

# U.S. Army Corps of Engineers St. Paul District Sunrise River Watershed-Based Mitigation Pilot Study Spatial Decision Support System

The U.S. Army Corps of Engineers St. Paul District, with technical support from the Corps' Engineering Research and Development Center, is currently developing a participatory GIS Spatial Decision Support System (SDSS) to prioritize compensatory wetland mitigation sites using a watershed approach. The SDSS involves a four-phase process: 1) completion of a baseline assessment of watershed conditions, 2) engagement of a stakeholder group to identify watershed needs and a set of weighted spatial factors that could be used to address those needs based on this assessment, 3) development of a GIS-based model to create maps of priority wetland restoration sites and, 4) development of an implementation strategy for the priority sites identified. This pilot project provides a unique example of stakeholder input and watershed assessments can be used to determine watershed conservation priorities and priority sites for wetland restoration and enhancement.

## OVERVIEW

**Lead developer(s):** U.S. Army Corps of Engineers (the Corps), St. Paul District; the Corps Engineering Research and Development Center (ERDC).

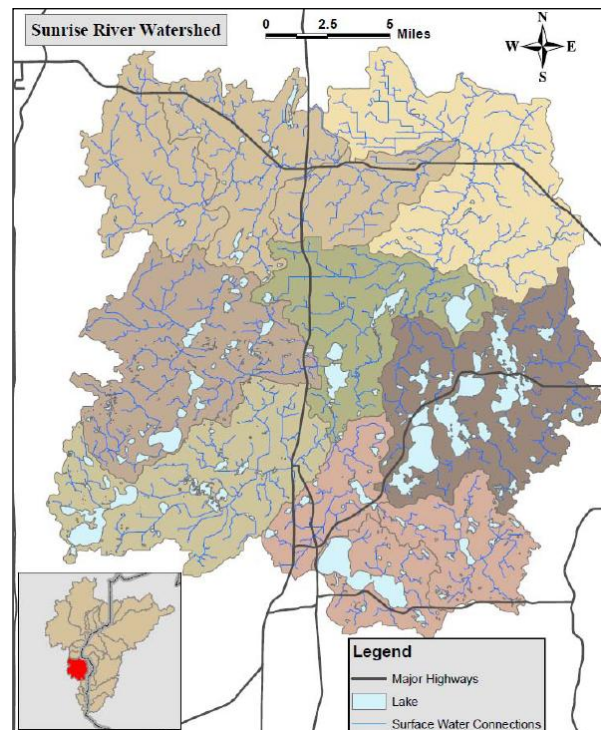
**Year developed:** Initiated in 2009.<sup>1</sup>

**Geographic area:** Sunrise River HUC-8 watershed, with the intention to expand the process to other watersheds in Minnesota (Fig. 1).<sup>1</sup>

**Resource types:** Wetlands.<sup>2</sup>

**Restoration/conservation:** Restoration (reestablishment and rehabilitation), enhancement.<sup>1</sup>

**Stakeholders:** The Corps, U.S. Environmental Protection Agency (EPA), Minnesota Pollution Control Agency (MNPCA), Minnesota Department of Natural Resources (MNDNR), Minnesota Board of Soil and Water (MNBSW), and local agencies responsible for implementing the Minnesota Wetland Conservation Act (WCA).<sup>1</sup>



**Figure 1. The SDSS is being developed to prioritize wetland priorities within the Sunrise River watershed, which lies within the St. Croix River Basin in eastern Minnesota. Used with permission from U.S. Army Corps of Engineers.**

**Current status:** Preliminary GIS outputs have been produced and the SDSS is almost complete. Remaining tasks include generating a weighted GIS map that reflects stakeholder input on watershed priorities, obtaining feedback from stakeholders on the GIS outputs, and generating and carrying out an implementation strategy. ERDC also plans to write a final technical report on the SDSS.<sup>1</sup>

### **PRIORITIZATION ANALYSIS**

**Determination of input factors/weightings:** In a series of workshops, a stakeholder team collaborated to develop a framework for selecting mitigation sites that would best meet watershed needs. This stakeholder team consisted of representatives from EPA, MNPCA, MNDNR, MNBSW, and local agencies responsible for implementing the Minnesota Wetland Conservation Act. This process, which was administered by the Corps, involved three phases:

- 1) Identification of watershed vulnerability priorities: the stakeholder team identified subwatersheds within the Sunrise River watershed that it considered to be priorities for mitigation projects by drawing upon a baseline analysis that was prepared by the Corps.
- 2) Identification of criteria used for site prioritization: the stakeholder team identified criteria that it considered to be most important for targeting wetland compensation mitigation efforts within each subwatershed. These criteria included:
  - Hydrologic connection to tributaries
  - Land costs
  - Potential to reconnect riparian buffers
  - Potential beneficial effects on fisheries
  - Threats from urban growth
  - Adjacency to public lands
  - Opportunities to improve or protect areas of significant biodiversity
  - Distance from roads and population centers
  - Locations within the floodplain of a tributary
  - Opportunities to improve water quality impairments

An analysis of the input received during this process, which will identify overall stakeholder priorities for each subwatershed, remains under development.<sup>2</sup>

- 3) Following the workshops, stakeholders completed a web-based survey in which they ranked selected criteria against one another in a series of pairwise comparisons (Figure 3). Survey results were used to assess the overall importance of each criterion to the group as a whole using the Analytic Hierarchy Process (AHP), a type of Multi-Criteria Decision Analysis (MCDA). These importance ratings were then used to determine the weightings to use for each criterion as part of the SDSS model (see below). MCDA methods such as AHP provide a transparent, structured decisionmaking process for identifying stakeholder preferences based on complex, disparate, and conflicting preference data.<sup>3</sup> The survey was completed online, rather than as a group, to minimize bias and avoid concerns related to group think.

**Sunrise River Mitigation Site Selection Survey**

\* 12. When looking for potential mitigation sites within the Sunrise River Watershed, which is more important?

Targeting areas that have or could provide:

Low Land Costs (Criterion 2) or

Protection from Urban Sprawl (Criterion 5)?

\* 13. When looking for potential mitigation sites within the Sunrise River Watershed, which is more important?

Targeting areas that have or could provide:

Low Land Costs (Criterion 2) or

Connectivity with Existing Public Lands (Criterion 8)?

\* 14. When looking for potential mitigation sites within the Sunrise River Watershed, which is more important?

Targeting areas that have or could provide:

Low Land Costs (Criterion 2) or

High Biodiversity (Criterion 7)?

\* 15. When looking for potential mitigation sites within the Sunrise River Watershed, which is more important?

Targeting areas that have or could provide:

Low Land Costs (Criterion 2) or

Conditions Reasonably Distanced/Removed from Human Disturbance (Away from Roads and City Centers) (Criterion 8)?

\* 16. When looking for potential mitigation sites within the Sunrise River Watershed, which is more important?

Targeting areas that have or could provide:

Low Land Costs (Criterion 2) or

Mitigation Inside the Floodplain (Criterion 9)?

Figure 2. The Corps used web-based surveys to solicit the stakeholder team for weightings to apply in the SDSS prioritization model for each criterion identified by the team in the workshops. Used with permission from U.S. Army Corps of Engineers.

**Input data QA/QC:** While validating the SDSS model, the Corps realized that its roads dataset was inaccurate. In response, it updated some roads data in some areas and removed some mapped roads that were no longer present. In addition, the Corps discovered that some sites identified as containing hydric soils were actually forested. In order to avoid inadvertently advocating conversion of forested areas to wetlands, the Corps excluded these areas from consideration as priority areas.<sup>1</sup>

### Landscape prioritization tool(s):

Baseline analysis: To inform its prioritization analysis, the Corps assessed watershed needs using a baseline assessment of watershed conditions. The baseline assessment involved gathering existing and obtaining new aquatic resource data for the Sunrise River watershed and conducting the analyses listed below. Factors and data used for these analyses are detailed in Table 1.<sup>2</sup>

- Historic extent of aquatic resources

- Current extent of aquatic resources
- Cumulative impacts analysis
- Compensatory mitigation analysis
- Impervious surface analysis
- Tributary buffer analysis
- Tributary hydrologic alteration assessment
- Water quality assessment
- Identification of sites with significant biodiversity
- Geomorphic analysis of major tributaries
- Fish and invertebrate sampling
- Other analyses based on other available datasets

