Michigan Tech Research Institute
Wetland Mitigation Site Suitability Tool

Michigan Tech Research Institute's (MTRI) Wetland Mitigation Site Suitability Tool (WMSST) integrates data layers for eight biophysical characteristics to score sites in terms of their suitability for wetland restoration or creation. Using an ArcGIS interface, programmed and embedded into ArcGIS by MTRI, users first identify watershed or ecoregional boundaries for their analysis before indicating the input layers to be included in the analysis and assigning weights to the selected layers. After running this analysis, users can readily visualize the output – a site suitability map for the selected watershed or ecoregion – produced using the standard GIS formats of transportation agencies. The WMSST was developed for field use by the Michigan Department of Transportation (MDOT) to increase the efficiency with which they are able to identify suitable mitigation sites within watersheds compared to traditional field-intensive mitigation site selection techniques.

OVERVIEW

Lead developer(s): Michigan Tech Research Institute (MTRI).

Year developed: 2008.[2]

Geographic area: The state of Michigan (Figure 1).[1]

Resource types: Wetlands.[1]

Restoration/conservation: Restoration (reestablishment and rehabilitation) and creation.[2]

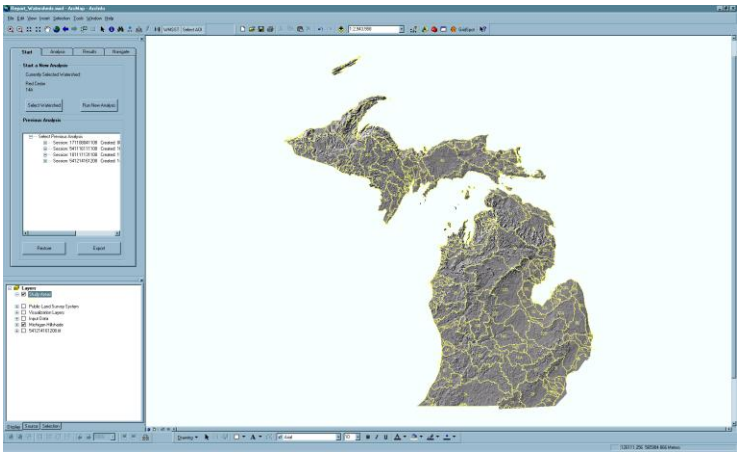

Figure 1. The WMSST identifies suitable sites for wetland restoration and creation within watersheds. Used with permission of Michigan Tech Research Institute (MTRI).

Stakeholders: MDOT Environmental Section staff.[2]

Current status: MTRI developed the WMSST for MDOT and installed the tool on all of their field computers as part of a 2008-2009, MDOT funded demonstration project. However, since that time some of the input GIS data have become outdated and it is unclear whether MDOT has continued to use the WMSST as part of its process for selecting mitigation sites. In order to make the tool operational (i.e., used on a day-to-day basis), MDOT's Environmental Section would need to provide MTRI with additional funding and guidance on how to further integrate the tool with MDOT's mitigation site selection process. Currently, MDOT does not have extra room available in their budget to do this.[2]

PRIORITIZATION ANALYSIS

Input data QA/QC: MDOT's recommended workflow for the WMSST directs users to examine input and visualization data prior to running the analysis. By comparing input data with other

information provided in the visualization data layers (e.g., National Wetland Inventory (NWI) data, aerial photography, etc), users are able to evaluate the data inputs for QA/QC.[1]

Landscape prioritization tool(s):

Wetland Mitigation Site Suitability Tool: MTRI combined eight statewide raster datasets (Table 1) in ArcGIS to score the feasibility of wetland restoration or creation for each pixel. Two of these layers, Topographic Wetness Index (TWI) and Soil Moisture Index (SMI), required additional processing by MTRI before they could be integrated into the WMSST. The TWI was calculated based on slope and elevation data and served as a measure of the wetness at each site. The SMI was calculated based on the relationship between surface temperature and vegetation and served as a measure of soil moisture levels.[1]

All eight data layers were first reclassified, based on feedback from MDOT environmental personnel and published literature, to convert the original data values of each layer to values of 0, 25, 50, 75, and 100. Doing so ensured that all data layers, including those containing both nominal (Figure 2A) and interval (Figure 2B) data, used a standard scale. Once reclassified, each layer was clipped in order to divide each statewide layer into smaller areas that matched watershed and ecoregional boundaries to minimize the run-time of the final WMSST.[1]

