

Appendix A

LANDFIRE model descriptions for ecological systems that represent sagebrush in Utah

About LANDFIRE Vegetation Dynamics Models

Colorado Plateau Mixed Low Sagebrush Shrubland

Great Basin Xeric Mixed Sagebrush Shrubland

Inter-Mountain Basins Big Sagebrush Shrubland

Inter-Mountain Basins Big Sagebrush Steppe

Inter-Mountain Basins Montane Sagebrush Steppe

Inter-Mountain Basins Montane Sagebrush Steppe - Low Sagebrush

Inter-Mountain Basins Montane Sagebrush Steppe - Mountain Big Sagebrush

About LANDFIRE Vegetation Dynamics Models

Vegetation dynamics models for LANDFIRE help to synthesize the best available knowledge of vegetation dynamics and quantify the natural range of variability in vegetation composition and structure. Models consist of two components: (1) a comprehensive description and (2) a quantitative, state-and-transition (box) model, created in the public domain software VDDT¹.

Models were developed during workshops across the United States where regional vegetation and fire ecology experts synthesized the best available data on vegetation dynamics and disturbances for vegetation communities in their region. A peer review process following workshops garnered additional expert input and offered an opportunity to refine models.

LANDFIRE vegetation models were based on a simple, standardized five-box model that combines three generic succession stages with two canopy cover classes (Table 1). Each class is specifically defined for individual models. Variations on this standardized model were also developed.

Quantitative models are based on inputs such as fire frequency and severity, the probability of other disturbances, and the rate of vegetation growth. Inputs are derived from literature review and expert input during and after modeling workshops. Models simulate several centuries of vegetation dynamics and produce outputs such as the percent of the landscape in each class and the frequency of disturbances. Outputs are checked against available data whenever possible, and are peer-reviewed during and after expert workshops.

Table 1. Classes in the standard five-box model. Models for LANDFIRE use this standard model with modifications as needed. Letters represent unique classes (combinations of cover and structure) and correspond to boxes in the state-transition models.

	Canopy Cover	
Succession Stage	<i>Closed</i>	<i>Open</i>
<i>Early development</i>	A	
<i>Mid-development</i>	B	C
<i>Late-development</i>	E	D

Model descriptions and quantitative outputs were used in LANDFIRE to help define and map biophysical settings (BPS), or the vegetation communities that are likely to exist under the natural range of variability in biophysical environments and ecological processes, including fire and other disturbances. Models are used as inputs to the spatial fire and succession simulation model, LANDSUM, which generates reference conditions used to calculate Fire Regime Condition Class (FRCC)², a standardized, interagency index to measure the departure of current conditions from reference conditions.

A key to the fields that appear in Model Descriptions appears below. For a complete description of the methodology used to develop LANDFIRE vegetation models, please consult the *LANDFIRE Vegetation Dynamics Modeling Manual*³.

¹ ESSA Technologies Ltd. 2005. Vegetation Dynamics Development Tool User's Guide, Version 5.1. Prepared by ESSA Technologies Ltd., Vancouver, BC. 188 pp. Available at: www.essa.com.

² Hann, W.J., D. Havlina, A. Shlisky, et al. 2004. Interagency Fire Regime Condition Class Guidebook. Available at: www.frcc.gov.

³ The Nature Conservancy, USDA Forest Service, and Department of the Interior. LANDFIRE Vegetation Dynamics Modeling Manual, Version 4.0. December 2005. Boulder, CO. 69 pp. Available at: www.landfire.gov.

Key to Fields in Model Descriptions

Biophysical Setting	
Field Name	Explanation
<i>Biophysical Setting</i>	<p>The biophysical setting (BPS) code is listed first. Codes follow this general format:</p> <p style="text-align: center;"><i>MZCODE#</i></p> <p>Where:</p> <ul style="list-style-type: none"> • MZ = The two digit map zone number. • CODE = The four digit code for the BPS from Nature Serve’s Ecological Systems numbering system. • # = A number indicating if a model was split. A zero indicates that the model was not split. A number other than zero indicates that the model was split. If a split occurred, this would be noted in the check box below the code and explained. <p>The name of the BPS is listed second. This is typically a descriptive title that includes the dominant species, region and qualifier. The LANDFIRE project defines BPS as the vegetation communities that are likely to exist under the natural range of variability in biophysical environments and ecological processes, including fire and other disturbances.</p>
General Information	
Field Name	Explanation
<i>Contributors</i>	Those who contributed to the model are listed here, along with email addresses. This may include modelers (i.e., people who directly created the model) and reviewers (i.e., people who reviewed the model and provided feedback after its development). Additional contributors may be listed in the “Model Evolution and Comments” field.
<i>Vegetation Type</i>	<p>The vegetation type (UNESCO world physiognomic classification) for the <i>majority</i> of the BPS. Classes are defined as follows:</p> <ul style="list-style-type: none"> • <u>Forest</u>: >5 m tall; 60-100% cover • <u>Woodland</u>: >5 m tall; 25-60% cover • <u>Shrubland</u>: 0.5-5 m tall; >25% cover (<25% cover of trees) • <u>Grassland</u> (herbaceous): >25% cover (<25% cover of trees and shrubs)
<i>Dominant Species</i>	The NRCS Plants Code of up to eight dominant species for the BPS. These reflect the <i>majority</i> of the landscape in the BPS and are in order of dominance. To look up a NRCS Plants Code, please visit http://plants.usda.gov .
<i>General Model Source</i>	<p>The sources of information consulted in the development of the model.</p> <ul style="list-style-type: none"> • <u>Literature</u>: the model generally came from published sources. • <u>Local data</u>: the model generally came from local research or information. • <u>Expert estimate</u>: the model was generally estimated by experts.

General Information

Field Name	Explanation
<i>Map Zones</i>	Up to ten LANDFIRE mapping zones (numbered below) that this model applies to.
<i>Model Zones</i>	The LANDFIRE Rapid Assessment model zone(s) for which this model applies. See the map above for the delineation of model zones.
<i>Geographic Range</i>	Describes the geographic distribution of this BPS.
<i>Biophysical Site Description</i>	Describes the biophysical characteristics for this BPS and may include factors such as geographic distribution, elevation, aspect, soils, and slope.
<i>Vegetation Description</i>	Describes the vegetation of this BPS, including species, structure, and botanical characteristics.
<i>Disturbance Description</i>	Describes the dominant disturbances that impact this BPS, including the agents, frequency, severity, and seasonality.
<i>Adjacency or Identification Concerns</i>	<p>Information that may help identify the BPS in the field, including:</p> <ul style="list-style-type: none"> • synonymous local classifications (e.g., habitat type, plant association), • adjacent BPSs, • BPSs that this one may be confused with, • typical identifiers not described elsewhere, and • uncharacteristic types (i.e., patterns or processes that would not have existed under the historic range of variability, like exotics) that may frequently occur in this BPS today.
<i>Scale Description</i>	Describes the typical scale of the most common disturbance extent, the general minimum analysis area (e.g., the minimum size that would encompass the mosaic of this BPS), and/or the average patch size.

General Information

Field Name	Explanation
<i>Source of Scale Data</i>	Documents the sources of information about scale. <ul style="list-style-type: none"> • <u>Literature</u>: the values entered came from published sources. • <u>Local data</u>: the values entered came from local observations or records. • <u>Expert estimate</u>: the values entered were estimated by experts.
<i>Issues/Problems</i>	Describes any difficulties, issues, or concerns contributors have about the model, the availability of data on this BPS, or other considerations.
<i>Comments</i>	Tracks the changes, edits, and improvements to the model through the development and peer review processes. Describes any disagreements among experts about how to model the system.

Vegetation Classes

Field Name	Explanation
<i>Class Label</i>	Name of the class (A-E) and definition, representing a unique combination of succession stage (Early, Mid-, and Late Development) and canopy cover (All, Open, or Closed).
<i>Class %</i>	The percent of the landscape in this class from the VDDT model, rounded to the nearest 5%.
<i>Description</i>	Describes the structure, composition, and other attributes for each class.
<i>Dominant Species</i>	The NRCS Plants Code of up to four dominant species for the vegetation class, in order of dominance.
<i>Dominant Species Canopy Position</i> (optional)	The relative position of each dominant species in the canopy: <ul style="list-style-type: none"> • <i>Upper</i>: upper-most portion of the canopy; dominant or emergent. • <i>Mid-Upper</i>: ranging from middle to upper portions of the canopy; co-dominant. • <i>Middle</i>: middle section of the canopy; co-dominant or intermediate. • <i>Lower-Mid</i>: ranging from the lower to the middle portions of the canopy; intermediate or suppressed. • <i>Lower</i>: below the main canopy; may be suppressed or understory. • <i>All</i>: can vary between any canopy position, or occupies all levels of the canopy.
<i>Upper Layer Lifeform</i> (optional)	The lifeform of the vegetation at the top of the canopy, either tree, shrub, or herbaceous.

Fuel Model
(optional)

The 13 Fire Behavior Fuel Models⁴ for the class, if known. Fuel models are:

#	Vegetation Type	Fuels
1	Perennial grasslands, annual grasslands, savannahs, grass-tundra, grass-shrub with < 1/3 shrub or timber	Cured fine, porous herbaceous; .5-.9 tons surface fuel load per acre; .5-2 foot depth
2	Shrub, pine, oak, pinyon-juniper with < 2/3 shrub or timber cover	Fine herbaceous surface cured or dead, litter, dead stem or limb wood; 1-4 tons surface fuel load per acre; .5-2 foot depth
3	Tall grassland, prairie, and meadow	Tall herbaceous surface with > 1/3 dead or cured; 2-4 tons fuel load per acre; 2-3 foot depth
4	Coastal/Sierra chaparral, pocosin shrub (fetterbrush, gallberry, bays), southern rough shrub, closed jack pine, pine barrens	Flammable foliage and small dead woody material with or w/o litter layer; 10-15 tons fuel load per acre; 4-8 foot depth
5	Moist or cool shrub types (laurel, vine maple, alder, manzanita, chamise), forest/shrub, regeneration shrubfields after fire or harvest	Green foliage with or w/o litter; 3-5 tons per acre; 1-3 foot depth
6	Pinyon-juniper w/ shrubs, southern hardwood/ shrub w/ pine, frost killed gambel oak, pocosin shrub, chamise, chaparral, spruce-taiga, shrub-tundra, hardwood slash	Flammable foliage, but shorter and more open than FM 4 w/ less dead small wood and litter; 4-8 tons per acre; 2-4 foot depth
7	Palmetto-gallberry w/ or w/o pine overstory, black spruce/shrub, southern rough, slash pine/gallberry	Flammable foliage even when green; 4-6 tons per acre; 2-3 foot depth
8	Closed canopy short needle conifer types, closed canopy broadleaf or hardwood types	Usually low to moderately flammable foliage with litter or scattered vegetation understory; 4-6 tons per acre surface fuels; .1-.5 foot depth
9	Long needle (ponderosa, Jeffrey, red, southern) conifer types, oak-hickory and similar hardwood types	Flammable foliage with needle or leaf litter and some dead down woody material; 3-4 tons per acre; .1-.5 feet
10	Any forest type with > 3" down dead woody fuels)	Dead down > 3" woody fuels and litter; 10-14 tons per acre of total surface fuel < 3"; .5-2 foot depth
11	Light logging slash, partial cut slash	10-14 tons per acre total fuel load < 3"; .5-2 foot depth
12	Moderate and continuous logging slash in clearcuts or heavy partial cuts and thinned areas	30-40 tons per acre total fuel load < 3"; 2-3 foot depth
13	Heavy and continuous logging slash in clearcuts or heavy partial cuts and thinned areas	50-60 tons per acre total fuel load > 3"; 2-4 foot depth

⁴ Anderson, Hal. 1982. Aids to determining fuel models for estimating fire behavior. USDA Forest Service. Intermountain Forest and Range Experiment Station, Ogden, UT. General Technical Report INT-122. 28 pp.

