SPATIAL ANALYSIS OF POTENTIAL IMPACTS OF LOCAL FORESTRY ORDINANCES

David R. Daversa, Stephen P. Prisley, and Michael J. Mortimer
Department of Forestry, Virginia Tech, Blacksburg, VA 24061

ABSTRACT

Local government organizations in Virginia have created a variety of ordinances that restrict forestry operations. A recent study found over 250 forest-related ordinances in Virginia, nearly a five-fold increase in 13 years. In order to estimate the potential impact of these ordinances on forest production, we used spatial analysis to determine the amount of forest area within four study counties that would be directly or indirectly affected by ordinance implementation. Direct impacts included restrictions on harvesting trees within buffer zones of streams, water bodies, roads, and parcel boundaries. Indirect impacts included the parcelization of forest areas (by these buffers) into isolated patches less than 20 acres, which are far less likely to be managed for production of timber. Using simple GIS operations of buffer and overlay in conjunction with publicly available datasets of forest cover, roads, streams, zoning, and parcel boundaries, we found that forest ordinances affected nearly 30% of operable forest area in the four study counties. For every three acres directly affected by the ordinances, another acre was indirectly affected by parcelization from buffers. Ordinances designed to protect visual quality (e.g., road and parcel boundary buffers) affected twice as much forest area as ordinances designed to protect water quality.

KEYWORDS. Buffer, harvest restrictions, regulations, forest area.

INTRODUCTION

County governments throughout the Commonwealth of Virginia have passed ordinances that have the potential to seriously impact the forest industry, and to negatively affect the ability of private forest landowners to derive forest-based incomes from their properties. This study looks at a sample of four counties: Clarke County, James City County, Prince William County, and York County. Local ordinances passed in these counties were examined and their impact on forests assessed. The primary types of ordinances considered in this study require vegetative buffers along streams, roads, and/or property boundaries; harvesting is either prohibited or restricted in these buffers. These four counties were selected as their respective ordinances constitute some of the most comprehensive and restrictive in the Commonwealth. Should other localities embrace these ordinances as models for their own use, it will be important to appreciate the impacts on forests and forest landowners.

We suggest that the ordinances passed by county governments impact forest management in direct and indirect ways. First, forestland that falls within the buffer boundaries is subject to

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restrictions that limit management options. The impact of the ordinance on a landowner or forestry operation may range from additional operational and monitoring costs to ensure compliance to partial or complete removal of timber resources from the potential commercial market. Second, these buffers create an indirect effect by fragmenting existing forest management units into smaller discontinuous blocks. Because forest harvesting relies on economies of scale for economic efficiency, commercial timber operations usually require a forest tract of at least 20 acres in size. While there are certainly exceptions, for the purposes of this analysis we consider discontinuous forested parcels (under a single ownership) less than 20 acres to be commercially inoperable. In many instances, the buffers required by ordinances parcelize once-operable forest tracts (those at least 20 acres in size) into inoperable forest tracts (less than 20 acres in size). By assessing the total forest area directly affected by these ordinances as well as those forest patches deemed inoperable as a result of ordinance implementation, we can better understand the potential impact of ordinances on a land area basis.

The purpose of this study, therefore, was to quantify the amount of forest land directly and indirectly by the promulgation of ordinances restricting forestry activities in buffer zones. In the absence of detailed forest inventory data on a site-specific basis, we cannot quantify the potential timber quantity affected, but land area should be a useful surrogate of the magnitude of potential impact.

METHODS

A comprehensive statewide GIS analysis was not possible due to budget and time constraints; therefore four counties were selected that represented some of the more rapidly urbanizing areas of the state where county ordinances are proliferating. The counties selected were Clarke County, Prince William County, James City County, and York County (Figure 1).

