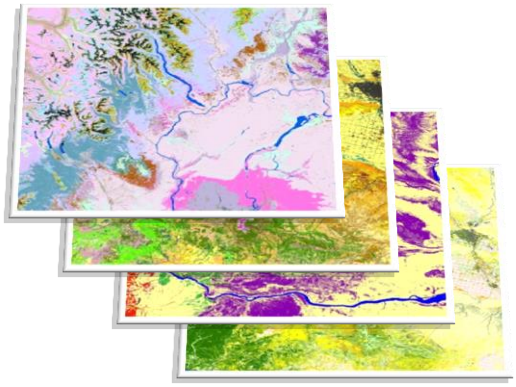
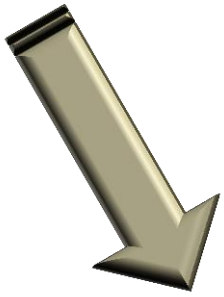
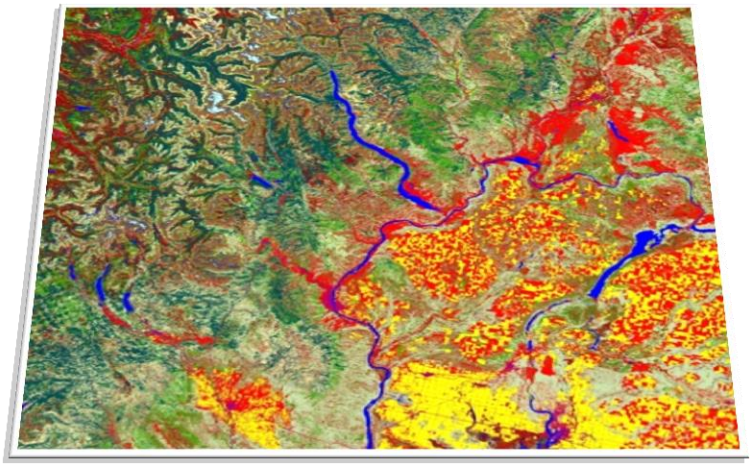
How to Map Successional Stages Using LANDFIRE Products







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Overview

LANDFIRE maps the current succession classes, or the ontogenetic stages, of Biophysical Settings (BpS). This succession class (S-class) spatial dataset allows land managers and other interested data users to assess current percentages of each S-class for large areas. These percentages can be compared to reference percentages (also provided by LANDFIRE) and/or desired future conditions. S-classes and their mapping rules, based on canopy cover, height and indicator species, are defined in the LANDFIRE BpS MODEL DESCRIPTIONS and the LANDFIRE MODEL TRACKER DATABASE (MTDB). To map S-classes, LANDFIRE combines the BpS grid with the Existing Vegetation Type (EVT), Existing Vegetation Cover (EVC) and Existing Vegetation Height (EVH) grids and applies the S-class rules from the BpS model description (Figure 1).

For many users, the LANDFIRE S-class product may be sufficient as delivered, but in other cases users may choose to modify it or create their own S-class grid. Modifying the S-class grid can be done by adjusting the input spatial data, reference conditions models, or both. You may want to consider locally adjusting LANDFIRE's S-class product if:

1. you have spatial data with more appropriate thematic or spatial resolution or data that are more current than LANDFIRE's;
2. you have additional spatial datasets that can help predict S-class such as a stand age or an invasive species map;
3. you have spatial data representing recent large disturbances or management activities on your landscape that were not captured by LANDFIRE;
4. there are local reference condition models for some or all BpS; and/or
5. the S-class rules need to be adjusted.

The process described in this guide focuses on using LANDFIRE products. However, as mentioned above, S-classing can be performed using other spatial data sets, rule sets or benchmark conditions that are more relevant for the local landscape. Since this could require different processing steps and create different issues, a supplemental "How-To User Guide" supporting local spatial data in S-class mapping will be developed.

The S-class procedure documented here involves four major steps:

1. combining relevant S-class geospatial data in ArcMap;
2. exporting the combined table to an Excel spreadsheet and applying S-class rule sets;
3. joining the Excel table with S-class assignments back to the combined grid; and
4. creating a new grid based on the S-class assignments.

Depending on the landscape, the number of combinations that a user must analyze may be quite large. In these cases, it may be preferable to automate parts of the process by using the MTDB, a Microsoft (MS) Access database, Python scripting in ArcMap or another method, so as to auto-assign as many combinations as possible based on the S-class rule sets (see Appendix 1 for more information on automating the S-class process). However, these rule sets usually do not encompass all possible combinations; therefore, some level of hand assignment is generally needed. Automation may also save time if the S-class process

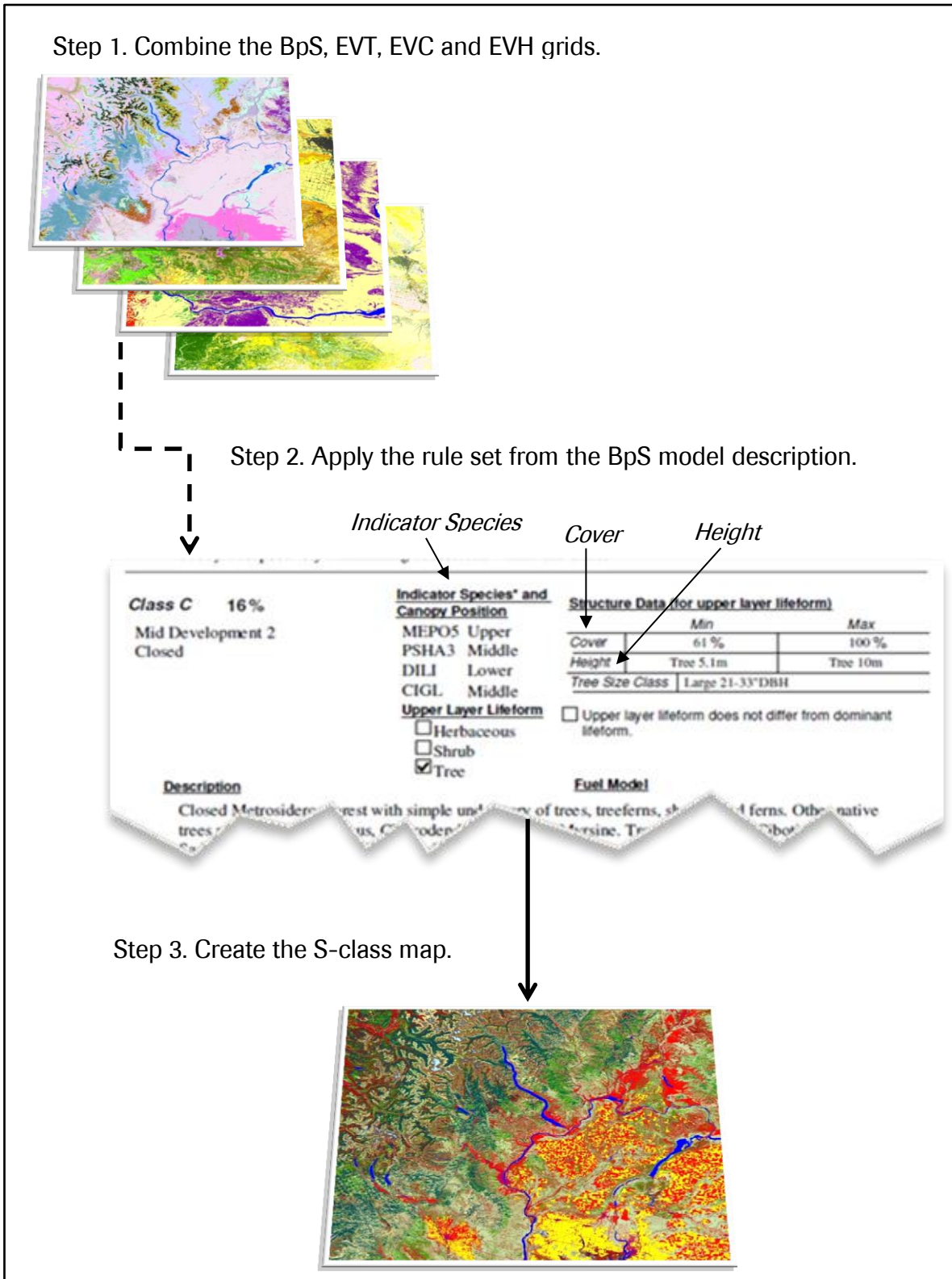
will be repeated for the same project area, e.g. with newer data, or a project area with many of the same BpSs.

