Appendix X

Vegetation Dynamics Development Tool

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X. Great Basin Vegetation Modeling using Vegetation Dynamics Development Tool

X.1 Introduction

Numerous factors influence sagebrush dynamics in the Great Basin. Each year acres of sagebrush increase in density, or are burned, grazed, converted to invasive annual grass, damaged by insects and disease, encroached by conifers, or altered by various management treatments. Due to the importance of sagebrush cover for greater sage-grouse, a process to account for all of these changes in sagebrush communities is important in evaluating trends of greater sage-grouse habitat. The greater sage-grouse land use plan amendments being developed and analyzed in each sub-regional EIS in the Great Basin each have different alternative approaches to management of greater sage-grouse habitat. Alternatives propose actions that will influence the extent and distribution of sagebrush. In order to evaluate and compare the estimated effects of each alternative, a team of vegetation ecologists representing each sub-regional EIS in the Great Basin was assembled. The team used the Vegetation Dynamics Development Tool (VDDT, copyright 1995-2003, ESSA Technologies, Vancouver, BC) to accomplish this task. This modeling effort does not include changes in habitat conditions associated with permitted activities such as infrastructure development, travel management, or mineral development.

X.2 Methods

The Great Basin Region planning area was divided into Analysis Areas based upon the Population/subpopulation areas from the *Conservation Assessment of Greater Sage-Grouse and Sagebrush Habitats* (Connelly et al. 2004). These polygons were overlaid on the PPH/PGH layers identified by each state to ensure all habitat was included. The acreage calculations were based on the underlying PPH/PGH. Attachment A shows this base map.

Existing vegetation was determined using a combination of LANDFIRE, local knowledge, GAP analysis, SENS Map in Nevada, and ILAP in Oregon (each state process is described in Attachment B). These acres were estimated for each vegetation class in each vegetation model in each analysis area. Five models were developed to characterize the vegetation:

- Low Sagebrush (shallow, dry)
- Wyoming Big Sagebrush (warm, dry)
- Mixed Sagebrush
- Mountain Big Sagebrush with conifer(cool, moist)
- Mountain Big Sagebrush without conifer (cool, moist)

Each model has different states or conditions of the vegetation, which are called classes. The classes were designed to best represent both the available vegetation data for the planning area, as well as the sage-grouse habitat requirements. The following are the classes for each Model:

Low Sagebrush

1. Early Seral: <10% sagebrush cover
2. Late Seral: >10% sagebrush cover
3. Late Seral with conifer: >10% sagebrush with >10% conifer
4. Annual Grass

Wyoming Big Sagebrush

1. Early Seral: <10% sagebrush cover
2. Mid Seral: 10-30% sagebrush cover
3. Late Seral: >30% sagebrush cover
4. Late Seral with conifer: >30% sagebrush cover with >10% conifer cover
5. Annual Grass
6. Exotic Perennial Grass

Mixed Sagebrush

1. Early Seral: <10% sagebrush cover
2. Mid Seral: 10-30% sagebrush cover
3. Late Seral: >30% sagebrush cover
4. Late Seral with conifer: >30% sagebrush cover with >10% conifer cover

Mountain Big Sagebrush with conifer

1. Early Seral: <10% sagebrush cover
2. Mid Seral: 10-30% sagebrush cover
3. Late seral: >30% sagebrush cover
4. Late Seral with conifer: >30% sagebrush cover with >10% conifer cover
5. Annual Grass

Mountain Big Sagebrush without conifer

1. Early Seral: <10% sagebrush cover
2. Mid Seral: 10-30% sagebrush cover
3. Late seral: >30% sagebrush cover
4. Annual Grass

The following natural and background disturbances were applied to the models: stand replacement wildfire, mosaic wildfire, overgrazing, insects and disease, and conifer encroachment. The rates of occurrence of these disturbances varied by model in order to reflect the variable rates for each of the vegetation types represented by these models. Several web meeting/conference calls were conducted to gain consensus among the team members on which models to develop, what disturbances/succession processes to include and determine what amount should be included in each model. The initial foundation was the Biophysical Settings for applicable sagebrush sites from LANDFIRE. Each team member had the opportunity to bring their local knowledge and experience to the discussion and changes were made to reflect that experience.

After agreement was reached on these rates, a review of the models and disturbance rates was conducted by the Science Review Team. This team made several suggestions that were incorporated into the models.

Wildfire history data (1980-2012) was used from the National Interagency Fire Center to determine the average annual acreage burned in each area, magnitude of extreme fire years, and frequency of extreme years. The size and extent of fires vary significantly from year to year, with most acres burned occurring on few years that represent extreme conditions; therefore using an average fire size would not accurately represent the influence of fire on the landscape. Due to the short time period in the fire history data (32 years) the data was reviewed and the most extreme year (most acres burned) and the smallest fire year (fewest acres burned) were dropped. The presence of only 1 extreme year in the data set does not indicate the interval between extreme events unless 2 data points are found within the fire history range. Therefore it is not accurate to make assumptions about an extreme event occurring every 32 years. Annual wildfire probability for each class in each model was estimated based on mean fire return interval (MFRI) information gained from LANDFIRE and adjusted based on team members' experience. The variability in year-to-year fire totals did not alter the long term fire probabilities derived from MFRI.

X.3 Model Outputs

Alternative A in each Sub-Regional EIS is the No-Action or Current Management Alternative. This alternative represents the existing rates of conifer treatment, sagebrush mechanical treatment, prescribed fire, herbicide treatment, grass seeding, sagebrush seeding, and firebreak utilization. In order to display current vegetation conditions, acres of each type of treatment were collected from the field and input into VDDT. Field monitoring data was used to determine the success rates for grass seeding, herbicide application, and sagebrush seeding. These treatments are all considered as one package of restoration treatments in the models to avoid double counting acres and thereby overestimating their positive benefit to vegetation. Firebreak utilization was not directly input to the model, but was assumed to be correlated to the existing rates of wildfire in areas where the firebreaks are used.

Upon completion of the Current Management Alternative, the model output reports were reviewed by the team as well as field staff from BLM and FS to ensure the results reflected existing levels of treatment, current vegetation and results of treatment. This review resulted

in re-running the models four times in order to capture changes suggested by the reviewers. Changes made included: modification of treatment success rates to reflect field monitoring, removal of double counted acres of treatment when multiple treatment occurred, and errors found within models estimating rates of vegetation change.

