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Seasonal Operability Predictor Tool for Forest Operations
Technical Operations Guide

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Prepared for:

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1.0 INTRODUCTION

The objective of the seasonal operability predictor tool was to utilize existing enhanced forest inventory (eFRI) information and supplemental elevation-based datasets to automatically analyze and produce raster-based datasets that support the seasonal scheduling of forest operations in Ontario.

There are many challenges associated with harvesting forested lands in Ontario. One of the biggest challenges faced by AV Terrace Bay is the ability to maintain year-round, uninterrupted operations due to the seasonal imbalance of operable areas across its woodshed. The primary intent of the tool is to model the potential for seasonal operability on a cell-by-cell basis to predict seasonal operability at the landscape and polygon level.

Several modeling scenarios were developed throughout the duration of the project. With consideration to broadly available geographic information systems, an ArcGIS model was developed. The model is designed to incorporate readily available geographic data that is accessible to tenure holders. These datasets include the eFRI, the Canadian Digital Elevation Model (CDEM) and where available, the Ontario Provincial Digital Elevation Model (PDEM). While some of the challenges identified throughout the course of development indicate the need for better localized elevation data such as LiDAR datasets, the model was designed and calibrated to use readily-available data. Where better remotely-sensed information exists, the model was designed to be able to utilize it accordingly.

The following documentation outlines the tool requirements for execution, a guide for successful implementation and the procedures associated with analyzing the output datasets of the seasonal operability predictor tool.



2.0 PREREQUISITES AND SYSTEM REQUIREMENTS

2.1 Prerequisites

The predictor tool requires ESRI ArcGIS for Desktop 10.1 or newer installed prior to model installation and execution. The tool uses the Spatial Analyst extension and several other utilities that require ArcGIS for Desktop Advanced licensing. A list of the prerequisites include;

- ESRI ArcGIS for Desktop 10.1 (or newer)
- ArcGIS for Desktop Service Pack 1 (SP1)
- ESRI Spatial Analyst Extension
- Microsoft .NET Framework 3.5 SP1
- WinZip or 7Zip, or other compatible archive compression utility

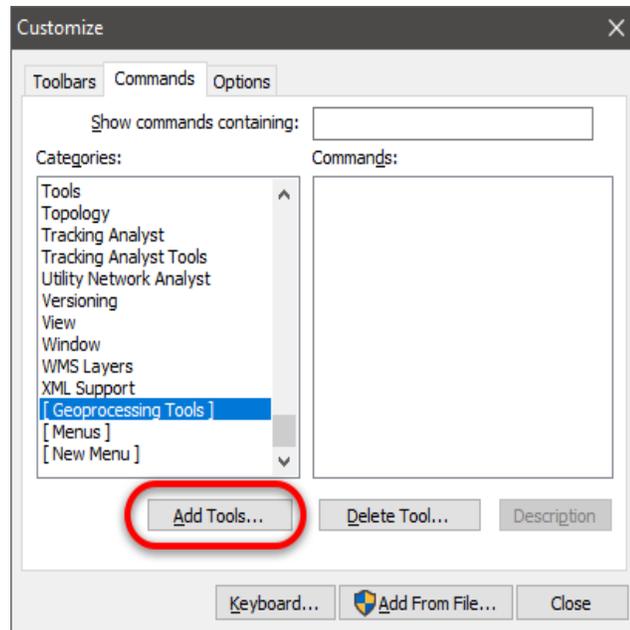
2.2 System Requirements

The seasonal operability predictor tool runs within the ESRI ArcGIS for Desktop environment and thus relies on compatible and recommended system requirements as outlined in the ArcGIS 10.1 for Desktop quick start guide. In addition to system default recommendations, the tool requires that a minimum of 10GB hard disk space is available within the geoprocessing environment.

