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LAND USE AND LANDSCAPE CHANGE IN THE COLORADO MOUNTAINS II: A CASE STUDY OF THE EAST RIVER VALLEY

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ABSTRACT Rural land in the U.S. Rocky Mountains is being subdivided and developed for residential and commercial use at an unprecedented rate. In the East River Valley, Colorado, land ownership parcel size began to decline sometime during the last two decades after increasing for over a century—since the first European settlement. Roughly 20% of the private land in the valley has been divided into parcels smaller than about 45 acres (18 ha), parcels that cannot economically support agriculture. Development in the valley has caused significant land-cover fragmentation, especially in aspen, meadow, mixed conifer, and sagebrush cover types. Increased rates of house construction, from 3% per year during 1964–1990 to 8% per year from 1990 to 1994, and the conspicuousness of new roads and houses on the valley slopes, have enhanced local perception of rapid landscape change. Residents' concern over land use especially focuses on the creation of "ranchettes"—large-lot residential areas carved out of former cattle ranches—and on the community changes associated with population growth, absentee home ownership, and class distinctions between recent immigrants and long-time residents. This paper documents these changes in the ecological and social landscape of this rapidly developing mountain valley using landscape metrics and interviews of key residents.

RÉSUMÉ *Utilisation des terres et changement du paysage dans les montagnes du Colorado II: Une étude de cas dans l'East River Valley.* Les terres rurales des Montagnes Rocheuses des Etats-Unis sont en train d'être subdivisées et aménagées à des fins résidentielles et commerciales à une vitesse sans précédent. Dans l'East River Valley, la taille des parcelles des propriétaires fonciers a commencé à décliner au cours des deux dernières décennies après avoir augmenté pendant plus d'un siècle, c'est-à-dire depuis le premier établissement européen. Environ 20 pour cent des terres privées de la vallée ont été divisés en parcelles de moins de 18 hectares incapables économiquement de soutenir l'agriculture. Les aménagements dans la vallée ont entraîné une fragmentation importante de la couverture végétale, en particulier les peupliers, les près, les conifères mêlés et l'armoise. Le taux accru de construction des maisons, de 3% par an entre 1964 et 1990 à 8% par an entre 1990 et 1994, et la présence évidente de nouvelles routes et maisons sur les versants de la vallée, ont renforcé la perception locale d'un changement rapide du paysage. La préoccupation des résidents concernant l'utilisation des terres s'oriente principalement sur la création de «ranchettes», c'est-à-dire des lots de grande superficie découpés dans ce qui était des ranches d'élevage bovin, et sur les changements de la communauté associés à la croissance démographique, à l'absentéisme des propriétaires et aux différences de classe entre les immigrants récents et les résidents de longue durée. Cet article documente les changements du paysage économique et social de cette vallée de montagne à aménagement rapide, sur la base de mesures du paysage et d'interviews avec des résidents clés.

ZUSAMMENFASSUNG *Landnutzung verändert das Landschaftsbild in den Bergen von Colorado, Teil II: Eine Fallstudie im East River Tal.* In den Rocky Mountains der U.S.A. werden ländliche Gebiete zur Besiedelung und kommerziellen Nutzung in beispiellosem Ausmaß parzelliert und erschlossen. In den letzten 20 Jahren sind im East River Tal von Colorado die Grundstücksgrößen zurückgegangen, während vorher über ein Jahrhundert lang–seit der ersten europäischen Besiedelung- der Trend zur Vergrößerung vorlag. Ungefähr 20% des privaten Landbesitzes im Tal verteilt sich auf Grundstücke mit Flächen von 45 acres (18 ha) oder kleiner; eine Größe, die landwirtschaftliche Nutzung unökonomisch macht. Daneben zerstückelte die Erschließung des Tals die natürliche Bewachsung, wobei insbesondere die Bestände mit Espen, Wiesen, Misch-Nadelwald und Steppenbewuchs betroffen wurden. Steigende Wachstumsraten als Folge der Besiedelung–von 3% pro Jahr während des Zeitraums 1964–1990, bis auf 8% pro Jahr für die Periode von 1990 bis 1994–und nicht zu übersehende neue Straßen und Bebauungen an den Talhängen sind die Merkmale von drastischen Änderungen im Landschaftsbild. Die Formung von "ranchettes" (großflächige Siedlungseinheiten, die ehemalige Rinderfarmen absorbieren) und die veränderte Struktur der Gemeinde durch den starken Zuwachs der Bevölkerung verursachen Probleme für die Einwohner. Gebietsfremde Hauseigentümer und die Unterscheidung zwischen Zugereisten und Ortsansässigen haben die Situation polarisiert. Die vorliegende Veröffentlichung dokumentiert auf der Grundlage von Bebauungsplänen und Interviews mit maßgebenden Einwohnern die Veränderungen im ökologischen und sozialen Gefüge dieses sich schnell entwickelnden Gebirgstals.

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INTRODUCTION

Rapid commercial and residential land development throughout the North American Rocky Mountains has caused significant, but poorly assessed, ecological and social effects. The broader aspects of mountain development in Colorado, described in the companion piece (Riebsame *et al.*, this issue, pp. 395–405), provide context for this closer look at the changing landscape of the East River Valley, in the south-central Colorado Rockies.

Principles of landscape ecology are used to analyze the valley's changing land-use structure, and interactions of social and natural patterns. The fragmenting effects of land subdivision and development were examined using a geographic information system (GIS) containing data on vegetation cover, land parcel ownership, road network, and building location. Social impacts were assessed through interviews of land managers, planners, ranchers, developers, environmentalists, and ecologists.

LAND DEVELOPMENT IN THE COLORADO MOUNTAINS

The most notable political landscape feature in the Colorado mountains (and most of the western U.S.A.) is the dominance of public lands. Roughly 60% of land in the Colorado mountains is public, managed primarily by the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM). These public lands attract tourists and, increasingly, new residents eager to live near the open spaces and natural habitats they provide. Residential and commercial development is constrained by public holdings to private land corridors and islands, mostly in valley bottoms (Riebsame *et al.*, this issue, pp. 395–405).

