

10801

Inter-Mountain Basins Big Sagebrush Shrubland - Basin Big Sagebrush

BpS Model/Description Version: Aug. 2020

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Vegetation Type

Shrubland

Map Zones

21, 22, 28

Model Splits or Lumps

This Biophysical Setting (BpS) is split into multiple models. Wyoming Big Sagebrush and Basin Big Sagebrush variants were split out from the Inter-Mountain Basins Big Sagebrush Shrubland to represent differences in the fire regimes, floral composition, and biophysical sites.

Basin big sagebrush is found at lower elevations and is usually restricted to comparatively moist ravines or valleys (Barker and McKell 1983 in Knight 1994). It also grows taller than any other species of *Artemisia* (up to 2m or more). Basin big sagebrush is more common on sandy soils and Wyoming big sagebrush more common on fine-textured soils (Knight 1994). Basin big sagebrush tends to grow in deeper, more fertile soils with greater moisture availability compared to Wyoming big sagebrush sites. Basin big sagebrush is an indicator of productive sites.

Wyoming big sagebrush is the most common shrub of the inter-mountain basins. It is normally <0.5 m tall and occupies drier upland sites, with basin big sage occurring in adjacent ravines (Knight 1994). It tends to grow on shallower, well-drained, and xeric soils when compared to mountain and basin big sagebrush (Barker and McKell 1983). When Wyoming big sagebrush occurs with black, longleaf (*A. longiloba*), and threetip sagebrush communities, it often occupies relatively deeper soils (Tweit and Houston 1980). Where Wyoming, basin, and mountain big sagebrush ranges overlap, Wyoming big sagebrush tends to grow on shallowest, most well-drained, and hottest soils relative to the other two subspecies.

Geographic Range

Basin big sagebrush, as described here, is found throughout Wyoming and in parts of southwestern Montana. This particular model focuses on the Wyoming Basins, Middle Rockies, and Southern Rockies ecoregions (Cleland et al. 2007). It does not apply to Grand Teton and Yellowstone national parks.

Biophysical Site Description

This type is found between 3,000-8,000ft elevation on deep, well-drained, alluvial soils and has been observed on sandy sites where soil moisture prevails until August.

This type tends to follow streams and can be a few meters wide on ephemeral streams to 100m wide on larger streams. Although it is found in a riparian setting, it is not wet enough to support willows, cottonwoods, and other riparian vegetation.

Vegetation Description

A dense canopy of basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) dominates the shrub layer, except on alkaline soils, where greasewood (*Sarcobatus vermiculatus*) makes up as much as 25% cover. Greasewood, however, is not a significant component of the basin big sagebrush community in map zone (MZ) 21; some greasewood may occur in the southern portion but not in significant quantities. Rabbitbrush (*Chrysothamnus* spp.) and Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) may also be present. This type may intergrade with the Wyoming big sagebrush. Some stands have silver sagebrush (*Artemisia cana* ssp. *cana*) intermixed (Williams, personal communication), and in early seral states, *Artemisia dracunculus* may occur in the understory.

Understory grasses include needle-and-thread (*Hesperostipa comata*), basin wildrye (*Leymus cinereus*), squirreltail (*Elymus elymoides*), slender wheatgrass (*Elymus trachycaulus*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Sandberg bluegrass (*Poa secunda*), and Idaho fescue (*Festuca idahoensis*).

Forbs were sparse and included hawksbeard (*Crepis acuminata*), bird's beak (*Cordylanthus* spp.), blue bell (*Mertensia* spp.), lupine (*Lupinus* spp.), buckwheat (*Eriogonum* spp.), Rocky Mountain aster (*Aster* spp.), daisies (*Erigeron* spp.), and *Phlox* species.

