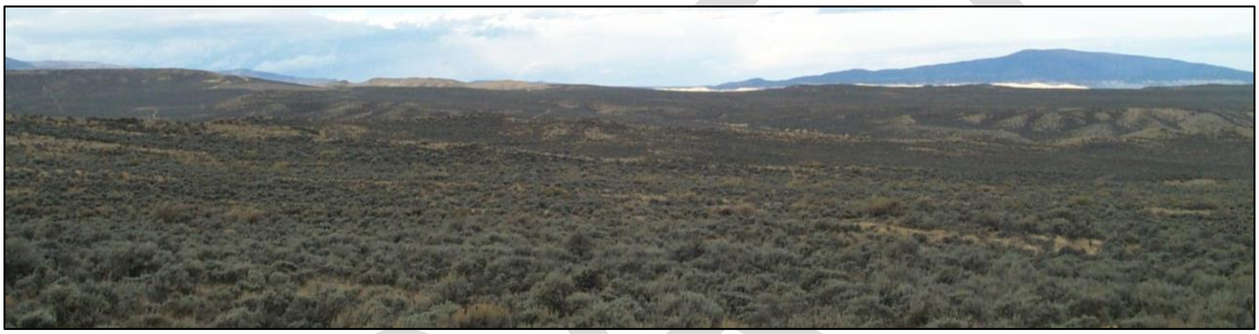
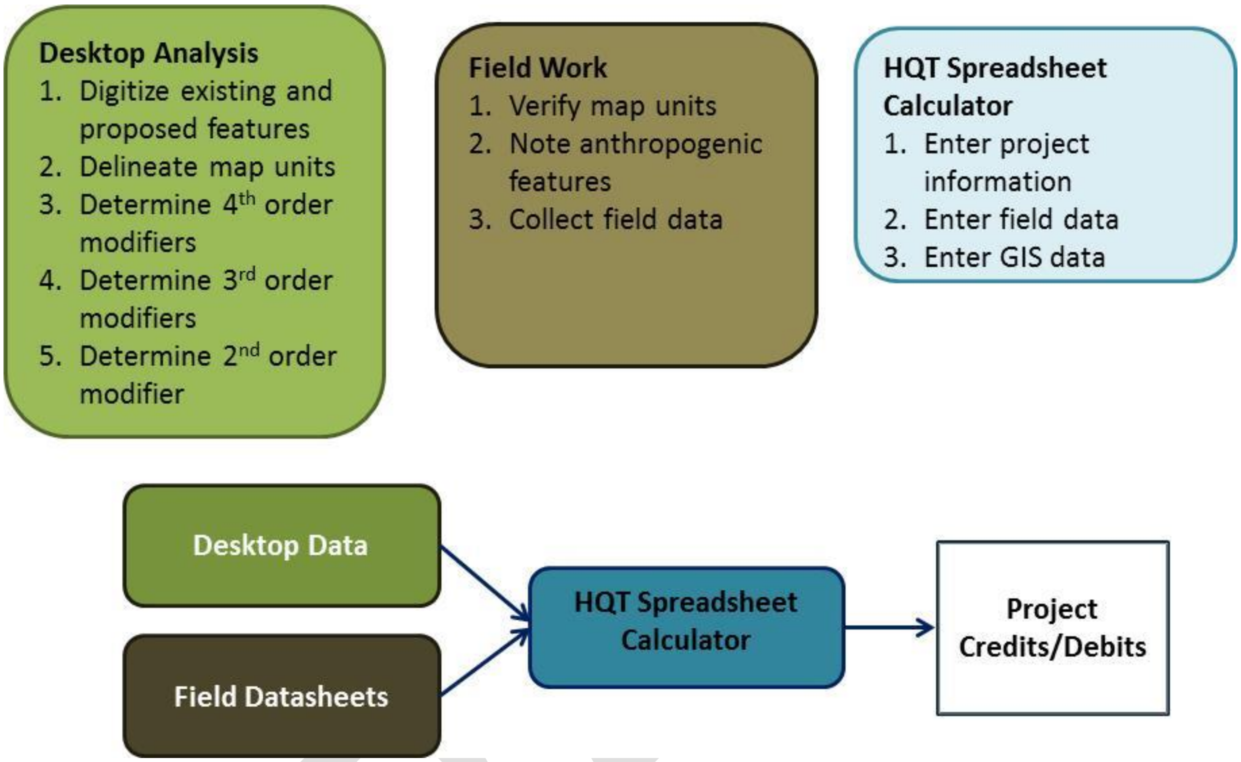
Greater Sage-Grouse Habitat Quantification Tool: A Multi-Scaled Approach for Assessing Impacts and Benefits to Greater Sage-Grouse Habitat

DRAFT User's Guide, Version 2



Contents

1.0 Workflow



Desktop Analysis
1. Digitize existing and proposed features
2. Delineate map units
3. Determine 4th order modifiers
4. Determine 3rd order modifiers
5. Determine 2nd order modifier
Field Work
1. Verify map units
2. Note anthropogenic features
3. Collect field data
HQT Spreadsheet Calculator
1. Enter project information
2. Enter field data
3. Enter GIS data
Desktop Data
Field Datasheets
HQT Spreadsheet Calculator
Project Credits/Debits

2.0 Introduction

This User's Guide describes the process for calculating functional acres for a project site based on the Greater Sage-Grouse Habitat Quantification Tool (HQT) Scientific Methods document.

2.1 HQT Overview

The Greater Sage-Grouse Habitat Quantification Tool (HQT) is a multi-scaled approach for quantifying credits and debits to greater sage-grouse (GRSG) habitat for the Colorado Habitat Exchange (Exchange). The HQT uses a set of measurements and methods, applied at multiple spatial scales, to evaluate criteria related to GRSG habitat quality. The HQT measures habitat quality at the following four orders:

- 1st order selection represents the geographic range of the GRSG population of interest—1st order habitat attributes are those necessary for the species to occur.
- Within this geographic range, 2nd order selection is based on habitats required by subpopulations; for example the habitats necessary to support the GRSG associated with a lek or lek complex.
- 3rd order selection refers to the habitats used by individuals in the subpopulation and is defined by the attributes necessary for an individual to survive and thrive throughout a year; this order is relevant at the scale of a home range.
- 4th order selection establishes the food and cover attributes at particular sites.

To quantify the quality of GRSG habitat, conditions are measured at the site (4th order) and modified to account for the surrounding context (2nd and 3rd order). To calculate the number of functional acres, the quality of the habitat—expressed as a percent of optional conditions—is multiplied by the acreage of habitat within the project area. Different criteria are measured for each of the three seasonal habitat types essential to the GRSG lifecycle (breeding, summer and winter), thus functional acres for each of the three seasonal habitat types are calculated.

To calculate credits or debits, the number of pre-project functional acres is compared to the number of post-project functional acres. The scoring process requires both a desktop computer-based analysis (GIS and Excel spreadsheet Calculator) and a field analysis. The desktop analysis should be completed first. The desktop analysis will determine the sampling protocol used in the field analysis.

This Guide describes the desktop analysis portion of the scoring process and the process for incorporating the results of the field analysis to calculate credits or debits for a project. For more information on the field analysis, see Appendix F *Field Data Collection Methods* in the HQT Scientific Methods document.

2.2 Scoring Process Overview

To quantify the quality of GRSG habitat, the ecological conditions of the site (4^{th} order) are modified by the surrounding local context (3^{rd} order) and by the landscape condition (2^{nd} order). Within the HQT Calculator, the results of the field analysis are multiplied by the results of the desktop analysis.

The first step of the desktop analysis is to digitize the project boundary. The debit project boundary (or project area) is defined by the footprint of the project (i.e. the land on which the development will occur) plus the area of behavioral avoidance effect of any anthropogenic or natural feature (e.g. transmission line or conifer cover) that occurs on the site. For debit projects, the project boundary is based on the anthropogenic feature type assessed by the Exchange, as described in Table 1. For all projects, existing anthropogenic features must also be digitized, segmenting polygons based on the feature type assessed by the Exchange, as described in Table 1. The credit project boundary does not include the area of behavioral avoidance effect of anthropogenic or natural features if those effects extend beyond the site itself. Therefore, credits can only be generated on land that the participant has enrolled in the program.Next, map units are delineated within the project area. All data are collected at the map unit level and each map unit is scored individually for each seasonal habitat type. A systematic grid for all service areas delineates map units and indicates specific plot sampling locations within the map unit. Vegetation attributes are measured at the sampling location within each map unit to calculate 4^{th} order habitat quality. For each map unit,

- 4^{th} order modifiers are calculated for 1) existing anthropogenic disturbances for pre-project condition; 2) proposed added or removed anthropogenic disturbances for post-project condition; and 3) conifer cover.
- 3^{rd} order modifiers are calculated for 1) distance to known leks; and 2) presence of sagebrush within 300-meters;
- 2^{nd} order modifier is calculated for the Landscape Disturbance Index (LDI).