Private land use in Colorado mountain valleys features a few small towns and resort centers plus isolated residential subdivisions and commercial establishments carved out of the matrix of agricultural lands (cattle and sheep ranches). Traditionally, land subdivision for residential use occurred on parcels contiguous with existing townsites, but the process now frequently leap-frogs across rural open spaces used for agriculture. A new subdivision pattern has also emerged in Colorado (and other Rocky Mountain states): the "ranchette," large lots each with an isolated, large house, built for people who want some of the qualities of ranch life (isolation, open space, natural surroundings, and space to board and ride horses) but who do not wish to purchase an operating ranch. In a revealing instance of political impacts on landscape, state laws in the Rockies tend to set the size of ranchette lots through statutes giving county governments authority over subdivision planning (including requirements for water, sewer, access, etc.) only for subdivisions comprised of parcels below a certain size—e.g., 35 acres (14 ha) in Colorado and Wyoming, 160 acres (65 ha) in Montana. Colorado developers thus tend to design rural subdivisions with parcels just over 35 acres (14 ha) to minimize regulatory constraints, creating a landscape carved into extensive lots dotted with dispersed houses. Ranchettes introduce roads, pets, and human presence into large areas previously disturbed only by livestock grazing. They also frustrate local planning officials because not only do ranchettes lessen their ability to guide land use, but they consume large amounts of land and more infrastructure (e.g., roads) per home.

In some respects, the ranchette phenomenon fills the spatial niche between traditional, small-lot subdivisions near towns, and extensive ranches, two main features of Rocky Mountain private land use since European settlement (Wyckoff and Hansen, 1991). Mountain development and its ecological and social effects at this scale, intermediate to intensive and extensive land uses, has been little analyzed.

THE EAST RIVER VALLEY

Our case study focuses on a peninsula of private land jutting into the Gunnison National Forest along the East River in Gunnison County, Colorado (Figure 1). The study area is representative of the private–public land pattern in Colorado (and in the Rocky Mountains more generally) and also of conflicts among different uses of private and public lands.

Significant residential subdivision has occurred in the East River Valley especially since the 1960s (Grudowski, 1994), but large tracts of contiguous, private agricultural land, mostly cattle ranches, still exist. A valley at this intermediate stage of land-use change was selected so that the recently transformed landscape could be analyzed and compared to the relict agricultural pattern. In addition, parcel-by-parcel analysis, necessary in landscape change studies, is more feasible in a less-developed valley than in areas where most ranches already have been subdivided, like the Roaring Fork Valley near Aspen. Finally, the East River valley is contained in one county and one National Forest jurisdiction, simplifying data collection and analysis.

The East River Valley (Figure 1) extends from the town of Almont, where the East River joins the Taylor River to form the Gunnison River, up-valley to the towns of Crested Butte (roughly 20 miles northwest of Almont), the Mt. Crested Butte ski resort (3 miles north of Crested Butte), and old mining towns further up-valley, including Gothic, now the site of a mountain ecology research station. The study boundary approximates the watershed, although where this would have extended the study far into pure public lands, the boundary was drawn roughly five miles on either side of the valley bottom. The 87,300 acres (35,300 ha) study area forms a peninsula of private land in the valley bottom surrounded by public lands on the upland slopes.

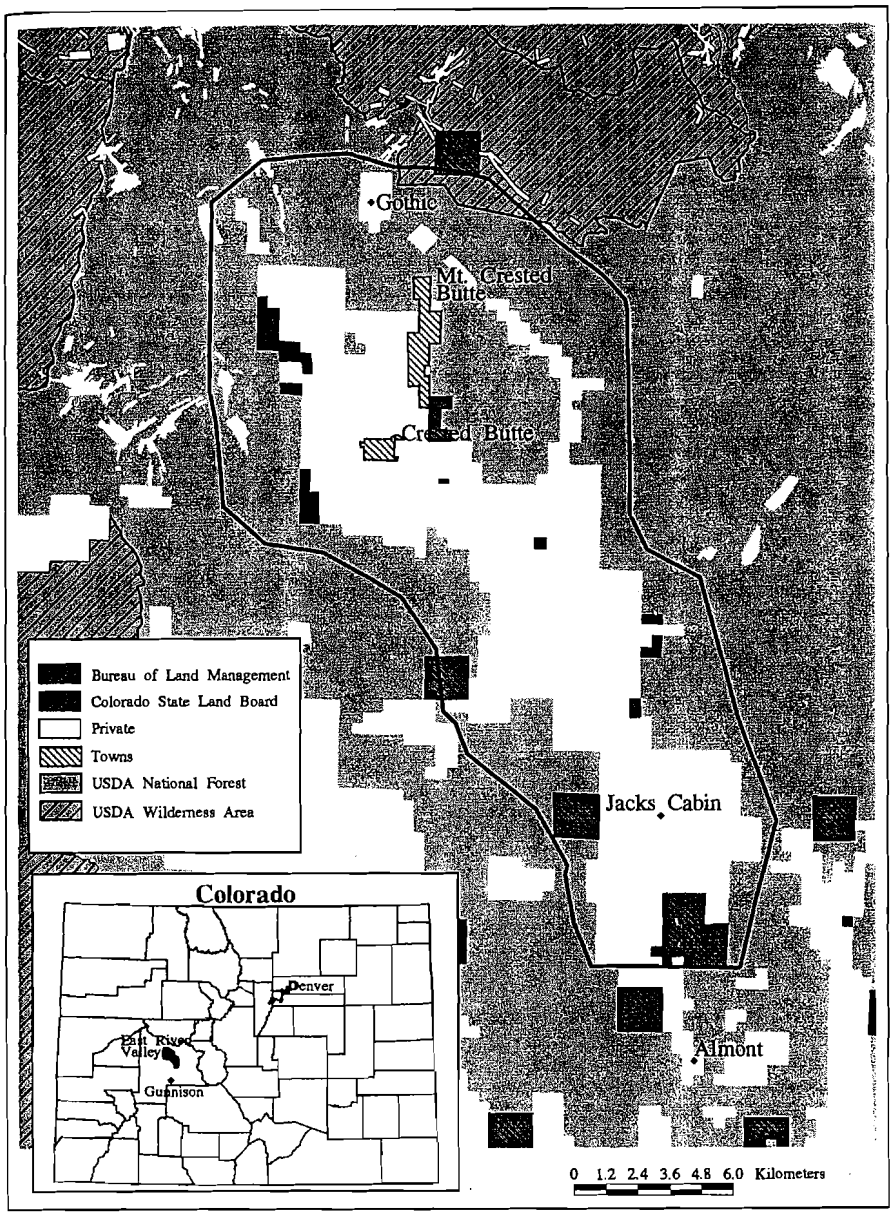

FIGURE 1. The East River Valley, Colorado, study area.

APPROACHES TO LANDSCAPE CHANGE ANALYSIS

We applied the analytical techniques of landscape ecology (Forman and Godron, 1986) to track land use and cover change in the valley. Landscape ecology has typically been used to study only vegetation patterns, but by applying it to social features such as land ownership and use we were able to develop quantitative and reproducible descriptions of the cultural landscape as well.

