NCSSF Multi-Scale Spatial Analysis Tool

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Software Requirements:
MS Windows OS, created and tested using XP with service pack 2
MS .Net framework 1.1 or higher
ArcGIS 9.0 with service pack 1 or higher
Spatial Analyst Extension for ArcGIS
Administrative Privileges Are Required for Install

Data Requirments:
All data must be in the same projection prior to input. All calculations are made assuming projection units to be in meters. Failure to input data using proper spatial units may result in erroneous output.
The tool was designed and tested using the following spatial reference:

```
Projection: Albers
Parameters:
  False_Easting: 0.000000
  False_Northing: 0.000000
  Central_Meridian: -96.000000
  Standard_Parallel_1: 20.000000
  Standard_Parallel_2: 60.000000
  Latitude_Of_Origin: 40.000000
Linear Unit: Meter (1.000000)
Geographic Coordinate System: GCS_North_American_1983
Angular Unit: Degree (0.0174532925199433299)
Prime Meridian: Greenwich (0.000000000000000000)
Datum: D_North_American_1983
  Spheroid: GRS_1980
    Semimajor Axis: 6378137.000000000000000000
    Semiminor Axis: 6356752.314140356100000000
    Inverse Flattening: 298.257222101000020000
```

Input Variable Requirements

Forest Inventory Variables

Stand Boundaries – Shapefile or featureclass (vector) with the following attributes permanently joined to the table:

- Age of the stand or the year that the stand was planted (initial year)
- Stems per acre (TPA):
  - Pine
  - Hardwood
- Basal Area (BA):
  - Pine
  - Hardwood
- Stand Classification for all non-forest stands, other types will be calculated using the percentage of pine and hardwood.

Environmental Variables

Digital elevation model; horizontal and vertical units in meters

Roads; Shapefile or featureclass (vector)

- 1:24,000 scale
- 1:100,000 scale

Streams; Shapefile or featureclass (vector)

- 1:24,000 scale
- 1:100,000 scale

Output Calculations

The following datasets will be produced (ESRI Grid format). Please note that some of these calculations and equations differ from previous version of similar models. If calculations or formulas differ from previous models the equations are provided.

ELEVA – USGS elevation above mean sea level for the plot (meters).

ASPCT360 – Aspect, Orientation towards north for the plot. Calculated from 30m digital elevation model and surrounding pixels using the "Aspect" command of ESRI's ArcGIS 9.0.

ASPECT – Beers Transformation (range 0-2), .

CURV- Net curvature, range -1 = concave (collecting water) to 1 = convex (shedding water). Calculated from 30m digital elevation model and surrounding pixels using the "pSurfaceOp.Curvature" command of ESRI's ArcGIS ArcGIS 9.0.

SLOPE – Mean slope, for the plot. Calculated from 30m digital elevation model and surrounding pixels using the "Slope" command of ESRI's ArcGIS ArcGIS 9.0.

IS_AREA – Individual Stand Area (m2) of stand where the species count was conducted. This statistic is calculated by the GIS software using an internal algorithm that is designed to calculate precise areas for complex polygons.

IS_AGE - Individual Stand Age, Age of stand where the species count was conducted. This value is extracted from the stand inventory data

IS_TYPE – Individual Stand Type, Overstory Classification of stand where the species count was conducted. For simplification, we are generalizing the forest inventory data to the following overstory classes: pine, mixed, hardwood, harvest and non-forest.

Hard – Indicated as "hardwood" by stand inventory data or aerial photos and basal area < 25% pine.
Mix – Area Indicated as "mixed forest" by stand inventory data or aerial photos, not having a clear indication of basal areas > 75% hardwoods or > 75% pine.
Non – Area Indicated as "non-forest" by stand inventory data or aerial photos.
Pine – Indicated as "hardwood" by stand inventory data or aerial photos and basal area > 75% pine.
Hvst – Stands where harvest event has occurred/not yet replanted or less than 1 year old regeneration.

IS_HBA – Individual Stand Hardwood Basal Area. Units are square feet/acre.

IS_PBA– Individual Stand Pine Basal Area. Units are square feet/acre.

IS_HTPA– Individual Stand average Hardwood Trees per Acre. Units are square feet/acre.

IS_PTPA– Individual Stand average Pine Trees per Acre.

IS_PBIO - Individual Stand Pine Biomass estimate kg/hectare.

IS_PHIO - Individual Stand Hardwood Biomass estimate kg/hectare.

IS_BIO - Individual Stand Total Biomass estimate kg/hectare.

Biomass estimates were calculated using equations from:
Jenkins, J.C., D.C. Chojnacky, L.S. Heath, and R.A. Birdsey, 2003, National-scale biomass estimators for United States tree species, Forest Science 49(1):12-35)

The equations use DBH and forest composition to estimate above ground biomass. We used two species groups "pine" and "mixed hardwoods".
DBH measurements were provided by forest managers or calculated using stems-per-acre and basal areas.

