Weantinoge Parcel Prioritization Analysis Methods

Prepared for Weantinoge Heritage Land Trust by the Center for Community GIS

9 January 2019, Updated 27 November 2019

Analysis area

Litchfield County and town of Sherman, CT

Data preparation

This analysis converts all input datasets to 30m resolution rasters to match the grid of TNC's Climate Change Resiliency dataset (NAD 1983 Albers). Each grid cell is assigned a value between 0 and 1, as described below. Datasets are cropped to the analysis area to improve computational time and storage space.

Repeatable Analysis

The raster datasets can be used by the Weantinoge Heritage Land Trust to investigate different conservation priorities, by repeating the analysis. In a single analysis run, each raster dataset is assigned an integer weight to compare its relevance for conservation to the other datasets. All integer weights must add up to 100, so that results are comparable across multiple analyses. For example, if just two datasets are used and one is considered twice as important, it should receive a weight of 67, while the other one should receive a weight of 33. Each raster dataset is multiplied by its assigned weight and then added to the other weighted raster datasets. The output is one raster with each cell scored between 0 and 100.

Vector polygons of available parcels are used to aggregate the raster scores using zonal statistics. Statistics calculated per parcel include: summed score (all cells in the parcel are added up), area-weighted score (summed score divided by area of cells in the parcel), and maximum score (value of highest cell score in the parcel).

Datasets: Summary and Analysis Considerations

1) Climate Change Resilience (source: TNC)

A site's Resilience Score estimates its capacity to maintain species diversity and ecological function as the climate changes. Lands with "Above Average Resilience" will have sufficient variability and micro-climate options to enable species and ecosystems to persist in the face of climate change and will maintain this ability over time.

This 30m raster dataset has 8 classes; this analysis uses Average (value = 0.25), Slightly Above Average (value = 0.5), Above Average (value = 0.75), and Far Above Average classes (value = 1). All other classes received 0 value.

2) CT Natural Diversity Database (NDDB) (source: CT DEEP)

The Natural Diversity Database Areas is a 1:24,000-scale, polygon feature-based layer that represents general locations of endangered, threatened, and special concern species and significant natural communities. Natural Diversity Data Base Areas are a generalized representation of species and community locations. The exact locations and species names have been masked to protect sensitive species from collection and disturbance.

This dataset does not have qualitative attributes, so each polygon is considered of equal value. Raster cell values are 1 (presence of polygon in cell) or 0 (absence of polygon in cell), and polygons are not buffered because of the already generalized nature of this dataset.

- Dataset updated 11/27/19

3) CT Critical Habitats (source: CT DEEP)

Connecticut Critical Habitats is a polygon feature-based layer with a resolution of +/- 10 meters that represents significant natural community types occurring in Connecticut. These habitats are known to host a number of rare species including highly specialized invertebrates with very specific habitat associations. Connecticut Critical Habitats can serve to highlight ecologically significant areas and to target areas of species diversity.

All classifications are of equal importance. A dissolved buffer of 750 feet outward from a critical habitat area is applied. Raster cell values are 1 (presence of buffered polygon in cell) or 0 (absence of buffered polygon in cell).

- Dataset updated 11/27/19

4) Surface Water Quality Classifications Polygons/Lines (source: CT DEEP)

Surface Water Quality Classifications is a line and a polygon feature-based layer compiled at 1:24,000 scale that includes water quality classification information for surface waters for all areas of the State of Connecticut. Class AA designated uses are: existing or proposed drinking water, fish and wildlife habitat, recreational use (maybe restricted), agricultural and industrial supply. Class A designated uses are: potential drinking water, fish and wildlife habitat, recreational use, agricultural and industrial supply. Class B designated uses are: fish and wildlife habitat, recreational use, agricultural and industrial supply and other legitimate uses including navigation. Class B* surface water is a subset of Class B waters and is identical in all ways to the designated uses, criteria and standards for Class B waters except for the restriction on direct discharges. Coastal water and marine classifications are SA and SB.

4A) Surface Water Polygons

Relevant classification categories are A, AA, B, B* (SA and SB are coastal). Class A and AA waterbodies are separated and have a dissolved buffer of 300 feet outward applied. These are assigned value 1. Class B and B* waterbodies are separated and have a dissolved buffer of 300 feet outward applied. These are assigned value 0.5. Rasters of these two datasets are combined; where there is a cell that is both within an A/AA buffer and a B/B* buffer, the cell is assigned value 1. Other cells retain their originally assigned value.