GIS DATABASE CONSTRUCTION

At a minimum, geographical analysis at the landscape scale requires spatial data on land use and ownership (parcel information), land cover (vegetation), roads, and public land boundaries. Depiction of individual building locations is necessary for site-level analysis. Data must be sufficiently fine-scaled (detailed) to capture individual parcels and land-cover patches (e.g., individual aspen groves), but few existing data-bases meet these needs anywhere in the U.S.A. We created six data layers using ARC/INFO: land cover, land ownership parcels, buildings, roads, political boundaries, Public Land Survey System grid, and hydrography. Cover, ownership, and buildings were not available on existing electronic data-bases, and even existing data were incomplete so that air photographs from 1978 and 1990 and multiple field visits in 1993 and 1994 were used to correct and complete the basic data layers.

Land cover was digitized from Colorado State Forest Service "ecosystem maps" based on 1:15,840 scale, 1962 air photography, and 1975 field-checks. Land ownership parcels were digitized from the county tax assessor's

"quadrangle parcel maps" (1:24,000). Data on recently subdivided (since the 1960s) parcels were digitized from subdivision plat maps (usually at a scale of 1:1,000) and checked against tax assessor records to verify parcel acreage. Major buildings (e.g., houses and barns) were located and digitized from 1964 topographic maps, 1978 and 1990 air photographs, and 1994 field inspections.

LAND USE AND LANDSCAPE ECOLOGY

Landscape morphology indices (e.g., Forman and Godron, 1986; Turner and Gardner, 1991) were used to characterize spatial structure in the valley and to link this to ecological effects. A landscape is composed of land elements or *patches,* which are distinguished by causal agent and configuration. Measures of patch size, shape, and resource quality within the patch are used to determine, in traditional ecological analysis, biological aspects such as the number of species a given area can support. In theory, larger patches support more species, although "edge effects" reduce the area of a patch as conditions outside the patch (e.g., heavy predation) bleed in from the matrix in which the patch is embedded. The magnitude of this effect depends on the species considered, the shape of the patch (patches with high perimeter-to-area ratio experience more edge effect), and its position in the landscape (Saunders *et al.*, 1991).

Development alters the landscape directly through habitat destruction, modification, and fragmentation—all of which alter landscape functioning. Fragmentation tends to lower average patch size, increase the number of patches, alter the shape of patch interiors, change edge geometry, and increase edge effects (Schonewald-Cox and Buechner, 1992). Typical fragmentation occurs through bisection, such as when a road is built through a patch of vegetation. Patches are also fragmented by edge retreat and by "perforation" as new covers and uses are inserted into existing patches (Harris and Silva-Lopez, 1992). Most human-used landscapes tend to become more fragmented over time (Soulé, 1991).

Roads are an important cause of habitat fragmentation. They create ecotones; add edge to adjacent patches; are sources of pollutants (Schonewald-Cox and Buechner, 1992); and act as filters (allowing some species to cross but not others), barriers (prohibiting movement), and population sinks (e.g., mortality through road kills or hunting). Roads also act as corridors and may enhance the spread of exotic species (Tyser and Worley, 1992), movement of predators, and, of course, human interaction with species.

Quantitative landscape measures range from simple patch indices, such as number and mean size, to indices derived from information theory and fractal geometry, such as contagion index and fractal dimension (e.g., O'Neill *et al.*, 1988). We used number of patches (e.g., land-cover polygons or ownership parcels), average patch size, patch distribution, and patch shape in this study. Data layers containing 1964, 1978, 1990, and 1994 roads were overlaid on the land-cover data, and habitat fragmentation was determined by counting any type of road as a new edge. Patch perforation was defined simply as the presence of buildings in a patch and used to reveal the cover "preference" of building sites. Spatial data on federal lands, the number of lots, number of units per lot, and area subdivided between 1960 and 1994 were used for the cultural landscape analysis.

THE CHANGING PHYSICAL LANDSCAPE

We separate the landscape analysis into sections on physical and cultural change and include the interviews of valley residents in the cultural section. Interactions between cultural and physical landscapes are addressed in the concluding section.

FRAGMENTATION BY ROADS AND BUILDINGS

Road and building patterns in the study area were relatively stable over most of this century, but began to change markedly in the 1970s, with accelerated development in the recent period (1990–1994). The rate of road building increased dramatically in the 1990s, and building site preference shifted to upland cover types where houses command views and can be sited in appealing aspen and conifer groves. Thus, more roads and houses are appearing further up the valley slopes, areas that historically have not experienced significant development. New roads increased the study area's total road length 17% a year during 1990–1994, almost entirely due to 39.2 km (24.5 miles) of new subdivision roads. Roading increased only 5% per year during the 12-year period 1978–1990 during which only 21.3 km (13.3 mi) of roads were added. The total length of roads in the study area (Figure 2) increased from 182.5 km (114.0 mi) in 1964 to 292.6 km (182.8 mi) in 1994.

The number of buildings in the study area increased from 216 in 1964 to 552 in 1994. These figures exclude buildings located in the towns of Crested Butte and Mt. Crested Butte (though they also increased in number). The annual increase is about 3% from 1964 to 1990 and 8% during 1990–1994. Nearly 90% of the buildings are located in meadow, grassland, and sagebrush cover types—that is, in lower elevation habitats. But in recent years more houses are located in aspen and conifer (higher altitude) covers. Figure 3 illustrates this as changes in the ratio of cover area (calculated, in this case, only for cover on private land, where almost all building occurs) to number of buildings. This calculation reveals building preference weighted for the total area of that cover; a decrease in the ratio means that buildings have been added to that cover area. All area/building ratios decline over time because all covers get some building, but riparian areas are especially targeted in the first period, while conifer and (to a greater extent) aspen attract building in later years. Although relatively fewer homes are being built in higher elevation conifer and aspen

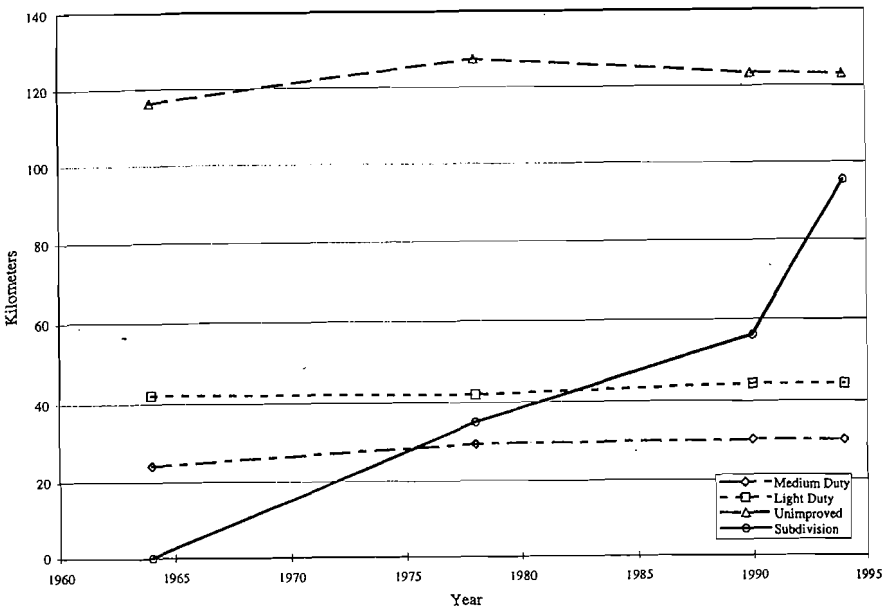

FIGURE 2. Road length in the study area by type for 1964, 1978, 1990, and 1994.

