Where to Work (advanced)

User Manual

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2022

Table of Contents

1. About

1.1. Intended audience

This manual was written for NCC-CNC GIS staff to provide explanations for the basic functionalities of the *Where to Work* tool (advanced version), to allow testing and recommendations for improvement during the development phase. As such, it is subject to change.

1.2. Purpose of tool

NCC is adopting a systematic and standardized approach to land prioritization via the introduction of a spatial prioritization tool *Where to Work* to NCC's conservation planning framework. Doing so enables NCC to establish quantitative, organization-wide conservation goals and positions NCC to report on its collective impact in a way that resonates with donors, partners and funders.

Where to Work is a web-based, graphical user interface that uses an algorithm to build and solve complex conservation planning problems. The spatial prioritization tool that Tool 1 interfaces, or interacts, with is prioritzr, which uses integer linear programming techniques to solve problems. The exact algorithms used are guaranteed to find the optimal result (Hanson et al., 2020; Groves and Game, 2016) and can analyze large, complex datasets efficiently, providing near real-time analysis for stakeholder meetings and discussions (Hanson et al., 2020). However, it is important to note that what is optimal mathematically may not be optimal from a practicality standpoint, and the results are dependent on the input data. Thus, the tool is intended for decision support, but is not meant to dictate final decisions.

1.3. Software dependencies

The tool is available as an online web application. For the best experience, it is recommended to use the latest version of the Google Chrome web browser (https://www.google.com/chrome/). Efforts have been made to support other web browsers, such as Mozzillla Firefox, Microsoft Edge, and Apple Safari.

1.4. Code availability

All code for the *Where to Work* tool is publicly available on GitHub here: https://github.com/NCC-CNC/wheretowork

If you find problems with the *Where to Work* tool you can submit a ticket, or Issue as GitHub calls it here: https://github.com/NCC-CNC/wheretowork/issues
If you are not a GitHub user, you can get in touch via email.

2. Terminology and concepts

2.1. Systematic conservation planning

A commonly used decision-support framework that seeks to optimize where to act and what to do in a systematic and repeatable way – two key outputs of a conservation planning process.

2.2. Spatial prioritization tool

A problem-solving tool that uses an algorithm to inform the spatial allocation of conservation actions (e.g., *prioritzr*, *Marxan*, *Zonation*).

2.3. Theme

Themes describe facets of biodiversity that are important for conservation (e.g., species, habitats, ecosystems). To help safeguard Themes, you can set goals to ensure a minimum level of coverage by solutions (e.g., setting a goal of 20% ensures that 20% of the overall spatial extent of the theme is covered by the solution). Some Themes can contain multiple components that are termed Features. For example, a Theme pertaining to Threatened Species may contain Features, wherein each Feature corresponds to a different species.

➔ Note that "goals" are similar to Marxan's "targets"

2.4. Weight

A weight describes properties of places that can impede or improve conservation efforts. Set the weight factor between -100 and 100 to indicate how important it is to avoid or cover (respectively) a given weight in the solution. To completely avoid a weight (e.g., to avoid all areas with mining leases), use a value of -100 (i.e. ensure that planning units with the lowest possible values in the weight dataset are selected). To include as much of the weight as possible (e.g., to include all areas of cultural significance), use a value of 100 (i.e. ensure that planning units with the highest possible values in the weight dataset are selected). Setting a value of zero (deselecting the weight using the toggle) means that it is not considered at all in the prioritization.

2.5. Includes

This term refers to areas that are already managed for conservation; to build on the current reserve network, these areas should be automatically included. However, solutions can be constructed that do not automatically include the current reserves. These are also useful to explore counterfactuals and management plans generated using other processes (e.g., what if we built a new system from scratch?).

➔ Note that "includes" are similar to Marxan's "locked-in" areas.

2.6. Planning Unit

A spatial locality (or area) that can be managed independently from other localities. In many cases, planning units are defined using property boundaries. In other cases, especially in large-scale planning exercises, landscapes are often divided into equal-area (e.g., 1 km^2) grid cells that are used to serve as different planning units.

2.7. Reserve

A contiguous set of planning unit selected for prioritization.