Structure Data Structure data for the upper layer lifeform including the minimum and maximum cover and height and the tree size class. Fields include:

Field Name	Explanation					
Cover	Canopy cover of the upper layer lifeform. Canopy cover breaks are:					
	<i>Canopy Cover (%)</i>					
	<20					
	21-30					
	31-40					
	41-50					
	51-60					
	61-70					
	71-80					
	81-90					
91-100						
Height	Height of the upper layer lifeform. Height breaks are:					
	<i>Upper Layer Lifeform</i>	<i>Height Breaks(meters)</i>				
	Herb	.5	1.0	>1.1		
	Shrub	.5	1.0	3.0	>3.1	
	Tree	5	10	25	50	>50.1
Tree Size Class (optional)	The tree diameter class. Size classes are:					
	<i>Size Class</i>	<i>Diameter Class</i>				
	Seedling	<4.5 ft tall (~<1.4 m)				
	Sapling	>4.5 ft tall; <5" DBH (~>1.4m tall; ~<13 cm DBH)				
	Pole	5-9" DBH (~13-23 cm DBH)				
	Medium	9-21" DBH (~23-53 cm DBH)				
	Large	21-33" DBH (~53-84 cm DBH)				
Very Large	>33" DBH (~>84 cm DBH)					

Upper layer lifeform differs from dominant lifeform If the upper layer lifeform is different from the dominant lifeform (e.g., in a savanna type system), the canopy cover range and height for the dominant lifeform are described here.

Disturbances

Field Name	Explanation
<i>Fire Regime Group</i>	The single <i>dominant</i> Fire Regime Group (FRG). <ul style="list-style-type: none"> FRG I = 0-35 year frequency; surface and mixed severity FRG II = 0-35 year frequency; replacement severity FRG III = 35-200 year frequency; surface and mixed severity FRG IV = 35-200 year frequency; replacement severity FRG V = 200+ year frequency; replacement severity
<i>Historical Fire Size</i> (optional)	The estimated average, minimum, and maximum fire size (in acres) under the natural range of variability. These values are entered by modelers based on observation and/or literature for informational purposes only. These are not statistical values, nor are they derived from the VDDT model.

Disturbances

Field Name	Explanation																								
<i>Sources of Fire Regime Data</i>	<p>Indicates the sources of information about fire regimes:</p> <ul style="list-style-type: none"> • <u>Literature</u>: the values entered came from published sources. • <u>Local data</u>: the values entered came from local observations or records. • <u>Expert estimate</u>: the values entered were estimated by experts. 																								
<i>Additional Disturbances Modeled</i>	All of the non-fire disturbance types used in the model are checked.																								
<i>Fire Intervals</i>	<p>A summary table with information on fire frequency, probability, and severity. Fields include:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;"><i>Field Name</i></th> <th style="text-align: left;"><i>Explanation</i></th> </tr> </thead> <tbody> <tr> <td>Avg FI</td> <td>Average fire interval (number of years between fires) for each severity class (replacement, mixed, and surface) in years, as in the VDDT model.</td> </tr> <tr> <td>Min FI</td> <td>Minimum fire interval (number of years between fires) for each severity class (replacement, mixed, and surface) in years. This value is entered by modelers based on observation and/or literature for informational purposes only. This is not the statistical minimum, nor is it derived from the VDDT model.</td> </tr> <tr> <td>Max FI</td> <td>Maximum fire interval (number of years between fires) for each severity class (replacement, mixed, and surface) in years. This value is entered by modelers based on observation and/or literature for informational purposes only. This is not the statistical maximum, nor is it derived from the VDDT model.</td> </tr> <tr> <td>Probability</td> <td>Probability is equal to 1/Avg FI. It should closely mirror the probability of fire in the VDDT model.</td> </tr> <tr> <td>Percent of All Fires</td> <td>Percent of fires that burned for a given severity class. Percent of all fires is equal to the probability of a severity/All Fire Probability.</td> </tr> <tr> <td>Replacement</td> <td>Fire severity class with greater than 75% top-kill.</td> </tr> <tr> <td>Mixed</td> <td>Fire severity class with 25-75% top-kill.</td> </tr> <tr> <td>Surface</td> <td>Fire severity class with less than 25% top-kill.</td> </tr> <tr> <td>All Fires</td> <td>All severity classes (replacement, mixed, and surface) combined.</td> </tr> <tr> <td><i>All Fires / Avg FI</i></td> <td><i>All fires average fire interval is equal to 1/All Fires Probability. It should reflect the All Fires frequency in the model.</i></td> </tr> <tr> <td><i>All Fires / Probability</i></td> <td><i>All Fires Probability is equal to the sum of probabilities for the three severity classes.</i></td> </tr> </tbody> </table>	<i>Field Name</i>	<i>Explanation</i>	Avg FI	Average fire interval (number of years between fires) for each severity class (replacement, mixed, and surface) in years, as in the VDDT model.	Min FI	Minimum fire interval (number of years between fires) for each severity class (replacement, mixed, and surface) in years. This value is entered by modelers based on observation and/or literature for informational purposes only. This is not the statistical minimum, nor is it derived from the VDDT model.	Max FI	Maximum fire interval (number of years between fires) for each severity class (replacement, mixed, and surface) in years. This value is entered by modelers based on observation and/or literature for informational purposes only. This is not the statistical maximum, nor is it derived from the VDDT model.	Probability	Probability is equal to 1/Avg FI. It should closely mirror the probability of fire in the VDDT model.	Percent of All Fires	Percent of fires that burned for a given severity class. Percent of all fires is equal to the probability of a severity/All Fire Probability.	Replacement	Fire severity class with greater than 75% top-kill.	Mixed	Fire severity class with 25-75% top-kill.	Surface	Fire severity class with less than 25% top-kill.	All Fires	All severity classes (replacement, mixed, and surface) combined.	<i>All Fires / Avg FI</i>	<i>All fires average fire interval is equal to 1/All Fires Probability. It should reflect the All Fires frequency in the model.</i>	<i>All Fires / Probability</i>	<i>All Fires Probability is equal to the sum of probabilities for the three severity classes.</i>
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References

Field Name	Explanation
<i>References</i>	Lists all of the references used while creating this model, whether or not they are cited directly in the text.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2310640

Colorado Plateau Mixed Low Sagebrush Shrubland

- This BPS is lumped with:
 This BPS is split into multiple models:

General Information

Contributors (also see the Comments field) **Date** 2/24/2005

Modeler 1 Louis Provencher lprovencher@tnc.org **Reviewer** Tim Christiansen tchristiansen@tnc.org

Modeler 2 **Reviewer**

Modeler 3 **Reviewer**

Vegetation Type

Upland Shrubland

Map Zone

23

Model Zone

- | | |
|--|---|
| <input type="checkbox"/> Alaska | <input type="checkbox"/> N-Cent.Rockies |
| <input type="checkbox"/> California | <input type="checkbox"/> Pacific Northwest |
| <input type="checkbox"/> Great Basin | <input type="checkbox"/> South Central |
| <input type="checkbox"/> Great Lakes | <input type="checkbox"/> Southeast |
| <input type="checkbox"/> Northeast | <input type="checkbox"/> S. Appalachians |
| <input type="checkbox"/> Northern Plains | <input checked="" type="checkbox"/> Southwest |

Dominant Species*

ARNO4 BOGR2
ARBI3 HECO26
ACHY PLJA
ARPU9 ERIOG

General Model Sources

- Literature
 Local Data
 Expert Estimate

Geographic Range

BpS occurs in the Colorado Plateau, Tavaputs Plateau, and Uinta Basin. Also extends across northern NM into the southern Great Plains.

Biophysical Site Description

Occurs in canyons, gravelly draws, hilltops and dry flats at elevations below 1800m. Soils are often rocky, shallow and alkaline. Found on limestone ridges in northern NM and southern Great Plains. Black sagebrush (*Artemisia nova*) tends to grow where either a calcareous or volcanic cement layer exists in the soil profile.

Vegetation Description

Open shrublands dominated by *Artemisia nova* or *Artemisia bigelovii* sometimes with *Artemisia tridentata* ssp. *wyomingensis* co-dominant. Generally have relatively low fuel loads with low growing and cushion forbs and scattered semi-arid grasses such as *Achnatherum hymenoides*, *Aristida purpurea*, *Boutela gracilis*, *Hesperostipa comata*, *Pleuraphis jamesii* or *Poa fendleriana*. Graminoid layer will often have over 25% cover. Forbs often include buckwheats (*Eriogonum* spp), fleabanes (*Erigeron* spp), phloxs (*Phlox* spp), paintbrushes (*Castilleja* spp), globemallows (*Sphaeralcea* spp) and lupines (*Lupinus* spp).

Disturbance Description

Black sagebrush generally supports more fire than other dwarf sagebrushes. This type generally burns with mixed severity (average FRI of 100-140yrs) due to relatively low fuel loads and herbaceous cover. Bare ground acts as a micro-barrier to fire between low stature shrubs. Oils and resins present in the foliage and stems of sagebrush allow fire to spread. Stand-replacing fires (average FRI of 200-240yrs) can occur in this type when successive years of above average precipitation are followed by an average or dry year. Stand replacement fires dominate in the late succession class where the herbaceous component has diminished.

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.

**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

Fires may or may not be wind driven and only cover small areas. This type fits into Fire Regime Groups IV and III.

Grazing by wild ungulates occurs in this type due to the high palatability of *A. nova* compared to other browse. Native browsing tends to open up the canopy cover of shrubs but does not often change the succession stage.

Prolonged drought may reduce the foliar and basal covers of graminoids but not that of shrubs. Reduced foliar cover of graminoids will affect fire behavior. This effect is assumed minor and not included in the model.

Adjacency or Identification Concerns

The dwarf sagebrush type tends to occur adjacent to Wyoming big sagebrush. The dwarf sagebrush types create a mosaic within the Wyoming big sagebrush, acting as a fire break that burns only under severe conditions.

Native Uncharacteristic Conditions

Scale Description

Disturbance patch size for this type is not well known but is estimated to be 10s to 100s of acres due to the relatively small proportion of the sagebrush matrix it occupies and the limited potential for fire spread.

Issues/Problems

Comments

This model is identical to the model for the same BpS in MZ16 (Utah High Plateaus) and did not receive any peer review for MZ23 and MZ24. The model for this BpS and description were largely based on the Rapid Assessment PNVG R2SBDW developed by Sarah Heide (Sarah_Heide@blm.gov) and Gary Medlyn (gmedlyn@nv.blm.gov) for dwarf sagebrushes. Reviewers of R2SDDW were Michael Zielinski (mike_zielinski@nv.blm.gov), Gary Back (gback@srk.com) and Paul Tueller (ptt@intercomm.com).

Vegetation Classes			
Class A	10%	Indicator Species* and Canopy Position	Structure Data (for upper layer lifeform)
			<i>Min</i> <i>Max</i>
Early Development 1	All Structures	ACHY Lower	<i>Cover</i> 0% 50%
		BOGR2 Lower	<i>Height</i> Herb 0m Herb >1.1m
		ARNO4 Upper	<i>Tree Size Class</i> None
		ARBI3 Upper	<input checked="" type="checkbox"/> Upper layer lifeform differs from dominant lifeform.
Upper Layer Lifeform			Scattered sagebrush recovering. Dominant vegetation is bunch grasses.
<input checked="" type="checkbox"/> Herbaceous			
<input type="checkbox"/> Shrub			
<input type="checkbox"/> Tree	Fuel Model 1		
Description			

Early seral community dominated by herbaceous vegetation; less than six percent sagebrush canopy cover; up to 24yrs post-disturbance. Replacement fire occurs every 250yrs on average. Succession to B after 24yrs.

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.
 **Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

Class B 70%

Late Development 1 Open

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model 2**Indicator Species* and Canopy Position**

ARNO4 Upper
 ARBI3 Upper
 ACHY Lower
 BOGR2 Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	10 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

 Upper layer lifeform differs from dominant lifeform.**Description**

Mid-seral community with a mixture of herbaceous and shrub vegetation; 6-10% sagebrush canopy cover present; between 20-59yrs post-disturbance. Replacement fire (FRI of 240yrs) causes a transition to A, whereas mixed severity fire (FRI of 100yrs) maintains the site in its present condition. In the absence of fire for 120yrs, the site will follow an alternative succession path to class C. Otherwise, succession and mixed severity fire keeps site in class B.

Class C 20%

Late Development 1 Closed

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model 2**Indicator Species* and Canopy Position**

ARNO4 Upper
 ARBI3 Upper
 ACHY Lower
 BOGR2 Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	10 %	30 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

 Upper layer lifeform differs from dominant lifeform.**Description**

Late seral community with a mixture of herbaceous and shrub vegetation; >10% sagebrush canopy cover present; 75yrs+ post-disturbance. Replacement fire is every 200yrs on average (transition to A), whereas mixed severity fire happens on average every 140yrs due to a diminished herbaceous component compared to class B. Mixed severity fire causes a transition to B. Succession will keep the site in class C without fire.

Class D 0%

[Not Used] [Not Used]

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model**Indicator Species* and Canopy Position****Structure Data (for upper layer lifeform)**

	Min	Max
Cover	%	%
Height		
Tree Size Class		

 Upper layer lifeform differs from dominant lifeform.**Description****Class E 0%**

[Not Used] [Not Used]

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model**Indicator Species* and Canopy Position****Structure Data (for upper layer lifeform)**

	Min	Max
Cover	%	%
Height		
Tree Size Class		

 Upper layer lifeform differs from dominant lifeform.