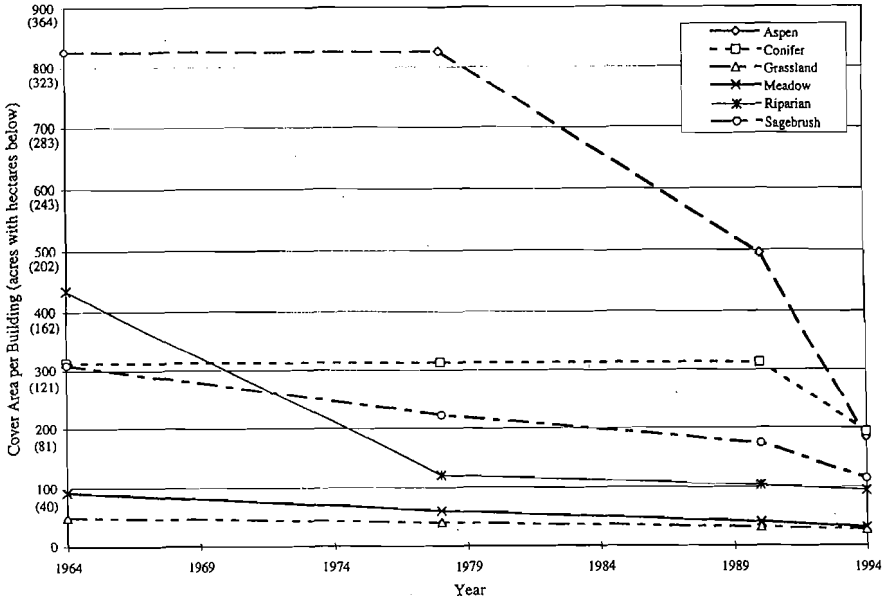

FIGURE 3. Ratio of the area in different land covers to number of buildings in that land cover. This ratio declines as more buildings are built, illustrating the decline of habitat remaining for wildlife.

cover, both cover types have about the same number of buildings per area as the other covers by 1994 because they do not cover large areas of private lands, and because building in the 1990s has been increasingly attracted to these higher elevation areas.

To assess the fragmenting effects of increased roads and buildings, we calculated the patchiness of the "natural" cover (without roads), and patchiness of the cover due to roads in 1964, 1978, 1990, and 1994. The number of patches increased steadily for most cover types during this period (Figure 4). The most prominent fragmentation (increased patchiness) occurs in aspen (from 304 to 364 patches during 1964 to 1994), meadow (28 to 111), and sagebrush (89 to 264) cover types. These habitat types, especially aspen and sagebrush, are preferentially subjected to road development. Aspen has been steadily fragmented by roads over the study period, even given its small average natural patch size of roughly 49 acres (19 ha). Patchiness of the alpine, mixed conifer, and mountain shrub covers increased more slowly over time, presumably because these covers exist mostly on public lands less subject to roading.

Building has been relatively intense, compared to total area of habitat, in meadow and grassland covers—valley-bottom types subject to intense subdivision (Figure 3). Riparian, which covers less than 4% of the study area, has also attracted building, so that there exists only 94 acres (38 ha) of riparian habitat for every building in that cover type. Note, however, that riparian building slowed markedly after 1978. Attention then turned to conifer sites, which were preferentially perforated with new homes in the 1980s and early 1990s as valley-slope sites became more available due to recent sales of large ranches.

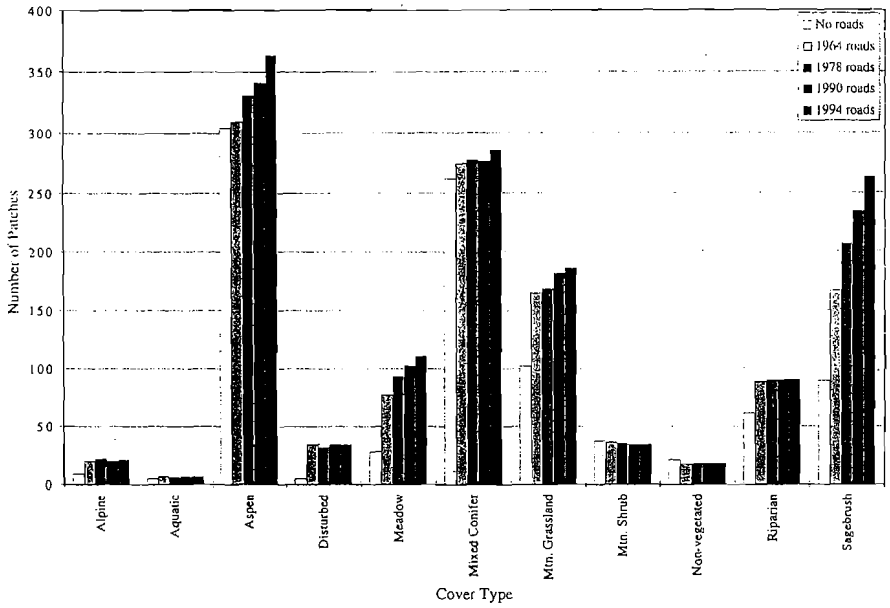

FIGURE 4. Land-cover fragmentation as illustrated by the number of patches in each land-cover type, calculated for "no roads" and for the road system as it existed in 1964, 1978, 1990, and 1994.

ECOLOGICAL IMPLICATIONS

Development has resulted in a more fragmented landscape in the East River Valley, especially in the aspen, meadow, and sagebrush cover types. Riparian land cover was affected earlier than the other land types, as roads and home construction first focused along streams (especially before 1978), and then moved onto the upper slopes. Traditional, high-density subdivisions are located in valley bottomland covers (riparian, meadow, and sagebrush), while low-density ranchette subdivisions tend to extend from the valley bottom up into aspen and conifer covers.