For example, the Corps used compensatory mitigation analysis, including the data shown in Figure 3, to identify wetland types to target for compensatory mitigation based on projected demand for different wetland credit types in the watershed.<sup>2</sup>

	Deep Marsh	Shallow Marsh	Sedge Meadow	Wet Meadow	Shrub Carr	Hardwood Swamp
Existing credits	0.03	5.97	0	4.96	8.77	0.1
Average annual demand	0.05	0.73	0.66	1.61	0.24	0.05
Projected date of deficit	2010	2018	2010	2012	2036	2012

Figure 3. The Corps used several analyses, including compensatory mitigation analysis (shown above) to identify priority wetland credit types for compensatory mitigation within the Sunrise River watershed. Used with permission from U.S. Army Corps of Engineers.

*Prioritization objectives assessed:*

- Wetland condition

Table 1. Factors and data sources used by the Corps to assess the condition of the Sunrise River watershed.<sup>2</sup>

Factor used in analysis	Data source
Amount of historic aquatic resource lost	St. Paul District Analysis of Historical Extent Aquatic Resources and Current Extent of Aquatic Resources (approximately 2008)
Degree of tributary hydrologic alteration	St. Paul District Analysis Utilizing Known Locations of Dams and Diversions along with NHD Data and Air Photo Interpretation to Identify Channelized and Altered Stream

	Segments
Potential for future urban growth	St. Paul District Analysis Utilizing Growth Projections from State, County, and Local Plans
Current extent of riparian buffers	St. Paul District Analysis Utilizing Air Photographs and GIS Analysis of Adjacent Land Use
Quality of the fish and invertebrate community	Index of Biological Integrity (IBI) score
Water quality	State of Minnesota 303(d) List of Impaired Waters (2208)

**Spatial Decision Support System (SDSS) GIS model:** The criteria and weightings that were derived by the expert group were used to identify raster data layer inputs for a raster calculator model that was used to quantify the ability of each 30m<sup>2</sup> pixel to attain the expert-defined criteria. The most highly rated areas in the resulting output map were considered the highest priorities for compensatory mitigation using a watershed approach. Factors and associated data sources used for the GIS analysis (Table 2) reflected each of the criteria identified by the expert team.<sup>3</sup>

*Prioritization objectives assessed:*<sup>1</sup>

- Habitat quality
- Water quality
- Cost-effectiveness

**Table 2. Factors and data sources used to address the function/value needs of the Sunrise River watershed.**

Factor used in analysis		Data source(s)
Hydrologic connection to tributaries	Distance to nearest tributary	NHD
Land costs		Real estate sales data
Potential to reconnect riparian buffers		St. Paul District analysis
Potential beneficial effects on fisheries	Proximity to areas with a low Index of Biological Integrity (IBI) score	N/A
Threats from urban growth	Distance to urban land use	Land use data
Distance to public lands		State of Minnesota land ownership data
Opportunities to improve or protect areas of significant biodiversity	Distance to native plant communities of sites of high biodiversity significance	MCBS Native Plant Communities; MCBS Site of Biodiversity Significance
Distance from roads and population centers		Minnesota roads and land use data
Locations with the floodplain of a tributary		FEMA floodplain data
Opportunities to improve water quality impairments	Distance to 303(d) impaired waters	State of Minnesota 303(d) list of impaired waters (2008).

NHD = National Hydrography Dataset; MCBS = Minnesota County Biological Survey; FEMA = Federal Emergency Management Agency.

