Landscape Attributes Of Subdivided Ranches

The trend toward "ranchettes" is leaving range and forest lands fragmented and will create new challenges for livestock, wildlife and range managers.

By John E. Mitchell, Richard L. Knight and Richard J. Camp

The western states have become the fastest growing region in the United States during the 1990's. Previously, people living in the West could be divided into two dissimilar groups—urban dwellers in cities and larger towns, and those residing in rural areas on farms and ranches and in small towns (Figure 1).

Today, differences between Western urban and rural areas are less distinct as a new segment of the population moves onto small acreages, commonly called "ranchettes." These small tracts of land sold for rural residences come almost exclusively from the subdivision of farms and ranches. As a result, many rural localities are experiencing rapid population growth from such demographic shifts (Riebsame 1997). These rural areas are attracting a disproportionate share of young families and college graduates (Nord and Cromartie 1999).

Most notably, subdivisions fragment rangelands primarily from construction of roads and buildings. Theobald and his associates (1996) evaluated landscape change following recent subdivisions of ranches in the East River Valley above Gunnison, Colorado. They found that total road length increased by 60 percent between 1964 and 1994, with more than one-third of new road construction occurring during the last five years. The number of buildings more than doubled during the same 30-year period.

Subdivided parcels in the mountains are frequently situated in valley bottoms and on nearby mountain slopes (Figure 2). Along the foothills between the plains and montane zone of the Rocky Mountain Front Range, rural areas are similarly being subdivided for residences. However, the physiographic features of privately-owned Front Range landscapes are somewhat different than those found at higher elevations. Proximity to public lands, primarily National Parks and National Forests, is common to both situations.

Unlike 19th Century pioneers to the region who commonly established homesites in drainages for protection from wind and storms, foothills subdivisions are repeatedly laid out on high ground overlooking surrounding landscapes. New home construction and well digging technologies, coupled with no necessity of having to care for livestock, allow today's foothills ranchette resident to place a premium upon panoramic viewscapes.

Although subdivision parcels exceeding 35 acres are widespread, many are partitioned into smaller sizes. Land val-

Fig. 1. ***Looking south over Pueblo, Colorado. The definite separation between the city and a relatively unoccupied rural landscape can be seen.***

Fig. 2. ***Subdivided rangeland along upper Ohio Creek, Gunnison County, Colorado.***

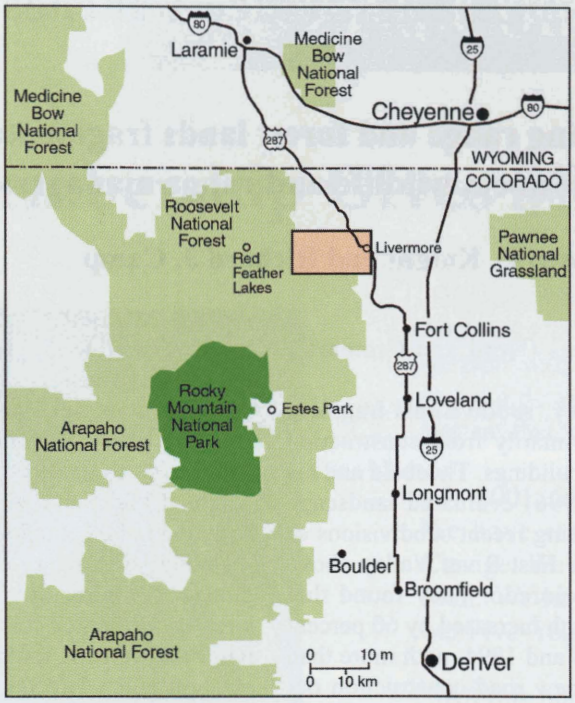

Fig. 3. ***Study area in Colorado Front Range foothills in vicinity of Livermore, Colorado.***

ues make it more profitable to do so, even when going through local and/or state planning requirements. Callies and colleagues (1994) noted that lot sizes smaller than 5 acres spell the demise of rural land characteristics, resulting in more urban conditions on a larger rural countryside.