The links between habitat fragmentation and wildlife impacts are just now receiving attention in ecological research. Schonewald-Cox and Buechner (1992) showed that road fragmentation causes loss of biodiversity and Harris and Silva-Lopez (1992) found decreased densities of wildlife populations near roads. By reducing the area of habitat patches and increasing edge area, development reduces populations of area-sensitive species while simultaneously encouraging the proliferation of edge-loving species like elk and deer (Knight, 1992). In general, fragmentation favors generalist species, such as skunk and coyote, and reduces specialist species like the cockaded woodpecker (Knight, 1994, pers. comm.). Even less research is available on the effects of individual buildings. Significantly lower numbers of deer were found even in low density subdivisions near Bozeman, Montana, and the "building effect" (disturbances associated with buildings and human activity) was found to stretch as far as 900 m away from houses (Vogel, 1989). Sensitive species decline in human-modified landscapes due to both the initial human disturbance and to subsequent natural disturbances (like blow-down, mass movement, increased runoff, and erosion/siltation) that tend to follow, especially where humans clear vegetation.

Fragmentation affects animal movement by increasing distances between useful cover, a critical factor in surviving predation, particularly for birds and small mammals. Some simulation studies suggest that animal movement is susceptible to both edge permeability and patch shape and area (Stamps *et al.*, 1987), but measures relating the friction of a landscape to wildlife movement are problematic, due to the detailed information required for discerning edge types (e.g., fenced vs. unfenced) and poor understanding of species movement behavior. Nevertheless, it does appear that development in valley bottoms impedes or re-directs migration as animals increasingly encounter buildings, fences, pets, and roads with high traffic volumes (Edge and Marcum, 1990).

Finally, greater human presence in a landscape causes wildlife to devote more energy and time to avoiding human contact rather than to feeding. Even a lone hiker reduces activity in songbird habitat (Gutzwiller *et al.*, 1994). The "subsidized predators" such as domesticated cats and dogs that humans introduce also reduce the populations of small mammals and birds through hunting; thus they also compete directly with native predators (Coleman and Temple, 1993).

Some of the negative effects of fragmentation by development could be mitigated by clustering building sites, retaining other lands in relatively undisturbed condition, changes in fence alignment and design, and dozens of other small changes in residential and commercial land use. But the work needed to evaluate these benefits and to assess more complex relationships among development density, infrastructure, configuration, and ecological effects, is just beginning. Empirical studies linking development patterns and impacts on specific species are also lacking.

THE CHANGING CULTURAL LANDSCAPE

The cultural and political ecology of the valley is also undergoing rapid transformation. We used both the GIS landscape change approach and personal interviews to assess how development affects the East River cultural landscape. Landscape patch structure analysis was applied to land ownership, and cultural ramifications of land-use change were explored through interviews of key East River Valley residents who play a significant role in landscape change or are especially sensitive to the changes (Table 1). The goal of this "key informant interviewing" (Gilchrist, 1992) was to assess attitudes about land-use issues from a small number of the most informed opinion-leaders, rather than from a statistical sample of residents. Interviewees were asked about historic land-use patterns, current trends in recreation, and their sense of changing social relations in the valley.

LAND OWNERSHIP AND LAND COVER: THE VALLEY'S POLITICAL ECOLOGY

Homesteaders were drawn to the valley by mining and agricultural opportunities as early as the 1880s. According to the few remaining ranchers, cattle operations proliferated until about 30 existed, mostly in the lower reach of the valley (the Jacks Cabin area; see Figure 1) at the turn of the century; ranch numbers then declined during most of the 20th century, slowly for several decades and then quite rapidly by the 1970s. Only half as many ranches could be identified in the same area by late-1978, with only six still in business in 1994. The total acreage of ranch land in the valley did not change significantly prior to the 1970s, although the amount of land owned by remaining ranchers increased steadily as a few families hung on and acquired land from those who quit. The recent pattern, in which ranch land is sold to residential developers rather than to neighboring ranchers, marks the first time since initial homesteading that the average size of land ownership parcels in the valley has declined.

Residential development in the East River Valley increased in the 1970s, and accelerated markedly in the early 1990s. Most development has been single family housing, except in 1980–1985 when mostly apartments and condominiums were built to accommodate skiers and workers in nearby mines. Recent development emphasizes ranchettes. Although the simple number of lots created was greatest in 1970–1975, the total land area subdivided increased dramatically in the 1990s (Table 2), reflecting the switch to a more dispersed residential pattern.

The ownership parcel map (Figure 5) was used to calculate the total acreage, average size, land-cover types, and number of land parcels (Figure 6 and Table 3). Like any landscape experiencing subdivision, the highest parcel frequency occurs in the smaller parcel size classes (848 parcels comprising 301 acres/121 ha in the 0–0.5 acre/0–0.2 ha class), but the greatest acreage remains in the larger parcel size classes (18 parcels comprising 16,995 acres/6,866 ha in the 500 acre/202 ha and greater class). The 30–45 acre class peak (150 parcels comprising 5,522 acres/2,230 ha) reflects the influence of state law on ranchette parcel size described earlier.

Joint analysis of land cover and parcel patterns shows that the smallest subdivision sizes (parcels less than 1 acre) are almost entirely located in meadow and sagebrush cover, both valley-bottom types (Table 3). The conifer cover in the middle and upper slopes is not present significantly in the subdivision size spectrum until the 30–45 acre/12–18 ha class. While aspen cover shows up in all parcel classes, the largest percentage of aspen is in parcels larger than 30 acres/12 ha. The ranchette subdivisions apparently prefer the wooded valley slopes. Alpine cover, which is almost entirely on public land, shows up only in the large parcel classes (greater than 100 acres/40 ha).

Unlike roading and buildings, which result in *physical* fragmentation, parcel subdivision necessarily results only in ownership fragmentation, which may or may not entail physical landscape change. But because ownership subdivision in Rocky Mountain valleys almost always entails a switch from agricultural to residential or commercial use, it also typically brings physical change. For example, subdivided landscapes include more fencing, changes in grazing (either a switch from cattle to horses or to no

TABLE 1
Identifiers and brief descriptions of interviewees

Interviewee identifier	Description
Rancher A, 1994	A current rancher
Rancher B, 1994	A current rancher
Rancher C, 1994	A former rancher who recently sold land for a subdivision
Developer, 1994	A local real estate developer
Range Manager, 1994	A US Forest Service Range Conservationist
Planner A, 1993, 1994	A county planner
Planner B, 1993	A municipal planner
Ecologist, 1994	An ecological scientist and local activist
Forest Manager, 1994	A US Forest Service Planner
Environmentalist, 1994	An environmental and community activist

TABLE 2
Number of lots, units, total area, and density (area per dwelling unit) formally subdivided in the East River Valley from 1960 to 1994