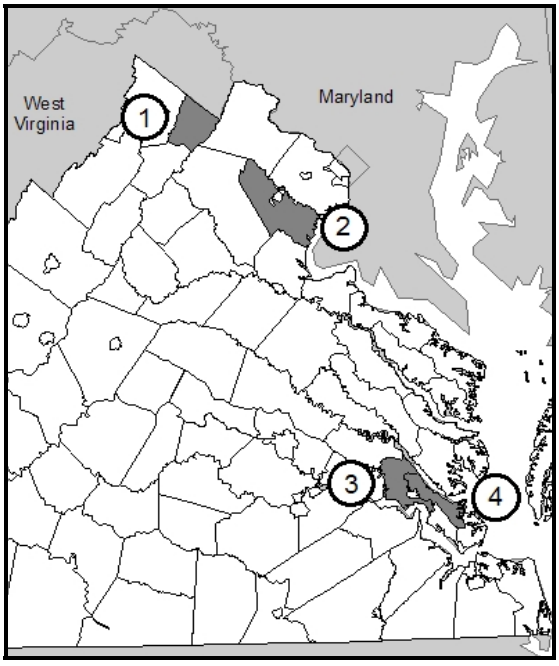

Figure 1. The location of four Virginia counties examined in this study: (1) Clarke County, (2) Prince William County, (3) James City County, (4) York County.

Current County Ordinances

A concurrent ordinance inventory conducted in Virginia (Mortimer et al., 2006) identified ordinances pertaining to restriction of harvesting opportunities in zones around geographic features. The following ordinances were simulated in this study:

Clarke County:

1. 25 foot buffer along public right-of-ways (thinning can not exceed 50% of crown cover or basal area);
2. 25 foot buffer along property lines (thinning can not exceed 50% of crown cover or basal area);
3. If a perennial stream or wetland flows through parcels qualifying for the Land Preservation Assessment (at least 20 acres in size), the following streamside buffer regulations apply:
   - Streambank is less than a 15 percent slope: 100 foot buffer
   - Streambank is between a 15 and 25 percent slope: 125 foot buffer
   - Streambank is at least a 25 percent slope: 150 foot buffer
4. If a perennial stream or wetland flows through parcels too small to qualify for the Land Preservation Assessment (less than 20 acres in size), the following streamside buffer regulations apply:
   - Streambank is less than a 15 percent slope: 35 foot buffer
   - Streambank is between a 15 and 25 percent slope: 45 foot buffer
   - Streambank is at least a 25 percent slope: 55 foot buffer
5. Intermittent streams falling outside of the Stream Protection Overlay District must have a 50 foot streamside buffer.

Prince William County:

1. In Areas zoned as A-1 agricultural, no timbering within 50 feet of any property line adjoining areas zoned other than A-1 or whose primary use is residential.
2. Wooded slopes of 25 percent and greater that abut perennial streams and have contiguous area of 10,000 square feet or greater must be placed in a conservation area, and shall not be disturbed.

James City County:

1. In General Agricultural Zones (A-1): Timbering shall be located 50 feet from any public right-of-way.
2. In all other Zones: Timbering shall not occur within 75 feet of public roads.
3. In residentially zoned areas, no timbering shall occur within 150 feet of community character corridors.

York County:

1. A 200 foot buffer along all reservoirs and tributary streams flowing into reservoirs;
2. 50 foot buffers along all public roads;
3. 25 foot buffer along all property lines;

4. 50 foot Streamside Management Zone (SMZ) along all perennial or intermittent streams where harvesting is prohibited or 100 foot SMZ along all perennial or intermittent streams where harvesting can only take 50 percent of the cover.

Spatial Data Compilation

We then compiled data on forest cover within the Commonwealth of Virginia, as well as spatial data relevant to ordinances in the study counties (e.g., roads, streams, ownership parcels, topography, protected areas, and zoning overlays). A list of the data layers and sources used in this study is presented in Table 1. The general analysis approach began by identifying and excluding existing protected areas, such as parks, preserves, and easements. This was done using data obtained from various federal and state agencies. These protected areas were excluded from this analysis because management is already restricted in these areas. Then, we identified land

Table 1. Data layers and sources for spatial analyses of ordinance impacts.

