Preliminary Calculation of Landscape Integrity in West Virginia Based on Distance from Weighted Disturbances

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Abstract

We calculated preliminary landscape integrity values on a 30-meter grid for the state of West Virginia. Calculations are based on distance from weighted landscape disturbance features including mining and other industries, residential and urban development, transportation corridors, and agriculture. The calculated values provide an overview of the distribution of high-integrity landscapes in West Virginia, but the authors do not consider the model to be sufficiently accurate for site-specific landscape integrity assessment.

Introduction

West Virginia's natural landscapes are known for their high quality wildlife habitat, relatively low fragmentation, and high overall landscape integrity. As part of the on-going assessment of natural habitats by the West Virginia Division of Natural Resources, a statewide landscape integrity model was developed based on the work of Tuffly and Comer (2005). This preliminary model incorporates publicly available spatial data describing known landscape disturbances including mining and other industries, residential and urban development, transportation corridors, and agriculture. Disturbances are weighted for severity of impact, and landscape integrity is calculated as distance from the weighted disturbances.

Method

Our methodology follows Tuffly and Comer (2005) with slight modifications. Spatial data were obtained from the WV GIS Technical Center's statewide GIS data clearinghouse (wvgis.wvu.edu). See Table 1 for a detailed list of data and sources used. The geographic information systems software used for this project was ArcGIS 9.2 from Environmental Systems Research Institute. Analysis steps included:

1) Determining the disturbance features to be included in the landscape integrity index (Table 1).
2) Creating rasters for each disturbance feature. Raster cell size was arbitrarily chosen to be 30 meters.
3) Using the ESRI Spatial Analyst (SA) Path Distance tool to calculate the surface distance for each disturbance feature in Table 1.

4) Using the SA Slice tool to discretize the continuous distances calculated in the previous step into standard distance classes using the example slice table below. A linear distance decay function with a ceiling was chosen for simplicity to represent the maximum distance beyond which a disturbance will likely have an effect. One hundred meter distance classes and a ceiling of 1000 meters were chosen arbitrarily.

Distance (meters)	Distance Class
0-99	1
100-199	2
200-299	3
...	...
800-899	9
900-999	10
1000+	11

5) Assigning disturbance weights for each disturbance feature in the index. High disturbances = 1, low disturbances = 10. Disturbance weights were adapted for West Virginia based on similar indices developed by Hauer et al. (2002) and Mack (2006). These weights may change in further iterations of the method, as we learn more about the relationships between mapped disturbance features and actual disturbance impacts at field sites.
6) Calculating the Landscape Integrity Index by multiplying the distance class grid calculated in step 4 by the disturbance weight for each disturbance feature. These products were then summed for all disturbance features in the index. An index structured in this way produces high values for areas far away from disturbance features, and low values for areas closer to disturbance features.

Table 1. Disturbance Features, Data Sources, and Weights

Name	**Sources**	**Description**	**Resolution**	**Weight***
Structures	Statewide Addressing and Mapping Board (SAMB) 2003 http://wvgis.wvu.edu	Points for structures < 7000 sq ft; polygons for structures >= 7000 sq ft	1:4800 (automated feature extraction from 2003 orthophoto)	1
Divided Highways	WVDNR modified 2000 TIGER Roads	Interstate, US or WV State divided highways	1:12,000	1
Developed, High Intensity	National Land Cover Data Set 2001 Land Cover (NLCD) http://www.mrlc.gov/mrlc2k_nlcd.asp	Class 24 (urbanized, commercial, road corridors, etc.; impervious surfaces 80-100%)	30m pixel	1
Roads	SAMB 2003	Public roads	1:4800 (automated feature extraction from 2003 orthophoto)	2
Barren	NLCD http://www.mrlc.gov/mrlc2k_nlcd.asp	Class 31 (barren areas, strip mines, quarries,	30m pixel	2