Increased human densities in historically rural areas may have tangible effects on landscape characteristics and, consequently, wildlife communities (Riebsame et al. 1996). Several studies have indicated that residential development of lands adjoining public lands alters wildlife communities (Odell and Knight, in press). Little is known about the exact impacts subdivisions have on rangeland ecosystems, but evidence suggests that changes in both the ecological and social landscape tend to follow development of rural areas (Theobald 1995).

Some changes in landscape parameters can be detected using aerial photographs. To describe these changes, we focused on subdivided ranches in the foothills of the Rocky Mountain Front Range in Larimer County, Colorado (Figure 3).

Vegetation along the northern Colorado Front Range is a mosaic of grassland, shrubs (primarily mountain mahogany and bitterbrush), and stands of ponderosa pine at higher elevations. Riparian areas and meadows occur along the North Fork of the Poudre River and other streams. Elevation in the area ranges from 5,600 ft. at the eastern limit to 7,800 ft. at the western limit.

The population in unincorporated Larimer County has grown rapidly over the past 25 years, rising from 26,000 to 66,000 residents between 1970 and 1999 (Larimer County data; see <http://www.co.larimer.co.us/about/vitals.htm). As a result, landscapes neighboring the Roosevelt National Forest have become a mosaic of intact and subdivided ranches. Structures vary from small vacation cabins to large houses with outbuildings that are inhabited year-round (Figure 4).

The tendency towards larger, permanently-occupied houses corresponds with the interpretation made by Davis and associates (1994) that cities with attractive adjacent rural areas generate an outlying zone they called "exurbs", comprised of relatively wealthy rural-dwellers who commute to jobs in town.

The Ranches

For our investigation, we selected two intact ranches and two ranches that had been subdivided into small tracts ap-

Fig. 4. ***Large home situated on subdivided ranch in Larimer County, Colorado.***

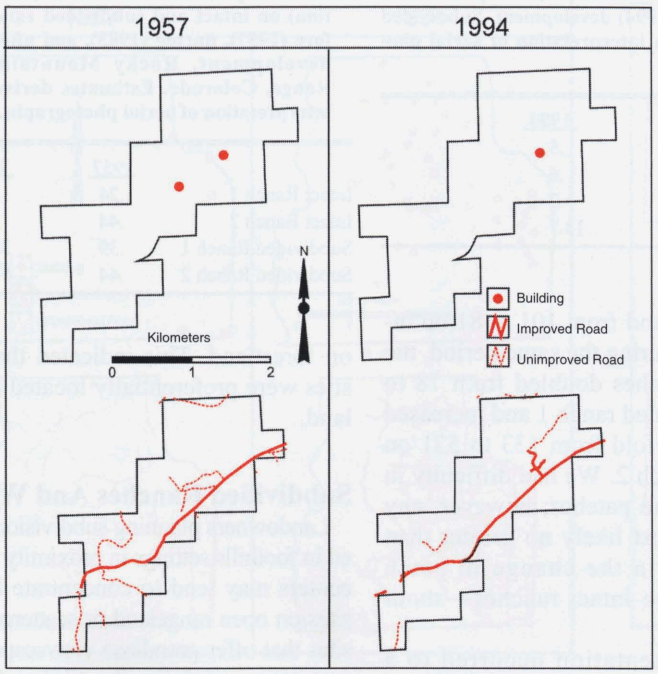

Fig. 5. ***Distribution of buildings and roads on intact ranch 1, Rocky Mountain Front Range, Colorado.***

proximating 35 acres. We wanted to minimize total variation in landscape by limiting the sampling population to ranches with similar physiography and encompassing a contiguous area of at least two sections of land (1,280 acres). Two subdivided ranches in the Front Range foothills of northern Colorado met these criteria.

