

APPENDIX G: Black-Tailed Prairie Dog Habitat Suitability Model

Introduction

OSMP developed a Habitat Suitability Model to predict where the best habitat for black-tailed prairie dogs was likely to be found in the Grassland Planning Area. Information about the location and extent of areas of suitable habitat was then combined with other factors (block size, trail density, proximity to human activity, known occurrences of sensitive prairie dog associates) to develop recommendations for management designations to conserve affected Grassland Plan targets.

Habitat Suitability Model

The GIS habitat suitability model for black-tailed prairie dogs developed by the Grassland Planning team (planning team) was based completely upon ecological habitat attributes using the best available data. Previously published GIS-based habitat suitability models have used similar habitat variables, often with less precision than our model. For example, most models used vegetation classes derived from 30-meter Landsat satellite imagery – such as GAP (Proctor 1998, Gribb et al. 2002). Such data is useful for large spatial scales (e.g. a statewide assessment); but over-generalizes vegetation classes at smaller spatial scales. Landsat imagery cannot distinguish between different grassland association, forest and woodland community types, and likely has difficulty differentiating riparian woodland from shrub land or other woodland types. The planning team's vegetation data were derived exclusively from field surveys recorded on one meter aerial imagery. Vegetation communities as small as 0.25 acre (the equivalent of a square with 100 foot sides). Field maps were entered into GIS as vector data allowing vegetation community boundaries to be more precisely drawn when compared to maps created from Landsat imagery.

Methods

Proctor (1998) found that vegetation and then slope were the two most important variables predicting prairie dog occupancy in Montana. Soil texture and soil depth, in that order, were included in Proctor's model but were less important in predicting occupancy.

The planning team used Model Builder in ArcInfo (ArcGIS, ESRI, Redlands, CA) to develop their habitat suitability model (Figure 1). Each feature within each habitat

variable was ranked, and then each habitat variable was weighted according to previous literature (Proctor, 1998, Clippinger 1989, Gribb et al. 2002). Using Model Builder, each variable was converted to grid, then reclassified before calculating the weighted geometric mean. The final output had a cell size of 10m, the minimum of the input variables.

Habitat Model Variables & Ranks

Four variables were chosen to be a part of the Prairie dog habitat suitability model. Each value within these habitat features were ranked 0–9 with zero indicating inhospitable, one indicated low suitability. Nine indicated high habitat suitability for prairie dogs. Rankings were developed by the planning team using published literature and best professional judgment in the absence of documentation.

1. Vegetation

- a. We used OSMP's Vegetation Map GIS database to classify the vegetation variable in the model. We ranked vegetation at the USNVC "Alliance" level by prairie dog's affinity to each vegetation alliance as well as for their suitability to prairie dog occupation. Each Alliance ranking was based on the best professional judgment of the planning team including the Grassland Ecologist and Agricultural Resource Specialist. Alliance ranks were based on each vegetation type's preference by prairie dogs as well as each the Alliance's resilience to grazing by prairie dogs (see Table 1).

2. Slope

- a. Flatter slopes are preferred by prairie dogs (Clippinger, 1989; Proctor, 1998; Roe & Roe, 2003). Therefore, higher ranks in the model were given to flatter slopes (0–5%) and lower values were progressively given to higher slope values (see Table 2). This GIS data layer was created from the USGS 10m Digital Elevation Model (DEM) of the Boulder Valley.

3. Soil Texture

- a. Soil texture classes were derived using the Natural Resource Conservation Services' (NRCS) Soil Survey Geographic Database (SSURGO) Soils GIS layer. Soil classes were grouped into major texture classes and ranked according to their suitability and perceived

preference for prairie dog burrow excavation. For example, “rock” was ranked with a zero value; whereas “fine sandy loam” was ranked nine indicating a greater preference for these soil types because of a greater ability to dig burrows (Table 3).

4. Soil Depth

- a. Soil depth rankings were also derived using the NRCS SSURGO Soils GIS layer. Soil depth – defined here as the depth to bedrock or to the water table – is an indicator of the suitability of a given soil class for prairie dog burrow excavation. The average burrow is 2–5 meters deep (Hoogland, 1995). Each soil class was ranked using the “Shallow Excavations” rank in the NRCS Soil Survey. If the soil type was a rock outcrop, then the soil was given a zero ranking for soil depth. “Severe” soils were given a rank of three; “Moderate” soils were given a rank of six, and “Slight” soils were given a rank of nine (see Table 4).