Location	Layer	Source
Clarke County	Parcel Boundaries	Clarke County Government
	Hydrography	USGS National Hydrography Dataset
	Road Centerlines	Clarke County Government
James City County	Zoning	James City County Government, Real Estate Assessment Division
	Parcel Boundaries	James City County Government, Real Estate Assessment Division
	Road Centerlines	James City County Government, Real Estate Assessment Division
Prince William County	Zoning	Prince William County Government
	Parcel Boundaries	Prince William County Government
	Hydrography	Prince William County Government
	Digital Elevation Model	USGS
York County	Hydrography	York County Government, GIS Department
	Road Centerlines	York County Government, GIS Department
	Parcel Boundaries	York County Government, GIS Department
	200 foot stream buffer	York County Government, GIS Department
Virginia (Statewide)	National Forests	United States Forest Service
	National Parks	National Park Service
	National Wildlife Refuges	United States Fish and Wildlife Service
	State Wildlife Management Areas	VA Dept. of Game and Inland Fisheries
	Natural Area Preserves	VA Dept. of Conservation and Recreation
	State Forests	VA Dept. of Forestry
	Conservation Easements	VA Dept. of Conservation and Recreation
	Locally owned Conservation lands	VA Dept. of Conservation and Recreation
	Privately owned conservation lands	VA Dept. of Conservation and Recreation
	Forest Land Use	VA Dept. of Forestry

areas subject to ordinances by depicting areas within a specified proximity (buffer) of relevant features such as streams, roads, or parcel boundaries. Forest areas (as defined by the Virginia Forest Land Use layer from Virginia Department of Forestry, VDOF) that lie within these buffer zones are deemed to be subject to the restrictions imposed by the ordinances. Then, the amount of forest cover within these areas was determined and compared to total forest area in the county. This provides a relative index of the potential direct impact of ordinance buffers affecting forestry operations.

Several of the counties required buffers along property boundaries. To model this, we assumed that buffers would not be required along internal parcel boundaries. That is, when the same person or organization owns parcels on either side of a boundary, then that boundary would not require a forest buffer. To model this assumption, we dissolved boundaries between parcels owned by the same entity.

All spatial analyses were conducted using ArcGIS 9.1 Geographic Information System (GIS) software from Environmental Systems Research Institute (ESRI). Buffers were defined using vector buffer functions, based on relevant vector layers. However, overlay of buffers with forest cover was done using raster functions. This was done for two reasons: (1) raster overlay processing, especially with such large datasets, is more efficient and avoids problems due to polygon slivers, and (2) the fundamentally important layer of forest cover was a raster layer. Because many buffers were smaller than the original raster resolution of the forest cover layer (15m), we resampled the forest cover layer to a spatial resolution of approximately 15 feet, and converted all subsequent layers to match this base.

Analysis of indirect impacts required identification of patches of forest land under a single ownership that comprised less than 20 acres. We used the *regiongroup* function in ArcGIS to assign unique identifiers to forest patches under single ownership, then selected all of these patches that were less than 20 acres to quantify the amount of inoperable forest, both before and after simulation of ordinances.

Data Analysis

A hypothetical example of the analysis for two owners with 68 acres of forest land is depicted in Figure 2 (not drawn to scale). Prior to simulation of ordinances (a), Owner A begins with a parcel containing 18 acres of forested land. Owner B has a parcel with 50 acres of forested land with a public road crossing the property. Because Owner A's forest contains less than 20 acres, we consider it commercially inoperable even prior to ordinance implementation. We simulate ordinances restricting harvest within a specified distance of property boundaries and roads by creating buffers adjacent to these features (b). Owner A now has 4 acres in parcel buffer; 14 acres remain commercially inoperable. Owner B now has 7 acres of forest within a road buffer, 9 acres of forest within a parcel buffer, and 3 acres that lie within both buffer zones and are therefore duplicated. Because of this duplication, the combined buffer area is 17 acres. Of the remaining forest outside buffer zones, 16 acres are now in a discontinuous piece and therefore considered commercially inoperable. Owner B has 21 acres of commercially operable forest land remaining. We summarize the impact of the ordinances on the hypothetical 68 acres of forested land as follows:

Pre-ordinance inoperable:	14 acres
Parcel buffer:	13 acres (4 in A; 9 in B)
Road buffer:	7 acres
Duplicated buffer:	3 acres
Combined buffer:	17 acres (13 + 7 - 3)
Post-ordinance inoperable:	16 acres
Unaffected:	21 acres

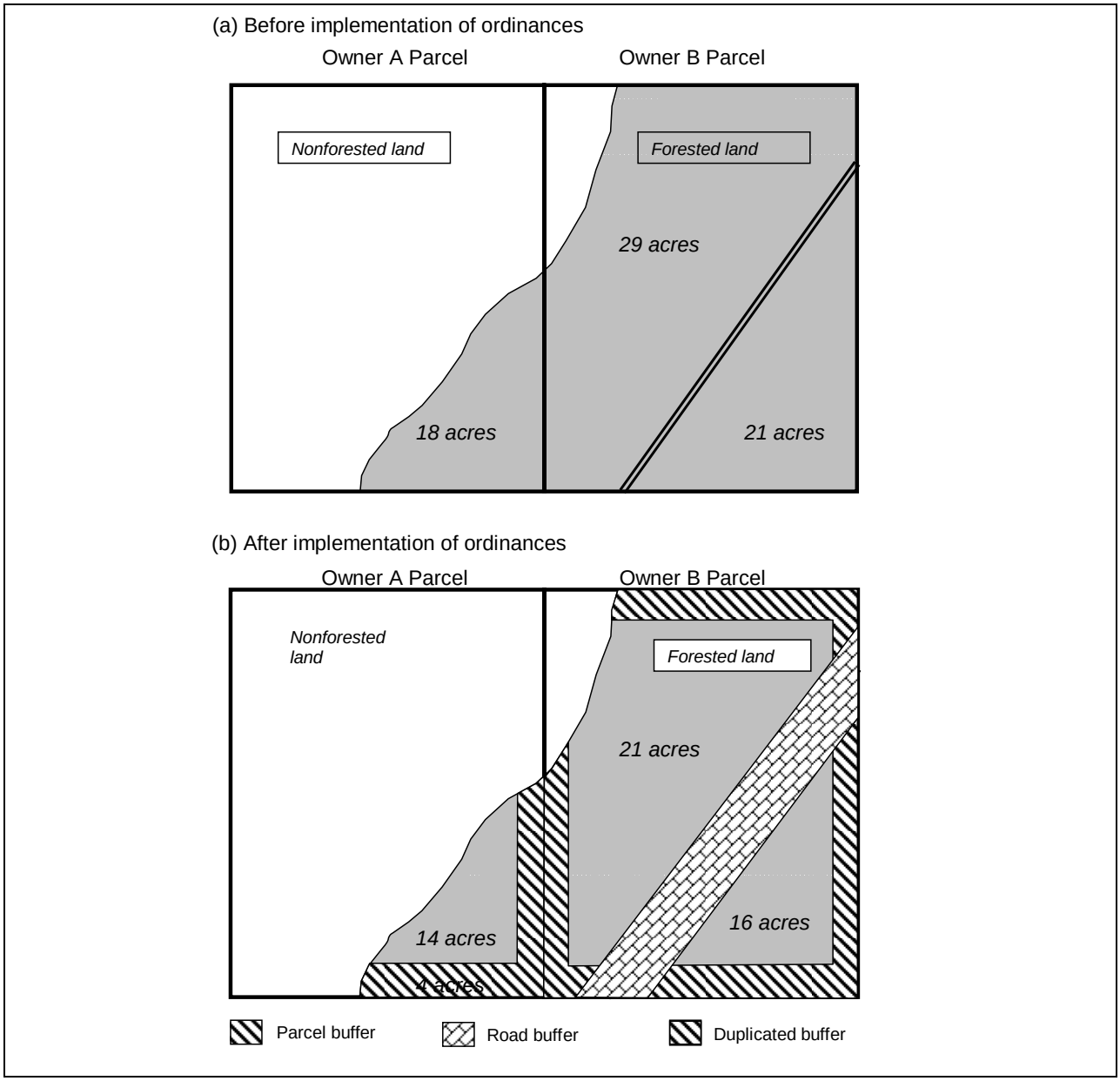

Figure 2. Maps illustrating simulation of forest ordinances for two hypothetical parcels.

