Competition Index

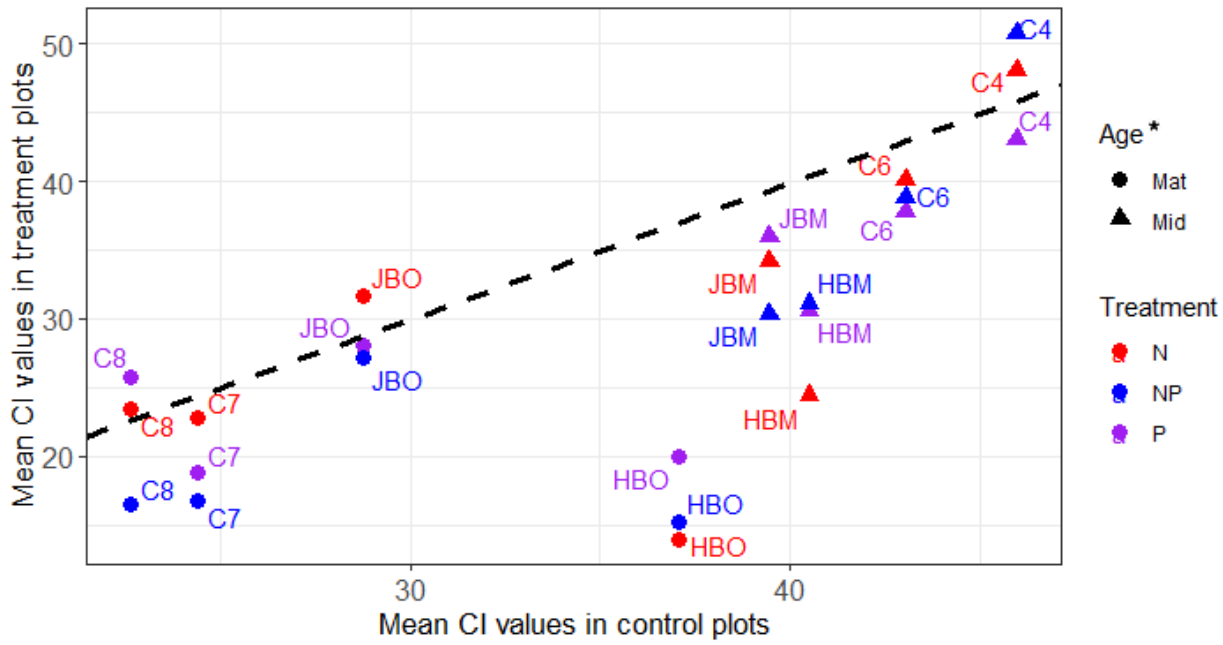


Figure: One-to-one scatterplot of the difference in mean CI values from control plots (control) to treatment plots (N, NP, and P). CI values were significantly impacted by only stand age via a full-factorial ANOVA (p<0.05, df=1). Treatment effects were not significant.

Competition Index Equation and Mapping

The following equation from Rouvinen and Kuuluvanien (1997) was used with the stem location dataset to establish CI values at every 1x1-m square across the interior of applicable MELNHE treatment plots:

$$CI = \sum_{i=1}^{n} \arctan\ arctan\left(d_i/dist_i\right)$$

where

d_i= tree DBH (cm)

$dist_i$=distance (m) from point of interest to tree

This equation used untagged buffer tree data as well as the tagged trees within the measurement area. The search radius for each competition point was set to 10 m—the same length as the buffer around all treatment plots. This followed a similar protocol to Contreras *et al.* (2011) wherein all trees were assessed in a search radius of 11 m–a radius 3.5 times the average radius of tree crowns and roughly the span of an average mature tree's root system (Lorimer 1983). The reduction from 11 m to 10 m was unlikely to reduce the efficacy of the competition index for the MELNHE plots.