Soils with a rank of “Severe” show bedrock or a spring and summer water level at 0.5 – 1 meter (NRCS 1980). “Moderate” soils have a greater depth to bedrock or water and “Slight” have limited barriers to excavations.

Weighted Geometric Mean Analysis

The weighted geometric mean, as compared to the weighted arithmetic mean, more accurately models species’ habitat requirements. This is due to certain habitat features being inhospitable or entirely unsuitable to many species. If a species cannot occupy a given habitat type, no number of other variables coincident with that habitat type will make it habitable – a zero value cannot be ameliorated by higher values of other habitat variables (Beier et al., 2007). For example, if an organism cannot forage or burrow on rock outcrops (a rank of zero for rock outcrops) then it is understood that values greater than zero for any number of other habitat variables coincident with rock outcrops – will not increase the habitat rank of that habitat type.

ArcGIS Spatial Analyst Raster Calculator

The following expression was used to calculate the Weighted Geometric Mean in the Raster Calculator tool in ArcGIS's Spatial Analyst extension. This expression took the place of the "Weighted Sum Overlay" which is just the Weighted Arithmetic Mean stated differently.

[pow(pow([Habitat_re],4) * pow([Sloperank],3) * pow([soiltext],2) * pow([soildepth],1), 0.25)]

This translates into the GIS calculating each 10x10m cell value in the analysis extent to: (VegMap Alliance ranks⁴ * Slope ranks³ * soil texture ranks² * soil depth ranks¹)/4

Ranking Classification:

The planning team used ArcGIS's symbology tool to calculate the mean and standard deviation of the cell values of the weighted geometric mean analysis and symbolize the data. The planning team then excluded zero values to calculate the mean and standard deviation because of the overabundance of zero values due to completely unsuitable habitat such as rock outcrops, forests, and very steep slopes in the western portion of the OSMP system. The planning team used the standard deviation values calculated in the above method to classify the data distribution *without* zero values excluded into five categories:

- Unsuitable (all values > 1.5 standard deviations below the mean),

Less Suitable

- Poor quality habitat (0 – 1.5 standard deviations below the mean),
- Fair quality habitat (0.5 – 1.5 standard deviations below the mean),

More Suitable

- Good quality habitat (1/2 standard deviation below and above the mean), and
- Very good quality habitat (>0.5 standard deviations above the mean).

Testing the Model

The results of the HSM were compared to mapping of prairie dog occupation (in plague and non-plague years). All prairie dog activity on OSMP was in the Grassland Planning Area (GPA). The majority of actual prairie dog occupancy was found to overlay areas identified by the model as "More Suitable", and some prairie dog occupation overlapped areas characterized by the model as "Less Suitable". OSMP

staff visited selected areas of “unsuitable habitat” and determined that these areas were generally not used by prairie dogs.

Table 1. Vegetation Community Ranks.

Vegetation Alliance Number	Vegetation Alliance Description	Rank
100	CRP	6
101	Fallow	2
102	Moving Water	0
103	Quarry	0
104	Standing Water	0
105	Development	0
106	Easement	0
107	Restoration	2
118	Lodgepole Pine Forest Alliance	0
124	Ponderosa Pine Forest Alliance	0
134	Ponderosa Pine – Douglas–fir Forest Alliance	0
157	Douglas Fir Forest Alliance	0
259	Green Ash – (American Elm) Temporarily Flooded Forest Alliance	0
267	Paper Birch Forest Alliance	0
274	Quaking Aspen Forest Alliance	0
278	Box–elder Temporarily Flooded Forest Alliance	0
300	Quaking Aspen Temporarily Flooded Forest Alliance	0
310	Narrowleaf Cottonwood Temporarily Flooded Forest Alliance	0
399	Ponderosa Pine – Quaking Aspen Forest Alliance	0
426	Quaking Aspen – Douglas–fir Forest Alliance	0
530	Ponderosa Pine Woodland Alliance	0
533	Ponderosa Pine – Douglas–fir Woodland Alliance	0
552	Douglas–fir Woodland Alliance	0
565	Ponderosa Pine Temporarily Flooded Woodland Alliance	0
568	Douglas–fir Temporarily Flooded Woodland Alliance	0
610	Quaking Aspen Woodland Alliance	0
632	Netleaf Hackberry Woodland Alliance	2
636	Eastern Cottonwood Temporarily Flooded Woodland Alliance	0
641	Narrowleaf Cottonwood Temporarily Flooded Woodland	0
642	Box–elder Temporarily Flooded Woodland Alliance	0
645	Peachleaf Willow Temporarily Flooded Woodland Alliance	0
835	Rubber Rabbitbrush Shrubland Alliance	0
896	Mountain–mahogany Shrubland Alliance	0
919	Choke Cherry Shrubland Alliance	1
923	White Squaw Currant Shrubland Alliance	1

