RMRScience

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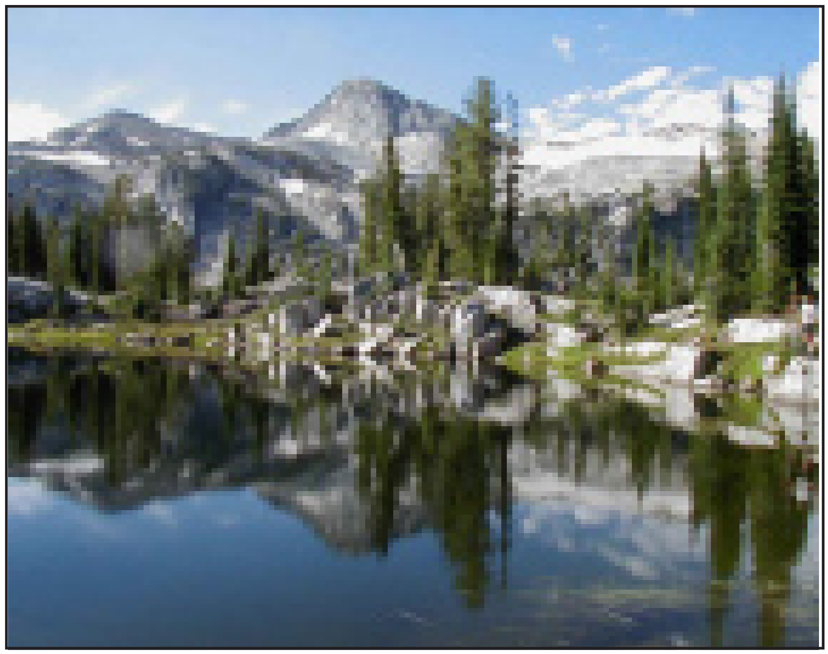
What Role Can GIS Play in Wilderness Management?



Wilderness management decisions and actions are based ideally on an intimate knowledge of the natural landscape, its use, and the multitude of internal and external threats to wilderness. "However, sufficient information about current wilderness resource conditions, uses, threats and the interrelationships among these is lacking," says Peter Landres, with the Aldo Leopold Wilderness Research Institute in Missoula, Montana. Landres is a Research Ecologist at the Institute, which is administered by the Rocky Mountain Research Station, and develops knowledge to improve the ecological management of wilderness. "This lack of information likely results from the perception that these areas are intact ecological systems with little need for active management, and there are no commodity values within wilderness, both suggesting that there is no need for new or better information. The large area and general inaccessibility of wilderness also contributes to the perception that collecting new information would be too costly and time-consuming," he says.

Landres points out that traditional means for keeping records and analyzing issues worked well in their day, but in comparison to computer-based methods, paper-based records are difficult to analyze and easily lost. In addition, interactively demonstrating the effects of different management options to the public on paper maps is difficult or impossible. Furthermore, understanding complex spatial relationships among different types of variables, such as the influence of trailhead location on the availability of solitude and the influx of exotic plants, is difficult on paper.

Landres worked with Leopold Institute Biologist Dave Spildie and University of Montana Professor Lloyd Queen to assess the use of GIS (geographic information systems) and other rapidly developing computer-based technologies, such as remote sensing and spatial analysis, as a means for overcoming some of the problems mentioned. The availability of large amounts of geospatial data and powerful analysis tools to help understand relationships among these different types of data, and being able to manipulate these data over large areas for different planning goals, allow new ways of thinking about wilderness.

What is GIS?

A GIS is a computer application that stores, retrieves, manipulates, analyzes and displays geographically referenced information or geospatial data. Geographic referencing ties objects to a known location on the ground and can relate the objects to all other objects or features on the ground. Two basic types of data are managed by a GIS: geospatial data that define the location of a feature or object on the ground, and attribute data that describe the characteristics of this feature. GIS offers the unique ability to link spatial and attribute data, and then manipulate and analyze relationships among them.

Wilderness Applications

What can GIS do for wilderness management? "The unique ability of a GIS to store, manipulate and analyze spatial and attribute data provides one of the best means for assessing and understanding the status and trends of resource conditions, threats to resources, and the consequences of different management actions on these resources," says Landres. In the past, this information was stored on hard-copy paper documents and maps. With GIS, it can be stored digitally, making it readily accessible for evaluation and analysis, and it can be shared among wilderness managers, other staff, and the public. Specifically, GIS offers the potential to significantly improve the accuracy and long-term cost-efficiency of five basic actions of wilderness management: inventorying, monitoring, analysis, planning and communication.