Best Practices

Before beginning, consider the following recommended actions.

- Review and adjust the spatial data before you begin.
- Review the S-class rule set for applicability to the landscape, for rule overlaps and for conflicting rules and adjust as needed.
- Use the model descriptions and look for experts who can help classify combinations of input values that are not covered by the rule set. The "Uncharacteristic Native Conditions" and the "Vegetation Classes" fields in the model description often provide insight. In LANDFIRE's AK MTDB, an EVT field was added and often used to distinguish classes.
- Document any changes to the rule sets (e.g. changing height or cover limits) and/or decisions that are not covered by the rule set (e.g. classifying certain EVTs as uncharacteristic). This will help during review, provide reporting documentation and help you re-create the process if necessary.
- Keep track of the identification fields required for joining values after grid processing. You may need to rename fields to keep track of them and delete unneeded fields after joining to reduce confusion.
- Develop strategies for managing your assignment spreadsheet. For example, before moving from one BpS to the next after making S-class assignments, go to the "SCLASS" column filter drop-down and check for "Blanks," and color rows grey after completion.
- Always ask yourself, "Does this make sense?" Use your knowledge of the project area and input from others to create an informed product.
- Have the final S-class grid reviewed.

Figure 1: LANDFIRE creates the S-class grid by applying rule sets to every unique combination of BpS, EVT, EVC and EVH.



Procedure

Assemble and Pre-process Datasets

1. Assemble the required data and any optional data you wish to use.

   Required Resources:
   - Biophysical Settings grid (BpS)
   - Existing Vegetation Type grid (EVT)
   - Existing Vegetation Cover grid (EVC)
   - Existing Vegetation Height grid (EVH)
   - Succession Class (S-class) mapping rules from LANDFIRE's Model Tracker Database (MTDB) or Model PDF Description Documents or a local source
   - GIS, ecology and landscape expertise
     - Although the following procedure is largely a GIS exercise, additional expertise is generally needed to complete the S-classing process. A local expert who is familiar with the landscape of interest and the ecology of the ecosystems can help review and localize S-class rules, assign combinations not covered by the rules and review the final product.

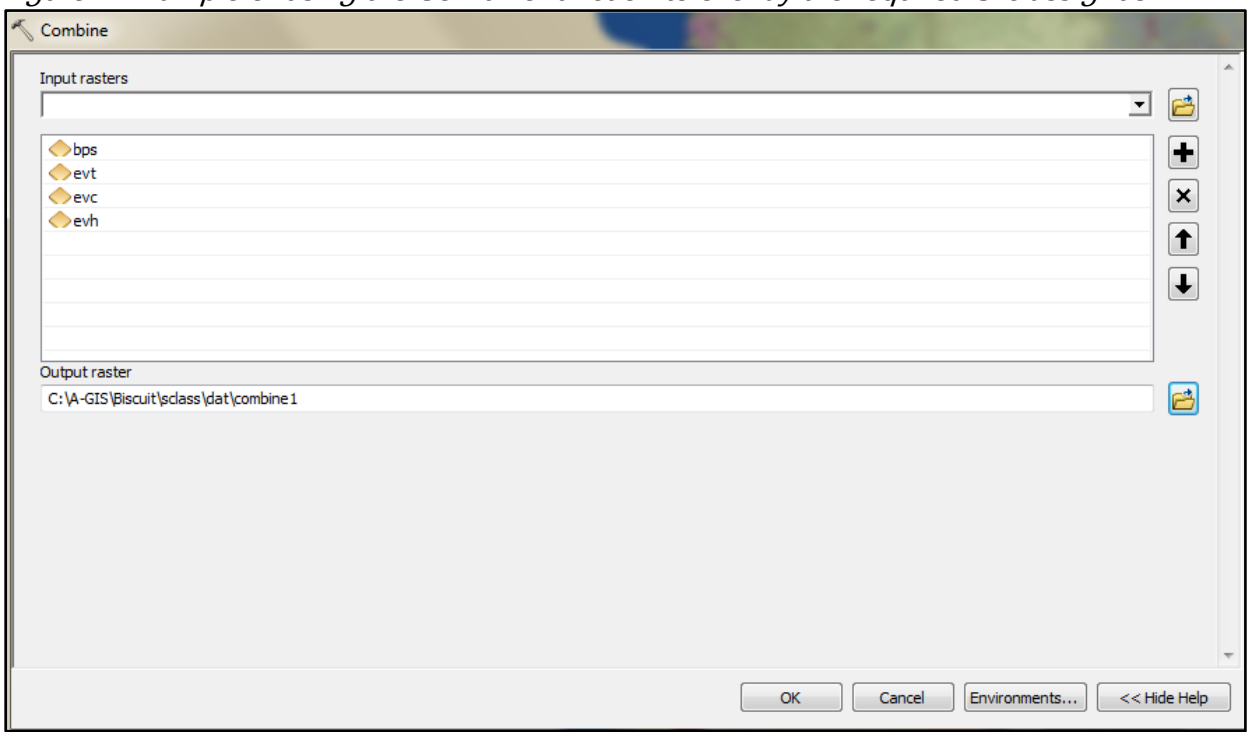
   Optional Resources:
   - Ancillary data that can help distinguish successional classes such an invasive species presence or a vegetation cover type grid
   - Local data in place of any of the required data listed above
     - An option for landscapes with good local inventory data such as US Forest Service Continuous Inventory of Stand Condition (CISC) or FSVeg data, is to use proxy stand density and stand maturity attributes to replace LANDFIRE EVC and EVH. This is only a viable option where inventory data are reliable and available for the entire landscape of interest.
   - S-class grid
     - This could be useful if you want to analyze or apply rules from an existing S-class grid.