Subdivided ranch 1 began subdivision in the mid-1970's and was still undergoing active development in 1994, the last year of data acquisition. Located west of U.S. Highway 287 and south of Livermore, Colorado, its area spanned 6,450 acres. Most of the western one-third of the former ranch remained undeveloped because of steep terrain above the North Fork of the Cache la Poudre River.

Subdivided ranch 2 was platted for subdivision in the late 1960's and development began in the early 1970's. It is situated along the south side of a paved county highway connecting Livermore, Colorado with Red Feather Lakes, Colorado. The total area subdivided was approximately 8,900 acres, and had been largely developed by 1990. Improved access roads and home sites were concentrated along the northern half of the former ranch because of steep terrain in the southern half above the Cache la Poudre River.

The two intact ranches were located within a few miles of the subdivided ranches. Elevations, physiography, and vegetation were similar to the subdivided ranches. They also possessed all the qualities that lend themselves to be valued for subdivision; i.e., access to an all-weather highway, scenery, and within commuting distance of Front Range urban centers.

Intact ranch 1 was fairly small with a contiguous area of 1,250 acres, while intact ranch 2 contained 6,930 acres, a size which more closely approximated the dimensions of the subdivided ranches.

Our Evaluation

Data were acquired from aerial photographs, provided by U.S. Department of Agriculture, Consolidated Farm Service Agency, Salt Lake City, Utah. The 1:20,000 photographs were taken in 1957 and 1994. These years were selected to acquire landscape information prior to any development activity on the subdivided ranches and after most development activity had been completed.

We suspected that subdivision of ranches would change both patch characteristics and the distributions of features such as fences and roads. We defined a landscape patch as a relatively discrete area of similar vegetation or obvious land use. Forest communities in the area were all dominated by ponderosa pine and the rangeland communities were combined into one land-use category. No land within the four ranches was being farmed, so the land cover/use categories were fairly simple (Table 1). Information on the aerial photographs were digitized into a GIS using ARC/INFO.

We were interested in how subdivision changed the density of buildings, fences, and improved roads, and if these features would increase the number of landscape patches. Preliminary aerial photo interpretation showed that we could not identify the presence of fences, which were then dropped as a variable.

Unimproved ranch roads were not considered as barriers because of their narrowness and the presence of native vegetation between the tracks. Wild and domestic ungulates tend to cross these roads as if they do not exist. Likewise, vehicular traffic is slow moving, light and sporadic, which minimizes encounters with wild animals. Road density was expressed in miles per section (640 acres).

We also wanted to find out whether the two subdivisions were more likely to fragment rangeland or forest land in an area where the ponderosa pine zone met the high plains.

Table 1. List of features used for assessing patch characteristics resulting from subdividing intact ranches, Rocky Mountain Front Range, Colorado.

Feature	Categories
Land Use	Forest, rangeland, riparian, water.
Roads	Improved (paved/gravel with shoulders), unimproved (dirt with no shoulders).
Structures	All (houses, barns, sheds, etc.).

Table 2. Building densities per section (640 ac.) on intact and subdivided ranches, Rocky Mountain Front Range, Colorado, before (1957), during (1983), and after (1994) development. Subdivided ranch 2 is not yet completely developed. Estimates derived from interpretation of aerial photographs.

		1957	1994
Intact Ranch 1	(1,250 ac.)	1.0	.5
Intact Ranch 2	(6,930 ac.)	.5	.6
Subdivided Ranch 1	(6,450 ac.)	.6	5.2
Subdivided Ranch 2	(8,900 ac.)	.8	13.7

Table 3. Improved road densities (mi. per section) on intact and subdivided ranches before (1957), during (1983), and after (1994) development, Rocky Mountain Front Range, Colorado. Estimates derived from interpretation of aerial photographs.