An interdisciplinary team conference call/meeting was held with vegetation and wildlife staff to determine the Desired Conditions that would be applied to each analysis area. We determined that 70% of an area should be in 10-30% sagebrush canopy cover. This determination was made after a discussion of the *Guidelines to Manage Sage-Grouse Populations and Their Habitats* (Connelly et al. 2000) and the National Technical Team Report (NTT 2011). Connelly et al. suggested 80% of an area should have 10-30% sagebrush cover and the National Technical Team Report suggested 50-70% of an area should have 10-30% sagebrush cover.

The modeling team then reviewed the amount of each analysis area that currently has 10-30% sagebrush cover. Vegetation treatment projects were then modeled to determine the amount of a particular treatment necessary to move the vegetation conditions to the Desired Conditions. The amount of treatment varied by the amount of departure of the area from Desired Conditions and the vegetation dynamics of the area. The team reviewed amounts of acres available for treatment when developing these treatments to avoid the error of proposing treating acres that did not exist. When analysis areas had Current Conditions at or above 70% no additional treatment projects were proposed. The model outputs for this phase of the analysis are called Proposed Action. These treatment acres may be used to develop objectives in the Sub-regional Alternative D such as:

- "In the North Snake Population area, treat 10,000 acres annually of annual grass."
- "In the North Snake Population area, treat 1000 acres annually of phase 1 conifer encroachment."

Alternatives will be compared by the amount of each Population Area in suitable habitat condition (10-30% sagebrush cover) projected to occur in 50 years.

X.4 Model Assumptions:

Alternative A: No Action: Natural and background disturbances equal to historical averages, vegetation treatments equal to current management rates.

Alternative B – NTT: The modeling team reviewed any actions proposed by this alternative and attempted to quantify the effect of implementation of these actions in order to model the effects of these actions on vegetation. The following are actions found within the NTT that were included in the modeling for Alternative B:

- Natural and background disturbances same as Alt A except 50% less wildfire in Wyoming sage model to estimate the effect of fuels projects.

- No Prescribed Fire in <12" precipitation areas Wyoming sagebrush.
- Desired Condition to maintain 70% of area in 10-30% shrub cover
- Conifer encroachment treatment included
- Annual grass restoration included: Herbicide treatment, grass and sagebrush seeding

Alternative C: The modeling team reviewed actions proposed and modeled the following:

- Natural and background disturbances
- No Prescribed Fire in <12" precipitation areas
- Restore all crested wheatgrass seedings to native vegetation
- Maintain 80% of area in 10-30% shrub cover
- No livestock grazing
- Wildfire increased 25% due to lack of maintenance of existing fuel breaks, and no additional constructed
- Invasive annual grass would increase due to minimal use of herbicide for treatments resulting in a 50% decline in restoration treatment success

Alternative D: The modeling team reviewed actions proposed and modeled the following:

- Maintain 70% of area in 10-30% sagebrush cover
- Natural and background disturbances same as Alt A except 50% less wildfire in Wyoming sage model to estimate the effect of fuels projects.
- Desired Condition to maintain 70% of area in 10-30% shrub cover
- Conifer encroachment treatment included
- Annual grass restoration included: Herbicide treatment, grass and sagebrush seeding

Alternative E: The modeling team reviewed actions proposed and modeled the following:

- Each Sub-regional EIS has a different Alt E. Modeling was changed by Sub-region to reflect those differences.
- In general, this alternative was modeled similar to Alternative D

Alternative F:

- Natural and background disturbances same as Alt A except 50% less wildfire in Wyoming sage model to estimate the effect of fuels projects.

- No Prescribed Fire in <12" precipitation areas Wyoming sagebrush.
- Livestock grazing reduced by 50%.
- Desired Condition to maintain 70% of area in 10-30% shrub cover
- Conifer encroachment treatment included
- Annual grass restoration included: Herbicide treatment, grass and sagebrush seeding

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Literature Cited:

A Report on National Greater Sage-grouse Conservation Measures. Sage-grouse National Technical Team. December 2011.(aka NTT Report)

Conservation Assessment of Greater Sage-Grouse and Sagebrush Habitats (Connelly et al. 2004)

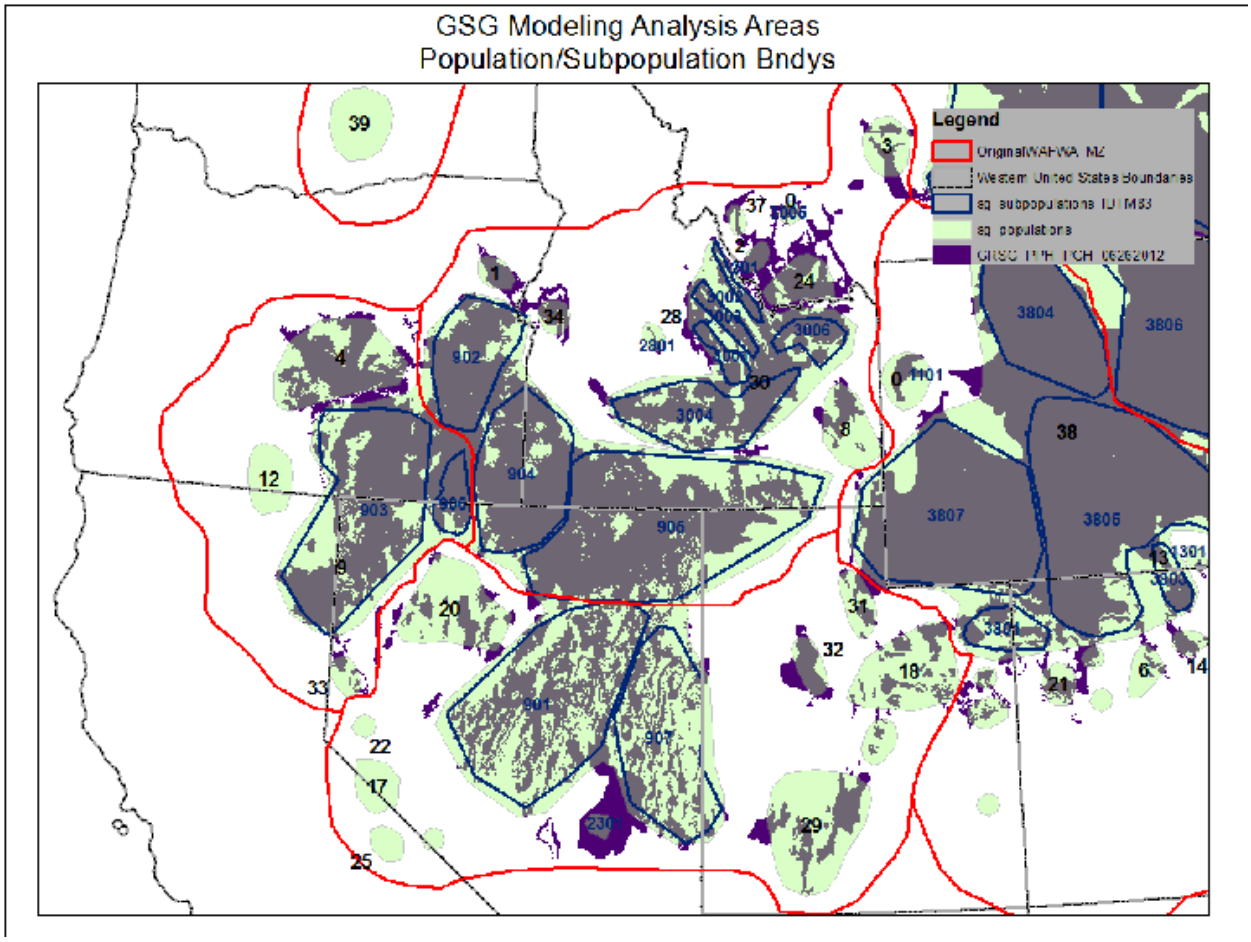
Guidelines to Manage Sage-grouse Populations and Their Habitats. Connelly et. al. 2000.

