APPENDIX A

Developing GIS Data Layers and Analysis for the American Burying Beetle Species Status Assessment February 2019

INTRODUCTION

Background

The American Burying Beetle (*Nicrophorus americanus;* hereafter ABB) once widely distributed throughout temperate North America, is now known to exist in widely dispersed populations within the Great Plains (United States) and on Nantucket and Block islands (hereafter New England), off of Rhode Island (United States). The species was listed as endangered in 1989. Habitat loss and fragmentation are the primary drivers for its population decline (USFWS, 1991).

Purpose

This GIS analysis is to examine the current condition of the land cover within specified areas of the known populations, within the Great Plains and New England. As part of this effort, all presence/absence survey data (spatial and tablature) from multiple sources, dates, and locations were assembled into one normalized geographic dataset. All information and results generated from this analysis will be discussed in the formal Species Status Assessment (SSA) document. This report will be an appendix of the SSA document, and will limit discussions to geoprocessing methods and any other technical procedures applied to spatial data.

Study Area/Analysis Areas

The current area for this analysis was developed from available existing presence/absence survey data collected throughout the last century. Positive (present) survey points were buffered (then dissolved) in a GIS, to 30 kilometers (potential moving distance; Bedick et al. 1999, Creighton and Schnell, 1998, Jurzenski 2012, USFWS, 2014) to create large polygons (see SSA report, figure 2-6 and 5-1). These polygons will be the confines of the current condition land cover analysis. These areas were further subdivided based on general physiographic features into smaller Analysis Areas to provide a smaller, regional analysis. These smaller areas also expedite the geoprocessing routines for the GIS (see SSA Report – Chapter 4).

Data Limitations

All source landcover/ownership datasets used were developed by entities outside the USFWS. All these datasets are publicly available. The quality and accuracy of these data (ecological and spatial) may vary. Remotely sensed data products and large national datasets may contain inherent errors of omission and commission. Current land cover/ownership status may differ from the data displayed in the analysis. Actual, on-the-ground, quality and/or condition of mapped cover types is not addressed. No field verification or reviews of ancillary datasets/aerial imagery were done to verify the accuracy of the data. Raster land cover data has a minimum spatial resolution of 30 meters. These datasets, the analysis, and all maps/products created from it are subject to change.

Projections and Transformations

For this project, all data was projected into North American Albers Equal Area Conic, North American Datum (NAD) 1983. Typically, the raster datasets are downloaded in WGS 84, or other geographic coordinate systems. Re-projecting to Albers does slightly alter the shape of the pixels, but the change is nearly proportional, so there is negligible effect to the acreage of each pixel.

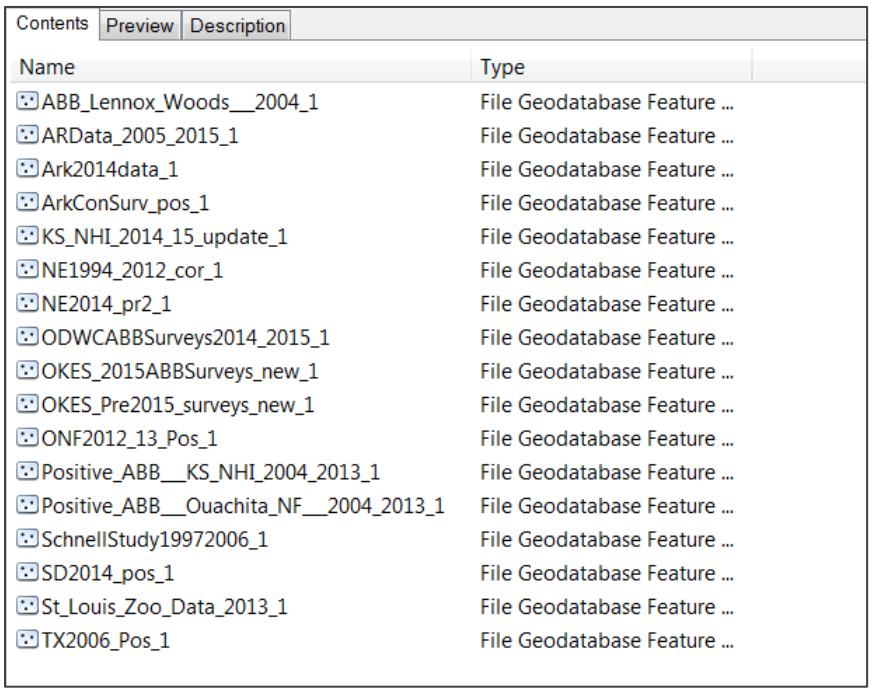
GIS Platform
All GIS analysis and mapping work was done using ArcGIS 10.3.