DST2_WTR_A – Distance (in meters) to nearest water feature. This refers to all water features and uses 1:24,000 scale datasets derived from USGS topographic maps. Dataset includes major tributaries and water bodies as well as small streams, ponds and man made canals.

DST2_WTR_C – Distance (in meters) to nearest water feature. This refers to only water features included in the US census Bureau's hydrology coverage. Scale 1:100,000. Dataset includes major tributaries and water bodies.

DST2_RDS_A – Distance (in meters) to nearest road feature. This refers to all road features and uses 1:24,000 scale datasets derived from USGS topographic maps and or supplied by landowners. Dataset includes major roads and highways as well as minor unpaved service and/or private roads.

DST2_RDS_C – Distance (in meters) to nearest road feature. This refers to only road features included in the US census Bureau's road coverage. Scale 1:100,000. Dataset includes major roads and highways.

The following list of neighborhood variables refers to measurements or calculations for buffer areas/neighborhoods. The suffix indicates the scale of the measurement, 1=100m, 2=250m, 5=500m, k=1000m.

LNDPO - Landscape Position
This variable captures relative position of the sample location on the landscape. Essentially, it quantifies degree to which the observation location is exposed (ridge) or sheltered (valley) relative to the surrounding landscape, at various scales. Positive values indicate exposed and negative values indicate sheltered. The suffix indicates the scale of the measurement, 1=100m, 2=250m, 5=500m, k=1000m.

Equation: **E / MA + (1* (E-MA/Abs(E-MA)) *S)**
MA = Mean elevation of an annulus around the sample location. The radius of this annulus varies with scale. The term annulus refers to a hollow ring.
E = Elevation at sample location.
S = Standard Deviation, for the entire landscape, of MA + E

SL_BA – Stream Length Best Available
This refers to all water features and uses 1:24,000 scale datasets derived from USGS topographic maps. Dataset includes major tributaries and water bodies as well as small streams, ponds and man made canals.

RL_BA – Road Length Best Available
SCA – Proprietary data provided by MeadWestvaco, Approximate scale 1:24,000, known to include small forestry and logging roads, coverage doesn't extend beyond property boundaries.
SCW – Provided by International Paper, Approximate scale 1:24,000, known to include small forestry and logging roads, coverage doesn't extend beyond property boundaries.
WV – Provided by MeadWestvaco, scale 1:24,000, Source; USGS Topographic maps.
AR – Roads provided by collaborators are identical to US Census Bureau road coverage.

SL_CEN and **RL_CEN** – Stream and Road Length Census Bureau
Approximate Scale 1:100,000 and includes all major and secondary roads as well as most larger access roads.

M_AGE - Mean age of buffer area

AGE_STD - Standard Deviation of the mean age of buffer polygons, weighted by area (m2).

SWDIV - Shannon-Wiener Diversity index (H') calculated using area and overstory classification.

Shannon-Wiener Diversity index (H') calculated using area and overstory classification. A routine, written in Visual Basic, loops through the buffer's attributes. It calculates the Shannon-Wiener index and adds these values to the attribute table.
Formula:

SWDIV or $H' = -\sum_{i=1}^{s} \rho_i * \ln \rho_i$

$\rho_i =$ area (m^2) of cover type i / total area (m^2) of the buffer

EVNS - Evenness of landscape, using class and area (m2).

Evenness (E) of landscape, using class and area (m^2).
A routine, written in Visual Basic, loops through the buffer's attributes. It calculates the evenness for each buffer and adds these values to the attribute table.
Formula:

EVNS or $E = H'/ H_{max}$

$H_{max} = \ln S$

S = the total number of cover types found in the buffer

HARD - Area (m2) of the neighborhood classified as hardwood forest.

MIX - Area (m2) of the neighborhood classified as mixed forest.

NON - Area (m2) of the neighborhood classified as perpetual non-forest (agriculture, right-of-ways, etc.).

PINE - Area (m2) of the neighborhood classified as pine forest.

HVST_- Area (m2) of the neighborhood classified as harvested forest, not yet replanted, undergoing continued preparation.

FRGFT – Mean fragmentation of forest type for the neighborhood calculated using a raster fragmentation formula.

Raster Formula:

$$Fr = 1 - \frac{\sum_{i=1}^{s} n_i}{\sum_{i=1}^{s} N_i}$$

N = Total number of possible comparisons made.
n = Number of comparisons where neighbors are similar.

AC0_ - Age Class, Area (m2) of the neighborhood where: age = 0.

