1872 vs 2004: Mining Claim Meets the World Wide Web

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Abstract—*Inappropriate development or land use on private inholdings in a matrix of predominantly public land have the potential to profoundly impact backcountry landscapes. Beyond damage to natural systems and cultural resources, ramifications include impacts on neighboring communities dependent upon tourism and backcountry recreation for their economic vitality. Limited financial resources make geotechnologies an ideal tool for prioritizing inholdings for land conservation acquisition or other means of protection. The World Wide Web holds tremendous promise for distributing geographic information and applications for use in conservation planning by local governments, land managers, and conservation professionals. Two example projects in the rugged San Juan Mountains of southwestern Colorado illustrate the potential and challenges that these technologies hold for rural communities.*

Introduction

Land ownership patterns around many of Colorado's mountain communities reflect the legacy of the region's mining past. While visitors see forested hillsides and high mountain tundra, an unseen world of jumbled private inholdings within a matrix of public land exists beneath this alpine landscape. A remnant of 19th century legislation intended to help settle the sparsely inhabited and mineral rich west; this ownership pattern presents significant 21st century challenges for surrounding mountain communities. The General Mining Law of 1872 provided for "patenting" open public land – a process in which public land is converted to private ownership. Figure 1 shows the chaotic ownership pattern of patented mining claims in the northern San Juan Mountains in southwestern Colorado.

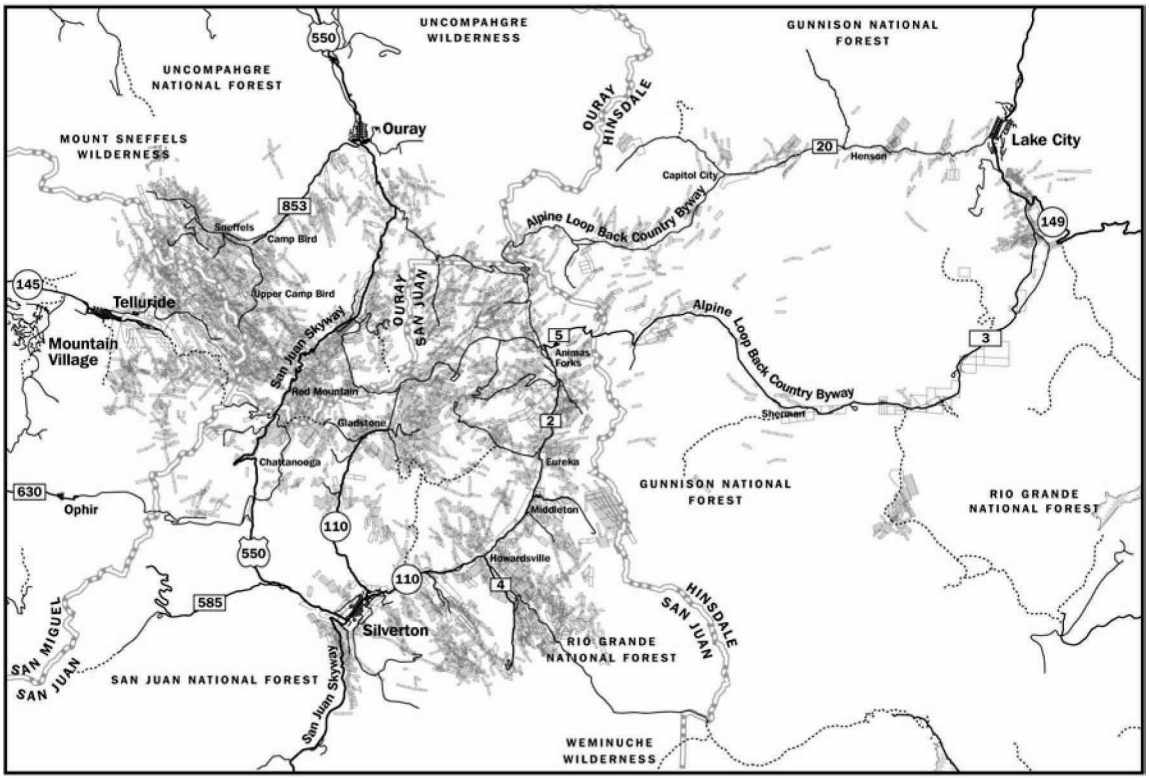

Figure 1. Patented mining claims in a portion of the northern San Juan Mountains.

