Appendix D. Landscape Condition Model

Relative Landscape Condition

Ecological condition commonly refers to the state of the physical, chemical, and biological characteristics of natural ecosystems, and their interacting processes. Many human land uses affect ecological condition, (e.g., through vegetation removal or alteration, stream diversion or altered natural hydrology, introduction of non-native and invasive species, etc.). Landscape condition assessments commonly apply principles of landscape ecology with mapped information to characterize ecological condition for a given area (e.g., USEPA 2001, Sanderson et al. 2002). Since human land uses - such as built infrastructure for transportation or urban/industry, and land cover such as for agriculture or other vegetation alteration – are increasingly available in mapped form, they can be used to spatially model inferences about ecological stress and ecological condition.

Maps of this nature can be particularly helpful for identifying relatively unaltered landscape blocks, or for making inferences about the relative ecological integrity of natural habitats on the ground. They can also be used for screening ecological reference sites; i.e., a set of sites where anthropogenic stressors range from low to high. Ecological condition within reference sites is often further characterized in the field to determine how ecological processes respond to specific stressors, but spatial models can provide a very powerful starting point to build upon (Faber-Langendoen et al. 2008, 2012). Knowledge from reference sites may then apply to surroundings for many types of environmental decisions.

The **Landscape Condition Models** used in this project build on a growing body of published methods and software tools for ecological effects assessment and spatial modeling; all aiming to characterize relative ecological condition of landscapes (e.g., Knick and Rotenberry 1995, Forman and Alexander 1998, Trombulak and Frissel 1999, Theobald 2001, Seiler 2001, Sanderson et al. 2002, Riitters and Wickham 2003, Brown and Vivas 2005, Hansen et al. 2005, Leu et al. 2008, Comer and Hak 2009, Comer and Hak *in prep*, Theobald 2010, Rocchio and Crawford 2011). The intent of this modeling approach is to use regionally available spatial data to transparently express user knowledge regarding the relative effects of land uses on natural ecosystems and habitats. In these cases, the authors' expert knowledge forms the basis of stressor selection, and relative weightings, but numerous examples from published literature have been drawn upon to parameterize the model for application in this ecoregion. Independent data sets were drawn upon for subsequent model evaluation. The current model applied to the Snake River Plain ecoregion has been developed and evaluated for the entire western United States. Western regional model development and evaluation was completed in cooperation with the Western Governors Association landscape connectivity working group.

Each input data layer is summarized to a 90m grid and, *where the land use occurs*, given a **site impact score** from 0.05 to 0.9 (Table A2-2) reflecting presumed ecological stress or impact. Values close to 1.0 imply relatively little ecological impact from the land use. For example, a given patch of 'ruderal' vegetation – historically cleared for farming, but recovering towards natural vegetation over recent decades, is given a Very Low (0.9) score for site impact as compared with irrigated agriculture (High Impact 0.3) or high-density urban/industrial development (Very High Impact 0.05). Certainly, there are some ecological values supported in these intensively used lands, but their relative condition is quite limited when compared with areas dominated by natural vegetation (Table).

NOTE: While the categories of "introduced" species were included in these models their mapped locations were based on those found in LANDFIRE and SW ReGAP maps (see Lowry et al. 2007), and should be presumed to reflect only the most severe centers of infestation. Lower levels of invasive species presence should not be presumed to be reflected in these models (see subsequent discussion of

invasive plant models). Similarly, effects of overgrazing, such as soil compaction and disturbance, were not available in mapped form, and therefore not at all represented.
A second model parameter – *again, for each data layer* - represents a **distance decay** function, expressing a decreasing ecological impact with distance away from the mapped location of each feature as applied to the Euclidian Distance value described above (Table). Mathematically, this applies a function, based on the formula that characteristically describes a “bell curve” shape that falls towards plus/minus infinity. Those features given a high decay score (approaching 1.0) result in a map surface where the impact value dissipates within a relatively short distance. Those features given a low decay score (approaching 0.0) create a map surface where the per-pixel impact value dissipates more gradually with distance away from the impacting feature. Values for each layer will approach 1.0, symbolizing negligible impact, at the distance listed in the right-hand column of Table A2-2.

The result is a map surface indicating relative scores between 0.0 and 1.0 (Figure D1). This provides one composite view of the relative impacts of land uses across the entire ecoregion. Darker green areas indicate apparently least impact and orange to red areas most impact.

Table D1. Ecological stressor source, site-impact scores, and distance decay scores implemented for the landscape condition model

Ecological Stressor Source	**Site Impact Score**	**Presumed Relative Stress**	**Distance Decay Score**	**Impact Approaches Negligible**
Transportation				
Dirt roads, 4-wheel drive	0.7	Low	0.5	200m
Local, neighborhood and connecting roads	0.5	Medium	0.5	200m
Secondary and connecting roads	0.2	High	0.2	500m
Primary Highways with limited access	0.05	Very High	0.1	1000m
Primary Highways without limited access	0.05	Very High	0.05	2000m
Urban and Industrial Development				
Low Density Development	0.6	Medium	0.5	200m
Medium Density Development	0.5	Medium	0.5	200m
Powerline/Transmission lines	0.5	Medium	0.9	100m
Oil /gas Wells	0.5	Medium	0.2	500m
High Density Development	0.05	Very High	0.05	2000m
Mines	0.05	Very High	0.2	500m
Managed and Modified Land Cover				
Ruderal Forest & Upland	0.9	Very Low	1	0m
Native Veg. with introduced Species	0.9	Very Low	1	0m
Pasture	0.9	Very Low	0.9	100m
Recently Logged	0.9	Very Low	0.5	200m
Managed Tree Plantations	0.8	Low	0.5	200m
Introduced Tree & Shrub	0.5	Medium	0.5	200m
Introduced Upland grass & forb	0.5	Medium	0.5	200m
Introduced Wetland	0.3	High	0.8	125m
Cultivated Agriculture	0.3	High	0.5	200m