2.8. Algorithm

An optimization technique that aims maximize performance according to certain criteria. Specifically, the *Where to Work* tool uses exact algorithms implemented with the CBC (Coin-or branch and cut) source mixed integer programming solver (https://github.com/coin-or/Cbc).

3. Launching *Where to Work*

3.1. Accessing the *Where to Work* tool

The tool can be accessed with the following link: Where to Work
This User Manual is written for the "advanced" user.

3.2. Select import method

To begin, select the method for importing data into the application. To use a previously prepared publicly available project, select "built-in project."

To upload a project dataset that was previously prepared for you personally, select "upload project data."

To upload a spatial dataset that has not been prepared specifically for the tool, select "spatial dataset."

3.2.1. Built-in project

Sample projects are pre-loaded into the app. Select the project you wish to view, then click "Import." Several of projects are sample projects (e.g., those with the name "simulated") and others have been prepared by GIS technicians.

3.2.2. Upload project data

A project dataset comprises multiple files. These files include configuration file, spatial data, attribute data, and boundary data files. These files are generated created using custom R scripts or the ArcGIS plugin currently under development. In most cases, the user would only use this option if they have personally been provided with a project dataset (e.g., by a GIS technician). Please note that all of these files need to be uploaded to the application.

3.2.2.1. Select configuration file

A configuration file contains the specification for the project. It specifies the Themes, Includes and Weights that are part of the project, along with default settings and colors for visualization. This file is encoded using YAML (e.g, project.yml) file format (https://yaml.org/)

3.2.2.2. Select spatial data

A spatial data file contains the geographic information used to display the data on a map. Project can be spatial data file organized in the GeoTIFF format (e.g., spatial_data.tif) or the ESRI Shapefile format. Note that the ESRI Shapefile format is a file format that spans multiple files with the same prefix and different file extensions. For example, when uploading the "spatial_data" ESRI Shapefile, one must upload all four of the following files: spatial_data.shp, spatial_data.prj, spatial_data.shx, and spatial_data.dbf.

3.2.2.3. Select attribute data

An attribute data file contains information the expected amount of each Theme, Weight, or Include within each planning unit. The attribute data files can be supplied in the Comma Separated Values format (e.g., "attribute_data.csv"), or a compressed version of this format (e.g., "attribute_data.csv.gz"). Here, each column pertains to a different Theme, Weight, or Include, and each row corresponds to a different planning unit. The last column in this file should be called "_index" and indicate the spatial index associated with each planning unit (e.g., the index of the grid cell or geometry each planning unit is associated with in the spatial data file).