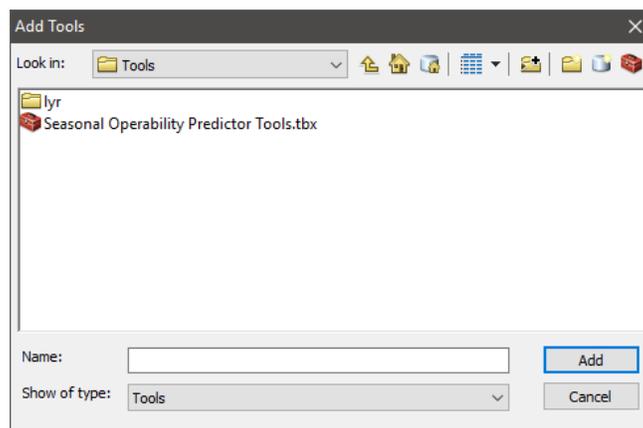


3.0 INSTALL

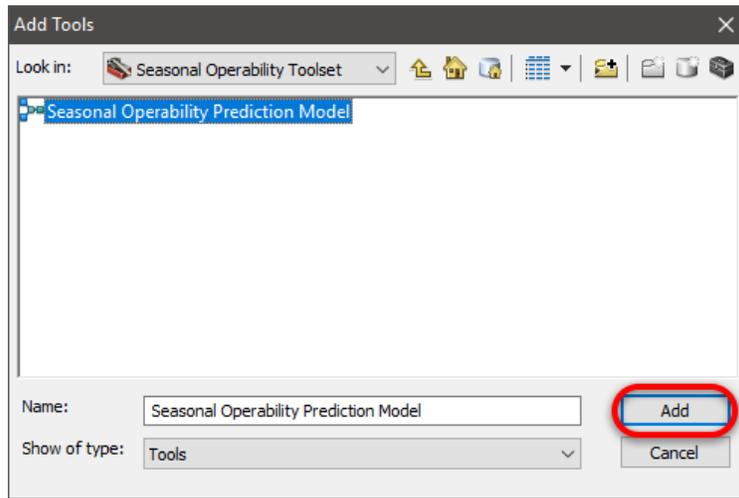
1. Extract the Seasonal Operability Predictor Tool.zip archive zip file to a known location, either locally on a workstation or on a network drive accessible via a network connection within ArcGIS for Desktop.
2. Run ArcGIS for Desktop and start a new blank map document.
3. Open “Customize Mode...” by clicking Customize and Customize Mode.
4. Select the “Commands” tab. In the Categories pane, scroll to the bottom and select “[Geoprocessing Tools]”, then select “Add Tools...”.



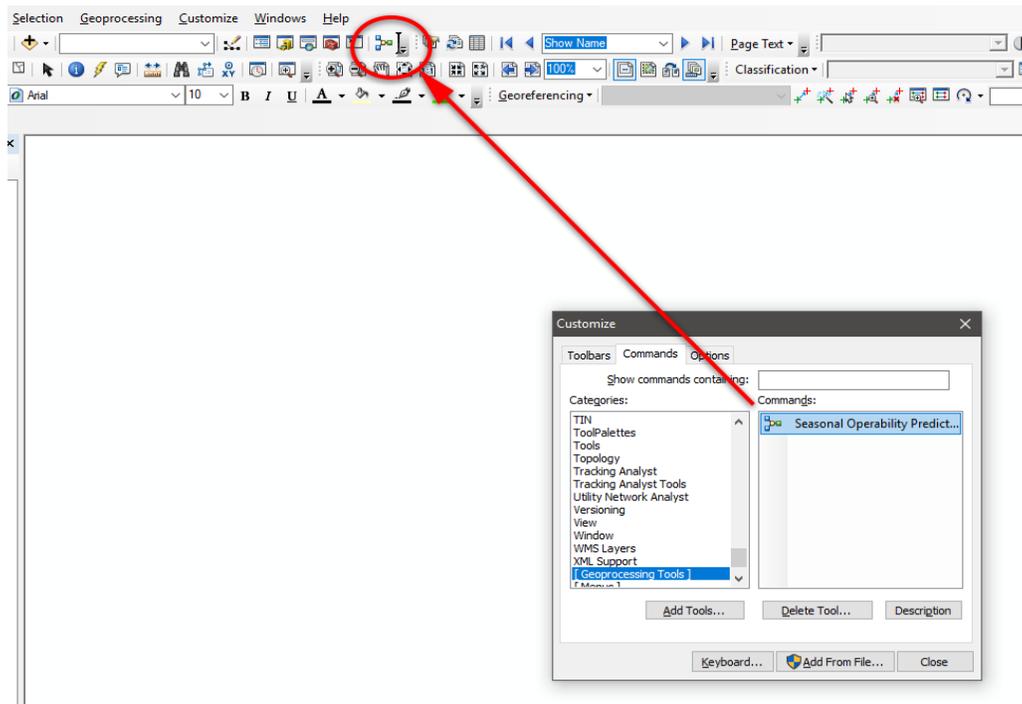
5. Browse to the location of the toolbox that was extracted in step 1.



