McCall Subregion Elk Winter Range Habitat Preference 2001 vs. 2010

Pamela Bond

Abstract

Using geographic information systems has helped overcome some of the problems that arose from using more traditional techniques for creating wildlife habitat suitability maps by allowing more flexibility and having a powerful set of spatial analysis tools. Through the use of ESRI ArcGIS 9.3.1 ModelBuilder, this research demonstrates the power of GIS for wildlife habitat suitability modeling. The Spatial Analyst Weighted Overlay seems to be an especially helpful tool for creating a categorical habitat suitability map. Data from 2001 and 2010 aerial elk surveys was used to create a model for each year and the results were visually compared. Although the results of the model could be more robust through the use of statistics or addition of more data layers, the maps created could probably still be very useful for making landscape-scale management decisions.

Introduction

Wildlife habitat modeling can be a very useful tool to wildlife managers for evaluating change over time due to habitat fragmentation or disturbance and for understanding and predicting biogeographic patterns (Franklin 1995). Animals move within and between habitat areas and this makes spatial analysis a vital part of evaluating habitat (Rickers et al. 1995). In the early 1990's, geographic information systems (GIS) began to be seen as a tool for wildlife habitat modeling. Using GIS to create habitat models has helped overcome some of the problems that arose using more traditional techniques by allowing more flexibility to create different management scenarios, allowing data to be compiled and inventoried more efficiently, and having tools for analyzing spatial patterns (Rickers et al. 1995). Johnston (1993) found that by using GIS it was possible to model populations that are limited by environmental carrying capacity based on mapped environmental variables that are related to their survival. Habitat suitability index (HSI) modeling is one of the most widely used methods for mapping wildlife habitat (Rickers et al. 1995, Yamada et al. 2003). The HIS for a given species represents a conceptual model that relates each measurable variable of the environment to the suitability of a site for the species (Burgman et al. 2001, Roloff and Kernohan 1999, USFWS 1996, Yamada et al. 2003). Typically, each environmental variable (soils, cover type, elevation, etc) is scaled from 0 (unsuitable) to 1(suitable), all variables are multiplicatively or additively combined, and the result expresses the suitability of a particular area for a species. Weights may also be assigned to variables to reflect its relative importance for the model (Burgman and Lindenmayer 1998, Yamada et al. 2003).

This research introduces a preliminary Rocky Mountain elk (*Cervus canadensis nelson)* winter range habitat suitability model for the years 2001 and 2010 for the Idaho Fish and Game McCall subregion. Although winter range often comprises a small portion of their annual range, it is considered to be the principle determinant of range carrying capacity (Cook 2002, Poole and Mowat 2005). By using ESRI ArcGIS ModelBuilder and the tools provided in ESRI ArcMap 9.3.1, I will first investigate the habitat needs of elk on winter range and then create habitat suitability index models for both years. These maps would be useful for identifying habitat selection changes over the last 9 years and influencing landscape management decisions.

Methods

Three ESRI ArcGIS models were used to create habitat suitability maps of elk winter range for the years 2001 and 2010 in the McCall Subregion, central Idaho. The first model was created to identify the habitat parameters selected by the elk. The data layers the habitat parameters were selected from include: LANDFIRE canopy cover, existing vegetation type, existing vegetation height, and existing vegetation cover (http://www.landfire.gov/products_national.php); Gap Analysis Program (GAP) level 3 landcover (most detailed, http://gapanalysis.nbii.gov); Natural Resources Conservation Service U.S. general soils (http://soildatamart.nrcs.usda.gov/USDGSM.aspx); and a DEM downloaded from the USGS National Map Seamless Server (http://seamless.usgs.gov/).