A

USDA SSURGO Drainage Class	Excessively Drained	0
	Well Drained	25
	Poorly Drained	50
	Very Poorly Drained	100

B

MTRI Topographic Wetness Index	< 0	0
	0.5 – 25	25
	25.5 -50	50
	50.5 - 75	75
	75.5 - 100	100

Figures 2A and 2B. MTRI reclassified input layers for the WMSST so that all original data values were converted to values of 0, 25, 50, 75, or 100. This ensured that all data, including both nominal (Fig. 2a) and interval (Fig. 2b) data, shared a standard scale. Used with permission of Michigan Tech Research Institute (MTRI).

Prioritization objectives assessed:

- Feasibility for restoration

Table 1. MTRI used the following factors and associated data source as inputs in its WMSST model to calculate the suitability of sites for wetland restoration.[1]

Factor used in analysis		**Data source(s)**
Soil drainage class		USDA SSURGO drainage class data
Soil flood frequency		USDA SSURGO flood frequency data
Presence of hydric soils		USDA SSURGO hydric classification data
Soil ponding frequency		USDA SSURGO ponding frequency data
MTRI Topographic Wetness Index (TWI)	Slope	USGS Percent Slope Classification
	Elevation	USGS DEM

MTRI Soil Moisture Index	Relationships between surface temperature and vegetation levels	Landsat satellite imagery
Percent slope		USGS Percent Slope Classification
Land cover		MNFI presettlement land cover data

USGS = United States Geological Survey; DEM = Digital Elevation Model; SSURGO = Soil Survey Geographic (Database); MNFI = Michigan Natural Features Inventory; USDA = United States Department of Agriculture

Validation of the landscape prioritization tool(s): MDOT staff evaluated the accuracy of the WMSST by comparing its results for 20 sites against those obtained for the same sites by MDOT using field monitoring data. This process was completed in two steps:[3]

1. For ten sites, MTRI analysts followed workflow procedures developed by MDOT for the WMSST to report site suitability rankings (high, medium, low). MDOT staff then compared these rankings to those obtained for each site based on evaluations of previously-collected field monitoring data.
2. For the other ten sites, MTRI and MDOT staff followed MDOT's workflow procedures collaboratively to obtain site suitability rankings, which were then compared to rankings MDOT obtained for each site through an evaluation of field monitoring data.

The WMSST correctly assessed wetland suitability for 19 of the 20 sites. For the one site that had been classified incorrectly, MTRI and MDOT determined the cause of the error by applying the step in MDOT's workflow procedures that directs users to explore WMSST input and visualization data. Following this step, MTRI and MDOT determined the USGS SSURGO hydric soil classification for the site had been incorrect. They determined that had the classification been correct, the site's suitability would have been modeled correctly.[1]

Overall, the validation study demonstrated that the WMSST could produce substantial savings for MDOT, reducing the costs required for evaluating potential mitigation sites by 73%.[3]

Refinement of landscape priorities: Based on the priority sites that it identifies using the WMSST site suitability analysis, MDOT may contact local real estate offices to obtain additional information (e.g., land ownership) on potential wetland mitigation sites.[2]

Prioritization products: To apply the WMSST, MTRI loads the eight data layers into ArcGIS on a field-ready notebook computer that is connected to a GPS unit and on which the WMSST dockable window interface – programmed by MTRI – has been installed. MTRI distributes the WMSST for installation on field computers as a Microsoft Windows dynamic-link library.

In ArcGIS, users select the watershed or ecoregion in which to identify priorities and then indicate whether the model should exclude any of the eight layers from the analysis and set weightings for each of the included layers. The user then runs the WMSST to calculate a weighted average of all weighted layers included in the analysis to obtain final site suitability scores for each pixel. In the output map, high scores indicate the most suitable locations for wetland restoration or creation. The GPS unit shows users their current position within the WMSST and facilitates real-time data modeling, navigation, visualization, and decision-support capabilities.[1] Within the WMSST, users visualize the site suitability output map together with

several other data layers to obtain further information about the suitability of potential wetland mitigation sites. These additional visualization layers include:[1]

- Watershed boundaries from the Michigan Department of Environmental Quality.
- Regional landscape ecosystems data from the Michigan Natural Features Inventory.
- Michigan Geographic Features data for roads, hydrography, cities and villages, counties, and Public Land Survey Sections (PLSSs).
- Existing wetland boundaries data from the United States Fish and Wildlife Service (FWS) National Wetland Inventory (NWI).
- Digital Elevation Model (DEM) data from the United States Geographic Survey (USGS).
- Cropland data from 2007 from the United States Department of Agriculture (USDA).
- Aerial photography data from 1998-2007.

