when looking at certain scales—rate of change, change points, and population fluctuation. This exemplifies the utility of old data that were based on single observations.
- In the Powder River Basin, trends might be different from those in the rest of the State. In 1995, the basin underwent a crash that paralleled what was happening in the rest of the State. Where you see statewide recoveries, however, the Powder River Basin does not recover.
- You can apply this to other species. I got data for other sagebrush obligate species to apply these models to compare to sage grouse. These are data from burrow sparrows. What you can see is there is very little correlation between what they are doing before 1995 and 1996, but after, there is a big correlation. Same for some other species. Post-1995 the correlation is significant.
- The important point is that these models give an accurate description of population trends. The caveat is that if GPS data are not valid the model results are not valid.
- You can apply this across multiple species if you have count data on them.
- The identification of the change point is interesting in that it is a change in increase or decline rates. We may be able to use this to identify the beginning of decline or increase, provided they continue to cycle as they have the last 40 years.
- For the next step, we will be looking at long-term influences of climate on population fluctuation and using timestamp climate data and then timestamp well density data to look at the influence of well density over time.
- We would like to thank Tom Christiansen and Mike O'Donnell for on-the-ground work as I am new to Wyoming.

Questions

- When looking at sage grouse population dynamics you also have to look at populations being extricated on local scales. How are you looking at what has disappeared?
  - You are right. What has disappeared is important. If a lek has disappeared, it is taken out of trend data. These are active leks that we are using.

Anna Chalfoun, Department of Zoology and Physiology, UW

Energy Development Effects on Songbirds: Patterns and Potential Mechanisms

- I was hired to address nongame wildlife research needs, so would love to hear any research needs or ideas.
- This is the project of M.S. student Michelle Gilbert, who is out in the field collecting data right now.
- Why care about songbirds? We know sage grouse habitat has been disappearing and that shrubland birds

are among one of the fastest declining groups. But while we know a lot about what is happening to sage grouse, we do not know as much about nongame birds, and they are also declining.

- On average sage sparrow are declining at a rate of 2.2 percent annually, while sage thrasher are at about 1 percent annually. These are migratory birds that winter in New Mexico and the southern United States that come up here to breed. They are considered a Wyoming species of greatest conservation need. They require sufficient densities of mature sage grouse habitats to establish territories and successfully nest.
- Human-induced habitat changes like energy development are significant and disturb survival and reproduction of population trajectories.
- There are reasons to expect energy development to have impacts. The simplest cause is that we are losing habitats. The ramifications of that are obvious; there is a reduced carrying capacity. Fragmentation is another way this has an impact, influencing species' movement and dispersal. But also consider reduced habitat quality and its inability to provide critical resources. This can manifest with birds in that the condition of vegetation layers influences insects, which are a main food source.
- We can also think about species interactions. For example, the Jonah Field has increased densities in ravens because they use drill rigs as nest structures and take advantage of food sources. They are of course potential nest predators to songbirds.
- Also, behavioral avoidance could lead some songbirds to not use destructed habitat at all.
- The overarching objective was first to document initial patterns to see if there were effects from energy development on songbirds. If there were preliminary effects from energy development, the objective then was to determine if there are thresholds and what the potential mechanisms driving these effects are.
- The study area is in Sublette County in the Upper Green River Basin. Sampling was conducted within three different overall energy fields. The sites stratify across gradients in energy development intensity, anywhere from 0–15 wells per 1 kilometer. A total of 240 point counts and 123 nest plots were collected on the landscape to quantify abundance and diversity.
- Preliminary results, as this is ongoing, show a slight decrease so far in three focal species with increasing levels of energy development. Perhaps more importantly the probability of nest success decreased with decreased distance from the nearest well pad. These results were generated from an original sample of 220 nests from last season.
- Focused on shrub vigor—what percentage is live, healthy, and green? Average shrub vigor goes down with energy development. This vegetation layer influences food sources such as insects. There is a distinct decrease in nesting size.
- So, we have documented effects from energy development on the songbird community. The next steps are to collect an additional year of data and count sizes. If our hypotheses are supported, we might be able to make some predictions.
- Hypotheses are potentially mutually occurring:
  - Loss of habitat leads to lower abundance and richness.
  - If fragmentation occurs, expect lower avian metrics in smaller habitat patches or in the vicinity of habitat edges.
  - Expect decrease in shrub vigor.
  - Nest predator augmentation—expect increased nest predation with increased energy development.
  - Decrease in songbird presence in areas because of behavioral avoidance.
- Ultimately the desired outcome of this work is to develop an improved understanding of the relation between species and energy development and to tweak management to alleviate effects.
- Matt Kauffman got the ball rolling on this project. Tasha Carr and Steve Germaine have been wonderful collaborators, and we have had wonderful brainstorming sessions on synergizing our efforts. Our funding source is mainly from the WLCI and the WGFD.

Questions

- Have you looked at settlement patterns to see if animals come back? I wonder if higher quality animals are farther away and if lower quality animals are coming closer to well pads.
  - Yes. One way to do this is to look at surveys of the first settled sites.

Cam Aldridge, USGS

Effects of Anthropogenic Features and Habitat on the Distribution of Sagebrush-Associated Species in the Wyoming Basins

- This project was funded by the BLM to fill in gaps on other ecoregional assessments that have been conducted.
- We expanded the Wyoming Basin regional assessment area to fit in with other ecoregional assessment areas. It covers about 25 percent of sagebrush habitat area. The Wyoming Basin is a core stronghold for sage grouse.
- The impetus of why the ecoregional assessment was important was to analyze existing information on primary land use changes and impacts to sage grouse habitats and the implications for wildlife species of concern. Goals were to develop methods to provide tools for management and observation.
- One of the first things we did was develop a human footprint assessment. You can see there is not a place in this study area that you can get more than 3 kilometers from a mapped human disturbance. This is based on map data from more than 3 years ago, so there is more disturbance now.
- We summarized vertebrate species of concern and the effects of energy development on these species. There is an extensive amount of functional habitat loss. Not a direct footprint, but if an animal avoids it, it is being impacted.
- Modeling approaches mapped the spatial distribution of exotic and invasive species in habitats of species of concern. We used Federal species listings to identify the priority species we would assess. In 2005 and 2006 went to 230 sites where we conducted vegetation sampling at five plots at each site. Also conducted rare and invasive species counts and ungulate surveys.
- Our input variables included habitat characteristics, abiotic variables, and anthropogenic variables assessed at multiple spatial scales.
- One model shows invasive cheatgrass. We predicted where it was likely to occur. All areas along roadsides and along wells have a high probability of cheatgrass occurrence. Fifteen feet or so from major roads and well pads, you are guaranteed to have cheatgrass. Railroads have a large-scale similar effect.
- We modeled six species. All six of the species sampled are likely to be affected by invasive species caused by energy development. This helps us understand risk of exotic species invasion.
- We developed approximately 20 different models so far for Wyoming Basin environmental assessment species, including bird species. I am going to focus today on two models—the sage grouse model and the brewer's sparrow model.
- Sage grouse are associated with a large abundance of sagebrush and heterogeneity. They avoid rugged terrains. As you have more sagebrush the probability of having sage grouse increases.
- The WLCI area is a hotbed for the brewer's sparrow. Again, the species is associated with mature, structurally complex sagebrush. Also associated with riparian habitat at a smaller scale, it avoided large structures on large landscape scale.
- For about half of the species we did not find a strong correlation between behavioral disturbance and avoidance.
- So, what can we do with data on 20 different species models? We summed empirical predictions to identify potential biodiversity hotspots and mapped them. The hotspots are where we should focus management and money.
- The southwest Wyoming region has five sagebrush obligate species, including the brewer's sparrow, the sage sparrow, the sage thrasher, and the pygmy rabbit. Is the sage grouse an umbrella species? If we are managing for sage grouse alone, many areas would be considered from a management context. We overlaid those areas for the four other species. There is a lot of overlap. We quantified it. If we focus on sage grouse areas we would protect 70 percent of the other four species. The knowledge on sage grouse is useful, then, because they do appear to be somewhat of an umbrella for the other species.
- We can also ask "what if" questions and look at potential future energy development scenarios. We can overlay hotspot biodiversity maps with areas of potential conventional oil and gas and coal bed and natural gas development. When you do this, some areas of all five of the sagebrush obligate species are overlapping with development. There is a conflict. It is not necessarily beneficial to put easements into areas that have high probability of energy development. These tools can help us define a conservation management plan.
- The next stage will design where to put all resources and money and not conflict with development and still be able to protect species of concern.

- These will provide incredible planning tools for the WLCI. We can identify priority conservation areas and areas of conflict and areas for mitigation. Future scenario applications can be developed as well, and models can be applied to them to predict how these species will respond and develop plans for how to best manage this landscape.
- Book completion is scheduled for fall 2009.

Questions

- When I saw the analysis of biodiversity hotspots and how you overlaid it with future energy development, I saw that there were few unaffected areas left. So maybe we should focus on oil and gas development to see how it can be less detrimental rather than focusing on other unaffected areas.
  - I agree. My job as a scientist is to find impacts, though, and it is up to managers and politicians to make these tradeoff decisions.
- How big were these survey areas, and with what degree of confidence did you measure this data?
  - This is a cumulative sum. The songbird study was the best because we have point count samples. The mammals were captured. The scale was 100–150 meters from sites. It all varies.

Plenary Session 5

Discussion

- This information is great and could have helped a lot of BLM planning documents. I heard about people going out to the Moxa Arch, which was a work site for me. It would be nice if we knew when you were going out to collect data. Please go to the office that is managing the land so that we know about the data being collected.
- This is a great collection of information and resources. Please, in a nutshell, say what the greatest priorities for research topics are for folks coming up in the next few years?
  - The first thing that comes to mind is what is going to happen on the landscape. Wind power development is an issue that we are all reacting to rather than being proactive about. From my perspective, to wildlife, the wind turbines are almost as grave as an oil well.
- We are all trying to understand the impact of energy development or any development and the response of and effects upon wildlife. I would push for more future scenarios such as energy development and climate change, and we need to have great overlays for this so that we can have great confidence intervals.
- I think the next important step is to understand thresholds and how different levels and types of development will affect landscapes, habitats, and wildlife. Development will happen. If we can better understand differences between types of development, we can make decisions on what impacts we are willing to accept and make management plans.
- We need to get a better handle on how species relate to one another across fragmented landscapes.
- While I agree that on a large scale sage grouse as an umbrella species can be useful, we have to be careful to pay attention to the smaller scale distinctions when talking about managing for particular attributes.
- How do we identify what groups of patterns on the landscape are hanging together? How can we maximize the results that we get from management plans?

Plenary Session 6

Changing Landscapes

Session Leads

Vito Nuccio, USGS
Chris Potter, USGS

- There are several simultaneous changes taking place on the landscape in this area: oil development, but also uranium and hard rock mining, road infrastructure, oil shale, wind, and climate change.
- The session is divided into two parts. The first will be three speakers talking about geologic energy sources and the future of gas development through time. The second part will include wind energy, climate change, and ranching issues.

Chris Potter, USGS

Geologic Energy Resources as Drivers of Change in Southwest Wyoming

- The purpose of my talk is to provide an overview of geologic energy resources currently being produced or anticipated to be produced in the future from southwest Wyoming.
- I hope this talk will provide you with a geologic context for understanding the Greater Green River Basin from a geologic perspective. The various topics I am going to hit will include conventional oil and gas, unconventional gas including basin-centered gas, coal bed methane, shale gas, oil shale, and uranium.
- Before that, I would like to present a bit of geological perspective. The oldest geological units in the Greater Green River Basin are exposed in the Rock Springs uplift (see fig. 1–4), and exposed around the basin are younger units of Tertiary age. The basin is bounded on the western side by the Utah-Wyoming Thrust Belt and on the other sides by large uplifts, for example the Wind River uplift and the Uinta uplift that are pre-Cambrian crystal rock brought to the surface by faults.
- A cross section across the southwest corner of the basin (see fig. 1–5) illustrates structures that have influenced the evolution of this basin. On one side is the folded thrust belt impinging on the basin, and on the other side is the Uinta uplift. These folded thrust belt structures are classic examples of thin-skin folded thrust belts. The rocks have been compressed in earliest Tertiary time, and an older stack of sedimentary rocks have been compressed and stacked along curved faults that come down and merge into a relatively flat detachment surface. It all evolved through compression. The other structure that bounds this basin is an uplifted crystalline basin risen up along a moderate to gently dipping thrust fault.
- This basin largely evolved in Cretaceous and early Tertiary time.
- Unconventional oil and gas is most significant in southwest Wyoming. The broad type of deposits that are most important in the Greater Green River Basin are continuous or unconventional deposits where essentially there is a gas resource developed in a more widespread way in the basin without a discrete easily defined seal. The nature of the gas fields in Wyoming is controlled by the fact that they are essentially more continuous accumulations of so-called basin center gas.
- The USGS assessment of gas in southwest Wyoming estimated there are 84 trillion cubic feet of recoverable natural gas in the Green River Basin.
- In the USGS energy program, as we study these oil and gas resources, we do it from a standpoint of petroleum systems. As we view the petroleum systems, we must understand the source rocks from which the oil and gas were generated (rich in organic matter, buried, and heated) and then the migration of those fluids through geologically defined passageways into their eventual resting place within a geologic structure or container.
- Coal bed methane is a resource produced from coal beds at a depth in which methane has been produced through water-saturated coal beds through microbial activity. Water and methane are produced together, and the methane is separated out at the surface.
- There is a tremendous amount of coal bed methane development in the Atlantic Rim area, more than we would have anticipated on the basis of geological surveys a few years back. There are also several places with development potential. The southeast part of the Rock Springs uplift has exploratory wells.
- Brief discussion of oil shale in the Greater Green River Basin. Oil shale is a resource that is organically very rich. It is composed of shales that have never been buried deeply enough to generate oil but potentially contain huge oil resources. The USGS, particularly a

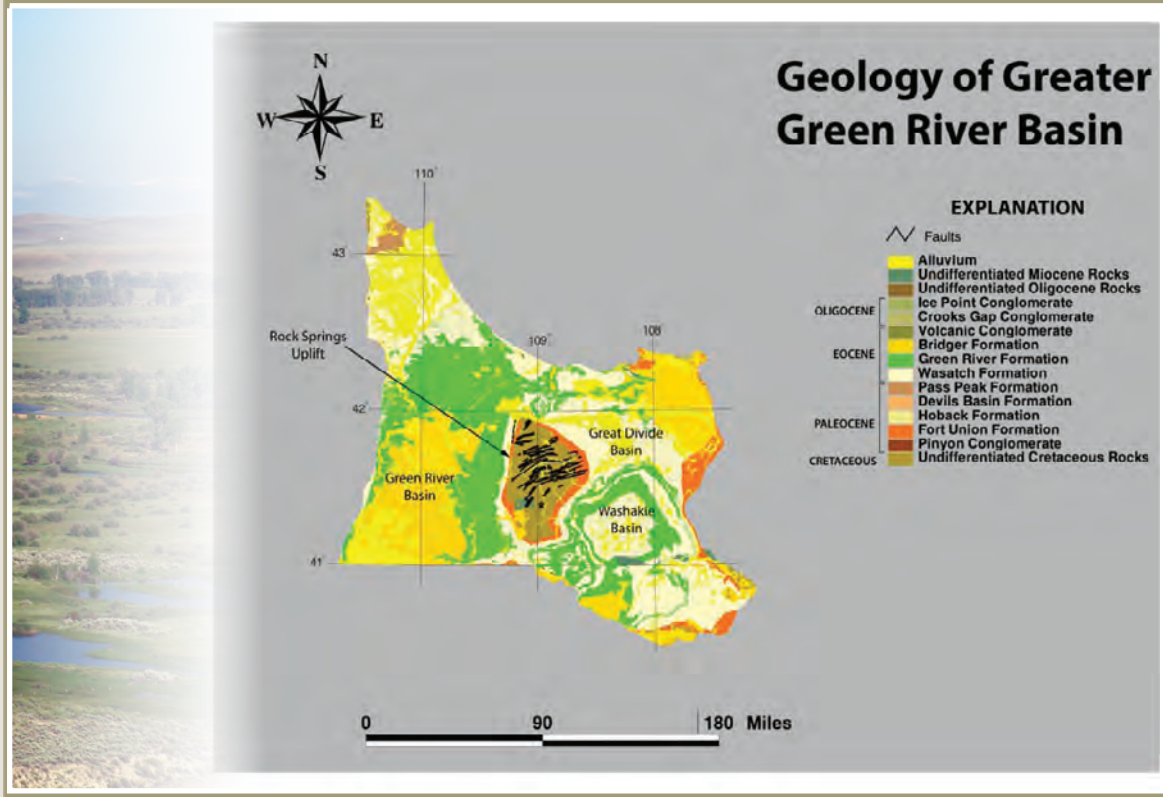


Figure 1–4. Geology of the Greater Green River Basin.