RESULTS & DISCUSSION

The potential impacts of the ordinances in the four study counties are summarized in Table 2. The evaluation began with identification of total forest area within the county, as measured by the forest land cover data from VDOF that falls within the county boundaries. Next, existing protected areas were subtracted to provide net forest area. Forest patches identified as being commercially inoperable prior to ordinance implementation were subtracted, resulting in "Current Operable Forest Area".

Table 2. Area (acres) of forest and potential ordinance impacts by ordinance type and by county.

	Clarke County	James City County	Prince William County	York County	Total
Total Forest Area	53,796	62,308	124,558	45,858	287,118
Existing protected areas	2,907	5,350	16,236	14,525	39,018
Net Forest Area	50,889	56,958	108,321	31,334	248,100
Currently commercially inoperable (< 20 ac)	14,004	16,955	39,196	9,468	79,623
Current Operable Forest Area	36,885	40,003	73,081	21,866	168,477
Road ordinance buffers	1,791	3,781	-	1,935	7,507
Stream ordinance buffers	3,004	-	2,955	5,040	11,400
Parcel boundary ordinance buffers	4,608	-	15,247	4,096	24,350
Combined Ordinance Buffers	8,584	3,819	16,542	7,201	36,089
Post-ordinance inoperable forest	4,879	748	1,252	5,069	11,948
Total ordinance impact (acres)	13,463	4,567	17,840	12,270	48,037
Ordinance Impact (% of total forest area)	25%	7%	14%	27%	17%
Ordinance Impact (% of current operable forest)	36%	11%	24%	56%	29%

Forest areas subject to various ordinances were identified and categorized as road, stream, or parcel boundary ordinances. The combined area of ordinance buffer is the measure of the direct effect of ordinances within a county. Note that this number will be smaller than the sum of the individual ordinance buffer areas, due to overlap among buffers.

After identification of areas directly affected by ordinances, the indirect effect of creation of inoperable small parcels was measured and is expressed in the table at post-ordinance inoperable forest. Finally, the ordinance impact is expressed as the percentage of forest area affected both directly and indirectly by county ordinances. These figures are presented as both percent of total forest area and percent of current operable forest area.

Direct impacts ranged from 10% of operable forest area (James City County) to 33% (York County). Indirect impacts ranged from 2% of operable forest (James City and Prince William Counties) to 23% (York County). In general, indirect impacts amounted to about one-third of direct impacts, meaning that for every three acres of forest land in ordinance buffers, another acre is likely to be removed from management due to reductions in forest patch sizes. The county with the least area affected by ordinances was James City County, which had neither stream nor parcel boundary buffer ordinance. York County had the highest proportion of forest affected by ordinances, with over half of the operable forest affected directly or indirectly.

Different types of ordinances had different relative impacts. Stream buffer ordinances are generally intended to protect water quality; roadside and parcel boundary buffer ordinances are enacted to protect visual impacts from forest harvesting. Taken together, these ordinances designed to improve scenic values affected 31,857 acres directly and 9,625 acres indirectly. This may be compared to stream protection ordinances which directly and indirectly affected 11,400 acres and 9,052 acres, respectively (Figure 3). Thus, visual quality ordinances have more than double the impact of water quality protection ordinances.

SUMMARY & CONCLUSIONS

Local ordinances regulating aspects of forest management are increasing in Virginia. Many of these ordinances affect timber harvesting within certain proximity of roads, streams, and property boundaries. Taken together, these ordinances can have a substantial impact, directly and indirectly, on forest land available for management. In this study of four counties in the Commonwealth of Virginia, about a fifth of operable forest area was directly affected by ordinances; and another 7% was broken into parcels deemed too small for cost-effective forest management.

While results from these study counties cannot be extrapolated directly to other counties in this or other states, they provide an indication of the range of magnitude of potential impacts of ordinances on the amount of operable forested land in urbanizing areas. The process used herein demonstrates a procedure that could readily be used for evaluating potential impacts prior to enactment of ordinances that may affect forestry operations.

