Historic Fire Regimes And Shrub Demography:

What Does It Mean On The Ground?

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Historic Fire Frequency, Seasonality, and Spatial Scale

The mean fire interval during the last several hundred years in the Rochelle Hills area of the Thunder Basin National Grasslands, is 7.4 years with a range of 1 to 23 years (Perryman and Laycock 2000). This is very similar to intervals calculated in neighboring northern mixed-grass prairie plant communities. Intervals calculated from fire scars in neighboring areas range from 3.5 to 8.5 years in the Nebraska Sandhills (Bragg 1985); 30 yrs at Jewell Cave (Brown and Sieg 1996) and 13 to 21 years at Wind Cave (Shilts et al. 1980) both in the Black Hills of South Dakota; and 14 to 27 years at Devils Tower, Wyoming (Fisher et al. 1987). Fire seasonality in the Thunder Basin National Grasslands over the last few centuries was predominately late season fires (84%), which occurred between July and the dormant season; only 16% of the fires were early season, April-June (Perryman and Laycock 2000). Higgins (1984) demonstrated that in northern plains grasslands, 73% of 294 lightning-ignited fires documented between 1940 and 1981 occurred during July and August. Given society's propensity for suppressing fires (both actively and passively), Baker (1992) determined that fire patch size has decreased since European settlement, effectively increasing the fire interval in many areas. This activity has set the stage for more large, catastrophic fires due to a build up of woody fuels throughout much of the western U.S. (Miller and Rose 1999).

Pre-European settlement eyewitness accounts of fire frequency are less reliable in a quantitative sense, however they do provide important insights. Based on pioneer

journals, Wendtland and Dodd (1990) calculated a 5 to 20 year fire interval for the northern mixed-prairie area near Scott's Bluff National Monument, NE. The Lewis and Clark Expedition (Moulton and Dunlay 1983) reported 7 fires between Mandan Village (North Dakota) and Three Forks, Montana. Near Three Forks, they reported 44 miles traveled and the landscaped burned as far as could be seen in every direction. Stansbury (1852) reported 300 miles distance burned along the Platte River in every direction. Intentional burning by Native Americans was also prevalent, and reported by a number of early European contacts. To summarize, on average prior to the fire suppression era, fires were frequent, larger in spatial scale and generally cooler than today. However, as woody fuels accumulate (e.g., sagebrush) a point is reached when fires begin to burn hotter and become less manageable in terms of control because of increased fuel loads and continuity.

Sagebrush Demography

The dominant shrub on the Thunder Basin National Grasslands is Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), a non-sprouting species (Thilenius et al. 1995). This is an important attribute with respect to demography. Wyoming sagebrush only reproduces by seed, and it is also very sensitive to fire. After a stand burns, re-colonization must rely on propagules in the seed bank or from adjacent seed sources. Recent research has demonstrated that Wyoming sagebrush (as well as other *A. tridentata* subspecies) recruitment is episodic (Perryman et al. 2001, Maier et al. 2001). Several pulses of establishment generally dominate any particular stand. Perryman et al. (2001) calculated a mean recruitment interval of 2.3 (±0.7) years for sagebrush stands in the Rochelle Hills Area. During the 75-year period of record, recruitment occurred in

only 28 of the 75 years, or 37% (±5%) of the time. Recruitment is not random, but clustered or aggregated through time and best described by the negative binomial distribution model. Put simply, distributions have a large number of years with no recruitment, a moderate amount of years with some recruitment, and a few years with high recruitment. High recruitment episodes are controlled primarily by specific, regionally important climatic conditions that occur rather infrequently. On Thunder Basin Grasslands, above average winter precipitation (e.g. snow pack) is required (Maier et al. 2001). These large recruitment pulses dominate the vertical structure, foliar cover, and density of sagebrush stands.

What does it mean on the ground?

Considering historic fire intervals and sagebrush recruitment patterns, how should the landscape appear if fire intervals and recruitment are in a dynamic balance? On average, should a shrubland or a grassland matrix characterize the Thunder Basin National Grasslands? Fire should be relatively frequent, and recruitment pulses relatively infrequent. This would indicate that the dense, older stands of non-sprouting shrubs like Wyoming sagebrush should be limited primarily to fire-safe areas similar to woodland areas of the intermountain region where pinyon pine and juniper species occur. In Thunder Basin, fire-safe areas would include rough, undulating topography containing sites with the ecological potential to support sagebrush, surrounded or at least buffered by areas where fuel loads and continuities are generally insufficient to carry fires. This does not mean that we should manage sagebrush so that it is confined to only these types of areas, but manage so that on average more grassland dominated areas rather than sagebrush-dominated areas will be present on the landscape.

Torrey (1845) (traveling up the North Platte River) made no mention of sagebrush until the party arrived in the vicinity just east of Douglas, Wyoming. Johnson (1987) conducted a repeat photo interpretation study using photos from the Hayden Expedition in 1870; the review indicated the presence of sagebrush in central Wyoming but generally lower landscape abundance or dominance than occurs today.

The relative dominance of sagebrush is important for characterizing the vertical structure of plant communities, and also because sagebrush affects understory potential. As sagebrush stands mature, stem density usually increases. For Wyoming sagebrush, as foliar cover reaches about 25%, understory or herbaceous vegetation cover and production declines (Winward 1991, Benkobi and Uresk 1996). If a stand continues to mature and shrub density continues to increase, eventually the understory vegetation will effectively disappear (even in the absence of grazing). Very mature (climax) sagebrush stands are often characterized by little if any herbaceous understory and few juvenile sagebrush plants. Competition between shrub and herbaceous plants shifts to mature shrub and juvenile shrub competition. Landscapes characterized by large areas of decadent, climax sagebrush stands provide for instance, poor brood habitat for sage grouse, the type of habitat usually considered most limiting for this species.

If fire occurs in a mature or climax sagebrush community, several ecological problems can occur. Early stages of recovery are slower because there are few perennial herbaceous plants in the community, and the seed bank is often depauperate from years of little or no seed production. This condition may require rehabilitation efforts such as re-seeding. Slowed recovery also facilitates colonization of invasive or noxious plants such as cheatgrass (*Bromus tectorum*), or one of the many knapweeds (*Centaurea* sp.).

Management Implications

Management of sagebrush grasslands in the Thunder Basin National Grasslands must include fire as a significant component. Fire has been frequent and large scale in the past. This does not mean the entire area should be burned in some frenzied, maniacal fashion. However, fire should be used where appropriate as a tool for intervening in the successional process, removing sagebrush stands before they become over mature and decadent. If large acreages or decadent sagebrush stands are present, then relatively large acreages should be burned. A good model for this management approach is the Dinosaur National Monument prescribed burning program (Perryman et al. 2002).

Of course, burning often presents a short-term problem related to lack of forage for a permittee or landowner. In the planning process, alternative ideas such as grass banks should be considered. Thinning sagebrush with tebuthiuron herbicide is another viable alternative presenting little hazard and good success potential (Johnson et al. 1996, Olson et al. 1994). However, this short-term forage problem is more easily mitigated than the long-term alternative if sagebrush stands are allowed to reach the climax stage.

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