2. Make sure all grids have the same projection, same extent and same cell size.
   a. If you are masking data to a project area, specify a **Snap Raster** from the **Environment Settings** > **Processing Extent** menu, to ensure that the grid cells align.

Combine Datasets

1. Combine the grids in the following order: BpS, EVT, EVC, EVH, using the **Spatial Analyst** > **Tools** > **Local** > **Combine** function in ArcToolbox (Figure 2).
    a. The order of the combine is important so that the attributes appear in a logical way in the resulting attribute table.

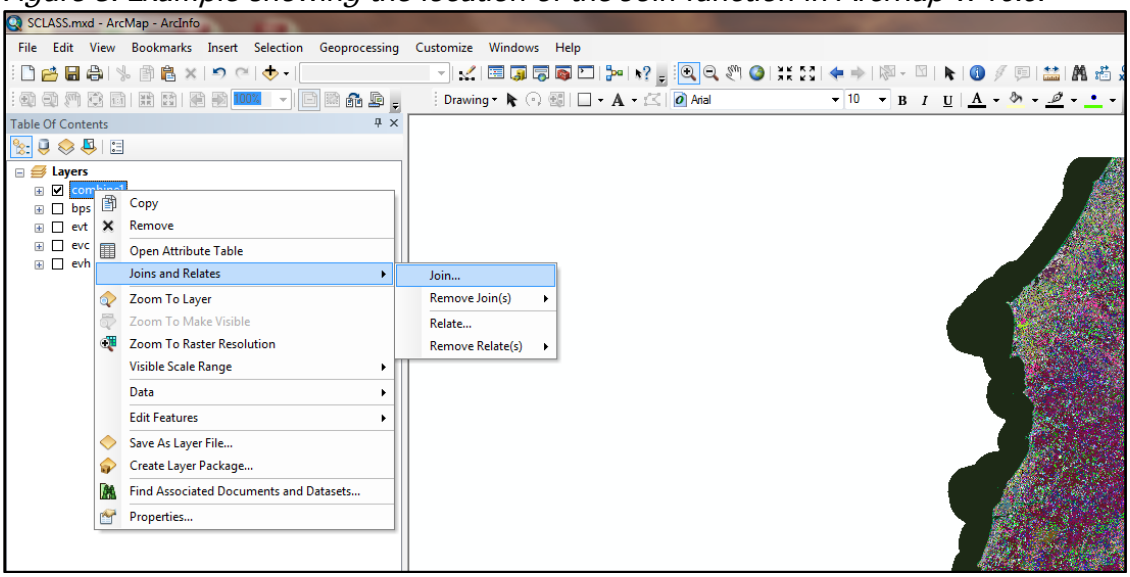
Figure 2: Example of using the Combine function to overlay the required S-class grids.



Manage the Attributes

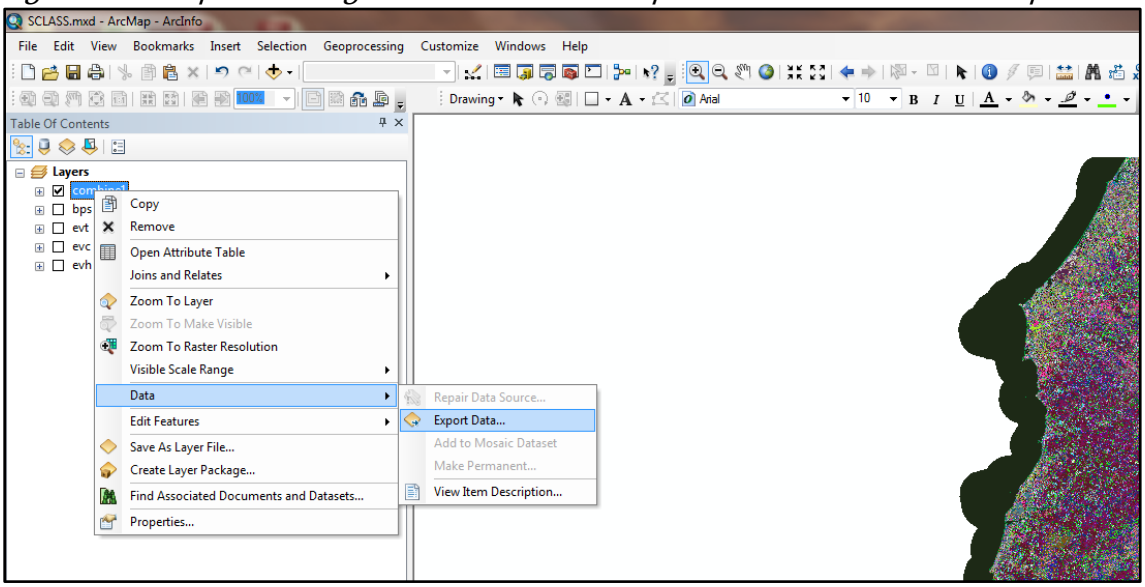
1. Join the attributes for each input grid to the combined grid using the **Joins and Relates** > **Join** function (Figure 3).
    a. The attributes can be joined from the input grids or from comma delimited files (CSV) available from the LANDFIRE WEBSITE for every LANDFIRE dataset.

Figure 3: Example showing the location of the Join function in ArcMap v. 10.0.



2. Export the combined grid using the **Data** > **Export Data** function to make it permanent (Figure 4).

Figure 4: Example showing the location of the Export Data function in ArcMap v. 10.0.