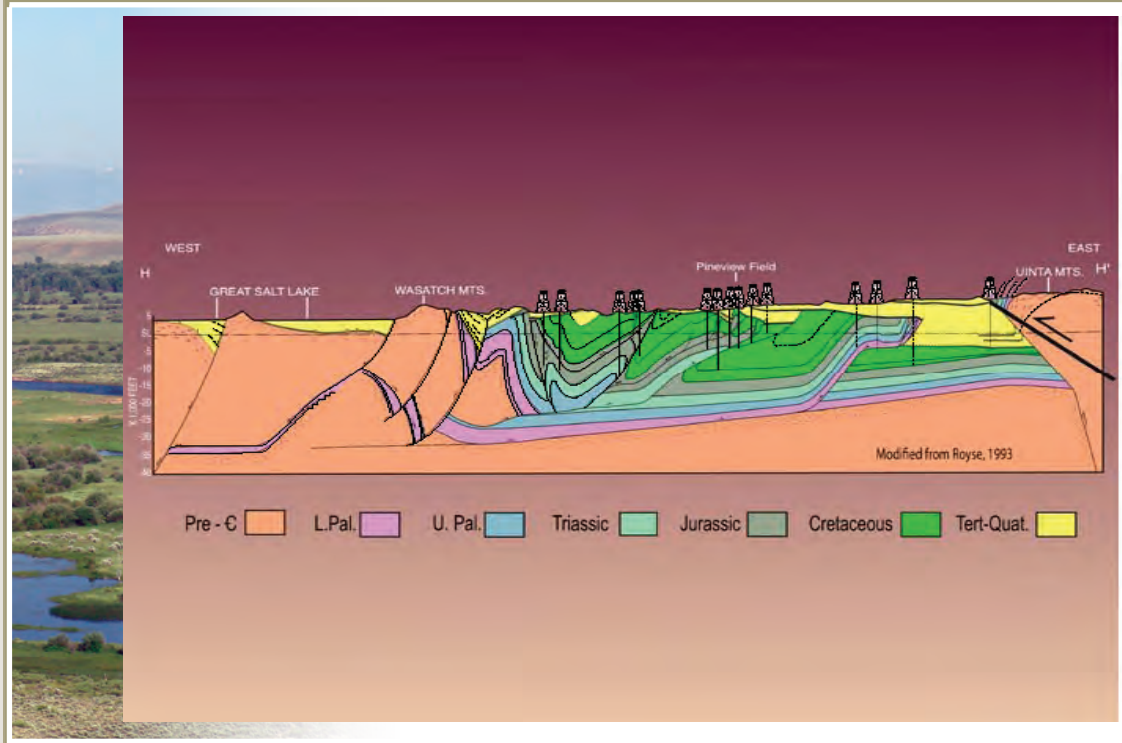


Figure 1–5. Geologic cross section, southwest corner of the Green River Basin (modified from Royse, F., Jr., 1993, An overview of the geologic structure of the thrust belt in Wyoming, northern Utah, and eastern Idaho, *in* Snoke, A.W., and others, eds., Geology of Wyoming: Geological Survey of Wyoming Memoir no. 5, p. 273–311).

group headed by Ron Johnson, is currently conducting a major project to reassess potential oil resources within oil shale in the Green River Basin, the Piceance Basin, and the Uinta Basin. Recent estimates indicate the presence of a trillion barrels of "in-place" oil (which is not the same as oil that could be actually produced). There is potential for a resource that large within the Piceance Basin, but because the shales present in the Piceance Basin are much richer and much more geographically spread out there is not a viable economic means for recovering oil from the oil shales. This resource is quite a ways out from being developed, even in the Piceance Basin.

- The last resource I will talk about is uranium. Right now in the Great Divide Basin there are at least 29 active uranium projects. All the production of uranium in the United States now is done through in situ recovery as opposed to traditional hard rock mining. In situ recovery is a process by which fluids that have been enriched are pumped into ground while the uranium is separated out at the surface. This is the process that would almost certainly be used with respect to that Great Divide Basin. There is controversy as to the ability to sufficiently restore operations after the in situ leaching process has been initiated in a particular area.

Questions

- Does the 84 trillion cubic feet of gas you reference include deep resources?
  - That is not an easy question to answer. There is no definite depth limit, but I would say that number does not include resources in the deepest part of the basin.

Mark Kirschbaum, USGS

Hydrocarbon Potential in the WLCI Area

- The purpose of the presentation is to explain our role in trying to understand hydrocarbon potential in the WLCI area, to give a broad overview of geology and assessments, and to explain how assessments may be used to predict future development.
- In two of our recent assessments we developed geological provinces. Two of these provinces, the Wyoming Thrust Belt Province and the Southwest Wyoming Province, cover the entire WLCI area (see fig. 1–6). You will hear me interchange Green River Basin with the Southwest Wyoming Province.
- What we are looking for are various geological basins that have unique depositional environments, like marine shale, shore face deposits, coastal plain deposits, and riverine deposits. Marine shale contains a lot of preserved marine organisms, so there is a high total organic carbon content.
- We deal with petroleum systems, which link deposits, source rocks, and reservoir rocks.
- The region has a great diversity of ecosystems but is also one of the most prolific gas regions in the country. It is the 14th largest producing hydrocarbon basin and is near number one in terms of potential for production.
- The assessments we do to predict potential areas of oil and gas production are mandated through the Energy Policy and Conservation Act. We also identify potential additions to reserves and specifically what quantities underlie federally administered lands. All done by using current technology and peer-reviewed

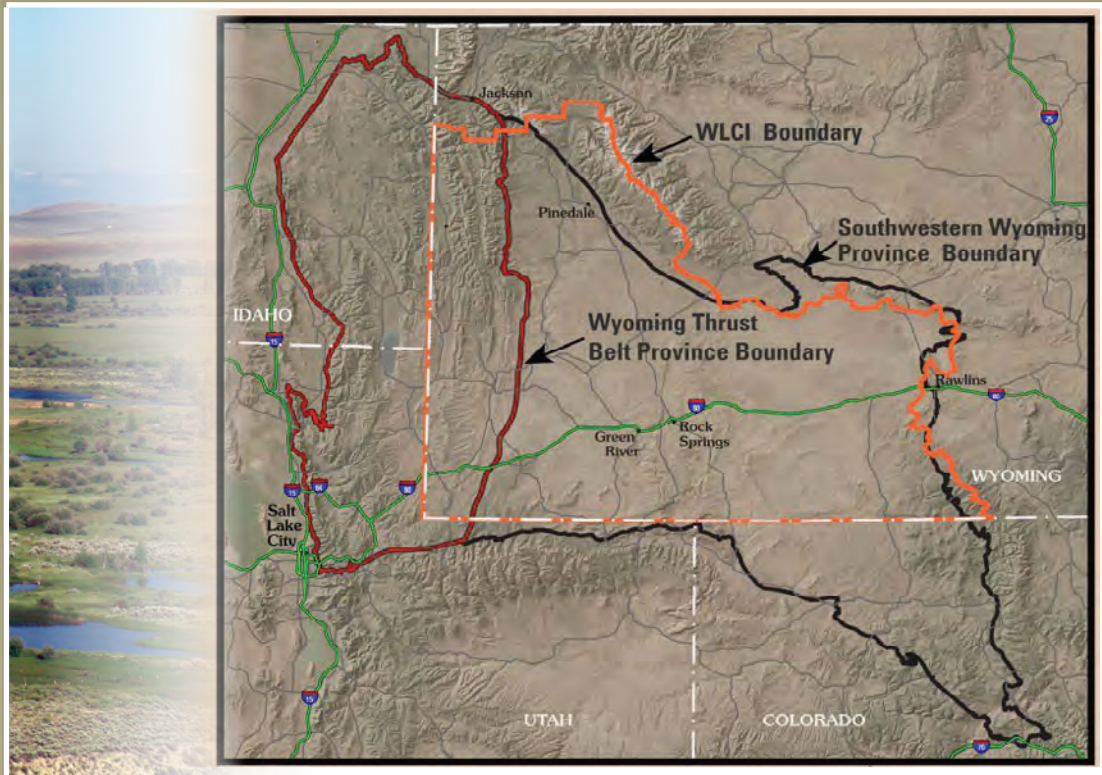


Figure 1–6. Geological provinces defined in recent USGS petroleum assessments. The Wyoming Thrust Belt Province (red line) and the Southwest Wyoming Province (black line) cover the entire WLCI area (orange line).

methodology to identify simply where can you uncover gas—there are no economic models yet.

- There are two scenarios so far, one by TNC, which is based on an MIT [Massachusetts Institute of Technology] model, and then another developed by Dean Stillwell with a qualitative estimate of low to high potential for reserves.
- There are several different types of accumulations. Structural accumulations, which are the easiest to explore, have been found by and large in United States. The other types of accumulations are much more subtle and require much more geologic input to quantify. In many cases the USGS is not privy to the wealth of information U.S. companies have accumulated.
- Within the WLCI there is a thrust belt. Loading of the crust causes the development of these basins, so you get paired systems. While the Green River Basin was being born we were having a replacement of the Sierra Nevadas.
- Thrust belts around the world do not have the tremendous resources that one might expect to find in their paired basins.
- Eighty-eight million years ago the overall areas of Colorado and Wyoming were a mile or so lower because of tectonics, and there were no continental glaciations, so sea level was much higher. So you see early in time there was a lot of marine shale with micro-organisms that died and gradually were buried and that caused the production of oil and gas. Later in time marine sand and delta shale juxtaposed and created sandstone in this area.
- Production from the Frontier Formation is largely isolated in the Moxa Arch area and the Rock Springs uplift area. The majority of current production is in an area of less than 16,000 feet or 3 miles.
- What these assessments will not account for is any emerging concepts people come up with—basically how fast the Atlantic Rim is being developed.

Laura Biewick, USGS

Oil and Gas Development in Southwest Wyoming

- Purpose of this talk is to provide historical and geologic perspective of oil and gas in southwest Wyoming. Information regarding geology and oil and gas resources is provided in a GIS format on the Energy Resources Science Center Web site, http://energy.usgs.gov/index.html, which has a map server.
- First want to talk about domestic oil and gas production. The United States has had several production peaks and valleys, with peaks in 1972 and then a decline in 1983 partly due to a gas shortage. Since the mid-1980s, production has overall been increasing steadily.
- Looking at production in 5-year increments for the WLCI area, the Pinedale fields showed up in the 1940s, then Jonah in the 1990s, and then coal bed methane production.
- When geologists did the geologically based assessment for this area, they estimated the amount of gas in nine different petroleum systems. Nearly all of the undiscovered gas (97 percent) is in six petroleum systems. A generalized stratigraphic column points out the different intervals these reservoirs are in. The shallowest interval is the Lance/Fort Union system. In the western area the Mesaverde/Lance covers Cretaceous rocks. The Lewis system, then the Mesaverde system, and then the upper composite formations are next.
- Because the resources are distributed in six of the undiscovered areas, this is where my study has been—it is focused on just the Southwest Wyoming Province. Looking at detailed geologic logs of the seven assessment units that contain the majority of the undiscovered resource shows that they all contain 7.5 trillion cubic feet of gas or more. In comparison to other units, these contain a larger percentage of gas.
- For each assessment unit, I looked at the wells associated with each unit. Because the Wyoming Oil and Gas Conservation Commission (WOGCC) database does not have an attribute for the units, I instead looked at stratigraphic intervals within the units. The purpose is to indicate exploration and production activity in a particular stratigraphic interval. Some of the wells do extend past a particular unit, but often the extent is into another of the seven stratigraphic units of study.
- Where the Lewis Shale exists, it overlies the Mesaverde Group, and it forms a seal to separate the Mesaverde from the Lewis system. Where the Mesaverde pinches out, there is no other system overlying in this area—no seal. In this other stratigraphic area, they are all combined to form the Fort Union and Mesaverde system.
- Since the assessment, there has been extensive coal bed methane (CBM) development on the Atlantic Rim and by Rock Springs. Looking at the wells drilled since the assessment through last spring, there were 6,171 wells in total, 461 of which are CBM wells.
- The publication was published just in time for this workshop. It contains live maps and downloadable GIS data. The map documents are available as interactive maps and are available on the WLCI Web site. You can download GIS datasets and portable map files. If you do not have GIS you can use free ArcReader.
- In the process, our team has upgraded from ArcGIS to Arc Server technology, which has better performance in some instances. We are working with the latest technology to improve performance.
- Future work includes working with coal data from the National Coal Resource Data Systems (NCRDS), which contains thousands of coal locations. Oil shale data have points in Fischer essays; not published yet but will be made available. Uranium data are being prepared for publication. Some CBM data for this area; most are data on the Powder River Basin. Minerals data will soon be available.
- The goal of the WLCI is to enhance the quality and quantity of aquatic and terrestrial habitat while facilitating development. Data can be shared by using different GIS technologies and facilitate integrating existing data.
- The dataset I work with represents the work in this area since last spring and has been updated to make it current for this year. I put the new data "behind" the data I was working with. One hundred and thirty-eight additional wells were drilled this year in the Atlantic Rim, Jonah, Pinedale, and some other scattered locations. The URL to the publication is http://pubs.usgs.gov/ds/437/. Also available from WLCI main Web page.

Questions

- Not all wells drilled are active. Are data available to represent these wells through WOGCC?
  - Yes, those data do exist and are in my dataset.

Heather Nino, BLM

Wind Energy Development

- Wind energy has hit Rawlins quite hard, with over 50 site monitoring locations in the surrounding area. Wyoming is the center for the best wind in the United States.
- Background on how we authorize wind farm site testing and monitoring. It is all managed under Title V of the Federal Land Management Policy Act (FLMPA), Regulation 43 CFR 2300, Policy Instruction Memorandum No. 2009-043, and NEPA's 2005 Wind Energy Development Programmatic Environmental Impact Statement and associated land use plan amendments. The instruction memorandum is the main source for information and was last updated in December 2008. It made a large difference in the amount of bonding charged for towers and pricing. The NEPA document, completed in 2005, helps determine the level of NEPA for each project because each application is different.
- There are three types of applications:
  - site-specific grants for testing and monitoring;
  - project area grant for testing and monitoring; and
  - development grants.
- Changing environment:
  - A met tower is not the biggest thing out there. It is comparable to a communications tower or another tall structure. Three to eight met towers are going up per application. They are hard to hide. We do have a color scheme, but since they are 200 feet high there is potential for low-flying-aircraft safety issues. So, we have to color the top of the met towers orange and white to make them stand out.
  - For wind turbines, 50 percent gray is the best color for purposes of blending with the landscape, but they will still be seen from about 20 miles away.
- Issues and concerns:
  - There are a lot of cultural issues no matter which way we turn.
  - No matter where the application is located, there is always a wildlife issue. Sage grouse seem to be the biggest issue right now.
  - Enormous amounts of concrete and road construction.
  - Turbines can be seen from 20 miles away.
  - General public access needs to be protected.
  - Dust.
  - Each wind farm needs a permanent person in each community for every 10 wind turbines. This creates concerns about where to put extra people.
  - Traffic concerns about how to safely bring equipment to project areas.
  - There are both private and Federal oil and gas rights in the Rawlins area—need to make sure that turbines, oil and gas, ranching, and recreation can coexist.
- Wind energy development will bring a great source of energy, but we need to be environmentally conscious of what we are doing.

Questions

- Where will transition lines go?
  - The TransWest Express will go to a substation from Rawlins and then south to Las Vegas. The gateway west will be the overland pass line and the zephyr. There will be five transmission lines, but they have not told us which they will go on yet.

Stephen Gray, Wyoming Water Resources Data System, University of Wyoming

Climate Change in the Green River Basin: New Challenges for Natural Resource Management

- Would like to suggest we all need to know that there are many factors that make places like Wyoming and the Green River Basin in particular very susceptible to any type of climate change.
- There is a big reason why this is the case. Places like the Green River Basin are truly very dry places. When you look at the Green River Basin you see that the majority of the area receives very little precipitation in the average year. There are less than 16 inches of average annual precipitation in the basin, and that is very dry. To put it into perspective, if that is scaled up to the State of Wyoming and then ranked to compare to other States in the United States, we come out to be the fifth driest, ranked up there with places like Nevada, Utah, and Arizona. So any type of climate change that causes it to get wetter or drier will have a

dramatic impact on the ecosystems and the way people live here.