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.
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Description

Disturbances

Fire Regime Group:** III

Historical Fire Size (acres)

Avg 50
Min 10
Max 100

Sources of Fire Regime Data

- Literature
- Local Data
- Expert Estimate

Additional Disturbances Modeled

- Insects/Disease
- Native Grazing
- Other (optional 1)
- Wind/Weather/Stress
- Competition
- Other (optional 2)

Fire Intervals	<i>Avg FI</i>	<i>Min FI</i>	<i>Max FI</i>	<i>Probability</i>	<i>Percent of All Fires</i>
<i>Replacement</i>	238	100	240	0.004202	33
<i>Mixed</i>	119	75	140	0.008403	67
<i>Surface</i>					
<i>All Fires</i>	79			0.01262	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class.

References

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Zamora, B. and P.T. Tueller. 1973. *Artemisia arbuscula*, *A. longiloba*, and *A. nova* habitat types in northern Nevada. *Great Basin Naturalist* 33: 225-242 .

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 1310790

Great Basin Xeric Mixed Sagebrush Shrubland

- This BPS is lumped with:
 This BPS is split into multiple models:

General Information

Contributors (also see the Comments field) **Date** 9/8/2005

Modeler 1 Jan Nachlinger jnachlinger@tnc.org **Reviewer**
Modeler 2 **Reviewer**
Modeler 3 **Reviewer**
FRCC

Vegetation Type

Upland Shrubland

Map Zones

12

17

13

Model Zones

- Alaska N-Cent.Rockies
 California Pacific Northwest
 Great Basin South Central
 Great Lakes Southeast
 Northeast S. Appalachians
 Northern Plains Southwest

Dominant Species*

ARNO
ACHY
ACTH

General Model Sources

- Literature
 Local Data
 Expert Estimate

Geographic Range

Western Utah and throughout Nevada. In MZ 13, especially common in the Desert National Wildlife Refuge (Sheep Range; Ackerman 2003).

Biophysical Site Description

This type describes black sage and low sagebrush, mostly on convex slopes with big sagebrush occurring in concave slopes and inset alluvial fans. Alluvial fans, piedmont, bajadas, rolling hills and mountain slopes. Can also be found on flats and plains. Other species include horsebrush, spiny hopsage, rubber rabbitbrush, although these are mostly associated with big sagebrush areas. Low/green rabbitbrush is associated with black sagebrush, as well as shadscale. Elevations range from 1500m to 2600m. Low sagebrush tends to grow where claypan layers exist in the soil profile and soils are often saturated during a portion of the year. Black sagebrush tends to grow where there is a root-limiting layer in the soil profile. Big sagebrush generally occur on moderately deep to deep soils that are well-drained.

Vegetation Description

This type includes communities dominated by black sagebrush (*Artemisia nova*), low sagebrush (*Artemisia arbuscula*), and big sagebrush (*Artemisia tridentata*) where there is a potential for pinyon (*Pinus monophylla*) and/or juniper (*Juniperus osteosperma*) establishment. Black sagebrush is the dominant shrub in this system with big sagebrush and winterfat occurring in minor compositions, sometimes scattered but mostly continuous. Black sagebrush generally has relatively low fuel loads with low growing and cushion forbs and scattered bunch grasses such as needlegrasses (*Achnatherum* spp.), Sandberg's bluegrass (*Poa secunda*) and Indian ricegrass (*Achnatherum hymenoides*). Forbs often include buckwheats (*Eriogonum* spp.), fleabanes (*Erigeron* spp.), phloxs (*Phlox* spp.), paintbrushes (*Castilleja* spp.), globemallows (*Sphaeralcea* spp.), lupines (*Lupinus* spp.), and milkvetches (*Astragalus* spp.).

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.

**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

Disturbance Description

Black sagebrush generally supports more fire than other dwarf sagebrushes. FRG could be either IV or III. This type generally burns with mixed severity (average FRI of 100-140 yrs) due to relatively low fuel loads and herbaceous cover. Bare ground acts as a micro-barrier to fire between low statured shrubs. Stand-replacing fires (average FRI of 200-240 yrs) can occur in this type when successive years of above average precipitation are followed by an average or dry year. Stand replacement fires dominate in the late successional class where the herbaceous component has diminished or where trees dominate.

Grazing by wild ungulates occurs in this type due to its high palatability (mostly for *A. nova* and *A. arbuscula*). Native browsing tends to open up the canopy cover of shrubs but does not often change the successional stage. Native grazing was not included in the model.

Severe drought occurs on average every 75 years (10 yr duration) and causes two equally probably transitions: moderate thinning of the stand (maintaining conditions in the current class), or severe thinning (causing a transition to the previous development class).

Burrowing animals and ants breaking through the root restrictive zone of low and black sagebrush types create mounds of mineral soil (seedbed) that is readily colonized by big sagebrush. Burrowing creates small patches (i.e., generally less than 200 sq. ft) of big sagebrush in the low sagebrush types, which could affect fuel loads. This was not considered in the model.

Adjacency or Identification Concerns

The black and low sagebrush type tends to occur adjacent to either big sagebrush (nearly exclusively basin big sagebrush in the Mojave Desert; BpS 131080) types and adjacent to Mojave Desert mixed scrub and blackbrush (BpS 131082) at lower elevations. The big sagebrush types create a mosaic within the black and low sagebrush types. These big sagebrush types have a different fire regime that acts to carry the fire, with black and low sagebrush serving as fire breaks most of the time.

After mixed- or low-severity fires, composition is primarily islands of black sagebrush with interspaces dominated by low rabbitbrush that resprouts, and with time, increases of shadscale and herbaceous composition.

Native Uncharacteristic Conditions

Shrub cover greater than 30% is considered uncharacteristic. Tree cover greater than 40% is uncharacteristic.

Scale Description

Sources of Scale Data Literature Local Data Expert Estimate

Black sagebrush can occupy large areas (50,000 acres) in MZ 13. Disturbance patch size for this type is not well known but is estimated to be 10s to 100s of acres due to the relatively small proportion of the sagebrush matrix it occupies and the limited potential for fire spread. Where these sites exist in a more herbaceous state, fire expands readily where there is continuity of fine fuels to carry it to the extent that there is wind in a low intensity burn. Fire sizes up to 800 acres are possible in situations like this.

Issues/Problems

The effect of insect outbreaks (independent of drought) on mature pinyon and juniper in class D can cause a 50% reduction in class D (from 10 to 5%) if part or all of the outbreak sufficiently thins older trees (transition to class C). We assumed that 25% of outbreaks results in a transition to class C from D.

Comments

BpS 131079 is essentially BpS 171079 developed by Crystal Kolden (ckolden@gmail.com) and Gary Medlyn (gmedlyn@nv.blm.gov). Modifications to BpS 171079 for MZ 13 are for species composition and reducing the return interval of drought from 200 to 75 years as used in other Mojave Desert models.

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.

**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

Therefore, changes to the model and output were made with the greatest difference being a 5% absolute reduction of class D. Another modification was to reduce the maximum tree cover in class D from 40% to 30%, as in juniper savanna (BpS 131115).

BpS 171079 was originally based on the Rapid Assessment model R2SBDW (dwarf sagebrush) developed by Gary Medlyn (gmedlyn@nv.blm.gov) and Sarah Heidi (sarah_heidi@blm.gov). Following expert review, choice of model was switched to R2SBDWwt (dwarf sagebrush with trees) developed by Gary Medlyn and Sarah Heidi because the NatureServe description includes pinyon and juniper encroachment and the appropriate elevation. Also, the reviewer indicated that black sagebrush is usually associated with juniper or pinyon in northcentral Nevada and recommended the version of the model with tree encroachment. Modifications were made to weather stress pathways and probabilities for R2SBDWwt. R2SBDW was reviewed by Paul Blackburn (paul.blackburn@usda.gov), Gary Back (gback@srk.com), and Paul Tueller (ptt@intercomm.com), whereas R2SBDWwt was reviewed by Paul Tueller.

Vegetation Classes

Class A 20 %
 Early Development 1 All Stru
Description
 Early seral community dominated by herbaceous vegetation; less than 6% sagebrush canopy cover; up to 24 years post-disturbance. Fire-tolerant shrubs (green/low rabbitbrush) are first sprouters after stand-replacing, high-severity fire. Replacement fire (mean FRI of 250 yrs) maintains vegetation in state A. Prolonged drought every 200 yrs on average maintains vegetation in class A. Succession to B after 25 years.

Indicator Species* and Canopy Position
 ACTH7 Middle
 POSE Low-Mid
 ACHY Middle

Upper Layer Lifeform
 Herbaceous
 Shrub
 Tree

Fuel Model 1

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:
 Dominant lifeform is primarily herbaceous with some resprouting rabbitbrush. Canopy cover 4-10%, height 18-36cm (0.2-0.4m).

Class B 60 %
 Mid Development 1 Open
Description
 Mid-seral community with a mixture of herbaceous and shrub vegetation; 6 to 25% sagebrush (sagebrush/brush) canopy cover present; between 20 to 59 years post-disturbance. Drought every 200 yrs causes two transitions: 50% of times drought thins shrubs while maintaining vegetation in class B, whereas 50% of times

Indicator Species* and Canopy Position
 ARNO4 Upper
 POSE Lower
 ACHY Mid-Upper

Upper Layer Lifeform
 Herbaceous
 Shrub
 Tree

Fuel Model 1

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	30 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

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 **Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

drought causes a stand replacing event. Replacement fire (FRI of 250 yrs) causes a transition to A, whereas mixed severity fire (FRI of 100 yrs) maintains the site in its present condition. In the absence of fire for at least 120 yrs, the site will follow an alternative successional path to C.

Class C 15%

**Late Development 1 Open
Description**

Late seral community with a mixture of herbaceous and shrub vegetation; 10-25% sagebrush canopy cover present; and dispersed conifer seedlings and saplings established at <6% cover. Insect attack the vegetation in this state every 60 yrs on average, but does not causes a transition to another state. Severe droughts (return interval of 200 yrs) causes two thinning disturbances: to class B (50% of times) and within class C. Replacement fire is every 200 years on average, whereas mixed severity fire is less frequent than in class B (FRI of 130 yrs). Succession is to class D after 75 yrs.

Indicator Species* and Canopy Position

ARNO4 Upper
JUOS Upper
POSE Mid-Upper
ACHY Mid-Upper

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 2

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Tree 0m	Tree 5m
Tree Size Class	Seedling <4.5ft	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Juniper, and maybe pinyon, overtopping shrubs. Tree cover <6%. Shrub canopy cover may reach 25%

Class D 5%

**Late Development 1 Closed
Description**

Late seral community with a closed canopy of conifer trees (6-30% cover). The degree of tree canopy closure differs depending on whether it is a low sagebrush (max 15%) or black sagebrush (max 40%) community. In low sagebrush communities a mixture of herbaceous and shrub vegetation

Indicator Species* and Canopy Position

JUOS Upper
PIMO Upper
ARNO Middle
ACHY Lower

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 2

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	30 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

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**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

with >10% sagebrush canopy cover would still be present. In black sagebrush communities the herbaceous and shrub component would be greatly reduced (<1%). When Ips beetle outbreaks occur the pinyon component is reduced (return interval of 60 yrs): 75% of times thinning is not intense enough to cause a transition whereas in 25% of cases a transition to class C will occur. The only fire is replacement (FRI of 150 yrs) and driven by a greater amount of woody fuel than in previous states. Prolonged droughts have the same effect as before. Succession from class D to D without fire.

Class E 0%

Late Development 1 Open

Description

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class	None	

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Fuel Model

Disturbances

Fire Regime Group:** 3

Historical Fire Size (acres)

Avg 50
Min 1
Max 2000

Sources of Fire Regime Data

- Literature
- Local Data
- Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	232	100	250	0.00431	38
Mixed	141	75	140	0.00709	62
Surface					
All Fires	88			0.01141	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class.

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.

**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

Additional Disturbances Modeled

- Insects/Disease Native Grazing Other (optional 1)
 Wind/Weather/Stress Competition Other (optional 2)

References

Ackerman, T. L. 2003. A flora of the Desert National Wildlife Range, Nevada. Edited by J. Bair and A. Tiehm. *Mentzelia* 7.

Blackburn, W. H. and P. T. Tueller. 1970. Pinyon and juniper invasion in black sagebrush communities in east-central Nevada. *Ecology* 51(5):841-848.