Managing the landscape to preserve natural values, historic resources, and recreational access is a daunting challenge within this incoherent ownership framework. Construction of second homes and vacation cabins - "backcountry sprawl" - further fragments wildlife habitat, compromises scenic vistas and strains local government's ability to provide services and infrastructure. Furthermore, drainage from open adits and runoff from tailings piles can create downstream water quality problems with consequential environmental liability issues for organizations that seek to mitigate these negative impacts.

For workers concerned with conservation-oriented land management alternatives, the magnitude of the inholding problem can be overwhelming. To make the problem more manageable, we've developed a methodology that ranks private parcels according to their conservation priority. This methodology takes into account both the intrinsic conservation resource values associated with each parcel along with an estimate of the likelihood of (residential or commercial) development based upon physical constraints present on the property. The highest ranking properties are those with the greatest occurrence of conservation resources and the highest development potential based upon physical constraints. Conservation workers can then design management or acquisition scenarios based upon available financial resources matched with critical priority parcels.

With many land managers located in dispersed, rural locales, internet-based technologies have become an important distribution vehicle for geospatial data and services. Cash strapped local governments, federal agencies and nonprofits need only an internet connection and web browsing software to access capabilities that typically costs thousands of dollars a "seat" for desktop licensing. Two projects – the Red Mountain component of the San Juan Skyway Spatial Analysis and Mapping Project and the Alpine Loop Back Country Byway Spatial Analysis and Mapping Project – in portions of Hinsdale, Ouray, San Juan and San Miguel counties utilized the conservation priorities methodology to rank private inholdings within the area illustrated in figure 1. References to the "northern San Juan" area that follow indicate the area of figure 1 and the two projects mentioned above.

Economics, Demographics and Politics

Figure 2 shows the change in the number of jobs in different industries over time for Ouray County. This chart illustrates the decline of mining as an employment base and the ascendance of recreation / tourism related jobs in the retail and service sectors. It also depicts the increasing importance of the construction and real estate industries for this county. These trends are fairly typical of other northern San Juan counties. The recreation and tourism industries are highly dependent on the region's natural and cultural amenities. Consequently, protecting the region's natural and cultural resources also helps to protect the region's economic vitality.

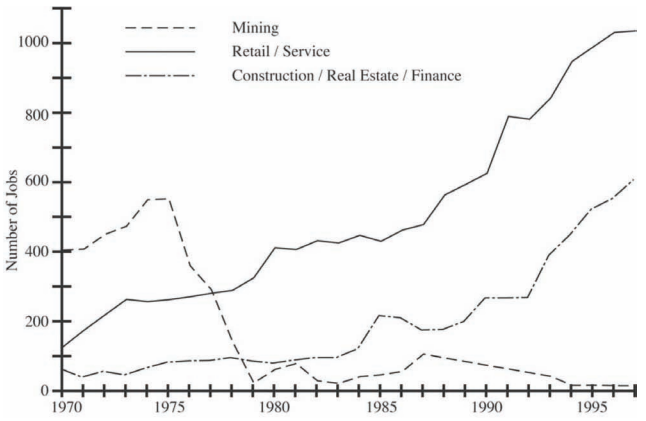

Figure 2. Economic profile for Ouray County, Colorado. This graph illustrates the number of jobs in selected industries as a function of time. Large scale mining ended with the closure of the Idarado mine in 1978 (adapted from The Wilderness Society 2000).

The outdoor amenities offered by the San Juan region have made the area desirable for part-time residents. Table 1 shows the percentage of second or seasonal homes for counties within the northern San Juan area determined from the 2000 Census. The table also gives the county's second home ranking within the state. Seasonal activities such as winter skiing, fall hunting and high country summer recreation are major draws to the mountainous counties including those in the San Juans. The second home industry contributes significantly to local economies through jobs in construction, real estate, and finance (fig. 2).

Many San Juan Mountain counties have very high levels of public land ownership. Table 2 shows the land stewardship breakdown for four northern San Juan counties. The percentage of land in public ownership is particularly high for San Juan and Hinsdale counties (~89

Table 1. Percentage of second or seasonal homes for 4 northern San Juan counties. The rank is within 63 Colorado counties in 2000 (Bureau of Census 2000).

County	2nd Homes (%)	Rank in Colorado
Hinsdale	61.3	1
San Juan	49.4	4
San Miguel	33.5	10
Ouray	12.7	24

Table 2. Percentage of land in public ownership (undifferentiated). The rank is within 63 Colorado counties (Division of Wildlife, NDIS web site).