AC5_- Age Class, Area (m2) of the neighborhood where: 0 < age < 5.

AC20_- Age Class, Area (m2) of the neighborhood where: 0 < age < 20.

AC30_- Age Class, Area (m2) of the neighborhood where: 0 < age < 30.

ACO40_ - Age Class, Area (m2) of the neighborhood where: age > 40.

ACO60_ - Age Class, Area (m2) of the neighborhood where: age > 60.

FRGAC – Mean fragmentation of age class for the neighborhood calculated using a raster fragmentation formula.

Age classifications:
Class 1 – Age = 0-5
Class 2 – Age = 6 -12
Class 3 – Age = 13 -20
Class 4 – Age = 21-30
Class 5 – Age > 30

Raster Formula:

$$Fr = 1 - \frac{\sum_{i=1}^{s} n_i}{\sum_{i=1}^{s} N_i}$$

N = Total number of possible comparisons made.
n = Number of comparisons where neighbors are similar.

Installation

1) Run: NCSSF_Setup.msi and follow wizard (be sure to select 'everyone').

2) Open ArcMap and navigate to the customize dialog.

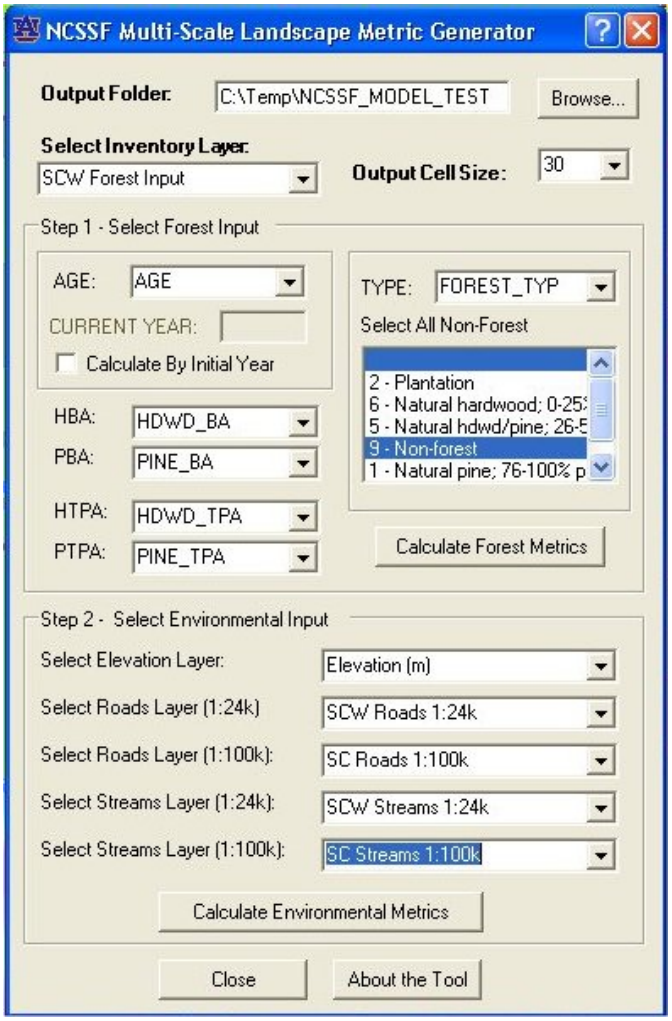
3) Select the 'Commands' tab and click 'Add from File'.

4) Navigate to the installation directory and select 'AvianModel.tlb'.
Default path is "C:\Program Files\NCSSF\Forest Landscape Model Builder".

5) Three new tools should appear in the NCSSF category.
Drag these tools to the desired toolbar.

User Interface

The 'Calculate Multi-Scale Statistics' button  displays the following dialog:

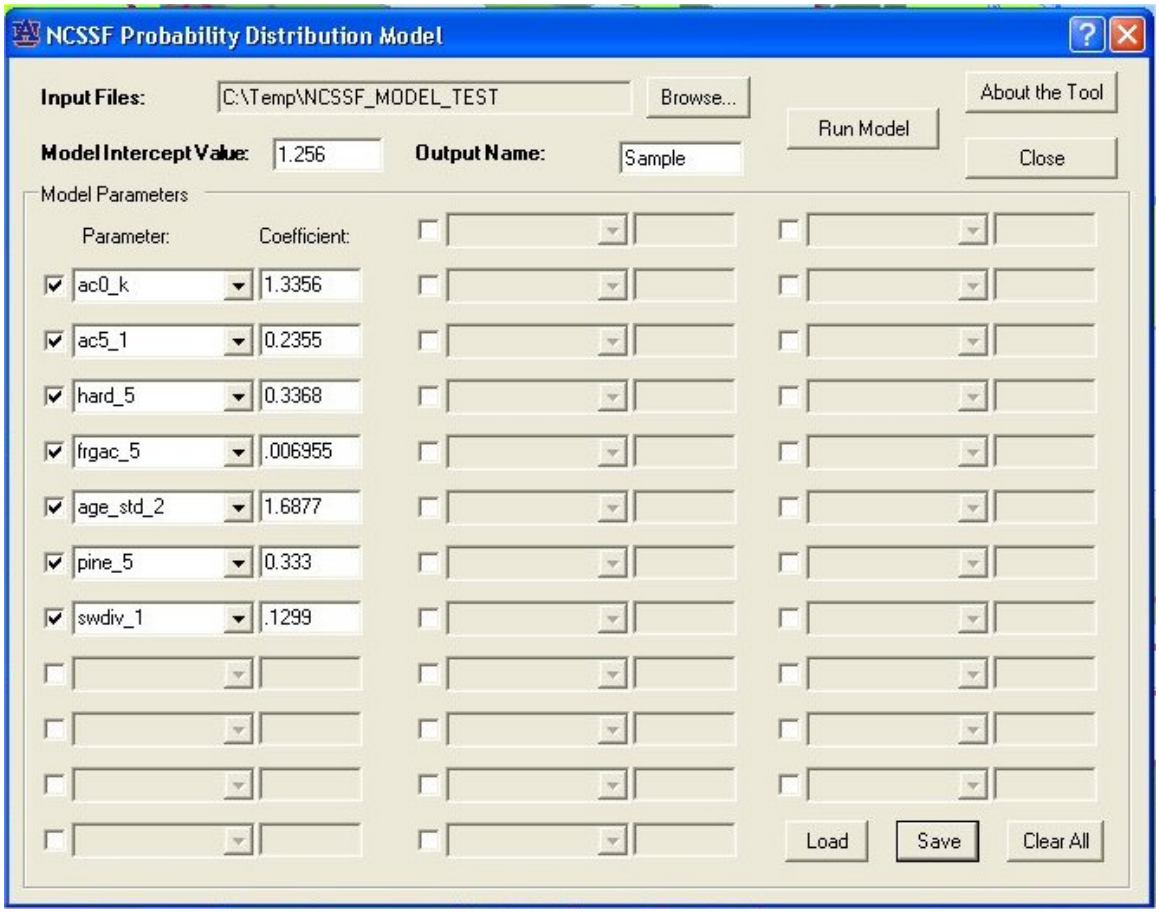


This dialog allows the user to define the input data using layers that are present in the map.
The Forest Inventory and Environmental Statistics are calculated separately. Select the output folder to store the grids and select the desired cell size. **Warning:** The smaller the cell size the longer it takes to calculate the statistics. Selecting a cell size below 30 meters is not recommended.

Temporary datasets will be stored in a '…\tempfiles' folder that will be created automatically. These files can be manually deleted after the calculations are complete to conserve disk space.

Click the '?' icon and then click on items in the form for more information.

The 'Calculate Species Distribution' button will display the following dialog:



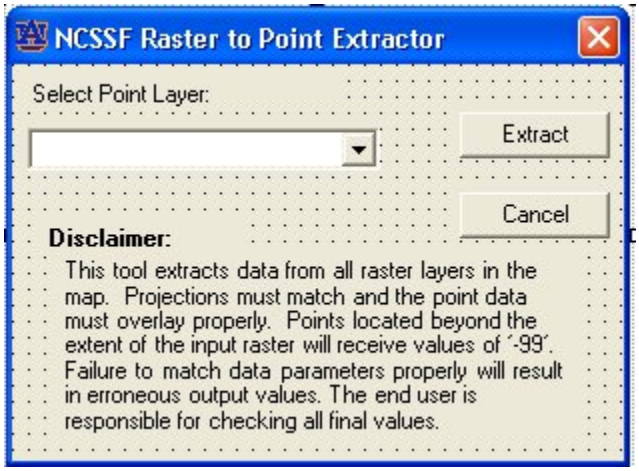
Selecting a check box will allow the user to choose from a list of ESRI Grids that are stored in the input directory (they do not need to be layers in the map). Enter the coefficient for each parameter. The model can be stored as a text file and reloaded to run additional models.

The model runs using the following equation:

logit = Intercept + (Coefficient $_1$ * Grid $_1$) + (Coefficient $_2$ * Grid $_2$)… (Coefficient $_n$ * Grid $_n$)

Probability Surface = EXP(logit) / (1+EXP(logit))

The ‘Extract Raster Data’ button  will display the following dialog:



This tool can be used to extract the values of the raster datasets to a point file. The coincident values of all raster layers in the map will be added to the selected point layer. New fields are added and named after the each raster layer.