All of the modifiers are inputted into the HQT Calculator as described in the *Instructions* worksheet of the HQT Calculator.

2.3 Tools Required

In order to complete the scoring process, the following tools are required:

- ArcGIS™ (ArcDesktop license or better required)
    - Spatial Analyst Extenstion for ArcGIS
    - For projects in Colorado, we strongly suggest that the coordinate system used in this analysis is UTM Zone 13N, projected in NAD83 or WGS84.
- HQT Calculator
- GIS Calculator

- Field Data Collection Methods (Appendix F in the HQT Scientific Methods document)
- Field datasheets (Available in the HQT Calculator)
- HQT Scientific Methods document (recommended for reference)

2.4 Data Required

The following data should be acquired before beginning the scoring process:

- **For Debit Projects the Proposed Disturbance(s) location/footprint, for Credit Projects, the area of land outlined in the participant's contract.** This is the area that is being proposed for the credit or debit project. For debit projects this should be a series of shapefiles corresponding to the new anthropogenic feature types intended for the project. For credit projects, this should be a single shapefile corresponding to the land intended for use in the credit calculation.
- **¼ Square Mile Grid for Map Unit Delineation.** This grid is pre-generated for the Exchange and standardizes map unit delineation and the sampling protocol for all Exchange participants. This dataset is available as a single feature class in the data package available at the website provided.
- **Landscape Disturbance Index (LDI).** This represents the cumulative impact of anthropogenic disturbance on the landscape. This is a raster dataset which is available in the data package available at the website provided.
- **Local Anthropogenic Disturbance Modifier Zip File.** This zip file contains two geodatabases and two Python scripts. It is available in the data package available at the website provided.
- **Distance to Lek.** This grid represents the distance to known greater sage-grouse lek locations within the state in units of km. It is available in the data package available at the website provided.
- **Reclassified Conifer and Sagebrush Cover raster layers.** These grids represent the reclassification of the more comprehensive Colorado Parks and Wildlife Basinwide land cover data layer to identify areas of conifer and sagebrush within the region. They are available in the data package which can be downloaded from the website provided.

3.0 Preliminary Desktop Analysis

3.1 Digitize the Credit or Debit Project Boundary

For all projects, the Exchange participant must generate a minimum of one shapefile.

1. Digitize proposed disturbance(s) or credit project boundary:
   a. For credit projects: Digitize the area of land outlined in the participant's contract (**CE**), if not provided by the project proponent.
   b. For debit projects: Digitize the proposed anthropogenic disturbances. Each proposed disturbance sub-type (unpaved roads vs. state highways, vs producing wells for example) for a given project should be included in its own shapefile and be represented by a single feature. For reference, individual disturbance types are identified in Table 1.

Table 1. Distance Effects for Anthropogenic Features Considered in the Colorado Habitat Exchange

Disturbance	Subtype	Distance (km)
Oil & Gas Wells	Active	2.1
	Inactive	0
Towers (cell/met/etc)		0
Transmission Lines		3
Wind Turbines		3
Mines	Active – Large	2.1
	Active – Med or small	0
	Inactive – Large	0
	Inactive – Med or small	0
Agriculture	Tilled	0
	Untilled	0
Urban Development	Med – High	4.2
	Low	1.5
Roads	Major Roads	4.2
	Secondary Roads	1.5

* The edges of tilled agricultural fields were considered to have value for GRSG; the curve therefore is implemented into the field rather than an indirect effect away from the field.

3.2 Delineate Map Unit Boundaries and Transect Locations

Map units are based on an initial quarter-section grid system where each base map unit is a 160 acre square, the transect sample points will be assigned for each map unit.

Note: for debit projects the following steps should be completed to include all proposed anthropogenic disturbance types as defined in Table 1.

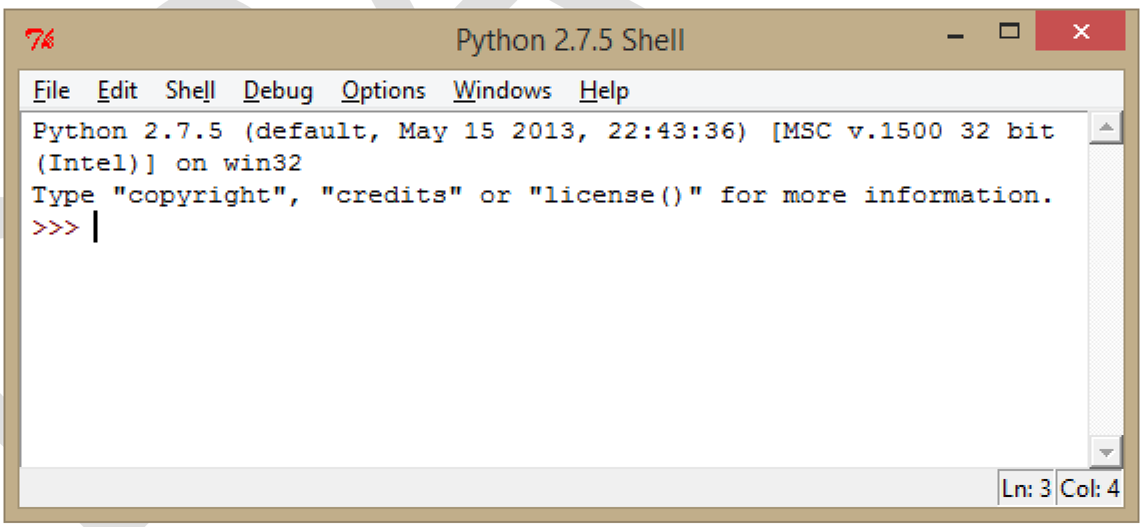
2. For Debit Projects load Disturbance Shapefile(s) (**DS_i**) into ArcMap. For Credit Projects load **CE**.

3. Load ¼ Square Mile Polygon Grid for Map Unit Delineation (**MU_Grid**) which is located in the ColoradoDataPackage.zip file which should be downloaded in the required data section of this document (Section 2.4).
4. **IF Credit Project, Skip to Step 7, IF Debit Project, Continue with Step 4:** Open Buffer Analysis tool from: Analysis Tools → Proximity → Buffer
    a. Load **DS_i** into 'Input Features' field.
    b. Choose 'Output Feature Class' (**OFC_i**) name and location.
    c. Ensure that the Distance, 'Linear unit' option is checked and that the units are meters (if they are not meters by default this may be a flag that the projection for something in your dataset is not UTM), then enter the number of meters corresponding to the maximum distance associated with impacts from that disturbance type found in Table 1 (2,100m for active wells, 1,500m for secondary roads, etc.).
    d. Under Dissolve Type, select 'ALL'
    e. Run Buffer Tool and ensure that the new buffer layer (**OFC_i**) is added to the map project.
    f. Step 4 should be completed for each disturbance type shapefile (**DS_i**).

5. If only one disturbance type is used in Step 4: **OFC_i** from Step 4e becomes **OFC** and you should skip the remainder of Step 5. If more than one disturbance type is used in Step 4, continue through the remainder of this step (Step 5).
    a. Open the Merge tool from: Data Management Tools Toolbox -> General -> Merge
    b. Load all of the new buffer output shapefiles (**OFC_i**) generated from Step 4 as 'Input Datasets'
    c. Set the output path to an appropriate location and run the tool.
    d. The output for this step should be a single shapefile containing all of the new buffer polygons (**OFC_Merged**).
6. Run the Dissolve tool from: Data Management Tools -> Generalization -> Dissolve
    a. Use **OFC_Merged** as the input,
    b. Set an appropriate output location,
    c. Scroll to the bottom of the tool window and uncheck 'Create multipart features (optional)'
    d. Leave everything else set to default and run the tool, the output should be: **OFC**
7. **If Debit Project, Skip to Step 8, If Credit Project, Continue with Step 7:** In the next several steps you will use a combination of ArcMap and Python scripting to identify existing anthropogenic features within the area of land outlined in the participant's contract and the total merged maximum distance effect associated with those features.
    a. Download and unzip the 'ColoradoDataPackage.zip' folder. In this folder you will find a 'Scripts' directory with two geodatabases and two Python scripts.