DATA AND SPATIAL ANALYSIS

GIS Analysis, Phase I: Presence/Absence Survey Data Collection Normalization (Great Plains only)

Normalization Process

1. All ES office ABB data was imported into a feature dataset with the appropriate coordinate system to normalize locational data in the spatial extent. North America Albers Equal Area Conic was used to minimize distortion over the large area necessary to display the data. This projection is used by the USGS and US Census Bureau. The following original shapefiles were used (Figure X):



Contents | Preview | Description

Name	Type
ABB_Lennox_Woods__2004_1	File Geodatabase Feature ...
ARData_2005_2015_1	File Geodatabase Feature ...
Ark2014data_1	File Geodatabase Feature ...
ArkConSurv_pos_1	File Geodatabase Feature ...
KS_NHI_2014_15_update_1	File Geodatabase Feature ...
NE1994_2012_cor_1	File Geodatabase Feature ...
NE2014_pr2_1	File Geodatabase Feature ...
ODWCABBSurveys2014_2015_1	File Geodatabase Feature ...
OKES_2015ABBSurveys_new_1	File Geodatabase Feature ...
OKES_Pre2015_surveys_new_1	File Geodatabase Feature ...
ONF2012_13_Pos_1	File Geodatabase Feature ...
Positive_ABB__KS_NHI_2004_2013_1	File Geodatabase Feature ...
Positive_ABB__Ouachita_NF__2004_2013_1	File Geodatabase Feature ...
SchnellStudy19972006_1	File Geodatabase Feature ...
SD2014_pos_1	File Geodatabase Feature ...
St_Louis_Zoo_Data_2013_1	File Geodatabase Feature ...
TX2006_Pos_1	File Geodatabase Feature ...

2. When merged, all shapefiles together contained over 70+ fields, due to data collection techniques that varied across time. Rather than picking existing fields, new fields were created to then populate with existing data. The following fields were created and populated (Table 1):

Field	Description
a_county_	County original data was recorded in**
a_dataset_	Original dataset
a_date_	Date - if only one date given
a_date_end_	Date end of surveys if given
a_date_start_	Date start of surveys if given
a_general_hab_	General habitat from original dataset
a_landclass_	Landclass of survey site from original dataset
a_landclass_veg_	Vegetation of survey site from original dataset

a_lat_	Latitude in decimal degrees
a_long_	Longitude in decimal degrees
a_method_	Survey method from original dataset
a_pos_neg_ABB_	Binary code of presense (1) or absense (0) from modified from original dataset
a_sex_	Sex of ABB trapped from original dataset
a_soil_	Soil type from original dataset
a_state_	State original data was recorded in**
a_surveyor_	Surveyor of original dataset
a_TotABB_	Total number of ABB from original dataset
a_trap_surv_num_	Trap number or survey site number from original dataset
a_year_	Year of data collection for original dataset
EVT_GP_N	Merged landclass value from LANDFIRE_LC data
Acres	Patch size, in acres, of landclass polygon
Sq_Miles	Patch size, in square miles, of landclass polygon
	****Corrected based on location of point data**

Table 1. Attributes for LANDFIRE dataset.

3. Many of the fields contain null values because the original dataset did not have these data fields populated.
4. Many original fields were dropped due to the specific nature or formatting with which the data was collected. For example, some datasets had a matrix of days in which surveys were completed. These data are preserved in the original datasets but became too cumbersome to normalize across all datasets.
5. Final field selection was based on which fields were most likely important to capture in reference to presence absence data.

Data Anomalies

1. Not all original datasets contained both presence and absence recorded data. Therefore, the master dataset contains all presence data recorded but only a portion of the absence data collected. Rectifying this would require locating missing portions of the datasets that only contained presence data.
2. Some datasets contained data that overlapped other datasets. To rectify this, ArcGIS tool "Find Identical" was used to locate data points that contained the same spatial location, as well as the same date. QA/QC was then conducted manually to compare identified records to determine if the data points were indeed identical.
    a. Multiple identical data points were located; however, less than 300 were true duplicates. This is due to the limitation of the ArcGIS tool to only be able to sort on a few fields.

GIS Analysis, Phase II: Current Condition of Land Cover within the Analysis Areas (Great Plains)

Data Source

Next, an examination of land cover data, looking at a depiction of current condition, as it relates to ABB suitability was undertaken. For this effort, USGS LANDFIRE 2012, Existing Vegetation Type (EVT) was used. This is a publicly available dataset that can be downloaded from the USGS LANDFIRE website. The spatial resolution of this data is 30 meters.

Ranking
Based on the land cover classification, Biologists determined a generalized suitability ranking and physiographic description for each classification. The suitability ranking was primarily based on the assumption of human impact on each classification category. There is collateral information within the data table that provides generalized information on natural condition and human disturbance (See Appendix A for complete table.).

