DEER HABITAT MODELING

Deer Habitat and Corridor

Focusing on Deer Habitat and Corridor modeling, in this report there will be descriptions of procedures using ArcGIS to create a habitat suitability model, also to determine potential habitats for wildlife and then lastly this will determine what the best corridor would be between two areas.

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Introduction

This project was created to identify the best corridor between two locations for potential Deer Habitat. They can often be considered an annoyance because they eat farmer's corn, soy beans, and they also bring hunters out and makes for walking in the fall time more dangerous to walk along the railways or any other woodland trails. Then the other reason that they are becoming an annoyance is due to that their numbers are somewhat growing out of control, and wondering into the city, where they are not normally seen. So, the most effective way to keep the numbers under control and have a better understanding of what they need for survival and what they need just in general.

This report starts off by introducing the four constraints that were taken into consideration when making this project's habitat model. This report then goes on to talk about the methodology and the parameters when rating the areas in question for suitability. The third section that is title Model Procedure, takes an in depth look at the habitat suitability grid. This section also includes details on all the processes that were done during the making of the final product, as well as all the data that was used to make this Habitat Model, and all of the rankings for the model parameters. The process of identifying a wildlife corridor between two areas is also going to be discussed in this section. In the concluding paragraph it will discuss the restriction of the model. At the end of this paper there are three appendices that will provide further information regarding this project's methods and also this project's data. Appendix I will go over the data that is being referred to in the procedure section. Appendix II will outline all the procedures that were followed to make the hexagon patch grid. Appendix III shows the complete ArcGIS model builder for the deer habitat that is being described during this report.

Deer Habitat Constraints

Even though that deer live in the woods, the land around them must meet a certain criteria, there should be a field within a certain distance. There should also be a water source within a certain distance of the area that the deer is living in. Also when the land meets the criteria in the model then it is considered a suitable for the deer to live in and around. The purpose of this project and paper of the deer habitat is to take a look at locations that are suitable for the deer activity that they do. The model, that you will see at the end of this report, takes into consideration four factors when identifying suitable habitat; field edge, proximity to water, urban development, and also proximity to roads. These elements are discussed in the following sub-sections, so you, the reader, have a better understanding of the importance of these elements in identifying suitable locations for a deer's habitat.

Water (Rivers)

Water is vital for identifying deer habitat. This is due to they need some sort of water supply to survive. If the location does not have enough of a water supply then the deer will move on to find a more suitable location that does have enough water to survive on. Also shallow water could serve as a safe crossing to the other side, so that is another thing that the deer has to "take into consideration" when finding a suitable location for them and their family (if they have one). Due to the fundamental requirement of water within a deer's environment, it is important to take into consideration the proximity to water when identifying suitable areas of deer habitat. Deer's can be seen browsing along the water's edge and also other watercourses, this mostly happens in the hot summer days, they also tend to seek shade on those hot days.

Roads

Roads are important for the deer to stay away from due to the fact that they may get hit by traffic. If the location that the deer are living in has too many roads then, they must do one of two things. One be careful when crossing the road or find another location that has either less roads going through it or no roads what so ever.

Field Edge

The deer likes to consume the new wood growth that is commonly found on the edge of fields, roadbeds, water bodies, and orchards. The field's edge gives the deer a fast cover if needed from other animals that might be after them or from humans who are hunting them. When the deer hits the fields edge they know that they are now heading into danger, where humans can see them.

Urban Development

When judging deer habitat suitability it is important to consider urban development, since it is not right to suggest that deer live in highly developed areas where there are roads and human living would have a negative impact on the deer activity. Thus for this reason that is why urban development was taken into consideration when identifying deer habitat suitability.

Project Methodology and Parameters

The suitability model for this project/paper is being created by taking into consideration the four elements that were discussed in the section called 'Deer Habitat Constraints'. Within the study area I used a standardized scoring system that rates areas in the study area based on the suitability for each of the constraints.

Patch Methodology

A patch analysis is made once the suitability grid is created. This patch analysis will show the mean suitability of 30 hectares within the study area that we are working with. This analysis consists of dividing the study area into regular cells that are repeated, in this project it would be hexagons that are being repeated. When creating a pattern analysis it is dividing the study area into regular zone sizes and the shape helps as well. The way that the patch mean works is it is an overlay tool it overlays grids of equal area zones. (See Figure: hex537) right over the suitability grid.

Model Procedure

The following pages of this section discuss the process of creating the deer habitat suitability network and also the wildlife corridor network all being made through ArcGIS. All procedures, with exception to those that deal with shapefiles, are done through the map algebra in Arc's raster calculator. Each and every process is explained in as much detail as possible.

Habitat Suitability Grid

Taking into account proximity to urban areas, field edge, roads (paved), and water the habitat suitability gird was created. Each factor is scored in a suitability grid and it then has four grids that are then compiled to produce an overall suitability gird. A patch analysis is then done to produce a gird that shows the best 30% of the habitat areas within the study area.

Water (Rivers) Suitability

Since water is such an important part of a deer's habitat, it's necessary to identify locations within the study area that are most suitable within a certain distance.

The first step that was take to get to our goal was to take all of the waterways within the study area and produce a raster image. The hydrographic data that was used in the project came to me from two different sources: the 'queens_wtaer_poly.shp' is the DNR hydrographic data set for my study area, and is used for the polygon features; the 'nsgc_merge_water.shp' comes from the NSGC 1:10000 data set for my study area and is used for the line features of the data.

The process to create a raster that contains all the rivers and includes all the lakes (not just the outlines), the most relevant polygon features and also the most relevant line features must be selected out and then all the data saved in a raster format to be merged later on in the project.

This is done by using the following tools and settings:

Select By Attributes: Layer, Field, SELECT* FROM nsgc_merge_water WHERE: (done outside of Raster Calculator)

Feature to Raster Conversion: (input_feature, field, output_raster, {cell_size}) (done outside of Raster Calculator)

The following tools were used to create a raster, data set, featuring just the line water features in the line water layer:

Select By Attributes: nsgc_merge_water, FCODE, "FCODE LIKE WARVS%"

Feature to Raster Conversion: "nsgc_merge_water", "FCODE", "q_rv", 10

Using the 'Select by Attributes' tool, select all the water feature that start with "WARVS%" under the FCODE field (which will/should be all the single line water features in the study area). Once everything is selected use the feature to raster tool to convert everything selected to into a raster format and name the output q_rv, by using the FCODE field again and a cell size of 10.

Then for the polygon features, which would be all the lakes and the double lined rivers that will be selected and then converted to into a raster format:

Select By Attributes: queens_water_poly, Water_ID, "Water_ID = 351 OR Water_ID = 352"

Feature to Raster Conversion: "queens_water_poly", "Water_ID", "q_lk", 10

Using the 'Select by Attributes' tool, and select all the lakes and double lined rivers and then by using the feature to raster tool convert the selected to a raster format named q_lk. Using the field Water_ID for the value field for the feature to raster tool and a cell size of 10.