Vegetation Alliance Number	Vegetation Alliance Description	Rank
938	Skunkbush Intermittently Flooded Shrubland Alliance	1
947	(Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland Alliance	0
952	Rocky Mountain Maple Temporarily Flooded Shrubland Alliance	0
954	(Black Hawthorn, Fleshy Hawthorn) Temporarily Flooded Shrubland Alliance	0
959	Woods' Rose Temporarily Flooded Shrubland Alliance	0
961	Western Snowberry Temporarily Flooded Shrubland Alliance	0
976	Bluestem Willow Temporarily Flooded Shrubland Alliance	0
996	Water Birch Seasonally Flooded Shrubland Alliance	0
1192	Big Bluestem – (Yellow Indiangrass) Herbaceous Alliance	3
1195	Timothy Herbaceous Alliance	5
1213	(Tall Fescue, Meadow Fescue) Herbaceous Alliance	4
1225	Little Bluestem – Sideoats Grama Herbaceous Alliance	5
1232	Western Wheatgrass Herbaceous Alliance	10
1234	Needle-and-Thread – Blue Grama Herbaceous Alliance	7
1252	Sand Dropseed Herbaceous Alliance	0
1260	Mountain Muhly Herbaceous Alliance	0
1261	Green Needlegrass Herbaceous Alliance	0
1262	Indian Ricegrass Herbaceous Alliance	5
1267	Alkali Sacaton Herbaceous Alliance	0
1272	New Mexico Needlegrass Herbaceous Alliance	2
1281	Poverty Oatgrass Herbaceous Alliance	0
1282	Blue Grama Herbaceous Alliance	9
1316	Parry's Oatgrass Herbaceous Alliance	0
1332	Saltgrass Intermittently Flooded Herbaceous Alliance	3
1335	Nuttall's Alkali Grass Intermittently Flooded Herbaceous Alliance	0
1347	Prairie Cordgrass Temporarily Flooded Herbaceous Alliance	0
1354	Western Wheatgrass Temporarily Flooded Herbaceous Alliance	8
1358	Foxtail Barley Temporarily Flooded Herbaceous Alliance	4
1374	Baltic Rush Seasonally Flooded Herbaceous Alliance	3
1381	Reed Canary Grass (introduced) Seasonally Flooded Herbaceous Alliance	0
1414	Woolly Sedge Seasonally Flooded Herbaceous Alliance	0
1417	Nebraska Sedge Seasonally Flooded Herbaceous Alliance	0
1419	Clustered Field Sedge Seasonally Flooded Herbaceous Alliance	0