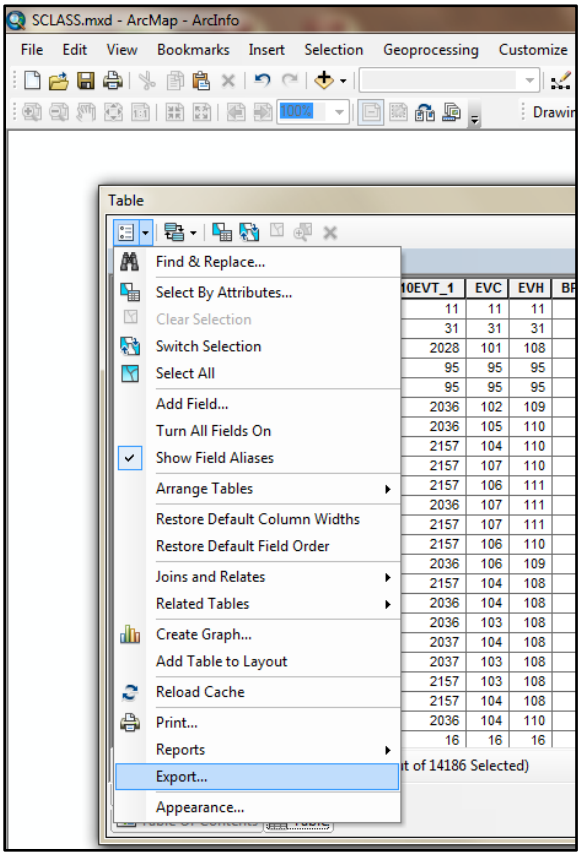


3. Clean up the table by deleting unnecessary fields using the Delete Field function in the **Data Management Tools** > **Fields** menu in ArcToolbox.
    a. At a minimum, the map zone (Zone), BpS name (BPS_NAME) and/or BpS Group name (GROUPNAME), EVT name (EVT_NAME), EVC class name (CLASSNAMES)

and EVH class name (CLASSNAMES) fields should be maintained along with any other fields the user believes will assist in identifying S-classes.

4. Export the attribute table as a database file (dbf) using the **Table Options** > **Export** function (Figure 5).

Figure 5: Example showing the location of the Table Options, Export function in ArcMap v. 10.0.



Prepare to Make S-class Assignments

1. Open and format the dbf table in Excel (Figure 6).
    a. Save as an xls or xlsx file.
    b. Copy all data from “Sheet 1” to a second sheet, renamed “S-class” or similar, for manipulation.
    c. Remove unneeded columns.
    d. Adjust the column size so that you can easily see all the columns.
    e. Add a column at the end, labeled “SCLASS” or similar, where you will make assignments.
    f. Auto Filter the spreadsheet using the **Filter** button on the **Data** dropdown menu.

Figure 6: Example of a formatted Excel spreadsheet showing the information needed to assign S-classes.

	A	B	G	H	I	J	K	L	M	N	O	P
1	VALUE	COUNT	BPS_CODE	ZONE	BPS_NAME	GROUPID	GROUPMODEL	GROUPNAME	EVT_NAME	CLASSNAMES	CLASSNAM_1	SCLASS
2	4	71	10360	02	North Pacific Hypermaritime Sitka Spruce Forest	126	0000126	Sitka Spruce-Western Hemlock-5	Mediterrane	Tree Cover >= 10 and < 20%	Forest Height 0 to 5 meters	
3	16	389	10360	02	North Pacific Hypermaritime Sitka Spruce Forest	126	0000126	Sitka Spruce-Western Hemlock-5	North Pacifi	Tree Cover >= 40 and < 50%	Forest Height 0 to 5 meters	
4	17	2658	10360	02	North Pacific Hypermaritime Sitka Spruce Forest	126	0000126	Sitka Spruce-Western Hemlock-5	North Pacifi	Tree Cover >= 40 and < 50%	Forest Height 0 to 5 meters	
5	18	5392	10360	02	North Pacific Hypermaritime Sitka Spruce Forest	126	0000126	Sitka Spruce-Western Hemlock-5	North Pacifi	Tree Cover >= 30 and < 40%	Forest Height 0 to 5 meters	
6	19	153	10360	02	North Pacific Hypermaritime Sitka Spruce Forest	126	0000126	Sitka Spruce-Western Hemlock-5	North Pacifi	Tree Cover >= 40 and < 50%	Forest Height 0 to 5 meters	
7	20	201	10360	02	North Pacific Hypermaritime Sitka Spruce Forest	126	0000126	Sitka Spruce-Western Hemlock-5	North Pacifi	Tree Cover >= 30 and < 40%	Forest Height 0 to 5 meters	
8	21	1618	11570	02	North Pacific Swamp Systems	256	0000256	Thinleaf Alder-Oregon Ash-Weste	North Pacifi	Tree Cover >= 30 and < 40%	Forest Height 0 to 5 meters	
9	22	2808	11570	02	North Pacific Swamp Systems	256	0000256	Thinleaf Alder-Oregon Ash-Weste	North Pacifi	Tree Cover >= 40 and < 50%	Forest Height 0 to 5 meters	
10	35	9841	10280	02	Mediterranean California Mesic Mixed Conifer For	117	0000117	Douglas Fir-White Fir-Sugar Pine-1	Mediterrane	Tree Cover >= 30 and < 40%	Forest Height 0 to 5 meters	
11	36	6276	10280	02	Mediterranean California Mesic Mixed Conifer For	117	0000117	Douglas Fir-White Fir-Sugar Pine-1	Mediterrane	Tree Cover >= 50 and < 60%	Forest Height 0 to 5 meters	
12	60	2778	10360	02	North Pacific Hypermaritime Sitka Spruce Forest	126	0000126	Sitka Spruce-Western Hemlock-5	North Pacifi	Tree Cover >= 20 and < 30%	Forest Height 0 to 5 meters	
13	63	2050	10360	02	North Pacific Hypermaritime Sitka Spruce Forest	126	0000126	Sitka Spruce-Western Hemlock-5	North Pacifi	Tree Cover >= 60 and < 70%	Forest Height 0 to 5 meters	
14	64	2003	10360	02	North Pacific Hypermaritime Sitka Spruce Forest	126	0000126	Sitka Spruce-Western Hemlock-5	North Pacifi	Tree Cover >= 70 and < 80%	Forest Height 0 to 5 meters	
15	66	101	10360	02	North Pacific Hypermaritime Sitka Spruce Forest	126	0000126	Sitka Spruce-Western Hemlock-5	Mediterrane	Tree Cover >= 80 and < 90%	Forest Height 0 to 5 meters	

Make S-class Assignments

1. Assign a value to the combinations that will NOT be given an S-class using the filter on the EVT and/or CLASSNAME fields (Figure 7). These include areas classified as water, snow/ice, urban, barren, sparsely vegetated and agriculture (Figure 8). A partial list of LANDFIRE EVTs that are likely to fit into this category is provided at the end of this document (Appendix 2).

Figure 7: Example of selecting EVTs using the filter menu by clicking on the arrow in the EVT_NAME field.

