CANADA LYNX – PHASE 2

Feature Source Data:

1. Montana Natural Heritage Program Suitability Habitat Model – covers approximately 75% of MT portion of Crown LCD project area; 4 suitability classes (including 'unsuitable') created using Maximum Entropy software (see http://mtnhp.org/models/).

R:\Base_Data\CROWN_LCD_Phase2\Feature_Layers_P2\CALY\CALY_MTNHP_HabSuitability.shp

2. Montana Natural Heritage Program Direct Observations

R:\Base_Data\CROWN_LCD\Features\CanadaLynx\MTNHP_ObsData_CALY.shp

3. Canada Lynx Range Shift - part of the data describing CALY climate response in the Gostout report "Implications of a shifting climate for lynx and wolverine in the Crown of the Continent" (Christian Gostout, 2019, Wilderness Society). This data doesn't not cover the full extent of AB on the LCD Project Area. Unless augmented with additional data it is not useful for AB.

C:\Users\SFinn\OneDrive - DOI\Documents\ArcGIS\Packages\Canadian Lynx Range Shift Model Agreement_238C0AD4-D3E7-4604-8DD4-E74988537409\commondata\raster_data\lyca

4. AB_Snow_layer – a snow retention layer provided by Danielle Pendelbury. Has been used by Alberta Parks as a proxy for lynx and wolverine distribution in AB.

D:\Base_Data\CROWN_LCD\Features\Wolverine\AB_Snow_layer\mosaic.tif

5. Remote camera observations from a data set provided by Anthony Clevenger

R:\Base_Data\CROWN_LCD\Features\CanadaLynx\Clevenger_Lynx_camera_detections2.shp

6. Canada Lynx Current – 'gridded' polygon data for AB

R:\Base_Data\CROWN_LCD\Features\SourceFeatureData\canada-lynx-current\CanadaLynx_current.gdb\CanadaLynx_current

C:\Users\SFinn\OneDrive - DOI\Documents\ArcGIS\Packages\MIR_TS_C_180585_lynx_distrb_Lynx_Distribution_USFS_308E28B0-781F-49F7-8A9D-E55DF946B6F6\commondata\raster_data\lynx_distrb.img

C:\Users\SFinn\OneDrive - DOI\Documents\ArcGIS\Packages\MIR_TS_C_180585_lynx_hab_mask_69B1AE81-3BE7-4F65-84D8-B19E26F78AF0\commondata\raster_data\lyn_hab_msk.img

Source	MT NHP	Score	MT_obs	Score	AB_Snow_layer	Score	CameraSta	Score
Data/Field	ClassDesc				Value			
	Optimal	10000	observed	10000	6.5 – 10.214	10000	observed	10000
	Moderate	5000			1.5 – 6.49	5000		
	Low	2000			0.5 – 1.49	2000		
	Unsuitable	0	Not	0	0 – 0.49	0	Not	0

Source 1:

Add Field (MTNHP_CALY; ShortInt); Field Calculator (while using select records) to assign values from Table to MTNHP_CALY field.

Step 1: MTNHP_CMP_Predicted_Habitat_Suitability_CALY: Clip MTNHP_CMP_Predicted_Habitat_Suitability_CALY to Crown_PA_MTonly2.shp to constrain data to Crown LCD Project Area (output = MTNHP_CrownLCD_Predicted_Habitat_Suitability_CALY.shp); Use Union tool spatially union this layer with < Crown_PA_MTonly2.shp> (the Crown LCD project area clipped to Montana) to ensure entire MT portion of Crown is scored; assign a score of optimal suitability 10,000; moderate suitability 5,000; low suitability 2,000; unsuitable 0 (zero)

> Output: The predicted suitability model from MT NHP extended to the full area of the Crown LCD Project Area scored to represent values for Marxan

Feature Source data alignment

Visual inspection of the three parallel Marxan outputs indicate inconsistent data interpretations. Scenario 5 is the first attempt to rectify & align data across the Project Area.

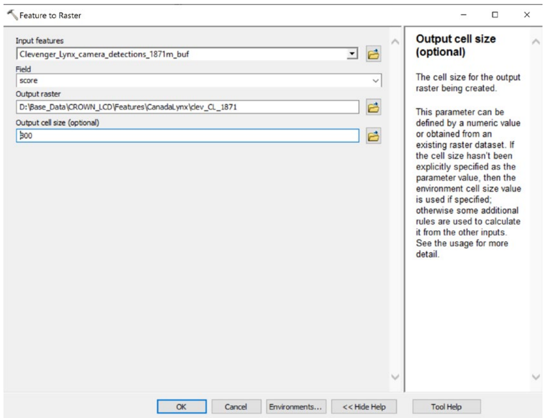
Dataset 1: Clevenger_CCoC_photo_data_14-16_complete2.xlsx – source data from Anthony Clevenger reports on camera station visits to a set of stations (x = xx) along the Rocky Mountain crest in CA. Source excel file has 2 worksheets: <wolverine detections by session> has site names and X Y location data for all cameras; <all species detection> lists detections by species and behaviors.

Created a point shapefile from XY data in Clevenger_CCoC_photo_data_14-16_complete2.xlsx/ wolverine detections by session called Clevenger_camera_stations_AB_BC.shp (in …/Features/Wolverine). Added Field in attribute table called CALY_obs (Short Integer) and populated with data from all species detection. If lynx detected at camera in 1 month only (regardless of the number of detections in that month) CALY_obs ranked '1'; if detected in 2 different months and detections > 10 days apart, CALY_obs ranked '2'; if detected in 3 different months, CALY_obs ranked '3'. Select by Attribute where CALY_obs >=1; Reproject the shapefile (using Project tool) to < D:\Base_Data\CROWN_LCD\Features\CanadaLynx\Clevenger_Lynx_camera_detections2.shp> resulting in a point shapfile with only camera stations having lynx detections (n = 55).

To approximate lynx space use, I buffered Clevenger_Lynx_camera_detections2.shp twice using estimates of CALY home range size as reported by Koehler and Aubry (1994). The first buffer, using a 1871 m radius, approximates the lower home range estimate, 11 km2 (output: Clevenger_Lynx_camera_detections_1871m_buf.shp); the second buffer, using a 3970 m radius, approximates the larger home range estimate, 49.5 km2 (output: Clevenger_Lynx_camera_detections_3970m_buf.shp.

For both buffer shapefiles, Add Field 'score' (short integer). Use Field Calculator to populate score Field 4,000 in Clevenger_Lynx_camera_detections_1871m_buf.shp and 2,000 in Clevenger_Lynx_camera_detections_3970m_buf.shp, which indicates they lower estimate of a lynx home range surrounding a visited camera station is valuable for lynx; whereas the area within the high estimate for lynx home range is valuable, but less so.

Feature to Raster for both Clevenger_Lynx_camera_detections_1871m_buf.shp and Clevenger_Lynx_camera_detections_3970m_buf.shp producing clev_CL_1871 and clev_CL_3970.



Koehler, G. M. & Aubry, K. B. (1994). "Lynx". In Zielinski, W. J. & Kucerala, T. E. (eds.). The scientific basis for conserving forest carnivores: American marten, fisher, lynx and wolverine in the western United States (General Technical Report RM-254) (Report). Rocky Mountain Forest and Range Experiment Station, USDA Forest Service. pp. 74–98. ISBN 978-0-7881-3628-3.

Dataset 2: ab_snow_alb (ESRI GRID format) derived from D:\Base_Data\CROWN_LCD\Features\Wolverine\AB_Snow_layer\mosaic.tif – a snow retention layer provided by Danielle Pendelbury. Has been used by Alberta Parks as a proxy for lynx and wolverine distribution in AB. Cells are assigned values ranging from 0 – 17. According to metadata received and close inspection of the data 0 (zero) is no data (non-forest?); 17 is no persistent snow and 1-16 is the number of years with persistent spring snow cover – in reverse (i.e., low values indicate more regular snow). I reclassed these data as follows:

Original	Reclass
0	0
1-4	5,000
5-9	2,500
10-16	1,500
17	0

Output file: D:\Base_Data\CROWN_LCD\Features\CanadaLynx\absnow_recl

Dataset 3: C:\Users\SFinn\Documents\ArcGIS\Packages\Canadian Lynx Range Shift\lyca is part of the data describing CALY climate response in the Gostout report "Implications of a shifting climate for lynx and wolverine in the Crown of the Continent" (Christian Gostout, 2019, Wilderness Society). This data (in ESRI GRID format) doesn't not cover the full extent of AB on the LCD Project Area therefore it needs to be augmented with additional data for it to be useful for AB. It does extend across the BC portion of the Project Area. The source GRID has 6 classes:

Stable (Value = 42) indicates areas of the species' current range that are projected to remain climatically suitable by both GCMs (i.e. range is expected to remain "stable").
Contraction 2 (Value = 40) areas are projected to become less climatically suitable by both GCMs (i.e. range is expected to "contract").
Contraction 1 (Value = 41) areas are projected to become less suitable under one model but remain stable under the other.
Expansion 2 (Value = 22) areas are areas not within the species' current range that are projected to become climatically suitable by both GCMs (i.e. the range is expected to "expand").
Expansion 1 (Value = 21) areas are projected to become climatically suitable by one GCM, but not the other.
No Presence (Value = 20)

Clip C:\Users\SFinn\Documents\ArcGIS\Packages\Canadian Lynx Range Shift\lyca to Project Area – output: D:\Base_Data\CROWN_LCD\Features\CanadaLynx\CG_CALY_lcd.

Reproject D:\Base_Data\CROWN_LCD\Features\CanadaLynx\CG_CALY_lcd to project projection, creating D:\Base_Data\CROWN_LCD\Features\CanadaLynx\CG_CALY_alb.

Use Reclassify on <D:\Base_Data\CROWN_LCD\Features\CanadaLynx\CG_CALY_alb> to create a raster output < D:\Base_Data\CROWN_LCD\Features\CanadaLynx\CG_CALY_rcl> scored 5000 [stable and contraction 1] or 0 (zero).

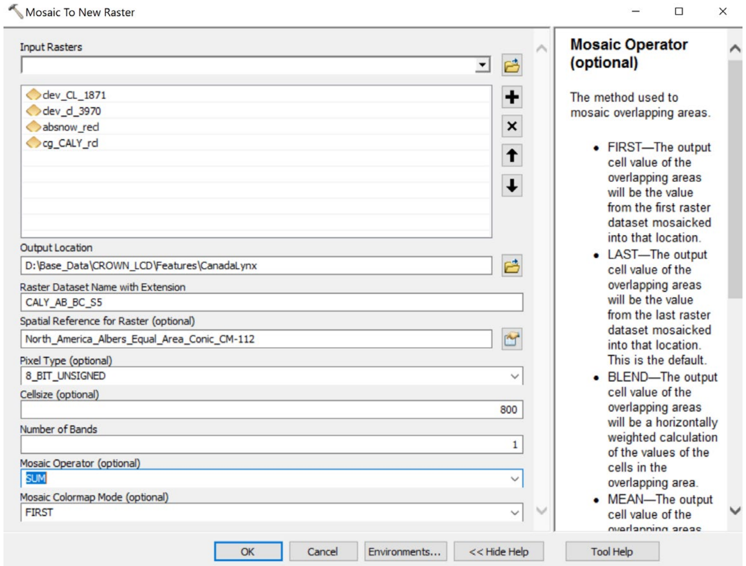
Class	Original Value	Reclass Value
No Presence	20	0
Expansion 1	21	0
Expansion 2	22	0
Contraction 2	40	0
Contraction 1	41	5,000
Stable	42	5,000

Output file: D:\Base_Data\CROWN_LCD\Features\CanadaLynx\CG_CALY_rcl

The above processing results in four raster datasets:

clev_CL_1871
clev_CL_3970
absnow_recl
CG_CALY_rcl

Use Mosaic to a New Raster tool to merge and sum values of the above 4 data rasters into output file D:\Base_Data\CROWN_LCD\Features\CanadaLynx\CALY_AB_BC_Mo.



Reclass CALY_AB_BC_Mo such that the highest value is 10,000. The output file D:\Base_Data\CROWN_LCD\Features\CanadaLynx\CALY_AB_BC_S5, is then ready for zonal statistics.

Reclassify to max value = 10,000; new grid named: CALY_AB_BC_S5

Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the 2 "pulayer" files (pulayer_AB_2km_hex.shp, pulayer_BC_2km_hex.shp):

Input data: the pulayer_AB_2km_hex [pulayer_BC_2km_hex]
Zone Field: PUID
Input value raster: CALY_AB_BC_S5
Output table: zonalst_caly_s5ab [zonalst_caly_s5bc]
Statistics type: ALL

Open zonalst_caly_s5ab Table; Table Options/Export Table –export as a text file named CALY_S5AB_SPEC.txt. Don't need to add table to map.

Open zonalst_caly_s5bc Table; Table Options/Export Table –export as a text file named CALY_S5BC_SPEC.txt. Don't need to add table to map.

Step 7: Prepare Table for Marxan

Open D:\Base_Data\CROWN_LCD\CanadaLynx\CALY_S5AB_SPEC.txt in Excel. Delete all fields except PUID and Mean. Change "Mean" field name to "FEAT_3"; Save As: CALY_feats_S5AB.csv as a comma delimited file. Close file (keeping it in current format).

Open D:\Base_Data\CROWN_LCD\CanadaLynx\CALY_S5BC_SPEC.txt in Excel. Delete all fields except PUID and Mean. Change "Mean" field name to "FEAT_3"; Save As: CALY_feats_S5BC.csv as a comma delimited file. Close file (keeping it in current format).

Cost Source Data:

Crown Snowpack – LCD – 8/10/2022 This was developed for wolverine but is applicable for Lynx, although the reclassification might eventually need to look different…but maybe not.

Source data used:

Mosaic.tif (snow pack data compiled by Garth Mowat for snow density regarding Wolverines – see Readme_SnowCover.txt in D:/CMP/LCD/Spatial_Data/SnowCover_17yrGrid). 17 years of data showing number of years without spring snow.