Vegetation Alliance Number	Vegetation Alliance Description	Rank
1422	Marsh Spikerush Seasonally Flooded Herbaceous Alliance	0
1433	Threesquare Herbaceous Alliance	0
1436	Cattail Herbaceous Semipermanently Flooded Alliance	0
1443	Hardstem Bulrush – (Softstem Bulrush) Semipermanently Flooded Herbaceous Alliance	0
1444	Saltmarsh Clubrush Semipermanently Flooded Herbaceous Alliance	0
1488	Ponderosa Pine Tallgrass Savannah Herbaceous Alliance	2
1536	Smooth Sumac Shrub Savannah Herbaceous Alliance	0
1537	Skunkbush Shrub Savannah Herbaceous Alliance	4
1538	Mountain-mahogany Shrub Herbaceous Alliance	0
1540	Soapweed Yucca Shrub Savannah Herbaceous Alliance	5
1546	Rubber Rabbitbrush Shrub Short Herbaceous Alliance	0
1814	Cheatgrass Annual Grassland	1
1836	Open Cliff Sparsely Vegetated Alliance	0
1838	Rock Outcrop Sparsely Vegetated Alliance	0
1864	Sand Flats Temporarily Flooded Sparsely Vegetated Alliance	0
2528	Snakeweed Dwarf-shrubland Alliance	6
2529	Intermediate Wheatgrass Semi-natural Herbaceous Alliance	4
2578	(American Mannagrass, Fowl Mannagrass) Seasonally Flooded Herbaceous Alliance	0
3561	Smooth Brome Semi-Natural Herbaceous Alliance	5
3562	Kentucky Bluegrass Semi-Natural Herbaceous Alliance	6
3563	Crested Wheatgrass Semi-Natural Herbaceous Alliance	7
3564	Canada Thistle Weedy Forb Great Plains Herbaceous Vegetation [Provisional]	0
9000	American Plum Shrubland Alliance	1
9001	Smooth Sumac Shrubland Alliance	2
9002	Emory Sedge Seasonally Flooded Herbaceous Alliance	0
9003	Ponderosa Pine Wooded Mixed Herbaceous Alliance (Savannah)	0
9004	Redtop (introduced) Seasonally Flooded Herbaceous Alliance	1
9005	Mountain Ninebark Shrubland	0
9006	Wood's Rose Shrub Herbaceous Alliance (Savannah)	0
9007	Crack Willow (introduced) Temporarily Flooded Woodland Alliance	0
9008	Russian Olive Semi-Natural Woodland Alliance	1
9009	Soapweed Yucca Evergreen Shrubland	5
9010	Montane Talus Sparsely Vegetated	0

Vegmap Alliance Number	Vegetation Alliance Description	Rank
9011	Cultivated Alfalfa / Smooth Brome Hay	6
9012	Cultivated Grass Hay	5
9013	Introduced Species Agricultural Pasture	7
9014	Disturbed Cultivated Agricultural Pasture	5
9016	Canada Bluegrass Semi-Natural Herbaceous Alliance	6
9017	Black Tailed Prairie Dog Grassland Complex	8
9018	Cultivated Alfalfa Hay	3
9019	Cultivated Corn (Annual)	0
9020	Cultivated Barley (Annual)	1
9021	Cultivated Oats (Annual)	0
9022	Cultivated Winter Wheat (Annual)	1
9023	Bracken Fern Herbaceous Alliance	0
9024	Pursh seepweed Seasonally Flooded Herbaceous Alliance	0
9025	Three-leaved Sumac Upland Shrubland Alliance	3
9026	Equisetum hyemale Semipermanently Flooded Herbaceous Alliance	0
9027	Desert False Indigo Temporarily Flooded Shrubland Alliance	0
9028	Creeping Oregon-Grape Dwarf-Shrubland Alliance	0
9029	Sun Sedge-Agassiz Kentucky Bluegrass Herbaceous	0
9030	Fendler's Ceanothus Deciduous Shrubland	0
9031	Non-Native Dominated Temporarily Flooded Woodland	0
9033	Annual-dominated Upland Disturbance	0
9035	Perennial Forb Disturbance Community	4
9036	Perennial Graminoid Disturbance Community	6
9037	Shale Barrens Sparsely Vegetated Alliance	0

Table 2. Slope Ranks Used in Prairie Dog HSM Model

Slope from (%)	Slope to (%)	Rank
0	0	9
0	5	8
5	10	7
10	15	5
15	20	3
20	25	2

25	30	1
30	35	0
35	40	0
40	2670	0

Table 3. Soil Texture Ranks.

Soil #	Soil Class	Rank
1	Clay	2
2	Cobbly Clay Loam	5
3	Clay Loam	6
4	Colluvial Land	2
5	Fine Sandy Loam	9
6	Gravel Pit/ Mine dump	0
7	Loam	9
8	Rock	0
9	Sandy Clay Loam	6
10	Silty Clay Loam	6
11	Sandy Loam	9
12	Stony Sandy Loam	8
13	Stony Loam	8
14	Terrace Escarpments	4
15	Very Cobbly Sandy Loam	7
16	Very Fine Sandy Loam	8
17	Very Gravelly (new soil)	3
18	Very Gravelly Sandy Loam	7
19	Very Stony Sandy Loam	7
20	Gravelly Sandy Loam	8

Table 4. Soil Depth Ranks.