Young, J. A. and D. E. Palmquist. 1992. Plant age/size distributions in black sagebrush (*Artemisa nova*): effects on community structure. *Great Basin Naturalist* 52(4):313-320.

Ratzlaff, T. D. and J. E. Anderson. 1995. Vegetal recovery following wildfire in seeded and unseeded sagebrush steppe. *Journal of Range Management* 48:386-391.

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Zamora, B. and P. T. Tueller. 1973. *Artemisia arbuscula*, *A. longiloba*, and *A. nova* habitat types in northern Nevada. *Great Basin Naturalist* 33: 225-242.

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.

**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 1310800

Inter-Mountain Basins Big Sagebrush Shrubland

- This BPS is lumped with:
 This BPS is split into multiple models:

General Information

Contributors (also see the Comments field) **Date** 9/8/2005

Modeler 1 Jan Nachlinger jnachlinger@tnc.org **Reviewer**
Modeler 2 **Reviewer**
Modeler 3 **Reviewer**
FRCC

Vegetation Type

Upland Shrubland

Map Zones

16

12

17

13

Model Zones

- Alaska N-Cent.Rockies
 California Pacific Northwest
 Great Basin South Central
 Great Lakes Southeast
 Northeast S. Appalachians
 Northern Plains Southwest

Dominant Species*

ARTR ATCO
CHVI8 ELELE
ACHY POSE
HECO PLJA

General Model Sources

- Literature
 Local Data
 Expert Estimate

Geographic Range

This ecological system is found in eastern CA, central/southern NV, and UT and is distinct from sagebrush steppe (Inter-Mountain Basins Big Sagebrush Steppe) found on the Columbia Plateau and in Wyoming. This BpS extends into MZ 13 but at higher elevations than in central NV and is not a common system.

Biophysical Site Description

This widespread system is common to the Basin and Range province, but much less widespread in the Mojave Desert. In elevation it ranges from 3,000 - 7,000 ft (above 4,000ft at lower latitudes), and occurs on well-drained soils on foothills, terraces, slopes and plateaus. It is found on soil depths greater than 18 inches and up to 60+ inches. Elevationally it is found between low elevation salt desert shrub or blackbrush and mountain big sagebrush zones where pinyon and juniper can establish. Occurs from 4 to 14 inch precipitation zones, however. Thus, other sites characteristics (e.g. aspect, drainage) should be considered in identifying this ecotype. At the precipitation extremes, this system generally occurs as small patches and stringers.

Vegetation Description

Shrub canopy cover generally ranges from 5 to 25%, but can exceed 30% at the upper elevation and precipitation zones. Basin big and/or Wyoming big sagebrush sites have fewer understory species relative to other big sagebrush types. Wyoming big sagebrush is absent from many parts of MZ 13, whereas basin big sagebrush is the diagnostic shrub (NRCS 2003b). Rubber rabbitbrush is co-dominant.

Perennial forb cover is usually <10% with perennial grass cover reaching 20 - 25% on the more productive sites. Sandberg bluegrass (*Poa secunda*) may be a dominant species following replacement fires and as a co-dominant after 20 years, but only in precipitation zones above 10". Bottlebrush squirreltail, Indian ricegrass, James galleta or sandy needle and thread grasses are common on more xeric sites. Percent cover

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and species richness of understory are determined by site limitations. Pinyon (generally *Pinus monophyla*) and juniper (generally *Juniper osteosperma*) present, occasionally reaching 50% canopy cover in areas that have escaped fire.

Disturbance Description

This ecological system is characterized by replacement fires where shrub canopy exceeds 25% cover (i.e., class C) or where grass cover is >15% and shrub cover is > 20% (i.e., class B). Mixed Severity fires account for 20% of fire activity (mean FRI of 500 years) where shrub cover ranges from 10 to 20% (i.e., class B). Surface fires occur where shrub cover is <10% (i.e., class A) and is generally uncommon (FRI of 200 years). Where pinyon or juniper has encroached after 100 years without fire, mean FRI of fire replacement increases from 100 to 125 years. In MZs 12 and Z17, reduced shrub cover associated with more xeric sites pushes FRI to longer periods.

Weather stress: Prolonged drought (1 in 50 years; 20-30 yr Pacific cycle modified by 7 yr El Nino/El Nina cycle) on the more xeric sites will reduce woody cover.

Herbivory (non-insect); Herbivory can remove the fine fuels that support Mixed Severity fires and result in woody fuel build up that leads to severe Replacement fires.

Adjacency or Identification Concerns

This community may be adjacent to mountain big sagebrush at elevations above 6,500 ft., or adjacent to pinyon-juniper, ponderosa pine, at mid- to high-elevations, and salt desert shrub and blackbrush at low elevations. Low sagebrush or black sagebrush (BpS 1079) may form large islands within this community where soils are shallow or have root-restrictive layers. Black sagebrush is very common in the Desert National Wildlife Refuge and forms matrix communities.

Post-settlement conversion to red brome with cheatgrass is common and results in change in fire frequency and vegetation dynamics. Fire suppression can lead to pinyon-juniper encroachment with subsequent loss of shrub and herbaceous understory. Disturbance of this community may result in establishment of annual grasslands (e.g., red brome) and/or noxious weeds. Lack of disturbance can result in pinyon-juniper encroachment where adjacent to pinyon-juniper woodlands.

Post-settlement issues center around the high amount of big sagebrush with minimal to no understory, and whether these decadent stands are related to fire exclusion, historic livestock overgrazing, or natural physiological/ecological progression.

Native Uncharacteristic Conditions

Shrub cover greater than 50% is uncharacteristic. Tree cover greater than 50% is uncharacteristic.

Scale Description

Sources of Scale Data Literature Local Data Expert Estimate

BpS occupies small areas (<1,000's acres). Historic disturbance (fire) likely ranged from small (< 10 ac) to moderate (<1,000 acres) depending on conditions, time since last ignition, and fuel loading. The average fire patch size is assumed to be 100 acres.

Issues/Problems

There is uncertainty about whether or not Wyoming big sagebrush is present at all in MZ 13. NRCS considers Wyoming big sagebrush absent from the Mojave Desert, whereas a recent flora for the Desert National Wildlife Refuge describes Wyoming big sagebrush as the only big sagebrush subspecies. While recognizing the difficulty of identifying big sagebrush species, Dr. Wes Niles from University of Nevada, Las Vegas (wniles@ccmail.nevada.edu) (pers. comm.) confirmed that all his Mojave Desert herbarium specimens, including those from the Desert National Wildlife Refuge, are basin big sagebrush. Similarly,

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**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

older flora for the Spring Mountains National Recreation Area describes basin big sagebrush, not Wyoming big sagebrush. The problem with the absence of Wyoming big sagebrush is that basin big sagebrush looks like Wyoming big sagebrush and occupies what appears to be "classic" Wyoming big sagebrush sites as seen in the Great Basin.

There are no data, although abundant opinions, for the percentage of replacement and mixed severity fires, especially during mid-development, or whether surface fires occurred at all during early development under reference (pre-settlement) condition.

NOTE regarding depleted sagebrush: Late seral stage was not modeled as it was identified that sagebrush depletion rate is much slower than the rate of juniper invasion. Further, sagebrush is unable to exclude grass/forb, thereby maintaining fire and moving the system back to earlier classes.

Comments

BpS 131080 is based on BpS 171080 (or 121080), which was adapted to MZ 12 and 17 by Don Major (dmajor@tnc.org), Gary Medlyn (gmedlyn@nv.blm.gov), and Crystal Kolden (ckolden@gmail.com). Modifications to BpS 121080 for MZ 13 are about species composition, smaller spatial scale, disturbances, and geographic range. Wyoming big sagebrush is uncommon to absent in many parts of the Mojave Desert mountain ranges, whereas basin big sagebrush is the dominant shrub for BpS 131080. Model was changed because defoliation by Aroga moth and prolonged flooding were removed, and the drought cycle shortened from 100 to 50 yrs to reflect the different climate cycles of the Mojave Desert compared to the Great Basin. New dynamics changed results, but not dramatically (5% less or class B and 5% mode of class D).

S-class height and cover rules should be rectified to match zones 12 and 17.

BpS 121080 (171080) was closely based on R2SBWY and R2SBWYwt originally modeled by Gary Back (gback@srk.com) and modified by Louis Provencher (lprovencher@tnc.org) based on reviews by Stanley G. Kitchen (skitchen@fs.fed.us), Peter Weisberg (pweisberg@cabnr.unr.edu), and Jolie Pollet (jpollet@blm.gov). This model assumes the sites are near pinyon-juniper savanna or woodlands and without frequent fire, pinyon or juniper will encroach into the sagebrush range site. In areas without a potential for tree invasion (e.g., lower elevation), the Historic Range of Natural Variability for classes A, B, and C, respectively, is 10%, 55%, and 35% (results of R2SBWY).

The first three development classes chosen for this ecological system correspond to the early, mid-, and late seral stages familiar to range ecologists. The two classes with conifer invasion (classes D and E) approximately correspond to Miller and Tausch's (2001) phases 2 and 3 of pinyon and juniper invasion into shrublands.

Vegetation Classes

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.

**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

Class A 15 %

Early Development 1 All Stru

Description

Post-replacement disturbance; grass dominated with scattered shrubs. Fuel loading discontinuous. Surface fire occurs every 200 years on average but has no effect on succession. Succession to class B after 20 years.

Indicator Species* and Canopy Position

ACHY Upper
HECO2 Upper
CHVI8 Upper
ARTR2 Upper

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 1

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	10 %
Height	Shrub Dwarf <0.5m	Shrub Short 0.5-0.9m
Tree Size Class	None	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Early development is dominated by grasses and forbs with scattered shrubs representing <10% upper canopy cover.

Class B 45 %

Mid Development 1 Open

Description

Shrubs and herbaceous vegetation can be co-dominant, fine fuels bridge the woody fuels, but fuel discontinuities are possible. Replacement fire accounts for 80% of fire activity (mean FRI of 125 years), whereas mixed severity fire occurs every 500 years on average (20% of fire activity) and maintains vegetation in class B. Succession to class C after 40 years.

Indicator Species* and Canopy Position

ARTR2 Upper
ACHY Lower
CHVI8 Mid-Upper
HECO2 Lower

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 2

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	20 %
Height	Shrub Dwarf <0.5m	Shrub Short 0.5-0.9m
Tree Size Class	None	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Class C 25 %

Mid Development 1 Closed

Description

Shrubs dominate the landscape; fuel loading is primarily woody vegetation. Shrub density sufficient in old stands to carry the fire without fine fuels. Establishment of pinyon and juniper seedlings and saplings widely scattered. Replacement fire (mean FRI of 100 years) and rare flood events (return interval of 333 years) cause a transition to class A. Prolonged drought (mean return interval of 50 years) cause a transition to class B.

Indicator Species* and Canopy Position

ARTR2 Upper
CHVI8 Mid-Upper
ELEL5 Lower
HECO2 Lower

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 2

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	40 %
Height	Shrub Dwarf <0.5m	Shrub Short 0.5-0.9m
Tree Size Class	None	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

Succession to class D after 40 years.

Class D 10 %

Late Development 1 Open
Description
 Pinyon-juniper encroachment where disturbance has not occurred for at least 100 years (tree species cover <15%). Saplings and young trees are the dominant lifeform. Sagebrush cover (<25%) and herbaceous cover decreasing compared to class C. Replacement fire occurs every 125 years on average. Prolonged drought (every 50 years) thin both trees and shrubs, causing a transition to class C. Succession to class E after 50 years.

Indicator Species* and Canopy Position

JUNIP Upper
 PIMO Upper
 ARTR2 Mid-Upper
 HECO2

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 2

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Tree Regen <5m	Tree Regen <5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:
 Shrubs may still represent the dominant lifeform with pinyon and juniper saplings common (1-15% upper canopy cover).

Class E 5 %

Late Development 1 Closed
Description
 Shrubland encroached with mature pinyon and/or juniper (cover 16-90%) where disturbance does not occur for at least 50 years in Class D. Shrub cover <10% and graminoids scattered. Replacement fire occurs every 125 years on average. Prolonged drought (about every years) thins trees, causing a transition to class B. Succession maintains class E.