- When it comes to resource management you have to look at where the water comes from. Here, water comes from snowpack. In the Green River Basin most of the water comes from sources that are up high in the 10,000-foot range, and the majority of runoff comes from snowpack. If you have any change to the system that impacts this snow it will affect the availability of water over a much broader area. All of our eggs are in one basket here.
- Couple that with what the future might look like, and you can sum up predictions in this way: the West will be warmer. It boils down to basic chemistry and physics. If we keep operating in the way we are operating now the West will be warmer; there is no way around it. What we do not know is how changes in temperature and precipitation will interact, but the West will likely be drier than it has been historically.
- As for a specific prediction based on forecast models, what we might expect is a 3 degree Fahrenheit warming by midcentury and a 6 degree Fahrenheit warming by the end of the 21st century. It is more difficult to make predictions about precipitation; however, the range of forecasting suggests something between a 5 percent decline or increase. That is not terribly different from what we see today. But how climate responds to warming at a global level will be significant, with drier summers and slightly wetter winters. The interactions between changing temperature and precipitation regimes might lead to a greater swing in intensities.
- Even if you keep precipitation the same with a tiny bit of warming added on top of that it begins to look like a drier Western U.S. outcome. The Palmer Drought Severity Index—which chronicles drought impacts over time—is an experiment that took precipitation of the past century plus warming of 2.5 degrees Fahrenheit, and it looks like average conditions by midcentury look like the 1950s drought. A 5 degree increase looks like the worst years of the drought we have just been through—and this is keeping the precipitation the same. The bottom line is that a little bit of temperature change has potential for severe impacts.
- A little temperature change means significant change in snowpack and hydrology. We are seeing a preview of that. Comparing historical data and data from the last decade or so about changes in April 1 snowpack in the Western United States, we see that the amount of snow is going down over time even if we keep precipitation the same. That translates to river systems like this: in some cases we see less water in wintertime, but that is not always the case. There is also potential for more flow in winter and increased winter flooding events. More uncertainty surrounding earlier timing of peak flow and diminished peak. At the end of the summer—what happens to late season flows?
- Also, what about terrestrial systems and linkages to river systems? Just adding a little bit of warmth extends the length of both growing and drying (that is, fire seasons). Already seeing impacts of warming in the extent of fires and fire behavior over the past few decades, and the future seems to be shaping up to look like that. In some cases more extreme fire.
- What does a little warming mean for pest outbreaks? What we are seeing now is that warmer temperatures have facilitated or contributed to outbreaks like mountain pine beetle, plus trees' defenses are weakened by drought. Sets the stage for unprecedented insect outbreaks that could majorly change ecosystems.
- We also are seeing exotic species and land use changes on the ground already. This introduces the possibility of new management strategies in the face of new species moving in to the area.
- The problems we are dealing with now in terms of natural resource management are at the least complicated and will be amplified by the effects of warming, and the bottom line is that we will be drier in the future. We have the possibility for new management strategies.
- With climate change we render our assumptions about the past and its relation to the present invalid. Keeping landscapes the same may no longer be a viable option. Climate change may render the way we do business today—policy and active/passive management—invalid; our approaches in place today might not work. It demands hard looks at the way we do things today and some flexibility.
- So, it does not matter what is driving climate change; we just need to adapt to a changing climate. There are many opportunities for win-win strategies—things we can do to mitigate the effects of climate change at the same time that we are addressing on-the-ground challenges we face today.
- We need to put money into the monitoring of climate and into resources on the ground to prepare for drought and regulatory challenges. We can start investing in ways to get climate and natural resources data out to people.
- We do not have to know exactly what the future looks like to start planning for it today. All we really need

to know is what range of possible futures are out there and use scenario planning to look for vulnerabilities or opportunities to increase the resilience of the systems on the ground today.

Questions

- What will the influence of climate change be on sagebrush in Wyoming? Will it change distribution?
  - That depends on precipitation and also the seasonality of that precipitation. If there is more precipitation in the spring versus in May and June we will have to take a hard look at what is going to happen in these areas and do a physiological type modeling.

Jessica Montag, USGS

Ranching Community Perceptions Toward Energy Development

- First let me point out my coauthor Justin Caudill. As I said yesterday with a coauthor, I will take the blame for any inaccuracies, and Justin can take all of the accolades. Also, so you have an understanding of where I am in this presentation, this morning I started practicing and it dawned on me that there is a better way to convey some of this information. So in keeping with this whole session of changes, I revamped the whole presentation.
- What was really the catalyst for this was that I started thinking about change. I started thinking about the changes that have occurred in just my lifetime. When I was growing up we had a rotary phone. When we had to give that up for a touch-tone phone, it bothered me. We have gone now to answering machines to cell phones.
- Think about the landscape-level changes that we have seen in our lifetime. When you go back to where you grew up, you realize there are changes that have occurred on the landscape which have then changed how you view that landscape.
- I grew up in a small town of 300 people in rural Wisconsin with family rural farms in the vicinity. There was one in particular I drove by every day. Back then it was common that every farm in their fields had wind breaks. One had a beautiful oak tree with a redtail hawk that nested in that tree. I would see it every day as I went back and forth. When I was in college and went back, the farm had been taken over by corporate owners who had cut down that wind break. When I drive by that, not seeing the tree or the hawk brings a sense of loss to me that still hangs onto me now. Not only has the landscape changed, but my view of it also has changed. I have come to realize that landscape is an integral part of who I am and how I view any other landscape now.
- If you think about what is occurring in southwest Wyoming and the rapid landscape changes, you can start to imagine the impacts those landowners and residents might be feeling. There has been a real concern about the ranching community in this area. What planners and managers need to deal with is trying to incorporate the values the communities have towards the landscape and towards the management of the landscape.
- Part of what makes this difficult is there has been a paradigm shift in how the public views land managers and their expertise. When these agencies started, the public trusted managers as experts. There has been a shift; the managers are still the experts but feel like they just need to educate the public as to what is correct and that the public's knowledge is not valuable.
- Now, we are seeing another shift, and the public is demanding input on land management decision in ways that have not been needed before.
- There are a lot of values people hold toward the landscape, and the values they hold are as important as any scientific information. That is not to dismiss the science but to say that people's values need to be incorporated into the decisionmaking process.
- The WYDOA has recognized potential impacts from landscape changes in southwest Wyoming to ranchers. They have developed, with the USGS, a survey instrument which will be mailed out at the beginning of the summer.
- There is a lot of support for ranchers in Wyoming. Previous studies indicate that Wyomingites believe in the conservation of ranches and the ranching way of life. Studies also show there is a lot of support for ranchers because of the benefits they provide, including wildlife habitat.
- Research has shown that impacts and concerns over water quality and water quantity are issues for ranchers in terms of energy development, and increases or reduction in forage and quality are also concerns. In terms of wind there are concerns over stray voltage and access rights and also just concerns over the quality of their life and how that is going to be changing with energy development in the area.

- The collaboration between the WYDOA and the USGS mentioned earlier helps illustrate what the WLCI has been able to afford these different agencies. The WYDOA had a real concern and need to try and identify what ranching perceptions are towards all types of energy development (not only oil and gas but also wind). So we have developed the survey, and what that focuses on is a lot of these issues in terms of the quality of life:
  - How are ranchers seeing change in their communities, and how does that stand in respect to the past? In the 1980s, research indicated that ranchers saw a considerable change in their communities because of boom and bust. Many ranchers even moved out of their communities because of a lack of neighborliness and friendliness. There is concern that quality of life is going to change.
  - Not only quality of life but the actual operation. How is energy development going to impact not only the landscape but also their economic bottom line?
  - What management actions would ranchers support? What actions can they work with agency folks on?
- We are hoping to mail out 1,300 surveys with the hope of getting 800 back. They will be sent out in the WLCI area and in all of Carbon County. Randomly selected ranches will be asked to participate. We will be getting the surveys back and doing the analysis hopefully during summer and fall and then will work to highlight current ranching perceptions against past ranching perceptions.
- With this current boom, very little research has been done in terms of the social and economic components of energy development. The WYDOA is being incredibly proactive in helping these people deal with changes occurring on the landscape in an effective manner.
- The real value of this type of research is trying to show that there is science in terms of people's views and values and there is a real role for incorporating those values into a decisionmaking process. When those processes are lacking there are issues in terms of increased litigation and increased ballot initiatives so that the public has a voice in land planning.

Plenary Session 6

Discussion

- Research has shown that meteorological towers can be a danger to birds as much as wind turbines themselves. The USFWS has recommended that bird diverters be placed on met towers. Has the BLM discussed this, or does the BLM require use of bird diverters?
  - We are requiring bird diverters. Every met tower we authorize has one. It might be those on private lands that you are seeing towers without bird diverters.
  - I had trouble even seeing the bird diverters even when I knew they were there. There definitely is research that needs to be done on how well those things work. Anyway, they are just little silver flappers that have a sticker on one side and metal on the other; you have to watch for them to see them.
- From Kemmerer you can see the turbines down on Interstate 80 (I–80) 50 miles away. People in the east do not understand how bad those things affect your viewshed.
- In reference to the proposed pipeline to take 25 percent of the water from the Green River and take it to Colorado—what am I missing here?
  - It is going through the Army Corps of Engineers right now because of the water takeout issue, and we are in scoping right now. The plan of development has not come in from the company yet—we are very much in the basic stages—but the scoping comment period is open until July 27th. It is a very high profile project.
- I was just thinking in terms of the climate data presented here today.
  - In a general sense, when you are considering any project like this in the Colorado River Basin in particular, you need to think about how often you expect that amount of imaginary water to actually be there in the stream and about taking a very good look at the data and the historical time period you are using to base your calculations off of. What we see when we use tree rings to look at Colorado River Basin climate going back, it turns out the 20th century is among the wettest in millennia. That means the gage records we have that we base the legal water amounts off of may give us a very wrong picture. You add on to the fact that it will be warmer here, and warming means more evaporation and likely more evapotranspiration, which takes even more water off the top. Unless you are thinking about large water projects in that kind of context you could very well be getting into a situation where you will not have enough water to meet the obligations you set up for yourself.

Plenary Session 7

Monitoring

Session Leads

Jay Hestbeck, USGS
Pat Anderson, USGS

- The monitoring framework will do the following:
  - Occur at varying spatial and temporal scales for the life of the WLCI.
  - Be a fundamental element in the integration of science and management.
  - Provide information on the status and trends of the environment.
  - Provide information on the effectiveness of WLCI management and restoration efforts.
  - Build on monitoring practices of all entities already in place.
  - Report to STAC.

Dan Manier, USGS

USGS Monitoring for WLCI

- There are many contributors to this project from several different disciplines and offices. The point of this presentation is to give us a review of things happening across the region, bring us up to speed, get us thinking about how we can work together and get moving on long-term processes, and think about ways to do things better.
- Webster's definition of "monitoring" is "a device for observing a biological condition or function; to watch, observe, or check, esp. for a special purpose; to keep track of, regulate, or control…" (from Latin "monitus": one that warns, an overseer).
- Elzinga, Salzer, and Willoughby define "monitoring" as "the collection and analysis of repeated observations or measurements to evaluate changes in condition or progress toward meeting a management objective."
- Here, we think of it as repeated observations (measurements) of the amount or condition of a defined target as it changes through time, "to warn or report" to managers in a timely manner.
- The simple reality is that things are changing. We know that as landowners, as scientists, and as land managers. The question is "What to do?" Adaptive management gives feedback. When you start talking about cumulative effects and added pressure for accountability, well, we have to have some idea of what we have and how it is doing out there.
- It is challenging to do something like this. All sagebrush is not the same; neither is the underlying geology. The WLCI area has a lot of underlying heterogeneity that triggers differences in patterns, vegetation, and how people and animals use those landscapes.
- In order to say something about trends over time, we have to have some understanding of spatial variability. If we repeat measures over time we can start to get trends. We need also the help of a design and data representing things that we think are driving patterns on the landscape to help us sort out the spatial patterns and the complexity. If we want to be able to make meaning from trends we need to account for sources of variability in preliminary design efforts.
- The design process is a small piece of the larger process. We need some context to let us know how one treatment fits into the larger region. The steps we have been working on over the last year are to whittle concepts and needs into things we can do on the ground. We are considering things like the WLCI plan and outcomes from the last workshop, as well as work on the ground within the USGS, to make sure we have reasonable interpretation of what was documented to get down to what are we exactly trying to measure.
- Review with stakeholders. We need feedback as to where monitoring is going and what is important to measure—how does it resonate with you?
- Results of a Generalized Random Tessellation Stratified (GRTS) design developed by the EPA gave us 46 potential monitoring sites for the WLCI (see fig. 1–7). We used this modern statistical approach so we could end up with spatial bounds and randomness. We get bounds to represent the whole area and to represent each unit across the landscape.

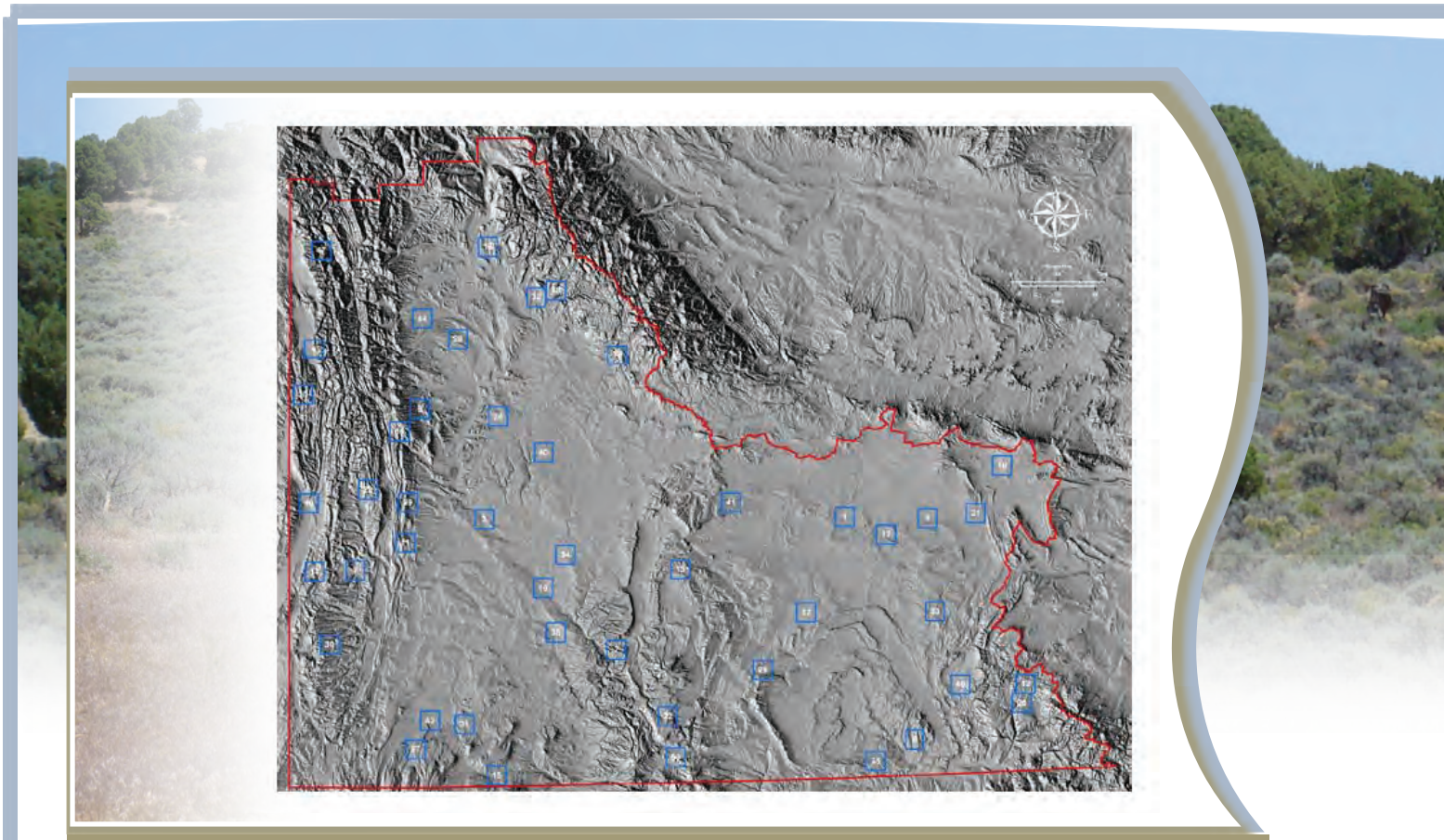


Figure 1–7. Potential monitoring sites for the Wyoming Landscape Conservation Initiative (WLCI).

- We want to make sure that in this whole area we have samples. When we start working on our designs we realized that there are places in high elevations in the WLCI area where we could not get samples, so we narrowed the target area just a little bit.
- Looking at other things besides just patterns and natural resource samples, we also have represented oil and gas potential. We want to map different potentials for development, as well as other things across the landscape.
- One design we are testing is to sample about 45 sites to represent all different ecozones. We have introduced that design in the BLM offices. If implementation needed to be broken up according to field office, each could move forward with a representative sample of just their field office. The point of a design like this is to be a framework for different people, different agencies, and different purposes so sampling can be done in a colocated manner.

Pat Anderson, USGS

- We've been focusing on the conservation planning process that we developed. The biggest point to take here is that a unique role of integrating science with the local project development teams gave us the opportunity to develop this effectiveness monitoring to be an integral part of the conservation process. Because we built both of these together we have inputs that help everything from resource assessment to design, to developing priorities, and to the effectiveness monitoring part.
- There is also a big technical aspect of this that requires all USGS disciplines. This technical aspect involves everything from taking our science as they [the local project development teams] plan a project to making sure they design appropriate monitoring plans to go along with the project. It is coming out to meetings and telling them about our science so they can develop conservation actions that get at drivers and stressors of this system. Typically, people tend to address the effects, not necessarily the drivers and stressors, and it takes a lot of people to integrate our science and allow local people to develop these projects that get at drivers and stressors.
- Other activities included hosting a meeting in Laramie that we called the Friends of Muddy Creek. The area has a lot of partner issues and a lot of science and a lot

of issues that people are interested in. So we brought in people doing science and monitoring in this area to provide information.

