Management Unit Prioritization Tools

U.S. Department of the Interior
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Introduction

Where are the most important places to direct conservation effort? Such a simple question is not so easily answered. There are a myriad of priorities, constraints, and capacities, both scientific and socio-economic, which in combination guide the allocation of management effort. An honest accounting of these priorities, constraints, and capacities are essential for efficient, effective action. The Management Unit Prioritization Tools provide a means to do this.

Background

In 2011, researchers from the U.S. Geological Survey, Upper Midwest Environmental Sciences Center and the U.S. Fish and Wildlife Service, Morris Wetland Management District developed models and tools to allow managers to prioritize and target management amongst their management units based upon a user-defined set of criteria (Rohweder and others 2015). These tools provided an effective way for district personnel to be able to rank numerous, spatially dispersed management units. It became clear that the methods employed would be useful to a more general audience and revised tools would be beneficial. The revised toolset, entitled "Management Unit Prioritization Tools", consists of two separate tools: the Conservation Objective Prioritization Tool and the Overall Prioritization Tool. These tools were developed within ArcMap using Python scripts.

Conservation Objective Prioritization Tool

The Conservation Objective Prioritization Tool allows the user to prioritize the management units under their control based upon a user-specified set of input criteria. The conservation objectives and associated input criteria could be identified through internal planning or as part of a structured decision making workshop held between the managing agency and relevant stakeholders. Input criteria can be in two forms:

1. Input field: Values within attribute fields contained in the management unit boundary spatial data set.
2. Raster: Raster data sets underlying the management units that are subsequently summarized (averaged) for each unit by the tool (Figure 1).

The data contained within the fields or raster data sets must be in a numerical format, but the range of data values are not restricted. There should be a value assigned to each management unit if using the input field criteria and the raster data should cover the entire extent of the management unit area if using the input raster criteria. A total of six input criteria fields and six input criteria rasters can be entered as input for the prioritization analysis.

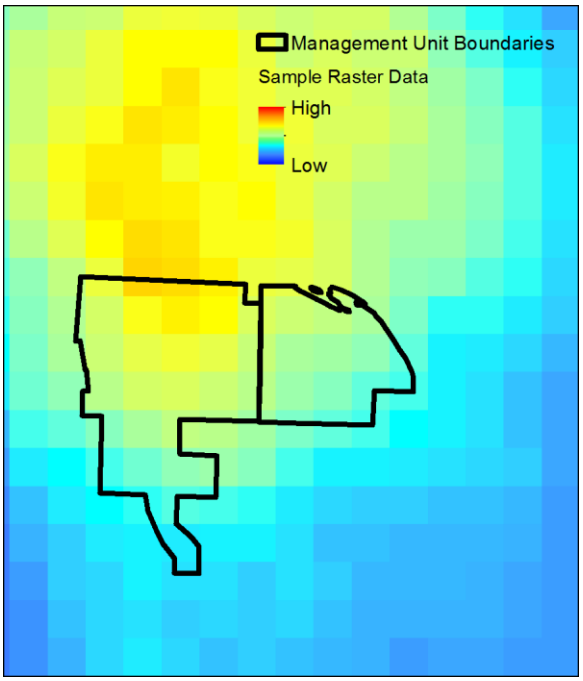

Figure 1. Example showing management unit overlying sample raster data.

The user also specifies a relative weight for each input criteria. Higher weights are given to those input criteria that are considered higher priority. The cumulative weight for all individual input criteria must equal 100. Also, the tool includes check boxes which allow the user to designate whether a low score is preferred for each input criteria. Another check box is included to force the final model output score to zero if the score for that particular input criteria is zero. This was added by U.S. Fish and Wildlife Service staff in order to be able to designate input criteria that were "deal-breakers". That is, criteria that are so important that their absence from the management unit renders any other input criteria inconsequential.

Once initiated, the first step this tool performs is to normalize all possible scores for each management unit for each input criteria to a consistent scale of 0 to 100. This is done using the following formula:

$$\frac{[\text{value for individual management unit}] - [\text{minimum value}]}{([\text{maximum value}] - [\text{minimum value}]) * 100}$$

This operation is performed individually for each input criteria.

Next, for each management unit the normalized score for each separate input criteria is multiplied by the user-defined weight. Figure 2 illustrates this weighted overlay process. In the case of Input Criteria 1, this particular unit had a normalized score of 90.85 (a), this was then multiplied by 0.16 (b), the weight (percent) specified by the user. The result (c) was then added for each input criteria to get the final output score. In the case of this example the final output score was calculated to be 60.70.

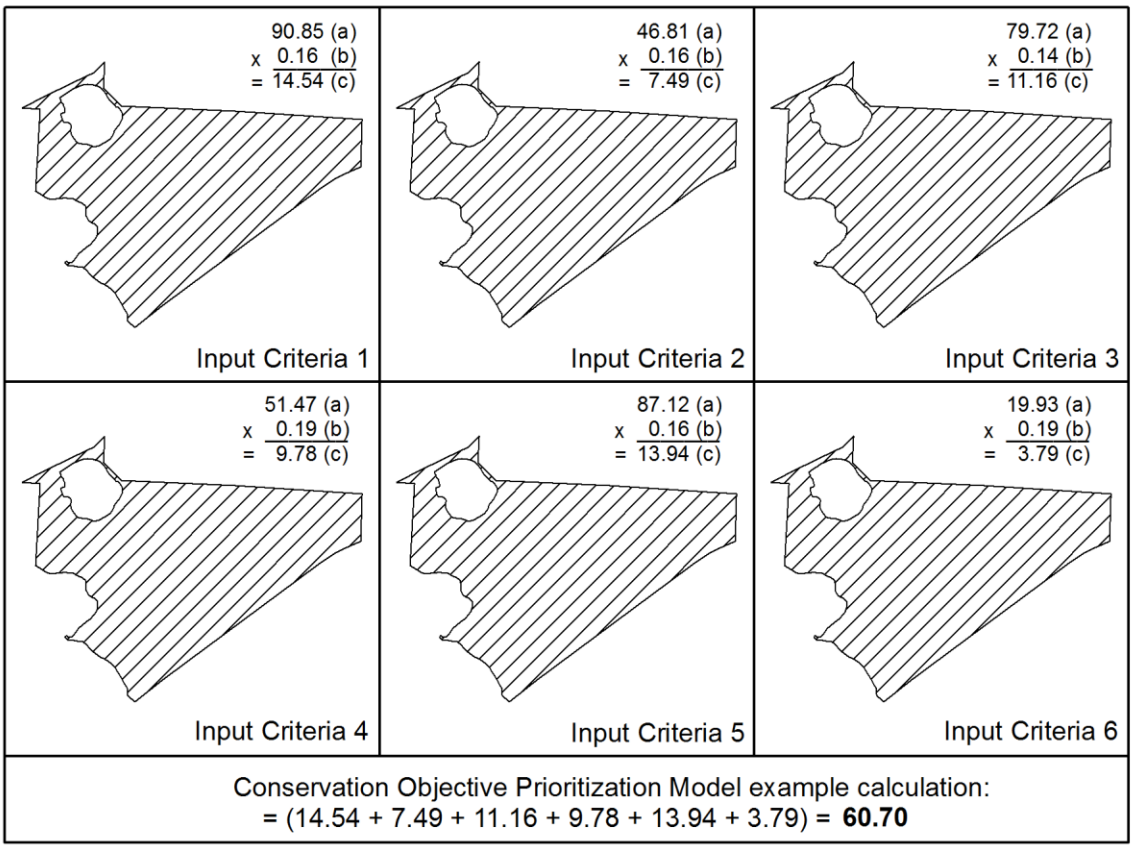

Figure 2. Diagram depicting how weighted overlay functions.

Overall Prioritization Tool

The individual Conservation Prioritization Objective Tool outputs are useful in helping the managing agency understand the value of each management unit for each objective, but realistically the agency often has the complex task of trying to integrate several objectives when making management decisions. To account for this, we created the Overall Prioritization Tool to integrate the results of all the individual Conservation Objective Prioritization Tool outputs. The Overall Prioritization Tool allows the user to overlay several Conservation Objective Prioritization Tool outputs and create a new modelled overall prioritization output. This overlay is weighted by the user to allow greater influence by those conservation objectives with a higher priority.

Toolbox Installation

There are some preliminary steps needed to ensure the management unit prioritization tools will function correctly on the computer. First are a few software requirements that need to be met:

1. ArcMap 10 (the main desktop application of ArcGIS, Environmental Systems Research Institute) or more recent
2. A Spatial Analyst License

3. Python 2.4 or more recent (Automatically installed with ArcGIS)
4. Pywin32 (Python for Windows extension)

Pywin32 allows Python to communicate with COM servers such as ArcGIS, Microsoft Excel, Microsoft Word, etc. Python scripting in ArcMap cannot work without this extension. This extension can be downloaded at:

http://sourceforge.net/projects/pywin32/files/pywin32/

Once these software requirements are met, the user needs to:

1. Extract the compressed file "ManUnitPriorTools.zip" to a project directory on your hard drive (Figure 3). Compressed data extraction software is freely available from http://www.7-zip.org/
2. Open ArcMap and activate ArcToolbox if not already activated (Geoprocessing -> ArcToolbox)
3. Right-click inside the ArcToolbox panel and select Add Toolbox… (Figure 4)
4. Open the extracted folder *ManUnitPriorTools* and click on the Management Unit Prioritization Tools.tbx toolbox icon and select Open (Figure 5)

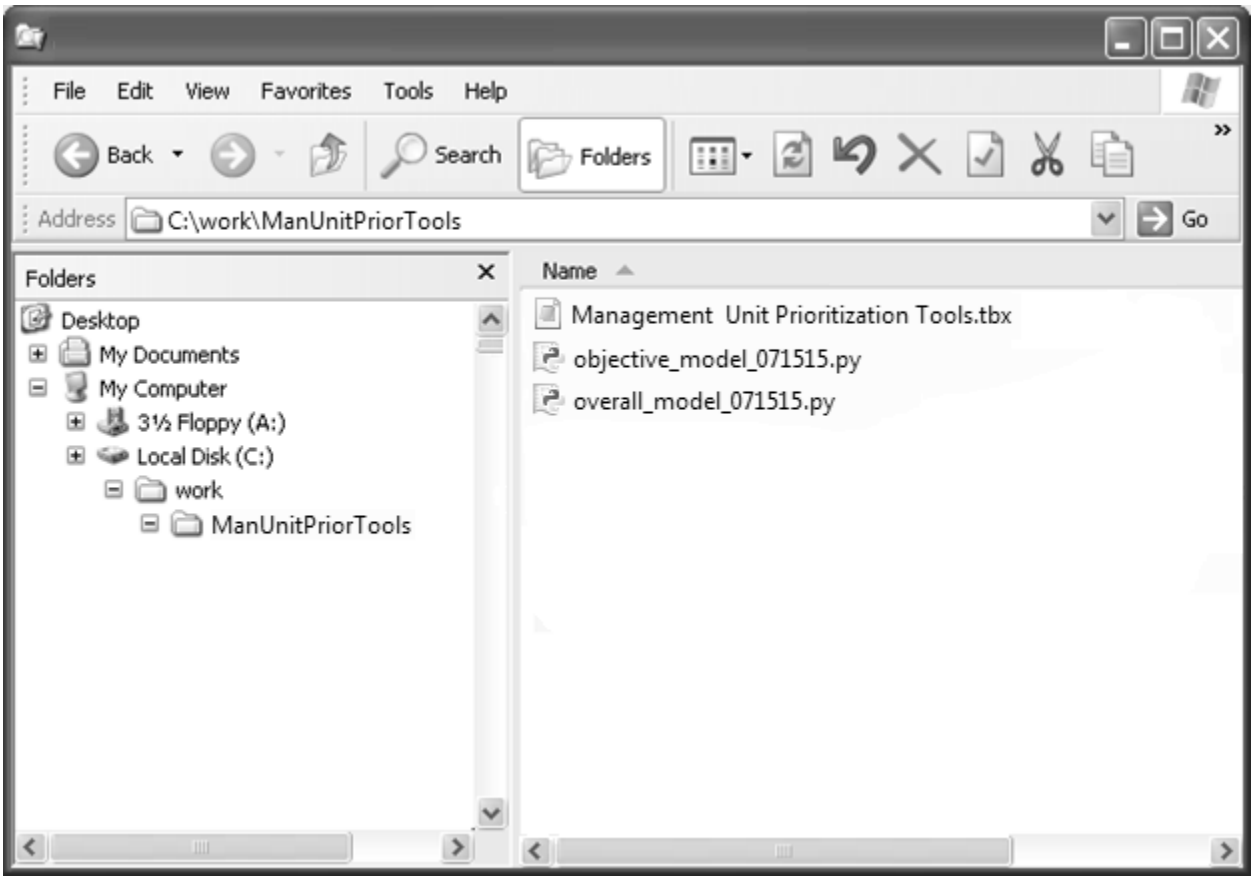

Figure 3. Windows Explorer view of extracted files.

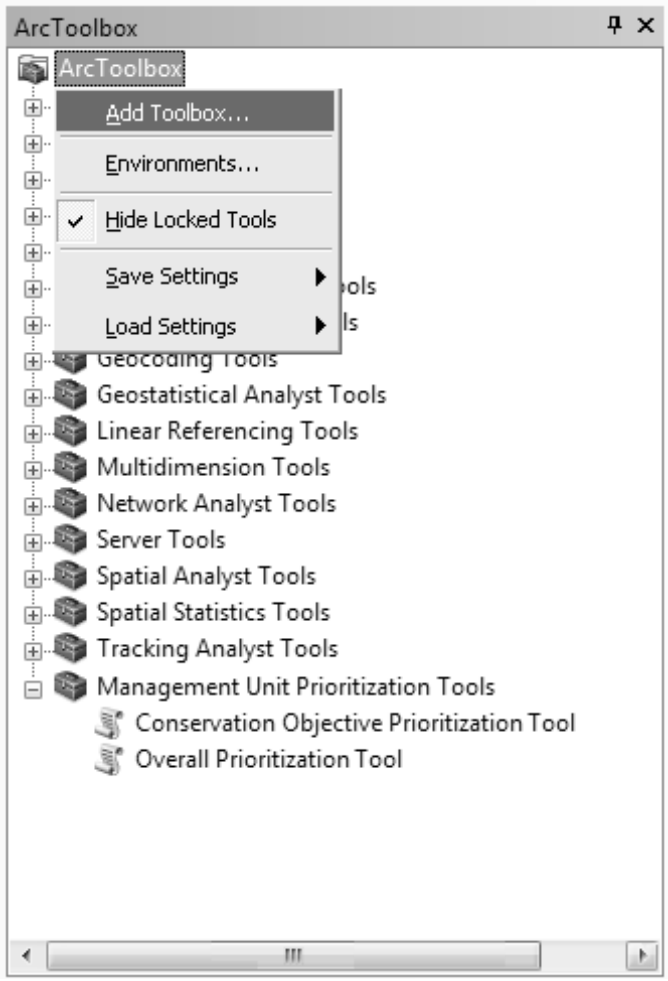

Figure 4. ArcToolbox view of Management Unit Prioritization Tools.

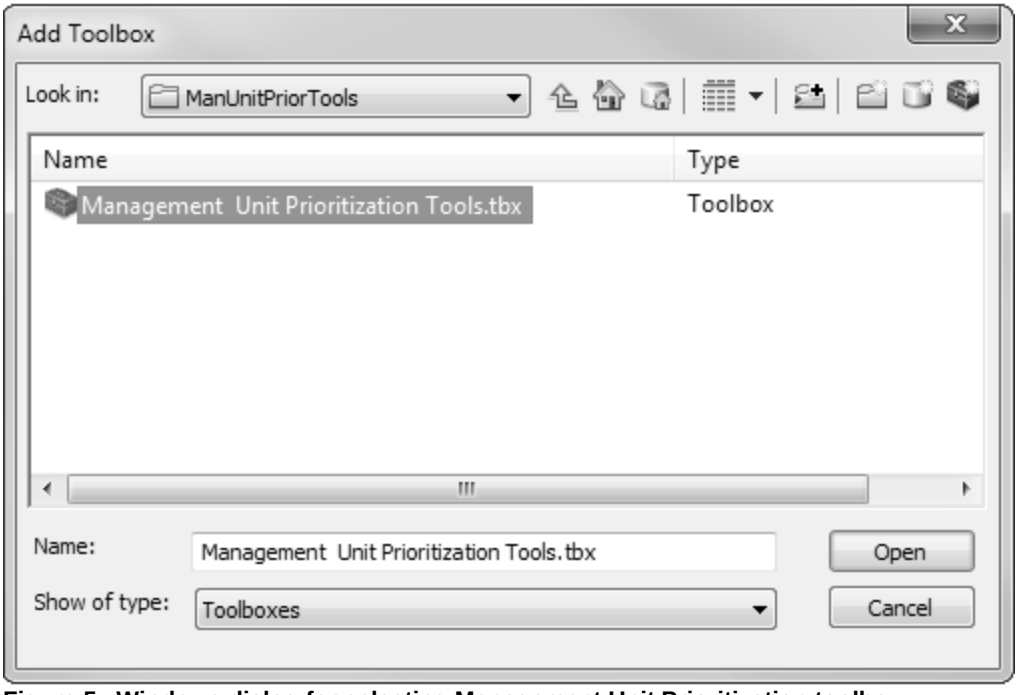

Figure 5. Windows dialog for selecting Management Unit Prioritization toolbox.

Tool Operation Instructions

The Management Unit Prioritization Tools operate within the geographic information system software ArcMap. Start ArcMap and make sure the extension "Spatial Analyst" is enabled. This can be done by selecting the menu option "Customize", then "Extensions", then checking the box next to "Spatial Analyst". Before the model can be executed, a scratch workspace must be designated by selecting the "Geoprocessing" menu options, then selecting "Environments…". Click "Workspace" and update the "Scratch Workspace" location. It is suggested that the user select a workspace (folder) for this parameter and not use a geodatabase (.gdb) as is sometimes suggested in the ArcGIS literature. There have been issues with the model not operating when a geodatabase or an invalid workspace was selected. The user should also use input files on their local hard drive and set the output workspace as a folder on the local hard drive.

Conservation Objective Prioritization Tool

To initiate the tool, double click the "Conservation Objective Prioritization Tool" within the Management Unit Prioritization Tools toolbox. In the tool's dialog window navigate to the management unit boundary shapefile on the computer's hard drive (Figure 6). Then select the field within that shapefile that contains the unique identifier for each unit. Next, select a directory where model outputs will be saved, an output file name for the shapefile generated, and a model name descriptive of that particular model run. This model name will be the final output model score field added to the shapefile.

Once that preliminary information is specified, the user then identifies input field criteria and/or input raster criteria (up to six of each) that the model calculations will be based on.

When an input field or raster is identified the user is required to input an integer weight for each (1-100) and also specify if a lower value is preferred, or if a zero for that input criteria should force the overall model score to zero. If the weights do not add up to 100 or if there are duplicate fields specified the user will get a warning. Once all inputs are entered correctly the user selects “OK” from the dialog window.

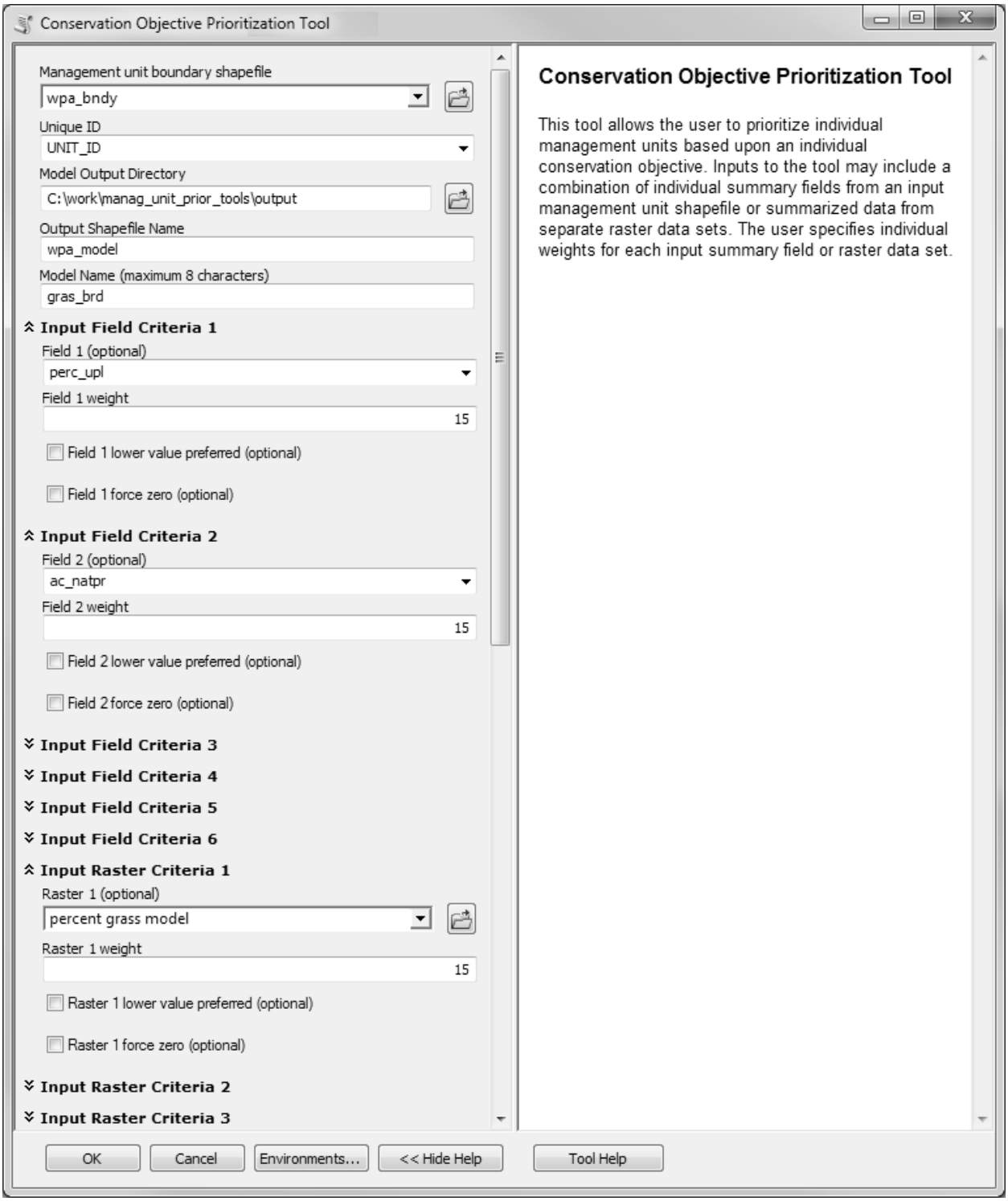

Figure 6. Input dialog window for Conservation Objective Prioritization Tool.

After the tool's operation has completed, the new shapefile created in the model output directory will be added to the data frame. Figure 7 displays the attribute values for an example query for one management unit. The input field criteria are maintained, plus three fields are

added for each input field criteria and four fields are added for each input raster criteria used. Additionally, the final conservation objective model output score is added as well.

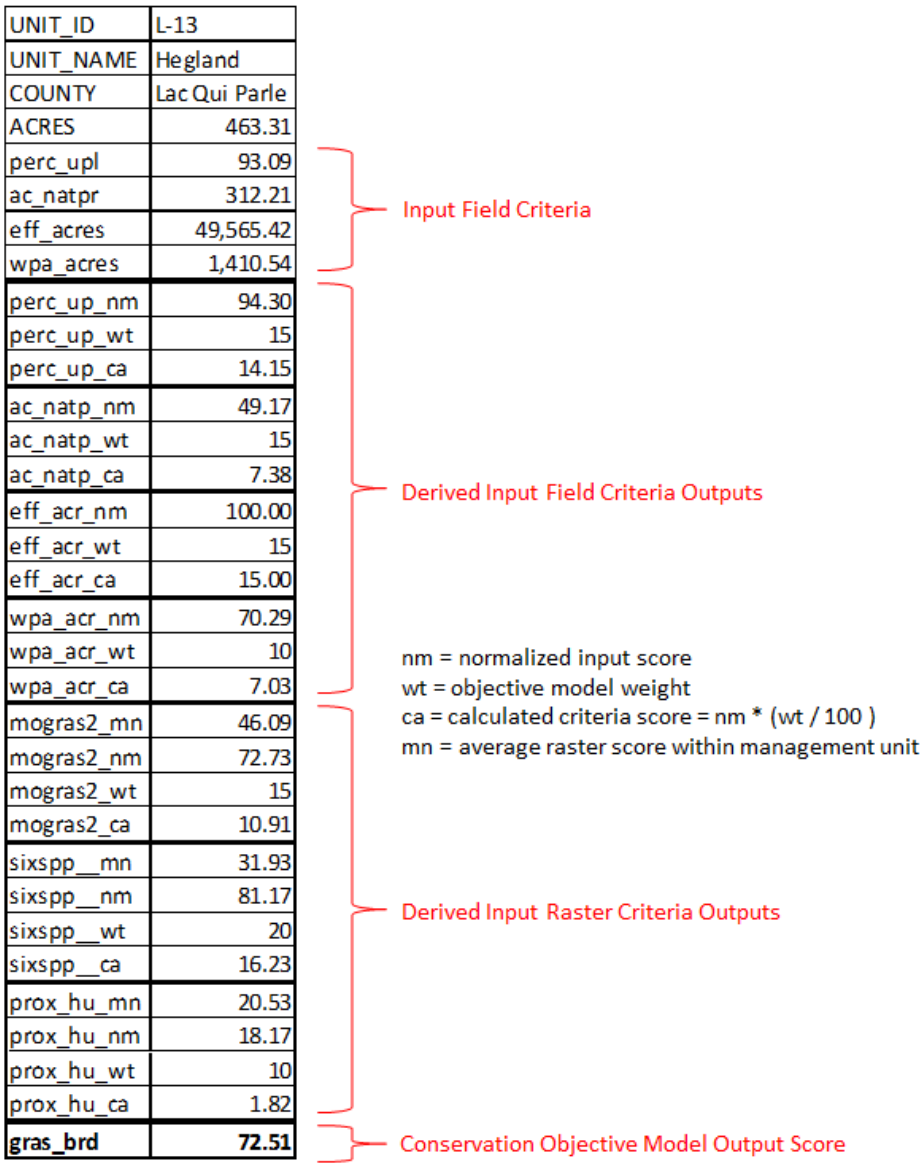

Figure 7. Attribute values for sample record in Conservation Objective Prioritization Tool output shapefile.

During execution of the tool a log text file is created and textual information is added. The file name for this text file is the same as the output shapefile generated by the tool but with a .txt extension (Figure 8). This text file contains information documenting which fields were used in the calculations and the weights designated. It also generates summary statistics for each input field and raster data set and also for the model output score.

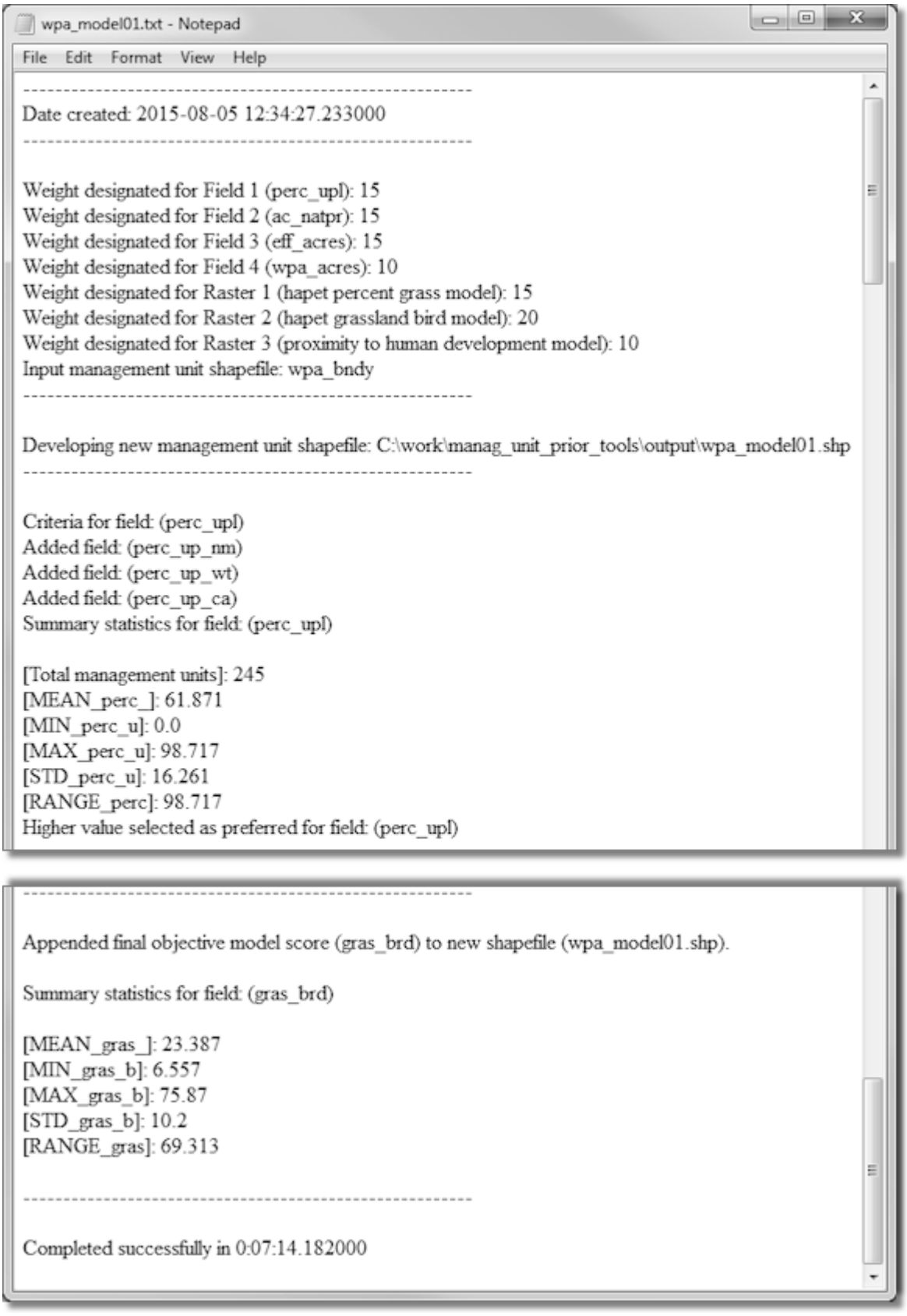

Figure 8. Sample output log generated from Conservation Objective Prioritization Tool.

Overall Prioritization Tool

In order to execute the Overall Prioritization Tool, the user needs to have at least two shapefiles depicting the results of Conservation Objective Prioritization Tool models loaded into the map's data frame. To initiate the tool, double click the "Overall Prioritization Tool" within the Management Unit Prioritization Tools toolbox. In the tool's dialog window first specify a Conservation Objective Prioritization Tool model output for Objective Model Output Criteria 1 (Figure 9). Next, specify the field within the objective model output criteria 1 shapefile selected that depicts that models output scores and then designate a weight for that model between 1 and 100. Next, fill in additional objective model output criteria, fields, and weights (2-5). Once this is done, select the unique management unit ID field and the overall model output shapefile name. The user will not be able to select a unique management unit ID field until the objective model output criteria 1 shapefile has been identified. If the weights do not add up to 100 or if there are duplicate shapefiles specified the user will get a warning. Once all inputs are entered correctly the user selects "OK" from the dialog window.

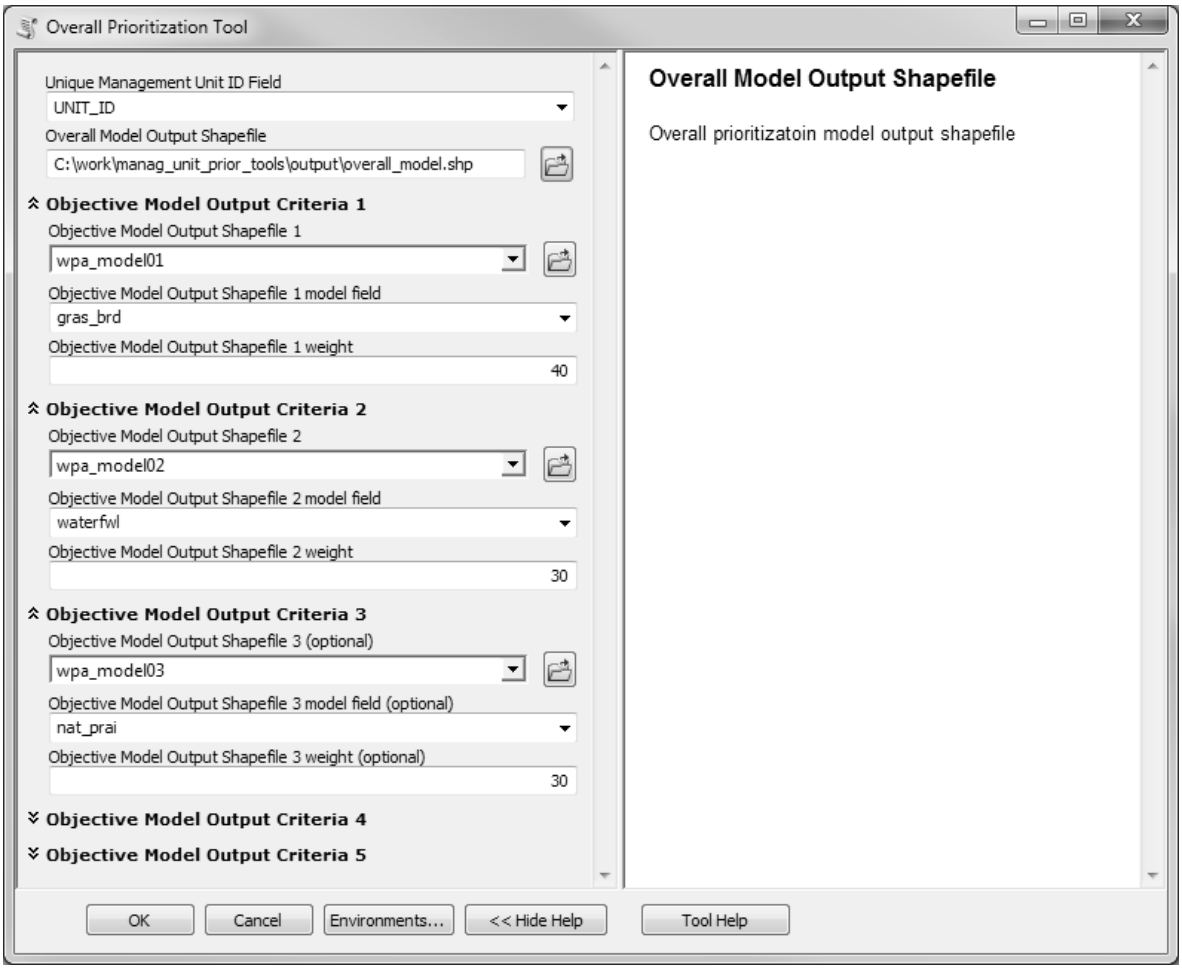

Figure 9. Input dialog window for Overall Prioritization Tool.

Once completed, the new shapefile created in the model output directory will be added to the data frame. Figure 10 displays the attribute values for an example query for one management unit. The input field criteria are maintained plus four fields are added for each objective model output criteria used. Additionally, the final overall prioritization model output score is added.

UNIT_ID	L-13
UNIT_NAME	Hegland
COUNTY	Lac Qui Parle
ACRES	463.31
m1_name	C:\work\manag_unit_prior_tools\output\wpa_model01.shp
m1_fld	gras_brd
m1_score	72.51
m1_wgt	40
m1_calc	29.00
m2_name	C:\work\manag_unit_prior_tools\output\wpa_model02.shp
m2_fld	waterfwl
m2_score	46.09
m2_wgt	30
m2_calc	13.83
m3_name	C:\work\manag_unit_prior_tools\output\wpa_model03.shp
m3_fld	nat_prai
m3_score	49.17
m3_wgt	30
m3_calc	14.75
ov_score	57.58

Management Unit Information

Derived Input Field Criteria Outputs

name = Objective model output shapefile
fld = Objective model output shapefile field
score = Objective model output score
wgt = Weight assigned for model
calc = Calculated score = score * (wgt / 100)

Overall Prioritization Model Output Score

Figure 10. Attribute values for sample record in Overall Prioritization Tool output shapefile.

During execution of the tool a log text file is created and textual information is added. The file name for this text file is the same as the output shapefile generated by the tool but with a .txt extension (Figure 11). This text file contains information documenting which models were used in the calculations and the weights designated. It also generates summary statistics for each input conservation objective model and for the overall prioritization model score.

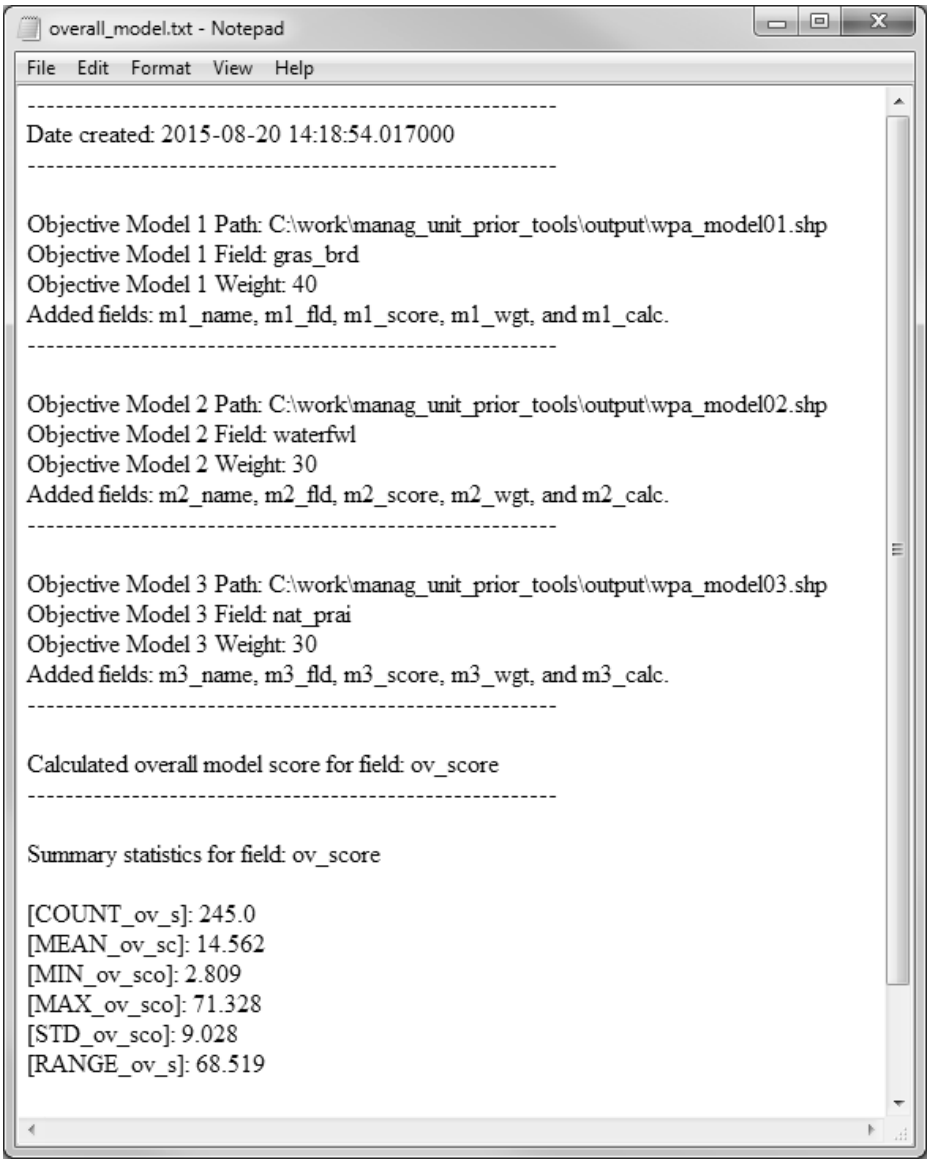

Figure 11. Sample output log generated from Overall Prioritization Tool.

Summary

These tools do not explicitly guide conservation planning efforts, but rather provide a means of identifying the maximum conservation gains possible within the priorities developed by the specific management entity. Developing tools that can be utilized by conservation managers is an important step towards building transparent and objective management strategies.

References Cited

Rohweder, J., S. Vacek, S. M. Crimmins, and W. E. Thogmartin. 2015. A case study of assigning conservation value to dispersed habitat units for conservation planning. Journal of Conservation Planning 11:13-27.
http://www.journalconsplanning.org/2015/JCP_11_2_Rohweder.pdf