LANDFIRE : Existing Vegetation and Biophysical Settings.

Manier, D.J., Wood, D.J.A., Bowen, Z.H., Donovan, R.M., Holloran, M.J., Juliusson, L.M., Mayne, K.S., Oyler-McCance, S.J., Quamen, F.R., Saher, D.J., and Titolo, A.J., 2013, Summary of science, activities, programs, and policies that influence the rangewide conservation of Greater Sage-Grouse (Centrocercus urophasianus): U.S. Geological Survey Open-File Report 2013–1098, 170 p., http://pubs.usgs.gov/of/2013/1098/.(aka BER)

U.S. Fish and Wildlife Service. 2013. Greater Sage-grouse (*Centrocercus urophasianus)* Conservation Objectives: Final Report. U.S. Fish and Wildlife Service, Denver, CO. February 2013.

Attachment A Population Area Map



Attachment B-Idaho/Southwest Montana

Greater Sage-grouse Habitat Characterization for Use in Non-Spatial Vegetation Modeling in the Idaho/Southwestern Montana Analysis Area

Vegetation Data

We evaluated available vegetation information to identifying the sagebrush habitat types and associated vegetation cover classes required by the modeling effort. These included Landfire (v115), ReGAP, and a site potential based evaluation of Idaho's Priority and General Sage-grouse Habitat (D. Major pers com). Upon evaluation and acknowledgment of the numerous limitations of available data, we determined the most effective approach would incorporate the following criteria: 1) dataset covers the entire sub-regional project area, 2) the vegetation data has an associated accuracy assessment;, and 3) data provides appropriate resolution of sagebrush habitat types and associated cover classes for the VDDT models. The Landfire raster data sets (Existing Vegetation Type, Biophysical Site Type, and Existing Vegetation Cover) best met our criteria and the general objective of the modeling effort. The above Landfire datasets were clipped to the combined Priority and General Habitat data for Idaho and Montana to serve as our vegetation basemaps for subsequent analysis.

GSG Habitat Characterization

To facilitate characterization of sage-grouse habitat classes we developed a crosswalk from Landfire Existing Vegetation Type (EVT) to a NVCS Macro-group characterization of Tall Sagebrush and Dwarf Sagebrush (See Table 1). For the purposes of this effort, the Semi-Desert Macro-group was included and merged into the Tall Sage Group. In addition we also identified the need for a Shallow/Dry Low Sagebrush Group. We used NRCS Soils Data (SSURGO) to identify a select group of ecological site types and associated soil conditions (shallow soils, precipitation zone ≤ 12 inches, small statured native grass spp)(Table 2). The process involved reclassifying any Tall Sage/Dwarf Sage pixels contained within the Shallow/Dry Low sage polygons to Shallow/Dry Low Sage. The resulting Macrogroup raster was combined (raster calculator) with the Landfire Existing Vegetation Cover data to categorize the following cover classes within the Tall Sage, Dwarf Sage, and Shallow/Dry Low sage groups (Class A = herbaceous cover 0-100%; Class B = shrub cover 10 – 30%; Class C = shrub cover >30%).

Conifer encroachment (Class D = tree cover >10%) was determined using 2 analyses: 1) identification of any Tall Sage, Dwarf Sage, or Shallow/Dry Low Sage occurring within the GSG Priority Habitat – Conifer Encroachment Category. The process involved reclassifying any Tall Sage/Dwarf Sage pixels contained within the Conifer Encroachment Category polygon to Class D; and 2) identification of pixels classified as Juniper and/or conifer in the Landfire EVT raster (see Table 2 for select types) that were also classified as a sagebrush habitat type in the Landfire Biophysical Site Potential (BPS)raster(See Table 3 for select types). The resulting rasters were combined, reclassified and added back to the base Macrogroup raster.

Soil temperature regime was selected as the primary filter to separate the lower productivity warm/dry sagebrush characterized by soil temperature regime-mesic (WYO Model) from the higher productivity cool moist sagebrush soil temperature regime – frigid (MTN Model). Specifically, we characterized NRCS SSURGO soil mapunits into 2 soil temperature groups, mesic and frigid/cryic

and converted the resulting polygon into a raster dataset. The resulting soil temperature raster was then combined (raster calculator) with the base Macrogroup raster to provide the habitat base for our WYO and MTN and MIX VDDT models. No soil temperature regime was evaluated for the Shallow/Dry Low sagebrush (LOW) model. Soil temp regime was used as it represents a finer-scale soils-based attribute important to ecological site characterization and is less variable than available precipitation information (PRISM). Soil temp regime information was not available on most USFS lands and a few smaller areas. In these locations, we used general elevation and precipitation information to describe general proportions of the soil temperature regimes.

