

Linkage Mapper Toolbox: Centrality Mapper User Guide

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Acknowledgements

Centrality Mapper builds on much of the Python code developed with **Darren Kavanagh** for Linkage Mapper, and uses Circuitscape, developed with **Viral Shah**. I am grateful for Darren's and Viral's excellent contributions.

Software Requirements and Licensing

Centrality Mapper requires **ArcGIS Desktop** (10.3 or greater) or **ArcGIS Pro**, with the **ArcGIS Spatial Analyst** extension. **Circuitscape 4** must also be installed on your machine. This software is provided free of charge and is licensed under a GNU General Public License.

Preferred Citation

McRae, B.H. 2012. Centrality Mapper Connectivity Analysis Software. The Nature Conservancy, Seattle WA. Available at: <https://circuitscape.org/linkagemapper>.

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1 Introduction

Centrality Mapper is part of the Linkage Mapper toolbox, which includes the Linkage Pathways tool (McRae and Kavanagh 2011) and other modules designed to support regional wildlife habitat connectivity analyses. Once corridors have been mapped using the Linkage Pathways, Centrality Mapper analyzes the resulting linkage networks, calculating current flow centrality across the networks. Current flow centrality is a measure of how important a link or core area is for keeping the overall network connected.

More details on centrality analyses can be found in Carroll et al. (2012). More details on circuit theory and on Circuitscape software can be found in McRae et al. (2008) and McRae and Shah (2009) respectively.

2 Installation

1) Install the latest version of Linkage Mapper

Follow the instructions in the Linkage Pathways User Guide to install the toolbox.

2) Install version 4 of Circuitscape

The most recent and stable version of Circuitscape 4 (v4.07) is available as raw code on Github and here as a zip file install package: https://drive.google.com/file/d/1Pj_PUgbmZ1d97M_F0T-F0tBpxHEKpBTf/view?usp=sharing

3) Verify your installation

You can test the code by running the tutorial below.

3 Using Centrality Mapper

3.1 Input data requirements

Centrality Mapper uses the link maps ('stick' and least-cost path maps) produced by Linkage Pathways and stored in the output directory, plus the link tables saved in the datapass directory. You only need to provide the project directory and the core area file.

3.2 Running the toolbox



Note: ArcGIS can be finicky about file locks. If you get schema lock or permission errors, you may need to close any active ArcGIS processes and start fresh without any output files displayed.



*Note: Several users have reported that they experience fewer ArcGIS Desktop errors when running from ArcCatalog. **We therefore suggest you run from ArcCatalog if you are having problems with ArcMap***

Click on the *Centrality Mapper* tool, which is located in the *Additional Tools* toolset in the *Linkage Mapper* toolbox. The following dialog should appear.