County	Total Public Land (%)	Rank in Colorado
Hinsdale	95.5	1
San Juan	88.9	3
San Miguel	62.2	23
Ouray	45.5	33

percent and ~96 percent respectively). As a consequence, acquisition of private land and subsequent transfer to public ownership frequently meets significant political opposition. Reasons for opposition include decreased property tax base, restriction of residential and commercial growth opportunities, and a general distrust of federal government intentions. This presents an added challenge to those interested in land conservation in these counties. Other land management alternatives such as land exchanges, recreational easements, or transfer of development rights should be considered in this political context.

Significant Resources

Several significant natural and cultural resources draw visitors to the region and add to the quality of life for local residents. These resources have been identified by project stakeholders for preservation and enhancement and were included as components in the GIS modeling process.

Recreation

Recreational activities in the area are numerous and include hiking, biking, off highway motorized use, mountaineering, rock climbing, skiing, snowshoeing, snowmobiling, camping, horseback riding, fishing, rafting and kayaking. As mentioned above, recreation and tourism have become the major components of the region's economy.

Recreational elements included in the GIS analysis were roads, trails, campgrounds and huts, trail heads, ski areas and historic railroads.

Historic

The northern San Juans contain an outstanding record of Colorado's hard rock mining era. Beyond a snapshot of life of a bygone time, the region's historical resources provide an important record of innovation in mining technology. The Red Mountain Pass area has been referred to as a mining "Silicon Valley" for the technical advancements that the area produced (Clifton 2003). Along with outdoor recreation, these historical resources provide a significant visitor draw.

The Colorado Historical Society (CHS) maintains a database of inventoried historic sites that were used in the spatial modeling exercise.

Ecological

The montane, subalpine, and alpine environments found in the northern San Juans provide habitat for a number of economic species and species of special concern, including elk, mule deer, boreal toad, ptarmigan, lynx, and moose. A number of potential conservation areas identified by the Colorado Natural Heritage Program (CNHP) occur within the northern San Juan region.

Important habitat and ecological areas from a variety of data sources were used in the GIS modeling.

Scenic

The San Juan region is renowned for its scenic splendor. The San Juan Skyway, which runs through the western portion of the study area, is referred to as the "most scenic drive in America." The City of Ouray uses the moniker of "Switzerland of America" for its scenic character.

Visual resources were modeled through viewshed mapping and skyline analysis (areas where structures would break the skyline) from designated roadways within the study area.

Watershed

Four significant drainages have their headwaters in the northern San Juan project area. The Lake Fork of the Gunnison and the Uncompahgre River are major tributaries to the Gunnison River. The San Miguel River is a major tributary to the Dolores River; the Animas River is a major tributary to the San Juan River. These watersheds provide source water for numerous downstream communities. Healthy watersheds result in healthier ecosystems and higher water quality for drinking water, recreation, and agricultural operations.

Buffers around streams and water bodies were used in the modeling.

Threats to Resource Integrity

Reliable recreational access to the region's "magnet" locations becomes especially important in the currently prevailing economic climate. While the vast majority of recreational destinations are located on public land,

backcountry access roads and trails frequently cross private inholdings. Conflict arises when public access through these inholdings is challenged by private landowners. In San Miguel County, access along the standard route up Wilson Peak, one of Colorado's popular "14ers" (peaks over 14,000 ft in elevation) has been blocked by the owner of a private inholding in U.S. Forest Service land. Since these 14ers are destinations for many thousands of hikers a year, closures of this type can have local economic ramifications.

With each passing year, the harsh high country conditions take their toll on historic structures. Stabilization and restoration efforts on private property cannot take place without landowner permission and adequate funding. While this "passive destruction" slowly degrades the structural integrity of historic sites, deliberately destructive acts can have an immediate and devastating impact. In August 2002, a Red Mountain Pass landowner destroyed historic structures on his property that had been built over a hundred years earlier (Greenhill 2002). Ostensibly to eliminate "attractive nuisance" liability, some felt that this destruction, together with the "for sale" signs on the property, were a form of blackmail to set a higher-than-market-rate price.

An owner of a patented mining claim has the same rights as owners of other private parcels, including the right to construct a home or cabin. In sensitive high country environments, construction of homes and access roads often fragments wildlife habitat, impacts scenic vistas and creates demand for new local government services, such as winter road maintenance and remote emergency services. In addition, for privacy, safety and liability reasons, new mountain residents may block recreational routes that have traditionally, though unofficially, crossed their property.