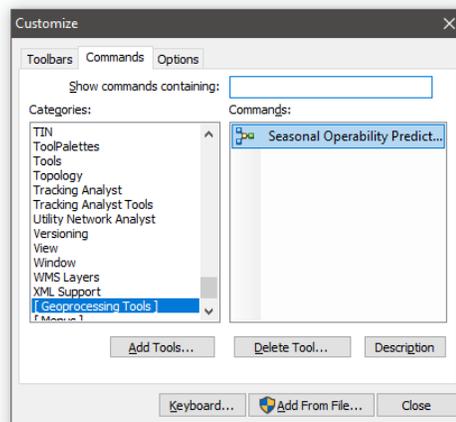
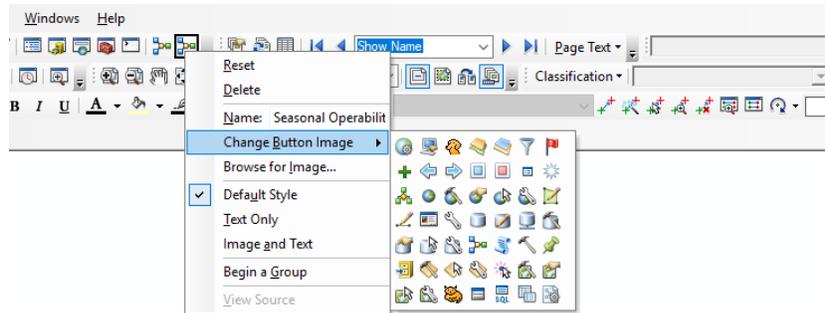
- Expand the Seasonal Operability Predictor tools.tbx toolbox, expand the Seasonal Operability Toolset and select the Seasonal Operability Prediction Model. Click “Add”.



- The tool should now be visible in the “Commands:” pane of the customize panel. Drag the model to a suitable location within a toolbar of ArcMap, such as the main toolbar.



- Optionally, a custom image can be set to differentiate the tool from other icons by right-clicking on the icon, selecting “Change Button Image” and selecting a different icon.



NOTE: *If the toolbox is relocated to another location either on a local intranet or another location on the workstation, the shortcut will no longer function properly and will need to be recreated using the steps illustrated above.*

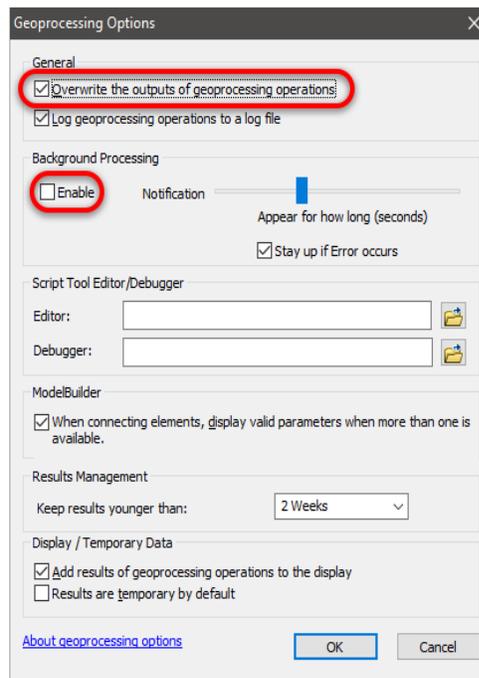


4.0 SETUP

Prior to executing the model for the first time, several environmental variables must be set.