Step 1 – Add field:

1A – add field called "GridCode" to mosaic.tif ;
Short integer

Step 2 -Calculate:

"grid code" = "value"

Step 3 – raster to polygon:

Convert mosaic.tif to snowpack_mosaic.shp

Step 4 – Dissolve:

Dissolve on "gridcode"

Step 5 – Clip:

Input Features: snowpack_mosaic.shp; Clip Features: pulayer_crown_2km_hex_P2_basegrid.shp;

Output Feature Class: snowmosaic_pulayer.shp;

Environments/Output Coordinates: Same as Layer "pulayer_crown_2km_hex_P2_basegrid.shp" XY Tolerance: none

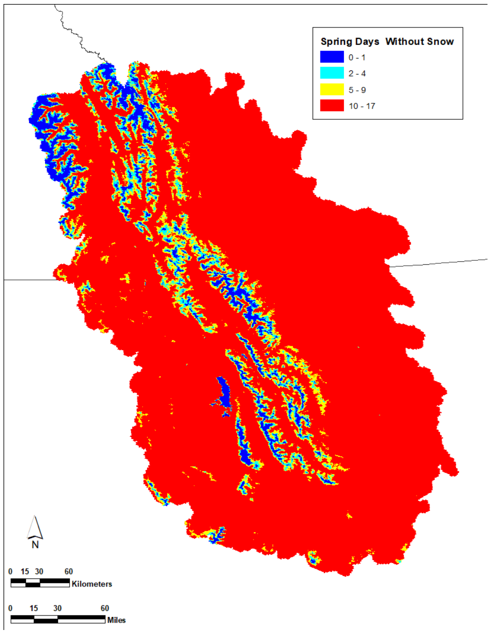
Step 6 – Identity:

Input Features: snowmosaic_pulayer.shp; Identity Features: pulayer_crown_2km_hex_P2_basegrid.shp; Output Feature Class: snowmosaic_pulayer_indent.shp

Did not need to run Identity as the snow data gets incorporated with the PU_Layer during the Zonal Stats step (below)

Symbology set to the following cutoffs (for visualization and validation):
Natural Jenks: These are subjective and in need of further discussion to define the breaks better…

0-1 = very good
2-4 = good
5-9 = fair
10-17 = poor



Step 5: Reclassify

Add field: Condition
Add field: ReclassVal

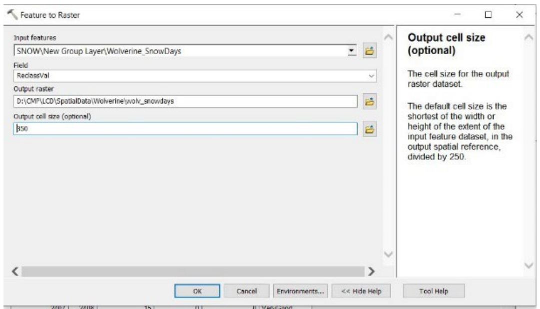
Years without Spring Snow:

Relative Condition	Source cutoffs	Reclass Value
Poor	10-17	4000
Fair	5-9	2000
Good	2-4	500
Very Good	0-1	0
NoData		0

Changed file name (in ArcCatalog) from snowmosaic_pulayer_indent.shp to:
CMP/LCD/SpatialData/Wolverine/wolverine_springsnowdays.shp

Step 6: Convert to Raster
Convert Roads\ wolverine_springsnowdays.shp to raster using Feature to Raster tool:

Input features: wolverine_springsnowdays.shp
Field: Reclass Calue
Output Raster: D:\CMP\LCD\SpatialData\Wolverine\wolv_snowdays
Output cell size: 350
Environments: Output coordinates - Same as “pulayer_crown_2km_hex_P2_basegrid.shp”



NOTE: Output cell size: 350 (this matches the buffer used for point data; it approximates ¼ of the hexagon size)

Step 2 - Mosaic to New Raster mosaic the new raster with the Snap Grid (This step ensures that every raster we generate will have the exact same pixel alignment.)

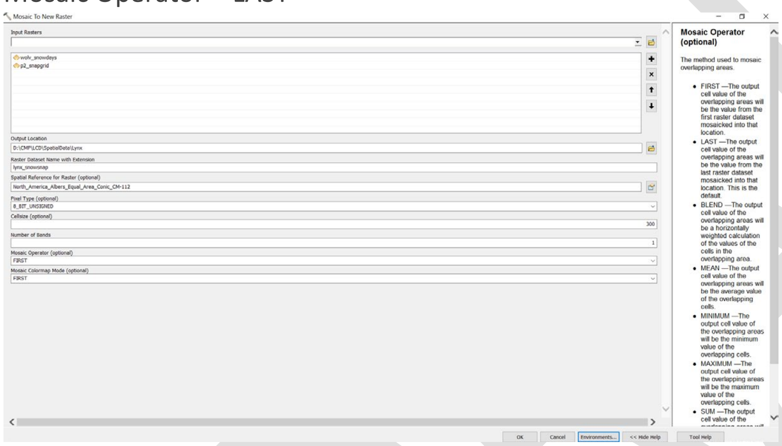
Input Rasters: D:\CMP\LCD\SpatialData\Wolverine\Wolv_snowdays and P2_Snapgrid

Output: D:\CMP\LCD\SpatialData\Lynx\ lynx_snowsnap

Cell Size = 300

Number of Bands = 1

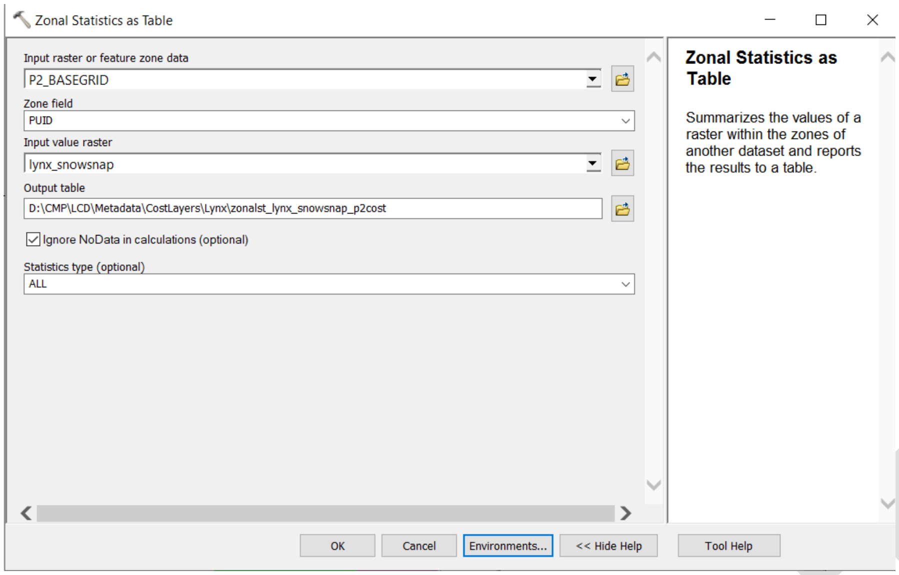
Mosaic Operator = LAST



Step 3: Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the “pulayer” file (in this case R:\Base_Data\CROWN_LCD_Phase2\Crown_Marxan_Database_P2\pulayer_crown_2km_hex_P2_BASEGRID.shp):

Input data: pulayer_crown_2km_hex_P2_BASEGRID.shp
Zone Field: PUID
Input value raster: **D:\CMP\LCD\SpatialData\Lynx\ lynx_snowsnap**
Output table: D:\CMP\LCD\Metadata\CostLayers\Lynx\zonalst_lynx_snowsnap_p2cost
Statistics type: ALL



Open ZonalSt_wolv_roads_p2cost; Table Options/Export Table –export as a text file named D:\CMP\LCD\Metadata\CostLayers\Lynx\Lynx_P2_S1_snowsnap.txt. Don't need to add table to map.

Lynx Habitat– Crown LCD – 8/19/2022

Step 1a – Reclassify

Reclassify LCD_DEM_100m

These are the categories as giving in feet from the feature attribute table:

0 -4,100ft; > 6,560ft = 4000

4,101 – 4,260ft = 2000

4,261 – 5,900ft = 0

5,901-6,560ft = 500

These are the values to be reclassed in meters:

0 -1,250m; > 2,000m = 4000

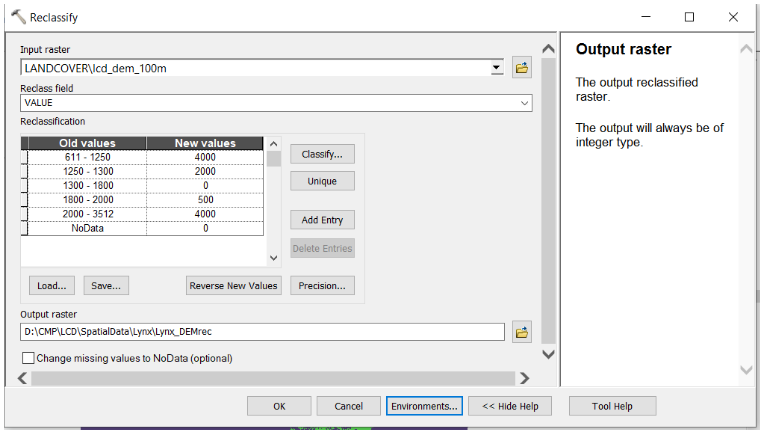
1,250 – 1,300m = 2000

1,300 – 1,800m = 0

1,800-2,000m = 500

Output = lynx_demrec

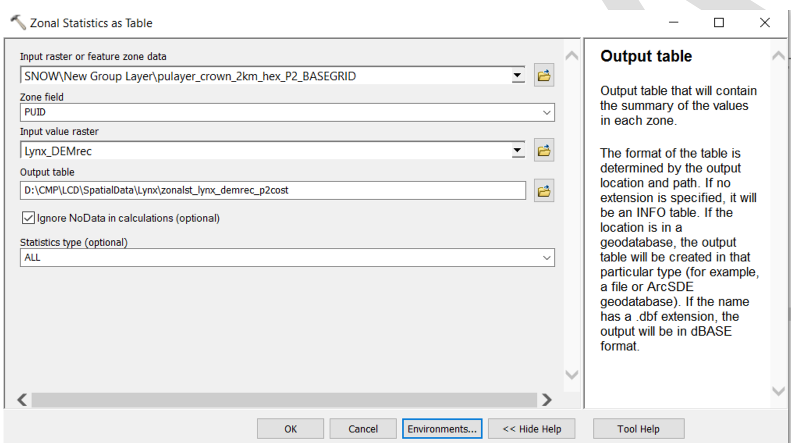
Environments: output coordinates/processing extent: Same as "pulayer_crown_2km_hex_P2_basegrid.shp"



Step 3: Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the “pulayer” file (in this case R:\Base_Data\CROWN_LCD_Phase2\Crown_Marxan_Database_P2\pulayer_crown_2km_hex_P2_BASEGRID.shp):

Input data: pulayer_crown_2km_hex_P2_BASEGRID.shp
Zone Field: PUID
Input value raster: lynx_demrec
Output table: ZonalSt_Lynx_demrec_p2cost
Statistics type: ALL



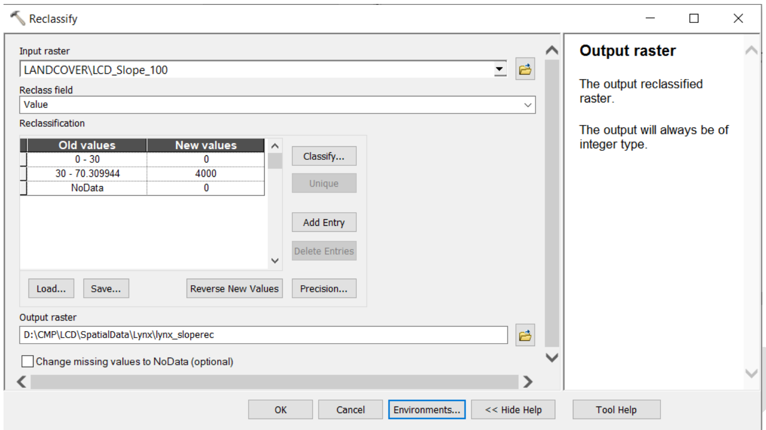
Open ZonalSt_lynx_landcover_p2cost; Table Options/Export Table –export as a text file named Lynx_P2_S1_demcost.txt. Don’t need to add table to map.

Step 1b – Spatial Analyst, slope tool:
Source data used: LCD_DEM_100m

Output = LCD_Slope_100

Step 1C – Reclassify
Reclassify slope in 2 categories; 0-30% and >30%
Lynx prefer gentler slopes of 30% or less

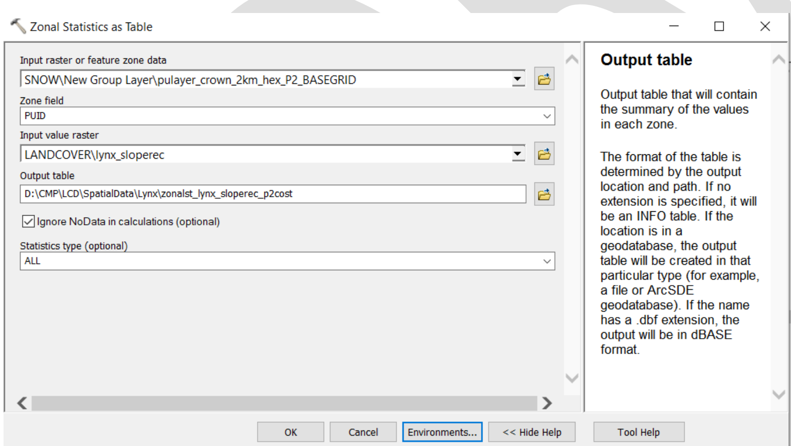
Reclass values:
0-30% = -
30-100% = 4000
Output = Lynx_sloperec
Environments: output coordinates/processing extent: Same as “pulayer_crown_2km_hex_P2_basegrid.shp”



Step 3: Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the “pulayer” file (in this case R:\Base_Data\CROWN_LCD_Phase2\Crown_Marxan_Database_P2\pulayer_crown_2km_hex_P2_BASEGRID.shp):

Input data: pulayer_crown_2km_hex_P2_BASEGRID.shp
Zone Field: PUID
Input value raster: Lynx_sloperec
Output table: ZonalSt_Lynx_sloperec_p2cost
Statistics type: ALL



Open ZonalSt_lynx_landcover_p2cost; Table Options/Export Table –export as a text file named Lynx_P2_S1_slopecost.txt. Don’t need to add table to map.

Step 2a –Select Features:

CMP_LCD_Landcover2017; select LandCover = “Conifer” and “Mixed”

Export selected features to “LCD_Landcover2020_lynx.shp”

Dissolved “LCD_Landcover2020_lynx.shp” on landcover; output = LCD_Landcover2017_lynxdis.shp

Step 2b –Select Features:

CMP_LCD_Landcover2017; select LandCover = “Agricultural, Barren, Deciduous, Developed, Grassland, Ice/Snow, Schrub/shrub, Water, Wetland”

Export selected features to “LCD_Landcover2020_antilynx.shp”

Dissolved “LCD_Landcover2020_antilynx.shp” on landcover; output = LCD_Landcover2017_antilynxdis.shp

Step 2 – add field:

Add field “Value”; short integer

Step 3 – Calculate:

Mixed, conifer = 0; all else = 4000

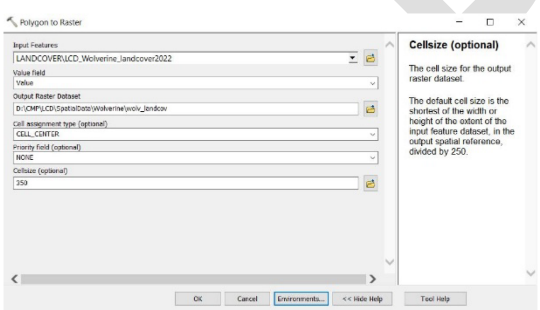
Step 3 – Merge:

Inputs = LCD_Landcover2017_lynx.shp and LCD_Landcover2017_antilynxdis.shp;

output = D:\CMP\LCD\SpatialData\Lynx\LCD_Lynx_landcover2017.shp

Step 4: Convert to Raster
Convert LCD_Lynx_landcover2017.shp to raster using Polygon to Raster tool:

Input features: LCD_Lynx_landcover2017.shp
Field: Value
Output Raster: D:\CMP\LCD\SpatialData\Lynx\Lynx_landcov
Output cell size: 350
Environments: Output coordinates - Same as “pulayer_crown_2km_hex_P2_basegrid.shp”



NOTE: Output cell size: 350 (this matches the buffer used for point data; it approximates ¼ of the hexagon size)

Rasters need to be integer for Zonal Stats. I suspect we want them signed to make sure we are not working with negative values. If you generate a raster that is floating point, just run the INT tool (Spatial Analyst – Math- INT).