Within the LANDFIRE data table, each land cover class was given a ranking descriptor (FWS_Condition) based on that information and expert opinion from Service Biologists:

> Favorable - Land cover types with suitable soils and vegetation to support all or critical portions of the ABB life cycle. Favorable lands may range from high to low quality ABB habitat, but most of these lands should be capable of supporting ABB populations. The ABB uses a wide variety of habitats and favorable land cover types including multiple forest, savanna, shrub, and grassland/herbaceous land covers.
>
> Conditional - Land cover types that can be favorable under some conditions and unsuitable under others. For example, most pasture land in southern plains analysis areas may be favorable habitat if grazing is light to moderate or infrequently mowed, but the same area may be unsuitable if it is heavily grazed or frequently mowed. Fields managed for hay can be unsuitable habitat when the vegetation is mowed at short heights, but can be favorable habitat between cuttings when the grass/hay is tall enough to provide suitable habitat for birds and mammals that are carrion sources for ABBs. Wetlands are another example. They may be unsuitable under flood conditions, but very important habitat during droughts, given that ABBs need moist soils.
>
> Marginal – Land cover types that can provide limited habitat for some portions of the ABB life cycle. Examples include land covers that have poor or thin soils (such as barren lands) that make them unsuitable for reproduction, but may provide habitat for day use or help support potential carrion species to some degree.
>
> Unsuitable – Land cover types that do not provide habitat that would be favorable for any portion of the ABB life cycle (such as open water or highly developed urban lands).

Landcover Analysis Limitations
This generalized land cover analysis was not intended to describe or predict where beetles might occur, but to take into account the current state of land use and land cover types and their relationship to human impact and development. There may be many other factors to examine and/or predict where beetles may occur, including soil type/material information and meteorological/climate information. For this analysis, these factors were not considered.

GIS Analysis, Phase III: Extent of Urbanization/Development

To further grasp a sense of the extent and nearby influence of urban development within the Analysis Areas, a road density surface was created to identify areas with the highest densities of roads.

Density Surface Construction
A density surface is a raster layer, created in ArcMap, to represent the relative density of specific features (points, lines, etc...). It can be a useful representation of large datasets (i.e.; a roads layer) where the actual features are not needed, just where they occur most frequently.

Density surfaces can easily be created in ArcMap by using the *Spatial Analyst* tool set in ArcToolbox. For this exercise, the U.S. Census Bureau 2015 TIGER roads layer was used. A large area, covering most of the central U.S. was extracted from the TIGER layer. This area covers far beyond the Analysis Areas. This was done to provide an accurate surface creation at the edges of the Analysis Areas. After the raster surface is created, it is then clipped to the Analysis Areas boundaries.

The parameters for the density surface were as follows;

<u>Central U.S. Study Areas</u>
Tool: Line Density, Spatial Analyst
Pixel Size (output): 500 meters
Search Radius: 5000 meters

The resulting raster surface was then classified (in Layer Properties, Symbology) with 30 classes at Equal Intervals. This provides a detailed stratification of 30 relative classes from no relative density to high relative density. This raster surface is then converted to a vector file so it can be analyzed with other vector layers. For this analysis, only the highest density category classes were used. This was done to recognize only human population centers. Selecting only these highest density categories, purposefully excludes other situations which can show high density road networks; such as logging and rural road grid systems, which are thought not to have a significant impact on the ABB.

<u>Geoprocessing; Data Layer Union</u>
This vectorized road density layer was then "Unioned" (a GIS geoprocessing tool, which analyzes overlapping layers) with the ABB land cover suitability layer, showing where the ABB class types are affected areas of higher development stress.

Union calculates the geometric union of any number of feature classes and feature layers. All input feature classes or feature layers must be polygons. The output feature class will contain polygons representing the geometric union of all the inputs as well as all the fields from all the input feature classes. See below for examples of how attribute values are assigned to the output features (Esri, Inc.).

Union does the following:

- Determines the spatial reference for processing. This will also be the output spatial reference. For details on how this is done, see Spatial Reference. All the input feature classes are projected (on the fly) into this spatial reference.
- Cracks and clusters the features. Cracking inserts vertices at the intersection of feature edges; clustering snaps together vertices that are within the x,y tolerance.
- Discovers geometric relationships (overlap) between features from all feature classes.
- Writes the new features to the output.

As mentioned above, this process does slightly alter the shapes of the new (unioned) polygons created, which can slightly alter the calculated acreages of the polygons (relative to pre-union acreage). This change is negligible, usually much less than one percent.

<u>Weighted Ranking of ABB Landcover Suitability Layer with Developed Area Layer</u>
The result of this union is reflected in the table below (Table 2). Any areas of the landcover suitability layer, that were within the urbanization/developed layer, were downgraded in suitability ranking.