After both of the water raster's have been created, then you can use map algebra to merge the two raster's. The syntax for the raster calculator to execute the cellstatistics tool is as follows:

Syntax: CellStatistics (in_raster, or, constants, (statistics, type), (ignore_nodata))

Expression Used: CellStatistics (["q_lk",” q_lk"], "MAXIMUM", "DATA")

Output: Water

“Calculates a per-cell statistic from multiple raster’s. The available statistics are Majority, Maximum, Mean, Median, Minimum, Minority, Range, Standard Deviation, Sum, and Variety.” (Taken from ArcGIS 10.2.2 Help summary window)

For the process of merging the two raster images the ‘MAXIMUM’ statistics was chosen, so the highest value from each of the inputs will be saved with the output. As you see in **Figure 1** this raster contains all of the water features for this study area.

Seeing that the proximity to water is one of the primary concerns when looking at the deer habitat, then it is important to create a raster that will show the distance from a water feature. To do that we use a tool/function called the EucDistance. The following is the syntax for that tool/function:

Syntax: EucDistance (in_source_data, (maximum, distance), {cell_size), (out_direction_raster))

Expression Used: EucDistance ("Water", "200")

Output: wat_buf200

Figure 1: Water

Figure 2: wat_buf200

When calculating the habitat suitability is based on scores between 1 and 10, wat_buf200 has to be re-calculated so that it will fit into this criteria. ReclassByASCIIFile command is the syntax that will be used to do this:

Syntax: ReclassByASCIIFile (in_raster, in_remap_file, (missing values))

Expression Used: ReclassByASCIIFile ("water_suit_tmp","WATER_SUIT.TXT")

Output: water_suit

The following is the remap that was used to create water_suit:

WATER_SUIT.TXT

0 1.0: 100

1.0 100.0: 1

100.0 150.0: 3

150.0 250.0: 7

250.0 2000.0: 10

This table shows that if things are water's edge then it will be classed as a '1' and the feather you get away from the water would be the better score. So, by the remap standards 10 would be the best areas to find the deer habitat. The areas that are labeled as '100' that would not be the best location to find a deer habitat seeing as that it would be in the lakes.

Figure 3: water_suit_tmp

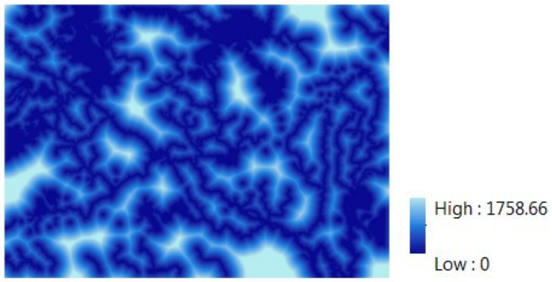
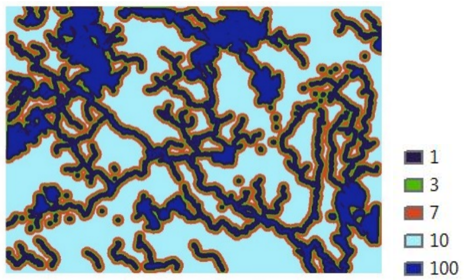


Figure 4: water_suit



Once you have these steps have been completed then you go on to make your 'Riparian buffers'. This is done by using the expand tool in the raster calculator.

The following syntax shows the breakdown of the syntax, the expression used, and also the output for the 'Riparian buffer':

Syntax: Expand (Con (IsNull (in_feature), 0, 1), 15, 1)

Expression Used: Expand (Con (IsNull ("Water"), 0, 1), 15, 1)

Output: rip_cor

The following syntax is to create the Non Riparian 'Corridor Impedance', by using the "Con" statement:

Syntax: Con (in_feature, values)

Expression Used: Con ("rip_cor" == 0, 5, 1)

Output: rip_imp

The final output for this function can be seen in Figure 6 below.

Figure 5: rip_cor

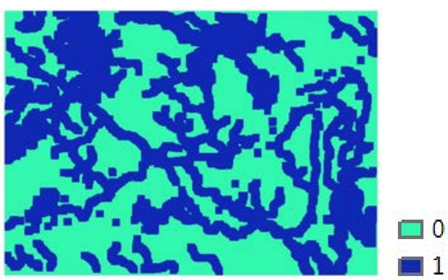
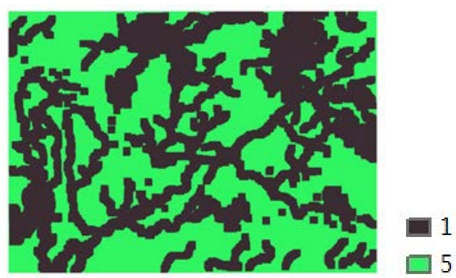


Figure 6: rip_imp



Roads Suitability

Roads are the one thing that deer need/want /should stay away from in order to survive. So it is important to identify locations within the study area that are suitable for deer habitats, but are also a safe distance for both deer and human.

The first step that is to be followed in this process is to use the ‘Feature to Raster’ tool to transform this dataset from a shapefile into a raster file. This step is done by using the ‘Feature to Raster’ tool.

This is done by using the following tool and settings:

Feature to Raster Conversion: (input_feature, field, output_raster, {cell_size}) (done outside of Raster Calculator)

The inputs for the tool above are as follows:

Feature to Raster Conversion: (queens_netlin, LRIS_FCODE, “q_rd”, (10)

The following this all about the paved roads and making sure that there is enough distance from them to find the deer habitat. There is an extremely high impedance level to prevent the corridor from matching the roads.