Indicator Species* and Canopy Position

JUNIP Upper
 PIMO Upper
 SYOR Lower
 HECO2 Lower

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 6

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	50 %
Height	Tree Regen <5m	Tree Short 5-9m
Tree Size Class	None	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Disturbances

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.
 **Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

Fire Regime Group:** 4

Historical Fire Size (acres)

Avg 100

Min 10

Max 1000

Sources of Fire Regime Data

- Literature
- Local Data
- Expert Estimate

Additional Disturbances Modeled

- Insects/Disease
- Native Grazing
- Other (optional 1)
- Wind/Weather/Stress
- Competition
- Other (optional 2)

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	135	30	200	0.00741	86
Mixed	1111	20	333	0.00090	10
Surface	3333	20	200	0.00030	3
All Fires	116			0.00861	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class.

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LANDFIRE Biophysical Setting Model

Biophysical Setting: 1711250

Inter-Mountain Basin Big Sagebrush Steppe

- This BPS is lumped with:
- This BPS is split into multiple models:

General Information

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Vegetation Type

Upland Savanna and Shrub-Steppe

Map Zones

16 0
12 0
17 0
0 0
0 0

Model Zones

- Alaska N-Cent. Rockies
- California Pacific Northwest
- Great Basin South Central
- Great Lakes Southeast
- Northeast S. Appalachians
- Northern Plains Southwest

Dominant Species*

ARTR
AGSP
STTH2
POSA1

General Model Sources

- Literature
- Local Data
- Expert Estimate

Geographic Range

This widespread matrix-forming ecological system occurs throughout much of the Columbia Plateau and northern Great Basin and Wyoming and is found at slightly higher elevations farther south.

Biophysical Site Description

Sagebrush steppe is found in continental, semi-arid climate with highly variable annual precipitation greater than 7" to 12" (~180 to 300 mm) (McArthur 2000) that may also include 14" precipitation zone. Common on foothills, undulating terraces, slopes, and plateaus, but also in basins and valley bottoms. Soil depths range from shallow to moderately deep, well-drained with an effective rooting depth of less than 40 inches (~ 1 m). NRCS Range Sites: Loamy 8-10" and 10-12" precipitation zones, and shallow loam 10-14" precipitation zones.

Vegetation Description

This shrub-steppe is dominated by perennial grasses and forbs (>25% cover) with *Artemisia tridentata* ssp *tridentata*, *Artemisia tridentata* ssp *wyomingensis*, and/or *Purshia tridentata* dominating or codominating the open to moderately dense (10-40% cover) shrub layer. In southern Idaho and northern Utah, *Artemisia tridentata* ssp *wyomingensis* dominates large landscape. *Atriplex confertifolia*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa*, or *Tetradymia* spp may be common especially in disturbed stands. Associated graminoids include *Achnatherum hymenoides*, *Elymus lanceolatus* ssp. *Lanceolatus*, *Festuca idahoensis*, *Festuca campestris*, *Koeleria macrantha*, *Poa secunda*, and *Pseudoroegneria spicata*. Common forbs are *Phlox hoodii*, *Arenaria* spp., and *Astragalus* spp. Areas with deeper soils more commonly support *Artemisia tridentata* ssp *tridentata* but have largely been converted for other land uses.

The sagebrush steppe landscape is a mosaic of shrub-dominated and herbaceous-dominated phases (West 2000). Forbs have low diversity but are important for wildlife, including the Greater Sage Grouse. Species

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diversity is lower in Wyoming big sagebrush communities than in other big sagebrush types (FEIS). Wyoming big sagebrush communities are critical habitat for Greater Sage Grouse and other sagebrush obligate species.

Disturbance Description

Historically, fire was the principal disturbance within this vegetation type; other disturbances included insects (e.g., moths and grasshoppers that eat leaves, moth larval grubs that eat roots; return interval of 75 years), periods of drought and wet cycles and shifts in climate (return interval of 100 yrs). Intervals between natural wildfires varied between 25 years (northern Yellowstone National Park [Houston 1973], cited in West 2000) and 100+ years (West 2000). West (1983) and Miller and Eddelman (2000) cite mean FRI <100 years for replacement fire. FEIS cites fire return interval ranges between 10 to 70 years with mean of 40 years for Wyoming sagebrush steppe. Studies cited in FEIS may underestimate FRIs or not hold up to scrutiny (Welch and Criddle 2003). It was assumed that dominant fires were stand replacement (mean FRIs of 75-94 years) due to the continuity of fine fuels typical of steppe ecosystems. Mixed severity (25-75% of area inside burn perimeter topkilled) played a minor role during mid-development. Assuming a MFI of 75 years (from the total fire probability), the mean FRI of mixed severity fire was 20% of fires, thus a mean FRI of 375 years, during mid-development. Re-establishment following fire is from seed germination and establishment. Establishment is dependent upon soil seedbank and/or proximity of seed sources, fire size and continuity, and climatic conditions.

Adjacency or Identification Concerns

The NatureServe description of BPS 1125 includes different species of sagebrush and steppe ecosystems that are structurally and ecologically different such as *Artemisia tridentata* ssp *tridentata* and *Artemisia tridentata* ssp *wyomingensis*. We highly recommend that, at least, *Artemisia tridentata* ssp *tridentata*, which is a taller shrub found in drainages and deeper soils, be separated from the other shrubs. Ultimately, the two sagebrush species should be modeled separately. *Artemisia tripartita* ssp *tripartita* is not part of this system in Nevada because it is generally associated with frigid soils (thus more typically mountain big sagebrush) under snow pockets. Bitterbrush is not found in a large area of northcentral Nevada on the more alkaline soils of Pleistocene Lake Lahontan.

Wyoming big sagebrush is known to hybridize with other subspecies of the big sagebrush complex; i.e., basin big sagebrush (*A. tridentata* ssp *tridentata*) and mountain big sagebrush (*A. tridentata* ssp *vaseyana*) (Freeman et al. 1991, McArthur et al. 1998). Across ecotones, populations of Wyoming big sagebrush probably intergrade with basin big sagebrush and mountain big sagebrush. Soils and elevation may help determine which species is present.

Invasion of cheatgrass has transformed this ecological system into large areas of uncharacteristic annual grasslands and shrublands with understories where annual grasses replaced perennial grasses.

Native Uncharacteristic Conditions

Scale Description

Sources of Scale Data Literature Local Data Expert Estimate

Sagebrush steppe covers vast landscapes >10,000 acres with inclusions of low sagebrush and basin big sagebrush. Historic disturbance (fire) likely ranged from small (< 10 ac) to large (> 10,000 acres) depending on conditions, time since last ignition, and fuel loading. Assumed the average patch size is 250 acres.

Issues/Problems

West (2000) cites wide range in FRI (25 to +100 years). West (1983) and Miller and Eddelman (2000) recommend a FRI of <100 yrs for replacement fire. FEIS gives 10 to 70 range (40 y average) (but see Welch and Criddle 2003). Current scientific opinion (Mike Pellant, BLM Range Ecologist on the Great

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Basin Restoration Initiative) puts the natural fire return interval at about 100 years (confirmed by Stephen Bunting and Dave Pyke). Given uncertainties and opinions of reviewers, a MFI of 75 years was chosen. Without this shorter MFI and differences in fire behavior, there would be no difference between Wyoming sagebrush steppe from the Snake River plains and Wyoming big sagebrush semi-desert from central Nevada, Utah, and eastern California. Because replacement fire is by far dominant over mixed severity fire, a FRG IV was selected to the recommendation of reviewers.

Comments

BPS 1125 for MZs 12 and 17 was obtained by slightly modifying the description of BPS 1125 for MZ 16 developed by Don Major (dmajor@tnc.org). BPS 1125 for MZ 16 is completely based on R2SBWYse developed by Eric Limbach (eric_limbach@blm.gov) for Wyoming big sagebrush steppe and reviewed by Krista Waid-Gollnick/Sarah Heidi (krista_waid@blm.gov, Stanley Kitchen (skitchen@fs.fed.edu), Michael Zielinski (mike_zielinski@nv.blm.gov), Jolie Pollet (jpollet@blm.gov), and Gary Back (gback@srk.com).

Vegetation Classes														
<p>Class A 20%</p> <p>Early Development 1 Open</p> <p>Description</p> <p>Perennial grasses and forbs dominate where woody shrub canopy has been top killed / removed by wildfire. Shrub cover <6%. (~ 0 to 19 years). Replacement fire every 120 years on average resets succession back to zero. Succession to class B after 20 years.</p>	<p>Indicator Species* and Canopy Position</p> <p>AGSP Upper STTH2 Upper POSA1 Upper ARTR Upper</p> <p>Upper Layer Lifeform</p> <p><input type="checkbox"/> Herbaceous <input checked="" type="checkbox"/> Shrub <input type="checkbox"/> Tree</p> <p>Fuel Model 1</p>	<p>Structure Data (for upper layer lifeform)</p> <table border="1"> <thead> <tr> <th></th> <th>Min</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Cover</td> <td>0%</td> <td>5%</td> </tr> <tr> <td>Height</td> <td>Shrub Dwarf <0.5m</td> <td>Shrub Short 0.5-0.9m</td> </tr> <tr> <td>Tree Size Class</td> <td colspan="2">None</td> </tr> </tbody> </table> <p><input checked="" type="checkbox"/> Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:</p> <p>Vegetation is primarily herbaceous with a few scattered shrubs accounting for < 5% cover.</p>		Min	Max	Cover	0%	5%	Height	Shrub Dwarf <0.5m	Shrub Short 0.5-0.9m	Tree Size Class	None	
	Min	Max												
Cover	0%	5%												
Height	Shrub Dwarf <0.5m	Shrub Short 0.5-0.9m												
Tree Size Class	None													
<p>Class B 50%</p> <p>Mid Development 1 Open</p> <p>Description</p> <p>Shrubs dominate (5-25% cover) with diverse perennial grass and forb understory (20 to 60 years). MFI is 75 years with 80% replacement fire (mean FRI of 94 years) and 20% mixed severity fire (mean FRI of 375 years). Mixed severity fire, insect/disease (return interval of 75 years), and weather related stress (return interval of 100 yrs) maintains vegetation in class B. Succession to class C after 40 years.</p>	<p>Indicator Species* and Canopy Position</p> <p>AGSP Lower STTH2 Lower ARTR Upper POSA1 Lower</p> <p>Upper Layer Lifeform</p> <p><input type="checkbox"/> Herbaceous <input checked="" type="checkbox"/> Shrub <input type="checkbox"/> Tree</p> <p>Fuel Model 1</p>	<p>Structure Data (for upper layer lifeform)</p> <table border="1"> <thead> <tr> <th></th> <th>Min</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Cover</td> <td>5%</td> <td>25%</td> </tr> <tr> <td>Height</td> <td>Shrub Dwarf <0.5m</td> <td>Shrub Medium 1.0-2.9m</td> </tr> <tr> <td>Tree Size Class</td> <td colspan="2">None</td> </tr> </tbody> </table> <p><input type="checkbox"/> Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:</p>		Min	Max	Cover	5%	25%	Height	Shrub Dwarf <0.5m	Shrub Medium 1.0-2.9m	Tree Size Class	None	
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Tree Size Class	None													

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Class C 30%

Late Development 1 Closed

Description

Mature shrub canopy > 25% cover with proportional reduction in understory productivity as canopy cover increases. The mean FRI for replacement fire is 75 years. Insect/diseases (return interval of 75 years), and weather related stress (return interval of 100 yrs) thin the shrub canopy, causing a transition to class B. Succession from class C to C.

Indicator Species* and Canopy Position

ARTR Upper
AGSP Lower
STTH2 Lower
POSA1 Lower

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 2

Structure Data (for upper layer lifeform)

	Min	Max
Cover	25 %	35 %
Height	Shrub Dwarf <0.5m	Shrub Medium 1.0-2.9m
Tree Size Class	None	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Class D 0%

Late Development 1 Open

Description

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class	None	

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Class E 0%

Late Development 1 Open

Description

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	%
Height		
Tree Size Class	None	

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Disturbances

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**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

Fire Regime Group:** 4

Historical Fire Size (acres)

Avg 250
Min 10
Max 10000

Sources of Fire Regime Data

- Literature
- Local Data
- Expert Estimate

Additional Disturbances Modeled

- Insects/Disease
- Native Grazing
- Other (optional 1)
- Wind/Weather/Stress
- Competition
- Other (optional 2)

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	92	30	120	0.01087	89
Mixed	714	120	500	0.00140	11
Surface					
All Fires	81			0.01228	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class.