The first model created is a habitat preference assessment model (Figure 1). I used an outline of the Idaho Fish and Game Subregion (the area of interest for this research) to create subsets of each data layer using the Spatial Analyst Extract by Mask tool. Outside of the model, I combined the 2001 and 2010 Elk locations using the Data Management Merge tool. The Elk location data was obtained from Idaho Fish and Game; the location data is a collection of GPS waypoints taken during aerial surveys. Back in the model, I used the Spatial Analyst Slope and Aspect tools to create two new data layers from the DEM. I used the Conversion Polygon to Raster Tool to convert the U.S. general soils polygon layer to a raster layer because you cannot extract values to points from polygons. Finally, I used the Spatial Analyst Extract Values to Points tool for each subset of data using the merged elk location point file to identify the habitat parameters they selected for.

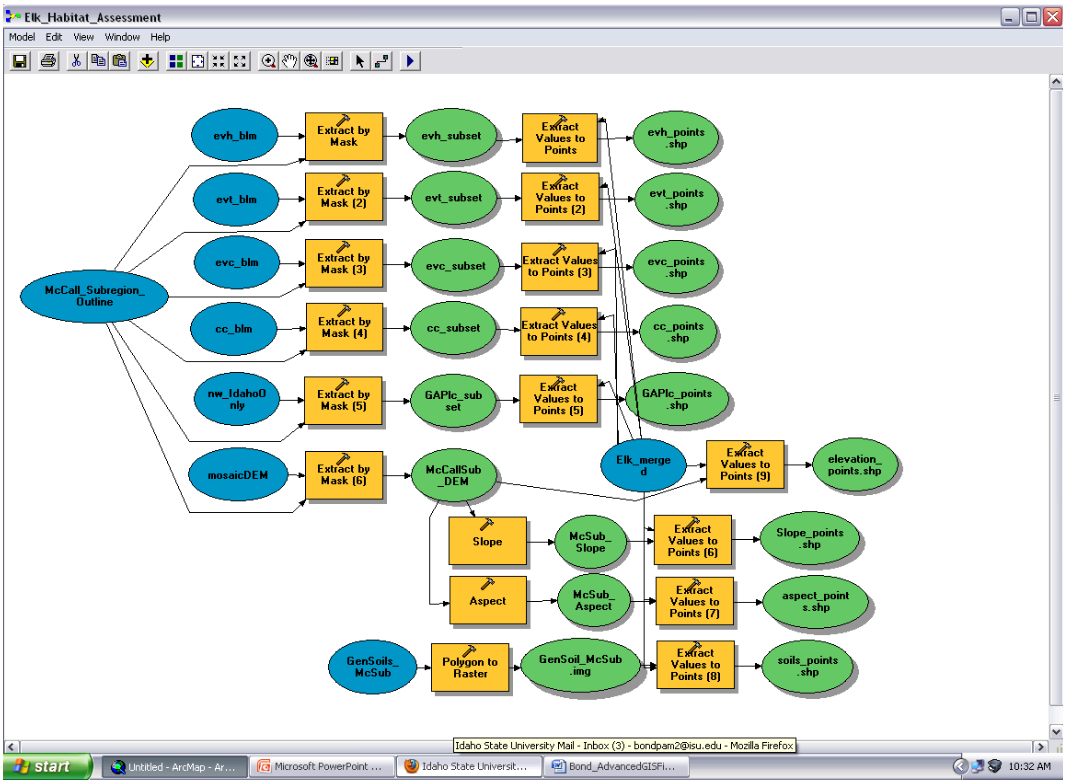

Figure 1. Habitat parameter preference model using merged 2001 & 2010 Elk location point data.

Next, I used Microsoft Excel 2007 to analyze the data generated by the habitat parameter preference model. I sorted the data by date so that all of the 2001 data was grouped together and all of the 2010 data was grouped together for each data layer. I conducted a count of each unique parameter within each data layer, calculated the percentage of the total each unique parameter was selected for, and identified the parameters that made up ~ 75% of the elks' parameter preferences to be used in the habitat suitability index models (Figure 2). I chose to use only the parameters selected for ~ 75% of the time to weed out any outliers and to provide the most robust results.