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
ARTRT	<i>Artemisia tridentata</i> ssp. <i>tridentata</i>	Basin big sagebrush
SAVE4	<i>Sarcobatus vermiculatus</i>	Greasewood
CHRY9	<i>Chrysothamnus</i>	Rabbitbrush
LECI4	<i>Leymus cinereus</i>	Basin wildrye
ELTR7	<i>Elymus trachycaulus</i>	Slender wheatgrass
POSE	<i>Poa secunda</i>	Sandberg bluegrass
SPAI	<i>Sporobolus airoides</i>	Alkali sacaton
FEID	<i>Festuca idahoensis</i>	Idaho fescue

Species names are from the NRCS PLANTS database. Check species codes at <http://plants.usda.gov>.

Disturbance Description

Non-fire disturbance factors may have included drought, grazing, and insects. Drought may have caused replacement disturbances but rarely. Mortality by drought is more common in Wyoming big sagebrush than basin big sagebrush, due to better soils, better water availability, and possibly deeper rooting habit. The frequency of drought that would be severe enough to broadly affect basin big sagebrush probably occurs once every 100-200yrs, not considering global warming (Williams, personal correspondence). Native grazing by large ungulates, including bison, elk, mule deer, and pronghorn, might have maintained more of an open condition and caused rare,

small degraded sites (i.e., wallows) that may have occupied <5% of the landscape. Insects and disease would have been replacement and mixed-severity disturbances in this type, but little information exists on the frequency of these disturbances under reference conditions.

There are few fire history studies in basin big sagebrush ecosystems (Tirmenstein 1999). Fires were mostly replacement severity (Tirmenstein 1999, Sapsis and Kaufman 1991), and the fire frequency likely varied considerably (Tirmenstein 1999). There was considerable debate between model contributors about the fire frequency and severity for this BpS. Estimates and comments on the fire regime included:

- It is generally accepted that the surrounding vegetation will have a large effect on fire regimes. For example, basin big sage at higher elevations that are surrounded by mountain big sagebrush may burn more frequently.
- In map zone (MZ) 21, modelers originally developed a model with a ca.70yr fire return interval (FRI). Reviewers for the MZ recommended an FRI of 50yrs or between 15-70yrs as per Sapsis (1990).
- It was noted by another reviewer that Sapsis (1990) is not a study of fire frequency and has no primary data about that. The two primary sources of information about fire frequency are fire scars on trees nearby and the recovery rate of sagebrush after fire. Neither has been measured adequately for basin big sagebrush. All we have to go on to estimate FRI in basin big sagebrush is that it seems to recover more quickly than does Wyoming big sagebrush; this might imply that it burns somewhat more often but probably not much. The occurrence of basin big sagebrush in small patch sizes next to mountain big sagebrush stands in this MZ may result in a shorter FRI than basin big sagebrush next to Wyoming big sagebrush in other MZs. However, more research is needed.
- In MZ22, modelers originally developed a model with a ca.110yr FRI. This interval was estimated as follows: Williams presented data on recovery rates in basin big sagebrush communities following prescribed fires that suggested it takes at least 50yrs on average for these communities to reach 40% canopy cover; 50yrs and 40% cover was therefore used as the threshold required to enter the late seral closed class (the cover threshold was changed later in model review); Baker, based on his estimate that the fire rotation is 2-3 times the recovery rate (Baker 2006), suggested a FRI of 140-160yrs, which is approximately 3 times the recovery rate (i.e., 3 x 50yrs). Since these data were collected from southern Wyoming, which is probably on the high end within MZ 22 with respect to recovery, contributors estimated an FRI of 110yrs for the entire zone.
- Romme (personal communication) stated that it is possible that prior to grazing, there was more frequent burning, but due to poor clay and low precipitation, the basin big sagebrush FRI was probably well over 100yrs.
- Tart (personal correspondence) stated that Johnson (2000) reports an FRI of 12-43yrs based on the thesis of Sapsis (1990). Where basin big sagebrush occupies small draws and swales, as in MZ21, its FRI would be controlled by the adjacent vegetation.
- Baker (personal communication) stated that fire scars provide little information on low-elevation sage where there are no forests nearby; fire scar estimates are therefore low estimates of fire rotation as they come from locations that would have had more fire than is typical of sagebrush.