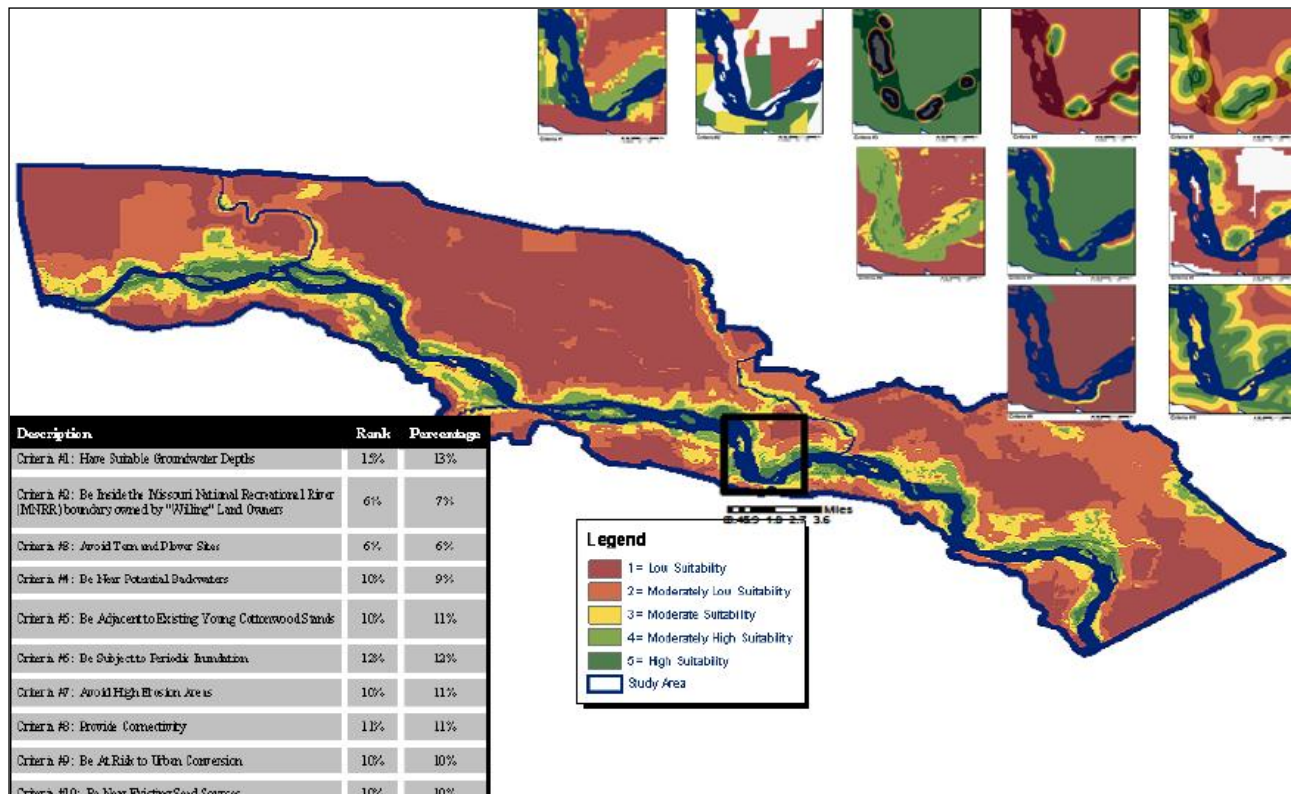
Updated: 5/8/2012



**Calibration of the landscape prioritization tool(s):** The output map resulting from the SDSS process will be evaluated by stakeholders and adjusted based on a final round of feedback before a final prioritization map is generated. The Corps expects this process to be iterative, with stakeholder feedback used to adjust inputs and weights for the model on a periodic basis. The SDSS will be rerun by the St. Paul District as necessary to update model results.<sup>2</sup>

**Validation of the landscape prioritization tool(s):** The Corps used rapid field surveys (more rapid than traditional rapid assessment methods) to validate two sites within each of ten subwatersheds of the Sunrise River watershed. These sites were all identified as high priorities by the SDSS and represented a wide variety of size classes. The sites evaluated were generally representative of wetlands within the watershed, though they may not have represented a statistically ideal sample. Results from the validation exercise showed that priorities identified by the model generally matched field observations.<sup>1</sup>

**Prioritization products:** The GIS outputs will be made available to stakeholders, including the general public, as static maps and GIS data as soon as the project is complete.<sup>1</sup> An example priority output map that ERDC produced for a section of the Missouri River is shown in Fig. 4.