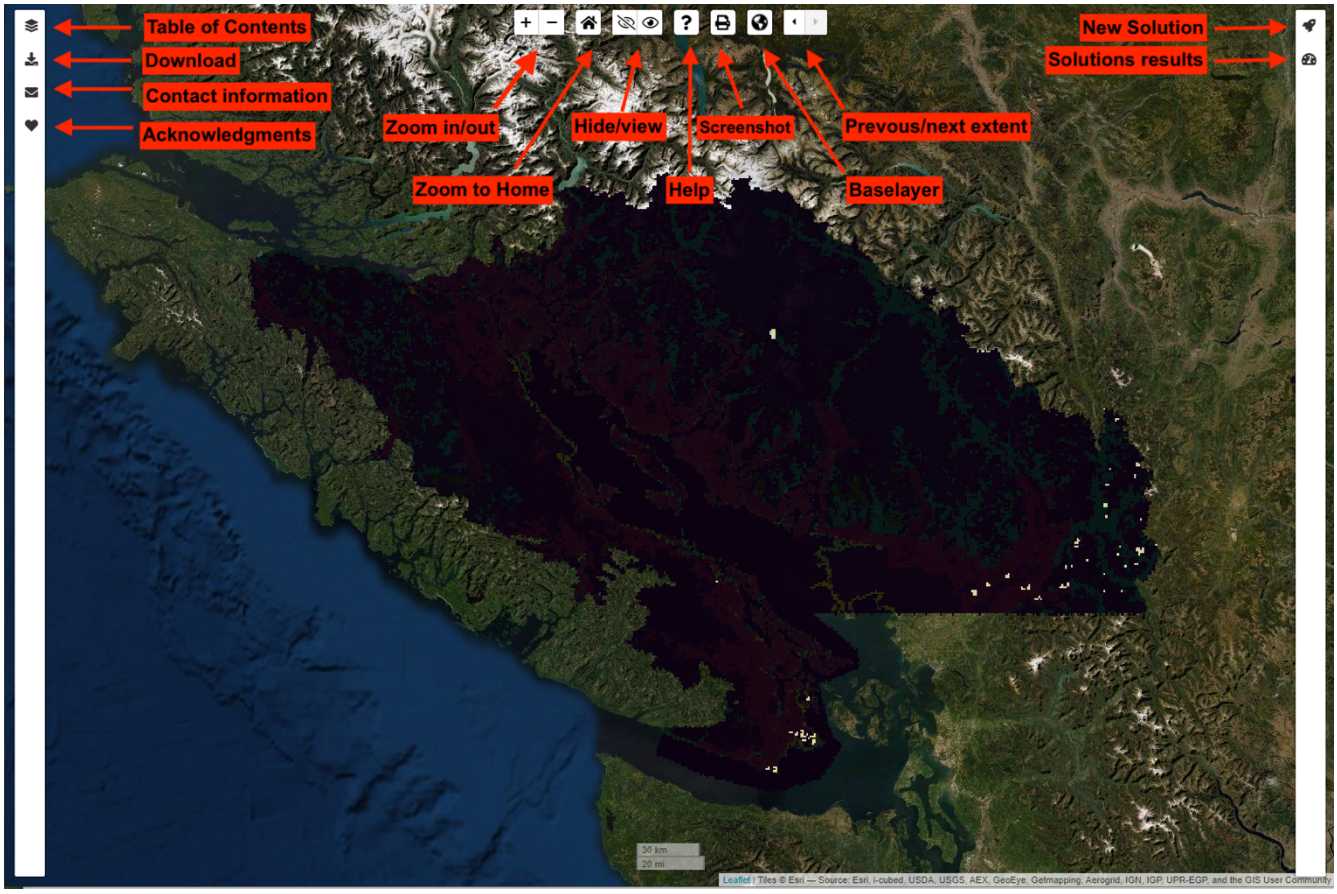
3.2.2.4. Select boundary data

A boundary data file contains information on the spatial boundaries of the planning unit. The boundary data file can be supplied in the Comma Separated Values format (e.g., “boundary_data.csv”), or a compressed version of this format (e.g., “boundary_data.csv.gz”). Specifically, it can be provided using the Marxan boundary data file format, wherein it contains the following three columns: “id1”, “id2”, and “boundary”. The “id1” and “id2” columns indicate the shared boundary between different planning units based on their spatial indices, and the “boundary” column indicates the length of these shared boundaries (e.g., 100m). To encode the length of boundaries along the outer edge of the study area, the “id1” and “id2” columns can contain the same spatial index value. This data is used when the spatial clustering options are enabled (see below).

3.2.3. Spatial dataset

An ESRI Shapefile can be uploaded to the application to automatically create a new project. Please note that this approach is not generally recommended for beginner users, because users need to ensure that the spatial dataset contains all relevant Themes, Weights, and Includes. Additionally, because the spatial dataset upload option involves creating a new project, this means that none of the Themes, Weights, or Includes will have sensible default options (e.g., goals or factors) and the provenance of the underlying data is unknown. Note that the ESRI Shapefile format is a file format that spans multiple files with the same prefix and different file extensions. For example, when uploading the “spatial_data” ESRI Shapefile, one must upload all four of the following files: spatial_data.shp, spatial_data.prj, spatial_data.shx, and spatial_data.dbf.