Annual Grass – Landfire has a designated Invasive Annual Grass vegetation type (999), however subsequent updates ("refreshes") had resulted in incorrect classification of numerous large fires as Invasive Annual Grass (999) within our vegetation analysis extent. Therefore, we reclassified any Landfire Invasive Annual Grass as Class A <10% cover and used the Landfire BPS to determine Tall or Dwarf sagebrush group assignment. To more accurately reflect Annual Grass (Class E) for our models we opted to use the Annual Grass (R2 Category) information available in the2011 Idaho Sage-grouse Key Habitat data. R2 Areas represented in the Key Habitat data typically represent past fires in sagebrush habitat and associated multi-year monitoring of annual grass establishment in these areas. Annual Grass polygons were identified within our Sage-grouse Population boundaries and/or adjacent (out to 2 kilomenters) to the GSG Priority/General habitat polygons. The resulting polygons were used as a mask to extract areas classified as a sagebrush habitat type in the Landfire Biophysical Site Potential (BPS)raster(See Table 3 for select types). The resulting raster was reclassified to appropriate VDDT Model and exported to excel for calculation of acreages for model Class E = Annual Grass. Environmental conditions across most of the Montana portion of the sub region afford limited suitability for annual grass establishment, and were not examined.

Table 1
Landfire Existing Vegetation Types (and associated NVCS Group) identified for Greater Sage-grouse habitat characterization

Macro-Group	EVT Value	Landfire Existing Vegetation Type
Tall Sagebrush Group(169)	2079	Great Basin Xeric Mixed Sagebrush Steppe
	2080	Inter-Mountain Basins Big Sagebrush Shrubland
	2123	Columbia Plateau Scabland Shrubland
	2125	Inter-Mountain Basins Big Sagebrush Steppe
	2126	Inter-Mountain Basins Montane Sagebrush Steppe
	2220	Artemesia tridentate spp. Vaseyena Shrubland Alliance
Dwarf Sagebrush Group(170)	2124	Columbia Plateau Low Sagebrush Steppe
	2065	Colorado Plateau Mixed Low Sagebrush Shrubland
	2065	Columbia Plateau Scabland Shrubland
	2072	Wyoming Basin Dwarf Sage Shrubland and Steppe
Semi-desert (171)	2135	Semi-Desert Grassland
	2127	Semi-Desert Shrub Steppe

Table 2
Ecological Site Types associated with the Shallow/Dry Low Sagebrush Vegetation Model

SSURGO Ecological Site Type
Cold Gravelly 8-12 ARNO4/HECOC8
Shallow Calcareous Loam 10-16 ARARN/PSSPS
Shallow Stony 8-10 ARNO4/ACTH7-SPCR
Very Shallow 12-20 ARRI2/POSE
Very Shallow Stony 8-12 ARNO4/ACTH7
Very Shallow Stony Loam 10-14 ARAR8/POSE-PSSPS
Windswept Ridge 8-11 ARFR4/POSE
Windswept Ridge 12-20 ARNO/PSSPS
Windswept Ridge 12-22 ARFR4-ARAR8/POA

Table 3
Landfire Biophysical Site Types/Groups identified for Greater Sage-grouse Invasive Annual Grass evaluation

BPS_CODE	BPS_NAME	GROUPID	GROUPNAME
10010	Inter-Mountain Basins Sparsely Vegetated Systems	100	Sparsely Vegetated
10620	Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland/Shrubland	164	Cur-leaf Mountain Mahogany-Mountain Big Sagebrush
10640	Colorado Plateau Mixed Low Sagebrush Shrubland	166	Bigelow Sage-Low Sage4
10650	Columbia Plateau Scabland Shrubland	167	Low Sage-Scabland Sage5
10790	Great Basin Xeric Mixed Sagebrush Shrubland	177	Black Sage-Low Sage3
10800	Inter-Mountain Basins Big Sagebrush Shrubland	178	Wyoming Big Sage-Spiny Hopsage1
10801	Inter-Mountain Basins Big Sagebrush Shrubland-Basin Big Sagebrush	179	Basin Big Sage-Greasewood4
10802	Inter-Mountain Basins Big Sagebrush Shrubland-Wyoming Big Sagebrush	179	Wyoming Big Sage-Indian Ricegrass4
10800	Inter-Mountain Basins Big Sagebrush Shrubland	180	Wyoming Big Sage-Rubber Rabbitbrush4
11230	Columbia Plateau Steppe and Grassland	218	Indian Ricegrass-Squirreltail4
11240	Columbia Plateau Low Sagebrush Steppe	219	Low Sage-Idaho Fescue3
11250	Inter-Mountain Basins Big Sagebrush Steppe	220	Wyoming Big Sage-Wheatgrass3
11250	Inter-Mountain Basins Big Sagebrush Steppe	221	Wyoming Big Sage-Wheatgrass4
11260	Inter-Mountain Basins Montane Sagebrush Steppe	222	Mountain Sagebrush-Blubunch Wheatgrass-Idaho Fescure4

Table 4
Landfire Existing Vegetation Types/Groups identified for Greater Sage-grouse Conifer Encroachment evaluation

Value	Existing Vegetation Type	System Group
2016	Colorado Plateau Pinyon-Juniper Woodland	Pinyon-Juniper Woodland
2017	Columbia Plateau Western Juniper Woodland/Savanna	Juniper Woodland/Savanna
2019	Great Basin Pinyon Juniper Woodland	Pinyon Juniper Woodland
2045	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	Douglas-fir-Ponderosa Pine-Lodgepole Pine Forest and Woodland
2053	Northern Rocky Mountain Ponderosa Pine Woodland	Ponderosa Pine Forest, Woodland, Savanna
2054	Southern Rocky Mountain Ponderosa Pine Woodland	Ponderosa Pine Forest, Woodland, Savanna
2115	Inter-Mountain Basins Juniper Savanna	Juniper Woodland/Savanna
2165	Northern Rocky Mountain Foothill Conifer Woodland Steppe	Douglas-fir Forest/Woodland
2166	Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	Douglas-fir Forest/Woodland
2203	Juniperous occidentalis Woodalnd Alliance	Juniper Woodland/Savanna
2227	Pseudotsuga menziesii Forest Alliance	Douglas-fir Forest/Woodland