The area's mining heritage has a downside as well. Mining's legacy extends beyond historic structures and the record of hard rock mining innovation to draining adits, tailings piles and downstream pollution. Researchers investigating frail-boned white tailed ptarmigan have linked this condition to elevated cadmium levels in willows, a primary ptarmigan food source (Larison and others 2000). Fish populations have been impacted for tens of miles and water quality standards have not been met for the Animas River, which provides drinking water for the communities of Silverton and Durango (Robinson and Odell 2002). Short term gain was emphasized at the expense of long term unintended or ignored consequences. It's worth reflecting on our actions today and their potential impact on future generations.

Conservation Priorities Methodology

To address the issues of land conservation within the context of these resources and threats, we've developed a methodology to prioritize lands based upon their conservation resource values and likelihood of development (fig. 3). The "Landscape-Based Conservation Priorities" section of the figure illustrates two vital components: "Resource Value" (or conservation resource value) and "Development Potential." This section is referred to as landscape-based because it focuses predominantly on the naturally occurring systems – in other words., topographic, vegetative, geologic, etc. - largely separate from the human imposed land ownership pattern.

Resource value is the combination of spatial factors that contribute to the intrinsic conservation value of the area. These conservation resources include scenic vistas, critical wildlife habitat, historic resources, recreational amenities, and areas important for watershed health.

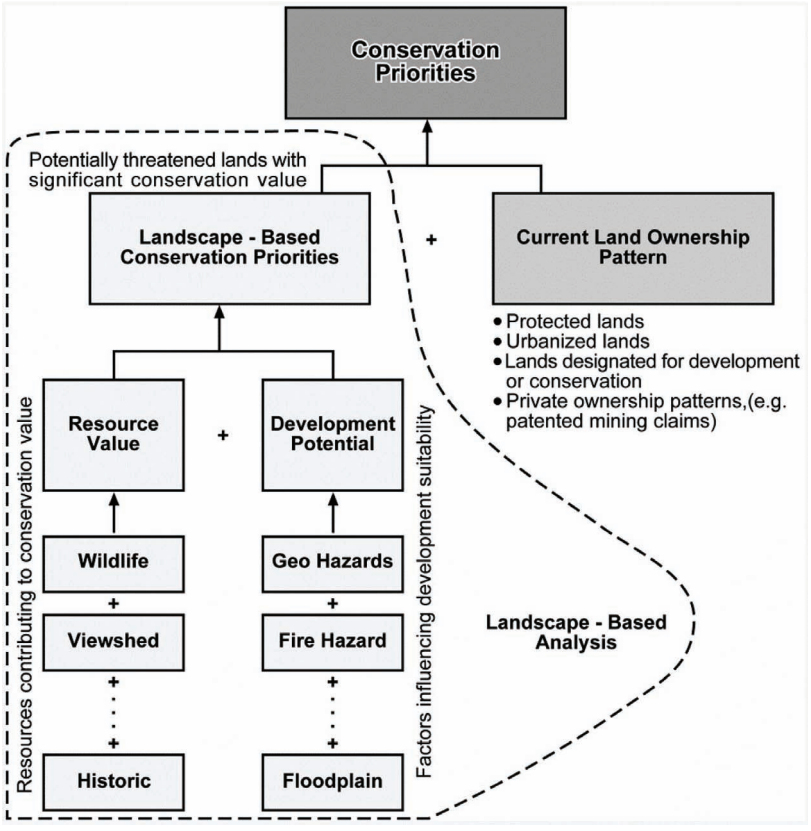

Figure 3. Conservation priorities methodology (Computer Terrain Mapping and others 2004).

Development potential combines factors that constrain the "buildability" of a parcel. These constraints include steep slopes, geologic hazards, avalanche hazard, proximity to existing roads (to access a property), floodplains, environmental constraints and wildfire hazard.

Resource value and development potential are combined to form the landscape-based conservation priorities. These are areas with high conservation value that are likely to be developed based upon building constraints. At this point, development potential has not been restricted to private parcels. The results of the landscape-based analysis are combined with the private land ownership pattern to produce the overall conservation priorities.