Users of the WMSST complete an analysis by using a sequence of four tab controls (Figure 3):[1]

1. Under the "Start" tab, users specify the extent of the analysis as either watershed or ecoregion boundaries. Users can also retrieve previously saved analyses, allowing modeling tasks to be reviewed later as part of the project planning process.
2. Under the "Analysis" tab, users select the weights to be applied to calculate the weighted mean for input layers in the WMSST. In addition, checkboxes allow users to indicate which layers to include or exclude in the analysis. Once weightings and layers to be included are set, the user runs the analysis.
3. After the site suitability map is displayed, users may use the "Results" tab to save the results of the analysis, print the results, create a new analysis, or navigate to a finer scale for a more detailed analysis of the results.
4. Under the "Navigate" tab, users can easily navigate to study area sites using Public Land Survey System Township, Range, and Section numbers (Figure 4), which are also used to reference project areas under MDOT project standards. This feature allows MDOT Environmental Section users to quickly view project areas within suitability model results. Users can also specify the latitude/longitude or address of the project area.

MTRI has made technical reports for the WMSST available to the public at http://www.tarut.org/. Among other deliverables, these reports include a technical and training manual that describes how the WMSST works, how to install the WMSST software, and how to prepare, conduct, and interpret a modeling session.[4] Another report summarizes results of a validation study that compared WMSST assessments of feasibility of restoration/creation with those obtained based on an MDOT assessment of field monitoring data.[3]