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**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 1311260

Inter-Mountain Basins Montane Sagebrush Steppe

- This BPS is lumped with:
 This BPS is split into multiple models:

General Information

Contributors (also see the Comments field) **Date** 9/8/2005

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Modeler 2 **Reviewer**
Modeler 3 **Reviewer**
FRCC

Vegetation Type

Upland Savanna and Shrub-Steppe

Map Zones

12
17
16
13

Model Zones

- Alaska N-Cent.Rockies
 California Pacific Northwest
 Great Basin South Central
 Great Lakes Southeast
 Northeast S. Appalachians
 Northern Plains Southwest

Dominant Species*

ARTR BRMA
 PUTR2
 SYOR
 POFE

General Model Sources

- Literature
 Local Data
 Expert Estimate

Geographic Range

Montane and subalpine elevations across the western U.S. from 1000 m in eastern Oregon and Washington to over 3000 m in the southern Rockies, and within the mountains of Nevada, including southern Nevada, western Utah, southeast Wyoming, and southern Idaho. In MZ 13, restricted to the highest mountains such as the Panamint Range, Inyo Range, and Spring Mountains.

Biophysical Site Description

This ecological system occurs in many of the western United States, usually at middle elevations (1000-2500 m). Within the Mojave Desert mapping zone (MZ 13), elevation is generally above 2450 m, with known occurrences above 2790 m in the Panamint Range. Immediately north of the Mojave Desert, mountain big sagebrush shrublands occur up 3200 m in the White Mountains of California (Winward and Tisdale 1977, Blaisdell et al. 1982, Cronquist et al. 1994, Miller and Eddleman 2000). The climate regime is cool, semi-arid to subhumid, with yearly precipitation ranging from 25 to 90 cm/year (Mueggler and Stewart 1980, Tart 1996). Much of this precipitation falls as snow. Temperatures are continental with large annual and diurnal variation. In general this system shows an affinity for mild topography, fine soils, and some source of subsurface moisture. Soils generally are moderately deep to deep, well-drained, and of loam, sandy loam, clay loam, or gravelly loam textural classes; soils often have a substantial volume of coarse fragments, and are derived from a variety of parent materials. This system primarily occurs on deep-soiled to stony flats, ridges, nearly flat ridgetops, and mountain slopes. Soils are typically deep and have well developed dark organic surface horizons (Hironaka et al. 1983, Tart 1996). However, at the high ends of its precipitation and elevation ranges mountain big sagebrush occurs on shallow and/or rocky soils. All aspects are represented, but the higher elevation occurrences may be restricted to south- or west-facing slopes. At lower elevations, mountain big sagebrush occurs in the understory of curlleaf mountain mahogany and pinyon-juniper woodlands.

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.

**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

Vegetation Description

Vegetation types within this ecological system are usually less than 1.5 m tall and dominated by *Artemisia tridentata* ssp. *vaseyana*. Mojave Desert communities of montane sagebrush have received less description than northern mapping zones. A variety of other shrubs can be found in some occurrences, but these are seldom dominant. They include *Artemisia arbuscula*, *Ericameria nauseosa*, *Chrysothamnus viscidiflorus*, *Ephedra viridis*, *Symphoricarpos oreophilus*, *Purshia tridentata*, *Peraphyllum ramosissimum*, *Ribes cereum*, and *Amelanchier alnifolia*. The canopy cover is usually between 20-80%. The herbaceous layer is usually well represented, but bare ground may be common in particularly arid or disturbed occurrences.

Graminoids that can be abundant include *Boutela gracilis*, *Festuca ovina*, *Elymus elymoides*, *Danthonia intermedia*, *Stipa* spp., *Pascopyrum smithii*, *Bromus carinatus*, *Elymus trachycaulus*, *Koeleria macrantha*, *Pseudoroegneria spicata*, *Bromus anomalus* and *marginatus*, *Achnatherum therburianum*, *Poa fendleriana*, or *Poa secunda*. Forbs are often numerous and an important indicator of health. Forb species may include *Castilleja*, *Potentilla*, *Erigeron*, *Phlox*, *Astragalus*, *Geum*, *Lupinus*, and *Eriogonum*, *Achillea millefolium*, *Antennaria rosea*, and *Eriogonum umbellatum*, *Artemisia ludoviciana*, and many others. Mueggler and Stewart (1980), Hironaka et al. (1983), and Tart (1996) described several of these types. Resprouting bitterbrush in mountain big sagebrush types is potentially important to wildlife in early stand development.

Disturbance Description

Mean fire return intervals in and recovery times of mountain big sagebrush are subjects of lively debate in recent years (Welch and Criddle 2003). Mountain big sagebrush communities were historically subject to stand replacing fires with a mean return interval ranging from 40+ years at the big sagebrush ecotone, and up to 80 years in areas with a higher proportion of low sagebrush in the landscape (Crawford et al. 2004, Johnson 2000, Miller et al. 1994, Burkhardt and Tisdale 1969 and 1976, Houston 1973, Miller and Rose 1995, Miller et al. 2000). Under pre-settlement conditions mosaic burns generally exceeded 75% topkill due to the relatively continuous herbaceous layer. Therefore, replacement fire with a mean FRI of 40-80 years was adopted here. Brown (1982) reported that fire ignition and spread in big sagebrush is largely (90%) a function of herbaceous cover. These communities were also subject to periodic mortality due to insects, disease, rodent outbreaks, drought, and winterkill (Anderson and Inouye 2001, Winward 2004). Periodic mortality events may result in either stand-replacement or patchy die-off depending on the spatial extent and distribution of these generally rare (50 to 100 years) events.

Recovery rates for shrub canopy cover vary widely in this type, depending on post fire weather conditions, sagebrush seed-bank survival, abundance of resprouting shrubs (e.g., snowberry, bitterbrush), and size and severity of the burn. Mountain big sagebrush typically reaches 5% canopy cover in 8 to 14 years. This may take as little as 4 years under favorable conditions and longer than 25 years in unfavorable situations (Pedersen et al. 2003, Miller unpublished data). Mountain big sagebrush typically reaches 25% canopy cover in about 25 years, but this may take as few as nine years or longer than 40 years (Winward 1991, Pedersen et al. 2003, Miller unpublished data). Mountain snowberry and resprouting forms of bitterbrush may return to pre-burn cover values in a few years. Bitterbrush plants less than fifty years old are more likely to resprout than older plants (Simon 1990).

Adjacency or Identification Concerns

Inter-Mountain Basins Montane Sagebrush Steppe dominated by mountain big sagebrush (BpS 1126) will contain low/black sagebrush in varying amounts. Small patches will naturally be part of BpS 131126, whereas more extensive areas truly belong to BpS 131079. Both systems (BpS 1126 and 1079) cover large high-elevation areas in the Intermountain West. Mountain big sagebrush is a medium-sized shrub with a mean FRI from 10-70 years, whereas high-elevation low sagebrush is a dwarf shrub with a mean FRI of 200+ years.

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**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

The NatureServe description does not distinguish between mountain big sagebrush that can be invaded by conifers at mid to high elevations (i.e., within the tolerance of pinyon and juniper) and mountain sagebrush steppe that is too high elevation for pinyon to encroach. The ability for pinyon to invade has a large effect on predicted HRV and management.

This type may be adjacent to forests dominated by aspen, white fir, limber pine, and bristlecone pine. It also occurs adjacent to pinyon-juniper and curlleaf mountain mahogany woodlands. The ecological system, where adjacent to conifers, is readily invaded by conifers (whitebark pine, limber pine, pinyon-pine, juniper spp.) in the absence of historic fire regimes (Miller and Rose 1999).

At lower elevational limits on southern exposures there is a high potential for cheatgrass invasion/occupancy where the native herbaceous layer is depleted. This post-settlement, uncharacteristic condition is not considered here.

Native Uncharacteristic Conditions

Shrub cover greater than 50% is uncharacteristic and conifer cover greater than 80% is uncharacteristic when

Scale Description

Sources of Scale Data Literature Local Data Expert Estimate

This type occupies areas ranging in size from 10's to 5,000's of acres, although patch sizes are generally smaller in the Mojave Desert. Disturbance patch size can range from 10's to 1,000's of acres. The distribution of past burns was assumed to consist of many small patches in the landscape.

Issues/Problems

BpS 131126, Inter-Mountain Basins Montane Sagebrush Steppe, was not part of list of keyed BpS for this mapzone due to the paucity of data. BpS 131126 is found, however, in the Inyo Range (Inyo National Forest) and Panamint Range (Death Valley National Park), and, perhaps, in the Spring Mountains depending on whether or not pinyon has invaded shrublands.

Comments

BpS 131126 was derived from BpS 121126, which was developed by Gary Medlyn (gary_medlyn@nv.blm.gov) and Crystal Kolden (ckolden@gmail.com). Modifications to BpS 121126 for MZ 13 were for species composition, elevation, and scale.

BPS 1126 for MZ 12 and 17 was based on BPS 1126_a (Mountain Big Sagebrush) from LF Mapping Zone 16. BPS 1126_a is essentially PNVG R2SBMTwc (mountain big sagebrush with potential for conifer invasion) developed by Don Major (dmajor@tnc.org), Alan R. Sands (asands@tnc.org), David Tart (dtart@fs.fed.us), and Steven Bunting (sbunting@uidaho.edu). R2SBMTwc was itself based on R2SBMT developed by David Tart. R2SBMTwc was revised by Louis Provencher (lprovencher@tnc.org) following critical reviews by Stanley Kitchen (skitchen@fs.fed.us), Michele Slaton (mslaton@fs.fed.us), Peter Weisberg (pweisberg@cabnr.unr.edu), Mike Zielinski (mike_zielinski@nv.blm.gov), and Gary Back (gback@srk.com). Reviewers and modelers had very different opinions on the range of mean FRIs and mountain big sagebrush recovery times for rapid Assessment models R2SBMT and R2SBMTwc where the (see Welch and Criddle 2003). It is increasingly agreed upon that a MFI of 20 years, which used to be the accepted norm, is simply too frequent to sustain populations of Greater Sage-grouse and mountain big sagebrush ecosystems whose recovery time varies from 10-70 years. Reviewers consistently suggested longer FRIs and recovery times. The revised model is a compromise with longer recovery times and FRIs. Modeler and reviewers also disagreed on the choice of FRG: II (modeler) vs. IV (reviewers). For Map zones 12 and 17, modelers placed this system in Fire Regime Group IV.

The first three development classes chosen for this PNVG correspond to the early, mid-, and late seral stages

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familiar to range ecologists. The two classes with conifer invasion (classes D and E) approximately correspond to Miller and Tausch's (2001) phases 2 and 3 of pinyon and juniper invasion into shrublands.

Vegetation Classes

Class A 20 %

Early Development 1 Open

Description

Herbaceous vegetation is the dominant lifeform. Herbaceous cover is variable but typically >50% (50-80%). Shrub cover is 0 to 5%. Replacement fire has a mean FRI of 80 years. Succession to class B after 12 years.

Indicator Species* and Canopy Position

POFE Upper
BRMA4 Upper
SYOR2 Lower
ARTRV Lower

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	80 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Dominant vegetation is herbaceous with scattered shrubs. Shrub cover will be <10% and <0.5m tall.

Fuel Model 1

Class B 50 %

Mid Development 1 Open

Description

Shrub cover 6-25%. Mountain big sagebrush cover up to 20%. Herbaceous cover is typically >50%. Initiation of conifer seedling establishment. Replacement fire mean FRI is 40 years. Succession to class C after 38 years.

Indicator Species* and Canopy Position

ARTRV Upper
PUTR2 Upper
PIPO5 Lower
SYOR2 Lower

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Shrub 0m	Shrub Tall >3.0 m
Tree Size Class	Seedling <4.5ft	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Herbaceous cover is the dominant lifeform with canopy >50%. Shrub cover is 6-25% and the upper lifeform.

Fuel Model 1

Class C 15 %

Late Development 1 Closed

Description

Shrubs are the dominant lifeform with canopy cover of 26-45+%. Herbaceous cover is typically <50%. Conifer (juniper, pinyon-juniper, ponderosa pine, or white fir) cover <10%. Insects and disease every 75 yrs on average will thin the stand and cause a transition to class B. Replacement

Indicator Species* and Canopy Position

ARTRV Upper
PUTR2 Upper
SYOR2 Low-Mid
CONIF Mid-Upper

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model 2

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	50 %
Height	Shrub 0m	Shrub Tall >3.0 m
Tree Size Class	None	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

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fire occurs every 50 years on average. In the absence of fire for 80 years, vegetation will transition to class D. Otherwise, succession keeps vegetation in class C.

Class D 10 %

Late Development 1 Open

Description

Conifers are the upper lifeform (juniper, pinyon-juniper, ponderosa pine, limber pine, or white fir). Conifer cover is 11- 25%. Shrub cover generally less than mid-development classes, but remains between 26-40%. Herbaceous cover <30%. The mean FRI of replacement fire is 50 years. Insects/diseases thin the sagebrush, but not the conifers, every 75 years on average, without causing a transition to other classes. Succession is from D to E after 50 years.