Right click on properties – source to double check

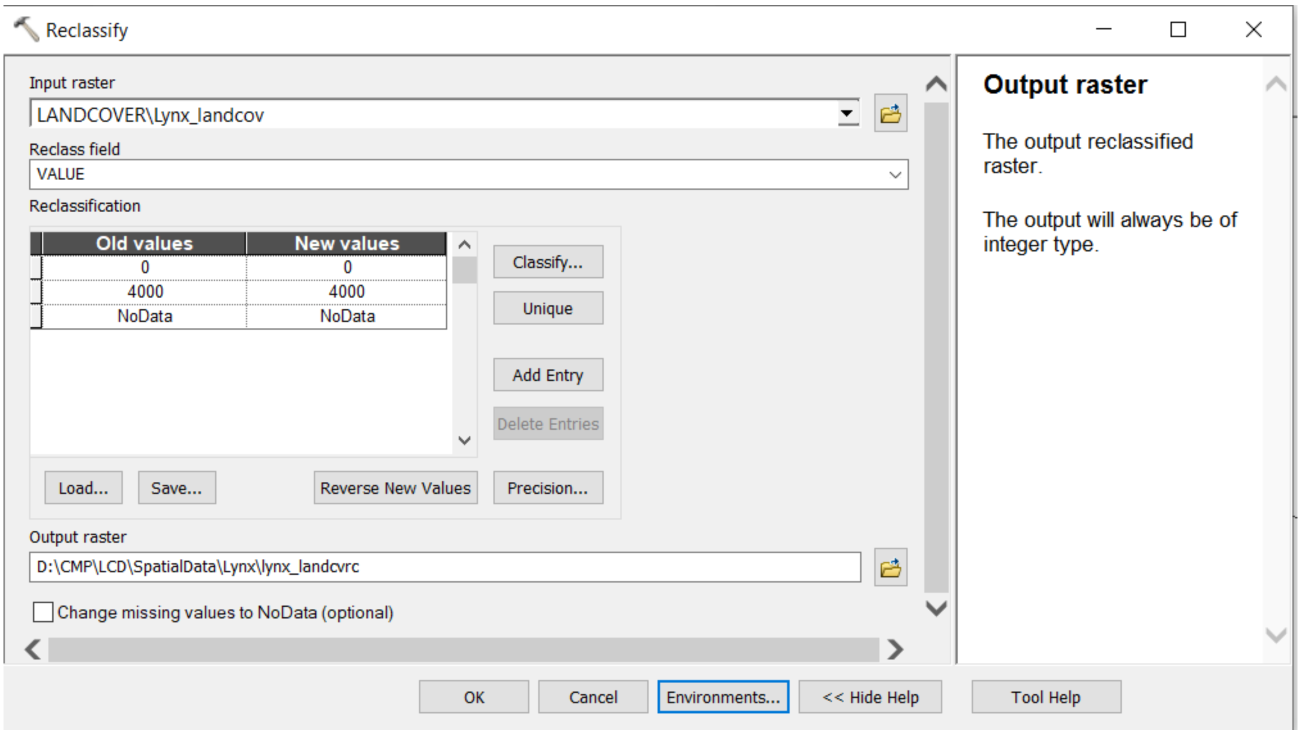
Step 5 - Reclassify

make sure ‘NoData’ is reclassed as a zero before running Zonal Stats

input = Lynx_landcov

reclass field = Value

Output Raster = D:\CMP\LCD\SpatialData\Lynx\Lynx_landcvcr



Step 2 - Mosaic to New Raster mosaic the new raster with the Snap Grid (This step ensures that every raster we generate will have the exact same pixel alignment.)

Input Rasters: D:\CMP\LCD\SpatialData\Lynx\Lynx_landcvcr **and P2_Snapgrid**

Output: D:\CMP\LCD\SpatialData\Lynx\ Lynx_habsnapb

Cell Size = 300

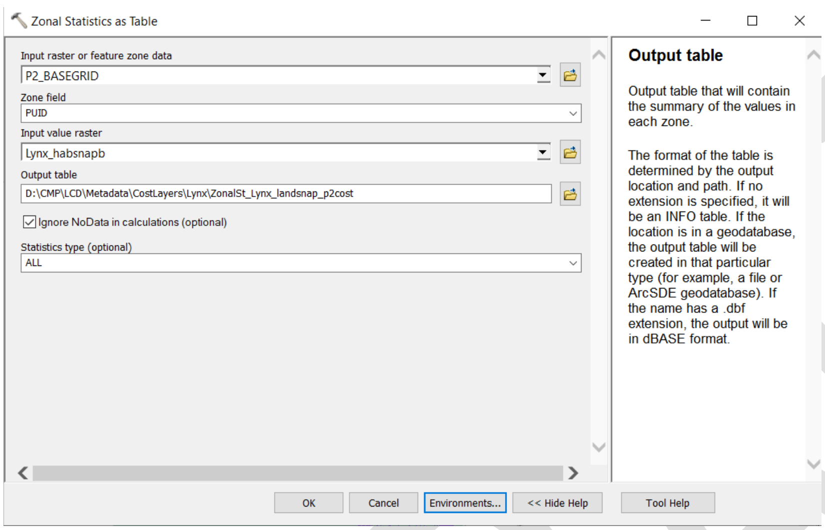
Number of Bands = 1

Mosaic Operator = FIRST (LAST did n0t work properly, although First did not work properly for the LCDfirerasteb…)

Step 3: Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the “pulayer” file (in this case R:\Base_Data\CROWN_LCD_Phase2\Crown_Marxan_Database_P2\pulayer_crown_2km_hex_P2_BASEGRID.shp):

Input data: pulayer_crown_2km_hex_P2_BASEGRID.shp
Zone Field: PUID
Input value raster: **D:\CMP\LCD\SpatialData\Lynx\ Lynx_habsnapb**
Output table: ZonalSt_Lynx_landsnap_p2cost
Statistics type: ALL



Open ZonalSt_Lynx_landsnap_p2cost; Table Options/Export Table –export as a text file named Lynx_P2_S1_landsnapcost.txt. Don’t need to add table to map.

Step 3 – raster to polygon:

Convert mosaic.tif to snowpack_mosaic.shp

Step 4 – Dissolve:

Dissolve on “gridcode”

Step 5 – Clip:

Input Features: snowpack_mosaic.shp; Clip Features: pulayer_crown_2km_hex_P2_basegrid.shp;

Output Feature Class: snowmosaic_pulayer.shp;

Environments/Output Coordinates: Same as Layer “pulayer_crown_2km_hex_P2_basegrid.shp” XY Tolerance: none

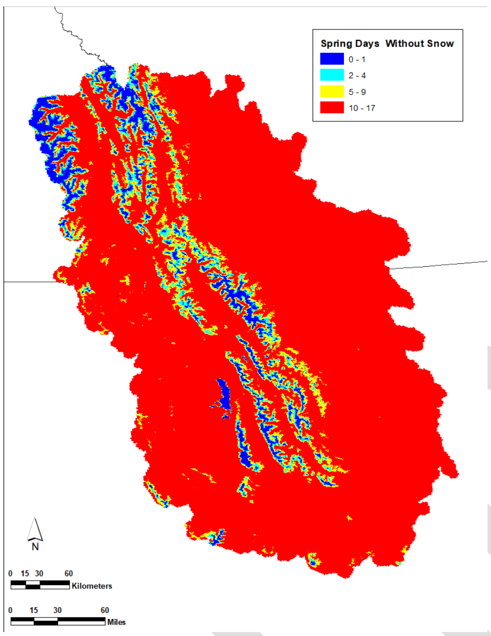
Step 6 – Identity:

Input Features: snowmosaic_pulayer.shp; Identity Features: pulayer_crown_2km_hex_P2_basegrid.shp; Output Feature Class: snowmosaic_pulayer_indent.shp

Did not need to run Identity as the snow data gets incorporated with the PU_Layer during the Zonal Stats step (below)

Symbology set to the following cutoffs (for visualization and validation):
Natural Jenks: These are subjective and in need of further discussion to define the breaks better…

0-1 = very good
2-4 = good
5-9 = fair
10-17 = poor



Step 5: Reclassify

Add field: Condition
Add field: ReclassVal

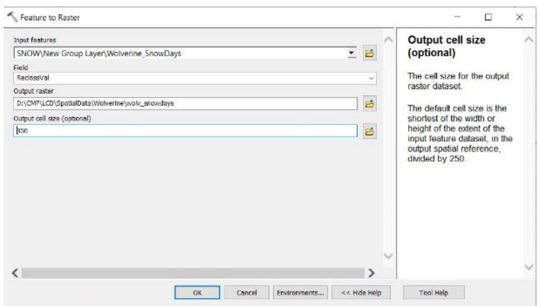
Spring Days without Snow:

Relative Condition	Source cutoffs	Reclass Value
Poor	10-17	4000
Fair	5-9	2000
Good	2-4	500
Very Good	0-1	0
NoData		0

Changed file name (in ArcCatalog) from snowmosaic_pulayer_indent.shp to:
CMP/LCD/SpatialData/Wolverine/wolverine_springsnowdays.shp

Step 6: Convert to Raster
Convert Roads\ wolverine_springsnowdays.shp to raster using Feature to Raster tool:

Input features: wolverine_springsnowdays.shp
Field: Reclass Calue
Output Raster: D:\CMP\LCD\SpatialData\Wolverine\wolv_snowdays
Output cell size: 350
Environments: Output coordinates - Same as "pulayer_crown_2km_hex_P2_basegrid.shp"

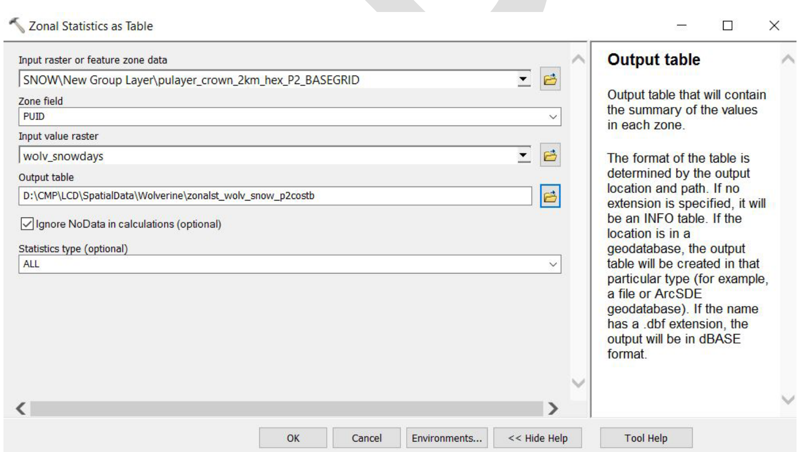


NOTE: Output cell size: 350 (this matches the buffer used for point data; it approximates ¼ of the hexagon size)

Step 3: Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the "pulayer" file (in this case R:\Base_Data\CROWN_LCD_Phase2\Crown_Marxan_Database_P2\pulayer_crown_2km_hex_P2_BASEGRID.shp):

Input data: pulayer_crown_2km_hex_P2_BASEGRID.shp
Zone Field: PUID
Input value raster: wolv_snowdays
Output table: ZonalSt_wolv_snow_p2cost
Statistics type: ALL



Open ZonalSt_wolv_roads_p2cost; Table Options/Export Table –export as a text file named Wolv_P2_S1_snowcost.txt. Don't need to add table to map.

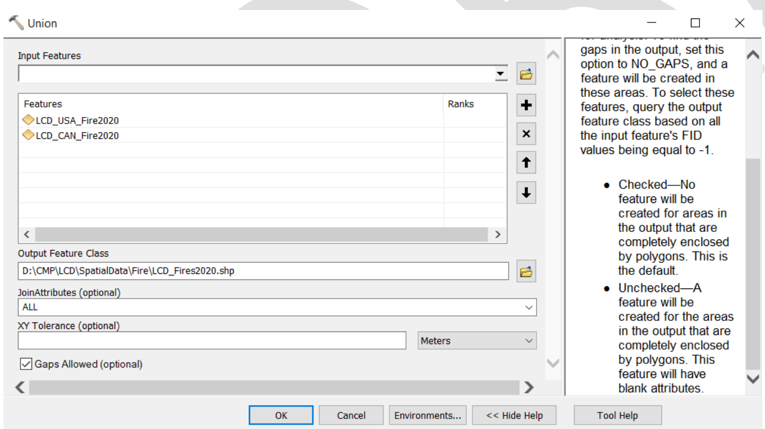
Fire (Lynx) – Crown LCD – 8/2022

Source Data:
InteragencyFirePerimeterHistory.shp (US)
NFDB_Poly_202110707 (CAN)

Step 1 - Clip
Clip InteragencyFirePerimeterHistory.shp
Clip feature: Crown_LCD_Boundary2020_AEA.shp
Output: LCD_US_Fires2020.shp
Environments: Output Coordinates = Same as "pulayer_crown_2km_hex_P2_basegrid.shp"
Clip NFDB_Poly_202110707.shp
Clip feature: Crown_LCD_Boundary2020_AEA.shp
Output: LCD_CAN_Fires2020.shp
Environments: Output Coordinates = Same as "pulayer_crown_2km_hex_P2_basegrid.shp"

Selected 4 fires along the US/CAN boarder and erased them from either shapefile…

Step 2 - Union Features
Input Features = LCD_CAN_Fire2020.shp
Update Features = LCD_USA_Fire2020.shp
Output Feature Class = LCD_Fires2020.shp
Gaps allowed checked
Environments: Output Coordinates = Same as "pulayer_crown_2km_hex_P2_basegrid.shp"



Step 2 – add field:

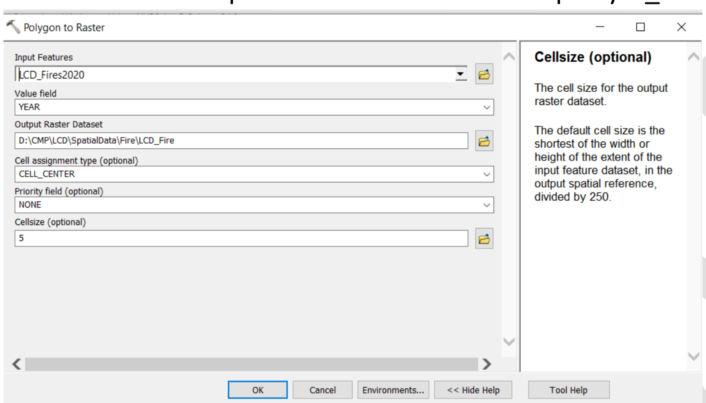
Add field "Value"; short integer

Step 3 – Calculate:
(lynx avoid recent burns (<10 years); lynx are positively associated with landscapes that were clearcut 15 to 35 years previously (Hoving et al. 2004, p. 291; Simons-Legaard et al. 2013b, pp. 573–574), some of which were also treated with herbicides to promote conifer regeneration (Scott 2009, p. 7). Lynx avoided mature stands (>40 years old) and short (3.4–4.3 m [11–14 ft]) regenerating clear-cut or partial harvested stands <10 years post-harvest (Fuller et al. 2007). Surface

fires, avalanches, insects, and forest pathogens have also been important agents of disturbance, creating more structural diversity at a smaller scale.
Disturbance < 10 years = 4000
mature stands >40 years old = 2000
Disturbance 10-15years = 500
Disturbance 15 – 35 years old = 0