**Figure 4. An example SDSS prioritization map produced for a segment of the Missouri River. Similar maps that provide suitability scores for areas of the Sunrise River watershed will soon be made available by the Corps St. Paul District. Used with permission from U.S. Army Corps of Engineers.**

**IMPLEMENTATION**

### **Regulatory/non-regulatory program applications:**

- Section 404 compensatory mitigation
  - Selection of wetland mitigation sites for restoration and enhancement.<sup>1</sup>
  - An original goal of this pilot project was to integrate Section 404 mitigation with the Sunrise River watershed Total Maximum Daily Load (TMDL) plan. However, the Corps did not receive input from MNPCA regarding selection criteria that the SDSS could use to prioritize wetland mitigation that supported TMDL water quality objectives. Additional input from the MNPCA could be obtained during the implementation phase of the project to prioritize certain types of activities that may benefit impaired waters.<sup>1</sup>
- State-required compensatory mitigation under the Minnesota Wetland Conservation Act. Because several local governments within the watershed administer the state Wetland Conservation Act, applying the SDSS tool to guide state-required mitigation may be challenging. Each local government has individual obligations under state law and preferences for mitigation siting within their geographic areas of responsibility.<sup>1</sup>
- Non-regulatory wetland restoration: The SDSS could inform site selection by applicants to the U.S. Department of Agriculture Natural Resources Conservation Service Wetland Reserve Program and other governmental and non-governmental entities pursuing aquatic resource restoration within the watershed.<sup>1</sup>
- Incentives for applying the prioritization results may be established during phase four of the project when the Corps works with state and local partners to develop implementation strategies. However, since the Sunrise River watershed encompasses multiple local jurisdictions that independently implement the state Wetland Conservation Act, creating such incentives throughout the entire watershed may be difficult unless the federal and state wetland permitting agencies seek to align their regulatory practices.<sup>1</sup>

### **Transferability:**

- The SDSS pilot project was intended to produce an approach that could be reapplied for watersheds nationally. The SDSS model is intended to help state and local agencies meet the needs of the 2008 compensatory mitigation rule by providing a repeatable approach for watershed planning for compensatory wetland mitigation.<sup>1</sup>

### **Data gaps:**

- Data to complete landscape-level functional assessments.<sup>1</sup>
- Land cost data.<sup>1</sup>
- Digital data for wetlands impacts. The state does not maintain a digital database for permitted wetland impacts, which makes some baseline analyses (e.g. assessing cumulative impacts, analyzing trends) more difficult.<sup>1</sup>
- County-level population growth projections. Often counties did not keep data for projected population growth. Where these data were available, they were often created in different ways than those of other counties, preventing or complicating the Corps' ability to combine these datasets. As a result, significant assumptions were sometimes required to integrate population growth in the watershed condition assessment, vulnerability analysis, and site selection process.<sup>1</sup>

**Barriers:**

- The St. Paul Corps District lacked the technical GIS knowledge to develop the SDSS model in-house. However, the District is working toward building this capacity. For example, the District is sending a staff member to train at ERDC for 4-5 weeks.<sup>1</sup>
- Achieving stakeholder buy-in across multiple levels of government has been difficult.<sup>1</sup>
- Lack of sufficient staff time to work on the pilot project.<sup>1</sup>
- Limited funding for the project.<sup>1</sup>
- Time required to run updated iterations of the model. Periodically receiving feedback from a variety of stakeholders on updated priorities and mapping efforts will require significant logistical coordination.<sup>1</sup>

**Future goals:**

- The Corps would like to see the output map from the SDSS model used by a wide range of stakeholders as a watershed-based plan to guide mitigation site selection. However, the fact that state wetland regulations are delegated to local governments may be a barrier to accomplishing this goal. Achieving collaboration among multiple local authorities to implement a watershed approach to site selection for compensatory mitigation may be difficult.<sup>1</sup>

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<sup>1</sup> Interview in 12/2011 with Tim Smith, Enforcement and Compliance Coordinator, U.S. Army Corps of Engineers, St. Paul District.

<sup>2</sup> Webinar “Watershed Based Identification and Evaluation of Compensatory Mitigation Site.” Presented by Timothy Smith and Thomas Mings, U.S. Army Corps of Engineers, St. Paul District.

<sup>3</sup> Smith T, Burks-Copes KA. 2010. Development of a GIS-Based Spatial Decision Support System to Target Potential Compensatory Mitigation Sites in Minnesota. National Wetlands Newsletter 32(6) 14-15.