Indicator Species* and Canopy Position

CONIF Upper
ARTRV Mid-Upper
PUTR2 Mid-Upper
SYMPH Low-Mid

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 2

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	30 %
Height	Tree 0m	Tree 10m
Tree Size Class	Sapling >4.5ft; <5"DBH	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Shrub cover generally decreasing but remains between 26-40% Conifers cover 10-25%.

Class E 5 %

Late Development 2 Closed

Description

Conifers are the dominant lifeform (juniper, pinyon-juniper, ponderosa pine, limber pine, or white fir). Conifer cover ranges from 26-80% (pinyon-juniper 36-80%(Miller and Tausch 2000), juniper 26-40% (Miller and Rose 1999), white fir 26-80%). Shrub cover 0-20%. Herbaceous cover <20%. The mean FRI for replacement fire is longer than in previous states (75 yrs). Conifers are susceptible to insects/diseases that cause diebacks (transition to class D) every 75 years on average.

Indicator Species* and Canopy Position

CONIF Upper
ARTRV Mid-Upper
PUTR2 Mid-Upper
SYMPH Mid-Upper

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 6

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	80 %
Height	Tree 0m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Disturbances

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Fire Regime Group:** 4

Historical Fire Size (acres)

Avg 100

Min 10

Max 1000

Sources of Fire Regime Data

- Literature
- Local Data
- Expert Estimate

Additional Disturbances Modeled

- Insects/Disease
- Native Grazing
- Other (optional 1)
- Wind/Weather/Stress
- Competition
- Other (optional 2)

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	49	15	100	0.02041	100
Mixed					
Surface					
All Fires	49			0.02043	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class.

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**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2311262

**Inter-Mountain Basins Montane Sagebrush
Steppe - Low Sagebrush**

This BPS is lumped with:

This BPS is split into multiple models: 1126_a is dominated by mountain big sagebrush and is FRG IV; 161126_b is dominated by low sagebrush and is FRG V.

General Information

Contributors (also see the Comments field)

Date 2/24/2005

Modeler 1 Louis Provencher lprovencher@tnc.org

Reviewer Tim Christiansen tchristiansen@tnc.org

Modeler 2

Reviewer

Modeler 3

Reviewer

Vegetation Type

Upland Savannah/Shrub Steppe

Map Zone

23

Model Zone

- | | |
|--|---|
| <input type="checkbox"/> Alaska | <input type="checkbox"/> N-Cent.Rockies |
| <input type="checkbox"/> California | <input type="checkbox"/> Pacific Northwest |
| <input type="checkbox"/> Great Basin | <input type="checkbox"/> South Central |
| <input type="checkbox"/> Great Lakes | <input type="checkbox"/> Southeast |
| <input type="checkbox"/> Northeast | <input type="checkbox"/> S. Appalachians |
| <input type="checkbox"/> Northern Plains | <input checked="" type="checkbox"/> Southwest |

Dominant Species*

ARAR8 PSSP6
ARNO4
ARCA13
ACTH7

General Model Sources

- Literature
 Local Data
 Expert Estimate

Geographic Range

Montane and subalpine elevations across the western US from 1000m in eastern OR and WA to over 3000m in the southern Rockies.

Biophysical Site Description

This type is found in subalpine and alpine zones. This ecological system describes low, black and occasionally silver sagebrush that grow on shallow soils where a root-limiting layer exists. Low sagebrush tends to grow where claypan layers exist in the soil profile and soils are often saturated during a portion of the year. Black sagebrush tends to grow where either a calcareous or volcanic cement layer exists in the soil profile. Elevations range from 1500m in eastern OR and WA to over 3000m in the southern Rockies.

Vegetation Description

This type includes communities dominated by low sagebrush (*Artemisia arbuscula*), black sagebrush (*Artemisia nova*) and, in the Utah High Plateau (MZ16), silver sagebrush (*Artemisia cana*). Although these types do not usually grow in combination, they do share similar fire regimes and are considered high-elevation dwarf sagebrushes. Dwarf sagebrushes generally have relatively low fuel loads with low growing and cushion forbs and scattered bunch grasses such as bluebunch wheatgrass (*Pseudoroegneria spicata*), needlegrasses (*Achnatherum* spp), Sandberg's bluegrass (*Poa secunda*) and Indian ricegrass (*Oryopsis hymenoides*). Forbs often include buckwheats (*Eriogonum* spp), fleabanes (*Erigeron* spp), phloxes (*Phlox* spp), paintbrushes (*Castilleja* spp), globemallows (*Sphaeralcea* spp) and lupines (*Lupinus* spp).

Disturbance Description

High elevation low sagebrush burns infrequently and burn sizes are small. Low sagebrush is very sensitive to fire. Bare ground acts as a micro-barrier to fire between low stature shrubs. Oils and resins present in the

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foliage and stems of sagebrush allow fire to spread. Stand-replacing fires (average FRI of 200-240yrs) can occur in this type when successive years of above average precipitation are followed by an average or dry year under windy conditions. Stand replacement fires dominate in the late succession class where the herbaceous component has diminished. This type fits best into Fire Group V.

Grazing by wild ungulates occurs in this type due to its high palatability (mostly for *A. nova* and *A. arbuscula*) compared to other browse. Native browsing tends to open up the canopy cover of shrubs but does not often change the succession stage.

Adjacency or Identification Concerns

Inter-Mountain Basins Montane Sagebrush Steppe (BpS 1126) was separated into two very distinct montane sagebrush steppe types not distinguished by NatureServe: Inter-Mountain Basins Montane Sagebrush Steppe dominated by mountain big sagebrush (1126_a) and Inter-Mountain Basins Montane Sagebrush Steppe dominated by low sagebrush (1126_b). Both systems cover large high-elevation areas in the Intermountain West. Mountain big sagebrush is a tall shrub with a mean FRI from 10-70yrs, whereas high-elevation low sagebrush is a dwarf shrub with a mean FRI of 200yrs+. Subalpine and montane dwarf sagebrush types (ie, Rocky Mountain Alpine Dwarf Shrubland (1070) and Inter-Mountain Basins Montane Sagebrush Steppe--Low Sagebrush (1126_b)) tend to occur adjacent to Inter-Mountain Basins Montane Sagebrush Steppe--Mountain Big Sagebrush (1126_a). The dwarf sagebrush types create a mosaic within the mountain big sagebrush types, acting as a fire break that burns only under severe conditions. Often, dwarf sagebrush types are the larger community in which mountain big sagebrush are stringers associated with drainages.

Native Uncharacteristic Conditions

Scale Description

Dwarf sagebrush communities occur from small patches of 10ac to vast areas of several 1000ac on mountain tops and high elevation mountain benches.

Disturbance patch size for this type is not well known but is estimated to be <100s of acres due to the limited potential for fire spread.

Issues/Problems

The dominant species in each vegetation class reflect a compilation of species found in the BpS but do not usually occur in the same communities.

Comments

This model is identical to the model for the same BpS in MZ16 (Utah High Plateaus) with minor descriptive changes based on peer review for MZ23 and MZ24. The model for this BpS and description were largely based on the Rapid Assessment PNVG R2SBDW developed by Sarah Heide (Sarah_Heide@blm.gov) and Gary Medlyn (gmedlyn@nv.blm.gov) for dwarf sagebrushes. The high elevation component of R2SBDW is developed here by Louis Provencher. Reviewers of R2SDDW were Michael Zielinski (mike_zielinski@nv.blm.gov), Gary Back (gback@srk.com) and Paul Tueller (ptt@intercomm.com).

Vegetation Classes

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Class A 10%

Early Development 1 All Structures

Indicator Species* and Canopy Position

PSSP6 Lower
POSE Lower
ACHY Lower
ACTH7 Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	6%
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 1

Description

Upper layer lifeform differs from dominant lifeform.

Herbaceous response post-fire is vigorous and dominant. Scattered shrubs recovering.

Early seral community dominated by herbaceous vegetation; less than six percent sagebrush canopy cover; up to 24yrs post-disturbance. Replacement fire occurs every 240yrs on average. Succession to B after 24yrs.

Class B 35%

Mid Development 1 Open

Indicator Species* and Canopy Position

ARAR8 Upper
ARNO4 Upper
ARCA13 Lower
PSSP6 Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	6%	10%
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 2

Description

Upper layer lifeform differs from dominant lifeform.

Mid-seral community with a mixture of herbaceous and shrub vegetation; 6-10% sagebrush canopy cover present; between 20-120yrs post-disturbance. Replacement fire (FRI of 240yrs) causes a transition to A. Succession to class C.

Class C 55%

Late Development 1 Closed

Indicator Species* and Canopy Position

ARNO4 Upper
ARAR8 Upper
ARCA13 Upper
PSSP6 Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	10%	20%
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 2

Description

Upper layer lifeform differs from dominant lifeform.

Late seral community with a mixture of herbaceous and shrub vegetation; >10% sagebrush canopy cover present; 120yrs+ post-disturbance. In class C, replacement fire is every 200yrs on average (transition to A). In the absence of replacement fire, this class will persist indefinitely.

Class D 0%

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model

Upper layer lifeform differs from dominant lifeform.

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Description

Class E 0 %

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model

Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** V

Historical Fire Size (acres)

- Avg 10
- Min 1
- Max 100

Sources of Fire Regime Data

- Literature
- Local Data
- Expert Estimate

Additional Disturbances Modeled

- Insects/Disease
- Wind/Weather/Stress
- Native Grazing
- Competition
- Other (optional 1)
- Other (optional 2)

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	217	100	240	0.004608	100
Mixed					
Surface					
All Fires	217			0.00463	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class.

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 **Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

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**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2311261

**Inter-Mountain Basins Montane Sagebrush
Steppe - Mountain Big Sagebrush**

This BPS is lumped with:

This BPS is split into multiple models: 1126_a is dominated by mountain big sagebrush and is FRG IV; 161126_b is dominated by low sagebrush and is FRG V.

General Information

Contributors (also see the Comments field)

Date 2/23/2005

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Modeler 2

Reviewer

Modeler 3

Reviewer

Vegetation Type

Upland Savannah/Shrub Steppe

Map Zone

23

Model Zone

- | | |
|--|---|
| <input type="checkbox"/> Alaska | <input type="checkbox"/> N-Cent.Rockies |
| <input type="checkbox"/> California | <input type="checkbox"/> Pacific Northwest |
| <input type="checkbox"/> Great Basin | <input type="checkbox"/> South Central |
| <input type="checkbox"/> Great Lakes | <input type="checkbox"/> Southeast |
| <input type="checkbox"/> Northeast | <input type="checkbox"/> S. Appalachians |
| <input type="checkbox"/> Northern Plains | <input checked="" type="checkbox"/> Southwest |

Dominant Species*

ARTRV

PUTR2

SYOR2

General Model Sources

- Literature
 Local Data
 Expert Estimate

Geographic Range

Montane and subalpine elevations across the western US from 1000m in eastern OR and WA to over 3000m in the southern Rockies.

Biophysical Site Description

This ecological system occurs in many of the western states, usually at middle elevations (1000-2500m). Within the Great Basin region, elevation ranges from 1370m in ID to 3200m in the White Mountains of CA (Winward and Tisdale 1977, Blaisdell et al 1982, Cronquist et al 1994, Miller and Eddleman 2000). However, elevations are predominantly between 1525-2750m.

The climate regime is cool, semi-arid to subhumid, with yearly precipitation ranging from 25-90cm/year (Mueggler and Stewart 1980, Tart 1996). Much of this precipitation falls as snow. Temperatures are continental with large annual and diurnal variation. In general this system shows an affinity for mild topography, fine soils and some source of subsurface moisture. Soils generally are moderately deep to deep, well-drained, and of loam, sandy loam, clay loam, or gravelly loam textural classes; soils often have a substantial volume of coarse fragments, and are derived from a variety of parent materials. Soils are typically deep and have well developed dark organic surface horizons (Hironaka et al 1983, Tart 1996). This system primarily occurs on deep-soiled to stony flats, ridges, nearly flat ridge tops and mountain slopes. However, at the high ends of its precipitation and elevation ranges mountain big sagebrush occurs on shallow and/or rocky soils. All aspects are represented, but the higher elevation occurrences may be restricted to south- or west-facing slopes.

Vegetation Description

Vegetation types within this ecological system are usually <1.5m tall and dominated by *Artemisia tridentata*

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ssp. vaseyana, *Artemisia cana* ssp. *viscidula* or *Artemisia tridentata* ssp. *spiciformis*. A variety of other shrubs can be found in some occurrences, but these are seldom dominant. They include *Artemisia rigida*, *Artemisia arbuscula*, *Ericameria nauseosa*, *Chrysothamnus viscidiflorus*, *Symphoricarpos oreophilus*, *Purshia tridentata*, *Peraphyllum ramosissimum*, *Ribes cereum*, *Rosa woodsii*, *Ceanothus velutinus* and *Amelanchier alnifolia*. The canopy cover is usually between 20-80%.