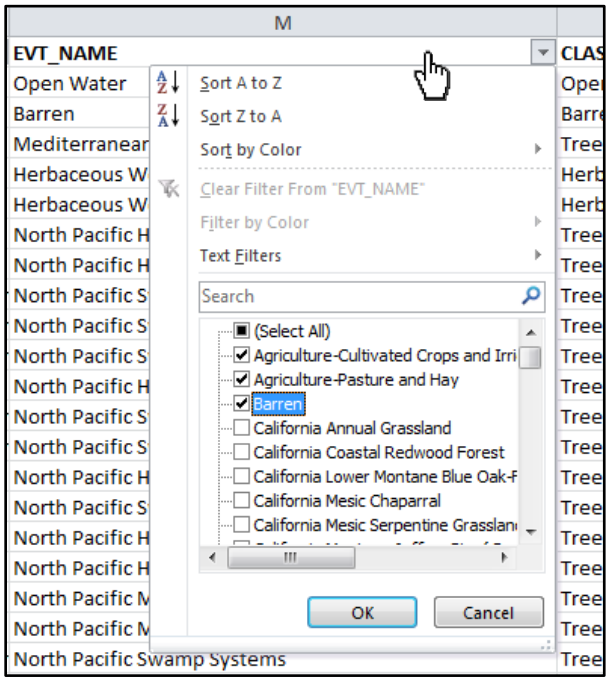


Figure 8: Example showing EVTs classified as Developed assigned to the S-class category "Urban."

M	N	O	P
EVT_NAME	CLASSNAMES	CLASSNAM_1	SCLASS
Developed-Upland Herbaceous	Developed-Upland Herbace	Developed-Upland Herbaceo	Urban
Developed-Roads	Developed-Roads	Developed-Roads	Urban
Developed-Upland Shrubland	Developed-Upland Shrublar	Developed-Upland Shrublanc	Urban
Developed-Roads	Developed-Roads	Developed-Roads	Urban
Developed-Upland Herbaceous	Developed-Upland Herbace	Developed-Upland Herbaceo	Urban
Developed-Upland Shrubland	Developed-Upland Shrublar	Developed-Upland Shrublanc	Urban
Developed-Upland Shrubland	Developed-Upland Shrublar	Developed-Upland Shrublanc	Urban
Developed-Upland Herbaceous	Developed-Upland Herbace	Developed-Upland Herbaceo	Urban
Developed-Medium Intensity	Developed - Medium Intens	Developed - Medium Intensit	Urban
Developed-Upland Mixed Forest	Developed-Upland Mixed Fo	Developed-Upland Mixed Foi	Urban
Developed-Upland Deciduous Forest	Developed-Upland Deciduo	Developed-Upland Deciduou	Urban
Developed-Roads	Developed-Roads	Developed-Roads	Urban
Developed-Upland Herbaceous	Developed-Upland Herbace	Developed-Upland Herbaceo	Urban

2. Assign a value to EVTs that are uncharacteristic exotic (UE) using the filter on the EVT field (Figure 9).
    a. A partial list of LANDFIRE EVTs that may fit into this category are provided at the end of this document (Appendix 3).

Figure 9: Example showing uncharacteristic exotic EVTs assigned to the SCLASS category "UE."

M	N	O	P
EVT_NAME	CLASSNAMES	CLASSNAM_1	SCLASS
Introduced Upland Vegetation-Shrub	Shrub Cover >= 60 and < 70%	Shrub Height 0.5 to 1.0 meter	UE
Introduced Upland Vegetation-Perennial Grassland and Fo	Herb Cover >= 90 and <= 100'	Herb Height 0.5 to 1.0 meters	UE
Introduced Upland Vegetation-Annual Grassland	Herb Cover >= 90 and <= 100'	Herb Height 0 to 0.5 meters	UE
Introduced Upland Vegetation-Annual Grassland	Herb Cover >= 90 and <= 100'	Herb Height 0.5 to 1.0 meters	UE
Introduced Upland Vegetation-Shrub	Shrub Cover >= 40 and < 50%	Shrub Height 1.0 to 3.0 meter	UE
Introduced Upland Vegetation-Shrub	Shrub Cover >= 20 and < 30%	Shrub Height 1.0 to 3.0 meter	UE
Introduced Upland Vegetation-Shrub	Shrub Cover >= 40 and < 50%	Shrub Height 1.0 to 3.0 meter	UE
Introduced Upland Vegetation-Shrub	Shrub Cover >= 50 and < 60%	Shrub Height 1.0 to 3.0 meter	UE
Introduced Upland Vegetation-Shrub	Shrub Cover >= 50 and < 60%	Shrub Height 1.0 to 3.0 meter	UE
Introduced Upland Vegetation-Perennial Grassland and Fo	Herb Cover >= 60 and < 70%	Herb Height 0 to 0.5 meters	UE
California Annual Grassland	Herb Cover >= 50 and < 60%	Herb Height 0 to 0.5 meters	UE

3. Assign S-classes A-E and Uncharacteristic Native (UN) based on rules. The LANDFIRE S-class rules can be found in the MTDB or pdf model description documents.
    a. Filter for one BpS at a time.
    b. First, use the filter on the EVT column to identify UN EVTs and assign them accordingly.
    c. Then, remove and add filters as needed to assign classes A-E based on your rule set.
    d. When all the rules have been applied, filter out the combinations (i.e. rows) for a given BpS that have an S-class assignment. The remaining combinations (rows) fell outside the rule set and they must be given an appropriate S-class assignment. Assigning these combinations can be difficult and often requires the best judgment of individuals who are knowledgeable about the project area (Table 1).
    e. Move to the next BpS and repeat steps a-d until all combinations have been assigned an S-class.
    f. Save the spreadsheet.

Table 1: Factors to consider when assigning S-classes to combinations not accounted for in the rule set.

Are the remaining combinations uncharacteristic (UN) because of the EVT?	This could be because of an EVT that should not be present on the BpS (e.g. a pinyon juniper woodland EVT encroaching on a sagebrush steppe BpS).
Are the remaining combinations uncharacteristic native (UN) because of the height and/or cover?	In some cases structural characteristics found on the landscape today are beyond the thresholds defined for a BpS. This situation is common in woodland BpS where management practices and other factors have allowed for higher canopy cover than was possible under the reference conditions. In these situations, an S-class value of UN should be assigned. Sometimes reading the model description, especially the "Uncharacteristic Native Conditions" and the "Vegetation Classes" fields, will provide insight. Generally, S-class rule sets are developed before mapping and without knowledge of the possible combinations of height and cover that might occur on the landscape. As a result, rule sets may not account for legitimate cover and height combinations. In these cases, use your best judgment to assign the most appropriate S-class.
How many pixels or acres are in an unassigned combination?	Knowing the extent of an unassigned combination provides a sense of how much of the landscape will be affected by an S-class assignment.