	1957	1994
Intact Ranch 1	1.24	1.52
Intact Ranch 2	.44	.64
Subdivided Ranch 1	.39	3.38
Subdivided Ranch 2	.44	5.71

Not surprisingly, subdividing a ranch into smaller parcels substantially increased the density of both buildings and improved roads. On average, buildings on both of the intact ranches were each surrounded by nearly 2 sections of land (1,280 acres) throughout the sampling periods of 1957 and 1994 (Figures 5 and 6). The two subdivided ranches had a building density similar to the intact ranches prior to subdivision (Table 2). Housing density was 17.5 times greater after subdivision on the area that had been almost completely developed (subdivided ranch 2) and 8.5 times greater on the area that was somewhat less developed (subdivided ranch 1) (Figures 7 and 8).

Road density before subdivision was about 0.4 mi. per section (640 acres) for all ranches except the smaller intact ranch (Table 3). Its road density was three times the other ranches because the state highway between Livermore and Redfeather Lakes ran through its long axis and the ranch was relatively small. If U.S. Highway 287 and the Red Feather Lakes highway were not included in our analyses, all four ranches had an improved road density of zero in 1957. Road density on the two intact ranches remained fairly constant in absolute terms throughout the two sampling periods.

On subdivided ranches 1 and 2, improved road density increased by more than eight times after subdivision (Table 3). Road construction had been completed on subdivided ranch 1, even though a number of available land parcels were not yet occupied in 1994. Assuming an average fenceline-to-fenceline improved road width of 50 ft., roads comprised approximately 3 to 5 percent of the total area on subdivided ranches.

Between 1957 and 1994, the number of patches decreased from 39 to 33 on intact ranch 1 and from 101 to 81 on intact ranch 2. During the same period, the number of patches doubled from 78 to 155 on subdivided ranch 1 and increased more then fourfold from 133 to 571 on subdivided ranch 2. We had difficulty in discerning some patches; however, any errors were most likely no greater than the variation in the change in patch numbers on the intact ranches—about 15–20 percent.

Patch fragmentation occurred to a much greater extent on rangeland than it did on forested areas (Table 4). There was twice the number of patches on rangelands following subdivision than on forestland. This indicated that home sites were preferentially located on open land.

Subdivided Ranches And Wildlife

Landowners planning subdivisions situated in foothills settings in proximity to urban centers may tend to concentrate building sites on open rangeland or scattered timber sites that offer grandiose viewscapes. Such a strategy explains the higher level of rangeland fragmentation we found in comparison to forest fragmentation.

People purchasing small acreage tracts in montane areas farther removed from

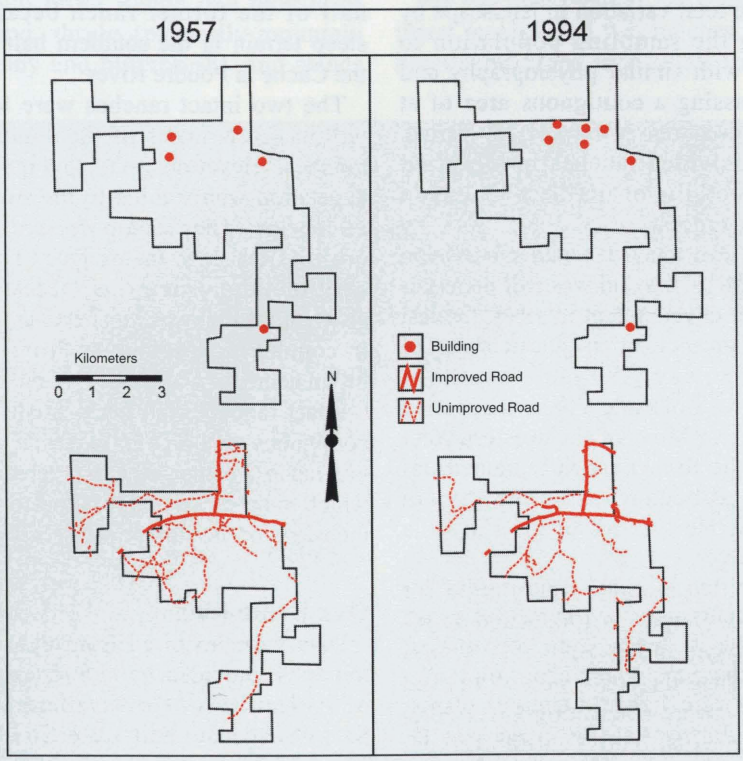

Fig. 6. ***Distribution of buildings and roads on intact ranch 2, Rocky Mountain Front Range, Colorado.***