Urbanization /Developed Area Layer	**ABB Landcover (Habitat) Suitability Layer**			
	Favorable	Conditional	Marginal	Unsuitable
No Development Impact	*Favorable*	*Conditional*	*Marginal*	*Unsuitable*
Development Impact	*Marginal*	*Marginal*	*Unsuitable*	*Unsuitable*

Table 2: ABB Habitat Suitability Matrix.

Results
The formal SSA document will further describe development and rationale of the landcover suitability classification and rankings, as well as providing the results/calculated areas of all the different suitability types.

GIS Analysis, Phase IV: Protection Status

A spatial representation of existing level of protection was developed to analyze the extent and distribution of areas, based on land ownership, indicating portions of the suitability layer which may have some protection for ABB. The land ownership data was "unioned" with the land cover suitability layer, which gives an ownership designation to each of the suitability layer polygons.

Data Source
Conservation Biology Institute (CBI); Protected Areas Database, U.S., CBI Edition, v2
Land Ownership, U.S.

Land ownership/Management and Protection Status
Protected Areas Database, U.S., CBI Edition, v2. Though the union process, the CBI land ownership data was used to give each suitable habitat polygon an ownership designation. Also, each ownership category was then given a management, or protection status designation, developed by USFWS biologists, to further describe the types, or levels, of protection occurring for that specific polygon. It was important to get a sense of not only areas there are considered protected by local, state or federal jurisdiction, but also to quantify areas where urban growth/development could occur in the long-term future.

Ownership Category:
Federal Government: Owned by a Federal agency (NPS, USFS, BLM, etc.)
State Government: Owned by state of Arizona agency (parks, historic areas, trust lands etc.)
Local Governments: Owned by county or municipal governments (parks, open spaces, facilities, etc.)
Private: Owned by private citizens or entities.
Private Conservation: Owned by non-governmental conservation entities (TNC, etc.)
Tribal: Sovereign or trust Native American territories.
None: Ownership information not available.

Assigned Protection Designation:
Managed: Land managed for wildlife habitat or low impact human activity (wilderness areas, wildlife management areas, preserves, some parks and monuments).
Multi-Use: Public land owned by public agencies (vast majority is Federal ownership), which allow more intrusive human activities (motorized vehicles, resource extraction, grazing, etc.) but provide some wildlife management benefits in addition to other uses.
Other: Highly variable or unknown protection status (i.e.; municipal, state, etc...).
Tribal: Native American holding, level and type of protection may vary.
Unprotected: Privately owned land.
N/A: Ownership information not available.

Results
All results and acreage calculations for the union of the ownership/protection status and the landcover suitability layer are discussed in the SSA Report. The Feature Class data table will contain all of the original source land cover types, FWS-developed habitat suitability ranking, indicated impact from development, land ownership, and protection designation for each polygon. A summary field (Cond_pro) will provide a quick determination for each polygon based on a combination of the suitability and assigned protection designations.

GIS Analysis, Phase V: Current Condition of Land Cover on Block and Nantucket Islands
Data Source
Land cover data (vector) was downloaded from the following State websites;
Rhode Island: *Rhode Island Geographic Information System (http://www.rigis.org/data/env)*

A. *Land Cover & Land Use 2011; (rilc11d.zip)*
B. *Ecological Communities Classification; (RIECC11.zip)*

Massachusetts: *Mass.gov, Administration and Finance, Research & Technology, MassGIS Datalayers (http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/layerlist.html)*

A. *Land Use (2005); (landuse2005_poly.zip)*

Ranking
Since the Atlantic Island populations are well-documented, no GIS/modeling effort was conducted, beyond assigning a suitability ranking. Each land cover type was assigned the same suitability ranking as the Great Plains areas (see; GIS Analysis, Phase II: Current Condition of Land cover within the Analysis Areas **(Great Plains)**). These determinations were made through expert opinion by Region 5 USFWS Biologists. No further analysis was conducted on these datasets.

Results
Only cartographic products were generated for the SSA report. Any other acreage or scenario discussions will be done in the SSA report.

GIS Analysis, Phase VI: Kriging Interpolation

Data Source
Presence/Absence Survey Data for the ABB, as described in Phase I above.

Kriging Analysis Methods
Kriging interpolations can be created in ArcMap by using the Spatial Analysis tool set in ArcToolbox. As described in ArcGIS 10.4.1 help "Kriging is an advanced geostatistical procedure that generates an estimated surface from a scattered set of points with z-values. Unlike other interpolation methods in the Interpolation toolset, to use the Kriging tool effectively involves an interactive investigation of the spatial behavior of the phenomenon represented by the z-values before you select the best estimation method for generating the output surface."