1. Select Geoprocessing from the ArcMap taskbar, and select Environment Settings.
2. Expand “Workspace” and ensure that the Scratch Workspace is set to a file geodatabase (.gdb).
Note: ArcGIS for Desktop automatically sets the scratch workspace to the Default.gdb, located in the user default documents directory. It is not mandatory that the scratch workspace is set to the Default.gdb, however it is mandatory that the scratch workspace is of a file geodatabase type that the user has read and write privileges to.
3. Select OK to close the Environment Settings.
4. Select Geoprocessing from the ArcMap taskbar, and select Geoprocessing Options.
5. Under the General pane, ensure that “Overwrite the outputs of geoprocessing operations” is enabled.

Note: While it is not mandatory, it is recommended that Background Processing is disabled. The model performs several CPU-intensive functions and executes several tasks that are stored in_memory. Disabling background geoprocessing enables the user to monitor and debug the process as it executes should the tool fail during processing.

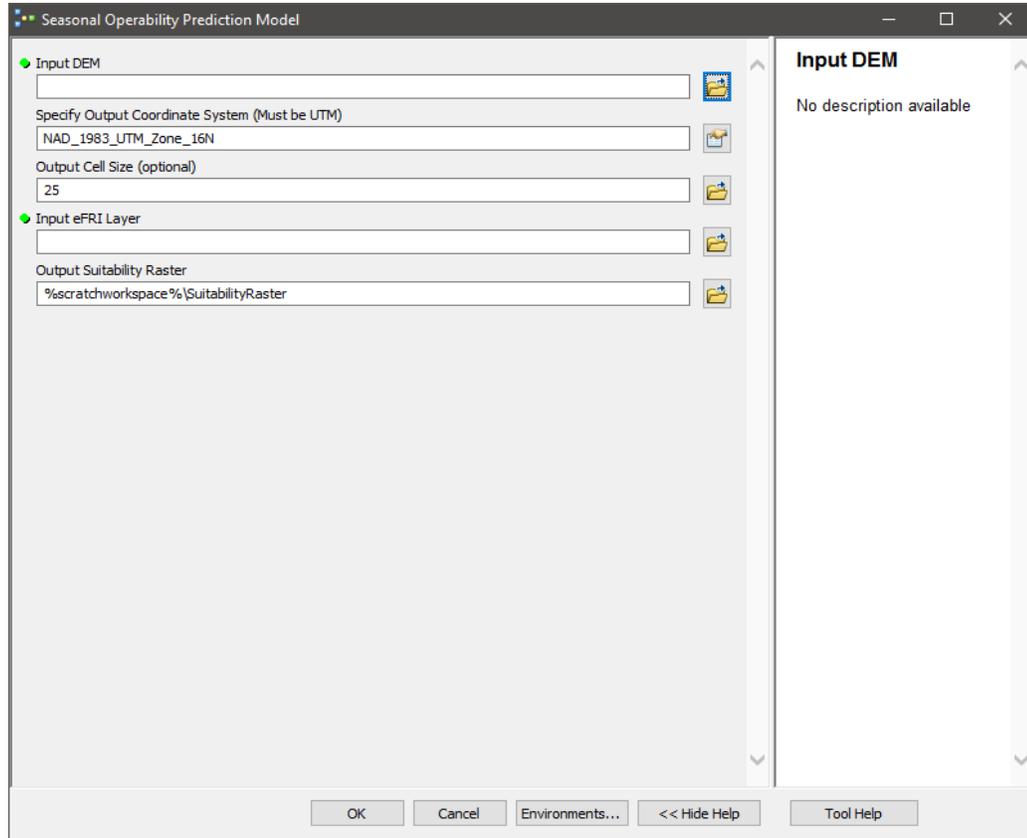


6. Select OK and close the Geoprocessing Options dialog.



5.0 EXECUTING THE MODEL

1. Run the model using the shortcut created in Section 3.0 or by running the model from the toolbox in its extracted location from Section 2.0.