Step 3 – Polygon to Raster
Convert LCD_Lynx_landcover2017.shp to raster using Polygon to Raster tool:

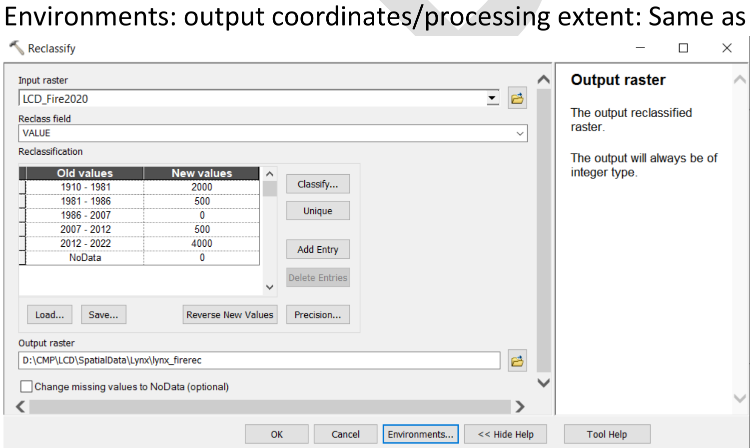
Input features: LCD_Fires2020.shp
Field: Year
Output Raster: D:\CMP\LCD\SpatialData\Fire\LCD_fire
Output cell size: 100
Environments: Output coordinates - Same as “pulayer_crown_2km_hex_P2_basegrid.shp”



Step 1a – Reclassify lynx avoid recent burns (<10 years)
Reclassify LCD_Fires2020.shp
Reclass Values:
Fire Year 2007-1987 = 0
Fire Year 2013- 2008; 1986 - 1982 = 500
Fire Year < 1981 = 2000
Fire Year 2020 - 2012 = 4000

Output = LCD_FireRec

Environments: output coordinates/processing extent: Same as “pulayer_crown_2km_hex_P2_basegrid.shp”



Step 2 - Mosaic to New Raster mosaic the new raster with the Snap Grid (This step ensures that every raster we generate will have the exact same pixel alignment.)

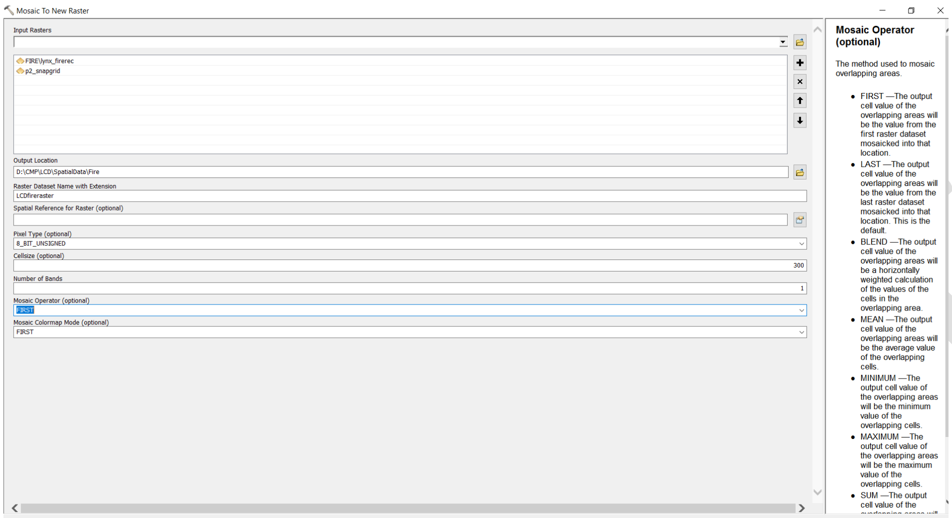
Input Rasters: Lynx_FireRec and P2_Snapgrid

Output: D:\CMP\LCD\SpatialData\Fire\LCDFireRasteb

Cell Size = 300

Number of Bands = 1

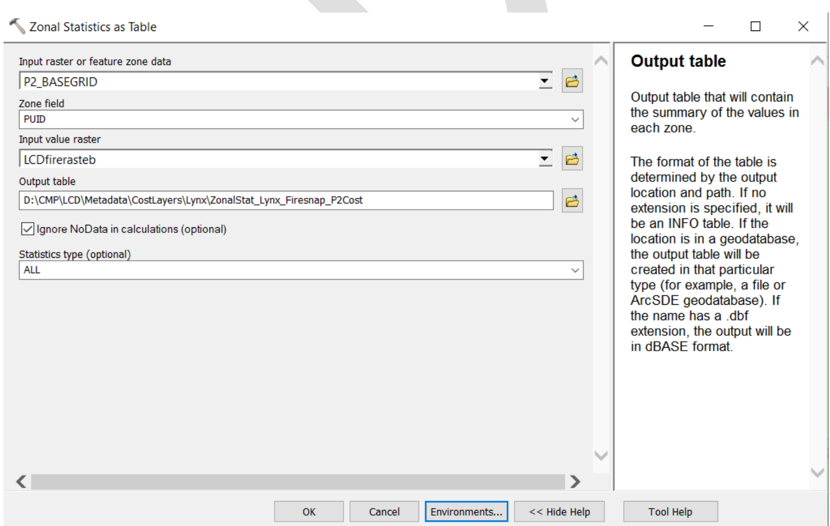
Mosaic Operator = LAST



Step 3: Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the "pulayer" file (in this case R:\Base_Data\CROWN_LCD_Phase2\Crown_Marxan_Database_P2\pulayer_crown_2km_hex_P2_BASEGRID.shp):

Input data: pulayer_crown_2km_hex_P2_BASEGRID.shp
Zone Field: PUID
Input value raster: **D:\CMP\LCD\SpatialData\Fire\LCDFireRasteb**
Output table: D:\CMP\LCD\Metadata\CostLayers\Lynx\ZonalStat_Lynx_Firesnap_P2Cost
Statistics type: ALL



Open D:\CMP\LCD\Metadata\CostLayers\Lynx\ZonalStat_Lynx_Firesnap_P2Cost; Table Options/Export Table –export as a text file named D:\CMP\LCD\Metadata\CostLayers\Lynx\Lynx_P2_S1_firesnap.txt. Don't need to add table to map.

Industry (Wolverine)

Step 1 – Select by Attributes (Wells)

GWIC_Wells_LCD_Clip.ship, selected industrial types of wells (petroleum, gas, mines, etc); output = GWIC_Wells_LCD_Clip_industry.shp

Step 2 – Erase (Wells)

Erased GWIC_Wells_LCD_Clip_industry.shp from Wells_CCE_50kmBuffer_UTM11 (due to redundancy); output = GWIC_Wells_LCD_Clip_industry_CCEWells_erased.shp

Step 3 – Merge (Wells)

Merged Wells_CCE_50kmBuffer_UTM11.shp with GWIC_Wells_LCD_Clip_industry_CCEWells_erased.shp; output CMP/LCD/SpatialData/Wells/CCE_LCDGWIC_Wells.shp

Step 4 – New Field (Wells)

Add new field = Type

Calc type = [SRC_Status] and [status]

(Could take out wells that are abandoned, but haven't done so yet)

Step 5 – Merge

a) Merge; Industrial Points

Merged Crown_LCD_OilandGas2020.shp, Crown_LCD_ProducingMines2020.shp, and CCE_LCDGWIC_Wells.shp;

output = LCD_Industry_Points

(to be used for competitor access into remote areas)

b) Merge; Industrial Lines

Merged All_Roads_Crown_LCD.shp, CMP_LCD_Railroads.shp, and Crown_LCD_Pipelines2020;

Output = LCD_Industry_Lines.shp

(to be used for competitor access into remote areas)

bb) Merge; Industrial Lines (No Roads)

Merged ~~All_Roads_Crown_LCD.shp~~, CMP_LCD_Railroads.shp, and Crown_LCD_Pipelines2020;

Output = LCD_Industry_LinesB.shp

(to be used for competitor access into remote areas)

a) Merge; Industry Polygons

Merged Recreation_Areas_All.shp and LCD_BC_Coalmines.shp;

output = LCD_Industry_Polygons.shp

(to be used for competitor access into remote areas)

Step 6a– Buffer (the 3 industry layers need to buffer these so show how far the competitor can spread - 32km) coyotes can travel about 20 miles a day according to How Far Do Coyotes Travel In A Day? - [Answer] 2022 - The Classic Wanderer

Buffer – input “LCD_Industry_Points.shp”

Buffer distance 5 km ~~32 km~~

Output = LCD_Industry_Points_5kmbuffer.shp

After running the buffer, the well coverage was crazy busy so I decided to drop the buffer down to 5km…

Also, these points contain abandoned wells. Should these be removed as they no longer pose a threat of disturbance?

Step 6b– Buffer (the 3 industry layers need to buffer these so show how far the competitor can spread - 5km)

Buffer – input “LCD_Industry_linesB.shp”

Buffer distance 5km

Output = LCD_Industry_LinesB_5kmbuffer.shp

These lines contain roads from the All_Roads_Layer.shp. Should these be taken out because we will be using road density as a cost layer? I created LCD_Industry_linesB.shp without the roads layer…

Step 6c– Buffer (the 3 industry layers need to buffer these so show how far the competitor can spread - 5km)

Buffer – input “LCD_Industry_polygons.shp”

Buffer distance 5km

Output = LCD_Industry_Polygons_5kmbuffer.shp

Step 7 - Add field

Add field called “Value” to each of the 3 industry layers

Calc Field – Each industry value was scored 4,000 to reflect the potential for competitor introduction into remote areas.

Step 8a - Dissolve
Input **=** LCD_Industry_LinesB_5kmbuffer.shp
Dissolve on Value
Output = LCD_Industry_LinesB_5kmbufdis.shp

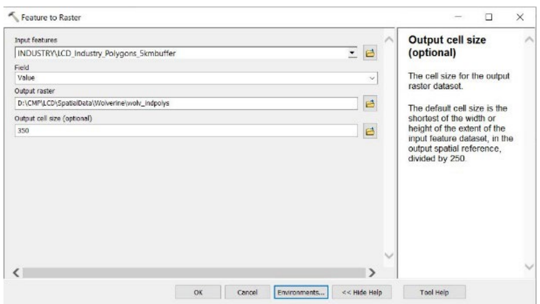
Step 8a - Dissolve
Input **=** LCD_Industry_Polygons_5kmbuffer.shp
Dissolve on Value
Output = LCD_Industry_Polygons_5kmbufdis.shp

Step 8b – clip

Input = LCD_Industry_Polygons_5kmbufdis.shp
Clip feature = pulayer_crown_2km_hex_P2_basegrid.shp
Output = LCD_Industry_Polygons_5kmbufdisclip.shp

Step 9a: Convert to Raster
Convert LCD_Industry_Points_5kmbuffer.shp to raster using Feature to Raster tool:

Input features: LCD_Industry_Points_5kmbuffer.shp
Field: Value
Output Raster: D:\CMP\LCD\SpatialData\Wolverine\wolv_indpts
Output cell size: 350
Environments: Output coordinates - Same as “pulayer_crown_2km_hex_P2_basegrid.shp”



NOTE: Output cell size: 350 (this matches the buffer used for point data; it approximates ¼ of the hexagon size)

Step 9b: Convert to Raster
Convert LCD_Industry_LinesB_5kmbufdis.shp to raster using Poly to Raster tool:

Input features: LCD_Industry_LinesBB_5kmbufdis.shp
Field: Value
Output Raster: D:\CMP\LCD\SpatialData\Wolverine\wolv_indline (or wv_linbuf for lines layer without roads)
Output cell size: 350
Environments: Output coordinates - Same as “pulayer_crown_2km_hex_P2_basegrid.shp”

Step 9c: Convert to Raster
Convert LCD_Industry_Polygons_5kmbuffer.shp to raster using Poly to Raster tool:

Input features: LCD_Industry_Polygons_5kmbufdisclip.shp.shp
Field: Value
Output Raster: D:\CMP\LCD\SpatialData\Wolverine\wv_indpolgon
Output cell size: 350
Environments: Output coordinates/Processing Extent - Same as “pulayer_crown_2km_hex_P2_basegrid.shp”

Step 10a : extract by mask
Input raster = wolv_indpts
 input feature =
R:\Base_Data\CROWN_LCD_Phase2\Crown_Marxan_Database_P2\pulayer_crown_2km_hex_P2_BASEGRID.shp
Output = wolv_indptscp

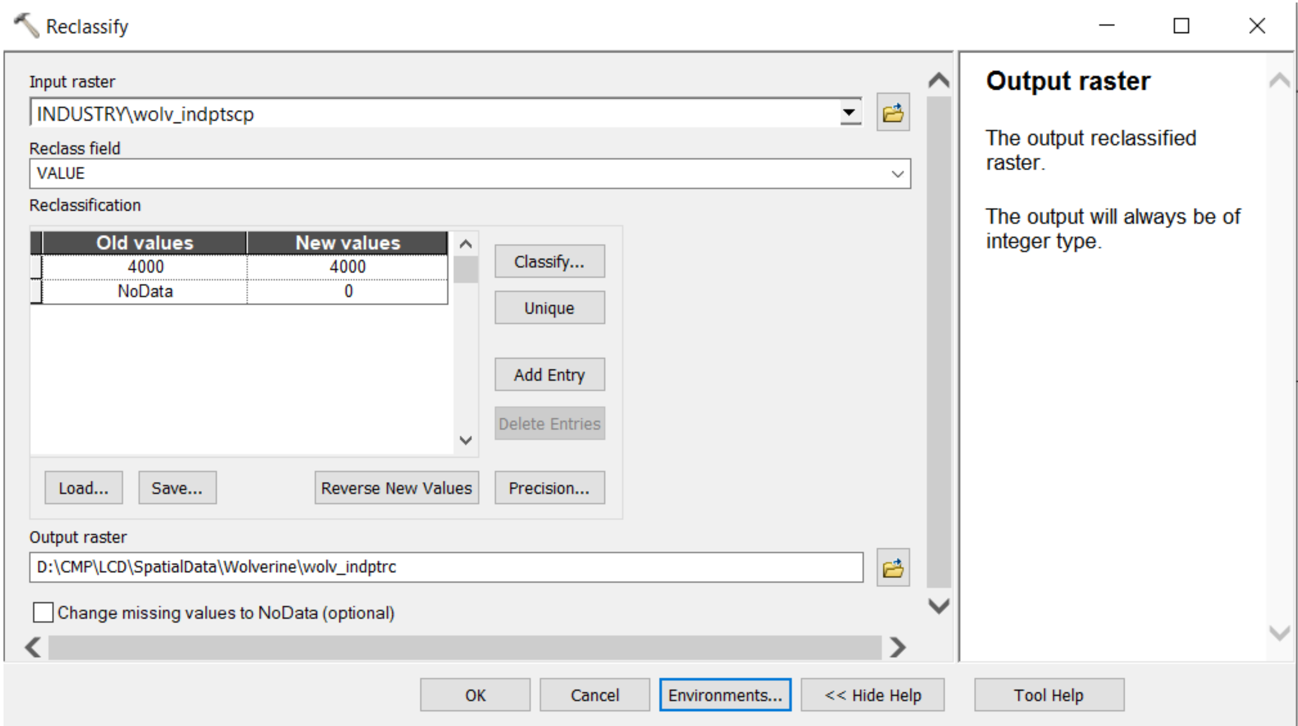
Step 10b : extract by mask
Input raster = wolv_indlineB
input feature =
R:\Base_Data\CROWN_LCD_Phase2\Crown_Marxan_Database_P2\pulayer_crown_2km_hex_P2_BASEGRID.shp
~~Output = wolv_indlincp~~
Output = wolv_indlinbc