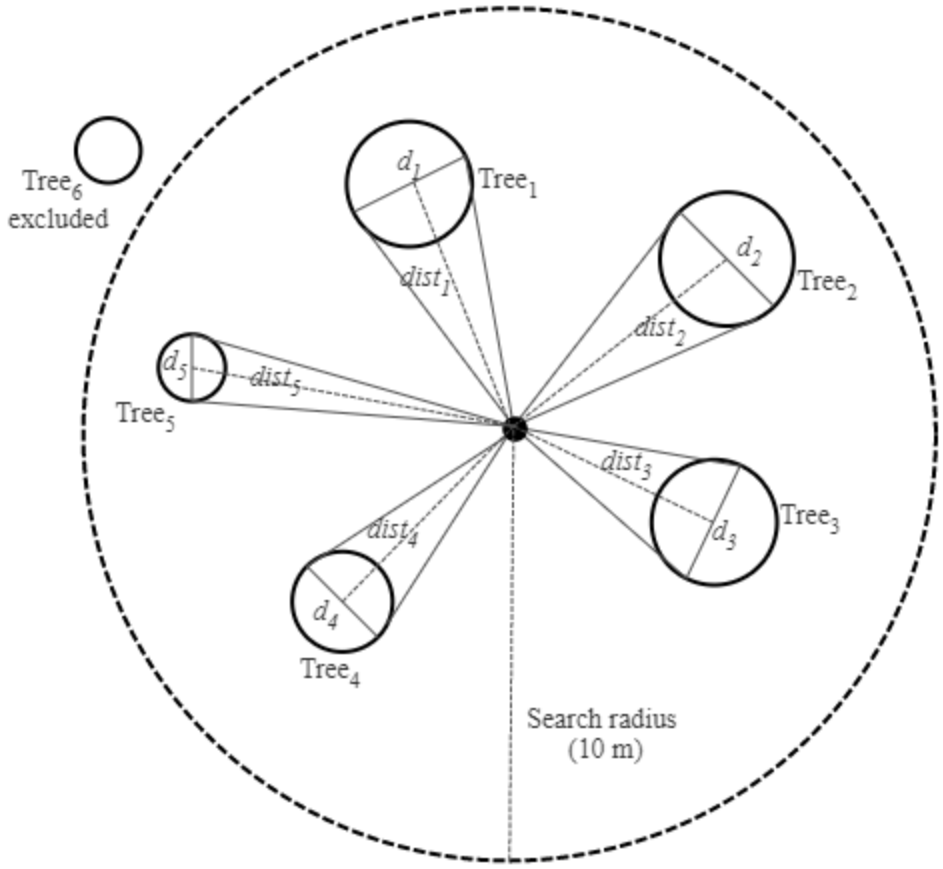


Figure 7 Model based on Contreras *et al.* (2011) of the CI model computation. Horizontal angles from the focal point (center) to all surrounding trees within 10 m were created using the arctangent of the distance and DBH. Focal points were based for calculation at the center of each 1x1-m across the experimental plots.

A map layer consisting of a grid of 1x1-m squares was added as a feature class layer in ArcGIS Pro overlapping all MELNHE stands where CI was applicable. Following calculation, these points were color-coded based on their calculated CI values from green (low competition) to red (high competition) to display tree-dictated competition within that 1x1-m area at that location within the plots. Each experimental plot contained 900 1x1-m CI squares. Plot features including boulders and seeps/periodic wet areas were added to the maps to offer possible explanation to some CI patterns.

Tutorial on generating competition index from the geopoints location of trees

What you need to begin:

- ArcGIS Pro
- Microsoft Excel or Google Sheets
- Tree locations (found on the MELNHE website under Maps)

Step 1:

Combine both inner trees and buffer trees into one continuous sheet on Excel. Be sure to include the locations of the trees with other parameters (DBH, species, tag number, etc.) depending on on what kind of equation you are using. Do this for all the stands you intend to map. Be aware that Ca trees may be included but will not have buffer trees.

Step 2:

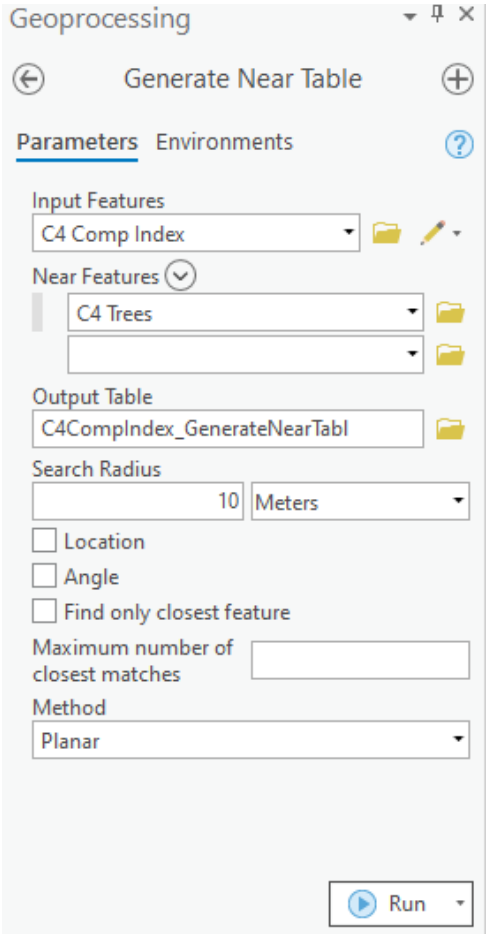
Open ArcGIS and import treatment plots you need using available the shapefiles from the MELNHE website. Also import trees from the Excel made in Step 1 using the Add Data dropdown on the Main pane in ArcGIS. A table will appear at the bottom of the Contents pane in ArcGIS after importing. Right click the table and select Display XY Data. A dialogue box will appear where you need to match the longitude and latitude to the longitude and latitude from the Excel file. To finish, select the appropriate projection system (probably NAD 1983 (2011) UTM Zone 19N) to display the trees on the map.

Step 3:

On ArcGIS, create a new polygon layer to serve as your competition index polygon. Make sure to add an additional field in the attribute table to copy in your competition index values later and make sure this field uses the double number data type. Once this is created, draw the new polygons over top of the interior of the stand. You will divide the polygon using the Divide tool to any area you intend to analyze. This process is tedious and takes the most time as there is not really a good way to divide polygons into equal areas with same length and widths with the base ArcGIS license.

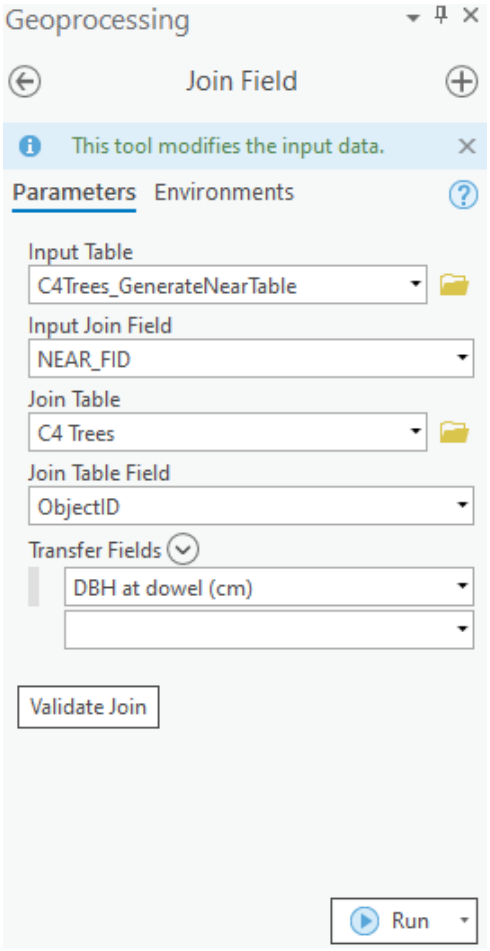
Step 4:

Use the Generate Near Table geoprocessing tool in ArcGIS Pro with the following settings applied. If you are performing the competition index under differing parameters, feel free to change the settings to fit your intended purposes. A table should now appear at the bottom of the Contents pane in ArcGIS.



Step 5:

Use the Join Field geoprocessing tool to Join any parameters from the trees to the Near Table created in the last step. This will use the Feature ID (which are automatically created when you add the tree into ArcGIS) of the trees and NOT the tree tags.



Step 6:

The DBH (or whatever information you selected) should now be included within the Near Table from Step 4. Select and copy this whole table to a new sheet in Excel. In Excel, create an equation that uses the distance calculated in the near table (for example, my equation for each row was =atan(dbh/distance)). Double-click to apply this equation to all rows. If you have any distances that =0, use the Find and Replace tool in Excel to change 0 to 0.01.

Step 7:

Still in Excel, select all the data and create a Pivot Table. Use the “In_ID” as the Rows and the equation (in my case “Sum of atan”) as the Values. Copy all of the sums as your competition index values and paste them into your competition index feature class in ArcGIS.

Step 8:

The last step is to make your symbology to show the differences in the competition values. For me, I used Unclassed Colors from green to red to show competition from low to high. I also removed borders from the 1x1-m squares for aesthetical reasons. You could also use Classed Colors to find areas of a more quantifiable competition value.