2. Populate the "Input DEM" parameter by browsing for an appropriate DEM raster dataset. The user can either specify a DEM located within the current map document by dragging and dropping into the field or browse a network connection and specify an appropriate DEM raster dataset that covers the extent of the study area.
3. Select the appropriate Output Coordinate System for the DEM. The default is NAD 1983 UTM Zone 16N and does not require to be changed however if the zone differs from the default, the user should change it accordingly. It is mandatory that the user specifies a projected coordinate system and not a geographic coordinate system.
4. Specify an appropriate raster cell size. If the input DEM has a cell size less than 25m, the user can specify it. Otherwise, the default 25 metres will be used for analysis.
5. Specify the location of the eFRI layer. This can be a layer within the current map document or a feature class residing in a geodatabase.



6. Specify the location of the output suitability raster index dataset. The default parameter stores the raster dataset within the scratch workspace specified in Section 4.0, step 2. If it is desired to store the dataset elsewhere for future use, it is recommended to change this directory to an alternate geodatabase. Suitable formats include .tiff, ESRI grid (no extension), .jpg, among other supported raster types.
7. Select OK to run the model.



6.0 ANALYSIS

Following successful execution of the model, a new raster layer will be added to the table of contents. The raster layer will use a default color map containing six values. The values represent site operability where a value of one represents areas that are suitable for operation during all seasons and six representing areas where operability may be limited to winter operations only.



Figure 1. Layer color ramp and symbology.

The color ramp represented by the raster dataset uses a relative scale range which implies that a value of one is most likely to be driest, and a value of three being somewhat dry. Conversely, values of six represent areas with the highest probability of limited operation and four represents areas that have a moderate probability of limited operation during wetter periods of the year.

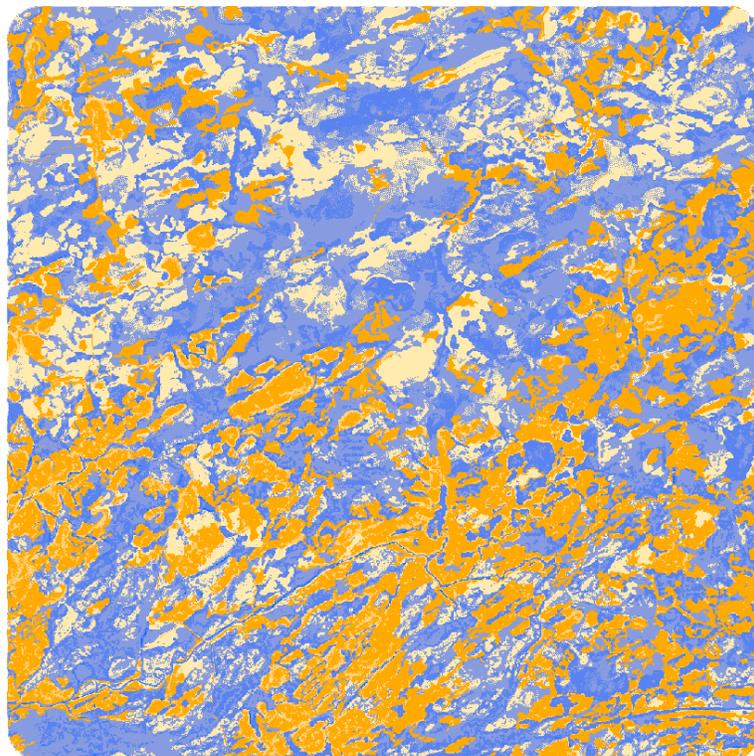


Figure 2. Raster layer indicating probability scenarios.

The model produces a raster dataset based on the analysis of a variety of eFRI polygon conditions. Primarily, the model assesses the eFRI dataset on a polygon-by-polygon basis to determine the interpreted ecotype. If the polygon is assessed as having an assigned ecotype value of six, nine or 10, it is processed further. The model then applies an appropriate weighting to each interpreted species and their association with individual site characteristics.