Step 10c : extract by mask
Input raster = wolv_indpolys input feature =
R:\Base_Data\CROWN_LCD_Phase2\Crown_Marxan_Database_P2\pulayer_crown_2km_hex_P2_BASEGRID.shp
Output = wolv_indpolcp wv_polbufcp

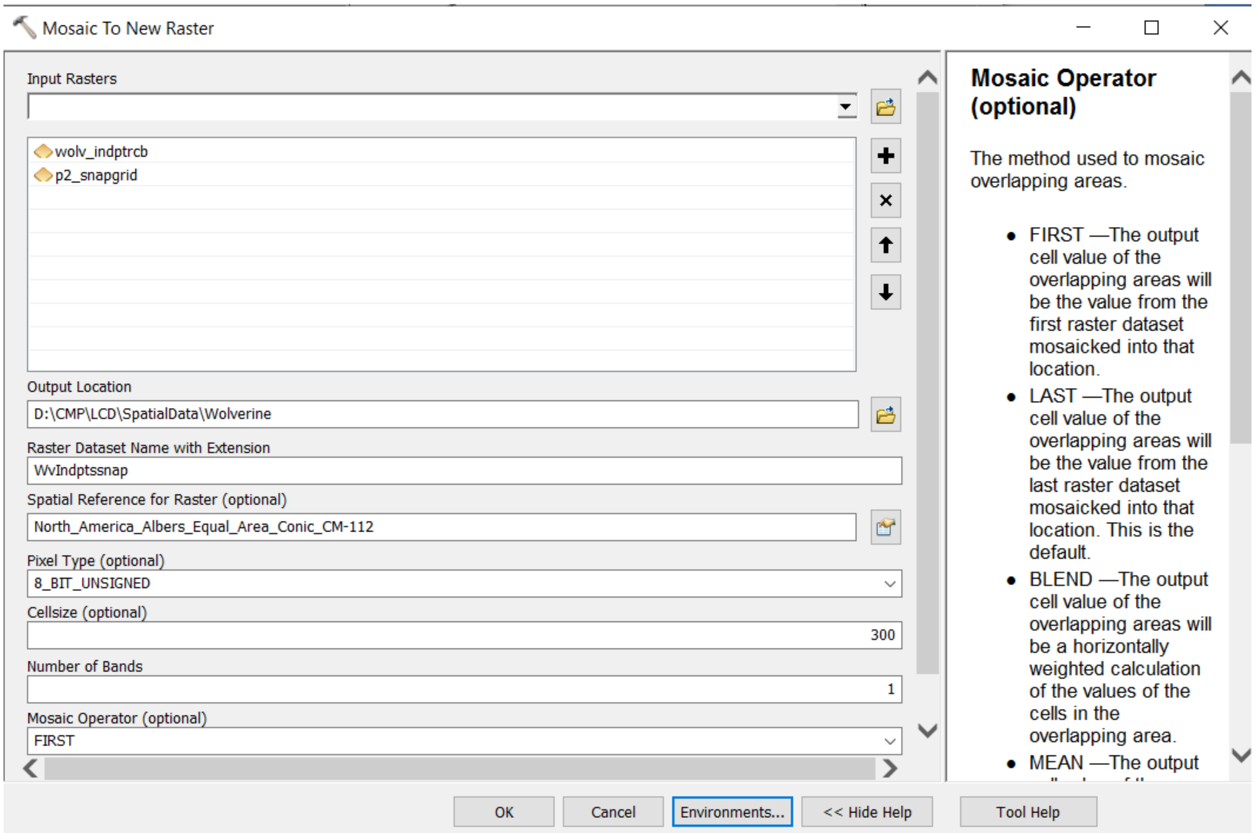
Step 10a - Reclassify
make sure 'NoData' is reclassed as a zero before running Zonal Stats
input = wolv_indptscp
reclass field = Value
Output Raster = D:\CMP\LCD\SpatialData\Wolverine\wolv_indptrc

Step 10b - Reclassify
make sure 'NoData' is reclassed as a zero before running Zonal Stats
input = wv_linbuf
reclass field = Value
Output Raster = D:\CMP\LCD\SpatialData\Wolverine\ wv_linbufrec

Step 10c - Reclassify
make sure 'NoData' is reclassed as a zero before running Zonal Stats
input = wv_indpolgon
reclass field = Value
Output Raster = D:\CMP\LCD\SpatialData\Wolverine\wv_indpolrec



Step 11a – **Mosaic to New Raster mosaic the new raster with the Snap Grid (**This step ensures that every raster we generate will have the exact same pixel alignment.)
Input Rasters: D:\CMP\LCD\SpatialData\Wolverine\ wv_indptrcb and P2_Snapgrid
Output: D:\CMP\LCD\SpatialData\Wolverine\ WvIndptssnap
Cell Size = 300
Pixel Type = 8 bit unsigned
Number of Bands = 1
Mosaic Operator = First



Step 11b – **Mosaic to New Raster mosaic the new raster with the Snap Grid (**This step ensures that every raster we generate will have the exact same pixel alignment.)

Input Rasters: D:\CMP\LCD\SpatialData\Wolverine\ wv_linbufrec and P2_Snapgrid

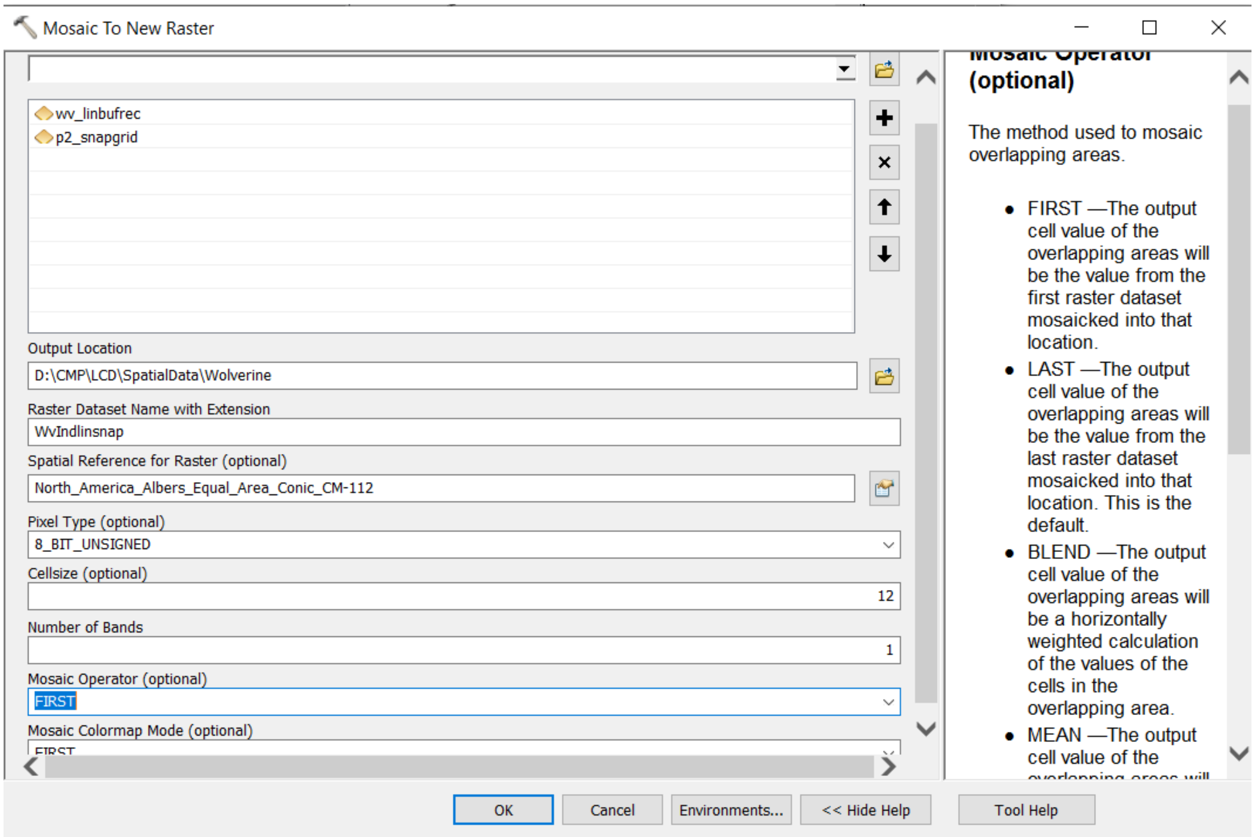
Output: D:\CMP\LCD\SpatialData\Wolverine\ WvIndlinsnap

Cell Size = 12 (to get as close to the roads layer as possible) 300 is too chunky

Pixel Type = 8 bit unsigned

Number of Bands = 1

Mosaic Operator = First



Step 11C – **Mosaic to New Raster mosaic the new raster with the Snap Grid (**This step ensures that every raster we generate will have the exact same pixel alignment.)

Input Rasters: D:\CMP\LCD\SpatialData\Wolverine\ wv_indpolrec and P2_Snapgrid

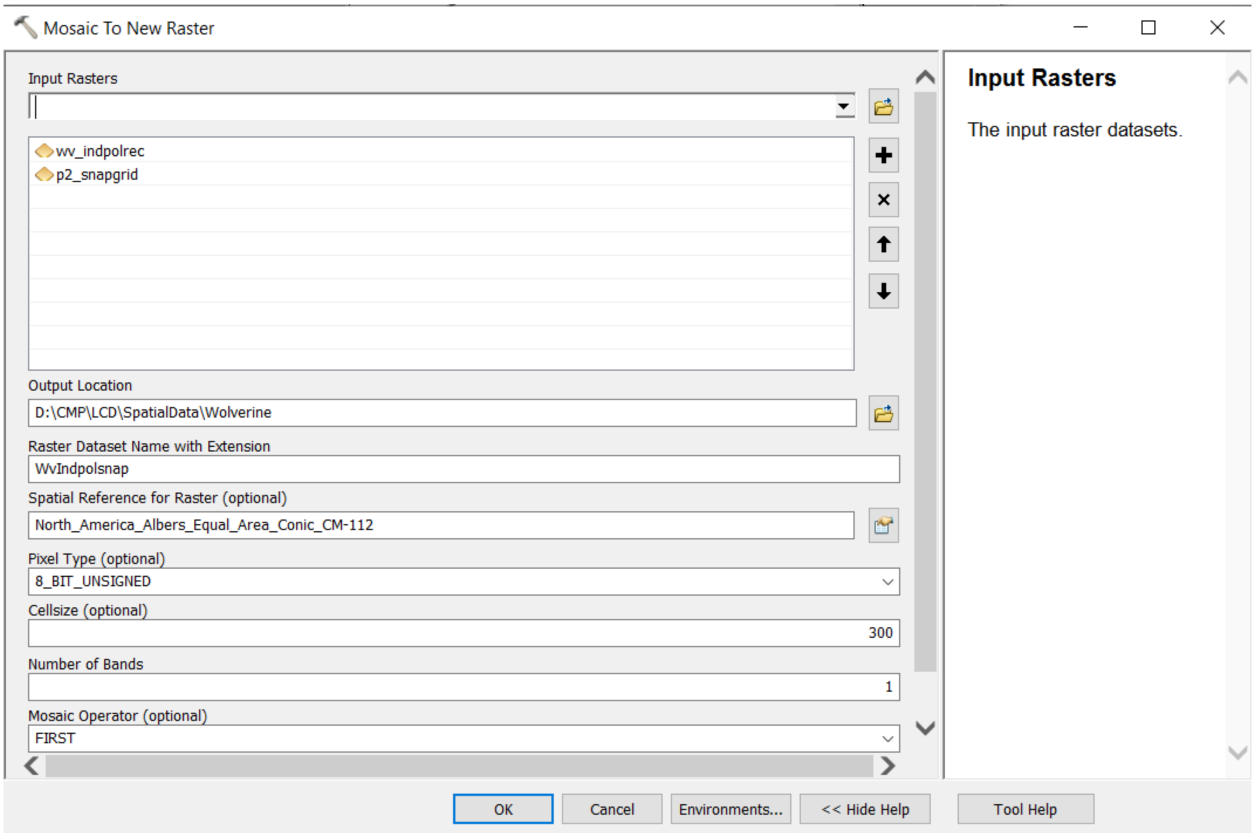
Output: D:\CMP\LCD\SpatialData\Wolverine\ WvIndpolsnap

Cell Size = 300

Pixel Type = 8 bit unsigned

Number of Bands = 1

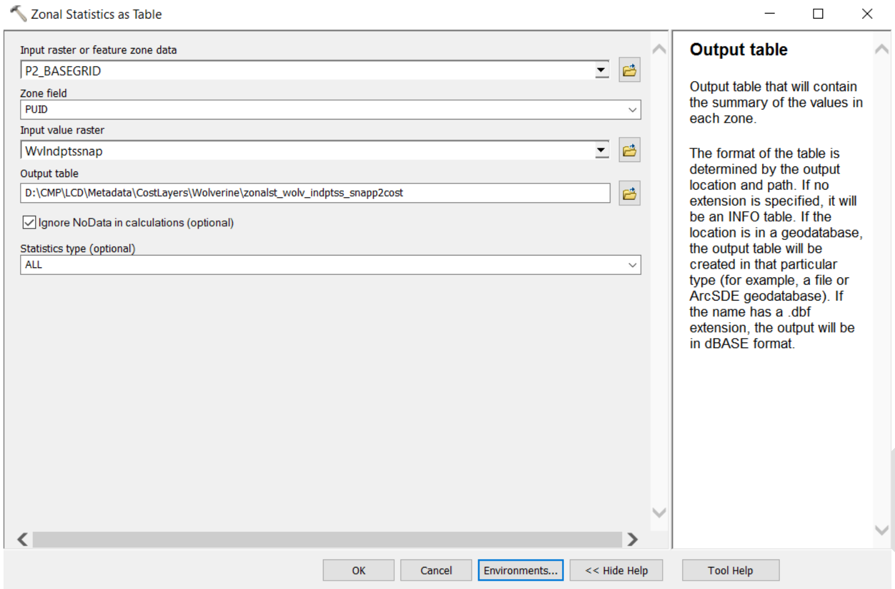
Mosaic Operator = First



Step 10a: Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the “pulayer” file (in this case R:\Base_Data\CROWN_LCD_Phase2\Crown_Marxan_Database_P2\pulayer_crown_2km_hex_P2_BASEGRID.shp):