Attachment B-Utah

Development of Data for VDDT Sage Grouse Habitat Models

LANDFIRE data were used to define the vegetation cover types that occupy sage grouse population areas in Utah. In order to do this the LANDFIRE Existing Vegetation Type (EVT), Biophysical Setting (BPS), and/or BPS Groups were used as the basis to determine which cover types would be included in which models. Especially because Wyoming and mountain big sagebrush species are mapped at all elevations in LANDFIRE, it was felt that steps needed to be taken to separate these species on an ecological basis. Goodrich and others (1999) found that annual precipitation for **Wyoming big sagebrush** populations was **between 6.8 and 12.6 inches**. The authors found that **mountain big sagebrush** occurred in zones where annual precipitation was between **11.8 and 27.7 inches**. According to these authors, **plants intermediate to Wyoming and mountain big sagebrush** occur in areas with precipitation that ranges from **8.1 to 14.6 inches**. Their data suggested that the pinyon-juniper belt in Utah was between 9 and 15 inches of annual precipitation. Payne (1980) suggested that the Intermountain pinyon-juniper zone fell between 10 and 14 inches annual precipitation. The Utah BLM State Office has a precipitation GIS layer[1] that breaks the landscape into 0-2, 2-4, 4-6, etc. inch breaks, which didn't allow us to use the 9 or 15 inch levels in our analysis. For this reason, the following rules were established.

- ✓ Below 10 inches annual precipitation, all sagebrush was considered to be Wyoming big sagebrush;
- ✓ Anything between 10 inches (about 2 inches less than the minimum amount listed for mountain big sagebrush) and 14 inches (about 2 inches more than the maximum precipitation for Wyoming big sagebrush, was considered to be a transition zone where either species could possibly occur;
- ✓ Within that 10-14 inch zone, the LANDFIRE EVT (Existing Vegetation Type), BPS (Biophysical Setting), and/or Group types were used to make the determination regarding species that occur;
- ✓ Any sagebrush that occurred in the zones above 14 inches was considered to be mountain big sagebrush; and finally
- ✓ Low sagebrush was low sagebrush, regardless of the precipitation zone if occurred in.

Following these rules, the following sagebrush zones were established:

- ✓ Zone 1 – Precipitation $\leq$ 10 inches. Non-Seral Zone in which there is insufficient precipitation for juniper to grow. Wyoming big sagebrush is the only *big* sagebrush that can occur with this low amount of precipitation
- ✓ Zone 2 – Precipitation 10-14 inches. Seral Zone in which there is sufficient precipitation for juniper to grow. In this transition zone, both Wyoming and mountain big sagebrush species can occur.

[1] blm\dfs\ut\loc\GisData\ut\so\data\AirClimate\precip_ut250

- ✓ Zone 3 – Precipitation 14-28 inches. Non-Seral Zone in which there is too much precipitation for juniper to be considered as a universal late seral species that replaces sagebrush. Only where juniper is the existing vegetation (EVT), what is considered a seral community. This zone is above where Wyoming big sagebrush is likely to occur, so all big sagebrush communities are considered to be mountain big sagebrush.
- ✓ Zone 4 – Precipitation ≥ 28 inches. Non-Seral Zone in which there is too much precipitation for juniper to be a late seral species. Only where juniper is the existing vegetation (EVT), what is considered a seral community. This is considered to be the cool, moist mountain big sagebrush zone.

Members of our GIS staff were able to combine (union) our EVT, BPS, and SClass (Cover Class) layers so that each polygon had the attributes needed to make the determinations needed for sage grouse habitat modeling. Then, the occupied habitat was selected from the layers that came out of this process, and were again unioned with a precipitation layer that broke the State into the zones listed above (≤10, 10-14, 14-28, ≥28 inches). It was the combination of all this information that was used to determine which models to develop and apply for the VDDT habitat modeling process used in the sage grouse EIS.

Key to Models Used with LANDFIRE Data

1	Precipitation ≤ 10 inches	2
1	Precipitation > 10 inches	8
2	EVT is Juniper dominated	3
2	EVT is not Juniper dominated	5
3	BPS and/or Group Juniper dominated	Not Modeled
3	BPS low or big sagebrush dominated (non-seral communities)	4
4	BPS and/or Group dominated by any big sagebrush	Wyo-Seral
4	BPS and/or Group dominated by any low sagebrush	Low-Seral
5	EVT is one of the non-native types	6
5	EVT is not one of the non-native types	7
6	BPS and/or dominated by any big sagebrush	Wyo-Non Seral
6	BPS and/or dominated by any low sagebrush	Low-Non Seral
7	EVT dominated by any big sagebrush	Wyo-Non Seral
7	EVT dominated by any low sagebrush	Low-Non Seral
8	Precipitation 10-14 inches (seral communities)	9
8	Precipitation ≥ 14 inches	17
9	EVT is Juniper dominated	10
9	EVT is not Juniper dominated	12

Key to Models Used with LANDFIRE Data

10	BPS and/or Group Juniper dominated	Not Modeled
10	BPS low or big sagebrush dominated (seral communities)	11
11	BPS and/or Group dominated by any big sagebrush	12
11	BPS and/or Group dominated by any low sagebrush	Low-Seral
12	BPS and/or Group dominated by Wyoming big sagebrush	Wyo-Seral
12	BPS and/or Group dominated by Mountain big sagebrush	Mtn-Seral
13	EVT is one of the non-native types	14
13	EVT is not one of the non-native types	17
14	BPS and/or Group dominated by any big sagebrush	15
14	BPS and/or Group dominated by any low sagebrush	Low-Seral
15	BPS and/or Group dominated by Wyoming big sagebrush	Wyo-Seral
15	BPS and/or Group dominated by Mountain big sagebrush	Mtn-Seral
16	EVT dominated by any big sagebrush	17
16	EVT dominated by any low sagebrush	Low-Seral
17	BPS and/or Group dominated by Wyoming big sagebrush	Wyo-Seral
17	BPS and/or Group dominated by Mountain big sagebrush	Mtn-Seral
18	Precipitation 14-28 inches	19
18	Precipitation $\geq$ 28 inches	25
19	EVT is Juniper dominated (seral communities)	19
19	EVT is not Juniper dominated (non-seral communities)	22
20	BPS and/or Group Juniper dominated	Not Modeled
20	BPS low or big sagebrush dominated (non-seral communities)	21
21	BPS and/or Group dominated by any big sagebrush	Mtn-Seral
21	BPS and/or Group dominated by any low sagebrush	Low-Seral
22	EVT is one of the non-native types	23
22	EVT is not one of the non-native types	24
23	BPS and/or dominated by any big sagebrush	Mtn-Non Seral
23	BPS and/or dominated by any low sagebrush	Low-Non Seral
24	EVT dominated by any big sagebrush	Mtn-Non Seral
24	EVT dominated by any low sagebrush	Low-Non Seral
25	EVT is Juniper dominated	26
25	EVT is not Juniper dominated	28