Inventorying

Inventorying is simply identifying things of interest, their location, and current condition. It is one of the earliest uses of GIS, and now one of the most common. Campsites, fire rings, trails, recreation opportunity classes, common vegetation types, exotic plants and vegetation types used by threatened and endangered species can all be inventoried and mapped into a GIS.

Monitoring

Monitoring is the process of repeatedly measuring an attribute over time to determine changes in location or condition. Nearly all of the resources traditionally monitored by wilderness staff can be assessed within a GIS. By facilitating the storage, retrieval and comparison of any attribute data over any time frame, a GIS can simplify the process of monitoring, assessing change and determining trends. Still in various stages of development, some inventory and monitoring needs may be accomplished by bringing satellite imagery and other remotely sensed data for a wilderness directly into a GIS. According to Landres, a major trend to watch for is spatial data from NASA's Earth Observing System satellite, which will provide frequent, high resolution data directly to the GIS user.

Analysis

GIS is much more than a tool for making maps, it is the analytical capabilities of GIS (the ability to integrate and overlay any number of data layers limited only by the imagination and experience of the user) that offer the most promise to wilderness managers. A GIS can explore relationships and determine trends and consequences of potential or planned actions.

Using a GPS unit to record campsite loctions.

Planning

GIS could facilitate wilderness planning in several ways. Once relationships among wilderness resources and threats to these are understood, managers could play "what if" scenarios within the GIS, varying different aspects of wilderness conditions and threats. GIS could also allow greater integration of wilderness planning across administrative units if these units are using a common, shared GIS database.

Communication

GIS is an effective tool for public outreach, communication and education because people understand information more readily when it is portrayed graphically, and one of the principal outputs of GIS is a map, combined with other data in graphical form. GIS-produced maps can improve communication among management personnel and the public, as well as among different stakeholders. Furthermore, a GIS can be set up in public meetings to allow immediate exploration of "what if" scenarios to illustrate potential effects and outcomes of different decisions.

GIS Limitations

GIS is one tool among many available to wilderness managers. While GIS may be a valuable and unique tool, there are basic issues in developing a wilderness GIS that must be resolved before any action is taken, and several practical issues can prevent or compromise the use of GIS. "It is crucial to first assess whether GIS is the most effective tool to answer management questions, as there are significant costs in terms of time, effort and money in developing a GIS," said Landres.

Although every situation is different, GIS practitioners have developed recommendations for initiating projects and ensuring that costs are controlled. One recommendation, the GIS Lifecycle planning and design framework, is a systematic planning and design process used prior to GIS acquisition, startup or the initiation of a new project on a GIS that has already been established. The four cyclical phases of the GIS Lifecycle are common sense steps in project design and analysis that are often overlooked in the "technical" arena of GIS:

Phase I: Planning begins with the crucial question "why consider a GIS?" Many planning, monitoring and assessment tasks can be effectively accomplished using methods other than GIS. Users need to be aware of what GIS is and is not designed to accomplish. Phase I considers who the GIS users are; what their goals are; what the anticipated products are; what data and analyses are needed to provide these products; and how decisionmakers will use this information.

Phase II: Design matches user needs and expectations to the appropriate GIS functions. Included in this phase are tasks of software selection, allocation of resources to training and education, and staging or scheduling tasks and outcomes so that progress toward planning goals can be measured.

Phase III: Implementation is where many users assume that GIS projects actually begin. During this phase, data are compiled, maps digitized, metadata records compiled, analyses conducted and output products generated. It is the realization of the planning and design goals.

Phase IV: Maintenance of data. Maintenance tasks clearly are necessary to support ongoing GIS use, but may also be required even if the project has no long-term programmatic use. Maintenance of data and expertise developed earlier in the GIS Lifecycle guards that investment and provides the opportunity for a longer-term return on the original investment.

Experience has shown that selecting an appropriate GIS solution that meets user needs and expectations can be challenging. Understanding the issues and the learning curve associated with new or expanded GIS projects is crucial. GIS projects can flounder on poorly defined goals and the use of poor quality or inappropriate data. Without clearly stated goals and precise questions or objectives, GIS can be easily mired in costly details of technology and data.

Despite these concerns, GIS can bring significant benefits to wilderness management. Wilderness managers need to be proactive in understanding what GIS is, how it can be used, and its limitations. "Ultimately, GIS is not so much about a new technology as it is a stepping stone for a new way of thinking about and improving our understanding of wilderness and its management," said Landres.