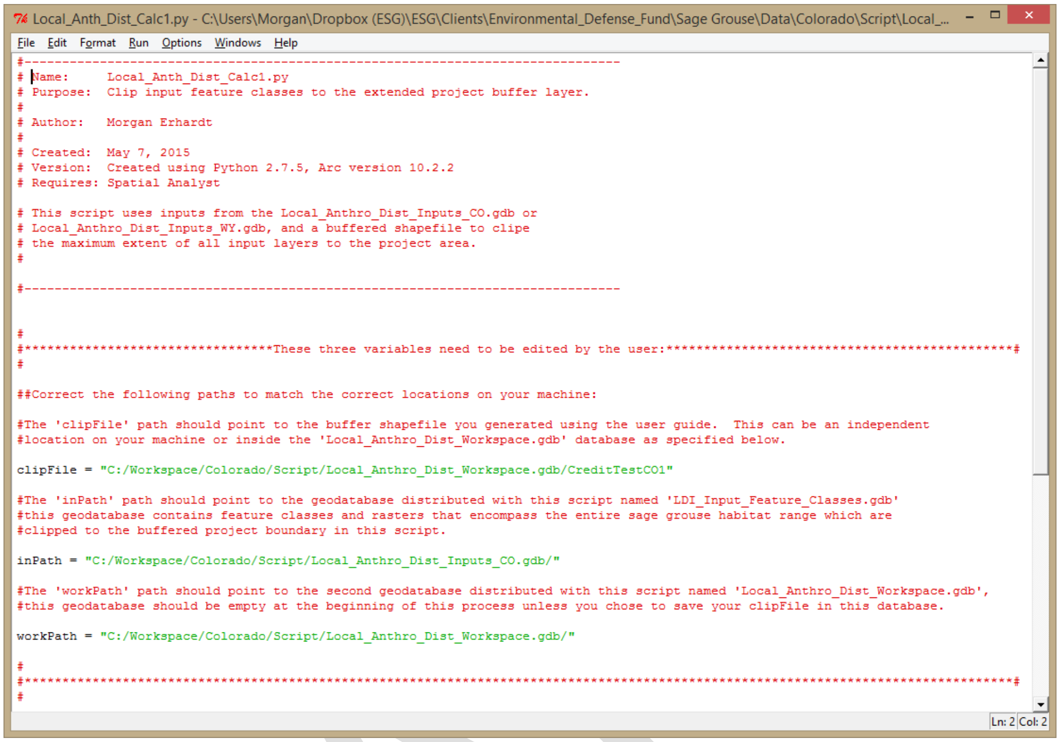
    i. The first geodatabase is called ‘Local_Anthro_Dist_Inputs_CO.gdb’. This geodatabase contains necessary feature classes and rasters to run Colorado credit or debit projects. These datasets represent the inputs used to generate buffer distances and Local Anthropogenic Disturbance Rasters. Do not make any changes to the layers in this database.
    ii. The second geodatabase is called ‘Local_Anthro_Dist_Workspace.gdb’ and this is the location where all of the temporary and final files will be stored while the python scripts are running.
    iii. The first Python script is named ‘Local_Anth_Dist_Calc1.py’ and it is used in both Debit and Credit projects to clip out areas of the input data layers found in the first geodatabase where they overlap with the buffer layer (**OFC**) created in Step 6 of this User’s Guide, or the area of land outlined in the participant’s contract (**CE**) specified in Step 1a.
    iv. The second Python script is named ‘Local_Anth_Dist_Calc2.py and it is used to generate local anthropogenic disturbance rasters specific to the project area being evaluated.

b. The first step, once the zip folder has been unpackaged, is to open the IDLE (Python GUI) program which is installed along with ArcGIS. This should open a fairly generic window depicted below:



c. From this window select File >> Open, then navigate to the first python script (Local_Anth_Dist_Calc1.py). This should open up the following window:

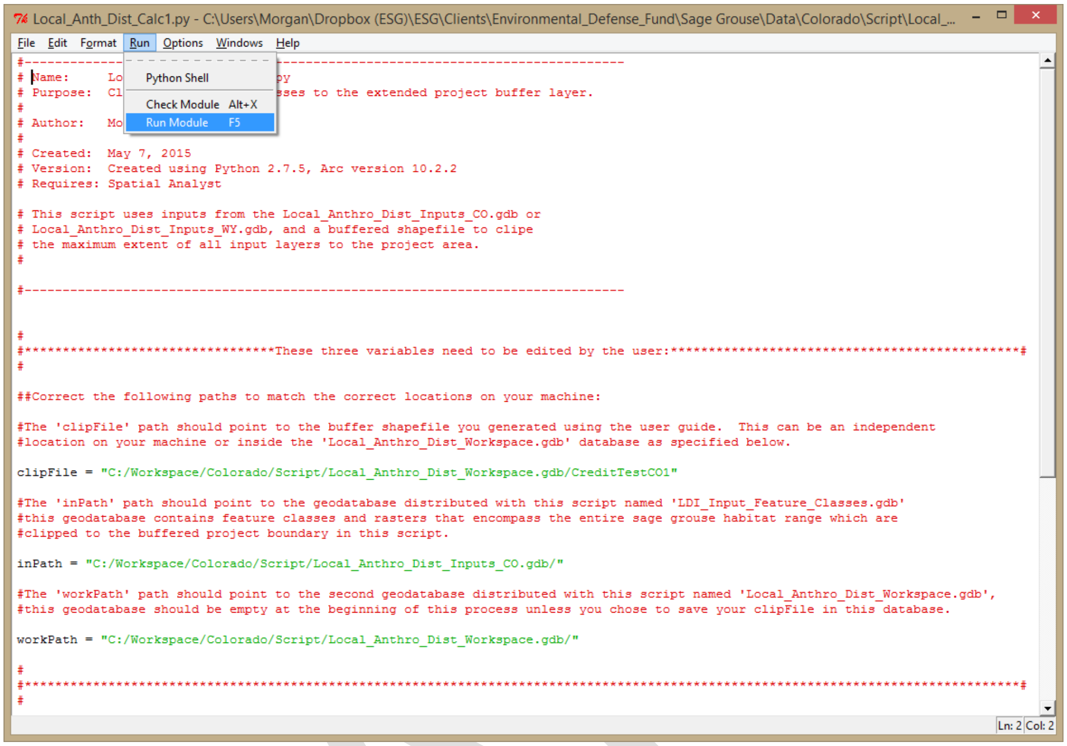
Note:
When editing paths in Python scripts it is best to use a forward slash '/' rather than a back slash '\' to show the file directory structure.



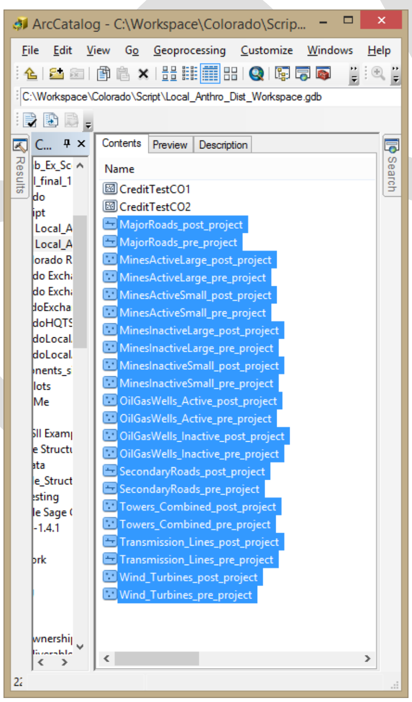

```
#-------------------------------------------------------------------------------
# Name:      Local_Anth_Dist_Calc1.py
# Purpose:   Clip input feature classes to the extended project buffer layer.
#
# Author:    Morgan Erhardt
#
# Created:   May 7, 2015
# Version:   Created using Python 2.7.5, Arc version 10.2.2
# Requires:  Spatial Analyst

# This script uses inputs from the Local_Anthro_Dist_Inputs_CO.gdb or
# Local_Anthro_Dist_Inputs_WY.gdb, and a buffered shapefile to clipe
# the maximum extent of all input layers to the project area.
#

#-------------------------------------------------------------------------------


#
#*********************************These three variables need to be edited by the user:**********************************************#
#

##Correct the following paths to match the correct locations on your machine:

#The 'clipFile' path should point to the buffer shapefile you generated using the user guide.  This can be an independent
#location on your machine or inside the 'Local_Anthro_Dist_Workspace.gdb' database as specified below.

clipFile = "C:/Workspace/Colorado/Script/Local_Anthro_Dist_Workspace.gdb/CreditTestCO1"

#The 'inPath' path should point to the geodatabase distributed with this script named 'LDI_Input_Feature_Classes.gdb'
#this geodatabase contains feature classes and rasters that encompass the entire sage grouse habitat range which are
#clipped to the buffered project boundary in this script.

inPath = "C:/Workspace/Colorado/Script/Local_Anthro_Dist_Inputs_CO.gdb/"

#The 'workPath' path should point to the second geodatabase distributed with this script named 'Local_Anthro_Dist_Workspace.gdb',
#this geodatabase should be empty at the beginning of this process unless you chose to save your clipFile in this database.

workPath = "C:/Workspace/Colorado/Script/Local_Anthro_Dist_Workspace.gdb/"

#
#*******************************************************************************************************************************#
#
```

d. Scroll up or down within the window until you see the three paths which will need to be edited. The three paths shown in green in this image need to be updated for your machine's specific directory structure. The first path should lead to the area of land outlined in the participant's contract (**CE**) generated in Step 1a (if not a feature class in a geodatabase then include file extensions, e.g. '**.shp**'). The second path should be corrected to match the path to the first geodatabase located on your machine which contains input files for Colorado (Local_Anthro_Dist_Inputs_CO.gdb). The third path should be corrected to match the workspace geodatabase located on your machine (Local_Anthro_Dist_Workspace.gdb).