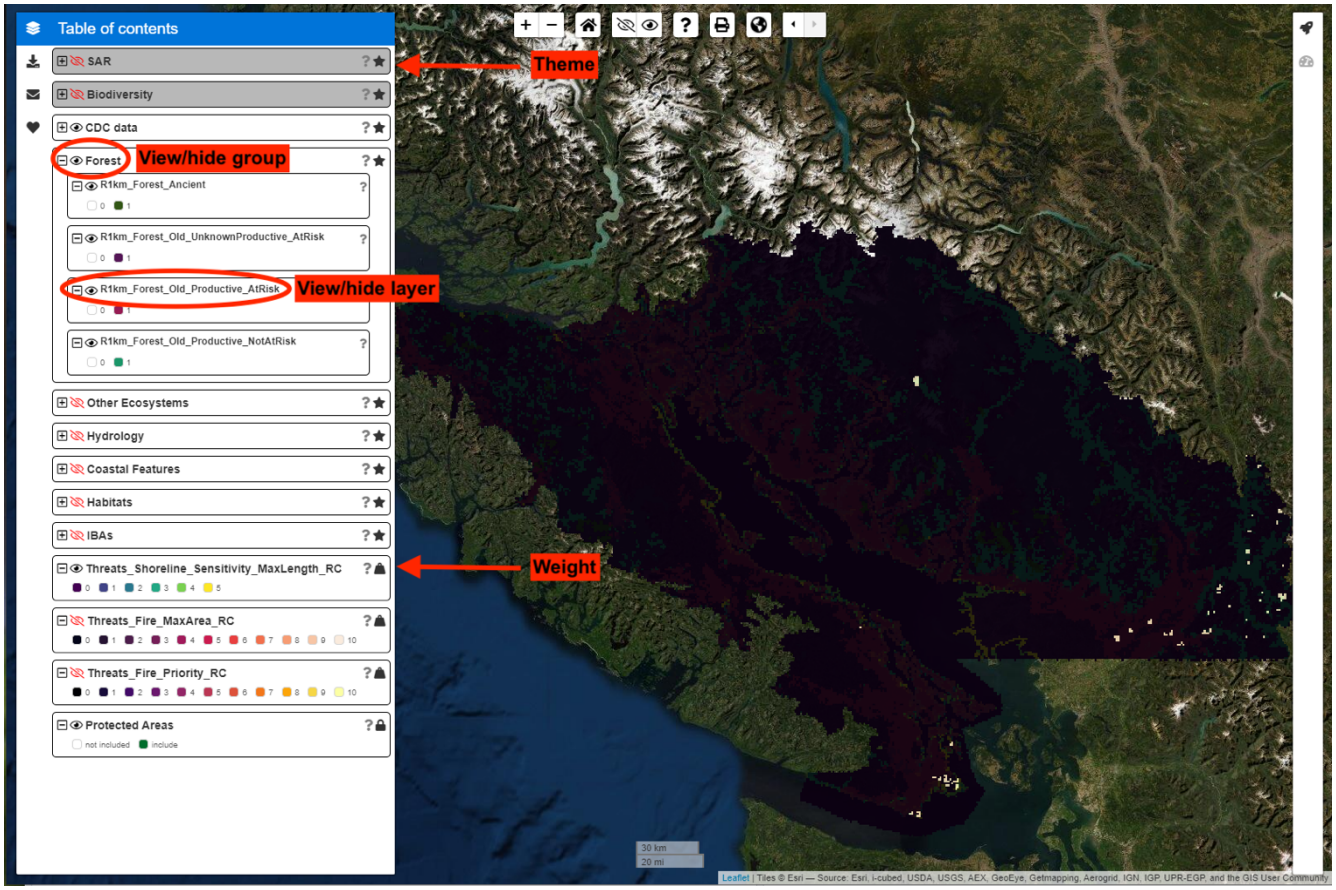
4. Sidebars



4.1. Table of contents

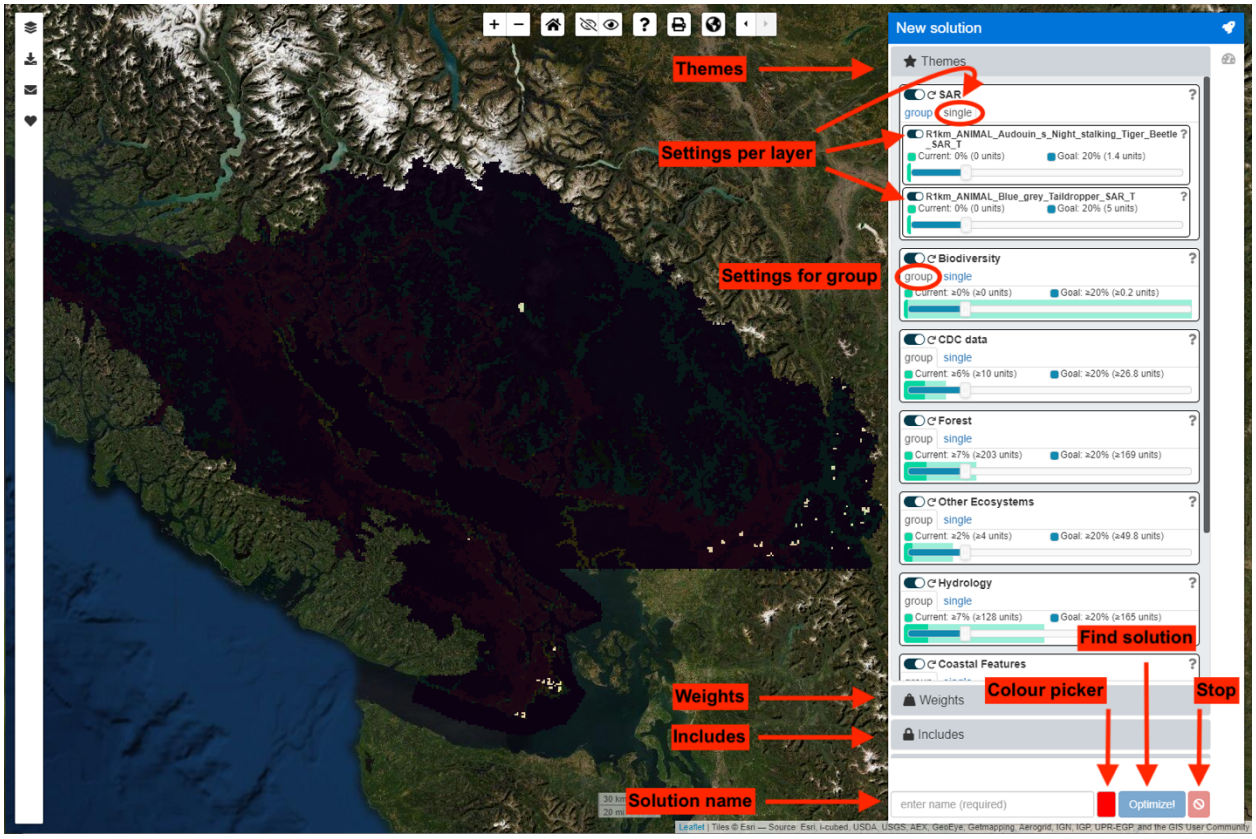
Open and close the *Table of contents* by clicking the layers icon. Themes are identified with the star icon. Weights are identified with the weight icon. Categorical data will automatically be assigned a colour category and continuous data will automatically be assigned a colour range.

To view/hide themes, features, and weights click the eye icon. Visibility of a feature or weight does not impact prioritization solutions.



4.2. New solution

Open and close the *New solution* sidebar by clicking the rocket icon. To generate a new solution, select the themes, features, weights, and attributes for inclusion to include in the solution with the toggle button to the left of each parameter. Enter a name for the solution in the bottom bar and select the display colour for your new solution with the colour picker. Click the “Optimize!” button to generate the new solution. Once a new solution is generated, it will appear in the *Table of contents* sidebar.



4.2.1. Themes

Themes can be selected (enabled) so that they are used to generate solutions (i.e., by clicking the toggle button next to each theme). If a Theme is enabled, then the slider can be used to specify a goal for the Theme. If a Theme contains multiple Features: the toggle buttons next to each Feature can a be used to enable or disable them (individually), and the sliders next to each Feature can also be specify the goals for each Features (individually). For convenience, the goals for Themes that contain multiple Features can be set simultaneously (under the "group" tab) or separately (under the "single" tab).