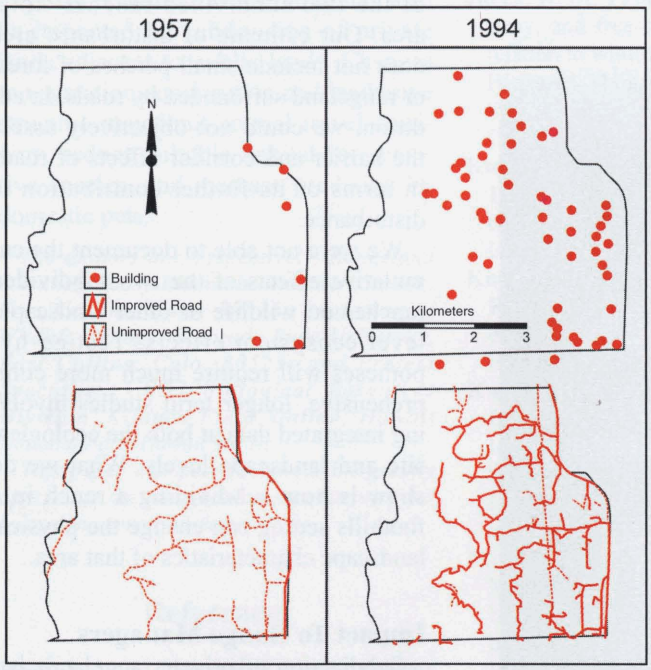

Fig. 7. ***Distribution of buildings and roads on subdivided ranch 1, Rocky Mountain Front Range, Colorado.***

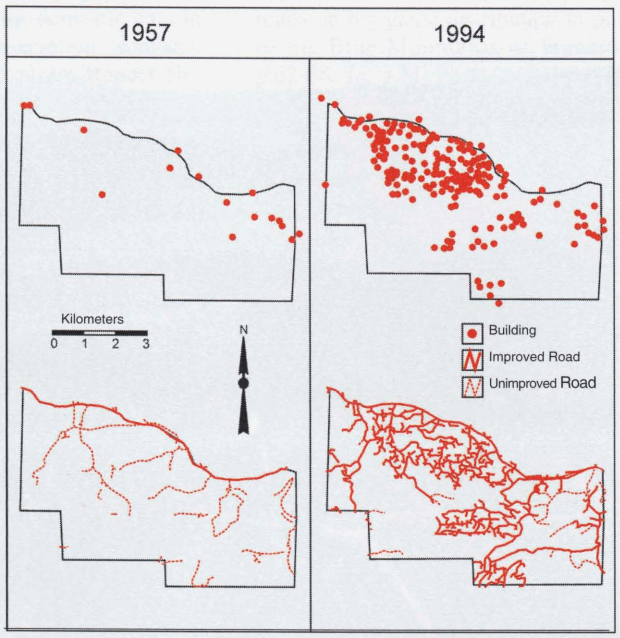

Fig. 8. ***Distribution of buildings and roads on subdivided ranch 2, Rocky Mountain Front Range, Colorado.***

urban centers apparently are more apt to desire forested cover types that hide their houses from passersby (Figure 9). If is not known if the size of a rural house, the size of individual tracts, or other factors are related to residences' position in the landscape.

Table 4. Total number of rangeland and forested land patches on two intact and two subdivided ranches before (1957) and after (1994) development, Rocky Mountain Front Range, Colorado.