- Allowed the development of adaptive management to take our knowledge and feedback into feedback loops, asking how we can take what we have learned and do a better job developing conservation actions.
- We have had local project development teams ask us questions of where and how to do better projects. The way we are doing this is turning these questions into hypotheses and relating those to conceptual models and degradation pathways. These models go from drivers and stressors, and that way we take these questions and rephrase them in a way that allows us to have our designs address them in a statistically rigorous way.
- Examples of effective monitoring include the following:
  - Aspen example: We had a few objectives including answering if we were getting aspens to sucker and if we were getting aspens to sucker after a burn. We also wanted to go further and look at how stand compositions, associated soils from years of conifer encroachment, and canopy species fit in. We ultimately wanted to be able to tell the team where the most risk of conifer encroachment is and how to prioritize treatments. We looked at subcanopy vegetation along conifer cover and quickly found that 50 percent of overhead cover species change drastically the more you get undercover. This results in decrease in forage and biodiversity, and so we want to monitor that as we treat those areas and determine how they respond to differing years of conifer encroachment.
  - Sagebrush example: Geneva Chong (USGS) addresses sagebrush treatments with a view toward ecosystem function, again with drivers and stressors. Her objective was to create more forage or get rid of decadent sagebrush. She is doing that through plant communities' structure and soil function and looking at how that changed with treatment and how those systems either recover or become more productive. All the work we are doing is trying to correlate these with NRCS ecosite descriptions. The outcome of ecosite correlations can help develop models of state and transition. (State is a plant community's response to topography, soil, and precipitation in an area, and transition is what occurrence has led it away from that state.) We want to validate those models, and in Wyoming those models have not been validated that much.
- Other activities we are really involved with include invasive species, mapping stands of tamarisk, and working with county weed and pest folks. We are delivering the science, and they are going out and applying treatments.
- Also looking at using remote sensing methods to help inform where we should do projects and what drivers and stressors are altering habitats. We want to determine what current conditions are combining to alter habitats. Looking for statistically significant changes in treatments.
- We will be working to inform the prioritizing process.

- We are using remote sensing to track invasive species. We can apply that technique to things like cheatgrass. There are hundreds of burn projects in the WLCI, and we can use site-specific monitoring and remote sensing.
- Vegetative phenology will allow for comparisons between treatments.

- Rangeland evaluations are also ongoing. Over in the Kemmerer area we want to use the monitoring of treatments to look at how well elk respond to and move around those treatments. We will collar elk and look at the relation between their patterns and habitat treatments in that area. We will also look at pellet counts to see if sage grouse are using those areas. Are the treatments attracting sage grouse or not?

Dan Manier, USGS

- Right now, water resources in the WLCI include an existing integrator water quality and quantity monitoring site out on the Green River. Looking at water flow coming out of that whole upper Green River watershed, and there is also another gage at Muddy Creek.
- There are a lot of things that could happen with both surface water and groundwater monitoring. We are talking about working at multiple scales—entire watershed and within it. The overall goal would be to get water balance modeling and see what is going on with water use and land use across the landscape.

Dave Smith, USGS

- Soil is a critical natural resource. Our very existence depends on it, and it forms the foundation of every ecosystem. It is quite fitting that soil is one of the components of the interdisciplinary science activities going on in southwest Wyoming as part of the WLCI.
- My piece of science is soil geochemistry. The primary purpose of this activity is to determine the natural variation in geochemical concentration of soils for the entire study unit. We will be looking at macronutrients, micronutrients, and potentially toxic elements.
- The purpose for the study is best depicted by this quote from Mary Lou Zoback 8 years ago: “Documenting and understanding natural variability is a vexing topic in almost every environmental problem. How do we recognize and understand changes in natural systems if we don’t understand the range of baseline levels?” This effort is all about understanding the range of baseline levels for soils in the WLCI study area.
- In 2008 we selected samples at 139 sites, selected by a generalized random tessellation stratified design throughout the WLCI study area. Samples were collected at a shallow depth because that represents the portion of soil that humans come into contact with most frequently. We did that at every site. At 39 of the sites we also did additional samples from the uppermost mineral horizon.
- The USGS labs analyzed these samples for 44 elements. Colorado State University’s soil, water, and plant testing labs also were testing for total nitrogen, pH, electrical conductivity, and sodium absorption ration (SAR). Unfortunately we do not have complete data back from the labs, so with that I will turn it back over.

Dick Grauch, USGS

- The Muddy Creek study area is a major drainage on the Atlantic Rim development site for gas. Muddy Creek itself runs most of the time for most of the year.
- As mentioned earlier, there is a lot of work going on. UW is doing some modeling to predict the amount of runoff and the amount of sediment yield that occur within specific subbasins of the Muddy Creek drainage. These are designed so that you can run a model based on today’s conditions, alter input that has to do with land use, and see what will happen with land use. The forward modeling is only as good as the data that go into it and is based on soil type, vegetation cover, and other parameters like topography. We need a fair amount of data that relate to that model, and those data need to be gathered on a scale appropriate for that model. In the Muddy Creek drainage we have to come up with a sampling method that is designed on the appropriate scale.
- Muddy Creek has sulfates/soils that occur naturally along a lot of the streambeds. In the brush country there is a little bit of salt. This material goes into the drainage, eventually finds its way into the Colorado River, and costs us in damages so that it can be used for agricultural purposes. The salts also carry environmentally sensitive elements such as selenium.
- Want to argue about soil being the foundation for every ecosystem. The real foundation is rock solid, and it is geology. So what we want to do is take an understanding of geology and how those rocks weather and turn into soil, determine what is happening in the soil, and study how that impacts the area.
- It all starts with geology. You have heard of the units within this part of the country. The Niobrara, the

Lewis, and the Steele are all marine shales. These shales are ones whose soils tend to concentrate selenium. They are distinct clay minerals. Once the rock moves and starts to form soil, a lot of minerals move around, and the soil profile then tends to aggregate. In the process the soluble material is moved up and down through the soil profile, and salt precipitates at the surface. If you wet the surface, the salt develops, and moving down in the soil you can end up with a precipitation of salts.

- That repeated process over time concentrates the more onerous elements, like selenium. The salt on the surface can go to 150–170 parts per million of selenium, and those are the guys that can dissolve when it rains.
- Another example is on road cuts, where salt precipitates. The impact for this kind of surface disturbance is to bring out more salt than would normally be in a drainage such as Muddy Creek. We need to quantify how much additional salt is brought up to the surface and ask if it is going to precipitate.
- The reason this is all important, in terms of all the salt being out there, is that in this kind of environment, you have got a fair amount of rain and you get tremendous runoff. All the salt is almost instantaneously dissolved, and all the salt goes down into the drainage.
- All of that material coming down the stream is missed when we look at salt loading to main drainages. In one particular rainstorm, it was documented that in excess of 50 percent of annually dissolved solids came off. That is a tremendous lug of contaminants and salinity going into the Colorado.
- So we are going to be monitoring salts and how to quantify the land class and how that impacts downstream and main stream.
- In the future, one of the things we need to monitor along with conditions of resources is "What are the human populations doing?"

Dan Manier, USGS

- One of the things that comes up is it is not typical to take all the data gathered for a project and represent them spatially. Importantly, not all data can be represented spatially, but many of these variables do have representations or indices that we can represent across the landscape. We can look at shifts in cultural values and in economic concentrations but can also predict where people will be in the future.
- Another part of our idea here is we want points on the landscape where we can monitor what is going on in the landscape and how wildlife are interacting with changes in the landscape. Mechanistically we can look at details of how certain species respond to pressures of infrastructure. We also have large-scale pictures of what is trending in species across the whole Western United States. That is fine, but we want to understand the picture of southwest Wyoming. We need to ask what the important pieces of habitat are and what species are responding to. We want to build that into our monitoring approach.
- Similarly, with small mammals we have been doing developmental work out of Fort Collins. Another important focus is getting at the pygmy rabbit. It is an interesting case because the distribution is not border-to-border WLCI.
- We are also conducting multiple-scale vegetation mapping and monitoring. We have been developing a system where we have three different scales where we can look at something about the habitat. The continuous distribution of these is a big chunk; it is an important and powerful tool when looking at connections between what population is doing and what habitat is doing.
- Land use
  - Mapping habitat and cover is not the same as mapping land use. It is a separate effort and a really important piece to this puzzle.
  - We have been spurred on by the idea of habitat degradation where we may not recognize a large State scale. We do have control sites where, as best as we could determine, we were not connecting to anything out there—the control sites are not anchored to a feature. We had about 35–40 species that showed up on our list from last summer, but only 12 showed up repeatedly over and over again. We need to go through and look at data and look at different features, which will give you different species. There seems to be a difference between where the invasive species are found.
  - Need to map and model current species distributions and get more information for treatments.

Mary Read, BLM

Monitoring Without Borders

- Short presentation on a meeting that Monitoring Without Borders had in February (2009).
- BLM biologists like me to work on environmental impact statements (EISs) out in the field with oil and gas companies, and soon we are going to be starting to work on wind farms and met towers. The hardest part is that, once you have the EIS signed, things get really busy. The reality is that you are supposed to monitor and to ask what is going on after projects are put in the ground, to determine what kinds of impacts are occurring and why they are occurring.
- The problem we have is that we have multiple EISs coming on top of multiple EISs. There are agencies out there doing their own thing, private folks doing their own things, and the efforts have not been coordinated. Because of these issues, we got together in 1997 and said "Let us all get together and figure out where and how and when we need to monitor and then figure out cause and effect."
- So we got started in 2000 with the BLM, the WGFD, the USFWS, and industry. It took 2 years to make industry feel like they were actually a partner in this project. A few of the EISs we have worked on are Creston-Blue Gap, Desolation Flats, and Atlantic Rim.
- The EIS areas are pretty big, and we are getting new areas and EISs like the new Continental Divide-Creston EIS. This translates to a whole lot of country for a handful of biologists at the BLM to be making all the decisions.
- So we [participants in Monitoring Without Borders] meet twice a year. At the last meeting, the issues discussed were annual reports for raptors, status updates for threatened and endangered species, status updates for sensitive species, the Continental Divide-Creston EIS monitoring field season, updated RMP and cooperative agreement, the Atlantic Rim shrub-dependent songbirds study, sage grouse monitoring, status updates for threatened and endangered fisheries, and amphibian monitoring in Muddy Creek.
- The team asked, "What are the species we have to prioritize?" We triaged as a team. Species proposed for threatened and endangered status and candidate species are the first we look at, and sensitive BLM species were the second component. The BLM biologists do a lot of raptor monitoring out in the gas fields, so we then split into individual EIS monitoring areas where you might have a specific area that might have to tier off one or two areas for a specific wildlife situation or impact analysis. And of course sage grouse exist throughout all of the areas, so we discussed those. Finally, we do also have a fisheries amphibian program that we have been more involved in for the last 5 or 6 years.
- The Monitoring Without Borders program is where we go outside of the actual parameter of the EIS. It took industry a while to understand that just because they have an EIS border does not mean that raptors and wildlife do not move outside of the border. Now, we are monitoring raptors and nests outside of the borders. For example, in 2008, we did 642 nest visits to find 107 new nests, 144 nests that were active, and 107 that became active.
- In the EIS Monitoring Without Borders area, we are working on a threatened and endangered species, so we have mapped all black-footed ferret habitat and lynx habitat. The Ute ladies' tresses is possibly inside riparian areas, but we had to triage it by saying we are going to stay 500 feet away from riparian areas. We may have to monitor it anyway if the need is there. The Wyoming toad is outside of the EIS, the Colorado butterfly plant is towards the eastern portion of the field office, and our fisheries biologists deal with the depletion components.
- Then we go on to our sensitive species program. Years ago, our sensitive species program was rather weak; now we are doing the best we can. Our goal is to talk about need and potential habitat, talk about potential impacts, and then get into cause and effect mitigation and potential response.
- We discussed the sensitive species for mammals. Right now we have basically mapped whitetail prairie dog. Nothing has been done with the bat. Work is going to start on the Wyoming pocket gopher this summer, and finally, while we have not mapped the swift fox, we are aware of his presence.
- Of course we do lek monitoring for greater sage grouse, and we have paired up nicely with the BLM, the WGFD, the USFWS, and even some industry guys. We have other species like brewer's sparrow and sage thrasher and keep asking, "What do we do with those?" That is why we hope to partner with the WLCI to start helping us out in the field and out on the ground to figure out how to monitor and how to determine impacts.
- We want to make sure that our program has sensitive plants issues as well. We do on-sites on every project and have a lot of biologists out there. Goal is to identify where these plants might be, and then the next goal is to get a team approach together.

- The fish and the amphibians in the area are being worked with. We are doing more work on the northern leopard frog.
- We are having seasonal monitoring of riparian habitats this summer throughout bat patch areas. Also working on the shrub-dependent songbirds and of course partnering with the WGFD in monitoring sage grouse lek information. We have two biologists using aerial photography and groundtruthing to map the whole western part of our field office for sage grouse habitat. Our RMP was signed in December and has mitigation that covers the entire habitat, not just the 2-mile buffer.
- The Continental-Divide Creston EIS has not yet been signed, but mountain plover have been monitored on all 1.1 million acres, 84 leks are being looked at in the area, and the next step is a mule deer collaring study. Also, pronghorn are now being collared in the EIS area.
- One final thing we are working on is looking at other factors besides just oil and gas, like roads, allotment, recreation, human activity, a diversity of other subject matters.

Kathy Raper, Sublette County Conservation District

Sublette County Surface Water Quality Monitoring Program

- The first program goal was to develop a water quality monitoring program in Sublette County to see what our surface water quality was. The second goal was to ensure that data collection was locally led.
- Sampling site selection was based on the following:
  - Furthest point upstream on the New Fork, Green, and Hoback Rivers as water leaves Federal lands.
  - Major tributary confluences with the above rivers—for early detection of possible impairment source.
  - Midpoint sites selected as deemed necessary.
  - Monitor the quality of water leaving Sublette County.
  - Joint project with Sweetwater County Conservation District to monitor Big Sandy and Little Sandy Rivers.
- The monitoring program began in 2000 with 17 sites on the New Fork. In 2001, 19 sites were added on the Green River. There are 7 sampling sites on the Hoback, 8 sites on the Pinedale anticline, and now 2 on the Big Sandy and the Little Sandy, for a total of 53 sites.
- Limited chemical and biological data have been collected within Sublette County. One of the earliest gaging stations was established in Sublette County on Boulder Creek in 1903.
- Chemical data are collected four times a year (spring, after runoff, early fall, and late fall), and biological data are collected once a year in the fall.
- Chemical parameters are alkalinity, carbonate, bicarbonate, calcium, chloride, hardness, magnesium, nitrates, phosphorus, potassium sodium, sulfate, total dissolved solids, total suspended solids, and for quality assurance and quality control measures we also have had the lab do ions, cations, and cation balance. The energy lab in Casper flags any data that exceed DEQ standards so they can be addressed immediately.
- For biological sampling, macroinvertebrates are collected by using a net placed on streambed in a riffle. Eight quadrants are collected and combined into one composite sample. The substrate is recorded including types of algae and plants, particle size, embeddedness of substrate, precipitate, and fine sediment. Flows are also recorded.
- The field parameters we measure include pH, dissolved oxygen, turbidity, temperature, total dissolved solids, and conductivity. Flows are measured when it is safe to do so.
- We have an access database that is checked three times for quality assurance and quality control. The information is made available to the public for review.
- We are funded by the Sublette County Commissioners for going on 10 years and also by the Wyoming Association of Conservation Districts, the DEQ, and the WYDOA. Cooperators include the county, private landowners, and agencies.
- Special projects include the Pinedale Anticline. This project is funded specifically by gas operators and addresses surface water and groundwater. Surface water sites were established in 2001 to help BLM operators fulfill the Pinedale Anticline ROD. We used the same sampling techniques. The only difference is that for this project we also sample for parameters such as total petroleum hydrocarbons and diesel range organics. The data are again checked three times for quality assurance and quality control, presented to the Pinedale Anticline Water Task Group, and then forwarded to the Pinedale Anticline Working Group

(PAWG) and to the BLM. Funding is 100 percent from operators.