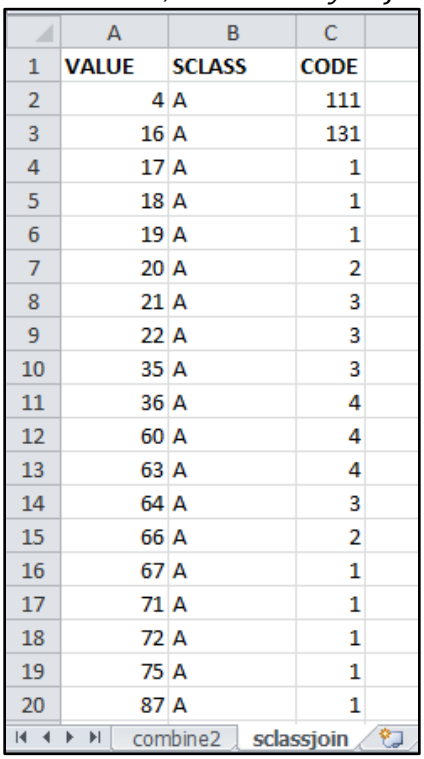
Create an S-class Worksheet for Joining

1. Create a copy of the worksheet that contains your S-class assignments so that you can edit it as need for joining in ArcMap. Give the copied worksheet a logical name such as "sclassjoin."

2. In the copied worksheet, delete all columns except those you want to join. At a minimum, this will include the value column, upon which the join will be based, and the column that contains your S-class assignments. If you want to retain the LANDFIRE S-class numeric code conventions, you will need to add those codes in a new column at this point (Figure 10). The LANDFIRE S-class code conventions are provided at end of this document (Appendix 4).

3. Save and close the spreadsheet.

Figure 10: Example of S-class assignment spreadsheet, using LANDFIRE numeric code conventions, that is ready to join in ArcMap.



	A	B	C
1	VALUE	SCLASS	CODE
2	4	A	111
3	16	A	131
4	17	A	1
5	18	A	1
6	19	A	1
7	20	A	2
8	21	A	3
9	22	A	3
10	35	A	3
11	36	A	4
12	60	A	4
13	63	A	4
14	64	A	3
15	66	A	2
16	67	A	1
17	71	A	1
18	72	A	1
19	75	A	1
20	87	A	1

combine2 sclassjoin

Join the S-class Worksheet

1. Join the S-class worksheet to your combined grid using the **Joins and Relates** > **Join** function.

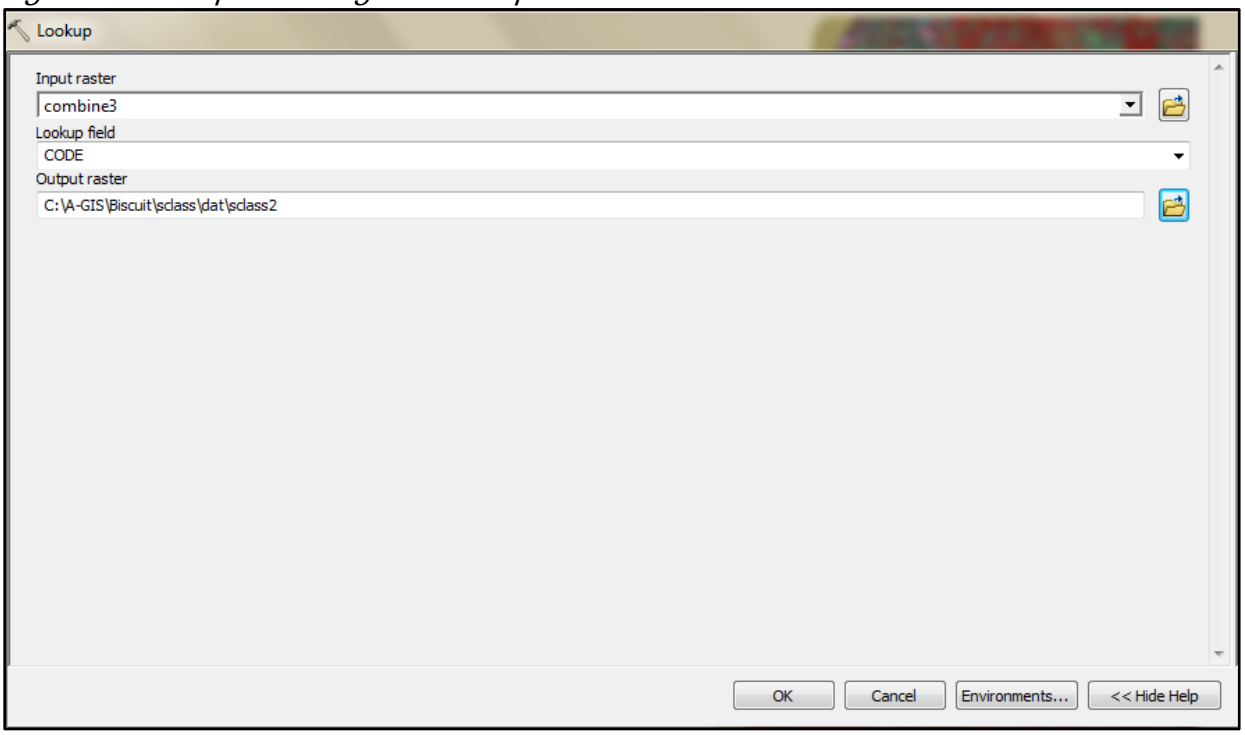
2. Export the data to make the grid permanent using the **Table Options** > **Export function**.

Create an S-class Grid

1. Use the **Spatial Analyst Tools** > **Reclass** > **Lookup** command in ArcToolbox to create a new grid based on either the S-class names or numeric S-class codes in your CSV file (Figure 11).
    a. If the lookup is based on a character field, e.g. S-class names, Arc will assign grid values automatically. Use the numeric codes if you want to control the grid values or if you want to use the same numeric codes as LANDFIRE.

b. If you use LANDFIRE codes, you can join the attribute table of the resulting grid to a LANDFIRE S-class attributes CSV file to get the LANDFIRE naming conventions and color map information.

Figure 11: Example of using the Lookup command.



Review the S-class Map

Once the S-class map is complete, have it reviewed by ecologists or others familiar with the landscape if possible. This is especially important if there was little review of the input data, if a significant proportion of the assignments fell outside the rule set or if you suspect that the rule set was not a good fit for the landscape.

Review of the S-class grid alone is difficult because its accuracy depends on the accuracy of the various input layers (especially EVT, EVC and EVH) used to derive it. Assuming the input layers were evaluated prior to undertaking the S-class process, the strengths and weaknesses of those layers should be identified and can then be accounted for in the review of the S-class grid. S-class review may highlight a need to modify some classes in the input data that were not identified earlier.

One way to review the S-class grid is to combine it with the BpS grid and create a summary that shows the distribution of S-classes for each BpS (Table 2). To facilitate evaluation of the uncharacteristic types, you will likely need to provide reviewers with a summary of what was

classified as UN and UE. It may also be useful to provide reviewers with the relevant BpS description documents and reference conditions. Prompting reviewers with questions may help elicit the feedback you need. For instance:

- Do the relative proportions for each S-class within a given BpS seem appropriate?
- Are any S-classes over- or under-represented?
- Are the thresholds used to classify UN appropriate for a given BpS?
- Are there datasets that were not used to create this S-class grid that can better distinguish the S-classes?