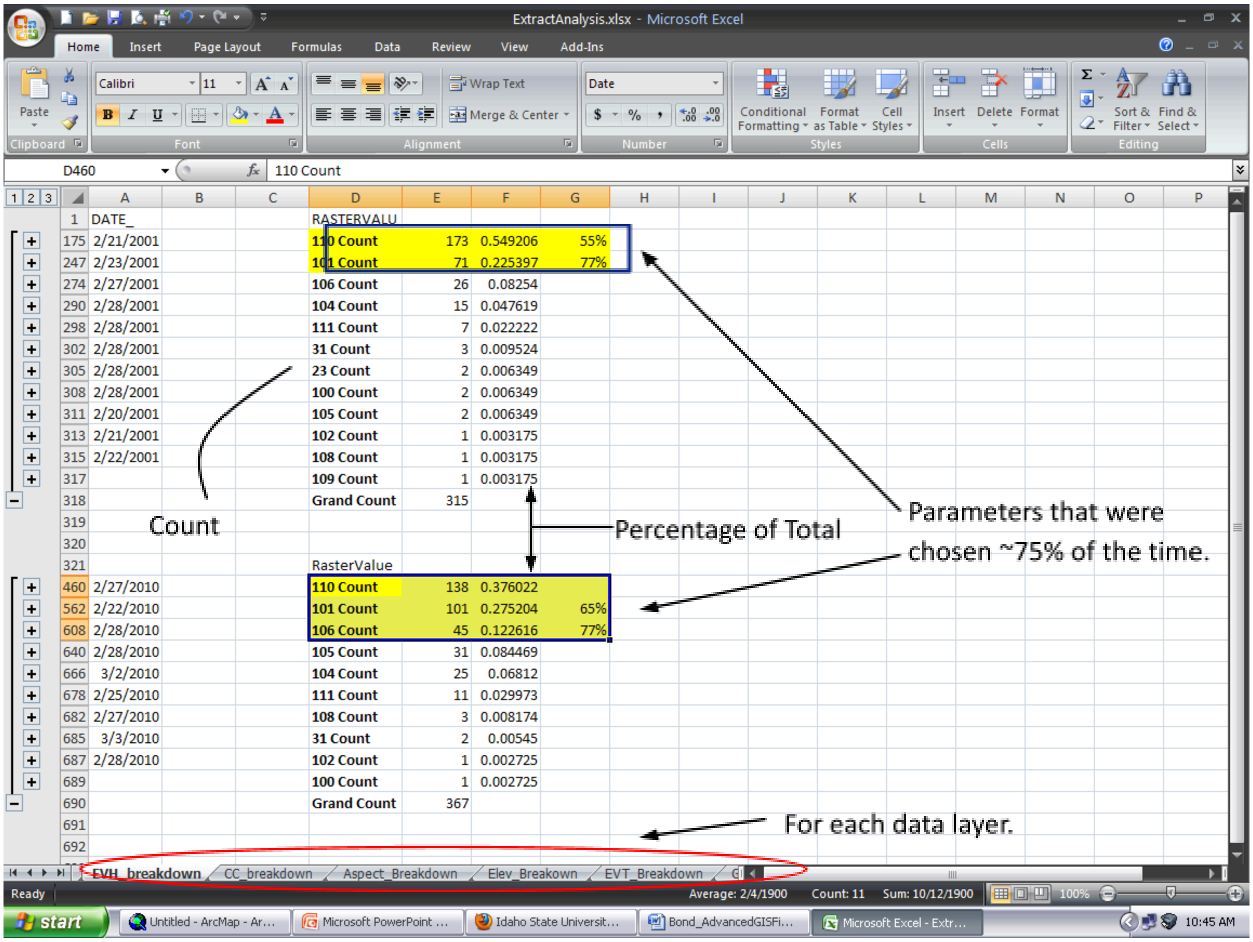

Figure 2. The Excel spreadsheet used to select the unique parameters within each data layer that would be used for the habitat suitability index model.