The following syntax that is put into the raster calculator is to make the paved roads. Here are the settings and data inputs:

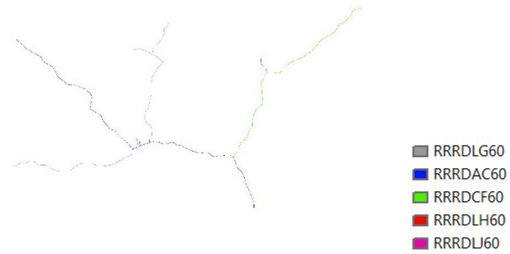
Syntax: ExtractByAttributes (in_feature, Select From)

Expression Used: ExtractByAttributes (“q_rd”, “Value = 10 or Value = 13 or Value = 16 or Value = 21 or Value = 24”)

Output: paved_rd

The following diagram is of the output that comes of running the raster calculator:

Figure 7: paved_rd



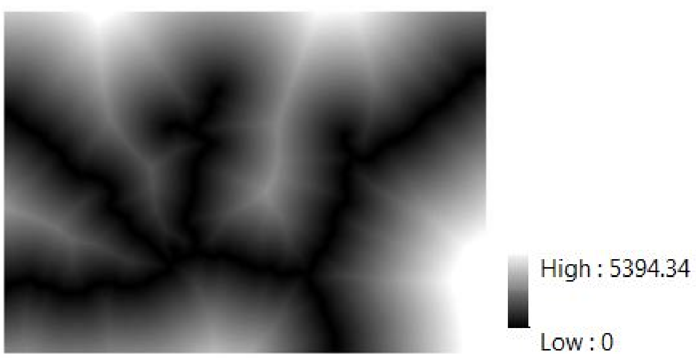
Since it is important to be a certain distance from paved roads, for this project there was a buffer placed around those paved roads. The following syntax shows the inputs and how to set things up to be put into a raster calculator:

Syntax: EucDistance (in_feature)

Expression Used: EucDistance (“paved_rd”)

Output: paved_rd_buf

Figure 8: paved_rd_buf



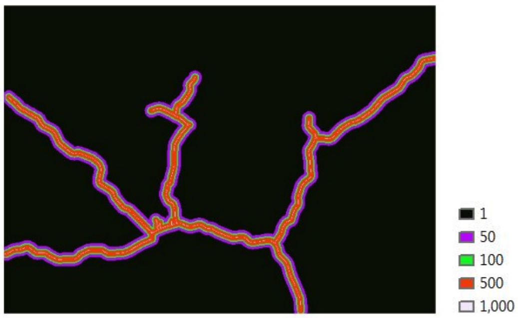
Then once that process if finished you take that paved_rd_buf raster and remap it with a txt file that you create yourself. The impedance values for this step is extremely high for this step. Here is the syntax and all the elements that go into the raster calculator:

Syntax: ReclassByASCIIFile (in-feature, in_remap_file)

Expression Used: ReclassByASCIIFile (“paved_rd_buf”, “PAVED_ROAD_COR_IMP.TXT”)

Output: road_cor_suit

Figure 9: road_cor_suit



Remap table for PAVED_ROAD_COR_IMP.TXT

PAVED_ROAD_COR_IMP.txt

0 1.0: 1000

1.0 100.0: 500

100.0 150.0: 100

150.0 250.0: 50

250.0 20000.0: 1

Field Suit

There are pros and cons for deer living on the edge of fields. One of the main pros is there is always going to be fresh green grass and plenty of it, but the major con that goes with it is that they are in the wind open so hunters can see them. So, there had to be a happy medium for this factor of the project.

The first step that was taken to get to the final product of the field portion of the project was to use the ‘Extract By Attributes’ tool, its does the same thing as the ‘select by attributes’ tool but instead of using another tool to export the selected features you can use the extract by attributes tool to not only extract the features that you are looking for but you can also export them at the same time.

The following is the syntax that will be used to execute this command:

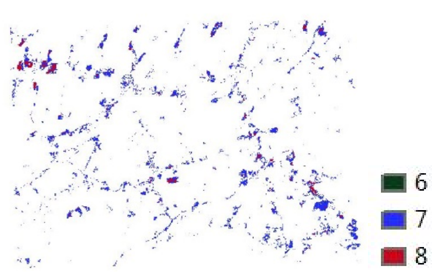
Syntax: ExtractByAttributes (in_feature, “Select From___ Where”)

Expression Used: ExtractByAttributes (“classc6”, “value > 5”)

Output: field

The diagram below shows what the output looks like after you run the raster calculator for the extract by attributes on the classc6 dataset.

Figure 10: Field



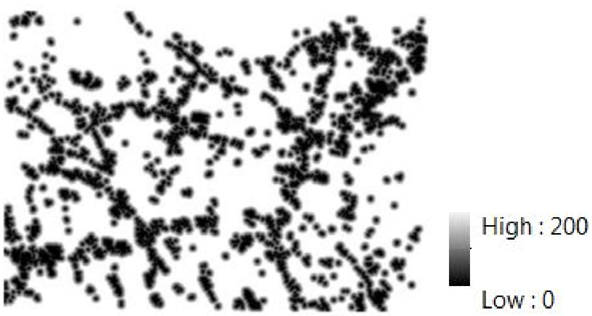
The following step would be to put a buffer on the fields. That is done by using the 'EucDistance' tool just like in the "Water (Rivers) Suitability" section, but the input field would be to field instead of water, so it would something like the following:

Syntax: EucDistance (in_source_data, (maximum, distance), {cell_size)

Expression Used: EucDistance ("field", "200")

Output: field_buf200

Figure 11: field_buf200



Once all of these steps have been completed then you have to go on and do an extract by attributes through the raster calculator. The following syntax is not you go about doing that:

Syntax: ExtractByAttributes (EucDistance (in_feature, Value) "Select From___ Where")

Expression Used: ExtractByAttributes (EucDistance ("field", "", "", 10), "value = 10")

Output: field_edge10

Then the next step after that is to put a buffer around that. The buffer that we used is 150m from the edge of the field. This buffer goes both ways into the field and also into the surrounding area of the field that could be anything from a forest to a lake and anything in between. The syntax for that step would look something like this:

Syntax: EucDistance (in_feature, buffer distance)

Expression Used: EucDistance (“field_edge10”, 150)

Output: f_edge_buf150

Figure 12: field_edge10

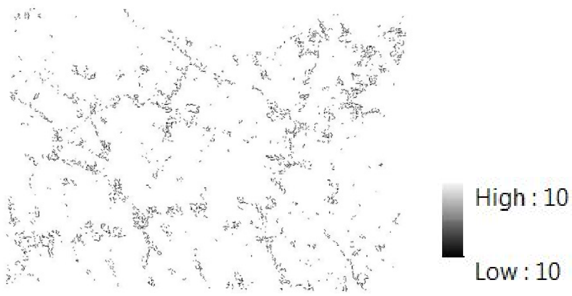
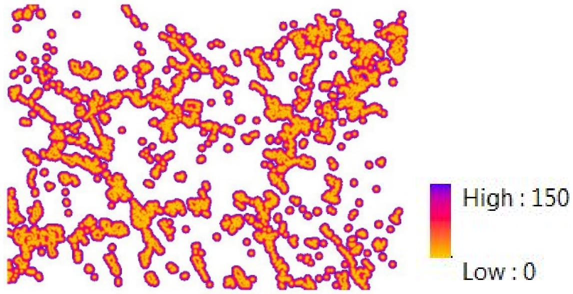


Figure 13: f_edge_buf150



The final step in the field suit section of this project is the remap of the ‘f_edge_buf’ data set. So, here is the syntax and all of the elements that are need to make the final product and also the table that is needed to make ‘field_suit’.