- Warren (personal communication) stated that the 120yr FRI was too long for basin big sagebrush.
- Kitchen (personal communication) stated that we have no means to accurately measure historic fire frequency in sagebrush communities and that there are conflicting opinions as to the approaches taken to determine the FRI for these systems. Based on what has been shown through different approaches and field experience of those who know the system, the estimate of total FRI for basin big sagebrush shrubland is between 75-150yrs. We really don't know how fire might have behaved across the fuel threshold at the forest/shrubland ecotone. Therefore, we don't know how accurately proxy fire chronologies derived from fire-scarred trees predict fire regimes in nearby shrublands. Kitchen suggested that the FRI for basin big sagebrush could range from 75-150yrs.
- Williams (personal communication) stated that basin big sagebrush extends from Cody through Rawlins, Wyoming, and that the fire frequency may have varied across this range. The Cody area probably burns more often than Rawlins; in the Yellowstone area, recovery is much faster than in other parts of Wyoming.
- Harrell (personal communication) stated that the later the successional stage, the more likely it will be stressed by competition and drought. This may decrease live fuel moisture and cause drought mortality or dry fuel conditions, which could increase the flammability of the fuel and, after a fire, send it to an earlier successional stage or state. The fire frequency may be shorter for later seral conditions and longer for earlier seral stages.
- The LANDFIRE Rapid Assessment model for this type had a mean fire return interval (MFRI) of 60yrs. There was disagreement among contributors, and estimates of the MFRI varied from 40-150yrs.

After an extensive model review process, LANDFIRE leadership/guidance determined that a ca.70yr MFRI for this BpS was reasonable based on available literature and represented a compromise between the differing views of contributors.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	73	100	30	150
Moderate (Mixed)				
Low (Surface)				
All Fires	73	100		

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

Fuel may be continuous, resulting in spread throughout patches. Disturbance size therefore probably resembles the patch size of the vegetation. This type may occur in small patches, especially compared to other sagebrush subspecies, and may best be mapped by soil characteristics.

Adjacency or Identification Concerns

Basin big sagebrush grows along streams, ephemeral drainages, sometimes with greasewood or silver sagebrush intermixed or adjacent, often with Wyoming big sagebrush and mountain big

sagebrush on adjoining drier slopes. Sometimes, incised channels may decrease the contact with the water table, and the resulting terrace may provide conditions for basin big sagebrush. Distribution is a result of local soil characteristics on a fine scale (1-500ac). This type occurs on deeper soils than Wyoming or mountain big sagebrush types.

This BpS is sometimes confused with the riparian systems. It is also sometimes mistaken for the mountain big sage communities if the basin big sagebrush occurs at higher elevations.

Much of this type has been lost due to land clearing for agriculture. Some stands have been converted to cheatgrass (*Bromus tectorum*); others have substantial cheatgrass component. Occasionally, in some areas, stands may have been replaced by greasewood after burning (Williams, personal communication).

There is much variability for this type and its site dynamics.

Issues or Problems

It is difficult to map and identify the subspecies of big sagebrushes (*Artemisia tridentata*) without the aid of field assessments.

Native Uncharacteristic Conditions

Comments

In 2017, Alan Sands reviewed all Big Sagebrush Shrubland BpS descriptions and models. Sands comments on the MZ 21 and 22 models included:

- Sands suggested that MZs 21 and 22 were similar ecologically, had similar descriptions, and should be represented by the same model. Blankenship noted that the models for these zones differed only in the replacement fire frequency, 72yrs in MZ21 versus 110yrs in MZ22. It was also noted that the succession class descriptions had very similar text descriptions but differences in the structure (height/cover values). Blankenship decided to combine the zones based on Sands's recommendation and because the models and descriptions were very similar and combining models would not change the fire regime group. Blankenship chose the original MZ21 model to represent both MZs 21 and 22 because LANDFIRE leadership review previously indicated that the ca.70yr fire frequency of the MZ21 model better aligned with the literature and expert opinion.
- The fire frequencies should be the same as Wyoming big sagebrush variant (BpS 10802) for the same zones (i.e., ~90-100yrs). Blankenship, noting the past debate of the fire frequency for this BpS (see disturbance description), decided not to change the FRI.
- Sands and some LANDFIRE National reviewers for MZ22 indicated that the 90% maximum canopy cover value in the Late Closed Class was too high. Kori Blankenship reduced the maximum cover to 50%, which is consistent with 10802-21-22 and is on the high end of estimates for this type throughout its range.

MZ28 was added to the MZ21/22 group during the 2017 review of all Big Sagebrush Shrubland models. Reviewer Alan Sands indicated that the description for MZ28 described a Montane Sagebrush Steppe system and that it should be rewritten or lumped with a similar zone. In MZ28, the dominant shrub species was *Artemisia tridentata* ssp. *vaseyana*, an indicator for Montane Sagebrush Steppe (BpS 11260), not Big Sagebrush Shrubland. Blankenship noted that for the

Big Sagebrush Steppe (BpS 11250), MZ28 was grouped with a MZ06 group centered on the Great Basin. For the Big Sagebrush Shrubland, Blankenship decided to group MZ28 with MZ21 because both zones are part of the Western Cordillera ecoregion. MZ22 is part of the Cold Deserts ecoregion. Future review should consider whether this is the most appropriate grouping. The modelers for the MZ28 model were Joe Vinyard, Ken Holsinger, and an anonymous contributor. The MZ28 reviewers were Vic Ecklund and Chuck Kosteka.

During the BpS Review in 2017, this model was part of a “macro-review” where all models representing this BpS were reviewed and evaluated relative to one another. One goal of the review was to check for logical consistency between the models. Outstanding questions from this review that should be evaluated in the future include:

- Has LANDFIRE appropriately identified and classified the big sage shrubland (BpS 10800) relative to big sage steppe (BpS 11250)? In his system-wide review of these BpSs, Alan Sands indicated that what was mapped and modeled as Big Sage Shrubland should be Big Sage Steppe in the following MZs: 10, 19, 21, 22, 31, and 33. Kori Blankenship consulted NatureServe range maps to evaluate this suggestion and found that they reported Big Sage Shrubland occurring in all these MZs. Blankenship felt that more input was needed from local ecologists and NatureServe on the distribution of the types and the distinctions between them before changing the classification. This suggestion should be considered in future review.
- What is an appropriate fire frequency and severity for this BpS? Estimates for these fire regime parameters vary widely, and during LANDFIRE National, there was considerable debate about these values in some areas (see 10801-21-22-28 and 10802-21-22-28).
- Does the Wyoming big sagebrush versus basin big sagebrush split applied in the model representing MZs 21, 22, and 28 apply elsewhere, and can it be successfully mapped from 30m imagery? Descriptions for this BpS in some other zones indicated a need for distinct BpS models and mapping units for the different big sagebrush subspecies, but questions arose about the ability to map the distinctions from satellite imagery.
- Does the upland versus semi-desert split applied in the model representing MZs 06, 12, 15, 16, 17, 18, 23, 24, and 25 apply elsewhere? The split helps distinguish differences in species, fire frequency, and management options for sites on upland soils that receive enough precipitation to support trees from semi-desert sites that cannot.

The modelers listed in the table at the top of this document were LANDFIRE National contributors for MZ21. Additional MZ21 modelers included Don Delong and Tristan Fluharty. For LANDFIRE National, the MZ22 modelers were Mark Williams, Vicki Herren, Dave Roberts, Destin Harrell, Tim Kramer, Eve Warren, and an anonymous contributor. Reviewers were Dan Stroud, Carl Bezanson, Kirk Strom, Carrie Dobey, and Jay Esperance.