Input data: pulayer_crown_2km_hex_P2_BASEGRID.shp
Zone Field: PUID
Input value raster: WvIndptsSnap
Output table: D:\CMP\LCD\Metadata\CostLayers\Wolverine\ZonalSt_wolv_indpts_snapp2cost
Statistics type: ALL

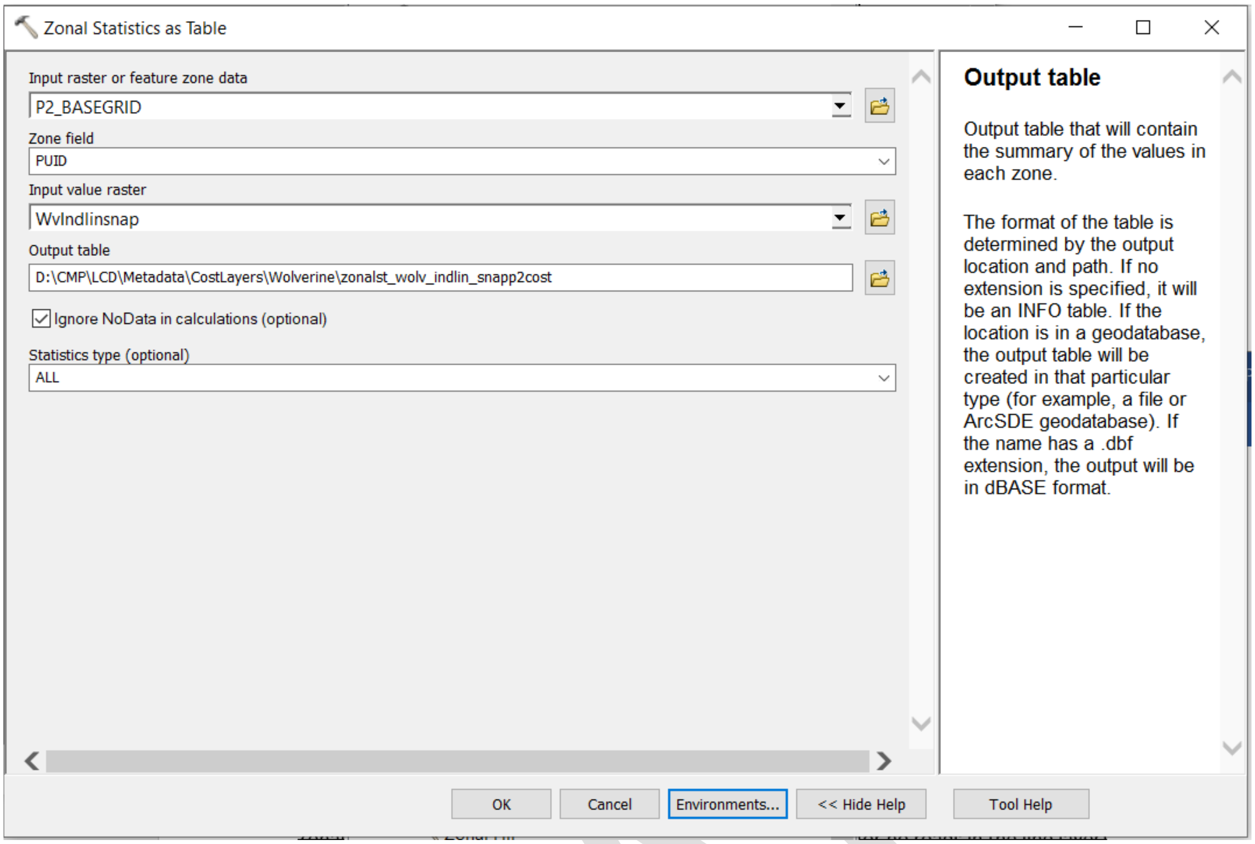


Open ZonalSt_wolv_indpts_snapp2cost; Table Options/Export Table –export as a text file named D:\CMP\LCD\Metadata\CostLayers\Lynx\Wolv_P2_S1_indptssnapcost.txt. Don't need to add table to map.

Step 10b: Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the "pulayer" file (in this case R:\Base_Data\CROWN_LCD_Phase2\Crown_Marxan_Database_P2\pulayer_crown_2km_hex_P2_BASEGRID.shp):

Input data: pulayer_crown_2km_hex_P2_BASEGRID.shp
Zone Field: PUID
Input value raster: WvIndlinsnap ~~wolv_indlines~~ ~~(or wv_linbufrec for no roads)~~
Output table: D:\CMP\LCD\Metadata\CostLayers\Wolverine\ZonalSt_wolv_indlin_snapp2cost
~~ZonalSt_wolv_indlines_p2cost (or ZonalSt_wv_linbufrec_p2cost for no roads in the line layer)~~
Statistics type: ALL

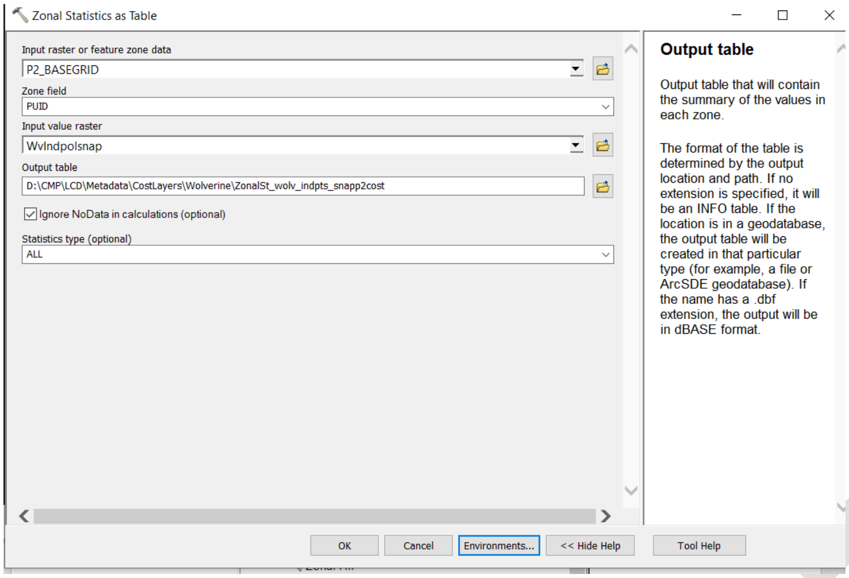


Open ZonalSt_wolv_indlin_snapp2cost; Table Options/Export Table –export as a text file named D:\CMP\LCD\Metadata\CostLayers\Lynx\Wolv_P2_S1_indlinsnapcost.txt ~~Wolv_P2_S1_industlinescost.txt (or Wolv_P2_S1_industlinesBcost.txt for no roads)~~. Don't need to add table to map.

Step 10c: Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the "pulayer" file (in this case R:\Base_Data\CROWN_LCD_Phase2\Crown_Marxan_Database_P2\pulayer_crown_2km_hex_P2_BASEGRID.shp):

Input data: pulayer_crown_2km_hex_P2_BASEGRID.shp
Zone Field: PUID
Input value raster: ~~wv_indpolrec~~ WvIndpolSnap
Output table: D:\CMP\LCD\Metadata\CostLayers\Wolverine\ZonalSt_wolv_indpols_snapp2cost
~~ZonalSt_wolv_indpolys_p2cost (or ZonalSt_wv_indpolys_p2cost for no roads)~~
Statistics type: ALL



Open ZonalSt_wolv_indpts_snapp2cost; Table Options/Export Table –export as a text file named D:\CMP\LCD\Metadata\CostLayers\Lynx\Wolv_P2_S1_indpolysnapcost.txt. Don't need to add table to map.

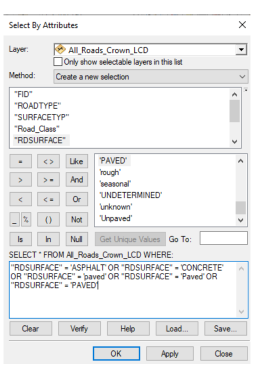
Traffic Volume – **this data was from Mule Deer (Sean). Need to get this data from him for the lynx analysis…**

Step 5: Reclass All_Roads_Crown_LCD.shp (field = RDSURFACE) to estimate relative use from heavy (e.g., CITY) to light (e.g., minor rural); based on source data – elected to generate 3 classes of road: Paved, Unpaved and Unknown Surface. I also recognized and withdrew a few roads where RDSURFACE = decommissioned or overgrown – these were not classified as roads but removed from further analysis

Geoprocessing/Environments: Set Output Coordinates and Processing Extent to "Same as: Crown_LCD_PlanningUnit_Mask.shp"

Add Data: All_Roads_Crown_LCD.shp

Select by Attribute where RDSURFACE = ASPHALT, CONCRETE, paved, Paved or PAVED

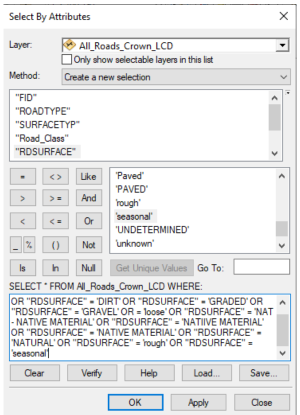


67019 of 281231 features selected.

Data/Export; Output Feature Class: R:\Base_Data\CROWN_LCD_Phase2\Cost_Layers_P2\Roads\Paved_Roads_Crown_LCD.shp

Add New Data (Paved_Roads_Crown_LCD.shp) & Clear selection

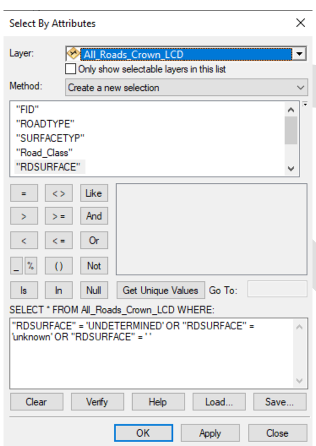
Select by Attribute where RDSURFACE = Aggregate, bladed, dirt, graded, gravel, loose, native material (all), natural, rough, seasonal or unpaved



131751 of 281231 features selected

Data/Export; Output Feature Class:
R:\Base_Data\CROWN_LCD_Phase2\Cost_Layers_P2\Roads\Unpaved_Roads_Crown_LCD.shp

Select by Attribute where RDSURFACE = Undetermined, unknown or <no value>

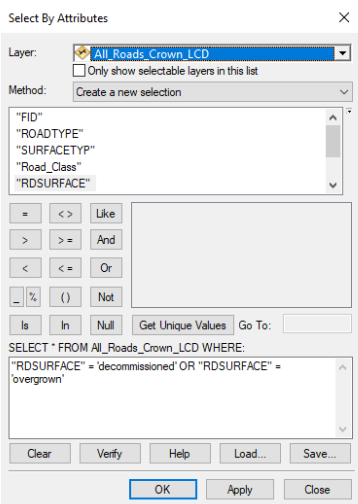


73279 of 281231 features selected

Data/Export; Output Feature Class:
R:\Base_Data\CROWN_LCD_Phase2\Cost_Layers_P2\Roads\Unknown_Surface_Roads_Crown_LCD.shp

Add New Data (Unknown_Surface_Roads_Crown_LCD.shp) & Clear selection

Also selected where RDSURFACE = decommissioned or overgrown (9182 records) to cross check selection numbers but no further attributes or processes added to these records

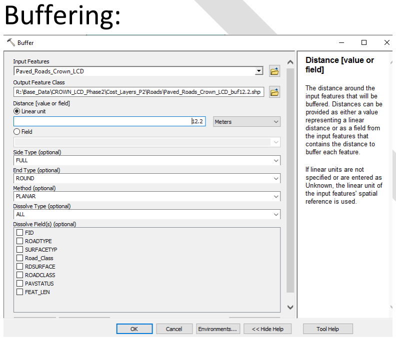


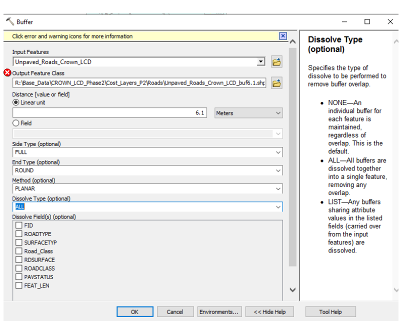
Step 5 resulted in 3 shapefiles based on road surface type. To more accurately characterize the spatial footprint of the traffic and the disturbance it represents, the three road types were buffered at different widths.

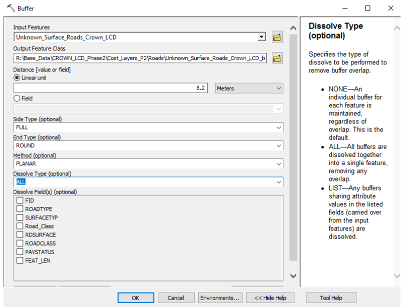
Step 6: Buffer

Selection output file	Number of Records	Buffer Width	Buffer Output File
Paved_Roads_Crown_LCD.shp	67019	12.2 m	Paved_Roads_Crown_LCD_buffer12.2.shp
Unpaved_Roads_Crown_LCD.shp	131751	6.1 m	Unpaved_Roads_Crown_LCD_buffer6.1.shp
Unknown_Surface_Roads_Crown_LCD.shp	73279	8.2 m	Unknown_Surface_Roads_Crown_LCD_ buffer8.2.shp
< decommissioned or overgrown>	9182	-none-	
Total	281231		

Buffering:





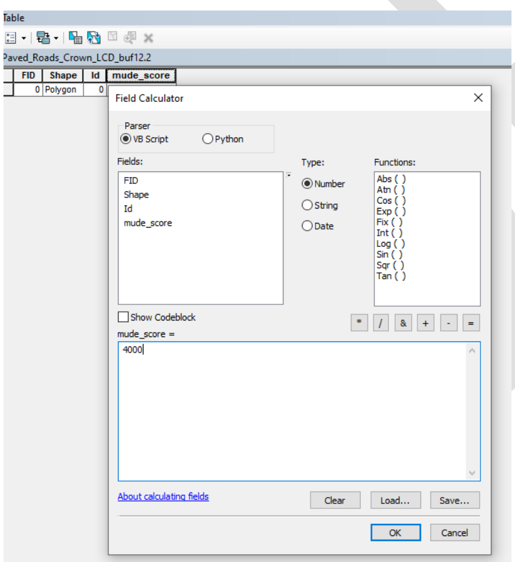


Step 7: Scoring and completing traffic volume cost input

We don’t currently have reliable data that estimates relative threat levels based on traffic volume but, again we can hypothesize that higher traffic volumes represent a more intense threat to mude. The following score estimates those relative threat levels:

Buffer Output File	Score
Paved_Roads_Crown_LCD_buffer12.2.shp	4000
Unpaved_Roads_Crown_LCD_buffer6.1.shp	1000
Unknown_Surface_Roads_Crown_LCD_ buffer8.2.shp	2500

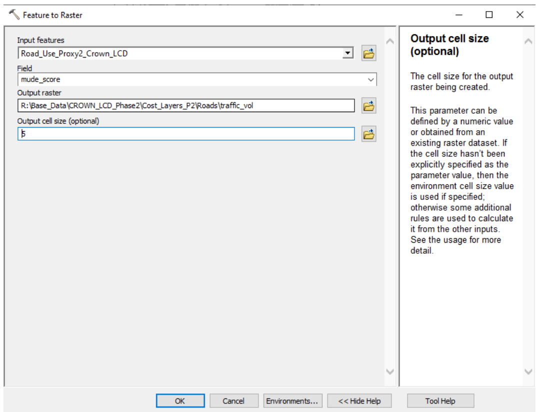
For each of the above 3 files:
Open Attribute Table/Table Options/Add Field (“mude_score”; short intiger; precision = 0). Right click on the header of the new field (mude_score), select Field Calculator (say ‘yes’ to edit outside of editor function). In the Field calculator enter the appropriate score (see table, above) in the box under mude_score. Click OK.