Tim Morrison, Little Snake River Conservation District

Little Snake River Water Monitoring

- Standing in for Larry Hicks and will talk about conservation districts in the State of Wyoming.
- The conservation districts were created in the 1930s and became a partner with the soil conservation society, now the Natural Resources Conservation Service (NRCS). We are locally led and provide capabilities for producers and landowners and cooperators at a local level and give them the capability to interface with U.S. Department of Agriculture (USDA) programs. There are 34 conservation districts in Wyoming. Some are funded by local tax levies, some by county commissioners, and some by grants. It is sometimes hard to keep these conservation districts going.
- Our conservation district has done monitoring on Muddy Creek since 1954. We monitor during high flow times from runoff or storms. About 700 cubic feet per second can be coming down the Muddy Creek, and the water is about 10 feet deep. It makes monitoring interesting.
- The conservation district was involved in two Section 319, Clean Water Act programs through the EPA to get water quality monitoring programs.
- We do all the monitoring Kathy Raper (with the Sublette County Surface Water Quality Monitoring Program) does and more. We have been learning these systems. We are trying to focus on high and low flows. High is when sediment is being transported, and we take chemical analysis then, too. We have taken over a site from UW and have monitoring at that location 24 hours a day 7 days a week. We use flow pressure transducers and a troll and measure six to seven parameters 24 hours a day four times per week.
- In addition to water quality measurements, we have a program where substrate, riparian vegetation, stream channel morphology, and permanent photopoints were used to monitor watershed treatments and responses.
    - The location for this program is Loco Creek, a tributary of Muddy Creek where measurements were started in 1992–93. We take photos and use fire fencing and water to get best management practices (BMPs) instituted. The BLM was our partner in this; their range staff was involved to get photopoints established and the grazing system the producer used.
- Every time we get increased willow growth, the width of the channel decreases, and we have to clear the stream. We try to keep cows out of riparian areas. We created water developments out in the upland areas to give riparian areas a chance to recover. We use prescribed fire to restore age class and diversity of plants. The sage has turned into grassland. There are good opportunities for grazing and wildlife use here.
- Before the BMPs were in place and wetlands were operating, beavers were living there. The beaver dams were taken out to avoid impinging on grazing areas. The creek has moved and is moving through wetlands and around them.
- We believe that stopping off the headcuts on Muddy Creek is reducing total suspended sediment and turbidity. Generally, we see substantial bank building and sediment reduction because of improved riparian habitats.
- We have documented 120 bird species that can use the wetland. If you ever make it down to see these birds, swans and white face ibis and snowy egrets, it is amazing. They do not leave all the time. We have duck communities that are staying and geese that are staying. The purpose of the wetlands was to attenuate the flow of Muddy Creek and reduce sediment, which is deposited in the wetlands. It allows the valley to even out and prevents gorges from being formed.
- Upcoming in 2009, we will have an assessment of BMP effects on rangeland stream water quality using multivariate statistical techniques.

Kevin Spence, WGFD

Wyoming Game and Fish Department Habitat Monitoring Efforts in Southwest Wyoming

- In southwest Wyoming, habitat programs typically collect habitat data for management decisions rather than for research and developing strategies for managing populations.
- How do we use that data to make management decisions? It is most often used to evaluate the results from habitat improvements. Inventories are also used to justify the need for habitat monitoring and are used to evaluate the effectiveness of land management strategies.
- Here are the common types of monitoring we do, which we often combine in evaluating habitats:

- Aspen: We do quite a bit of aspen inventory and mapping. We collect data on regeneration stand densities and use a live-dead index. We prioritize aspen stands for treatment.
- Riparian: We utilize the Greenline trend survey method to provide stream land stability and evaluate the condition of willows and cottonwood stands. We use the live-dead index as well.
- Sagebrush: We work to identify priority communities. Use mountain shrub communities to assess the condition of watershed health and function and to assess big game crucial winter range.
- Lotic aquatic habitats: We collect stream attributes and use habitat quality indices to assess habitat quality for trout. Use instream flow to promote habitat protection for aquatic wildlife.
- Tall forb communities: Data are collected to determine presence or absence of indicator species.
- Watershed area: We characterize basic conditions of select watersheds and segments. Information is used to identify restoration needs and opportunities for each survey. We use beaver dam trend surveys because the number of active dams through time reveals changes that might occur with the composition of species and watershed function.
- Wildlife habitat use evaluation: An example of this is trend monitoring on big game winter range to determine production and utilization of herbaceous forage.

Joe Bohne, WGFD

WGFD Monitoring Efforts Within the WLCI Project Area

- There is a laundry list of surveys that the WGFD does for terrestrial wildlife. The WGFD is a data-driven agency. We try to use the best science to drive our management. The department deals a lot with the social carrying capacity, as well as the biological carrying capacities upon which our objectives are set. We have other management parameters that we use as objectives—these surveys are designed to give information to push us towards those objectives.
- Most avian surveys are designed to monitor long-term trends in populations, but some surveys are designed to determine annual productivity, presence/absence, and habitat selection.
- Sage grouse survey/counts are designed to collect information on population trends and indices of abundance for lek complexes and core areas and populations. Data from wings from harvested birds are used to determine productivity.
- Most big game surveys are designed to collect population data (productivity and composition) used to estimate population size (POP2) and trend and to determine effects of hunting seasons.
- Most nongame mammal surveys are designed to collect information on species of greatest conservation need. Surveys are designed to monitor long-term trends in populations, but some surveys are designed to determine annual productivity, presence/absence, and habitat selection.
- Survey techniques for most of the surveys reported in this presentation can be found in the WGFD Handbook of Biological Techniques, which is available from the Biological Service section of the WGFD. Distribution information is stored on the WGFD Wildlife Observation System, which is available to the public.
- Nongame surveys:
  - Breeding bird survey routes span North America and are a collaborative effort. Long-term trends in most bird species from 1966 are useful for tracking bird composition.
  - Trumpeter swan: We conduct two aerial surveys and some ground survey work to get an idea of productivity of fledged birds. The fall and winter surveys are coordinated with Idaho and Montana.
  - Bald eagle monitoring is coordinated with lots of agencies. Every known nest is looked at.
  - Peregrine falcon: We conduct random sampling of every known nest in the WLCI area.
  - Monitoring Wyoming birds: We obtain count-based data by using randomized habitat and stratified design to get an idea of changes in compositions and diversity over time.
  - Colonial nest water bird: We are working with USFWS in the next 3 years to do a Western States colonial nest water bird project. This includes great blue herons.
  - Long billed curlew: May be in other areas in the WLCI?
  - Ferruginous hawk: Work completed in Baggs in 2008 demonstrated a significant

decline, and we are not sure why. This might trigger further studies.

- Game bird surveys:
  - Waterfowl surveys: Goose breeding pair survey and molting surveys; midwinter waterfowl surveys. Some thought to reinstate waterfowl production surveys.
  - Mourning dove call count survey for USFWS' nationwide survey.
  - Sage grouse: The biggest program we have is the sage grouse lek surveys and counts. We do lots of work with cooperative fish and wildlife units on this to do counts on standardized protocol and data. This is useful in identifying trends—we have 50 percent of the sage grouse in the Western United States. Sage grouse wing surveys are also conducted, and some areas are closed to hunting for loss of habitat or low population numbers. Restricting the harvest also restricted data collection.
- Big game:
  - Elk: We conduct "sightability" surveys where it is hard to get a good classification survey. Post-hunt aerial and ground classification surveys and winter trend counts.
  - Moose: Post-hunt aerial and ground classification surveys and winter trend counts. Potential for using sightability survey that correlates habitat and site.
  - Pronghorn: Preseason aerial or ground classification surveys; line transect surveys to estimate population size every 3 years.
  - Mule deer: Post-hunt classification survey; spring mortality surveys; change in ratio surveys (December versus April fawn:adult classification survey); and possibly expanding population surveys to include sightability surveys and/or quadrant sampling surveys to derive population estimates with some level of precision.
  - Also conduct random surveys of winter range. Looking at the dead deer gives the adult/fawn proportions. Might include a sightability survey, but the results can throw everybody into a tizzy if the numbers are low. It is possible we will do a quadrant sampling to get actual population estimates.
  - White-tailed deer: Incidental post-hunt classification.
  - Bighorn sheep: June/July lambing survey; winter post-hunt classification survey and trend count.
- Nongame mammals (species of greatest conservation need):
  - Forest bat inventory: Martin Grenier WGFD lead. Surveys of western forests to determine presence/absence and species diversity (fiscal year [FY] 2009–10).
  - Pygmy rabbit survey: Conducted by Dr. Steve Buskirk (UW) to determine impacts of controlled burns on the species (FY 2009).
  - Small mammal trapping: Conducted by Anna Chalfoun (UW Wyoming Cooperative Game and Fish Unit) to determine presence/absence, habitat affinities, and potential impacts from development in the Green River Basin (FY 2010).
  - River otter project: Conducted by Merav Ben-David (UW) to inventory drainages for otters and evaluate potential to use river otters as an indicator of long-term water quality (FY 2010).
  - White-tailed prairie dog surveys: Completed in 2008. Mapped distribution, and estimated abundance.
  - Black-footed ferret surveys: Most completed in the 1980s in the WLCI area. Most of the State has been cleared for the need for additional surveys.
- Wildlife disease monitoring:
  - Brucellosis: Feedground herds and adjacent free-ranging herds in western Wyoming and the Jackson Bison Herd.
  - Chronic wasting disease is very prevalent in Wyoming. Mule deer, white-tailed deer, elk, and moose. Disease is just beginning to enter the WLCI area.
  - Avian flu: Waterfowl and other migratory shorebirds statewide as part of a national surveillance program for highly pathogenic bird flu.
  - West Nile virus: Any time someone finds a dead sage grouse in late August or September we would like to get the carcass. When they are exposed to the virus they have almost 100 percent mortality. Seems to be spotty and local for other populations.

Kevin Gelwicks, WGFD

Wyoming Game and Fish Department Aquatic Monitoring Projects in the WLCI Area

- Routine aquatics monitoring has been ongoing. Examples of aquatic monitoring since the 1960s or

1970s include trout population estimates conducted on 3-year intervals in Wyoming's major fisheries. Ongoing monitoring on reservoirs and natural lakes involves routine standardized netting, hydroacoustics, and fish counting reservoirs. Information gathered is used to improve fisheries through recommendations about changes in flow and changes in stocking and regulations.

- In 2002 and 2003 there was a dramatic shift in the fish division involving funding that allowed us to meet our managing needs for all wildlife. A herpetologist was hired in 2003. Most projects would not be considered monitoring yet because we do not have a lot of historical information on amphibian or reptile populations. Work right now is initial survey and inventory work. Plan on using this information to conserve and restore native species.
- Sensitive species monitoring began in earnest in 2003. Keep in mind that these are not just WGFD projects. Many are conducted by university researchers, and the WGFD is just involved at some level.
    - Native fish surveys have been done in the Green River Basin since 2002 to get a better idea of the distribution of three species of concern. We have distribution information for 8 native and 20 introduced species throughout the drainage. This information can be used for prioritization.
    - A lot of work has been conducted in the Muddy Creek drainage on three species. The first four projects were on Muddy Creek with following work on the Big Sandy and Little Sandy. There is a project in progress on interactions between lake trout and native species.
- One major threat to native suckers is introduced white suckers. We need to eliminate nonnative fish to benefit native fish. We have identified four priority areas, three of which have the goal of removing nonnative species and restoring native fish assemblages. The fourth area, the Bitter Creek, has more of a preservation goal.
- In 2009, we will be doing mechanical removal in the three drainages and starting a larval drift study in the Big Sandy to see how isolation impacts native fish. We would like to estimate native species in all three drainages.
- Native cutthroat trout management: Studying impacts of diversion structures on the Snake. Phase I was recently completed and looked at the status of isolated populations above these barriers. Phase II is looking at direct impacts on these fish and where they go to navigate through structures. Also looking at spawning movements of cutthroat trout on the Snake River.
- In the Pinedale region, conducting the LaBarge Creek restoration. Conducted chemical treatments and restored Colorado cutthroat. We are restocking and hopefully will have populations by 2010.
- Also conducting a project on climate change and the Colorado River. It is more involved than just temperatures because there are lots of interacting factors that could impact trout. This project hopes to look at all factors involved and model how they impose a risk.
- Northern leatherside chub project will start next year. This species is native to the Bear and Snake River drainages and was petitioned for listing in 2007.
- Herpetological work determines habitat needs of these species and better conservation needs for them. Includes the midget faded rattlesnake. We need information to guide remediation and conservation efforts.
- Road networks project in the Green River area. Focus will be to look at impacts of roads from energy development on native herpetological species and fauna.
- Southwest Wyoming herpetological studies are being done to get a better idea of the distribution of amphibians and reptiles in the Pinedale and Green River areas. Species of greatest conservation need include the midget faded rattlesnake, the smooth green snake, the boreal toad, and the Great Basin spadefoot toad.
- We are moving beyond vertebrates with plans to begin survey efforts on gastropods and bivalves. Need some funding to ramp up these survey efforts.

Ramesh Sivanpillai, WyGISC

Increasing UW Student Participation in WLCI Monitoring Activities Through WyomingView

- I would like to talk about UW's program WyomingView. So many speakers before me today talked about the value of remote sensing. Usually, we use visual analysis or mapping techniques. Last year there was a lot of talk about how the Wilkins Ice Shelf would break off (and now it is gone, in a matter of 9 months). This type of imagery

helps us monitor what is happening in remote places that are difficult to reach.

- We have an archive of images that goes back to 1973 that is a story of how we have managed the land. For those interested in water, land, or drought, we have pathfinder images. All these images are free and can be downloaded from the USGS Web site.
- Finally, for those folks who are interested in agriculture or anything to do with rapid monitoring, we have growth documentation. You can measure these things and compute an estimate of what growth will be.
- But there are challenges, including data types and too many data formats, no standard format, and image processing. Information extraction is often hard, so we get this perception of "leave it to the experts."
- USGS came up with this program called AmericaView to overcome these challenges. There are four objectives: to promote awareness among users, to provide free remotely sensed data, to train current and future workforces, and to use pilot projects to demonstrate the value of remote sensing.
- WyomingView is now a consortium of universities, government agencies, and other partners. We do have an archive, but now it is not as important because the USGS has made all land information freely available. You are still welcome to come to our Web site. The difference between the USGS site and our site is that on our site the images are in a ready-to-use format. If you download information from the USGS each band is stored as a separate file, and you have to stack it before you can make use of it.
- We do a lot of workshops and have trained about 150 people. We recognize that not everyone wants to do image processing, so we provide a freeware, ERDAS ViewFinder, that takes only half a day to learn, and with it you can do a lot with bringing in two images and seeing how things have changed. The software is completely free, and we have a mobile lab with 12 laptops that we can take to anywhere in the State.
- The main focus is on the three remote sensing courses we offer at UW, as well as several directed studies and internships. We have one basic, one applied, and one advanced remote sensing class. With my outreach efforts, I have been able to get a partial list of what agencies are interested in, and I hand it over to the students who have done wonderful things through directed studies and internships. I see an opportunity for the WLCI.
- The last part of the WyomingView program is that we do talk to agency folks, and they tend to say they do not know whether remote sensing will solve the problem, or they do not have the images, software, image processing skills, or time. They have and are willing to provide field data, though. WyomingView provides satellite data, so WyomingView people and students can process the images. The first 2 years I was the only one working; now it is all with the students.
- Examples of WyomingView applied research include the following:
  - WGFD conifer encroachment;
  - American Range Society (ARS) range vegetation mapping;

  - WYDOA conifer encroachment pasture;
  - UW water bodies in the Powder River Basin; and
  - sugar beet growth in Worland.
- We have yet to start the following projects:
  - UW vegetation response to drought;
  - BLM underground coal mine fires; and
  - UW soil properties mapping.
- This year we have been asked to focus on education and training and applied research. I would like to combine these. I have students needing project topics and ideas, and I hear from folks that agencies need people to take small pieces of their bigger projects.
- We get 40 students in these two remote sensing classes every fall, and everybody is required to do a project. Most are done in Wyoming. They never have a topic. They waste a lot of time hunting for topics and/or data. Some will benefit from their WyomingView contacts.
- As part of AmericaView, Landsat data are completely free. At the national level we have signed MOUs with other data vendors. The USDA has collected all the remote sensing data on Native American lands, and we can tap into that with AmericaView. We have also signed MOUs with SPOT and AV satellite programs. The catch is that this project must involve a student or faculty researcher. Same for multispectral satellite and for QuickBird, IKONOS, and WorldView-1. We can just take small pieces, and as long as we have a student involved in it we will be able to get this data. We are also talking to two other data providers.
- So, because sometimes Landsat is cloudy and it only comes every 16 days, you may want to be able to access this longer list. I have to caution that Landsat spectral values do provide more value than sometimes the higher resolution you get from QuickBird and IKONOS.
- Most of our students are Wyoming natives, are familiar with vegetation and environment, and come from range, agroecology, botany, and geography. Some, not all, have GIS skills. They learn the basics of remote sensing, image processing, interpretation, and classification.
- Examples include Tanna George, who digitized conifer encroachment in Medicine Bow National Forest for 1992 and 2001. Vince Salemo worked with a farmer and used satellite remote sensing technology.
- In the fall, we will have three graduate students and eight undergraduates, as well as four new interns.
- Obtained funding for three graduate students through the National Fish and Wildlife Foundation and University of Wyoming Agricultural Experiment Station.
- Have two journal articles in print, have three in review/in preparation, and have had conference presentations at the UW graduate and undergraduate student symposiums.
- Next steps are to determine the questions of interest to the WLCI and determine if field data are available and if folks are willing to answer students' questions via email.