Succession Classes

Mapping Rules

Upper Layer Lifeform	Height (m)	Canopy Cover (%)									
		0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Herb	0-0.5	A	A	A	A	A	UN	UN	UN	UN	UN

Herb	0.5-1.0	A	A	A	A	A	UN	UN	UN	UN	UN
Herb	>1.0	A	A	A	A	A	UN	UN	UN	UN	UN
Shrub	0-0.5	A	B	B	C	C	UN	UN	UN	UN	UN
Shrub	0.5-1.0	A	B	B	C	C	UN	UN	UN	UN	UN
Shrub	1.0-3.0	B	B	B	C	C	UN	UN	UN	UN	UN
Shrub	>3.0	B	B	B	C	C	UN	UN	UN	UN	UN
Tree	0-5	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Tree	5-10	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Tree	10-25	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Tree	25-50	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Tree	>50	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leaf form distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

Description

Class A 19 Early Development 1 - All Structures

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
LECI4	Leymus cinereus	Basin wildrye	Upper
ELTR7	Elymus trachycaulus	Slender wheatgrass	Mid-Upper
PSSP6	Pseudoroegneria spicata	Bluebunch wheatgrass	Mid-Upper
SPAI	Sporobolus airoides	Alkali sacaton	Mid-Upper

Description

Grass-dominated community. Grass cover percentage depends on potential for basin wildrye, for example. Shrub cover is ~0-10% or 15% with height up to 1m. If soils are alkaline, resprouting greasewood may also be present.

Maximum Tree Size Class

None

Class B 36 Mid Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ARTRT	Artemisia tridentata ssp. tridentata	Basin big sagebrush	Upper
ELTR7	Elymus trachycaulus	Slender wheatgrass	Low-Mid
LECI4	Leymus cinereus	Basin wildrye	Low-Mid
PSSP6	Pseudoroegneria spicata	Bluebunch wheatgrass	Low-Mid

Description

Sagebrush-dominated, open-shrub community with abundant grasses. Maximum shrub height in this class is ~1.5m. Another indicator species would be alkali sacaton.

Maximum Tree Size Class

None

Class C 45 Late Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ARTRT	Artemisia tridentata ssp. tridentata	Basin big sagebrush	Upper
PSSP6	Pseudoroegneria spicata	Bluebunch wheatgrass	Lower
ELTR7	Elymus trachycaulus	Slender wheatgrass	Lower
LECI4	Leymus cinereus	Basin wildrye	Lower

Description

Mature and over-mature sagebrush with suppressed understory. There was some disagreement about the maximum shrub cover for this class. Height of shrubs could reach 15ft. Average height might be ~4.5ft. Another indicator species would be alkali sacaton.

Maximum Tree Size Class

None

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:ALL	0	Mid1:OPN	15
Mid1:OPN	16	Late1:CLS	49
Late1:CLS	50	Late1:CLS	999

Probabilistic Transitions

Disturbance Type	Disturbance occurs In	Moves vegetation to	Disturbance Probability	Return Interval (yrs)	Reset Age to New Class Start Age After Disturbance?	Years Since Last Disturbance
Replacement Fire	Early1:ALL	Early1:ALL	0.0142	70	Yes	0
Replacement Fire	Mid1:OPN	Early1:ALL	0.0142	70	Yes	0
Wind or Weather or Stress	Late1:CLS	Mid1:OPN	0.005	200	Yes	0
Replacement Fire	Late1:CLS	Early1:ALL	0.0133	75	Yes	0