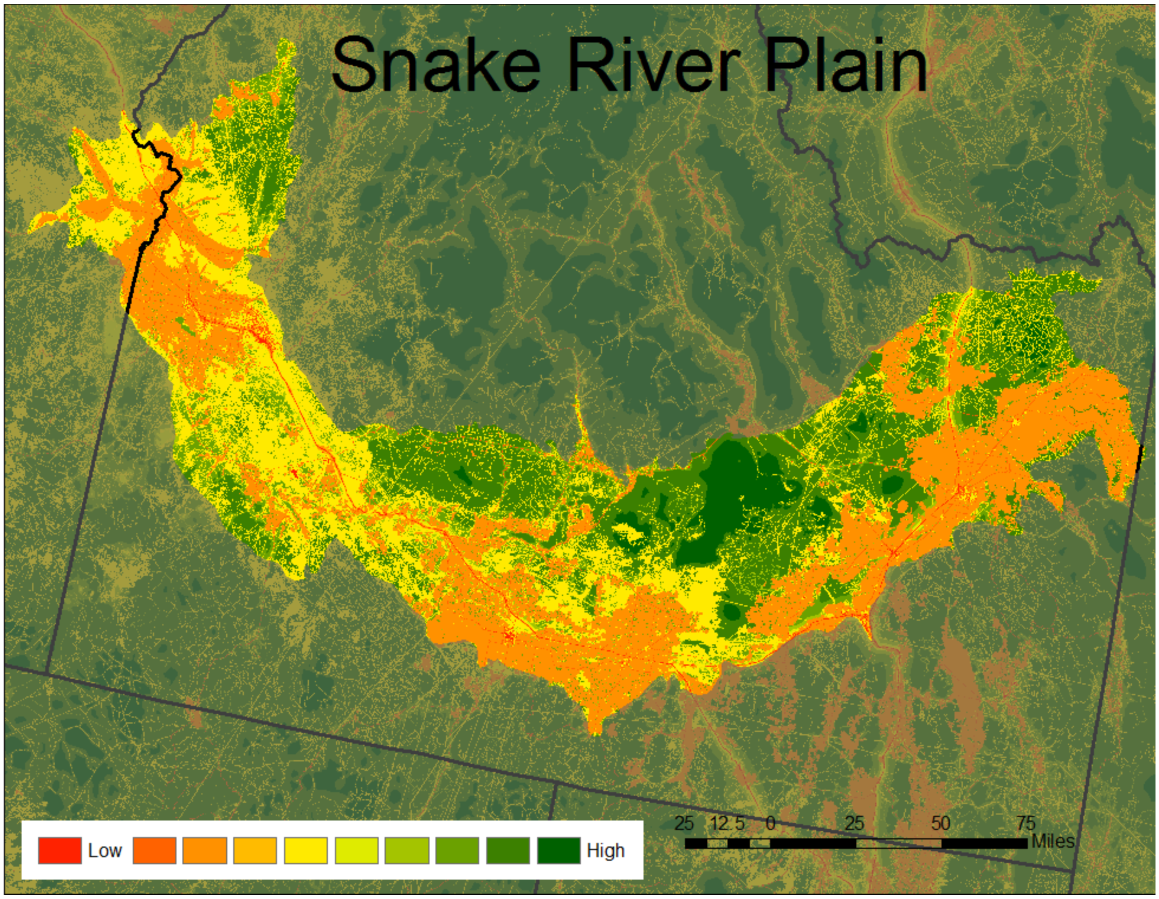

Figure D1. Landscape Condition Model for Snake River Plain ecoregion. Darker green areas indicate apparently least impact and orange to red areas most impact.

Current Landscape Condition (2010): Current Landscape Condition of each system was assessed using these landscape condition models (LCM). This indicator is measured by intersecting the mapped area or habitat distribution map of the community type with the LCM layer and reporting the average per-pixel LCM index value for the type within the ecoregion. The average per-pixel score provides a relative index for landscape condition resulting with a score from 0 to 1 with 1 being very high landscape condition and values close to 0 likely having very poor condition.

Past landscape condition (1960): Historical landscape condition data were lacking for analysis using a Landscape Condition Model so landscape condition of area of target ecological systems were researched and summarized based on estimated extent of roads and other development and various anthropogenic disturbances. An expert estimate for each community type was built upon a review of available historical information and was scaled between 0-1, with 1 equaling pristine conditions. Examples of disturbance include historic grazing (since mid 1800's), which has significantly affected most ecosystems and transportation system of highways and roads have fragmented many areas. Additionally, water diversions and ground water pumping has affected springs and surface flows in riparian ecosystems, and local disturbance from agriculture, urbanization and mining have converted many sites.

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