Syntax: ReclassByASCIIFile (in_feature, in_remap_file)

Expression Used: ReclassByASCIIFile (“f_edge_buf”, “FIELD_SUIT.TXT”)

Output: field_suit

The remap table that was used to make this final product is as follows:

0 75.0: 1

75.0 150.0: 3

150.0 250.0: 7

250.0 20000.0: 10

Urban Suitability

For this urban development suitability data it has been taken from two different and separate datasets. Those datasets that were used to make this urban development suitability dataset was "class2" a raster that contains 'urban, roadbed, and also rock outcrop'; this "class2" dataset came from the classified Landsat scene. The second dataset that was used in the making of this urban development suitability was the '"queens_netlin.shp", this shapefile contains all of the transmission line and also all of the roads for this area that we are looking at.

The first thing that needs to be done is to create the urban suitability raster. That is done by merging the data from the "class2" and the "queens_netlin.shp", but before that can happen the top scores of probability must first be extracted from the "class2":

Syntax: ExtractByAttributes (in_raster, where_clause)
Expression Used: ExtractByAttributes ("classc2", "value > 6")
Output: Urban

All the cells greater than 6 will be extracted from "class2" with the extract by attributes command. These extract values are then saved to a raster format and name that Urban.

The next step that has to be done before these two datasets can be merged is the "queens_netlin.shp" must be converted from a vector format to a raster format. This step is done by using the Feature to Raster too in ArcGIS:

Feature to Raster Conversion: (input_feature, field, output_raster, {cell_size}) (done outside of Raster Calculator)

Feature to Raster Conversion: (queens_netlin, LRIS_FCODE, "Roads", (10)

The queens_netlin was converted to a raster format and all of the cell values were given from the LRIS_FCODE field that can be found in the attributes of the queens_netlin. At the same time there was a 10 meter cell size that was set at this point as well and then the output raster was saved and then named Roads.

Once all the features that are needed for this section are converted to a raster format, the raster's can be merged by using the CellStatistics tool:

Syntax: CellStatistics (in_rasters_or_constants, {statistics_type}, {ignore_nodata})
Expression Used: CellStatistics (["Roads", "Urban"], "MAXIMUM")
Output: Urban_com

Seeing as the deer habitat is going to be graded on the distance from the urban raster feature, it is important to create a raster that shows distance. This is done by using the EucDistance tool in ArcGIS:

Syntax: EucDistance (in_source_data, {maximum_distance}, {cell_size}, {out_direction_raster})
Expression Used: EucDistance ("Urban_com")
Output: Urban_Distance

This command/function, as stated before, calculates the distance of each cell from each of the cells in the input. The output for this function can be seen in Figure 15 below, as the colour gets light the increasing the distance is from urban development.

Figure 14: Urban_com

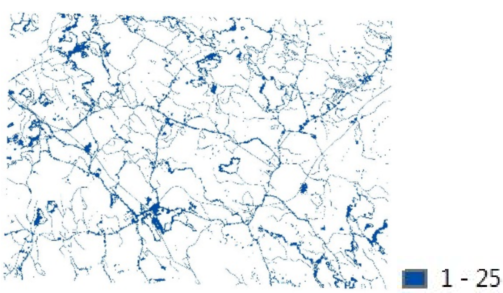
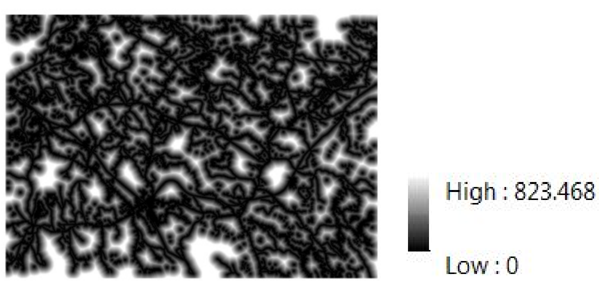


Figure 15: Urban_Distance



The final step when creating the grid for urban suitability is to reclassify the distance

Syntax: ReclassByASCIIFile (in_raster, in_remap_file, {missing_values})
Expression Used: ReclassByASCIIFile ("Urban_Distance", "URBAN_RECLASS.txt")
Output: Urban_Suit

The following is the remap table that was used:

URBAN_RECLASS.txt

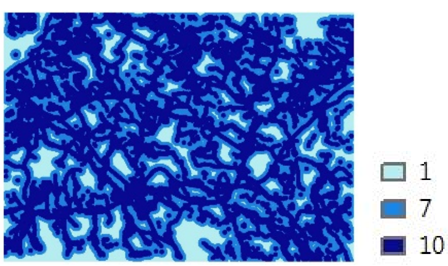
0.0 100.0: 10

100.0 250.0: 7

250.0 1000.0: 1

The reclassification for the urban raster has some elements that are different compared to the water reclassification. Areas that are within a 100 meters of such features are given a 10 for most suitable, The distances between 100 and 250 meters are given a 7 for moderately negative, then for the distances that are greater than 250 meters away from such features they are given a 1. The output from the reclassification is shown below in Figure 16, where the light blue stand for the most suitable areas , the med blue stands for the moderately negative suitability and then the dark blue stands for the areas that are considered to be unsuitable for a Deer Habitat.

Figure 16: Urban_Suit



Weighted Mean Habitat Suitability Grid

We can now merge all of the raster's that were created in the previous sections, all four of the constraints are now presented in the form of a suitability raster (four separate suitability raster's that is). This method is done by using the weighted mean, this allows some constraints to have a bigger impact over the output than the others. Seeing as the deer need both access to water and field to get food, these factors were given the most weight in the weighted mean equation. Paved roads and Urban development are the ones that have minimal effect on the deer's habitat, then these factors are given the lowest ranking in the weighted mean equation (as seen below).

Expression Used: ((3*"water_suit") + (1*"road_cor_suit") + (3*"f_edge_buf ") + (1*"Urban_Suit"))/8
Output: Deer_Suit

In this equation it ranks water and field edge three times as important as paved roads and urban development. When the equation is ran the output raster is calculated on the sum of the input raster's cell. Then the sum is divided by 9, which is the number of combined inputs (with the additional weighting). As you see in Figure 17 it shows all four of the suitability grids that were used in this equation. Figure 18 is the resulting raster output "Deer_Suit".