Table 2: The value attribute table resulting from the combine of a BpS and an S-class grid can be used for review. The acres field was calculated by multiplying the count by .222. The percent field was calculated using the sum of the count for each BpS and therefore estimates the relative percent of an S-class for a given BpS.

VALUE	COUNT	BPSNUM	SCLNUM	BPSNAME	SCLASS	ACRES	PERCENT
130	2	102	1	Quaking Aspen-4	A	0.4	2.6
86	28	102	2	Quaking Aspen-4	B	6.2	36.4
125	3	102	3	Quaking Aspen-4	C	0.7	3.9
96	7	102	4	Quaking Aspen-4	D	1.6	9.1
83	1	102	5	Quaking Aspen-4	E	0.2	1.3
82	27	102	6	Quaking Aspen-4	UN	6.0	35.1
122	9	102	7	Quaking Aspen-4	UE	2.0	11.7
56	2452	107	1	Two Needle Pinyon-Utah Juniper-3	A	544.3	1.0
54	39179	107	2	Two Needle Pinyon-Utah Juniper-3	B	8697.7	16.5
41	26974	107	3	Two Needle Pinyon-Utah Juniper-3	C	5988.2	11.3
39	139477	107	4	Two Needle Pinyon-Utah Juniper-3	D	30963.9	58.6
65	28810	107	6	Two Needle Pinyon-Utah Juniper-3	UN	6395.8	12.1
42	841	107	7	Two Needle Pinyon-Utah Juniper-3	UE	186.7	0.4
97	174	107	120	Two Needle Pinyon-Utah Juniper-3	Urban	38.6	0.1
150	2	107	132	Two Needle Pinyon-Utah Juniper-3	Sparsely Vegetated	0.4	0.0
124	33	107	180	Two Needle Pinyon-Utah Juniper-3	Agriculture	7.3	0.0
165	382	110	1	Singleleaf Pinyon-Utah Juniper-3	A	84.8	1.1
164	4905	110	2	Singleleaf Pinyon-Utah Juniper-3	B	1088.9	14.5
156	409	110	3	Singleleaf Pinyon-Utah Juniper-3	C	90.8	1.2
163	33	110	4	Singleleaf Pinyon-Utah Juniper-3	D	7.3	0.1
89	28145	110	5	Singleleaf Pinyon-Utah Juniper-3	E	6248.2	83.1

Making adjustments to the S-class grid will involve changing the classification rules and/or modifying the input data and recreating the S-class grid. In either case, the process of creating the S-class map is ideally an iterative one.

Appendix 1: Automating the S-class Process

Automating the S-class process has several advantages: 1) it may save time if your process is iterative, e.g. making changes based on review comments, 2) it can facilitate updating the S-class grid at a later date, e.g. to incorporate new data, and 3) once found, errors can be fixed and a new grid created more quickly.

Various techniques can be used to automate parts of the S-class process. In ArcMap, a geoprocessing script written in Python (see example script below), or ARC Macro Language (AML) could complete the combine function, apply the rule set and create a new grid. Macros or Visual Basic for Applications (VBA) code can be used in MS Excel or MS Access to automatically apply S-class rules, especially the LANDFIRE S-class rules that are stored in the MTDB MS Access database.

Example Python script for applying S-class rules

In this example Python script, created by Jan Koenig of The Nature Conservancy, S-class rule sets are applied to three BpS. S-class assignments are applied to each unique combination of BpS, size class, tree cover and canopy height in the attribute table of a raster that is stored in a personal geodatabase (that is, a MS Access database). Coding is particularly useful in this case because there are hundreds of unique combinations. The end result is a table with updated S-class assignments that can be joined back to the combined attribute table in ArcMap.

```
# Upper Monument Creek - Recalculate S-classes
#
# Author: Jan Koenig
# Due date: October 15, 2012

##MAIN MODULE##

'''
Calculates the updated s-class for each LANDFIRE BpS type.

Input:
    bps - biophysical setting (LANDFIRE)
    size - size class (USFS CVU)
    tc - tree cover (USFS CVU)
    ch - canopy height (LANDFIRE; units are meters * 10)

'''

#import modules
import arcpy
from arcpy import env
import sys

env.workspace =
r"C:\Users\jkoenig\Documents\UMC2\Calc_sclass\Z_UMC_TableManipulation.mdb"
env.overwriteOutput = 1
```

```
# Input files
tbl = "tbl_SclassBeforeWaldo"
print tbl

rows = arcpy.UpdateCursor(tbl)

for row in rows:
#    row = rows.next()
    bps=row.UMC_BPS_Name
    size=row.UMC_CVU_SizeClass_Descr
    tc=row.UMC_CVU_TreeCoverPCcat
    ch=row.UMC_CanopyHeight  # units of meters * 10
    print str(bps) + ", " + str(size) + ", " + str(tc) + ", " + str(ch)

    if bps == "Rocky Mountain Lodgepole Pine Forest UMC":
        if size == "NotSpecified":
            row.SclassBeforeWaldo="U"
        elif size == "Small" and (tc>5 and tc<=10):
            row.SclassBeforeWaldo="B"
        # model states tc>2
        elif size == "Small" and (tc>1 and tc<=5):
            row.SclassBeforeWaldo="C"
        # model states tc>5
        elif size == "Medium":
            if (tc>4 and tc<=10):
                row.SclassBeforeWaldo="D"
            else:
                row.SclassBeforeWaldo="U"
        # model states tc>3 and tc<=6
        elif size == "Large":
            if (tc>2 and tc<=7):
                row.SclassBeforeWaldo="E"
            else:
                row.SclassBeforeWaldo="U"
        else:
            row.SclassBeforeWaldo="fell through"

    elif bps == "Rocky Mountain Dry-Mesic Mixed Conifer Forest and Woodland
UMC":
        #s-class A, should have classified E as seedling, not small
        if size == "NotSpecified":
            row.SclassBeforeWaldo="U"
        elif size == "Small" and (tc>0 and tc<=8):
            row.SclassBeforeWaldo="A"
        elif size == "Medium" and (tc>5 and tc<=8):
            row.SclassBeforeWaldo="B"
        elif size == "Medium":
            if (tc>1 and tc<=5):
                row.SclassBeforeWaldo="C"
            else:
                row.SclassBeforeWaldo="U"
        elif size == "Large":
            if (tc>1 and tc<=4):
                row.SclassBeforeWaldo="D"
            elif (tc>4 and tc<=8):
                row.SclassBeforeWaldo="E"
            else:
                row.SclassBeforeWaldo="U"
        else:
            row.SclassBeforeWaldo="fell through"

    elif bps == "Rocky Mountain Mesic Mixed Conifer Forest and Woodland UMC":
        #s-class A, should have classified E as seedling, not small
        if size == "NotSpecified":
```

```
    row.SclassBeforeWaldo="U"
elif size == "Small" and (tc>0 and tc<=10):
    row.SclassBeforeWaldo="A"
elif size == "Medium" and (tc>4 and tc<=10):
    row.SclassBeforeWaldo="B"
# model states tc>1
elif size == "Medium" and (tc>0 and tc<=4):
    row.SclassBeforeWaldo="C"
# model states tc>1
elif size == "Large":
    if (tc>1 and tc<=4):
        row.SclassBeforeWaldo="D"
    elif (tc>4 and tc<=10):
```

Appendix 2: Vegetation Types That May be Excluded from the Seven Standard S-classes

The table below provides a partial list of LANDFIRE EVTs that are likely to be excluded from the seven standard S-classes (i.e. classes A-E, UN and UE). These include areas classified as water, snow/ice, urban, barren, sparsely vegetated and agriculture.