e. Once the paths have been corrected click Run >> Run Module and let the tool run. The script will prompt you when it is complete.



f. Open the second geodatabase, '**Local_Anthro_Dist_Workspace.gdb**' and you should see a group of different feature classes:



There should be two copies of each disturbance type feature class, one with a suffix of '**_pre_project**' and another with a suffix of '**_post_project**'. This is your opportunity to set the pre- and post-project conditions for your Credit model run. First, load all of the pre-project feature classes into a map document and ensure that all of the disturbances in the area are accounted for in the datasets. If disturbances are missing, i.e. an active well is not included where it is supposed to be, edit the appropriate feature class to add the missing point (**‘OilGasWells_Active_pre_project’**). Also make this change in the post-project feature classes. For the post-project condition, make edits to appropriate feature classes to reflect the changes associated with the credit project. If the project includes removal of an active well, for example, edit the appropriate feature class to remove the appropriate point (**OilGasWells_Active_post_project’**). Once all of the disturbances are added to, or removed from, their respective feature classes, save the changes, and stop editing. **NOTE: DO NOT CHANGE THE NAMES OF THE FEATURE CLASSES IN THE DATABASE PRIOR TO RUNNING THE SECOND SCRIPT! THIS WILL BREAK THE SCRIPT.**

   g. Once all of your edits are completed and saved, remove any open feature classes from your map project.
   h.

8. Open the Buffer Analysis tool from: Analysis Tools → Proximity → Buffer
   a. Load **OFC** for debit projects and **CE** for credit projects into the ‘Input Features’ field.
   b. Choose ‘Output Feature Class Extended’ (**OFC_Extended**) name and location.
   c. Ensure that the Distance, ’Linear unit’ option is checked and that the units are meters then enter 2,000m.
   d. Under Dissolve Type, select ‘ALL’
   e. Run Buffer Tool and ensure that the new buffer layer (**OFC_Extended**) is added to the map project.
9. Run the Intersect Tool from: Analysis Tools -> Overlay -> Intersect
   a. Use **MU_Grid** and **OFC** for debit projects or **CE** for credit projects as the Input Features
   b. Select an appropriate output location and save as a shapefile
   c. Leave the ‘JoinAttributes (optional)’ field set to ALL
   d. Leave the ‘XY Tolerance (optional)’ field blank
   e. Leave the ‘Output Type (optional)’ field set to INPUT
   f. Run the tool. The output from this tool should be: **NMUPoly**
10. Run the Add Geometry Attributes tool from: Data Management Tools -> Features -> Add Geometry Attributes
   a. Use the **NMUPoly** as the Input Feature
   b. Under ‘Geometry Properties’ check the boxes next to ‘AREA’ and ‘CENTROID_INSIDE’
   c. Leave the Length Unit (optional) blank,
   d. Set the Area Unit (optional) to ACRES.
   e. Set the Coordinate System (optional) to ‘WGS_1984_UTM_Zone_13N’

f. Run the tool, this will add these fields to the NUMPoly attribute table.

11. Export the **NMUPoly** shapefile attribute table as a dBASE table:
    a. Right-click on the shapefile (NMUPoly) name and select Open Attribute Table
    b. In the table view window that opens up, select the Table Options menu in the upper left corner, then select export.
    c. Click the folder icon to select the path for the new location, change the ‘Save as type:’ field to ‘dBASE Table’ and the ‘Name:’ field to ‘**NMU_Transect_Table.dbf’**
    d. Save this table to an appropriate location and ensure that it is added to the project.
    e. Right-click on the table name in the Table of Contents, and select ‘Display XY Data’,
    f. Change the ‘X Field:’ to INSIDE_X and the ‘Y Field:’ to INSIDE_Y, leave ‘Z Field’ as ‘<None>’,ensure that the coordinate system is WGS_1984_UTM_Zone_13N or NAD83 UTM Zone 13N, and select OK.
    g. At the top of the Table of Contents select the ‘List by Drawing Order’ icon.
    h. Right-click on the resulting feature layer (**NMU_Transect_Table Events**) in the Table of Contents, then click on Data -> Export Data…, set the ‘Output feature class…’ field to a desired location and save the new transect point shapefile (**NMUPoint**).
    i. Remove the temporary Event layer (**NMU_Transect_Table Events**)

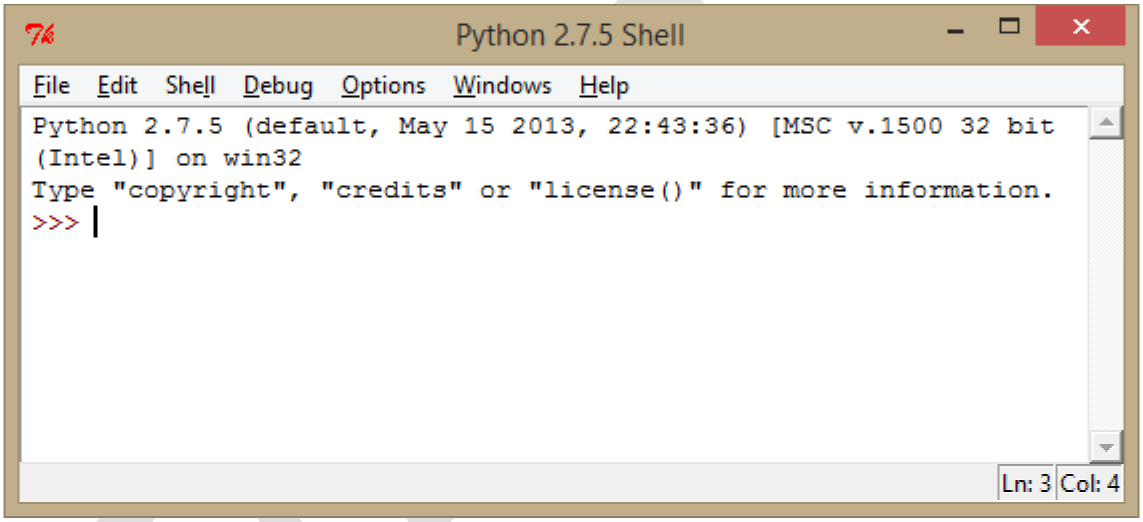
3.3 Compute Local Anthropogenic Disturbance Modifier Values

12. **IF Credit Project, skip to Step 12h below, IF Debit Project, continue with Step 12a**: In the next several steps you will use a combination of ArcMap and scripting to calculate local scores for conditions before and after the proposed project.
    a. Download and unzip the ‘ColoradoDataPackage.zip’ folder. In this folder you will find a ‘Scripts’ directory with two geodatabases and two Python scripts.
        i. The first geodatabase is called ‘Local_Anthro_Dist_Inputs_CO.gdb’. This geodatabase contains necessary feature classes and rasters to run Colorado credit or debit projects. These datasets represent the inputs used to generate buffer distances and Local Anthropogenic Disturbance Rasters. Do not make any changes to the layers in this database.
        ii. The second geodatabase is called ‘Local_Anthro_Dist_Workspace.gdb’ and this is the location where all of the temporary and final files will be stored while the python scripts are running.
        iii. The First Python script is named ‘Local_Anth_Dist_Calc1.py’ and it is used in both Debit and Credit projects to clip out areas of the input data layers found in the first geodatabase where they overlap with the buffer layer (**OFC**) created in

Step 6 of this User's Guide, or the area of land outlined in the participant's contract (**CE**) specified in Step 1a.

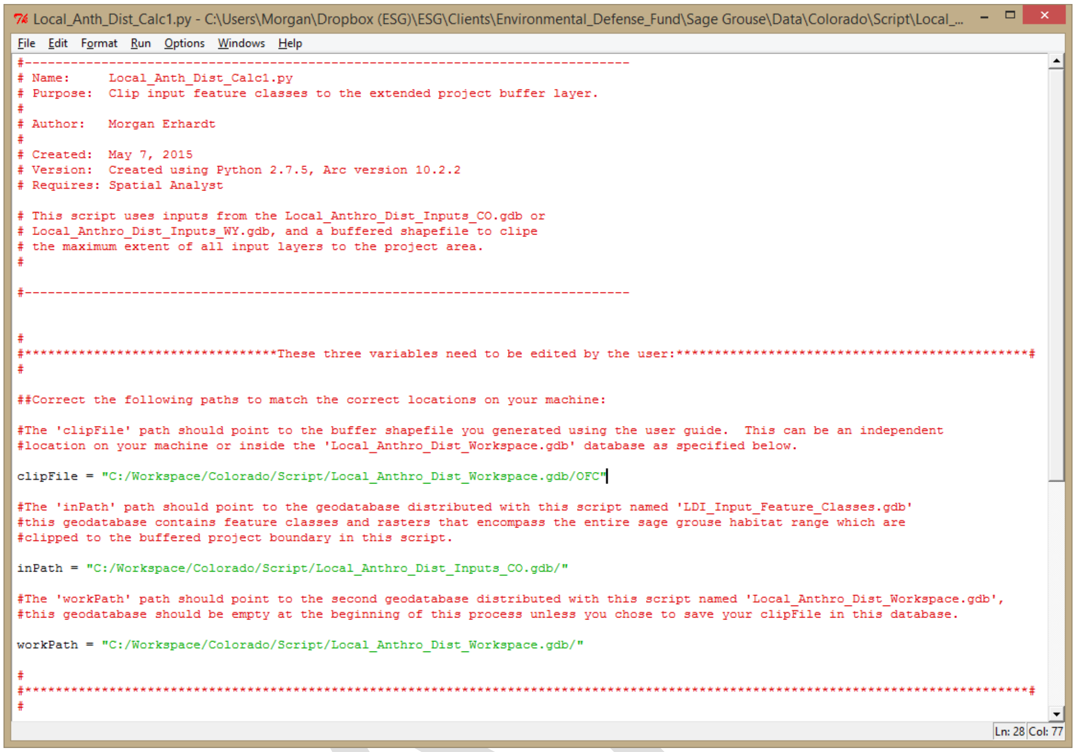
iv. The second Python script is named 'Local_Anth_Dist_Calc2.py and it is used to generate local anthropogenic disturbance rasters specific to the project area being evaluated.