There are advantages to decoupling the landscape-based computations from the human imposed land ownership pattern. First, the digital representation of a parcel's location may involve considerable uncertainty. If this digital representation shifts due to a more accurate set of locational parameters, the parcel's value and priority status can easily be recalculated. Another advantage allows public agencies to assess the conservation priority of a potential trade parcel that is currently in public ownership. If only private parcels are evaluated, then a separate analytical exercise would need to occur to similarly assess the conservation value of a potential publicly-owned trade parcel.

Challenges

This prioritization process provides a useful framework for evaluating and ranking parcels for land conservation purposes. However, a variety of factors present challenges in the data acquisition, analysis and interpretation stages. Familiar issues such as spatial accuracy and data completeness tend to be amplified in these more remote regions.

Many of the surveys for patented mining claims are over 100 years old and some reference locational monuments that have been destroyed. Wherever possible, GPS coordinates for locational monuments were utilized for locating parcels from mineral survey plats and "rubber-sheeting" surrounding claims.

Our analyses show a positive conservation bias toward roads – a somewhat unexpected result. Roads are viewed as a conservation positive in the recreational access they provide. Since roadways were the viewing platforms for the visual analysis, areas proximal to these roadways were more likely to be visible and thus have a higher visual resource value. Finally, close proximity to access roads increases development potential and consequently raises the conservation priority value for a parcel. Areas farther from roads tend to be less disturbed and have higher ecological value, however. This may be indirectly included in the analysis in the form of potential conservation areas and other areas of high natural values. In future projects it may be worthwhile considering "unroaded" areas as conservation resources.

Establishing a reasonable context for point data continues to be a struggle. Among project stakeholders, historic resources were considered to be at or near the top of the list in importance. Our source data consisted of individual sites or points. Determining an appropriate spatial context for a historic site, which could be translated into a buffer around the point data, is a problem that we have not adequately solved. BLM and USFS regulations typically forbid camping within a 50 to 100 ft buffer from the site, but a site's visual context may extend for hundreds of feet. So, for example, a parcel containing a significant historic structure may be conserved, but residential development on an adjacent parcel could greatly impact a visitor's experience.

Finally, some areas that are considered to be of great importance by stakeholders just don't show up as significant in the analysis. Whether this is due to inaccurate or incomplete source data, flaws in the modeling process, or the overall subjectiveness of the values that we're attempting to model, it's important to ultimately rely on "carbon-based" (rather than "silicon-based") thinking.

Internet Applications

The land managers, local governments, and conservation workers who are the ultimate users of the analytical results of these projects are located in dispersed sites, often in rural locales. Access to GIS capabilities and expertise vary widely among the different user groups. These reasons, together with the ubiquitous presence of the World Wide Web, make the internet a highly desirable venue for distributing data and capabilities. Both the northern San Juan projects made web-based mapping and geospatial applications an important task within the overall work scope.

A number of precepts guided development and component integration for the web-based applications:

- Minimal client-side software and hardware should be required. The current applications require only web browser software (with free plug-ins) and an internet connection.
- Most data and applications will reside on the server side of the connection. This will insure that users access the most current datasets available.

- Applications should be geared toward non-expert GIS users, but additional capabilities should be available for those with the expertise.
- Capabilities should be customized for land conservation / land management uses.
- The applications should be built primarily on open source components. Where in-house, proprietary components are used, they should be OGC-compliant to enable easy integration of future application and extensions.
- Because of the sensitive nature of some of the data and results, access to the applications should be password protected. Some real estate speculators in the area specialize in selling inholdings to the federal government; discouraging this type of use was important among project stakeholders.
- The resulting systems enable the user to perform a variety of GIS-based functions including basic raster and vector mapping capabilities, database querying, display of results in map or report form, polygon or point based raster queries (raster values that occur within a polygon or at a point), viewshed analysis and point-to-point line-of-sight analysis.

More advanced users develop conservation scenarios highlighting different resources and parcel selections. For example, a scenario could be developed highlighting the top 50 parcels based on visual resource value within BLM-managed lands. Just a few years ago, these types of capabilities were restricted to the realm of the "white lab coat" crowd.

Conclusions

The conservation priorities methodology provides land managers and conservation workers with a GIS-based guide to ranking private parcels for varying acquisition or management scenarios in inholding-riddled public lands. This process takes into account (1) an estimate of the occurrence of conservation resources within a parcel and (2) an estimate of the development potential of the parcel.

Web-based technologies, requiring minimal client-side investment in hardware and software, are delivering on the promise of putting the analytical power of geographic information systems into the hands of non-expert workers.

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