The parameters for the density surface were as follows;

Input point features: ABB Survey presence/absence data
Z value field: Postive/negative survey results (0=negative, 1=positive)
Kriging method: ordinary
Semivariogram model: spherical
Output cell size: 0.02
Number of points: 12

Maximum distance: none entered

Results
Although Kriging analyses can used to determine probability of occurrence, due to the limitations of our survey data we used the Kriging analysis only as an observational tool to visually compare areas of differing capture rates to determine a broad assessment of ABB distributions within each analysis area.

GIS Analysis, Phase VII: Future Climate Scenarios

Data Source

MACAv2-METDATA, Multi-Model Mean – Climate forcings in the MACAv2-LIVNEH were drawn from a statistical downscaling of global climate model (GCM) data from the Coupled Model Intercomparison Project 5 (CMIP5, Taylor et al. 2010) utilizing a modification (Hegewisch, Abatzoglou, in prep.) of the Multivariate Adaptive Constructed Analogs (MACA, Abatzoglou and Brown, 2012) method with the Livneh (Livneh et.al.,2013) observational dataset as training data. http://maca.northwestknowledge.net/index.php

Raster Display Method

MACAv2-METDATA, Multi-Model Mean raster data was obtained for projected change in summer (Jun-July-Aug) maximum temperature for two emission scenarios (RCP 4.5 and 8.5) for three different time periods (2010-2039, 2040-2069, 2070-2099).

Raster colors for differing temperatures and for the temperature threshold analysis were created by using symbology in Layer Options.

Results
All results (in cartographic format) are displayed in Chapters 3 and 5 of the SSA Report – Figures 3-1, 5-4, 5-5, 5-6, and 5-7.

CONCLUSION

This report is a brief summation of the GIS data analysis (data layer usage and geoprocessing techniques) devised to help provide a spatial understanding of the location and extent of potentially suitable habitat for ABB and to analyze how specific threats may affect these areas. The larger SSA report will provide a more detailed discussion on the actual results and summaries of the various threat analysis scenarios.

LITURATURE CITED

Bedick, J.C., B. C. Ratcliffe, W. W. Hoback, and L. G. Higley. 1999. Distribution, ecology and population dynamics of the American burying beetle *Nicrophorus americanus* Olivier (Coleoptera, Silphidae)] in South-central Nebraska, USA. Journal of Insect Conservation 3(3): 171-181.

Creighton, J.C. and G. Schnell. 1998. Short-term movement patterns of the endangered American burying beetle *Nicrophorus americanus*. Biological Conservation 86: 281-287.

Jurzenski, J. 2012. Factors affecting the distribution and survival of endangered American burying beetles, *Nicrophorus americanus* Olivier. Dissertations and Student Research in Entomology. Paper 20. http://digitalcommons.unl.edu/entomologydiss/20

U.S. Fish and Wildlife Service (USFWS). 1991. American burying beetle (*Nicrophorus americanus*) recovery plan. Newton Corner, Massachusetts. 80 pp.

U.S. Fish and Wildlife Service (USFWS). 2014. American Burying Beetle (*Nicrophorus americanus - Oliver*). Tulsa, Oklahoma. 29 pp.

ONLINE RESOURCES

Conservation Biology Institute,
Protected Areas Database of the US, PAD-US (CBI Edition)
https://consbio.org/products/projects/pad-us-cbi-edition
Metadata:
https://d2k78bk4kdhbpr.cloudfront.net/media/content/files/PADUS_CBIEdition_V2_Metadata.pdf

Rhode Island Geographic Information System; http://www.rigis.org/data/env
Land Cover & Land Use 2011 (rilc11d.zip)
Metadata: http://www.rigis.org/geodata/plan/rilc11d.html
Ecological Communities Classification (RIECC11.zip)
Metadata: http://www.rigis.org/geodata/plan/rilc11d.html

State of Massachusetts, MassGIS Datalayers;
http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/layerlist.html
Land Use (2005); (landuse2005_poly.zip)
Metadata: http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/lus2005.html

U.S. Census Bureau, TIGER Products (Roads for urban area density surface)
https://www.census.gov/geo/maps-data/data/tiger.html
Metadata:
http://www2.census.gov/geo/pdfs/maps-data/data/tiger/tgrshp2015/TGRSHP2015_TechDoc.pdf

U.S. Geological Survey LANDFIRE; http://landfire.gov/
Existing Vegetation Type (EVT) Metadata:
http://landfire.cr.usgs.gov/distmeta/servlet/gov.usgs.edc.MetaBuilder?TYPE=HTML&DATASET=FBI

Table 3: Landfire Land Cover Classes and their Associated Suitability Ranking (Great Plains only)