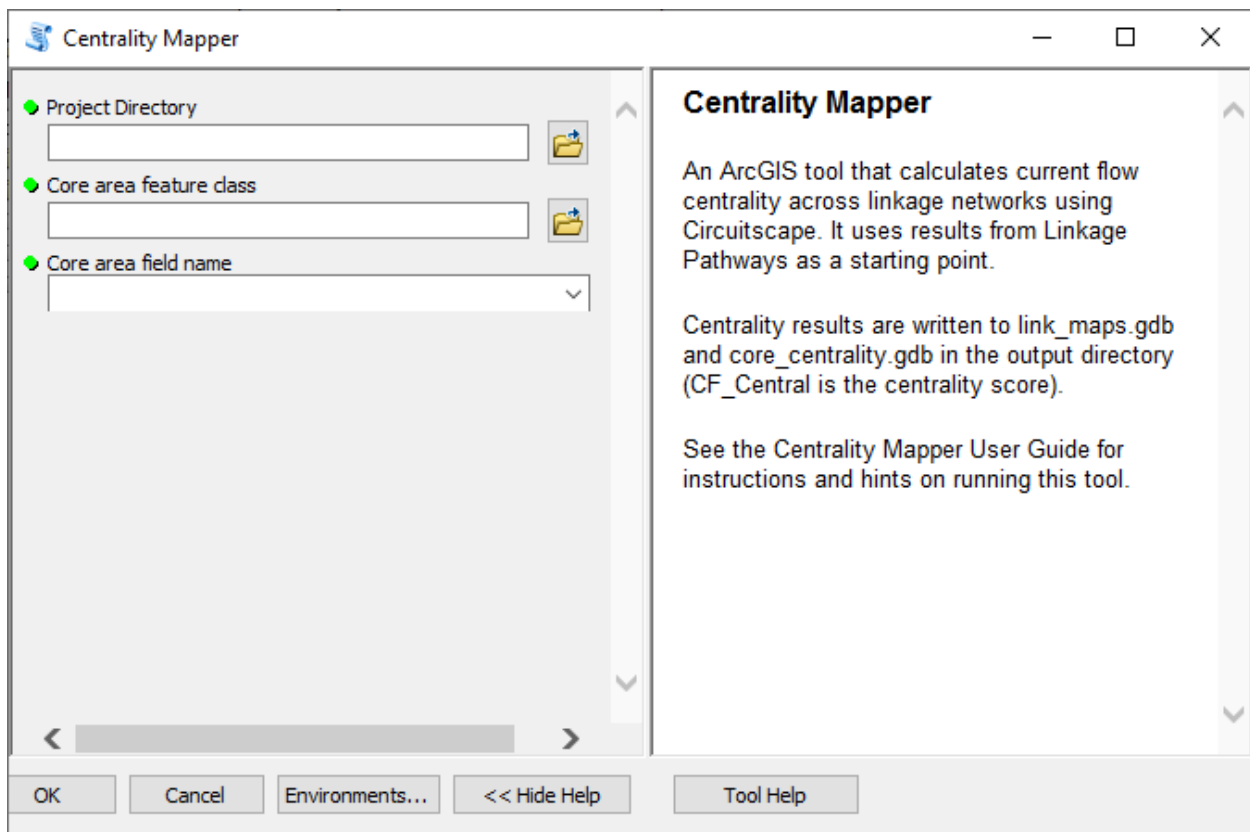


Figure 1. Centrality Mapper dialog in ArcGIS Desktop.

Input data

- a. **Project directory:** Use the same project directory used for the Linkage Pathways run.
- b. **Core area feature class:** Use the same core area file you used to create corridors using Linkage Pathways.
- c. **Core area field name:** Use the same core area field name you used to create corridors using Linkage Pathways.

3.3 What Centrality Mapper does

Centrality Mapper reads in the vector outputs (least-cost path and stick maps) from Linkage Pathways. It then calculates current flow centrality on the linkage network using Circuitscape (McRae and Shah 2009). Each core area is treated as a node, and each link is assigned a resistance equal to the cost-weighted distance of the corresponding least-cost corridor. Centrality Mapper then iterates through all core area pairs, injecting 1 Amp of current into one core area and setting the other to ground. It adds up the results across all core areas and links to generate a centrality score.

Outputs are written to `link_maps.gdb` and `core_centrality.gdb` in your output directory. The file names in `link_maps.gdb` are unchanged, but an attribute is added to each link with a centrality score. A copy of the core area feature class will be written to the `core_centrality.gdb` with a centrality score attribute added.

4 Centrality Mapper tutorial

After running the Linkage Pathways tutorial, you can analyze network centrality on the linkage network it created. Open up *LM Demo Results.mxd* or the *LM Results* map in *ArcGIS Pro Demo.aprx*, and run Centrality Mapper using the following settings.