b. The first step, once the zip folder has been unpackaged, is to open the IDLE (Python GUI) program which is installed along with ArcGIS. This should open a window that looks like this:



c. From this window select File >> Open, then navigate to the first python script (Local_Anth_Dist_Calc1.py). This should open up a window that looks like this:

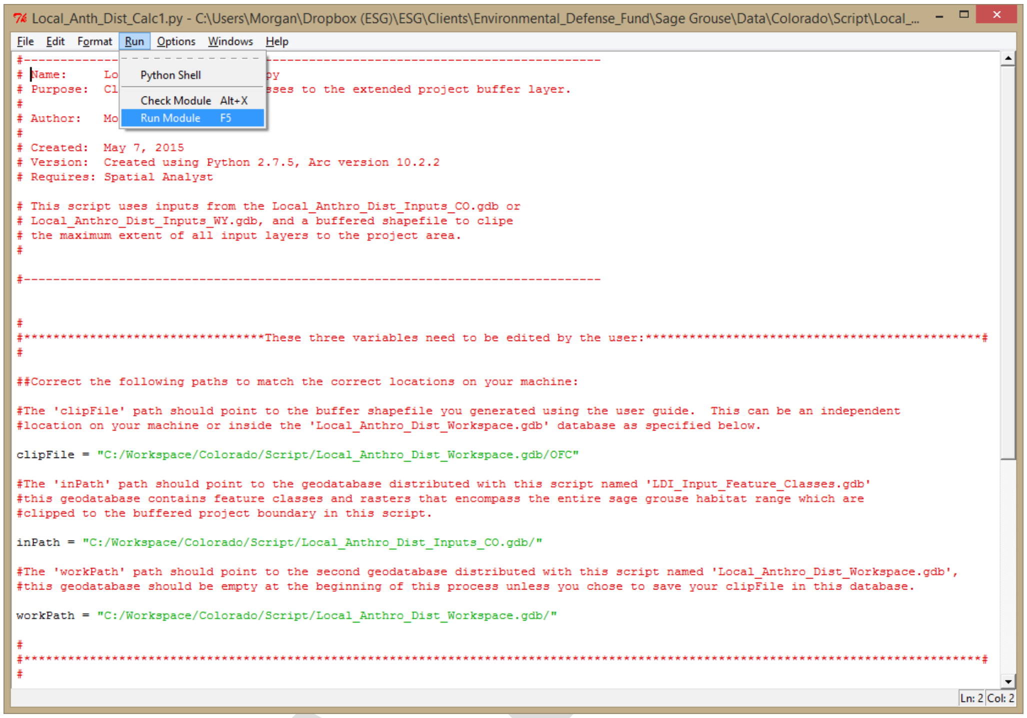
Note:
When editing paths in Python scripts it is best to use a forward slash '/' rather than a back slash '\' to show the file directory structure.



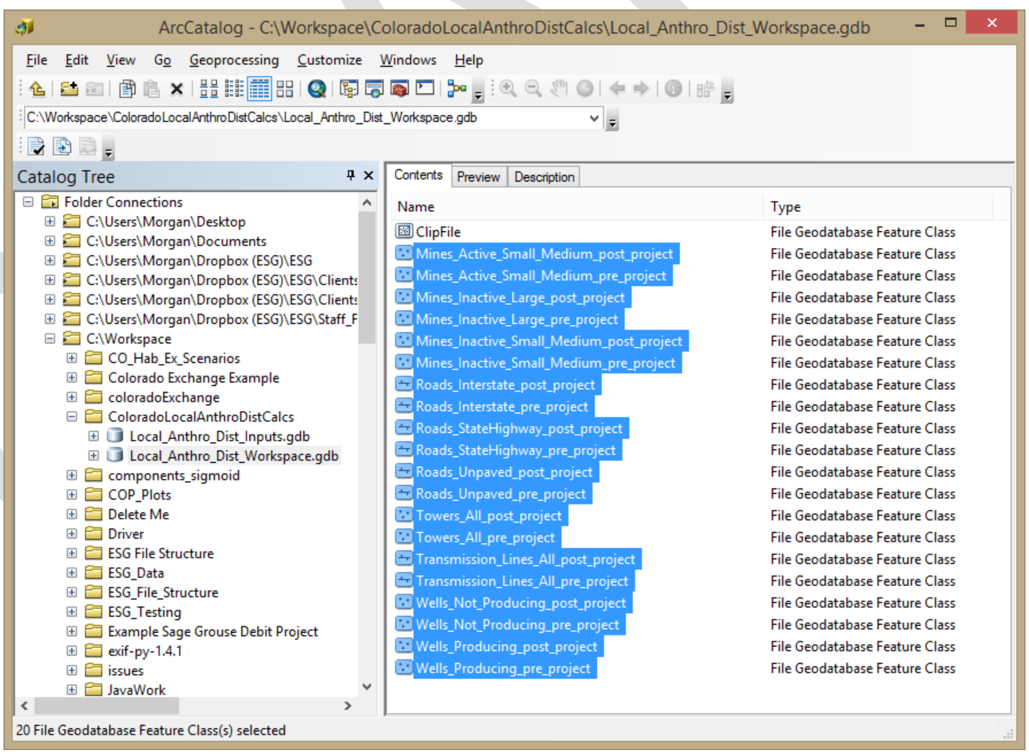

```
#-------------------------------------------------------------------------------
# Name:     Local_Anth_Dist_Calc1.py
# Purpose:  Clip input feature classes to the extended project buffer layer.
#
# Author:   Morgan Erhardt
#
# Created:  May 7, 2015
# Version:  Created using Python 2.7.5, Arc version 10.2.2
# Requires: Spatial Analyst

# This script uses inputs from the Local_Anthro_Dist_Inputs_CO.gdb or
# Local_Anthro_Dist_Inputs_WY.gdb, and a buffered shapefile to clipe
# the maximum extent of all input layers to the project area.
#

#-------------------------------------------------------------------------------


#
#*********************************These three variables need to be edited by the user:*********************************************#
#

##Correct the following paths to match the correct locations on your machine:

#The 'clipFile' path should point to the buffer shapefile you generated using the user guide.  This can be an independent
#location on your machine or inside the 'Local_Anthro_Dist_Workspace.gdb' database as specified below.

clipFile = "C:/Workspace/Colorado/Script/Local_Anthro_Dist_Workspace.gdb/OFC"

#The 'inPath' path should point to the geodatabase distributed with this script named 'LDI_Input_Feature_Classes.gdb'
#this geodatabase contains feature classes and rasters that encompass the entire sage grouse habitat range which are
#clipped to the buffered project boundary in this script.

inPath = "C:/Workspace/Colorado/Script/Local_Anthro_Dist_Inputs_CO.gdb/"

#The 'workPath' path should point to the second geodatabase distributed with this script named 'Local_Anthro_Dist_Workspace.gdb',
#this geodatabase should be empty at the beginning of this process unless you chose to save your clipFile in this database.

workPath = "C:/Workspace/Colorado/Script/Local_Anthro_Dist_Workspace.gdb/"

#
#*******************************************************************************************************************************#
#
```

d. Scroll up or down within the window until you see the three paths which will need to be edited. The three paths shown in green in this image need to be updated for your machine's specific directory structure. The first path should lead to the buffer file (**OFC**) generated in Step 6 (if not a feature class in a geodatabase then include file extensions, e.g. '**.shp**'). The second path should be corrected to match the path to the first geodatabase located on your machine which contains input files for Colorado (Local_Anthro_Dist_Inputs_CO.gdb). The third path should be corrected to match the workspace geodatabase located on your machine (Local_Anthro_Dist_Workspace.gdb).

e. Once the paths have been corrected click Run >> Run Module and let the tool run. The script will prompt you when it is done running.