I then created a habitat suitability index model for each year. The models are identical in every way except for the unique parameters used for reclassification, etc (Figure 3).

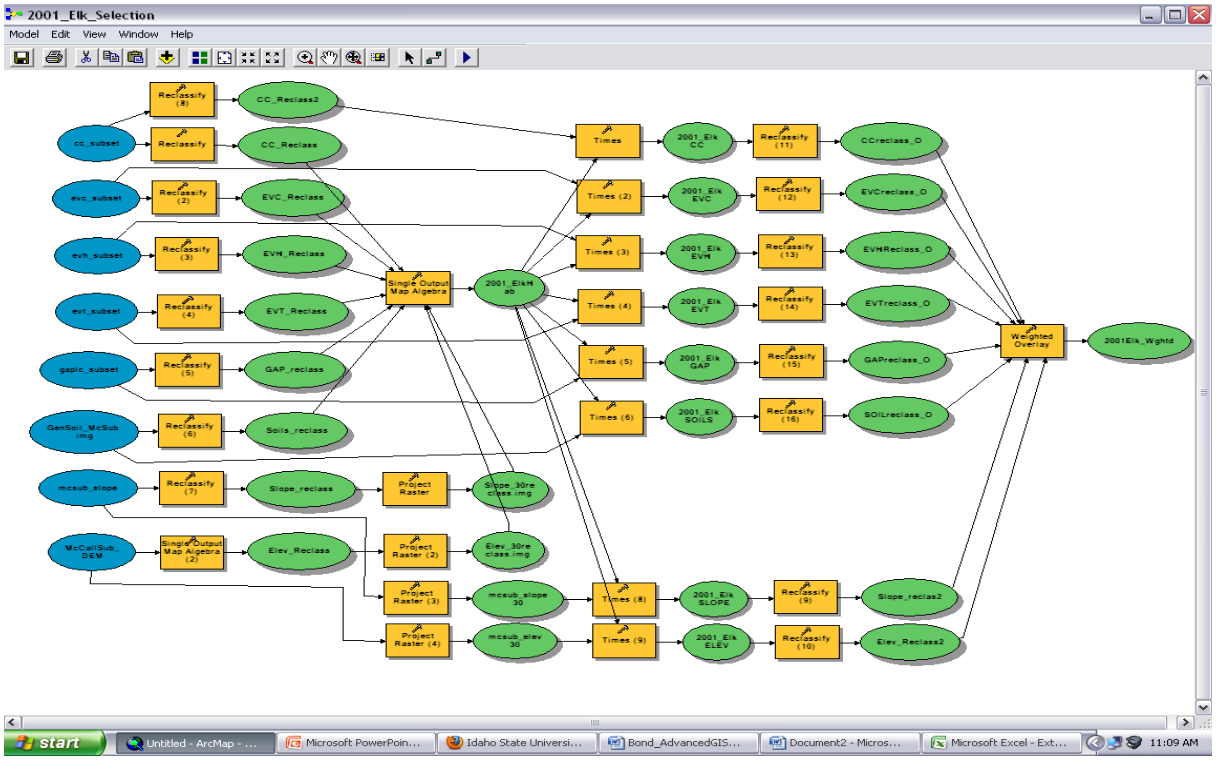

Figure 3. 2001 McCall Subregion Elk Winter Range Habitat Suitability Index Model.

I first created a Boolean mask of each data set by using the Spatial Analyst Reclassify tool (Figure 4). Using the results from the Excel spreadsheet, selected parameters were given a value of 1 and those not selected a value of 0. This was done for all data layers except for the DEM (elevation) layer because I wanted to select a range of values. I used the Spatial Analyst Single Output Map Algebra tool to create a Boolean Mask of the elevation layer using the equation: Con (McCallSub_DEM >= 700 AND McCallSub_DEM <= 2000, 1, 0).