➔ Note that "goals" are similar to Marxan's "targets"

Each theme shows the overall amount that is currently Included (both as a percentage and the units specified for the theme, e.g., hectares), and the overall amount that is specified by the goal (both as a percentage and the units specified for the theme, e.g., hectares). For example, setting a goal of 30% for a Theme, means that each solution will aim to cover 30% of the overall amount of the Theme.

4.2.2. Weights

Weights can be selected (enabled) so that they are used to generator solutions (i.e., by clicking the toggle button next to each Weight). If a Weight is enabled, then the slider can be used to specify a factor for the Weight. Depending on the nature of the Weights, it may be important to increase their coverage within solutions (by using a positive weight value), or important to decrease their coverage within solution (by using a negative weight value). If there are multiple Weights that should be considered simultaneously when generating solutions, the relative importance of different Weights can be specified by setting factors that are increasingly or decreasingly further from zero. For example, if we had two weights, we could assign a factor of 20 to one weight to increase its coverage by the solution, and a factor of -80 to the second Weight to decrease its coverage by the solution. Although the tool will consider both criteria, there may be trade-offs (e.g., some planning units might have high values for both Weights). In such cases, because -80 is much further away from zero than 20, we are saying that it is more important for solutions to decrease coverage of the second Weight than it is to increase coverage of the first Weight.

4.2.3. Includes

Select the Includes to ensure that certain planning units are selected in the solution.

➔ Note that “includes” are similar to Marxan’s “locked-in” areas.

4.2.4. Settings

The settings are used to customize the prioritization process. Unlike the Themes, Weights, and Includes, the settings are not associated with any spatial data.

4.2.4.1. Total area budget

The area budget specifies the maximum spatial extent for the solution (as a percentage of the study area). This is the largest area that the solution can prioritize. Critically, specifying a total area budget means that the tool can generate prioritizations that do not meet the goals for all of Themes.

4.2.4.2. Spatial clustering

The spatial clustering parameter controls how important it is for solutions to select planning units that are sited next to each other.

This parameter is similar to the Boundary Length Modifier parameter in Marxan (Ball et al., 2009). Here, the spatial clustering parameter is a percentage that describes how much more costly (i.e. in terms of total area budget or selected weights) that the solution can be to reduce spatial fragmentation.

4.3. Solutions results toolbar

4.3.1. Summary

Open and close the Summary sidebar by clicking the speedometer icon. Use the drop-down menu to select which solution to view in the sidebar. Alternatively, click the table icon to view the summaries in table format.

4.3.2. Themes, Weights, Includes

Radial bar charts indicate the ratio of units included in the solution, the goal (set by the user), and the units already located in protected areas. Mousing over each bar will reveal the statistics for each parameter. These statistics are also available in the table format.

4.4. Download data

Open and close the Download data sidebar by clicking the download icon. Select a data layer or a solution to download.

4.5. Contact toolbar

Open and close the Contact sidebar by clicking the envelope icon. Developer contact information is located here.

4.6. Acknowledgements toolbar

Open and close the Acknowledgements sidebar by clicking the envelope icon. Developer contact information is located here.

4.7. Map navigation

4.7.1. Zoom in/out

Use the [+/-] icon to navigate the map.

4.7.2. Zoom to Home

Use the house icon to return to the original extent.

4.7.3. Hide/unhide layers

Use the eye icon to remove or view all layers.

4.7.4. Help

Open a popup with a brief overview of the tool.

4.7.5. Screenshot

Take a screenshot of the map by clicking on the printer icon.

4.7.6. Background layer

Select which background layer to visualize.

4.7.7. Go to Previous/Next Extent

Toggle between different views.

5. References

Ball, I. R., Possingham, H. P., & Watts, M. 2009. Marxan and relatives: software for spatial conservation prioritisation. Spatial conservation prioritisation: Quantitative methods and computational tools, 14, 185-196.

Groves, C.R. and E.T. Game. 2016. Conservation Planning: Informed Decisions for a Healthier Planet. Roberts and Company Publishers, Inc. 580 pp.

Hanson, J.O., R. Schuster, N. Morrell, M. Strimas-Mackay, M.E. Watts, P. Arcese, J. Bennett and H.P. Possingham. 2020. Systematic Conservation Prioritization in R. Available here: https://prioritizr.net/