Period	Lots	Dwelling Units	Acres/ha	Density units/ac
1960–65	36	36	73/29	2.0
1965–70	0	0	0/0	0
1970–75	894	894	596/241	0.6
1975–80	68	70	896/361	12.8
1980–85	80	384	590/238	1.5
1985–90	27	27	305/123	11.3
1990–94	148	163	5060/2044	31.0

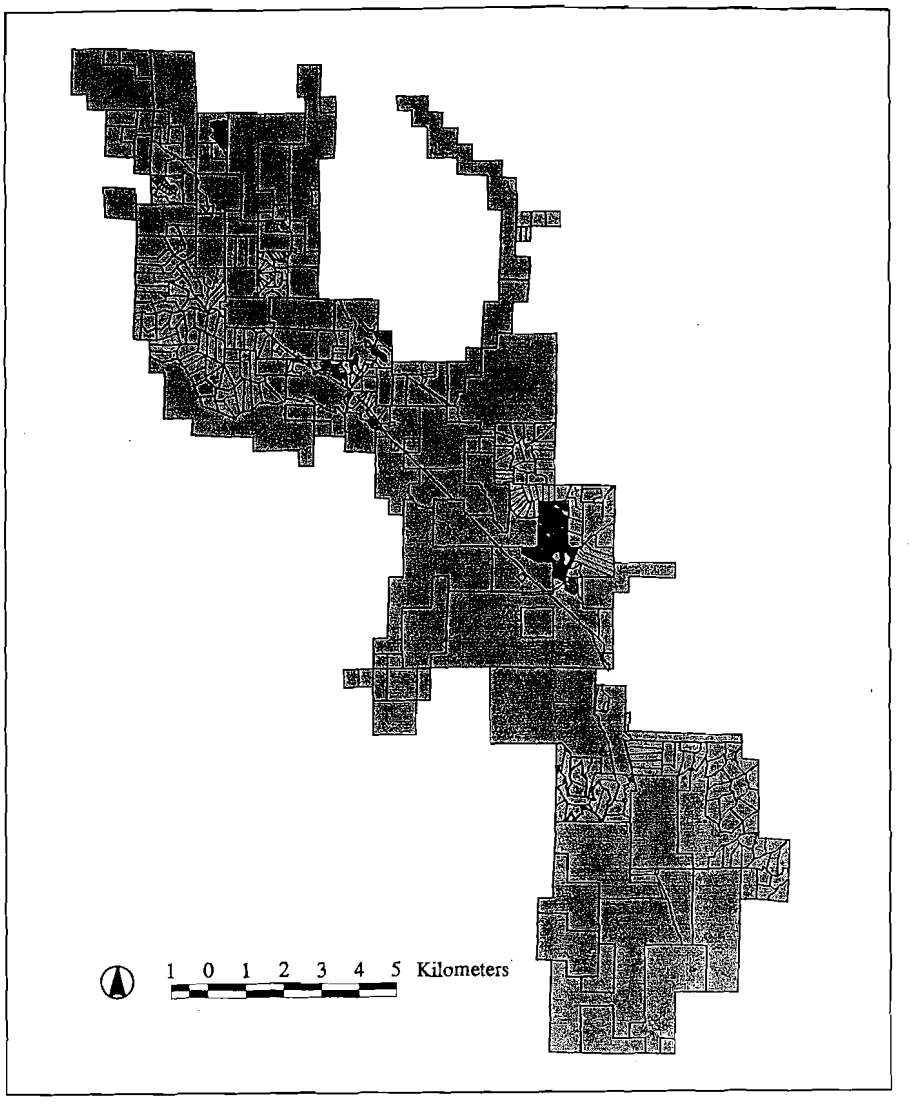

FIGURE 5. Private land parcels in the East River Valley. The largest blocks are mostly agricultural lands. Low density "ranchette" subdivisions are visible as collections of irregularly shaped lots, and the most dense subdivisions show up as black areas at this map scale.

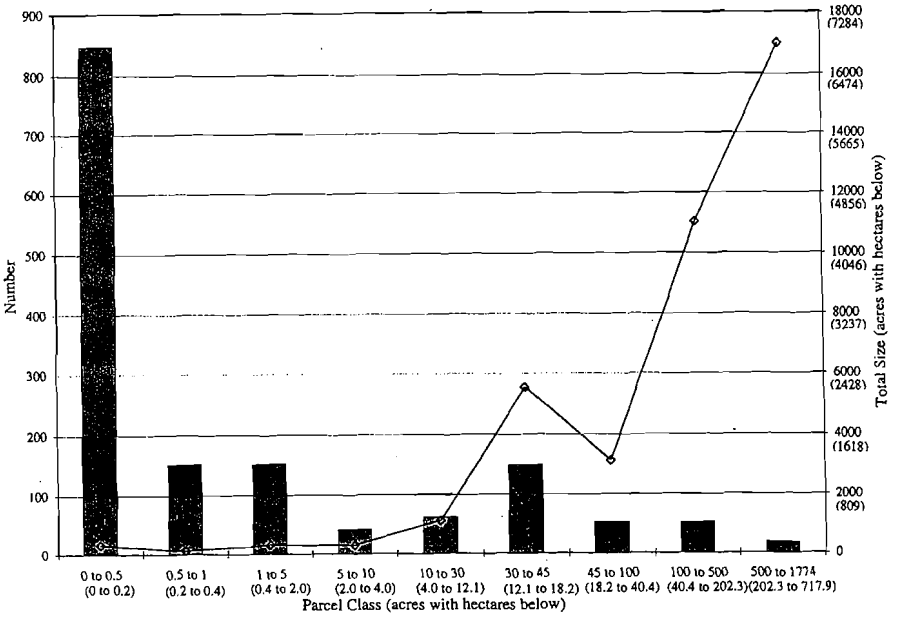

FIGURE 6. The distribution of land parcels by size and total area of land in each parcel size class.

TABLE 3
Land area by land-cover type and parcel class

Ac:	0–.5	.5–1	1–5	5–10	10–30	30–45	45–100	100–500	500+	
Ha:	0–.2	.2–.4	.4–2	2–4	4–12	12–18	18–40	40–202	202+	Total
Cover	Acres									
Alpine	0	0	0	0	0	0	0	49	0	49
Aquatic	0	0	1	1	0	0	16	64	17	98
Aspen	17	17	11	2	167	1,110	516	826	2,302	4,967
Mixed Conifer	0	0	0	2	22	1,221	413	931	1,502	4,091
Meadow	124	33	86	87	137	371	218	2,928	3,256	7,239
Mtn. Grass.	32	13	24	8	103	259	191	475	1,145	2,249
Mtn. Shrub	0	0	0	3	2	37	0	152	187	382
Non-veget.	0	0	0	0	0	0	0	3	3	7
Disturbed	0	0	0	0	7	2	0	91	27	127
Riparian	2	7	22	30	100	155	251	925	719	2,210
Sagebrush	126	38	151	147	569	2,367	1,528	4,558	7,838	17,322
Total	301	107	293	281	1,107	5,522	3,133	11,001	16,995	38,740

grazing), irrigation (from hay to lawns), and vegetation (e.g., clearing to reduce the fire danger, and vegetation replacement—often from shrubs to a grass lawn).