Key to Models Used with LANDFIRE Data

26	BPS and/or Group Juniper dominated	Not Modeled
26	BPS low or big sagebrush dominated (non-seral communities)	27
27	BPS and/or Group dominated by any big sagebrush	Cool Mtn-Seral
27	BPS and/or Group dominated by any low sagebrush	Cool Low-Seral
28	EVT is one of the non-native types	29
28	EVT is not one of the non-native types	30
29	BPS and/or dominated by any big sagebrush	Cool Mtn-Non Seral
29	BPS and/or dominated by any low sagebrush	Cool Low-Non Seral
30	EVT dominated by any big sagebrush	Cool Mtn-Non Seral
30	EVT dominated by any low sagebrush	Cool Low-Non Seral

Literature Cited

Goodrich, S.; D. McArthur; A.H. Winward. 1999. *Sagebrush Ecotones and Average Annual Precipitation*. pp. 88-94. In: McArthur, E. Durant; Ostler, W. Kent; Wambolt, Carl L., comps. 1999. **Proceedings: shrubland ecotones**; 1998 August 12-14; Ephraim, UT. Proc. RMRS-P-11. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 299 p.

Attachment B-Nevada-California

VDDT Modeling Procedures for Nevada

Vegetation Data

The Nevada team considered available vegetation layers to determine which would be most effective in identifying the sagebrush habitat types pertinent to the modeling effort. These included xxxxx The Nevada Heritage synthesis vegetation map (raster data) was selected as it provided the best resolution of sagebrush habitat types pertinent to the required model inputs. The plant cover report for the Humboldt Toiyabe National Forest Land Use Plan Revision (2005) served as a relevant proxy for distributing crown cover classes among the sagebrush types. Subpopulation areas were derived from the Western Association of Fish and Wildlife Agencies (Connelly et al 2004). Other BLM data included polygon data showing areas above 6,500 feet elevation, and fire history data which also included other sources.

The vegetation map was clipped using the sub population areas and the raster data converted to polygons. Vegetation types that didn't include Low Sage, Mountain Sage, Wyoming Sage, Pinyon pine, or juniper were deleted. All vegetation types that contained Mountain sage were merged into the Mountain sage classification. All vegetation types containing Wyoming sagebrush (minus any that had mountain sage) were merged into the Wyoming sagebrush classification. Low sage was handled the same (minus Wyoming and mountain sagebrush). All Pinyon and Juniper types were merged together..

All the fires since 2000 were combined. All the fires above 6,500 feet elevation were "erased" using the 6,500 foot elevation database under the assumption that habitat at these elevations would recover following fire. The remaining fires were used to "erase" any vegetation type under the fire perimeters. To define possible sage grouse habitat that had been burned, a lower elevation (1500 meters, or approx. 4,900 feet) was selected and all fire perimeters below this elevation were erased under the assumption that habitat conversion was occurring at these lower elevations. The fire perimeters were then inserted into the vegetation types as annual grasses. Total acres of all vegetation type was calculated using GIS. A dbase file type was exported for the next step.

Using the USFS crown cover report, percentages of crown cover by vegetation type were developed for each of the ranger districts. The adjacent or otherwise appropriate ranger district values were used for the subpopulation areas. In the absence of adjacent USFS crown cover information, fire histories, elevation, precipitation, and landform were considered to match similar USFS areas for the Montana Mountain and the CA/NV/OR subpopulation areas.

Low crown cover (<10%) for pinyon-juniper woodlands was considered as invasive conifer.

Total acres of low, mountain, and Wyoming sagebrush vegetation types were multiplied by the percentage of the low, medium, or high crown cover from the USFS crown cover report to develop crown class acreage starting points for the model, yielding total acres for each vegetation and crown cover classification.

Additionally, total acres of conifer invasion and annual grass conversion for each sagebrush vegetation type were calculated, based on the percent of each sagebrush type in each subpopulation area.

Point Fire data

Fire data was obtained from BLM Western Great Basin weather prediction meteorologist. Lat/long data were converted to decimal degree lat/long. Fires without spatial information were deleted. Fires with locational information outside of Nevada were removed. Locational data were spatially joined to sub population areas. The total sub population acres field was added and wildfire acres calculated for each subpopulation. The dbase file was imported into excel.

Attachment B-Oregon

Determining Acres of Each Sagebrush Group by Subpopulation

Vegetation data used came from the Integrated Landscape Assessment Project (ILAP), an American R and Recovery Act (ARRA)-funded project that, among other deliverables, provided a vegetation map of the semi-arid lands in Oregon and Washington. Louisa Evers and GIS staff Jeanne Keyes and Maria Fiorella in the Oregon State Office compared ILAP, LANDFIRE, and ReGAP vegetation layers to NAIP imagery to determine which layer best captured juniper and annual grasses. While all vegetation layers had relatively significant problems in identifying these two key vegetation types and the four layers compared at relatively low agreement between them, we determined that ILAP best captured the general extent of juniper encroachment and annual grasses.

Ideally, each sagebrush modeling group could be identified on the basis of soil moisture and temperature regime and ecological site description. However, lack of a complete soils layer and ecological site descriptions for eastern Oregon and the nature of the ILAP data table necessitated a non-spatial approach to determining which ILAP polygons belonged to which sagebrush modeling group and which successional class/community phase. The ILAP data table listed the four most common species and approximate canopy cover, although how these data were determined is not known. Certain species were used as indicators for which sagebrush group a given polygon belonged in and canopy cover was used to determine successional stage. Occasionally the indicators were ambiguous, requiring the use of professional judgment based on all four species. In a few cases, either the species or the canopy cover for that species was erroneous; either 1) it was not possible to determine which was in error or 2) it was clear that both were in error. For example, stiff sagebrush cannot reach >20% canopy cover given the type of sites it is associated with, so either the sagebrush species was misidentified or the canopy cover was.