Value	EVT_Name
11	Open Water
12	Snow-Ice
13	Developed-Upland Deciduous Forest
14	Developed-Upland Evergreen Forest
15	Developed-Upland Mixed Forest
16	Developed-Upland Herbaceous
17	Developed-Upland Shrubland
18	Developed-Herbaceous Wetland Vegetation
19	Developed-Woody Wetland Vegetation
20	Developed-General
21	Developed-Open Space
22	Developed-Low Intensity
23	Developed-Medium Intensity
24	Developed-High Intensity
25	Developed-Roads
31	Barren
32	Quarries-Strip Mines-Gravel Pits
60	NASS-Orchard
61	NASS-Vineyard
62	NASS-Bush fruit and berries
63	NASS-Row Crop-Close Grown Crop
64	NASS-Row Crop
65	NASS-Close Grown Crop
66	NASS-Fallow/Idle Cropland
67	NASS-Pasture and Hayland
80	Agriculture-General
81	Agriculture-Pasture and Hay
82	Agriculture-Cultivated Crops and Irrigated Agriculture
83	Agriculture-Small Grains
84	Agriculture-Fallow
85	Agriculture-Urban and Recreational Grasses

2001	Inter-Mountain Basins Sparsely Vegetated Systems
2002	Mediterranean California Sparsely Vegetated Systems
2003	North Pacific Sparsely Vegetated Systems
2004	North American Warm Desert Sparsely Vegetated Systems
2005	Pacific Coastal Dunes and Other Sparsely Vegetated Systems
2006	Rocky Mountain Alpine/Montane Sparsely Vegetated Systems
2007	Western Great Plains Sparsely Vegetated Systems
2190	Cultivated Crops and Irrigated Agriculture
2497	Central Interior and Appalachian Sparsely Vegetated Systems
2498	Gulf and Atlantic Coastal Plain Sparsely Vegetated Systems
2499	Laurentian-Acadian Sparsely Vegetated Systems
2613	Western North American Boreal Active Inland Dune
2632	Western North American Boreal Alpine Talus and Bedrock
2667	Alaskan Pacific Maritime Rocky Coastline
2713	Alaska Arctic Active Inland Dune
2716	Aleutian Rocky Headland and Sea Cliff
2717	Alaska Arctic Bedrock and Talus
2732	Aleutian Volcanic Rock and Talus
2733	North Pacific Montane Massive Bedrock-Cliff and Talus
2734	North Pacific Alpine and Subalpine Bedrock and Scree
2735	North American Glacier and Ice Field
2791	Aleutian Sparsely Vegetated
2792	Arctic Sparsely Vegetated
2793	Boreal Sparsely Vegetated
2794	Pacific Maritime Sparsely Vegetated
2829	Hawai'i Alpine Bedrock and Scree
2831	Hawai'i Dry-Site Lava Flow

Appendix 3: Vegetation Types That May be Uncharacteristic Exotic

The table below provides a partial list of LANDFIRE EVTs that may be classified as uncharacteristic exotic (UE).

Value	EVT_Name
2180	Introduced Riparian Vegetation
2181	Introduced Upland Vegetation-Annual Grassland
2182	Introduced Upland Vegetation-Perennial Grassland and Forbland
2183	Introduced Upland Vegetation-Annual and Biennial Forbland
2184	California Annual Grassland
2185	Introduced Wetland Vegetation-Mixed
2186	Introduced Upland Vegetation-Shrub
2187	Introduced Upland Vegetation-Treed
2188	Transitional Herbaceous Vegetation
2189	Transitional Shrub Vegetation
2193	Recently Logged-Tree Cover
2194	Ruderal Upland-Treed
2224	Elaeagnus angustifolia Semi-Natural Woodland Alliance
2225	Tamarisk spp. Semi-Natural Temporarily Flooded Shrubland Alliance
2226	Bromus spp. Semi-Natural Herbaceous Alliance
2530	Ruderal Wetland
2531	Ruderal Upland-Old Field
2532	Ruderal Forest-Northern and Central Hardwood and Conifer
2533	Ruderal Forest-Southeast Hardwood and Conifer
2534	Managed Tree Plantation-Northern and Central Hardwood and Conifer Plantation Group
2535	Managed Tree Plantation-Southeast Conifer and Hardwood Plantation Group
2536	Introduced Wetland Vegetation-Tree
2537	Introduced Wetland Vegetation-Shrub
2538	Introduced Wetland Vegetation-Herbaceous
2539	Modified-Managed Northern Tall Grassland
2540	Modified-Managed Southern Tall Grassland
2554	Norway Spruce Forest
2555	Scotch Pine Forest
2836	Hawaiian Introduced Wetland Vegetation-Tree
2837	Hawaiian Introduced Wetland Vegetation-Shrub
2838	Hawaiian Introduced Wetland Vegetation-Herbaceous
2845	Hawaiian Introduced Dry Forest

2846	Hawaiian Introduced Wet-Mesic Forest
2847	Hawaiian Introduced Deciduous Shrubland
2848	Hawaiian Introduced Perennial Grassland
2849	Hawaiian Introduced Evergreen Shrubland
2852	Introduced Coastal Wetland Vegetation - Tree
2853	Introduced Coastal Wetland Vegetation - Shrub
2854	Introduced Coastal Wetland Vegetation - Herbaceous
2855	Hawaiian Managed Tree Plantation

Appendix 4: LANDFIRE S-class Naming and Numbering Conventions

The table below shows the LANDFIRE S-class grid naming and numbering conventions.

Value	Label	Description
-9999	NODATA	NODATA
1	A	Succession Class A
2	B	Succession Class B
3	C	Succession Class C
4	D	Succession Class D
5	E	Succession Class E
6	UN	Uncharacteristic Native Vegetation Cover / Structure / Composition
7	UE	Uncharacteristic Exotic Vegetation
111	Water	Water
112	Snow / Ice	Snow / Ice
120	Urban	Urban
131	Barren	Barren
132	Sparsely Vegetated	Sparsely Vegetated
180	Agriculture	Agriculture