Figure 17: All four suitability grids that were used to create the Deer Suitability gird (See Figure 18)

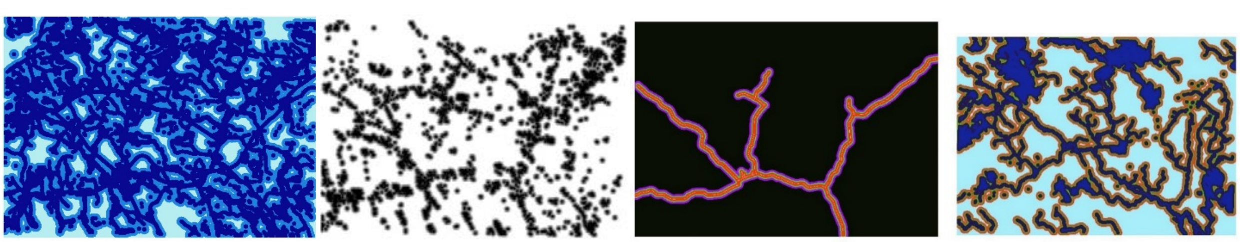
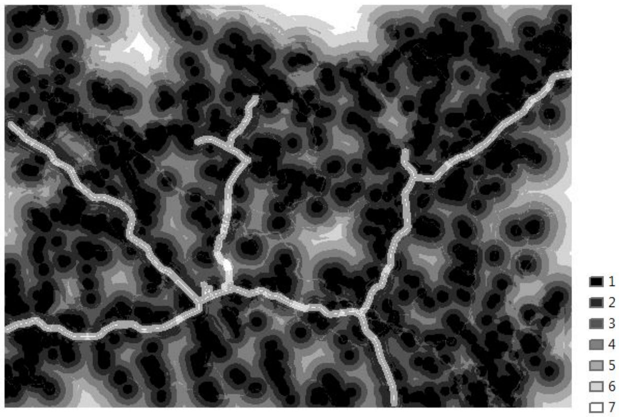


Figure 18: Deer_Suit



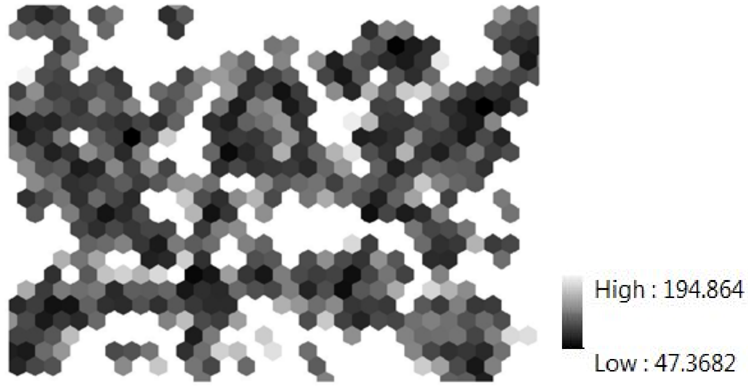
Habitat Patch Analysis

After the suitability grid for the habitat is created, the patch analysis can be done. This is done in order to help analyze the regions that are most suitable areas for the Deer habitat within the study area that I am looking at in this model. In order to perform the patch analysis the shape and also the patch size me be identified and then the patch grid will be created based on those specifications. In this model a 30 hec hexagon patch size was identified. The patch grid that is to be used for this step is called hex537. The tool that is used to calculate the mean of all the cell values within each hexagon patch is the ZonalStatistics tool:

Syntax: ZonalStatistics (in_zone_data, zone_field, in_value_raster, {statistics_type}, {ignore_nodata})
Expression Used: ZonalStatistics ("hex537", "Value", "Deer_Suit", "MEAN","DATA")
Output: Patchmean

This function calculates the value of each cell within each zone of the raster called in_zone_data, by calculating the statistics from all the cells covered by the zone in the in_value_raster. In this example, each hexagon path value is calculated by taking the mean. “DATA” is identified so that areas that have no data are ignored in this specific calculation. As you can see below, in Figure 19, the results for this function shows the darker grey as high suitability.

Figure 19: Patchmean

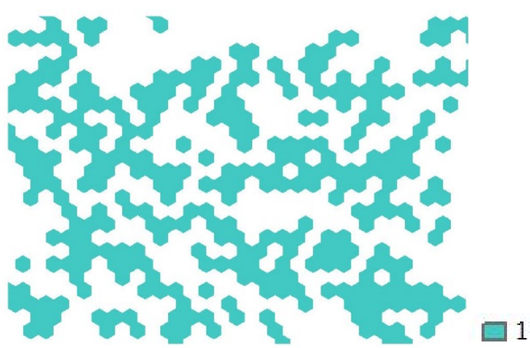


In order to get the best scoring areas/patches, a Con statement is used to select out the desired cells and as for all the cells that have data that don't fall into the scale, all their values get converted to a "No Data" value. The equation below helps us to do that:

Syntax: SetNull (0, Con (in_conditional_raster, in_true_raster_or_constant, {in_false_raster_or_constant}, {where_clause})
Expressions Used: SetNull (0, Con ("Patchmean", 1, "", "Value <= 85"))
Outputs: hab_patch

The output raster for the above equation is shown here. Since the field in_false_raster_or_constant is empty all of the results that are not in the 'true' where_clause they are given "No Data" for a value. Figure 20 shows the output for this equation, this is a grid that is showing the most suitable habitats for Deer in the study area that I am working with.

Figure 20: hab_patch



At this time you can now select out the two habitat patches that you wish to work with for the remainder of the project. But before that step can be done each region has to be given a unique value and this is done by using the RegionGroup tool in ArcGIS:

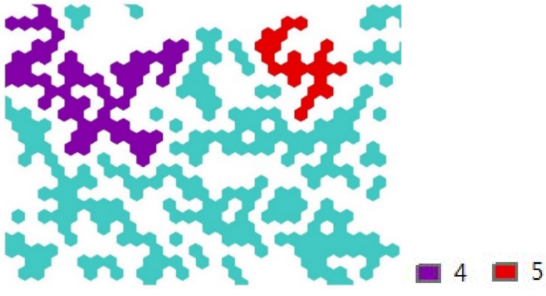
Syntax: RegionGroup (in_raster, {number_neighbors}, {zone_connectivity}, {add_link}, {excluded_value})
Expression Used: RegionGroup (“hab_patch”)
Output: hab_clust

This region group function selects all the cells within each grouping (that are also touching), the same value in the output raster. The result is that each habitat patch can be selected based on its unique cell value. The output for this function was saved and named hab_clust. Now that each cell has its own unique value, you can now select out the two largest patches (or any patches you think would be better, try to pick one from the top of the list and one from the bottom of the list), these two patches can now be selected/extracted out by using the ExtractByAttributes tool in ArcGIS:

Syntax: ExtractByAttributes (in_raster, where_clause)
Expressions Used: ExtractByAttributes ("hab_clust”, "value = 5")
ExtractByAttributes ("hab_clust”, "value = 4")
Outputs: Clust5 & Clust4

The results of these two equations above can be seen below in Figure 21, Clust4 is symbolized in a purple colour and then Clust5 is symbolized in the red, they are then overlaid on the hab_patch raster image.