The herbaceous layer is usually well represented, but bare ground may be common in particularly arid or disturbed occurrences. Graminoids that can be abundant include *Festuca idahoensis*, *Festuca thurberi*, *Festuca ovina*, *Elymus elymoides*, *Deschampsia caespitosa*, *Danthonia intermedia*, *Danthonia parryi*, *Stipa* spp, *Pascopyrum smithii*, *Bromus carinatus*, *Elymus trachycaulus*, *Koeleria macrantha*, *Pseudoroegneria spicata*, *Poa fendleriana*, or *Poa secunda* and *Carex* spp. Forbs are often numerous and an important indicator of health. Forb species may include *Castilleja*, *Potentilla*, *Erigeron*, *Phlox*, *Astragalus*, *Geum*, *Lupinus*, *Eriogonum*, *Balsamorhiza sagittata*, *Achillea millefolium*, *Antennaria rosea*, *Eriogonum umbellatum*, *Fragaria virginiana*, *Artemisia ludoviciana*, *Hymenoxys hoopesii* (= *Helenium hoopesii*), etc. Mueggler and Stewart (1980), Hironaka et al (1983) and Tart (1996) described several of these types. This ecological system is critical summer habitat for greater sage grouse. Moreover, resprouting bitterbrush in mountain big sagebrush types is potentially important to wildlife in early stand development.

Disturbance Description

Mean fire return intervals in and recovery times of mountain big sagebrush are complex and subject to lively debate in recent years (Welch and Criddle 2003). One reason for this complexity is that mountain big sagebrush is found on many and very different NRCS ecological range sites. Mountain big sagebrush communities were historically subject to stand replacing fires with a mean return interval ranging from 10yrs at the ponderosa pine ecotone, 40yrs+ at the Wyoming big sagebrush ecotone, and up to 80yrs in areas with a higher proportion of low sagebrush in the landscape (Crawford et al 2004, Johnson 2000, Miller et al 1994, Burkhardt and Tisdale 1969 and 1976, Houston 1973, Miller and Rose 1995, Miller et al 2000). Under pre-settlement conditions burns generally exceeded 75% topkill due to the relatively continuous herbaceous layer. Therefore, replacement fire with a FRI of 40-80yrs (mean of 50yrs) was adopted here.

Brown (1982) reported that fire ignition and spread in big sagebrush is largely (90%) a function of herbaceous cover. These communities were also subject to periodic mortality due to insects, disease, rodent outbreaks, drought and winterkill (Anderson and Inouye 2001, Winward 2004). Periodic mortality events may result in either stand-replacement or patchy die-off depending on the spatial extent and distribution of these generally rare (50-100yr) events.

Recovery rates for shrub canopy cover vary widely in this type, depending post-fire weather conditions, sagebrush seed-bank survival, abundance of resprouting shrubs (eg, snowberry, bitterbrush) and size and severity of the burn. Mountain big sagebrush typically reaches five percent canopy cover in 8-14yrs. This may take as little as four years under favorable conditions and longer than 25yrs in unfavorable situations (Pedersen et al 2003, Miller unpublished data). Mountain big sagebrush typically reaches 25% canopy cover in about 25yrs, but this may take as few as nine years or longer than 40yrs (Winward 1991, Pedersen et al 2003, Miller unpublished data). Mountain snowberry and resprouting forms of bitterbrush may return to pre-burn cover values in a few years. Bitterbrush plants less than fifty years old are more likely to resprout than older plants (Simon 1990).

Adjacency or Identification Concerns

Inter-Mountain Basins Montane Sagebrush Steppe (BpS 1126) was separated into two very distinct montane sagebrush steppe types not distinguished by NatureServe: Inter-Mountain Basins Montane Sagebrush Steppe dominated by mountain big sagebrush (1126_a) and Inter-Mountain Basins Montane Sagebrush Steppe

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dominated by low sagebrush (1126_b). Both systems cover large high-elevation areas in the Intermountain West. Mountain big sagebrush is a tall shrub with a mean FRI from 10-70yrs, whereas high-elevation low sagebrush is a dwarf shrub with a mean FRI of 200yrs+. Subalpine and montane dwarf sagebrush types (ie, Rocky Mountain Alpine Dwarf Shrubland (1070) and Inter-Mountain Basins Montane Sagebrush Steppe--Low Sagebrush (1126_b)) tend to occur adjacent to Inter-Mountain Basins Montane Sagebrush Steppe--Mountain Big Sagebrush (1126_a). The dwarf sagebrush types create a mosaic within the mountain big sagebrush types, acting as a fire break that burns only under severe conditions. Often, dwarf sagebrush types are the larger community in which mountain big sagebrush are stringers associated with drainages.

The NatureServe description does not distinguish between mountain big sagebrush that can be invaded by conifers at mid to high elevations (ie, within the tolerance of pinyon and juniper) and mountain sagebrush steppe that is too high elevation for pinyon to encroach. The ability for pinyon to invade has a large effect on predicted HRV and management.

This type may be adjacent to forests dominated by aspen, ponderosa pine, Douglas-fir, limber pine, bristlecone pine, or lodgepole pine. It also occurs adjacent to pinyon-juniper woodlands. The ecological system, where adjacent to conifers, is readily invaded by conifers (ponderosa pine, Douglas-fir, sub-alpine fir, whitebark pine, limber pine, pinyon-pine and juniper spp) in the absence of historic fire regimes (Miller and Rose 1999). This type probably served as an ignition source for adjacent aspen stands. Mountain big sagebrush is commonly found adjacent or intermingled with low sagebrush and mountain shrublands.

Uncharacteristic conditions in this type include herbaceous canopy cover <40% and dominance of the herbaceous layer by mulesears (*Wyethia amplexcaulis*) on clayey soils.

At lower elevation limits on southern exposures there is a high potential for cheatgrass invasion/occupancy where the native herbaceous layer is depleted. This post-settlement, uncharacteristic condition is not considered here.

Native Uncharacteristic Conditions

Scale Description

This type occupies areas ranging in size from 10s to 10000s of acres. Disturbance patch size can also range from 10s to 1000s of acres. The distribution of past burns was assumed to consist of many small patches in the landscape.

Issues/Problems

Reviewers and modelers had very different opinions on the range of mean FRIs and mountain big sagebrush recovery times (see Welch and Criddle 2003). It is increasingly agreed upon that a MFI of 20yrs, which used to be the accepted norm, is simply too frequent to sustain populations of greater sage grouse and mountain big sagebrush ecosystems whose recovery time varies from 10-70yrs. Reviewers consistently suggested longer FRIs and recovery times. The revised model is a compromise with longer recovery times and FRIs. Modeler and reviewers also disagreed on the choice of FRG: II (modeler) vs. IV (reviewers).

Comments

This model is identical to the model for the same BpS in MZ16 (Utah High Plateaus) with minor descriptive changes based on peer review for MZ23 and MZ24. Inter-Mountain Basins Montane Sagebrush Steppe--Mountain Big Sagebrush (BpS 1126_a) is essentially the Rapid Assessment PNVG R2SBMTwc (mountain big sagebrush with potential for conifer invasion) developed by Don Major (dmajor@tnc.org), Alan R. Sands (asands@tnc.org), David Tart (dtart@fs.fed.us) and Steven Bunting (sbunting@uidaho.edu) and

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revised by Louis Provencher (lprovencher@tnc.org) following critical reviews by Stanley Kitchen (skitchen@fs.fed.us), Michele Slaton (mslaton@fs.fed.us), Peter Weisberg (pweisberg@cabnr.unr.edu), Mike Zielinski (mike_zielinski@nv.blm.gov) and Gary Back (gback@srk.com).

If tree invasion is not possible due to high elevation, lack of tree seed sources, or soils, the Historic Range of Variability predicted by R2SBMT for classes A, B and C, respectively, is 20%, 45% and 35%.

The first three development classes chosen for this PNVG correspond to the early, mid-, and late seral stages familiar to range ecologists. The two classes with conifer invasion (classes D and E) approximately correspond to Miller and Tausch's (2001) phases 2 and 3 of pinyon and juniper invasion into shrublands.

Vegetation Classes

Class A 20%

Early Development 1 Open

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model 1

Description

Indicator Species* and Canopy Position

PSSP6 Upper
 FEID Upper
 SYOR2 Lower
 ARTRV Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	80 %
Height	Herb 0m	Herb 1.0m
Tree Size Class	None	

- Upper layer lifeform differs from dominant lifeform.

Dominant vegetation is herbaceous with scattered shrubs.

Herbaceous vegetation is the dominant lifeform. Herbaceous cover is variable but typically >50% (50-80%). Shrub cover is 0-5%. Replacement fire has a mean FRI of 80yrs in this class. Succession to class B after 12yrs.

Class B 50%

Mid Development 1 Open

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model 1

Description

Indicator Species* and Canopy Position

ARTRV Upper
 PUTR2 Upper
 CONIFE Lower
 SYMPH Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	10 %	30 %
Height	Shrub 0.6m	Shrub >3.1m
Tree Size Class	Seedling <4.5ft	

- Upper layer lifeform differs from dominant lifeform.

Shrubs are the dominant lifeform and shrub cover is 6-25%. Mountain big sagebrush cover is up to 20%. Herbaceous cover is typically >50%. Initiation of conifer seedling establishment. Replacement fire mean FRI is 40yrs. Succession to class C after 38yrs.

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Class C 15%
Late Development 1 Closed

Indicator Species* and Canopy Position

ARTRV Upper
PUTR2 Upper
SYMPH Low-Mid
CONIFE Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	50 %
Height	Shrub 0.6m	Shrub >3.1m
Tree Size Class	None	

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model 2

Upper layer lifeform differs from dominant lifeform.

Description

Shrubs are the dominant lifeform. Shrub cover is 26-45%+. Herbaceous cover is typically <50%. Conifer seedlings and saplings (juniper, pinyon-juniper, ponderosa pine or Douglas-fir) cover <10%. Insects and disease occur every 75yrs on average and will thin the stand, causing a transition to class B. Replacement fire occurs every 50yrs on average. In the absence of fire for 80yrs, vegetation will transition to class D. Otherwise, class C persists.

Class D 10%

Late Development 1 Open

Indicator Species* and Canopy Position

CONIFE Upper
ARTRV Mid-Upper
PUTR2 Mid-Upper
SYMPH Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	10 %	30 %
Height	Tree 0m	Tree 5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model 2

Upper layer lifeform differs from dominant lifeform.

Shrub cover generally decreasing but remains between 26-40%

Description

Conifers are the dominant lifeform (juniper, pinyon-juniper, ponderosa pine, limber pine or Douglas-fir). Conifer cover is 11-25%. Shrub cover is generally decreasing, but remains between 26-40%. Herbaceous cover is <30%. The mean FRI of replacement fire is 50yrs. Insects/diseases thin the sagebrush, but not the conifers, every 75yrs on average and do not cause a transition to another class. If replacement fire or insects/disease do not occur, succession is to E after 45yrs.

Class E 5%

Late Development 2 Closed

Indicator Species* and Canopy Position

CONIFE Upper
ARTRV Mid-Upper
PUTR2 Mid-Upper
SYMPH Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	80 %
Height	Tree 0m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model 6

Upper layer lifeform differs from dominant lifeform.

Description

Conifers are the dominant lifeform (juniper, pinyon-juniper, ponderosa pine, limber pine or Douglas-fir). Conifer cover ranges from 26-80% (pinyon-juniper 36-80% (Miller and Tausch 2000), juniper 26-40% (Miller and Rose 1999), Douglas-fir 26-80%). Shrub cover is 0-20%. Herbaceous cover is <20%. The mean FRI for replacement fire is longer than in previous states (75yrs). Conifers are susceptible to insects/diseases that cause diebacks and a transition to class D every 75yrs on average.

Disturbances

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Fire Regime Group:** IV

Historical Fire Size (acres)

Avg 100
Min 10
Max 10000

Sources of Fire Regime Data

- Literature
- Local Data
- Expert Estimate

Additional Disturbances Modeled

- Insects/Disease
- Wind/Weather/Stress
- Native Grazing
- Competition
- Other (optional 1)
- Other (optional 2)

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	50	15	100	0.02	100
Mixed					
Surface					
All Fires	50			0.02002	

Fire Intervals (FI):
 Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class.

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.