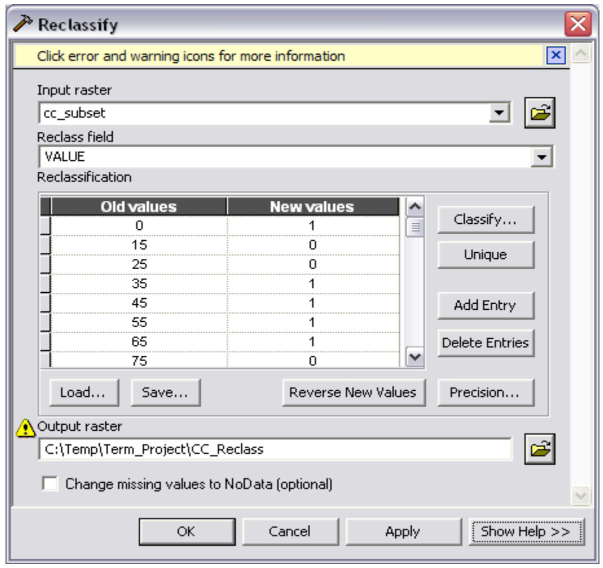

Figure 4. The Spatial Analyst Reclassify tool used to create a Boolean masks of each data layer, a value of 1 as assigned to selected parameters and a value of 0 was assigned to unselected parameters.

I next used the Data Management Project Raster tool to resize the pixels of the Slope and Elevation layers to 30m so that they were the same size as all of the other data layers pixels. To create a general habitat selection layer, I used the Single Output Map Algebra tool to multiple all of the reclassified data layers together using the equation: CC_Reclass * EVC_Reclass * EVH_Reclass * EVT_Reclass * GAP_reclass * Soils_reclass * Slope_30reclass.img * Elev_30reclass.img.

In order to create a habitat suitability index map, I had to first restore the original values of the data layers to the pixels that were selected for. To do so, I used the Spatial Analyst Times tool (for some reason the Single Output Map Algebra tool was not working for this) to multiple the original subset of each data layer by the general habitat selection layer. Note: For the LANDFIRE canopy cover layer I first reclassified the value 0 to 1 so that there wasn't any confusion of this being a NoData value later. I next used the Reclassify tool to assign a selection ranking value (from 9 to 1 or NoData) to each parameter for each data layer. This was done in order for the Weighted Overlay tool to work properly. Finally, I used the Spatial Analyst Weighted Overlay tool (Figure 5) to create the final habitat suitability index layer. Each data layer was given equal influence but the unique parameters within each data layer were scaled from 1-9 based on percentage of selection.

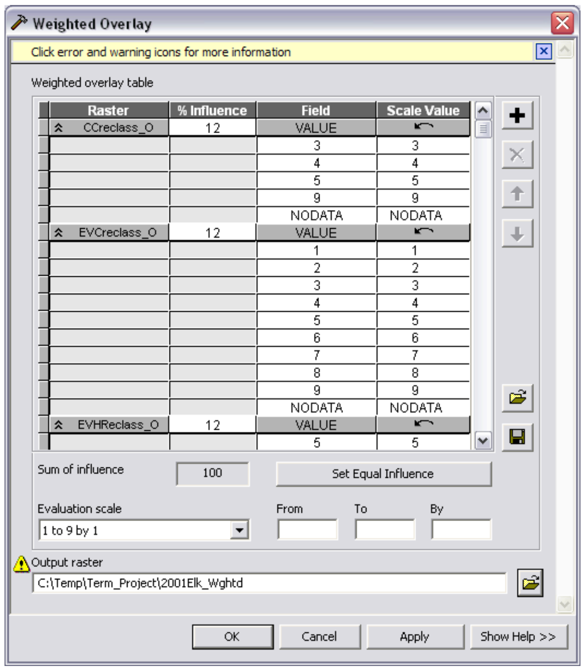

Figure 5. The Weighted Overlay tool used to create the final McCall Subregion elk winter range habitat suitability index layer.