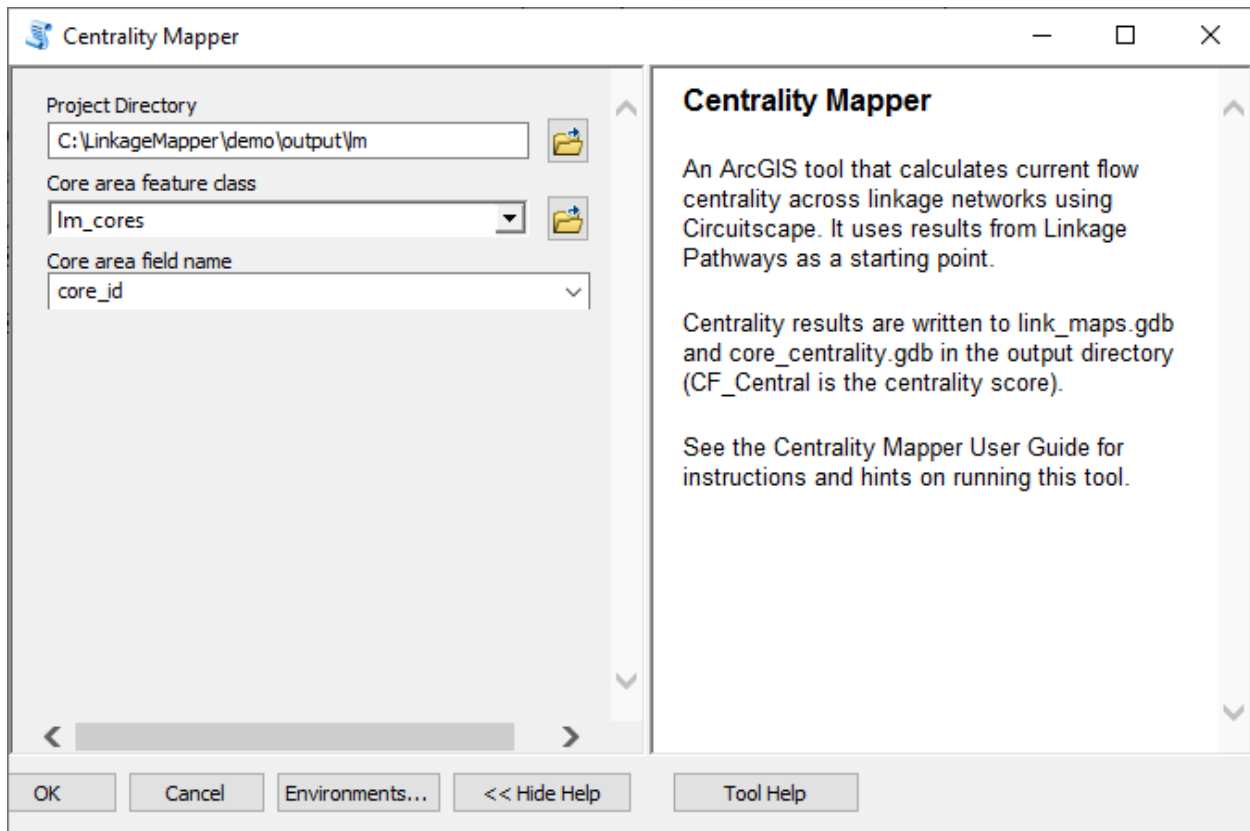


Figure 2. Tutorial settings. If applicable, substitute the input for the *Project Directory* parameter with the path to your demo project directory.

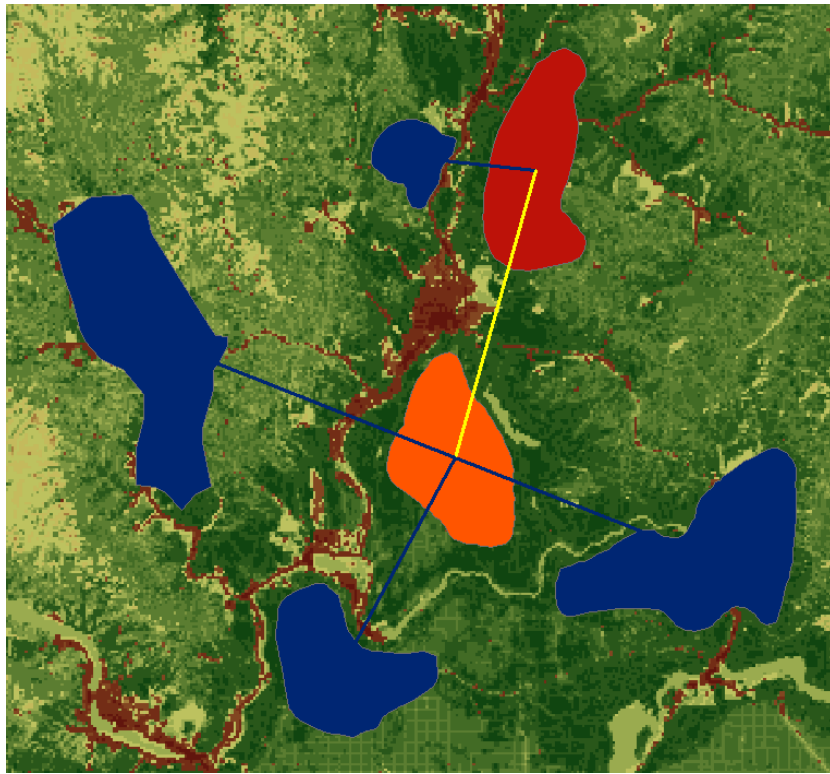


Figure 3. Tutorial outputs, found in `link_maps.gdb` and `core_centrality.gdb`. Link colors indicate link centrality score (the yellow link has a higher score than the others because its loss would disconnect more than one core area from the rest of the network). Core area colors indicate core area centrality; the orange core has the highest centrality because it is a 'hub' for keeping the network connected. The red core has a higher centrality score than the blue cores because its loss would disconnect more than one core area from the rest of the network.

5 Community

Please join the Linkage Mapper Google Groups forum at <https://groups.google.com/g/linkage-mapper> to get updates, report bugs, and suggest enhancements. Please also visit the project website at <https://circuitscape.org/linkagemapper/>.

To contribute to the development of Linkage Mapper explore our code repository on GitHub: <https://github.com/linkagescape/linkage-mapper>.

6 Literature cited

- Carroll, C., B.H. McRae, and A. Brookes. 2012. Use of linkage mapping and centrality analysis across habitat gradients to conserve connectivity of gray wolf populations in western North America. *Conservation Biology* 26(1):78-87.
- McRae, B.H., B.G. Dickson, T.H. Keitt, and V.B. Shah. 2008. Using circuit theory to model connectivity in ecology, evolution, and conservation. *Ecology* 10: 2712-2724.
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