An important geographical character of contemporary mountain subdivisions is their scattered nature; even the most dense subdivisions are not necessarily adjacent to townsites, nor are they coterminous with other subdivisions. Rather, they are spotted throughout the valley, separated by large agricultural parcels. This diverges from the "classic" residential land-use model of decreasing density with increasing distance from a town center. Moreover, unlike the developments depicted in Allan's (1986) mountain land-use conceptualization, *inaccessibility* seems a desirable aspect of ranchette location. Many homes in the valley's low density subdivisions are located on long, steep access roads, lending credence to arguments in the rural development and mountain resort literature that new, affluent residents take pride in isolation. The first buildings constructed on a recently subdivided East River ranch are located on the most remote lots, adjacent to Forest Service land. The lure of remoteness is also the lure of public lands. Nearly all of the new ranchette subdivisions border public lands and private access to public lands is marketed as an amenity, even at the expense of longer roads, driveways, and greater distance to other services.

CULTURAL EFFECTS OF LANDSCAPE AND ECONOMIC CHANGE

The East River Valley residents we interviewed identified a roster of negative and positive effects typically associated with rapid development in mountain areas. Transformation from a primarily agricultural, rural community and culture, to a fast-paced resort that not only attracts affluent vacationers and second homeowners but new permanent residents, yielded new social stresses and anxiety about a range of problems, such as degradation and loss of water quality and wildlife habitat, views compromised by large homes on valley slopes, and general loss of the valley's former "sense of community." Interviewees complained about crowding of their favorite recreational haunts, restaurants, and shopping spots, and loss of access to public lands. Growing year-round employment at the ski resort, and a shortage of affordable housing, has increased traffic up and down the valley as workers commute from distant towns with lower living costs. Long-term residents, especially those still engaged in natural resource extraction, felt that newer residents did not fit in or understand the valley's traditions and culture. Yet residents also reported satisfaction with increasing employment opportunities, and the wider range of services and amenities that come with population and tax-base growth. Some noted that service jobs do not necessarily pay poorly, as is often argued, and they appreciated job opportunities for spouses. Some noted that construction and associated trades have paid handsomely since the valley was "discovered."

Similar attitudes are well-documented in the mountain development and resort literature. Some perceptions of East River residents, however, are worth describing here in more detail, especially in the context of the landscape changes described above. One theme, little addressed in the development literature, is access to land. The Rockies are rich in public lands to which, in theory, all citizens have access. But private lands may intervene. Overall, land development trends in the Rocky Mountains reduce access both to private and public lands. In the East River, many ranchers and other large private landholders historically allowed access across their land to public lands on the upland slopes and ridges behind their properties; many also allowed use of their lands for recreation (Planner interview, 1993). But, crowding, inconsiderate behavior, and liability concerns have recently convinced many ranchers to deny such access, to locals and newcomers alike (Rancher A interview, 1994).

While ranchers are rethinking public access, new subdivisions, especially ranchettes, simply close it off (Anderson, 1994; Environmentalist interview, 1994). Some of the new subdivisions tout "private access to public lands" as an amenity while eliminating use by others. Decreased public access has led to trespassing problems and tensions over private property rights in the valley (Anderson, 1994).

Lifestyle conflicts among residents and visitors in the valley occur on public land as well. Ranchers report increasing conflict with recreationists such as mountain bikers, fishers, and hikers on their National Forest grazing allotments (Rancher A interview, 1994), especially that bane of every ranchers' existence, gate and fence problems (some wheeled recreationists knock down fences, and new residents with urban roots do not know "gate etiquette" in the West: leave them as found—opened or closed; Range Manager interview, 1994). Ranchers also report difficulty in "training" their new neighbors in the "ways" of rural life—like the simple fact that cattle often stray onto other people's land. Ranchers report that new residents tend to resent such trespasses, as well as complain when cattle operations slow traffic or cause odors (Rancher B interview, 1994).

At a more fundamental level, land-use conversion has also eroded a long-standing relationship between cattle ranching and landscape. Cattle have traditionally been moved from the lower valley in the spring, with a pause in the mid-valley, up to the high range in mid- and late-summer (Ecologist interview, 1994; Rancher C interview, 1994). This stair-step migration evolved to put cattle on the different ranges when the forage was ready, to protect resources by reducing their stay on any given pasture, and to ease cattle transport logistics. Residential development of the key, mid-valley stop-over pastures has disrupted this pastoral arrangement, and seasonal cattle drives on highway right-of-way between pastures have become difficult and stressful to the animals, forcing ranchers to truck cattle (Rancher A interview, 1994).

Irrigated hay fields have dominated the valley-bottom since the late 1800s, but as subdivisions replace meadows, less local hay is available and winter feeding costs have increased. Irrigated fields were also an important element in the visual quality of the valley; residents report that as they are developed for housing the valley bottom has become noticeably less green (Ecologist interview, 1994). Tourist-related business owners and local officials are especially sensitive to the effect of development on landscape aesthetics that attract people to the valley. The large residences and access roads of ranchette developments are often located on the valley slopes, where they are most noticeable and, to some people, visually offensive (Rancher C interview, 1994; Developer interview, 1994). Perception that the landscape was changing too fast led to creation of the Crested Butte Land Trust, a non-profit group raising money to purchase land that would otherwise be developed (Planner B interview, 1993).

An important cultural aspect of landscape change in the valley is residents' perception of its rate and extent. Interviewees were acutely concerned about valley development, even though the proportion of land actually converted from agricultural to residential and commercial uses is still relatively low. Twenty percent of the valley's private land has been subdivided into parcels of less than 45 acres (18 ha). These parcels are too small for most agricultural uses and have either been developed for residential use or will be developed soon. New homes scattered across the valley contribute to the sense of rampant development, as does the large visual impact of roads meandering up the valley slopes to large, dispersed houses in ranchette subdivisions. While the number of ranchette parcels is relatively small, they disproportionately affect the valley landscape because of their large size and visibility, and because they no longer offer an important Western landscape icon: cattle grazing against mountain backdrops. Residents' voiced concerns about each individual building project, but few interviewees were aware that only 22% of the valley's sub-divided lots contained a building in 1994, a fact that presages more landscape change in the future.