Results & Discussion

The results of the habitat parameter preference model and the Excel analysis are displayed in summarized in Table 1.

Table 1. The unique habitat parameters selected for in each data layer using 2001 and 2010 Elk location data. The habitat parameter of highest preference in each data layer is highlighted.

Elk Winter Range Habitat Selection Parameters		**2001**	**2010**
Canopy Cover	Nonforest	41%	59%
	30-40%	8%	-
	40-50%	9%	9%
	50-60%	11%	7%
	60-70%	10%	-
Veg. Height	Trees 10-25 m	55%	38%
	Herbaceous 0-0.5 m	23%	28%
	Shrubs 1-3 m	-	12%
Veg. Cover	Herbaceous 30-40%	8%	6%
	Herbaceous 40-50%	6%	10%
	Herbaceous 70-80%	2%	-
	Shrub 10-20%	2%	8%
	Shrub 20-30%	3%	13%
	Shrub 40-50%	4%	-
	Shrub 50-60%	2%	-
	Forest 20-30%	6%	7%
	Forest 30-40%	9%	6%
	Forest 40-50%	-	10%
	Forest 50-60%	10%	8%
	Forest 60-70%	9%	4%
	Forest 70-80%	6%	4%
	Forest 80-90%	5%	-
Veg. Type	Douglas fir forest Alliance	38%	27%
	N. Rocky Mtn. dry-mesic montane mixed conifer forest	12%	9%
	N. Rocky Mtn. lower montane-foothill-valley grassland	11%	8%
	Introduced upland vegetation - perennial grassland & forbland	10%	16%
	Mountain big sagebrush shrubland alliance	8%	9%
	Columbia plateau low sagebrush steppe	-	8%
Gap Landcover	N. Rocky Mtn. dry-mesic montane mixed conifer forest	31%	16%
	N. Rocky Mtn. P. pine woodland & savanna	17%	20%
	N. Rocky Mtn. montane-foothill deciduous shrubland	16%	13%
	Columbia basin foothill & canyon dry grassland	13%	21%
	N. Rocky Mtn. lower montane-foothill-valley grassland	-	9%
Soils	Argis Cryoborolls, Loamy-Skeletal, Mixed	53%	39%
	Ultic Argixerolls, Loamy-Skeletal, Mixed, Mesic	18%	25%
	Typic Cryorthents, Sandy-Skeletal, Mixed	17%	-
	Lithic Haploxerolls	-	10%
	Lithic Haploxerolls, Loamy-Skeletal, Mixed, Mesic	-	7%
Elevation	--->	700-2000	600-2000

Slope	--->	15-33%	13-37%

The results of the habitat preference assessment show that the elk selected for nearly the same habitat parameters for both 2001 and 2010. Interestingly, aspect did not seem to be a parameter of importance because no value was preferentially selected (I aspect direction stood out from the others). The elk locations and the general habitat layer seem to agree quite well (Figure 6 – the 2001 and 2010 habitat layers are shown together).