Plenary Session 8

Science Associated with Reclamation and Offsite Mitigation

Session Leads

Justin Caudill, WYDOA
Pat Anderson, USGS

Steve Williams, Wyoming Reclamation and Restoration Center

Wyoming Reclamation and Restoration Center

- I wanted to talk about the Wyoming Reclamation and Restoration Center for a few minutes this morning. I would like to start off by thanking folks who have been working with me closely on the center for the last several years. The center was created in 2002, but only in the last 2 years have we had money and people to work with. Faculty involved are Matt Anderson, Roger Coupal, Jeff Beck, Ann Hild, Jay Norton, K.J. Reddy, Pete Stahl, Ginger Paige, and Steve Williams. Other units of the university that are involved include WyGISC and WYNDD.
- We have been doing this for a few years, still at a formative level. Our focus has been mostly on disturbance, amelioration of disturbance of all kinds, but because of its prominence we have focused a good deal on energy-related reclamation and disturbances.
- It is logical we should do something like this. Wyoming's energy portfolio is substantial. Wyoming produces 11 percent of the energy required by the United States, is the largest exporter of energy to the rest of the United States, and ships over 10 quadrillion Btu out of the State every year.
- There is something in the neighborhood of 150,000 acres of coal-mined disturbance and also substantial disturbance from pipelines. There is a substantial energy footprint in the State. One of the things the Governor's office has started looking at recently is the energy footprint per billion kilowatt hours of energy produced.
- Let me talk principally about our philosophical underpinnings girding the center. Specific research and outreach activities can be viewed on our Web site.
- Our research philosophy is that reclamation methodology should be based on best available science, generally reclamation attempts in Wyoming are doomed to failure, and everything is connected to everything else.
- Even though we work mostly with soils and plants, wildlife habitat drives everything. People can connect with pygmy rabbits and mule deer, not with sodium absorption ratios.
- So, the first criterion, "best science," has distinct features:
  - Treatments should be compared to controls. How do you know it is working unless you compare?
  - Treatments and controls should be replicated.
  - Observations should be done across multiple seasons—no two seasons are ever alike here.
  - Decisions should be made on the absence of doubt, not on the presence of proof. You cannot prove things, but you can always doubt it. In the reclamation industry especially I have learned to be a rather strict doubter.
- The second undergirding principle is that most reclamation efforts are doomed to failure. They are doomed to failure starting with soil-forming factors. I appreciated the USGS folks yesterday who talked about that. Those factors are organisms, climate, parent materials, and topography and time.
  - You can divide these factors into biotic factors and abiotic factors. The abiotic factors are really topography and parent materials. The way I like to present this is to put this on a straight line, although they are not linear at all. In other words, organisms, climate, topography, and parent materials sort of form a continuum, and I have put up a teeter totter to represent how they swing in Wyoming and elsewhere (slants up from left to right).
  - If you get further east, or further any direction, you get into factors where biotic factors dominate the environment. These areas can often be managed intensively—if you put in energy and capital you can reharvest. These are often farm environments. You do not see a lot of this in Wyoming. Characteristics of the soil include very deep organic accumulates on the surface and being farmable. You can predict and rely on profit if you put in energy and capital. The organic matter accumulated at the surface is a strong indicator of a system where biotic factors dominate.
  - So, the other direction where parent material and topography and abiotic climatic factors dominate. Well, this is important habitat in the State of

Wyoming. You have environments people think are wastelands, and the biological activity is pretty low in terms of ground biomass. In the soils, you have to look carefully for organic matter. That indicates that the environment is extensively managed, not intensively. It just becomes a difficult situation.

- So, because of that continuum, we must recognize that in reclamation we are attempting to use intensive management methods on extensively managed lands where they historically do not work. There is no substitute for soil water available during the growing season; it does not matter how much nitrogen or phosphorus you put on these lands. If you do have soil water, you succeed; if you do not have soil water, you fail. We are trying to impose intensive agriculture methodology on these lands. It results in a peculiar situation. We have to put a lot of energy and money on these lands.

- For example, consider a freshly seeded pipeline track. It looks like a wheat field. Certainly there are other ways to get plants to grow in the environment, like irrigation pipes in Jonah. I do not subscribe to irrigating in these areas because ultimately you have to turn the water off. I think instead what we need to be doing is modifying our topography so as to catch every snowflake, every raindrop that comes by. Example is the Abandoned Mine Lands (AML) project 16N in the Gas Hills. Topography has been modified on a mesoscale and on a microscale (enhanced surface roughness). People have known for centuries that if you can enhance the roughness of the environment you really have a chance at success. The Chinese have been doing this for 1,000 years.

- Finally, everything is connected to everything else. We have been trying to develop what we call a reclamation trajectory, a model for reclamation that we can look at and think about in terms of the reclamation projection. The y-axis is some measure of ecological maturity; the x-axis is relative time. We graph ecological site condition before disturbance and after disturbance and look at how the ecological maturity, however you might measure it, recovers. We are especially interested in what the characteristics of the site are when you get halfway. We would like to know what it is like when you get all the way, but we do not have a lot of sites with finished ecological descriptions in Wyoming.

  - How long does it take us to reach halfway? What measures define halfway? We think it is below ground—pH, electrical conductivity, texture, soil structure, organic carbon, root penetration depth, nitrogen, phosphorus, microbial diversity, mycorrhizal fungi, invertebrates, and so on. Above the ground measures include graminoid abundance and diversity, shrub abundance and diversity, forb abundance and diversity, invasive species, cover, bare ground, and arthropod abundance and diversity.

  - I would also be remiss if I did not mention ground surface characteristics. These may be some of the most important things we can look at early on—the litter, the salt crusts, the biological crusts, evidence of wind and water erosions, color, and infiltration rate of water.

  - There is no single indicator to define halfway.

- So that is our research philosophy in a nutshell.

Tim Kearn, USGS

Assessing Reclamation Goals: Jonah Infill Data Management System

- This is about using an information system to track and assess reclamation goals. There is an intrinsic danger with building an IT system—unless you really have an eye for what questions you are going to answer with a system, unless you focus on a problem set, you run the risk of building a very expensive file cabinet. That was the case with the Jonah system, but fortunately the people in the Jonah office have put together a framework that lets them evaluate whether or not they have achieved reclamation success. Remember that success criteria are not the same as real reclamation—you define success by setting standards and seeing how close you come to those.

- The JIO created a framework where operators would do field data collection and the office would compare their data to a reference area, evaluate visual observations from operations, put those in context with spatial data, and evaluate photographic evidence they submitted. From that they could get an idea if they were getting close to their standards. The system we built let the office do just this; it also keeps track of all versions of submitted data so that people can go back in time and look for differences in trends.

- The basic data that the office collects are a set of status reports—quantitative data from field transects submitted and compared with a reference site. The system decides whether or not you are getting close to the reference site. You also submit visual data (are weeds apparent, and so on). The point is to know if we are achieving our goals. So we set up a system that allows two different ways to put up data. There is a form to fill out or submit data. It is done after a field data collection exercise at least biannually. They can

evaluate reclamation criteria by feature (pad, road) or by operator or for the Jonah Field as a whole.

- If you use the Web entry method then you end up with what we call a "summary." This would be a view that the JIO could look at on a feature basis. They can look at the last reports and the comparison from the reference area. Some measures are stand alone, and some you have criteria against the reference area. You also have a way to view previous reports through this page. The operators submit their data, and the JIO can review them.
- We also have an alternative data entry method. The JIO did a great job defining success, but there was a misstep in that there was no methodology defined to collect those data, so different operators used different protocols to get these data. That makes trend analysis somewhat problematic.
- The JIO chose to address this problem through a carrot and stick approach. The carrot is a portable application. You can go out in the field and just upload your data, and the system will put it into the right places and keep track of it for you. You enter a GPS location, it tells you where you are, you move on, and you collect the data on the basis of the preferred protocol by the JIO That way the operator can just use the system to submit to a server. When they get back to the office they just review and hit submit. It does all the summary statistics for them.
- The stick is, if you do not want to do that, you have to enter the data form by form, box by box, button by button. So the approach the JIO is taking is not saying, "Look you have to conform to this protocol." Rather, they are saying, "If you do use our preferred protocols you will have a lot easier time with your data submissions."
- We also collect data on the reference site. The JIO has to know where the reference site is so that they can verify and examine what the operator is using for their reference point.
- One success criterion is timely submission of reports. The system sets up a way for the office to sort and do reports and get a visualization of when the last report was submitted for a particular feature. This approach, filter reporting, gives the office an opportunity to get back to the operators. One of the things about any kind of information system is that they can become silent. The JIO works with the USGS, and especially the Fort Collins Science Center. We have to make sure that when a system is set up it has a way to get the information out to the scientists.
- Obviously we have formatted reports for the public, ad hoc reports (I want just pads reported last year showing decline in soil stability), shapefiles, spreadsheets (pick fields and get as spreadsheet), Web services feeds to other systems, and direct access to the system via ArcGIS (with permissions). You use basically a mirrored copy, so you cannot change the production data. That is available for power users and GIS experts.
- Again, the system is designed to answer the question "Are we meeting our reclamation goals?" With that design, it is fairly finite in the types of functions performed. The data are summarized for those goals. It is a fairly involved project, and the lesson is that we had to make sure we actually addressed those goals in building this system.

Peter Guernsey, Questar Corporation

Questar Reclamation and Rehabilitation Research on the Pinedale Anticline

- First a little bit about the history of our development and the reclamation problem up there, and then I will move into the reclamation research and guidance. I really believe the database is crucial and goes way beyond the comparison of the sites.
- Questar has been around for quite some time. Our first well was drilled in the 1960s. Our current development really came on in the late 1990s and in the 2000s, and expanded opportunities were approved in 2008 with the supplemental environmental impact statement (SEIS) ROD. At present we have 62 pads and 640 acres of disturbance, reclamation has occurred on 51 of those pads, and there are 464 total acres of long-term disturbance.
- There has been a lot more reclamation than what has gone on up there. We reoccupy pads, so a lot of work done already has been turned up. One new development feat under the new ROD is "once on a pad, stay on a pad." Right now we have one pad with 56 wells on it. That will improve reclamation efficiency certainly. Reclamation will occur at a rate of about 9–11 pads a year. Full reclamation means we are all done developing on that pad.
- So where do I get my reclamation guidance? Well, there is not anything like coal has for the oil and gas industry. The BLM has some reclamation policy. The most important tool that I use is the evaluations of the existing reclamation—that is, what has worked and what has not worked. There are temporal aspects to this, and there are components for each of the growth forms—grasses, forbs, shrubs, and weeds. I want site stability after 1 year.

- I do quite a bit more reclamation tracking than what we are talking about here with the JIO. I believe that there are reclamation actions that may be incredibly important that nobody really tracks. Some guys on coal mines have tracked some of those things, like what was the surface roughness before you put the seed in. It is important to have baseline conditions, but those are going to change annually. I have a series of references for each pad because sometimes you have multiple communities there and when you move soil and put it back you cannot say, "I just want old-growth sage brush."
- You want to track at some level—you certainly want to know what the conditions are, at least soil stability, on an annual basis.
- A little bit of the research we are doing is not about getting good cover by grass but more about how we can get a desired plant community. The objective is to get that in as short an amount of time as possible. We have got a shrub-planting trial with WGFD, BLM, NRCS, and the county, too, and we are planting shrubs and evaluating them for mule deer winter range. They were planted in 2006 and 2007, which were dry and windy, so we have seen very limited success. It is in the works to reinitiate this project right now to see what might take up there. We are thinking that if we run into a dry windy spring we will augment the water once or twice in that early growing season that first year.
- One other project we have gotten going is a DOI habitat inventory. You could call it a baseline assessment for the entire project area, but it is also comparing surface vegetation types with all other land uses occurring on the anticline and determining where crucial winter ranges are and how much is in sage grouse brooding habitats. The research is to guide us in reclamation planning, but it has other features for potential rehabilitation efforts we may choose to do in the long haul.
- Topsoil stockpiling is a key for reclamation success. If a lot of you have looked at roadsides you have seen that the topsoil is immediately put alongside road, and if you look at conditions in those areas, a lot of times the plants come right up. This is not the case for a long-term topsoil story. Soil scientists say you probably lose most of your biotic component in a matter of months if not weeks, so what can we do to maintain the topsoil? "Low piles, low durations" is the recommendation in the literature, so that is what we are doing. A lot of people use interim reclamation, but I started thinking about that and said, "OK, where is the topsoil?" It was under all that interim reclamation, so how do you reclaim the remaining acres? For right now I have long-term topsoil piles that will be maybe a foot to foot and a half deep. I have reasonably good surface soils.
- Seedbed preparations are another thing we are researching. As you can imagine, moving topsoil is a bear. I know a lot of the pads I am on I will be on again.
- As for mulch applications, we have straw and hay. We even have some hydromulching, which I have had zero success with. This year I will try some woodchip mulch, not sure if it will work or not.
- We have a sagebrush treatment project; tried nine different treatments just to see sagebrush response.
- We are going to continue joint research with other agencies, as well as internal evaluations of the detailed database I have constructed.

Questions

- Is industry sharing data they have collected with the community?
  - I am more than willing to share my data.
- On those stockpiles, what are you using to plant something on?
  - I have a lot of seed mixes, but in any given year for the most part I am planting the same thing as on interim sites—wide range of grasses, shrubs, forbs. I am successful with the grasses.
- What is the logic of putting shrubs on something that is just there for a couple years?
  - If it was just a couple years, I would agree. But in some cases it may be there for 8–10 years, and it also gives me an indication of what forbs in what condition might come up. I look at every planting as a research project just to see what works.

Dan Stroud, JIO

Monitoring and Ecological Site Descriptions

- Quick background on the JIO. We have been in business for about 3 years as a result of the ROD for the Jonah Infill. We are composed of the WGFD, BLM, and other agencies. We are

tasked to come up with some mitigation plan for wildlife.

- Without a lot of information we had a little bit of struggle at the beginning. Initially people wanted to see projects on the ground, so we started accepting proposals immediately. We knew we wanted to mitigate sagebrush obligates, and there is a guild of species, things like mountain plover and prairie dogs, that we wanted to mitigate.
- We developed a plan, and part of it was to look at what was on the ground with the ultimate goal being to get on the ground doing things to improve habitat. First stage was to figure out where to focus attention and what to collect on ground. One of first things we did was define focus areas. We had help from TNC. I look at ensuring we have healthy sagebrush systems on these sites. We had assistance from Upper Green River working group, which holds local knowledge.
- So we decided to do an inventory, a baseline vegetation inventory. Some considerations are impacted species' habitats. What are they? What are the best data for deciding what we can do on the ground with success? This led to the definition of ecosites.
- We start with soil surveys and those polygons that have been developed and modify them based on on-the-ground attributes, like water sources, wildlife use over time, roads, fences, and so on. This is what we try to capture in the premapping phase.
- The selection of data points—the polygons I mentioned—stems from the premapping. We pick a representation point that pretty well represents that polygon.
- We have a contractor do most of the work and supplement with agency personnel.
- There are about 15 to 20 data points on our map. You have to find one data point to represent so many acres—usually one spot for a 1,300- to 1,500-acre polygon.
- Our data sheets have a lot of information. They give you canopy, basal cover—we are documenting everything the line point hits. We have a similarity index, or what percentage of the historical plant community does that data point represent? That may or may not mean a lot depending on what you are managing. The second set of information includes some major grass, forb, and shrub species and their associated cover. Then you have the total live shrub density.
- There is a lot of information to cover; you almost need a whole day to go over this! Let us jump to the actual interpretation and use. We can see what is in the transition state and look at production, actual production versus potential. As for management, the entire picture needs to be looked at before you do anything on the ground. We must take into account the species present and blend the needs of what is there.

Shawn Nield, NRCS

Soil Data Resources and Tools

- Presenting to you about soil data resources and tools. We are in the process of conducting a lot of soil surveys in Wyoming, and we will be publishing those data to the Web, and I want to show you how to get to it.
- We have active soil survey projects going on in Big Horn, Park, and Sublette Counties. We are finishing in Uinta County, are going into Lincoln County this year, and are in Sweetwater County and Carbon County. We are looking to get the results from north Johnson County published, which is CBM land similar to what we are talking about. Would like to publish Johnson County and Uinta County within a year and Sublette County within the next 2 years. Information for the Wind River Basin (most of Fremont County) should be available by fall.
- We have a lot of data headed in the direction of being available to you very quickly through the Internet—my focus is talking about how to get at it.
- The NRCS was formerly the Soil Conservation Service, and so it has Federal responsibility for soil information in the United States.
- If you wanted to look at soils info and go from less detailed to more detailed, these are the tools: Major Land Resource Areas (MLRA) Explorer, the State Soil Geographic (STATSGO) Database, and the Soil Survey Geographic (SSURGO) Database. The STATSGO data are often very coarse scale, often generalized SSURGO data. The SSURGO data are typically the most detailed data that are publicly available, and that is what we are trying to push out right now.
- Our soil surveys contain soil data from one county, parish, or geographic area such as an MLRA. We are moving to an MLRA system, and the WLCI is in MLRA 34A. Soil scientists are responsible for determining the distribution and extent of dominant soils. It is backbreaking work, involving breaking holes to determine texture, color, structure, rock

identification and amount, and so on. We have to go down to 150 cm or deeper.