Heightened class distinctions and conflict is typical to areas experiencing rapid, affluent residential and commercial development, but this case has created a particular geo-political tension as well. Relations between East River Valley residents and the county government have been strained by an increasing geographic imbalance of tax values. The East River now holds the county's most valuable property, and produces a large portion of the county's property tax revenue, and many valley residents believe that they do not receive sufficient services in return. A move is under way to establish a new school district in the valley to reap the benefits of its burgeoning tax base, an idea unpopular with the rest of the county because school funding elsewhere is partly dependent on tax revenue from the East River (Rancher B interview, 1993).

Lack of affordable housing is a common problem in developing mountain areas, including the East River Valley (Fails, 1993), but its landscape impacts are less well assessed. In the case study area some workers try to live illegally on public lands; the Forest Service displaced 50–100 "squatters" in 1993 (Forest Manager, 1994). Others commute 5–10 miles, via cross-country skis or skimobiles in the winter, from Lake Irwin, a mining town founded in 1888. Mining claims and townsites laid out but never developed are increasingly marketed for low-cost housing, though most are marginally suitable for residential development because of terrain and distance from roads and other services (Olgeirson, 1994). The housing shortage has put development pressure on private parcels embedded in Forest Service land ("inholdings"), and even seasonal cabins are being winterized for year-round occupancy. The agency would like to purchase in-holdings and abolish leases for seasonal cabins because developed in-holdings make forest management difficult, especially given government policies to let fires burn naturally whenever possible.

While the interviews dwelled on negative effects of development, most interviewees voiced some positive changes: the tax base increased, the economy and job market strengthened, and cultural events and personal services proliferated. The conventional wisdom about

Rocky Mountain development—that new jobs are mostly low-paying service positions—did not withstand scrutiny. Residents reported increasing opportunities in skilled trades and high-end services like real estate and finance. Nevertheless, as in numerous other studies of booming mountain towns (e.g., Ringholz, 1992), the general attitude is that rapid growth is reducing the valley's overall quality of life.

LOCAL RESPONSES

Residents' efforts to gain some control over the changing landscape yielded mixed results. A task force committee of town and county representatives created to build consensus on land-use issues immediately bogged down in a debate about its geographic jurisdiction (Hall, 1994). Some members argued that only a comprehensive, whole-valley approach would work (including not only the town and ski resort, but high-elevation mining towns under pressure for residential development), while others wanted to limit the committee's purview to just the area around the town of Crested Butte that might logically be formally incorporated into the town and developed in the near future.

This debate echoes the abiding American ambivalence over control of private land use, and reflects an enduring inability of local groups to shape landscape change processes (Caldwell, 1987). The area's representative in the state government sought to increase the 35 acre (14 ha) limit on subdivision oversight (Powers, 1994), but this effort failed in a state legislature more interested in assisting rather than limiting development. The governor then initiated a state-wide effort to consider alternative growth management strategies, but this also produced little substantive change in local ability to influence land-use change.

Approaches to reducing the rate of landscape change in the valley may yet be emerging through an unlikely coalition of ranchers and environmentalists, a perhaps temporary collaboration fueled by their perception that loss of agricultural land is the chief threat to the valley's cultural and ecological well-being. This so-called "cows vs. condos" debate evokes only awkward coalitions because it divides environmentalists themselves: some feel that the negative effects of grazing are worse than the residential development that replaces ranches (Wuerthner, 1994) and others argue that ranching better maintains natural biodiversity than development (e.g., Knight *et al.*, 1995). This difference of opinion has reduced environmentalists' willingness to cooperate with agricultural organizations in the Rockies, but, at least in the East River, the local environmental group broke with national organizations and argued that ranching, done properly, has less impact on local ecosystems than residential development (Sprung, 1994).

One local developer attempted to meld ranching and residential land uses by clustering homes on a ranchette subdivision so that the remaining open space can still function as a cattle ranch and wildlife habitat—no mean feat given the poor cattle market and the stellar real estate market (Developer interview, 1994). Clustering reduces the number of lots carved out of the former ranch (only 11% of the original 4,900 acres is divided into 15 building sites), while the remainder is protected from development by conservation agreements requiring that home owners allow a rancher to graze cattle on the property. Such "green" subdivisions are most feasible where prospective residents appreciate, and will pay highly for, the common open space provided by either fewer homes or clustered homes, or both. In most cases, the developer must also be willing to forgo some potential profit, although this is mitigated in places like the East River by rapid real estate inflation. The apparent inevitability of widespread residential subdivision of private land in the Rocky Mountains clearly calls for more land-use innovations like this. Some conservation groups, notably The Nature Conservancy, have purchased and preserved small amounts of Colorado ranch land (Wright, 1993), but the potential landscape protection provided by ranches that shift from agriculture to private conservation use remains to be evaluated.

CONCLUSIONS

Colorado's East River Valley is experiencing marked landscape change associated with both resort and dispersed residential development. The long-standing historical trend of ranch enlargement, common throughout the West, has reversed. The average size of land parcels in Colorado's East River Valley decreased during the last three decades, the first decrease in over a century. Yet, the average residential lot size is simultaneously increasing, reflecting the emergence of remote, ranchette development as opposed to the more traditional, town-edge subdivision. This dispersed residential development increases habitat fragmentation and the visual impacts of development through more extensive road building and isolated building sites.

Rural in-filling of the Rocky Mountains is driven both by tourism and recreational development as well as broader changes in regional economy and land-use preferences (see Riebsame *et al.*, this issue, pp. 395–405). Population growth in the high mountain valleys of the Rockies creates a landscape irony. Immigrants are drawn by the natural spaces, views, recreational opportunities, and vestiges of the "Old West" (Developer interview, 1994). But their arrival changes these very landscape attributes by: reducing agricultural operations; drying up irrigated meadows; blemishing valley slopes with roads and houses; decreasing access to public lands; and increasing recreational use and conflicts among people and between people and nature. Yet, in many ways, this "neo-home-steading" of the Rocky Mountains is similar to past immigrations—a rush is on to own and settle a pristine landscape. The current rush inculcates the so-called "last settler's syndrome," in which each new settler wants the area to remain as it was on their arrival (White, 1986). Perhaps the greatest challenge to places experiencing

intense amenity migration is to "...find means of continuing to cultivate among the last settlers the same kind of high aspiration for an overriding ethic of community well-being which was so deeply ingrained in the first settlers..." (White, 1986: 355). Economic and social mobility in the U.S.A. would seem to assure continued population growth in charismatic landscapes such as the Rocky Mountains; the landscape transformations discussed in this study are likely to intensify as the focus of development shifts to rural areas.

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