SSURGO Soil Description	Soil Depth Rank
ASCALON SANDY LOAM, 0 TO 1 PERCENT SLOPES	9

SSURGO Soil Description	Soil Depth Rank
ASCALON SANDY LOAM, 1 TO 3 PERCENT SLOPES	9
ASCALON SANDY LOAM, 3 TO 5 PERCENT SLOPES	9
ASCALON SANDY LOAM, 5 TO 9 PERCENT SLOPES	9
ASCALON-OTERO COMPLEX, 0 TO 3 PERCENT SLOPES	9
ASCALON-OTERO COMPLEX, 3 TO 5 PERCENT SLOPES	9
ASCALON-OTERO COMPLEX, 5 TO 9 PERCENT SLOPES	9
ASCALON-OTERO COMPLEX, 9 TO 20 PERCENT SLOPES	9
Argiustolls-Rock outcrop complex, 15 to 60 percent slopes	0
BALLER STONY SANDY LOAM, 9 TO 35 PERCENT SLOPES	3
Baller-Rock outcrop complex, 15 to 50 percent slopes	0
CALKINS SANDY LOAM, 0 TO 1 PERCENT SLOPES	6
CALKINS SANDY LOAM, 1 TO 3 PERCENT SLOPES	6
COLBY SILTY CLAY LOAM, 3 TO 5 PERCENT SLOPES	9
COLBY SILTY CLAY LOAM, 5 TO 9 PERCENT SLOPES	9
COLBY-GAYNOR ASSOCIATION	6
COLLUVIAL LAND	9
Denver-Kutch-Midway clay loams, 9 to 25 percent slopes	3
Englewood clay loam, wet, 0 to 3 percent slopes	6
FERN CLIFF-ALLENS PARK-ROCK OUTCROP COMPLEX, 15 TO 60 PERCENT SLOPES	0
Flatirons very cobbly sandy loam, 0 to 3 percent slopes	3
Flatirons very stony sandy loam, 0 to 5 percent slopes	3
Flatirons very stony sandy loam, 5 to 9 percent slopes	6
Flatirons very stony sandy loam, 9 to 15 percent slopes	6
GOLDVALE-ROCK OUTCROP COMPLEX, 9 TO 55 PERCENT SLOPES	0
GRAVEL PITS AND MINE DUMPS	0
HARGREAVE FINE SANDY LOAM, 1 TO 3 PERCENT SLOPES	3
HARGREAVE FINE SANDY LOAM, 3 TO 9 PERCENT SLOPES	3
HELDT CLAY, 0 TO 3 PERCENT SLOPES	6
HELDT CLAY, 3 TO 5 PERCENT SLOPES	6
Haverson loam, 0 to 3 percent slopes	3
Haverson loam, 3 to 9 percent slopes	3
JUGET-ROCK OUTCROP COMPLEX, 9 TO 55 PERCENT SLOPES	0
KUTCH CLAY LOAM, 3 TO 9 PERCENT SLOPES	3
LAPORTE VERY FINE SANDY LOAM, 5 TO 20 PERCENT SLOPES	3
LONGMONT CLAY, 0 TO 3 PERCENT SLOPES	3
LOVELAND SOILS	3
Leyden-Primen-Standley cobbly clay loams, 15 to 50 percent slopes	3
Leyden-Standley-Primen cobbly clay loams, 9 to 15 percent slopes	6
MANTER SANDY LOAM, 0 TO 1 PERCENT SLOPES	6
MANTER SANDY LOAM, 1 TO 3 PERCENT SLOPES	6