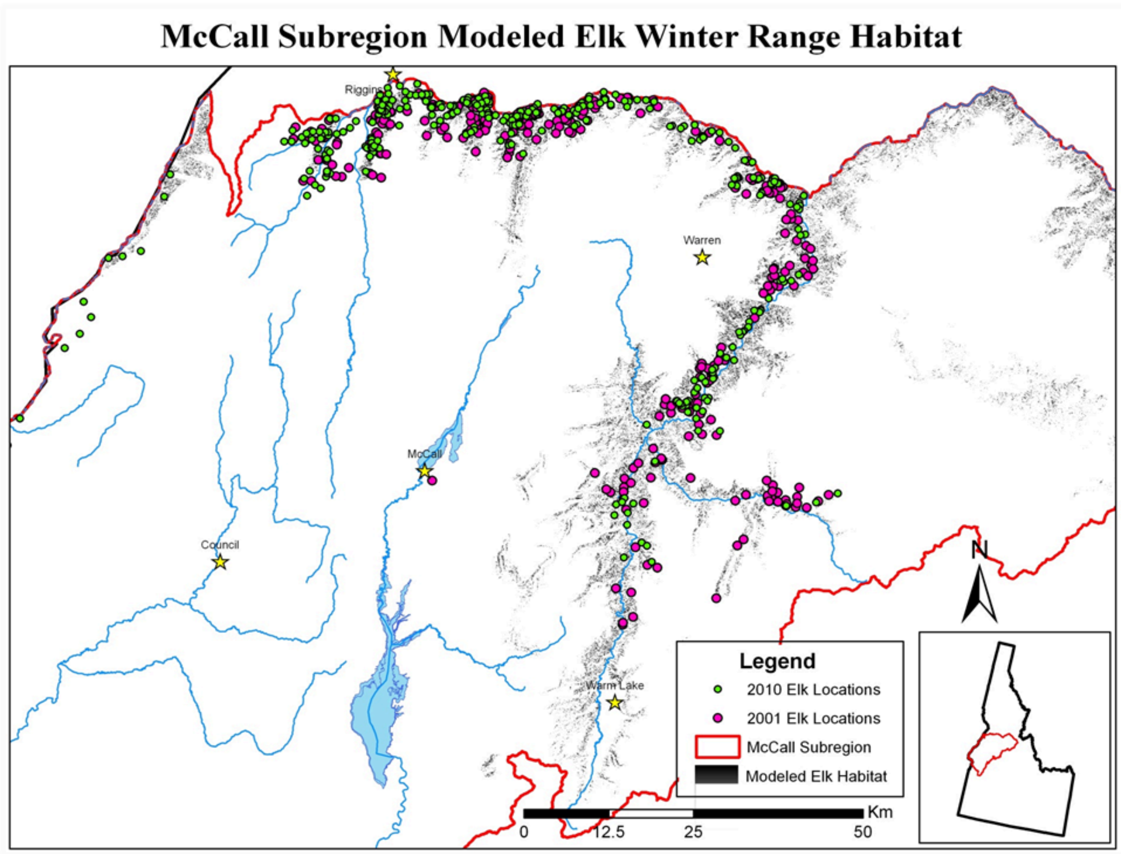

Figure 6. Depiction of 2001 & 2010 elk locations and the modeled general habitat layer.

Just performing a visual inspection of the 2001 and 2010 indexed (or weighted) habitat suitability layers, you can see there are some differences (Figure 7 and 8). The most noticeable being the absence of habitat in the 2010 model north of Warm Lake. Otherwise, habitat selection is very similar with differences only in the level of preference.