Figure 21: Final habitat grid showing the two habitat regions I will be working with



Wildlife Corridor

Since I have identified the two most likely habitat regions within the study area, now it is possible to work on the wildlife corridor that will in the end connect the two areas that I am looking at. The first step in making the corridor is by constructing an impedance grid, through this the corridor must pass through. The function CostDistance is used to determine the path that has the least impedance that the corridor should follow through to get from one habitat to another. Four factors have been taken into consideration when creating all of the impedance grids. These four factors include Water, Urban areas, Field Edge, and also Paved Roads. The discussion for each created impedance girds for the factors stated above, are in the following sub sections, which is then followed by the creating of the final corridor grid.

Water Impedance

As stated above it is preferred that the habitat corridor was in a riparian zone of water bodies. This is somewhat due to that deer need water to survive. All they need are small rivers that are not too deep that they cannot cross, so they could escape the hunters that threatens them. It is important that the habitat corridor follow the water bodies for the simple fact that deer need water to survive. The gird that is being used for the water impedance is water_suit, in where the distances from the water are already scored according to the model 1-10 scale, which means increasingly negative scores as the distance from the water increases.

Urban Impedance

Since it is important to avoid areas that host human activities, an urban feature of impedance raster was added to the model. This impedance raster was made from the Urban_Imp, by using a few map algebra functions called Expand, Con, and also IsNull; these tools will create the final output that I am looking for. Here is the expression that is used:

Syntax: IsNull (in_raster)
Con (in_conditional_raster, in_true_raster_or_constant, {in_false_raster_or_constant}, {where_clause})
Expand (in_raster, number_cells, zone_values)
Expression Used: Expand (Con (IsNull ("Urban_com"), 1, 10), 3, 10)
Output: Urban_Imp

This function, the IsNull was used to identify "No Data" cells within the Urban_com raster, that was then used to convert cells to a value of 1 and all of the other cells were given a output value of 10, the highest score for impedance. Then the expand function was used on the urban zone areas by expanding them. When using the expand tool the urban features are buffered with a 30 meter buffer on each side, this is considered an acceptable distance around in which the habitat corridor could be placed. The output expression, Urban_Imp, is seen in Figure 23, when the purple shows no impedance and the green shows high impedance.

Figure 22: water_suit

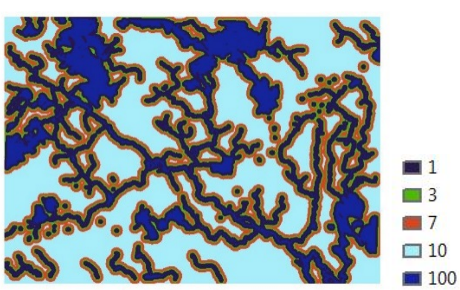
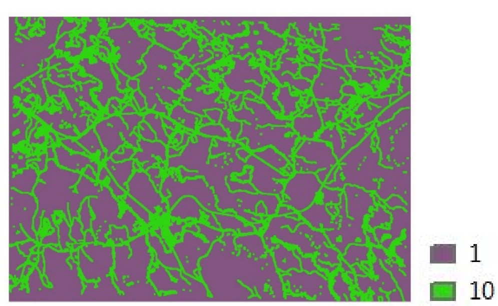


Figure 23: Urban_Imp



Paved Roads Impedance

The reason that paved roads are being singled out is due to the high speeds at which vehicles travel on those roads. These paved roads stand for a serious threat to both the deer population and also human well-being. To decrease the likeliness of collisions between cars and animals, the impedance gird is created to give features like this a high impedance value.

The first step when creating the impedance grid for paved roads, is to select all of the paved roads from the q_rd. All hard surfaces will be selected when this tool is ran. All the roads that have a cell value in the q_rd: 5, 10, 13, 16, 18, 20, 21, 24, and 25. The following expression will select all roads with these cell values:

Syntax: ExtractByAttributes (in_feature, Select From)

Expression Used: ExtractByAttributes (“q_rd”, “Value = 10 or Value = 13 or Value = 16 or Value = 21 or Value = 24”)

Output: paved_rd

This function will extract all the cells with values that are specified, and save them in a new raster named paved_rd (See Figure 24). Once all the paved roads are in one raster (of their own), it will be possible to execute the function EucDistance, and this will classify distances from roads on an impedance scale:

Syntax: EucDistance (in_feature)

Expression Used: EucDistance (“paved_rd”)

Output: paved_rd_buf

See Figure 25, to see the increasing lightness that is showing a increasing distance from paved roads. As I stated earlier the EucDistance tool results in a grid that shows the distance from the closest cells in the source data.

Figure 24: paved_rd

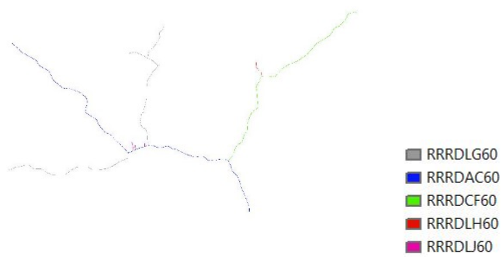
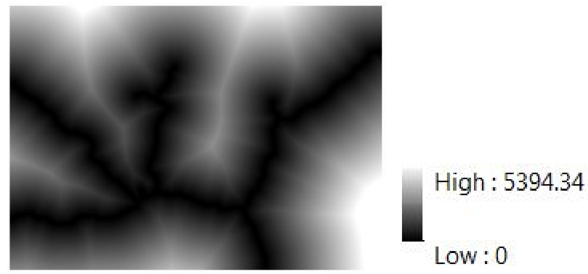


Figure 25: paved_rd_buf



To create the impedance grid for the correct scoring of values, the distance grid is now reclassified by using an ASCII remap table:

Syntax: ReclassByASCIIFile (in-feature, in_remap_file)

Expression Used: ReclassByASCIIFile (“paved_rd_buf”, “PAVED_ROAD_COR_IMP.TXT”)

Output: road_cor_suit

Remap table for PAVED_ROAD_COR_IMP.TXT

0 1.0: 1000

1.0 100.0: 500

100.0 150.0: 100

150.0 250.0: 50

250.0 20000.0: 1

Habitat Impedance

Since the wildlife corridor should follow the areas that are most suitable for the deer habitat, the values from the Patchmean should be reclassified so they can be included into the corridor impedance grid. The Reclassification on the Patchmean dataset is done by using the slice command in the Raster Calculator:

Syntax: Slice (in_raster, number_zones, {slice_type}, {base_output_zone})
Expression Used: Slice (Int (“Patchmean”), 10, “EQUAL_INTERVAL”, 1)
Output: hab_imp

The values of the input cells are reclassified, by using the slice command, into categories of equal intervals, or of equal areas, or of even natural breaks. The Patchmean values are sliced into 10 equal categories to match the scale of the scoring of this model which is based on a scale of 1 to 10. Before you can even run the slice command, Int is to be used to convert all the values of Patchmean into integers, this is due to the slice command only working with integer data. Now, the slice command can be run, this command classifies the integer values of the Patchmean into 10 equal interval categories, and the lowest output value would be specified as a 1. The results of this command are shown in Figure 27.