Sagebrush Groups

Cool-Moist sagebrush group indicators – mountain big sagebrush, antelope bitterbrush, Idaho fescue, Idaho fescue-bluebunch wheatgrass, cool and moist site indicator forbs

Warm-Dry sagebrush group indicators – Wyoming big sagebrush, basin big sagebrush, Thurber's needlegrass, needle-and-thread, bluebunch wheatgrass, bluebunch wheatgrass-Idaho fescue, crested wheatgrass

Shallow-Dry sagebrush group indicators – low sagebrush, stiff sagebrush, black sagebrush, bluegrass species

Because the sagebrush groups in Oregon are tied to site productivity, the sagebrush species was used in combination with the herbaceous species to determine group membership. For example, a polygon with either low sagebrush or Wyoming big sagebrush and Idaho fescue as the first and second species were assigned to the Cool-Moist group. Mountain big sagebrush and Thurber's needlegrass as the first and second species were assigned to the Warm-Dry group. Wyoming big sagebrush and Sandberg's bluegrass as the first and second species was assigned to the Shallow-Dry group.

Polygons with western juniper as the first or second species could be assigned to any sagebrush group, but the bias was to assign it to the Cool-Moist group. Juniper would be assigned to either of the other two groups based on the herbaceous layer (lack of high productivity indicators).

Polygons with annual grass as the first or second species could be assigned to any sagebrush group, but the bias was to assign it to the Warm-Dry group unless higher or lower productivity indicators were the first, second, or third species listed.

Polygons with salt-tolerant or halophytic species, willow, cottonwood, other conifer species, and wet meadow species were excluded.

Successional Classes

Early Seral Class Indicators: sagebrush cover is <10% or sagebrush is not listed. Rabbitbrush may be the first or second species listed. Juniper and annual grasses either not listed or present only in trace amounts.

Mid-seral Class Indicators: sagebrush cover is 10-30%, juniper not listed or present only in trace amounts. Annual grasses the third or fourth species listed. This class includes at-risk community phases for annual grasses.

Late Seral Class Indicators: sagebrush cover >30% in the Cool-Moist and Warm Dry Sagebrush groups, >10% in the Shallow-Dry group. Juniper and annual grasses either not listed or the third or fourth species listed. This class includes Phase I juniper and at-risk community phases for annual grasses.

Late Seral with Conifer Class Indicators: Juniper the first or second species listed; sagebrush may or may not be present and cover is variable. Annual grasses may or may not be present. This class includes Phase II and Phase III juniper encroachment and old growth juniper.

Annual Grass Class Indicators: Annual grasses the first or second species listed.

Exotic Perennial Grass Class Indicators: Crested wheatgrass the first or second species listed. This class not used in the final models.

Greater Sage-grouse Habitat Characterization for Use in Non-Spatial Vegetation Modeling across the Great Basin

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Vegetation Data

We evaluated available vegetation information developed for the Greater Sage-grouse Regional and Sub-regional efforts to identify the sagebrush habitat types and associated vegetation cover classes required in our modeling effort. We determined the most effective approach would incorporate the following criteria: 1) dataset covers the entire western region, 2) the vegetation data has an associated accuracy assessment, and 3) data provides appropriate resolution of sagebrush habitat types and associated cover classes for the VDDT models. The baseline vegetation data sets developed for the region-wide Disturbance Monitoring and Vegetation Basemap Team (**) met these criteria. The datasets were developed using Landfire v12 (updated through 2010) data products and consisted of 1) existing sagebrush base, 2) conifer base, 3) potential sagebrush base (for details on methodology see Appendix – Vegetation Basemap in Disturbance Monitoring Report). In addition, we used Landfire v12 Existing Vegetation Type to identify Invasive Annual grass and Introduced Crested Seedings. Existing Vegetation Cover was used to identify sage-grouse cover class characteristics required for the modeling effort. The above datasets were combined and clipped to BLM and USFS ownership within each Sub-regional Area (Oregon, Idaho/Montana, Utah, Nevada/California) to serve as our sagebrush modeling basemaps for subsequent analysis.

GSG Habitat Characterization for Vegetation Models

We modified the sagebrush modeling basemap to facilitate characterization of sage-grouse habitat and associated development classes identified in our models. We modified the Soil Moisture and Temperature Regime data (Chambers et al 2014, Fire and Invasives Team Report, 2014) to identify 4 Vegetation Model Types – Warm/Dry sagebrush, Mixed sagebrush, Mountain sagebrush w/conifer, and Mountain sagebrush no conifer (Table 1). In addition we identified the need for a Low Sagebrush Group. We used the Landfire v12 Biophysical Settings dataset and selected low sagebrush vegetation groups (Table 2). The resulting Model Group raster was combined (raster calculator) with the Landfire Existing Vegetation Cover data to categorize the following cover classes within the Low sage [LOW], Warm/Dry Sage[WARM/DRY], Mixed Sage[MIX], Mountain Sage w/ conifer[MTN7], and Mountain sage no conifer[MTN8] (Class A = herbaceous cover 0-100%; Class B = shrub cover 10 – 30%; Class C = shrub cover >30%). To identify Annual Grass and Crested Seeding, we assigned any Landfire Introduced Upland Vegetation -Annual Grassland (evt code 3181) or – Perennial Grassland Forbland (evt code 3182) that had a sagebrush site potential to Class Invasive Annual and Class CWG Seeding, respectively. Conifer encroachment (Class D = tree cover >10%) was determined using the Conifer base dataset subset to areas with

sagebrush site potential. The resulting rasters were combined, reclassified and added back to the base Model Group raster.

Soil Moisture Temperature information was limited in some higher elevation areas or shrubland-forest transitional areas. Therefore we incorporated 30 year average annual precipitation data (PRISM ppt 30yr normal 800m2 annual) to inform any unclassified sagebrush pixels in our Model Group dataset. Specifically, we set the following criteria: Average annual precipitation 14 – 28 inches = MTN7; Average annual precipitation ≥ 28 inches = MTN8. Results were reclassified and added back to the base Model Group raster.

Additional Filters

To provide a biologically meaningful geographic extent, we filtered the final sagebrush modeling basemap to Greater sage-grouse population Areas and associated Priority Areas for Conservation (PACs) from the Conservation Objectives Team Report (USFWS, 2014). The above datasets were combined and clipped to BLM and USFS ownership within each Sub-regional Area (Oregon, Idaho/Montana, Utah, Nevada/California) to serve as our sagebrush modeling basemaps for subsequent acreage reporting and analysis.