For more information, request *GIS Applications to Wilderness Management: Potential Uses and Limitations*, by Peter Landres, David Spildie and Lloyd Queen, 2001, General Technical Report RMRS-80, available from the Rocky Mountain Research Station at http://www.fs.fed.us/rm/main/pubs/newpubs/np01_3js.html, or e-mail rschneider@fs.fed.us, (970) 498-1392.

Publication Reviews

Assessing Crown Fire Potential by Linking Models of Surface and Crown Fire Behavior

(RMRS-RP-29)

Fire managers are increasingly concerned about the threat of crown fires, yet only now are quantitative methods for assessing crown fire hazard being developed. Links among existing mathematical models of fire behavior are used to develop two indices of crown fire hazard – the Torching Index and Crowning Index. These indices can be used to ordinate different forest stands by their relative susceptibility to crown fire and to compare the effectiveness of crown fire mitigation treatments. The coupled model was used to simulate the wide range of fire behavior possible in a forest stand, from a low-intensity surface fire to a high-intensity active crown fire, for the purpose of comparing potential fire behavior. The hazard indices and behavior simulations incorporate the effects of surface fuel characteristics, dead and live fuel moistures (surface and crown), slope steepness, canopy base height, canopy bulk density, and wind reduction by the canopy. Example simulations are for western Montana Pinus ponderosa and Pinus contorta stands. Although some of the models presented here have had limited testing or restricted geographic applicability, the concepts will apply to models for other regions and new models with greater geographic applicability. This publication is available from the Rocky Mountain Research Station. It can also be ordered on our website at http://www.fs.fed.us/rm/main/pubs.html.

Southwestern Rare and Endangered Plants: Proceedings of the Third Conference

(RMRS-P-23)

Contributed papers in this conference proceedings review current research findings related to the demographic, monitoring, reintroduction, ecological and genetic studies done on southwestern rare plant species. Topics covered include: Plant Conservation Strategies in the Southwest; Demography and Monitoring; Autoecology, Ecology and Genetics; Threats to Rare Plants; and Factors Influencing the Distribution of Rare Plants. This proceedings is available by writing the Rocky Mountain Research

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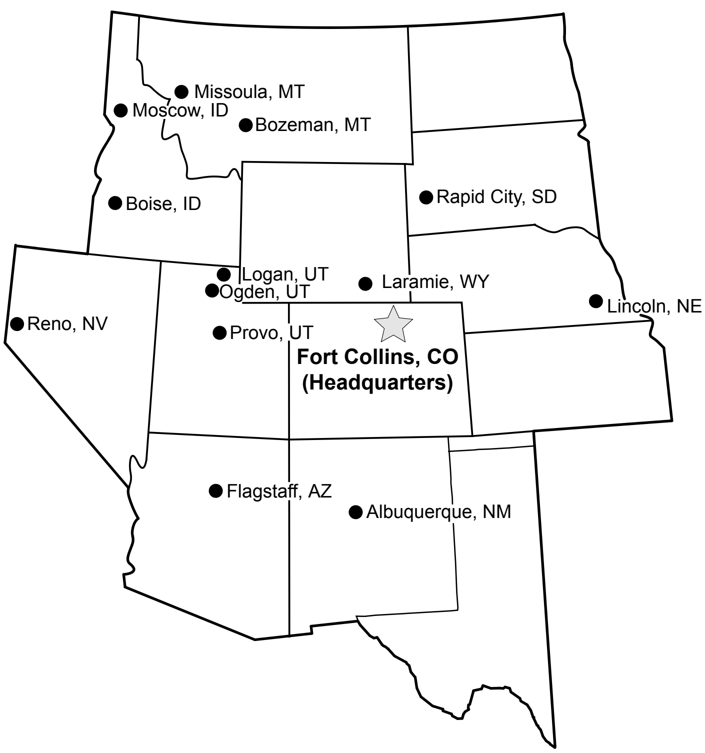

The USDA Forest Service's Rocky Mountain Research Station is one of seven units nationwide that make up the most extensive natural resource research organization in the world. Headquartered at the foot of the Rockies in Fort Collins, CO, the Station maintains 14 field laboratories within a 14 state territory (see map). Scientists conduct studies nationwide, with emphasis on the Rocky Mountains, Great Basin, Great Plains, and Southwest. Research serves the Forest Service, as well as other federal agencies, international organizations, private groups, and individuals. For more information, visit our website at http://