4B) Surface Water Line

The attribute HY_LEGEND classes ‘No Show’ and ‘Shore’ are removed, leaving only ‘Water.’ Classification categories are A, AA, B, B* (SA and SB are coastal). Class A and AA waterways are separated and have a dissolved buffer of 300 feet outward applied (on each side of the line). These are assigned value 1. Class B and B* waterways are separated and have a dissolved buffer of 300 feet outward applied (on each side of the line). These are assigned value 0.5. Rasters of these two datasets are combined; where there is a cell that is both within an A/AA buffer and a B/B* buffer, the cell is assigned value 1. Other cells retain their originally assigned value.

Raster datasets 4A and 4B are combined. Where there is a cell that has value 1 from either or both datasets (regardless of if the other dataset contributes a 0.5 value in that same cell), the 1 value is retained. For a cell that only has a value of 0.5 from either or both datasets (and not a 1 value), the 0.5 value is retained.

5) Wetlands (source: NWI)

The National Wetlands Inventory (NWI) provides information on the characteristics, extent, and status of the nation's wetlands and deepwater habitats and other wildlife habitats. The inventory is conducted by the U.S. Fish and Wildlife Service.

The analysis retains only palustrine wetlands for analysis (ATTRIBUTE code starts with P). The estuarine, marine, lacustrine, and riverine values are not relevant for this work (the latter two because they are incorporated in the surface water data). Wetlands have a dissolved buffer 300 feet outward from their extents. Raster cell values are 1 (presence of buffered polygon in cell) or 0 (absence of buffered polygon in cell).

6) Drinking Water and Groundwater datasets

The following datasets have overlapping polygons and are unioned to determine which cells have one or both of the desired characteristics. Raster cell values are 1 (presence of a polygon from either dataset in the cell) or 0 (absence of a polygon from either of the datasets in cell).

6A) Drinking Water Resources (source: HVA-Greenprint)

The Drinking Water Resource Area was created from the combination of two datasets related to the availability of drinking water. The first dataset is derived from the 2010 CTDEEP Surficial Aquifer Texture database. The Glacial Meltwater Deposits groups capable of yielding a sufficient quantity of water for groundwater wells were selected. Further classification was not done, other than high yield or lower yield categories, due to less accuracy in the depth to bedrock data needed to rank the surficial materials textures. The second dataset is one containing local basins selected from the 2010 CTDEEP Basins database that are important to maintaining high quality surface drinking water sources for public supplies.

6B) Ground Water Quality Classifications (CT DEEP)

Ground Water Quality Classifications is a polygon feature-based layer compiled at 1:24,000 scale that includes water quality classification information for groundwaters for all areas of the State of Connecticut. The digital layer includes groundwater water quality classifications. It does not include water quality classifications for groundwaters below surface waterbodies. The Ground Water Quality Classes are GA, GAA, GAAs, GB and GC. Classes GAA and GA designate areas of existing or potential drinking water. All groundwaters not otherwise classified are considered as Class GA. Class GAAs is for groundwater that is tributary to a public water supply reservoir. Class GB is used where groundwater is not suitable for drinking water. Class GC is used for assimilation of permitted discharges. Modified classes GA-Impaired, GAA-Impaired, GAA-Well-Impaired, GAA-Well and GA-NY are found in the data layer to categorize special cases of GA or GAA that may not be meeting the goal (Impaired), surround public water supply wells (Well) or contribute to a public water supply watershed for another state (NY).

The analysis includes only areas attributed as GAA/GAAs in the field named WQCLASSP (and excludes the GA-Impaired, GAA-Impaired or GAA-Well-Impaired as well as GA, GB, and GC classes).

7) Aquifer Protection Area (CT DEEP)

Aquifer Protection Areas is a 1:24,000-scale, polygon feature-based layer that includes all Preliminary (Level B) and Final (Level A) Aquifer Protection Areas approved by the Connecticut Department of Energy and Environmental Protection (DEEP). These areas represent the land area contributing groundwater to active public water supply wells or well fields that serve more than 1000 people that are set in sand and gravel aquifers (stratified drift deposits). These areas are commonly referred to as wellhead protection areas.