- Soils are tested for certain soil properties.
- Soil surveys are meant to be useful on a scale of 1:24,000. Like any tool, a soil survey is helpful only if you know what it can and cannot do and if you use it accordingly. Sometimes people want to overuse the soil survey.
- A soil survey is made up of mapping units, each representative of an area dominated by one or more major kinds of soil, termed components, or miscellaneous areas. Components are defined by taxonomic classifications and further by series criteria. Map units are named by the dominant soil series that occupy the maps.
- Map units come in the following types:
  - consociation, or one major soil type;
  - complex, or two or more soils that are difficult to pick out on the ground; and
  - association, or two or more components shown as one that are easy to pick out but are not practical to map out separately.
- MLRA Explorer is a tool you can utilize. If you are going to write a report about an area you are unfamiliar with, this is a nice tool. It is based on MLRAs, is interactive, and is fairly intuitive. For select MLRAs, you can generate a map and report based on certain characteristics (that is, cool centric desert basins and plateaus). A custom report is generated online, and you can save to your machine—everything you check off will have a writeup. The basic information is really nice for people not familiar with area, basics on biology, dominant vegetation, soil, statistics for typical land uses, and so on.
- STATSGO data are very coarse. You can get to STATSGO from soildatamart.nrcs.usda.gov. Click on "US General Soil Map," which will bring you to a screen. You can download the entire STATSGO dataset for the United States.
- The source maps for SSURGO are 1:12,000 or 1:24,000. Minimum mapping size in SSURGO is 1–10 acres, versus STASTGO, which is coarse. To further reinforce this, SSURGO is much finer than STATSGO.
- You can get into SSURGO data through Soil Data Mart; you can select your county, survey area, and so on. If you want to generate reports on chemical and physical properties without having to download all of this, you can use the "Generate Reports" button by selecting the soils of interest. You can mark what format you would like the report generated in. Then for map units you can get components (sandy), the depth ranges, cation exchange capacity, soil reaction, calcium carbonate percentage, gypsum, salinity, and SAR. It is handy and quick. If you want to download spatial and tabular data and work with it you can do that. If you want to generate those same reports on your own, you have to download the template database. If you have intensive use needs you have to know how to do it.
- You can select one or many map units to report. You can select minor components (which constitute less than 15 percent of the map unit), different report types. It is pretty data intense.
- If you have never used this, the first report to generate is "how to understand the user database."
- For the breakout I will go into Web soil survey, and we can generate a nice PDF [Adobe Portable Document Format] document for the area we pick out, and it will look like a custom report.

Karen Clause, NRCS

Revegetation Trials in the Pinedale Anticline Project Area (PAPA)

- We are a private lands organization, but we like to stay abreast and share technology with our private landowners.
- The NRCS has a plant materials program where we have helped develop plant materials for conservation needs. The Bridger Plant Materials Center and the Meeker Plant Center are the closest to WLCI area. We also benefit a lot from the Aberdeen Research and Extension Center in Idaho that emphasizes a lot of forbs found in the Rocky Mountain West.
- A lot of the products being used for reclamation out in field are products we have helped initiate and get on the market.
- Cooperators involved in the project I am going to talk to about are the BLM, WGFD, NRCS, SWEPI LP (formerly known as Shell Production Company), and the Sublette County Conservation District.

- The goal of the project was to look at reclamation from a scientific approach. We wanted to test grass, forb, and shrub species—and also test cultivars and varieties of grass, forb, and shrub species—and then test seeding mixtures and rates. It is one thing to plant something as a monoculture and clearly a totally different thing to put it in a mixture.
- We had a broad overhanging goal—we wanted to test these for adaptation and desired ecological diversity in the Pinedale resource area with emphasis on plants native to the Rocky Mountain region that provide forage production, ecological diversity, and habitat.
- We attempted to institute replications and controls. We had four planting methods: precision planting using a cone seeder, broadcast planting of two different mixes, Truax drill seeding for same two mixes [Truax Company, Inc.], and then hydroseeding also in areas adjacent to well pads that Shell is going to do because of slope.
- The following results are all preliminary.
- On the very southern tip of the anticline in MLRA 34A we are working in small pieces and trying to apply what we learn to a larger framework.
- We have a broadcast seeding of the Bridger mix, dominated by mostly grasses with a good smattering of forbs and shrubs. The quantities of those are much lower than in the other mix. For the Bridger mix we also used the Truax drill. The other mix is called the Shell mix, and if you have been to reclamation workshops you have seen Amy, who is hugely influential in this project. Shell is maintaining this, and she does so much to help with the evaluations. The mix is called a Shell habitat mix, a mix Shell derived with Wind River Seed Company. It strongly emphasizes the forbs and shrubs, mostly shrubs, Wyoming big sage, and grasses. Uses competitive cool grasses rather than Indian ricegrass, that kind of thing. One acre Truax drill and one-half acre broadcast site.
- So we planted the plot in the fall of 2005. A good part of what is going on when you do this is to observe it at a lot of different times of year. We started weekly germination visits in 2006 in the spring. We used relative rating to try to judge percentage of seeds and get a general idea of what kind of germination is occurring. We did that because if we came early in summer/late fall to evaluate and nothing was there we would need to know if it even germinated.
- Later on in the year we took quantitative measurements, density, and photos of each plot. We have done this now for 3 years. The addition in the third year is production data. It is one thing to see that density, but a lot of folks have production requirements.
- We are willing to share more detailed results. We have three publications out on this already, but this is the third year of a 5-year study. We want success in 5 years, but I think time will tell us the appropriate success.
- The Bridger mix is more grass dominated. The grasses were the ones that tended to be very aggressive (wheatgrass, bluebunch), and they did the very best. The seeded rate with the drill was 39 seeds per square foot. Plant density in 2008 was 0.42 plants per square foot, which would not be considered a successful stand. Seeded rate with the broadcast was 78 seeds per square foot. The 2008 plant density was 0.73 plants per square foot. Overall, the establishment rate for both was 1 percent.
- With the Shell mix the very first thing you notice is the amount of sagebrush; they planted copious amounts of sage in this mix. With the drill, it ends up at 1 percent establishment rate. The broadcast establishment rate, although visually it stood out, was only 0.5 percent.
- Now the replicated plots. Statistically, the top performers are as follows:
  - Appar is the top performing forb, but it is a nonnative blue flax. Another flax is in trial, and the true prairie flax Maple Grove also performed well and is more available on market.
  - Top performing grass is this L-46 which has no name and is not released yet. Hopefully they will reconsider release on the basis of these results.
  - The Wytana fourwing saltbush is the top performing shrub.
- Top grasses are as follows:
  - L-46 basin wildrye (LECI4).
  - Sodar streambank wheatgrass (ELLAL).
  - Critana thickspike wheatgrass (ELLAL).
  - Bannock thickspike wheatgrass (ELLAL).
  - Copperhead slender wheatgrass (ELTR7). Brand new release from Bridger Plant Materials Center as part of Anaconda Smelter superfund site in Deer Lodge, Mont. Animals went for this grass. Could be a buffer for forbs and shrubs.
  - Continental basin wildrye (LECI4).
  - Washoe basin wildrye (LECI4).

- P-24 bluebunch wheatgrass (PSSPS). ARS accession that is not released and the results of our trial have been taken off the shelf. It was not being considered because it failed compared to other bluebunches in a 17-inch precipitation zone. They feel it now has a different application because this was in a 5-inch precipitation zone.

- Top forbs are as follows:
  - Appar blue flax (LIPE2)
  - Richfield firecracker penstemon (PEEA)
  - Old Works fuzzytongue penstemon (PEER)
- Top shrubs are as follows:
  - Wytana fourwing saltbush (ATxAP)
  - Snake River Plains fourwing saltbush (ATCA)
  - Hatch winterfat (KRLA2)
  - 9016134 Gardner's saltbush (ATGA)
- Needs we have identified are as follows:
  - bottlebrush squirreltail for Red Desert;
  - bluebunch wheatgrass for the Intermountain West and Red Desert—most on market come from low elevation; we want to reinstate efforts for seed collections;
  - scarlet globemallow that works! There has been limited success, but we have hope. The ARS has shelved the project, but we have some initial plantings that we will evaluate;
  - Gardner's saltbush that works; and
  - forbs, forbs and more forbs. Will keep working!

Dave Lockman, Wildlife Management Services of the Rockies

Applying Science to Long-Term Management

- The data we are going to present today we thought should be shared with the scientists and managers out here, relative to the sagebrush community.
- The areas where we have been working are in Sublette County, Fremont County, and Sweetwater County. Most of our data are representative of the lower end of the precipitation zones for sagebrush communities in Wyoming.
- We have encompassed a lot of landscapes, plant communities, wildlife, habitat arrangements and configurations, soils and climates, agricultural systems, and land uses.
- In our evaluations we look for weak and missing links (ecological and human), limiting factors, and spatial gaps in each system and how they affect the function of the system for wildlife and agriculture.
- One thing we are interested in is the measure of the sagebrush stand function and health. We evaluated by looking at the age structure of stands, regeneration capabilities, and influencing factors. We focused a lot on the boundary between sagebrush systems and wetland or riparian areas.
- We had reference and experimental transects and plots. We looked at canopy and soil distribution to see how that compares to other sites. We looked primarily at Wyoming big sage, low sage, and basin big sage.
- We looked at available sparse to dense stands of Wyoming big sage. In lower precipitation zones the Wyoming big sage is more confined to lowland landscape positions. We find low sage mixed in with big sage through most of the area.
- There has been a drought going on in the I–80 area that you see when driving, but then you get a year like 2008, and you can see the difference. It is quite dramatic. Our measurements are on an annual basis, and we have seen quite a range of precipitation. It is really interesting to see the variation from year to year.
- Sagebrush age samples were collected in stands associated with overstory and understory transects and plots in upland and lowland landscape positions.
- We used 10 square meter plots offset from our permanent transects, and there we classified young and mature sagebrush plants by species.
- There was high mortality in the first year, so we basically looked at everything 2 years or greater when it starts to take root.
- We measured heights, and we wanted to look at the age structures of the populations. We had hundreds of specimens in these transects to do age analysis by using standard ring dating.
- We found a strong correlation between basal circle and age in years. As plants age, that correlation weakens and variation weakens,

which you would expect because of variations in soil and moisture. The correlation held up in drier precipitation zones like the Lysite area for big sage and is also effective in zones by soil depth and type.

- A little interpretation and preliminary analysis.
- Looking at precipitation you can see through the 1960s into the 1970s in the upper Green River Basin we had higher precipitation and snowfall. The weather patterns have become chaotic in the past several years. Cumulative precipitation (occurring in March through June) is the most critical period for sage, forbs, and grasses. You see more constant precipitation prior to 1988. After that it is very chaotic.
- When we look at age compositions we find canopy young plants that run between 5 percent and 11 percent whether they are in an uplands or lowlands position.
- Low sage is important because it tends to have higher palatability. One thing we are running into is that antelope in the winter go for areas with mixed low sage and Wyoming big sage—they tend to like to feed on the low sage. We have done a lot of documentation of habitat use in these areas. Low sage, alkali sage—the ones that fluoresce better—tend to be higher palatability.
- Two good growth years in a row through winter and summer makes a difference.
- Sage height or stand height is not a reliable way of estimating age.
- Drivers like grazing and precipitation affect the ultimate density of the canopy.
- There are cases where we have found sagebrush plants that are 100 years old, but they are not typical. Some plants look huge, and what you find is that they are not old.
- We have been doing a lot of insect work and hope to share in the future. We are finding a higher relation with litter. The combination of it and the effects of soil moisture and temperature are important to when these bugs start crawling around.

Questions and Discussion

- Not sure which panelist to address this to, but I would like to know if there is a feeling that reclamation activities that have taken place in the last years are meeting the needs, or is it too early to tell? Can you give a progress report?
  - The places that I am working are relatively young in terms of years since seeding. Where they were older I am seeing a trajectory towards the ecological site that belongs there. It depends on whom you ask with regards to needs. Good livestock forage quickly? Yes. Good sage grouse nesting habitat quickly? No. But we are getting faster at it.
- With the various cultivars and varieties, to what degree are there concerns about varieties competing with the native species?
  - We are in a harsh environment, and sometimes you have to pick your poison. What we want and what we get may be two different things. There are two camps out there when it comes to use of native species—one thinks these varieties have caused more problems than they have solved, and another wants to see the use of the native types. I think one point to be made is that as long as there is not a sensitive species issue maybe it is growing there because it is the best able. There are species that we will find we either do or do not care about. Plants can be promiscuous, and that is kind of how they survive. That probably needs to be dealt with on a site-by-site basis. I do not have any trepidations with what we used on our site.

Plenary Session 9

Breakout Reports

Reclamation Breakout Group

- Breakout group had about 12–14 people. Objective 1 was to identify new science and technology needs. We came up with a few visceral things:
  - finish the soil surveys;
  - finish the ecosite descriptions;
  - more and better data are needed; and
  - create a central location for data and a standard assessment protocol for reclamation.
- Objective 2 was to identify science activities that would benefit on-the-ground management activities:
  - More accurate data at a finer scale for all resources (for example, fences and not just for vegetation). There are lots of human impediments and features that are not mapped.
  - Create more opportunities for communication between managers, agencies, and academics. Major theme we addressed. We live in a hard environment to communicate in physically—by the time the weather is good for travel it is the field season. I would still like to meet face to face.
  - Control trials for future climate scenarios. This might take some interpretation, but it is essentially that we are facing climate change, and we need to be proactive and plan for that. Think of what the USFS is doing for planning for grizzly survival in Idaho.
  - Climate-modeling expertise to identify what will be around. Further investments in seeds mixes for 30 years from now.
- Objective 3 was to identify ways to integrate science and management to benefit adaptive management:
  - Apply lessons learned from science. Seems pretty simple, but that is a difficult item. Politicians are always trying to marginalize things that came from science, and decisions are not always based on the science we have repeated many times.
  - Create structure for adaptive management where managers supply the questions and scientists shape their answers. If we can ask the right questions the answers sometimes fall out of the sky.
  - Conduct more direct comparison of management techniques. So often a new technique comes up, and we are just imposing and not comparing.
  - Pay more formal attention to reclamation monitoring.
  - Increase interactions with scientists and managers at the start of the program—upfront planning.
- Objective 4 was to identify the most valued aspect of the WLCI:
  - Increased level of detail and accessible data share and transfer.
  - Integration of multiple scientific disciplines interfaced with multiple individuals from organizations.
  - We need the opportunity to communicate face to face.

Reclamation Breakout Group Comments

- Would creating a central location for data be different from the Web site data clearinghouse?
  - Maybe it is just making people aware of the data clearinghouse that is already there. There is some duplication amongst Web sites, and it seems like there ought to be less duplication of effort.
  - A similar thing came up in our group. We need to take advantage of existing ways to share.
  - Need for some targeted data stewardship. There are great capability and resources that should be pulled together and facilitated. That is a role we need somebody to fill.
  - Do we fill that with existing people or create something new? And one central location or Web site is needed.
- The WLCI is working on pulling together some crews for this year to identify local populations that are doing well and seeds that need to be pulled together. We will collect seeds as we get them and get them ready for next year.
  - Have you thought about amplifying seed this year, enough to raise a crop?

- We are thinking about that. This is the first year WLCI has been involved in the seed program, so it is just getting off the ground. We will have increased storage capabilities this year, but unfortunately this takes years. There will be things like cushion plants, which are not commercially profitable. There is also a proposal to have some facility where we could propagate those noncommercial species.
- One key is having adaptive seed. Pete Stahl and I looked at fungi for years, and we cultivate them in the greenhouse, and they do not work out in the field. I would assume that happens with seed.

Fish and Wildlife Breakout Group

- We had a very wide representation in our group and some really good and lively discussions. Each objective started with a long list of ideas, and we prioritized the top three or four. Out of 15 or so members, we did not have any aquatic folks in the room, so there are some needs being omitted here.
- Objective 1, identifying new science and technology needs:
  - Need for some type of landscape-scale prioritization of habitats and critical areas. You saw all this data coming together in the plenary sessions, and we saw biodiversity hotspots. We have a lot of data now that we can put together and prioritize now for biodiversity and conservation.
  - Idea of getting a better handle on the ecology of sagebrush systems, how we understand their dynamic, and how we do treatments to improve this habitat. There are lots of treatments out there right now with a simple understanding of sagebrush needs in terms of disturbance and so on, so better management requires a better understanding of sagebrush ecology.
  - Get at the mechanisms and ask the right questions. There are lots of development pressures and species, and if we focus our research on mechanisms we will have a better understanding that is transferable across species.
  - Facilitate interactions among agencies. There is a need for better communication among agencies to leverage resources. A great example is Monitoring Without Borders. All agencies have limited resources, so if they work together, more would benefit.
  - Need to integrate the science into management and policy. At the workshop we saw a lot of good science and a lot of coming to reasonable conclusions without a lot of uncertainty. We need to not just think about what to put on the shelf but how can we move that science into policy and management.
- Objective 2, identifying science activities that would benefit management activities on the ground:
  - Developing a conservation plan which could identify critical areas for conservation action. The research side of it is how to do the science to understand where the priorities are. The management side would be creating a map that guides on-the-ground activities but also a map that would guide development. A conservation plan that managers could use to guide development.
  - In order to produce such a plan, quite a few inputs are needed. Gather baseline data on energy infrastructure, soils, vegetation, species distribution, and habitat enhancements. This is being done in the USGS science strategy.
  - Get to goals for numbers and viability thresholds. Identify what we want to conserve, and then have that feed into the conservation plan—the lines on the map are placed depending on what our conservation objectives are.
- Objective 3, finding ways to integrate science and management to benefit adaptive management (this is an unprioritized laundry list):
  - Educate ourselves about what adaptive management means. It is a buzzword, but implementation is difficult.
  - Establish and communicate the idea that adaptive management is best seen as a clinical trial used to see how a treatment works.
  - Integrate the researcher and the manager. Join them at the hip for these activities.
  - Recognize the need to identify management and political realities. Adaptive management requires a level of commitment at every level of the process.
  - Conduct monitoring. In order to engage in adaptive management there has to be a commitment to monitoring. There are a lot of on-the-ground projects that are not monitored. If you want to do adaptive management you have to monitor, not just treat. This came up time and time again.

- If possible, colocate managers and researchers to help facilitate adaptive management.
- Garner buy-in all the way down the line!

- Objective 4, identifying the most valuable component of the WLCI:
  - Value of the WLCI is in the integration that is occurring among agencies and between scientists and managers.

Fish and Wildlife Breakout Group Comments

- I get the feeling that things are morphing from a scientific gathering to wanting to affect land use decisions. It seems this community thinks their work is complete enough that the next step is either to influence the executive committee or land managers. Is that a fair assessment of what is going on here?
  - In other large initiatives where people present habitat conservation plans, their notion was that housing, not energy development, was the threat, and they thought they needed to quickly identify areas where development can and cannot occur. In the science plan of WLCI, one goal is sustaining wildlife. We are developing a lot of science knowledge that can allow us to do that, but that is not the role of scientists. The next step is to create a management tool that is guided by that best information and put it in the hand of managers. We are seeing a disconnect between these. That loop is not supposed to be left open in initiatives like this.
  - Our framework may not have been explained enough, but in terms of adaptive management our framework is very interactive and iterative. Adaptive management is working in terms of integrating science to inform actions. I think the talk gets confusing when people say "managers" because in this initiative many folks are managers in terms of different tasks. The challenge is how to synthesize so the information is available to the planners so that when they are planning the next development it is incorporated.
  - I agree that that framework needs to be available to those managers. If we are going to continue down that road that was expressed earlier (influencing management and policy actions), the mission statement needs to be changed. The WLCI is more concerned with projects and enhancing habitats, and otherwise you are looking at trying to become an influential organization.
  - As a science agency we have no intention of influence. Our science may influence things, but that is not our driving factor. We are hopeful that the science will provide information for NEPA objectives but that managers make decisions based on more than just science. We recognize that, and we just provide the science that will hopefully help.
  - One reason it is hard as a policymaker is that you make controversial decisions. I understand the want to use the science to make a decision, but if it is not there you cannot really blame the land manager for making a decision that is not informed.
  - It is easy for scientists to want their science to be more useful. I do not see an agenda in our breakout group. We would just like to make the science more operational and accessible. We are not making a judgment on a conservation plan; we are saying there should be a conservation plan so we have the science in place to be used as a tool by managers. That is a natural extension of science, which has no bias to it.
  - It seems that one more solution to this is built around the framework. The solution is how we as scientists can organize our information so that it is easily understood and applicable and how we can use forums like this workshop to help. If we need to better involve managers, we should have a workshop that draws them. This room is filled with scientists and not managers. The information we presented, if left here, will not get to the managers we are talking about, and that is how we try to drive this. Put it in a way the managers understand and hand it to them in way that they are receptive to.

Monitoring Breakout Group

- Several people in our group are on the WLCI Monitoring Team, which if you remember from Jay's description the other day is just getting going. What I think we were doing today was critiquing the progress of WLCI in regards to monitoring.
- The Monitoring Team itself is in its infancy. One of the things we had to do quite quickly was remind ourselves of the mission and goals of the WLCI to help frame our discussion. One of the first points someone brought up was that

because the WLCI goals are so broadly phrased we do not have a monitoring strategy to tell us if we are making progress on that goal.

- So, we need to tier down the WLCI goals and refine to more specific questions that monitoring can truly address. A need to focus or identify more specific questions.
- I sorted our thoughts by things that the Monitoring Team needs to pay attention to. The first is the possible duplication of effort in monitoring; we may have different folks monitoring the same idea in different ways. So the first step for the Monitoring Team may be to create an inventory of all monitoring efforts and report duplication back to Executive Committee. The Web site could be the repository of all the different monitoring happening in WLCI.
- We talked about the ability to design monitoring schemes that will truly detect the change that you are interested in. That was one of the reasons we thought the questions needed to be narrowed. We need to watch whether monitoring will detect the type of change we are interested in. We do not want to describe the threshold that shows when a population crashes; we want a monitoring scheme that lets us know when we are approaching that threshold.
- One thing I think the Monitoring Team needs to pay attention to is a need for more public outreach and more public involvement. There are other universities that have people that would want to get involved. As part of public outreach we wondered if there is an opportunity to provide monitoring tools to private landowners, allowing them to use compatible methods, so that they can monitor their own lands and see for themselves how their land is doing. We would like to engage more landowners; there is some question as to if we have access to enough private land to monitor this large ecosystem.
- Those were things I thought the Monitoring Team should keep in mind as they are developing the monitoring plan.
- Objectives 1 through 3, science needs, science activities that will benefit management activities, and integrating science and management for the sake of adaptive management:
  - more fish and aquatic monitoring, particularly for invertebrates;
  - surface water and groundwater monitoring as far as gas production inputs;
  - water quality and quantity monitoring from oil and gas and CBM areas;
  - forage monitoring—several agencies have in place forage-monitoring practices, and we do not know how they will contribute to the WLCI's needs to understand forage production across this area;
  - more coordination and participation between stakeholders; and
  - effectiveness monitoring when we do a project to improve habitat or address a problem—we need good monitoring to see if the objective of the project was achieved.
- Objective 4, identifying what we value most about the WLCI:
  - By far the biggest votegetter in regards to WLCI's greatest value was the attention WLCI is giving to ecosystem integrity at a large scale. That is one of the great benefits.
  - Others mentioned were cross-agency and cross-disciplinary work.
  - We see great value in connecting applied science to management.
  - People like the bottom-up approach of WLCI, that it is people on the ground really engaging. Sets a good example for future large-scale projects like this. The WLCI serves as a good model.
- One other issue came up right towards the end, to acknowledge that the WLCI area is a headwaters source for millions of people. The water that comes from this headwaters area is an opportunity to acknowledge that there is a broader base of the American public that would be interested in this issue.

Closing Remarks

Frank D'Erchia, USGS

- We have come to the end of a productive week. First, let us get a round of applause for all the speakers, the Executive Committee members, the Science Team presentations, and the STAC and Coordination Team presentations. Would especially like to recognize Dave and the Communications Team he works with. We have had coverage through the AP [Associated Press] wire, and some of you have been on TV. This

was an excellent opportunity for outreach. We worked with him a few weeks ago while visiting folks in Washington, and that kind of thing is helping us.

- The Coordination Team and the STAC will be working to present an assessment of the science that was presented—a review of this workshop.
- Cannot say enough about the USGS integrated science team, especially as led by Zack Bowen. Under his leadership we have really connected with the community, WLCI partners, folks like TNC, and other peripheral and important partners. Job well done over the past 2 years.
- Do want to thank the session leads. They were key in helping find speakers, organize speakers, and for the most part keeping them on time—Renee, Pat, Zach, Vito, Jay, Jay, and Natalie.
- Special thanks to the Ruckelshaus Institute folks. Especially Jill Lovato, who led the facilitation.
- And of course all the attendees and participants. We had a good crowd, a good cross section.
- A few final comments about the idea of science and monitoring. We are starting to see how habitat is connected to all the various biotic and abiotic factors, underlying geology, and land use cover and change and how important this is in understanding disturbed habitats. Best management practices must be considered across all these different factors so we can be successful instead of "doomed to failure." We have shown success, and we will show more in the future.
- We have a long way to go in integrating all of this. We need to bring this together. Two years ago we were struggling. We have come a long way and done a lot, and now we need to integrate not only with our partners but also as a part of the whole cycle of management. We have to keep in mind it is not just science that influences management, but our role is to provide the best science we can.
- From this workshop we will be producing the workshop summary report similar to the one we did 2 years ago.
- We also need to do other outreach. That will be a focus of the Executive Committee tomorrow: "How do we not wait 2 years to find out everything that is being done?" We have to do more of that and share data throughout the year, find better ways of sharing information.
- We need to be proactive throughout the next few years. I was amazed at how many people found out about things at this workshop. We need to communicate as much as we can.
- In addition to that, there will be science publications and also reports and fact sheets that USGS and others can help provide that will come out in the interim so that folks are not waiting around for the publication. We want information out as soon as possible in any format. We will have more data, more maps, and an improved Web site.
- Anyone who has any additional comments, let me know. We will get the draft report in a few months, and we will share that and make sure we captured everything.

Appendix 2. Workshop Agenda

Wyoming Landscape Conservation Initiative (WLCI) Science and Management Workshop

U.S. Geological Survey

University of Wyoming

Laramie, Wyoming

May 12–14, 2009

Agenda

Tuesday, May 12

7:00	Registration
8:00	Welcome
8:15	Opening Address
8:45	Plenary Session 1: WLCI Background and Overview Presentations
9:30	Break
9:45	Plenary Session 2: WLCI Foundations for Science-Based Conservation
11:30	Plenary Session 2 Discussion
11:45	Lunch
12:45	Plenary Session 3: Mapping and Modeling Resources for Decisionmaking
2:45	Plenary Session 3 Discussion
3:00	Break
3:15	Plenary Session 4: Data and Information Management
5:00	Poster Session/Social

Wednesday, May 13

7:00	Registration
8:00	Agenda Review/ Announcements
8:15	Plenary Session 5: Fish and Wildlife Research
9:15	Break
9:30	Plenary Session 5: Fish and Wildlife Research (continued)
10:30	Plenary Session 5 Discussion
10:45	Plenary Session 6: Changing Landscapes
11:45	Lunch

1:00 Plenary Session 6: Changing Landscapes (continued)

2:00 Plenary Session 6 Discussion

2:15 Break

2:30 Plenary Session 7: Monitoring

4:45 Plenary Session 7 Discussion

5:00 Poster Session/Social

Thursday, May 14

8:00 Agenda Review/ Announcements

8:10 Plenary Session 8: Science Associated with Reclamation and Offsite Mitigation

9:55 Plenary Session 8 Discussion

10:05 Break

10:20 Breakout Instructions and Proceed to Breakout Groups

10:30 Breakout Group Discussions and Demonstration Session on Data Access

12:00 Lunch and Breakout Group Preparation

1:15 Breakout Reports

2:30 Closing Remarks/Next Steps

2:45 Adjourn

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Appendix 4. Plant and Animal Species Discussed at the Wyoming Landscape Conservation Initiative Science Workshop, May 12–14, 2009

[Scientific nomenclature is according to the Integrated Taxonomic Information System (www.itis.gov); listing is alphabetical by common name]

Birds

Bald eagle (*Haliaeetus leucocephalus*)
Brewer's sparrow (*Spizella breweri*)
Ferruginous hawk (*Buteo regalis*)
Great blue heron (*Ardea herodias*)
Greater sage grouse (*Centrocercus urophasianus*)
Long billed curlew (*Numenius americanus*)
Mountain plover (*Charadrius montanus*)
Mourning dove (*Zenaida macroura*)
Northern goshawk (*Accipiter gentilis*)
Peregrine falcon (*Falco peregrinus*)
Raven (*Corvus* sp.)
Redtail hawk (*Buteo jamaicensis*)
Sage grouse (*Centrocercus* sp.)
Sage sparrow (*Amphispiza belli*)
Snowy egret (*Egretta thula*)
Swan (*Cygnus* sp.)
White face ibis (*Plegadis chihi*)

Fish and Other Aquatic Species

Cutthroat trout (*Oncorhynchus clarkii*)
Lake trout (*Salvelinus namaycush*)
Leatherside chub (*Snyderichthys copei*)
Sucker (*Catostomus* sp.)
White sucker (*Catostomus commersonii*)

Insects

Mountain pine beetle (*Dendroctonus ponderosae*)

Mammals

Antelope (Bovidae)
Beaver (*Castor canadensis*)
Bighorn sheep (*Ovis canadensis*)
Bison (*Bison bison*)
Black-footed ferret (*Mustela nigripes*)
Elk (*Cervus elaphus*)
Forest bat (*Eptesicus* sp.)
Grizzly bear (*Ursus arctos*)
Hoary bat (*Lasiurus cinereus*)
Lynx (*Lynx* sp.)
Moose (*Alces alces*)
Mule deer (*Odocoileus hemionus*)
Northern pocket gopher (*Thomomys talpoides*)
Prairie dog (*Cynomys* sp.)
Pronghorn (*Antilocapra americana*)
Pygmy rabbit (*Brachylagus idahoensis*)
River otter (*Lontra*)
Swift fox (*Vulpes velox*)
White-tailed deer (*Odocoileus virginianus*)
Whitetail prairie dog (*Cynomys leucurus*)
Wyoming pocket gopher (*Thomomys clusius*)

Plants

Alkali sage (*Artemisia arbuscula* ssp. *longiloba*)
Aspen (*Populus* sp.)
Basin big sage (*Artemisia tridentata* ssp. *tridentate*)
Basin wildrye (*Leymus cinereus*)
Big sage (*Artemisia tridentata*)
Blue flax (*Linum* sp.)

Bluebunch wheatgrass (*Pseudoroegneria spicata*)
Bottlebrush squirreltail (*Elymus elymoides*)
Cheatgrass (*Bromus tectorum*)
Colorado butterfly plant (*Gaura neomexicana* ssp. *coloradensis*)
Cottonwood (*Populus* sp.)
Firecracker penstemon (*Penstemon eatonii*)
Fourwing saltbush (*Atriplex canescens*)
Fuzzytongue penstemon (*Penstemon eriantherus*)
Gardner's saltbush (*Atriplex gardneri*)
Indian ricegrass (*Achnatherum hymenoides*)
Low sage (*Artemisia arbuscula*)
Prairie flax (*Linum lewisii*)
Sagebrush (*Artemisia* sp.)
Scarlet globemallow (*Sphaeralcea coccinea*)
Slender wheatgrass (*Elymus trachycaulus*)
Streambank wheatgrass (*Elymus lanceolatus*)
Tamarisk (*Tamarix* sp.)
Thickspike wheatgrass (*Elymus macrourus*)
Ute ladies' tresses (*Spiranthes diluvialis*)
Wheatgrass (*Agropyron* sp.)
Willow (*Salix* sp.)
Winterfat (*Ceratoides* sp.)
Wyoming big sage (*Artemisia tridentata* ssp. *wyomingensis*)

Reptiles and Amphibians

Boreal chorus frog (*Pseudacris maculate*)
Boreal toad (*Anaxyrus boreas boreas*)
Great Basin spadefoot toad (*Scaphiopus intermontanus*)
Midget faded rattlesnake (*Crotalus oreganus concolor*)
Northern leopard frog (*Lithobates pipiens*)
Northern sagebrush lizard (*Sceloporus graciosus graciosus*)
Smooth green snake (*Opheodrys vernalis*)
Tiger salamander (*Ambystoma tigrinum*)
Wyoming toad (*Anaxyrus baxteri*)

Appendix 5. WLCI STAC and Coordination Team Members

Science and Technical Advisory Committee

Reg Rothwell STAC Lead; Wyoming Game and Fish
Reg will be retiring at the end of June; his replacement will fill the position and lead of STAC.

Adrienne Pilmanis BLM

Dan Blake USFWS

Pat Deibert USFWS *Pat and Dan share commitments to this team.*

Jessica Crowder WYDOA

Matt Kauffman USGS

Cay Ogden NPS

USFS slot is vacant (*has been for more than 1 year*).

Coordination Team

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