

A Conservation Prioritization Tool for the Missouri Headwaters Basin

Quick-Start Guide

The screenshot displays the web-based interface of the Missouri Headwaters Basin Cross-Realm Management Prioritization Tool. The interface is divided into several sections:

- Header:** "Missouri Headwaters Basin Cross-Realm Management Prioritization Tool"
- Left Panel (Controls):**
 - Name your prioritization run:** A text input field containing "GrazingMgmt_Run1".
 - Select Action of Interest:** A dropdown menu set to "Reduce grazing pressure".
 - Set weights for each target:** A series of sliders for different targets:
 - Forest connectivity: 0.0
 - Shrub connectivity: 0.5
 - Grassland connectivity: 0.0
 - Upland vegetation: 0.5
 - Riparian Potential: 0.2
 - Stream health: 0.3
 - Consider downstream benefits for stream target(s)?** A dropdown menu set to "Moderate benefits".
- Map Area:**
 - Buttons for "Explore the Map" and "Get More Information".
 - A topographic map of the Missouri Headwaters Basin with a conservation priority rank overlay. The map shows various geographical features like the Sapphire Range, Big Belt Mountains, and Yellowstone National Park.
 - A legend on the right side of the map:
 - Topographical (checked)
 - Satellite (unchecked)
 - Action Footprint (checked)
 - Forest connectivity (unchecked)
 - Shrub connectivity (unchecked)
 - Grassland connectivity (unchecked)
 - Upland vegetation (unchecked)
 - Riparian Potential (unchecked)
 - Stream health (unchecked)
 - Prioritization Result (checked)
 - A "Conservation Priority Rank" color scale legend ranging from "High" (dark purple) to "Low" (light purple).
 - Map controls (zoom in/out) and a copyright notice at the bottom.
- Bottom Panel (Actions):**
 - Load last settings:** A button.
 - Save run settings:** A button with the feedback "Your settings have been saved."
 - Run prioritization:** A button with the feedback "Please wait. Your results will be saved to 'runs/GrazingMgmt_Run1'."
 - Check run status:** A button with the feedback "Your prioritization is done! Please wait a moment for the map to load."

This guide is a supplement to the following document and the tool described therein:

Creech, T., McClure, M., and van Rees, C. 2018. [A Conservation Prioritization Tool for the Missouri Headwaters Basin](#). Center for Large Landscape Conservation, Bozeman, MT.

Overview

Both terrestrial and freshwater aquatic management practices contribute to maintaining a healthy, connected landscape, yet these two ecological realms are often managed independently rather than as intertwined components of a single system. Cross-realm management, which explicitly considers the connections between terrestrial and aquatic realms, is a promising new direction in natural resource management that has great potential to benefit ecosystem functions that are not realm-specific, such as connectivity, and to inform more efficient management decisions by identifying co-benefits: management actions that benefit both the terrestrial and aquatic realms. However, examples of successful applications of cross-realm management frameworks remain rare.

This prioritization tool is the product of a project funded by the National Fish and Wildlife Foundation to support, integrate, and build on existing efforts towards terrestrial and freshwater management in the Missouri Headwaters Basin (MHB) of southwestern Montana and northwestern Wyoming. The objectives of the project were to (1) examine how joint actions can be prioritized and applied on the ground, and (2) pilot a repeatable approach that can be applied to other areas.

We first developed a conceptual model of ecological integrity in the MHB that identified relationships between key conservation targets, threats to those targets, and potential management actions that can address identified threats. We compiled spatial data representing the condition of conservation targets relative to specific actions capable of addressing threats to those targets. We then integrated the conceptual model and spatial data into a conservation prioritization tool to allow stakeholders to identify areas where conservation actions can simultaneously yield the greatest benefits for multiple conservation targets, and to do so in a quantitative, repeatable, and defensible way. Our hope is that the tool will help resource managers and conservation practitioners working in the MHB to quickly, easily, and flexibly evaluate where to implement conservation action to achieve the greatest co-benefits for a variety of desired conservation targets, in both terrestrial and freshwater realms.