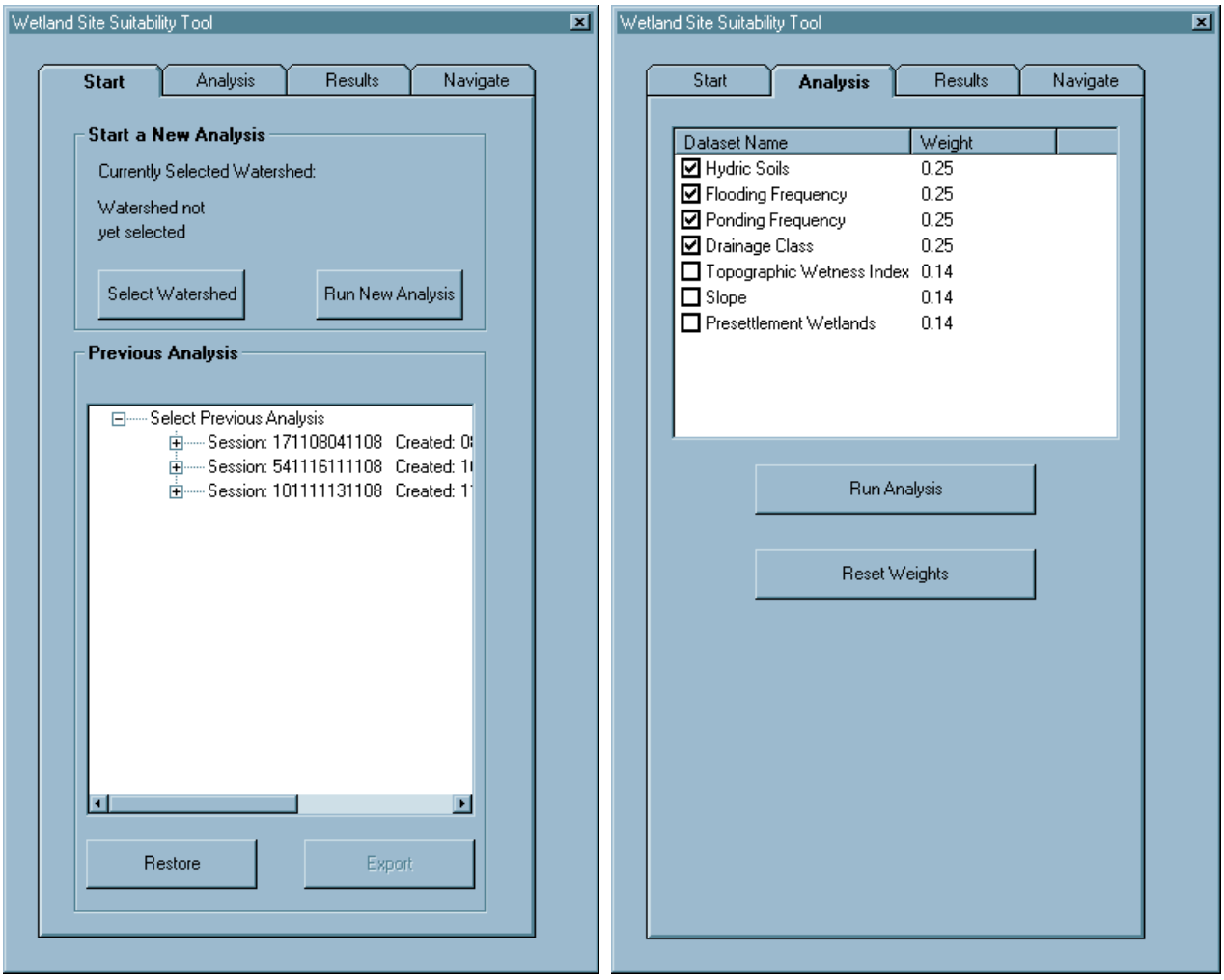

Figure 3. Users of the WMSST specify the watershed or ecoregion in which the analysis will be run (*left*) before indicating which of eight possible input layers, and their weights, should be included in the analysis (*right*). Used with permission of Michigan Tech Research Institute (MTRI).