Literature Cited

Chambers, Jeanne C.; Pyke, David A.; Maestas, Jeremy D.; Pellant, Mike; Boyd, Chad S.; Campbell, Steven B.; Espinosa, Shawn; Havlina, Douglas W.; Mayer, Kenneth E.; Wuenschel, Amarina. 2014. Using resistance and resilience concepts to reduce impacts of invasive annual grasses and altered fire regimes on the sagebrush ecosystem and greater sage-grouse: A strategic multi-scale approach. Gen. Tech. Rep. RMRS-GTR-000. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Greater Sage-grouse Disturbance Monitoring and Vegetation Basemap Assessment Team Report. 2014

Greater Sage-grouse Wildfire, Invasive Annual Grasses and Conifer Expansion Assessment FIAT Report. 2014.

Miller R. F; Chambers, J. C.; Pellant, M. 2014a. A field guide to selecting the most appropriate treatments in sagebrush and pinyon-juniper ecosystems in the Great Basin: Evaluating resilience to disturbance and resistance to invasive annual grasses and predicting vegetation response. Gen. Tech. Rep. RMRS-GTR-322. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Miller R. F.; Chambers, J. C.; Pellant, M.[In press]. A field guide for rapid assessment of post-wildfire recovery potential in sagebrush and pinon-juniper ecosystems in the Great Basin: Evaluating resilience to disturbance and resistance to invasive annual grasses and predicting vegetation response. Gen. Tech. Rep. RMRS-GTR-###. . Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

U.S. Fish and Wildlife Service [USFWS]. 2013. Greater sage-grouse (*Centrocercus urophasianus*) conservation objectives: Final Report. Denver, CO: U.S. Fish and Wildlife Service. 91 p.

U.S. Geological Survey (USGS). 2013: LANDFIRE 1.2.0 Existing Vegetation Type layer. Updated 3/13/2013. Washington, DC: U.S. Department of the Interior, Geological Survey. Online: http://landfire.cr.usgs.gov/viewer/. [Accessed 10 July 2014].

Table 1
VDDT Model Groups associated with predominant sagebrush ecological types in Sage-Grouse Management Zones III, IV, V, and VI based on soil temperature and soil moisture regimes, typical characteristics, and resilience to disturbance and resistance to invasive annual grasses (modified from Chambers et al. 2014, Miller et al. 2014 a,b).

Ecological type	Characteristics	VDDT Model
Cold and Moist (Cryic/Xeric)	Ppt: 14 inches + Typical shrubs: *Mountain big sagebrush, snowfield sagebrush, snowberry, serviceberry, silver sagebrush, and/or low sagebrushes*	MTN8, LOW
Cool and Moist (Frigid/Xeric)	Ppt: 12-22 inches Typical shrubs: *Mountain big sagebrush, antelope bitterbrush, snowberry, and/or low sagebrushes* Piñon pine and juniper potential in some areas	MTN7, LOW
Warm and Moist (Mesic/Xeric)	Ppt: 12-16 inches Typical shrubs: *Wyoming big sagebrush, mountain big sagebrush, Bonneville big sagebrush, and/or low sagebrushes* Piñon pine and juniper potential in some areas	MIX, LOW
Cool and Dry (Frigid/Aridic)	Ppt: 6-12 inches Typical shrubs: *Wyoming big sagebrush, black sagebrush, and/or low sagebrushes*	WARM/DRY, LOW
Warm and Dry (Mesic/Aridic, bordering on Xeric)	Precipitation: 8-12 inches Typical shrubs: *Wyoming big sagebrush, black sagebrush and/or low sagebrushes*	WARM/DRY, LOW

Table 2
Landfire 120 Potential Vegetation Types identified for the Greater Sage-grouse LOW Sagebrush model.

BPS Value	Landfire Potential Vegetation Type
10640	Colorado Plateau Mixed Low Sagebrush Shrubland
10650	Columbia Plateau Scabland Shrubland
10790	Great Basin Xeric Mixed Sagebrush Steppe
11240	Columbia Plateau Low Sagebrush Steppe
11262	Inter-Mountain Basins Montane Sagebrush Steppe - Low

Datasets Used in the Vegetation Analysis

From Disturbance Monitoring and Baseline Vegetation Teams (Spring 2014)

Landfire 18 Class EVT (Current) related to sagebrush systems [dataset: lf_evt_v12_sagebrush_recode]

Landfire BPS (Potential) Associated with the 18 Class EVT above [dataset: lf_bps_v12_sagebrush_recode]

Binary Landfire 18 Class informed w Dev/Ag/Fires/Conif-sage [dataset: 2010_existing_sagebrush_base]

Binary Conifer in Sage (near neighbor analysis w/ State bio acceptance) [dataset: lf_evt_v12_conifers_binary]

Data from Fire/Invasives (FIAT) Team

SSURGO Soil Temperature/Moisture Regimes (Chambers et al 2014)

[dataset: SGMZ_SSURGO_temp_moist_regimes_v2.gdb]

Additional spatial data

Landfire Annual Grass Only [dataset:]

Landfire EVC (Cover) associated w/ the above Landfire Binary Sagebrush Basemap [dataset: US_120_EVC]

PRISM [dataset: PRISM_ppt_30yr_normal_800mM2_annual_bil]

Management Scale Information filters

GSG PAC Boundaries [dataset: GSGCOT_ALL_PAC_Atts_Albers_Dis_2014]

GSG Population boundaries [dataset: COT_SG_Populations_2014_WAFWA_UT]

Subregional EIS Boundaries [dataset: EISSubmittedBoundaries_mrg_dis]

State Boundaries [dataset: States5_ESRI_2008_Albers]

Surface Mgmt Boundaries (including FS Forests/Districts; BLM District/Field Offices)

[dataset: SMA_Dec2013_Monitoring_AOI_cli]

BLM – Subset: Agency: BLM, DOE, DOI,OTHFE

USFS – Subset: Agency: FS, USDA

USFS – For USFS Forest Name [dataset: USFS_GRSG_FS_Boundaries_Aug262013_Dissolved]

Utah specific to inform COT PAC and COT POP [dataset: UT_AltF_VDDT]

COT Population Unit Number - (ver. 07232014) for GSG VDDT Analysis