Landfire Value	Landfire CLASSNAME	FWS_Condition
3412	North-Central Interior Sand and Gravel Tallgrass Prairie	Conditional
3534	Managed Tree Plantation-Northern and Central Hardwood and Conifer Plantation Group	Marginal
3941	Western Cool Temperate Undeveloped Ruderal Evergreen Forest	Favorable
3951	Eastern Cool Temperate Undeveloped Ruderal Evergreen Forest	Favorable
3955	Eastern Warm Temperate Undeveloped Ruderal Deciduous Forest	Favorable
3094	Western Great Plains Sandhill Shrubland	Favorable
3310	North-Central Interior Dry-Mesic Oak Forest and Woodland	Favorable
3367	Ozark-Ouachita Shortleaf Pine Forest and Woodland	Favorable
3383	Edwards Plateau Limestone Woodland	Favorable
3480	Gulf and Atlantic Coastal Plain Swamp Systems	Marginal
3582	Ozark-Ouachita Oak Forest and Woodland	Favorable
3059	Southern Rocky Mountain Pinyon-Juniper Woodland	Marginal
3085	Northwestern Great Plains Shrubland	N/A
3148	Western Great Plains Sand Prairie Grassland	Conditional
3149	Western Great Plains Shortgrass Prairie	Favorable
3162	Western Great Plains Floodplain Forest and Woodland	Favorable
3181	Introduced Upland Vegetation-Annual Grassland	Conditional
3182	Introduced Upland Vegetation-Perennial Grassland and Forbland	Conditional
3191	Recently Logged-Herb and Grass Cover	Conditional
3192	Recently Logged-Shrub Cover	Favorable
3195	Recently Burned-Herb and Grass Cover	Conditional
3204	Western Great Plains Mesquite Shrubland	Unsuitable
3253	Western Great Plains Floodplain Shrubland	Favorable
3254	Western Great Plains Floodplain Herbaceous	Favorable
3274	Central Interior and Appalachian Floodplain Herbaceous	Unsuitable
3291	Central Interior Highlands Calcareous Glade and Barrens Herbaceous	Marginal
3292	Open Water	Unsuitable
3294	Barren	Marginal
3296	Developed-Low Intensity	Unsuitable
3297	Developed-Medium Intensity	Unsuitable
3298	Developed-High Intensity	Unsuitable
3299	Developed-Roads	Unsuitable
3300	Central Interior and Appalachian Riparian Herbaceous	Favorable
3304	Ozark-Ouachita Dry-Mesic Oak Forest	Favorable
3308	Crosstimbers Oak Forest and Woodland	Favorable
3314	North-Central Interior Maple-Basswood Forest	Marginal
3334	Ozark-Ouachita Mesic Hardwood Forest	Favorable
3364	Ozark-Ouachita Dry Oak Woodland	Marginal

3385	Western Great Plains Wooded Draw and Ravine	Favorable
3401	Central Interior Highlands Calcareous Glade and Barrens Woodland	Marginal
3415	Arkansas Valley Prairie and Woodland	Favorable
3421	Central Tallgrass Prairie	Conditional
3422	Texas Blackland Tallgrass Prairie	Conditional
3423	Southeastern Great Plains Tallgrass Prairie	Conditional
3462	West Gulf Coastal Plain Seepage Swamp and Baygall	Conditional
3471	Central Interior and Appalachian Floodplain Forest	Favorable
3472	Central Interior and Appalachian Riparian Forest	Favorable
3495	Western Great Plains Depressional Wetland Systems	Favorable
3519	East-Central Texas Plains Post Oak Savanna and Woodland	Favorable
3523	Edwards Plateau Dry-Mesic Slope Forest and Woodland	Favorable
3529	Ruderal Upland Herbaceous	Favorable
3535	Managed Tree Plantation-Southeast Conifer and Hardwood Plantation Group	Marginal
3539	Modified/Managed Northern Tallgrass Grassland	Conditional
3540	Modified/Managed Southern Tallgrass Grassland	Conditional
3564	Modified/Managed Southern Tallgrass Shrubland	Favorable
3583	Ozark-Ouachita Shortleaf Pine-Oak Forest and Woodland	Favorable
3900	Western Cool Temperate Urban Deciduous Forest	Marginal
3901	Western Cool Temperate Urban Evergreen Forest	Marginal
3902	Western Cool Temperate Urban Mixed Forest	Marginal
3903	Western Cool Temperate Urban Herbaceous	Unsuitable
3904	Western Cool Temperate Urban Shrubland	Marginal
3905	Eastern Cool Temperate Urban Deciduous Forest	Marginal
3906	Eastern Cool Temperate Urban Evergreen Forest	Marginal
3907	Eastern Cool Temperate Urban Mixed Forest	Marginal
3908	Eastern Cool Temperate Urban Herbaceous	Unsuitable
3909	Eastern Cool Temperate Urban Shrubland	Marginal
3920	Western Cool Temperate Developed Ruderal Deciduous Forest	Unsuitable
3924	Western Cool Temperate Developed Ruderal Grassland	Unsuitable
3930	Eastern Cool Temperate Developed Ruderal Deciduous Forest	Unsuitable
3931	Eastern Cool Temperate Developed Ruderal Evergreen Forest	Unsuitable
3932	Eastern Cool Temperate Developed Ruderal Mixed Forest	Unsuitable
3933	Eastern Cool Temperate Developed Ruderal Shrubland	Unsuitable
3934	Eastern Cool Temperate Developed Ruderal Grassland	Unsuitable
3954	Eastern Cool Temperate Undeveloped Ruderal Grassland	Favorable
3964	Western Cool Temperate Row Crop	Unsuitable
3965	Western Cool Temperate Close Grown Crop	Unsuitable
3966	Western Cool Temperate Fallow/Idle Cropland	Favorable
3967	Western Cool Temperate Pasture and Hayland	Conditional
3968	Western Cool Temperate Wheat	Unsuitable