Using the Tool

The instructions below will quickly get you started using the MHB prioritization tool to identify places in the MHB where a conservation action of interest may offer the greatest benefits to multiple conservation targets of interest. However, it is critical for interpretation and application of results to fully understand the conceptual basis for the action-target linkages represented in the tool, the data

sources used, how conservation or restoration opportunity was quantified, and implications of run settings in order to assess whether the result captures useful aspects of action-target relationships for your individual goals and applications. We strongly recommend reviewing the full [Project Summary and User Guide](#), particularly sections describing relevant data sources (Appendix A: Spatial Data Sources), how 'Conservation Target Opportunity Value' was calculated for each action-target combination of interest (Links Between Actions and Targets), and descriptions of key tool settings (Appendix B: Zonation Parameterization) to ensure that the results of the tool meet your needs.

System Requirements and Setup

The MHB conservation prioritization tool is powered by the R statistical programming environment (www.r-project.org; R Core Team 2017). Although there is no need for users to have any familiarity with R, users do need to download and install R (version 3.0.1+) as well as the RStudio software (version 1.0+) to run the tool. Unfortunately, because the Zonation software is Windows-only, the MHB prioritization tool can only be run on Windows operating systems.

To install the necessary software on your computer:

1. Download and install the current version of R for Windows [here](#). The link will download an .exe file; open it to be guided through the install process.
2. Download and install the current version of RStudio for Windows [here](#). Again, open the downloaded .exe file to be guided through setup of RStudio on your computer.
3. If you are already an RStudio user, please ensure that you have updated to version 1.0 or later. [These instructions](#) highlight the most straightforward means of updating R as well as RStudio on Windows machines.

Accessing the Tool

In order to download and open the MHB prioritization tool on your computer:

1. Download the zip file containing the prioritization tool and all necessary data [here](#). Save the file to a permanent directory of your choosing; do **NOT** simply save to your Downloads folder.
2. Unzip the zip file to your preferred location on your computer. (If you do not already have a means of opening compressed zip files, we recommend the free, open-source [7-Zip](#).)

3. In the unzipped tool folder, double-click the file 'MHB_ToolSetup.R' to open the setup file. This only needs to be run once prior to your first use of the tool (Fig. 1).

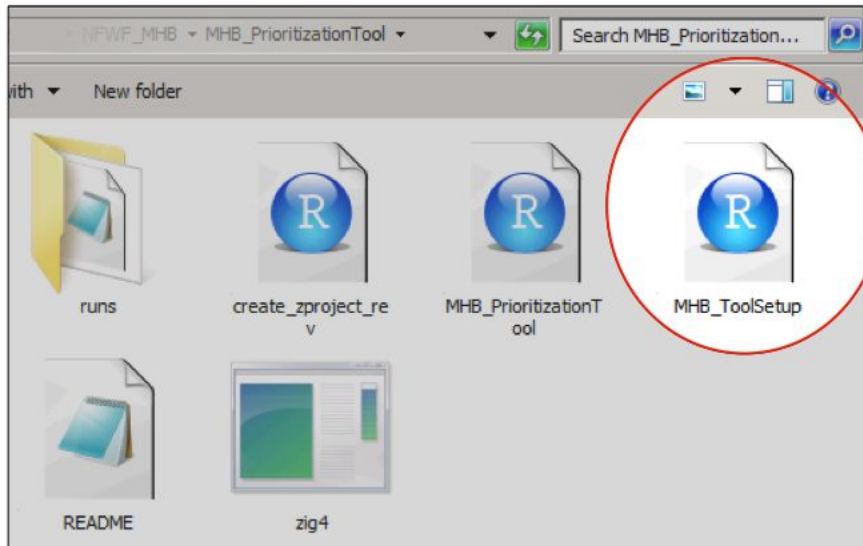


Figure 1. To set up R to run the tool, first open 'MHB_ToolSetup.Rmd' in the main tool directory.

4. A short install script will open in RStudio - **DON'T PANIC!** All you need to do is click the 'Source' button in the header bar (Fig. 2). The script will install the necessary R packages to support the tool. This will take about 5-10 minutes, and only needs to be run the first time you use the tool.