Rangeland	1957	1994
Intact Ranches	35	49
Subdivided Ranches	55	411
Forested land	**1957**	**1994**
Intact Ranches	23	19
Subdivided Ranches	107	206

Subdivision of ranches into exurban developments has been shown to cause an increase in free-ranging dog and cat populations, vehicular traffic, illumination from yard lights, nonnative plants, and the number of people present on the land (Knight et al. 1995). Each of these changes creates disturbance zones around houses and along roads that can diminish wildlife populations (Odell and Knight, in press). Rural dog and cat populations result in increased predation on small mammals and songbirds, and even some larger mammals like weasels and deer fawn (see references in Jurek 1994). Effects of yard lights on wildlife are not adequately understood, but it appears that bright lights may alter the movement of some species such as mountain lions (Beier 1995).

Roads accessing subdivided parcels are graded and often well-traveled (Figure 10). Hence, they can affect wildlife in a variety of ways. Some species that do not do well in edge habitat or are sensitive to humans, are unwilling to cross roads. Others seek roads for heat or food. Nocturnal species tend to avoid lights (Schonewald-Cox and Buechner 1993). For some big game species, the disturbance impact is correlated with the intensity of road use and the openness of vegetation (Perry and Overly 1976).

Rural subdivisions result in an increased number of people, and human activity is one of the principal ways that wildlife is disturbed (references in Knight and Gutzwiller 1995). Not all wildlife species are equally sensitivity to human presence. Some species tend to avoid humans while others are attracted to them.

For example, Odell and Knight (in press) recorded decreases of black-headed grosebeaks, blue-gray gnatcatchers and orange-crowned warblers and increases of black-billed magpies, brown-headed cowbirds, and European starlings numbers with increasing housing development. They also found elevated populations of dogs and cats and fewer foxes and coyotes near exurban homes in Colorado.

The distribution of rural residences on the two subdivided ranches we examined appeared to be somewhat clustered. The aggregated nature of the improved road networks and building distributions are a result of terrain considerations. Theobald and colleagues (1997) have demonstrated that, when rural subdivisions are spatially clustered, the proportion of land that would disturb wildlife is considerably reduced.

The circles depicting buildings in figures 5 through 8 represent a disturbance zone with a 100-m radius (Odell and Knight, in press). Assuming this sized disturbance zone for all buildings leads to a total disturbance area of about 1,900 acres for the subdivided ranches in 1994. We estimate that roads add 900 acres of disturbance area. Thus, the total disturbance caused by homesites and roads comes to approximately one-fifth

Fig. 9. ***Subdivided land in the Wet Mountain Valley, Colorado. Note the location of homes within ponderosa pine patches.***

Fig. 10. *Road network on subdivided ranch in southern Colorado.*

of the two subdivided ranches' total area. Our estimate of disturbance area does not include small patches of forest or rangeland surrounded by roads. In addition, we could not objectively assess the barrier and corridor effects of roads in terms of its further contribution to disturbance.

We were not able to document the cumulative effects of the two subdivided ranches on wildlife or other landscape-level ecosystem effects. Testing hypotheses will require much more comprehensive, longer term studies involving integrated data at both the ecological site and landscape levels. What we do show is how subdividing a ranch in a foothills setting can change the physical landscape characteristics of that area.

Impact To Range Managers

Subdivision of private rangelands has the potential to affect nearby public and private rangeland managers in a number of ways. Subdivision can result in increased populations of nonnative weedy species as a result of landscaping, vegetation and soil disturbance during building and road construction, and overgrazing on small horse pastures (Knight and Clark 1998). These actions increase the potential for nonnative species and noxious weed invasion of adjacent rangelands and forests.

Additionally, vegetation management objectives that include the use of prescribed fire or managed wildfire may be limited due to the danger posed to new housing developments.

Subdivision of rangelands adjacent to public lands creates resource management issues as well. One of the attractions of rural subdivisions is private access to public lands. The overall effects of larger populations living along the borders of public lands, while still uncertain, are slowly being recognized.

One consequence of these changing residence patterns, for example, has been a cross-boundary demand for water from public lands that can impact management plans for wildlife and livestock grazing (Mitchell and Wallace 1998). More limited access to public lands by non-residents may result in increased usage of remaining access areas, leading to issues of overuse (Theobald 1995).