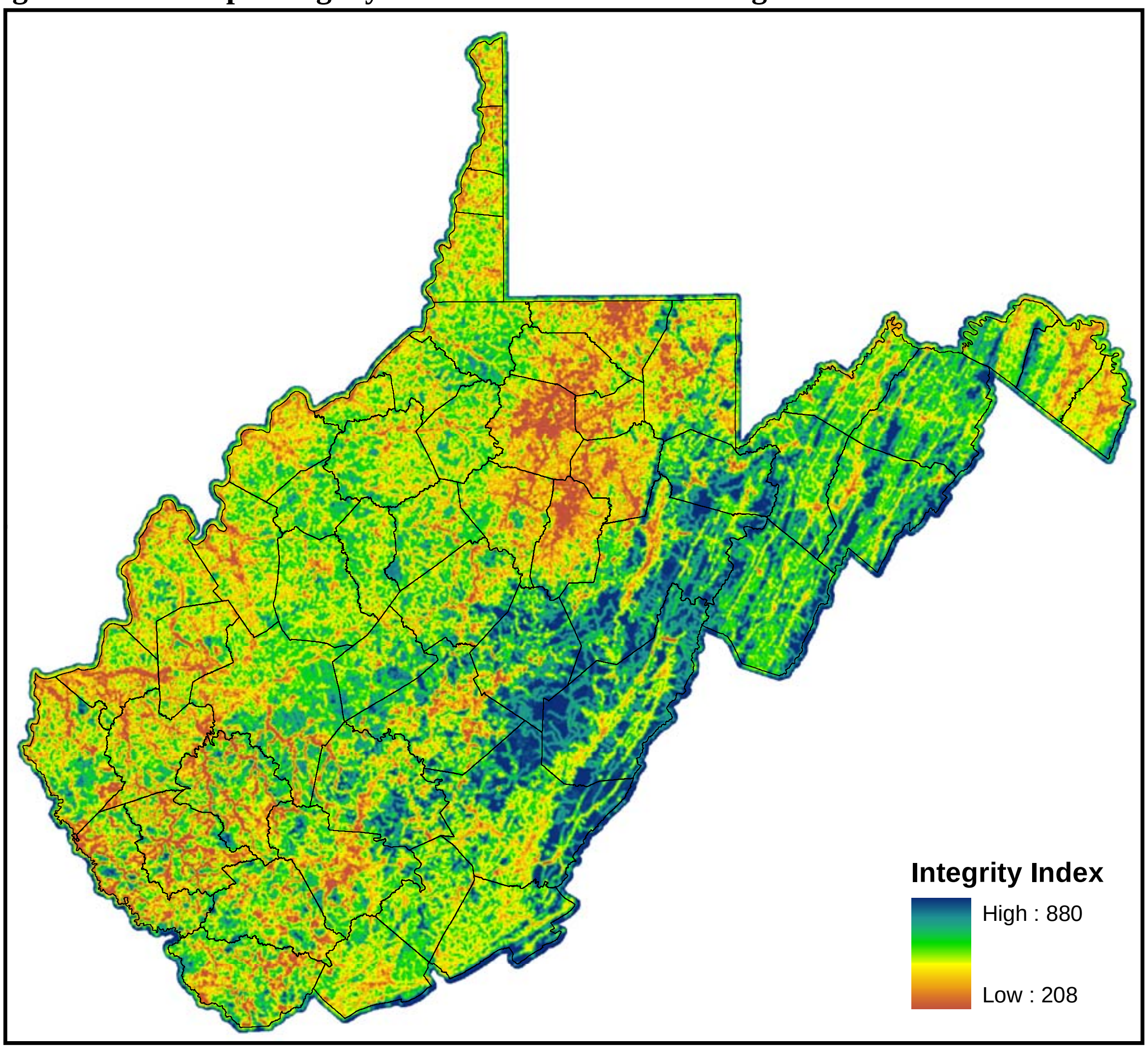
Name	Sources	Description	Resolution	Weight*
		etc. vegetation < 15%)		
Above Ground Mining	WV Dept. of Environmental Protection (WVDEP) http://wvgis.wvu.edu	Surface mining areas, auger mining, mining roads	1:24,000	2
Valley Fills	WVDEP http://wvgis.wvu.edu	Valley fills	1:24,000	2
Landfills	WVDEP http://wvgis.wvu.edu	Land fills	1:24,000	3
Developed, Medium Intensity	NLCD http://www.mrlc.gov/mrlc2k_nlcd.asp	Class 23	30m pixel	3
Railroads	USGS Digital Line Graph	Railroads		4
Industrial Facilities	WVDEP http://wvgis.wvu.edu	Industrial parks/sites/buildings, EPA listed facilities	1:24,000	4
Developed, Low Intensity	NLCD http://www.mrlc.gov/mrlc2k_nlcd.asp	Class 22	30m pixel	4
Row Crops	NLCD http://www.mrlc.gov/mrlc2k_nlcd.asp	Class 82	30m pixel	6
Utility Corridors	WVGAP 1999	Class 10,001 (major power lines)	30m pixel	6
Abandoned Mine Lands	WVDEP http://wvgis.wvu.edu	Abandoned mine lands	1:24,000	7
Developed, Open Space	NLCD http://www.mrlc.gov/mrlc2k_nlcd.asp	Class 21	30m pixel	7
Oil & Gas Wells	WVDEP http://wvgis.wvu.edu	Oil, natural gas, Martinsburg formation, Trenton formation, coal bed methane wells	1:24,000	7
Pasture/Hay	NLCD http://www.mrlc.gov/mrlc2k_nlcd.asp	Class 81	30m pixel	8
Underground Mining Limits	WV Geologic and Economic Survey (WVGES) http://wvgis.wvu.edu	Underground mining limits	1:24,000	10

*High Disturbance = 1, Low Disturbance = 10

Uses and Limitations

Derived landscape integrity values are presented in Figure 1. These data are useful in gaining an overall sense of the distribution of landscape integrity in West Virginia. These data may also be used to estimate a landscape integrity index for ecological integrity assessments using a watershed-based approach (Faber-Langendoen et al. 2008). The methodology is not designed to authoritatively assess landscape integrity for specific sites nor to replace field-based assessments, although it may assist in prioritizing sites for field assessment. There are many potential sources of error and bias in this preliminary analysis. Errors certainly exist in the individual data layers used to create the model, although random errors may cancel since multiple data layers are used. Bias is of concern since data layers were ranked based on a subjective adaptation of existing indices and, in many cases, the data layers contain disturbances of varying importance. For example, an industrial facility might include features ranging from a highly disturbed toxic waste disposal site to minimally disturbed semi-natural vegetation. Bias is also introduced in the grouping of the data layers. The resulting calculations may over-estimate the impacts of groups with many layers and underestimate the impacts of groups with few layers. The relative weighting of disturbances is, in some cases, less important than the number of nearby disturbances, since the weighting is additive between groups. Systematic sensitivity analysis has not been conducted. Finally, this representation is an incomplete and inverse measure of integrity, since it is based solely on disturbance data. Further work is needed, especially in terms of adding positive landscape integrity features to the model. Positive landscape integrity features might include mature forest, native wetlands, unchannelized streams, or high concentrations of natural biodiversity.

Figure 1. Landscape integrity based on distance from weighted disturbances



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