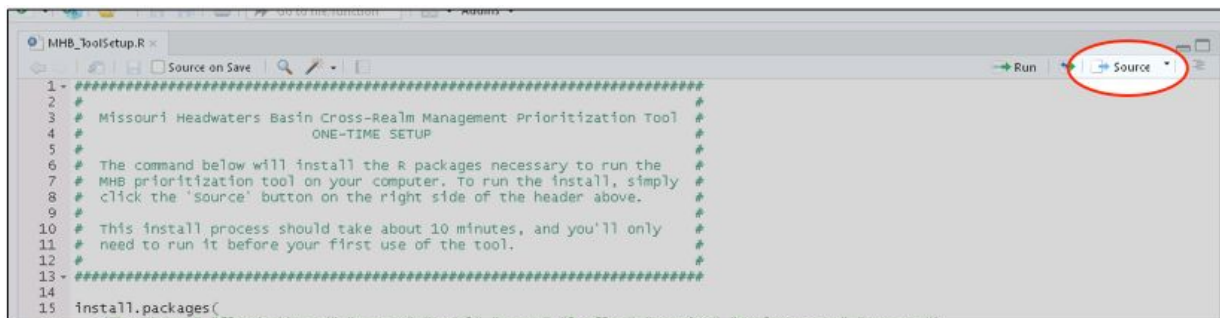


Figure 2. Run the short tool setup from RStudio by clicking the 'Source' button.

5. To run the prioritization tool itself, double-click the file 'MHB_PrioritizationTool.Rmd' to open.
6. The script underlying the tool will open in RStudio - **DON'T PANIC!** You can ignore the code and simply click the 'Run Document' button in the header bar (Fig. 3).



Figure 3. Run the prioritization tool user interface from RStudio.

7. If prompted further to “Install Required Packages”, click “Yes”. This will only be required the first time you run the tool.
8. The user-friendly tool interface will open in a browser window (Fig. 4).

Using the Tool

The tool interface allows you to first specify options for your prioritization run (Fig. 4), then to explore the map results. To set up your run:

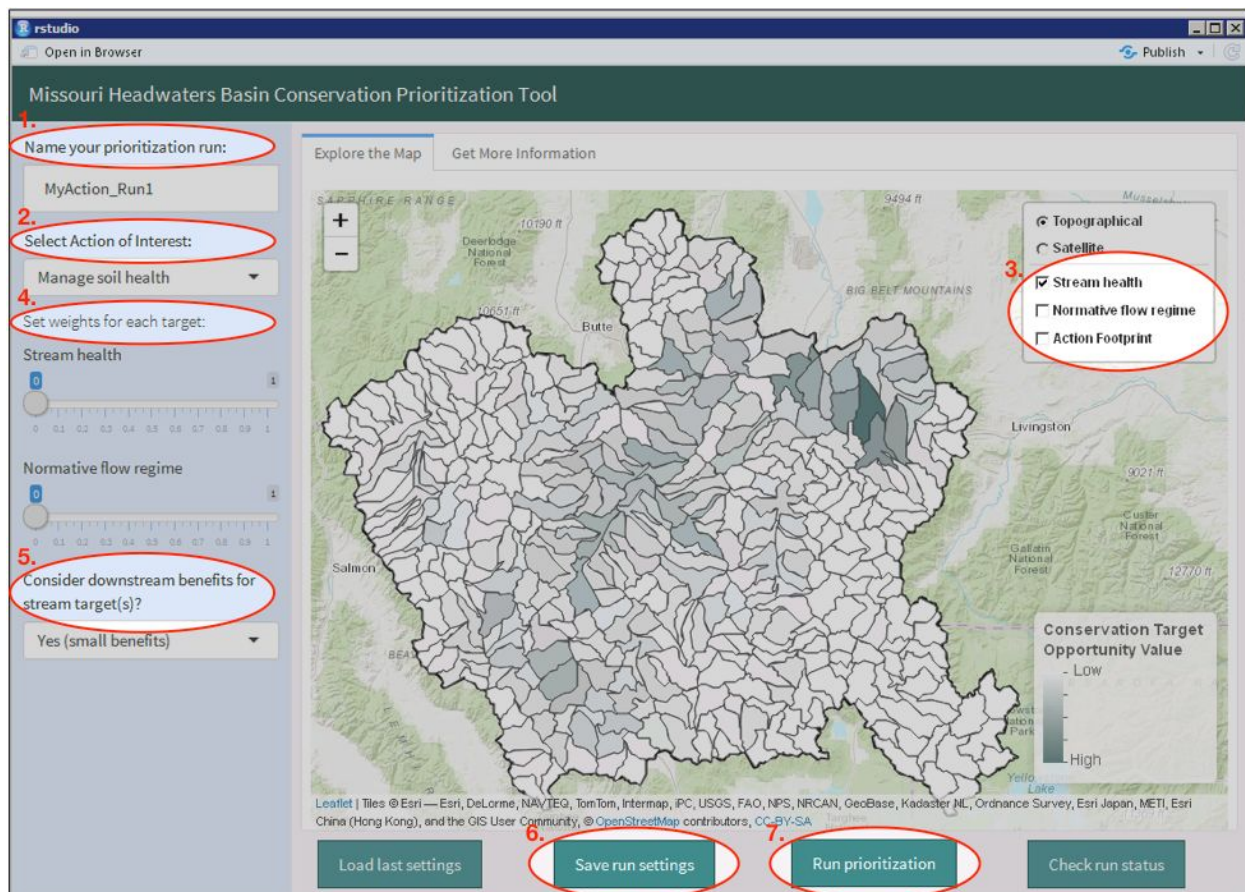


Figure 4. Steps for running the prioritization tool from the user interface.

1. Name your prioritization run. Run names should not contain spaces or slashes. Your run settings and output will be saved under the name you choose in the 'MHB_PrioritizationTool/runs' directory.

Hint: If you expect to run several versions of your prioritization (e.g., with different actions, targets, or weights), it may be helpful to use names that specify these choices.

2. Select your conservation action of interest. You will see the list of conservation targets change with your selection to reflect which targets could be linked directly to the chosen action in the [full documentation](#) (Conceptual Model).

For further description of each action and its links to conservation targets, see [Links Between Actions and Targets in the full documentation](#).

3. Explore the target condition layers associated with the selected action on the map. Layers can be turned on and off in the legend. The 'Action Footprint' layer can be turned on to view the areas in which your action of interest can be applied.

Remember that 'Conservation Target Opportunity Value' for each subwatershed unit was calculated in a way that accounts for the area available for the action of interest within the unit (see [Links Between Actions and Targets in the full documentation](#)). A unit may have low Opportunity Value because it contains no areas to which the action of interest can be applied.

4. Select weights for each conservation target associated with your action of interest. Targets that are very important to you should receive higher weights; a target that is not at all important to you can be assigned a weight of zero to be ignored. Weights need not sum to 1, but this might make interpretation easier.

Hint: If you are running several slightly different iterations of a prioritization, it might be helpful to use the 'Load last-used settings' option. This will reload the action and weights selected the last time the tool was used.

5. If your selected action is applicable to stream-based targets (stream health and/or normative flow regime), choose whether and how strongly potential downstream benefits of the action will be considered. If downstream benefits are considered, headwater units with high target value that are upstream of other units with high target value will be prioritized more heavily.

Hint: It may be helpful to run the same prioritization with different downstream benefits options implemented for comparison.