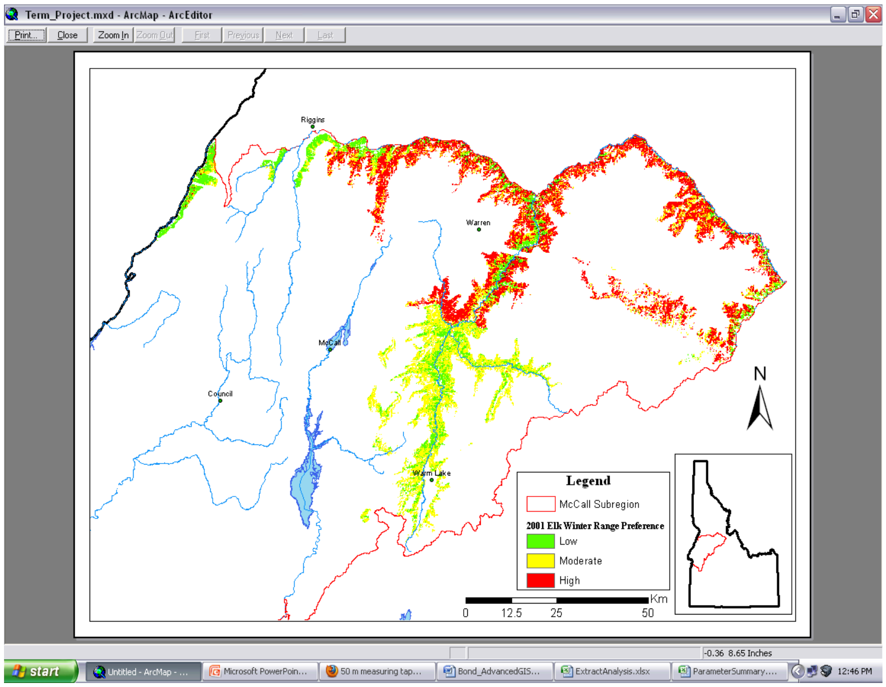

Figure 7. 2001 McCall Subregion modeled elk winter range habitat suitability.

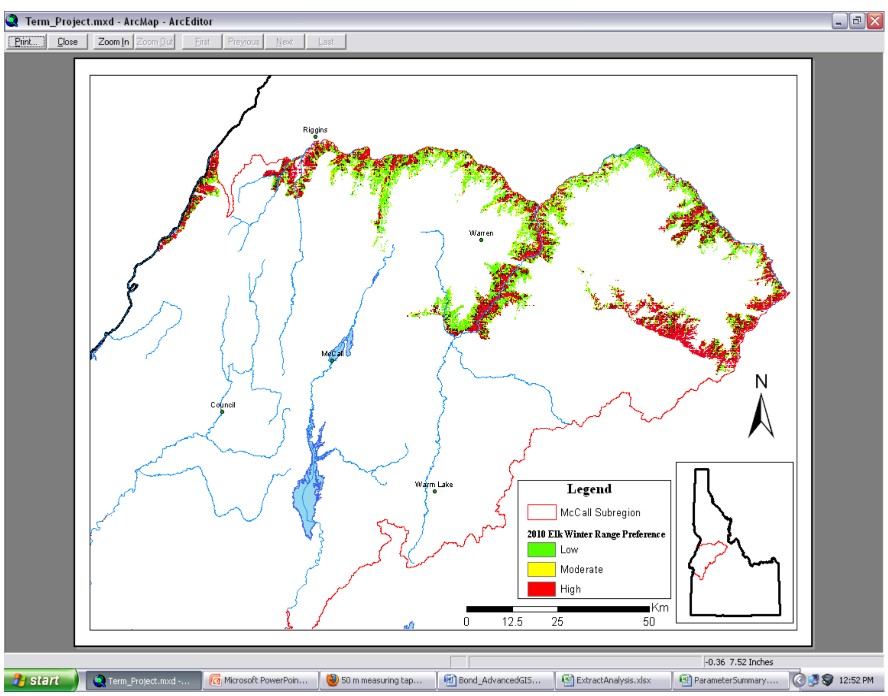

Figure 8. 2010 McCall Subregion modeled elk winter range habitat suitability.

Conclusion

The Weighted Overlay tool seems to be an effective technique for creating a categorical habitat suitability model. These are very general models that could be useful for making landscape-scale management decisions. Although the results "look" good, there is definitely some room for improvement. Other data layers could be incorporated into the models to further define suitable habitat such as snow cover, average air temperature, or proximity to roads. Although, I think elevation may be indicative of general snow levels. Also, the accuracy of the elk location waypoints is a little questionable. Points are generally not taken exactly over the elk but probably within 25 m (I know this from experience). Also, these models do not take density into account. Each point could represent one or many elk. Gender is also not taken into account – males and females most likely select different habitat (generally, females and young are found in larger groups than males who are found in small groups or alone, etc). The model could be more robust by using programs like Maxent (http://www.cs.princeton.edu/~schapire/maxent/) or SAS (http://www.sas.com/technologies/analytics/statistics/stat/) software to create a more statistically sound models. Although there is room for improvement, this research demonstrates the power of GIS spatial analysis for creating wildlife habitat suitability models.

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