Figure 26: road_cor_suit

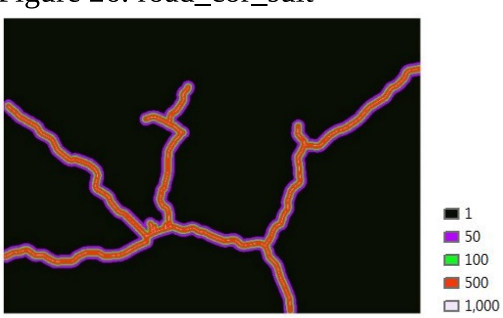
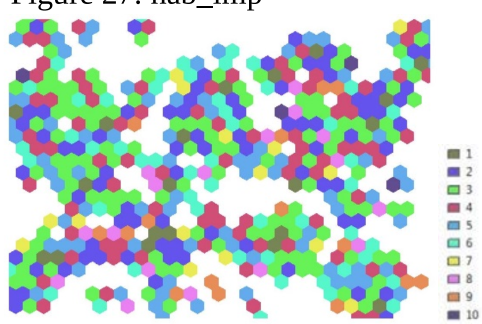


Figure 27: hab_imp



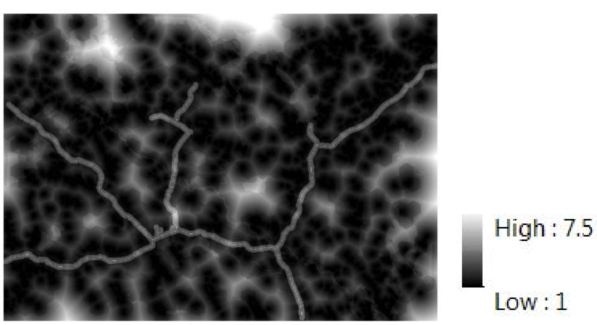
Final Wildlife Corridor Grid

After all of the impedance grids are created, it is possible to make the final corridor impedance grid for this model. This is done by using the CellStatistics to calculate the mean of all the cell values. Con and IsNull function are used in this expression to deal with the areas that have "No Data" within the hab_imp.

Syntax: IsNull (in_raster)
Con (in_conditional_raster, in_true_raster_or_constant, {in_false_raster_or_constant}, {where_clause})
CellStatistics (in_rasters_or_constants, {statistics_type}, {ignore_nodata})
Expression Used: CellStatistics ([Con (IsNull ("hab_imp"), 10, "hab_imp"), "Urban_Imp", "road_cor_suit", "f_edge_buf", "water_suit"], "MEAN", "DATA")
Output: Cor_imp

"No Data" cells do not stand a problem when the "MAXIMUM" statistic is used in the CellStatistics function. To avoid getting "No Data" values in each of the corridor impedance raster, the Con command is used to transform all the null data cell values in hab_imp into value of 10. The final corridor impedance grid, Cor_imp is shown below in Figure 28, where the the lighter areas stand for areas that have a greater impedance.

Figure 28: Cor_imp



Syntax: CostDistance (in_source_data, in_cost_raster, {maximum_distance}, {out_backlink_raster})
Expressions Used: CostDistance ("Clust4", "Cor_imp")
CostDistance ("Clust5", "Cor_imp")
Outputs: Cost4 & Cost5

The Cost Distance tool calculates the value of each cell based on a least costly distance to the source. Each 'cost' distance is affected by the impedance values of the Cor_imp, which can make for shorter paths, but these paths are more costly than the longer ones because of the higher impedance values. The cost distance raster's for habitats 4 and 5 are shown here is Figures 29 and 30.

Figure 29: Clust4

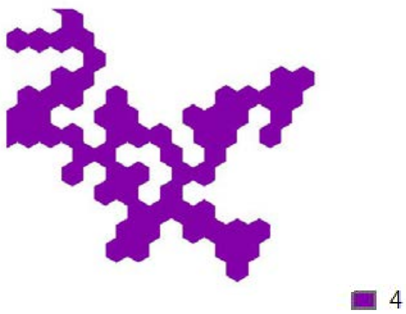
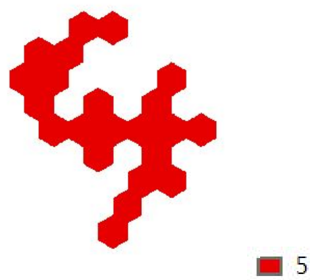


Figure 30: Clust5



Syntax: Corridor (in_distance_raster1, in_distance_raster2)
Expressions Used: Corridor ("Cost4", "Cost5")
Output: COR5_4

The results of the final corridor expression is a raster that is showing the least costly corridor between the two habitat regions 4 and 5. COR5_4 is shown in Figure 31(see below), with increasing cost shown in the increasingly darker shades of gray.

Figure 31: COR5_4

Syntax: Contour (in_raster, out_polyline_features, contour_interval, {base_contour}, {z_factor})
Expressions Used: Contour (“Cor5_4”, 500, 0)
Output: Cont_500

Figure 32: Contours over the Habitat Corridor Grid

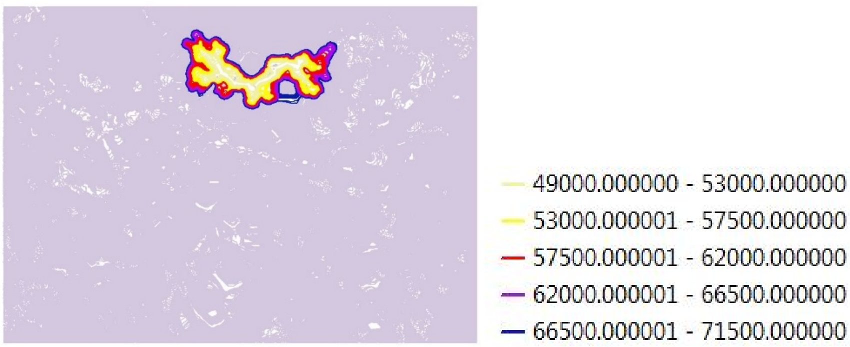
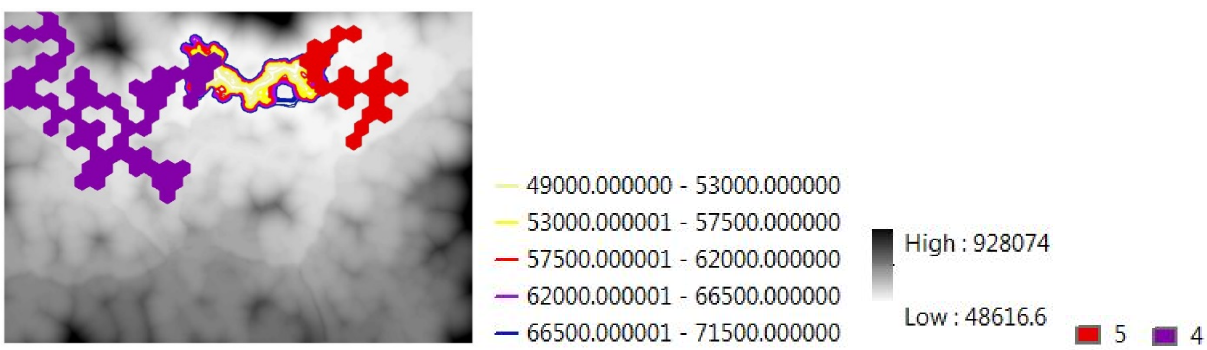