In addition to eFRI evaluation, the raster dataset is also analysed against topographical features such as polygon positioning in relation to slope. The model applies a series of weights with respect to slope profile curvature (where the polygon resides on a slope and how water moves perpendicularly to the slope) and plan curvature (where the polygon resides on a slope and how water moves across the slope). Using these values, a series of additional weights are applied to compute the relative polygon seasonal operability conditions for each cell/pixel within a polygon. Given the broad scale and availability of high resolution digital elevation data, a default value of 25m ground sample distance was used. Using slope positional calculations, the model assumes that cells within a polygon that reside at the toe or bottom of a slope contain the highest probability of seasonal operability constraints. Conversely, cells within a polygon that reside at mid and upper positions within a slope have a lower probability of limited seasonal operability constraints.



Figure 4. Imagery comparison of probability raster of same area.

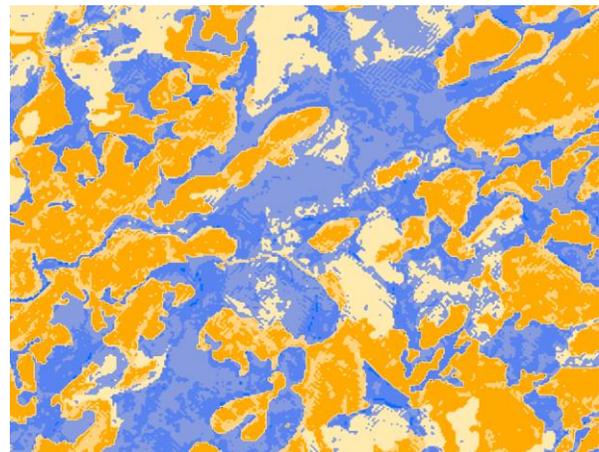


Figure 3. Probability raster.

7.0 RECOMMENDATIONS AND CONCLUSION

The seasonal operability predictor tool is designed to utilize readily-available geographic data such as the enhanced forest inventory and the Ontario provincial digital elevation model (PDEM). The enables a broader scale of use without the requirement of custom datasets and new acquisitions. There are many advantages of predicting seasonal operability in a geoprocessing environment such as ArcMap. It was observed that the seasonal operability tool reduces the requirement of using a stereo environment to manually identify sites which may have limited operability during seasonal changes. The process of viewing and assessing the landscape using stereo imagery is time consuming and the use of automated prediction models reduces the expense associated with manual stereo interpretation.

Several challenges were identified throughout the development of the prediction models. Most notably, the availability of high-resolution digital elevation model data. While the prediction tool was able to identify areas of limited operability potential, the availability of higher resolution data (such as LiDAR) limited the overall results. The coarser resolution of freely-available elevation data provided limited abilities to perform accurate analysis in lowland areas and other areas that have little to no elevation change. Results can be significantly improved with the integration of higher resolution digital elevation data such as LiDAR and other remotely-sensed datasets. The seasonal operability models are designed to process widely-available lower resolution elevation data such as the Canadian Digital Elevation Model (CDEM) and the Ontario PDEM. However, should higher-resolution elevation data such as LiDAR become available for a given area, the model is designed to utilize the alternate data inputs without significant recalibration of the model components.

In addition to challenges associated with readily-available high resolution elevation data, the models rely heavily on the eFRI as a primary input. The eFRI does not typically capture small scale details such as isolated lowlands and wet areas and thus are challenging to identify using the model. The eFRI is generated using stereo interpretation methods and in addition to limited small-scale details, human error can also affect model outputs and results. It is recommended that to obtain the best possible results for seasonal operability prediction, a more significant emphasis and weighting is placed on higher-resolution elevation data with a decreased emphasis placed on the eFRI. Using high-resolution digital elevation data with the eFRI as a secondary input will increase the quality of model outputs and ensure that issues such as human error and small-scale feature discrepancies are minimized in the suitability index raster.