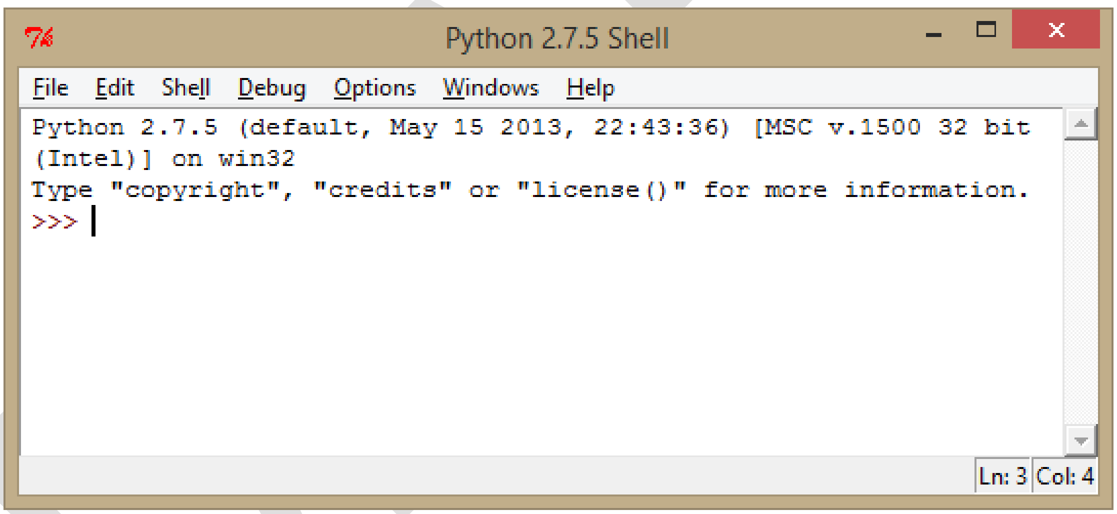


f. Open the second geodatabase '**Local_Anthro_Dist_Workspace.gdb** ' and you should see a group of different feature classes:

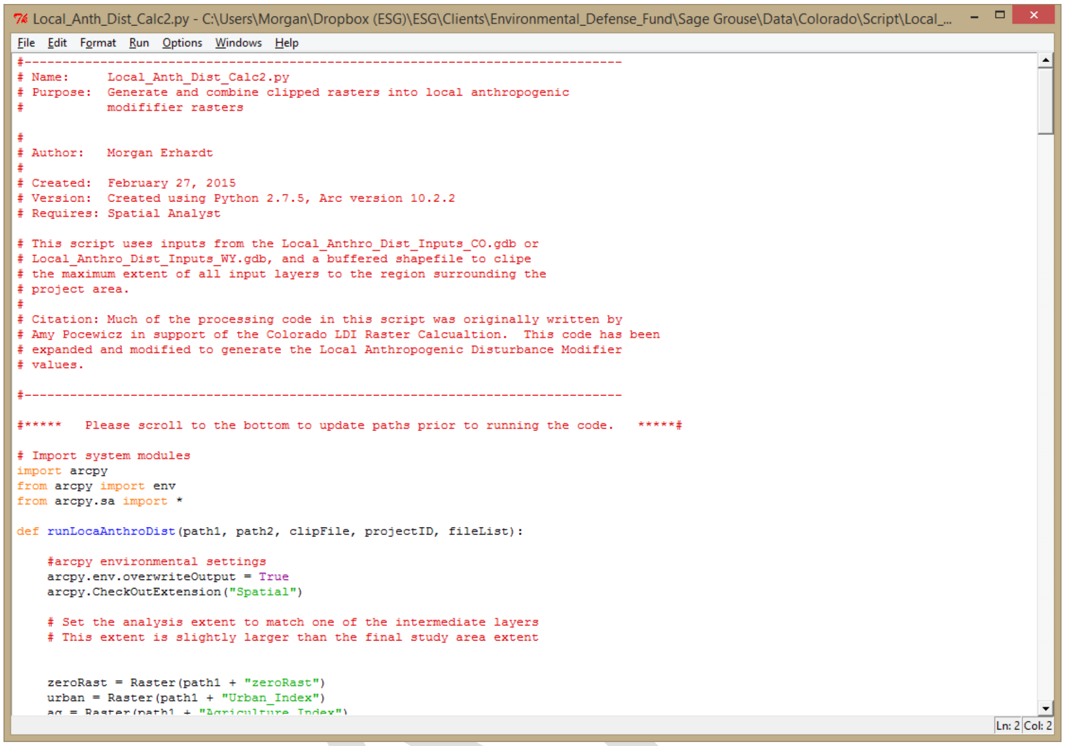


There should be two copies of each disturbance type feature class, one with a suffix of '**_pre_project**' and another with a suffix of '**_post_project**'. This is your opportunity to set the pre- and post-project conditions for your Debit model run. First, load all of the pre-project feature classes into a map document and ensure that all of the disturbances in the area are accounted for in the datasets. If disturbances are missing, i.e. an active well is not included where it is supposed to be, edit the appropriate feature class to add the missing point (**'OilGasWells_Active_pre_project'**). Also make this change in the post-project feature classes. For the post-project condition, make edits to appropriate feature classes to reflect the changes associated with the Debit project. If the project includes addition of an active well, for example, edit the appropriate feature class to add the appropriate point (**OilGasWells_Active_post_project'**). Once all of the disturbances are added to, or removed from, their respective feature classes, save the changes, and stop editing. **NOTE: DO NOT CHANGE THE NAMES OF THE FEATURE CLASSES IN THE DATABASE PRIOR TO RUNNING THE SECOND SCRIPT! THIS WILL BREAK THE SCRIPT.**

g. Once all of your edits are completed and saved, remove any open feature classes from your map project. It is now time to run the last script.

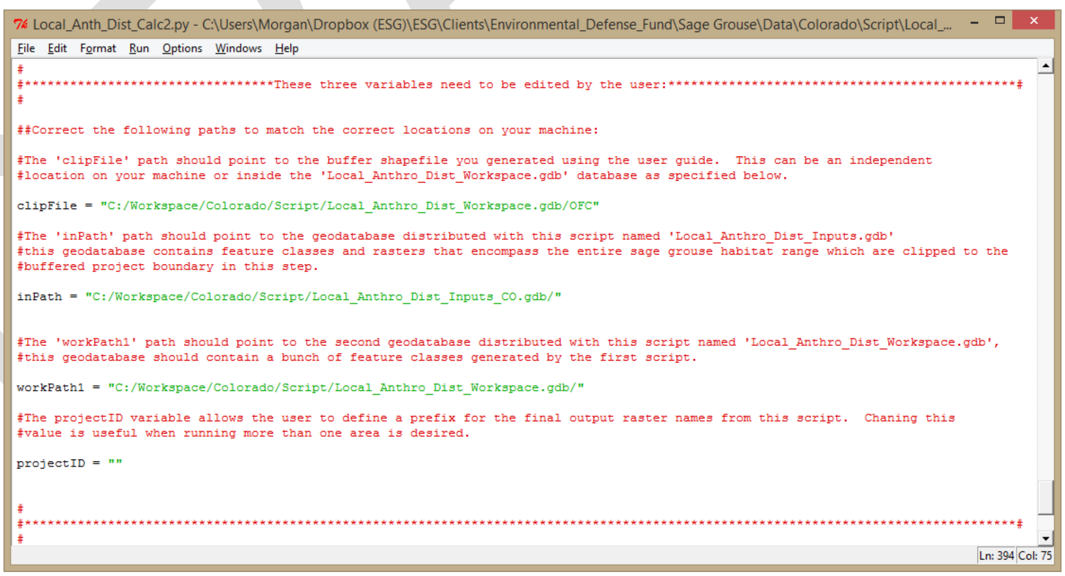


h. From the IDLE (Python GUI) window select File >> Open, then navigate to the second python script (Local_Anth_Dist_Calc2.py). This should open up a window that looks like this:



```
Local_Anth_Dist_Calc2.py - C:\Users\Morgan\Dropbox (ESG)\ESG\Clients\Environmental_Defense_Fund\Sage Grouse\Data\Colorado\Script\Local_...
File Edit Format Run Options Windows Help
#-------------------------------------------------------------------------------
# Name:     Local_Anth_Dist_Calc2.py
# Purpose:  Generate and combine clipped rasters into local anthropogenic
#           modifier rasters

#
# Author:   Morgan Erhardt
#
# Created:  February 27, 2015
# Version:  Created using Python 2.7.5, Arc version 10.2.2
# Requires: Spatial Analyst

# This script uses inputs from the Local_Anthro_Dist_Inputs_CO.gdb or
# Local_Anthro_Dist_Inputs_WY.gdb, and a buffered shapefile to clipe
# the maximum extent of all input layers to the region surrounding the
# project area.
#
# Citation: Much of the processing code in this script was originally written by
# Amy Pocewicz in support of the Colorado LDI Raster Calcualtion.  This code has been
# expanded and modified to generate the Local Anthropogenic Disturbance Modifier
# values.

#-------------------------------------------------------------------------------

#*****   Please scroll to the bottom to update paths prior to running the code.   *****#

# Import system modules
import arcpy
from arcpy import env
from arcpy.sa import *

def runLocaAnthroDist(path1, path2, clipFile, projectID, fileList):

    #arcpy environmental settings
    arcpy.env.overwriteOutput = True
    arcpy.CheckOutExtension("Spatial")

    # Set the analysis extent to match one of the intermediate layers
    # This extent is slightly larger than the final study area extent


    zeroRast = Raster(path1 + "zeroRast")
    urban = Raster(path1 + "Urban_Index")
    ag = Raster(path1 + "Agriculture_Index")
Ln: 2 Col: 2
```