6. Save your settings, then run the prioritization using the buttons at the bottom of the interface window.
7. Monitor the status of your run. A console window will appear and display the progress of the Zonation algorithm (Fig. 5). Do not close this window, or the run will be canceled! The window will close itself when the run is complete.

```

C:\Windows\system32\cmd.exe
Removing PLU, id: 3, cells: 7756, x: 2024, y: 2166
10000 99.7591% 4.14036e+06 1657237 1
8
Removing PLU, id: 44, cells: 5428, x: 790, y: 2088
20000 99.5181% 4.13036e+06 1657732 0.999999
11
Removing PLU, id: 45, cells: 4997, x: 767, y: 2036
Removing PLU, id: 363, cells: 18541, x: 2567, y: 1907
30000 99.2772% 4.12036e+06 1659982 0.999998
19
40000 99.0362% 4.11036e+06 1649982 0.999998
19
Removing PLU, id: 200, cells: 16014, x: 824, y: 1191
50000 98.7953% 4.10036e+06 1668012 0.999907
22
Removing PLU, id: 129, cells: 12046, x: 1767, y: 1932
60000 98.5543% 4.09036e+06 1682298 0.99926
26
70000 98.3134% 4.08036e+06 1672298 0.99926
26
Removing PLU, id: 323, cells: 5891, x: 2291, y: 1875
Removing PLU, id: 173, cells: 5246, x: 239, y: 1083
80000 98.0725% 4.07036e+06 1728512 0.997436
34

```

Figure 5. Pop-up console window displaying progress of prioritization run.

8. Check the status of your run using the 'Check run status' button. When the run is complete, clicking this button will load the result on the map interface to explore (Fig. 6).

Prioritizations typically take less than 5 minutes to complete, but may take up to 10 minutes, depending on settings used and processor speed. If for any reason you need to interrupt and/or restart a running prioritization, you can do so by selecting the console and entering 'Control+C' or simply closing the console window.

Figure 6. Example result map after completion of prioritization run.

8. For GIS users, the result file is available for import to ArcMap or other GIS software for further viewing, custom symbolization, comparison with results from other runs, and further analysis in the context of other available data for the region. To access the results file, go to 'MHB_PrioritizationTool/runs/[yourRun]/[yourRun]_out/' and select the geoTiff file ending in 'rank.compressed.tif' (Fig. 7). Higher raster values indicate higher priority rank.

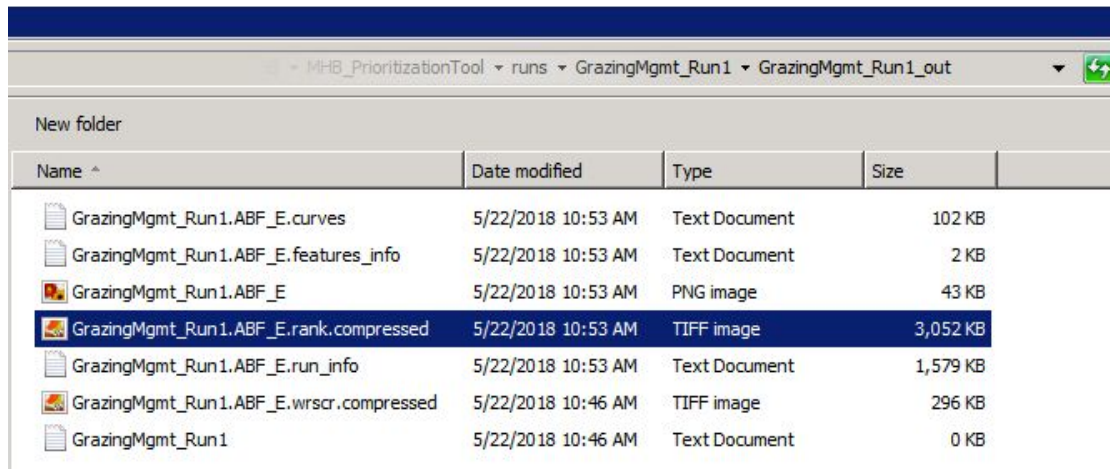


Figure 7. Example of output geoTiff file for use in GIS software.

Additional Guidance

The instructions above should allow you to successfully run the prioritization tool. However, we again strongly recommend that you review the full [Project Summary and User Guide](#) to understand the context, meaning, and appropriate application of your prioritization results. If you've encountered any difficulties running the tool, please consult the Troubleshooting section of the full documentation. If, after reviewing the Troubleshoot guide, you still encounter difficulties, please contact the authors:

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