All APAs within Litchfield County are classified as “Final Adopted Aquifer Protection,” meaning that the areas are mapped based on “extensive, site-specific, detailed modeling of the groundwater flow system.” Raster cell values are 1 (presence of polygon in cell) or 0 (absence of polygon in cell).

8) CT Farmland Soils (source: CT DEEP, NRCS)

Farmland classification identifies the location and extent of the most suitable land for producing food, feed, fiber, forage, and oilseed crops. Farmland classification identifies map units as prime farmland, farmland of statewide importance, farmland of local importance, or unique farmland.

The first shapefile (from DEEP) includes Prime Farmland Soils, Statewide Important Farmland Soils, and Locally Important Farmland Soils (the latter, just for some towns). NRCS provided an additional shapefile that supplements Locally Important Farmland Soils for more of the towns in Litchfield County. However, there are some towns with no locally important soil data: Canaan, Harwinton, Thomaston, and Plymouth as well as Sherman (in Fairfield County). Raster cells containing either Prime or Statewide Important Farmland Soils are valued at 1, while cells containing Locally Important Farmland Soils are valued 0.75.

9) Core Forest (source: HVA-Greenprint)

Core Forest Habitats and wetland core areas are intact, well-connected places that, if protected, will support a diversity of fish, wildlife, and plants, and the ecosystems they depend upon. Core areas contains important or unique features, including intact, resilient examples of every major ecosystem type in the Northeast and Mid-Atlantic.

This dataset does not have qualitative attributes, so each polygon is considered of equal value. Raster cell values are assigned 1 (presence of polygon in cell) or 0 (absence of polygon in cell), because of the already generalized/modeled nature of this dataset.

10) Important Bird Areas and Bird Conservation Areas (source: Audubon)

Important Bird Areas (IBAs) are based on an established program that uses standardized criteria to identify essential habitats, which are areas that hold a significant proportion of the population of one or more bird species. To qualify as a globally significant IBA, a proposed site must hold a significant number of a globally threatened species, or a significant percentage of a global population, as evidenced by documented, repeated observation of substantial congregations in an area. Audubon supplied another dataset of IBAs in review that have not yet been publicly recognized, which are termed “bird conservation areas.”

The two datasets are combined, with IBAs being valued at 1 and bird conservation areas valued at 0.5. Values are assigned for presence of a polygon in a cell.

11) Priority Road Segments (source: TNC)

Priority road segments are places where activities like land protection and changes to transportation infrastructure will provide the greatest benefit for wildlife connectivity. The Critical Linkages project identifies road segments, road stream crossings, and key habitats. Within these places, decisions and actions are further informed by wildlife tracking information, location of protected lands, site visits, and local knowledge. These segments have been identified for the creation of wildlife passage under or over high-priority road barriers.

The dataset is for Berkshire Wildlife Linkage area of Connecticut only. These lines have a 150 foot dissolved buffered to capture parcels that fall on either side of the road segments. Grid cell value is 1, regardless of if the cell abuts/contains more than one priority road segment.

12) Priority Connectivity Areas (source: TNC)

Priority connectivity areas represent zones that are most critical for maintaining connectivity across the Berkshire Linkage. Areas were identified using three criteria: 1) irreplaceability and importance to the network as measured by the Critical Linkages II 10K link importance scores, 2) contribution to connectivity within and between TNC forest cores, and 3) contribution to a north – south continuous pathway linking the Green Mountains and the Hudson Highlands. Connectivity areas may meet one or more of these criteria. Links are shown as generalized elliptical shapes to emphasize that site-specific priorities must take into account finer scale local land cover and features that were not analyzed.

The dataset is for Berkshire Wildlife Linkage area of Connecticut only. Raster cell values are 1 (presence of polygon in cell) or 0 (absence of polygon in cell), because of the already generalized/modeled nature of this dataset.

13) Protected Lands (source: Weantinoge Heritage Land Trust and HVA-Greenprint)

This dataset includes known lands with conserved status (fee, easement, private, unknown).

Adjacency or close proximity to an already conserved land is relevant for habitat connectivity. These parcels have a dissolved buffer to give the same 1 value to all grid cells within 150m (5 pixels) of the parcel boundary. All cells beyond this buffer distance are assigned a 0 value.

14) Trails (source: HVA-Greenprint, Sherman)

Trails data were combined from three different sources to create a more complete dataset for public-access trails in Litchfield County and Sherman. Some are on conserved lands, others are not.