SSURGO Soil Description	Soil Depth Rank
MANTER SANDY LOAM, 3 TO 9 PERCENT SLOPES	6
MANVEL LOAM	9
MCCLAVE CLAY LOAM	6
NEDERLAND VERY COBBLY SANDY LOAM, 1 TO 12 PERCENT SLOPES	3
NIWOT SOILS	3
NUNN CLAY LOAM, 0 TO 1 PERCENT SLOPES	6
NUNN CLAY LOAM, 1 TO 3 PERCENT SLOPES	6
NUNN CLAY LOAM, 3 TO 5 PERCENT SLOPES	6
NUNN CLAY LOAM, 5 TO 9 PERCENT SLOPES	6
NUNN SANDY CLAY LOAM, 0 TO 1 PERCENT SLOPES	6
NUNN SANDY CLAY LOAM, 1 TO 3 PERCENT SLOPES	6
NUNN-KIM COMPLEX	6
Nederland very cobbly sandy loam, 15 to 50 percent slopes	3
PEYTON-JUGET VERY GRAVELLY LOAMY SANDS, 5 TO 20 PERCENT SLOPES	3
PINATA-ROCK OUTCROP COMPLEX, 5 TO 55 PERCENT SLOPES	0
RENOHILL LOAM, 3 TO 9 PERCENT SLOPES	3
RENOHILL SILTY CLAY LOAM, 1 TO 3 PERCENT SLOPES	3
RENOHILL SILTY CLAY LOAM, 3 TO 9 PERCENT SLOPES	3
ROCK OUTCROP	0
Rock outcrop, sedimentary	0
Rock outcrop-Cathedral-Ratake complex, 50 to 100 percent slopes	0
Rogert-Herberman-Rock outcrop complex, 30 to 70 percent slopes	0
SAMSIL CLAY, 3 TO 12 PERCENT SLOPES	3
SAMSIL-SHINGLE COMPLEX, 5 TO 25 PERCENT SLOPES	3
SIXMILE STONY LOAM, 10 TO 50 PERCENT SLOPES	3
TERRACE ESCARPMENTS	3
Torrifluents, very gravelly, 0 to 3 percent slope	6
Ustorthents, cool-Rock outcrop complex, 15 to 50 percent slopes	0
VALMONT CLAY LOAM, 1 TO 3 PERCENT SLOPES	6
VALMONT CLAY LOAM, 3 TO 5 PERCENT SLOPES	6
VALMONT COBBLY CLAY LOAM, 1 TO 5 PERCENT SLOPES	6
VALMONT COBBLY CLAY LOAM, 5 TO 25 PERCENT SLOPES	6
Valmont clay loam, 0 to 3 percent slopes	6
Veldkamp-Nederland very cobbly sandy loams, 0 to 3 percent slopes	3
WELD FINE SANDY LOAM, 1 TO 3 PERCENT SLOPES	6
WELD LOAM, 1 TO 3 PERCENT SLOPES	6
WELD-COLBY COMPLEX, 0 TO 3 PERCENT SLOPES	6
WELD-COLBY COMPLEX, 3 TO 5 PERCENT SLOPES	6
Yoder variant-Midway complex, 15 to 60 percent slopes	3

Figure 1. Prairie dog Habitat Suitability Model using ESRI's Model Builder Tool.