References

- Baker, W.L. 2006. Fire and restoration of sagebrush ecosystems. Wildlife Society Bulletin, in press.
- Barker, J.R. and C.M. McKell. 1983. Habitat differences between basin and Wyoming big sagebrush in continuous populations. J. Range Manage. 36(4): 450-454.
- Bunting, S.C., B.M Kilgore and C.L. Bushey. 1987. Guidelines for prescribed burning sagebrush-grass rangelands in the northern Great Basin. Gen. Tech. Rep. INT-231. Ogden, UT: USDA Forest Service. 33 pp.
- Bushey, C.L. 1987. Short-term vegetative response to prescribed burning in the sagebrush/grass ecosystem of the northern Great Basin; three years of postburn data from the demonstration of prescribed burning on selected Bureau of Land Management districts. Final Report. Cooperative Agreement 22-C-4-INT-33. Missoula, MT: Systems for Environmental Management. 77 pp.
- Champlin, M.R. and A.H. Winward. 1982. The effect of simulated fire on emergence of seeds found in the soil of big sagebrush communities. Abstract of Papers. Society for Range Management. Calgary, Alberta. 37 pp.
- Cleland, D.T.; Freeouf, J.A.; Keys, J.E.; Nowacki, G.J.; Carpenter, C.A.; and McNab, W.H. 2007. Ecological Subregions: Sections and Subsections for the conterminous United States. Gen. Tech. Report WO-76D [Map on CD-ROM] (A.M. Sloan, cartographer). Washington, DC: U.S. Department of Agriculture, Forest Service, presentation scale 1:3,500,000; colored.
- Hodgkinson, K.C. 1991. Shrub recruitment response to intensity and season of fire in a semi-arid woodland. The Journal of Applied Ecology 28(1): 60-70.
- Knight, D.H. 1994. Mountains and Plains: The Ecology of Wyoming Landscapes. Yale University Press, New Haven/London. 338 pp.
- NatureServe. 2007. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. Data current as of 10 February 2007.
- Perryman, L., A.M. Maier, A.L., Hild and R.A. Olson. 2001. Demographic characteristics of three *Artemisia tridentata* Nutt. subspecies. Journal of Range Management. 54(2): 166-170.
- Sapsis, D.B. and J.B. Kauffman. 1991. Fuel consumption and fire behavior associated with prescribed fires in sagebrush ecosystems. Northwest Science 65(4): 173-179.
- Sapsis, D.B. 1990. Ecological effects of spring and fall prescribed burning on basin big sagebrush/Idaho fescue--bluebunch wheatgrass communities. Corvallis, OR: Oregon State University. 105 pp. Thesis.

Sturges, D.L. 1994. High-elevation watershed response to sagebrush control in southcentral Wyoming. Res. Pap. RM-318. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 19 pp.

Tirmenstein, D. 1999. *Artemisia tridentata* spp. *tridentata*. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis/> [2004, September 9].

Tirmenstein, D. *Sarcobatus vermiculatus*. 1987. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis/> [2004, September 10].

Tweit, S.J. and K.E. Houston. 1980. Grassland and shrubland habitat types of the Shoshone National Forest. Cody, WY: USDA Forest Service, Shoshone National Forest. 143 pp.

Vale, T.R. 1975. Presettlement vegetation in the sagebrush-grass area of the Intermountain West. *Journal of Range Management*. 28(1): 32-36.

Van Auken, O.W. 2000. Shrub invasion of North American semiarid grasslands. *Annual Review of Ecology and Systematics*. 31: 197-215.

Welch, B.L and C. Criddle. 2003. Countering Misinformation Concerning Big Sagebrush. Research Paper RMRS-RP-40. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station. 28 pp.

Winward, A.H. 1991. A renewed commitment to management of sagebrush grasslands. In: *Research in rangeland management*. Corvallis, OR: Oregon State University. Ag Exper. St. Special Rep. 880. 7 pp.

Wyoming Interagency Vegetation Committee. 2002. Wyoming Guidelines for Managing Sagebrush Communities with Emphasis on Fire Management. Wyoming Game and Fish Department and Wyoming BLM. Cheyenne, WY. 53 pp.

Young, J.A. and R.A. Evans. 1978. Population dynamics after wildfires in sagebrush grasslands. *Journal of Range Management*. 31: 283-289.

Young, J.A. and R.A. Evans. 1981. Demography and fire history of a western juniper stand. *Journal of Range Management*. 34: 501-506.