The analysis aims to capture proximity to existing trails. These trails have a dissolved buffer to give the same 1 value to all grid cells within 150m (5 pixels) of the trail. All cells beyond this buffer distance are assigned a 0 value.

15) Calcareous Soils (source: Open Space Institute) ADDED 11/27/19

OSI's Resilient Landscapes Initiative builds on TNC's resiliency analysis. OSI defines an Underrepresented Setting as a Geophysical Setting (defined by elevation zone and dominant geology type) with regionally 1) a relatively low percentage conserved and 2) a relatively high percentage converted out of natural land cover. Since conserving high quality habitat in all Geophysical Settings is critical to ensure a broad range of biodiversity, focusing protection on Underrepresented Settings aims to protect the best examples of these "at-risk" settings.

WHLT identified the underrepresented data for calcareous soils as mapped by OSI to be relevant to this analysis. Grid cells classified as "very low calcareous" and "low calcareous" soils are assigned a 1 value; all other cells are assigned a 0 value.

16) Regional Flow (source: Open Space Institute) ADDED 11/27/19

Regional Flow is a measurement designed to identify potential pathways for directional movements by species at a larger-scale than TNC's Local Connectedness dataset. Regional Flow data uses models that identify multiple options for movement Rthat could be significant for species range shifts, migrations, or other dispersal patterns in response to climate change. Regional Flow highlights where land use patterns are likely to cause movements to become concentrated because limited surrounding options exist, as well as places where movement is diffuse when many options exist. This measure is useful for identifying the linkage areas important to maintaining permeability across the whole region.

The classes for high concentrated flow, concentrated flow, and medium diffuse flow are all assigned a 1 value.

Parcels

These are used to summarize the weighted and summed raster grid for the analysis. Two parcel datasets were provided, one named PARCEL.shp (prepared for protected open space mapping) and the other CT_PARCELS.shp (prepared for national broadband mapping project), and both were dated 2010. The CT_PARCELS dataset included more parcel ID numbers, so this was used as the base layer. Any towns that did not have parcel data in this dataset were extracted from PARCEL and combined with CT_PARCELS to provide the most comprehensive parcel data possible. Neither of these datasets included parcels in Harwinton or Barkhamsted, so these towns are excluded from current analysis.

These datasets are older and do not accurately reflect how land has been subdivided in recent years. They also do not always maintain topological accuracy, so there may be parcels that overlap or are missing slivers. There are also waterbodies and road networks present which are not easily sorted out by attributes. These can be manually deleted, or just ignored visually.

On visual inspection, it became clear that many large parcels have subparcels which have been conserved. Thus, it is impossible to accurately remove conserved parcels from the analysis because many parcels with conservation potential would be removed. Thus, each parcel is assigned a percentage of acreage that is conserved. There is some error, due to parcel boundary discrepancies and the existence of duplicate overlapping parcels in the conserved lands dataset. Any parcel that received a conserved percentage greater than 100% was reclassed to 100%. Many of the very low percentage parcels can be ignored, due to aforementioned error. However, some are truly partially conserved (often in the case of a buffer around a waterway), so their percentages have been retained.

Running the Model in ArcMap

In order to run the model in ArcMap, the Spatial Analyst tool must be activated. In ArcMap, go to Customize > Extensions and then check Spatial Analyst. This is a standalone extension that must be purchased and activated separately from ArcMap.

To run the model in ArcMap:

1. Navigate to the “parcel_analysis_tool_edit” folder in the ArcCatalog pane in ArcMap.
2. Open the Parcel_Analysis toolbox. Double click the “Parcel Prioritization Model” tool.
3. In the user interface that opens, set the priority weights for each of the 16 analysis datasets. Note that these weights must add up to 100, and the “Model Weight Sum” line totals the weights as they are entered. Finally, use the folder icon next to the line “Model Data folder” to navigate to the location of the MODEL_DATA folder.
4. Click OK and wait for the model to run. A symbolized feature class* will be added to the ArcMap document when the model is completed.