i. Scroll down toward the bottom of the window until you see three paths and one (optional) variable which will need to be edited.



```
Local_Anth_Dist_Calc2.py - C:\Users\Morgan\Dropbox (ESG)\ESG\Clients\Environmental_Defense_Fund\Sage Grouse\Data\Colorado\Script\Local_...
File Edit Format Run Options Windows Help
#
#**********************************These three variables need to be edited by the user:**********************************************#
#

##Correct the following paths to match the correct locations on your machine:

#The 'clipFile' path should point to the buffer shapefile you generated using the user guide.  This can be an independent
#location on your machine or inside the 'Local_Anthro_Dist_Workspace.gdb' database as specified below.

clipFile = "C:/Workspace/Colorado/Script/Local_Anthro_Dist_Workspace.gdb/OFC"

#The 'inPath' path should point to the geodatabase distributed with this script named 'Local_Anthro_Dist_Inputs.gdb'
#this geodatabase contains feature classes and rasters that encompass the entire sage grouse habitat range which are clipped to the
#buffered project boundary in this step.

inPath = "C:/Workspace/Colorado/Script/Local_Anthro_Dist_Inputs_CO.gdb/"


#The 'workPath1' path should point to the second geodatabase distributed with this script named 'Local_Anthro_Dist_Workspace.gdb',
#this geodatabase should contain a bunch of feature classes generated by the first script.

workPath1 = "C:/Workspace/Colorado/Script/Local_Anthro_Dist_Workspace.gdb/"

#The projectID variable allows the user to define a prefix for the final output raster names from this script.  Chaning this
#value is useful when running more than one area is desired.

projectID = ""


#
#*************************************************************************************************************************************#
#
Ln: 394 Col: 75
```

Scroll up or down within the window until you see the three paths which will need to be edited. The three paths shown in green in this image need to be updated for your machine's specific directory structure. The first path should lead to the area of land outlined in the participants contract (CE) generated in step 1a (if not a feature class in a geodatabase then include file extensions, e.g. '.shp'). The second path should be corrected to match the path to the first geodatabase located on your machine which contains input files for Colorado (Local_Anthro_Dist_Inputs_CO.gdb). The third path should be corrected to match the workspace geodatabase located on your machine (Local_Anthro_Dist_Workspace.gdb). The last variable is optional and may be set to match the Project ID you are working on; if entered, this will be used as a prefix on the final output rasters from this script.

   j. Once the paths have been corrected click Run >> 'Run Module' and let the tool run.
   k. A series of notifications should scroll across your screen. This may take some time but when the model is done running a notification indicating that the model run is complete should be printed to your screen.
   l. When this model run is completed two new rasters will have been added to the second geodatabase (**Local_Anthro_Dist_Workspace.gdb**). One represents the pre-project condition (**pre_project_Local_Anthro_Dist**), and the other represents the post-project condition (**post_project_Local_Anthro_Dist**)

3.4 Calculate Local Anthro. and LDI Values

13. Load **NMUPoly** to the map project.
14. Load the pre-project local anthropogenic disturbance raster (**pre_project_Local_Anthro_Dist**), the post-project local anthropogenic disturbance raster (**post_project_Local_Anthro_Dist),** and the LDI raster (**LDI**) (located in the Colorado Regional Data Layers Geodatabase downloaded with the data package) to the map project.
15. Open the Zonal Statistics as Table tool from: Spatial Analysis Toolbox → Zonal → Zonal Statistics as Table:
    a. Run the tool 3 times (once for each raster), using the **NMUPoly** shapefile as the 'Input Raster or Feature Zone Data', the Zone Field to FID, the individual rasters (**LDI**, **pre_project_Local_Anthro_Dist**, and **post_project_Local_Anthro_Dist**) in the 'Input value raster' field, and the Statistic Type: MEAN
    b. Output Tables should be exported to text and compiled into an excel document which lists the mean values for each raster in rows associated with each map unit.
16. These data should be entered into the HQT Calculator Spreadsheet as the pre-project anthropogenic disturbance modifier, post-project anthropogenic disturbance modifier, and LDI values.

3.5 Calculate Conifer Cover (4th order modifier) and 3rd Order Modifiers

For each map unit, modifiers are calculated for 1) conifer cover; 2) distance to known leks; and 3) presence of sagebrush within 300-meters.

3.5.1 Conifer and Sagebrush Cover

17. Load **NMUPoint** (map transect locations) to map project
18. Load **NMUPoly** (map unit polygons) to map project
19. Load the Reclassified Conifer raster (**Conifer**) (Reclassification key shown in Table 2)
20. Load the Reclassified Sagebrush raster (**Sage**) (Reclassification Key shown in Table 3)
21. Load the **OFC_Extended** shapefile

Table 2

BASINWIDE class name	Assigned Conifer Cover Value
Conifer Riparian	1
Douglas Fir	1
Douglas Fir/AspenMix	0.5
Douglas Fir/Englemann Spruce Mix	1
Engleman Spruce/Fir Mix	1
Fir/Lodgepole Pine Mix	1
Juniper	1
Juniper/Mtn Shrub Mix	0.5
Juniper/Sagebrush Mix	0.25
Limber Pine	1
Lodgepole Pine	1
Lodgepole Pine/Aspen Mix	0.5
Lodgepole/Spruce/Fir Mix	1
Mixed Forest Land	0.75
Mixed woodland	0.5
P.Pine/Aspen/Gamble Oak Mix	0.3
Pinion-Juniper	1
PJ-Mtn Shrub Mix	0.5
PJ-Oak Mix	0.5
PJ-Sagebrush Mix	0.3
Ponderosa Pine	1
Ponderosa Pine/Aspen Mix	0.5
Ponderosa Pine/Aspen/Mesic Mtn	0.3
Ponderosa Pine/Douglas Fir Mix	1
Ponderosa Pine/Mesic Mtn. Shrub	0.5
Sparse Juniper/Shrub/Rock Mix	0.2
Sparse PJ/Shrub/Rock Mix	0.2
Spruce/Fir Regeneration	1
Spruce/Fir/Aspen Mix	0.7
Spruce/Fir/Lodgepole/Aspen Mix	0.25
Spruce/Lodgepole Pine Mix	1
Sub-Alpine Fir	1

Table 3

Class Name	Sagebrush
Sagebrush Community	1
Sagebrush/Gambel Oak Mix	1
Sagebrush/Grass Mix	1
Sagebrush/Greasewood	1
Sagebrush/Mesic Mtn Shrub Mix	1
Sagebrush/Rabbitbrush Mix	1

22. Open the Clip tool from: Data Management Tools -> Raster -> Raster Processing -> Clip
    a. Set the Input Raster to the **CONIFER** dataset, set the Output Extent to the same as **OFC_Extended**, leave everything else set to default except for the output filename.
    b. The output for this step is **Conif_Clipped**
23. If the project does not include changes to Conifer Cover, skip to Step 27. If you do intend to change Conifer Cover, continue with Step 23:
    a. Create a new polygon shapefile using our standard WGS84 or NAD83 UTM Zone 13N coordinate system (**Conif_Edit_Shape**).
    b. Open the attribute table for **Conif_Edit_Shape** and create a new Float field called *Value*.
    c. Start editing the shapefile by right clicking on its name in the Table of Contents, clicking Edit Features, then Start Editing.
    d. Add polygons to the shapefile that match the extent where you intend to make changes to Conifer cover.
    e. Change the value in the Value field of the attribute table for the polygon(s) you created so that the appropriate value from Table 2 above is selected for each polygon, and 0 indicates no conifer cover. Save your edits and stop editing.
24. Open the Polygon to Raster tool from: Conversion Tools -> To Raster -> Polygon to Raster.
    a. Set the input Features to **Conifer_Edit_Shape**
    b. Set the Value field to 'Value' from your shapefile
    c. Set the output raster (**Conifer_Mask**) to an appropriate location
    d. Leave Cell assignment type (optional) set to 'CELL_CENTER'
    e. Leave Priority field (optional) set to 'NONE'
    f. Set the Cellsize (optional) field to 25.
    g. Open the Environment Settings window by clicking on the 'Environments…' button at the bottom of the tool window.
        i. Select the Processing Extent drop-down
            1. Change the Extent to match the **Conif_Clipped** raster
            2. Set Snap Raster to **Conif_Clipped**
            3. Click OK at the bottom of the Environmental Settings window.