Merge: Paved_Roads_Crown_LCD_buffer12.2.shp, Unpaved_Roads_Crown_LCD_buffer6.1.shp, Unknown_Surface_Roads_Crown_LCD_ buffer8.2.shp to create Road_Use_Proxy_Crown_LCD.shp <R:\Base_Data\CROWN_LCD_Phase2\Cost_Layers_P2\Roads\Road_Use_Proxy_Crown_LCD.shp>

Convert Roads\Road_Use_Proxy_Crown_LCD.shp to raster using Feature to Raster tool:

Input features: Road_Use_Proxy_Crown_LCD.shp
Field: mude_score
Output Raster: R:\Base_Data\CROWN_LCD_Phase2\Cost_Layers_P2\Roads\traffic_vol
Output cell size: 5
Environments: Output coordinates - Same as “Crown_LCD_PlanningUnit_Mask”



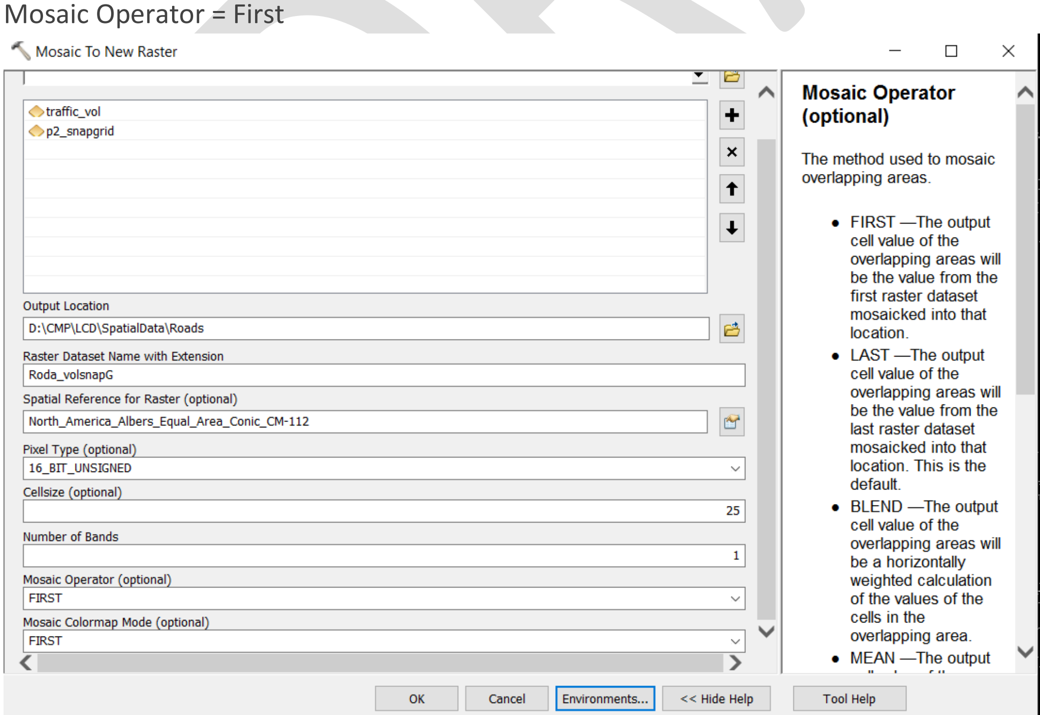
NOTE: the cell size for this analysis is small – 5 meters. That is so we can capture with detail the relative traffic volumes on the narrowest roads (6.1 m). In subsequent steps pay attention to the variation in cell size (aka resolution) to ensure we capture the data at this scale while characterizing and scoring planning units.

Step 2 - Mosaic to New Raster mosaic the new raster with the Snap Grid (This step ensures that every raster we generate will have the exact same pixel alignment.)

Input Rasters: D:\CMP\LCD\SpatialData\Roads\LCD_TrafficVolume\ traffic_vol and P2_Snapgrid

Output: D:\CMP\LCD\SpatialData\Roads\Roads_volsnapK

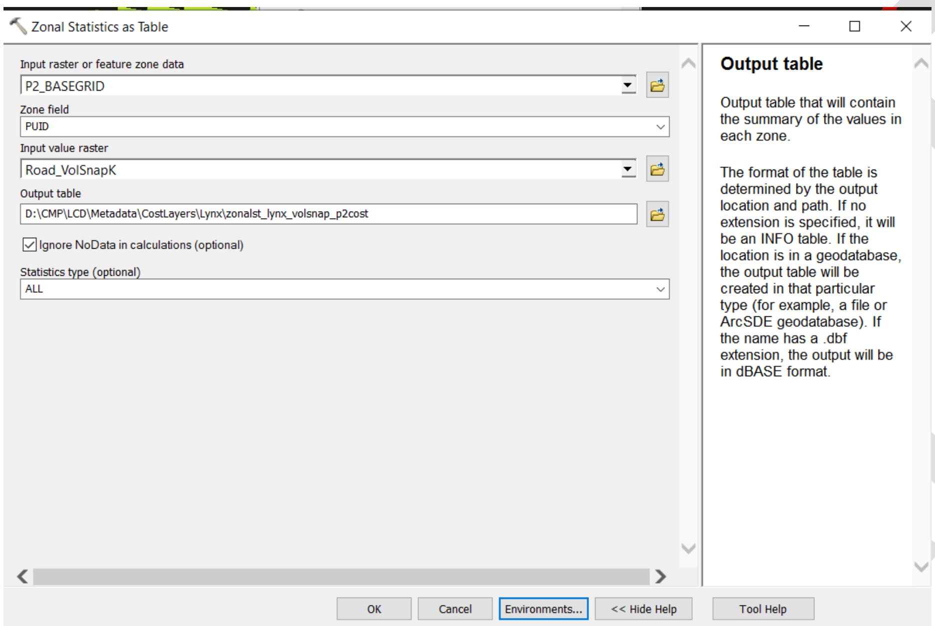
Cell Size = ~~300 (~~changed this to **12** to get as close to the 5m mimicking the traffic volume raster Sean Made above)
Pixel Type = 16 bit unsigned
Number of Bands = 1
Mosaic Operator = First



Step 3: Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the “pulayer” file (in this case R:\Base_Data\CROWN_LCD_Phase2\Crown_Marxan_Database_P2\pulayer_crown_2km_hex_P2_BASEGRID.shp):

Input data: pulayer_crown_2km_hex_P2_BASEGRID.shp
Zone Field: PUID
Input value raster: **D:\CMP\LCD\SpatialData\Roads\Roads_volsnapK**
Output table: ZonalSt_Lynx_volsnap_p2cost
Statistics type: ALL



Open ZonalSt_Lynx_volsnap_p2cost; Table Options/Export Table –export as a text file named Lynx_P2_S1_trafvolsnapcost.txt. Don’t need to add table to map.

End Phase 2

Other Canada Lynx

Canada Lynx Connectivity Summer Corridors

Squires et al. 2013. Combining resource selection and movement behavior to predict corridors for Canada lynx at their southern range periphery

https://www.sciencebase.gov/catalog/item/54b037e1e4b0a211ade11f28

CanadaLynx_SummerCorridors.zip

Canada Lynx Connectivity Winter Corridors

Squires et al. 2013. Combining resource selection and movement behavior to predict corridors for Canada lynx at their southern range periphery

https://www.sciencebase.gov/catalog/item/54b05a0ee4b078c4c44376df

CanadaLynx_WinterCorridors.zip

This layer provides information on putative winter corridors facilitating dispersal from northern populations to patches capable of supporting Canada lynx in the Northern Rocky Mountains. These results combine resource selection, step selection, and least-cost path models to define movement corridors for lynx in the Northern Rocky Mountains.

D:\Base_Data\CROWN_LCD\Features\SourceFeatureData\GOUSTAT\GOUSTAT\Spatial_Data\Lynx\Climate_niche

MIR_TS_C_180585_lynx_distrb_Lynx_ Distribution_USFS.lyr - lynx diatribution southern crown -- GYE -- Winds and Bighorns

(C:\Users\SFinn\Documents\ArcGIS\Packages\\MIR_TS_C_180585_lynx_distrb_Lynx_ Distribution_USFS_308E28B0-781F-49F7-8A9D-E55DF946B6F6\commondata\raster_data\lynx_distrb.img)

MIR_TS_C_180585_lynx_hab_mask.lyr - 'blurred boundary of above

(C:\Users\SFinn\Documents\ArcGIS\Packages\MIR_TS_C_180585_lynx_hab_mask_69B1AE81-3BE7-4F65-84D8-B19E26F78AF0\commondata\raster_data\lyn_hab_msk.img)

Canada Lynx Climatic Niche Model

(C:\Users\SFinn\Documents\ArcGIS\Packages\Canadian Lynx Range Shift\Model Agreement_238C0AD4-D3E7-4604-8DD4-E74988537409\commondata\raster_data\lyca)

Phase 1:

Canada Lynx Data Sources, Data Selection and Process Steps

Montana – Scenario #1

Source data with comments

MTNHP_Predicted_Habitat_Suitability_CALY.shp – covers approximately 75% of MT portion of Crown LCD project area; 4 suitability classes (including ‘unsuitable’) created using Maximum Entropy software (see http://mtnhp.org/models/).

Lynx_CH.shp – USFWS Critical Habitat designations for Canada Lynx. The source layer identifies several units of the United States (will need to clip to Unit #3 Northern Rockies, Montana). Critical Habitat (including exclusions) span about 40-50% of the MY portion of the Crown LCD study area.

Step 1: MTNHP_CMP_Predicted_Habitat_Suitability_CALY: Clip MTNHP_CMP_Predicted_Habitat_Suitability_CALY to Crown_PA_MTonly2.shp to constrain data to Crown LCD Project Area (output = MTNHP_CrownLCD_Predicted_Habitat_Suitability_CALY.shp); Use Union tool spatially union this layer with < Crown_PA_MTonly2.shp> (the Crown LCD project area clipped to Montana) to ensure entire MT portion of Crown is scored; assign a score of optimal suitability 10,000; moderate suitability 5,000; low suitability 2,000; unsuitable 0 (zero)

> Output: The predicted suitability model from MT NHP extended to the full area of the Crown LCD Project Area scored to represent values for Marxan

Step 2: Lynx_CH.shp: Select all records where Unit = 3 to pull out critical habitat in the Crown LCD project area < FWS_Unit3_CriticalHabitat_CALY.shp>; Use Union tool spatially union FWS_Unit3_CriticalHabitat_CALY.shp with < Crown_PA_MTonly2.shp> (the Crown LCD project area clipped to Montana) to ensure entire MT portion of Crown is scored; assign a score of 1,500 to all designated critical habitat (including exclusions).

> Output: Canada Lynx critical habitat in the Crown LCD project area identified with a “bonus” of 1,500 to differentiate critical habitat from non-designated.

Data processing described above results in 2 vector layers:

MTNHP_CMP_Predicted_Habitat_Suitability_CALY.shp
FWS_CrownLCD_CriticalHabitat_CALY2.shp

Step 3: Use Spatial Join tool join the 2 vector files while retaining all feature attribute data:

> Having ‘issues’ with Spatial join, I used Dissolve tool on MTNHP_CMP_Predicted_Habitat_Suitability_CALY.shp to create MTNHP_CMP_Predicted_Habitat_Suitability_dissolve_CALY.shp

Spatial Join:
Target Feature: FWS_CrownLCD_CriticalHabitat_CALY.shp
Join Feature: MTNHP_CMP_Predicted_Habitat_Suitability_dissolve_CALY.shp
Output Feature Class: Suitability_plus_CriticalHabitat_CrownLCD_CALY.shp
Join Operation: JOIN_ONE_TO_ONE
Match Option: Intersect

Step 4: Sum up scores from MTNHP_CMP_Predicted_Habitat_Suitability_dissolve_CALY.shp and FWS_CrownLCD_CriticalHabitat_CALY.shp. These two layers which were just spatially joined each have an attribute field called ‘score’. Inspect the joined layer layer <Suitability_plus_CriticalHabitat_CrownLCD_CALY.shp> and notice a field called ‘score’ (with values of 0 or 1500 – this field originated from FWS_CrownLCD_CriticalHabitat_CALY.shp) and another field called ‘score_1’ (with values of 0, 2000, 5000 or 10000 – this field originated from MTNHP_CMP_Predicted_Habitat_Suitability_dissolve_CALY.shp). We need to add these field and then cap the maximum value at 10,000. Open the Suitability_plus_CriticalHabitat_CrownLCD_CALY.shp attribute table; Table Options/Add Field, name it Sum_score, Type = short integer; Right click on the Sum_score field name/Field Calculator; create a formula: score + score_1 and calculate; select all records where Sum_score > 10000 and again Right click on the Sum_score field name/Field Calculator; enter 10000 in formula box and calculate.

Using ArcCatalog, copy Suitability_plus_CriticalHabitat_CrownLCD_CALY.shp and rename the copy MT_CALY_for_Marxan_Scenario1.shp

At this point inspect MT_CALY_for_Marxan_Scenario1.shp to make sure it's accurate. Use Properties/Symbology, Show: Categories/Unique Values; Value Field = Score (Add All Values). Click OK and inspect map to ensure scoring looks right. Check the attribute table, particularly the "score" field.

Step 4: Feature to Raster tool

To simplify the process of formatting the data for Marxan entry, the next step is to convert the vector feature data to a grid or raster.

Input Features: MT_CALY_for_Marxan_Scenario1.shp
Field: Sum_score
Output Raster: D:\Base_Data\CROWN_LCD\Features\CanadaLynx\MT_CALY_S1 (Note: the raster file name must be 13 characters or less)
Output cell size: 350 (this matches the buffer used for point data; it approximates ¼ of the hexagon size)

Step 6: Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the "pulayer" file (in this case pulayer_MT_2km_hex.shp):

Input data: the pulayer_MT_2km_hex
Zone Field: PUID
Input value raster: MT_CALY_S1
Output table: ZonalSt_CALY_S1
Statistics type: ALL

Open ZonalSt_GRBE_S1 Table; Table Options/Export Table –export as a text file named CALY_S1_SPEC.txt. Don't need to add table to map.