Data Outputs in the MODEL_OUTPUT folder:

1. Feature Class named “model_parcels_YEAR_MO_DY_HR_MN_SC” where the last 6 abbreviations represent the date/time stamp from when the model was run. A symbolized version of this dataset* is automatically added to the ArcMap document at the end of the model run. Add the original unsymbolized feature class from the MODEL_OUTPUT folder to query and display in different ways, depending on project needs. This dataset includes the original parcel attributes (municipality, parcel IDs, site address, acres, source file, acres conserved, and percentage conserved), model statistics (sum, max, and area-weighted sum), and the summed scores for each of the 16 analysis rasters (e.g., resil_1_wr_sum represents the sum of all pixels within the parcel of the weighted raster for climate change resilience). These latter fields help to determine which rasters most heavily influenced the final scores for a parcel (e.g., did a parcel rank highly because it was very resilient to climate change or because it contained a lot of critical habitat?).
2. Raster “model_raster_YEAR_MO_DY_HR_MN_SC” where the last 6 abbreviations represent the date/time stamp from when the model was run. Each pixel in this raster contains the summed weight of all of the analysis rasters, and thus has a value between 0 and 100 (though the maximum value of 100 for a pixel may not be achieved in a raster, depending on the weighting scheme used).
3. A table called “model_runs” which shows each time the model was run, including the date/time stamp, the weights applied to each analysis raster, and the completion status. To see the results of this table, first add it to the ArcMap document, then right-click Open.

**Symbolized feature class*

This is automatically generated at the end of the model run. This feature class queries the data to show only parcels that are 50 acres or larger and that are 50% conserved or less (ACRES >= 50 AND ConsPerc <= 50). It then divides the remaining parcels into 3 categories for display, based on which percentile the area-weighted score of each parcel falls into: 50 to 75th percentile, 75 to 90th percentile, and over 90th percentile. Parcels below the 50th percentile are not shown.

To resymbolize the output parcel feature class

1. Navigate to the "parcel_analysis_tool" folder in the ArcCatalog pane in ArcMap.
2. Open the Parcel_Analysis toolbox. Double click the "Visualize Parcels" tool. Use the folder icon to navigate to the model_parcels feature class to be symbolized, use the SQL button to create a query to apply to the data (e.g., ACRES >= 25 AND ConsPerc <= 50), then click OK to run the tool.
3. Using the specified query, the tool then divides the remaining parcels into 3 categories for display, based on which percentile the area-weighted score of each parcel falls into: 50 to 75th percentile, 75 to 90th percentile, and over 90th percentile. Parcels below the 50th percentile are not shown.
4. Note: the ArcMap document needs to be a saved document for this tool to work.

Updating datasets in the model

Analysis datasets may be updated over time and can replace the original raster datasets included with the model, to give more current model results. Any replacement dataset needs to be formatted according to the analysis specifications including:

1. Prepare the vector data as needed, e.g., create buffers, query to include only relevant data.
2. Convert to 30m resolution raster with the same grid as TNC's Climate Change Resiliency dataset (NAD 1983 Albers). Start by zooming into the extent of existing analysis rasters. When converting from vector to raster (polyline/polygon to raster tool), use the Environments > Processing Extent settings to set the Extent to "Same as Display" and the Snap Raster to the resiliency dataset. In the Environments > Raster Analysis settings, set the cell size to be the same as the resiliency dataset.
3. The resulting raster may need to be reclassed in order to be assigned the necessary 0-1 values in each cell. The Reclassify and Raster Calculator tools can be used in conjunction to accomplish this. "No Data" values must be reclassed to 0 for the analysis to work properly. Note that the Reclassify tool only outputs integers, so for the datasets with non-integer values (e.g, average resiliency is scored 0.25), set the classes as multiples of 100 (e.g. 25, 50, 75, 100) and then use the Raster Calculator to divide by 100 (you will need to divide by "100." in order to get correct significant digits).

Once the new replacement raster dataset has been prepared, it can be exported into the analysis_rasters.gdb geodatabase. Use the Copy Raster Tool to import the dataset into the geodatabase, with a different name than the file that it will replace (e.g., apa_7_new). Parameters to set are:

Configuration Keyword - blank
Ignore Background Value- blank
NoData Value - 255
Convert 1 bit data to 8 bit - unchecked
Colormap to RGB - unchecked

Pixel Type - 8_BIT_UNSIGNED
scale pixel value - unchecked
RGB to Colormap - unchecked
Format - Esri BIL
Apply Transformation - unchecked

Once the raster is in the geodatabase, delete the older raster and rename the newly imported raster (e.g., apa_7). Restart ArcGIS to clear any file locks that might prevent the analysis tool from accessing the new data. With the same name in the same location, this raster will now be used by the analysis tool.