Figure 33: Final Habitat Regions and Corridor Grid with the best 5% of the corridor highlighted



Conclusion

This report has outlined all of the procedures it took to create a Deer Habitat Suitability grid and also a wildlife corridor that leads between two areas that are potential deer habitat. This model is a great example of how you can gather additional data from the already existing datasets that you have. There is one important thing to remember and that is the results are only as accurate as the data that is being used.

The two most likely probabilities, for example, from the 'class2' dataset was used to represent the urban areas with in the study area that was being looked at. Since the classification raster's that were used during this model have not been check correctly, there is some potential for errors, since the given classifications my not be correct themselves. This issue could be avoided, by using data that has gone through several check and ground truthing.

Thus this means that the results from this model must be looked at with caution. All the process that are outlined in this report be identified as an example of which a simple habitat suitability model could be created from, rather than just looking at a map of where deer's should be living in the Queens area.

Sources

Data:

Title page photo:

N/A. (2014, n/a n/a). *"Spotting" North American Whitetial Fawns*. Retrieved from The Whitetail Deer: http://www.the-whitetail-deer.com/North-American-Whitetail.html

Model procedures and methodology are based on information given in GISD 3020 class lectures entitled “GISD 3020 Grid Modelling and Map Algebra 03 - Part 1- Habitat Modelling” and “GISD 3020 Grid Modelling and Map Algebra 03 - Part 2 - habitat corridor modeling” by Mark Hebert (COGS faculty).

All ‘classc’ data is derived from Landsat 7 TM data classified using COVAR Probability Analysis. This data was provided by Mark Hebert to the GISD 3020 class for use in this assignment.

Software Used

All grids were created in ArcMap v. 10.2. Raster calculator was used to perform the map algebra equations necessary to create each grid. The model builder solution was created using Model Builder in ArcGIS v. 10.2. The hexagon shapefile was created using ET GeoWizards v. 10.2.

Microsoft Window’s ‘Snipping Tool’ was used to copy legend descriptors from ArcMap to Microsoft Word.

Microsoft Word was used to write this report.

Appendix I: Data Referenced In 'Model Procedure'

queens_netlin.shp: roads network line data from the DNR, assembled from four map sheets covering the study area

queens_wtaer_poly.shp: hydrography polygon data from the DNR, assembled from four map sheets covering the study area.

nsgc_merge_water.shp: hydrography line data from the NSTDB 1:10 000 series dataset.

classc2: raster dataset of **'**Urban, roadbed, and Rock outcrop'.

class6: raster dataset of 'Field and Pasture'.

Appendix II: Procedure for Creating a Hexagon Grid

In the model there was a hexagon grid that was used for the patch analysis that was created by using the ET GeoWizards. In this short section will give a brief description of the procedure that was followed to create the hexagons.

The first thing that had to be done before starting was to calculate the distance between the middle of the two desired patches. For this project/report, the patch size was that of a 30 hectare hexagon.

The calculation for the distance between centers for this patch size is: Two times the square root of (the desired area in hectares divided by (0.0006 times the tan of 30)).

This comes out to a distance between the centers are 537 meters.

By using the 'Create Point Grid' tool in the ET GeoWizards a point grid was made. The extent of the point grid was set to the queens_clip.shp. Then the next step was to use the triangular grid type, make sure to set the cell size to 537 meters. The output raster of this tool was saved as point537 (See Figure 34)

The next tool that was used was the ‘Build Thiessen Polygons’, this tool was used to create polygons out of the points in the point537 shapefile.

The polygon shapefile that this tool creates using the points to determine the edges of each of the polygons.

The points in the point537 shapefile are in a triangular formation the Thiessen Polygons end up being the hexagon shape. The point attributes were then attached to the hexagons and the output shapefile was named hex537 (See Figure 35)

To ensure that there were no overshoots, undershoots or other potential problems, in the hex537 shapefile, the tool called ‘Clean’ was used. The output from the clean tool was then saved and named hex537_cg.

The process of creating the hexagons is now complete, but in order to be used, in zones, in the patch analysis the ‘Zonal Statistics’ tool was used. But first the vector has to be converted to a raster, for this the ‘Feature to Raster’ tool was used in ArcGIS. The input shapefile for this final step was the hex537cg, the field that was used was the ET_ID, and then the cell size was 10 pixels as specified. The output was then saved and named hex537 (See Figure 36).

Figure 34: point537

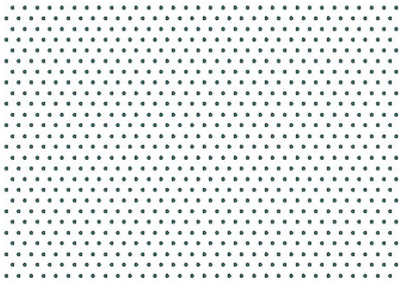


Figure 35: hex537cg

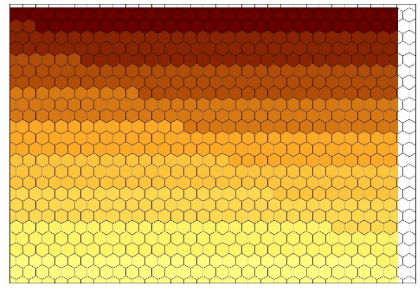
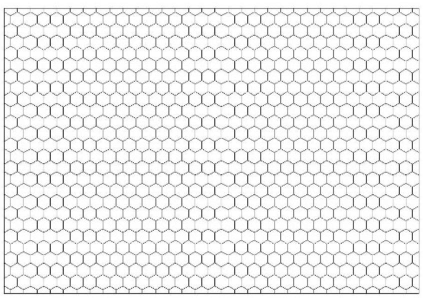


Figure 36: hex537



Appendix III: Model Builder Solution