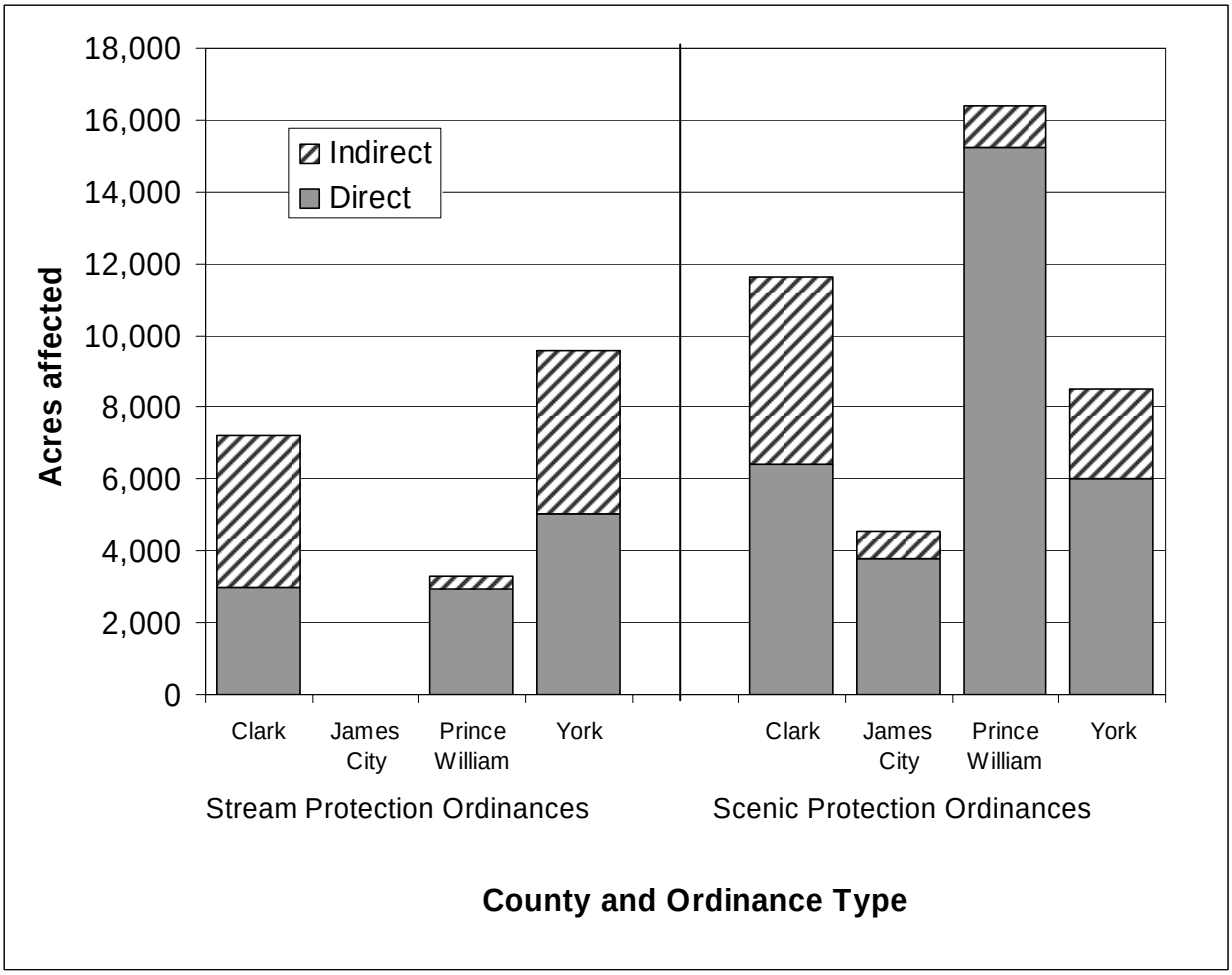

Figure 3. Area affected directly and indirectly by stream protection ordinances and scenic protection ordinances (i.e., road and parcel boundary buffers).

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