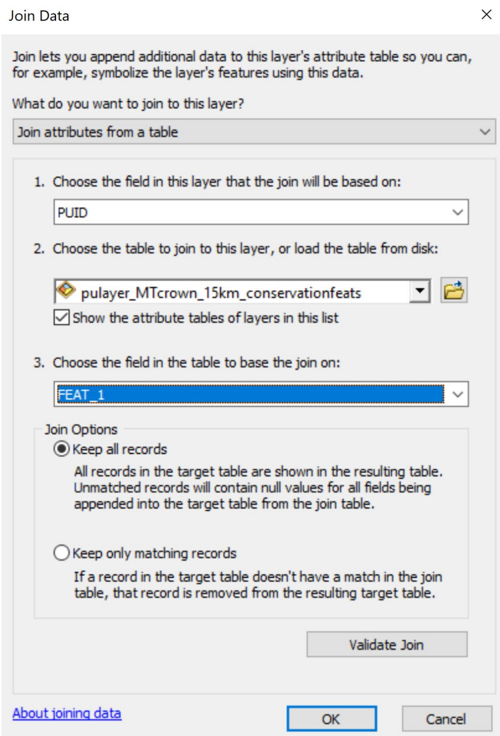
Step 7: Prepare Table for Marxan

Open D:\Base_Data\CROWN_LCD\CanadaLynx\CALY_S1_SPEC.txt in Excel. Delete all fields except PUID and Mean. Change "Mean" field name to "FEAT_3"; Save As: CALY_feats.csv as a comma delimited file. Close file (keeping it in current format).

DONE with Canada lynx Data! Move to next species ☺

NOTE: These instructions are for a single feature (feat) … will need to do a little more prep work for multiple features. See Section 3.3.5 (page 14) in Marxan handbook.

Back in ArcMap, right click on pulayer_MTcrown_15km_hex; select Joins and Relates/Remove Joins to make sure there is nothing Joined. Then Joins and Relates/Join… Join Attributes from a Table; base join on PUID field; choose the table to join conservationfeats.csv using PUID field (image below is not exact)



Open the attribute table of pulayer_MTcrown_15km_conservationfeats.shp and inspect. Review the fileds, number of records; use symbology to visualize the data and make sure it look accurate.

Using Table Options, Add a Field called ‘species’ Type Short integer. Use Field Calculator to assign species the value “1”.

Export the table as a text file naming it puvsp.txt. Don’t add table to current map

Open puvssp.txt in Excel. Set up fields as follows ‘species’ | ‘pu’ | ‘amount’ where amount is the data from FEAT_1. Delete all other fields. Save as puvsp.dat.

In windows explorer, remove the “.txt” from puvsp.dat (ignore the warning). Move puvssp.dat to the input folder.

Alberta – Scenario #3

Source data with comments

C:\Users\SFinn\Documents\ArcGIS\Packages\Canadian Lynx Range Shift is part of the data describing CALY climate response in the Gostout report “Implications of a shifting climate for lynx and wolverine in the Crown of the Continent” (Christian Gostout, 2019, Wilderness Society). This data doesn’t not cover the full extent of AB on the LCD Project Area. Unless augmented with additional data it is not useful for AB.

D:\Base_Data\CROWN_LCD\Features\Wolverine\AB_Snow_layer\mosaic.tif – a snow retention layer provided by Danielle Pendelbury. Has been used by Alberta Parks as a proxy for lynx and wolverine distribution in AB.

Clevenger_CCoC_photo_data_14-16_complete2.xlsx

Step 1: Use Reclassify on < C:\Users\SFinn\Documents\ArcGIS\Packages\Canadian Lynx Range Shift> to create a raster output < D:\Base_Data\CROWN_LCD\Features\CanadaLynx\Gost_CALY_rcl> scored 4000 [contraction (2 models), contraction (1 model) and stable] or 0 (zero). Reproject Gost_CALY_rcl to project projection, creating Gost_CALY_alb. **Repair: used Reclassify to reclass the 4000 values to 8000; (Gost_CALY5_ab)**

Step 2: Created a point shapefile from XY data in Clevenger_CCoC_photo_data_14-16_complete2.xlsx/ wolverine detections by session called Clevenger_camera_stations_AB_BC.shp. Added Field in attribute table called CALY_obs (Short Integer) and populated with data from all species detection. If lynx detected at camera in 1 month only (regardless of the number of detections in that month) CALY_obs ranked '1'; if detected in 2 different months and detections > 10 days apart, CALY_obs ranked '2'; if detected in 3 different months, CALY_obs ranked '3'. Select by Attribute where CALY_obs >=1; Reproject the shapefile (using Project tool) to < D:\Base_Data\CROWN_LCD\Features\CanadaLynx\Clevenger_Lynx_camera_detections2.shp> resulting in a point shapfile with only camera stations having lynx detections. Buffer Clevenger_Lynx_camera_detections2.shp by 800 m radius to indicate CALY use a larger area than the single-point camera station: output Clevenger_Lynx_camera_detections_800m_buf.shp; Add field: score (short integer); using Select by Attribute and Field Calculator, score CALY_obs values of 1 = 3,000, CALY_obs values of 2 = 5,500, and CALY_obs values of 3 = 8,000. **Repair: using Select by Attribute and Field Calculator, score CALY_obs values of 1 = 6,000, CALY_obs values of 2 = 8,000, and CALY_obs values of 3 = 10,000. (Clev_CALY5_al)**

Step 3: Reprojected D:\Base_Data\CROWN_LCD\Features\Wolverine\AB_Snow_layer\mosaic.tif to project projection: D:\Base_Data\CROWN_LCD\Features\Wolverine\AB_Snow_layer\AB_snow_alb; used Reclass by Ascii to reclass the 17 values as follows: 0-5 = 5000; 6-10 = 3000; 11-14 = 1000; 15-17 = 0 and create D:\Base_Data\CROWN_LCD\Features\Wolverine\AB_Snow_layer\AB_snow_rcl **Repair: used Reclass by Ascii to reclass the 17 values as follows: 0-5 = 8000; 6-10 = 5000; 11-16 = 3000; 17 = 0 (ab_snow_rc2).**

Data processing described above results in 1 vector layers and 2 raster layer:

Clevenger_Lynx_camera_detections_800m_buf.shp
gost_caly_alb
AB_snow_rcl

Step 4: Feature to Raster tool

Convert Clevenger_Lynx_camera_detections_800m_buf.shp to a raster layer in prep for Marxan input.

Be sure to clear all selections.

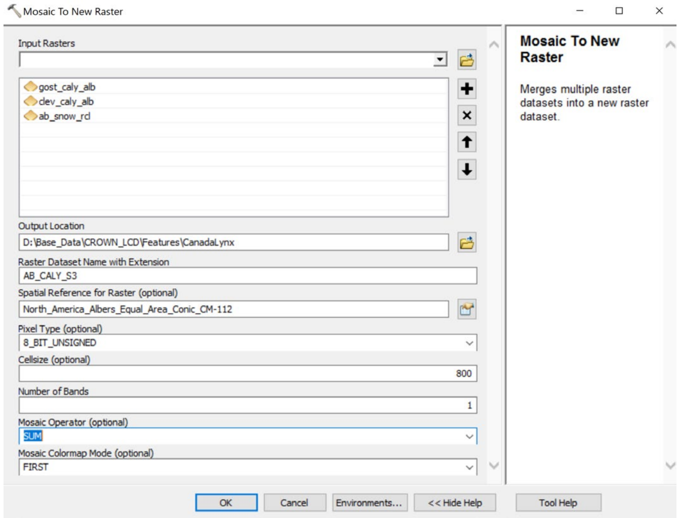
Input Features: Clevenger_Lynx_camera_detections_800m_buf.shp
Field: score
Output Raster: D:\Base_Data\CROWN_LCD\Features\CanadaLynx\clev_caly_alb (Note: the raster file name must be 13 characters or less)
Output cell size: 800 (this matches the gost_caly_alb raster)

Also: Click on 'Environments…' at bottom of Feature to Raster dialog box. Select Processing extent.

Set Extent to 'Same as layer Clevenger_Lynx_camera_detections_350m_buf.shp' and Snap Raster to gost_caly_alb

Step 5: Mosaic to a New Raster tool

Merges gost_caly_alb, clev_caly_alb and AB_snow_rcl, and sums values of both rasters. Create output: AB_CALY_S3 which it then ready for zonal statistics.



Step 6: Reclassify to max value = 10,000; new grid named: **Repair: AB_CALY_S3a Mosaic to New Raster output AB_CALY_S5 and Reclassify output AB_CALY_S5a**

Step 6: Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the "pulayer" file (in this case pulayer_AB_2km_hex.shp):

Input data: the pulayer_AB_2km_hex_Scenario3_BASEGRID
Zone Field: PUID
Input value raster: AB_CL_S3a
Output table: ZonalSt_CALY_S3
Statistics type: ALL

Open ZonalSt_ CALY_S3 Table; Table Options/Export Table –export as a text file named CALY_S3_SPEC.txt. Don't need to add table to map.

Step 7: Prepare Table for Marxan

Open D:\Base_Data\CROWN_LCD\CanadaLynx\ CALY_S4_SPEC.txt in Excel. Delete all fields except PUID and Mean. Change "Mean" field name to "FEAT_3"; Save As: CALY_feats_s4.csv as a comma delimited file. Close file (keeping it in current format).

British Columbia – Scenario #4

Source data with comments

C:\Users\SFinn\Documents\ArcGIS\Packages\Canadian Lynx Range Shift is part of the data describing CALY climate response in the Gostout report "Implications of a shifting climate for lynx and wolverine in the Crown of the Continent" (Christian Gostout, 2019, Wilderness Society). This source data (grid) describes 6 classes (no presence, expansion (1 model), expansion (2 models), contraction (2 models), contraction (1 model), and stable) for BC portion of Crown and some of MT and AB. Since the coverage of this grid spans all of the BC jurisdiction; we will use it as a coarse range map and score all of contraction (2 models), contraction (1 model) and stable as 2000.

Clevenger_CCoC_photo_data_14-16_complete2.xlsx: Camera site info for T. Clevenger. Source excel file has 2 worksheets: <wolverine detections by session> has site names and X Y location data for all cameras; <all species detection> lists detections by species and behaviors.

Step 1: Use Reclassify on < C:\Users\SFinn\Documents\ArcGIS\Packages\Canadian Lynx Range Shift> to create a raster output < D:\Base_Data\CROWN_LCD\Features\CanadaLynx\Gost_CALY_rcl> scored 4000 [contraction (2 models), contraction (1 model) and stable] or 0 (zero). Reproject Gost_CALY_rcl to project projection, creating Gost_CALY_alb.

Step 2: Created a point shapefile from XY data in Clevenger_CCoC_photo_data_14-16_complete2.xlsx/ wolverine detections by session called Clevenger_camera_stations_AB_BC.shp. Added Field in attribute table called CALY_obs (Short Integer) and populated with data from all species detection. If lynx detected at camera in 1 month only (regardless of the number of detections in that month) CALY_obs ranked '1'; if detected in 2 different months and detections > 10 days apart, CALY_obs ranked '2'; if detected in 3 different months, CALY_obs ranked '3'. Select by Attribute where CALY_obs >=1; Reproject the shapefile (using Project tool) to < D:\Base_Data\CROWN_LCD\Features\CanadaLynx\Clevenger_Lynx_camera_detections2.shp> resulting in a point shapfile with only camera stations having lynx detections. Buffer Clevenger_Lynx_camera_detections2.shp by 800 m radius to indicate CALY use a larger area than the single-point camera station: output Clevenger_Lynx_camera_detections_800m_buf.shp; Add field: score (short integer); using Select by Attribute and Field Calculator, score CALY_obs values of 1 = 3,000, CALY_obs values of 2 = 5,500, and CALY_obs values of 3 = 8,000.

Data processing described above results in 1 vector layers and 1 raster layer:

Clevenger_Lynx_camera_detections_800m_buf.shp

gost_caly_alb

Step 3: Feature to Raster tool

Convert Clevenger_Lynx_camera_detections_800m_buf.shp to a raster layer in prep for Marxan input.

Be sure to clear all selections.

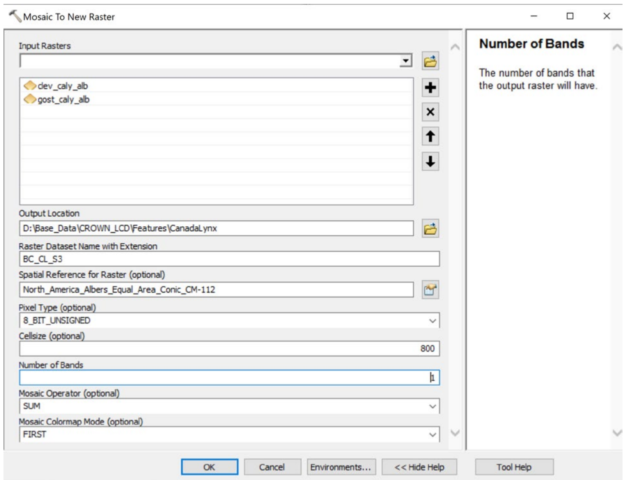
Input Features: Clevenger_Lynx_camera_detections_800m_buf.shp
Field: score
Output Raster: D:\Base_Data\CROWN_LCD\Features\CanadaLynx\clev_caly_alb (Note: the raster file name must be 13 characters or less)
Output cell size: 800 (this matches the gost_caly_alb raster)

Also: Click on 'Environments…' at bottom of Feature to Raster dialog box. Select Processing extent.

Set Extent to 'Same as layer Clevenger_Lynx_camera_detections_350m_buf.shp' and Snap Raster to gost_caly_alb

Step 4: Mosaic to a New Raster tool

Merges gost_caly_alb and clev_caly_alb and sums values of both rasters. Create output: BC_LC_S3 which it then ready for zonal statistics.



Step 5: Reclassify to max value = 10,000; new grid named: BC_CL_S3a

Step 6: Zonal Statistics as a Table & Export Table

Use Zonal Statistics as a Table to generate output data specifically linked to the "pulayer" file (in this case pulayer_BC_2km_hex.shp):

Input data: the pulayer_BC_2km_hex
Zone Field: PUID
Input value raster: BC_CL_S3a
Output table: ZonalSt_CALY_S4
Statistics type: ALL

Open ZonalSt_ CALY_S4 Table; Table Options/Export Table –export as a text file named CALY_S4_SPEC.txt. Don't need to add table to map.

Step 7: Prepare Table for Marxan

Open D:\Base_Data\CROWN_LCD\CanadaLynx\ CALY_S4_SPEC.txt in Excel. Delete all fields except PUID and Mean. Change "Mean" field name to "FEAT_3"; Save As: CALY_feats_s4.csv as a comma delimited file. Close file (keeping it in current format).