Lastly, wildlife management may also be impacted by subdivision of private lands adjacent to public lands. Changes in vegetation composition and landscape structure may limit animal travel corridors, reduce suitable habitat for sensitive species, and increase predation by domestic pets.

The authors are, respectively, Rangeland Scientist, Rocky Mountain Research Station, Fort Collins, Colo. 80526; Professor of Wildlife Biology, Colorado State University, Fort Collins, Colo. 80523; and Project Specialist, USGS Biological Resources Division, Kilauea Field Station, Hawaii National Park, Hawaii 96718.

This paper was peer reviewed. We greatly appreciate the thoughtful comments provided by one anonymous reviewer.

References

Beier, P. 1995. Dispersal of juvenile cougars in fragmented habitat. J. Wildlife Manage. 59:228-237.

Callies, D.L., R.H. Freilich, and T.E. Roberts. 1994. Cases and materials on land use. 2nd ed. West Publishing Co., St. Paul, Minnesota. 747 pp.

Davis, J.S., A.C. Nelson and K.J. Dueker. 1994. The new 'burbs': the exurbs and their implications for planning policy. J. Amer. Planning Assoc. 60:45-59.

Jurek, R. M. 1994. A bibliography of feral, stray, and free-roaming domestic cats in relation to wildlife conservation. Nongame Bird and Mammal Program Report No. 94-5. California Department of Fish and Game, Sacramento, California.

Knight, R. L. and K. J. Gutzwiller (ed.). 1995. Wildlife and recreationists: coexistence through management and research. Island Press, Covelo, California. 372 pp.

Knight, R. L., G. N. Wallace, and W. E. Riebsame. 1995. Ranching the view: subdivisions versus agriculture. Conserv. Biol. 9:459-461.

Knight, R.L. and T.W. Clark. 1998. Boundaries between public and private lands: defining obstacles, finding solutions, p.175-191. *In:* R.L. Knight and P.B. Landres (ed.), Stewardship across boundaries. Island Press, Washington, D.C.

Mitchell, J.E. and G.W. Wallace. 1998. Managing grazing and recreation across boundaries in the Big Cimarron watershed, p.217-236. *In:* R.L. Knight and P.B. Landres (ed.), Stewardship across boundaries. Island Press, Washington, D.C.

Nord, M. and J. Cromartie. 1999. Rural areas attract young families and college graduates. Rural Conditions and Trends 9(2):28-34.

Odell, E.A. and R.L. Knight. Wildlife communities and exurban development in Pitkin County, Colorado. Conserv. Biol., in press.

Perry, C. and R. Overly. 1976. Impact of roads on big game distribution in portions of the Blue Mountains of Washington, p.62-68. *In:* J.M. Peek (ed.), Proceedings of the elk-logging-roads symposium. Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow, Idaho.

Riebsame, W.E., H. Gosnell, and D.M. Theobald. 1996. Land use and landscape change in the Colorado mountains, I: Theory, scale, and pattern. Mountain Research and Development 16:395-405.

Riebsame, W.E. 1997. Atlas of the New West: Portrait of a changing nation. W.W. Norton Co., New York. 192 pp.

Schonewald-Cox, C. and M. Buechner. 1993. Park protection and public roads, p.373-395. *In:* P.L. Fiedler and S.K. Jain (ed.), Conservation Biology. Chapman and Hall, New York, NY.

Theobald, D.M. 1995. Morphology and effects of mountain land use change in Colorado: A multi-scale landscape analysis. PhD. Dissertation. University of Colorado, Boulder. 243 pp.

Theobald, D. M., H. Gosnell, and W. E. Riebsame. 1996. Land use and landscape change in the Colorado mountains, II: A case study of the East River Valley. Mountain Research and Development 16:407-418.

Theobald, D.M., J.R. Miller, and N.T. Hobbs. 1997. Estimating the cumulative effects of development on wildlife habitat. Landscape and Urban Planning 39:25-36.