3970	Eastern Cool Temperate Orchard	Unsuitable
3973	Eastern Cool Temperate Row Crop - Close Grown Crop	Unsuitable
3974	Eastern Cool Temperate Row Crop	Unsuitable
3975	Eastern Cool Temperate Close Grown Crop	Unsuitable
3976	Eastern Cool Temperate Fallow/Idle Cropland	Favorable
3977	Eastern Cool Temperate Pasture and Hayland	Conditional
3978	Eastern Cool Temperate Wheat	Unsuitable
3997	Eastern Warm Temperate Pasture and Hayland	Conditional
3312	Ouachita Montane Oak Forest	Marginal
3268	Eastern Great Plains Tallgrass Aspen Shrubland	N/A
3331	Eastern Great Plains Tallgrass Aspen Forest and Woodland	N/A
3007	Western Great Plains Sparsely Vegetated Systems	Unsuitable
3013	Western Great Plains Dry Bur Oak Forest and Woodland	Unsuitable
3049	Rocky Mountain Foothill Limber Pine-Juniper Woodland	Unsuitable
3054	Southern Rocky Mountain Ponderosa Pine Woodland	N/A
3072	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	N/A
3081	Inter-Mountain Basins Mixed Salt Desert Scrub	N/A
3117	Southern Rocky Mountain Ponderosa Pine Savanna	N/A
3132	Central Mixedgrass Prairie Grassland	Conditional
3141	Northwestern Great Plains Mixedgrass Prairie	Conditional
3150	Western Great Plains Tallgrass Prairie	Conditional
3179	Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna	Unsuitable
3183	Introduced Upland Vegetation-Annual and Biennial Forbland	Conditional
3194	Ruderal Upland-Treed	Favorable
3207	Central Mixedgrass Prairie Shrubland	Favorable
3209	Western Great Plains Sand Prairie Shrubland	Favorable
3212	Western Great Plains Sandhill Grassland	Favorable
3273	Eastern Great Plains Floodplain Herbaceous	Favorable
3275	Central Interior and Appalachian Floodplain Shrubland	Unsuitable
3295	Quarries-Strip Mines-Gravel Pits	Marginal
3311	North-Central Interior Dry Oak Forest and Woodland	Favorable
3319	Central Interior and Appalachian Riparian Shrubland	Favorable
3323	West Gulf Coastal Plain Mesic Hardwood Forest	Favorable
3332	Gulf and Atlantic Coastal Plain Floodplain Herbaceous	Favorable
3348	West Gulf Coastal Plain Upland Longleaf Pine Forest and Woodland	Favorable
3359	Gulf and Atlantic Coastal Plain Floodplain Shrubland	Favorable
3363	Central Interior Highlands Dry Acidic Glade and Barrens	Marginal
3371	West Gulf Coastal Plain Pine Forest	Favorable
3378	West Gulf Coastal Plain Sandhill Shortleaf Pine Forest and Woodland	Favorable
3428	West Gulf Coastal Plain Northern Calcareous Prairie	Conditional
3429	West Gulf Coastal Plain Southern Calcareous Prairie	Conditional