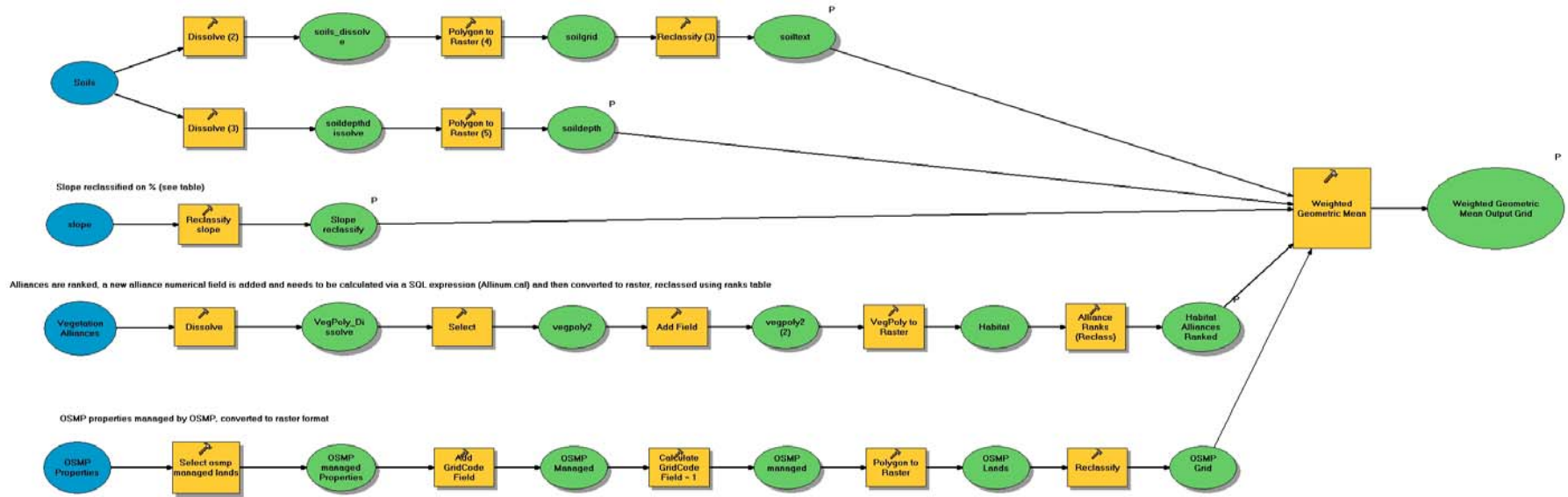
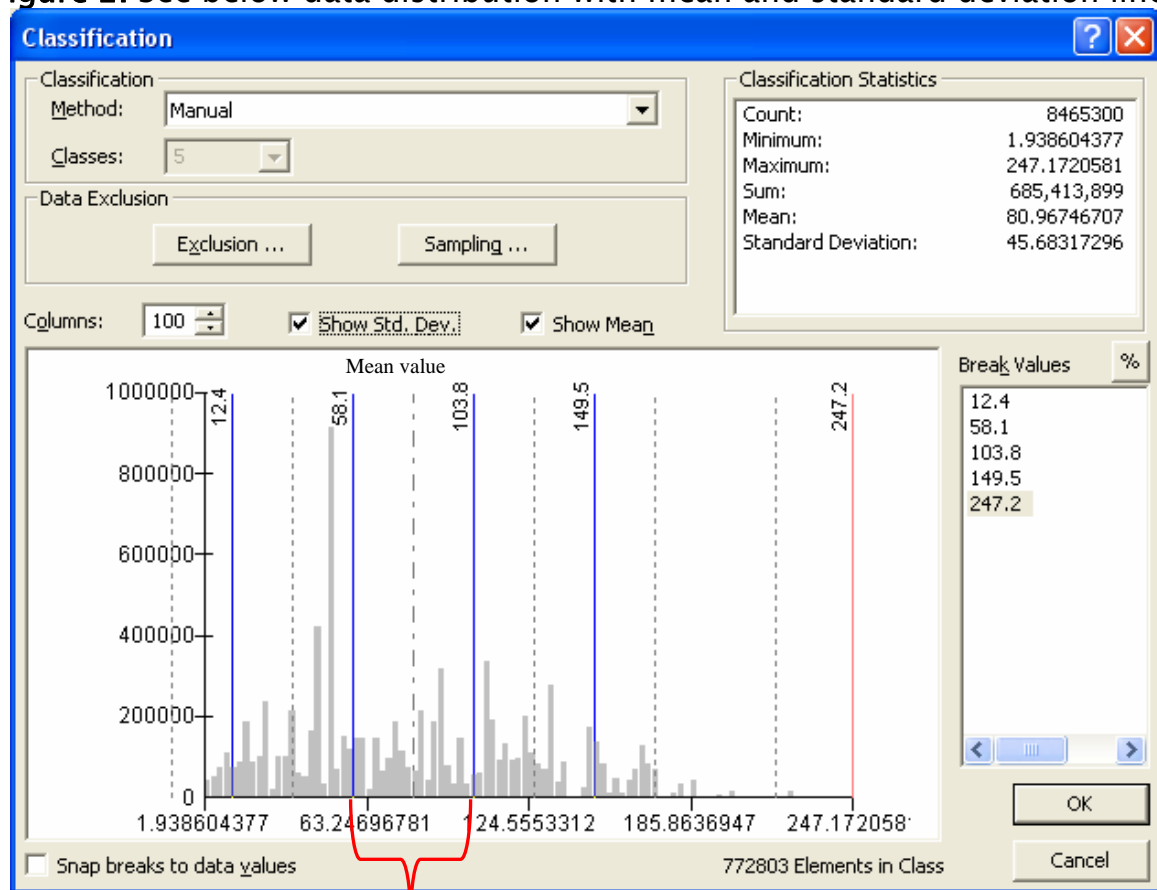


Figure 2. See below data distribution with mean and standard deviation lines and class breaks:



1 std dev
around the
mean

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