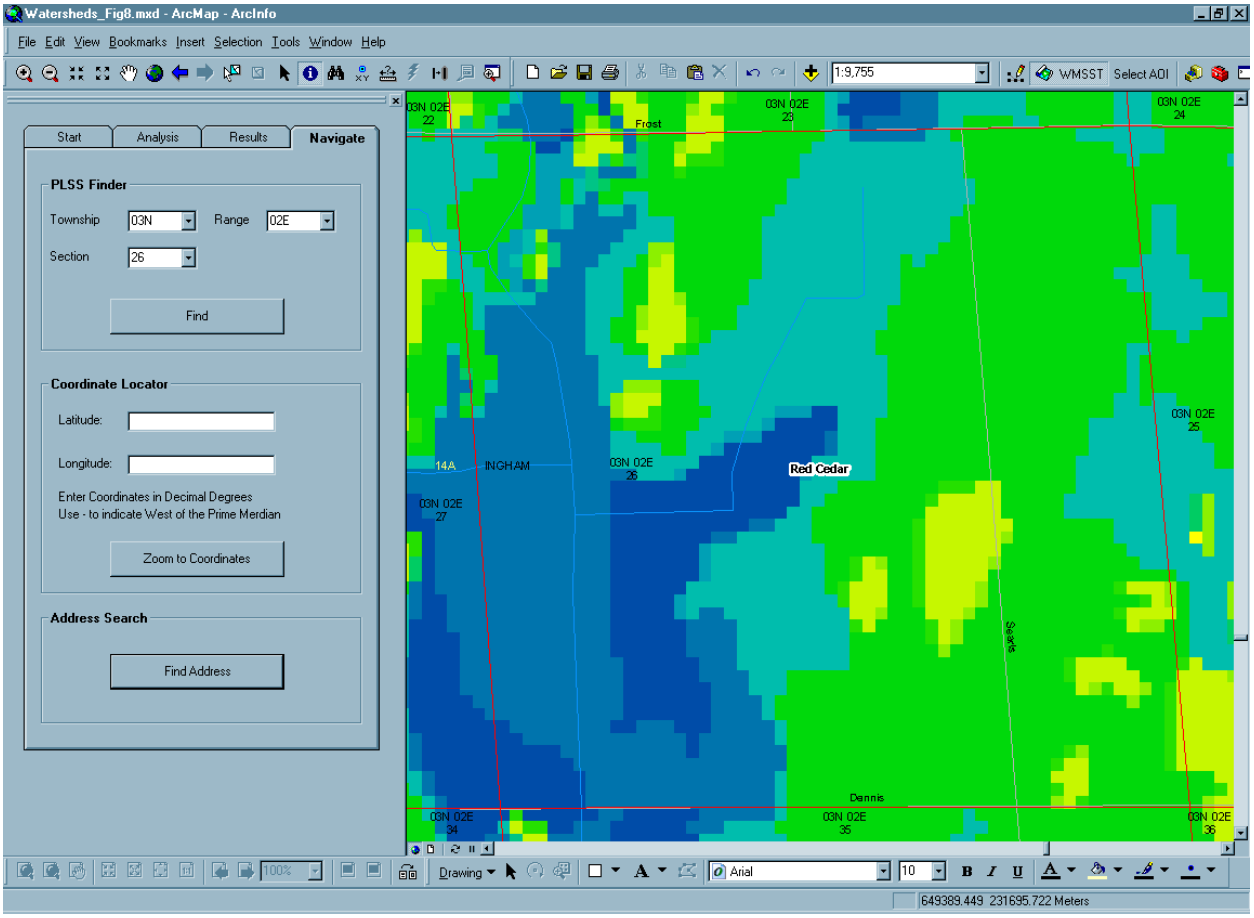

Figure 4. Users of the WMSST can locate their project site within the site suitability map by specifying PLSS Township, Range, and Section codes, which are used to reference projects under MDOT project standards. Used with permission of Michigan Tech Research Institute (MTRI).

IMPLEMENTATION

Regulatory/non-regulatory programs:

- Section 404 wetland compensatory mitigation.
  - For MDOT, the tool helps staff to select wetland mitigation sites more efficiently than traditional methods that demand large amounts of staff time. With MDOT currently undergoing budget cuts, the tool enables them to address mitigation requirements more effectively with limited resources.[2]
  - Watershed approach to mitigation: The WPSST identifies feasible sites for wetland restoration and creation within watershed units to support MDOT's effort to comply with a watershed approach to compensatory mitigation.[2]
- State requirements for wetland compensatory mitigation.[2]

Transferability:

- Although the WMSST primarily uses national data inputs (e.g., DEM data, SSURGO data, aerial photography), the use of presettlement data – used in the model to assess whether a site was once covered by wetland – could affect the tool's transferability. Presettlement data are based on county surveys conducted in the 1800s that may not have

been completed for all states. However, because presettlement data are readily available for other states in the Midwest (e.g., Wisconsin and Minnesota), the WMSST input datasets can simply be reapplied throughout the Midwest.[2]

Data gaps:

- MTRI could not generate SMI data input for the entire state of Michigan. However, the TWI map effectively filled gaps in the SMI where necessary.[2]
- Parcel boundary data were limited. Parcel boundary data is typically produced at the city level, but cities are generally cautious about releasing it. In visualizing the site suitability output map, parcel data – where available – were highly valuable to MDOT because it allowed them to quickly obtain property ownership information for potential sites.[2]

Barriers:

- Funding to obtain parcel data from counties where they are not freely available.[2]
- Motivation of MDOT to commit funding to expanding the use of the WMSST to an operational scale. Because the MDOT Environmental Section represents only a small division within MDOT it has a limited ability to push for further funding to make the WMSST operational.[2]
- The WMSST was coded in Visual Basic to run in ArcGIS 9.3.1. However, because ArcGIS 10 uses Python code, and not Visual Basic, MTRI will need funding to recode the tool to run in more recent versions of ArcGIS.[2]

Future goals: Expand the use of WMSST to support the selection of compensatory mitigation sites across many states – or at least throughout the Midwestern states, which could adopt the tool relatively easily.[2]

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[1] Brooks C, Powell R, Shuchman R, Leonard G. Developing and applying a geospatial decision support tool for efficient identification of wetlands mitigation sites.

[2] Interview on 1/17/2012 with Colin Brooks, Manager of the Environmental Science Laboratory at Michigan Tech Research Institute.

[3] Michigan Tech Research Institute. 2009. Validation Report: Wetland Mitigation Site Suitability Tool. Accessed from: http://quickplace.mtri.org/QuickPlace/tarut/PageLibrary8525724B004F2A59.nsf/h_Toc/BA5057037CC37873852575B60045FF3C/?OpenDocument

[4] Michigan Tech Research Institute. 2009. Wetlands Mitigation Site Identification Desktop GIS Tool Technical and Training Manual. Accessed from: http://quickplace.mtri.org/QuickPlace/tarut/PageLibrary8525724B004F2A59.nsf/h_Toc/9961BE31CEFF2A888525757B004F9E26/?OpenDocument