3451	West Gulf Coastal Plain Wet Longleaf Pine Savanna and Flatwoods	Marginal
3458	West Gulf Coastal Plain Pine Flatwoods	Favorable
3469	Eastern Great Plains Floodplain Woodland	Favorable
3473	Gulf and Atlantic Coastal Plain Floodplain Forest	Favorable
3474	Gulf and Atlantic Coastal Plain Small Stream Riparian Woodland	Favorable
3479	Central Interior and Appalachian Swamp Forest	Conditional
3482	Great Plains Prairie Pothole	N/A
3488	Eastern Great Plains Wet Meadow-Prairie-Marsh	Favorable
3493	Central Interior and Appalachian Herbaceous Wetlands	Conditional
3497	Central Interior and Appalachian Sparsely Vegetated Systems	Unsuitable
3506	West Gulf Coastal Plain Nonriverine Wet Hardwood Flatwoods	Favorable
3507	Ozark-Ouachita Shortleaf Pine-Bluestem Woodland	Favorable
3528	Ruderal Upland Shrubland	Favorable
3531	Ruderal Upland Forest	Favorable
3532	Ruderal Forest-Northern and Central Hardwood and Conifer	Favorable
3573	Gulf and Atlantic Coastal Plain Small Stream Riparian Herbaceous	Favorable
3574	Gulf and Atlantic Coastal Plain Small Stream Riparian Shrubland	Favorable
3584	West Gulf Coastal Plain Hardwood Forest	Favorable
3585	West Gulf Coastal Plain Pine-Hardwood Forest	Favorable
3586	West Gulf Coastal Plain Sandhill Oak Forest and Woodland	Favorable
3587	West Gulf Coastal Plain Sandhill Oak and Shortleaf Pine Forest and Woodland	Favorable
3590	West Gulf Coastal Plain Hardwood Flatwoods	Favorable
3591	West Gulf Coastal Plain Pine-Hardwood Flatwoods	Favorable
3915	Eastern Warm Temperate Urban Urban Deciduous Forest	Marginal
3916	Eastern Warm Temperate Urban Urban Evergreen Forest	Marginal
3917	Eastern Warm Temperate Urban Urban Mixed Forest	Marginal
3918	Eastern Warm Temperate Urban Urban Herbaceous	Unsuitable
3919	Eastern Warm Temperate Urban Urban Shrubland	Unsuitable
3921	Western Cool Temperate Developed Ruderal Evergreen Forest	Unsuitable
3922	Western Cool Temperate Developed Ruderal Mixed Forest	Unsuitable
3923	Western Cool Temperate Developed Ruderal Shrubland	Unsuitable
3925	Western Warm Temperate Developed Ruderal Deciduous Forest	Unsuitable
3929	Western Warm Temperate Developed Ruderal Grassland	Unsuitable
3935	Eastern Warm Temperate Developed Ruderal Deciduous Forest	Unsuitable
3936	Eastern Warm Temperate Developed Ruderal Evergreen Forest	Unsuitable
3937	Eastern Warm Temperate Developed Ruderal Mixed Forest	Unsuitable
3938	Eastern Warm Temperate Developed Ruderal Shrubland	Unsuitable
3939	Eastern Warm Temperate Developed Ruderal Grassland	Unsuitable
3940	Western Cool Temperate Undeveloped Ruderal Deciduous Forest	Favorable
3943	Western Cool Temperate Undeveloped Ruderal Shrubland	Favorable
3944	Western Cool Temperate Undeveloped Ruderal Grassland	Favorable

3950	Eastern Cool Temperate Undeveloped Ruderal Deciduous Forest	Favorable
3952	Eastern Cool Temperate Undeveloped Ruderal Mixed Forest	Favorable
3953	Eastern Cool Temperate Undeveloped Ruderal Shrubland	Favorable
3956	Eastern Warm Temperate Undeveloped Ruderal Evergreen Forest	Favorable
3957	Eastern Warm Temperate Undeveloped Ruderal Mixed Forest	Favorable
3958	Eastern Warm Temperate Undeveloped Ruderal Shrubland	Favorable
3959	Eastern Warm Temperate Undeveloped Ruderal Grassland	Favorable
3960	Western Cool Temperate Orchard	Unsuitable
3963	Western Cool Temperate Row Crop - Close Grown Crop	Unsuitable
3983	Western Warm Temperate Row Crop - Close Grown Crop	Unsuitable
3984	Western Warm Temperate Row Crop	Unsuitable
3985	Western Warm Temperate Close Grown Crop	Unsuitable
3986	Western Warm Temperate Fallow/Idle Cropland	Favorable
3987	Western Warm Temperate Pasture and Hayland	Conditional
3988	Western Warm Temperate Wheat	Unsuitable
3990	Eastern Warm Temperate Orchard	Unsuitable
3993	Eastern Warm Temperate Row Crop - Close Grown Crop	Unsuitable
3994	Eastern Warm Temperate Row Crop	Unsuitable
3995	Eastern Warm Temperate Close Grown Crop	Unsuitable
3996	Eastern Warm Temperate Fallow/Idle Cropland	Favorable
3998	Eastern Warm Temperate Wheat	Unsuitable
3999	Eastern Warm Temperate Aquaculture	Unsuitable