    h. Run the tool, the output for this step is **Conifer_Mask**

25. Open the Raster Calculator tool from: Spatial Analyst Tools -> Map Algebra -> Raster Calculator
    a. Enter the following Conditional Statement in the equation builder window: Con(IsNull(**Conifer_Mask**), **Conif_Clipped**, **Conifer_Mask**), e.g. Con(IsNull("Conif_Masked"), "Conif_Clipped","Conif_Masked")
    b. Where **Conifer_Mask** is our newly created raster from Step 24h above and **Conif_Clipped** is from Step 22b above.
    c. The output for this step is **Conifer_Post_Project**
26. Open the Focal Statistics tool from: Spatial Analyst Tools -> Neighborhood -> Focal Statistics
    a. Set the Input raster to **Conifer_Post_Project**, the output raster name to **Conifer_Post_Focl**, the Neighborhood type to **Circle**, the Units to **Map**, the Radius to 1000, and the Statistic Type to **MEAN**
    b. The output for this step is **Conifer_Post_Focl**
27. Open the Focal Statistics tool from: Spatial Analyst Tools -> Neighborhood -> Focal Statistics
    c. Set the Input raster to **Conif_Clipped**, the output raster name to **Conifer_Focl**, the Neighborhood type to **Circle**, the Units to **Map**, the Radius to 1000, and the Statistic Type to **MEAN**
    d. The output for this step is **Conifer_Focl**
28. Open the Zonal Statistics as Table tool from: Spatial Analysis Toolbox → Zonal → Zonal Statistics as Table:
    a. Run the tool once for the Conifer focal statistic raster (**Conifer_Focl)** and, ***where applicable***, once for the post-project conifer focal statistic raster (**Conifer_Post_Focl**), using the **NMUPoly** shapefile as the 'Input Raster or Feature Zone Data', the Zone Field to FID, the raster(s) in the 'Input value raster' field, and the Statistic Type: MEAN
29. Output Tables should be exported to text and compiled into an excel document which lists the mean values for each raster in rows associated with each map unit.
30. Enter these data into the HQT spreadsheet for their corresponding map units.
31. Open the Clip tool from: Data Management Tools -> Raster -> Raster Processing -> Clip
    a. Set the Input Raster to the **SAGE** Raster, set the Output Extent to the same as **OFC_Extended**, leave everything else set to default except for the output filename.
    b. The output for this step is **Sage_Clipped**
32. If the project does not include changes to Sage Cover, skip to Step 36. If you do intend to change Sage Cover, continue with Step 32:
    a. Create a new polygon shapefile using our standard WGS84 or NAD83 UTM Zone 13N coordinate system (**Sage_Edit_Shape**).
    b. Open the attribute table for **Sage_Edit_Shape** and create a new Short Integer field called *Value*.

c. Start editing the shapefile by right clicking on its name in the Table of Contents, clicking Edit Features, then Start Editing.

d. Add polygons to the shapefile that match the extent where you intend to make changes to Sage cover.

e. Change the value in the Value field of the attribute table for the polygon(s) you created so that the appropriate value from Table 3 above is selected for each polygon, and 0 indicates no sagebrush cover. Save your edits and stop editing.

33. Open the Polygon to Raster tool from: Conversion Tools -> To Raster -> Polygon to Raster.
    a. Set the input Features to **Sage_Edit_Shape**
    b. Set the Value field to 'Value' from your shapefile
    c. Set the output raster (**Sage_Mask**) to an appropriate location
    d. Leave Cell assignment type (optional) set to 'CELL_CENTER'
    e. Leave Priority field (optional) set to 'NONE'
    f. Set the Cellsize (optional) field to 25.
    g. Open the Environment Settings window by clicking on the 'Environments…' button at the bottom of the tool window.
        i. Select the Processing Extent drop-down
            1. Change the Extent to match the **Sage_Clipped** raster
            2. Set Snap Raster to **Sage_Clipped**
            3. Click OK at the bottom of the Environmental Settings window.
    h. Run the tool, the output for this step is **Sage_Mask**
34. Open the Raster Calculator tool from: Spatial Analyst Tools -> Map Algebra -> Raster Calculator
    a. Enter the following Conditional Statement in the equation builder window: Con(IsNull(**Sage_Mask**), **Sage_Clipped**, **Sage_Mask**)
    b. Where **Sage_Mask** is our newly created raster from Step 33h above and **Sage_Clipped** is from Step 31b above.
    c. The output for this step is **Sage_Post_Project**
35. Open the Focal Statistics tool from: Spatial Analyst Tools -> Neighborhood -> Focal Statistics
    a. Set the Input raster to **Sage_Post_Project**, the output raster name to **Sage_Post_Focl**, the Neighborhood type to **Circle**, the Units to **Map**, the Radius to 300, and the Statistic Type to **MEAN**
    b. The output for this step is **Sage_Post_Focl**
36. Open the Focal Statistics tool from: Spatial Analyst Tools -> Neighborhood -> Focal Statistics
    a. Set the Input raster to **Sage_Clipped**, the output raster name to **Sage_Focl**, the Neighborhood type to **Circle**, the Units to **Map**, the Radius to 300, and the Statistic Type to **MEAN**
    b. The output for this step is **Sage_Focl**

3.5.2 Extracting Values for Sage Cover and Lek Distances

37. Load the Sage Grouse Euclidean Distance to Lek raster (**LEK_Ras**)
38. Open the Extract Multi Values to Points tool from: Spatial Analyst → Extraction → Extract Multi Values to Points
    a. Load the sample transect point shapefile (**NMUPoint**) as the input point features for the tool.
    b. Load the Distance to Lek Raster (**LEK_Ras**) and the Sage Landcover Focal Statistic raster (**Sage_Focl)** as the Input Rasters. If you made changes to the Sage Canopy Cover as part of your project, load the Sage output raster (**Sage_Post_Focl**).
    c. Run the tool.
    d. Open the Attribute Table of the sample transect point shapefile (**NMUPoint**) and export it to a text file.
    e. The resulting text file should include the UTM Zone 13 North coordinates, the distance to Lek in units of KM, the Sage Focal Statistic proportion (scaled from 0-1), and the post-project Sage Focal Statistic proportion (scaled from 0-1) ***where applicable***.
    f. Values from this text file should be loaded into the excel HQT Calculator.

4.0 HQT Spreadsheet Calculator

The HQT Calculator is required for calculating credits and debits in the Exchange. The HQT Calculator modifies the results of the field analysis by the results of the desktop analysis to calculate expected credits or debits for a project.

39. Open HQT Calculator.
40. Follow the instructions on the “Instructions” worksheet. All data are entered in the worksheets highlighted in green, and in the green highlighted cells.

5.0 Field Datasheet

EcoMetrix
SAGE-GROUSE Attribute Measurements

Revised 12-07-14 (JKa)

Site Name:		
Map Unit ID:	Date:	Observers:
Transect #:	Transect UTM E:	Transect UTM N:
Transect Sample Bearing (°):	Camera / Photo #'s:	
Site is: ARID or MESIC (circle one)	% Slope: <5% or >5% (Circle one)	Aspect (°):

LINE INTERCEPT (SHRUB COVER)

Sagebrush Spp. Plant #	Start	Stop	Shrub Height (cm)	Columnar / Spreading	Sagebrush Spp. Plant #	Start	Stop	Shrub Height (cm)	Columnar / Spreading
1					11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Sagebrush Spp. Plant #	Start	Stop	Shrub Height (cm)	Columnar / Spreading	Sagebrush Spp. Plant #	Start	Stop	Shrub Height (cm)	Columnar / Spreading
21					31				
22					32				
23					33				
24					34				
25					35				
26					36				
27					37				
28					38				
29					39				
30					40				

Sagebrush Spp. Plant #	Start	Stop	Shrub Height (cm)	Columnar / Spreading	Sagebrush Spp. Plant #	Start	Stop	Shrub Height (cm)	Columnar / Spreading
41					51				
42					52				
43					53				
44					54				
45					55				
46					56				
47					57				
48					58				
49					59				
50					60				

Notes for Line Transect:

DAUBENMIRE PLOTS (HERBACEOUS COVER)

Record percent cover

Plot #	Presence of Facultative Species*	Grass Height (cm)	% Grass Cover	% BROTEC Cover	# of Forb Species	% Forb Cover	100% Noxious Weed Cover? (Y/N)	Comments
1								
2								
3								
4								
5								

Total number of unique forb species along transect:

Sum total number of unique forb species found across all plots within this transect:

Notes for Daubenmire plots and unknown species codes/descriptions: