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Great Basin Integrated Landscape Monitoring Pilot Project

The Great Basin Integrated Landscape Monitoring Pilot Project is an interdisciplinary undertaking initiated in 2005 to address the topic of monitoring ecological systems in the Great Basin at the scale of a landscape. The Great Basin provides an excellent opportunity to develop tools to acquire and analyze monitoring data and predict landscape change. Natural resource managers are invited to participate in this undertaking. Their involvement is critical to the project's success and in return, they can gain understanding and decision-making support from the project's outcomes.

Project Overview

The Great Basin Integrated Landscape Monitoring Pilot Project is one of the priority efforts of the U.S. Geological Survey (USGS) to explore and test integrated landscape monitoring in order to observe, understand, and predict change. In this context, a landscape is defined as a varied land area composed of clusters of interacting ecosystems. As a test project, we aim to accomplish both scientific and institutional goals (Sidebox 1).

Within the vast Great Basin landscape (Sidebox 2, see page 2), the project's initial emphasis is the monitoring of ecological characteristics, particularly ecological functions. This emphasis does not completely exclude human dimensions because of the inextricable linkages between people and nature; however, the science mission of the USGS, the available scientific information, the nature of issues in the Great Basin, and the needs of natural resource managers have led the project development team to focus first on ecological functions.

Why Integrated Landscape Monitoring

As the diversity and pace of change accelerate, it is increasingly important to understand and predict the cumulative effects of management activities and environmental factors, for example climate change. The summation of local change leads to cumulative and synergistic effects that society often seeks to describe and manage. Extensive, rapid change often results in conflict and litigation, and our society increasingly considers cumulative effects in legal and regulatory decisions. Landscape analysis and monitoring enables managers to consider and prioritize options for mitigation and restoration and understand how local actions relate to landscape-scale matters, such as species conservation and habitat fragmentation.

An Invitation to Partners

The success of this pilot project relies on building partnerships to address common needs, and the USGS extends an invitation to you to join. Whereas the primary clients are Department of Interior agencies, (e.g., the Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service), we need the involvement of many others in order to develop perspectives, identify monitoring needs and questions, locate key data sets, and ensure that outcomes are relevant, useful, and cost effective.

Sidebox 1. Scientific and Institutional Project Goals

- Assess, detect, and predict landscape changes in the Great Basin
- Increase understanding of landscape-scale ecosystem interactions and outcomes from natural processes and human actions
- Produce scientific information, monitoring tools, and analysis techniques to detect and predict landscape changes in the Great Basin
- Support managers with accessible information and analytical tools to address landscape-level issues in the Great Basin
- Build a partnership for long-term coordinated landscape monitoring in the Great Basin
- Develop and document a staged approach to build a monitoring program
- Create and document an approach useful for landscape monitoring in other locations

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

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Project Approach

An interdisciplinary project team has formed that consists of over 30 professionals from the USGS and from agencies involved with management of natural resources in the Great Basin. The USGS membership includes representatives from all four disciplines: hydrology, biology, geography, and geology. The team has devised a staged approach to accomplish the project's goals, with some of the steps completed and others pending. The six key steps are

- Develop a conceptual model of the Great Basin landscape and systems
- Identify and prioritize ecosystem drivers
- Develop management and monitoring questions
- Mine and analyze data to answer management and monitoring questions and identify data gaps
- Predict landscape changes
- Develop, test, and implement monitoring (Fig. 2)

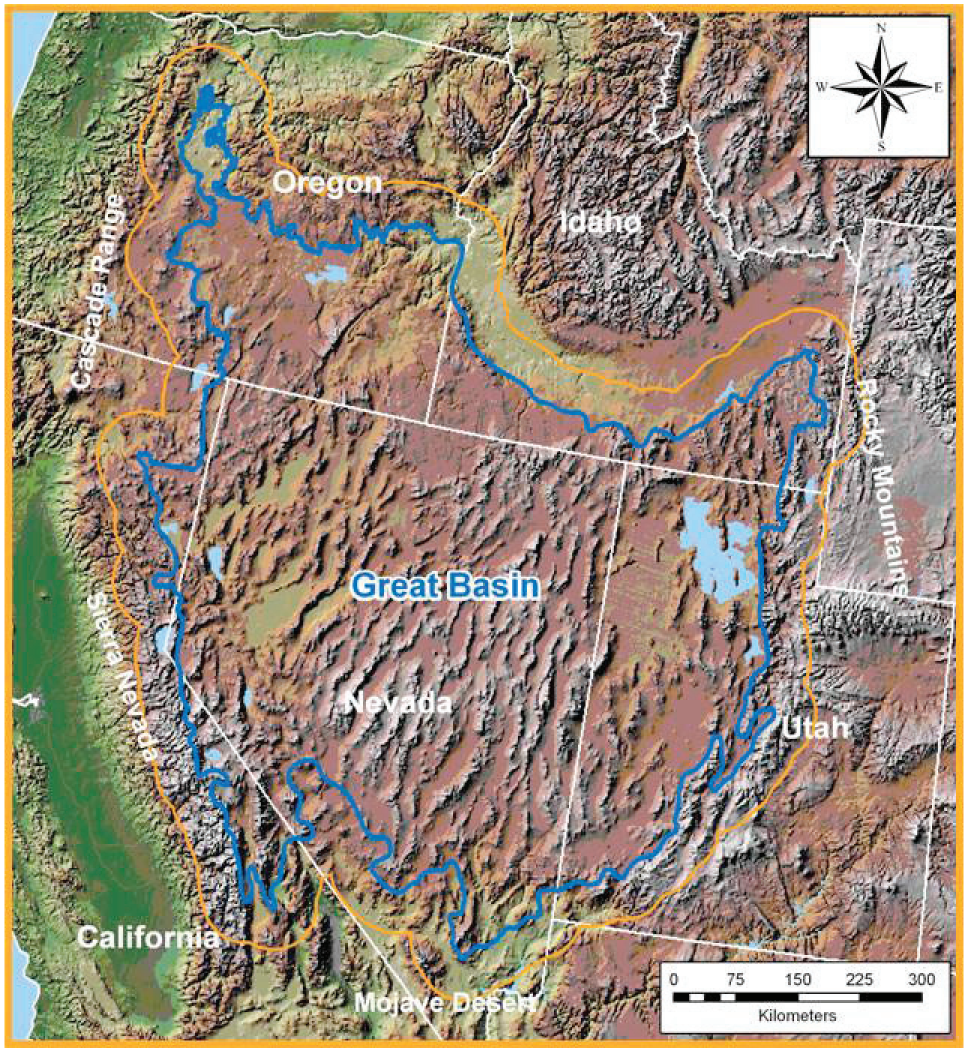

Figure 1. The Great Basin (derived from Omernik, 1987).

Sidebox 2. Characteristics of the Great Basin

Ecologically, the Great Basin is a semi-arid landscape, with a rich mosaic of shrublands, grasslands, and mountain-associated forests that are interspersed with rare, critical wetlands, aquatic resources, and riparian areas. Many of the basin's ecological communities and wildlife populations are rare or unique because of their patchy distribution, isolation, and response to climate, but others are rare or imperiled because of direct and indirect effects of human activities.

The Great Basin includes over 111 million acres of land and water in five western states (Fig.1). Almost 80 percent of these lands are under public ownership, with 80 percent of the public land managed by one agency, the Bureau of Land Management. Most people recognize the basin hydrologically as a region of interior drainages, but we also included the Columbia Plateau, which drains to the Columbia River and on to the Pacific Ocean. The decision to include the Columbia Plateau is based on similarities with the Great Basin in climate, physiography, vegetation, and management issues.

The Great Basin tends to be rural in character, yet this condition has not exempted the region from change associated with humans. Common examples of land use are road development, surface and ground water development, mineral and energy extraction, livestock grazing, agriculture, and recreation. Furthermore, there are several large and rapidly expanding urban areas. All of these human activities resonate throughout the region and result in cumulative ecological and social changes.

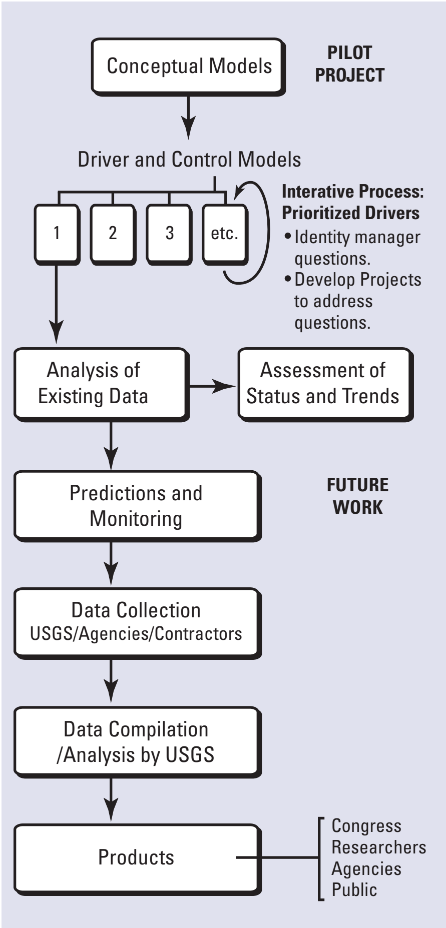

Figure 2. The project approach.

Conceptual Modeling

Conceptual models are used to organize what we know about a system and summarize that knowledge in a way useful for communication, learning, decision-making, and accountability. Using a hierarchical approach (Fig. 2), we have developed a set of models that organizes our understanding of Great Basin ecosystem components, functions, and drivers. The models are complex enough to show temporal, spatial, and ecological detail, but they also have a degree of simplicity for the sake of understanding. The model that is largest in scope is the framework model (Fig. 3). Together, all of the models illustrate a pathway for linking potential management actions or natural events to outcomes that may be relevant to society's values and associated management objectives. For this project, these models are especially critical for developing monitoring questions because they focus and define the scope of the monitoring program.

Ecosystem Drivers

Based on research, professional knowledge, and considerable discussion, the project team has identified and ranked the most influential ecosystem drivers in the Great Basin. Drivers are defined as any natural or human-induced factor that directly or indirectly causes a change in an ecosystem, or simply stated, "a stressor." We have focused on drivers that are relevant across spatial and temporal scales, significant to and manageable by land manager agencies, have potentially irreversible effects, and urgently require attention. The obvious significance of water to deserts of the Great Basin provided the basis to distinguish between precipitation-event-driven systems ('dry' systems) and surface- and groundwater systems ('wet' systems), which respond to precipitation at longer time scales. Within the dry and wet systems, we have identified a short list of priority drivers (Table 1) and a suite of 10 relatively discrete ecological units (called "subsystems") that are relevant to land managers, for example riverine and riparian, salt-desert steppe, and sagebrush steppe. A second round of modeling revealed relationships among these components. A fourth-tier of models, called "control and stressor models" (Fig. 3), will be prepared as additional insights are gained. A final critical step of the conceptual modeling process will be the development of a model of cumulative effects, which will integrate spatial and temporal scales as well as the interactive effects of multiple drivers.

Table 1. Priority drivers in the wet and dry systems.

Wet System	Dry System
Water extraction	Fire regime
Flow regime	Invasive species-fire interaction
Livestock grazing	Livestock grazing
Invasive exotics	Land treatments
Climate change and variability	Motor vehicle use and road development
	Climate change and variability

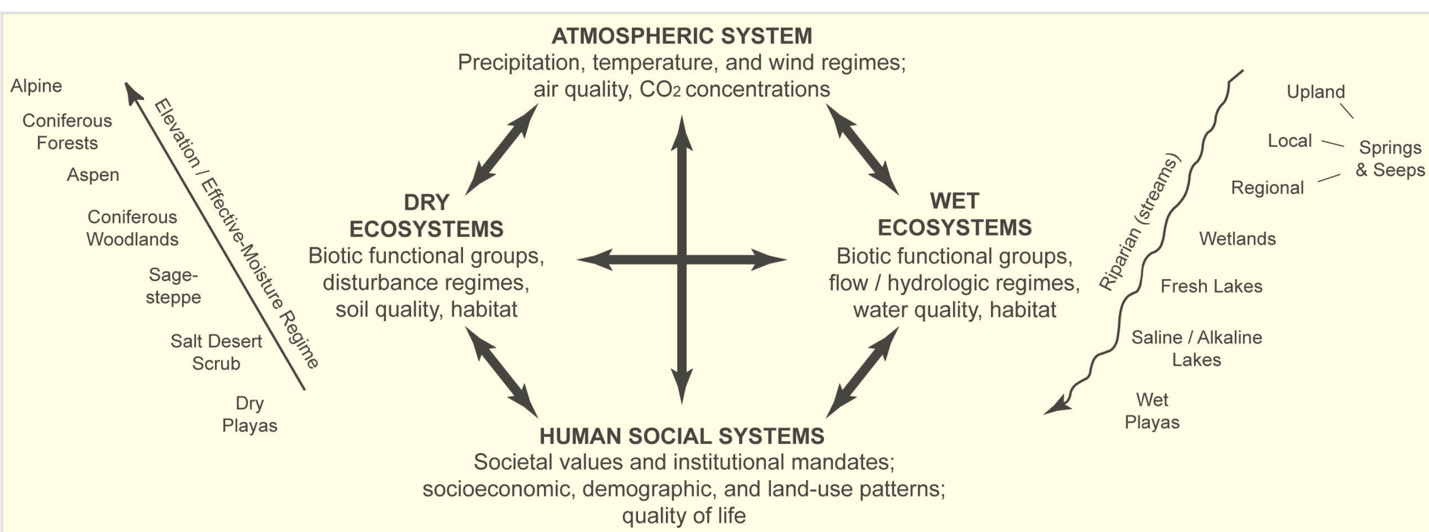

Figure 3. The framework model.

Table 2. Examples of questions and potential monitoring applications.

Driver	Water extraction in the wet system	Fire-invasives interaction in the dry system
Management Questions	How will increased water extraction impact phreatophytes[1]? Can phreatophytic communities serve as an indicator of impacted groundwater systems?	How should land managers prioritize efforts to manage fire regimes to retain and restore desired plant communities? What can managers do now to manage current and potential fire regimes?
Study Questions	Where are potential phreatophytic communities and what are are their landscape characteristics? What are the effects of aquifer drawdown on phreatophytic communities? How do groundwater systems operate and what is the natural envelope of variability? What are the areal relationships between groundwater extraction sites and impacted. vegetation communities?	What are the recent patterns of fire regime variables? How do patterns relate to landscape characteristics? How do patterns compare with historic conditions? Is there evidence of shifts in fire regimes due to exotic plants? How may patterns and relationships respond to climate change?
Monitoring Applications	Identify indicators of change in spring discharge and groundwater levels. Develop methods to measure change in indicators.	Develop best approaches and tools to monitor and predict fire. regimes and associated vegetation change.
Proposed Pilot Project	Predict locations of phreatophytic communities and identify areas at risk from increased water withdrawals.	Use spatial patterns of fire and landscape characteristics to evaluate the effects of invaders on fire regimes.

[1]Deep-rooted plants that obtain water from a permanent ground supply or from the water table.

Monitoring Questions

Management issues can be translated into monitoring questions. These questions can then be used to develop assessments and ask questions about landscape-scale conditions and projected changes. Initially, the project is focusing on priority drivers to test the approach of developing monitoring questions and analyzing existing data to begin to answer these questions. As an example, Table 2 displays questions and monitoring applications for two drivers: groundwater extraction in the wet system and fire-invasive interactions in the dry system.

Participation by management agencies is particularly critical in identifying and testing monitoring questions. Their involvement with driver and question selection will ensure that many of their management needs are addressed. They also can help evaluate the practicality of collecting information to answer any given question.

Data Mining and Analysis

Realistic considerations have led us initially to focus on existing monitoring data rather than new data collection. Existing data that address high-priority management questions can contribute to question development in the monitoring process if the data are compiled and cataloged across jurisdictional boundaries. Therefore one set of tasks is to identify, compile, and catalog appropriate data and then see how these data can help refine monitoring applications. While we work on this set of tasks, we also have identified a short list of projects that can be completed using existing monitoring data. These projects will test whether existing monitoring data can be used to identify trends and causes of change at the landscape scale.

Once a full slate of monitoring questions is available, the team will develop protocols and analysis tools to answer those that are selected as a priority. Again, we will maximize the use of existing data because so much work and money has been invested in collecting vast amounts of information over preceding decades. At every stage, the USGS will document, archive, and deliver information and data, as well as identify information gaps to focus further research and monitoring. A public Internet portal, still in the planning stage, will be the primary tool for portraying the results of data mining and analysis.

Predicting Change and Future Landscape Monitoring

This project is fully successful once it leads to prediction of change and to implementation of future monitoring. To better understand how this will occur, consider the stressor “fire-invasive species interactions” in the dry system from Table 2. We will use the results of the initial assessments based on existing data to evaluate ways that invaders have altered fire regimes and predict how these relationships will change in the future. Subsequently, we will develop monitoring tools and sampling designs, which relate to monitoring questions. These will be used to monitor changes in fire regimes and vegetation conditions. Then we can evaluate monitoring findings against predictions and continue to refine our models and associated findings. Outcomes for this particular driver and associated work will include maps and spatial data, manuscripts, trend and threat assessments for altered fire regimes among major vegetation types, and land-management options. Assessment, prediction, and monitoring, can then continue to occur in an iterative fashion for all priority drivers and questions as long as society needs and supports the process.

Additional Information

A full project plan is available on the website of the USGS Forest and Rangeland Ecosystem Science Center at http://fresc.usgs.gov/. Click on the link to research and enter the search term “Great Basin Integrated Landscape Monitoring” in the study-title field.
The project director is listed below, including contact information.

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